Deutsche Physikalische Gesellschaft DPG

86. Jahrestagung der DPG

86th Annual Conference of the DPG

DPG-Frühjahrstagung 2023

DPG Spring Meeting 2023

of the Matter and Cosmos Section (SMuK)

with its Divisions

Extraterrestrial Physics, Gravitation and Relativity, Hadronic and Nuclear Physics, Particle Physics, Plasma Physics, Radiation and Medical Physics, Theoretical and Mathematical Physics

together with Environmental Physics and Short Time-scale Physics and Applied Laser Physics

and the Working Groups

Accelerator Physics, Energy, Equal Opportunities, Information, Philosophy of Physics, Physics and Disarmament, Physics , Modern IT and Artificial Intelligence, Young DPG

Foto: Nils Eisfeld

20-24 March 2023

Technische Universität Dresden

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Deutsche Physikalische Gesellschaft

Preisverleihung

Max-Planck-Medaille 2023
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Stern-Gerlach-Medaille 2023
an Prof. Dr. Manfred Fiebig
ETH Zürich

Ehrenmitgliedschaft der DPG
an Prof. Dr. Horst Schmidt-Böcking
Goethe-Universität Frankfurt

Ehrennadel der DPG
an Prof. Dr. Ulrich Platt
Universität Heidelberg

Dissertationspreis der Sektion SMuK
(Der/die Preisträger:in wird nach dem
Dissertationspreissymposium SYMD ausgewählt.)

Festvortrag

Prof. Dr. Monica Dunford
Kirchhoff-Institut für Physik, Universität Heidelberg

„The once unattainable – new breakthroughs in particle physics“

Dienstag, 21. März 2023, 14:00 Uhr

HSZ/AUDIMAX

Deutsche Physikalische Gesellschaft DPG

Greeting

Dear Participants,

Welcome to the 86. Annual Meeting of DPG and DPG-Frühjahrstagung (DPG Spring Meeting) of the Matter and Cosmos Section (SMuK) with the participating divisions and working groups involved on the campus of the Technical University Dresden.

I am very pleased that with our DPG Spring Meetings, even more so in presence, we can once again set a widely visible and public sign for the outstanding importance of basic research for scientific and societal progress. Basic research is indispensable for tackling the major societal challenges. Above all a sustainable energy supply with regard to climate change with its dramatic consequences for all life on our planet. On the other hand, the Spring Meetings are probably the most important instrument of the DPG to enable as many scientists as possible, especially young scientists, to participate in a cross-border, international and peaceful scientific exchange.

The last year has shown us with full force how important and by no means self-evident such a necessary and international exchange is, how vulnerable our world order is, and how quickly a change can take place that even threatens the existence of countries. Therefore, it is the special responsibility of the DPG – guided by the values in our DPG Statutes, our compass – to stand up for freedom, tolerance, truthfulness and dignity in science and to act in awareness that we are particularly responsible for shaping the whole of human life: Especially and particularly in troubled times!

The DPG Spring Meeting in Dresden plays an outstanding role for peaceful international scientific exchange and discourse as well as for the perception and appreciation of the work of the DPG. I would therefore like to thank all those involved for their great commitment to the success of this conference.

My special thanks go to the Technical University Dresden for its hospitality and support. I would like to sincerely thank the Wilhelm and Else Heraeus Foundation for once again generously supporting all DPG spring conferences. My great appreciation goes to the participating divisions and working groups for a great programme. I would especially like to thank the Local Organising Committee, Dr. Frank Siegert und Prof. Kai Zuber, Technical University Dresden, and their entire team. For the support of all DPG Spring Meetings, my special thanks go to the DPG Head Office.

Prof. Dr. Joachim Ullrich
President
Deutsche Physikalische Gesellschaft e.V.

Organisation

Organiser

Deutsche Physikalische Gesellschaft e.V.
Hauptstraße 5, 53604 Bad Honnef

Phone	+49 (0)2224 9232-0
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Email	dpg@dpg-physik.de
Homepage	www.dpg-physik.de

Local Organiser

Dr. Frank Siegert
Technische Universität Dresden
Institut für Kern- und Teilchenphysik
Zellescher Weg 19, 01069 Dresden

Phone	+49 (0) 351 463-33700
Email	frank.siegert@tu-dresden.de

Scientific Organisation

Chair of the Matter and Cosmos Section (SMuK)

Prof. Dr. Silvia Masciocchi
GSI mbH
Planckstr. 1, 64291 Darmstadt

Email	s.masciocchi@gsi.de

Chairs of the Participating Divisions of the DPG:

(EP)	Extraterrestrial Physics	–	Dr. Miriam Sinnhuber (miriam.sinnhuber@kit.edu)
(GR)	Gravitation and Relativity	–	Prof. Dr. Bernd Brügmann (bernd.bruegmann@uni-jena.de)
(HK)	Hadronic and Nuclear Physics	–	Prof. Dr. Bernhard Ketzer (bernhard.ketzer@uni-bonn.de)
(K)	Short Time-scale Physics and Applied Laser Physics	–	Dr. Andreas Görtler (agoertler@gmx.de)
(MP)	Theoretical and Mathematical Physics	–	Prof. Dr. Johanna Erdmenger (erdmenger@physik.uni-wuerzburg.de)
(P)	Plasma Physics	–	Prof. Dr. Ronny Brandenburg (brandenburg@inp-greifswald.de)
(ST)	Radiation and Medical Physics	–	M.Sc. Anna Bakenecker (bakenecker@dpg-mail.de)
(T)	Particle Physics	–	Prof. Dr. Kerstin Borras (kerstin.borras@desy.de)
(UP)	Environmental Physics	–	Prof. Dr. Christian von Savigny (csavigny@physik.uni-greifswald.de)

Chairs of the Participating Working Groups

(AGA)	Physics and Disarmament	–	Prof. Dr. Götz Neuneck (neuneck@ifsh.de)
(AGI)	Information	–	Dr. Uwe Kahlert (kahlert@physik.rwth-aachen.de)
(AGPhil)	Philosophy of Physics	–	Prof. Dr. Dennis Lehmkuhl (dennis.lehmkuhl@uni-bonn.de)
(AKBP)	Accelerator Physics	–	Prof. Dr. Kurt Aulenbacher (aulenbac@kph.uni-mainz.de)
(AKC)	Equal Opportunities	–	OStR Agnes Sandner (akc@dpg-physik.de)
(AKE)	Energy	–	Dr. Karl-Friedrich Ziegahn (ziegahn@kit.edu)
(AKjDPG)	Young DPG	–	Sabine Rockenstein (rockenstein@jdpg.de)
(AKPIK)	Physics, Modern IT and Artificial Intelligence	–	Dr. Tim Ruhe (tim.ruhe@tu-dortmund.de)

Symposia

SYMD	–	SMuK Dissertation Prize
SYSC	–	Strange Clouds – from the Earth to Exoplanets

Organisation of the Exhibition of Scientific Instruments and Literature

DPG-Ausstellungs-, Kongreß- und Verwaltungsgesellschaft mbH
Hauptstraße 5, 53604 Bad Honnef

Phone	+49 (0)2224 9232-0
Fax	+49 (0)2224 9232-50
Email	dpg@dpg-physik.de
Website	www.dpg-gmbh.de

Programme

The scientific programme consists of **1.929** contributions:

10	Plenary Talks
2	Evening Talks
7	Prize Talks
1	Ceremonial Talk
1	Lunch Talks
95	Invited Talks
24	Topical Talks
65	Group Reports
1519	Talks
205	Posters

The programme stated in this document corresponds to the status of the programme publication February 2, 2023 and will not be updated!

Deutsche Physikalische Gesellschaft DPG

62. Wochenendseminar „Physiker:innen im Beruf“

Der Übergang von der Hochschule in die **berufliche Karriere** fällt vielen nicht leicht: Die Möglichkeiten und Aufgabengebiete sind vielfältig - und wer kennt schon nach Studium oder Promotion die verschiedenen Anforderungen und Arbeitsabläufe?

Das Seminar bietet durch **Erfahrungsberichte** etablierter Physiker:innen sowie junger Berufsanfänger:innen Orientierung. Die 15 Vortragenden repräsentieren ganz verschiedene Arbeitsgebiete und zeigen damit das breite **Einsatzspektrum** von Physikerinnen und Physikern.

Neben den Vorträgen bietet der gemütliche Lichtenbergkeller des Physikzentrums Bad Honnef ein ideales Forum, mit den Vortragenden am Abend **in kleiner Runde offen** zu **diskutieren** und Erfahrungen zu sammeln.

Zielgruppe:
Physikstudierende ab Bachelor bis zur Promotion. Max. 80 Personen.

5. bis 7. Mai 2023

Physikzentrum Bad Honnef

Weitere Infos und Anmeldung: www.pib.dpg-physik.de

Information for Participants

The conference will be held March 20 — 24, 2023.

1. Conference Information

1.1 Conference Venue

Technische Universität Dresden
Campus Südvorstadt
Bergstraße 64
01069 Dresden

The central activities like registration etc. will take place in the Lecture Hall Center (HSZ) of the TU Dresden (Bergstraße 64). For a detailed map of the campus and the buildings please see end of this booklet. The position of the lecture rooms on the campus can be found at the campus navigator of TU Dresden *https://navigator.tu-dresden.de/* or the DPG-App (see 1.3.1).

1.2 Conference Office / Information Desk

The conference office and the information desk are located in the Lecture Hall Center, HSZ E01.

		Registration	**Information Desk**
Sunday	19 March	closed	closed
Monday	20 March	08:00 – 19:00	08:00 – 18:00
Tuesday	21 March	08:00 – 17:00	08:00 – 18:00
Wednesday	22 March	08:00 – 17:00	08:00 – 18:00
Thursday	23 March	08:00 – 17:00	08:00 – 18:00
Friday	24 March	08:00 – 12:00	08:00 – 16:00

You will receive your name tag, a receipt for your conference fee, the short programme and the Login-Password for using WLAN (WiFi) at the conference office. The name tag must be worn visibly during the entire conference.
Please note: This year, no conference ticket for public transportation is included in the conference pass. We kindly ask you to buy a ticket yourself if you need it (the DVB one-week-ticket price level A1 Dresden tariff zone at the normal price of 22,90 EUR is transferable, i.e. it is not personal).

The organisers, staff of the conference desk and student assistants will be identifiable by colored name tags and T-shirts. Please contact them if you have any questions. Do not hesitate to come to the information desk and inquire about the conference, orientation in Dresden, accommodation, restaurants, going out and cultural events.

1.3 Lecture Rooms

The lecture rooms will be signposted by abbreviations for the respective buildings and the room number. The campus map and location of the buildings are printed in the end of this booklet.

Abbr.	**Building** *(see also: https://navigator.tu-dresden.de/)*
CHE	Chemiegebäude (Chemistry Building)
GER	von-Gerber-Bau
HSZ	Hörsaalzentrum (Lecture Hall Center)
JAN	Jante-Bau
MOL	Mollier-Bau
POT	Gerhard-Potthoff-Bau
REC	Recknagel-Bau
SCH	Georg-Schumann-Bau
Tent	Tent behind the Lecture Hall Center
WIL	Willers-Bau
ZEU	Zeuner-Bau

1.3.1 With the DPG-App through the Spring Meetings!

With the app you can find out not only about the conference programme but also about the venue and exhibitors at the industry and book exhibition. With the help of new functions such as “What’s going on now?” or the building plan overview it is now even easier to find your way around on site. Download the free “DPG Spring Meetings” app for Android or iOS now!

1.4 Presentation
Scientific presentations will be held either orally or by poster. Presentations with a German abstract will be given in German.

1.4.1 Oral Presentation
All lecture halls will be equipped with a projector and computer. Speakers are requested to upload their presentations on the conference website one day before the corresponding session. An email with the access data and the upload deadlines was sent to the lecturers before the conference. If you require to change your uploaded contribution, you may again upload the document at latest 4 hours before the session starts (not before the talk starts). In any case you should also bring a copy your presentation on an USB drive as a backup.

The file format accepted for all parallel sessions is pdf or Powerpoint. Own laptops cannot be used for the presentation. The presentations will be transferred to the provided PCs/laptops in the lecture hall before the session. The lecturers are asked to keep the presentation file on a USB stick and to bring it into the session.

All lecture theatres will be opened, at the latest, 30 minutes prior to the talks. Speakers are requested to be in the lecture hall at least 20 minutes prior to the start of the session, reporting to the chairperson of the session as well as the technical staff ensure that the presentation upload was successfull and to receive a brief introduction to the equipment in the lecture hall. If you need other presentation facilities, please ask for availability at the information desk as soon as you arrive at the conference.

Usually, presentations will have the following durations. For exact information, please refer to your division.

- Contributed talks are 15 minutes including discussion and speaker change
  (12 min talk + 3 min discussion / speaker change).
- Invited talks are 30 minutes including discussion and speaker change
  (25 min talk + 5 min discussion / speaker change).
- Plenary presentations are 45 minutes without discussion.

1.4.2 Poster Presentation
Sites for poster sessions are named and located as follows:

HSZ EG	HSZ: ground floor (foyer)
HSZ OG1	HSZ: 1st floor (hallway)
HSZ OG2	HSZ: 2nd floor (hallway)
HSZ OG3	HSZ: 3rd floor (hallway)

Posters must fit within a rectangle 90 cm wide and 120 cm high (DIN A0), portrait format!
The poster boards will be marked with the number according to the scientific programme. Authors are asked to mount their poster when the poster board is prepared with the corresponding poster number. Usually this will be arranged in the morning, or one hour before the session when there are several poster sessions per day. Each poster should display the number according to the scientific programme.

For the mounting of the poster please use the prepared “power strips” at the poster frame or contact the available student staff. Please make sure to use only power strips for mounting the poster (residue-free removing). The presenting authors should be at hand for discussion at their poster during at least half of the poster session and should note this time at the poster.

The posters have to be removed after the poster session. Any posters remaining on display walls after the poster session will be removed and destroyed without requesting your permission. The conference management accepts no liability for the posters.

1.5 Notice Board
All changes to the conference programme (i.e. cancellation of presentations, change of rooms, etc.) are also transferred directly to the online version of the programme which will be updated continuously and is available in different formats (sorted by publication date, filterable by conference parts and as an rss-feed). Please use the form
https://smuk23.dpg-tagungen.de/programm/notice-board-form to notify changes or cancellations.

2. General Information

2.1 Internet

EDUROAM

The TU Dresden is member of the eduroam-network. Users from eduroam institutions, who have registered for eduroam, can use WLAN at the TU Dresden without local registration in Dresden. Eduroam in Dresden is possible with WLAN SSID eduroam.

WLAN (WiFi)

In addition internet access is possible via WLAN network (WiFi) in almost all buildings of the TU-Campus.

WLAN in the buildings of TU-Campus

For internet access at TU Dresden, please use your individual login-password on your registration document. Please search for and connect to the network named „VPN/WEB“. If this network isn't shown in the list of available networks, the access isn't possible. After you have been connected, please visit any website with your browser to get redirected to the login page of the network. Enter your given username and password and click on „Login“. Afterwards you should be able to use the access to the internet. This connection is not encrypted.

2.2 Message Board

All alterations in the scientific programme will be announced via the conference website "Notice Board". All further important information for participants is displayed on a message board in the foyer of the Lecture Hall Center (HSZ).

2.3 Public Working Area

Public working rooms where you can work on your laptop are located in GER 037, GER 050 und GER 054.

2.4 Cloakroom

A guarded cloakroom is located in the basement of the Lecture Hall Centre (HSZ). The opening hours are as follows:

Monday	March 20	08:00 — 21:30
Tuesday	March 21	08:00 — 20:30
Wednesday	March 22	08:00 — 21:30
Thursday	March 23	08:00 — 20:30
Friday	March 24	08:00 — 15:00

2.5 Lost and Found Property

You can bring found items to the Lecture Hall Center, room E03 (next to the information desk). There you can also get your lost property back.

3. Catering

3.1 Coffee Breaks

Coffee and tea are offered for free during the breaks in nearly all conference locations (see also in the legend of the campus map). You want actively contribute to protect our climate and environment? If possible please bring your own cup or use your paper cup several times. Thank you!

3.2 Snacks

You can get coffee, tea, refreshments and snacks as indicated in the campus map at the:

• Tent B behind the Lecture Hall center	Monday to Thursday,	08:00 – 19:00; Friday 08:00 – 14:00
• „Grill-Cube“ next to the exhibition tent B	Monday to Friday,	09:00 – 15:00
• Zeuner-Bau (ZEU) in room ZEU 148	Monday to Thursday	08:00 – 18:00; Tuesday 08:00 – 14:00
• Restaurant of the Leibniz-Institute IFW Dresden	Monday to Friday,	08:00 – 15:00
• „insgrüne coffeebar“ in the Georg-Schumann-Bau (SCH)	Monday to Friday,	10:00 – 15:00
• Cafeteria & Mensa "Alte Mensa", Mommsenstraße 13	Monday to Thursday,	08:00 – 16:00; Friday 08:00 – 15:00
• Cafeteria & Mensa Zeltschlösschen, Nürnberger Str. 55	Monday to Friday,	08:00 – 15:30
• Cafeteria & Mensa Siedepunkt, Zellescher Weg 17	Monday to Friday,	11:00 – 15:00

as well as at Bergstr. 68 „FIRAT-Kebap-Haus“ and Münchner Str. „DERSIM-Dürüm-Kebab-Haus“ and bakery „Möbius“.

3.3 Lunch
The Mensa Zeltschlösschen, Mensa Siedepunkt and the Mensa Mommsenstraße offer plenty of opportunities for lunch at moderate prices (self-payment, please note the above mentioned opening hours).

Please note: only cash payments are possible in all mensas (no cards!).

4. Events

4.1 Opening of the conference
A short opening address will be given by the chair of the SMuK Section on Monday, March 20 from 08:45 until 09:00 in HSZ/AUDI.

4.2 Datathon
On Sunday March 19, 2023, 10:00 to 16:00, Recknagel Bau (Haeckelstraße 3, REC/C213/H), the working group on physics, modern IT and artificial intelligence (AKPIK) will host the very first AKPIK Datathon, prior to the Spring Meeting of the Matter and Cosmos Section (SMuK) in Dresden.
Within this Datathon, teams of two to five persons will work on solving an interesting and challenging task on a given data set. Although the results will be inspected by a jury, the performance of the results is not the only criterion and a special award will be given to the group with the most creative approach.
The AKPIK Dathathon is intended for younger members of the German Physical Society (DPG) and offers an exciting challenge, as well as the possibility for networking in relaxed atmosphere during coffee breaks. A comprehensive knowledge on Data Science is not required for participation. The participation is free of charge. Further information as well as a registration link can be found at https://smuk23.dpg-tagungen.de/veranstaltungen/datathon

4.3 Ordentliche Mitgliederversammlung der DPG 2023 (Annual General Meeting of the DPG 2023)
Date: Monday, March 20, 18:00, Room HSZ 0304 (3rd floor), Bergstraße 64, 01069 Dresden
The Annual General Meeting of the Deutsche Physikalische Gesellschaft will take place on Monday evening. Members of the DPG are kindly requested to attend the meeting. Please bring your membership card.

4.4 Welcome Evening
On Monday, March 20, at 19:30 the Welcome Evening will be held in the Tent A close to the Main Lecture Hall Centre. When registering for the conference you will receive your badge and **food and drink vouchers** for the Welcome Evening. Small food, beer and soft drinks will be served. Do not miss the opportunity to register (08:00 to 19:00) before the official beginning of the conference and to meet people in an informal atmosphere. Please wear your name tag which you have received at the registration.

4.5 jDPG Pub Crawl
Time: Monday, March 20, from 19:30
Meeting place: in front of the HSZ (Bergstraße side)
On Monday evening, the young DPG invites to a pub crawl through Dresden. Next to the opportunity to be on a move outside and network with others, the members of the local regional group will tell about the Dresden physics, the life in the city and other facts worth knowing.

4.6 jDPG Lunch Gathering
Time: Monday, March 20 + Tuesday, March 21 + Friday, March 24, from 13:00
Meeting place: will be announced on the conference website
On several days, the jDPG regional group of Dresden meets to lunch gatherings. During these meetings, young conference participants shall get to know each other better and especially make contact to local (PhD-)students. An intensive exchange of experiences is also intended to take place there, concerning important topics like e.g. starting a doctorate and mental health during the studies.

4.7 Physicists in Industry
Tuesday, March 21, 19:00 – 21:00, HSZ 0004
How do physicists work in industry? How does everyday life differ from the life at university and the institute? Which additional skills should students acquire beside their curriculum? We will investigate these and other questions with three colleagues who work in different areas of industry. They will provide insights into their career path and their daily work and will be available to answer questions afterwards.

4.8 Ceremonial Session with Award Ceremony *(in German language)*

On Tuesday, March 21, at 14:00 the Ceremonial Session with Award Ceremony will take place in HSZ/AUDI. The programme is as following:

Music
„Viviendo Trio"

Welcome
Dr. Frank Siegert, TU Dresden
Local Organiser

Prof. Dr. Michael Kobel
Vice-Rector Education at the TU Dresden

Speech
Dr. Lutz Schröter, DPG e.V., Bad Honnef
Vice-President of the Deutsche Physikalische Gesellschaft

Music

Award Ceremony

Max Planck Medal 2023
to Prof. Dr. Rashid A. Sunyaev, Max-Planck-Institut für Astrophysik, Garching

Stern Gerlach Medal 2023
to Prof. Dr. Manfred Fiebig, ETH Zürich

Honorary Membership of the DPG
to Prof. Dr. Horst Schmidt-Böcking, Goethe-Universität Frankfurt

Pin of Honor of the DPG
to Prof. Dr. Ulrich Platt, Universität Heidelberg

SMuK Dissertation Prize 2023
(The Laureate will be announced after the Dissertations-Prize Symposium (SYMD))

Music

Ceremonial Lecture

Prof. Dr. Monica Dunford, Kirchhoff-Institut für Physik, Heidelberg Heidelberg
„The once unattainable – new breakthroughs in particle physics"

4.9 Public Evening Lectures (in German language)

All Evening Talks will be held at the Audimax (Hörsaalzentrum) and are open for the interested public and all conference participants. The entrance is free.

Max-von-Laue-Lecture
Wednesday, March 22, 20:00 - 21:00, Audimax (HSZ 01)
Prof. Dr. Gerd Gigerenzer, Universität Potsdam will speak about:
„Risikokompetenz – informiert und entspannt mit Risiken umgehen"

Public Evening Talk
Thursday, March 23, 20:00 - 21:30, Audimax (HSZ 01)
Prof. Dr. Christian Stegmann, DESY, Zeuthen will speak about:
„Von Sachsen ins Universum"

4.10 Exhibition of Scientific Instruments and Literature

From Tuesday to Thursday there will be an exhibition of Scientific Instruments and Literature. The exhibition will take place in the Lecture Hall Center (Foyer). Several companies (see list of exhibitors at the end of this booklet) will present their products. Opening hours are from 10:00 to 18:00. All conference participants are welcome to attend the exhibition. The entrance is free.

4.11 Video competition: Physics in the Future

The public and also the physics community have various imaginations of how physics will look like in the future and what physics will be needed for in the future. The aim of this video competition is to bring together these different views

and ideas for the “future of physics”. Even without a modified DeLorean and flux capacitor, the competition will bring to light many exciting answers. Time will show which ones will come true.
A Video box will be available from Monday to Friday in Tent A to help you easily participate in the video competition. Take part and tell us what you think about “physics in the future”.

5. Wilhelm and Else Heraeus-Communication Programme

Important notes for participants who apply for a grant of the Wilhelm and Else Heraeus Foundation:
At the beginning of the conference you will receive an identification form at the conference office. The participation in the conference must be certified by the conference desk. You have the possibility to leave this certificate by the staff members of the DPG (recommended!) in the conference office or submit it to the DPG head office (DPG-Geschäftsstelle, Hauptstr. 5, 53604 Bad Honnef, Germany) by April 14, 2023 at the latest.
For more detailed information refer to *https://smuk23.dpg-tagungen.de/registrierung/weh*.

The Deutsche Physikalische Gesellschaft thanks the Wilhelm and Else Heraeus Foundation for the generous financial support of young academic talents. We hope that young physicists will continue to seize the offered opportunity for active scientific communication at scientific conferences. A total of about 37,800 young academics were supported by this programme so far.

6. Acknowledgement

The organisers want to thank

- the Wilhelm and Else Heraeus Foundation, Hanau
- the TU Dresden

for supporting the conference and all staff, who make the conference possible.

7. CO_2 compensation for the DPG conferences

By decision of the Executive Board, the DPG will compensate for fossil CO_2 emissions resulting from mobility for DPG conferences and committee meetings.

8. SAY CHEESE!

The DPG Spring Meetings are basically public to the press. Please note: On behalf of DPG, photos and videos will be recorded during the Spring Meetings. In the context of public relations, these recordings (as the case may be) will be published on our website, in social media or within prints of the DPG for example.

9. Disclaimer of liability

Participants are asked to look carefully after their wardrobe, valuables, laptops, and other belongings. The organisers are not liable.

Deutsche Physikalische Gesellschaft DPG

1. DATATHON
des AKPIK

Teamwettbewerb

Teilnahme kostenlos

attraktive Preise

Sonderpreis für kreative Lösungen!

Du magst Physik, Daten und Algorithmen und wolltest Deine Fähigkeiten in diesem Bereich schon immer mal mit anderen Physiker:innen messen? Dann bilde mit bis zu 4 gleichgesinnten Personen ein Team und mach mit!

Übrigens: Performance ist nicht alles! Eine hochrangig besetzte Jury prämiert den kreativsten Ansatz mit einem Sonderpreis!

Sonntag, 19.03.2023
10 bis 16 Uhr

TU Dresden
Haeckelstraße 3 (Recknagel Bau)
01069 Dresden

unterstützt von
d-fine

Weitere Infomationen und
Anmeldung unter:
www.dpg-physik.de/anmeldungen/anmeldung-zum-datathon

Deceased members

The following members of the German Physical Society passed away in 2022:

Wolfgang Ackermann, Swisttal
Karl-Richard Albrand, Wedel
Ulf Amelung, Lüneburg
Kristof Adam Balazs, Frankfurt
Stefan Balle, Germering
Uwe Helmut Bauder, München
Werner Bausch, Darmstadt
Ulrich Becker, Genf
Götz-Peter Behringer, Weissach im Tal
Hans-Georg Bell, Hellenthal
Heinz Berger, Berlin
Joachim Berk, Berlin
Wolfhard Beyer, Aachen
Eckhard Bill, Mülheim/Ruhr
Kurt Binder, Nieder-Olm
Klaus Birgmeir, Putzbrunn
Claus Birkholz, Berlin
Albrecht Böhm, Aachen
Ulrich Bonse, Dortmund
David Böttger, Troisdorf
Wolfgang Braunschweig, Aachen
Wilhelm Brenig, Baldham
Dieter Brunner, Karlsruhe
Rene Donatus Degele, Itzehoe
Walter Dietrich, Hanau
Mattias Dietrich, Boston, MA
Heinz-Dietrich Doebner, München
Wolfgang Doetsch, Mayen
Katharina Domogala, Dülmen
Hans-Werner Drawin, Gundelfingen
Albrecht Elsner,Garching
Hans-Ulrich Finzel, Coburg
Karl Fischer, Saarbrücken
Christian Forstner, Jena
Heino Freese, Hamburg
Rolf Freitag, Leonberg
Hans-Jürgen Frischkorn, Oberursel (Taunus)
Harald Fritzsch, München
Friedrich Gönnenwein, Tübingen
Jochen Görres, Düsseldorf
Wolfgang Grafe, Mainz
Uwe Grimm, Milton Keynes
Carola Grünewald, Chemnitz
Werner Grzemba, Hannover
Philipp Gütlich, Roßdorf
Horst Haeske, Oberursel (Taunus)
Roland Hahnefeld, München
Hans-Jürgen Hartmann, Lübeck
Volker Häselbarth, Königswinter
Johann Haserer, Mühldorf
Rüdiger Haupt, Brühl
Werner Heindl, Regensburg
Dieter Herlach, Kerpen
Frank Hinterberger, Bonn
Horst Hoffmann, Regensburg
Sigurd Hofmann, Gross-Umstadt
Josef Honerkamp, Emmendingen
Andreas Hörstemeier, Aachen
Klaus Hübner, Heidelberg
Christof Illgner, Darmstadt
Gert Irmer, Freiberg
Christopher John, Hargesheim
G. Michael Kalvius, Meggen
Franz Käppeler, Bruchsal
Franz Rudolf Kessler, Düren
Alexander Kirchberger, Rastatt
Fritz Kix, Uelzen
Maria Klein, Klingenberg
Hans-Hermann Klein, Bad Nauheim
Peter Kleinheinz, Jülich
Wilhelm Kley, Tübingen
Wolfgang Klose, Essen
Stephan W. Koch, Fronhausen
Herbert Koch, Jena
Armin Kohlrausch, Eindhoven
Eckhard Krätzig, Osnabrück
Horst Kraus, Ehringshausen
Horst Krause, Berlin
Gernot Krauss, Sankt Augustin
Erich Krebs, Wiesbaden
Franz-Georg Kreuzer, Bonn
Bernd Krusche, Grenzach-Wyhlen
Joachim Laatsch, Aachen
Heinz Lange, Leichlingen
Franz Lappe, Bad Tölz
Udo Lingner, Nürnberg
Bernd Litzenburger, Potsdam
Konstantin Lobov, Essen
Heinz Lübbig, Berlin
Wolfgang Mader, Dresden
Hans F. Mahlein, Unterhaching
Wolfgang Manthei, Berlin
Roland May, St. Ismier
Christoph Meier, Toulouse
Dieter Meiners, Heitersheim
Günther Meissner, Köln
Horst Merz, Friedenweiler
Lothar Michalowsky, Witzenhausen
Karl-Heinz Möbius, Radolfzell
Heinz Morgenroth, Berlin
Andreas Müller, Lichtenstein
Stefan Müller, Hamburg
Karl-Heinz Pantke, Berlin
Hans-Peter Pavel, Icking
Rolf Perthel, Jena
Helmut Pohl, Heidelberg
Herbert Porsche, Seefeld
Torsten Prasse, Potsdam
Ernst Rathmann, Fulda
Karl-Heinz Reichstein, Göppingen
Dieter Robaschik, Cottbus
Wolfgang Roether, Bremen
Dorothee Rohmann, Hagermarsch
Erhard Sailer, Korntal-Münchingen
Hanno Schaumburg, Hamburg
Christian Schenk, Weißenhorn
Horst Schiller, Bad Schwartau
Rüdiger Schmidt, Rabenau
Rudi Schmitz, Aachen
Heinz-Helmut Schramm, Berlin
Wolfgang Schreier, Warngau
Wolfgang Schreier, Leipzig
Kurt Schroeder, Düren
Joachim Schröter, Berlin
Florian Schubert, Wiesbaden
Gerd Schwarz, Gießen
Erwin Sedlmayr, Zangberg
Bernd Seidel, Berlin
Klaus Seidel, Oelsnitz
Mir Heliassudin Il Seifie, Hamburg
Gerhard Simonsohn, Berlin
Volker Soergel, Heidelberg
Ulrich Sondermann, Marburg
Bernhard Spaan, Wetter
Hubert Staerk, Bovenden
Berthold Stech, Heidelberg
Susanne Steeger, Hamminkeln
Michael Steiner, Berlin
Markus Steinert, Braunschweig
Ulrich Sum, Lörrach
Jakob Szer, Süderlügum
Herbert Tietje, Twist
Ursula Tödheide-Haupt, Karlsruhe
Reimund Torge, Potsdam
Frank Träger, Sandhausen
Kurt Tretner, Oldenburg
Jost Trier, Braunschweig
Inge Tzschach, Darmstadt
Helmut Viefhaus, Mettmann
Wolfgang Vogel, Hamburg
Walter Vogl, Horhausen
Waltraud Vollmann, Chemnitz
Robert von Hahn, St. Leon-Rot
Clemens Wächter, Lauffen
Gerhard Weber, Freiburg
Holger Wegmann, Dortmund
Winfried Weirauch, Braunschweig
Claus Wengel, Colmberg
Thorsten Wierzkowski, Heilbronn
Hans-Jörg Wingender, Mömbris
Horst Winterhoff, Dreieich
Petra Wintgen, Aachen
Joachim Wolter, Waalre
Diethard Wruck, Berlin
Helmut Wühl, Karlsruhe
Johann Peter Wurm, Schriesheim
Andreas Zacchi, Dreieich
Wolf Zechnall, Hildesheim
Elmar H. Zeitler, Berlin
Markus Zeuschner, Lüneburg
Paul Ziesche, Dresden
Eckhard Zschiesche, Gevelsberg

We will honor the memory of our members.

Deutsche Physikalische Gesellschaft e. V.

Einladung zur ordentlichen Mitgliederversammlung 2023

Montag, 20. März 2023, 18:00 Uhr
Technische Universität Dresden, HSZ-304 (3. OG),
Bergstraße 64, 01069 Dresden

Hiermit lade ich alle Mitglieder satzungsgemäß zur diesjährigen Mitgliederversammlung ein.

Zur Teilnahme an der Mitgliederversammlung sind nur DPG-Mitglieder zugelassen. Teilnehmende Mitglieder müssen sich am Eingang durch einen gültigen Mitgliedsausweis legitimieren und werden in einer Liste der Teilnehmenden erfasst. Bitte bringen Sie Ihren gültigen Mitgliedsausweis mit.

TAGESORDNUNG

1 Eröffnung und Totengedenken

2 Feststellung der Tagesordnung

3 Bericht des Präsidenten (J. Ullrich)

4 Bericht des Vizepräsidenten (L. Schröter)

5 Berichte aus den Vorstandsbereichen

- 5.1 Bildung und wissenschaftlicher Nachwuchs (K. Mecke)
- 5.2 Industrie und Wirtschaft (S. Friebel)
- 5.3 Internationale Aktivitäten (K. Zach)
- 5.4 Junge Mitglieder und Berufsfragen (M. Zimmermann)
- 5.5 Öffentlichkeitsarbeit (C. Lämmerzahl)
- 5.6 Publikationen (R. Moessner)
- 5.7 Schule (Y. Struck)
- 5.8 Wissenschaftliche Programme und Preise (A. Buchleitner)

6 Bericht des Hauptgeschäftsführers (B. Nunner)

7 Bericht des Schatzmeisters über die Jahresabschlussrechnung des Geschäftsjahres 2022 (R. Pfrengle)

8 Bericht der Rechnungsprüfer (A. Belias, G. Mussler)

9 Entlastung des Vorstands und des Hauptgeschäftsführers

10 Bericht zum Haushaltsplan für das Geschäftsjahr 2023 und zu den Mitgliedsbeiträgen (R. Pfrengle)

11 Anträge von Mitgliedern

12 Wahlen

- 12.1 Bericht über das Ergebnis der Wahlen im Jahr 2022 zum DPG-Vorstand und zu weiteren Gremien der DPG
- 12.2 Wahl eines Rechnungsprüfers bzw. einer Rechnungsprüferin

13 Verschiedenes

Unterlagen zu TOP 10 sind im Physik Journal (Ausgabe Januar 2023) veröffentlicht. Weitere Unterlagen zu TOP 7, 10 und 12.1 können rechtzeitig vor der Versammlung im internen Bereich des DPG-Internetangebots http://www.intern.dpg-physik.de unter dem Menüpunkt Mitgliederversammlung eingesehen werden.

Bad Honnef, Januar 2023

DEUTSCHE PHYSIKALISCHE GESELLSCHAFT E. V.
Der Präsident
J. Ullrich

Deutsche Physikalische Gesellschaft DPG

Synopsis of the Daily Programme

Monday, March 20, 2023

08:45	HSZ/AUDI		**Opening**
			Plenary Talks, Prize Talk
09:00	HSZ/AUDI	PV I	Low Temperature Plasma – About a Hidden Champion or a Silent Revolution •Klaus-Dieter Weltmann
09:45	HSZ/AUDI	PV II	Thin film technology for fabrication of nonlinear active optical components and its future application in photonic circuits •Marco Jupe
12:30	HSZ/AUDI	PV III	Two milestones in the life of the Universe: Last Scattering Surface and Black Body Photosphere •Rashid Sunyaev (Laureate of the Max-Planck-Medal 2023)

SYMD

			Session
14:00	HSZ/AUDI	SYMD 1	SMuK Dissertation Prize 2023

EP

			Invited Talks
10:45	HSZ/0004	EP 1.1	A Melting Probe for the Exploration of Subglacial Lakes within the TRIPLE project line •Mia Giang Do
16:15	ZEU/0160	EP 2.1	The exoplanet revolution: towards habitable worlds •Alexis Smith
			Sessions
10:45	HSZ/0004	EP 1	Planets and small Objects
16:15	ZEU/0160	EP 2	Exoplanets and Astrobiology

GR

			Sessions
16:30	ZEU/0260	GR 1	Black Holes
16:30	ZEU/0255	GR 2	Cosmology I

HK

			Invited Talks
11:00	HSZ/0002	HK 1.1	Nucleosynthesis of heavy nuclei – moving a supernova into the laboratory •Felix Heim
11:30	HSZ/0002	HK 1.2	Exploring the 3D nucleon structure with CLAS and CLAS12 at JLAB •Stefan Diehl
12:00	HSZ/0002	HK 1.3	Lattice simulations with chiral effective field theory at N3LO •Serdar Elhatisari
			Sessions
11:00	HSZ/0002	HK 1	Invited Talks I
16:30	SCH/A251	HK 2	Instrumentation I
16:30	SCH/A.101	HK 3	Instrumentation II
16:30	SCH/A117	HK 4	Instrumentation III
16:30	SCH/A216	HK 5	Heavy-Ion Collisions and QCD Phases I
16:30	SCH/A315	HK 6	Heavy-Ion Collisions and QCD Phases II
16:30	SCH/A316	HK 7	Hadron Structure and Spectroscopy I
16:30	SCH/A419	HK 8	Nuclear Astrophysics I
16:30	SCH/A118	HK 9	Structure and Dynamics of Nuclei I
16:30	SCH/A215	HK 10	Structure and Dynamics of Nuclei II
16:30	HSZ/0204	HK 11	Outreach Public/Teilchenwelt

Monday, March 20, 2023

MP

			Invited Talk
11:00	HSZ/0003	MP 1.1	Insights from random matrices on dissipative quantum dynamics •Pedro Ribeiro
			Sessions
11:00	HSZ/0003	MP 1	Quantum Dynamics and Quantum Information
16:30	ZEU/0250	MP 2	Quantum Field Theory I

P

			Invited Talks
11:00	CHE/0089	P 1.1	Ion Beam Sputter Deposition – Fundamentals and Applications •Carsten Bundesmann
11:00	CHE/0091	P 2.1	Deuterium-Tritium Plasmas at JET with ITER-like Wall and the Role of Isotope Mass and Transport for H-mode Access •Gregor Birkenmeier
			Sessions
11:00	CHE/0089	P 1	Low Pressure Plasmas and their Application I
11:00	CHE/0091	P 2	Magnetic Confinement I/HEPP I
16:30	CHE/0089	P 3	Astrophysical Plasmas
16:30	CHE/0091	P 4	HEPP II

T

			Invited Talks
11:00	HSZ/AUDI	T 1.1	What we learned about the Higgs Boson from the LHC so far •Duc Bao Ta
11:30	HSZ/AUDI	T 1.2	QCD at the LHC – Precision for Discoveries •Malgorzata Worek
12:00	HSZ/AUDI	T 1.3	The charm and beauty of flavour physics •Marco Gersabeck
			Sessions
11:00	HSZ/AUDI	T 1	Invited Overview Talks I
16:30	HSZ/0004	T 2	Flavor I
16:30	HSZ/0401	T 3	Top I
16:30	HSZ/0403	T 4	Searches I
16:30	HSZ/0101	T 5	Higgs Searches
16:30	HSZ/0103	T 6	Other Exp., EW
16:30	HSZ/0105	T 7	Higgs, Di-Higgs I
16:30	HSZ/0204	T 8	Outreach Public/Teilchenwelt
16:30	HSZ/0301	T 9	DAQ NN/ML – HW
16:30	HSZ/0405	T 10	ML Methods I
16:30	POT/0051	T 11	Neutrinos, Dark Matter I
16:30	POT/0151	T 12	Gamma Astronomy I
16:30	POT/0251	T 13	Neutrinos I
16:30	POT/0361	T 14	Neutrinos, Dark Matter II
16:30	POT/0006	T 15	Neutrinos, Dark Matter III
16:30	POT/0112	T 16	Neutrino Astronomy I
16:30	POT/0013	T 17	Cosmic Ray I
16:30	POT/0351	T 18	Exp. Methods, CTA, others
16:30	POT/0106	T 19	Detector Systems, Electronics
16:30	WIL/A317	T 20	Pixel ITk, Si-Strips/Other
16:30	WIL/A124	T 21	Si-Strips/CMS, Pixel/Sensor
16:30	WIL/C133	T 22	Calorimeter / Detector Systems I
16:30	WIL/A120	T 23	Gas-Detectors / Muon MDT

Monday, March 20, 2023

AKBP

			Sessions
16:00	CHE/0183	AKBP 1	Particle and Photon Sources
16:00	CHE/0184	AKBP 2	Advanced Light Sources and their Instrumentation

AKE

			Invited Talks
11:00	GER/038	AKE 1.1	Zellulare Energiesysteme – Zukunft der Energietechnik? •Joachim Seifert
16:30	GER/038	AKE 2.1	The German primary energy consumption – status and trends •Larissa Breuning
			Sessions
11:00	GER/038	AKE 1	Konzepte und Technologien
16:30	GER/038	AKE 2	Energieversorgung

AKPIK

			Session
16:00	HSZ OG2	AKPIK 1	Poster

AGPhil

			Session
11:00	JAN/0027	AGPhil 1	Quanten und Prozesse

13:00	(refer to website)	**jDPG Lunch Gathering**
18:00	HSZ/0304	**Annual General Meeting of the DPG** (for DPG members only)
19:30	In front of the HSZ	**jDPG Pub Crawl**
19:30	Tent A	**Welcome Evening (for registered participants)**

Tuesday, March 21, 2023

			Plenary Talks, Prize Talk, Ceremonial Talk
09:00	HSZ/AUDI	PV IV	Characterising exoplanet atmospheres with the Webb space telescope •Pierre-Olivier Lagage
09:45	HSZ/AUDI	PV V	The European Destination Earth initiative – a paradigm change for weather and climate prediction •Peter Bauer
12:30	HSZ/AUDI	PV VI	The Higgs boson at the (HL)LHC – precisely! •Adinda de Wit (Laureate of the Hertha-Sponer-Prize 2023)
14:00	HSZ/AUDI		**Special Plenary Session with Award Ceremony**
			Ceremonial Talk
		PV VII	The once unattainable – new breakthroughs in particle physics •Monica Dunford

SYSC

			Invited Talks
11:00	HSZ/0004	SYSC 1.1	Not all clouds are created equal – strange clouds in our solar system •Thomas Leisner
11:20	HSZ/0004	SYSC 1.2	Clouds to the Edge of Space •Gerd Baumgarten
11:45	HSZ/0004	SYSC 1.3	The dynamic clouds of Venus •Javier Peralta
12:10	HSZ/0004	SYSC 1.4	Observational constraints of exoplanet clouds •Nicolas Iro
12:35	HSZ/0004	SYSC 1.5	Gemstone clouds in JWST target exoplanets •Dominic Samra
			Session
11:00	HSZ/0004	SYSC 1	Strange Clouds – From the Earth to Exoplanets

EP

			Sessions
16:45	ZEU/0160	EP 3	Clouds in Planetary Atmospheres
18:00	ZEU/0160	EP 4	Planetary atmospheres

GR

			Invited Talk
11:00	HSZ/0401	GR 3.1	Scalaron-Higgs inflation •Christian Steinwachs
			Sessions
11:00	HSZ/0401	GR 3	Cosmology II
17:00	ZEU/0260	GR 4	Quantum Gravity
17:00	ZEU/0255	GR 5	Classical Relativity

HK

			Invited Talks
11:00	HSZ/0002	HK 12.1	Baryon spectroscopy at ELSA and MAMI •Farah Afzal
11:30	HSZ/0002	HK 12.2	ALICE upgrades, status and perspectives for ALICE-3 •Robert Muenzer
12:00	HSZ/0002	HK 12.3	Nuclear parton distribution functions •Michael Klasen

Tuesday, March 21, 2023

HK

			Sessions
11:00	HSZ/0002	HK 12	Invited Talks II
17:00	SCH/A251	HK 13	Instrumentation IV
17:00	SCH/A.101	HK 14	Instrumentation V
17:00	SCH/A117	HK 15	Instrumentation VI
17:00	SCH/A216	HK 16	Heavy-Ion Collisions and QCD Phases III
17:00	SCH/A315	HK 17	Heavy-Ion Collisions and QCD Phases IV
17:00	SCH/A316	HK 18	Hadron Structure and Spectroscopy II
17:00	SCH/A419	HK 19	Nuclear Astrophysics II
17:00	SCH/A118	HK 20	Structure and Dynamics of Nuclei III
17:00	SCH/A215	HK 21	Structure and Dynamics of Nuclei IV
17:00	SCH/A252	HK 22	Outreach

MP

			Invited Talks
11:00	HSZ/0304	MP 3.1	Renormalization of singular stochastic partial differential equations •Pawel Duch
11:30	HSZ/0304	MP 3.2	Integral decomposition of modular operators in QFT •Daniela Cadamuro
12:00	HSZ/0304	MP 3.3	Emergence of gravity from conformal field theory •Nele Callebaut
			Sessions
11:00	HSZ/0304	MP 3	Quantum Field Theory II
10:30	HSZ OG3	MP 4	Poster
17:00	ZEU/0250	MP 5	Scattering Amplitudes and Conformal Field Theory

P

			Invited Talks
11:00	CHE/0089	P 5.1	Diagnostics of metal-grid micro cavity plasma arrays •Marc Böke
11:00	CHE/0091	P 6.1	The physics of ELM-free regimes •Michael Dunne
17:00	CHE/0091	P 8.1	Fuel retention and removal in the JET tokamak •Dmitry Matveev
			Sessions
11:00	CHE/0089	P 5	Atmospheric Pressure Plasmas and their Applications I
11:00	CHE/0091	P 6	Magnetic Confinement II/HEPP III
17:00	CHE/0089	P 7	Atmospheric Pressure Plasmas and their Applications III
17:00	CHE/0091	P 8	Plasma Wall Interaction I/HEPP IV

ST

			Sessions
11:00	GER/038	ST 1	Accelerators for Radiation Therapy
17:00	ZEU/0146	ST 2	Medical Imaging Concepts

T

			Invited Talks
11:00	HSZ/AUDI	T 24.1	Searching for Long-Lived Particles at the LHC and Beyond •Juliette Alimena
11:30	HSZ/AUDI	T 24.2	The Neutrino-Dawn of Galaxies •Wolfgang Rhode
12:00	HSZ/AUDI	T 24.3	Galactic cosmic rays: What have we learned and what’s next? •Philipp Mertsch

Tuesday, March 21, 2023

T

			Sessions
11:00	HSZ/AUDI	T 24	Invited Overview Talks II
17:00	HSZ/0304	T 25	Flavor II
17:00	HSZ/0401	T 26	Flavor III
17:00	HSZ/0403	T 27	Searches II
17:00	HSZ/0101	T 28	Forward Physics
17:00	HSZ/0103	T 29	Other Exp., EW
17:00	HSZ/0105	T 30	Higgs Charm, Di-Higgs
17:00	HSZ/0201	T 31	Theory Higgs, BMS
17:00	HSZ/0204	T 32	Di-Higgs, Higgs BSM
17:00	HSZ/0301	T 33	DAQ NN/ML – GRID I
17:00	HSZ/0405	T 34	ML Methods II
17:00	POT/0051	T 35	Neutrino Astronomy II
17:00	POT/0151	T 36	Gamma Astronomy II
17:00	POT/0251	T 37	Neutrinos, Dark Matter IV
17:00	POT/0361	T 38	Neutrinos, Dark Matter V
17:00	POT/0006	T 39	Neutrinos, Dark Matter VI
17:00	POT/0112	T 40	Astro Particle Theory
17:00	POT/0013	T 41	Cosmic Ray II
17:00	POT/0351	T 42	Exp. Methods, IceAct, Auger, RNO-G
17:00	POT/0106	T 43	Electronics, DAQ, Exp. Methods
17:00	WIL/A317	T 44	Pixel/LHCb, Si-Strips/CMS
17:00	WIL/A124	T 45	Si-Strips, Pixel
17:00	WIL/C133	T 46	Calorimeter / Detector Systems II
17:00	WIL/A120	T 47	Gas-Detecors, Detector Systems
17:00	WIL/C129	T 48	Exp. Methods I
17:00	SCH/A252	T 49	Outreach

K

			Invited Talk
11:00	REC/C213	K 1.1	Information, Abstände und Gravitation ? •Rudolf Germer
			Sessions
11:00	REC/C213	K 1	Laser Applications and Laser-Beam Material Interaction
12:35	REC/C213	K 2	Members' Assembly
16:45	HSZ OG2	K 3	Poster

UP

			Session
16:45	ZEU/0160	UP 1	Clouds in Planetary Atmospheres

AKBP

			Sessions
11:00	GER/038	AKBP 3	Accelerator and Medical Physics
16:30	CHE/0183	AKBP 4	Plasmas and Lasers
16:30	CHE/0184	AKBP 5	Hadron Accelerators

AKE

			Invited Talk
17:00	GER/038	AKE 3.1	Activation calculations for decommissioning planning of NPPs •Reuven Rachamin
			Session
17:00	GER/038	AKE 3	Zukunftsperspektiven

Tuesday, March 21, 2023

AKPIK

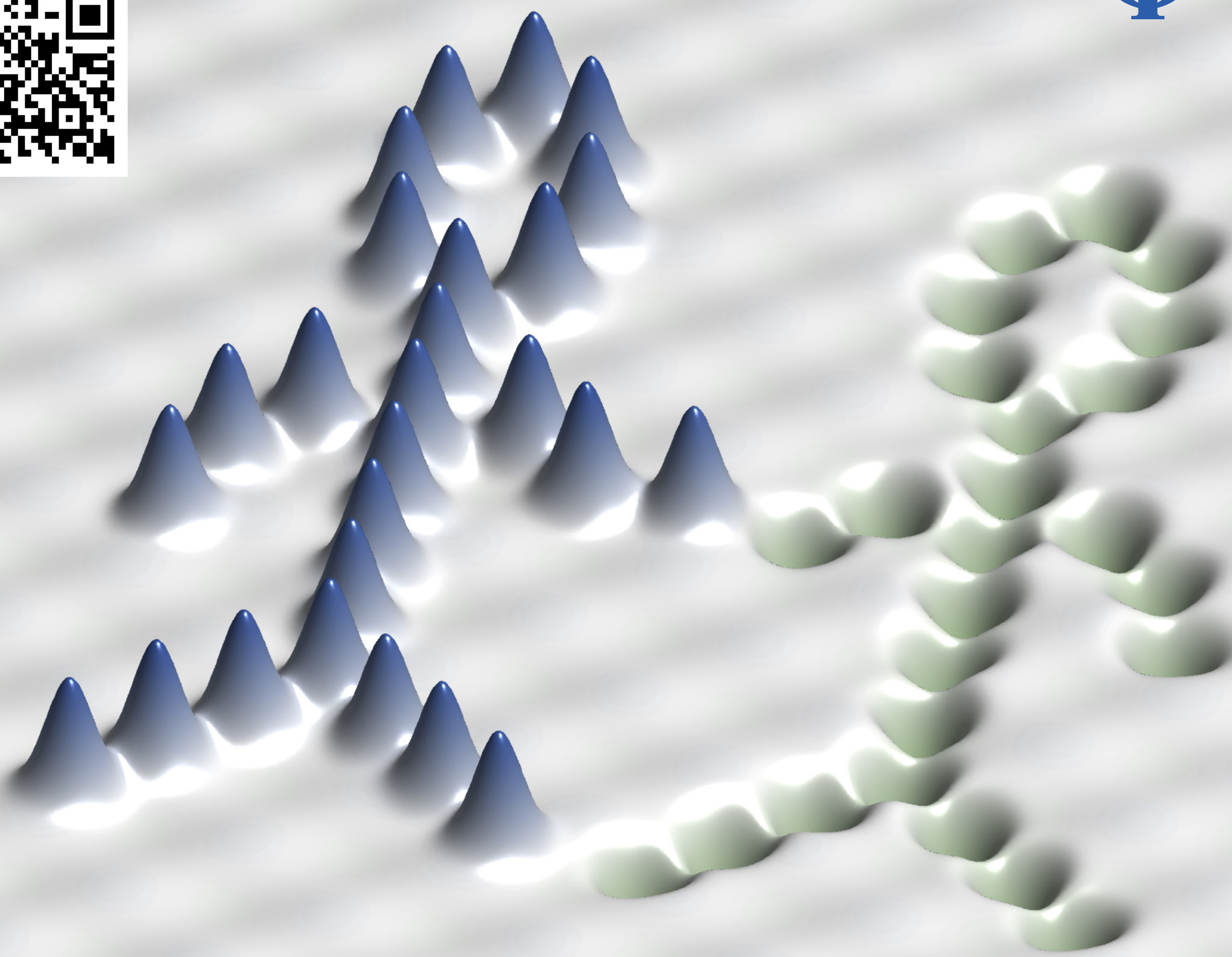
			Session
17:00	ZEU/0118	AKPIK 2	Applications in Particle and Astroparticle Physics

AGPhil

			Sessions
11:00	JAN/0027	AGPhil 2	Space and Time
17:30	JAN/0027	AGPhil 3	Philosophy of Physics

10:00	Foyer Lecture Hall Centre	**Exhibition of Scientific Instruments and Literature**
19:00	HSZ/0004	**Physicists in Industry**

Deutsche Physikalische Gesellschaft DPG



DPG Mentoring Programm 2023

Jetzt anmelden unter:

mentoring.dpg-physik.de

Anmeldezeitraum: 21. April - 21. Mai 2023

Profitiere als **Mentee** von erfahrenen Physiker:innen im Berufsleben.

Begleiten Sie als **Mentor:in** junge Physiker:innen beim Berufseinstieg.

DPG mentoring

Wednesday, March 22, 2023

Plenary Talks, Prize Talk, Lunch Talk

09:00	HSZ/AUDI	PV VIII	25 years of the AdS/CFT correspondence: Current status and future prospects •Koenraad Schalm
09:45	HSZ/AUDI	PV IX	The origin of the chemical elements •Marialuisa Aliotta
12:30	HSZ/AUDI	PV X	News from the Flavour Expedition to the Zeptouniverse •Andrzej Buras (Laureate of the Max-Planck-Medal 2020)
13:15	HSZ/AUDI	PV XI	From ab initio to nemo tenetur – Working on cyber crime as an IT analyst with the State Criminal Police Office •Wojciech Morawiec

EP

Invited Talks

10:45	ZEU/0160	EP 5.1	New insights into the elusive magnetic processes operating in the solar corona with SolO/EUI •Lakshmi Pradeep Chitta
11:30	ZEU/0160	EP 5.3	Studying solar flares with the X-ray telescope STIX during the cruise and early science phase of Solar Orbiter •Alexander Warmuth
14:15	ZEU/0160	EP 7.1	Advances in energetic particle physics with Solar Orbiter & Parker Solar Probe •Robert F. Wimmer-Schweingruber
15:00	ZEU/0160	EP 7.3	New Insights in Simulations of SEP Events with the PARADISE+ICARUS Model •Edin Husidic
16:00	ZEU/0160	EP 8.1	Precision measurements of cosmic ray fluxes from AMS-02 with a daily time resolution •Stefan Schael

Sessions

10:45	ZEU/0160	EP 5	Sun and heliosphere I
13:00	ZEU/0160	EP 6	Members' Assembly
14:15	ZEU/0160	EP 7	Sun and heliosphere II
16:00	ZEU/0160	EP 8	Sun and heliosphere III
17:30	HSZ OG1	EP 9	Poster

GR

Invited Talks

11:00	ZEU/0260	GR 6.1	Geodesic motion in relativistic astrophysics •Eva Hackmann
11:45	ZEU/0260	GR 6.2	Modelling the multi-messenger signals of gravitational wave sources •Stephan Rosswog

Sessions

11:00	ZEU/0260	GR 6	Relativistic Astrophysics
14:00	ZEU/0260	GR 7	Gravitational Waves I
14:00	ZEU/0255	GR 8	Foundations and Alternatives I
16:00	ZEU/0260	GR 9	Gravitational Waves and Astrophysics I
16:00	ZEU/0255	GR 10	Foundations and Alternatives II

HK

Invited Talks

11:00	HSZ/0002	HK 23.1	High-Precision Laser Spectroscopy of C^{4+} for an All-Optical Determination of the Nuclear Charge Radius •Phillip Imgram
11:30	HSZ/0002	HK 23.2	ALICE determines the transparency of our galaxy to the passage of antihelium nuclei •Laura Serksnyte

Wednesday, March 22, 2023

HK

12:00	HSZ/0002	HK 23.3	The world of light and strange mesons: from spectroscopy puzzles to low energy QCD phenomena •Stephan Paul

Sessions

11:00	HSZ/0002	HK 23	Invited Talks III
14:00	SCH/A251	HK 24	Instrumentation VII
14:00	SCH/A.101	HK 25	Instrumentation VIII
14:00	SCH/A117	HK 26	Instrumentation IX
14:00	SCH/A216	HK 27	Heavy-Ion Collisions and QCD Phases V
14:00	SCH/A315	HK 28	Heavy-Ion Collisions and QCD Phases VI
14:00	SCH/A316	HK 29	Hadron Structure and Spectroscopy III
14:00	SCH/A419	HK 30	Nuclear Astrophysics III
14:00	SCH/A118	HK 31	Structure and Dynamics of Nuclei V
14:00	SCH/A215	HK 32	Structure and Dynamics of Nuclei VI
14:00	SCH/A252	HK 33	Fundamental Symmetries I
15:45	SCH/A251	HK 34	Instrumentation X
15:45	SCH/A.101	HK 35	Instrumentation XI
15:45	SCH/A117	HK 36	Computing I
15:45	SCH/A216	HK 37	Heavy-Ion Collisions and QCD Phases VII
15:45	SCH/A315	HK 38	Heavy-Ion Collisions and QCD Phases VIII
15:45	SCH/A316	HK 39	Hadron Structure and Spectroscopy IV
15:45	SCH/A419	HK 40	Nuclear Astrophysics IV
15:45	SCH/A118	HK 41	Structure and Dynamics of Nuclei VII
15:45	SCH/A215	HK 42	Structure and Dynamics of Nuclei VIII
15:45	SCH/A252	HK 43	Fundamental Symmetries II
17:30	SCH/A251	HK 44	Instrumentation XII
17:30	SCH/A.101	HK 45	Instrumentation XIII
17:30	SCH/A216	HK 46	Heavy-Ion Collisions and QCD Phases IX
17:30	SCH/A315	HK 47	Heavy-Ion Collisions and QCD Phases X
17:30	SCH/A316	HK 48	Hadron Structure and Spectroscopy V
17:30	SCH/A118	HK 49	Structure and Dynamics of Nuclei IX
17:30	SCH/A215	HK 50	Structure and Dynamics of Nuclei X
17:30	SCH/A252	HK 51	Fundamental Symmetries III

MP

Invited Talk

11:30	ZEU/0250	MP 6.2	Deep neural networks and the renormalization group •Ro Jefferson

Sessions

11:00	ZEU/0250	MP 6	AI Topical Day – Neural Networks and Computational Complexity
14:00	ZEU/0250	MP 7	Classical and Quantum Gravity
16:00	ZEU/0250	MP 8	Members' Assembly

P

Invited Talks

11:00	CHE/0089	P 9.1	Modelling and analysis of single-filament dielectric barrier discharges at atmospheric pressure •Markus M. Becker
11:00	CHE/0091	P 10.1	Diagnosing the plasma edge with helium beam spectroscopy •Michael Griener

Sessions

11:00	CHE/0089	P 9	Atmospheric Pressure Plasmas and their Applications III
11:00	CHE/0091	P 10	Magnetic Confinement III/HEPP V
14:00	HSZ EG	P 11	Poster I
17:30	HSZ EG	P 12	Poster II

Wednesday, March 22, 2023

ST

Invited Talks

14:00	ZEU/0146	ST 4.1	Innovationen in die Praxis bringen – die EXIST Gründungsförderung •Antje Dewitz
14:20	ZEU/0146	ST 4.2	Development and Certification of an IGRT system •Claus Promberger
14:40	ZEU/0146	ST 4.3	Klinische Anwendung von Protonen-/Partikeltherapie •Esther Troost

Sessions

11:00	ZEU/0146	ST 3	Poster Session
14:00	ZEU/0146	ST 4	DPG meets DGMP: Von der Idee bis zur klinischen Anwendung
15:50	ZEU/0146	ST 5	Physics and Technology for Radiation Detection
17:45	ZEU/0146	ST 6	Members' Assembly

T

Invited Topical Talks

11:00	HSZ/AUDI	T 50.1	Search for leptoquarks at the ATLAS experiment •Mahsana Haleem
11:20	HSZ/AUDI	T 50.2	Making the most of Yukawa couplings: searching for Dark Matter accompanied by heavy quarks •Danyer Perez Adan
11:40	HSZ/AUDI	T 50.3	Precision predictions for transverse momentum distributions of Higgs and vector bosons at the LHC •Maximilian Stahlhofen
12:00	HSZ/AUDI	T 50.4	Axion fragmentation •Enrico Morgante
11:00	HSZ/0003	T 51.1	LUXE – A new experiment to study non-perturbative QED in electron-laser and photon-laser collisions •Ruth Jacobs
11:20	HSZ/0003	T 51.2	Precision timing with silicon sensors •Annika Vauth
11:40	HSZ/0003	T 51.3	Recent advancements in Micro-Pattern Gaseous Detectors: Exciting research ahead towards future experiments •Michael Lupberger
12:00	HSZ/0003	T 51.4	Recent Liquid Scintillator Developments for Astroparticle Physics •Stefan Schoppmann
14:00	HSZ/AUDI	T 52.1	Commissioning of the new LHCb trigger system •Marian Stahl
14:20	HSZ/AUDI	T 52.2	Alignment of the CMS Tracker: Automation is Key •Marius Teroerde
14:40	HSZ/AUDI	T 52.3	ITk – ATLAS tracker upgrade •Dennis Sperlich
15:00	HSZ/AUDI	T 52.4	Role of simulation in silicon tracker sensors R&D •Anastasiia Velyka
14:00	HSZ/0003	T 53.1	LST-1: Initial scientific results from the first CTA telescope •Dominik Elsaesser
14:20	HSZ/0003	T 53.2	Multimessenger astronomy with the Pierre Auger Observatory •Marcus Niechciol
14:40	HSZ/0003	T 53.3	Positron annihilation as an astrophysical messenger •Thomas Siegert
15:00	HSZ/0003	T 53.4	The first results of the XENONnT experiment and an outlook to the future DARWIN observatory •Andrii Terliuk

Sessions

11:00	HSZ/AUDI	T 50	Invited Topical Talks I-A
11:00	HSZ/0003	T 51	Invited Topical Talks I-B
14:00	HSZ/AUDI	T 52	Invited Topical Talks II-A

Wednesday, March 22, 2023

T

14:00	HSZ/0003	T 53	Invited Topical Talks II-B
15:50	HSZ/0304	T 54	Flavor IV
15:50	HSZ/0401	T 55	Flavor V, Top-BSM
15:50	HSZ/0403	T 56	Searches EW I
15:50	HSZ/0101	T 57	Single Top – Higgs Top
15:50	HSZ/0103	T 58	Other Exp. tt,
15:50	HSZ/0105	T 59	QCD Theory and Experiment I
15:50	HSZ/0201	T 60	Theory BMS
15:50	HSZ/0204	T 61	Higgs I
15:50	HSZ/0301	T 62	DAQ NN/ML – GRID II
15:50	HSZ/0405	T 63	ML Methods III
15:50	POT/0051	T 64	Neutrino Astronomy III
15:50	POT/0151	T 65	Gamma Astronomy III
15:50	POT/0251	T 66	Neutrinos II
15:50	POT/0361	T 67	Neutrinos, Dark Matter VII
15:50	POT/0006	T 68	Neutrinos, Dark Matter VIII
15:50	POT/0112	T 69	Neutrinos, Dark Matter IX
15:50	POT/0013	T 70	Cosmic Ray III
15:50	POT/0351	T 71	Exp. Methods AP, PMTs
15:50	POT/0106	T 72	Exp. Methods II
15:50	WIL/A317	T 73	Pixel/CMS
15:50	WIL/A124	T 74	DetSys MAGIX, DetSys KATRIN
15:50	WIL/C133	T 75	Calorimeter / Detector Systems III
15:50	WIL/A120	T 76	Gas-Detectors
17:20	HSZ/0401	T 77	Flavor VI
17:30	HSZ/0304	T 78	Flavor VII
17:30	HSZ/0403	T 79	Searches III
17:30	HSZ/0101	T 80	Searches EW II
17:30	HSZ/0103	T 81	Single Top, Top Properties
17:30	HSZ/0105	T 82	Higgs, Di-Higgs II
17:30	HSZ/0201	T 83	Theory BSM
17:30	HSZ/0204	T 84	Theory EW
17:30	HSZ/0301	T 85	DAQ, Data Techniques
17:30	HSZ/0405	T 86	ML Methods IV
17:30	POT/0051	T 87	Neutrinos III
17:30	POT/0151	T 88	Gamma Astronomy IV
17:30	POT/0251	T 89	DM, Neutrino Theory
17:30	POT/0361	T 90	Neutrinos, Dark Matter X
17:30	POT/0006	T 91	Neutrinos IV
17:30	POT/0013	T 92	Cosmic Ray IV
17:30	POT/0351	T 93	Exp. Methods – Scint., HESS, Auger
17:30	POT/0106	T 94	DAQ, Exp. Methods
17:30	WIL/A317	T 95	Pixel, Det/Sys LHCb, HGT
17:30	WIL/A124	T 96	TestBeam, RadHard for Si and Pixel
17:30	WIL/C133	T 97	Calorimeter / Detector Systems IV
17:30	WIL/A120	T 98	Gas-Detecors, Detector Systems
19:00	HSZ/0101	T 99	Annual Meeting of Young Scientists in High Energy Physics (yHEP)

K

			Session
11:00	REC/C213	K 4	X-Ray Lasers

UP

			Invited Talk
11:00	MOL/0213	UP 2.1	Volcanic radiative forcing: past and future •Anja Schmidt

Wednesday, March 22, 2023

UP

			Sessions
11:00	MOL/0213	UP 2	Volcanic Effects on Atmosphere and Climate
13:00	MOL/0213	UP 3	Members’ Assembly
14:00	MOL/0213	UP 4	Aerosols & Hydrological Cycle
16:00	MOL/0213	UP 5	Measurement Techniques and Simulations
17:30	HSZ OG1	UP 6	Poster

AKBP

			Sessions
11:00	HSZ/0304	AKBP 6	New Results from Accelerators for Hadron Physics
14:00	HSZ/0304	AKBP 7	Experiments for Advanced Light Sources
15:45	CHE/0183	AKBP 8	Advanced IT Tools
15:45	CHE/0184	AKBP 9	Beam Dynamics I
17:30	CHE/0183	AKBP 10	Instrumentation I
17:30	CHE/0184	AKBP 11	RF and SRF Research

AKC

			Invited Talks
11:00	HSZ/0004	AKC 1.1	What’s wrong with me? •Pauline Gagnon
11:45	HSZ/0004	AKC 1.2	Workplace cultures in physics as a game changer for equal opportunities •Martina Erlemann
12:30	HSZ/0004	AKC 1.3	Belonging – a key to success in STEM?! •Barbara M. Gordalla
			Session
11:00	HSZ/0004	AKC 1	AKC

AKPIK

			Sessions
14:00	ZEU/0118	AKPIK 3	Neural Networks I
15:45	ZEU/0118	AKPIK 4	Neural Networks II
11:00	ZEU/0250	AKPIK 5	AI Topical Day – Neural Networks and Computational Complexity

AGA

			Invited Talk
14:00	HSZ/0004	AGA 1.1	Acoustic, Seismic and Magnetic Detection of Banned Activities – 3.5 Decades of Physics-based Peace Research •Jürgen Altmann
			Sessions
14:00	HSZ/0004	AGA 1	Acoustic, Seismic and Magnetic Measurements
14:45	HSZ/0004	AGA 2	New Verification Concepts and Forensics
16:25	HSZ/0004	AGA 3	Simulation and Physics Teaching for Security and Disarmament

AGPhil

			Invited Talks
14:00	JAN/0027	AGPhil 5.1	Physical probability is relative frequency •Simon Saunders
14:45	JAN/0027	AGPhil 5.2	Locality and the Metaphysics of Many Worlds Quantum Mechanics •Alyssa Ney
16:00	JAN/0027	AGPhil 6.1	The structure of entangled properties: Distributional holism •Paul Näger

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AGPhil

			Sessions
11:00	JAN/0027	AGPhil 4	Quantum Foundations 1
14:00	JAN/0027	AGPhil 5	Quantum Foundations 2
16:00	JAN/0027	AGPhil 6	Quantum Foundations 3
18:00	JAN/0027	AGPhil 7	Members’ Assembly

10:00	Foyer Lecture Hall Centre	**Exhibition of Scientific Instruments and Literature**

			Max-von-Laue-Lecture (Evening Lecture)
20:00	HSZ/AUDI	PV XII	Max-von-Laue Lecture: Risikokompetenz – informiert und entspannt mit Risiken umgehen •Gerd Gigerenzer

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			Plenary Talks, Evening Talk, Prize Talk
09:00	HSZ/AUDI	PV XIII	The role of artificial intelligence in modern radiation therapy •Guillaume Landry
09:45	HSZ/AUDI	PV XIV	Machine Learning Advances in Particle Physics •Lukas Heinrich
12:30	HSZ/AUDI	PV XV	Direct dark matter detection: What if there's no WIMP? •Belina von Krosigk (Laureate of the Hertha-Sponer-Prize 2023)

EP

			Invited Talks
11:00	ZEU/0160	EP 10.1	Arne-Richter Lecture: From nonthermal plasmaastrophysics to modeling of pandemic outbreaks •Reinhard Schlickeiser
14:00	ZEU/0160	EP 11.1	Energetic Particle Precipitation reflected in the Global Secondary Ozone Distribution •Jia Jia
15:45	ZEU/0160	EP 12.1	Ultra-relativistic Electrons in the Earth's Van Allen Radiation Belts •Yuri Y. Shprits
17:30	ZEU/0160	EP 13.1	Time-dependent data analysis of a blazar flare •Maximilian Albrecht
			Sessions
11:00	ZEU/0160	EP 10	Astrophysics: Cosmic Rays and Galaxies I
14:00	ZEU/0160	EP 11	Near-Earth Space I
15:45	ZEU/0160	EP 12	Near-Earth Space II
17:30	ZEU/0160	EP 13	Astrophysics: Galaxies II

GR

			Invited Talks
11:00	ZEU/0260	GR 11.1	From quarks to black holes: micro- and macrophysics of neutron star mergers •Andreas Bauswein
11:45	ZEU/0260	GR 11.2	Tracing beyond GR physics with gravitational waves •Daniela Doneva
			Sessions
11:00	ZEU/0260	GR 11	Gravitational Waves and Astrophysics II
14:00	ZEU/0260	GR 12	Relativistic Astrophysics and Scalar Fields
16:00	ZEU/0260	GR 13	Relativity and Data Analysis
16:00	ZEU/0255	GR 14	Gravitational Waves II
18:30	ZEU/0260	GR 15	Members' Assembly

HK

			Sessions
11:00	HSZ/AUDI	HK 52	AI Topical Day – Invited Talks
14:00	HSZ/0103	HK 53	AI Topical Day – Computing II
14:00	HSZ/0105	HK 54	AI Topical Day – Heavy-Ion Collisions and QCD Phases XI
14:00	SCH/A251	HK 55	Instrumentation XIV
14:00	SCH/A.101	HK 56	Instrumentation XV
14:00	SCH/A316	HK 57	Hadron Structure and Spectroscopy VI
14:00	SCH/A419	HK 58	Hadron Structure and Spectroscopy VII
14:00	SCH/A118	HK 59	Structure and Dynamics of Nuclei XI
14:00	SCH/A215	HK 60	Structure and Dynamics of Nuclei XII
14:00	SCH/A117	HK 61	Structure and Dynamics of Nuclei XIII
14:00	SCH/A252	HK 62	Astroparticle Physics I
15:45	SCH/A251	HK 63	Instrumentation XVI
15:45	SCH/A.101	HK 64	Instrumentation XVII

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HK

15:45	SCH/A216	HK 65	Heavy-Ion Collisions and QCD Phases XII
15:45	SCH/A315	HK 66	Heavy-Ion Collisions and QCD Phases XIII
15:45	SCH/A316	HK 67	Hadron Structure and Spectroscopy VIII
15:45	SCH/A419	HK 68	Hadron Structure and Spectroscopy IX
15:45	SCH/A118	HK 69	Structure and Dynamics of Nuclei XIV
15:45	SCH/A215	HK 70	Structure and Dynamics of Nuclei XV
15:45	SCH/A117	HK 71	Structure and Dynamics of Nuclei XVI
15:45	SCH/A252	HK 72	Astroparticle Physics II
15:50	HSZ/0204	HK 73	Outreach Diverse
17:30	HSZ EG	HK 74	Poster
19:00	HSZ/0002	HK 75	Members’ Assembly

MP

Sessions

11:00	ZEU/0250	MP 9	AdS/CFT Correspondence and Hydrodynamic Transport
14:00	ZEU/0250	MP 10	AdS/CFT Correspondence II
16:00	ZEU/0250	MP 11	Quantum Field Theory III (QED and Particle Detection)
17:05	ZEU/0250	MP 12	Quantengravitation und Thermodynamik

P

Invited Talks

11:00	CHE/0089	P 13.1	Acceleration of spin-polarized ion beams from laser-plasma interaction •Lars Reichwein
11:00	CHE/0091	P 14.1	Experimental validation of turbulence codes •Klara Höfler
14:00	CHE/0089	P 15.1	Tumor irradiation in mice with a laser-accelerated proton beam •Florian Kroll
14:00	CHE/0091	P 16.1	Development of a Laser-based Diagnostic for in situ Monitoring of Fuel Retention in ITER and future fusion devices •Alexander Huber
17:30	CHE/0089	P 19.1	Numerical and experimental investigations of a linear microwave plasma source for metal foil pumps for DEMO •Stefan Merli
17:30	CHE/0091	P 20.1	Laser-Induced Breakdown Spectroscopy (LIBS) for the detection of hydrogen isotopes stored in high-Z metals tungsten and tantalum •Steffen Mittelmann

Sessions

11:00	CHE/0089	P 13	Laser Plasmas I
11:00	CHE/0091	P 14	Magnetic Confinement IV/HEPP VI
14:00	CHE/0089	P 15	Laser Plasmas II/Low Pressure Plasmas and their Applications II
14:00	CHE/0091	P 16	Plasma Wall Interaction II/Codes and Modeling I
15:45	CHE/0089	P 17	Complex Plasmas and Dusty Plasmas/Codes and Modeling II
15:45	CHE/0091	P 18	HEPP VII
17:30	CHE/0089	P 19	Magnetic Confinement V/HEPP VIII
17:30	CHE/0091	P 20	Laser Plasmas III/Codes and Modeling III
19:00	CHE/0089	P 21	Members’ Assembly

ST

Invited Talk

17:30	ZEU/0146	ST 10.1	Online-adaptive particle therapy: Current status and vision for the future •Christian Richter

Sessions

11:00	HSZ/AUDI	ST 7	AI Topical Day – Invited Talks
14:00	ZEU/0146	ST 8	AI Topical Day – AI in Medicine

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ST

15:50	ZEU/0146	ST 9	Radiation Therapy
17:30	ZEU/0146	ST 10	Keynote: Online-Adaptive Particle Therapy
18:00	ZEU/0146	ST 11	Prize Ceremony and Closing Session

T

			Invited Topical Talks
14:00	HSZ/0003	T 101.1	How to Study the Higgs Boson in its Bosonic Decays •Benedict Winter
14:20	HSZ/0003	T 101.2	Measuring *H —> WW* with the ATLAS Experiment •Carsten Burgard
14:40	HSZ/0003	T 101.3	Belle II opportunities in B-decays with invisible signatures •Slavomira Stefkova
15:00	HSZ/0003	T 101.4	Two Pieces of a Puzzle: Inclusive and Exclusive V cb •Markus Prim
14:00	HSZ/0004	T 102.1	Expanding the Frontiers of Galactic Neutrino Astronomy via Machine Learning •Mirco Hünnefeld
14:20	HSZ/0004	T 102.2	Enhancing the CMS Level-1 Trigger with real-time Machine Learning •Artur Lobanov
14:40	HSZ/0004	T 102.3	Higgsino Hunting at ATLAS •Michael Holzbock
15:00	HSZ/0004	T 102.4	New Ideas for Baryo- and Leptogenesis •Kai Schmitz
			Sessions
11:00	HSZ/AUDI	T 100	AI Topical Day – Invited Talks
14:00	HSZ/0003	T 101	Invited Topical Talks III-A
14:00	HSZ/0004	T 102	Invited Topical Talks III-B
15:45	HSZ/0004	T 103	AI Topical Day – Simulation, Inverse Problems and Algorithmic Development
15:50	HSZ/0304	T 104	Flavor VIII
15:50	HSZ/0401	T 105	Flavor IX
15:50	HSZ/0403	T 106	Searches IV
15:50	HSZ/0101	T 107	Searches – Neutrino at accelerators
15:50	HSZ/0103	T 108	Top, EW I
15:50	HSZ/0105	T 109	Higgs, Di-Higgs III
15:50	HSZ/0201	T 110	Other Theory
15:50	HSZ/0204	T 111	Outreach Diverse
15:50	HSZ/0301	T 112	DAQ Test/RO – GRID I
15:50	HSZ/0405	T 113	QCD Theory and Experiment II
15:50	POT/0051	T 114	Neutrinos V
15:50	POT/0151	T 115	Gamma Astronomy V
15:50	POT/0251	T 116	Neutrinos Legend, Neutrino Theory
15:50	POT/0361	T 117	Dark Matter I
15:50	POT/0006	T 118	Dark Matter II
15:50	POT/0112	T 119	Neutrino Astronomy IV
15:50	POT/0013	T 120	Cosmic Ray V
15:50	POT/0351	T 121	Cosmic Ray VI
15:50	POT/0106	T 122	DAQ Systems
15:50	WIL/A317	T 123	Pixel/Belle II, Si/Other
15:50	WIL/A124	T 124	Si-Strip/CMS, Pixel/DMAPS
15:50	WIL/C133	T 125	Calorimeter / Detector Systems V
15:50	WIL/A120	T 126	Gas-Detecors, Detector Systems
15:50	WIL/C129	T 127	Exp. Methods III
17:30	HSZ/0004	T 128	AI Topical Day – New Methods
17:30	HSZ/0304	T 129	Flavor X
17:30	HSZ/0401	T 130	Top II
17:30	HSZ/0403	T 131	Searches V
17:30	HSZ/0101	T 132	Searches VI
17:30	HSZ/0103	T 133	Top, EW II

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T

17:30	HSZ/0105	T 134	Higgs, Di-Higgs IV
17:30	HSZ/0201	T 135	Top Mass, Top BSM
17:30	HSZ/0204	T 136	Higgs TH, VH
17:30	HSZ/0301	T 137	DAQ Test/RO – GRID II
17:30	HSZ/0405	T 138	QCD Experiment III
17:30	POT/0051	T 139	Neutrinos VI
17:30	POT/0151	T 140	Gamma Astronomy VI
17:30	POT/0251	T 141	Neutrino Astronomy V
17:30	POT/0361	T 142	Neutrinos, Dark Matter XI
17:30	POT/0006	T 143	Neutrinos VII
17:30	POT/0013	T 144	Cosmic Ray VII
17:30	POT/0351	T 145	Cosmic Ray VIII
17:30	POT/0106	T 146	DAQ Systems, Exp. Methods
17:30	WIL/A317	T 147	Pixel/HV-Maps, Si/Diamond
17:30	WIL/A124	T 148	Si/SiPM, Pixel/Other
17:30	WIL/C133	T 149	Detector Systems / Muon
17:30	WIL/A120	T 150	Gas-Detecors, Pixel/TANGERINE
17:30	WIL/C129	T 151	Exp. Methods IV
20:00	HSZ/0003	T 152	Members' Assembly

UP

Invited Talks

11:00	MOL/0213	UP 7.1	Towards monitoring of anthropogenic greenhouse gas emissions from satellites •Hartmut Bösch
14:00	MOL/0213	UP 8.1	Destabilization of carbon in tropical peatlands by enhanced weathering •Alexandra Klemme
14:30	MOL/0213	UP 8.2	Widespread forest decline in central Europe following three extreme summers in 2018-2020 •Ana Bastos

Sessions

11:00	MOL/0213	UP 7	Greenhouse Gases: Remote Sensing
14:00	MOL/0213	UP 8	Carbon Cycle & Climate Change

AKBP

Prize Talks

14:00	HSZ/0304	AKBP 13.1	TBA •Carl A. Lindström (Laureate of the DPG-Nachwuchspreis für Beschleuniger-physik)
14:45	HSZ/0304	AKBP 13.2	TBA •Ferdinand Willeke (Laureate of the Horst-Klein-Forschungspreis)

Sessions

11:00	HSZ/AUDI	AKBP 12	AI Topical Day – Invited Talks
14:00	HSZ/0304	AKBP 13	Preisverleihung des AKBP Nachwuchspreises und des Horst-Klein Preises
15:30	CHE/0183	AKBP 14	Instrumentation II
15:30	CHE/0184	AKBP 15	New Accelerator Concepts
15:45	HSZ OG3	AKBP 16	Poster
17:30	CHE/0183	AKBP 17	Instrumentation III
17:30	CHE/0184	AKBP 18	Beam Dynamics II
19:00	CHE/0091	AKBP 19	Members' Assembly

AKjDPG

Invited Talk

16:00	ZEU/0148	AKjDPG 1.4	Open data and open-source tools throughout research data life cycle: KCDC example •Victoria Tokareva

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AKjDPG

			Session
14:00	ZEU/0148	AKjDPG 1	Hacky Hour

AKPIK

			Invited Talks
11:00	HSZ/AUDI	AKPIK 6.1	AI Techniques for Event Reconstruction •Ivan Kisel
11:30	HSZ/AUDI	AKPIK 6.2	Accelerator operation optimisation using machine learning •Pierre Schnizer
12:00	HSZ/AUDI	AKPIK 6.3	Is this even physics? – Progress on AI in particle physics •Gregor Kasieczka
			Sessions
11:00	HSZ/AUDI	AKPIK 6	AI Topical Day – Invited Talks
14:00	HSZ/0101	AKPIK 7	AI Topical Day – Research Data Management and Medical Applications
15:45	HSZ/0004	AKPIK 8	AI Topical Day – Normalizing Flows and Invertible Neural Networks
17:30	HSZ/0004	AKPIK 9	AI Topical Day – New Methods
14:00	HSZ/0103	AKPIK 10	AI Topical Day – Computing II
14:00	ZEU/0146	AKPIK 11	AI Topical Day – AI in Medicine
14:00	HSZ/0105	AKPIK 12	AI Topical Day – Heavy-Ion Collisions and QCD Phases

AGA

			Invited Talks
14:00	HSZ/0002	AGA 4.1	Mass Starvation? Impacts of Nuclear War on Climate Change and Food Security •Lili Xia
15:45	HSZ/0002	AGA 5.1	Nuclear forensic science – when nuclear scientists and law enforcement meet •Maria Wallenius
16:30	HSZ/0002	AGA 5.2	Applied Physics in the Alva Myrdal Centre for Nuclear Disarmament: Non-Proliferation and Safeguards Activities •Sophie Grape
			Sessions
14:00	HSZ/0002	AGA 4	Nuclear Weapons and the Atmosphere
15:45	HSZ/0002	AGA 5	Applied Nuclear Physics
17:30	HSZ/0002	AGA 6	Members’ Assembly

AGI

			Invited Talks
11:00	ZEU/0148	AGI 1.1	Programming and Computational Physics Education in the Physics Curriculum at University of Göttingen •Fabian Heidrich-Meisner
11:30	ZEU/0148	AGI 1.2	Integrating Digitalization and Research Data Management (RDM) into the Curricula of Bachelor and Master Students in Chemistry •Fabian Fink
12:00	ZEU/0148	AGI 1.3	News from PUNCH4NFDI: Education of students •Carsten Burgard
			Sessions
11:00	ZEU/0148	AGI 1	Data Literacy in the Physics Curriculum
14:00	ZEU/0148	AGI 2	Hacky Hour

AGPhil

			Invited Talks
11:00	JAN/0027	AGPhil 8.1	Interpreting Quantum Mechanics on an Informational Approach •Michael Cuffaro

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AGPhil

11:45	JAN/0027	AGPhil 8.2	Does science need intersubjectivity? The problem of confirmation in orthodox interpretations of quantum mechanics •Emily Adlam
			Sessions
11:00	JAN/0027	AGPhil 8	Quantum Foundations 4
14:00	JAN/0027	AGPhil 9	Quantum Foundations 5
16:15	JAN/0027	AGPhil 10	Quantum Foundations Poster Session

10:00	Foyer Lecture Hall Centre	**Exhibition of Scientific Instruments and Literature**

			Public Evening Lecture
20:00	HSZ/AUDI	PV XVI	Von Sachsen ins Universum •Christian Stegmann

Friday, March 24, 2023

			Plenary Talks, Prize Talk
09:00	HSZ/AUDI	PV XVII	The Einstein Telescope •Harald Lück
09:45	HSZ/AUDI	PV XVIII	The LHC legacy and prospects •Markus Klute
13:00	HSZ/AUDI	PV XIX	The science and technology of DUNE and its future as an international neutrino observatory •Stefan Söldner-Rembold (Laureate of the Max-Born-Prize 2023)

EP

			Invited Talk
11:00	HSZ/0004	EP 14.1	Unveiling the secrets of hot, massive stars with modern stellar atmosphere models •Andreas A C Sander
			Sessions
11:00	HSZ/0004	EP 14	Astrophysics: Stellar Astrophysics
14:00	HSZ/0004	EP 15	Astrophysics: Cosmology

GR

			Session
11:00	HSZ/0401	GR 16	Experimental Tests

HK

			Invited Talks
11:00	HSZ/0002	HK 76.1	Thermalization of heavy quarks in the QGP •Federica Capellino
11:30	HSZ/0002	HK 76.2	Hadron structure in Lattice QCD •Konstantin Ottnad
12:00	HSZ/0002	HK 76.3	LISA: LIfetime measurements with Solid Active targets •Kathrin Wimmer
			Session
11:00	HSZ/0002	HK 76	Invited Talks IV

T

			Invited Talks
11:00	HSZ/AUDI	T 153.1	The Standard Model on the test bench: What bosons and the top quark (will) tell us •Valerie Lang
11:30	HSZ/AUDI	T 153.2	Gravitational wave observations: Current results & future expectations •Harald Pfeiffer
12:00	HSZ/AUDI	T 153.3	Precise muon detection: novel technologies for the luminosity frontier •Kerstin Hoepfner
13:30	HSZ/AUDI	T 154.1	ECN3: Experimental Opportunities at a Future High-Intensity Proton Facility at the CERN SPS (BDF/SHiP and HIKE+SHADOWS) •Annika Hollnagel
			Sessions
11:00	HSZ/AUDI	T 153	Invited Overview Talks III
13:30	HSZ/AUDI	T 154	Invited Overview Talks IV

Friday, March 24, 2023

AGA

			Invited Talks
13:00	HSZ/0002	AGA 7.1	Fireworks or Threat? – Recent Missile Developments in North Korea •Markus Schiller
13:45	HSZ/0002	AGA 7.2	The Challenge of Nuclear-Powered Submarines to IAEA Safeguards •Tariq Rauf
			Sessions
13:00	HSZ/0002	AGA 7	Proliferation Challenges
14:50	HSZ/0002	AGA 8	Mathematical Modelling of Conflicts

AGPhil

			Session
10:45	HSZ/0304	AGPhil 11	Quantum Mechanics, Philosophy and Information

Deutsche Physikalische Gesellschaft DPG

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Physics in the Future

March 20-24, 2023

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Tell us your vision - only time will tell if it comes true.

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Plenary, Prize, Ceremonial, Lunch, and Evening Talks

Plenary Talk PV I Mon 9:00 HSZ/AUDI

Low Temperature Plasma – About a Hidden Champion or a Silent Revolution — •Klaus-Dieter Weltmann, Thomas von Woedtke, Jürgen F. Kolb, Torsten Gerling, and Angela Kruth — Leibniz Institute for Plasma Science and Technology, Greifswald, Germany

The plenary lecture presents an overview of the achievements and future potentials of low-temperature plasma physics and technology. Such plasmas are particular states of matter consisting of neutral, ionized and excited species, free electrons as well as radicals, photons and excited species. While the electrons have a mean energy of a few eV to 10 eV, the temperature of the heavy species is several orders of magnitude lower. These properties make them very attractive for applications. The fundamental knowledge gained so far supported the worldwide boom in the automotive industry, lighting, materials processing, optics, electronics, textile processing, and other fields. Basic research is the common prerequisite for the successful development of processes, technologies and products. Low-temperature plasma physics has steadily opened up new fields. It belongs to the cross-cutting technologies. In this contribution, the opening to new and interdisciplinary research topics is demonstrated by the example of plasma medicine. In particular, the research and development of plasma sources and their transfer into medical practice is reported. Low-temperature plasmas will play an important role to face ”older” and new scientific challenges by interdisciplinary approaches, representing a renewed growth opportunity for the plasma community.

Plenary Talk PV II Mon 9:45 HSZ/AUDI

Thin film technology for fabrication of nonlinear active optical components and its future application in photonic circuits — •Marco Jupe — Laser Zentrum Hannover e.V., Hollerithallee 8, 30419 Hannover

The development of optical components is currently at a point where traditional concepts need to be extended. In particular, applications in the field of communications as well as highly innovative approaches for photonic quantum computing and quantum communications require not only high optical performance but also massive parallelization. Such concepts can only be sensibly implemented if the integration density of the optical circuits is massively increased. Concepts such as those used in telecommunications applications also appear to be target-oriented for applications in quantum technology. In addition to the ”traditional” passive components, which are just as indispensable here as in classical signal processing, there is an increasing demand for ultra-fast active components. Such components must integrate seamlessly into the concepts. The mass market suitability of current solutions is a particular challenge that should not be underestimated. For this reason, various institutes are working on such components in particular. The presentation gives an overview of the components that are already established and new concepts especially in combination with interference films like FTMs for the frequency tripling, and Kerr band switches for fast optical switches, as well as for electro-optical components using Pockels effect.

Prize Talk PV III Mon 12:30 HSZ/AUDI

Two milestones in the life of the Universe: Last Scattering Surface and Black Body Photosphere — •Rashid Sunyaev — Max Planck Institute for Astrophysics — Institute for Advanced Study, Princeton — Laureate of the Max-Planck-Medal 2023

Our Universe is filled by cosmic microwave background (CMB) radiation which is extremely isotropic and has an excellent black body spectrum with a temperature of 2.7 Kelvin, and no spectral deviations from the blackbody have yet been detected in the CMB monopole.

However, the theory of Thomson scattering by hot Maxwellian electrons predicts the shadows of the CMB toward galaxy clusters filled with dark matter and hot gas. This prediction (thermal SZ effect) dates back to 1970, and only in 2011, the first three unknown galaxy clusters were discovered using this method. Now many thousands of galaxy clusters are being discovered using such shadows. Any energy release in the early Universe (due to the decay or annihilation of unknown particles, dissipation of the low-scale density perturbations due to radiative viscosity, etc, hydrogen recombination at redshift 1300) should lead to the CMB spectral distortions. Detecting such specific spectral deviations is one of the key goals of microwave radioastronomy.

There are other theoretical predictions that led to the experimental discovery of the “acoustic peaks” in the power spectrum of the CMB angular fluctuations and enabled the measurement of key parameters of our universe with unprecedented accuracy. The kinematic SZ effect enabled the measurement of galaxy cluster velocities relative to the local coordinate system in which the CMB is isotropic. The kSZ effect permitted the proof of Copernicus’ principle up to redshift z~2, where the most distant galaxy clusters and protoclusters are observed.

A decrease in the CMB temperature in the course of the Universe expansion leads to the recombination of hydrogen, transparency of the Universe for photons, and appearance of the “surface of the last scattering”. The “acoustic peaks” are formed due to the presence of this surface. The recombination rate (and the effective thickness of this “surface”) is determined by the two-photon decay of the 2s level of the hydrogen atom.

Emission of low-frequency photons due to the double Compton effect and their redistribution along the spectrum due to multiple Thomson scatterings on hot electrons manage to maintain the blackbody spectrum while the redshift exceeds z=2 million. This value determines the position of the “blackbody photosphere” of the Universe. Spectral distortions of the CMB can be observed only if the energy release occurred at redshifts of less than 2 million.

Plenary Talk PV IV Tue 9:00 HSZ/AUDI

Characterising exoplanet atmospheres with the Webb space telescope — •Pierre-Olivier Lagage — CEA Paris-Saclay, Gif-sur-Yvette, France

Thanks to its large collecting area (25 square meters) and its large wavelength coverage (0.6 * 28 microns), the Webb space telescope is a game changer. In the exoplanet domain, it takes us right into what can be called the second chapter of the study of exoplanets: the characterization of their atmosphere (atomic and molecular composition, presence of hazes and clouds, vertical temperature-pressure profile, presence of zonal circulation, just to name a few). Such information is needed to test and improve the chemistry and dynamics incorporated in the atmospheric models applied to alien worlds which have no equivalent in the Solar System. Two types of observations are in use: direct imaging thanks to coronagraphic observations and spectroscopic observations of transiting exoplanets. A large diversity of exoplanets, ranging from giant exoplanets with masses several times that of Jupiter to Earth-sized rocky exoplanets, has started to be characterized. In this talk, I will discuss the first results, which are remarkable, and show the great perspectives in front of us.

Plenary Talk PV V Tue 9:45 HSZ/AUDI

The European Destination Earth initiative – a paradigm change for weather and climate prediction — •Peter Bauer — ECMWF, Reading, UK

Destination Earth is a new European Commission funded activity to create a so-called digital twin of the Earth. Digital twins create unprecedented opportunities to generate and interact with highly realistic digital replica created from the combination of computer simulations and observations. Destination Earth’s primary focus is on the use of twinning for dealing responsibly with extreme weather and climate change.

Weather and climate prediction are high-performance computing and big data applications with outstanding societal and economic impact ranging from the daily decision-making of citizens to that of civil services for emergency response, and from predicting environmental impacts on food, agriculture and energy markets as well as for risk and loss management by insurances. The uncertain evolution of weather extremes with climate change adds significant political pressure to accelerate scientific development and turn science into societal benefit.

Destination Earth is the result of a decade worth of planning by leading European climate, geoscience and computing scientists. The activity will create a new information system in support of the European Green Deal and Digital Strategy.

Prize Talk PV VI Tue 12:30 HSZ/AUDI

The Higgs boson at the (HL)LHC – precisely! — •Adinda de Wit — Universität Zürich, Switzerland — Laureate of the Hertha-Sponer-Prize 2023

In the ten years since the discovery of the Higgs boson, the precision on its cross section and property measurements has continued to increase. In this talk, the latest measurements, their prospects, and how they could help us find new physics, will be discussed.

As the CMS and ATLAS experiments prepare to upgrade their detectors, we will also look towards the future of Higgs physics at the HL-LHC.

PV VII: Ceremonial Session with Award Ceremony

Time: Tuesday 14:00–16:30 Location: HSZ/AUDI

Ceremonial Talk PV VII HSZ/AUDI

The once unattainable – new breakthroughs in particle physics — •Monica Dunford — Kirchhoff-Institut für Physik (KIP), Ruprecht-Karls-Universität Heidelberg

The dynamics of the Standard Model of particle physics play a central role in the properties of not only the microscopic world but also the biggest structures of our universe. The Higgs boson, for example, plays a critical part in how particles obtain their masses but also perhaps to dark matter and how our universe evolved. In this talk, I will focus on a handful of recent developments in particle physics that were considered out of reach, but through innovative ideas and powerful data science are now attainable. I will highlight how these results have connections beyond the microscopic world to dark matter, matter and anti-matter differences and beyond.

Plenary Talk PV VIII Wed 9:00 HSZ/AUDI

25 years of the AdS/CFT correspondence: Current status and future prospects — •Koenraad Schalm — Institute Lorentz, Leiden University, Leiden, The Netherlands

Maldacena's 1997 discovery that certain gauge theories have an equivalent description in terms of anti-de-Sitter quantum gravity in one extra dimension has led to several dramatic new physics insights. Three of these are: 1) From the gauge theory perspective the gravitational force is emergent and recent research on black holes and wormholes has elucidated that this is best phrased in terms of quantum entanglement. 2) The classical gravity limit dual to strongly coupled physics has a universal hydrodynamic limit at low energies. This fluid/gravity aspect has shed new light on the century-old physics of fluids from computational control to non-thermal fixed points. 3) Finally in context of condensed matter physics AdS/CFT indicated the existence of novel IR fixed points, subsequently validated in Sachdev-Ye-Kitaev models. Moreover, these fixed points are strong candidates to explain high Tc superconductors. We review each briefly and discuss how these new insights can point the way for current experiments as well as possibly test quantum gravity holographically in the lab.

Plenary Talk PV IX Wed 9:45 HSZ/AUDI

The origin of the chemical elements — •Marialuisa Aliotta — School of Physics and Astronomy, University of Edinburgh, EH9 3FD Edinburgh, UK

Questions around the composition and origin of our material world have fascinated mankind since ancient times, but it wasn't until the advent of the Mendeleev's periodic table in 1869 that it became clear how ordinary matter is made up of a finite number of different building blocks, the chemical elements. Yet, deeper questions remained: where, when, and how did the chemical elements originate?

These questions are still at the core of nuclear astrophysics research today. Thanks to the advances of the last century and to the interplay of astronomical observations, nuclear physics experiments, and astrophysical models of stellar evolution and nucleosynthesis, we now know that only hydrogen, helium and few other light species were produced during the first few minutes of existence of the Universe, while all other elements, from carbon to gold, to uranium, were (and still are!) forged through nuclear reactions in different stages of stellar evolution.

In my talk, I will present an overview of the main processes responsible for the creation of the elements and recall the astrophysical sites in which these processes occur. I will also address the experimental challenges that we face in replicating stellar reactions on Earth in our attempt to reveal the origin of every chemical element and the intimate connection we bear with long-gone stars.

Prize Talk PV X Wed 12:30 HSZ/AUDI

News from the Flavour Expedition to the Zeptouniverse — •Andrzej Buras — TUM Institute for Advanced Study (IAS) , Garching, Germany — Laureate of the Max-Planck-Medal 2020

After finding an important cornerstone of the Standard Model (SM) through the Higgs discovery, particle physicists are waiting for the discovery of new particles either directly with the help of the Large Hadron Collider (LHC) and its upgrade (HL-LHC) or indirectly with the help of experiments like LHCb, NA62 and Belle II through quantum fluctuations causing certain rare processes with a change of quark flavour to occur at different rates than predicted by the SM. While the latter route is very challenging, requiring very precise theory and experiment, it allows the resolution of short distance scales as short as the Zeptometer corresponding to energies of order 100 TeV or even shorter scales. In the coming flavour precision era, in which the accuracy of the measurements of rare processes and of the relevant theory calculations will be significantly improved, this goal could be reached. The main strategies for reaching this goal will be explained in simple terms including the most recent advances. We will summarize the present status of deviations from SM predictions for a number of flavour observables and discuss possible explanations of these so-called anomalies. A short outlook for coming years will be given.

Lunch Talk PV XI Wed 13:15 HSZ/AUDI

From ab initio to nemo tenetur – Working on cyber crime as an IT analyst with the State Criminal Police Office — •Wojciech Morawiec — LKA Rheinland-Pfalz

While many workplaces pride themselves with providing 'unique challenges every day', I believe that working in law enforcement is one of the rare fields where this statement might be true for the whole length of one's career. As an IT analyst with the Landeskriminalamt Rheinland-Pfalz, the State Criminal Police Office of Rhineland-Palatinate, one faces new and complicated puzzles almost daily. Solving these puzzles, doing proper documentation on them and explaining the results to detective colleagues and later to the prosecutor's office lie at the core of the support of ongoing investigations. Additionally there is some research-like work, where new tools, tactics and procedures have to be developed to expand the possibilities of the state police.

In this talk, after giving an overview of the legal framework, I would like to present how an analyst might work on a fictitious case to collect evidence pointing towards the perpetrator of a cyber crime. While there are no differential equations to solve and also no density functional theory simulations to run in such a case, a strong analytical mindset and simple procedures in data analysis can greatly improve the end result of an investigation.

Evening Talk PV XII Wed 20:00 HSZ/AUDI

Max-von-Laue Lecture: Risikokompetenz – informiert und entspannt mit Risiken umgehen — •Gerd Gigerenzer — Direktor des Harding-Zentrums für Risikokompetenz an der Universität Potsdam — Direktor emeritus des Forschungsbereichs „Adaptive Behavior and Cognition“ (ABC) am Max-Planck-Institut für Bildungsforschung, Berlin

In dieser Welt ist nichts gewiss, außer dem Tod und den Steuern – so schrieb Benjamin Franklin vor mehr als 200 Jahren. Dennoch suchen noch heute Menschen nach Gewissheiten die nicht existieren und vertrauen auf Horoskope und Marktvorhersagen. Statt der Illusion der Sicherheit und dem Wunsch nach Nullrisiko braucht eine lebendige Demokratie Menschen, die kompetent und entspannt statt ängstlich und verunsichert mit Risiken umgehen können. Risikokompetenz kann man lernen – und darüber geht dieser Vortrag.

Risikokompetenz ist die Fähigkeit, die Gefahren und Möglichkeiten einer technologischen Welt zu verstehen statt diese zu verdrängen, und mit Unsicherheit emotional entspannt leben zu lernen. Unsere Gesellschaft ist von einem rationalen Umgang mit Risiken noch weit entfernt, ein Zustand, der jedes Jahr beträchtliche finanzielle Mittel, Ängste und das Leben von Bürgern kostet. In diesem Vortrag berichte ich über die mangelnde Fähigkeit von Ärzten, Richtern, Journalisten und Politikern, Risiken zu verstehen und zu kommunizieren. Dann zeige ich anhand meiner Forschung, wie man mit nachhaltigen Methoden diese allgemeine Konfusion in Einsicht verwandeln kann.

Plenary Talk PV XIII Thu 9:00 HSZ/AUDI

The role of artificial intelligence in modern radiation therapy — •Guillaume Landry — Department of Radiation Oncology, University Hospital, LMU Munich, Munich, Germany

As in many other fields, artificial intelligence (AI) has found applications in radiation therapy. By now, the most widespread use of AI is for the automatic delineation of organs on computed tomography or magnetic resonance images of the patient, which serve as basis for radiation delivery planning. For this task, the ubiquitous U-net convolutional neural network has been widely adopted, and several commercial solutions are available. Just as AI is continuously evolving, radiation therapy has seen exciting developments, notably the clinical introduction of online adaptive radiotherapy at MR-linacs, which allows daily plan adaptation and tumor tracking using cine-MRI. MR guided radiotherapy (MRgRT) is ideally suited for the adoption of AI methods, since it generates large amounts of data with imaging at every fraction, and there is a need to reduce the time patients spend in the MR-linac bore waiting for plan adaptation. Thus, besides automatic segmentation, in MRgRT AI may allow to generate pseudo-CT images from MR images and to help track and predict tumor motion on cine-MRI. Even for segmentation, some specific approaches such as patient-specific model fine tuning may find a role in MRgRT. Finally, for radiotherapy in general, AI may allow to correlate imaging and treatment outcomes.

Plenary Talk PV XIV Thu 9:45 HSZ/AUDI

Machine Learning Advances in Particle Physics — •Lukas Heinrich — Technical University of Munich

The year 2012 has been marked by two breakthroughs in science. One is very familiar to particle physicists: the discovery of the Higgs. The other would would soon capture the attention of scientists and non-scientists alike: the breakthrough of deep learning which started with the "AlexNet" moment and kicked off a decade of impressive advancements in a wide range of domains, including fundamental physics. However, applications in fundamental physics must go beyond black-box point prediction and typically enable a rich interpretation of the data, including robustness to systematic uncertainties, interpretability and optimization with respect to multiple possibly competing objectives. In this talk I will review recent successes in ML that proved impactful within the context of fundamental physics and discuss future directions including differentiable and probabilistic programming, foundation models and fast simulation.

Prize Talk PV XV Thu 12:30 HSZ/AUDI

Direct dark matter detection: What if there's no WIMP? — •Belina von Krosigk — Karlsruhe Institute of Technology, Institute for Astroparticle Physics, Eggenstein-Leopoldshafen, Germany — Laureate of the Hertha-Sponer-Prize 2023

More than a century has passed since the first hint of the existence of dark matter in the Universe. This hint has since been corroborated by a plethora of further astronomical observations revealing that even most of the matter in the Universe is dark. Observing the respective dark matter particles, and elucidating their nature, became one of the most tantalizing endeavors of modern physics, with the Weakly Interacting Massive Particle (WIMP) being a prime suspect. Tremendous experimental efforts and successes have allowed a large portion of the WIMP parameter space to be explored in recent decades, with optimized experiments for direct dark matter detection taking the lead in these searches. But no WIMP in sight thus far. Today, a new generation of highly sensitive, large-scale direct detection experiments is at the ready to observe WIMPs, and their successors are already being planned. But what if there's no WIMP? This talk will discuss the diversity of the worldwide direct dark matter search program beyond the traditional WIMP and provide a glimpse of where the near future will take us in this effort to directly observe dark matter in the laboratory.

Evening Talk PV XVI Thu 20:00 HSZ/AUDI

Von Sachsen ins Universum — •Christian Stegmann — Deutsches Elektronen-Synchrotron DESY, Zeuthen

Forschende teilen Wissenschaft in Disziplinen auf, die Natur tut das nicht. Astronomie, Astrophysik, Astroteilchenphysik und Kern- und Teilchenphysik haben in den vergangenen Jahren neue Fenster in unser Universum geöffnet. Von den kleinsten bis zu den größten Abständen, von den Anfängen des Universums bis heute, haben sie unser Verständnis der Welt geprägt. Neue Observatorien werden uns noch tiefer in unser Universum blicken lassen. Sie bieten die Chance, Perspektiven zu verbinden und Antworten auf Fragen nach dem Ursprung und der Entwicklung des Universums zu liefern – mit viel „irdischem" Potenzial.

Im September vergangenen Jahres haben die Bundesrepublik Deutschland und der Freistaat Sachsen als Ergebnis des größten offenen Wissenschaftswettbewerbs in der Geschichte Deutschlands entschieden, in der Lausitz das Deutsche Zentrum für Astrophysik zu errichten. Eine Investition in dieser Größenordnung in Grundlagenwissenschaft – das ist bemerkenswert. Sie zeigt nicht nur die große Faszination, die Astronomie und Astrophysik ausüben, sondern auch, dass sie ganz konkret wichtige technologische und innovative Impulse setzen können und einen nachhaltigen Strukturwandel in der Lausitz, einer Region im Zentrum Europas, ermöglichen.

Der Vortrag nimmt Sie mit in die Weiten unseres Universums, in die Vergangenheit bis zum Tag, der kein Gestern hatte und eine Zukunft mit großen Chancen für Innovationen in Technologie und Digitalisierung.

Plenary Talk PV XVII Fri 9:00 HSZ/AUDI

The Einstein Telescope — •Harald Lück — Institut für Gravitationsphysik, Leibniz Universität Hannover und Max-Planck Institut, Hannover

The detections of gravitational waves with the current gravitational wave detectors enabled us to eavesdrop on hidden processes in the universe and obtain information about processes that we cannot see with other methods. They marked the beginning of gravitational astronomy. But we are only at the beginning of this new era. We know how to build new instruments with even better sensitivity that will allow us to listen out into the early times of the universe and constantly register the quiver of spacetime caused by a vast number of sources. With the Einstein Telescope, we want to build such an instrument in Europe. Bigger than before, more sensitive, underground and definitely cool. I will report on the plans and the current state of developments.

Plenary Talk PV XVIII Fri 9:45 HSZ/AUDI

The LHC legacy and prospects — •Markus Klute — KIT, Karlsruhe, Germany

The Large Hadron Collider (LHC) at CERN has had two successful and highly productive runs (2009-2013 and 2015-2018), colliding protons and heavy ions with center-of-mass energies of up to 13 TeV and collecting an unprecedented amount of data. Its highlight, the Higgs Boson discovery in 2012, completed the Standard Model of fundamental particle interactions. The particle physics world has changed dramatically in the last decade. While the impact of the collected data has been tremendous, many open questions in the world of elementary particle physics remain. I will review the main conclusions from the LHC to date and present the prospects of the LHC program and beyond.

Prize Talk PV XIX Fri 13:00 HSZ/AUDI

The science and technology of DUNE and its future as an international neutrino observatory — •Stefan Söldner-Rembold — University of Manchester, United Kingdom — Laureate of the Max-Born-Prize 2023

The preponderance of matter over antimatter in the early universe, the dynamics of the supernovae that produced the heavy elements necessary for life, the search for physics beyond the standard model – these mysteries at the forefront of particle physics and astrophysics are key to understanding the evolution of our universe. DUNE is an international neutrino experiment dedicated to addressing these questions as it searches for leptonic charge-parity symmetry violation, stands ready to capture supernova neutrino bursts, test the three-flavour paradigm and search for new physics. To achieve its science goals, it will employ the technology of liquid-argon time projection chambers at an unprecedented scale and precision. DUNE will comprise a far detector located at the SURF laboratory in South Dakota and a near detector close to the neutrino beam source at Fermilab near to Chicago. The presentation will introduce the science and technology of DUNE and discuss the status of the international project.

Symposium SMuK Dissertation Prize 2023 (SYMD)

jointly organised by
the divisions of the Matter and Cosmos Section (SMuK)

Claus Lämmerzahl
ZARM, Universität Bremen
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The Matter and Cosmos Section, with its divisions Extraterrestrial Physics (EP), Gravitation and Relativity (GR), Hadronic and Nuclear Physics (HK), Theoretical and Mathematical Physics (MP), Plasma Physics (P), Radiation and Medical Physics (ST), and Particle Physics (T), awards a dissertation prize in recognition of outstanding research in the context of a doctoral thesis and its excellent communication. The award committee selects up to four candidates from the nominations who will present their doctoral theses at this symposium.

Overview of Invited Talks and Sessions

(Lecture hall HSZ/AUDI)

Sessions

SYMD 1	Mon	14:00–16:00	HSZ/AUDI	**SMuK Dissertation Prize 2023**

The abstracts of the talks of the candidates will be published at https://www.dpg-verhandlungen.de prior to the conference.

Sessions

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SYMD 1: SMuK Dissertation Prize 2023

Time: Monday 14:00–16:00 Location: HSZ/AUDI

The abstracts of the candidates will be published at https://www.dpg-verhandlungen.de prior to the conference.

Symposium Strange Clouds – from the Earth to Exoplanets (SYSC)

jointly organised by
the Environmental Physics Division (UP) and
the Extraterrestrial Physics Division (EP)

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Clouds serve an essential purpose in the Earth's lower atmosphere due to their impact on the radiative balance of the atmosphere. Clouds are found also in other planetary atmospheres throughout the solar system and even on exoplanets, and those clouds can differ strongly in their chemical composition from Earth's water/ice clouds. This session provides a forum on the fascinating properties of these "strange clouds": clouds in planetary atmospheres that differ from the ordinary clouds in the Earth's troposphere.

Overview of Invited Talks and Sessions

(Lecture hall HSZ/0004)

Invited Talks

SYSC 1.1	Tue	11:00–11:20	HSZ/0004	**Not all clouds are created equal – strange clouds in our solar system** — •Thomas Leisner
SYSC 1.2	Tue	11:20–11:45	HSZ/0004	**Clouds to the Edge of Space** — •Gerd Baumgarten, Ronald Eixmann, Jens Fiedler, Michael Gerding, Mykhaylo Grygalashvyly, Franz-Josef Lübken, Ashique Vellalassery, Christian von Savigny, Robin Wing
SYSC 1.3	Tue	11:45–12:10	HSZ/0004	**The dynamic clouds of Venus** — •Javier Peralta
SYSC 1.4	Tue	12:10–12:35	HSZ/0004	**Observational constraints of exoplanet clouds** — •Nicolas Iro
SYSC 1.5	Tue	12:35–13:00	HSZ/0004	**Gemstone clouds in JWST target exoplanets** — •Dominic Samra, Christiane Helling

Sessions

SYSC 1.1–1.5	Tue	11:00–13:00	HSZ/0004	**Strange Clouds – From the Earth to Exoplanets**

Sessions

– Invited Talks –

SYSC 1: Strange Clouds – From the Earth to Exoplanets

Time: Tuesday 11:00–13:00 Location: HSZ/0004

Invited Talk SYSC 1.1 Tue 11:00 HSZ/0004

Not all clouds are created equal - strange clouds in our solar system — •Thomas Leisner — Institut für Meteorologie und Klimaforschung, Karlsruher Institut für Technologie — Institut für Umweltphysik, Universität Heidelberg

We are accustomed to the appearance of liquid water and ice clouds in the Earth's atmosphere. This contribution introduces clouds in other parts of the solar system and discusses how their appearance and optical properties are shaped by the thermodynamic and microphysical boundary conditions in these worlds.

Invited Talk SYSC 1.2 Tue 11:20 HSZ/0004

Clouds to the Edge of Space — •Gerd Baumgarten[1], Ronald Eixmann[1], Jens Fiedler[1], Michael Gerding[1], Mykhaylo Grygalashvyly[1], Franz-Josef Lübken[1], Ashique Vellalassery[1], Christian von Savigny[2], and Robin Wing[1] — [1]Leibniz Institute of Atmospheric Physics at the University of Rostock — [2]Institute of Physics, University of Greifswald

While the troposphere is rich of clouds, the stratosphere and mesosphere is virtually free of clouds. Two examples of strange clouds above the troposphere are Polar Stratospheric Clouds (PSC) and Noctilucent Clouds (NLC). Extraterrestrial sources or space traffic may lead to cases of clouds that quickly disappear. Because of their importance to society, these strange clouds have attracted great interest. For example, PSC are responsible for Ozone destruction following polar winter, ultimately leading to the Ozone hole. NLC are a one-of-a-kind source of information from the Edge of Space, at an altitude of 85 km, dating back to 1885. Only a few lidar instruments are capable of observing NLC, and only the RMR lidar at the ALOMAR observatory in northern Norway is using three different wavelengths. We make use of these multicolor observations to understand microphysical processes in clouds. A new instrument setup in Kühlungsborn allows studying NLC with subsecond resolution and in 3 different directions, allowing to investigate their morphology which reveals atmospheric motion in the transition region of waves to turbulence. We will present strange clouds observed by lidars above Northern Norway and Kühlungsborn. The importance of these observations is investigated using model simulations of NLC from 1885 to 2100.

Invited Talk SYSC 1.3 Tue 11:45 HSZ/0004

The dynamic clouds of Venus — •Javier Peralta — Facultad de Fisica (Universidad de Sevilla), Sevilla, Spain

Venus is an excellent laboratory to study terrestrial planets permanently covered by clouds. In fact, Venus exhibits a thick cloudy layer which extends along an altitude range of 20 km, these clouds being mainly composed of sulphuric acid droplets and hiding a mysterious absorber proven to be a main driver of its atmospheric dynamics. The spectroscopic and imagery data set acquired during the last 15 years thanks to the space missions Venus Express (ESA) and Akatsuki (JAXA) not only have allowed us to better understand their composition and the prevailing atmospheric dynamics, but the clouds of Venus have also proven their potential to study the generation and impact of the thermal tides, characterize diverse planetary-scale waves and atmospheric instabilities, confirm the vertical propagation of waves generated at the surface, and discover new atmospheric phenomena yet without explanation. The clouds of Venus have also been shown to represent a false positive when inferring surface properties from time-series measurements of reflected starlight on exoplanets.

Invited Talk SYSC 1.4 Tue 12:10 HSZ/0004

Observational constraints of exoplanet clouds — •Nicolas Iro — German Aerospace Centre (DLR), Berlin, Germany

We entered a new era in extrasolar planets characterisation. We are indeed given access to constraints on their meteorology.

New facilities have been designed specifically for exoplanet atmospheric characterisation. Higher spectral resolution of exoplanet atmosphere observations allow us to infer atmospheric properties with unprecedented details, including the presence of clouds.

Moreover, time varying observations could in principle study the variability of exoplanet atmospheres, such as climate and cloud coverage temporal variations.

Here we will review the recent observational constraints relative to clouds in exoplanet atmospheres, as well as discuss the exciting prospects for the near future.

Invited Talk SYSC 1.5 Tue 12:35 HSZ/0004

Gemstone clouds in JWST target exoplanets — •Dominic Samra[1] and Christiane Helling[1,2] — [1]Space Research Institute, Austrian Academy of Sciences, Schmiedlstrasse 6, A-8042 Graz, Austria — [2]Institute for Theoretical Physics and Computational Physics, Graz University of Technology, Petersgasse 16, A-8010 Graz, Austria

Exoplanets provide excellent test-beds for exploring the diversity of atmospheric physics. However, clouds remain a key challenge in observations by altering the local atmospheric composition through condensation, as well as obscuring deeper atmospheric layers. State-of-the-art instruments (e.g. JWST) will make spectral features of cloud particle composition observable. Cloud formation in exoplanet atmospheres traces local thermodynamic conditions. Microphysical cloud modelling is a powerful tool which provides the details of cloud formation processes (nucleation, growth, collisions, settling and mixing) necessary for understanding observations over a wide wavelength range. Gas-giant atmospheres condense clouds formed from a diverse range of materials, such as silicates, metal oxides and salts. We model cloud formation for 1D atmosphere profiles using a kinetic cloud formation model consistently combined with equilibrium gas-chemistry. Using results from 3D general circulation models as input to our model allows us to study cloud formation in JWST targets, such as WASP-96b. We find a significant gap between known theory and retrieved results from observations. However, additional processes could reconcile these differences and yield a greater understanding of the reality of cloud formation on such planets.

Extraterrestial Physics Division
Fachverband Extraterrestrische Physik (EP)

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Overview of Invited Talks and Sessions

(Lecture halls HSZ/0004 and ZEU/0160; Poster HSZ OG 1

Plenary Talk of the Extraterrestrial Physics Division

PV IV	Tue	9:00– 9:45	HSZ/AUDI	**Characterising exoplanet atmospheres with the Webb space telescope** — •Pierre-Olivier Lagage

Invited Talks

EP 1.1	Mon	10:45–11:15	HSZ/0004	**A Melting Probe for the Exploration of Subglacial Lakes within the TRIPLE project line** — •Mia Giang Do, Jan Audehm, Clemens Espe, Marco Feldmann, Gero Francke, Fabian Schöttler, Dirk Heinen, Stefan Kaiser, Andreas Nöll, Christopher Wiebusch, Yuting Ye, Simon Zierke
EP 2.1	Mon	16:15–16:45	ZEU/0160	**The exoplanet revolution: towards habitable worlds** — •Alexis Smith
EP 5.1	Wed	10:45–11:15	ZEU/0160	**New insights into the elusive magnetic processes operating in the solar corona with SolO/EUI** — •Lakshmi Pradeep Chitta
EP 5.3	Wed	11:30–12:00	ZEU/0160	**Studying solar flares with the X-ray telescope STIX during the cruise and early science phase of Solar Orbiter** — •Alexander Warmuth
EP 7.1	Wed	14:15–14:45	ZEU/0160	**Advances in energetic particle physics with Solar Orbiter & Parker Solar Probe** — •Robert F. Wimmer-Schweingruber, Javier Rodriguez-Pacheco, George C. Ho, Robert A. Allen, Raul Gomez-Herrero, and the Solar Orbiter EPD Team
EP 7.3	Wed	15:00–15:30	ZEU/0160	**New Insights in Simulations of SEP Events with the PARADISE+ICARUS Model** — •Edin Husidic, Nicolas Wijsen, Tinatin Baratashvili, Stefaan Poedts, Rami Vainio
EP 8.1	Wed	16:00–16:30	ZEU/0160	**Precision measurements of cosmic ray fluxes from AMS-02 with a daily time resolution** — •Stefan Schael
EP 10.1	Thu	11:00–11:45	ZEU/0160	**Arne-Richter Lecture: From nonthermal plasmaastrophysics to modeling of pandemic outbreaks** — •Reinhard Schlickeiser
EP 11.1	Thu	14:00–14:30	ZEU/0160	**Energetic Particle Precipitation reflected in the Global Secondary Ozone Distribution** — •Jia Jia, Lisa E. Murberg, Tiril Løvset, Yvan J. Orsolini, Patrick J. Espy, Jude Salinas, Jae N. Lee, Dong Wu, Jiarong Zhang
EP 12.1	Thu	15:45–16:15	ZEU/0160	**Ultra-relativistic Electrons in the Earth's Van Allen Radiation Belts** — •Yuri Y. Shprits, Hayley Allison, Nikita Aseev, Dedong Wang, Alexander Drozdov
EP 13.1	Thu	17:30–18:00	ZEU/0160	**Time-dependent data analysis of a blazar flare** — •Maximilian Albrecht, Felix Spanier
EP 14.1	Fri	11:00–11:30	HSZ/0004	**Unveiling the secrets of hot, massive stars with modern stellar atmosphere models** — •Andreas A C Sander

Invited Talks of the joint Symposium Strange Clouds – from the Earth to Exoplanets (SYSC)

See SYSC for the full program of the symposium.

SYSC 1.1	Tue	11:00–11:20	HSZ/0004	**Not all clouds are created equal – strange clouds in our solar system** — •Thomas Leisner
SYSC 1.2	Tue	11:20–11:45	HSZ/0004	**Clouds to the Edge of Space** — •Gerd Baumgarten, Ronald Eixmann, Jens Fiedler, Michael Gerding, Mykhaylo Grygalashvyly, Franz-Josef Lübken, Ashique Vellalassery, Christian von Savigny, Robin Wing
SYSC 1.3	Tue	11:45–12:10	HSZ/0004	**The dynamic clouds of Venus** — •Javier Peralta
SYSC 1.4	Tue	12:10–12:35	HSZ/0004	**Observational constraints of exoplanet clouds** — •Nicolas Iro
SYSC 1.5	Tue	12:35–13:00	HSZ/0004	**Gemstone clouds in JWST target exoplanets** — •Dominic Samra, Christiane Helling

Sessions

EP 1.1–1.8	Mon	10:45–13:00	HSZ/0004	**Planets and small Objects**
EP 2.1–2.5	Mon	16:15–17:45	ZEU/0160	**Exoplanets and Astrobiology**
EP 3.1–3.5	Tue	16:45–18:00	ZEU/0160	**Clouds in Planetary Atmospheres (joint session EP/UP)**
EP 4.1–4.4	Tue	18:00–19:00	ZEU/0160	**Planetary atmospheres**
EP 5.1–5.6	Wed	10:45–12:45	ZEU/0160	**Sun and heliosphere I**
EP 6	Wed	13:00–14:00	ZEU/0160	**Members' Assembly**
EP 7.1–7.4	Wed	14:15–15:45	ZEU/0160	**Sun and heliosphere II**
EP 8.1–8.4	Wed	16:00–17:15	ZEU/0160	**Sun and heliosphere III**
EP 9.1–9.20	Wed	17:30–19:00	HSZ OG1	**Poster**
EP 10.1–10.6	Thu	11:00–13:00	ZEU/0160	**Astrophysics: Cosmic Rays and Galaxies I**
EP 11.1–11.5	Thu	14:00–15:30	ZEU/0160	**Near-Earth Space I**
EP 12.1–12.5	Thu	15:45–17:15	ZEU/0160	**Near-Earth Space II**
EP 13.1–13.5	Thu	17:30–19:00	ZEU/0160	**Astrophysics: Galaxies II**
EP 14.1–14.7	Fri	11:00–13:00	HSZ/0004	**Astrophysics: Stellar Astrophysics**
EP 15.1–15.6	Fri	14:00–15:30	HSZ/0004	**Astrophysics: Cosmology**

Members' Assembly of the Extraterrestial Physics Division

Wednesday 13:00–14:00 ZEU/0160

Sessions

– Invited Talks, Contributed Talks, and Posters –

EP 1: Planets and small Objects

Time: Monday 10:45–13:00 Location: HSZ/0004

Invited Talk EP 1.1 Mon 10:45 HSZ/0004

A Melting Probe for the Exploration of Subglacial Lakes within the TRIPLE project line — •Mia Giang Do[1], Jan Audehm[1], Clemens Espe[2], Marco Feldmann[2], Gero Francke[2], Fabian Schöttler[2], Dirk Heinen[1], Stefan Kaiser[1], Andreas Nöll[1], Christopher Wiebusch[1], Yuting Ye[1], and Simon Zierke[1] — [1]RWTH Aachen University - Physics Institute III B, Aachen, Germany — [2]GSI - Gesellschaft für Systementwicklung und Instrumentierung mbH, Aachen, Germany

Jupiter's moon Europa is a prime candidate for the search for extraterrestrial life in the solar system. Previous observations suggest the existence of a global ocean beneath the moon's icy shell. To explore the hidden water reservoir, future missions will need to penetrate the massive ice layer. The development of key technologies for such a mission is the subject of the TRIPLE project line (Technologies for Rapid Ice Penetration and Subglacial Lake Exploration) initiated by the German Space Agency at DLR. Within TRIPLE, an electrothermal probe will be used as the carrier system for transporting scientific payloads. A terrestrial analogous demonstration of the system is planned in the Dome C region in Antarctica. With an expected subglacial lake underneath a 4 km thick icy shell, Dome C does not only provide an ideal test site, but also a great challenge for TRIPLE. To fulfill the mission, it is mandatory for the melting probe to be retrievable and capable of releasing and recapturing payloads at the ice-water interface. This talk will focus on the technological challenges of the melting probe and present the latest terrestrial test campaigns.

EP 1.2 Mon 11:15 HSZ/0004

Material properties of matter in Saturn's interior from ab initio simulations — •Martin Preising[1], Martin French[1], Christopher Mankovich[2], Francois Soubiran[3], and Ronald Redmer[1] — [1]Universität Rostock, Rostock, Germany — [2]California Institute of Technology, Pasadena, USA — [3]Commissariat à l'énergie atomique et aux énergies alternatives, Arpajon, France

Calculation of material properties from ab inito simulations along Jupiter [1] and Brown Dwarf adiabats [2] have been subject of earlier studies. However, accurate models of Saturn's interior are still very challenging. A recent study by Mankovich and Fortney on Jupiter and Saturn models was based on a single physical model [3] which predicts a strongly differentiated helium distribution in Saturn's deep interior, resulting in a helium-rich shell above a diffuse core.

We focus on the calculation of material properties of matter at P-T conditions along the Saturn model proposed by Mankovich and Fortney. We present results on thermodynamic and transport properties of a hydrogen-helium-water mixture that closely resembles the element distribution of the Saturn model. We discuss implications of the results on our understanding of Saturn's interior and evolution.

[1] French et al., Astrophys. J. Suppl. Ser., 202, 5 (2012). [2] Becker et al., Astron. J., 156, 149 (2018). [3] Mankovich and Fortney, Astrophys. J., 889, 51 (2020). [4] Monserrat et al., Phys. Rev. Lett., 112, 055504 (2014). [5] Preising and Redmer, Phys. Rev. B, 102, 224107 (2020).

EP 1.3 Mon 11:30 HSZ/0004

The interior and thermo-chemical evolution of Mars — •Ana-Catalina Plesa and Doris Breuer — DLR, Institute of Planetary Research, Germany

The observational data currently available about Mars provide us with the opportunity to study the interior and thermochemical evolution of the planet with unprecedented detail. This includes geological and mineralogical datasets, gravity and topography data, magnetic field data, and most recently, seismic data from the InSight mission. In this talk, we will show what we have already learned about the interior and thermochemical evolution of Mars, and where there are still open (new) questions - especially through the analysis of the new data from InSight - for the geodynamic reconstruction of the Martian interior.

EP 1.4 Mon 11:45 HSZ/0004

On the propagation of linear and nonlinear waves in the Venusian ionosphere — •Horst Fichtner[1], Alaa Fayad[1,2], Samy Salem[1,2], Marian Lazar[1,3], Waled Moslem[1,2], and Sara Morsi[1,2,4] — [1]Institut für Theoretische Physik IV, Ruhr-Universität Bochum, 44780 Bochum, Germany — [2]Department of Physics, Faculty of Science, Port Said University, Port Said 42521, Egypt — [3]Centre for mathematical Plasma Astrophysics, KU Leuven, 3001 Leuven, Belgium — [4]The British University in Egypt, El-Shorouk City, Cairo, Egypt

The ionosphere of Venus represents, partly due to its interaction with the solar wind, a dynamic plasma environment that hosts a variety of plasma waves. These waves play potentially significant roles for the structure of this region, for the atmospheric erosion, or for the transport and acceleration of energetic particles. In the presentation both linear and nonlinear waves are studied within the framework of (multi-species) hydrodynamics and magnetohydrodynamics, which allows, depending on the model assumptions, to analyze their dispersion in a linearizing approach and their nonlinear dynamics using a perturbative approach. Within the hydrodynamic treatment also the ion outflow from the Venusian atmosphere can be investigated.

EP 1.5 Mon 12:00 HSZ/0004

Conformal mapping for the planetary bow shock and magnetopause studies — •Yasuhito Narita[1], Simon Toepfer[2], and Daniel Schmid[1] — [1]Space Research Institute, Austrian Academy of Sciences, Graz, Austria — [2]Institut für Theoretische Physik, Technische Universität Braunschweig, Germany

The concept of conformal mapping is introduced to the planetary magnetospheric research as a useful tool to characterize the bow shock and magnetopause geometry and to directly compare the in-situ measurements of magnetic field and plasma flow with the theoretical models. Various models of the planetary bow shock and magnetopause can be extended from the real-number expression to the conformal mapping in the complex plane. By doing so, the spatial domains around the bow shock and magnetopause are easily expressed in orthogonal curvilinear coordinates. In particular, the parabolic bow shock and the tail-elongated magnetopause are found to be conformally mapped using only elementary analytic expressions. Conformal mapping opens the door to construct a high-precision steady-state model of the magnetic field and plasma flow in the planetary magnetosheath region by transforming the Kobel-Flueckiger scalar potential, the exact solution of Laplace equation in parabolic magnetosheath coordinates, to arbitrary two-dimensional bow shock and magnetopause shapes. Such a model will significantly ease the interpretation of magnetic field or plasma data in the planetary missions, as one obtains the global picture of bow shock, magnetopause, and magnetosheath from the model either from the measurements or from the given solar wind condition.

EP 1.6 Mon 12:15 HSZ/0004

Mirror Modes in the Hermean Magnetosheath — •Martin Volwerk[1], Charlotte Goetz[2], Daniel Heyner[3], Tomas Karlsson[4], Ferdinand Plaschke[3], Daniel Schmid[1], and Cyril Simon Wedlund[1] — [1]Space Research Institute, Austrian Academy of Sciences, Graz, Austria — [2]Northumbria University, Newcastle upon Tyne, United Kingdom — [3]Institut für Geophysik und extraterrestrische Physik Technische Universität Braunschweig, Germany — [4]Space and Plasma Physics School of Electrical Engineering and Computer Science KTH Royal Institute of Technology Stockholm. Sweden

Mirror modes are quasi-stationary structures in the plasma frame, consisting of a train of magnetic depressions combined with plasma density enhancements. They are created by a temperature asymmetry in the plasma, where the perpendicular temperature (with respect to the magnetic field) is higher than the parallel temperature. These structures are ubiquitous in planetary magnetosheaths, and have been detected at Venus, Earth, Mars, Jupiter and even at comets. Similar structures to mirror modes are magnetic holes, usually born in the solar wind upstream of the shock and can be transported into the magnetosheath (Karlsson et al., 2021). Here we study magnetic field data during the orbital phase of the MESSENGER mission at Mercury to identify mirror mode-like structures with a magnetic-field-only method. Properties of mirror mode structures will be compared to those of isolated magnetic holes observed in the magnetosheath earlier, to investigate if they are related phenomena

EP 1.7 Mon 12:30 HSZ/0004

Deformed bow shock and magnetic depression: Lessons from BepiColombo's flyby-2 at Mercury — •Daniel Schmid[1], David Fischer[1], Werner Magnes[1], Yasuhito Narita[1], Martin Volwerk[1], Wolfgang Baumjohann[1], Ayako Matsuoka[2], Uli Auster[3], Ingo Richter[3], Daniel Heyner[3], Ferdinand Plaschke[3], and Rumi Nakamura[1] — [1]Istitut für Weltraumforschung (IWF) Graz, Österreichische Akademie der Wissenschaften (OeAW) — [2]World Data Center for Geomagnetism, Kyoto University — [3]Institut für Geophysik und Extraterrestrische Physik, Technische Universität Braunschweig

Understanding Mercury's magnetospheric structure remains a challenge due to the planet's proximity to the Sun. The magnetic field data from BepiColombo's flyby-2 at Mercury in June 2022 allows us to study the magnetosphere and its space environment in-situ. The bow shock crossing analysis reveals that the shock normal direction is significantly deformed during the inbound crossing and is comforting to the steady-state bow shock shape during the outbound crossing. The magnetosphere crossing analysis reveals a short-time magnetic field depression in the midnight sector before the closest approach, indicating either occurrence of a transient event or crossing of a current layer separating the dipolar from the tail-field region. The BepiColombo flyby-2 magnetic field data analysis shows that Mercury's magnetosphere is highly dynamic and identification of transient events from the quasi-steady state of the magnetosphere plays a crucial role in constructing the magnetospheric structure from the magnetic field data.

EP 1.8 Mon 12:45 HSZ/0004

Analysis of IMF penetration into Mercury's Magnetosphere — •Kristin Pump, Daniel Heyner, and Ferdinand Plaschke — TU Braunschweig, IGEP, Mendelssohnstraße 3, 38106 Braunschweig

Mercury is the smallest an innermost planet of our solar system and has a dipole-dominated internal magnetic field that is relatively weak, very axisymmetric and significantly offset towards north. Through the interaction with the solar wind, this field leads to a magnetosphere. Compared to the magnetosphere of Earth, Mercury's magnetosphere is smaller and more dynamic. A semi-empirical magnetospheric model can capture the large-scale magnetospheric structures. Using the residuals between in-situ data and the model prediction we further seek to improve our understanding of the Hermean magnetosphere. To first order the magnetopause completely separates the magnetosphere from the magnetosheath and thus no magnetic field may penetrate this boundary. In reality, the magnetosheath field may diffuse across the very thin boundary within a finite time. Here, we investigate this penetration and compare the different interplanetary field (IMF) components by their ability to enter into Mercury's Magnetosphere. For this, we use in-situ MESSENGER magnetic field data to estimate the IMF for the time frame with the probe located inside the magnetosphere. The amount of penetration is found by least-square fitting to magnetospheric model results. First statistical results indicate that the penetration is stronger under southward IMF conditions.

EP 2: Exoplanets and Astrobiology

Time: Monday 16:15–17:45 Location: ZEU/0160

Invited Talk EP 2.1 Mon 16:15 ZEU/0160

The exoplanet revolution: towards habitable worlds — •Alexis Smith — Institut für Planetenforschung, Deutsches Zentrum für Luft- und Raumfahrt, Berlin

In the nearly 30 years since the discovery of the first exoplanets, planet detection has continued to accelerate, driven in large part by the space-based transit missions Kepler/K2 and TESS; there are now more than 5000 confirmed exoplanets. These detections have enabled insights into the demographics of the exoplanet population, and hence into the formation and migration processes that sculpted the planetary systems that we observe today. As we begin to place our own planetary system into a Galactic context, there have been innumerable surprises such as the discovery that the most common type of planet is not represented in our Solar System. Meanwhile, bright transiting systems, such as those discovered by TESS, are increasingly amenable to atmospheric characterisation with existing ground-based facilities, as well as with JWST. In the near future, the ESA Ariel mission and the ground-based ELTs will continue to expand the available parameter for atmospheric exploration. Finally, ESA's upcoming PLATO mission will enhance our planet detection abilities, putting Earth-like planets in reach for the first time.

EP 2.2 Mon 16:45 ZEU/0160

Habitability inside astrospheres — •Klaus Scherer[1], Konstantin Herbst[2], Dominik J. Bomans[3], N. Eugene Engelbrecht[4], Stefan .E.S. Ferrerira[4], Lennart Baalmann[5], Frederiic Effenberger[1], and Jen Kleimann[1] — [1]Institut für Theoretische Physik IV, Ruhr-Universität Bochum, Germany — [2]Institut für Experimentelle and Angewandte Physik, Christian-Albrechts-Universität zu Kiel, Germany — [3]Astronomisches Institut, Ruhr-Universität Bochum, Germany — [4]Centre for Space Research, North-West University, Potchefstroom, South Africa — [5]Institute for Particle and Astroparticle Physics, ETH Zürich, Switzerland

The habitable planets around a host star are not only influenced by the stellar wind or flare activity, but are also embedded in the interstellar environment, which can also influence these planets and their atmospheres. We will show that, for certain classes of astrospheres, the inflow of the neutrals on the top of an exoplanetary atmosphere can be large. This is done by modelling the interaction between the stellar wind and the interstellar medium using a two fluid MHD model. Moreover, such an 3D MHD simulation will also allow us to study the modulation of galactic cosmic rays in 3D, incorporating a turbulence transport model, so that the diffusion coefficients and the drift velocities can be modelled as far as possible from first principles. We will also discuss the latter point.

EP 2.3 Mon 17:00 ZEU/0160

Examining the orbital decay targets KELT-9 b, KELT-16 b, and WASP-4 b, and the transit-timing variations of HD 97658 b — •Jan-Vincent Harre — DLR - Institute of Planetary Research, Berlin, Germany

Tidal orbital decay is suspected to occur for hot Jupiters in particular, with the only observationally confirmed case of this being WASP-12 b. By examining this effect, information on the properties of the host star can be obtained using the so-called stellar modified tidal quality factor Q_*', which describes the efficiency of the planetary kinetic energy dissipation within the star. In this study, we aim to improve constraints on the tidal decay of the KELT-9, KELT-16, and WASP-4 systems, making it possible to constrain the Q_*' value for each star. In addition, we aim to test the existence of the TTVs in the HD 97658 system, which previously favoured a quadratic trend with increasing orbital period. Making use of newly acquired photometric observations from CHEOPS and TESS, combined with archival data, we fit three models to the data, namely a constant-period model, an orbital-decay model, and an apsidal-precession model. We find that the KELT-9 system is best described by an apsidal-precession model for now, with an orbital decay trend at over 2σ being a possibility as well. A Keplerian orbit model provides the best fit to the transit timings of KELT-16 b because of the scatter and scale of their error bars. The WASP-4 system is best represented by an orbital decay model at a 5σ significance, although apsidal precession cannot be ruled out. For HD 97658 b, we find no conclusive evidence for the suspected trend in the data.

EP 2.4 Mon 17:15 ZEU/0160

Deciphering Dayglow as Biosignature of Planet Earth — •Katharina Uhlmannsiek[1], Michael Sterzik[1], Claudia Emde[2], and Stefano Bagnulo[3] — [1]ESO, Garching, Germany — [2]Institute for Meteorology LMU, München, Germany — [3]Armagh Observatory, Belfast, UK

Biosignatures in the near-infrared spectrum of Earth's atmosphere include the simultaneous presence of H2O, O2 and CH4 molecular absorption bands, but also abundant skyline emission features caused by chemo-photolytic reaction networks of Oxygen in the upper atmosphere such as OH. New infrared spectra of Earthshine were obtained with the CRIRES+ instrument at the VLT and achieve a high spectral resolution of R > 100 000. Thus, narrowband features of day- and nightglow emission (e.g. OH, O2) can be resolved. We compare airglow lines caused by different mechanisms, and try to discern day- and nightglow from contaminating atmospheric transmission. Earthshine spectra consist of the spatially integrated light of the illuminated Earth and Earth's atmosphere and are therefore considered analogous to direct observations of exoplanets. Hence, tracing biosignatures in our high-resolution CRIRES+ observations of Earthshine opens a novel window for the detection of biosignatures of Earth-like planets.

EP 2.5 Mon 17:30 ZEU/0160

Origin of life - RNA viruses first? — •Karin Moelling — Inst Med Mikrobiol Uni Zürich Schweiz

The first biomolecules are replicating non-coding RNA enzymes, ribozymes, which can cleave and join and evolve. The ribozymes are the active component for protein synthesis, ribosomes are ribozymes. They are also designated as viroids. RNA is essential at many most prominent steps in metabolism, on planet Earth, as primers, as chief regulators (circRNA), in sperm for non-Mendelian transgenerational inheritance, for silencing, defense , evolution etc. RNA can do it all. It is unstable and sensitive and needs protection. The most versatile living entities are the archaea, which can cope with extreme environmental conditions, and were named extremophiles. They are very complicated and specialized to Earth conditions, they are innovative but evolution of metabolic pathways takes time. What are the most likely or unlikely conditions on Planet Earth, which allow to extrapolate to possible extraterrestric living conditions. The conflict is either a unique earth versus astronomical numbers of exoplanets. (Moelling K: Viren die Supermacht des Lebens (C.H. Beck Press) or "Viruses, more Friends than Foes (WSPress)).

EP 3: Clouds in Planetary Atmospheres (joint session EP/UP)

Time: Tuesday 16:45–18:00 Location: ZEU/0160

EP 3.1 Tue 16:45 ZEU/0160

Wellen und Wolken in der Atmosphäre über den südlichen Anden gemessen mit einem Rayleigh-Lidar — •Natalie Kaifler, Bernd Kaifler, Andreas Dörnbrack und Markus Rapp — Deutsches Zentrum für Luft- und Raumfahrt e.V., Institut für Physik der Atmosphäre

Das CORAL-Lidar misst seit November 2017 in Tierra del Fuego, Argentinien (54°S) die Temperatur der Atmosphäre bis in 100 km Höhe. In der Stratosphäre treten über den südlichen Anden durch Gebirgswellen verursachte Temperaturstörungen von über 20 K Amplitude auf. In den kalten Phasen der Wellen können auf diese Weise polare Stratosphärenwolken auch in mittleren Breiten entstehen. In größeren Höhen, am oberen Rand der Mesosphäre, ist die Temperatur im Sommer kalt genug für die Bildung von Eiswolken, den sogenannten leuchtenden Nachtwolken. Sie werden durch die Gezeitenwinde beeinflusst, sind stark durch Schwerewellen moduliert, und treten in der Südhemisphäre nicht seltener auf als in der Nordhemisphäre, was man aufgrund der höheren Hintergrundtemperatur der südlichen polaren Mesosphäre erwarten könnte. Wir zeigen eine Übersicht und ausgewählte Beobachtungen von Wellen und Wolken in der mittleren Atmosphäre aus mehr als fünf Jahren Lidar-Messungen.

EP 3.2 Tue 17:00 ZEU/0160

Preferential adsorption of para and ortho water molecules on charged nanoparticles in planetary ice clouds — •Johanna Weidelt[1], Thomas Dresch[2], Denis Duft[2], and Thomas Leisner[2,3] — [1]Ultrafast Science Research Unit, University of Bielefeld, Germany — [2]Institute of Meteorology and Climate Research, Karlsruhe Institute of Technology, Germany — [3]Institute of Environmental Physics, University of Heidelberg, Germany

In the Earth mesopause, nanometer-size singly charged particles form by condensation of evaporated meteorite material. They exhibit an enhanced water adsorption cross section due to the strong charge-dipole-interaction. In this work, we study how the nuclear spin state of water molecules affects this enhancement and whether there are conditions that could lead to the formation of spin-polarized ice. Due to symmetry constraints on the total molecular wavefunction, ortho (proton spins parallel) and para (spins antiparallel) water occupy different rotational states, resulting in a different average dipole orientation in electric fields. Therefore, we expect ortho and para water to exhibit distinct adsorption enhancement factors onto charged nanoparticles. Based on Stark-shifts of individual rotational states of water, average dipole orientations of a molecular ensemble and the resulting collision cross section was calculated for various temperatures and particle sizes. We found that in the mesosphere of the Earth (T~150K) the adsorption enhancement of ortho- and para- water is approximately equal while at lower temperatures prevailing around ice giant planets and their moons, significant spin polarizations up to 15% occur.

EP 3.3 Tue 17:15 ZEU/0160

On the colour of noctilucent clouds — •Christian von Savigny[1], Anna Lange[1], Gerd Baumgarten[2], and Alexei Rozanov[3] — [1]Institute of Physics, University of Greifswald, Greifswald, Germany — [2]Leibniz Institute of Atmospheric Physics, Kühlungsborn, Germany — [3]Institute of Environmental Physics, University of Bremen, Bremen, Germany

Noctilucent clouds, also known as polar mesospheric clouds, are a polar summer mesopause phenomenon and they are typically characterised by a silvery-blue or pale blue colour. In this contribution, we investigate the reasons for this colour using the radiative transfer model SCIATRAN in combination with the CIE (International Commission on Illumination) colour-matching functions in order to the determine the resulting colour impression in an objective way. Different processes and parameters potentially affecting the colour of NLCs are investigated, i.e. the size of the NLC particles, the abundance of middle atmospheric O3 and the importance of multiply scattered solar radiation. We confirm earlier studies indicating that absorption of solar radiation in the O3 Chappuis bands can have a significant effect on the colour of the NLCs. It is, however, found that for sufficiently large NLC optical depths O3 plays only a minor role for the blueish colour. The simulations also show that the size of NLC particles affects the colour of the clouds. Cloud particles of unrealistically large sizes can lead to a reddish colour. Furthermore, the simulations show that the contribution of multiple scattering to the total scattering is only of minor importance, providing additional justification for the earlier studies on this topic, which were all based on the single-scattering approximation.

EP 3.4 Tue 17:30 ZEU/0160

Exoplanetary clouds: The potential of high-precision polarimetry — •Moritz Lietzow and Sebastian Wolf — Institute of Theoretical Physics and Astrophysics, Kiel University, Germany

The reflected flux from planets is polarized due to scattering in their atmosphere. While polarimetry is used to study objects in the Solar System, it has also been proposed for detection and characterization of extrasolar planets. In particular, the reflected polarized flux depends not only on the planetary phase angle and observed wavelength, but also on the atmospheric composition, allowing to distinguish between various cloud compositions. Given the accuracy of existing high-precision polarimeters, scattered light polarimetry indeed has the potential to become a powerful tool to characterize exoplanetary atmospheres. First measurements of planet-induced polarization were reported during recent years. To provide the basis for theoretical studies and the interpretation of dedicated polarization measurements, we developed a radiative transfer simulation software that contains all relevant continuum polarization mechanisms for the comprehensive analysis of the polarized flux resulting from the scattering in the atmosphere, on the surface, and in the local planetary environment. In addition, we investigated the impact of the cloud composition and exoplanetary rings on the scattered light polarization.

EP 3.5 Tue 17:45 ZEU/0160

Retrieval of cloud properties using spectropolarimetric simulations of Earthshine — •Orsolya Pari[1], Claudia Emde[1], Michael Sterzik[2], and Mihail Manev[1] — [1]Ludwig-Maximilians-Universität, München, Germany — [2]European Southern Observatory, Garching bei München, Germany

In order to be able to interpret future observations of the atmospheres of Earth-like planets and detect signatures of life, it is important to understand Earth's atmospheric and surface properties. Observations of Earthshine, which is sunlight scattered by Earth to the Moon, and then reflected back to Earth, make it possible to study Earth as an exoplanet.

We use the Monte Carlo radiative transfer model MYSTIC to simulate polarized spectra in the atmosphere of the Earth for Ocean and Lambertian surfaces. A water or an ice cloud layer is included and we vary the cloud parameters (cloud altitude, cloud optical thickness, effective droplet radius).

The focus is on the $O_2 - A$ and H_2O bands, where the degree of polarization can be higher or lower than the adjacent continuum. To quantify this behavior we use the equivalent width, which is the area in the passband between the absorption line and the simulated spectrum without absorption across a specific spectral region.

We find that the equivalent width is highly sensitive to cloud altitude and cloud optical thickness.The simulations are compared to the observations of Earthshine obtained by FORS2 at the VLT for different Sun-Earth-Moon phase angles.

EP 4: Planetary atmospheres

Time: Tuesday 18:00–19:00 Location: ZEU/0160

EP 4.1 Tue 18:00 ZEU/0160

Jupiter moon Ganymede's atmosphere observed with the Hubble Space Telescope — •Lorenz Roth[1], Gregorio Marchesini[1], Tracy Becker[2], Jens Hoeijmakers[3], Philippa Molyneux[2], Kurt Retherford[2], Joachim Saur[4], Shane Carberry Mogan[5], and Jamey Szalay[6] — [1]KTH Royal Institute of Technology, Stockholm Sweden / ESO Garching bei München — [2]Southwest Research Institute, San Antonio, TX, USA — [3]Lund University, Sweden — [4]Universität zu Köln — [5]University of California, Berkeley, CA, USA — [6]Princeton University, Princeton, NJ, USA

Jupiter's moon Ganymede is the largest moon in the Solar System and the only one that generates its own magnetic field in the interior. Ganymede also possesses a tenuous water-based atmosphere, produced by the solar and Jovian plasma irradiation of its icy surface. Here we report results from far-ultraviolet observations by the Hubble Space Telescope of Ganymede transiting across the planet's dayside hemisphere. Within a targeted campaign on 9 September 2021 two exposures were taken during one transit passage to probe for attenuation of Jupiter's hydrogen Lyman-α dayglow above the moon limb. The background dayglow is slightly attenuated over an extended region around Ganymede. The obtained vertical H column densities are consistent with previous results. Constraining angular variability around Ganymede's disk, we derive an upper limit on a local H2O column density such as could arise from outgassing plumes in regions near the observed moon limb.

EP 4.2 Tue 18:15 ZEU/0160

Investigation of the Influence of Stellar Particle Events and Galactic Cosmic Rays on the Atmosphere of TRAPPIST-1e — •Andreas Bartenschlager[1], Miriam Sinnhuber[1], John Lee Grenfell[2], Benjamin Taysum[2], Fabian Wunderlich[2], and Konstantin Herbst[3] — [1]Karlsruher Institute of Technology, Germany — [2]German Aerospace Center, Berlin, Germany — [3]University of Kiel, Germany

The launch of the James Webb Space Telescope (JWST) in December 2021 opens up the possibility of studying the composition of exoplanetary atmospheres in habitable zones in the near future. We investigate the influence of stellar energetic particles (SEPs) on the atmospheric chemistry of exoplanets around a very active M-star TRAPPIST-1, using the ion chemistry model ExoTIC. We perform model experiments with different N_2 or CO_2 dominated atmospheres, depending on the initial CO_2 partial pressure, as well as humid and dry conditions, taking into account the ionization rates for such events. A further specification is the distinction between dead and alive atmospheres, whose atmospheric composition is characterized by a lower or higher oxygen fraction in the initial conditions. Within ExoTIC we calculate the impact of the ionization events on these atmospheres both as a single and as a series of events with different strengths. Preliminary results show a significant impact of SEP events on the chemical composition of the atmosphere, including biosignatures such as O_3. The strength of these impacts depends on the starting atmospheres' relative oxygen, nitrogen and water vapour content.

EP 4.3 Tue 18:30 ZEU/0160

Simulating exoplanetary atmospheres in the laboratory: comparing experimental data with output from an atmospheric model — •Florence Hofmann[1], Paul Mabey[1], Egemen Yüzbasi[1,2], John Lee Grenfell[2], Heike Rauer[1,2,3], and Andreas Elsaesser[1] — [1]Freie Universitaet Berlin, Germany — [2]Institute for Planetary Research, Berlin, Germany — [3]Berlin University of Technology, Germany

Since the discovery of the first exoplanet, several thousand have have been found including some rocky planets in the habitable zone. The new generation of instruments such as the James Webb Space Telescope will search for spectroscopic signals of atmospheric biosignatures on these worlds. Correctly interpreting such signals requires atmospheric models with consistent and flexible climate and chemical modules over a wide parameter range. With our new Planetary Simulation Chamber at FU Berlin, we are capable of simulating a large set of atmospheric parameters for Earth-like planets in the laboratory. We are able to vary the incoming spectra to simulate the photochemical and climate effects of Earth-like planets orbiting different stars. Many telescopes operate in the VIS/NIR range that corresponds to the fingerprint regions of interesting organic molecules. Our facility allows continuous spectroscopic in-situ monitoring of samples in the UV/IR region and simultaneous mass spectroscopic analysis. In collaboration with our partners at the DLR institute for planetary research, we compare experimental results from our chamber with output from their climate-chemistry model 1D-TERRA.

EP 4.4 Tue 18:45 ZEU/0160

Simulating Atmospheric Climate and Chemical Responses on a hypothetical, Earthlike Planet orbiting AD Leonis — •Julian Graupner[1], John Lee Grenfell[1], Hella Garny[2], Anna Goetz[2], and Heike Rauer[1,3,4] — [1]Department of Extrasolar Planets and Atmospheres, Instiute of Planetary Research, German Aerospace Centre (DLR), Berlin, Germany — [2]Department of Earth System Modelling, Institute for Atmospheric Physics, German Aerospace Centre (DLR), Oberpfaffenhofen-Wesling, Germany — [3]Centre for Astronomy and Astrophysics, Berlin Institute of Technology, Berlin, Germany — [4]Institute for Geological Science, Free University of Berlin, Berlin, Germany

Simulating a hypothetical Earth orbiting the active M-dwarf star AD Leonis is well-established since the stellar spectrum is well-characterized and there are numerous model studies in the literature. A long-term aim is to estimate the transport, climate and photochemical effects using a column climate-photochemical model loosely coupled with a parameterized 3D model. The column model is integrated over a range of latitudes which then generates a temperature map used as input for the 3D transport model. In the present study we report only results from the 1D model study for Earth placed around AD Leonis at an orbit where it receives the same instellation. Compared with previous column model studies we find that recent improvements in our climate and chemistry modules has led to modest changes in our simulated cold trap, hence water vapor abundances and also in the middle atmosphere ozone amount.

EP 5: Sun and heliosphere I

Time: Wednesday 10:45–12:45 Location: ZEU/0160

Invited Talk EP 5.1 Wed 10:45 ZEU/0160

New insights into the elusive magnetic processes operating in the solar corona with SolO/EUI — •Lakshmi Pradeep Chitta — Max Planck Institute for Solar System Research, Justus-von-Liebig-Weg 3, 37077 Göttingen

The solar corona, million Kelvin hot outer atmosphere of the Sun, is governed by magnetic fields. Streams of charged particles continuously escape this hot atmosphere into the heliosphere as solar wind. Magnetic processes responsible for coronal heating and for powering the solar wind are a subject of active debate for over six decades. With its unprecedented high-resolution, high-cadence view of the Sun, the Extreme Ultraviolet Imager (EUI) onboard the Solar Orbiter mission is shedding new light on the elusive magnetic processes operating in the corona. At closest approach, EUI can provides data with a spatial resolution of about 200 km and a cadence of below 3 s. During the first science perihelion observing campaigns of Solar Orbiter, the EUI instrument imaged untangling of small-scale coronal magnetic braids through reconnection, and subsequent heating of plasma in some active region coronal loops. These observations suggest that magnetic reconnection in coronal loops might be operating on short timescales of a few 10 s and on spatial scales of a few 100 km. The EUI data also revealed ubiquitous high-speed reconnection-driven jets from coronal holes. These jets can channel sufficient heated material to sustain the solar wind mass flux. In this talk, we present these novel observations and discuss the role of magnetic reconnection in the heating of coronal plasma and in the driving of solar wind.

EP 5.2 Wed 11:15 ZEU/0160

Picoflares in the Quiet Solar Corona Observed by the Solar Orbiter — •Olena Podladchikova[1,2], Alexander Warmuth[1], Francis Verbeeck[3], Marco Velli[4], Susanna Parenti[5], Frederic Auchere[5], Astrid Veronig[6], Stefan Purkhart[6], Stefan Hofmeister[1], Udo Schuehle[7], Luca Teriaca[7], Aznar Cuadrado[7], Andrea Battaglia[8], Frederic Schuller[1], and Anik De Groof[9] — [1]AIP, Potsdam, Germany — [2]Kiev Polytechnic University, Ukraine — [3]ROB, Belgium — [4]UCLA, USA — [5]IAS, France — [6]University of Graz, Austria — [7]MPS, Germany — [8]ETH, Switzerland — [9]ESA, Madrid, Spain

On May 30, 2020, the Solar Orbiter High-Resolution Imager (HRIEUV) operating in 174 A being for the first time approximately at 0.5AU to the Sun, registered a large number of sudden heating events so-called campfires with rich morphology and smaller space-time characteristics than nanoflares. We found that campfires emit thermal energy in the picoflares range of $3.4\times10^{20}-9.8\times10^{23}$ ergs per event. The relationship between the emission measure and the temperature of campfires can be fitted by the power law covering 1 - 2.7 MK temperature range similar to large X-Ray flares. Their frequency distribution can be fitted by power-law $f(E) \approx E^{2.82\pm0.11}$, but at higher than nanoflares frequencies and lower energy range. The additional previously unaccounted energy input of $\geq 3\sigma$ is 1.0075 percent of the total required power to sustain a quiet solar corona. The observed power law would have to continue to about 1.25×10^{18} ergs in order to fulfill the observed coronal heating requirement.

Invited Talk EP 5.3 Wed 11:30 ZEU/0160

Studying solar flares with the X-ray telescope STIX during the cruise and early science phase of Solar Orbiter — •Alexander Warmuth — Leibniz-Institut für Astrophysik Potsdam (AIP)

Of the six remote-sensing instruments aboard Solar Orbiter, the Spectrometer/Telescope for Imaging X-rays (STIX) is the one dedicated to the study of solar flares. It performs X-ray imaging spectroscopy in the hard X-ray regime, which provides key physical diagnostics on both the hot thermal plasma as well as on the accelerated energetic electrons. During its operation since launch in 2020, which now includes the first year of the nominal mission phase, STIX has detected over 10000 solar flares. The first scientific results based on these novel observations will be discussed. In particular, we will focus on studies that use STIX jointly with other observational assets, such as the other remote-sensing instruments on Solar Orbiter, various X-ray instruments on other spacecraft, and in-situ particle detectors.

EP 5.4 Wed 12:00 ZEU/0160

Joint LOFAR and STIX observations of flare-accelerated electrons in the solar corona — •Malte Bröse — Leibniz-Institut für Astrophysik Potsdam (AIP), Germany

A joint analysis approach is used to study flare signatures both in the low and higher corona. STIX, AIA and LOFAR data provide an extensive picture about different aspects of flare characteristics. Recent data by the STIX instrument complement the picture of accelerated electrons, which propagate along magnetic field lines towards the Sun. These observations are linked to the LOFAR data, which contain information about the elctrons propagating away from the Sun through the corona above the active region. Although, the active region and its thermal evolution (Differential Emission Measure (DEM) reconstruction of AIA data), flare accelerated electrons and their radio traces (LOFAR, STIX) are in principal all associated with the energy release during the flare process, they are often studied seperatly. Hence, the investigation of possible relations is part of this project. Solar magnetic fields as a binding element between low and high corona, accelerated electrons and heated flare loops are included in the analysis via a Potential Field Source Surface (PFSS) model.

EP 5.5 Wed 12:15 ZEU/0160

Exploring the inner heliosphere with combined LOFAR and Solar Orbiter / Parker Solar Probe observations — •Christian Vocks for the LOFAR Solar and Heliospheric KSP-Collaboration — Leibniz-Institut für Astrophysik Potsdam (AIP), Potsdam, Germany

The phenomena of the active Sun, like flares and coronal mass ejections (CMEs), have significant influence on Earth and our technical civilization. This is usually referred to as ”Space Weather”. Flares and CMEs accelerate electrons and ions to high energies. These particles are studied both remotely by ground- and space-based telescopes, and in situ by spacecraft. Energetic electrons emit radio waves as they move through the coronal plasma. This plasma emission is observed by radio telescopes, e.g. LOFAR. Since the frequency decreases with plasma density higher in the solar atmosphere, and radio waves below 10 MHz cannot pass Earth's ionosphere, spacecraft are needed to continue observations further into interplanetary space. They are also required for measuring energetic particles and observations of X-ray emission in the corona. Therefore, combining LOFAR and spacecraft data provides new insights into the physical processes in the region where the solar corona turns into the solar wind. Parker Solar Probe (PSP) and Solar Orbiter are two missions currently exploring the inner heliosphere. I'll present LOFAR observing campaigns during PSP and Solar Orbiter perihelia, that cover the Sun and it's surroundings by making use of LOFAR's capability of running multiple observing modes in parallel, and show how they connect the corona with the heliosphere.

EP 5.6 Wed 12:30 ZEU/0160

Quasi-discontinuous solar wind solutions — •Lukas Westrich — Ruhr-Universität Bochum, Institute for theoretical physics IV

In this talk the solar wind and its acceleration and heating will be examined. Recently Shergelashvili et al. (2020) developed a new class of discontinuous solar wind solutions. They considered a case of quasi-adiabatic radial expansion with a jump in the flow velocity, density, and temperature but a continuous Mach number at the critical point and derived analytical solutions. Therefore, they proposed a localized external heating source without actual modeling. First I will present the motivation and the physical background for this solutions. After a discussion of this new discontinuous concept for the solar wind, I will develop and discuss continuous numerical solutions, more similar to the classical Parker solar wind model, but with quasi-adiabatic radial expansion with an explicitly formulated localized heating source. This will be done both stationary and dynamically. This kind of solutions can reproduce the analytically derived solutions without discontinuous jumps in the physical properties.

EP 6: Members' Assembly

Time: Wednesday 13:00–14:00 Location: ZEU/0160

All members of the Extraterrestrial Physics Division are invited to participate.

EP 7: Sun and heliosphere II

Time: Wednesday 14:15–15:45 Location: ZEU/0160

Invited Talk EP 7.1 Wed 14:15 ZEU/0160

Advances in energetic particle physics with Solar Orbiter & Parker Solar Probe — •Robert F. Wimmer-Schweingruber[1], Javier Rodriguez-Pacheco[2], George C. Ho[3], Robert A. Allen[3], Raul Gomez-Herrero[2], and and the Solar Orbiter EPD Team[4] — [1]Institute of Experiemental and Applied Physics, Kiel University, Kiel, Germany — [2]Universidad de Alcalá, Space Research Group, 28805 Alcalá de Henares, Spain — [3]Johns Hopkins University Applied Physics Laboratory, Laurel, MD, USA — [4]all over the world

Parker Solar Probe (PSP) and Solar Orbiter are investigating the inner heliosphere and approaching the Sun closer than any previous mission ever has. The state-of-the-art energetic particle instruments aboard the two spacecraft - together with other instruments on multiple spacecraft - present us with a wealth of data that are helping us to understand how the Sun shapes and controls the heliosphere.

Being so close to the Sun allows to disentangle transport effects from the original signatures of particle acceleration at the Sun. The sophisticated remote-sensing instrumentation provides crucial information about the solar source regions.

We will present new results from PSP and Solar Orbiter and provide an update on their current status.

EP 7.2 Wed 14:45 ZEU/0160

Anisotropies of solar energetic electrons in the MeV range measured with SolO/EPD/HET — •Sebastian Fleth[1], Patrick Kühl[1], Alexander Kollhoff[1], Robert F. Wimmer-Schweingruber[1], Bernd Heber[1], Javier Rodríguez-Pacheco[2], and Nina Dresing[3] — [1]Institute of Experimental & applied Physics, Kiel University, 24118 Kiel, Germany — [2]Space Research Group/Universidad de Alcalá, Madrid, Spain — [3]Department of Physics and Astronomy, University of Turku, Turku, Finland

Solar Orbiter is an ESA-led mission of international collaboration with NASA to investigate how the Sun creates and controls the heliosphere, and why solar activity changes with time. One of its top-level science questions is how solar eruptions produce energetic particle radiation that fills the heliosphere. With its four viewing directions the High-Energy telescope (HET) provides critical information about the sources and transport of high-energy particles. This study analyses relativistic electron measurements obtained by HET in the energy range from 200 keV to above 10 MeV. The purpose of this study is to analyse anisotropies of relativistic solar energetic electrons utilizing the different viewing directions of HET. Time periods with enhanced fluxes of relativistic electrons, have been identified. A list of these time periods including additional observations such as maximum energy and flux as well as the first order anistropy will be presented. This is the first time since the Helios mission that anisotropies of high energy electrons have been measured.

Invited Talk EP 7.3 Wed 15:00 ZEU/0160

New Insights in Simulations of SEP Events with the PARADISE+ICARUS Model — •Edin Husidic[1,2], Nicolas Wijsen[1,3,4], Tinatin Baratashvili[1], Stefaan Poedts[1,5], and Rami Vainio[2] — [1]KU Leuven, Belgium — [2]University of Turku, Finland — [3]NASA, Goddard Space Flight Center, Greenbelt, USA — [4]University of Maryland, USA — [5]University of Maria Curie-Skłodowska, Lublin, Poland

The study of solar energetic particle (SEP) events plays a particularly important role in space weather research. While propagating through interplanetary space, fast coronal mass ejections (CMEs) generate shock waves that can efficiently accelerate ions and protons to energies of deka-MeV and beyond, posing a significant threat to astronauts and spacecraft. It is thus of major concern to develop numerical simulations that can realistically model the acceleration and transport of SEPs. We present simulations of SEP events in the inner heliosphere with the novel PARADISE+ICARUS model. The MPI-AMRVAC-based ICARUS code generates realistic background solar wind configurations from 0.1 au onward that serve as input for PARADISE (PArticle Radiation Asset Directed at Interplanetary Space Exploration). By solving the focused transport equation in a stochastic manner, PARADISE obtains intensities of SEP distributions. Using ICARUS's ability of adaptive mesh refinement (AMR) allows us to increase the spatial resolution at interplanetary shock waves and investigate how simulation results are affected by it. Our results are compared to previous ones obtained by the AMR-lacking PARADISE+EUHFORIA model.

EP 7.4 Wed 15:30 ZEU/0160

Nonlinear diffusive shock acceleration in a spherical geometry* — •Dominik Walter, Horst Fichtner, and Frederic Effenberger — Ruhr-Universität-Bochum Tp4, Bochum, Germany

Based on previous investigations in a Cartesian geometry, we now discuss the influence of a self-consistent diffusion coefficient on the transport of energetic particles in a spherical geometry. The formulation of the diffusion coefficient is motivated by taking into account the diffusing particles' influence on the scattering centers in the background medium. The resulting single transport equation is nonlinear due to a dependence of the diffusion coefficient on the gradient of the particle distribution. After trying to predict, based on insights from linear theory, the behaviour of the solutions of the nonlinear equation in a shock acceleration model in spherical geometry, numerical methods are applied to the equation to explore the time evolution of the solutions and to investigate the features of the steady-state shock spectra. The results are dicussed in the context of Cosmix Ray modulation in the heliosphere.

*Supported by DFG (SFB\,1491)

EP 8: Sun and heliosphere III

Time: Wednesday 16:00–17:15 Location: ZEU/0160

Invited Talk EP 8.1 Wed 16:00 ZEU/0160

Precision measurements of cosmic ray fluxes from AMS-02 with a daily time resolution — •Stefan Schael — I. Physikalisches Institut, RWTH Aachen, Sommerfeldstr. 14, D-52074 Aachen

The Alpha Magnetic Spectrometer, AMS-02, is a general-purpose high-energy particle physics detector. It was installed on the International Space Station in May 2011 to conduct a unique long duration mission of fundamental physics research in space. In 11 years AMS-02 has continuously collected data from more than 200 billion cosmic rays. The AMS-02 precision measurements have revealed new and distinct information that change our understanding of the production, acceleration and propagation of charged cosmic rays. In this presentation the recent measurements of the proton, helium, electron and positron fluxes with a daily time resolution will be summarized. These new precision measurements provide unique inputs to the understanding of cosmic rays in the heliosphere.

EP 8.2 Wed 16:30 ZEU/0160

Studies of energetic particle transport in synthetic turbulence with intermittency features — •Frederic Effenberger, Jeremiah Lübke, Horst Fichtner, and Rainer Grauer — Ruhr-Universität Bochum, Theoretische Physik

The transport of fast charged particles in turbulent magnetic fields is a key research topic in space- and astrophysics. In particular, regimes of superdiffusive or subdiffusive propagation and interactions with large and small-scale coherent features are important to study in more detail. A common approach to investigate turbulence-particle interactions is based on full-orbit calculations of test-particle trajectories in artificially generated turbulence. These turbulence models have the advantage, when compared to an MHD approach, that they can potentially cover a wider dynamical range of turbulence scales. However, almost all synthetic turbulence models to this date only include second-order Gaussian statistics and thus fail to include coherent structures and intermittent features. Our new model is based on a continuous wavelet transform of a log-normal cascade process, which results in realistic intermittent scaling properties. We investigate the particle transport properties by solving a large number of particle orbits in these synthetic turbulence realisations and specifically look for non-diffusive regimes and non-standard energy dependences resulting from the intermittency of the generated fields. The implications for solar energetic particle and cosmic ray transport are discussed.

EP 8.3 Wed 16:45 ZEU/0160

Comparison of spatial diffusion tensors using an axisymmetric model of heliospheric modulation of cosmic rays — •Dustin Lee Schröder, Horst Fichtner, and Jens Kleimann — Ruhr-Universität Bochum, Bochum, Deutschland

A 3D partial differential equation solver is used to solve the steady state Parker transport equation for an axisymmetric model of the heliosphere in order to study the influence of spatial diffusion tensors on cosmic ray modulation. The diffusion tensor can either be specified as an analytical function or be used as a value calculated with a turbulence model.

EP 8.4 Wed 17:00 ZEU/0160

The effect of kinetic turbulence on particle transport — •Felix Spanier — Institut für Theoretische Astrophysik, Universität Heidelberg

The transport of energetic charged particles depends on the underlying turbulence. Commonly non-dispersive waves and associated turbulence models (Kolmogorov or in some cases Goldreich-Sridhar) are used in modeling transport parameters. For frequencies close to and beyond the ion-gyrofrequency these assumptions are not applicable anymore.

We have used MHD as well as Particle-in-Cell simulations to study the difference between transport of particles in non-dispersive fluid and dispersive kinetic models. We will focus specifically on the transport of particles moving perpendicular to the magnetic field. The results are specifically interesting for the diffusion of electrons and positrons which resonate with waves with frequencies beyond the ion gyrofrequency.

EP 9: Poster

Time: Wednesday 17:30–19:00 Location: HSZ OG1

EP 9.1 Wed 17:30 HSZ OG1

PUNCH4NFDI - Synergies & Services for SMuK — •Michael Zacharias for the PUNCH4NFDI Consortium-Collaboration — LSW, Universität Heidelberg

PUNCH4NFDI (Particles, Universe, NuClei & Hadrons) is a consortium of the NFDI, and merges the SMuK community's efforts to store, manage and connect (big) data streams and their related metadata following the FAIR principles. Here, I will present the Synergies & Services that PUNCH is going to offer to the community at large - with a focus on Astrophysics. The main tool will be the Science Data Platform, where any connected data can be accessed and analyzed. The Marketplace will be a community forum to share and distribute data management tools and scripts. I will present examples for such tools, namely the ontology platform phyics.tools and an arxiv search tool for software products used in research.

EP 9.2 Wed 17:30 HSZ OG1

Extragalactic neutrino factories — •Sara Buson[1], Andrea Tramacere[2], Leonard Pfeiffer[1], Lenz Oswald[1], Gaetan De Fichet Clairfontaine[1], Alessandra Azzollini[1], Vardan Baghmanyan[1], Marco Ajello[3], and Eleonora Barbano[1] — [1]Lehrstuhl für Astronomie, Universität Würzburg, Emil-Fischer-Straße 31, 97074, Würzburg — [2]Department of Astronomy, University of Geneva, Ch. d'Ecogia 16, Versoix, 1290, Switzerland — [3]Department of Physics and Astronomy, Clemson University, Kinard Lab of Physics, Clemson, SC 29634-0978, USA

Identifying the astrophysical sources responsible for the high-energy cosmic neutrinos has been a longstanding challenge. In a previous study, we report evidence for a spatial correlation between blazers from the 5th Roma-BZCat catalog and neutrino data collected by the IceCube Observatory in the Southern celestial hemisphere. The probability that such correlation is found by chance is about one in a million (2 x 10-6). In this conference contribution, we present an extension of the analysis to a complementary IceCube dataset, and put the findings into the context of the previous results.

EP 9.3 Wed 17:30 HSZ OG1

BlaST: A machine-learning estimator for the synchrotron peak of blazars — Theo Glauch and •Tobias Kerscher — Technische Universität München, Physik-Department, James-Franck-Str. 1, Garching bei München, D-85748, Germany

Blazars, jetted Active Galaxy Nuclei (AGN) pointing towards us, occupy an important place in the field of high-energy astrophysics. Their classification depends heavily on the peak frequency of the synchrotron emission in the spectral energy disitribution (SED), yet this value is usually determined manually. In this contribution, we present a tool using machine learning to not only streamline this process, but also give a reliable uncertainty evaluation. By the very nature of this method, additional components of the SED stemming from the host galaxy or disk emission, possible sources of confusion, are accounted for.

EP 9.4 Wed 17:30 HSZ OG1

Analytic solutions for the hadronic time-dependent two-zone blazar model — •Vito Aberham and Felix Spanier — Institut für Theoretische Astrophysik (ITA), Albert-Ueberle-Str. 2, 69120 Heidelberg

Active galactic nuclei's (AGN) distinct variability is examined analytically by applying an evolving two-zone model to their jets. It is focused on hybrid jets containing both electrons and protons, since they allow for the additional emission of neutrinos. The dominant source of variability, jets of AGN are characterized by the cooling process mainly driving the emergence of the spectral energy distribution's high-energy peak. A scenario comprising blazars with proton synchrotron radiation as the predominant emission mechanism for high energies, while, as usual, electron synchrotron radiation drives the low energy emission, is chosen here. Dominant emission due to cascades is among cases considered in upcoming works. Incorporating both their acceleration and cooling in the respective zones, the particle distributions are calculated by solving two coupled partial differential equations while the effect of second-order Fermi acceleration is neglected. The associated photon density is obtained, which, combined with the proton distribution, eventually yields the emerging neutrino flux. Both the according light curves and neutrino fluxes in specific energy bands are ultimately inferred, enabling comparisons to observed blazars. Ultimately, a tool, which simulates a blazar's flare by exploiting the analytical results' dependence on the set of free model parameters, is presented to very quickly cross-check numerical simulations at low computational cost.

EP 9.5 Wed 17:30 HSZ OG1

ComPol - A Compton polarimeter in a Nanosat — •Matthias Meier for the ComPol-Collaboration — Excellence Cluster ORIGINS, Garching, Germany — Technical University of Munich (TUM), Munich, Germany

It is hardly possible to resolve the geometry of astrophysical compact objects due to their small size. One possibility to indirectly learn about their structure are polarization measurements. Especially in the hard X-ray range polarization data is still partially missing. Therefore, the aim of the CubeSat mission ComPol is to improve the physical model of the black hole binary system Cygnus X-1 by measuring the polarization of its hard X-ray spectrum (20-200keV).
The detector system developed for the ComPol project is composed of a Silicon drift detector used as a scatterer and a $CeBr_3$ scintillator read out by a SiPM matrix. From the scintillation light distribution it is possible to determine the absorption position in the $CeBr_3$ which is done to capture the full Compton kinematics. The next step is to perform an event-wise reconstruction from the measured energies and interaction points. The resulting distribution of the azimuthal scatter angles allows to directly infer the polarization of the initial radiation.
The talk will give an overview of the scientific motivation, the underlying physics and the detector setup.
This research is supported by the Excellence Cluster ORIGINS which is funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under Germany's Excellence Strategy - EXC-2094-390783311

EP 9.6 Wed 17:30 HSZ OG1

Das Universum als Energiesystem ermöglicht die Große Vereinheitlichte Theorie — •Günter von Quast — Winterweg 4; 76344 Eggenstein-Leopoldshafen

Die *Neue Physik* geht von einem Universum aus, das aus einem Energiefeld besteht. Die physikalischen Parameter dieses Energiefeldes sind die Planck-Einheiten und belegen ein Medium mit Planck-Druck und Planck-Dichte und der Planck-Energie sowie der Planck-Masse und der Planck-Ladung und vielen weiteren physikalischen Parametern und mathematischen Beziehungen. Alle Vorgänge in diesem Energiefeld sind energetische Vorgänge. Dazu gehören die Energetische Strahlung als Licht aller Frequenzen und auch das Wesen der Gravitation. Auch die Materie entsteht in diesem Energiefeld und ist nur ein vorübergehender Aggregatzustand der Raum-Energie und kann sich somit auch wieder zu der Raum-Energie auflösen. Die Fusionsstrahlung der sich abbauenden Sterne füllt den Raum aus. Somit ist die Hintergrundstrahlung die Plancksche Schwarzkörperstrahlung als energetischer Zustand des Raumes. Energie geht nicht verloren und Materie verschwindet nicht in den Schwarzen Löchern der Galaxien, was zu beachten ist. Die Zentren der Galaxien sind Strudelsysteme in dem Feld der Raum-Energie. Die Materie entsteht in den Zenten der Galaxien. Die Materie besteht aus den Strudelfeldern, den Quarks und diese bilden die Elementarteilchen und Atome aus. Die Materie besteht aus der Energie des Feldes der Raum-Energie. Dafür gibt es die *Neue Physik* als Energiefeld-Theorie. Die Standard- Theorien erklären nicht die Natur der Physik des Universums.

EP 9.7 Wed 17:30 HSZ OG1

Unveiling the dense molecular environments of evolved massive stars — •Michaela Kraus[1], María Laura Arias[2], Michalis Kourniotis[1], Andrea Torres[2], and Lydia S. Cidale[2] — [1]Astronomical Institute, Czech Academy of Sciences, Ondřejov, Czech Republic — [2]Instituto de Astrofísica de La Plata, CONICET, UNLP, La Plata, Argentina

The evolution of massive stars passes through states with intense mass-loss and eruptions, leading to the formation of dense and warm circumstellar environments, in which molecules and dust can form. Our research focuses on two specific such evolutionary stages: the B[e] supergiants and the yellow hypergiants, with the aim to reveal the structure and dynamics of their circumstellar matter. For this, we collected high-resolution near-infrared spectra for a sample of stars, using facilities at GEMINI Observatory. We discovered emission from hot CO gas in a few objects, based on which we derive the gas temperature, column density and kinematics within the line-forming regions. Interestingly, the yellow hypergiants and the B[e] supergiants with CO band emission share the same evolutionary tracks, and we discuss possible implications of this finding regarding potential evolutionary connections between these two phases.

EP 9.8 Wed 17:30 HSZ OG1

Evolution and radio emission of interacting plasma bunches in pulsar magnetospheres — •Jan Benáček[1], Patricio Muñoz[2,3], Jörg Büchner[3,2], and Axel Jessner[4] — [1]Intitute for Physics and Astronomy, University of Potsdam, Germany — [2]Max Planck Institute for Solar System Physics, Göttingen, Germany — [3]Center for Astronomy and Astrophysics, Technical University of Berlin, Germany — [4]Max Planck Institute for Radio Astronomy, Bonn, Germany

Pulsars are neutron star that emits coherent radio beams out of their magnetic poles. However, the origin of their radio emission is still under investigation. One of the proposed emission mechanisms exploits plasma bunches/clouds of electron-positron pairs created during spark events in gap regions. We utilized particle-in-cell simulations of relativistically hot bunches to investigate the bunch's nonlinear evolution and radiation by linear acceleration emission. We found that the main parameter influencing the bunch evolution is the initial drift velocity between electrons and positrons. For zero drift, the bunches can freely expand, and adjacent bunches may overlap in the phase space and form relativistic streaming instability. Otherwise, for non-zero drifts, the bunches are constrained from expansion and form strong oscillating electrostatic fields. Plasma particles may oscillate in these fields and emit radio waves. Furthermore, we found that the bunches constrained from expansion have similar observational characteristics as those observed for pulsars. Their spectrum contains a flat part for low frequencies and power-law profiles for higher frequencies.

EP 9.9 Wed 17:30 HSZ OG1

Quantitative spectroscopy of B-type supergiants — •David Wessmayer[1], Norbert Przybilla[1], and Keith Butler[2] — [1]Institut für Astro- und Teilchenphysik, Universität Innsbruck, Technikerstr. 25/8, 6020 Innsbruck, Austria — [2]LMU München, Universitätssternwarte, Scheinerstr. 1, 81679 München, Germany

B-type supergiants are a resourceful tool in adressing various astrophysical questions concerning stellar atmospheres, stellar and galactic evolution and the cosmic distance scale. To facilitate a comprehensive analysis of these objects we assess the applicability of a hybrid non-LTE approach, in which line-blanketed model atmospheres computed under the assumptions of local thermodynamic equilibrium (LTE) are combined with non-LTE line-formation calculations. High-resolution Echelle spectra – constituting an observational sample of 14 Galactic B-type supergiants with masses below about 30 $M_\odot$ – serve as the basis of this investigation. The results of the analysis, including atmospheric and fundamental stellar parameters, multi-species abundances and derived spectroscopic distances, are probed via multiple checks of consistency. Finally, we also test the employed methodology for analyses of intermediate-resolution spectra of extragalactic B-type supergiants.

EP 9.10 Wed 17:30 HSZ OG1

Characterization of B supergiant variability — •Suryani Guha[1,2], Michaela Kraus[1], and Julieta Arias Sanchez[1] — [1]Astronomical Institute, Czech Academy of Sciences, Ondrejov, Czech Republic — [2]Charles University, Prague, Czech Republic

B supergiants (BSGs) are famous for their spectroscopic variability that has been assigned to pulsations and related changes in their stellar wind properties. The pulsation modes of BSGs are strongly correlated to the stellar evolution phase. When a massive star has lost significant mass during its red-supergiant stage, it would return to the blue region in the Hertzsprung-Russell diagram and spend a part of the core-He burning stage as a BSG. In this particular phase it excites many pulsation modes including radial strange modes. The latter have been proposed to facilitate mass-loss. Our studies utilize data from the TESS (Transiting Exoplanet Survey Satellite) mission, which revealed that numerous BSGs display a rather irregular behaviour of their light curves, a likely indicator of radial strange mode pulsations. The optical spectra obtained from our observation campaign with the PEREK 2-m telescope are analyzed to search for variations in temperature and radius. Any detected variability can be directly linked with radial pulsations. Moreover changes in the strength and profile of the H-alpha line provide complementary information about wind variability. In this poster we will present highlights from a few interesting stars selected from our target list.

EP 9.11 Wed 17:30 HSZ OG1

Local HD flows at the Apex of an Astropause — •Kuljeet Singh Saddal[1,2] and Dieter H Nickeler[1] — [1]Astronomical Institute AV CR Ondrejov, Fricova 298, 25165 Ondrejov, Czech Republic — [2]Charles University, Faculty of Mathematics and Physics, V Holešovickách 2, 180 00 Praha 8, Czech Republic

Astrospheres are the interaction regions between the stellar wind and the ambient interstellar medium, which consists of various HD (or MHD) discontinuities. Astropause is a contact discontinuity that separates the two flows, and its structure is described by one of the separatrices of the fluid flow. In 2D, there must be at least one X-type null point (X-point) close to the apex. This analysis aims to study hydrodynamically the geometrical and topological structures of the streamlines in the vicinity of the X-point. As the flow close to the apex can be considered incompressible, one can make use of stream functions to describe such flows. The definition of streamlines, along with the equations of ideal HD, gives a single, (non-)linear elliptic partial differential equation, known as the Grad-Shafranov equation (GSE). This equation is analysed by approximating the stream function close to the null point as a series of polynomials to various orders, and assuming specific forms for the pressure function. Depending on the choice of the pressure function and the order at which the polynomial is truncated, either the original null point can become an X-point of higher order, or more null points can appear in its vicinity. Moreover, an isotropic pressure might not exist for every choice of stream functions, and hence adding an extra anisotropic term becomes important.

EP 9.12 Wed 17:30 HSZ OG1

The Liquid Metallic Hydrogen Model of the Sun — •Alexander Unzicker — Pestalozzi-Gymnasium München

Though the standard solar model based on a gaseous plasma dominates the scientific discourse, a considerable amount of experimental evidence may also be interpreted assuming a real, liquid surface of the sun, as proposed by Robitaille (Progress in physics vol.3, 2011). Data from new missions must be open to such a different paradigm.

EP 9.13 Wed 17:30 HSZ OG1

Extending SOHO-EPHINs energy range for Helium nuclei — •Malte Hörlöck, Bernd Heber, Patrick Kühl, and Stefan Jensen — Christian-Albrechts-Universität zu Kiel

Galactic cosmic rays are composed mainly of protons, helium nuclei and electrons. The flux of these particles is modulated due to the heliospheric magnetic field that shields lower energy particles from the heliosphere. Hence, the flux depends on the solar activity. During phases of low and high solar activity, a maximum and minimum in the flux is observed, respectively. The SOlar and Heliospheric Observatory (SOHO) was launched in 1995. The Electron Proton Helium INstrument (EPHIN) onboard SOHO is a particle telescope, consisting of a stack of 6 silicon semiconductor detectors surrounded by an anticoincidence detector. The instrument stops protons and helium nuclei up to energies of 51 MeV/nucleon. At higher energies, these particles penetrate the telescope. As shown previously EPHIN provides sufficient information to obtain the flux of protons up to an energy of about a GeV. Here we investigate the instrument capabilities to obtain helium fluxes for energies above 51 MeV/nucleon using the dE/dx-dE/dx-method. However, the task is hampered by the fact that two detectors became noisy in 1998 and 2017, respectively. Thus, extensive modeling utilizing the GEANT4 package is needed in order to derive helium fluxes up to about 100 MeV/nucleon.

EP 9.14 Wed 17:30 HSZ OG1

Flux-rope nonequilibrium in the slow-rise phase of solar eruptions — •Bernhard Kliem — Universität Potsdam, Institut für Physik und Astronomie

Solar eruptions are nearly always preceded by a slow-rise phase that comprises an ascent of the eventually erupting filament (or prominence) in the corona and a slow increase of the soft X-ray flux. This is a distinct phase characterized by intermediate velocities of typically several 10 $\mathrm{km\,s^{-1}}$ (in active regions up to $\sim 100\ \mathrm{km\,s^{-1}}$), 1–2 orders of magnitude faster than the quasi-static evolution during energy storage, which scales with the driving photospheric velocities, and 1.5–3 orders of magnitude below the coronal Alfvén velocity, V_A, which is the scaling parameter of eruption speeds and their upper limit. Proposed mechanisms of this phase range from distributed small-scale ("tether-cutting") reconnection events in sheared field to a nonequilibrium and even ideal magnetohydrodynamic instability of a flux rope. I present simulations of flux cancellation that show the formation of a flux rope, a quasi-static evolution with a rise speed similar to the imposed photospheric driver, then a slightly faster rise, gradually accelerating up to $\approx 10^{-2}\ V_A$, and eventually the eruption of the rope by onset of the torus instability. The flux rope is shown to be in a nonequilibrium state during the slow rise.

EP 9.15 Wed 17:30 HSZ OG1

Neutral Current Sheet Displacement in Reaction to the Radial Interplanetary Magnetic Field at Mercury: Statistical Results from MESSENGER Data. — •Daniel Heyner[1], Kristin Pump[1], David Hercik[2], Willi Exner[3], Yasuhito Narita[4], Ferdinand Plaschke[1], Daniel Schmid[4], Jim Slavin[5], and Martin Volwerk[4] — [1]TU Braunschweig, Braunschweig, Germany — [2]Institute of Atmospheric Physics, Prague, Czech Republic — [3]ESA, Noordwijk, Netherlands — [4]IWF, Graz, Austria — [5]University of Michigan, Ann Arbor, USA

Mercury possesses a small magnetosphere and on the nightside, a neutral current sheet elongates the magnetic field lines. From hybrid simulations it is known that this current sheet reacts to changes in the interplanetary magnetic field (IMF). The radial IMF at Mercury facilitates magnetopause reconnection in high latitudes which decreases the magnetic pressure in one of the magnetospheric lobes depending on the radial IMF polarity. This produces a north-south shift of the neutral sheet. We present statistical results from in-situ MESSENGER magnetic field data analysis on the IMF direction as well as the neutral sheet displacement. MESSENGER was a single probe in orbit around Mercury and it was blind to the IMF after having entered the bow shock. We need to estimate the current IMF radial polarity for the time with the probe inside the magnetosphere. We evaluate different interpolation methods with an adapted bootstrap analysis method on solar wind data at Mercury. The analysis results on the neutral sheet displacement is compared to hybrid simulations done in the past.

EP 9.16 Wed 17:30 HSZ OG1

Concepts for the measurement of permittivity profiles in extraterrestrial cryospheres to improve subsurface radar images — •Gianluca Boccarella, Fabian Becker, Alexander Kyriacou, and Klaus Helbing — Bergische Universität Wuppertal, Gaußstraße 20, 42119 Wuppertal

Icy moons like Europa and Enceladus may contain microbial life in their subsurface oceans. Surface and subsurface imaging with radar is a promising technique to investigate their interior and identify a target for a subsurface exploration with melting probes. The main uncertainty of radar images is the unknown permittivity (ϵ) of the medium through which the electromagnetic waves travel. Therefore, we developed two methods to measure the ϵ from the medium of interest. Both methods were successfully tested on alpine glaciers as comparable terrestrial environments and the results will be presented. The initiatives involved are the DLR-funded projects EnEx and TRIPLE.

The first method is a cross-borehole FMCW radar: by sending signals between two antennas, it is possible to use the time of flight for permittivity reconstruction. An inversion of radio propagation simulations is used to reconstruct the permittivity profile from time of flight measurements at different depths. The second approach is to use a permittivity sensor, which is placed in a melting probe with an integrated radar system. This sensor can measure in the near field of the melting probe and immediately corrects the radar image. It represents a part of the forefield reconnaissance system being developed for melting probes.

EP 9.17 Wed 17:30 HSZ OG1

About the Radiative Transfer (RT) and inversion codes used in the characterization of planetary atmospheres — Rengel Miriam[1] and •Adamczewski Jakob[1,2] — [1]Max-Planck-Institut für Sonnensystemforschung — [2]Georg-August-Universität Göttingen

This contribution represents a tour on Radiative Transfer (RT) and inversion codes used in the planetary and exoplanetary communities from the perspective of a user. Such codes predict and interpret spectra of planetary atmospheres (hydrostatic equilibrium atmospheres and expanding comas) and infer atmospheric properties like temperature and abundance profiles (forward modelling and inversion algorithm, respectively). The retrieved atmospheric properties can offer crucial information into the atmospheric physico-chemical processes of planets and their formation mechanisms.

Here we present a mini overview of some existing forward and inversion codes used in the planetary science and some examples of applications. Space and ground-based telescope facilities used in the field (feasibility studies, observational planning, etc.) depend on the quality and extent of these codes.

EP 9.18 Wed 17:30 HSZ OG1

Retrieval of planetary albedo and cloud's properties of Earth with spectropolarimetry — •Giulia Roccetti[1,2], Michael Sterzik[1], Claudia Emde[2], and Mihail Manev[2] — [1]European Southern Observatory, Garching bei München, Germany — [2]Ludwig-Maximilians-Universität München, München, Germany

To prepare the search for life outside our Solar System, we must characterise Earth as an exoplanet. In this work we present a novel approach to retrieve the planetary albedo and cloud's properties (mean water cloud optical depth and cloud cover) of Earth with spectropolarimetry. Incoming (unpolarised) stellar light is polarised by molecular or particle scattering in the Earth's atmosphere or from reflection at the planetary surface. The polarization phase curve, and its spectral dependencies, allow to constrain many atmospheric and surface properties of the planet.

We show that planetary albedo can be retrieved analyzing the slope of the polarization spectra, while for the could's properties we use a two-tier approach: we first determine the mean optical depth using the cloudbow feature at small phase angles (for a wavelength in the near-infrared range), and then we estimate the cloud cover using the maximum of the phase curve (for a wavelength in the B band).

The results are compared with Earthshine observations, i.e. sunlight scattered by the dayside Earth and reflected back to Earth from the darker portion of the visible moon, which allows to observe the Earth as an exoplanet at different phase angles, as the relative Sun-Earth-Moon viewing geometry changes.

EP 9.19 Wed 17:30 HSZ OG1

Empirical modelling of SSUSI-derived auroral ionization rates — •Stefan Bender[1,2], Patrick Espy[1,2], and Larry Paxton[3] — [1]Norwegian University of Science and Technology, Trondheim, Norway — [2]Birkeland Centre for Space Science, Bergen, Norway — [3]APL, Johns Hopkins University, Laurel, Maryland, USA

Solar, auroral, and radiation belt electrons enter the atmosphere at polar regions leading to ionization and affecting its chemistry. Climate models usually parametrize this ionization and the related changes in chemistry based on satellite particle measurements. Widely used particle data are derived from the POES and GOES satellite measurements which provide in-situ electron and proton spectra.

Here we use the electron energy and flux data products from the Special Sensor Ultraviolet Spectrographic Imager (SSUSI) instruments on board the Defense Meteorological Satellite Program (DMSP) satellites. The currently three operating satellites directly observe the auroral emissions in the UV on a ≈3000 km wide swath with a $\approx 10{\times}10\ \mathrm{km}^2$ pixel resolution. From the UV emissions electron energies and fluxes are inferred in the range from 2 keV to 20 keV. We use these observed electron energies and fluxes to calculate auroral ionization rates in the lower thermosphere (90–150 km). We present an empirical model of these ionization rates according to magnetic local time and geomagnetic latitude. The model is particularly targeted for use in climate models that include the upper atmosphere, such as WACCM-X or EDITh. We also present a comparison to current implementations for ionization rates used in these two models.

EP 9.20 Wed 17:30 HSZ OG1

Modeling of the count and dose rate of the DOSimetry TELescope (DOSTEL) aboard the International Space Station — Hanna Giese, Sönke Burmeister, •Bernd Heber, Konstantin Herbst, and Lisa Romaneehsen — Christian-Albrechts-Universität Kiel

The DOSimetry Telescope (DOSTEL) measures the radiation environment within the Columbus module of the International Space Station (ISS) by utilizing two semiconductor detectors. The Earth is continuously exposed to galactic cosmic rays and occasionally by Solar Energetic Particles. The magnetized solar wind in the heliosphere and the Earth's magnetic field alters the flux of these particles. In addition these particles need to propagate through the Earth magnetosphere leading to maximum and minimum fluxes at polar and equatorial latitudes. This dependency can be described by the Dorman function. In combination with the primary spectra of ions approximated by the force field solution, the Dorman function is ideally suited to describe the response of the instrument within the ISS. Thus it is sufficient to determine the response function (yield) for a few selected periods. In order to validate the yield function we predict the measurements for other periods including Forbush Decreases and compare to the actual observations.

We received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 870405.

EP 10: Astrophysics: Cosmic Rays and Galaxies I

Time: Thursday 11:00–13:00 Location: ZEU/0160

Invited Talk EP 10.1 Thu 11:00 ZEU/0160

Arne-Richter Lecture: From nonthermal plasmaastrophysics to modeling of pandemic outbreaks — •Reinhard Schlickeiser — Institut für Theoretische Physik, Lehrstuhl IV: Weltraum- und Astrophysik, Ruhr-Universität Bochum, D-44780 Bochum, Germany — Institut für Theoretische Physik und Astrophysik, Christian-Albrechts-Universität zu Kiel, Leibnizstr. 15, D-24118 Kiel, Germany

During the last 45 years of my career I almost exclusively did research on topics of nonthermal astrophysics including gamma-ray astronomy, radio astronomy, cosmic ray transport and acceleration in partially turbulent electromagnetic fields, astroparticle physics, kinetic theory of fluctuations in collision-poor plasmas and cosmological magnetogenesis. I had the privilege to meet and interact with a number of splendid and marvelous scientists including Arne Richter. In the talk I will cover important milestones of my career and summarize my positive experiences with fellow scientists.

EP 10.2 Thu 11:45 ZEU/0160

Modelling magnetic turbulence with log-normal intermittency by continuous cascades* — •Jeremiah Lübke[1], Frederic Effenberger[2], Horst Fichtner[2], and Rainer Grauer[1] — [1]Institute for Theoretical Physics I, Ruhr-University Bochum, Universitätsstr. 150, 44801 Bochum — [2]Institute for Theoretical Physics IV, Ruhr-University Bochum, Universitätsstr. 150, 44801 Bochum

The transport of cosmic rays in turbulent magnetic fields is commonly investigated by solving the Newton-Lorentz equation of test particles in synthetic turbulence fields. These fields are typically generated from superpositions of Fourier modes with prescribed power spectrum and uncorrelated random phases, bringing the advantage of covering a wide range of turbulence scales at managable computational effort. However, almost all of these models to date only account for second-order Gaussian statistics and thus fail to include intermittent features. Recent observations of the solar wind suggest that astrophysical magnetic fields are strongly non-Gaussian, and the question of how such higher-order statistics impact cosmic ray transport has only received limited attention. To address this, we present an algorithm for generating synthetic turbulence based on Kolmogorov's log-normal model of intermittency. It generates a divergence-free magnetic field by computing the curl of a vector potential, which in turn is obtained from an inverse wavelet transform of a continuous log-normal cascade process. We investigate the statistics of the generated fields, show that anomalous scaling properties are accurately reproduced and discuss implications on cosmic ray transport. *Supported by DFG (SFB 1491)

EP 10.3 Thu 12:00 ZEU/0160

From test particle simulations to cosmic-ray transport — Marco Kuhlen, •Vo Hong Minh Phan, and Philipp Mertsch — TTK, RWTH Aachen University, Aachen, Germany

The transport of high-energy particles in the presence of small-scale, turbulent magnetic fields is a long-standing issue in astrophysics. Analytical theories disagree with numerical simulations at rigidities where the particles' gyroradii are slightly smaller than the correlation length of turbulence. At the same time, extending the numerical simulations to lower rigidities has proven computationally prohibitive. In this talk, we will discuss a solution to the problem of perpendicular transport in isotropic turbulence at both, high and low rigidities. Our study has important implications for the transport of Galactic cosmic rays, acceleration at perpendicular shocks and for high-energy particles in the heliosphere.

EP 10.4 Thu 12:15 ZEU/0160

Particle acceleration capability of a black hole at the Galactic centre — •Arman Tursunov — Institute of Physics, Silesian University in Opava, Czech Republic — Max Planck Institute for Radio Astronomy, Bonn, Germany

A compact supermassive source Sagittarius A* located at the centre of our Galaxy has been observed at different wavelengths across the electromagnetic spectrum. It is the closest and largest in projection supermassive black hole candidate. At the same time, its particle acceleration capability related to the cosmic ray and neutrino messengers were not yet experimentally probed despite indirect indications of the existence of a PeVatron at the Galactic centre. In this talk, I will present a novel scenario of particle acceleration at the Galactic centre involving electromagnetic extraction of rotational energy from the central black hole. I will show that the maximum energy of accelerated protons may reach a few PeV at the source, contributing thus to the knee of the observed cosmic ray spectrum.

EP 10.5 Thu 12:30 ZEU/0160

Multi-wavelength modelling of FR0 galaxies — •Therese Paulsen[1] and Foteini Oikonomou[2] — [1]Bergische Universität Wuppertal, Gaußstraße 20, 42119 Wuppertal, Germany — [2]Norwegian University of Science and Technology, Høgskoleringen 5, NO-7491 Trondheim, Norway

In the last decade, high-sensitivity radio and optical surveys have unveiled a new class of radio galaxies, called the Fanaroff-Riley type 0 (FR0). Due to their abundance in the local universe, this source class is of particular interest in the context of multi-messenger analyses as a possible neutrino emitter. The properties of FR0s at γ-ray energies are still largely unexplored due to the lack of observational data. However, observations have been made for the galaxies LEDA 55267, LEDA 57137, and LEDA 58287.

The multi-wavelength emission of these galaxies was modeled to determine the physical conditions under which the observed radiation is generated. The synchrotron, synchrotron self-Compton and the external Compton processes were considered. As a first result, we find that all the sources are consistent with being powered by the synchrotron self-Compton mechanism.

EP 10.6 Thu 12:45 ZEU/0160

Bayesian Inference of the 3D Galactic HI-Gas Density — •Laurin Söding, Philipp Mertsch, and Vo Hong Minh Phan — Institute for Theoretical Particle Physics and Cosmology, RWTH Aachen University, Aachen, Germany

While other galaxies can be observed with various techniques in great detail and precision, the structure of our own galaxy is mostly obscured from view due to our vantage point. Creating a 3D map of e.g. HI gas density or magnetic fields is therefore a challenging task. We have used the 21-cm emission line from atomic hydrogen - together with a velocity model - to reconstrcut a 3D-map of the galactic distribution of HI gas using new Bayesian inference techniques. While the first results look very promising, we have characterised systematic uncertainties of the method due to, e.g. the choice of velocity model. In the future, we will strive to determine velocity fields and gas densities in a common inference machinery to obtain the best maps of the Galaxy yet.

EP 11: Near-Earth Space I

Time: Thursday 14:00–15:30 Location: ZEU/0160

Invited Talk EP 11.1 Thu 14:00 ZEU/0160

Energetic Particle Precipitation reflected in the Global Secondary Ozone Distribution — •Jia Jia[1,2], Lisa E. Murberg[1,3], Tiril Løvset[1], Yvan J. Orsolini[1,3], Patrick J. Espy[1,2], Jude Salinas[4,5], Jae N. Lee[4,5], Dong Wu[4], and Jiarong Zhang[6] — [1]Norwegian University of Science and Technology (NTNU), Trondheim, Norway — [2]Birkeland Centre for Space Science (BCSS), Norway — [3]NILU - Norwegian Institute for Air Research, Kjeller, Norway — [4]NASA Goddard Space Flight Center, Greenbelt, Maryland, USA — [5]University of Maryland, Baltimore County, Maryland, USA — [6]Coastal Carolina University, Conway, South Carolina, USA

The secondary ozone layer is a global peak in ozone abundance in the upper mesosphere-lower thermosphere (UMLT) around 90-95 km. The effect of energetic particle precipitation (EPP) from geomagnetic processes on this UMLT ozone has not been well studied. In this research we investigated how the secondary ozone response to EPP from the Microwave Limb Sounder (MLS) and the Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) instrument on the Aura and TIMED satellites, respectively. In addition, the Whole Atmosphere Community Climate Model with thermosphere and ionosphere extension and specified dynamics (SD-WACCM-X) was used to characterize the residual circulation during EPP events. By comparing ozone and circulation changes under High- and low-Ap conditions, we report regions of secondary ozone enhancement or deficit across low, mid and high latitudes as a result of circulation and transport changes induced by EPP.

EP 11.2 Thu 14:30 ZEU/0160

Comparison of D-region ion-chemistry in ExoTIC and EMAC with MIPAS observations — •Monali Borthakur[1], Miriam Sinnhuber[1], Thomas von Clarmann[1], Gabriele Stiller[1], and Bernd Funke[2] — [1]Karlsruhe Institute of Technology, Karlsruhe, Germany — [2]Instituto de Astrofísica de Andalucía, CSIC, Granada, Spain

Energetic particle precipitation (EPP) and ion chemistry affect the neutral composition of the polar middle atmosphere. For example, production of odd nitrogen and odd hydrogen during strong events like solar proton events can decrease ozone. However, the standard ion chemistry parameterisation used in atmospheric models neglects the effects on some important species. Studies have also shown that the increase of some species measured during solar proton events (SPEs) cannot be reproduced using the standard parameterisation of HOx and NOx production, while models considering D-region ion chemistry in detail agree better with the observations. Here we present results with D-region ion-chemistry in a 1D model ExoTIC and 3D model EMAC, which includes a set of lower ionosphere (D-region) chemistry: 413 reactions of 46 positive ions and 28 negative ions. Using AISSTORM ionisation rates, ExoTIC and EMAC simulations in the Northern polar region are compared with MIPAS satellite observations for the Halloween SPE of 2003. A focus is on the analysis of the chemical composition changes of different species due to the chlorine ion-chemistry in EMAC.

EP 11.3 Thu 14:45 ZEU/0160

Ring current electron precipitation during multiple geomagnetic storm events: the mechanism and the effect on the atmosphere — •Alina Grishina[1,2], Yuri Shprits[1,2,3], Miriam Sinnhuber[4], Michael Wutzig[1], Hayley Allison[1], Dedong Wang[1], Alexander Drozdov[3], and Matyas Szabo-Roberts[1] — [1]GFZ German Research Centre for Geosciences, Potsdam, Germany — [2]University of Potsdam, Potsdam, Germany — [3]University of California, Los Angeles, Los Angeles, CA, USA — [4]Karlsruhe Institute of Technology, Karlsruhe, Germany

The particle flux in the near-Earth environment can increase by orders of magnitude during geomagnetically active periods, which leads to intensification of particle precipitation into Earth's atmosphere and can further affect atmospheric chemistry and temperature. In this research, we concentrate on ring current electrons and investigate precipitation mechanisms using a numerical model based on the Fokker-Planck equation.

We investigate a time period that covers 4 corotating interaction region and 2 coronal mass ejection storms. Our results are validated against observations from the POES satellite mission, low Earth orbiting meteorological satellites, and Van Allen Probes. Maps of precipitating modeled fluxes for different energies allow us to understand in which regions on Earth precipitation is the most intensive. The output of the model is further used for calculation of ionization rates at different altitudes, allowing it to estimate effects of geomagnetically active periods on chemical and physical variability near the polar areas.

EP 11.4 Thu 15:00 ZEU/0160

A new approach to constrain space weather effects on the Earth's atmosphere — •Florian Haenel[1], Miriam Sinnhuber[1], Alina Grishina[2], and Yuri Shprits[2] — [1]Karlsruhe Institute of Technology, Eggenstein-Leopoldshafen, Germany — [2]Helmholtz Centre Potsdam, GFZ German Research Centre for Geosciences, Potsdam, Germany

We investigate the impact of space weather on the Earth's middle atmosphere and its climate system using state of the art numerical models of the magnetosphere and atmosphere. In particular, we study the impact of electrons with medium-range energy, mostly from the Earth's radiation belts, lost into the atmosphere during geomagnetic storms. Previous studies, using ionization rates, based on electron fluxes measured by satellites show an underestimation of produced NOx ($NO+NO_2$) by comparison with satellite observations and exhibit a large uncertainty. NOx produced by electron precipitation in the mesosphere and lower thermosphere is the starting point of the so-called "indirect effect" altering stratospheric temperatures and winds, which even might impact surface climate. As consequence, this effect is consistently being underestimated in chemistry-climate models. We use a new approach to shed light on these uncertainties. We use precipitating electron fluxes simulated by the magnetospheric model VERB-4D, which will serve as an input for chemistry-climate simulations by the atmospheric model EMAC. Here, we will apply this combination of models in a case study of a geomagnetic active period in March/April 2010 and compare with previous data sets.

EP 11.5 Thu 15:15 ZEU/0160

Good timing — •David Wenzel — Deutsches Zentrum für Luft- und Raumfahrt, Institut für Solar-Terrestrische Physik, Neustrelitz

Several quantities observable on Earth follow day or year trends due to a significant impact of Sun light. The DLR Neustrelitz is for instance monitoring radio signals for reconstructing ionospheric properties in order to gain a deeper insight into the general coupling processes as well as developing warning systems for protecting technological systems from harm or malfunctioning by sudden disturbances like solar flares. The GIFDS (Global Ionospheric Flare Detection System) network of VLF receivers aims at issuing immediate alerts when possibly harmful flare events occur. The continously available VLF signals are heavily influenced by these. However, the measurements also experience a pronounced daytime variation, which has to be taken into account in designing warning algorithms. On the other side, the long-term observations moreover unveil annual characteristics. There is a sharp decrease of signal amplitudes during fall that is not symmetric to the increase in spring. This "October effect" is investigated in the project AMELIE. Grasping the year trends here will improve our view on the physics behind. Giving measurements an analytic representation is of interest for many reasons, but can turn out to be complicated. We will demonstrate that by adjusting the time scale in certain natural manner, modelling becomes easier with respect to appropriate ansatz functions and more accessible to relevant properties.

EP 12: Near-Earth Space II

Time: Thursday 15:45–17:15 Location: ZEU/0160

Invited Talk EP 12.1 Thu 15:45 ZEU/0160

Ultra-relativistic Electrons in the Earth's Van Allen Radiation Belts — •Yuri Y. Shprits[1,2,3], Hayley Allison[1], Nikita Aseev[1], Dedong Wang[1], and Alexander Drozdov[3] — [1]Department of Geophysics, German Research Center for Geociences, GFZ, Potsdam, Germany — [2]Institute of Physics and Astronomy, University of Potsdam, Germany — [3]Department of Earth, Planetary, and Space Sciences, UCLA

New measurements from the NASAs Van Allen Probes demonstrate that the Earth radiation belts cannot be considered as a bulk population above approximately electron rest mass, but ultra-relativistic electrons form a new population that shows a very different morphology and behavior. We show that acceleration to multi-MeV occurs locally due to energy diffusion by whistler mode waves. Local heating appears to be able to transport electrons in energy space from 100s of keV all the way to ultra-relativistic energies. Acceleration to such high energies occurs only for the conditions when cold plasma in the trough region shows extreme depletions. The difference between the loss mechanisms at MeV and multi-MeV energies is due to EMIC waves that can very efficiently scatter ultra-relativistic electrons but leave MeV electrons unaffected. We also present how the new understanding can be used to produce the most accurate data-assimilative forecast. Under the recently funded EU Horizon 2020 Project Prediction of Adverse effects of Geomagnetic storms and Energetic Radiation (PAGER), we will study how ensemble forecasting from the Sun can produce long-term probabilistic forecasts of the radiation environment.

EP 12.2 Thu 16:15 ZEU/0160

Magnetospheric formation processes of the diffuse aurora: Sensitivity of wave-induced electron scattering to the hot electron distribution — •Katja Stoll[1,2], Leonie Pick[1], Dedong Wang[3], and Yuri Shprits[2,3,4] — [1]DLR Institute for Solar-Terrestrial Physics, Neustrelitz, Germany — [2]University of Potsdam, Potsdam, Germany — [3]GFZ Potsdam, Potsdam, Germany — [4]University of California, Los Angeles, CA, USA

Resonant wave-particle interactions in the Earth's magnetosphere can lead to the scattering of plasma sheet electrons which in turn cause the optical phenomenon of diffuse aurora. Specifically, electrostatic electron cyclotron harmonic (ECH) waves can effectively precipitate hundreds of eV to tens of keV electrons into the upper atmosphere. This process can generally be treated as a diffusion problem, requiring the numerical calculation of bounce-averaged quasi-linear diffusion coefficients.

ECH waves are thought to be generated by the loss cone instability of the ambient hot electron distribution. Therefore, the determination of ECH wave-induced scattering rates requires information about the properties of the hot plasma sheet electrons responsible for the wave excitation. We report our progress on analysing the sensitivity of ECH wave-induced electron scattering effects to the temperature of the hot electron components, which has an influence on the growth rate of the waves.

EP 12.3 Thu 16:30 ZEU/0160

Measurements of cosmic rays by a mini neutron monitor aboard the German research vessel Polarstern. — •Bernd Heber[1], Sönke Burmeister[1], Hanna Giese[1], Konstantin Herbst[1], Lisa Romaneehsen[1], Carolin Schwerdt[2], Dutoit Strauss[3], and Michael Walter[2] — [1]Christian-Albrechts-Universität Kiel, D — [2]Deutsches Elektronen-Synchrotron DESY in Zeuthen, D — [3]Center for Space Research, NWU Potchefstroom, SA

Neutron monitors are ground-based devices that measure the secondary particle population, i.e., neutrons produced by, e.g., galactic cosmic rays (GCRs). Due to their functionality, they are integral counters whose flux is proportional to the variation of the input spectrum. However, the measured flux also depends on the geomagnetic position and the pressure at the monitor's location. To better understand the NM response regular monitoring of the GCR intensity as a function of latitude is needed. Therefore a portable NM was installed aboard the German research vessel Polarstern in 2012. The vessel is ideally suited for this research campaign because it covers extensive geomagnetic latitudes (i.e., goes from the Arctic to the Antarctic) at least once per year. Since the installation aboard the vessel, 12 latitude scans were performed, allowing us to compute the so-called yield function by experimental means presented in this contribution.

The Kiel team received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 870405. The team would like to thank the crew of the Polarstern and the AWI for supporting our research campaign.

EP 12.4 Thu 16:45 ZEU/0160

Yield function of the DOSimetry TELescope (DOSTEL) count and dose rates aboard an aircraft — •Lisa Romaneehsen, Hanna Giese, Bernd Heber, Konstantin Herbst, and Sönke Burmeister — Christian-Albrechts-Universität Kiel

The Earth is continuously exposed to galactic cosmic rays. The magnetized solar wind in the heliosphere and the Earth's magnetic field alters the flux of these particles. If cosmic rays hit the atmosphere, they can form secondary particles. The total flux measured within the atmosphere depends on the atmospheric density above the observer. Therefore, the ability of a particle to approach an aircraft depends on its energy, the altitude, and the position of the plane. The cutoff rigidity describes the latter.

The radiation detector of the detector system NAVIDOS (NAVIgation DOSimetry) is the DOSimetry Telescope (DOSTEL), measuring the count and dose rates in two semiconductor detectors. From 2008 to 2011, two instruments were installed in two aircraft. First, we corrected the data for pressure variation by normalizing them to one flight level and determined their dependence on the cutoff rigidity by fitting a Dorman function to the observation. The latter was used to compute the yield function, which describes the ratio of incoming primary cosmic rays, approximated by a force field solution, to the measured count and dose rate for a particular instrument.

We received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 870405.

EP 12.5 Thu 17:00 ZEU/0160

Development of a plasmapause model derived from Van-Allen-Probe data and IMAGE RPI data via automatic detection — •Daniela Banyś[1], Joachim Feltens[1,2], Norbert Jakowski[1], Mainul Hoque[1], Rene Zandbergen[3], and Werner Enderle[4] — [1]Institute for Solar-Terrestrial Physics, DLR, Germany — [2]Telespazio-VEGA Deutschland GmbH c/o European Space Operations Centre, Germany — [3]European Space Operations Centre, Germany - retired — [4]European Space Operations Centre, Germany

The outer boundary of the plasmasphere, the plasmapause, is characterised by a sharp electron density gradient which changes under varying space weather conditions. With NEPPM (Neustrelitz ESOC Plasmapause Model), we introduce a new model of the plasmapause location Lpp based on electron density measurements made by the Van Allen probes from 2012 to 2016 and the IMAGE satellite from 2000 to 2005 that were automatically processed, yielding an improved performance for plasmapause detection. Applying a dipole based transformation of measurements, NEPPM is described by a simple elliptical approach in the equatorial plane determined by the semi-major axis, the eccentricity, and the orientation angle. The Lpp varies as a function of Dst index and magnetic local time (MLT), resulting in a tighter fit compared to the GCPM (Global Core Plasma Model). The distinctive bulge in the evening hours follows the level of solar activity. By extending the ellipse fitting from the equatorial plane to a 3D approach, the NEPPM also allows non-dipole B vectors, providing 3D positions on the plasmapause torus for given latitude, longitude, epoch and Dst.

EP 13: Astrophysics: Galaxies II

Time: Thursday 17:30–19:00 Location: ZEU/0160

Invited Talk EP 13.1 Thu 17:30 ZEU/0160

Time-dependent data analysis of a blazar flare — •Maximilian Albrecht and Felix Spanier — Universität Heidelberg - ITA

Active Galactic Nuclei (AGN) have been discussed as possible accelerators of ultra high-energy cosmic rays for quite some time. While direct observations of cosmic ray sources are still difficult, the emission of neutrinos could be observed directly. Various AGN emission models link the photon, cosmic ray and neutrino emission. Understanding and modeling the emission can help identifying AGN as cosmic accelerators. The available observational data does not yet allow for unique models, but considering also the time domain may aid in understanding the underlying emission mechanisms.

In this talk results of modeling the eruption of the blazar TXS 0506+056 in 2017 are discussed. This blazar was identified as the source of the high-energy muon neutrino IceCube-1709222A detected by the IceCube telescope. From a subsequent multimessenger-campaign a longer time series is available. Using the time-dependent, self-consistent, lepto-hadronic UNICORN-0D the observational data was simulated. We will discuss the possibilities of using time-dependent models to unveil the emission mechanisms and subsequently the associated spectrum of ultra-high energy cosmic rays.

EP 13.2 Thu 18:00 ZEU/0160

ExHaLe-jet: Modeling blazar jets with an extended hadro-leptonic radiation code — •Michael Zacharias — LSW, Universität Heidelberg

Blazars emit across all electromagnetic wavelengths. While the so-called one-zone model has described well both quiescent and flaring states, it cannot explain the radio emission and fails in more complex data sets, such as AP Librae. In order to self-consistently describe the entire electromagnetic spectrum emitted by the jet, extended radiation models are necessary. Notably, kinetic descriptions of extended jets can provide the temporal and spatial evolution of the particle species and the full electromagnetic output. Here, we present the initial results of a newly developed hadro-leptonic extended-jet code: ExHaLe-jet. As protons take much longer than electrons to lose their energy, they can transport energy over much larger distances than electrons and are therefore essential for the energy transport in the jet. Furthermore, protons induce injection of additional pairs through pion and Bethe-Heitler pair production, which can explain a dominant leptonic radiation signal while still producing neutrinos. In this talk, we discuss the differences between leptonic and hadronic dominated SED solutions, the SED shapes, evolution along the jet flow, and jet powers. We also highlight the important role of external photon fields, such as the accretion disk and the BLR.

EP 13.3 Thu 18:15 ZEU/0160

Improved numerical scheme for solving shock acceleration in jets using stochastic differential equations — •Patrick Günther, Sarah Wagner, and Karl Mannheim — Institute for Theoretical Physics and Astrophysics, University of Würzburg

Supersonic jets ejected from active galactiv nuclei show in situ acceleration of charged particles to ultrarelativistic energies far away from the central black hole. Diffusive shock acceleration and momentum diffusion, also known as 1st and 2nd order Fermi acceleration, are mechanisms that can explain the observed particle spectra. In the test-particle and diffusion approximation regime, the governing transport equations are Fokker-Planck equations equivalent to stochastic differential equations which can be solved numerically in a fast way. Advantages and disadvantages of this Monte-Carlo sampling method are discussed. The accuracy of the results depends on the choice of the numerical integrator used and a number of schemes are tested and compared. Basic integrators like the Cauchy-Euler scheme fail to predict the acceleration accurately in a scenario with steep shock gradients. It is shown that a semi-implicit second-order scheme can remedy this problem allowing for using the method in hybrid magnetohydrodynamical jet simulations in order to predict their non-thermal emissions.

EP 13.4 Thu 18:30 ZEU/0160

Beginning a journey across the Universe: the discovery of extragalactic neutrino factories — •Lenz Oswald[1], Sara Buson[1], Andrea Tramacere[2], Leonard Pfeiffer[1], Alessandra Azzollini[1], and Marco Ajello[3] — [1]Lehrstuhl für Astronomie, Universität Würzburg, Emil-Fischer-Straße 31, 97074, Würzburg — [2]Department of Astronomy, University of Geneva, Ch. d'Ecogia 16, Versoix, 1290, Switzerland — [3]Department of Physics and Astronomy, Clemson University, Kinard Lab of Physics, Clemson, SC 29634-0978, USA

Identifying the sources of extragalactic neutrinos is one of the foremost challenges in the astrophysics field. Amongst the most promising candidate sources that can be associated there are blazars, active galactic nuclei hosting a relativistic jet pointed towards us. In this work, we provide evidence for an association between high-energy (>100TeV) IceCube neutrinos and a well-defined, sample of blazars (5th Roma BZCat catalog) in the Southern celestial Hemisphere. This results in a probability to find such correlation by chance that is as low as 2 x 10-6.

EP 13.5 Thu 18:45 ZEU/0160

Investigating the blazar-neutrino connection with public IceCube data — •Julian Kuhlmann and Francesca Capel — Max-Planck-Institut fuer Physik

The IceCube collaboration has found evidence for two active galactic nuclei, NGC 1068 and TXS0506+056, being sources of high energy neutrinos. However, catalog-based searches have yet to yield conclusive evidence for the role of different source populations in contributing to the observed astrophysical neutrino flux.

We present two open-source statistical analysis frameworks for the investigation of possible sources with publicly available IceCube data, which implement complementary frequentist and Bayesian approaches. We first demonstrate the capabilities of these frameworks on simulated data, and then apply them to investigate blazars as possible neutrino sources. We focus on bringing more information from multi-wavelength studies into the analyses, and studying both individual sources and the population as a whole. We discuss the advantages of the novel Bayesian approach and the implications of our results for the blazar-neutrino connection.

EP 14: Astrophysics: Stellar Astrophysics

Time: Friday 11:00–13:00 Location: HSZ/0004

Invited Talk EP 14.1 Fri 11:00 HSZ/0004

Unveiling the secrets of hot, massive stars with modern stellar atmosphere models — •Andreas A C Sander — Astronomisches Rechen-Institut, Zentrum für Astronomie der Universität Heidelberg, Heidelberg, Germany

Even in the time of multi-messenger astrophysics, it is the light from stars that mostly determines what we know about the Universe beyond our Earth. To decode the information that is imprinted in the starlight, we need to understand its origin in the outermost layers of the stars, the so-called stellar atmosphere. Modelling these transition layers allows us to translate our observations from small and big telescopes into a proper physical quantities, thereby enabling us to not just understand the stars themselves, but also their impact and interactions with their host environment and their role in the chemical evolution of the Universe.

My Emmy Noether research group at the ARI in Heidelberg focuses on the application and development of stellar atmosphere models for hot, massive stars. In my talk, I will briefly introduce the techniques and challenges of these expanding, non-equilibrium models as well as outline the concept for including a consistent hydrodynamic treatment. Afterwards, I will provide an overview about the observational and theoretical research efforts of my group, where we use the atmosphere models to unveil the secrets and impact of massive stars, ranging from the spectral analysis of individual stars and the theoretical investigation of radiation-driven winds to the prediction of stellar feedback in unresolved populations.

EP 14.2 Fri 11:30 HSZ/0004

Stellar oscillations in B supergiant stars. — •Julieta Paz Sanchez Arias[1], Matias Agustin Ruiz Diaz[2], and Peter Nemeth[1,3] — [1]Astronomical Institute, Czech Academy of Sciences. Ondrejov, Czech Republic — [2]Instituto de Astrofísica de La Plata. CONICET-UNLP. La Plata, Argentina — [3]Astroserver.org, Foter 1, 8533 Malomsok, Hungary

The evolution of massive stars depends on many stellar parameters and small changes in them during the evolution of the stars can yield widely diverging outcomes. Additionally, these parameters, such as the initial mass, metalicity, mass loss rate and the type and distribution of chemical mixing in their interiors are far from being firmly established. B supergiant stars are one peculiar group of massive stars that undergo stellar oscillations. These objects can be found in different evolutionary stages. The study of their spectra provides us with information on the surface chemical abundances left by their evolution and the current mass loss rate. On the other hand, the study of stellar oscillations is a powerful tool that allows to inspect the stellar interiors through the analysis of the light curves and numerical simulations of their evolution, interior and oscillations. In this work, we combine both tools to unveil the physical parameters involved in the evolution of 3 B supergiant stars in different stages of their evolution but sharing the same location in the Hertzsprung-Russell diagram.

EP 14.3 Fri 11:45 HSZ/0004

Super-kilonovae from Massive Collapsars as Signatures of Black Hole Birth in the Pair-instability Mass Gap — Daniel Siegel[1,2], •Aman Agarwal[1,2], Jennifer Barnes[3], Brian Metzger[3], Mathieu Renzo[3], and Ashley Villar[3] — [1]Perimeter Institute for Theoretical Physics, Waterloo, Ontario, N2L 2Y5, Canada — [2]Institute of Physics, University of Greifswald, D-17489 Greifswald, Germany — [3]Columbia Astrophysics Laboratory, Columbia University, New York, NY 10027, USA

The core collapse of rapidly rotating massive ~ 10 solar masses stars (collapsars), and the resulting formation of hyperaccreting black holes, comprise a leading model for the central engines of long-duration gamma-ray bursts (GRBs) and promising sources of r-process nucleosynthesis. Here, I will discuss the signatures of collapsars from progenitors with helium cores >~ 130Me above the pair-instability mass gap. The disk outflows can potentially generate a large quantity (up to >~ 50 solar masses) of ejecta, comprised of >~ 5-10 solar masses in r-process elements. Radioactive heating of the disk wind ejecta powers an optical/IR transient, with a characteristic luminosity ~ 10^42 erg/s and a spectral peak similar to kilonovae from neutron star mergers, but with longer durations >~1 month. These super-kilonovae herald the birth of massive black holes >~ 60Me and can populate the pair-instability mass gap from above. SuperKNe could be discovered through planned telescopes like Roman Space Telescope. Multiband gravitational waves of ~ 0.1-50 Hz from these systems are potentially detectable by proposed observatories out to hundreds of Mpc.

EP 14.4 Fri 12:00 HSZ/0004

General relativistic radiation hydrodynamics simulations of hypermassive star evolutions — •Ninoy Rahman, Andreas Bauswein, and Gabriel Martínez-Pinedo — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

We investigate the evolutions of hypermassive neutron stars (HMNSs) formed by the mergers of binary neutron stars (BNSs) with initial gravitational masses of 1.35-1.35$M_\odot$, 1.362-1.362$M_\odot$, 1.292-1.4362$M_\odot$, 1.143-1.633$M_\odot$, and 1.37-1.37$M_\odot$ by 2D general relativistic hydrodynamical simulations. We employ the general relativistic hydrodynamics code NADA-FLD with energy-dependent three-flavor flux-limited diffusion neutrino transport to study the transiently formed HMNSs until their collapse to black holes (BHs). The newly born rapidly rotating HMNS with high temperatures and densities above nuclear saturation density is supported by the nuclear force, the thermal pressure, and the centrifugal force against gravity. We study the impact of the thermal and rotational properties of HMNSs on their lifetime. Additionally, we investigate the influence of viscous transport on the HMNS evolution. The lifetimes of HMNSs consider in this work vary from ~50 ms to ~150 ms. At Darmstadt, funding by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (ERC Advanced Grant KILONOVA No. 885281) is acknowledged.

EP 14.5 Fri 12:15 HSZ/0004

Weak Field Approximation of HAT-P-11s Magnetic Field via Stokes Polarimetry — •Andrew Rosenswie[1,2], Klaus Strassmeier[1,2], Silva Jaervinen[2], Thorsten Carroll[2], Martina Baratella[2], and Ilya Ilyin[2] — [1]Institut fuer Physik und Astronomie, Universitaet Potsdam, D-14476 Potsdam, Germany — [2]Leibniz-Institut fuer Astrophysik Potsdam (AIP), An der Sternwarte 16, D-14482 Potsdam, Germany

Presented in this work is the discovery of the magnetic field strength of the K dwarf star, HAT-P-11, which we measured in polarized light of the Stokes parameter V. The magnetic field was discovered to be 2.73 G. Our methodology can be applied to future polarimetric analyses of magnetically active stars via Stokes V polarimetry. Usage of echelle spectrographs with high spectral resolution allows for the determination of magnetic fields of stars and other celestial objects. We utilize the Potsdam Echelle Polarimetric and Spectroscopic Instrument (PEPSI), with spectral resolution R = 130 000. Due to the effects of orbital parameters of HAT-P-11 b, we predicted the detectability of a change of magnetic field strength of HAT-P-11 during the primary transiting eclipse of HAT-P-11 b, detected with PEPSI, consigned in the Large Binocular Telescope (LBT). By our discovery, it provides conclusive evidence via SVD profiles for deducing the magnetic field of a star known to be magnetically active for the past decade.

EP 14.6 Fri 12:30 HSZ/0004

An exact analytical solution for the weakly magnetized flow around an axially symmetric paraboloid, with application to magnetosphere models — •Jens Kleimann[1] and Christian Röken[2,3] — [1]Theoretische Physik IV, Ruhr-Universität Bochum, Germany — [2]Department of Geometry and Topology, Faculty of Science, University of Granada, Spain — [3]Lichtenberg Group for History and Philosophy of Physics, Institut für Philosophie, Universität Bonn, Germany

Rotationally symmetric bodies with parabolic cross sections are frequently used to model astrophysical objects such as magnetospheres immersed in interplanetary or interstellar plasma flows. We discuss a simple formula for the potential flow of an incompressible fluid around an elliptic paraboloid whose axis of symmetry coincides with the direction of incoming flow. Prescribing this flow, we derive an exact analytical solution to the induction equation of ideal magnetohydrodynamics, obtaining explicit expressions for an initially homogeneous magnetic field of arbitrary orientation being passively advected in this flow. Our solution procedure employs Euler potentials and Cauchy's integral formalism based on the flow's stream function and isochrones. Furthermore, a novel renormalization procedure allows us to generate more general analytic expressions modeling the deformations experienced by arbitrary scalar or vector-valued fields embedded in the flow as they are advected towards and then past the parabolic obstacle. Finally, both the velocity field and the magnetic field embedded therein are generalized from incompressible to mildly compressible flow.

EP 14.7 Fri 12:45 HSZ/0004

Emulation of density and temperature structures in front of astrospheres: an incompressible approach — •Dieter H. Nickeler — Astronomical Institute, Czech Academy of Sciences, Ondrejov, Czech Republic

Stars with their winds traveling through the interstellar medium (ISM) can form stellar wind cavities called astrospheres, separating the ISM gas from the inner stellar wind material by the astropause. By using the Grad-Shafranov equation (GSE) formalism, based on the stream function method of Langrange and Stokes for incompressible hydrodynamics, we compute possible density and temperature profiles in the vicinity of the astropause. We start with a simple, single X-type stagnation point. By variation of the density function, where the density depends on the stream function only, it is possible to construct a huge variety of temperature profiles, with fixed pressure, automatically guaranteed by the fulfillment of the GSE. These profiles in density and temperature are essential for calculating expressions, with which synthetic radiation profiles from the regions in front of the astropause nose can be computed and compared to observations.

EP 15: Astrophysics: Cosmology

Time: Friday 14:00–15:30 Location: HSZ/0004

EP 15.1 Fri 14:00 HSZ/0004

Searching for sub-TeV neutrino counterparts for sub-threshold GW events — •Tista Mukherjee — Institute for Astroparticle Physics (IAP), Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

Neutrinos have been identified as promising cosmic messenger which can carry useful information about their astrophysical sources. Similarly, gravitational wave (GW) and photons can also serve the same purpose. By combining information from two or more than two messengers, we can perform multi-messenger studies which in principle, can provide us more complete information about an astrophysical site. So far, we have been able to correlate photons and neutrinos emitted from a blazar, now very famously known as the 'TXS blazar' in 2017. We also identified photons emitted from a binary neutral star (BNS) system, which was also the progenitor of GW, marked as GW170817 event by the LIGO-Virgo collaboration. But, a correlation between GW and neutrinos is yet to be identified, which serves as the motivation for my ongoing work. Here, I present the current status of it, where I am looking for sub-TeV neutrinos detected by IceCube, spatially and temporally correlated with sub-threshold GW events identified from the Gravitational Wave Transient Catalog (GWTC) 2.1.

EP 15.2 Fri 14:15 HSZ/0004

Determining H_0 without a distance ladder — •Hanna Belgardt and Dieter Horns — Institut für Experimentalphysik, Universität Hamburg, Luruper Chausseee 149, D-22761 Hamburg

The Hubble constant H_0 gives the present expansion rate of the universe. The value of H_0 is commonly determined using the cosmic distance ladder. Here, we present a method to measure H_0 via the distance-dependent attenuation of very-high energy (VHE) gamma-ray photons propagating in the extra-galactic background light (EBL).

We use a sample of VHE photon spectra of extragalactic sources including active galactic nuclei and gamma-ray bursts. We fit spectral models, which include the attenuation due to the pair production with the EBL photons. This attenuation can be characterized by an optical depth $\tau(H_0)$. We perform a fitting procedure to minimise the χ^2 and hence obtain an estimator for the Hubble constant.

Using the Domínguez et al. (2010) EBL model our preliminary analysis yields a best fit value of $H_0 = 76 \pm 6$ km/s/Mpc. This result is close and competitive to the value found with the cosmic distance ladder technique, e.g., $H_0 = 73(+2.6/-2.3)$km/s/Mpc (Kenworthy et al. 2022.) Final results will be shown at the conference.

EP 15.3 Fri 14:30 HSZ/0004

Modeling the extragalactic background light — •Devesh Chopra and Dieter Horns — Institut für Experimentalphysik, Universität Hamburg, Luruper Chausseee 149, D-22761 Hamburg

The Extragalactic Background Light(EBL) consists of the background light from all of the stars throughout the history of universe and hence contains a great deal of information about the evolution of galaxies from very early times up to the present. Although it is difficult to observe the EBL directly it could me modeled using various methods. Here, we present an updated model of the EBL computed directly from the global SFR.

We use the Starburst99(STScI) to generate simple stellar population spectra (SSPS) for which the IMF and metallicity are the most important parameters. The updated Cosmic Star-Formation History is used and a minimal set of assumptions are used so that it clearly connects the input physics to the output EBL. For all the input parameters of our model depending upon cosmological parameters a 737 cosmology is used but the resulting EBL intensity do not explicitly the cosmological parameters.

All the input parameters for our model are based on the most recent data hence yielding a very dependable EBL model. Our results provides a reliable lower-limit flux for the evolving Extragalactic Background Light up to redshift of 5 using minimum of parameters and assumptions. It allows a practical estimate of attenuation length for GeV-to-TeV gamma-rays. The comparison of our model with observed data points and other EBL models would be presented.

EP 15.4 Fri 14:45 HSZ/0004

Cross-Correlation of Artificial Diffuse Gamma-Ray Background Radiation and Corresponding Simulated Cosmic Shear — •Tristan Gradetzke and Stefan Fröse — TU Dortmund University

The cross-correlation of the diffuse gamma-ray background and cosmic-shear obtained from weak-lensing surveys yields the possibility to constrain dark-matter properties. This has been done already using Fermi-LAT data. Since Imaging Atmospheric Cherenkov Telescopes have a large effective area and are able to detect very-high energy gamma rays, the usage of their data for cross-correlation analyses is investigated. In this talk, a feasibility study, consisting of the cross-correlation of mock shear and diffuse gamma-ray background maps generated from a common mass distribution is discussed. We present the current state of the project.

EP 15.5 Fri 15:00 HSZ/0004

WISPFI: WISP searches on a fiber interferometer — •Josep Maria Batllori Berenguer, Yikun Gu, Rebecca Harte, Dieter Horns, Marios Maroudas, and Johannes Ulrichs — Institut für Experimentalphysik, Universität Hamburg, Luruper Chausseee 149, D-22761 Hamburg

The search for new physics at the sub-eV scale has been particularly active in the last years. Our principal aim is the detection of the QCD axion although our design is applicable to other axion-like particles (ALPs). We introduce a new table-top experiment to detect photon-axion conversion: WISP Searches on a Fiber Interferometer (WISPFI).

The experimental setup consists of a partial free-space Mach-Zehnder-type interferometer. In one of the arms, the fiber is coiled and placed inside the bore of a superconducting solenoid magnet (14 T, 140 mm diameter warm bore), where mixing occurs. The photon-axion oscillations would be detected by measuring changes in phase/amplitude.

For the detection at resonant mixing, we will use hollow-core photonic crystal fibers (HC-PCF), taking advantage of their unique guiding and optical properties. In particular, a large axion mass range (10 meV–100 meV) is achievable by regulating the air pressure inside the core of the HC-PCF. The effect of the core radius, wavelength and bending in the mode propagation is also discussed. Finally, implementations of squeezed light, higher-power laser or the application of an external electric field can improve the sensitivity even further.

EP 15.6 Fri 15:15 HSZ/0004

Searching for photon-ALPs mixing effect in AGN gamma-ray spectra — •Qixin Yu and Dieter Horns — Institut für Experimentalphysik, Universität Hamburg, Luruper Chausseee 149, D-22761 Hamburg

High energy gamma-rays propagating in external magnetic fields may convert into axion-like particles (ALPs). We use the energy spectra of 20 extra-galactic gamma-ray sources recorded during 10 years of Fermi-LAT observations. We define a test statistics based upon the likelihood ratio to test the hypothesis for a spectral model without vs. a model with photon-ALPs coupling. The conversion probability is calculated for fixed values of the mass and two-photon coupling of the pseudoscalar particle while the external magnetic field is characterized by the additional free parameters length scale s and average field strength B. We find for 20 of the 20 sources a favorable fit. The test statistics of the sources are combined and estimated to correspond to a significance of 2.7 sigma (test statistics summed in local maxima of all sources) and 4.9 sigma (global maxima). The locally best-fitting values of B and s fall into the range that is expected for large scale magnetic fields present in the intra-cluster medium of galaxy clusters and in large scale filaments.

Gravitation and Relativity Division
Fachverband Gravitation und Relativitätstheorie (GR)

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Overview of Invited Talks and Sessions

(Lecture halls ZEU/0260, ZEU/0255, and HSZ/0401)

Plenary Talk of the Gravitation and Relativity Division

PV XVII	Fri	9:00– 9:45	HSZ/AUDI	**The Einstein Telescope** — •Harald Lück

Invited Talks

GR 3.1	Tue	11:00–11:45	HSZ/0401	**Scalaron-Higgs inflation** — •Christian Steinwachs
GR 6.1	Wed	11:00–11:45	ZEU/0260	**Geodesic motion in relativistic astrophysics** — •Eva Hackmann
GR 6.2	Wed	11:45–12:30	ZEU/0260	**Modelling the multi-messenger signals of gravitational wave sources** — •Stephan Rosswog
GR 11.1	Thu	11:00–11:45	ZEU/0260	**From quarks to black holes: micro- and macrophysics of neutron star mergers** — •Andreas Bauswein
GR 11.2	Thu	11:45–12:30	ZEU/0260	**Tracing beyond GR physics with gravitational waves** — •Daniela Doneva

Sessions

GR 1.1–1.5	Mon	16:30–18:10	ZEU/0260	**Black Holes**
GR 2.1–2.6	Mon	16:30–18:30	ZEU/0255	**Cosmology I**
GR 3.1–3.3	Tue	11:00–12:25	HSZ/0401	**Cosmology II**
GR 4.1–4.4	Tue	17:00–18:20	ZEU/0260	**Quantum Gravity**
GR 5.1–5.3	Tue	17:00–18:00	ZEU/0255	**Classical Relativity**
GR 6.1–6.2	Wed	11:00–12:30	ZEU/0260	**Relativistic Astrophysics**
GR 7.1–7.4	Wed	14:00–15:20	ZEU/0260	**Gravitational Waves I**
GR 8.1–8.4	Wed	14:00–15:20	ZEU/0255	**Foundations and Alternatives I**
GR 9.1–9.6	Wed	16:00–18:00	ZEU/0260	**Gravitational Waves and Astrophysics I**
GR 10.1–10.5	Wed	16:00–17:40	ZEU/0255	**Foundations and Alternatives II**
GR 11.1–11.2	Thu	11:00–12:30	ZEU/0260	**Gravitational Waves and Astrophysics II**
GR 12.1–12.4	Thu	14:00–15:20	ZEU/0260	**Relativistic Astrophysics and Scalar Fields**
GR 13.1–13.4	Thu	16:00–17:20	ZEU/0260	**Relativity and Data Analysis**
GR 14.1–14.5	Thu	16:00–17:40	ZEU/0255	**Gravitational Waves II**
GR 15	Thu	18:30–20:00	ZEU/0260	**Members' Assembly**
GR 16.1–16.5	Fri	11:00–12:40	HSZ/0401	**Experimental Tests**

Members' Assembly of the Gravitation and Relativity Division

Thursday 18:30–20:00 ZEU/0260

- Bericht
- Wahl
- Verschiedenes

Sessions

– Invited and Contributed Talks –

GR 1: Black Holes

Time: Monday 16:30–18:10 Location: ZEU/0260

GR 1.1 Mon 16:30 ZEU/0260

Light propagation in a plasma on an axially symmetric and stationary spacetime: Separability of the Hamilton-Jacobi equation and shadow — Barbora Bezděková[1], •Volker Perlick[2], and Jiří Bičák[3] — [1]KIPAC, Stanford University, Stanford, CA 94305, USA — [2]ZARM, University of Bremen, Germany — [3]Institute of Physics, Charles University, Prague, Cech Republic

We study the effects of a non-magnetised, pressure-less plasma on light rays under the assumption of stationarity and axisymmetry. The necessary and sufficient conditions on the metric and on the plasma frequency are formulated, such that the rays can be analytically determined from a fully separated Hamilton-Jacobi equation. We demonstrate how these results allow to analytically calculate the photon region and the shadow, if they exist. As a special example, a rotating wormhole is considered. - For more details see J. Math. Phys. 63, 092501 (2022).

GR 1.2 Mon 16:50 ZEU/0260

Black holes at the Planck scale — •Piero Nicolini — Universität Triest, Triest, Italien — FIAS, Frankfurt am Main, Deutschland — Johann Wolfgang Goethe-Universiät Frankfurt am Main, Frankfurt am Main, Deutschland

Despite the difficulty in formulating a quantum theory of gravity, the good news is that the existing quantum gravity proposals seem to converge towards a unique scenario for the physics of black holes. In this talk, I will present an overview about the phenomenology of Planckian black holes and the possibility of detecting some effects in present and near future experiments. As a conclusion, I will comment about some of the existing open questions and future directions of investigation.

GR 1.3 Mon 17:10 ZEU/0260

Formulation Improvements for Critical Collapse Simulations — •Daniela Cors[1], Sarah Renkhoff[1], Hannes Rüter[2], David Hilditch[3], and Bernd Brügmann[1] — [1]Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität Jena — [2]CFisUC, Department of Physics, University of Coimbra — [3]CENTRA, Instituto Superior Técnico, University of Lisbon

We use our adapted pseudospectral code bamps, with its new hp adaptive mesh refinement, to tune close to the barrier between gravitational collapse and dispersed fields, in order to study the critical phenomena that emerges near that threshold. To achieve that goal and improve our previous results, we introduce adjustments to the generalised harmonic gauge formulation of General Relativity adapting it to the specific case of near collapse simulations. In particular, we adjust the constraint violations damping scheme, taking into account the collapse of the lapse that occurs in extreme spacetimes. We also prevent coordinate singularities by carefully choosing the gauge source function for collapsing spacetimes. As a result of these changes, we manage to improve our threshold estimation results. In spherical symmetry, we show critical phenomena of a massless scalar field minimally coupled to the Einstein field equations. In axisymmetry, we study gravitational waves in vacuum, revisiting our previous results.

GR 1.4 Mon 17:30 ZEU/0260

Wave optical image formation of exact scalar wave scattering in Kerr-de Sitter spacetime — •Felix Willenborg[1], Dennis Phillip[1,2], and Claus Lämmerzahl[1,2] — [1]Zentrum für angewandte Raumfahrt und Mikrogravitation (ZARM), University of Bremen, 28359 Bremen, Germany — [2]Gauss-Olbers Center, c/o ZARM, University of Bremen, 28359 Bremen, Germany

Linear perturbations of black holes have been discussed widely in many contexts. Of interest are properties such as differential cross-sections, quasinormal modes, scattering or the intereference. A useful tool in this respect is the Newman-Penrose formalism and the resulting Teukolsky equations, giving seperated angular and radial differential equations. These were mostly evaluated by numerical means. However, the introduction of a cosmological constant allows the problem to be solved in an exact analytical manner by transforming the differential equations into the Heun differential equation, the most general second-order differential equation with four regular singularities.

We show for the Kerr-de Sitter spacetime that scattering of waves from a point source needs an additational discussion around the so-called Heuns function, which enables a then possible normalization of the angular solution, similarly to the case of spherical harmonics. We assume in the discussion and analysis a scalar source star of fixed frequency and solve the scattering problem by a partial wave sum. The observed wave optical image formation by means of Kirchhoff-Fresnel diffraction and the resulting shadow will be compared to the geodesic black hole shadow.

GR 1.5 Mon 17:50 ZEU/0260

Gravitational Lensing of Massive Particles in the NUT Spacetime — •Torben Frost — ZARM, University of Bremen, Bremen, Germany

Gravitational lensing of light is already a well-investigated question. Gravitational lensing of massive particles on the other hand did not receive much attention so far. This has mainly two reasons. First, appropriate particles, currently only neutrinos, are rare, hard to detect and their emission events short-lived. Second, particle detectors capable of detecting them only have a low angular resolution. However, considered in the framework of a multimessenger approach gravitational lensing of massive particles may provide us with supplementary information to gain a better understanding about their source and the lens. Therefore, in this talk we will discuss the potential of gravitational lensing of massive particles using the example of a NUT black hole acting as lens. We will first discuss and solve the equations of motion for timelike geodesics using elementary as well as elliptic functions and integrals. Then we will introduce latitude-longitude coordinates on the celestial sphere of an observer in the domain of outer communication and relate them to the constants of motion. Finally, we will derive the angular radius of the particle shadow, write down a lens equation, and calculate the travel time of the particles. We will also discuss differences with respect to lightlike geodesics.

GR 2: Cosmology I

Time: Monday 16:30–18:30 Location: ZEU/0255

GR 2.1 Mon 16:30 ZEU/0255

Anisotropies in the Cosmological Gravitational Wave Background — •Florian Schulze — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

The cosmological stochastic gravitational wave background (CGWB) is expected to be detected by future gravitational wave (GW) interferometers. A map of angular fluctuations in the CGWB provides an independent measurement of cosmological parameters, similar to the cosmic microwave background (CMB). Furthermore, it contains information about the cosmological model and a multitude of possible CGWB sources, such as inflation, primordial black holes or phase transitions in the early universe.

In this presentation, I will discuss anisotropies in the CGWB and introduce CLASS_GW, an extension of the Cosmological Linear Anisotropy Solving System (CLASS) to calculate CGWB anisotropies. Using CLASS_GW, I present forecasts for future GW experiments, showing their capabilities of testing the early universe physics and the cosmological model.

GR 2.2 Mon 16:50 ZEU/0255

Redshift Drift in Linear Perturbation Theory — Pedro Bessa, •Dennis Stock, and Ruth Durrer — Département de Physique Théorique, Université de Genève, Switzerland

The technical advance and continuously increasing precision of cosmological observations will make measurements of time variations of the redshift of a given source possible in the near future. This so-called redshift drift effect promises to be an exciting future cosmological probe of the Universe. In this talk, we derive its fully relativistic, gauge-invariant expression within linear perturbation theory and study in detail its angular power spectrum based on large scale structure observations.

GR 2.3 Mon 17:10 ZEU/0255

Lightcone invariant observables in cosmology — Bhuvan Agrawal[1], Markus Fröb[2], and •William Lima[2] — [1]Mathematisch-Naturwissenschaftliche Fakultät, Universität zu Köln, Köln, Germany — [2]Institut für Theoretisches Physik, Universität Leipzig, Leipzig, Germany

I will discuss a recent proposal by Brunetti et al. to construct gauge-invariant relational observables in gravity in the context of cosmological perturbation theory. I will report on new results showing how their method can be use to produce invariant observables adapted to measurements along the observer's past lightcone. These observables aim to model the experimental situation in cosmology, where virtually all experimental data is gathered via light-like signals. The lightcone observables are constructed using a field-dependent coordinate system, which I will take to be geodesic lightcone coordinates. As a concrete application, I will present a new computation of the correlator of an observable measuring the redshift produced by quantum-gravitational fluctuations on the de Sitter spacetime.

GR 2.4 Mon 17:30 ZEU/0255

Cosmological backgrounds and their pertubations in teleparallel gravity — •Manuel Hohmann — University of Tartu, Estonia

Within the framework of teleparallel gravity, a flat affine connection is used as a dynamical field in addition to the metric tensor. This general teleparallel connection may further be restricted by imposing either vanishing torsion, giving rise to symmetric teleparallel gravity, or vanishing nonmetricity, which then leads to metric teleparallel gravity. In the field of cosmology, a homogeneous and isotropic connection must been chosen alongside the homogeneous and isotropic metric. This presentation gives a complete classification of all homogeneous and isotropic teleparallel geometries (general, metric and symmetric), as well as their perturbations. For the latter, gauge transformations and gauge invariant quantities are presented.

GR 2.5 Mon 17:50 ZEU/0255

Torsional dark energy in quadratic gauge gravity — •Armin van de Venn[1], David Vasak[2], Johannes Kirsch[3], and Jürgen Struckmeier[4] — [1]Frankfurt Institute for Advanced Studies, Frankfurt am Main, Germany — [2]Frankfurt Institute for Advanced Studies, Frankfurt am Main, Germany — [3]Frankfurt Institute for Advanced Studies, Frankfurt am Main, Germany — [4]Frankfurt Institute for Advanced Studies, Frankfurt am Main, Germany

The Covariant Canonical Gauge theory of Gravity (CCGG) is a gauge field formulation of gravity which a priori includes non-metricity and torsion. It extends the Lagrangian of Einstein's theory of general relativity by terms at least quadratic in the Riemann-Cartan tensor. This work investigates the implications of metric compatible CCGG on cosmological scales. For a totally anti-symmetric torsion tensor we derive the resulting equations of motion in a Friedmann-Lemaître-Robertson-Walker (FLRW) Universe. In the limit of a vanishing quadratic Riemann-Cartan term, the arising modifications of the Friedmann equations are shown to be equivalent to spatial curvature. Furthermore, the modified Friedmann equations are investigated in detail in the early and late times of the Universe's history. It is demonstrated that in addition to the standard ΛCDM behaviour of the scale factor, there exist novel time dependencies, emerging due to the presence of torsion and the quadratic Riemann-Cartan term. Finally, at late times, we present how the accelerated expansion of the Universe can be understood as a geometric effect of spacetime through torsion.

GR 2.6 Mon 18:10 ZEU/0255

Consistent solution of Einstein-Cartan equations with torsion outside matter — •Klaus Morawetz — Münster University of Applied Sciences, Stegerwaldstrasse 39, 48565 Steinfurt, Germany — International Institute of Physics-UFRN, Campus Universitário Lagoa nova,59078-970 Natal, Brazil

The Einstein-Cartan equations in first-order action of torsion are considered. Inside matter the torsion is given by the spin which leads to an extended Oppenhaimer-Volkov equation. Outside matter a second solution is found besides the torsion-free Schwarzschild one with the torsion completely determined by the metric and vice-versa. This solution is shown to be of non-spherical origin and its uniqueness with respect to the consistence is demonstrated. Unusual properties are discussed in different coordinate systems where the cosmological constant assumes the role of the Friedman parameter in Friedman-Lamaître-Robertson-Walker cosmoses. Parameters are specified where wormholes are possible. Possible consequences on cosmological scenarios are discussed. [Class. Quantum Grav. 38 (2021) 205003]

GR 3: Cosmology II

Time: Tuesday 11:00–12:25 Location: HSZ/0401

Invited Talk GR 3.1 Tue 11:00 HSZ/0401

Scalaron-Higgs inflation — •Christian Steinwachs — University of Freiburg, Germany

After discussing various theoretical properties of scalar field theories in curved spacetime from an effective field theory point of view, I propose a concrete model that offers a unified description of inflationary cosmology, dark matter, and elementary particle physics at the electroweak scale. Except for a non-minimal coupling of the Standard Model Higgs boson to a modified gravitational sector, no new physics is required.

GR 3.2 Tue 11:45 HSZ/0401

Universality in cosmic structures — •Matthias Bartelmann — Institut für Theoretische Physik, Universität Heidelberg

Kinetic field theory allows describing cosmic structure formation analytically quite deeply into the non-linear regime of density fluctuations. We have used this theory to investigate several questions concerning the universality of cosmic structures. This talk will focus on three main results, partly obtained within a suitable mean-field approximation: (1) the universality of cosmic structures in the asymptotic small-scale limit; (2) generic effects of modified gravity theories on cosmic structure formation; and (3) possible imprints of the dark-matter model on small-scale cosmic structures.

GR 3.3 Tue 12:05 HSZ/0401

Inflation and its Discontents — •Marc Holman — Utrecht University, Utrecht, The Netherlands

Since their basic inception in the early 1980s, inflationary models have been shown to exhibit various physical and conceptual deficits. The main purpose of the present talk is to provide a systematic review of these deficits. One well-known issue, for instance, is that of initial conditions: originally invoked to address a very specific perceived fine-tuning in initial conditions, inflation inevitably seems to lead to fine-tuning problems of its own. Other problems include the transition to classicality, the spontaneous breaking of symmetry and crucially, as I will argue, the "multiverse" and the very rationale for inflation in the first place. A feature that is often claimed as a major success of inflationary models is their generic prediction of a (nearly) scale invariant, Gaussian spectrum of CMB density perturbations. As is less commonly emphasized however, effectively such a prediction was already made well before the entire notion of inflation even existed and, more importantly, is not unique to the specific inflationary mechanism of exponential primordial expansion. Time permitting, routes for viable alternatives to inflation are briefly discussed, emphasizing their key challenges.

GR 4: Quantum Gravity

Time: Tuesday 17:00–18:20 Location: ZEU/0260

GR 4.1 Tue 17:00 ZEU/0260

Quantum gravitational redshift — •David Edward Bruschi — Institute for Quantum Computing Analytics (PGI-12), Forschungszentrum Jülich, Germany

General relativity and quantum mechanics are the two frameworks through which we understand Nature. To date, they have remained valid to great extent in their respective domains. Regardless of the myriad of attempts to find a unified theory that can describe all of observable phenomena, the quest for unification continues.

One avenue for investigating the overlap of general relativity and quantum mechanics that is less ambitious but can still provide potentially observable and measurable predictions is that of quantum field theory in curved spacetime viewed through the lens of quantum information. In recent years, a great deal of attention has been given to this approach, which has provided novel and intriguing insights into phenomena that can be tested in the laboratory.

We present an investigation in the quantum nature of the gravitational redshift, seeking to understand which are the expected quantum dynamics that lead to the effective classical observable effect. We discuss the classical regime and show that more intriguing aspects are expected. We conclude discussing potential for detection in space-based experiments.

GR 4.2 Tue 17:20 ZEU/0260

A Rigorous Neutrino Oscillation Formula in Curved Spacetime — •Dominik Hellmann — TU Dortmund, 44227 Dortmund, Germany

In the light of upcoming experiments searching to detect neutrino signals from astrophysical sources, the question for a rigorously derived neutrino oscillation formula in curved spacetime from first principles seems to be well motivated.

Based on the theoretical foundations of quantum field theory in curved spacetime (cQFT), we generalize the well known external wave packet approach to neutrino oscillations from flat to curved spacetime.

In this framework, external particles are represented by wave packets, while the neutrino is described by its Feynman propagator and PMNS matrix elements. In addition to that, we incorporate non-trivial cQFT effects like the non-uniqueness of the vacuum and show how these modify the oscillation behavior. Finally, we derive the conditions under which a neutrino oscillation probability is well defined and show how it is calculated from cQFT amplitudes.

GR 4.3 Tue 17:40 ZEU/0260

Proton Stability and Quantum Gravity: Towards an asymptotically safe perspective — Astrid Eichhorn and •Shouryya Ray — CP3 Origins, Institut for Fysik, Kemi og Farmaci, Syddansk Universitet, Campusvej 55, 5230 Odense M, Denmark

The observed long lifetime ($\gtrsim 10^{34}$ yrs) of the proton can pose serious constraints on UV completions of the Standard Model. In those that include quantum gravity, fluctuations of the spacetime metric are often argued to break all effective global symmetries; baryon number conservation, which prevents proton decay, being one of them. Here, I shall present our computations concerning the proton lifetime within asymptotically safe quantum gravity. Time permitting, I shall speculate on how asymptotically safe metric fluctuations may in fact reconcile a significantly reduced quantum gravity scale with proton stability, and thereby possibly also stabilize the proton in certain GUT scenarios afflicted by excessive proton decay.

GR 4.4 Tue 18:00 ZEU/0260

Asymptotically nonlocal gravity — •Jens Boos and Christopher D Carone — William & Mary, Williamsburg, VA, USA

Asymptotically nonlocal field theories interpolate between Lee-Wick theories with multiple propagator poles, and ghost-free nonlocal theories. Previous work on asymptotically nonlocal scalar, Abelian, and non-Abelian gauge theories has demonstrated the existence of an emergent regulator scale that is hierarchically smaller than the lightest Lee-Wick partner, in a limit where the Lee-Wick spectrum becomes dense and decoupled. We generalize this construction to linearized gravity, and demonstrate the emergent regulator scale in three examples: by studying the resolution of the singularity (i) at the origin in the classical solution for the metric of a point particle, and (ii) in the nonrelativistic gravitational potential computed via a one-graviton exchange amplitude; (iii) we also show how this derived scale regulates the one-loop graviton contribution to the self energy of a real scalar field. We comment briefly on the generalization of our approach to the full, nonlinear theory of gravity.

GR 5: Classical Relativity

Time: Tuesday 17:00–18:00 Location: ZEU/0255

GR 5.1 Tue 17:00 ZEU/0255

Spinning light source orbiting a compact Schwarzschild object — •Jan-Menno Memmen and Volker Perlick — Zentrum für angewandte Raumfahrttechnik und Mikrogravitation, Bremen, Deutschland

In this talk, we determine the radiation of an extended, *spinning* light source in circular orbit in the symmetry plane of an stationary, axially symmetric spacetime. The light source is assumed to be a test particle, as to not interfere with the background spacetime. We derive the necessary transformations for a reference frame that is at rest on the surface of the rotating emitter, and link the emission angle on the surface of the emitter to the constants of motion of the light ray. Two emitter geometries are considered; a sphere and a Maclaurin spheroid that is flattened as a result of its spin. In particular, we investigate the influence of the emitter spin on the radiation in a Schwarzschild background. Specifically, the influnece of the spin on the redshift distribution and flux at an arbitrarily positioned observer is studied in detail.

GR 5.2 Tue 17:20 ZEU/0255

Gravitational field recovery via inter-satellite redshift measurements — •Jan P. Hackstein, Eva Hackmann, Dennis Philipp, and Claus Lämmerzahl — Center of Applied Space Technology and Microgravity, Bremen, Germany

Satellite gravimetry is a common technique to monitor global changes in the Earth system. High-precision atomic clocks are currently used in first experiments in terrestrial gravimetry to measure physical heights. In relativistic gravity, a clock comparison is sensitive to their positions in the gravity field and relative velocity. This makes clocks ideal tools to investigate the Earth's gravity field. Equipping Earth-orbiting satellites with clocks and comparing them to terrestrial ground stations allows for global and continuous measurements. However, one important obstacle for Earth-satellite chronometry is the low measurement accuracy of satellite velocity, which enters into the redshift via the Doppler effect. We present an alternative approach based on the framework of general relativity without velocity measurements from ground stations. Considering an idealised satellite setup in the Schwarzschild spacetime, pairwise redshift measurements between satellites equipped with clocks are used to recover the gravitational field's monopole moment. We investigate whether or not only relative observables between satellites suffice to recover the complete information about the gravitational field. This method promises higher accuracy for gravity field recovery by improving control of the Doppler effect. We compare the results and error estimates of this setup with conventional Earth-satellite measurements and conclude with future steps to generalise this approach.

GR 5.3 Tue 17:40 ZEU/0255

On the redshift and relativistic gravity potential determination in GR — •Dennis Philipp[1,2], Eva Hackmann[1,2], and Claus Laemmerzahl[1,2] — [1]ZARM, University of Bremen, 28359 Bremen, Germany — [2]Gauss-Olbers Center, c/o ZARM, University of Bremen, 28359 Bremen, Germany

We derive exact, formal expressions for the relativistic redshift and timing between observers in various configurations on stationary spacetimes for the purpose of chronometry, i.e., relativistic gravimetry based on clocks. These observers are assumed to transport standard clocks along their respective worldlines and may move in an arbitrary way - on geodesics, accelerated, or are simply stationary. It is shown how redshift observations can be used to infer the (mass) multipole moments of the underlying spacetime, i.e., a decomposition of the gravito-electric potential. In particular, an Earth-bound observer is considered that is meant to model a standard clock on the Earth's surface (or on the geoid). Its clock is continuously compared to a satellite's clock to determine a relativistic gravity potential from redshift measurements. Results shown here are in agreement with the Newtonian potential determination from the so-called energy approach. The framework is intended for applications within relativistic geodesy and is applied in different exact vacuum spacetimes for illustration.

GR 6: Relativistic Astrophysics

Time: Wednesday 11:00–12:30 Location: ZEU/0260

Invited Talk GR 6.1 Wed 11:00 ZEU/0260

Geodesic motion in relativistic astrophysics — •Eva Hackmann — ZARM, Universität Bremen

Astrophysical systems are usually composed of two major bodies. The throughout analysis of relativistic binary systems is therefore very important, but far from trivial due to the nonlinear nature of General Relativity. A limiting case, that can be handled analytically but is still informative for a wide range of systems, is the extreme mass ratio or one-body problem. In this presentation, we will first quickly review analytical solutions methods for this case, and then explore a range of applications in modern astrophysics, for example pulsar timing in extreme mass ratio systems.

Invited Talk GR 6.2 Wed 11:45 ZEU/0260

Modelling the multi-messenger signals of gravitational wave sources — •Stephan Rosswog — Sternwarte Hamburg, Gojenbergsweg 112, 21029 Hamburg

Compact binary systems that contain at least one neutron star are exiting sources of gravitational waves. Apart from relativistic gravity, their dynamics during a merger is governed by the microphysics of the neutron stars such as the nuclear matter equation of state or various neutrino processes. Observations of such mergers via gravitational and electromagnetic waves (and, ideally, also neutrinos) can provide many complementary facettes of the same event which can break degeneracies in the interpretation of observations.

While such multi-messenger approaches carry an enormous discovery potential, they come at the price of having to model very different physical processes (e.g. strong field gravity, nuclear matter, atomic opacities and radiative transfer) and very different length and time scales. These requirements also place high demands on the simulation methodology.

In my talk, I will review the physical and numerical challenges of such simulations, discuss a novel approach for relativistic hydrodynamics and show some first applications.

GR 7: Gravitational Waves I

Time: Wednesday 14:00–15:20 Location: ZEU/0260

GR 7.1 Wed 14:00 ZEU/0260

LISA Pathfinder — •Sarah Paczkowski for the LPF collaboration — Max Planck Institute for Gravitational Physics (Albert Einstein Institute), D-30167 Hannover, Germany — Leibniz Universität Hannover, D-30167 Hannover, Germany

The Laser Interferometer Space Antenna (LISA) is a satellite mission to observe gravitational waves in the frequency range from 0.1mHz to 1Hz. In this talk, I will give an overview of its technology demonstrator mission LISA Pathfinder (2015-2017), and how it is paving the way for LISA.

Conceptually, the idea of LISA Pathfinder was to mimic one arm of the triangular LISA constellation. The LISA Pathfinder satellite, therefore, hosted two free-falling test masses and their relative positions and orientations were measured using heterodyne laser interferometry. Combined with a drag-free attitude control system and micronewton thrusters in a quiet environment, a nearly perfect free-fall was achieved. The undesired remaining differential acceleration between the two test masses was only $(1.74 \pm 0.05)\,\mathrm{fms}^{-2}/\sqrt{\mathrm{Hz}}$ above 2 mHz. This was significantly below the requirements and exceeded expectations. Accordingly, LISA Pathfinder has demonstrated the ability to realise the low-frequency science potential of the LISA mission. The interferometric readout on LISA Pathfinder also worked immediately and reliably throughout the mission with a sensing noise of only $32.0^{+2.4}_{-1.7}\,\mathrm{fm}/\sqrt{\mathrm{Hz}}$. Since it will be similar to the local LISA interferometry, LISA Pathfinder has successfully proven this concept to work in space.

GR 7.2 Wed 14:20 ZEU/0260

Potential of Gravitational Waves Detection with SCRF Cavities — •Gudrid Moortgat-Pick[1], Robin Löwenberg[1], Daniel Klein[1], Krisztian Peters[2], and Marc Wenskat[2] — [1]II. Inst. for Theoretical Physics, University of Hamburg, Luruper Chaussee 149, 22761 Bahrenfeld — [2]DESY, Notkestrasse 85, 22603 Hamburg

We study the physics potential of detecting gravitational waves via superconducting high-frequency cavities. The direct coupling of gravitational waves to electromagnetic fields is widely known as the (inverse) Gertsenshtein effect. We have described gravitational waves in the framework of linearized theory in general relativity. In this regard it is substantial to define the proper detector frame. We use a heterodyne cavity setup, extend the theoretical approach to calculate different scenarios in an unified and accurate way, including cavity perturbation theory and the effects of wall deformation.

GR 7.3 Wed 14:40 ZEU/0260

Gravitational wave induced perturbation of atomic levels — •Falk Adamietz[1,2], Friedemann Queisser[1,2], and Ralf Schützhold[1,2] — [1]Helmholz-Zentrum Dresden-Rossendorf — [2]Technische Universität Dresden

Motivated by partly controversial results in the literature and recent studies regarding the detection of gravitational waves with atoms instead of photons (as in LIGO), we study the response of atomic levels to gravitational waves. For slow gravitational waves, we may employ lowest-order stationary perturbation theory. We find that the perturbation Hamiltonian consists both of a kinetic and a potential correction term and explicitly evaluate their matrix elements.

GR 7.4 Wed 15:00 ZEU/0260

A Michelson interferometer as a demonstrator for gravitational wave detection in outreach activities — •David Koke and Alexander Kappes — Institut für Kernphysik der Westfälischen Wilhelms-Universität Münster, Deutschland

Gravitational waves are one of the most exciting phenomena in astrophysics and have given us new insights into our universe since their first direct detection in 2015. To easily demonstrate the basic principles of gravitational wave detection in outreach activities, a demonstration experiment based on a Michelson interferometer was created in the framework of a master thesis. Subject of this talk is the presentation of the results of the project with focus on the technical realization, as well as a live demonstration of the interferometer's features.

GR 8: Foundations and Alternatives I

Time: Wednesday 14:00–15:20 Location: ZEU/0255

GR 8.1 Wed 14:00 ZEU/0255

Der physikalische Hintergrund der dunklen Materie — •Albrecht Giese — Taxusweg 15, 22605 Hamburg

Dunkle Materie bedeutet einen Überschuss an Gravitation im Umfeld von Galaxien im Vergleich zur Physik Newtons.

Gegenwärtig werden zwei Theorien dazu diskutiert: Die Annahme von unentdeckten, schwach wechselwirkenden Teilchen und eine Modifikation der Gravitation Newtons (MOND). Jedoch erklären beide Theorien nur einen Teil der Beobachtungen und sind im Konflikt mit anderen. Das heißt, es gibt keine nutzbare Theorie in der heutigen Physik. Und die Suche nach neuen Teilchen ist völlig erfolglos geblieben.

Neuerliche intensivierte Beobachtungen haben jedoch eine verblüffende Eigenschaft der dunklen Materie geliefert: Sie hat eine Verteilung von 1/r^2 um das Zentrum der Galaxien. Damit ist die Verteilung identisch mit derjenigen der Photonen um diese Zentren. Das sieht zunächst aus wie eine Paarung zwischen dunkler Materie und Photonen. Auf dieser Basis präsentieren wir eine Erklärung, welche im Einklang mit allen Beobachtungen steht, und welche sogar *quantitativ* korrekte Ergebnisse liefert - ohne Adaptionen; dabei allerding von den Ansätzen Newtons und Einsteins abweicht bzgl. der Korrelation Gravitation zu Masse.

Wir können uns hier auch auf einen Ansatz der Gravitation berufen, dem Einstein selbst 1911 zunächst gefolgt ist. Wenn man diesen in geeigneter Weise weiter verfolgt, gelangt man ebenso zum obigen Ergebnis.

Weitere Info: www-ag-physics.org/gravity

GR 8.2 Wed 14:20 ZEU/0255

Geometrische Grundlagen der Nichtgleichgewichtsthermodynamik diskreter Systeme — •Marcus Hildebrandt — Uhlandstrasse 22a, 13158 Berlin

Aus thermodynamischer Sicht können kompakte Objekte wie Sterne und schwarze Löcher als diskrete Systeme behandelt werden, die sich im energetischen Austausch mit Ihrer Umgebung befinden (Schottky-Systeme). Zu einer konsistenten und erfolgreichen Beschreibung von solchen kompakten Objekten müssen die zentralen Feldtheorien der Physik, die Quantenmechanik, die Relativitätstheorie, die Elektrodynamik/Magnetohydrodynamik und die Thermodynamik zusammenspielen. Während alle Feldtheorien heutzutage in moderner geometrischer Formulierung auf Faserbündeln vorliegen, ist dies bisher in der Thermodynamik nur rudimentär der Fall. Der Autor zeigt, wie diese Struktur für diskrete Systeme aus einigen wenigen physikalischen Prinzipien abgeleitet werden kann und welche tiefe, geometrisch-physikalische Einsichten dies liefert. Zentrale Ergebnisse sind dabei: Relaxationsprozesse bleiben in den Fasern, in denen sie starten und enden auf einer Attraktormannigfaltigkeit, dem klassischen Gleichgewichtsteilraum der Thermostatik. Während in der Relativitätstheorie der Energie-Impulstensor die Geometrie des Raumes bestimmt, ist in der Thermodynamik die (1-Form der) Entropieproduktionsrate für das Entstehen einer geometrischen Struktur verantwortlich: Die Kontaktgeometrie.

GR 8.3 Wed 14:40 ZEU/0255

Mass & Charge — •Manfred Geilhaupt — Hochschule Niederrhein, Mönchengladbach, Germany

* General Relativity combined with Thermodynamic Principles reveals: Sommerfeld FSC: alpha=1/beta^2*1/g44*3/4*(1+1/beta*ln(W))^2 and W=1/3, Probability for each x, y, z- Direction.

* Elektron has a finite life span introduced into a Wave Function is the only chance to derive Sommerfeld FSC from a Principle Theory.

* Electron's restmass nature is inertial. Restmass and charge are effective (expectation) values from GR+TD to be compared with experimental values. Both mass and charge depend on the root of alpha.

Remark: If the superposition of two entangled Electrons collapses nevertheless mass (and charge) can not come out of nothing to exist as real. The collapse of a wave function also might come to existence when the metric g44 ("local

observer") of space changes. This would be a natural brake down - based on GR. https://www.youtube.com/watch?v=lxZ2Nu6_vC0
E=m(t)c^2+Q(t)=const=M*c^2 is the invariance within GR+TD.

GR 8.4 Wed 15:00 ZEU/0255

Was, wenn die Grundkraft "Gravitation" grundsätzlich abstoßend wirkt? — •Stefan Lahres — Aalen, Deutschland

Diese Hypothese nimmt an, dass Gravitation keine anziehende, sondern eine grundsätzlich abstoßende Wechselwirkung ist, und die anziehende Wirkung auf kosmologisch kleinen Maßstäben daher rührt, dass massebehaftete Strukturen die abstoßende Wirkung dämpfen.

Der Ansatz geht von einer isotropen, gravitativ vermittelten abstoßenden Kraftwirkung von allen Seiten auf jede Probemasse aus. Befindet sich nun in der Nähe einer Probemasse (z.B. Apfel) eine andere Masse (z.B. Erde), so schwächt die Erde als große Masse unter dem Apfel den "Druck" des Universums, der von unten auf den Apfel wirkt, ab. Die Kraft von oben ist also größer als die Kraft von unten. Der Apfel wird vom Universum mit einer zur Erde hin gerichteten Kraft nach unten gedrückt.

Eine lineare Näherung führt zum Newton'schen Gravitationsgesetz. Zwei mögliche Quellen der abstoßenden Wirkung werden vorgestellt:

1. Die sonstigen Massen des Universums
2. Eine gravitative kosmische Hintergrundstrahlung, die sich in einer frühen Phase des Universums von der Wechselwirkung mit anderen Energieformen abgekoppelt hat

Das Potenzial für Beiträge zur Beschreibung von Dunkler Energie, kosmischer Inflation und der Vermeidung von Singularitäten in der ART wird ebenso aufgezeigt wie Herausforderungen an die Beschreibung der physikalischen Mechanismen, die einer abstoßenden gravitativen Wechselwirkung zugrunde liegen könnten.

GR 9: Gravitational Waves and Astrophysics I

Time: Wednesday 16:00–18:00 Location: ZEU/0260

GR 9.1 Wed 16:00 ZEU/0260

Numerical-Relativity-Informed Effective-One-Body model for Black-Hole-Neutron-Star Mergers with Higher Modes and Spin Precession — •Alejandra Gonzalez[1], Rossella Gamba[1], Francesco Zappa[1], Gregorio Carullo[1], Sebastiano Bernuzzi[1], and Alessandro Nagar[2] — [1]Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität Jena, Fröbelstieg 1, 07743 Jena, Germany — [2]INFN Sezione di Torino, Via P. Giuria 1, 10125 Torino, Italy

We present the first effective-one-body (EOB) model for generic-spins quasi-circular black-hole - neutron-star (BHNS) inspiral-merger-ringdown gravitational waveforms (GWs). Our model is based on a new numerical-relativity (NR) informed expression of the BH remnant and its ringdown, it reproduces the NR (l, m) = (2, 2) waveform with typical phase agreement of about less than 0.5 rad (less than 1 rad) to merger (ringdown). The maximum (minimum) mismatch between the (2, 2) and the NR data is 4% (0.6%). Higher modes (HMs) (2, 1), (3, 2), (3, 3), (4, 4) and (5, 5) are included and their mismatch with the available NR waveforms are up to (down to) a 60% (1%) depending on the inclination. Phase comparison with a 16 orbit precessing simulation shows differences within the NR uncertainties. We demonstrate the applicability of the model in GW parameter estimation by perfoming the first BHNS Bayesian analysis with HMs (and non-precessing spins) of the events GW190814 and GW200105, together with a new (2, 2)-mode analysis of GW200115.

GR 9.2 Wed 16:20 ZEU/0260

To ring or not to ring, the tale of black hole quasi-normal modes — •Peter James Nee, Sebastian H. Völkel, and Harald Pfeiffer — Max Planck Institute for Gravitational Physics (Albert Einstein Institute), D-14476 Potsdam, Germany

The extraction of quasi-normal modes from compact binary mergers (also referred to as black hole spectroscopy) is one of the most promising pillars in current and future strong gravity tests. Recent works have sought to push current ringdown analysis into the non-linear merger part of the waveform via the inclusion of overtones, to better reproduce the waveform and ascertain the remnant black hole parameters. However it is well-believed that the presence of overtones is a non-trivial question, and as such caution is warranted. In this work we explore the potential pitfalls in both waveform reconstruction and parameter extraction in ringdown analysis. To this extent, we revisit the simpler problem of wave propagation in both Regge-Wheeler and Pöschl-Teller systems. We employ several modelling approaches to waveforms generated via a finite-difference evolution scheme, allowing for a varying number of overtones. The fitting is also performed over differently sized windows of the waveforms.

GR 9.3 Wed 16:40 ZEU/0260

Constraining modifications of black hole perturbation potentials near the light ring with quasinormal modes — •Sebastian Völkel[1,2,3], Nicola Franchini[1,2,4,5], Enrico Barausse[1,2], and Emanuele Berti[6] — [1]SISSA and INFN Sezione di Trieste, Trieste, Italy — [2]IFPU, Trieste, Italy — [3]Max Planck Institute for Gravitational Physics (Albert Einstein Institute), Potsdam, Germany — [4]Université Paris Cité, Paris, France — [5]CNRS-UCB International Research Laboratory, Berkeley, US — [6]Johns Hopkins University, Baltimore, USA

In modified theories of gravity, the potentials appearing in the Schrödinger-like equations that describe perturbations of non-rotating black holes are also modified. In this talk, we ask how such modifications can be constrained with future, high-precision measurements of quasi-normal modes. We use a perturbative framework that allows one to map modifications of the effective potential, in powers of M/R, to deviations in the quasi-normal mode spectrum. Using MCMC methods, we recover the coefficients in the M/r expansion in an "optimistic" scenario where we vary them one at a time, and in a "pessimistic" scenario where we vary them all simultaneously. In both cases, we find that the bounds on the individual parameters are not robust. However, inspired by WKB theory, we demonstrate that the value of the potential and its second derivative at the light ring can be robustly constrained. These constraints allow a more direct comparison between tests based on black hole spectroscopy and observations of black hole "shadows".

GR 9.4 Wed 17:00 ZEU/0260

Packed Message delivered by Tides in Binary Neutron Star Mergers — •Hao-Jui Kuan[1] and Kostas Kokkotas[2] — [1]Albert-Einstein-Institut, Potsdam, Germany — [2]University of Tübingen, Tübingen, Germany

The morphology of gravitational waveforms depends on almost all source parameters, and thus encodes a bunch of information about the radiating objects. In particular, tidal parameters of neutron stars may stringently constrain the nuclear equation of state, thus their precise estimation is of fundamental importance. Emphasizing the tidal phase shift by aligned, rotating stars, we provide an accurate, yet economical, method to generate f-mode-involved, premerger waveforms. We find for slow-rotating stars that the dephasing effects of the dynamical tides can be uniquely, equation-of-state-independently determined by the direct observables. In addition, for binaries with fast rotating members, the dephasing due to f-mode is larger than that caused by equilibrium tides by a factor of ~5, which may lead to a considerably overestimated tidal deformability if the dynamical tidal contribution is not accounted for. The influence of inclination angles of stellar spins will be discussed also, as well as the possibility of accompanying precursors flares associated with f-mode excitation.

GR 9.5 Wed 17:20 ZEU/0260

Binary neutron star merger simulations with neutrino transport and turbulent viscosity: impact of different schemes and grid resolution — •Francesco Zappa — Friedrich-Schiller-Universität Jena, Theoretisch-Physikalisches Institut, Jena, Germany

We present a systematic numerical relativity study of the impact of different treatment of microphysics and grid resolution in binary neutron star mergers.

We find that viscosity helps to stabilise the remnant against gravitational collapse but grid resolution has a larger impact than microphysics on the remnant's stability. The gravitational wave (GW) energy correlates with the maximum remnant density, that can be thus inferred from GW observations.

Simulations employing the M1 transport schemes show the emergence of a neutrino trapped gas that locally decreases the temperature a few percent when compared to the other simulation series. This out-of-equilibrium effect does not alter the GW emission at the typical resolutions considered for mergers.

Different microphysics treatments impact mass, geometry and composition of the remnant's disc and ejecta. Ejecta composition influences the nucleosynthesis yields, that are robust only if both neutrino emission and absorption are simulated. Synthetic kilonova light curves can be reliably predicted only including the various ejecta components.

We conclude that advanced microphysics in combination with resolutions higher than current standards appear essential for robust long-term evolutions and astrophysical predictions.

GR 9.6 Wed 17:40 ZEU/0260

GRMHD simulations with GR-Athena++ — •William Cook — Friedrich-Schiller-Universität Jena

We demonstrate the performance of the new code GR-Athena++ in evolving general relativistic magnetohydrodynamics (GRMHD) in a dynamically evolving spacetime. GR-Athena++ utilises the task-based parallelism and oct-tree based adaptive mesh refinement of the highly scaling Athena++ code, as well as its approach to solving GRMHD problems in stationary spacetimes; combined with new functionality to solve the Einstein equations in the Z4c formulation. We show the performance of this new code by simulating the evolution of Neutron Stars in a dynamical spacetime, presenting tests of our code, as well as strong and weak scaling tests.

GR 10: Foundations and Alternatives II

Time: Wednesday 16:00–17:40 Location: ZEU/0255

GR 10.1 Wed 16:00 ZEU/0255

The assumption of a continuous Lorentzian spacetime manifold in quantum gravity — •René Friedrich — Strasbourg

Spacetime is more and more often suspected of being at the origin of the problem of quantum gravity, and it is said that the concept of spacetime needs to be revised.

In this talk, we want to provide the concrete reason why the Lorentzian spacetime manifold is not compatible with quantum gravity, by showing that it is a man-made artefact: unlike the Euclidean metric, no Lorentzian pseudometric is able to span up a real-valued manifold. This is why - since its introduction with Minkowski's famous lecture "Space and time" and until today - Lorentzian manifolds require always the addition of a second metric in order to override the appearance of negative squares and of imaginary values.

This artificial "patchwork" of two opposite metrics is not only incompatible with quantum mechanics, it is even contradicting the very principles of general relativity.

GR 10.2 Wed 16:20 ZEU/0255

A Physically Founded and Exact Model of Dark Energy — •Hans-Otto Carmesin — Gymn. Athenaeum, Harsefelder Str. 40, 21680 Stade — Studienseminar Stade, Bahnhofstr. 5, 21682 Stade — Universität Bremen, Fachbereich 1, Postfach 330440, 28334 Bremen

While Newton proposed static space, Einstein used his general relativity, GR, and derived a possible dynamic expansion of space [1]. Hubble observed it [2]. When Perlmutter [3] discovered the energy density u_Λ of cosmological vacuum, dark energy, an essential property of space beyond GR had been discovered. So, what is dark energy? Here, I present a physically founded model of the dark energy u_Λ [4,5]. I provide an exact solution of that model, and I derive the dark energy $u_{\Lambda,model}$. It is in precise accordance with the observed value $u_{\Lambda,obs}$. Thereby, I do not apply any fit parameter. Using that model, I explain the H_0-tension [6]. Lit.: [2] Hubble, E. (1929): A relation between distance and radial velocity among extra-galactic nebulae. Proc. of National Acad. of Sciences, 15, pp. 168-173. [3] Perlmutter, S. et al. (1998): Discovery of a Supernova Explosion at Half the Age of the Universe. Nature, 391, pp. 51-54. [4] Carmesin, H.-O. (March 2021): Quanta of Spacetime Explain Observations, Dark Energy, Graviton and Nonlocality. Berlin: Verlag Dr. Köster. [5] Carmesin, H.-O. (December 2022): Unification of Spacetime, Gravity and Quanta. Berlin: Verlag Dr. Köster. [6] Riess, A. et al. (2022): A Comprehensive Measurement of the Local Value of the Hubble Constant with 1 km s^{-1} Mpc^{-1} Uncertainty from the Hubble Space Telescope and the SHOES Team. The Astrophys. J. Lett., 934:L7, pp. 1 - 52.

GR 10.3 Wed 16:40 ZEU/0255

Comparison of Models of Dark Energy — •Paul Sawitzki[1], Jannes Ruder[1], and Hans-Otto Carmesin[1,2,3] — [1]Gymn. Athenaeum, Harsefelder Str. 40, 21680 Stade — [2]Studienseminar Stade, Bahnhofstr. 5, 21682 Stade — [3]Universität Bremen, Fachbereich 1, Postfach 330440, 28334 Bremen

While Newton proposed a static and flat space, Einstein used his general relativity, GR, and derived a possible dynamic expansion of space [1]. Hubble observed that expansion [2]. When Perlmutter [3] discovered the energy density u_Λ of the cosmological vacuum, the dark energy, an essential property of space beyond GR had been discovered. Moreover, the dark energy amounts to 68 % of all energy in the universe. So, a basic question became relevant:

What is dark energy? Here, we summarize proposed models of dark energy, and we compare these models according to criteria of physics and epistemology [4,5]. [1] Einstein, A. (1917): Kosmologische Betrachtungen zur allgemeinen Relativitätstheorie. Sitzungsb. d. Königl. Preuß. Akad. d. Wiss., pp. 142-152. [2] Hubble, E. (1929): A relation between distance and radial velocity among extra-galactic nebulae. Proc. of National Acad. of Sciences, 15, pp. 168-173. [3] Perlmutter, S. et al. (1998): Discovery of a Supernova Explosion at Half the Age of the Universe. Nature, 391, pp. 51-54. [4] Humphreys, P. (2004): Scientific Knowledge. In: Niiniluoto, Ilkaa et al. (Eds.): Handbook of Epistemology. Dordrecht: Springer, pp. 549-569. [5] Styrman, A. (2020): Only a unified ontology can remedy disunification. Journal of Physics: Conference Series, 1466, pp. 1-25.

GR 10.4 Wed 17:00 ZEU/0255

Comparison of Models of the H_0 Tension — •Philipp Schöneberg[1], Phil Immanuel Gustke[1], and Hans-Otto Carmesin[1,2,3] — [1]Gymn. Athenaeum, Harsefelder Str. 40, 21680 Stade — [2]Studienseminar Stade, Bahnhofstr. 5, 21682 Stade — [3]Universität Bremen, Fachbereich 1, Postfach 330440, 28334 Bremen

While Newton proposed a static and flat space, Einstein used his general relativity, GR, and derived a possible dynamic expansion of space [1]. Hubble observed that expansion [2]. The dynamics of that expansion can be described by the Hubble parameter, and by its present-day limit H_0. However, the observed value at the early universe $H_{0,obs,early}$ differs from the observed value at the late universe $H_{0,obs,late}$ by five standard deviations [3]. So, what is the origin of that H_0 difference or H_0 tension? Here, we summarize proposed models of that H_0 difference, and we compare these models according to criteria of physics and epistemology [4].

[1] Einstein, A. (1917): Kosmologische Betrachtungen zur allgemeinen Relativitätstheorie. Sitzungsb. d. Königl. Preuß. Akad. d. Wiss., pp. 142-152. [2] Hubble, E. (1929): A relation between distance and radial velocity among extra-galactic nebulae. Proc. of National Acad. of Sciences, 15, pp. 168-173. [3] Riess, A. et al. (2022): A Comprehensive Measurement of the Local Value of the Hubble Constant with 1 km s^{-1} Mpc^{-1} Uncertainty from the Hubble Space Telescope and the SHOES Team. The Astrophys. J. Lett., 934:L7, pp. 1 - 52. [4] Humphreys, P. (2004): Scientific Knowledge. In: Niiniluoto, Ilkaa et al. (Eds.): Handbook of Epistemology. Dordrecht: Springer, pp. 549-569.

GR 10.5 Wed 17:20 ZEU/0255

Questionable predictions by EHT image of Sgr A* — •Jürgen Brandes — Karlsbad, Germany

The famous EHT image of Sgr A* predicts BH features in contradiction with observation: a*=0.9375 against a*=0.15; spin direction face-on against edge-on; accretion light variability arising with accretion disks against variability of accretion wind. And there is a theoretical shortcut by Broderick et al.: The missing UV bump agrees with *degenerate* supermassive objects being no BH. [1],[2]

[1] "*Observations questioning classical GRT ...*", chapter 13, homepage www.grt-li.de.

[2] J. Brandes, J. Czerniawski, L. Neidhart: *Spezielle und Allgemeine Relativitätstheorie für Physiker und Philosophen - Einstein- und Lorentz-Interpretation, Paradoxien, Raum und Zeit, Experimente*, 5th edition., VRI: 2022.

GR 11: Gravitational Waves and Astrophysics II

Time: Thursday 11:00–12:30 Location: ZEU/0260

Invited Talk GR 11.1 Thu 11:00 ZEU/0260

From quarks to black holes: micro- and macrophysics of neutron star mergers — •Andreas Bauswein — GSI Helmholtzzentrum fuer Schwerionenforschung, Darmstadt, Germany

Neutron stars are the densest stellar objects with densities exceeding those in atomic nuclei. Consequently, the collision of two neutron stars creates very extreme conditions and leads to a variety of different highly energetic and potentially observable phenomena: electromagnetic radiation from radio to gamma wavelengths, neutrinos and gravitational waves. Since the first unambiguous observation of a neutron star merger in 2017, a few more events have been detected, and increased instrumental sensitivity promises many more measurements in the future. We will provide an overview on which fundamental questions can be addressed by studying neutron star mergers. This includes the formation of black holes or the synthesis of heavy elements in the explosive outflows from these events. Moreover, mergers provide information on the properties of high-density matter including the prospect to identify the presence of a possible phase of deconfined quark matter in neutron stars.

Invited Talk GR 11.2 Thu 11:45 ZEU/0260

Tracing beyond GR physics with gravitational waves — •Daniela Doneva — Theoretical Astrophysics, University of Tübingen, 72076 Tübingen, Germany

Gravitational waves are among the ultimate tools to test fundamental physics and promise to answer the long-waiting question about the nature of gravity in the regime of strong fields. The degeneracies between different effects are a serious obstacle, though, to fulfilling this goal since modified gravity often leads to smaller cumulative changes. In the present talk we will focus on a few examples of interesting new effects we can observe in the gravitational wave spectrum that differ qualitatively from the standard picture in general relativity. This includes gravitational phase transition of neutron stars, jumps in the gravitational wave emission from merging black holes, and inverse chirp signal of extreme mass-ratio inspirals. Such effects are valuable because they are a smoking gun of beyond-GR physics that can be easily traced in observations.

GR 12: Relativistic Astrophysics and Scalar Fields

Time: Thursday 14:00–15:20 Location: ZEU/0260

GR 12.1 Thu 14:00 ZEU/0260

Testing scalar-tensor gravity with radio pulsars — •Alexander Batrakov[1], Huanchen Hu[1], Norbert Wex[1], Paulo Freire[1], Vivek Venkatraman Krishnan[1], and Michael Kramer[1,2] — [1]Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, 53121 Bonn, Germany — [2]Jodrell Bank Centre for Astrophysics, The University of Manchester, M13 9PL, United Kingdom

The talk will highlight some of the latest results in testing the strong-field aspects of scalar-tensor gravity (STG) with radio pulsars, which include spontaneous scalarization, dipolar radiation, and the violation of the universality of free fall by strongly self-gravitating bodies. Some of these results are based on a new timing model that provides a fully consistent analysis of pulsar timing data for certain classes of STG theories.

GR 12.2 Thu 14:20 ZEU/0260

Mergers of Dark Matter Admixed Neutron Stars — •Hannes Rüter[1], Violetta Sagun[1], Wolfgang Tichy[2], and Tim Dietrich[3] — [1]CFisUC, Department of Physics, University of Coimbra, 3004-516 Coimbra, Portugal — [2]Department of Physics, Florida Atlantic University, Boca Raton, FL 33431, USA — [3]Institut für Physik und Astronomie, Universität Potsdam, Haus 28, Karl-Liebknecht-Str. 24/25, Potsdam, Germany

We investigate mergers of neutron stars consisting of two non-interacting fluids minimally coupled to the gravitational field using the numerical relativity code BAM. The first fluid represents baryonic matter, whereas the second fluid models dark matter, which we describe using the equation of state of a degenerate Fermi gas.

We consider two different scenarios for the distribution of the dark matter. In the first scenario the dark matter is confined to the core of the star, whereas in the second scenario the dark matter extends beyond the surface of the baryonic matter forming a halo around the baryonic star.

We show how the dark matter impacts the binary dynamics and merger waveforms.

GR 12.3 Thu 14:40 ZEU/0260

Boson star head-on collisions — •Florian Atteneder[1], Daniela Cors[1], Hannes Rüter[2], Roxana Rosca-Mead[1], David Hilditch[3], and Bernd Brügmann[1] — [1]Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität Jena — [2]CFisUC, Department of Physics, University of Coimbra — [3]CENTRA, Instituto Superior Tecnico, The University of Lisbon

Colliding boson stars (BS) can be regarded as one potential source for astrophysical gravitational wave signals. Templates for the detection of such signals are now being constructed, which makes accurate calculations of such more important. In contrast to fluid matter, BS solutions are smooth, which makes them, in some sense, an optimal domain for the application of pseudospectral numerical methods. Simulations so far have been limited due to the difficulty in building initial data containing two BSs. Most groups undergoing such studies either use a simple superposition of two boosted BSs or an improved version thereof. In this talk I will present first results of BS head-on collisions that start from constraint solved initial data.

GR 12.4 Thu 15:00 ZEU/0260

Image of the thin accretion disk in gravity with a minimally coupled scalar field — •Galin Gyulchev — Faculty of Physics, Sofia University, James Bourchier Boulevard, Sofia 1164, Bulgaria

We study possible observable images of a black hole and naked singularity described by rotating geometry in Einstein gravity, minimally coupled to a scalar field. We consider a Kerr-like (KL) alternative to the rotating Fisher-Janis-Newman-Winicour solution. Our study includes analytical and numerical calculations of equatorial circular orbits, shadow images, and radiation from thin accretion disks for various values of the object's angular momentum and scalar charge. The KL solution cannot be ruled out by the observations for small values of the scalar charge either. As the scalar charge increases, the optical properties change dramatically. The photon region does not hide the singularity, so it should be classified as a strong singularity. The shadow of the compact object can become multiply connected and strongly oblate. This new qualitative feature can be used to distinguish observationally black holes from naked singularities via the contemporary Very Long Baseline Interferometry experiments at short wavelengths.

GR 13: Relativity and Data Analysis

Time: Thursday 16:00–17:20 Location: ZEU/0260

GR 13.1 Thu 16:00 ZEU/0260

bajes-mma: Joint Bayesian Inference Framework for Multi-Messenger Astronomy with Binary Neutron Star Coalescences — •Ssohrab Borhanian[1], Matteo Breschi[1], Gregorio Carullo[2], Giacomo Ricigliano[3], Lukas Lippold[1], Albino Perego[4], and Sebastiano Bernuzzi[1] — [1]Friedrich-Schiller-University Jena, Jena, Germany — [2]Niels-Bohr-Institute, Copenhagen, Denmark — [3]Technical University of Darmstadt, Darmstadt, Germany — [4]University of Trento, Trento, Italy

The coincident observation of three events GW170817, GRB170817A, and AT2017gfo—a gravitational-wave signal with associated electromagnetic counterpart observed via a short gamma-ray burst, kilonova, and successive long-term afterglow emission—marked the onset of multi-messenger astronomy using gravitational and electromagnetic waves. In expectation of further multi-messenger events during upcoming observing runs by the LIGO, Virgo, and KAGRA observatories we developed a data analysis pipeline to jointly examine the observational data associated with a multi-messenger event. The pipeline is built on the Bayesian inference framework `bajes` and leverages its strength to incorporate any data channel, i.e. for binary neutron star mergers the gravitational waves signal and associated electromagnetic transients—including klionovae, short gamma-ray bursts, and synchrotron from the fast-tail of the ejecta. Using this pipeline we analyzed the events associated to GW170817 simultaneously to perform kilonova model selection, improve the parameter constraints of prior studies, and constrain the neutron star equation of state.

GR 13.2 Thu 16:20 ZEU/0260

Noise transients in machine-learning based gravitational-wave searches — •Ondřej Zelenka[1,2], Bernd Brügmann[1,2], and Frank Ohme[3,4] — [1]Friedrich-Schiller-Universität Jena, D-07743 Jena, Germany — [2]Michael Stifel Center Jena, D-07743 Jena, Germany — [3]Max-Planck-Institut für Gravitationsphysik, Albert-Einstein-Institut, D-30167 Hannover, Germany — [4]Leibniz Universität Hannover, D-30167 Hannover, Germany

In the recent past, machine-learning based approaches have been proposed as a solution to some problems in gravitational-wave data analysis. One of these are noise transients, which significantly complicate detection of gravitational waves. Contemporary matched-filtering based searches as well as unmodeled searches employ systems which flag likely noise transients and reject potential false alarms. It is possible that machine-learning based algorithms can learn to distinguish noise transients from signals with astrophysical sources.

In this contribution, we present a machine-learning based gravitational-wave detection algorithm focused on binary black holes, which has been submitted to the MLGWSC-1 mock data challenge. Furthermore, we describe an issue which arose when the model encountered non-Gaussian background noise, and present its solution. In doing so, we demonstrate that a machine-learning based algorithm with a suitable training method is capable of distinguishing false alarms due to transients from binary black hole injections.

GR 13.3 Thu 16:40 ZEU/0260

Finding Universal Relations using Statistical Data Analysis — •Praveen Manoharan and Kostas D. Kokkotas — IAAT, University of Tübingen, 72076 Tübingen, Germany

We present applications of statistical data analysis methods from both bi- and multivariate statistics to find suitable sets of neutron star features that can be leveraged for accurate and EoS independent - or universal - relations. To this end, we investigate the ability of various correlation measures such as Distance Correlation and Mutual Information in identifying universally related pairs of neutron star features. We also evaluate relations produced by methods of multivariate statistics such as Principal Component Analysis to assess their suitability for producing universal relations with multiple independent variables.

As part of our analyses, we are able to put forward multiple entirely novel relations, including multivariate relations for the f-mode frequency of neutron stars with reduced error when compared to existing, bivariate relations.

GR 13.4 Thu 17:00 ZEU/0260

Ranging and Clock Synchronization in LISA Data Processing — •Jan Niklas Reinhardt — Albert Einstein Institut, Hannover

The Laser Interferometer Space Antenna (LISA) is an ESA-led mission for gravitaional wave detection in space aiming for the frequency band between 1 mHz and 1 Hz after its launch in 2035. In order to extract the gravitational wave signals from the LISA data, various instrumental noise sources must be suppressed. The dominating noise source is by far the laser frequency noise, which must be reduced by more than 8 orders of magnitude to meet the LISA requirement of 1 pm. This can be achieved by time delay interferometry (TDI), which combines the various data streams with the correct delays to virtually form equal arm Michelson interferometers, in which laser frequency noise naturally cancels. This algorithm, as its name fortells, relies on knowledge about the delays (corresponding to the inter spacecraft distances), its classical execution additionally requires nano second synchronization of the three LISA timers. The estimation of the delays and the clock synchronization are the topic of this presentation.

GR 14: Gravitational Waves II

Time: Thursday 16:00–17:40 Location: ZEU/0255

GR 14.1 Thu 16:00 ZEU/0255

Implementation of a Stray Light Simulation for the Einstein Telescope — •Hanna Marozava[1], Thomas Hebbeker[1], and Achim Stahl[2] — [1]III. Physikalisches Institut A, RWTH Aachen University — [2]III. Physikalisches Institut B, RWTH Aachen University

The Einstein Telescope (ET) will be the first gravitational wave detector of the third generation. Stray light is a severe problem for modern interferometers with high sensitivity, as another noise source contributing to the interferometer output. A simulation is required to tune detector settings to avoid undesirable light paths and to optimize the shape, number and position of baffles.

This talk will present the progress in developing a concept for the reduction of stray light in ET and first results.

GR 14.2 Thu 16:20 ZEU/0255

Test setup for cryogenic sensors and actuators working towards the Einstein Telescope — •Robert Joppe[1], Thomas Hebbeker[2], Tim Kuhlbusch[1], Oliver Pooth[2], Achim Stahl[2], Timo Wittler[1], and Franz-Peter Zantis[1] — [1]III. Physikalisches Institut A, RWTH Aachen — [2]III. Physikalisches Institut B, RWTH Aachen

The Einstein Telescope will be the first gravitational wave detector of the third generation. The sensitivity goal, especially in the low frequency region, will be achieved among other improvements by cooling the main parts of the interferometer. The required electronic components, sensors and actuators needed for mirror alignment and active dampening of suspension resonances have to perform at cryogenic temperatures.

The talk presents the progress on the development of electronics, optics and mechanics within the E-TEST project. Furthermore the performance of our cryogenic UHV test setup and the characterization of light emitting diodes at low temperatures will be explicated.

GR 14.3 Thu 16:40 ZEU/0255

A Cryogenic Displacement Sensor and Actuator for the Einstein Telescope — Thomas Hebbeker[1], Robert Joppe[1], •Tim Kuhlbusch[2], Oliver Pooth[2], Purnalingam Revathi[2], Achim Stahl[2], Timo Wittler[1], and Franz-Peter Zantis[1] — [1]III. Physikalisches Institut A, RWTH Aachen — [2]III. Physikalisches Institut B, RWTH Aachen

The Einstein Telescope will be the first third-generation gravitational wave detector. In achieving an increase in sensitivity of more than one order of magnitude at low frequencies compared to current detectors, mitigating thermal noises is essential. Thus cooling the mirrors of the interferometer to cryogenic temperatures is required. Consequently parts of the vibration isolation systems of the mirrors need to be working at these low temperatures.

This talk will present the developement of an actuator with an integrated absolute displacement sensor operating below 20 K. Sensitivity of the sensor, forces of the actuator and thermal design will be discussed. This includes the effects of cryogenic temperatures on diodes of the sensor and the electromagnet of the actuator.

GR 14.4 Thu 17:00 ZEU/0255

Wireless power transfer for cryogenic sensors and actuators in the Einstein Telescope — •santosh mutum[1], christian grewing[1], andre zambanini[1], and stefan van waasen[1,2] — [1]Central Institute of Engineering, Electronics and Analytics, Electronic Systems, Forschungszentrum Jülich, Germany — [2]Faculty of Engineering, Communication Systems, University of Duisburg-Essen, Germany

Gravitational wave detectors have to be extremely sensitive by nature. Hence, a significant effort is required to investigate in optimizing the hardware setup to reduce noise impacts as much as possible. For the upcoming Einstein Telescope, an optical power and information transfer is proposed and investigated to limit the mechanical coupling of cables. Additionally, in order to achieve more sensitivity in the proposed third generation gravitational wave detector, the main optics and consequently the electronics of the interferometer need to be cooled down to cryogenic temperatures.

This talk will address the wireless power transfer for the sensor-actuator system. The concept of a wireless power transfer in cryogenic using laser and solar cell will be discussed as well as first measurements and estimations for the expected performance.

GR 14.5 Thu 17:20 ZEU/0255

Development and Testing of Composite Vacuum Tubes for the Einstein Telescope — •Purnalingam Revathi[1], Ralf Schleichert[2], Tim Kuhlbusch[1], Robert Joppe[1], Thomas Hebbeker[1], Oliver Pooth[1], and Achim Stahl[1] — [1]III. Physikalisches Institut B, RWTH Aachen — [2]Institut für Kernphysik, Forschungszentrum Jülich

The Einstein Telescope, a proposed third-generation gravitational wave detector, requires about a 120 km long set of vacuum tubes with diameters of up to 1 m. Due to the vacuum requirements and mechanical integrity, stainless steel tubes are the standard for ultra high vacuum applications. But even with higher material costs, composite tubes may be a promising alternative to reduce the overall costs and to open possibilities for an on site production. This talk presents the details of the development and testing of prototypes made of Glass Fiber Reinforced Plastic wound around a stainless steel liner. Vacuum pressure stability and overpressure tests have been performed. Finite element simulations were done to optimize the material choice and thicknesses. The possibility of integrating sensors to measure temperature and pressure will be discussed.

GR 15: Members' Assembly

Time: Thursday 18:30–20:00 Location: ZEU/0260

All members of the Gravitation and Relativity Division are invited to participate.

GR 16: Experimental Tests

Time: Friday 11:00–12:40 Location: HSZ/0401

GR 16.1 Fri 11:00 HSZ/0401

New search for differences in active and passive gravitational masses using Lunar Laser Ranging — •Claus Lämmerzahl[1], Vishwa V. Singh[2], Liliane Biskupek[2], Jürgen Müller[2], and Eva Hackmann[1] — [1]ZARM, University of Bremen — [2]IfE, Leibniz Universität Hannover

Each body possesses three masses: inertial mass, passive gravitational mass (weight), and active gravitating mass. With MICROSCOPE the equality of inertial and passive gravitational mass has been confirmed at the order 10^{-15}. Laboratory test confirmed the equality of active and passive mass at the order 10^{-5}. Using Lunar Laser Ranging (LLR) data from 1970 to 2022, we obtained a new limit of 3.9×10^{-14} that improves the previous LLR-based result by two orders of magnitude. We also propose a new laboratory experiment for the search of a difference between active and passive masses, and present a new orbital analysis for stellar binary systems made of different masses. Finally, we add some remarks on active and passive charges.

GR 16.2 Fri 11:20 HSZ/0401

A concept for testing the gravitomagnetic clock effect with GNSS satellites — •Jan Scheumann[1,2], Dennis Philipp[1,2], Eva Hackmann[1,2], Sven Herrmann[1,2], Benny Rievers[1,2], and Claus Lämmerzahl[1,2] — [1]ZARM, University of Bremen, 28359 Bremen, Germany — [2]Gauss-Olbers Space Technology Transfer Center, Bremen, Germany

General Relativity (GR) predicts that the rotation of a central body influences the trajectory of an orbiting mass in a non-Newtonian way. One of the predicted effects was first described by Cohen and Mashhoon, concerning the proper time difference of two counter-revolving clocks in an orbit around a rotating mass, which is yet to be verified experimentally. After the accuracy of the tests of the gravitational redshift could be improved using two Galileo satellites on eccentric orbits, other possibilities to use GNSS satellites for tests of GR are under investigation. This work presents a concept to test the gravitomagnetic clock effect (GMCE) with GNSS satellites and looks into the technical requirements for such a test.

The introduced theoretical framework yields an incrementally defined observable, that is accesible e.g. via orbit and clock products. Some usage of the framework is presented, taking advantage of state-of-the-art orbit simulations as an a-priori data source.

A comparison of a dedicated mission's technical requirements with the state-of-the-art in SLR and modelling of gravitational and non-gravitational perturbations yields that a measurement is highly demanding, but might just be within reach of current technology.

GR 16.3 Fri 11:40 HSZ/0401

Taking gravity tests with the Double Pulsar to higher orders — •Huanchen Hu[1], Michael Kramer[1,2], Norbert Wex[1], and David J. Champion[1] — [1]Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, 53121 Bonn, Germany — [2]Jodrell Bank Centre for Astrophysics, The University of Manchester, Oxford Road, Manchester M13 9PL, UK

Relativistic binary pulsars are excellent testbeds for probing strong-field aspects of gravity. In particular, the Double Pulsar system PSR J0737-3039A/B offers a wealth of relativistic effects that can be studied in depth. Pulsar timing observations with MeerKAT and the future Square Kilometre Array (SKA) can bring the accuracy of these gravity tests to an unprecedented level, as well as enable precision tests of next-to-leading order (NLO) effects in the orbital motion and signal propagation. In this talk, I will present the timing results of PSR J0737-3039A based on 3-yr MeerKAT observations with a focus on the NLO signal propagation effects. These include the retardation effect due to the movement of pulsar B and the deflection of the signal of A by the gravitational field of B. Moreover, future observations with MeerKAT and the SKA are expected to provide one of the first measurements of the moment of inertia of a neutron star, hence an important complementary constraint on the equation of state at ultranuclear density. Finally, other prospects from future observations will be also demonstrated.

GR 16.4 Fri 12:00 HSZ/0401

Measurement of Gravitational Coupling of Planck Mass-sized Object — •Hans Hepach[1], Mathias Dragosits[2], and Jeremias Pfaff[2] — [1]IQOQI Vienna, OeAW, Austria — [2]University of Vienna, Austria

Gravity is the weakest of all known fundamental forces and continues to pose some of the most outstanding open problems to modern physics: it remains resistant to unification within the standard model of physics and its underlying concepts appear to be fundamentally disconnected from quantum theory. Testing gravity on all scales is therefore an important experimental endeavour. Thus far, these tests involve mainly macroscopic masses on the kg-scale and beyond. Here we show gravitational coupling between a gold sphere of 1mm radius and a Planck mass sized object. Periodic modulation of the source mass position allows us to perform a spatial mapping of the gravitational force. The current measurement improves upon our previous result by a reduction of the source mass by three orders of magnitude and opens the way to a yet unexplored frontier of microscopic source masses. This enables new searches of fundamental interactions and provides a natural path towards exploring the quantum nature of gravity.

GR 16.5 Fri 12:20 HSZ/0401

Measuring the gravitational field using quantum imaging — •Marian Cepok — ZARM, University of Bremen, 28359 Bremen, Germany

Quantum Imaging is a method which can be used to image an object using photons which have not interacted with the object. This scheme uses an entangled pair of photons, one of the photons interacts with the object while it is only the other photon which is being measured. Here a setup similar to quantum imaging is proposed which images the gravitational field instead of an object.

Hadronic and Nuclear Physics Division
Fachverband Physik der Hadronen und Kerne (HK)

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Overview of Invited Talks and Sessions

(Lecture halls HSZ/0002, HSZ/0103, HSZ/0105, SCH/A251, SCH/A118, SCH/A216, SCH/A316, SCH/A.101, SCH/A117, SCH/A215, SCH/A315, SCH/A419, and SCH/A252; Poster HSZ EG)

Plenary Talk of the Hadronic and Nuclear Physics Division

PV IX	Wed	9:45–10:30	HSZ/AUDI	**The origin of the chemical elements** — •Marialuisa Aliotta

Invited Talks

HK 1.1	Mon	11:00–11:30	HSZ/0002	**Nucleosynthesis of heavy nuclei – moving a supernova into the laboratory** — •Felix Heim
HK 1.2	Mon	11:30–12:00	HSZ/0002	**Exploring the 3D nucleon structure with CLAS and CLAS12 at JLAB** — •Stefan Diehl
HK 1.3	Mon	12:00–12:30	HSZ/0002	**Lattice simulations with chiral effective field theory at N3LO** — •Serdar Elhatisari
HK 12.1	Tue	11:00–11:30	HSZ/0002	**Baryon spectroscopy at ELSA and MAMI** — •Farah Afzal
HK 12.2	Tue	11:30–12:00	HSZ/0002	**ALICE upgrades, status and perspectives for ALICE-3** — •Robert Muenzer
HK 12.3	Tue	12:00–12:30	HSZ/0002	**Nuclear parton distribution functions** — •Michael Klasen
HK 23.1	Wed	11:00–11:30	HSZ/0002	**High-Precision Laser Spectroscopy of C^{4+} for an All-Optical Determination of the Nuclear Charge Radius** — •Phillip Imgram, Kristian König, Bernhard Maass, Patrick Müller, Wilfried Nörtershäuser
HK 23.2	Wed	11:30–12:00	HSZ/0002	**ALICE determines the transparency of our galaxy to the passage of antihelium nuclei** — •Laura Serksnyte
HK 23.3	Wed	12:00–12:30	HSZ/0002	**The world of light and strange mesons: from spectroscopy puzzles to low energy QCD phenomena** — •Stephan Paul
HK 52.1	Thu	11:00–11:30	HSZ/AUDI	**AI Techniques for Event Reconstruction** — •Ivan Kisel
HK 76.1	Fri	11:00–11:30	HSZ/0002	**Thermalization of heavy quarks in the QGP** — •Federica Capellino
HK 76.2	Fri	11:30–12:00	HSZ/0002	**Hadron structure in Lattice QCD** — •Konstantin Ottnad
HK 76.3	Fri	12:00–12:30	HSZ/0002	**LISA: LIfetime measurements with Solid Active targets** — •Kathrin Wimmer

Sessions

HK 1.1–1.3	Mon	11:00–12:30	HSZ/0002	**Invited Talks I**
HK 2.1–2.5	Mon	16:30–18:00	SCH/A251	**Instrumentation I**
HK 3.1–3.5	Mon	16:30–18:00	SCH/A.101	**Instrumentation II**
HK 4.1–4.5	Mon	16:30–18:00	SCH/A117	**Instrumentation III**
HK 5.1–5.6	Mon	16:30–18:00	SCH/A216	**Heavy-Ion Collisions and QCD Phases I**
HK 6.1–6.5	Mon	16:30–18:00	SCH/A315	**Heavy-Ion Collisions and QCD Phases II**
HK 7.1–7.5	Mon	16:30–18:00	SCH/A316	**Hadron Structure and Spectroscopy I**
HK 8.1–8.5	Mon	16:30–18:00	SCH/A419	**Nuclear Astrophysics I**
HK 9.1–9.5	Mon	16:30–18:00	SCH/A118	**Structure and Dynamics of Nuclei I**
HK 10.1–10.5	Mon	16:30–18:00	SCH/A215	**Structure and Dynamics of Nuclei II**
HK 11.1–11.6	Mon	16:30–18:00	HSZ/0204	**Outreach Public/Teilchenwelt (joint session T/HK)**
HK 12.1–12.3	Tue	11:00–12:30	HSZ/0002	**Invited Talks II**
HK 13.1–13.5	Tue	17:00–18:15	SCH/A251	**Instrumentation IV**

HK 14.1–14.5	Tue	17:00–18:45	SCH/A.101	**Instrumentation V**
HK 15.1–15.7	Tue	17:00–18:45	SCH/A117	**Instrumentation VI**
HK 16.1–16.5	Tue	17:00–18:30	SCH/A216	**Heavy-Ion Collisions and QCD Phases III**
HK 17.1–17.5	Tue	17:00–18:30	SCH/A315	**Heavy-Ion Collisions and QCD Phases IV**
HK 18.1–18.7	Tue	17:00–19:00	SCH/A316	**Hadron Structure and Spectroscopy II**
HK 19.1–19.5	Tue	17:00–18:30	SCH/A419	**Nuclear Astrophysics II**
HK 20.1–20.5	Tue	17:00–18:45	SCH/A118	**Structure and Dynamics of Nuclei III**
HK 21.1–21.6	Tue	17:00–18:45	SCH/A215	**Structure and Dynamics of Nuclei IV**
HK 22.1–22.7	Tue	17:00–18:45	SCH/A252	**Outreach (joint session HK/T)**
HK 23.1–23.3	Wed	11:00–12:30	HSZ/0002	**Invited Talks III**
HK 24.1–24.5	Wed	14:00–15:30	SCH/A251	**Instrumentation VII**
HK 25.1–25.6	Wed	14:00–15:30	SCH/A.101	**Instrumentation VIII**
HK 26.1–26.5	Wed	14:00–15:30	SCH/A117	**Instrumentation IX**
HK 27.1–27.5	Wed	14:00–15:30	SCH/A216	**Heavy-Ion Collisions and QCD Phases V**
HK 28.1–28.5	Wed	14:00–15:30	SCH/A315	**Heavy-Ion Collisions and QCD Phases VI**
HK 29.1–29.5	Wed	14:00–15:30	SCH/A316	**Hadron Structure and Spectroscopy III**
HK 30.1–30.5	Wed	14:00–15:30	SCH/A419	**Nuclear Astrophysics III**
HK 31.1–31.4	Wed	14:00–15:30	SCH/A118	**Structure and Dynamics of Nuclei V**
HK 32.1–32.6	Wed	14:00–15:30	SCH/A215	**Structure and Dynamics of Nuclei VI**
HK 33.1–33.4	Wed	14:00–15:30	SCH/A252	**Fundamental Symmetries I**
HK 34.1–34.5	Wed	15:45–17:15	SCH/A251	**Instrumentation X**
HK 35.1–35.3	Wed	15:45–17:00	SCH/A.101	**Instrumentation XI**
HK 36.1–36.6	Wed	15:45–17:15	SCH/A117	**Computing I**
HK 37.1–37.6	Wed	15:45–17:15	SCH/A216	**Heavy-Ion Collisions and QCD Phases VII**
HK 38.1–38.6	Wed	15:45–17:15	SCH/A315	**Heavy-Ion Collisions and QCD Phases VIII**
HK 39.1–39.5	Wed	15:45–17:15	SCH/A316	**Hadron Structure and Spectroscopy IV**
HK 40.1–40.4	Wed	15:45–17:00	SCH/A419	**Nuclear Astrophysics IV**
HK 41.1–41.5	Wed	15:45–17:15	SCH/A118	**Structure and Dynamics of Nuclei VII**
HK 42.1–42.5	Wed	15:45–17:15	SCH/A215	**Structure and Dynamics of Nuclei VIII**
HK 43.1–43.4	Wed	15:45–17:15	SCH/A252	**Fundamental Symmetries II**
HK 44.1–44.5	Wed	17:30–19:00	SCH/A251	**Instrumentation XII**
HK 45.1–45.6	Wed	17:30–19:00	SCH/A.101	**Instrumentation XIII**
HK 46.1–46.5	Wed	17:30–19:00	SCH/A216	**Heavy-Ion Collisions and QCD Phases IX**
HK 47.1–47.5	Wed	17:30–18:45	SCH/A315	**Heavy-Ion Collisions and QCD Phases X**
HK 48.1–48.6	Wed	17:30–19:00	SCH/A316	**Hadron Structure and Spectroscopy V**
HK 49.1–49.6	Wed	17:30–19:00	SCH/A118	**Structure and Dynamics of Nuclei IX**
HK 50.1–50.5	Wed	17:30–19:00	SCH/A215	**Structure and Dynamics of Nuclei X**
HK 51.1–51.4	Wed	17:30–19:15	SCH/A252	**Fundamental Symmetries III**
HK 52.1–52.3	Thu	11:00–12:30	HSZ/AUDI	**AI Topical Day – Invited Talks (joint session AKPIK/HK/ST/T/AKBP)**
HK 53.1–53.6	Thu	14:00–15:30	HSZ/0103	**AI Topical Day – Computing II (joint session HK/AKPIK)**
HK 54.1–54.6	Thu	14:00–15:30	HSZ/0105	**AI Topical Day – Heavy-Ion Collisions and QCD Phases XI (joint session HK/AKPIK)**
HK 55.1–55.5	Thu	14:00–15:30	SCH/A251	**Instrumentation XIV**
HK 56.1–56.5	Thu	14:00–15:30	SCH/A.101	**Instrumentation XV**
HK 57.1–57.5	Thu	14:00–15:30	SCH/A316	**Hadron Structure and Spectroscopy VI**
HK 58.1–58.5	Thu	14:00–15:30	SCH/A419	**Hadron Structure and Spectroscopy VII**
HK 59.1–59.5	Thu	14:00–15:30	SCH/A118	**Structure and Dynamics of Nuclei XI**
HK 60.1–60.6	Thu	14:00–15:30	SCH/A215	**Structure and Dynamics of Nuclei XII**
HK 61.1–61.5	Thu	14:00–15:15	SCH/A117	**Structure and Dynamics of Nuclei XIII**
HK 62.1–62.4	Thu	14:00–15:15	SCH/A252	**Astroparticle Physics I**
HK 63.1–63.4	Thu	15:45–17:00	SCH/A251	**Instrumentation XVI**
HK 64.1–64.3	Thu	15:45–16:45	SCH/A.101	**Instrumentation XVII**
HK 65.1–65.6	Thu	15:45–17:15	SCH/A216	**Heavy-Ion Collisions and QCD Phases XII**
HK 66.1–66.6	Thu	15:45–17:15	SCH/A315	**Heavy-Ion Collisions and QCD Phases XIII**
HK 67.1–67.4	Thu	15:45–17:00	SCH/A316	**Hadron Structure and Spectroscopy VIII**
HK 68.1–68.4	Thu	15:45–17:00	SCH/A419	**Hadron Structure and Spectroscopy IX**
HK 69.1–69.6	Thu	15:45–17:15	SCH/A118	**Structure and Dynamics of Nuclei XIV**
HK 70.1–70.5	Thu	15:45–17:15	SCH/A215	**Structure and Dynamics of Nuclei XV**
HK 71.1–71.5	Thu	15:45–17:15	SCH/A117	**Structure and Dynamics of Nuclei XVI**
HK 72.1–72.5	Thu	15:45–17:00	SCH/A252	**Astroparticle Physics II**
HK 73.1–73.6	Thu	15:50–17:20	HSZ/0204	**Outreach Diverse (joint session T/HK)**
HK 74.1–74.54	Thu	17:30–19:00	HSZ EG	**Poster**

HK 75	Thu	19:00–20:00	HSZ/0002	**Members' Assembly**
HK 76.1–76.3	Fri	11:00–12:30	HSZ/0002	**Invited Talks IV**

Members' Assembly of the Hadronic and Nuclear Physics Division

Thursday 19:00–20:00 HSZ/0002

Sessions

– Invited Talks, Group Reports, Contributed Talks, and Posters –

HK 1: Invited Talks I

Time: Monday 11:00–12:30 Location: HSZ/0002

Invited Talk HK 1.1 Mon 11:00 HSZ/0002

Nucleosynthesis of heavy nuclei – moving a supernova into the laboratory — •Felix Heim — University of Cologne, Institute for Nuclear Physics

Stars do not only produce visible light and energy via nuclear fusion reactions but are also responsible for the creation of heavy elements. Since its birth over 60 years ago, the field of nuclear astrophysics strives to describe the complex nuclear processes and astrophysical conditions that drive elemental nucleosynthesis. While many facets of this topic are well-understood, others do still remain a great puzzle. Many heavy isotopes are produced within explosive stellar scenarios such as supernova explosions or neutron-star merger events. The procedure and the outcome of these events is heavily affected by nuclear reactions and the rates at which they occur. Therefore, it is essential to study the relevant nuclear reactions in the laboratory and mimic the stellar conditions. Furthermore, theoretical models have to be employed in many cases, where no experimental data are yet available. Therefore systematic investigation and testing of the underlying nuclear physics parameters is essential.

This contribution will discuss some experimental techniques to study nuclear reactions under astrophysical conditions using ion beam accelerators. In addition, current experimental results will be put into context of modern theoretical models using statistical methods. Supported by the DFG (ZI 510/8-2).

Invited Talk HK 1.2 Mon 11:30 HSZ/0002

Exploring the 3D nucleon structure with CLAS and CLAS12 at JLAB — •Stefan Diehl for the CLAS-Collaboration — Justus Liebig Universität Gießen and University of Connecticut

Exploring the 3 dimensional structure of the nucleon can help to understand several fundamental questions of nature, such as the origin of the nucleon spin and the charge and density distributions inside the nucleon. In QCD, the 3-dimensional structure of the nucleon is described by Wigner functions. However, experimentally momentum and coordinate space have to be assessed independently. The momentum distribution can be accessed by transverse momentum dependent distribution functions (TMDs) measured in semi-inclusive deep inelastic scattering (SIDIS) or Drell-Yan processes. The distribution in transverse coordinate and longitudinal momentum space is described by generalized parton distributions (GPDs) which can be accessed for example by deeply virtual Compton scattering (DVCS) and hard exclusive meson production (DVMP). Based on the high quality data of CLAS and the recently upgraded CLAS12 detector at Jefferson Laboratory (JLAB), a detailed study of these distribution functions is being performed. With the new CLAS12 data, multidimensional, high precision studies in an extended kinematic range become possible for the first time. The talk will present the results of recent SIDIS, DVCS and DVMP studies with CLAS and CLAS12, as well as perspectives for 3D nucleon structure measurements with PANDA at FAIR and their impact on the understanding of the 3D nucleon structure.

*The work is supported by DFG (project number: 508107918) and BMBF.

Invited Talk HK 1.3 Mon 12:00 HSZ/0002

Lattice simulations with chiral effective field theory at N3LO — •Serdar Elhatisari — Faculty of Natural Sciences and Engineering, Gaziantep Islam Science and Technology University, Gaziantep, Turkey — Helmholtz-Institut fuer Strahlen-und Kernphysik, Universitaet Bonn, Bonn, Germany

In this talk I present a new approach called wave function matching for solving quantum many-body systems and recent results for ab initio calculations of nuclear structure. The method is applied to lattice Monte Carlo simulations of light nuclei, medium-mass nuclei, neutron matter, and nuclear matter. The goal of method is to ensure that the perturbative corrections used in the lattice calculations converge quickly. We use interactions at next-to-next-to-next-to-leading order in the framework of chiral effective field theory and we find that the method is producing good results for the binding energies and charge radii of light and medium mass nuclei as well as the equation of state for pure neutron matter and symmetric nuclear matter saturation. Also, these results are accompanied by new insights on the nuclear interactions that may help to resolve long-standing challenges in accurately reproducing nuclear binding energies, charge radii, and nuclear matter saturation in ab initio calculations.

HK 2: Instrumentation I

Time: Monday 16:30–18:00 Location: SCH/A251

Group Report HK 2.1 Mon 16:30 SCH/A251

Aufbau und Kalibration der Vorwärtsendkappe des elektromagnetischen Kalorimeters des $\overline{\text{P}}$ANDA-Experimentes am COSY in Jülich — •Lukas Linzen für die PANDA-Kollaboration — Ruhr Universität Bochum, Germany

Das $\overline{\text{P}}$ANDA-Experiment wird eines der Schlüsselexperimente an der sich im Bau befindlichen Beschleunigeranlage FAIR. Dort werden Kollisionen von Antiprotonen in einem Impulsbereich zwischen 1,5 GeV/c und 15 GeV/c mit verschiedenen Targets untersucht. Der $\overline{\text{P}}$ANDA-Detektor ist ein vielseitiger Detektor mit präziser Spurrekonstruktion und der Möglichkeit neutrale, sowie geladenen Teilchen zu detektieren.

Das homogene elektromagnetische Kalorimeter (EMC) des Target-Spektrometers besteht aus einem fassförmigen Mittelteil und zwei Endkappen. Es stellt eine zentrale Detektorkomponente für die Bestimmung der Energien von e^-, e^+ und γ dar. Als Szintillator wird Bleiwolframat ($PbWO_4$) unter anderem wegen seiner hohen Strahlenhärte, kurzen Abklingzeit und kurzen Strahlungslänge eingesetzt. Zur Verbesserung der Lichtausbeute wird das EMC auf $-25\,^\circ$C gekühlt.

Es wird ein Überblick über den Aufbau der Vorwärtsendkappe und die Vorbereitung für die am COSY geplante Vorkalibration gegeben. Hierbei wird auf die finalen Detektorkomponenten und die Entwicklung des Datenerfassungssystems näher eingegegangen. Zur Kalibration werden Photonen aus π^0- und η-Zerfällen verwendet, welche in pp- und pn-Kollisionen erzeugt werden. Dazu wird ein Protonenstrahl mit einer Energie von 2,5 GeV und ein PET-Target verwendet.

Gefördert durch das BMBF.

HK 2.2 Mon 17:00 SCH/A251

Performance studies of pixel layers for the ALICE-FoCal detector — •Youssef El Mard Bouziani for the ALICE Germany-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

The upgrade of the ALICE experiment at CERN-LHC for LHC-Run 4 includes the expansion of the physics program with a study of small-x gluon distributions via prompt photon production.

To facilitate this study a highly granular Si+W electromagnetic calorimeter combined with a conventional sampling hadronic calorimeter covering pseudorapidities of $3.4 < \eta < 5.8$ has been proposed: the FoCal detector. The FoCal-E subdetector will consist of a Si+W sampling calorimeter hybrid design using two different Si readout technologies, pad layers, and pixel layers based on ALPIDE-chip technology. The pixel layers have been successfully tested within the framework of the EPICAL-2 prototype detector.

In this talk, we report on studies of the shower measurements with the EPICAL- 2 design. Furthermore, simulation studies of performance tests of the implementation of the pixel layers in the FoCal detector setup will be discussed.

Supported by BMBF and the Helmholtz Association.

HK 2.3 Mon 17:15 SCH/A251

Performance of the EPICAL-2 ultra-high granularity electromagnetic calorimeter prototype — •Tim Sebastian Rogoschinski for the ALICE Germany-Collaboration — Institut für Kernphysik, Goethe-Uni Frankfurt

The EPICAL-2 detector has been designed and constructed within the endeavour to develop a novel electromagnetic calorimeter based on a SiW sampling design using silicon pixel sensors with binary readout. The R&D is performed in the context of the proposed Forward Calorimeter upgrade within the CERN-ALICE experiment and is strongly related to proton CT imaging studies as well as applicable to future collider projects.

EPICAL-2 consists of alternating W absorber and Si sensor layers employing the ALPIDE sensor developed for the ALICE-ITS upgrade. It has a total thickness of 20 radiation lengths, an area of 30 mm × 30 mm, and 25 million pixels of size ∼ $30 \times 30\ \mu\text{m}^2$. EPICAL-2 has been successfully tested with cosmic muons as well in test-beam campaigns at DESY and CERN-SPS.

We will report on results on calibration from cosmic muons and on the combined energy measurement performance obtained at both DESY and SPS. Furthermore, we will present results on the electromagnetic shower shape description. Both the performance and the shape description can be reproduced by simulation.

Supported by BMBF and the Helmholtz Association.

HK 2.4 Mon 17:30 SCH/A251

Tuning of GFlash for COMPASS calorimeter simulations — •Henri Pekeler, Laney Klipphahn, David Spülbeck, Mathias Wagner, and Bernhard Ketzer — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

Monte-Carlo simulations of detector setups are an essential element of physics analyses. At COMPASS, we use a high-level Monte Carlo program called TGEANT, which is based on GEANT4, to determine the acceptance of the detector system. For final states with photons from π^0 or η decays, the correct response of the electromagnetic calorimeter in the simulations is essential.

Instead of tracking every single particle in a shower, which is computationally very expensive, the GFlash algorithm is used. It models the energy distribution and the extend of the shower, which should change for different calorimeter module types.

The COMPASS calorimeters are a combination of homogeneous and sampling calorimeter modules and it is of great importance to verify that reality is described well enough by GFlash. During this talk, we present how we tuned GFlash in order to match the shower shape of real events in the different COMPASS calorimeter modules and showcase the improved photon reconstruction after the tuning.

Supported by BMBF.

HK 2.5 Mon 17:45 SCH/A251

A Feature Extraction Ansatz for the PANDA Forward-Endcap EMC — •Celina Frenkel — HISKP, Uni Bonn

The forward endcap of the electromagnetic calorimeter of the PANDA experiment consists of 3856 lead tungstate crystals. These are either readout by VPTTs in the high rate regime ($\theta \lesssim 13^\circ$) or by 2 APDs per crystal at larger angles. The signals are then digitized using sampling ADCs.

A feature extraction algorithm implemented on the FPGAs on the SADC boards is used to extract energy and time information from the SADC signals online in real-time. The expected particle rate in forward direction of the experiment reaches ~500 kHz such that pile-up is a relevant aspect. A signal deconvolution can be used to shorten the pulse in time and reduce the probability of pile-up.

The central topic of this talk is the investigation of an online feature extraction ansatz making use of the Pulse Shape Deconvolution (PSD). With this ansatz it is possible to even remove unwanted properties of the signal shape and provide a clean signal for the following extraction of the signal's features using a peakfinder algorithm.

Finally, the performance of the new PSD ansatz is compared to the less FPGA resource demanding moving window deconvolution based feature extraction, currently implemented.

HK 3: Instrumentation II

Time: Monday 16:30–18:00 Location: SCH/A.101

Group Report HK 3.1 Mon 16:30 SCH/A.101

Space-point distortion calibrations for the ALICE TPC in LHC Run 3 — •Matthias Kleiner for the ALICE Germany-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

The Time Projection Chamber (TPC) is the main tracking and particle identification detector of the ALICE experiment at the CERN LHC. In order to cope with the high interaction rates of up to 50 kHz in Pb-Pb collisions during Run 3, the Multi-Wire Proportional Chambers (MWPCs) were replaced by stacks of four Gas Electron Multiplier (GEM) foils to allow for continuous data acquisition. Despite the intrinsic ion-blocking properties of the 4-GEM system, a residual amount of ions produced during the electron amplification drifts into the active volume of the TPC, leading to space-point distortions of the nominal drift field. Various effects, such as variations in the number of collisions for a given time interval, cause fluctuations of the distortions due to space-charge on very short time scales. Additional effects such as charging up of the GEM frames contribute to the space-point distortions. The average space-point distortions as well as the fluctuations have to be corrected to preserve the intrinsic tracking precision of the TPC.

In this talk, an overview about space-point distortions and distortion fluctuations in the ALICE TPC in Run 3 will be presented, along with procedures developed for the calibration of the space-point distortions.

Supported by BMBF and the Helmholtz Association

HK 3.2 Mon 17:00 SCH/A.101

First tests of the time projection chamber and the trigger barrel of the PUMA experiment — Alexandre Obertelli[1,2], •Clara Klink[1,2], Sabrina Zacarias[2], Christina Xanthopoulou[2], Francois Butin[1], Frank Wienholtz[2], and Emmanuel Pollacco[3] — [1]CERN, Genève, Switzerland — [2]TU Darmstadt, Darmstadt, Germany — [3]CEA-IRFU, Paris-Saclay, France

The antiProton Unstable Matter Annihilation (PUMA) experiment plans on using antiprotons as probe for the nucleonic composition in the tail of the nuclear density distribution for stable and exotic nuclei. Antiprotons annihilate with the nucleons on the nucleus' surface: the combined charge of the annihilation products will reveal the neutron-to-proton content at the nuclear surface. This allows to investigate quantum phenomena like Halo nuclei and neutron skins. The products of the annihilation will be detected in a time projection chamber surrounded by a plastic-scintillator trigger barrel. In this talk, the working principle of the PUMA detection system will be explained, as well as the data acquisition system. The results of first tests with the system will be presented.

HK 3.3 Mon 17:15 SCH/A.101

Low Material TPC construction — •David Markus for the MAGIX-Collaboration — Institute of Nuclear Physics, JGU Mainz

The MAinz Gas Injection Target EXperiment MAGIX, currently under construction in Mainz, together with the Mainz Energy-Recovering Superconducting Accelerator MESA, will perform electron scattering measurements on various gases, provided by a gas jet target. With an intended luminosity of $10^{35}\ \text{cm}^{-2}\ \text{s}^{-1}$ at 105 MeV, MAGIX is capable of servicing a wide variety of phyiscal objectives, including dark sector searches, investigations into few body systems and nuclear astrophysics.

The scattered particles will be measured with two identical high resolution magnetic spectrometers. In their focal plane a short drift GEM-based Time Projection Chamber is placed to serve as tracking detector. The active area of the TPC is 768x192x140mm. The setup of the experiment, from the internal gas jet target to the TPC, is designed to limit the interaction of scattered particles before their detection, such that the only seperator of TPC gas volume and interaction point is single kapton foil entry window. To assure that the desired precision can be achieved, a space saving calibration system using UV-LEDs has been designed. Plastic scintillators mounted after the capton foil exit window serve as a trigger veto system.

The low material TPC contruction and calibration system will be the focus of this talk.

HK 3.4 Mon 17:30 SCH/A.101

The MAGIX StarryNight calibration system — •Daniel Steger for the MAGIX-Collaboration — Institute of Nuclear Physics, JGU Mainz

The MESA accelerator will host the MAGIX experiment, which is based on the scattering of an electron beam on a gas jet target. This enables scattering on gases like hydrogen while minimizing interaction with any other materials allowing us to perform high precision experiments. The measurement of the scattered particles is done by two magnetic spectrometers using a GEM based TPC to track the particles. To achieve the precision desired an independent system to calibrate the TPC is necessary. A prototype of such a system has been designed, utilizing LEDs with a wavelength of 275 nm that are operated in pulses above the cathode of the active volume of the TPC. Furthermore the cathode of the TPC has been replaced with aluminium based photon-electron-converter boards.

In this contribution the setup and development of this calibration system will be presented.

HK 3.5 Mon 17:45 SCH/A.101

Quality Control for the ALICE TPC — •Berkin Ulukutlu for the ALICE Germany-Collaboration — Technische Universität München, Munich, Germany

The ALICE TPC (Time Projection Chamber) detector at the LHC has recently been upgraded to handle higher interaction rates with a continuous readout mode. This upgrade includes a new readout system using GEMs for amplification, custom front-end electronics, and new reconstruction software. To monitor this essentially new detector's performance and assure its reliability under extreme operating conditions, a Quality Control framework has been developed. This framework provides tools for monitoring the TPC in real-time at both the hardware and physics observable levels, such as particle identification performance. The QC systems also include automated checks for alerting detector experts in case of any issues. However, pinpointing the source of issues in such a complex system is not easy. To assist with this, QC tools specifically designed for expert use are being developed, offering a direct and interactive interface to TPC observables in contrast to the predefined histograms and projections used in synchronous monitoring. In this talk, we will provide an overview of the TPC QC project, highlighting the challenges and the tools developed to address them.

HK 4: Instrumentation III

Time: Monday 16:30–18:00 Location: SCH/A117

Group Report HK 4.1 Mon 16:30 SCH/A117

Measurements with fast neutrons nELBE — •Roland Beyer[1], Roberto Capote[2], and Arnd R. Junghans[1] — [1]Helmholtz-Zentrum Dresden - Rossendorf, Dresden, Germany — [2]International Atomic Energy Agency, Vienna, Austria

The neutron time-of-flight facility nELBE at Helmholtz-Zentrum Dresden-Rossendorf features the first photo-neutron source at a superconducting electron accelerator, which provides a very precise time structure, high repetition rate and favorable background conditions due to the low instantaneous flux and the absence of any moderating materials. The neutron energy spectrum ranges from about 100 keV up to 10 MeV. The resulting very flexible beam properties at nELBE enable a broad range of nuclear physics experiments, e.g. determination of the reaction cross section of elastic and inelastic neutron scattering or neutron induced fission or the determination of the response of detectors for in-situ particle range verification during cancer treatment with proton or ion beams.

As an examples the neutron transmission measurement of thick iron samples will be described in detail. The results of this measurement help to eliminate significant shortcomings in the resolved resonance region of all existing evaluations of iron isotopes that have been identified in leakage neutron measurements to be related to inaccurate elastic cross sections minima between 50 and 700 keV.

This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 847594 (ARIEL).

HK 4.2 Mon 17:00 SCH/A117

Towards a low-background X-ray setup at Felsenkeller Dresden — •Christoph Seibt, Hans Fritz Rudolf Hoffmann, Marie Pichotta, Steffen Turkat, and Kai Zuber — Institute of nuclear and particle physics, TU Dresden, Germany

Gamma Spectrometry is one of the most commonly used tools in nuclear physics, and it has advanced over the last decades considering efficiency, resolution and background reduction. X-ray spectrometry on the other hand is barely used in the field of nuclear physics despite a wide range of applications in the field of rare nuclear decays. Low-background X-ray spectrometry may enable the investigation of decays with no gamma ray emission and decays with a low Q-value. Therefore, a low-background X-ray spectrometry setup is designed and installed in the Felsenkeller shallow-underground laboratory in Dresden, Germany. The setup consists of a Silicon Drift Detector, encapsulated by a multi-layer passive shielding. This presentation reports on the current status of the setup design, installation and background measurements.

HK 4.3 Mon 17:15 SCH/A117

HPGe-BGO Pair Spectrometer for ELI-NP — •Ilja Homm for the ELI-NP Pair Spectrometer-Collaboration — Technische Universität Darmstadt, Germany

The new European research facility called ELI-NP (The **E**xtreme **L**ight **I**nfrastructure - **N**uclear **P**hysics) is being built in Bucharest-Magurele, Romania. ELI-NP will offer unprecedented opportunities for photonuclear reactions with high intensity, brilliant and fully polarized photon beams at energies up to 19.5 MeV.

The 8 HPGe CLOVER detectors of ELIADE are important instruments for the γ-spectroscopic study of photonuclear reactions. We investigate the possibility to operate an advanced version of an anti-Compton shield (AC shield) as escape γ-rays pair spectrometer for one of the ELIADE CLOVERS. This should improve the performance at high energies where the pair production process dominates. The BGO shield operated as a stand-alone device can also be used as γ-beam intensity monitor and to investigate the cross section for pair production near the threshold. A prototype pair spectrometer, consisting of 64 BGO crystals with SiPM (silicon photomultiplier) readout, has been designed and built. Two test measurements with high energy photons have been performed at the University of Cologne and at the ILL in Grenoble. Results are going to be presented.

This work is supported by the German BMBF (05P15RDENA, 05P21RDFN2) and the LOEWE-Forschungsschwerpunkt "Nukleare Photonik".

HK 4.4 Mon 17:30 SCH/A117

Improved Pulse Shape Simulations for Highly Segmented HPGe Detectors — •Rouven Hirsch, Rainer Abels, Jürgen Eberth, Kai Henseler, Herbert Hess, Darius Luyken, and Peter Reiter — Institut für Kernphysik, Universität zu Köln

The Advanced GAmma Tracking Array (AGATA) utilizes the γ-ray tracking method to reconstruct the path of the γ rays through the detector array. Essential for the tracking is the determination of the γ-ray interaction positions with high spatial resolution. This is obtained via pulse-shape analysis (PSA) of the 37 preamplifier signals of the 36-fold segmented high purity germanium detectors. Simulated signal shapes are compared to measured signals to match the interaction positions. Simulated data bases of position dependent signals were generated for a cylindrical 36-fold segmented single ended coaxial HPGe detector employing the AGATA Detector Library [1] and Solid-StateDetectors.jl [2]. Systematic deviations at the crystal borders and segmentation lines were identified and investigated by comparing simulated pulse shapes and measured signals for both approaches. The impact of individual parameters on the simulated pulse shapes were identified to improve the overall PSA performance. Supported by BMBF Project 05P18PKFN9 and 05P21PKFN9

[1] B. Bruyneel et al. Eur. Phys. J. A (2016) **52**: 70
[2] I. Abt et al. 2021 JINST **16** P08007

HK 4.5 Mon 17:45 SCH/A117

Revision of the AGATA Triple Cluster detectors — •Rainer Abels, Jürgen Eberth, Kai Henseler, Herbert Hess, Rouven Hirsch, Darius Luyken, Peter Reiter, and Jasper Wehlitz — IKP Universität zu Köln, Cologne, Germany

The Advanced GAmma Tracking Array (AGATA) is a 4π position sensitive γ-ray spectrometer based on the principle of γ-ray tracking. It provides high energy resolution, high efficiency and position resolution for in beam γ-ray spectroscopy. A high reliability of the AGATA Triple Cluster (ATC) detectors is mandatory for continues long term operation without maintenance of ATC detectors. For this purpose the following modifications were implemented. The HPGe crystals are encapsulated in a new reusable aluminum housing using a temperature resistant full-metal elastic seal. To recover the energy resolution of detectors suffering from neutron damage, a reliable annealing procedure was developed. New vacuum feedthroughs are implemented in order to increase the longevity of the ATCs. To improve the vacuum properties the position of getter materials inside the cold part was put close to the capsules. Novel test procedures for cold j-FETs were developed and new cold core preamplifiers replace obsolete electronic components. After the physics campaign at GANIL, France, AGATA was erected with the revised ATCs at LN Legnaro, Italy. Successful commissioning and first experiments were performed with improved performance values. Supported by BMBF Projects 05P18PKFN9, 05P21PKFN9.

HK 5: Heavy-Ion Collisions and QCD Phases I

Time: Monday 16:30–18:00 Location: SCH/A216

HK 5.1 Mon 16:30 SCH/A216

Dilepton anisotropic flow in hadronic transport — •Renan Hirayama[1,2] and Hannah Elfner[1,2,3,4] — [1]Helmholtz Forschungsakademie Hessen für FAIR (HFHF), GSI Helmholtzzentrum für Schwerionenforschung, Campus Frankfurt, Frankfurt am Main, Germany — [2]Frankfurt Institute for Advanced Studies, Frankfurt am Main, Germany — [3]Institut für Theoretische Physik, Goethe Universität, Frankfurt am Main, Germany — [4]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

We present first calculations of dielectron anisotropic flow in heavy-ion collisions at HADES beam energies from a hadronic transport approach. The collectivity of the electromagnetic radiation produced during the evolution of these collisions has recently been dubbed as a barometer, serving as a probe for the flow velocity of the underlying hadronic matter. In particular, we study the elliptic flow coefficient v_2 of dileptons in different collisions systems, and its relation to the flow of hadrons.

HK 5.2 Mon 16:45 SCH/A216

Probing rapidity structure of A-A events with correlations of particle number ratios — •Igor Altsybeev for the ALICE Germany-Collaboration — Technische Universität München, James-Franck-Straße 1, 85748 Garching bei München

Measurements of fluctuations allow one to study phase transitions and other collective phenomena in systems formed in high-energy hadronic collisions. In this report, we will discuss properties of a recently proposed fluctuation observable, namely, the correlation coefficient between ratios of identified particle yields measured in two angular acceptance windows. With such an observable it is possible, for instance, to study the correlation between relative strangeness yield in separated rapidity intervals, which should be sensitive to the density of the fireball formed in A-A collisions. Such correlations are also sensitive to various short-range effects, in particular, they are affected by spin statistics. We will show first experimental measurements of particle ratio correlations in pp and Pb-Pb data recorded by ALICE, and compare with predictions from several models that include various physics effects. Such comparison allows one to exclude some of the models.

This work is supported by BmBf.

HK 5.3 Mon 17:00 SCH/A216

Elliptic flow of pions, kaons and protons relative to the spectator plane measured with ALICE at the LHC — •Michael Rudolf Ciupek[1,2], Lukas Kreis[1,2], and Ilya Selyuzhenkov[2] for the ALICE Germany-Collaboration — [1]Physikalisches Institut, Heidelberg, Deutschland — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Deutschland

In relativistic heavy-ion collisions, the shape of the initial energy density in the overlap region of the colliding nuclei is asymmetric and fluctuates. Due to interactions, these fluctuations are transferred to the momentum distribution of particles in the final state which is quantified by the flow coefficients v_n. The thermodynamic expansion of the quark-gluon plasma (QGP) results in a specific particle mass dependence of the v_n coefficients as a function of the transverse momentum. The measurements of the v_n relative to the spectator plane is of special interest, since the spectators decouple very early in the collision. Comparison of the v_n measured relative to the participant and the spectator plane with the corresponding eccentricities allow constraining the initial state models. The particle-type dependence of these differences is sensitive to the viscous effects in the QGP expansion.

ALICE measurements of the v_2 for pions, kaons and protons wrt. the spectator plane in Pb-Pb collisions at $\sqrt{s_{\rm NN}}$ = 2.76 TeV are presented. The measurement of the particle-type dependent difference between v_2 relative to spectator plane and that of four-particle cumulants extends on previously published results for charged hadrons and allow to separate effects from QGP evolution and initial state fluctuations.

HK 5.4 Mon 17:15 SCH/A216

Equation of motion of the shear stress tensor in the moment approximation — •Timo Füle — FIAS, Frankfurt am Main, Germany

One of the most prominent theories for the evolution of the hot quark gluon plasma is kinetic theory. The common equations of motion (EOM) by Israel and Stewart lack a method for consistently increasing accuracy, namely a power counting scheme. This is due to a truncation of the expansion of the distribution function before deriving the EOM. But in fact the equations of motion can be derived without closing the expansion leaving infinitely many moments of the Boltzmann equation and being able to decide on the order of the approximation afterwards. This work revises the EOM derived by Denicol et al. at the example of the shear stress tensor. The truncation will be done afterwards to arrive at the EOM of the 14-moment approximation with the incorporated power counting scheme in the Knudsen- and inverse Reynolds-number.

HK 5.5 Mon 17:30 SCH/A216

Collective flow at SIS energies within a hadronic transport approach: Influence of light nuclei formation and equation of state — •Justin Mohs[2,3] and Hannah Elfner[1,2,3] — [1]Gesellschaft für Schwerionenforschung — [2]Goethe-Universität Fankfurt — [3]Frankfurt Institute for Advanced Studies

Collective flow observables are known to be a sensitive tool to gain insights on the equation of state of nuclear matter from heavy-ion collision observations. Towards more quantitative constraints one has to carefully assess other influences on the collective behaviour. Since the formation of light nuclei is important in low-energy heavy-ion collisions, two different approaches to take the formation of light nuclei into account are contrasted to each other within the hadronic transport approach SMASH: A clustering algorithm inspired by coalescence and microscopic formation of deuterons via explicit cross-sections. The sensitivity of directed and elliptic flow observables in Au+Au collisions at $E_{\rm lab} = 1.23A$ GeV to the strength of the Skyrme mean field is explored and we find that a stiff equation of state describes the measurement best if no momentum dependence is included in the nuclear potentials. This study establishes the current understanding of collective behaviour within the SMASH approach and lays the ground for future more quantitative constraints on the equation of state of nuclear matter within improved mean field calculations.

HK 5.6 Mon 17:45 SCH/A216

Collective flow measurements with HADES in Au+Au collisions at 1.23 AGeV — •Behruz Kardan for the HADES-Collaboration — Goethe-Universität, Frankfurt am Main

HADES provides a large acceptance combined with a high mass-resolution and therefore allows to study dielectron, hadron and light nuclei production in heavy-ion collisions with unprecedented precision. The high statistics measurements of flow coefficients for protons, deuterons and tritons in Au+Au collisions at 1.23 AGeV are presented here. In addition to the directed (v_1) and elliptic (v_2) flow components also the higher coefficients v_3, v_4, v_5 and v_6 are investigated for the first time in this energy regime. The multi-differential analysis in different centrality classes over a large region of phase space, i.e. as a function of transverse momentum p_t and rapidity, will be shown and various scaling properties will be discussed. This provides the possibility to characterise the production process of light nuclei, i.e. via coalescence, and puts strong constraints on the determination of the properties of dense matter, such as its viscosity and equation-of-state (EOS).

Supported by the Helmholtz Forschungsakademie HFHF and HGS-HIRe.

HK 6: Heavy-Ion Collisions and QCD Phases II

Time: Monday 16:30–18:00 Location: SCH/A315

Group Report HK 6.1 Mon 16:30 SCH/A315

Dielectrons with ALICE - Past, Present, Future — •Sebastian Scheid for the ALICE Germany-Collaboration — Goethe University, Frankfurt, Germany

The measurement of dielectrons is a fundamental piece in the understanding of hot and dense matter produced in ultra-relativistic heavy-ion collisions. The dielectron spectra yield information that pierce the veil of final-state hadronic interactions and give direct access to the early phases of the collision. ALICE recently started the LHC Run 3 data taking campaign after a major upgrade of the detector, which will significantly improve the capabilities to measure dileptons.

In this talk, we will give an overview of the dielectron measurements achieved so far with ALICE in different collision systems. Furthermore, the status of the Run 3 analyses together with the prospects for the Runs 3 and 4 will be presented. In particular, the impact of the detector upgrades installed during the long shut down will be explained. Finally, ultimate precision dielectron measurements in the 2030s with ALICE 3, a next-generation heavy-ion experiment at the LHC, will be discussed.

HK 6.2 Mon 17:00 SCH/A315

Thermal dileptons as a multi-messenger probe of the fireball — •Florian Seck[1], T. Galatyuk[1,2], R. Rapp[3], N. Schwarz[1], J. Steinheimer[4,5], J. Stroth[4,2], and M. Wiest[1] — [1]Technische Universität Darmstadt — [2]GSI, Darmstadt — [3]Texas A&M University, College Station, USA — [4]Universität Frankfurt — [5]FIAS, Frankfurt

As dileptons are radiated from the extreme states of matter created in heavy-ion collisions with negligible final-state interactions, they retain the information imprinted on them at the time of their creation. Multi-differential measurements of dilepton invariant mass, momentum, and angular distributions can therefore serve as a multi-messenger tool to characterize the properties of matter in the interior of the hot and dense fireball. To compute thermal dilepton spectra, we integrate in-medium dilepton rates over the space-time evolution of the collision described by a coarse-graining method of hadronic transport or hydrodynamic simulations. While the general shape of the dilepton invariant mass spectrum probes the baryon density, the slope at moderate masses measures the average temperature reached during the collision. The yield in the low-mass range is related to the fireball lifetime and is enhanced if a significant fraction of the fireball volume crosses a possible first-order phase transition. The analysis of the collective flow and polarization of dileptons can provide additional insights into the space-time evolution of the fireball in the QCD phase diagram and possible changes in the composition of the emitting source.

This work has been supported by: VH-NG-823, Helmholtz Alliance HA216/EMMI, GSI, HFHF, and the DFG through grant CRC-TR 211.

HK 6.3 Mon 17:15 SCH/A315

Dielectron Analysis for the CBM Experiment — •Adrian Meyer-Ahrens for the CBM-Collaboration — Institut für Kernphysik WWU Münster, Münster, Deutschland

The Compressed Baryonic Matter (CBM) experiment is a fixed-target heavy-ion experiment currently under construction at FAIR in Darmstadt which will explore the QCD phase diagram at high net-baryon densities. Dielectrons serve as versatile probes for the properties of the hot and dense medium created in the collisions since they do not interact strongly and escape the fireball undisturbed. Dielectron physics relies on the efficient reduction of combinatorial background, dominated by misidentified hadrons as well as electrons from photon conversions in the target or detector material.

In this talk, simulation results concerning dielectron invariant mass spectra at CBM will be presented, focussing on background rejection using conventional cut-based selections as well as machine learning methods. This work is supported by BMBF grant 05P21PMFC1.

HK 6.4 Mon 17:30 SCH/A315

Real-time methods for spectral functions — Johannes Roth[1], •Leon Sieke[1], and Lorenz von Smekal[1,2] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität, 35392 Giessen, Germany — [2]Helmholtz Research Academy Hesse for FAIR (HFHF), Campus Giessen, 35392 Giessen, Germany

We compare different real-time methods to calculate spectral functions in dissipative open systems based on generalized Langevin equations. These are classical-statistical lattice simulations, a quasiclassical approximation and a Gaussian state approximation (GSA) which is the main focus of this talk. Results from exact diagonalization of the quartic anharmonic oscillator with damping serve as benchmark which can be seen as a (0+1)-dimensional toy theory for self-interacting scalar fields at finite temperature. Inspired by the well-known Caldeira-Leggett model, we extend the classical Langevin dynamics for the coupling to an external heat bath to the corresponding Heisenberg-Langevin dynamics in the GSA [1]. We furthermore use the latter to compute spectral functions in a self-interacting scalar field theory in (2+1) and (3+1) dimensional spacetime. To achieve this we employ two different methods to compute the spectral functions which work particularly well in complementary temperature regimes.

[1] J. V. Roth, D. Schweitzer, L. J. Sieke and L. von Smekal,
Phys. Rev. D 105 (2022) 116017.

HK 6.5 Mon 17:45 SCH/A315

Momentum dependence of thermal dilepton invariant mass spectra combining transport models and an FRG spectral function — •Maximilian Wiest[1], Tetyana Galatyuk[1,2,4], Ralf-Arno Tripolt[3], Lorenz von Smekal[3,4], and Jochen Wambach[1] — [1]Technical University of Darmstadt, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany — [3]Justus Liebig University Giessen, Germany — [4]Helmholtz Research Academy Hesse for FAIR (HFHF)

Dileptons provide a unique way to access the properties of the fireball in heavy ion-collisions. While the bulk of the detected particles stemming from heavy ion collisions are hadrons, particles heavily influenced by final state interactions, dileptons do not suffer from this disadvantage and can leave the fireball undisturbed, probing the hot and dense matter before it freezes out. We use the microscopic transport model UrQMD to simulate heavy-ion collisions at SIS18 energies in different centrality classes. Employing a Coarse Graining approach, we are able to combine the simulated microscopic dynamics with in-medium spectral functions obtained from FRG methods at finite momenta. This allows to study the impact of finite momentum effects of the spectral function on the dilepton spectra invariant mass spectra measured at SIS18 energies.

Supported by VH-NG-823, DFG CRC-TR 211 and GSI.

HK 7: Hadron Structure and Spectroscopy I

Time: Monday 16:30–18:00 Location: SCH/A316

Group Report HK 7.1 Mon 16:30 SCH/A316

A coupled channel analysis of e^+e^- annihilation in the bottomonium region — •Nils Hüsken[1,2], Ryan Mitchell[2], and Eric Swanson[3] — [1]Johannes Gutenberg-Universität Mainz — [2]Indiana University Bloomington — [3]University of Pittsburgh

In recent years, a large number of exotic hadron candidates have been discovered in the charmonium and bottomonium regions. Electron positron annihilation in experiments like BaBar, BESIII, Belle(II) and CLEO has played an important role in the discoveries of many of these charmonium- and bottomonium-like states, in particular of vector-states directly produced in the collision. Thus far, new resonances have regularly been studied using fits of simplified models to the cross sections of e^+e^- annihilation to exclusive final states, leading to large model dependencies. Here, we will present the first global and unitary analysis of $e^+e^- \to b\bar{b}$ cross sections including exclusive cross sections in the $B\bar{B}$, $B^*\bar{B}(+c.c.)$, $B^*\bar{B}^*$, $B_s^*\bar{B}_s^*$, $\Upsilon(nS)\pi^+\pi^-$ and $h_b(nP)\pi^+\pi^-$ channels as well as the total inclusive cross section for $b\bar{b}$ production. Pole positions and residues are determined for four vector-bottomonium states, which we associate with the $\Upsilon(4S)$, $\Upsilon(10750)$, $\Upsilon(10860)$ and $\Upsilon(11020)$. Strong evidence is found for the new $\Upsilon(10750)$ recently claimed by Belle, although with parameters not well constrained by the data. Results presented here cast doubt on the validity of branching ratios reported earlier using Breit-Wigner parametrizations or ratios of cross sections. * This work received funding from the European Union Horizon 2020 research and innovation program under Marie Skłodowska-Curie Grant Agreement No. 894790

HK 7.2 Mon 17:00 SCH/A316

Continuity Constraints for Partial-Wave Analyses* — •Florian Kaspar[1,2] and Jakob Knollmüller[1,2] for the COMPASS-Collaboration — [1]Technische Universität München, James-Franck-Straße 1, 85748 Garching — [2]Exzellenzcluster ORIGINS, Boltzmannstr. 2, 85748 Garching

The COMPASS experiment studies the light-meson spectrum in the three-pion final state. The conventional way of extracting resonance parameters, e.g. mass and width, is performing a partial-wave analysis in two steps. First, the individual partial-waves are extracted in bins of the three-pion mass, then a model fit is performed to the results of the first stage. The method reaches its limits for large numbers of partial-waves as the finite amount of data in the individual bins in combination with many free parameters leads to noisy results in this first analysis step. By combining the two analysis steps into one, we are able to apply our knowledge of continuity of the physical signal to the fits. The continuity constraints are implemented via Gaussian Processes. This stabilizes the fits while keeping the extraction effectively model-independent. We use the NIFTy framework for numerical information field theory to implement the continuous model and demonstrate the feasibility of the new method for the three-pion final state. We also outline the way towards the direct extraction of resonance parameters in a single fit to the data.

*funded by the DFG under Germany's Excellence Strategy - EXC2094 - 390783311 and BMBF Verbundforschung 05P21WOCC1 COMPASS

HK 7.3 Mon 17:15 SCH/A316

Understanding the Ambiguities in the Partial-Wave Decomposition of the $K_s^0K^-$ Final State* — •Julien Beckers for the COMPASS-Collaboration — Technical University of Munich

COMPASS is a multi-purpose fixed-target experiment at the CERN SPS. One of its main goals is to probe the excitation spectrum of light mesons in diffractive scattering reactions. This requires decomposing the data into partial-wave amplitudes with well-defined quantum numbers and searching for resonances in these amplitudes. Using this method, decays of light mesons into various final states are studied at COMPASS. In the case of final states with two spinless particles, mathematical ambiguities appear in the partial-wave decomposition, meaning that several sets of values for the amplitudes lead to the same measured intensity distribution, i.e. are indistinguishable by the data.

In this talk, we will present a new investigation of these ambiguities in the $K_s^0K^-$ final state, which allows us to study a_J- and π_J-like resonances with spin J with high precision and which complements the $\eta\pi^-$, $\eta'\pi^-$ and $\pi^-\pi^-\pi^+$ final states that have already been studied at COMPASS. We will explain how they arise and show how they evolve with the mass of the system, as well as present approaches to resolve them completely or to reduce the number of ambiguous solutions for the amplitudes, by introducing terms that break the exact invariance.

* funded by the DFG under Germany's Excellence Strategy - EXC2094 - 390783311 and BMBF Verbundforschung (05P21WOCC1 COMPASS)

HK 7.4 Mon 17:30 SCH/A316

Untersuchung von Charmonium-Zerfällen in $\phi\eta$, $\phi\eta'$ und $\phi\pi^0$ bei BESIII — •Frederike Hanisch — Ruhr-Universität Bochum, Institut für Experimentalphysik I, 44780 Bochum

Das BESIII-Experiment wird seit 2009 am Elektron-Positron Collider BEPCII in Peking am Institut für Hochenergiephysik (IHEP) betrieben und zeichnet sich durch große Datensätze mit Schwerpunktsenergien zwischen $\sqrt{s} = (2-4.95)$ GeV aus, wodurch die Untersuchung seltener Charmonium-Zerfälle möglich ist. Auf Basis von QCD-Rechnungen wird ein 12%-Verhältnis zwischen den Verzweigungsverhältnissen von J/ψ und $\psi(2S)$ in Hadronenzerfällen mit drei Gluonen oder einem Photon vorausgesagt. Diese Vorhersage wird in einigen Zerfällen, beispielsweise dem Zerfall über $\rho\pi$, nicht erfüllt. Die Ursache dieses sogenannten „$\rho\pi$-Puzzles", welches bereits seit 1983 erforscht wird, ist jedoch nicht vollständig bekannt. Durch die Bestimmung bisher nicht bekannter oder ungenau vermessener Verzweigungsverhältnisse von $\psi(2S) \to \phi\pi^0$, $\psi(2S) \to \phi\eta$ und

$\psi(2S) \to \phi\eta'$ soll ein Beitrag zum besseren Verständnis des $\rho\pi$-Puzzles geleistet werden. Die Analyse basiert auf einem Datensatz von über $22 \cdot 10^8$ $\psi(2S)$-Ereignissen. In diesem Beitrag werden vorläufige Ergebnisse für die Verzweigungsverhältnisse der Zerfälle von $\psi(2S)$ in $\phi\eta$, $\phi\eta'$ und $\phi\pi^0$ vorgestellt.
Gefördert durch die DFG (CRC 110 / NSFC-DFG).

HK 7.5 Mon 17:45 SCH/A316

Untersuchung der Zerfallskanäle $\psi(2S) \to \omega\pi^0$, $\omega\eta$ und $\omega\eta'$ bei BESIII — •Lisa Lou Krümmel — Ruhr-Universität Bochum, Institut für Experimentalphysik I, 44780 Bochum

Die Quantenchromodynamik sagt ein Verhältnis von 12,7 % zwischen hadronischen J/ψ- und $\psi(2S)$-Zerfällen voraus. Dies ist als "12 %-Regel" bekannt. Eine Abweichung wurde erstmals für den Zerfall in $\rho\pi$ festgestellt. Seitdem werden Zerfallskanäle, die diese Regel nicht erfüllen, unter dem $\rho\pi$-Puzzle zusammengefasst.
Um das Verhältnis zwischen J/ψ- und $\psi(2S)$-Zerfallsbreiten zu bestimmen, ist es essenziell, die einzelnen Zerfallsbreiten genau zu vermessen. Die Zerfallsbreiten $\psi(2S) \to \omega\pi^0$ und $\omega\eta'$ sind mit großen statistischen Fehlern behaftet. Der Prozess $\psi(2S) \to \omega\eta$ wurde bisher nicht beobachtet.
Das BESIII-Experiment am Elektron-Positron Collider BEPCII in Peking hat Datensätze mit hoher Statistik für die J/ψ- und $\psi(2S)$-Resonanzen aufgezeichnet. Die Prozesse $\psi(2S) \to \omega\pi^0, \omega\eta, \omega\eta'$ werden auf Basis von über $22 \cdot 10^8$ Ereignissen untersucht. Vorläufige Ergebnisse für die Bestimmung der Verzweigungsverhältnisse werden vorgestellt.
Gefördert durch die DFG (CRC 110 / NSFC-DFG).

HK 8: Nuclear Astrophysics I

Time: Monday 16:30–18:00 Location: SCH/A419

Group Report HK 8.1 Mon 16:30 SCH/A419

Activation experiments for p-process nucleosynthesis at the University of Cologne — •Martin Müller, Felix Heim, Svenja Wilden, Pina Wüstenberg, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics

For modeling the vast reaction networks involved in the production of heavy proton-rich isotopes in p-process nucleosynthesis, reaction cross sections for ten thousands of reactions are needed. It is impossible to measure all of these reactions in the laboratory because of which theoretical calculations of cross sections are imperative. To verify and adjust these calculations a comprehensive experimental database is needed [1]. A powerful method for extending the available database is the activation technique, which has been applied in various forms at the University of Cologne utilizing its 10 MV FN tandem and 6 MV HVE tandetron accelerators as well as the Cologne Clover Counting setup consisting of two clover-type HPGe detectors. Experiments combining the activation technique with in-beam measurements or the stacked-target method will be reported on, a method for utilizing two-step decays will be introduced, and results for the ^{168,170,172}Yb$(\alpha,n)^{171,173,175}$Hf, ^{55}Mn$(\alpha,(2)n)^{57,58}$Co, and ^{58}Fe$(p,n)^{58}$Co will be presented [2,3].
Supported by the DFG (ZI 510/8-2).
[1] M. Arnould and S. Goriely, *Phys. Rep.* **384**, 1 (2003)
[2] L. Netterdon *et al.*, *Nucl. Phys. A* **916**, 149-167 (2013)
[3] M. Müller *et al.*, submitted (2022)

HK 8.2 Mon 17:00 SCH/A419

New Cross Section Data for Radiative Proton Capture on Carbon for Nuclear Astrophysics at LUNA — •Axel Boeltzig[1] and Jakub Skowronski[2] for the LUNA-Collaboration — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Università degli Studi di Padova and INFN Sezione di Padova, Padua, Italy

The observable ratio of ^{12}C/^{13}C can be used as a probe for stellar nucleosynthesis as well as for mixing processes during hydrogen burning, provided that the reaction rates of ^{12}C(p, γ)^{13}N and ^{13}C(p, γ)^{14}N are known. To obtain direct cross section measurements at low energies, which are required to better constrain these rates in astrophysical scenarios, both reactions were studied in a series of experiments at the LUNA-400 accelerator. Different targets and complementary detector setups were employed for a systematic study, and the sensitivity afforded by the low-background underground environment allowed for precise measurements at lower energies than previously available. We will present these experiments and their results for both reactions.

HK 8.3 Mon 17:15 SCH/A419

Cross section measurements of the ^{12}C(p,γ)^{13}N reaction in the energy range of 130 keV to 640 keV — •Simon Rümmler — Helmholtz-Zentrum Dresden-Rossendorf, Institute of Radiation Physics — TU Dresden, Institute of Nuclear and Particle Physics

The CNO-cycle is the dominant hydrogen burning process in stars above a temperature of 17 million Kelvin. The rate of this cycle in the initial phase and in the outer shells of the burning zone is dominated by the rate of the ^{12}C(p,γ)^{13}N reaction. Furthermore, this reaction affects the ratio of ^{12}C to ^{13}C abundances. Efforts are underway to re-measure the cross section of the ^{12}C(p,γ)^{13}N in the energy region of the 400 keV resonance, leading to an improved extrapolation to astrophysically relevant energies.

In 2017 the reaction was studied in inverse kinematics at the 3 MV Tandetron accelerator at Helmholtz-Zentrum Dresden-Rossendorf in an energy range of 130 keV to 450 keV. Further measurements in the energy range of 330 keV to 640 keV with low background were done at the 5 MV Pelletron accelerator at the Felsenkeller shallow-underground laboratory in Dresden in 2022. The methods and results of these measurements, as well as a conclusion of the two campaigns, will be presented.

HK 8.4 Mon 17:30 SCH/A419

3α-Zerfälle der angeregten 3^-_1, 1^-_1 und 4^-_1 Zustände von ^{12}C — •Joe Roob[1], David Werner[1], Peter Reiter[1], Konrad Arnswald[1], Maximilian Droste[1], Pavel Golubev[2], Rouven Hirsch[1], Hannah Kleis[1], Nikolas Königstein[1], Madalina Ravar[1,3], Dirk Rudolph[2], Alessandro Salice[1] und Luis Sarmiento[2] — [1]University of Cologne, Institute for Nuclear Physics, Cologne, Germany — [2]Lund University, Department of Physics, Lund, Sweden — [3]TU Darmstadt, Institute of Nuclear Physics, Darmstadt, Germany

Die Eigenschaften des 3-Körper-Zerfalls der angeregten Zustände von ^{12}C ermöglichen einen direkten Vergleich mit theoretischen Modellen zur Struktur von ^{12}C. Es wurde ein Experiment mit einer $^{12}C(\alpha,\alpha')$ Reaktion mit einem 27 MeV α Strahl am 10-MV Tandem Beschleuniger des Instituts für Kernphysik der Universität zu Köln durchgeführt. Das Lund-York-Cologne-Calorimeter (LYCCA), mit 18 Silizium Streifen Detektoren (18432 Pixel), wurde für die Messung eingesetzt um die vollständige Rekonstruktion der 4 α-Kerne durch die hohe Raumwinkelabdeckung und gute Ortsauflösung zu ermöglichen. Es wurden der Hoyle-State und die höher liegenden 3^-_1, 1^-_1 und 4^-_1 Zustände bei 9641 keV, 10847 keV und 13316 keV in ^{12}C untersucht. Die Zerfälle der Zustände oberhalb des Hoyle-States werden insbesondere durch die Dalitz-Plots der 3 α-Teilchen charakterisiert. Vorläufige Ergebnisse werden diskutiert.

HK 8.5 Mon 17:45 SCH/A419

Analysis of the 3α-decay of the 0^+_2 state in ^{12} — •David Werner[1], Joe Roob[1], Peter Reiter[1], Konrad Arnswald[1], Maximilian Droste[1], Pavel Golubev[2], Rouven Hirsch[1], Hannah Kleis[1], Nikolas Königstein[1], Madalina Ravar[1,3], Dirk Rudolph[2], Alessandro Salice[1], and Luis Sarmiento[2] — [1]University of Cologne, Institute for Nuclear Physics, Cologne — [2]Lund University, Department of Physics, Lund, Sweden — [3]TU Darmstadt, Institute of Nuclear Physics, Darmstadt

The branching ratios between the direct and sequential three-particle decay of the 0^+_2 excited state in ^{12}C, the Hoyle state, are important probes for the inner structure of ^{12}C and provide insights into stellar nucleosynthesis. Two high-statistics experiments were performed at the 10 MV FN-tandem accelerator of the Institute for Nuclear Physics of the University of Cologne. A ^{12}C(α,α') reaction at a beam energy of 27 MeV was utilized to populate the state of interest. The Lund-York-Cologne-Calorimeter (LYCCA) was used to study the three-particle decay branches of the Hoyle state. The 18 segmented double-sided silicon strip detectors allowed individual detection of the reaction's four α particles with high angular precision. Results from particle spectra are compared with Geant4 Monte-Carlo simulations. Latest analysis results, in particular Dalitz plots and the search for the direct 3α decay, will be presented.

HK 9: Structure and Dynamics of Nuclei I

Time: Monday 16:30–18:00 Location: SCH/A118

Group Report HK 9.1 Mon 16:30 SCH/A118

Studying the Low-Energy Electric Dipole Response With Different Hadronic Probes — •Michael Weinert, Florian Kluwig, Markus Müllenmeister, Miriam Müscher, Barbara Wasilewska, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics

A concentration of electric dipole strength below the neutron separation threshold is known to be common in medium to heavy mass nuclei. The established picture of a neutron-skin oscillation being the single cause for this strength was questioned about 15 years ago, when comparing the excitation in bremsstrahlung experiments to results from a hadronic probe, i.e., $(\alpha,\alpha'\gamma)$ [1]. Recently, another experimental access was added to the repertoire by investigating the population of states via (d,p) reactions [2]. The strong single-particle character of excited states could be identified by combined experimental and theoretical efforts, describing various realistic observables with great accuracy [3]. This contribution presents an overview of the current status of the hadronic experiments on several nuclei with data taken with the SONIC@HORUS spectrometer at the University of Cologne. The comparison of ^{119}Sn$(d,p\gamma)$ data at $E_d = 8.5$ MeV and ^{120}Sn$(\alpha,\alpha'\gamma)$ data at $E_\alpha = 130$ MeV will be highlighted, as well as their theoretical comprehension within the Quasiparticle-Phonon-Model and corresponding reaction theory. Supported by the DFG (ZI 510/10-1).

[1] J. Endres *et al.*, Phys. Rev. C **80**, 034302 (2009)
[2] M. Spieker *et al.*, Phys. Rev. Lett. **125**, 102503 (2020)
[3] M. Weinert *et al.*, Phys. Rev. Lett. **127**, 242501 (2021)

HK 9.2 Mon 17:00 SCH/A118

Model-independent test of the Brink-Axel hypothesis — •O. Papst[1], J. Isaak[1], A. D. Ayangeakaa[2,3], T. Beck[1,4], S. W. Finch[3,5], U. Friman-Gayer[3,5,6], D. Gribble[2,3], X. James[2,3], R. V. F. Janssens[2,3], S. R. Johnson[2,3], J. Kleemann[1], F. Kluwig[7], P. Koseoglou[1], B. Löher[8], M. Müscher[7], N. Pietralla[1], D. Savran[8], V. Werner[1], and A. Zilges[7] — [1]TU Darmstadt — [2]UNC, Chapel Hill, NC, USA — [3]TUNL, Durham, NC, USA — [4]FRIB, MSU, East Lansing, MI, USA — [5]Duke U., Durham, NC, USA — [6]ESS, Lund, SE — [7]Univ. Köln — [8]GSI, Darmstadt

The Brink-Axel (BA) hypothesis states that the transition probability between two groups of states, described by the photon strength function (PSF) for a given multipolarity, only depends on the energy difference of the states. For ^{96}Mo, significant discrepancies between upward (excitation) and downward (deexcitation) PSF were found [1] with various experimental probes. A new method [2] allows for the simultaneous measurement of upward and downward PSF in a single nuclear resonance fluorescence (NRF) experiment. To test the discrepancies and BA hypothesis, NRF experiments on ^{96}Mo were performed at the High Intensity γ-ray Source (HIγS) and will be discussed.

Supported by the State of Hesse, grant “Nuclear Photonics” (LOEWE program), the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) – Project-ID 279384907 – SFB 1245, and the U. S. DOE, Grant No. DE-FG02-97ER41041 and No. DE-FG02-97ER41033.

[1] D. Martin *et al.*, Phys. Rev. Lett. **119**, 182503 (2017)
[2] J. Isaak *et al.*, Phys. Lett. B **788**, 225 (2019)

HK 9.3 Mon 17:15 SCH/A118

Investigation of the dipole strength distribution in ^{70}Zn up to the particle threshold[a] — •J. Hauf[1], V. Werner[1], M. Beuschlein[1], R. Beyer[2], T. Hensel[2], J. Isaak[1], J. Kleemann[1], P. Koseoglou[1], C. Nickel[1], O. Papst[1], N. Pietralla[1], K. Prifti[1], K. Römer[2], K. Schmidt[2], R. Schwengner[2], S. Turkat[2], J. Vogel[1], A. Wagner[2], and A. Yadev[2] — [1]IKP, TU Darmstadt — [2]Helmholtz-Zentrum Dresden-Rossendorf

The dipole strength distribution of the neutron-rich nucleus ^{70}Zn has been investigated up to its particle threshold of around 9.2 MeV. This study is motivated by shedding light on the E1 strength, typically attributed to the pygmy dipole resonance on top of the low-energy tail of the giant dipole resonance. A Nuclear Resonance Fluorescence (NRF) experiment was conducted at the γELBE-Setup at the Helmholtz- Zentrum Dresden-Rossendorf using a bremsstrahlung beam with an endpoint energy of 11.5 MeV. The experiment will be described. NRF spectra and the status of the data analysis, including integrated NRF cross sections and transition strengths, will be presented and discussed.

[a]This work was supported by DFG project number 279384907-SFB 1245

HK 9.4 Mon 17:30 SCH/A118

Investigation of the low-lying dipole strength in ^{62}Ni — •Tanja Schüttler[1], Florian Kluwig[1], Miriam Müscher[1], Ronald Schwengner[2], and Andreas Zilges[1] — [1]University of Cologne, Institute for Nuclear Physics — [2]Helmholtz-Zentrum Dresden-Rossendorf

Systematic studies within isotopic and isotonic chains are essential to investigate the properties of the low-lying dipole strength below and around the neutron-separation threshold. The nickel (Z = 28) isotopic chain is a well-suited candidate for this purpose because it consists of four stable, even-even isotopes covering a large range of N/Z ratios. Since photons just transfer small angular momenta, (γ,γ') experiments are ideally suited to study the dipole response in atomic nuclei [1]. The isotopes ^{58,60,64}Ni have already been measured in (γ,γ') experiments [2-5]. To complete the systematics, ^{62}Ni was investigated using energetically continuous bremsstrahlung with a maximal photon energy of $E_{\rm max}$ = 8.7 MeV at the γELBE facility [6]. First results of this experiment will be presented.

This work is supported by the BMBF (05P21PKEN9)

[1] A. Zilges *et al.*, Prog. Part. Nucl. Phys. **122** (2022) 103903
[2] F. Bauwens *et al.*, Phys. Rev. C **62** (2000) 024302
[3] M. Scheck *et al.*, Phys. Rev. C **88** (2013) 044304
[4] M. Scheck *et al.*, Phys. Rev. C **87** (2013) 051304(R)
[5] M. Müscher, private communication (2022)
[6] R. Schwengner *et al.*, Nucl. Instr. and Meth. A **555** (2005) 211

HK 9.5 Mon 17:45 SCH/A118

Parity-quantum numbers and branching ratios of ^{96}Mo dipole-excited states* — •V. Skibina[1], O. Papst[1], J. Isaak[1], A. D. Ayangeakaa[2,3], T. Beck[1,4], M. L. Cortés[1,5], S. W. Finch[3,6], U. Friman-Gayer[3,6,7], D. Gribble[2,3], X. James[2,3], R. V. F. Janssens[2,3], S. Johnson[2,3], J. Kleemann[1], F. Kluwig[8], P. Koseoglou[1], B. Löher[9], M. Müscher[8], N. Pietralla[1], D. Savran[9], V. Werner[1], and A. Zilges[8] — [1]IKP, TU Darmstadt — [2]UNC, NC, USA — [3]TUNL, NC, USA — [4]MSU, MI, USA — [5]RIKEN, JP — [6]Duke U., NC, USA — [7]ESS, SE — [8]IKP, U. Köln — [9]GSI, Darmstadt

Photonuclear reactions are well-suited to provide fundamental spectroscopic quantities of nuclei such as γ-ray transition energies, spin and parity quantum numbers [1]. The present work focuses on the study of the dipole strength distribution, its disentanglement into electric and magnetic contributions, and the decay behavior of excited states of ^{96}Mo. For that purpose, Nuclear Resonance Fluorescence (NRF) experiments were performed at the High Intensity Gamma-ray Source (HIγS) with linearly-polarized, quasi-monochromatic photon beams to assign parity quantum numbers and determine branching ratios of observed states. In this contribution, first results will be presented.

* Supported by the State of Hesse, grant “Nuclear Photonics” (LOEWE program), the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) – Project-ID 279384907 – SFB 1245 and the U.S. DOE, Grant Nos. DE-FG02-97ER41041 & DE-FG02-97ER41033.

[1] A. Zilges et al., Prog. Part. Nucl. Phys. **122**, 103903 (2022).

HK 10: Structure and Dynamics of Nuclei II

Time: Monday 16:30–18:00 Location: SCH/A215

Group Report HK 10.1 Mon 16:30 SCH/A215

Collinear laser spectroscopy at NSCL/FRIB — •Kristian König[1,2], Ronald Garcia-Ruiz[3], Kei Minamisono[2], and Wilfried Nörtershäuser[1] — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]Facility for Rare Isotope Beams, Michigan State University, USA — [3]Massachusetts Institute of Technology, USA

The National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University was recently upgraded to the Facility for Rare Isotope Beams (FRIB). With in-flight fragmentation, rare isotope beams from all over the nuclear chart can be produced and investigated, e.g., with collinear laser spectroscopy at the BECOLA setup. In this talk, we will summarize the latest results on Nickel, Scandium and Silicon that gave new insights in the nuclear structure at the neutron shell closures at $N = 20$ and 28. Furthermore, the investigation of the nuclear charge radius of mirror nuclei allowed us to constrain L, the slope parameter of the nuclear equation of state. Our result is consistent with results derived from the dipole polarizability and neutron star mergers. The capabilities of BECOLA in the FRIB era will be discussed as well as the status of the currently ongoing upgrade that will allow us to perform the more sensitive collinear resonance ionization spectroscopy with particle detection (RISE). This work was supported in

part by US NSF Grant No. PHY-21-11185 and DOE Office of Science Award No. DE-SC0000661, DE-SC0021176 and DE-SC0021179 and by the DFG – Project-Id 279384907*SFB 1245.

HK 10.2 Mon 17:00 SCH/A215

The Charge Radius of ^{26,26m}Al and its implication for CKM unitarity — •Peter Plattner — Max-Planck-Institut fuer Kernphysik, Heidelberg, Germany

For the COLLAPS and IGISOL collaborations.

In the study of atomic nuclei, nuclear charge radii provide intriguing physics insights into the evolution of nuclear structure far away from stability. Furthermore, charge radii have been used as experimental input for the determination of V_{ud} of the CKM quark mixing matrix from superallowed nuclear β-decays. In the Standard Model of particle physics, the CKM matrix is predicted to be unitary but recent reviews of the matrix values show a 2.2σ deviation for one of its unitarity tests.

This contribution will present the recent work of combined measurements of the charge radii of ^{26,26m}Al by means of Collinear Laser Spectroscopy (CLS) at the COLLAPS experiment/ISOLDE and at the IGISOL facility/Jyvaskyla, Finland. CLS takes advantage of the interaction between the atomic nucleus and its surrounding electrons giving rise to the hyperfine structure. Thus, properties of nuclear ground states and long-lived isomers, including nuclear charge radii, can be inferred from measured hyperfine spectra. Prior to the present work, the charge radius of the superallowed β emitter ^{26m}Al was not known experimentally but was extrapolated to evaluate the isospin symmetry breaking (ISB) correction required for the determination of V_{ud}.

The present measurements reveal a charge radius of ^{26m}Al which differs by more than 4 standard deviations from the value assumed in previous ISB calculations.

HK 10.3 Mon 17:15 SCH/A215

^{83m}Kr N-line spectrum measurement at KATRIN — Matthias Böttcher[1], Moritz Machatschek[2], Magnus Schlösser[2], and •Jaroslav Storek[2] for the KATRIN-Collaboration — [1]Institute of Nuclear Physics, University of Münster — [2]Institute for Astroparticle Physics, Karlsruhe Institute of Technology

The ^{83m}Kr conversion electrons are used for calibration purposes of different (astro-)particle physics experiments due to the narrow ^{83m}Kr line widths and short ^{83m}Kr half-life. In the KArlsruhe TRItium Neutrino experiment (KATRIN), that currently provides the best neutrino mass upper limit of 0.8 eV/c^2 (90% C. L.) in the field of direct neutrino-mass measurements, several systematic uncertainties are studied by a shape distortion of the quasi monoenergetic ^{83m}Kr spectrum. This creates high demands on precise knowledge of the undistorted spectrum.

In KATRIN we use the 32 keV N-lines lying in the high energy region of the spectrum including the weaker N_1 line. In this talk, results of a dedicated measurement of the ^{83m}Kr electron N-spectrum with emphasis on N_1 line position and width conducted at unprecedented precision at KATRIN will be presented.

This work is supported by the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3) and the Doctoral School "Karlsruhe School of Elementary and Astroparticle Physics: Science and Technology (KSETA)" through the GSSP program of the German Academic Exchange Service (DAAD).

HK 10.4 Mon 17:30 SCH/A215

Implementation of silicon photomultipliers to detect single photons — •Imke Lopp[1], Laura Renth[1], Bernhard Maass[2], Patrick Müller[1], Julian Palmes[1], Julien Spahn[1], and Wilfried Nörtershäuser[1] — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]Argonne National Laboratory, Chicago, IL, USA

Precise and sensitive measurements in collinear laser spectroscopy require detectors with a high detection efficiency for single photons. At the same time, the dark count rate of the detector and the generated background, e.g., from scattered light, should be as low as possible. Common systems use a combination of mirrors or lenses and photomultiplier tubes.

We investigated whether silicon photodiodes (SiPMs) are suitable for this application. Due to their square detection area, the photodiodes can be better arranged to cover the optimal detection area than photomultiplier tubes with their circular detection area. Collinear laser spectroscopy on $^{12}C^{4+}$ and Sr^+ ions was used to compare the detectors in the UV and optical region, respectively. Funded by BMBF, contract 05P21RDFN1.

HK 10.5 Mon 17:45 SCH/A215

Collinear Laser Spectroscopy on Neutron Rich Palladium — •Laura Renth for the ATLANTIS-Collaboration — Institut für Kernphysik, Technische Universität Darmstadt, Darmstadt, Germany

Collinear laser spectroscopy gives access to isotope shifts and hyperfine parameters at high precision. From this, nuclear charge radii, nuclear magnetic and electric moments and nuclear spins can be determined. The LASPEC beamline, originally designed for collinear laser spectroscopy at FAIR, has been connected to the Californium Rare Isotope Breeder Upgrade (CARIBU) and is now the central part of ATLANTIS (**A**rgonne **T**andem hall **LA**ser bemli**N**e for a**T**om and **I**on **S**pectroscopy). Results from its commissioning and a first physics run on neutron-rich palladium isotopes will be presented. Short-lived Pd ions were delivered from CARIBU and neutralized to a fast atomic beam. Laser fluorescence spectroscopy was performed on the isotopes $^{110,112-116}$Pd. Spectra of all stable isotopes (even $^{102-110}$Pd and ^{105}Pd) were taken for reference with ions delivered by a laser-ablation ion source. Further measurements will be performed on products of the CARIBU successor nuCARIBU.

This work was supported by DFG – Project-Id 279384907-SFB 1245, and by BMBF 05P19RDFN1

HK 11: Outreach Public/Teilchenwelt (joint session T/HK)

Time: Monday 16:30–18:00 Location: HSZ/0204

HK 11.1 Mon 16:30 HSZ/0204

The german LHC-Office for outreach, transfer and promotion of young talents — •Marius Hoffmann[1], Marie-Lena Dieckmann[2], Harald Appelshäuser[3], Johannes Haller[2], Stephanie Hansmann-Menzemer[4], and Arnulf Quadt[1] — [1]Georg-August-Universität Göttingen — [2]Universität Hamburg — [3]Goethe-Universität Frankfurt — [4]Universität Heidelberg

Communicating the scientific results to the public, fostering cooperation with partners in industry and the promotion of young talents are key tasks of the german LHC research groups. For this reason in 2020, the research focuses (”Forschungsschwerpunkte” short ErUM-FSPs) of the four LHC experiments have initiated a joint ”LHC-Office” which is funded by the Federal Ministry for Education and Research(BMBF). Since then, the LHC-office has been active in a multitude of areas, including a common broschure, a new joint website, the participation at major industry fairs as well as several workshops and events to promote young researchers. This talk will give an overview of the work of the LHC-office's work of the last two years and present an outlook into future activities.

HK 11.2 Mon 16:45 HSZ/0204

KCETA event summer — •Katrin Link — Karlsruhe Institute of Technologie, KIT Center Elementary Particle and Astroparticle Physics KCETA, Karlsruhe, Germany

In the summer of 2022, the traveling exhibition "Code of the Universe" (codeoftheuniverse.eu) designed by CERN, was displayed for four weeks in the center of Karlsruhe. Accompanying this, the KIT Center for Elementary Particle and Astroparticle Physics (KCETA) organized a colorful program of events for a broad audience. The series of events included a vernissage, a lecture evening as part of the Karlsruhe EFFEKTE series and a panel discussion on the topic "Kommen große Forschungsinfrastrukturen an ihre Grenzen? Neue Energiekonzepte für die Forschung der Zukunft". The main focus was on "Science Afternoons", during which the individual working groups of KCETA presented their research with a small exhibition, hands-on experiments and short lectures. Additionally a special programm for pupils was offered, including masterclasses and "Physik am Samstag". In this talk we want to present the different formats we used to interact with a broad audience and report from our experiences.

HK 11.3 Mon 17:00 HSZ/0204

Belle II - The Beauty goes public — •Johanna Häusler and Thomas Kuhr — LMU, München, Deutschland

Public outreach is an element feature of modern science. In particular, the large and internationally organized particle physics experiments have great potential to raise public awareness of physics - both in terms of the physics questions themselves and the technological developments associated with fundamental research. The Belle II experiment is a rather novel experiment based in Japan and involving worldwide collaboration. The German Belle II institutes - in close cooperation with partner organizations and supported by a BMBF *Forschungsschwerpunkt* - are in the process of building a network and developing a strategy to present Belle II particle physics research to the German public. This is particularly interesting in view of the important scientific results that are expected from Belle II in the coming years. The outreach strategy includes a corporate design, a strategy to present the Belle II institutes, scientific results and staff both on Twitter and on the Belle II homepage, basic outreach activities in education (such as Belle II Masterclasses, a Belle II coursework for students and the design of a Belle II model) and industry transfer to promote technological development and human potential in the broad field of industry.

HK 11.4 Mon 17:15 HSZ/0204

Urknall unterwegs: eine mobile Ausstellung zur Teilchenphysik — Uta Bilow, •Sarah Kästner, Michael Kobel und Philipp Lindenau für die Netzwerk Teilchenwelt-Kollaboration — TU Dresden, Institut für Kern- und Teilchenphysik

Urknall unterwegs ist eine mobile Ausstellung, die von Weltmaschine bei DESY in Hamburg in Zusammenarbeit mit Netzwerk Teilchenwelt und Expert:innen aus der Teilchenphysik und Didaktik der TU Dresden entwickelt wurde. Besucher:innen erfahren bei einer kurzen Zeitreise in fünf Schritten, wie das Universum sich seit dem Urknall entwickelt hat. Außerdem können sie etwas über die Menschen erfahren, die in der Teilchenphysik wissenschaftlich tätig sind: Wie und warum geforscht wird und vor allem wie sich das auf ihren Alltag und die Gesellschaft auswirkt. Interaktive Elemente wie der Teilchen-Twister vervollständigen die Ausstellung. Studierende und Physiker:innen vermitteln als Urknall-Guides wissenschaftliche Inhalte. Im Juli 2022 wurde die Ausstellung zum 10jährigen Jubiläum der Higgs-Entdeckung gezeigt. Es folgten weitere Stationen bei der Langen Nacht der Wissenschaften in Dresden, der Mainzer Science Week und Stadtteilfesten in Hamburg. Für das Wissenschaftsjahr 2023 Unser Universum gibt es bereits Planungen für bundesweite Stationen. Die Ausstellung wird auch an die MS Wissenschaft andocken und in einigen Häfen vor dem schwimmenden Science-Center zu sehen sein. Der Vortrag zeigt Beispiele der bisherigen Ausstellungstour, stellt Erweiterungen vor und gibt eine Aussicht auf Entwicklungen. Urknall unterwegs kann während der Tagung vor dem Hörsaalzentrum angeschaut werden.

HK 11.5 Mon 17:30 HSZ/0204

Nachwuchs für die Forschung gewinnen: Das Fellow-Programm von Netzwerk Teilchenwelt — •Andrea Mayer-Houdelet, Uta Bilow und Michael Kobel für die Netzwerk Teilchenwelt-Kollaboration — TU Dresden, Institut für Kern- und Teilchenphysik

Jedes Jahr kommen etwa 3.500 Jugendliche an den 30 Standorten von Netzwerk Teilchenwelt mit der Physik der kleinsten Teilchen in Kontakt. Die besonders Interessierten besuchen dann einen CERN-Workshop oder die Teilchenphysik-Akademie Mainz. Viele dieser Jugendlichen studieren danach Physik. Für diese vorgebildeten jungen Leute hat das Netzwerk Teilchenwelt das Fellow-Programm ins Leben gerufen. Ziel ist es sie möglichst früh mit den Forschungsgruppen zu vernetzen, sie fachlich weiter zu qualifizieren und so langfristig Nachwuchs für die Forschungsgruppen zu gewinnen. Wir stellen das Fellow-Programm vor, berichten von unseren bisherigen Erfahrungen und präsentieren die Ergebnisse einer Evaluation zu den vielfältigen Online- und Präsenz-Angeboten für Fellows.

HK 11.6 Mon 17:45 HSZ/0204

Die Netzwerk Teilchenwelt Projektwochen: aktive Teilhabe an der aktuellen Forschung für Jugendliche am CERN — •Uta Bilow[1], Niklas Herff[1,2], Michael Kobel[1], Franziska Rauscher[3] und Sascha Schmeling[2] für die Netzwerk Teilchenwelt-Kollaboration — [1]TU Dresden, Institut für Kern- und Teilchenphysik — [2]CERN — [3]Gymnasium Olbernhau

Im Stufenprogramm von Netzwerk Teilchenwelt bilden die Projektwochen am CERN eine außergewöhnliche Möglichkeit für motivierte Jugendliche. Bis zu zehn Jugendliche, die durch ihr vorheriges Engagement bereits ein umfassendes Wissen und eine große Begeisterung für die "Physik der kleinsten Teilchen" mitbringen, bekommen die Chance, selbst einmal richtig in die Forschung einzutauchen. Im Rahmen einer umfangreichen Forschungsarbeit, die von schulischer Seite und mit Unterstützung vom Netzwerk Teilchenwelt betreut wird, finden individuelle Projekte in verschiedenen Bereichen am CERN statt. Betreut von Wissenschaftler:innen arbeiten die Jugendlichen zwei Wochen in einem Team am CERN, in dem sie beispielsweise Daten analysieren oder Detektorkomponenten vermessen und auswerten.

In einem gemeinsamen Vortrag von Niklas Herff (der verantwortlichen Person am CERN) und Franziska Rauscher (einer Teilnehmerin der Projektwochen 2022) werden die besonderen Chancen dieses Programms genauer vorgestellt.

HK 12: Invited Talks II

Time: Tuesday 11:00–12:30 Location: HSZ/0002

Invited Talk HK 12.1 Tue 11:00 HSZ/0002

Baryon spectroscopy at ELSA and MAMI — •Farah Afzal for the CBELSA/TAPS-Collaboration — HISKP, Uni Bonn

To improve our knowledge of the exact dynamics between the constituents of baryons and to better understand quantum chromodynamics (QCD) in the non-perturbative regime, the baryon excitation spectrum is investigated.

Experimentally, it can be probed with a real photon beam by studying photoproduction reactions. Partial wave analyses are performed to extract the baryon resonance parameters from the experimental data. For an unambiguous solution it is not enough to only measure the unpolarized cross section, but several single and carefully chosen double polarization observables are essential as well.

Worldwide, various experimental facilities have dedicated programs to measure these polarization observables in different photoproduction reactions using polarized photon beams and polarized targets. Two of the leading experimental facilities are located in Germany, the CBELSA/TAPS experiment at the accelerator facility ELSA in Bonn and the Crystal Ball experiment at the accelerator facility MAMI in Mainz. Both experiments are excellent at measuring neutral mesons in the final states, using electromagnetic calorimeters covering almost the full angular range, while exploring complementary beam energy regions. This talk will give an overview about recent results in non-strange baryon spectroscopy at ELSA and MAMI.

Invited Talk HK 12.2 Tue 11:30 HSZ/0002

ALICE upgrades, status and perspectives for ALICE-3 — •Robert Muenzer for the ALICE Germany-Collaboration — Institut für Kernphysik, Goethe Universität Frankfurt, Deutschland

The ALICE experiment at CERN has undergone a major upgrade in preparation of LHC Run 3. A new Inner Tracking System and a system of new trigger detectors were installed while the Time Projection Chamber was upgraded with GEM-based readout chambers. The muon system was extended by the Muon Forward Tracker. In addition, the readout of all detectors and the computing infrastructure have been redesigned for continuous readout including a synchronous reconstruction. The whole system was running successfully during the first year of LHC Run 3. For the next long shutdown, a further upgrade of the inner tracking systems and an installation of a forwards calorimeter is planned. For the operation in LHC Run 5 and 6 a next-generation experiment named ALICE 3 is proposed to address unresolved questions about the quark-gluon plasma by precise measurements of heavy-flavour probes and thermal radiation. In order to achieve the best possible pointing resolution and the required particle identification performance a concept for the installation of a high-resolution vertex tracker in the beam pipe, surrounded by a silicon-pixel tracker, a combination of time-of-flight system and a Ring-Imaging Cherenkov detector is foreseen. Further detectors, such as an electromagnetic calorimeter, a muon identifier, and a dedicated forward detector for ultra-soft photons, are being studied. In this presentation, the status of the ALICE upgrades as well as the future perspectives will be presented.

Invited Talk HK 12.3 Tue 12:00 HSZ/0002

Nuclear parton distribution functions — •Michael Klasen — University of Münster, Münster, Germany

Investigations of the nuclear structure at high energies are not only important for our theoretical understanding of the fundamental quark and gluon dynamics in protons and neutrons bound in nuclei and of the initial conditions for the formation of the quark-gluon plasma, but also for precise predictions of scattering processes studied at the LHC and the future EIC. In this talk, we will review the recent rapid progress in global determinations of nuclear parton distribution functions (PDFs) from neutral-and charged deep-inelastic scattering, the Drell-Yan process and various hard probes at the LHC. Theoretical developments with respect to correlations with the underlying proton PDFs, saturation, shadowing, short-range correlations of nucleon pairs, higher-order perturbative and lattice QCD will also be briefly discussed.

HK 13: Instrumentation IV

Time: Tuesday 17:00–18:15 Location: SCH/A251

HK 13.1 Tue 17:00 SCH/A251

SiPM-characteristics after proton irradiation — •Vincent Verhoeven[1], Dieter Grzonka[3], and James Ritman[1,2,3] — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany — [2]Ruhr-Universität Bochum, Institut für Experimentalphysik I, 44801 Bochum, Germany — [3]Institut für Kernphysik, Forschungszentrum Jülich, 52428 Jülich, Germany

Silicon photomultipliers (SiPM) are frequently used for the photon read out of scintillation detectors as an alternative to a conventional photomultiplier. SiPMs exhibit a high photon detection efficiency in the order of 40%, achieve internal amplifications of 10^6 to 10^7, require rather low operating voltages, are insensitive to magnetic fields and, due to the small size, simplify the mechanical construction of detector components. A drawback is the sensitivity of SiPMs to irradiation resulting in a remarkable change of the behavior already at a rather low radiation dose.

In order to determine the effect of irradiation for the SiPM operation as photon sensors, the characteristics of SiPMs after irradiation with a 35 MeV proton beam have been studied. In addition to the basic properties, the performance as a photon detector at various photon numbers was investigated. With a bake-out at temperatures of up to 150 $^\circ C$ a regeneration to a certain degree was achieved.

The characteristics of SiPMs as a function of radiation dose and its possible regeneration at high temperatures will be presented.

HK 13.2 Tue 17:15 SCH/A251

Systematic Studies of Radiation Damage and Stimulated Recovery of PWO — •Pavel Orsich, Valery Dormenev, Hans-Georg Zaunick, Markus W. H. Moritz, Rainer W. Novotny, and Kai-Thomas Brinkmann — II. Physikalisches Institut, Justus-Liebig-Universität, Gießen

Degradation of the optical transmittance of lead tungstate (PWO) scintillation crystals in the luminescence spectrum under ionizing radiation leads to loss of the light output, which results in the deterioration of the energy resolution. Stimulated recovery allows to restore the optical transmittance losses and is achieved by inducing photons of different wavelengths via external light sources (laser diode, LED). Here we report on new results of studies on the stimulated recovery and the radiation damage under gamma irradiation cooled down and at room temperature of lead tungstate crystals. It includes light output and transmittance degradation of PWO, correlations between variations of transmittance at 420 nm and the radiation induced absorption coefficient. Moreover, we present the first lab experiment results of in-situ recovery of the PWO optical transmittance during radiation period[3]. We also propose the model of the radiation damage and the stimulated recovery of damaged PWO after gamma irradiation as well as spontaneous recovery.

This work is supported by BMBF, GSI and HFHF.

HK 13.3 Tue 17:30 SCH/A251

Pre production tests of the PANDA BARREL EMC Slice* — •Thorsten Erlen — II. Physikalisches Institut, JLU Gießen, Deutschland

The Electromagnetic Calorimeter (EMC) of the future PANDA-Experiment at the FAIR complex in Darmstadt will use lead tungsten scintillator crystals (PWO II) to convert energy into an according amount of light and in most parts two Large Area Avalanche Photo Diodes (LAAPD) per crystal are used to measure the amount of light created. Main characteristics of both the scintillator and the photosensors are temperature dependent. With decreasing temperature the light yield (photons per MeV) of the scintillators increases and the noise of the photosensors is reduced, while their gain-factor at a fixed voltage increases. The nominal operating temperature for the EMC is -25 degree celsius to meet the desired properties and allow the EMC to perform according to the needs of the experiment. Energy resolution and threshold depend on a system that is capable of achieving and maintaining stable crystal and photosensor temperatures. Topic of this talk will be the results of test measurments with the first in kind slice (one of sixteen) for the barrel part of the calorimeter, using the latest (pre)production versions of the cooling, monitoring and front end electronic systems. Cooling and monitoring system design solutions will be presented in more detail.

*gefördert durch das BMBF, GSI und HIC for FAIR.

HK 13.4 Tue 17:45 SCH/A251

Calibration of Detector Modules for the PANDA FAIR Phase-0 Calorimeter — Nicolo Baldicchi[1], Luigi Capozza[1], •Samet Katilmis[1], Dong Liu[1], Frank Maas[1,2,3], Julian Moik[1], Oliver Noll[1,2], David Rodriguez Piñeiro[1], Paul Schöner[1], Christoph Rosner[1], and Sahra Wolff[1] — [1]Helmholtz-Institut Mainz, Mainz, Germany — [2]Institute of Nuclear Physics, Mainz, Germany — [3]PRISMA+ Cluster of Excellence, Mainz, Germany

The PANDA FAIR Phase-0 Calorimiter consists of 48 submodules. Each submodule houses detector components, such as high voltage distribution boards, charge sensitive preamplifiers, avalanche photo diodes (APDs) and temperature sensors. The characteristics of these components must be determined to run the calorimeter in an optimal operating mode. Following parameters were determined and optimised. The APD gain as a function of the bias voltage at -25 °C, the entrance area of the PANDA charge sensitive preamplifier and the characteristic curves of both the HV boards and the platinum temperature sensors. Furthermore a first energy calibration of the submodules by utilising atmospheric muons was performed. The talk points out both technical developments and results.

HK 13.5 Tue 18:00 SCH/A251

Series calibration of the slow-control of the barrel part of the PANDA EMC front-end electronics* — •Christopher Hahn — Justus Liebig Universität, Giessen, Deutschland

The Electromagnetic Calorimeter (EMC) inside a 2T solenoid will be the main component of the upcoming PANDA experiment at the future FAIR complex in Darmstadt. Due to the targeted energy resolution, timing and spatial constraints, the individual high-voltage adjustments for the Large Area Avalanche Photodiodes (LAAPDs) demands innovative and customized electronics, such as, for example, the individual bias voltage adjustments for the Photodiodes with an accuracy of 0.1V or better. In the same time, no space can be occupied in the inner detector volume for individual cable routing and connections for the LAAPD bias voltage. The key elements of the high-voltage adjustment concept and the frontend electronics as well as environmental dependencies will be described. The first results of the calibration of the high-voltage distribution and the resulting calibration algorithm will be presented. *supported by BMBF, GSI und HFHF.

HK 14: Instrumentation V

Time: Tuesday 17:00–18:45 Location: SCH/A.101

Group Report HK 14.1 Tue 17:00 SCH/A.101

A State-of-the-Art Cluster-Jet Target for the PANDA Experiment at FAIR — •Philipp Brand, Daniel Bonaventura, Hanna Eick, Jost Froning, Lennart Halstenberg, Christian Mannweiler, Sophia Vestrick, Michael Weide, and Alfons Khoukaz for the PANDA-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany

The PANDA cluster-jet target that will be installed at the High Energy Storage Ring (HESR) at FAIR is the world's leading target of its kind. It allows for hydrogen target thicknesses of more than 10^{15} atoms/cm^2 at the interaction point, which is located more than 2 m below the nozzle. This is achieved by a complex machine that has been developed over the last years, including several systems for adjustment and diagnosis. Most of them are special developments just for this purpose. This also includes the diagnostic systems that will be mounted into a modified version of the cluster-jet beam dump, which is the latest development.

Furthermore, the target has already been tested extensively in our institute but also at the COoler SYnchrotron (COSY) at FZ Jülich, where the interaction of a proton beam with the target in presence of the HESR stochastic cooling devices has been studied.

The target with all the technical developments that will be installed at its final version will be presented and some results of measurements with the PANDA target will be discussed.

This project has received funding from BMBF (05P21PMFP1), GSI FuE (MSKHOU2023) and the EU's Horizon 2020 programme (824093).

Group Report HK 14.2 Tue 17:30 SCH/A.101

LHCspin: First Tests of the SMOG2 gas target at the LHC — •Erhard Steffens[1], Paolo Lenisa[2], Vito Carassiti[2], Giuseppe Ciullo[2], Pasquale Di Nezza[3,4], Luciano L. Pappalardo[2,4], and Marco Santimaria[3,4] — [1]FAU, Erlangen-Nürnberg, Germany — [2]U. Ferrara and INFN, Italy — [3]INFN Lab. Nat. di Frascati, Italy — [4]LHCb Collaboration, CERN

The LHCspin project aims at unpolarized (SMOG2) and polarized fixed-target measurements by means of a gas target upstream of the LHCb detector, close to the vertex detector VELO. The forward geometry of the LHCb spectrometer

($2 < \eta < 5$) allows for the reconstruction of particles produced in fixed-target collisions, with CM energies from $\sqrt{s_{NN}} = 72$ GeV with Pb beam, to $\sqrt{s} = 115$ GeV in pp collisions.

SMOG2 is an openable storage cell with wake field suppressors and unpolarized gas feed system, producing a localized pressure bump inside the 200mm long storage tube, with i.d. 10 mm in the closed state. The two halves of the cell are connected to and moving with the VELO detector boxes, opening during beam injection. The 7 TeV/1A beam traversing the target might develop instabilities which must be suppressed by a suitable coating and shape of the conducting surfaces. - The target was successfully tested with beams (p, Pb) in November 2022. It has been verified that beam-beam and beam-gas events can be measured simultaneously by the detector.

HK 14.3 Tue 18:00 SCH/A.101

Clustersize distribution measurement using the three wavelength extinction method — •Sophia Vestrick, Philipp Brand, Hanna Eick, Jost Froning, ErenCem Göktas, Lennart Halstenberg, Christian Mannweiler, Michael Weide, and Alfons Khoukaz — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany

In a cluster source, cryogenic hydrogen, gaseous or liquid, is forced through a Laval nozzle and expanded into a vacuum. The hydrogen formes droplets consisting of millions of atoms. The diameters of the resulting clusters vary by several orders of magnitude. When starting, e.g., with liquid hydrogen, the clusters can reach diameters from some nanometers up to several micrometers, but the specific distribution is not yet known. In the three wavelength extinction method (3WEM), three lasers with different wavelengths are aligned to an interaction region and collimated onto one detector each. When the cluster-jet crosses the interaction region the intensity of all three lasers is reduced. Since the resulting extinction ratio depends on the known wavelength of the laser as well as on the clustersizes, this method can be used to determine the size distribution of the clusters. The 3WEM was first tested with sprays of known diameter distribution for verification and afterwards installed at a Münster Cluster-Jet Target. First results are presented in this talk. This project has received funding from BMBF (05P21PMFP1), GSI FuE (MSKHOU2023) and the EU's Horizon 2020 programme (824093).

HK 14.4 Tue 18:15 SCH/A.101

Determination of hydrogen cluster size distributions for different cluster-jet target stagnation conditions — •Hanna Eick, Philipp Brand, Christian Mannweiler, Sophia Vestrick, and Alfons Khoukaz — Institute for Nuclear Physics, Westfälische Wilhelms-Universität Münster

The internal and windowless cluster-jet targets from the WWU Münster are a key component of several experiments at various research facilities. One of them is the HHU Düsseldorf where the 200 TW ARCTURUS laser was used to investigate the laser-cluster interaction. In this context measurements are performed in order to study some important properties of the used hydrogen clusters, like the size of the clusters and their size distribution. To find out the size of the clusters, they are visualized by the shadowgraphy method. For this purpose, the ultrashort pulse ARCTURUS laser is illuminating the cluster beam and shadowgrapy images are taken. The evaluation of cluster diameters has to be automated due to the large number of recorded photos. This talk provides an overview of the results of the analyzed shadowgraphy measurements for various target settings and also for different positions in the cluster beam. By comparing the effective flow of material through the nozzle with the flow of clusters visible in these shadowgraphs, the amount of (invisible) gas embedded in the clusters can be estimated. This project has received funding from BMBF (05P21PMFP1), GSI FuE (MSKHOU2023) and the EU's Horizon 2020 programme (824093).

HK 14.5 Tue 18:30 SCH/A.101

Transforming targets: Adapting a cluster-jet target for use as a droplet target — •Christian Mannweiler, Daniel Bonaventura, Jost Froning, Eva-Maria Hausch, Elena Lammert, and Alfons Khoukaz — WWU, Münster, Deutschland

Internal targets such as H_2 cluster-jet targets and H_2 pellet targets have found widespread use in different fields of physics such as particle- and plasma physics. A prominent example is the future PANDA experiment at FAIR which will employ both target technologies for hadron physics experiments using antiproton accelerator beams.

Both types of target make use of cryogenic hydrogen in different forms. In the cluster-jet target it takes the form of a continuous beam made up of many small hydrogen clusters which achieve sizes from the nanometer scale up to several microns in diameter while a droplet target produces a stream of mono-sized, well separated hydrogen droplets at diameters in the tens of microns. Up until now, both target technologies were considered separately from each other, with a target device either creating cluster-jet beams or pellet beams. However, they remain closely related, which led us to initiate an R&D program on the development of a hybrid target which can produce both types of beam with only short downtime between swapping modes.

In our contribution we will present how we successfully transformed a cluster-jet target into a droplet target as well as first, encouraging results.

This project has received funding from the EU Horizon 2020 programme (824093).

HK 15: Instrumentation VI

Time: Tuesday 17:00–18:45 Location: SCH/A117

HK 15.1 Tue 17:00 SCH/A117

Decelerating Antiprotons from 100keV to 4keV — •Jonas Fischer for the PUMA-Collaboration — IKP TU Darmstadt

The PUMA collaboration aims at trapping, storing and transporting 10^9 antiprotons in a cryogenic penning trap to perform experiments with radioactive nuclei and investigate the nuclear density at the outermost part of the nucleus itself. To achieve this, antiprotons delivered from the ELENA storage ring at CERN need to be decelerated from 100keV to 4keV in a first step to be able to capture them in the penning trap [1].

To minimise losses in the deceleration process, a Pulsed Drift Tube (PDT) was installed at a beam line connected to the ELENA storage ring (LNE51) at CERN. A vacuum of below 10^{-10} mbar is necessary to avoid the annihilations of the antiprotons with the residual gas. This, and the required high voltage of about 100 kV, impose strict restrains on the design and operation of the pulsed drift tube. In this talk I will introduce the current setup and its mayor design considerations. Furthermore, the first successful tests of the setup with antiprotons will be presented.

[1] Aumann, T., Bartmann, W., Boine-Frankenheim, O. et al. PUMA, antiProton unstable matter annihilation. Eur. Phys. J. A 58, 88 (2022). https://doi.org/10.1140/epja/s10050-022-00713-x

HK 15.2 Tue 17:15 SCH/A117

The PUMA trap setup at ELENA — •Alexander Schmidt for the PUMA-Collaboration — IKP TU Darmstadt

The antiProton Unstable Matter Annihilation (PUMA) experiment at CERN will provide the ratio of protons and neutrons in the nuclear density tail as a new observable to test nuclear structure theories. To determine this ratio, the concept of antiprotonic atoms is used. After capture onto an antiprotonic orbital, the antiproton cascades towards the nucleus and eventually annihilates with a nucleon in the tail of the nuclear density distribution [1].

As there is no facility worldwide which provides both low-energy antiprotons and radioactive ions, PUMA uses a transportable setup which combines a cryogenic Penning trap for the long-term storage of antiprotons after accumulation at the ELENA ring and a detection system for the identification of pions originating from annihilations of antiprotons and ions of interest, which are either provided by the offline ion source of PUMA at ELENA, for experiments with stable nuclei, or the ISOLDE facility at CERN for investigating radioactive nuclei.

The first commissioning of a part of the PUMA beam line is currently performed at the Antimatter factory at CERN. This talk will give an status report of the trap and cryostat development and its foreseen implementation for the upcoming ELENA beam time starting in April 2023.

[1] Aumann T. *et al.*, PUMA, antiProton unstable matter annihilation. Eur. Phys. J. A 58, 88 (2022).

HK 15.3 Tue 17:30 SCH/A117

Recent developments at the sources for ultra-cold neutrons located at the TRIGA research reactor Mainz — •Simon Kaufmann for the tauSPECT-Collaboration — Department of Chemistry, TRIGA site, Johannes Gutenberg University Mainz

Neutrons created by fission inside the TRIGA research reactor have kinetic energies in the range of MeV. When they are moderated in the range below kinetic energies of 350 neV, they are called ultra-cold neutrons (UCNs). Using materials with a larger Fermi potential than the kinetic energies allows to guide and trap these UCNs. This makes UCNs especially attractive for a variety of neutron based experiments.

In order to provide these UCNs, two UCN-sources are currently operated regularly at TRIGA's beam ports C&D. While the source at beam port C is mainly operated in a continuous irradiation mode of the reactor, the one at beam port D is operated in a pulsed mode of the reactor. Both face the challenge of converting the kinetic energy of the neutrons from MeV down to neV with a solid deuterium crystal as the main converter. Their efficiency is strongly influenced by the structure of the crystal. This structure can be influenced by controlled thermal changes in order to increase the conversion efficiency.

This talk will present the latest measurements that were performed at beam port D with the aim to create a controlled thermal change sequence to increase and saturate the moderation efficiency.

HK 15.4 Tue 17:45 SCH/A117

Simulations for the ultra-cold neutron lifetime experiment τSPECT — •Niklas Pfeifer for the tauSPECT-Collaboration — Institut für Physik, Mainz, Deutschland

The τSPECT experiment aims to measure the free neutron lifetime with an uncertainity goal of sub second by storing ultra-cold neutrons in a fully magnetic bottle. To study and understand systematic effects and reduce systematic uncertainties, simulations of neutron trajectories and their parameters during the whole measurement cycle are needed. For this we evaluate and use several software packages that can accurately simulate the trajectories of ultra-cold neutrons, protons, and electrons in complex electromagnetic fields as well as the precession of their spins.

This talk will present how the simulation for the τSPECT experiment is set up, challenges and limits of the simulation software and the latest results of the simulations.

HK 15.5 Tue 18:00 SCH/A117

A nuclear magnetic resonance magnetometer for position verification of a neutron spin-flipper — •Viktoria Ermuth for the tauSPECT-Collaboration — Institut für Physik, Johannes Gutenberg-Universität, Mainz

To measure the free neutron lifetime the τSPECT experiment stores ultra-cold neutrons fully using magnetic field gradients. By flipping the spin of spin-polarized neutrons and thereby transforming high-field-seeking neutrons, whose magnetic moments are aligned with the field, to the low-field-seeking state, where the magnetic moment is aligned opposite the field, the neutrons are filled into the magnetic trap. For the spin flip to be successful the frequency of the spin flipper has to be the Lamor frequency of the neutron at that point in the magnetic field. Therefore, it is necessary to know the magnetic field at the location of the spin flipper. The magnetic field is measured using a nuclear magnetic resonance (NMR) probe to monitor the stability of the magnetic field and provide a reference for the spin flipper. Although the NMR probe does not sit directly at the spin flipper, conclusions about the field at the spin flipper can be made. Despite of environmental challenges, like cryogenic temperatures in vacuum, it is possible to measure the magnetic field with a high accuracy and a constant offset and temperature dependency.
This talk will show the construction and functionality of such an NMR probe as well as commissioning data.

HK 15.6 Tue 18:15 SCH/A117

n2EDM - production and coating of ultra-cold neutron storage vessel — •Noah Yazdandoost — Department of Chemistry, Johannes Gutenberg-University, Mainz

A non-zero nEDM would break time and parity reversal symmetry and if large enough could explain observations like the matter-antimatter asymmetry of the universe. The standard model of particle physics predicts a neutron electric dipole moment (nEDM) on the order of (10^{-29}-10^{-34}) e·cm. To probe the standard model of particle physics and constrain the parameter space for other theories, a more precise measurement of the nEDM is needed (current upper limit $1.8 \cdot 10^{-26}$ e·cm). The aim of the n2EDM experiment is to measure or exclude an nEDM on the order of 10^{-27} e·cm.

In the n2EDM experiment polarized ultra cold neutrons (UCNs) are stored in a vessel across which a combination of a constant electric and magnetic field is applied along the cylinder axis. The vessel consist of the high voltage and ground electrodes and the insulating ring. The Larmor precession frequency of the neutrons is measured by the Ramsey method of separated oscillatory fields. If a shift in the Larmor precession frequency between parallel and antiparallel field orientation is measured, the nEDM is non-zero. To ensure long storage and long depolarization times of the UCNs which directly influence the sensitivity of the experiment, a special coating of the storage vessel is needed.

This talk gives an overview of the n2EDM experiment and the production and coating process of the insulating rings of the experiment.

HK 15.7 Tue 18:30 SCH/A117

Ion optical simulations for the NEXT solenoid separator — •Arif Soylu[1], Xiangcheng Chen[1], Julia Even[1], Alexander V. Karpov[2], Vyacheslav Saiko[2], Jan Sáren[3], and Juha Uusitalo[3] — [1]University of Groningen, Groningen, The Netherlands — [2]Dubna, Russia — [3]University of Jyväskylä, Jyväskylä, Finland

The NEXT project aims to study Neutron-rich, EXotic heavy nuclei produced in multi-nucleon Transfer reactions[1]. In order to focus and separate these transfer products from unwanted by-products and unreacted primary beam, a 3T solenoid magnet with an 87-cm wide bore will be used.

A Python code was developed to simulate the trajectories of ions through the magnetic field of the solenoid magnet. The purpose of this simulation is to determine the optimal settings for the solenoid separator in order to achieve the highest transmission yields for the ions of interest and the strongest background suppression.

In my contribution, I will explain the various stages involved in the simulations of the ion trajectories through the magnetic field. I will present the simulation results obtained for selected multinucleon transfer products that are of interest for nuclear structure and nuclear astrophysics.

References [1] J. Even et al., Atoms 10 (2022) 59.

HK 16: Heavy-Ion Collisions and QCD Phases III

Time: Tuesday 17:00–18:30 Location: SCH/A216

Group Report HK 16.1 Tue 17:00 SCH/A216

Hyperon and Hypernuclei Production in the High Baryon Density Region — •Yue Hang Leung — Physikalisches Institut, Heidelberg University

Hyperon and hypernuclei have been suggested to be sensitive probes to the medium properties of the nuclear matter created in heavy-ion collisions. Measurements on the properties of hypernuclei can also give constraints to the hyperon-nucleon interaction, which is an essential ingredient in the equation-of-state of high baryon density matter, such as neutron stars. In this presentation, recent results on hyperon and hypernuclei production from intermediate to low energy heavy-ion collisions will be discussed. Future prospects at FAIR, including the ongoing mCBM project, will be discussed.

HK 16.2 Tue 17:30 SCH/A216

Pining down the (anti-)hypertriton production with ALICE at the LHC — •Michael Hartung for the ALICE Germany-Collaboration — Institut für Kernphysik, Goethe-Universität, Frankfurt, Germany

At the Large Hadron Collider at CERN, copious production of light (anti-)hypernuclei has been measured in Pb–Pb collisions by the ALICE collaboration. The production of such (anti-)hypernuclei has recently become a topic of high interest, in particular since the properties of these objects are not measured to high precision.
The most prominent example is the (anti-)hypertriton, which is a bound state of a proton, a neutron and a Λ hyperon. It is often discussed as a bound state of a deuteron and a Λ hyperon. If one uses the known Λ separation energy of the hypertriton (about 130 keV) one can estimate a size of about 10 fm of the state, which would be larger as a lead nucleus. The size has consequences for its probability to be formed in a coalescence process, which is not expected from a statistical-thermal model approach.
The (anti-)hypertriton is reconstructed by its decay products, e.g. in the case for the charged two-body decay channel of the hypertriton: ${}^{3}_{\Lambda}\mathrm{H} \rightarrow {}^{3}\mathrm{He} + \pi^{-}$.
We will show the latest measurement of the (anti-)hypertriton production in different collision systems and a comparison to different production models. Furthermore, we will present a novel technique for the determination of the object size of the (anti-)hypertriton.

HK 16.3 Tue 17:45 SCH/A216

Investigation of mass $A = 4$ (anti-)hypernuclei production at the LHC — •Janik Ditzel for the ALICE Germany-Collaboration — Institut für Kernphysik, Goethe-Universität, Frankfurt, Germany

At the Large Hadron Collider at CERN, light (anti-)hypernuclei are produced abundantly in Pb–Pb collisions. The production of such (anti-)hypernuclei has recently become a topic of high interest, connecting for instance to the possible strangeness content in neutron stars.
The most prominent example is the (anti-)hypertriton, which is a bound state of a proton, a neutron and a Λ hyperon and the main (anti-)hypernucleus to study at the LHC.
Nevertheless, there are heavier hypernuclei which production yields are suppressed with respect to the (anti-)hypertriton. However, they could give further insights into the formation mechanism and the nature of the Y-N or Y-Y interaction. Recent measurements revealed excited states for two mass $A = 4$ (anti-)hypernuclei which make their measurement become feasible. These (anti-)hypernuclei decay weakly after a few centimeters into two or more daughter particles and are reconstructed by their decay products. With the excellent performance of the ALICE apparatus, a clear particle identification of the daughters and a precise reconstruction of the decay vertex is possible.
We will present new results on the measurement of (anti-)hypernuclei within

the $A = 4$ mass region, namely the hyperhydrogen-4 and the hyperhelium-4. Furthermore, first insights into the measurement of double-strange (anti-)hypernuclei will be shown.

HK 16.4 Tue 18:00 SCH/A216

Hypernuclei studies in heavy-ion collisions at CBM — •Susanne Glässel and Christoph Blume — IKF Frankfurt

Under the extreme conditions of relativistic heavy-ion-collisions the creation of exotic matter like hypernuclei is possible. Hypernuclei measurements provide insights into the equation-of-state of hadronic matter at high net-baryon densities, as well as into hyperon-nucleon and hyperon-hyperon-interactions. The Compressed Baryonic Matter (CBM) experiment at the future Facility for Anti-Proton and Ion Research (FAIR) in Darmstadt offers the perfect conditions to explore the production of hypernuclei. At beam energies of around 12A GeV, in combination with high interaction rates of up to 10 MHz, an exceptionally high amount of hypernuclei will be created, and even very rare double hypernuclei like $^{6}_{\Lambda\Lambda}$He are expected. The reconstruction of hypernuclei was implemented into the CBM software PFSimple and optimized with respect to important performance indicators. Expected efficiencies and signal-to-background-ratios were calculated for a reliable estimation of the number of reconstructable hypernuclei; the detector areas with the best performance were identified. Systematical uncertainties were estimated based on simulations from different transport models, like e.g. the novel PHQMD approach, as well as on the signal extrapolation to the full rapidity and transverse momentum range. The experimental sensitivity to properties of hypernuclei, such as their lifetime, was evaluated. Results for $^{3}_{\Lambda}$H will be discussed as an example. DFG-grant BL 982/3-1, DFG-grant BR 4000/7-1.

HK 16.5 Tue 18:15 SCH/A216

Status of the CBM Micro Vertex Detector Simulations* — •Julio Andary for the CBM-MVD-Collaboration — Goethe-Universität Frankfurt am Main — Helmholtz Forschungsakademie Hessen für FAIR

CBM's Micro Vertex Detector (MVD) will help identify rare particles emitted in violent heavy ion collisions at FAIR and supplements the main tracker (STS) with high-precision pointing capability close to the target. This places, besides outstanding radiation hardness, high demands on the material budget of the sensor which in turn has an impact on the performance of the detector. Thus, the detector has to be optimized w.r.t.multiple scattering and adding unwanted background tracks originating from external conversion of photons.

In order to optimize the detector geometry, CBMRoot simulation data are converted into a data format called AnalysisTree, which provides more user-friendly access to all physical quantities of the particles generated in the experiment. Before analyzing the performance of the MVD, it is necessary to clarify how the reconstruction and mapping in AnalysisTree is implemented, i.e. the criteria according to which AnalysisTree assigns Monte-Carlo particles to reconstructed tracks. The focus in this study is on the gain in tracking performance by the MVD, also considering alternative detector geometries.

*This work has been supported by BMBF (05P21RFFC2) and GSI.

HK 17: Heavy-Ion Collisions and QCD Phases IV

Time: Tuesday 17:00–18:30 Location: SCH/A315

Group Report HK 17.1 Tue 17:00 SCH/A315

Hydrodynamic modeling of J/ψ p_T spectra and anisotropic flow in the Statistical Hadronization Model — Anton Andronic[3], Peter Braun-Munzinger[1,2], •Hjalmar Brunssen[1], Jana Crkovská[1], Johanna Stachel[1], and Martin Völkl[1] — [1]Physikalisches Institut, Universität Heidelberg — [2]ExtreMe Matter Institute EMMI, GSI — [3]Institut für Kernphysik, WWU Münster

The Statistical Hadronization Model (SHM) has been shown to describe the observed particle yields in heavy-ion collisions very successfully. This is true not only for hadrons consisting of light-flavor valence quarks, but also for those containing charm quarks with the corresponding enhancement when one incorporates in the SHM that charm quarks are produced in initial hard collisions.

In this talk, we present the calculation of the transverse momentum spectra and anisotropic flow coefficients of the J/ψ. The assumption underlying the statistical hadronization of charm quarks is that they thermalize in the medium. This is supported by experimental evidence that they participate in the collective expansion. In order to come from a yield predicted by the SHM to the p_T-dependent anisotropic flow coefficients and transverse momentum spectra, the evolution of the quark gluon plasma (QGP) needs to be modeled by a hydrodynamic simulation. For the QGP evolution and the freeze-out, results from three different viscous hydrodynamic models are presented: 2+1D and 3+1D MUSIC as well as FluiduM. The results of these three approaches are compared to recent ALICE data.

HK 17.2 Tue 17:30 SCH/A315

Prompt and non-prompt J/ψ production as a function of multiplicity in pp collisions with ALICE — •Gauthier Legras for the ALICE Germany-Collaboration — Institut für Kernphysik, WWU Münster

J/ψ production involves a hard scale for the creation of the charm-anticharm pair, and a soft scale for its hadronization. Correlating it with the multiplicity, mainly determined by soft particle production processes, in small systems allows to investigate the interplay between hard and soft scales. However, a substantial part of the J/ψ, called non-prompt J/ψ, comes from the decay of open-beauty hadrons. Since open-beauty hadron production mechanism is different from the one for prompt J/ψ, it becomes necessary to disentangle the prompt contribution from the non-prompt one in order to know if the non-prompt fraction could impact the inclusive (prompt + non-prompt) distribution of J/ψ as a function of multiplicity.

This study aims at determining the fraction of non-prompt J/ψ as a function of multiplicity in pp collisions at $\sqrt{s}$ = 13 TeV, through its decay of J/ψ to an electron-positron pair at midrapidity. The fraction is determined from the study of displaced J/ψ decay vertices, using a Boosted Decision Tree algorithm for the identification of the J/ψ and its classification.

HK 17.3 Tue 17:45 SCH/A315

Statistical hadronization model for Au-Au collisions at SIS18 energies — •Szymon Harabasz[1], Jedrzej Kolas[2], Radoslaw Ryblewski[3], Wojciech Florkowski[4], Tetyana Galatyuk[5,1], Malgorzata Gumberidze[5], Piotr Salabura[4], Joachim Stroth[5,6], and Hanna Paulina Zbroszczyk[2] — [1]TU Darmstadt — [2]Warsaw University of Technology — [3]Institute of Nuclear Physics PAS — [4]Jagiellonian University in Krakow — [5]GSI Helmholtzzentrum für Schwerionenforschung GmbH — [6]Institut für Kernphysik, GU Frankfurt

We show that the transverse-mass and rapidity spectra of p and $\pi^{\pm}$ produced in Au-Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 2.4 GeV can be well reproduced in a thermal model of particle emission from a spheroid single freeze-out hypersurface. This scenario extends the one used by Siemens and Rasmussen in the original formulation of the blast-wave model by allowing for elongation or contraction of the source. We incorporate a Hubble-like expansion of QCD matter and resonance decays.

This work was supported in part by: the Polish National Science Center Grants No. 2018/30/E/ST2/00432, No. 2017/26/M/ST2/00600, No. 2020/38/E/ST2/00019 and No. 2021/41/B/ST2/02409; IDUB-POB-FWEiTE-3, project granted by Warsaw University of Technology under the program Excellence Initiative: Research University (ID-UB); TU Darmstadt, Darmstadt (Germany): HFHF, ELEMENTS:500/10.006, GSI F&E, DAAD PPP Polen 2018/57393092; Goethe-University, Frankfurt(Germany): HFHF, ELEMENTS:500/10.006, GET_INvolved Programme of FAIR/GSI.

HK 17.4 Tue 18:00 SCH/A315

Studies on J/ψ production as a function of the charged-particle multiplicity in pp collisions at the LHC — •Ailec de la Caridad Bell Hechavarria for the ALICE Germany-Collaboration — Institut für Kernphysik, Westfälische Wilhelms- Universität Münster

The inclusive J/ψ yields as a function of the charged-particle multiplicity exhibit a stronger than linear increase when the J/ψ is measured at midrapidity (|y|<0.9) than when it is measured at forward rapidity (2.5 <|y|< 4). Insight into this effect could be gained by using the J/ψ as a leading particle and studying the associated underlying events in the collision.

Data collected in pp collisions with ALICE at the LHC during Run 2 is used to investigate the relative J/ψ yield, measured at mid-rapidity (|y|<0.9) in its dielectron decay channel and as a function of the charged-particle multiplicity, in various regions of the azimuthal angle with respect to the emission of the J/ψ meson. This contribution will show these measurements in pp collisions at $\sqrt{s}$=13 TeV.

*Supported by DFG under GRK2149

HK 17.5 Tue 18:15 SCH/A315

Mid-Rapidity J/ψ production as a function of multiplicity at different rapidities in p–Pb collisions at the LHC with ALICE — •Tabea Eder for the ALICE Germany-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster

ALICE results from Run 1 data on the charged-particle multiplicity dependence of the inclusive normalized J/ψ production, both at mid-rapidity, indicate a stronger than linear increase for proton-lead collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV.

To better understand the multiplicity dependent J/ψ production and possible contributions from auto-correlation effects, the J/ψ production at mid-rapidity is studied as a function of multiplicity in different rapidity ranges. This can be done in ALICE using the V0A and V0C detectors for the multiplicity estimation, which are situated at different rapidities at either side of the collision point.

In this talk the inclusive J/ψ production at mid-rapidity will be shown as a function of multiplicity at different rapidity ranges for proton-lead collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV using ALICE Run 2 data. In addition studies of J/ψ production in ANGANTYR, the heavy-ion machinery of PYTHIA8, will be shown.

Supported by BMBF within the ErUM Program.

HK 18: Hadron Structure and Spectroscopy II

Time: Tuesday 17:00–19:00 Location: SCH/A316

Group Report HK 18.1 Tue 17:00 SCH/A316

Measurement of the proton charge radius at AMBER — •Martin Hoffmann for the AMBER-Collaboration — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

The proton charge radius can be measured either by hydrogen spectroscopy or in lepton-proton elastic scattering. Previous measurements resulted in discrepant radii, which became known as the proton radius puzzle. The AMBER collaboration at CERN plans to perform a new precision measurement of the proton form factor at low momentum transfer using high-energy muon-proton elastic scattering. This measurement has different systematic uncertainties compared to those of low-energy elastic scattering. The recoil proton will be detected with a high-pressurized hydrogen-filled Time Projection Chamber (TPC), measuring the transferred energy and thus the squared four-momentum Q^2. The muon kinematics will be measured with high-precision vertex detectors around the TPC and a downstream spectrometer, which allows to select for elastic scattering events.

The core setup consisting of silicon tracking detectors and a prototype TPC was studied under realistic beam conditions during a pilot run in 2021. In 2022, the newly developed unified tracking system consisting of scintillating fibers for accurate timing and monolithic pixel-silicon detectors for high spatial precision was tested. This talk will present results of the on-going analyses and an overview of further developments towards the final setup.

Supported by EU.

HK 18.2 Tue 17:30 SCH/A316

Testing Predictions of the Chiral Anomaly in Primakoff Reactions at COMPASS* — •Dominik Ecker and Andrii Maltsev for the COMPASS-Collaboration — Physik-Department, Technische Universität München

Chiral Perturbation Theory (ChPT) makes effective predictions for low-energy phenomena of QCD, i.e. dynamics and decays of light mesons, and their couplings to photons and nucleons. Processes, which are governed by the chiral anomaly, are described in the effective Lagrangian by the Wess-Zumino-Witten (WZW) term. The WZW term describes for example the coupling of one pion to two photons. Hence, it describes the π^0 lifetime, which has been well confirmed by multiple measurements.

There are however many more couplings governed by the chiral anomaly, which lack precise experimental verification: for example, the direct coupling of one photon to three pions. The corresponding coupling constant $F_{3\pi}$ is described by the WZW term and can experimentally be accessed in $\pi^- + \gamma \to \pi^- + \pi^0$ scattering reactions.

At the COMPASS experiment at CERN, we study pion-photon scattering reactions via the Primakoff effect. These data allow us to verify the ChPT prediction for $F_{3\pi}$. We will present preliminary result of this measurement and ongoing efforts to improve its accuracy.

*funded by the DFG under Germany's Excellence Strategy - EXC2094 - 390783311 and BMBF Verbundforschung (05P21WOCC1 COMPASS).

HK 18.3 Tue 17:45 SCH/A316

Small Angle Initial State Radiation Analysis of the Pion Form Factor at BESIII — •Yasemin Schelhaas, Riccardo Aliberti, and Achim Denig for the BESIII-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

The anomalous magnetic moment of the muon is one of the most precisely measured quantities in modern physics. However, there is a discrepancy of 4.2 standard deviations between the Standard Model (SM) prediction and the average of the latest direct measurements at BNL and FNAL. This discrepancy is known as the Muon $(g-2)$-puzzle. For the SM prediction the main uncertainty arises from hadronic contributions and can be improved systematically using measurements of hadronic cross sections at e^+e^- colliders. One of the most important processes is $e^+e^- \to \pi^+\pi^-$. Using a data set of 1.9 fb^{-1} (in the near future 20 fb^{-1}) at a center of mass energy of 3.77 GeV, the $\pi^+\pi^-$ cross section is measured at the BESIII experiment located at the BEPCII collider in Beijing, exploiting the initial state radiation technique at small angles. The analysis aims to determine the pion form factor at masses above 0.8 GeV, which is also interesting for hadron spectroscopy. In this talk the current status of the analysis is presented.

Supported by DFG.

HK 18.4 Tue 18:00 SCH/A316

SIDIS Kaon Beam Spin Asymmetry Measurements with CLAS12 — •Áron Kripkó[1], Stefan Diehl[1,2], and Kai-Thomas Brinkmann[1] for the CLAS-Collaboration — [1]Justus Liebig Universität Gießen, 35390 Gießen, Germany — [2]University of Connecticut, Storrs, CT 06269, USA

A multidimensional study of the structure function ratio $\mathrm{F}_{\mathrm{LU}}^{\sin(\phi)}/\mathrm{F}_{\mathrm{UU}}$ has been performed for $\mathrm{K}^\pm$, based on the measurement of beam-spin asymmetries. It uses the high statistics data recorded with the CLAS12 spectrometer at Jefferson Laboratory. The 10.6 GeV longitudinally polarized electron beam interacted with an unpolarized liquid hydrogen target during the experiment. $\mathrm{F}_{\mathrm{LU}}^{\sin(\phi)}$ is a twist-3 quantity that provides information about the quark gluon correlations in the proton.

The talk will present a simultaneous analysis of two kaon channels (K^+ and K^-) over a large kinematic range with virtualities Q^2 ranging from 1 GeV^2 to 8 GeV^2. The precise multidimensional measurement was performed in a large range of z, $\mathrm{x_B}$, $\mathrm{p_T}$ and Q^2 for the first time. This multidimensional binning will allow a comparison with different reaction models.

This work is supported by HFHF and funded by DFG (project number: 508107918).

HK 18.5 Tue 18:15 SCH/A316

Exposing the structure of pion — •Minghui Ding — Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

As the theory of quantum chromodynamics has unfolded, the pion has come to be understood as Nature*s most fundamental Nambu-Goldstone boson. It is attached to chiral symmetry, which is dynamically broken, quite probably as a corollary of emergence of hadron mass. Continuum Schwinger function methods are well suited to tackling the pion. This presentation describes the theoretical developments on pion structure in which the methods preserve the fundamental underlying symmetries, thereby providing challenges and opportunities for modern and anticipated high-luminosity, high-energy facilities - JLab at 12GeV, the AMBER project at CERN, and electron ion colliders in the USA and China - and surveys the developments in global phenomenological fits and lattice regularised QCD, enabling the picture of the pion to be drawn.

HK 18.6 Tue 18:30 SCH/A316

Numerische Analyse der nichtlinearen GLR-MQ-Gleichungen für nukleare Partondichtefunktionen — •Janik Rausch[1], Vadim Guzey[2] und Michael Klasen[3] — [1]Humboldt-Universität Berlin, Deutschland — [2]Universität Jyväskylä, Finnland — [3]Westfälische Wilhelms-Universität Münster, Deutschland

Wir untersuchen erstmalig die nichtlinearen GLR-MQ-Gleichungen für die Entwicklung nuklearer Partondichtefunktionen (nPDFs) numerisch bis zur next-to-leading order für verschiedene Kerne und quantifizieren den Einfluss von Gluonen-Rekombination bei kleinem Bjorken-x. Mit den nCTEQ15 nPDFs als Input bestätigen wir die Relevanz der nichtlinearen Korrekturen, deren Größe mit fallendem x und steigender Massenzahl A wächst, für $x \lesssim 10^{-3}$. Wir zeigen, dass die Quark-Singlet- und Gluon-Distributionen $\Omega(x,Q^2)$ und $G(x,Q^2)$ bei $x = 10^{-5}$ für schwere Kerne nach der nichtlinearen Evolution von $Q_0 = 2$ GeV bis $Q = 10$ GeV verglichen mit der linearen Evolution um 9 – 15% verringert sind. Wenn abwärts von $Q_0 = 10$ GeV bis $Q = 2$ GeV entwickelt wird, ist der relative Effekt deutlich größer, $\Omega(x,Q^2)$ ist um 40% reduziert und $G(x,Q^2)$ um 140% erhöht. Diese Trends finden sich in den Strukturfunktionen $F_2^A(x,Q^2)$ und $F_L^A(x,Q^2)$ wieder, die nach der Abwärtsentwicklung um 45% reduziert bzw. um 80% erhöht sind. Unsere Ergebnisse zeigen, dass die nichtlinearen Effekte in $F_L^A(x,Q^2)$ am deutlichsten auftreten und für schwere Kerne bereits bei $x \sim 10^{-3}$ erheblich sind.

HK 18.7 Tue 18:45 SCH/A316

Measuring Generalized Distribution Amplitudes in Proton-Antiproton Annihilation with PANDA at FAIR — •Faiza Khalid, Stefan Diehl, and Kai-Thomas Brinkmann — II. Physikalisches Institut, Justus Liebig Universität Gießen

The future PANDA experiment at FAIR with the HESR antiproton beam provides unique possibilities to study the 3D nucleon structure with exclusive channels in $\overline{p}p$ annihilation. One of the channels of interest for the measurement of Generalized Distribution Amplitudes (GDAs) is $\overline{p}p \to \pi^0\gamma$. Simulations at several center-of-mass energies were done for this signal channel ($\overline{p}p \to \pi^0\gamma$) and for the main background channel($\overline{p}p \to \pi^0\pi^0$) to check the feasibility of

the measurement. The talk will present the feasibility study for the measurement of the cos(θ) dependence of the differential cross-section for $\bar{p}p \to \pi^0\gamma$ at different integrated luminosities. The cross sections have been estimated based on data from the E760 experiment at Fermilab, which is available in a limited kinematic range. Various optimal set of cuts were investigated to reduce the high background in this channel. Results of count rate estimates and estimates of the expected statistical uncertainty are presented. Different event selection cuts have been investigated to optimize the signal to background ratio while keeping a reasonable reconstruction efficiency. Also presented is the feasibility study of the channel $\bar{p}p \to \pi^0\pi^0$ whose cross-section needs to be measured to subtract the high background in the channel $\bar{p}p \to \pi^0\gamma$.
The work is supported by BMBF and HFHF

HK 19: Nuclear Astrophysics II

Time: Tuesday 17:00–18:30 Location: SCH/A419

Group Report HK 19.1 Tue 17:00 SCH/A419
Neutrino flavor instability and nucleosynthesis associated with charged-current weak interactions in black hole accretion disks — •Zewei Xiong[1], Lucas Johns[2], Meng-Ru Wu[3], Huaiyu Duan[4], Gabriel Martínez-Pinedo[1,5], and Oliver Just[1] — [1]GSI Helmholtzzentrum für Schwerioneneforschung, Darmstadt, Germany — [2]UC Berkeley, CA, USA — [3]Academia Sinica, Taipei, Taiwan — [4]University of New Mexico, Albuquerque, NM, USA — [5]Technische Universität Darmstadt, Germany
Charged-current weak interactions destroy the flavor coherence among the weak-interaction states of a single neutrino. In a dense neutrino gas, however, these collision processes can trigger flavor conversion in cooperation with the strong neutrino-neutrino refraction. We show that the collisional flavor instability can exist in black hole accretion disks. As a result, large amounts of heavy-lepton flavor neutrinos can be produced through flavor conversion, which can have important ramifications in the subsequent evolution of the remnant.

In addition to the charged-current neutrino interactions with nucleons, the neutrino-nucleus interactions can possess larger cross sections in neutron-rich nuclei and affects the r-process nucleosynthesis. We investigate those neutrino-nucleus interactions in black hole accretion disks and show that they can affect electron fraction moderately in specific trajectories with high neutrino fluxes.

Z.X. is supported by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (ERC Advanced Grant KILONOVA No. 885281).

HK 19.2 Tue 17:30 SCH/A419
Nuclear equation of state from Δ-full chiral interactions — •Yannick Dietz[1,2], Jonas Keller[1,2], Kai Hebeler[1,2,3], and Achim Schwenk[1,2,3] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Planck-Institut für Kernphysik, Heidelberg
We report results for infinite homogeneous nuclear matter calculations for the energy per particle at zero temperature using a set of recently developed Δ-full interactions based on chiral effective field theory that exhibit smaller chiral uncertainties compared to previous calculations using Δ-less potentials. Our computations are carried out in many-body perturbation theory, where we include contributions from nucleon-nucleon forces up to third and three-nucleon forces up second order.

Funded by the ERC Grant Agreement No. 101020842 and by the DFG – Project-ID 279384907 – SFB 1245.

HK 19.3 Tue 17:45 SCH/A419
Gaussian processes for the nuclear equation of state — •Hannah Göttling[1,2], Jonas Keller[1,2], Kai Hebeler[1,2,3], and Achim Schwenk[1,2,3] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Planck-Institut für Kernphysik, Heidelberg
We use Gaussian processes as a non-parametric emulator for the nuclear equation of state based on chiral effective field theory interactions and to provide statistical uncertainties based on the effective field theory truncation. Moreover, the Gaussian process enables us to calculate observables that are obtained via thermodynamic derivatives. We use this to calculate properties relevant to neutron stars and properties of symmetric nuclear matter.

Funded by the ERC Grant Agreement No. 101020842 and by the DFG – Project-ID 279384907 – SFB 1245.

HK 19.4 Tue 18:00 SCH/A419
Magnetar crusts - influence of the magnetic field on the composition and the unified equation of state — •Yuliya Mutafchieva[1], Zhivko Stoyanov[1], Nicolas Chamel[2], John Michael Pearson[3], and Lyubomir Mihailov[4] — [1]Institute For Nuclear Research And Nuclear Energy, Bulgarian Academy of Sciences, Sofia, Bulgaria — [2]Institute of Astronomy and Astrophysics, Universite Libre de Bruxelles, Brussels, Belgium — [3]Departement de Physique, Universite de Montreal, Montreal, Canada — [4]Institute of Solid State Physics, Bulgarian Academy of Sciences, Sofia, Bulgaria
At the end point of stellar evolution, strongly magnetised neutron stars - magnetars, are not only among the most compact stars in the universe, but also the strongest magnets. These conditions can significantly alter the properties of the outermost regions of a neutron star. We have recently studied the influence of a very strong magnetic field on the equilibrium properties of magnetar crusts when taking into account the Landau-Rabi quantization of electron motion. Both the outer and inner regions of the crust are treated consistently within the framework of the nuclear-energy density functional theory, thus allowing us to calculate their composition and their equation of state in a unified way. Our study covers a wide range of magnetic-field strengths necessary for modelling astrophysical phenomena. Results using accurately calibrated Brussels-Montreal nuclear energy density functionals, which were constructed from generalized Skyrme effective nucleon-nucleon interactions, will be presented.

HK 19.5 Tue 18:15 SCH/A419
Supernova Simulations with Consistent Six Species Neutrino Transport — •Ignacio L. Arbina[1,2], Gabriel Martinez-Pinedo[2,1], and Tobias Fischer[3] — [1]Institut für Kernphysik (Theoriezentrum), Fachbereich Physik, Technische Universit *at Darmstadt, Schlossgartenstraße 2, 64289 Darmstadt, Germany — [2]GSI Helmholtzzentrum für Schwerioneneforschung, Planckstraße 1, 64291 Darmstadt, Germany — [3]Institute of Theoretical Physics, University of Wroclaw, Pl. M. Borna 9, 50-204 Wroclaw, Poland
Core-Collapse Supernova (CCSN) are expected to explode by the delayed neutrino-driven mechanism. It requires an accurate treatment of the neutrino-matter interactions together with a solution to the neutrino radiation transport for all lepton flavours. Typical implementations usually consider four species neutrino schemes assuming identical distributions for the muon and tau neutrino flavours. However, the conditions shortly after bounce allow for the production of muons as discussed in the studies by Bollig et al. (2017) and Fischer et al. (2020). This muon formation adds new reaction channels in the lepton sector that couple the electron and muon flavours through weak interaction processes. For this purpose, we implement a Boltzmann neutrino transport scheme for the six neutrino species that are evolved consistently with the internal energy, and the electron and muon abundances. We explore the sensitivity to different sets of opacities computed consistently with the underlying equation of state and determine the most important reactions contributing to the muonization of supernova matter.

HK 20: Structure and Dynamics of Nuclei III

Time: Tuesday 17:00–18:45 Location: SCH/A118

Group Report HK 20.1 Tue 17:00 SCH/A118
Recent R3B experiments with radioactive nuclear beams — •Valerii Panin for the R3B-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung, Planckstraße 1, Darmstadt 64291, Germany
R3B is a versatile experimental setup designed to tackle some of the most forefront problems in modern nuclear physics. The setup is developed within the FAIR project in Darmstadt and it has been extensively used for various experiments over the past few years. The studies conducted thus far include short-range correlations in unstable nuclei, density-dependence of the symmetry energy, helium burning in stars, fission of heavy radioactive nuclei and isospin evolution of single-particle shells. Owing to the radioactive-ion beams provided by the GSI accelerator facility, the involved nuclear reactions can be studied in relativistic energy regime and in some cases also around extremes of nuclear stability. An overview on the R3B experiment, its recent research program and detector upgrades, as well as ongoing developments will be presented.

Group Report HK 20.2 Tue 17:30 SCH/A118

Ab initio structure of neutron-rich calcium isotopes — •Matthias Heinz[1,2,3], Kai Hebeler[1,2,3], Jan Hoppe[1,2], Takayuki Miyagi[1,2], Achim Schwenk[1,2,3], S. Ragnar Stroberg[4], and Alexander Tichai[1,2,3] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Planck-Institut für Kernphysik, Heidelberg — [4]Department of Physics and Astronomy, University of Notre Dame

The in-medium similarity renormalization group (IMSRG) has emerged as a flexible and powerful method for the ab initio description of atomic nuclei. Its current standard truncation including up to normal-ordered two-body operators, the IMSRG(2), has been very successful in the description of systems up to mass numbers 100 and beyond. For certain observables, however, the IMSRG(2) truncation is not sufficient and the inclusion of three-body operators, the IMSRG(3), is required.

We apply the IMSRG(3) to neutron-rich calcium isotopes, delivering a more precise many-body treatment of these systems. We find an improved description of the shell-closure at ^{48}Ca. We also discuss sources of observed discrepancies between experiment and theory in the charge radii of these systems.

* Funded by the ERC Grant Agreement No. 101020842.

HK 20.3 Tue 18:00 SCH/A118

Halo-EFT desription of one-neutron halo nuclei with perturbative inclusion of core excitations — •Live-Palm Kubushishi and Pierre Capel — Institute of Nuclear Physics, Johannes Gutenberg-Universität Mainz - Johann-Joachim-Becher Weg 45 D-55099 Mainz, Deutschland.

Halo nuclei are fascinating short-lived nuclear objects found near the dripline. In standard reaction models, halo nuclei are usually described as an inert core with one or two weakly bound neutrons. However, some breakup data suggest that the excitation of the core to its excited states to have a significant influence in the dynamics of the reaction [1]. In order to shed more light on this phenomenon, we study the typical one-neutron halo nucleus Be11 and we propose a simple structure model of it based on the rigid rotor model. We assume the core to be weakly deformed, which we treat at the first order of perturbations to couple it to its 2+ first excited state. In this way, we explicitly account for core excitations as a new degree of freedom while still describing the interaction between the core and the neutron in halo-EFT [2]. Our calculations were performed using the calculable R-Matrix method on a Lagrange mesh. We have been able to reproduce with a good agreement, the coupled-channels results [3], improve the halo-EFT model [2] and bring another physical insight on the structure of the bound states of Be11.

[1] R. de Diego et al., Phys. Rev. C 95, 044611 (2017).
[2] P. Capel et al., Phys. Rev. C 98, 034610 (2018).
[3] F.M. Nunes et al., Nucl. Phys. A 596, 171 (1996).

HK 20.4 Tue 18:15 SCH/A118

Total Reaction Cross-Section Measurements in the S444 Commissioning Experiment for R3B — •Lukas Ponnath[1], Roman Gernhäuser[1], Tobias Jenegger[1], Philipp Klenze[1], and Thomas Aumann[2] for the R3B-Collaboration — [1]Technische Universität München — [2]Technische Universität Darmstadt

The R3B (Reactions with Relativistic Radioactive ion Beams) experiment at the research facility FAIR, currently under construction in Darmstadt, enables kinematically complete reaction studies for the most exotic nuclei.

The S444 commissioning experiment for R3B, performed in the FAIR Phase-0 campaign in 2019, was the first operation of many new R3B detectors in a common setup. With a stable 12C beam and a set of different beam energies ranging from 400AMeV to 1AGeV we challengend this large installation around the GLAD magnet using the 12C(p,2p)11B benchmark reaction.

During this successful commissioning we could measure the energydependence of total reaction cross-sections of a 12C beam on a 12C target, which is poorly known for energies above 400AMeV. This is an important input for current calculations based on the eikonal reaction theory in order to validate inmedium extensions of a parameter-free Glauber model.

I will present the current status and preliminary results of the analysis and discuss the technique and evaluated error budget for the different steps. (supported by BMBF 05P19WOFN1 & 05P21WOFN1)

HK 20.5 Tue 18:30 SCH/A118

Improving Skryme energy density functionals with chiral effective field theory — •Lars Zurek[1,2], Scott K. Bogner[3], Richard J. Furnstahl[4], Rodrigo Navarro Pérez[5], Nicolas Schunck[6], and Achim Schwenk[1,2,7] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Facility for Rare Isotope Beams and Department of Physics and Astronomy, Michigan State University — [4]Department of Physics, The Ohio State University — [5]Department of Physics, San Diego State University — [6]Nuclear and Data Theory group, Nuclear and Chemical Science Division, Lawrence Livermore National Laboratory — [7]Max-Planck-Institut für Kernphysik, Heidelberg

Nuclear energy density functionals (EDFs) successfully reproduce experimental binding energies but due to their phenomenological nature it is at present unclear how to improve the currently established forms. We construct hybrid EDFs by starting from a standard Skyrme functional, here considered to represent short-range physics, and adding explicitly pion exchanges derived from chiral effective field theory. Pions are included at the Hartree-Fock level without introducing further fit parameters to the functional. When going beyond next-to-leading order in the chiral expansion the functionals are significantly improved compared to a reference Skyrme EDF constructed with the same protocol. We compare the different functionals and analyze their performance.

* Funded by BMBF Contract No. 05P21RDFNB.

HK 21: Structure and Dynamics of Nuclei IV

Time: Tuesday 17:00–18:45 Location: SCH/A215

Group Report HK 21.1 Tue 17:00 SCH/A215

Recent Highlights of the DESPEC Experiment at FAIR Phase-0 — •Nicolas Hubbard for the DESPEC-Collaboration — Institut für Kernphysik, Technische Universitität Darmstadt, Germany — GSI Helmholtzzentrum für Schwerionenforschug, Darmstadt, Germany — Helmholtz Forschungsakademie Hessen für FAIR (HFHF) GSI Campus Darmstadt, Darmstadt, Germany

The DESPEC (DEcay SPECtroscopy) experiment is part of the NUSTAR pillar of FAIR and involves the measurement of decay properties of exotic radioisotopes far away from the valley of stability, in order to understand the nuclear force and the origin of the elements. This group report will report on the recent activities during 2022 of the DESPEC collaboration, including recent technical developments and preliminary results from two physics experiments performed at GSI in Darmstadt as part of the FAIR Phase-0 programme: The study of isomeric and beta decays of the N = 126 Nuclei ^{202}Os and ^{203}Ir, and the investigation of the β-strength crossing N = 126 and the formation of the 3rd r-process abundance peak via total absorption spectroscopy

HK 21.2 Tue 17:30 SCH/A215

Nuclear shell structure studies in the vicinity of doubly magic ^{100}Sn and ^{132}Sn — •Michał Mikołajczuk[1,2] and Magdalena Górska-Ott[2] — [1]Faculty of Physics, University of Warsaw, Poland — [2]GSI, Darmstadt, Germany

In the field of nuclear structure physics, the neighborhood of doubly magic nuclei such as ^{100}Sn and ^{132}Sn remains one of the most intriguing regions along the Segrè chart. Over the last few decades many experimental efforts were made to acquire data neccessary to describe and understand shell structure evolution in the aforementioned regions. Based on experimental data, the state-of-the-art shell model calculations provide further insight into the properties of nuclear structure, broadening our understanding of nucleon-nucleon interaction. This presentation will discuss results of employing well established interactions such as JUN45 [1], Gross-Frenkel [2] and MHJ [3], to neutron closed shell nuclei, namely ^{98}Cd, ^{130}Cd, ^{96}Pd, ^{128}Pd. Calculation results are compared with up to date available experimental data and validity of the used models and obtained conclusions will be discussed.

[1] M. Honma et al., PRC80, 064323 (2009).
[2] R. Gross and A.Frenkel, Nucl. Phys. A267, 85 (1976).
[3] M. Hjorth-Jensen et al., Phys. Repts, 267 (1995).

HK 21.3 Tue 17:45 SCH/A215

Investigation of shape coexistence in ^{116}Te via lifetime measurements — •Franziskus v. Spee[1], Marcel Beckers[1], Andrey Blazhev[1], Arwin Esmaylzadeh[1], Felix Dunkel[1], Christoph Fransen[1], Jan Jolie[1], Lisa Kornwebel[1], Casper-David Lakenbrink[1], and Claus Müller-Gatermann[2] — [1]Institut für Kernphysik, Cologne, Germany — [2]Physics Division, Argonne National Laboratory, Argonne, Illinois, USA

In mid-shell Te isotopes, hints for shape coexistence have been found [1]. However, experimental evidence is scarce, since experiments on neutron-deficient Te isotopes are challenging. Experimental data on transition strengths in ^{116}Te could give further insight. Therefore, a recoil distance Doppler shift experiment was performed to investigate transition strengths between low-lying states in ^{116}Te at the FN-Tandem accelerator facility of the IKP Cologne. To populate low-lying, low-spin states, the reaction ^{112}Sn(^{12}C,^{8}Be)^{116}Te was used. The γ rays were detected in coincidence with α particles stemming from the decay of ^{8}Be. To detect the α particles, silicon particle detectors were used. These were covered with aluminum foil that prevented any heavier ions to penetrate the detector. This results in very clean γ spectra even though the cross section for the reaction of interest is rather low. This allowed for the first-time determination of lifetimes of low-lying off-yrast states. This work was supported by the Deutsche Forschungsgemeinschaft (DFG) under contract numbers FR 3276/2-1 and DE 1516/5-1.

[1] P. Garrett *et al.*, Prog. Part. Nucl. Phys. **124** (2022) 103931.

HK 21.4 Tue 18:00 SCH/A215

Exploring the isoscalar - isovector symmetries in 94Ru, 95Rh, 94Pd and 96Pd nuclei by means of lifetime measurements — •Biswarup Das for the DESPEC-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH - Darmstadt, Germany

The nuclei of interest were produced in the projectile fragmentation of a 850 MeV/nucleon 124Xe beam impinging on a 4 g/cm2 9Be target, as the first of a series of commissioning *FAIR-0* experiments with the DESPEC experimental setup at the GSI- FAIR facility in Germany. The isomeric state of 94Pd and 96Pd were populated directly, whereas the β-decay of 95Pd populates the isomeric states of 94Ru and 95Rh. The nuclei were implanted on an active stopper, AIDA, and the γ-rays of interest were detected using the six triple cluster HPGe detectors as well as 36 LaBr3(Ce) detectors of the FAst Timing Detector Array (FATIMA). Direct lifetime measurements via γ- γ coincidences using FATIMA has been applied to determine the lifetimes for the yrast states below the isomer of the mentioned nuclei. The Generalised Centroid Difference (GCD) method was implemented for the lifetimes residing in the picosend regime. The transition rates were obtained from the measured lifetimes and the BE(2) values were compared with the standard shell model calculations. With the remeasured 96Pd lifetimes the new results for the 94Ru nucleus was successfully described using the $\Delta\nu$=2 seniority admixture allowed in the fpg model space using the Jun-45 interaction , on the other hand a large anomaly from the seniority scheme was found for the 95Rh.

HK 21.5 Tue 18:15 SCH/A215

Structural investigation of neutron-deficient ^{168}W — •Christoph Fransen[1], Lisa Kornwebel[1], Kalle Auranen[2], Marcel Beckers[1], Mike Carpenter[3], Tuomas Grahn[2], Paul Greenlees[2], Rauno Julin[2], Jan Jolie[1], Filip G. Kondev[3], Casper-David Lakenbrink[1], Claus Müller-Gatermann[1,3], Darek Seweryniak[3], Franziskus von Spee[1], Nigel Warr[1], and Shaofei Zhu[3] — [1]IKP, Univ. of Cologne, Germany — [2]JYFL, Jyväskylä, Finland — [3]Argonne Natl. Lab, Illinois, USA

In several neutron deficient nuclei in the A=180 region both shape coexistence and rapid shape transitions were identified. Further, $B(E2;4_1^+ \rightarrow 2_1^+)/B(E2;2_1^+ \rightarrow 0_1^+) = B_{4/2}$ ratios < 1 were found in some neutron deficient Os–W–Pt nuclei far from closed shells. This cannot be explained with any collective model. Shape coexistence could be an explanation, but there are no such cases known so far. Older data [1] yield that ^{168}W is just at the transition point from "normal" collectivity to the "island" of nuclei with $B_{4/2} < 1$. However, these data might suffer from assumptions on side feeding of the related states. Therefore, and to learn on the structural evolution within the yrast band of ^{168}W, we performed an experiment with the recoil distance Doppler-shift technique on ^{168}W at Argonne National Laboratory with the GAMMASPHERE spectrometer to determine transition strengths from level lifetimes using $\gamma\gamma$ coincidences. We present these data with respect to rapid shell evolution in this region.

Supported by the DFG, grant Nos. FR 3276/2-1 and DE 1516/5-1.

[1] G.D. Dracoulis et al. Phys. Rev. C 29, 1576 (1984)

HK 21.6 Tue 18:30 SCH/A215

Isomer and excited-state lifetimes around ^{190}W * — •Sultan Alhomaidhi[1,2], E. Sahin[1,2], V. Werner[1], P.H. Regan[3], J. Jolie[4], N. Pietralla[1], and J. Gerl[2] — [1]IKP, TU Darmstadt, Germany — [2]GSI, Darmstadt, Germany — [3]U Surrey, UK — [4]IKP, U Köln, Germany

In March 2021, the DESPEC experiment S452 was performed at GSI. The focus of the experiment was to measure the lifetimes and energies of exited states of neutron-rich isotopes in the A~190 mass region, to probe a predicted [1,2] prolate-oblate shape transition. The experimental setting allowed us to investigate the single-particle structures of isomers and connect their decays to the shape evolution. The main nuclei of interest, ^{189}Ta and ^{190}W, were populated by the fragmentation of a ^{208}Pb primary beam impinging on a ^{9}Be target. The cocktail beam was separated and identified using FRS to implant the nuclei of interest in AIDA. The γ rays from the implanted ions were detected by 36 $LaBr_3$(Ce) detectors of FATIMA and 2 EUROBALL cluster detectors, surrounding AIDA. Data obtained in this experiment is analyzed on an event-by-event basis, for which the analysis is in progress. An overview of the DESPEC setup, the analysis procedures and preliminary results of the isomeric lifetime of ^{189}Ta and the B(E2) strength of the first 2^+state of ^{190}W will be presented in the conference.

[1] J. Jolie et al., Phys. Rev. Lett. 89, 182502 (2002).

[2] J. Jolie and A. Linnemann, Phys. Rev. C 68, 031301(R), (2003).

* Supported by BMBF under Verbundprojekt 05P2021 (ErUM-FSP T07) grants 05P21PKFN1 and 05P21RDFN1.

HK 22: Outreach (joint session HK/T)

Time: Tuesday 17:00–18:45 Location: SCH/A252

HK 22.1 Tue 17:00 SCH/A252

Förderung des kritischen Denkens durch Teilchenphysikunterricht: Chancen und Herausforderungen — •Farahnaz Sadidi und Gesche Popsiech für die Netzwerk Teilchenwelt-Kollaboration — Professur für Didaktik der Physik, TU Dresden

Kritisches Denken (KD) ist eine der wünschenswerten Fähigkeiten, die in der Schule vermittelt werden sollten. Das Fehlen einer klaren, durch empirische Befunde gestützten Theorie für die Entwicklung eines fachspezifischen Unterrichts zur Förderung des kritischen Denkens der SchülerInnen stellt die Lehrkräfte jedoch vor große Herausforderungen. Um diese Lücke zu schließen, wurden im Rahmen eines Promotionsprojekts die Gestaltungsprinzipien für einen Teilchenphysikunterricht zume Thema Antimaterie für SchülerInnen der Klassen 10, 11 und 12 nach dem Ansatz der Design-Based Research (DBR) entwickelt, um KD zur fördern. In der Hauptstudie wurde der Antimateriekurs in 3 Klassen in verschiedenen Bundesländern Deutschlands durchgeführt. Die Daten wurden induktiv ausgewertet, um die Lernprozesse der SchülerInnen zu identifizieren. Die Ergebnisse zeigten die Effektivität des Antimateriekurses bei der Förderung der KD-Fähigkeiten der SchülerInnen und offenbarten auch die Herausforderungen, denen die SchülerInnen beim kritischen Denken gegenüberstehen. Die in dieser Studie angewandten und empirisch getesteten Gestaltungsprinzipien können für die Entwicklung anderer fachspezifischer Unterrichtseinheiten zur Förderung des KD verwendet werden.

HK 22.2 Tue 17:15 SCH/A252

Vorstellung einer Netzwerk Teilchenwelt Masterclass über das MuonPi-Projekt — •Lara Dippel, Hans-Georg Zaunick und Kai-Thomas Brinkmann für die Netzwerk Teilchenwelt-Kollaboration — II. Physikalisches Institut, Justus-Liebig-Universität, Giessen

Das MuonPi-Projekt ist ein verteiltes Netzwerk von Raspberry-Pi basierten Detektorstationen zur Messung von Myonenschauern, die bei der Wechselwirkung ultrahochenergetischer, kosmischer Primärstrahlung mit der Erdatmosphäre ausgelöst werden. Die Detektoren werden mit geringen Anschaffungskosten angeboten, sodass interessierte Laien einen Einblick in das Forschungsgebiet der Astroteilchenphysik gewinnen können. Für interessierte Schüler:innen wird im Rahmen des *Netzwerks Teilchenwelt* eine Masterclass angeboten, die durch verschiedene Experimente mit MuonPi-Detektoren die Grundlagen der hochenergetischen Teilchenphysik einführen soll. Dabei können sowohl Themen aus der theoretischen Physik, wie z.B. Konzepte der speziellen Relativitätstheorie und Teilchenzerfälle, als auch experimentelle Messtechniken vermittelt werden. Dazu stehen sowohl betreute Kurzzeitexperimente an Schulen als auch die angeleitete Durchführung von Langzeitversuche mit einer eigenen Station zur Verfügung.

HK 22.3 Tue 17:30 SCH/A252

A new Nuclear Astrophysics Masterclass - A Journey through the Elements — •Hannes Nitsche[1], Uta Bilow[1], Lana Ivanjek[1], Kai Zuber[1], and Daniel Bemmerer[2] for the Netzwerk Teilchenwelt-Collaboration — [1]Technische Universität Dresden — [2]Helmholtz-Zentrum Dresden-Rossendorf

Masterclasses are one-day outreach events for high school students, introducing them to topics of current research. Within the framework of the EU project ChETEC-INFRA, a new Masterclass on Nuclear Astrophysics has been developed. This interdisciplinary field of science provides a new didactic perspective on nuclear and astrophysical processes by addressing the link between these two subjects.

The Nuclear Astrophysics Masterclass picks up this didactic potential. It includes the analysis of measurement data from a nuclear reaction studied at the Felsenkeller Laboratory in Dresden. Furthermore, the processes behind nucleosynthesis are reconstructed with the help of various gamification elements. The talk will present the teaching materials, the didactic concept as well as the experiences made so far in the implementation of the Masterclass.

HK 22.4 Tue 17:45 SCH/A252

The Particle Therapy Masterclass for targeted education and outreach on real-world application of fundamental physics — •Niklas Wahl for the Netzwerk Teilchenwelt-Collaboration — Deutsches Krebsforschungszentrum (DKFZ), Heidelberg, Germany

The Particle Therapy Masterclass (PTMC) was established in 2019 by the piloting institutes CERN, DKFZ and GSI to showcase how fundamental physics can translate to applications with directly visible societal benefit. Over a day the PTMC introduces how fundamental physics research on accelerators as well as particle, hadron and detector physics enable cancer treatments utilizing the Bragg-peak. A hands-on session with the open source toolkit "matRad" facilitates interactive treatment planning for participants using open, virtual patient data.

In the following, the PTMC was integrated into the International Physics Masterclasses by IPPOG targeting high school students with more than 40 international course sessions during spring 2022. With Netzwerk Teilchenwelt, customized Masterclasses were held in fellowship meetings of senior grade students, intermediate level school project days or as interactive outreach events to the general public. Integration into university level courses at DKFZ was also successful.

Held over the last years in Germany, these sessions showed that the PTMC can be adapted to different educational levels from the general public to undergraduate students and is especially suited for online courses. The PTMC thus proved to be a flexible and interactive tool in education and outreach for different target groups to show directly visible "real-world" impact of fundamental physics research.

HK 22.5 Tue 18:00 SCH/A252

Machine Learning Masterclass - Physik trifft Daten — •Maike Hansen[1], Johanna Rätz[2] und Barbara Valeriani-Kaminski[1] — [1]Physikalisches Insitut, Universität Bonn — [2]Argelander-Institut für Astronomie, Universität Bonn

"Wieso sollen wir jetzt was programmieren? Ist doch Physik und kein Informatik..." - Schüler:innen ist kaum bewusst, welche zentrale Bedeutung Datenauswertung und Maschinelles Lernen in der modernen Physik sowie in anderen Naturwissenschaften haben. Die Machine Learning (ML) Masterclass vom Netzwerk Teilchenwelt, der Universität Münster und PUNCH4NFDI fördert das fächerübergreifende Denken und macht moderne Datenverarbeitung in der Teilchenphysik erlebbar. Neben dem Standardmodell der Teilchenphysik und der Funktionsweise eines Teilchendetektors geht es bei der ML Masterclass um den Einsatz Neuronaler Netze bei der Datenauswertung. Angeleitet durch junge Wissenschaftler:innen programmieren die Schüler:innen nach interaktiven Einführungsvorträgen und Übungen in einer Browser-basierten Programmierumgebung das Neuronale Netz, um so einen authentischen Datensatz aus der Teilchenphysik auszuwerten. Einzelne Schulpraktikant:innen und zwei Lerngruppen haben die Masterclass bereits getestet und Feedback zur Weiterentwicklung gegeben. In diesem Vortrag werden der aktuelle Entwicklungsstand und die bisherigen Erfahrungen mit der ML Masterclass vorgestellt.

HK 22.6 Tue 18:15 SCH/A252

Belle II Masterclass - Teilchenidentifikation und Dunkle Materie mit interaktiven Jupyter Notebooks — •Jonas Eppelt, Torben Ferber, Filipp Gostner, Isabel Haide, Alexander Heidelbach und Lea Reuter — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

Eine Masterclass im Rahmen des Netzwerk Teilchenwelt Projektes soll Schüler:innen physikalische Konzepte näher bringen und das Interesse an der Physik wecken. Dafür wurde am Karlsruher Institut für Technologie in der Belle II Gruppe eine Masterclass entwickelt, in welcher die Interaktionen der Teilchen mit Detektorkomponenten simuliert werden. Die Teilnehmer:innen können mithilfe interaktiver Jupyter Notebooks Spuren in einem vereinfachten Spurdetektor rekonstruieren, Energiedepositionen im elektromagnetischen Kalorimeter von Belle II zu einem Cluster zusammenfassen und durch zusätzliche Informationen aus dem Belle II-Myonendetektor Teilchen identifizieren. Die Ausnutzung von Energie- und Impulserhaltungssätze ermöglicht den Schüler:innen zudem, fehlender Energie Teilchenhypothesen zuzuordnen. Wir präsentieren das Konzept und die technische Umsetzung unserer Masterclass.

HK 22.7 Tue 18:30 SCH/A252

Higgs Entdeckung als ein Masterkurs für Fortgeschrittene — •Artur Monsch und Günter Quast — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

Im Rahmen des Vortrags wird ein Konzept einer fortgeschrittenen Masterclass vorgestellt, welche an die bestehende CMS Masterclass anknüpft und diese um zusätzliche Themen erweitert. Im Fokus stehen dabei interessierte Schülerinnen und Schüler der Oberstufe, welche Interesse daran haben, Ideen und Methoden der experimentellen Teilchenphysik anhand tatsächlicher Messdaten kennenzulernen. Hierzu werden die vom CERN Open Data Portal bereitgestellten Mess- und Simulationsdaten verwendet, welche auch zur Entdeckung des Higgs-Bosons ausgewertet wurden. Diese Entdeckung können die Schülerinnen und Schüler dann durch die Bearbeitung eines interaktiven, auf der Programmiersprache Python basierendem, Jupyter-Notebook selbst erleben. Ausgehend von aufbereiteten Originaldaten aus dem 'goldenen Zerfallskanal' $H \rightarrow ZZ \rightarrow 4\ell$ lernen Schülerinnen und Schülern grundlegende Konzepte aus der Physik und der Datenauswertung kennen, wie die Bedeutung der invarianten Masse oder die Notwendigkeit einer Datensatz-Bereinigung. Die anschließende Frage, inwieweit der beobachtete Überschuss in der Verteilung der invarianten Masse dem vorhergesagtem Higgs Boson der Masse 125 GeV/c^2 entspricht und ob die gewonnene Beobachtung signifikant ist, lässt sich mit den kennengelernten Methoden auch auf Themengebiete außerhalb der Teilchenphysik anwenden.

HK 23: Invited Talks III

Time: Wednesday 11:00–12:30 Location: HSZ/0002

Invited Talk HK 23.1 Wed 11:00 HSZ/0002

High-Precision Laser Spectroscopy of C^{4+} for an All-Optical Determination of the Nuclear Charge Radius — •Phillip Imgram[1], Kristian König[1], Bernhard Maass[2], Patrick Müller[1], and Wilfried Nörtershäuser[1] — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]Argonne National Laboratory, Chicago, IL, USA

Nuclear charge radii of radioactive isotopes are typically referenced to a stable nucleus in the isotopic chain through an atomic isotope shift measurement. In some cases, this can limit the uncertainty of the obtained charge radii of radioactive nuclei to the uncertainty of the reference measurements from elastic electron scattering or muonic atom spectroscopy. To overcome this limit in light mass nuclei like ^{10,11}B, an all-optical approach for the charge radius determination purely from laser spectroscopy measurements and non-relativistic QED calculations was tested with the well-known nucleus of ^{12}C through laser excitation of helium-like $^{12}C^{4+}$ from the metastable $2\,^3S_1$ state with a lifetime of 21 ms to the $2\,^3P_J$ states. The high-precision collinear laser spectroscopy of $^{12}C^{4+}$ has been performed at the Collinear Apparatus for Laser Spectroscopy and Applied Physics (COALA) at the Institute of Nuclear Physics of TU Darmstadt. This contribution will give an overview of the project and present the measured transition frequencies along with the extracted all-optical nuclear charge radius of ^{12}C. This project is supported by DFG (Project-ID 279384907 - SFB 1245).

Invited Talk HK 23.2 Wed 11:30 HSZ/0002

ALICE determines the transparency of our galaxy to the passage of antihelium nuclei — •Laura Serksnyte for the ALICE Germany-Collaboration — Technical University of Munich

The measurements of the inelastic cross sections of antihelium-3 nuclei were performed by employing the ALICE detector material as a target. The antimatter-to-matter ratio and TOF-to-TPC matching methods were used in pp and Pb-Pb collisions, respectively. These, for the first time, measured inelastic cross sections have been implemented in the GALPROP propagation model to estimate the losses in the antihelium-3 cosmic ray fluxes due to inelastic interactions with the interstellar medium. Indeed, some dark matter candidates, such as the WIMPs, are expected to annihilate in our galaxy and produce, among other particles, light antinuclei, which can be observed as cosmic rays. However, the same antinuclei can also be produced in ordinary cosmic ray collisions with the interstellar gas. Thus, precise modelling of signal and background cosmic ray fluxes, including the inelastic losses in the interstellar medium, is required to draw conclusions from future antinuclei cosmic-ray measurements.

The results of this interdisciplinary study by ALICE allowed the determination of the transparency of our galaxy to the propagation of the antihelium-3 from dark matter annihilation and ordinary cosmic ray collisions, and to demonstrate that antihelium-3 nuclei are a promising probe for indirect dark matter searches. This research was funded by BMBF Verbundforschung (05P21WOCA1 ALICE) and the DFG under Germany's Excellence Strategy - EXC2094 - 390783311.

Invited Talk HK 23.3 Wed 12:00 HSZ/0002

The world of light and strange mesons: from spectroscopy puzzles to low energy QCD phenomena — •Stephan Paul for the COMPASS-Collaboration — Technical University of Munich, Physics Department, Garching, Germany — Max-Planck-Institute for Physics, Munich, Germany

After 20 years of data taking, the COMPASS experiment looks back on important contributions in the fields of nucleon spin-structure, light-hadron spectroscopy, and measurements related to very-low-energy QCD. Here, we report new insights into the mesonic excitation spectrum based on the world's largest data set, which provides access to all iso-vector mesons in a self-consistent manner using novel analysis techniques. In addition to excitations with high angular momentum, we have unraveled exotic mesons and discovered new mesonic structures even at low masses whose interpretation is still unclear. At very low energies, QCD can be described by effective interactions in the framework of chiral perturbation theory. We have challenged numerous precision calculations with high accuracy even in multidimensional analyses. COMPASS has proven to be a versatile precision instrument allowing for studies of QCD with high energy beams complementary to low energy facilities.

HK 24: Instrumentation VII

Time: Wednesday 14:00–15:30 Location: SCH/A251

Group Report HK 24.1 Wed 14:00 SCH/A251

Advances in CMOS MAPS for the next generation of collider detectors — •Bogdan-Mihail Blidaru for the ALICE Germany-Collaboration — Heidelberg University, Germany

CMOS Monolithic Active Pixel Sensors (MAPS) are continuously proven to comply with the severe constraints set by present and future collider detectors which require high granularity, low mass, excellent spatial resolution, as well as moderate radiation hardness and timing. Moreover, their ease of integration and cost effectiveness for large areas makes them alluring for almost all particle detection applications.

The first large scale MAPS-based silicon tracker is the new 10 m^2 ALICE Inner Tracking System (ITS2). Results from its first in-beam operation at the LHC confirm the excellent performance of the single ALPIDE MAPS chips that span its surface.

To profit from the advances in the field of CMOS technology, the ITS collaboration is pioneering the usage of bent, wafer-scale pixel sensors for the replacement of the innermost tracking layers of ITS2 in the next upgrades. This roadmap is accompanied by a change in the technology node from 180 nm (ALPIDE) to 65 nm which allows the stitching of sensors and paves the path to an almost massless detector.

This contribution will give an overview of some of the ongoing developments in the field of CMOS MAPS, specifically the research done in the context of the ALICE collaboration for its future upgrades. Performance of bent sensors, 65 nm test structures and progress towards wafer-scale sensors, as well as the motivation of building such devices from a physics and detector performance point of view will be reviewed.

HK 24.2 Wed 14:30 SCH/A251

Towards the Pre-Production Module of the Largest Station of the CBM MVD — •Franz Alexej Matejcek for the CBM-MVD-Collaboration — Goethe-Universität Frankfurt

The Micro Vertex Detector (MVD) of the Compressed Baryonic Matter Experiment (CBM) consists of four planar stations, each built of four independent quadrants (modules), that are equipped with dedicated CMOS pixel sensors (MIMOSIS) and will operate in vacuum. Each detector plane features a material budget x/X_0 ranging between 0.3 and 0.5 %, depending on size. The sensors are glued onto 380 μm thick TPG (Thermal Pyrolytic Graphite) carriers that provide the necessary mechanical stiffness and a high thermal conductivity in the geometrical acceptance to cool the sensors well below 0 °C. The sensor are then wire-bonded to dedicated flex cables connecting the front end electronics which are mounted on a heat sink sitting outside the acceptance. The integration is mechanically challenging as the sensors have to be glued and bonded on both sides of the carrier to maximize the acceptance.

This contribution will focus on integration aspects of the pre-production module of the largest quadrants.

This work has been supported by BMBF (05P21RFFC2), Eurizon and HFHF.

HK 24.3 Wed 14:45 SCH/A251

Performance of the MIMOSIS-1 CMOS Monolithic Active Pixel Sensor — •Hasan Darwish for the CBM-MVD-Collaboration — Goethe University Frankfurt, Frankfurt, Germany

MIMOSIS is a CMOS Monolithic Active Pixel Sensor designed to be used for the Micro Vertex Detector (MVD) of the future CBM experiment at FAIR in Darmstadt. The 50 μm thin sensor featuring 1024 × 504 pixels with a pitch of 27 × 30 μm^2 will combine a spatial resolution of ∼ 5 μm with a time resolution of 5 μs and provide a peak rate capability of 80 MHz/cm^2. The first full size prototype, MIMOSIS-1, was tested with beams at CERN, DESY, COSY and GSI. Sensor performance including detection efficiency, spatial resolution and fake hit rate was tested for 12 different combinations of pixel micro-circuits and sensing elements. Moreover, the sensor tolerance to radiation doses of up to 5 MRad and $3 \times 10^{14} n_{eq}/cm^2$ was evaluated. The design and technology of the sensor is introduced and results from the beam tests are shown.

*This work has been supported by bmbf (05P21RFFC2), gsi, Eurizon, hgshire, and hfhf.

HK 24.4 Wed 15:00 SCH/A251

Beam test studies of bent MAPS for ALICE ITS3 — •Lukas Lautner for the ALICE Germany-Collaboration — Technische Universität München — CERN

Bent Monolithic Active Pixel Sensors (MAPS) provide the basis for the next generation of ultra low material budget, fully cylindrical tracking detectors. In this contribution, results of beam campaigns with 5.4 GeV electrons will be presented. They verify the performance of bent 50 μm thick ALPIDE chips in terms of efficiency and space point resolution after bending them to the ALICE ITS3 radii of 18, 24, and 30 mm. In particular, an efficiency larger than 99.9% and a space-point resolution of approximately 5 μm are observed, both in line with the nominal operation of flat ALPIDE sensors. These values are found to be independent of the bending radius and thus demonstrate the feasibility of the planned ITS3 detector in crucial aspects.

HK 24.5 Wed 15:15 SCH/A251

Test and characterization of an experimental apparatus with bent MAPS and CsI scintillators — •Laszlo Varga[1,2], Christopher Ehrich[1], Tobias Jenegger[1,2], Lukas Lautner[1,3], Lukas Ponnath[1], Isabella Sanna[1,3], Berkin Ulukutlu[1], Roman Gernhäuser[1], and Laura Fabbietti[1] for the ALICE Germany-Collaboration — [1]Technische Universität München, Germany — [2]Excellence Cluster ORIGINS, Garching, Germany — [3]European Organisation for Nuclear Research (CERN), Geneva, Switzerand

Particle detectors based on Monolithic Active Pixel Sensors (MAPS) provide the basis for the next generation of vertex detectors with ultra low material budget and truly cylindrical geometry. Arrays of sensor elements stitched into wafer-scale and curved in a barrel geometry serve as the next upgrade of the inner tracking system (ITS3) of the ALICE experiment at CERN. A test environment hosting six bent sensors in the uITS3 geometry and their read out synchronized with CsI scintillator crystals has been recently employed in the test beam experiment at the Bronowice Cyclotron Facility (CCB) in Poland.

In this talk, the sensors technique, the experimental setup and preliminary results of the CCB experiment will be discussed.

This research was supported by the Excellence Cluster ORIGINS funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under Germany's Excellence Strategy EXC-2094-390783311 and Bundesministerium für Bildung und Forschung, BMBF-05P21WOCA1 ALICE.

HK 25: Instrumentation VIII

Time: Wednesday 14:00–15:30 Location: SCH/A.101

HK 25.1 Wed 14:00 SCH/A.101

Bending Losses in Scintillating-Plastic Fibers* — Christian Dreisbach, Karl Eichhorn, Jan Friedrich, Igor Konorov, Martin Losekamm, Stephan Paul, •Alicia Pechan, and Thomas Pöschl — Technische Universität München, Physik-Department E18, Garching, Germany

The AMBER experiment at CERN's Super Proton Synchrotron aims to measure the proton radius in high-energy elastic muon-proton scattering. At the Technical University of Munich, we develop a scintillating-fiber hodoscope to provide precise time information for the incoming and outgoing muons. Each detector consists of four layers of 500-μm scintillating-plastic fibers read out by silicon photomultiplier (SiPM) arrays.

The detector layout requires bending of the fibers towards the SiPMs, resulting in signal-height variations due to the associated bending losses. To characterize this effect, we performed a dedicated experiment to study the dependence of the losses on the bending radius for the scintillating fibers we use. In this contribution, we present the experimental setup and the results of this investigation.

*funded by the DFG under Germany*s Excellence Strategy - EXC2094 - 390783311 and BMBF Verbundforschung (05H21WORD1 HighD)

HK 25.2 Wed 14:15 SCH/A.101

Simulation framework for the digitisation module of scintillators and its implementation in NeuLAND — •Yanzhao Wang[1], Jan Mayer[1], Igor Gasparic[2], and Andreas Zilges[1] — [1]University of Cologne, Institute for Nuclear Physics — [2]GSI Helmholtzzentrum für Schwerionenforschung

The New Large-Area Neutron Detector NeuLAND, as a part of the R^3B experiment in FAIR, aims at providing a high detection efficiency and spatial-temporal

resolution of the neutrons generated by the nuclear reaction from the high-intensity radioactive beam[1]. Simulations of the interactions between the neutrons and NeuLAND and its digitised output signals are imperative for the development of its event reconstruction algorithm.
In this talk, we are introducing a simulation framework and its implementation on the digitising module TAMEX most lately used in NeuLAND. Light yields of the scintillators are transformed into the actual energy values and time stamps of the particle interactions, taking into account multiple physical processes, such as light attenuation, PMT saturation, signal pile-up, the couplings between different PMT outputs and the variations among scintillators and digitiser channels. Additionally, the generic interface within the framework leaves a huge potential for similar implementations on different scintillation detectors in R^3B.
Supported by the BMBF (05P21PKFN1).
[1] K. Boretzky *et al.*, Nucl. Instrum. Methods Phys. Res. A1014 (2021) 165701

HK 25.3 Wed 14:30 SCH/A.101
Towards a spatially resolving detector for ultra-cold neutrons — •Konrad Franz for the tauSPECT-Collaboration — Department Chemie, Johannes Gutenberg Universität Mainz
One of the challenges in ultra-cold neutron (UCN) detection is to convert the electrically inert neutron into an electrical signal. In the presented detector design this is achieved by employing a conversion layer stacked with a scintillation layer, in which the neutron induced α-particle generates a light pulse. This scintillation light is then guided onto an array of silicon photomultipliers (SiPMs). Spatial resolution can be achieved by reading out each SiPM individually. A main advantage of this setup is its compatibility with high magnetic fields, which allows for in-situ detection of UCNs in such environments. Combining spatial resolution with a magnetic field gradient enables UCN energy resolution.
The talk will give an overview of the detector design and will outline its advantages. Furthermore, the current status of the development will be presented and the main challenges moving forward will be discussed.

HK 25.4 Wed 14:45 SCH/A.101
A normalization detector for the neutron lifetime experiment τSPECT — •Martin Engler for the tauSPECT-Collaboration — Department of Chemistry, Johannes Gutenberg University, Mainz
The τSPECT experiment aims to measure the free neutron lifetime, using fully magnetic storage. Neutrons with energies of ≈ 50 neV are stored in a magnetic field gradient and then counted after varying storage times. The individual measurements have to be normalized, in order to account for statistical and systematical changes in the yield of the neutron source. To monitor the flux of storable neutrons during the filling process, an in-situ neutron detector, detecting light from a ^{10}B coated ZnS:Ag scintillator coupled to an array of silicon photomultipliers, has been designed and built.
This talk will cover the detectors design, challenges, as well as the results of the first runs.

HK 25.5 Wed 15:00 SCH/A.101
A neutron trigger detector for pulsed neutron sources — •Julian Auler for the tauSPECT-Collaboration — Institut für Physik, Johannes Gutenberg-Universität, Mainz
A variety of experiments investigating properties of neutrons can be performed at pulsed source facilities like the research reactor TRIGA Mainz. A typical problem faced by these experiments is the non-availibility of a reliable facility-provided trigger signal in coincidence with the neutron production. Here we present the design, implementation and experimental results of a neutron pulse detector that provides a coincident trigger signal for precise experimental timing.
The described neutron pulse detector is based on a multilayer design with a ^{10}B top layer (∼ 80 nm) employing the ^{10}B(n,α)^{7}Li reaction and deposited on a scintillator foil (0.25 mm) with a one-sided coating of ZnS(Ag) as scintillation layer. A silicon photomultiplier (SiPM) is used as photosensor, which makes the detector suitable for use in experimental areas with high magnetic fields and at the same time has the advantage that no high-voltage supply is required.

HK 25.6 Wed 15:15 SCH/A.101
Polyethylene Naphthalate Based Neutron and Radon Detectors — •Kim Tabea Giebenhain, Hans-Georg Zaunick, Roman Bergert, and Kai-Thomas Brinkmann — Justus-Liebig-Universität, Giessen, Germany
Polyethylene naphthalate (PEN) is a material with intrinsically scintillating capabilities. Using a thin foil of PEN together with a SiPM array has shown to be an excellent combination for alpha detection and therefore as a radon detection device. Coupled with a BNNT mat with a high ^{10}B content, it was tested for its capabilities as a neutron detector in the thermal energy range.
Supported by BMBF via EFRE.

HK 26: Instrumentation IX

Time: Wednesday 14:00–15:30 Location: SCH/A117

Group Report HK 26.1 Wed 14:00 SCH/A117
Status of the readout system for the Micro-Vertex-Detector of the PANDA experiment — Kai-Thomas Brinkmann, •Marvin Peter, and Hans-Georg Zaunick — Justus-Liebig-Universtität Giessen, Germany
The Micro-Vertex-Detector (MVD) is situated in the center of the PANDA experiment and will take on an important role in particle tracking and identification. A readout system for the silicon strip detectors is currently in development and being tested in combination with the detectors. This talk will give an overview of the readout system of the MVD strip detector prototypes. *gefördert durch BMBF

HK 26.2 Wed 14:30 SCH/A117
The front-end signal path of the P2 experiment at MESA — Sebastian Baunack[1], Boris Gläser[1], •Rahima Krini[1], Frank Maas[1,2,3], David R. Pineiro[2], Tobias Rimke[1], and Malte Wilfert[1] for the P2-Collaboration — [1]Institute for Nuclear Physics, Mainz, Germany — [2]Helmholtz Institute Mainz, Germany — [3]PRISMA+ Cluster of Excellence, Johannes Gutenberg-Universität Mainz
The weak mixing angle $\sin^2\theta_W$ can be measured in parity violating elastic electron-proton scattering. The aim of the P2 experiment is a very precise measurement of the weak mixing angle with an accuracy of 0.15% at a low four-momentum transfer of Q^2=4.5·10^{-3}GeV^2. In combination with existing measurements at the Z pole with comparable accuracy, this comprises a test of the standard model with a sensitivity towards new physics up to a mass scale of 50 TeV. The experiment will be built at the future MESA accelerator in Mainz.

The small asymmetries $\mathcal{O}(10^{-8})$ and the high precision require very high statistics and therefore an integrating measurement with the associated integrating data acquisition readout chain. A joint read-out electronics for P2 experiment in Mainz and for Moeller experiment at the Jefferson Laboratory is under development in collaboration with the University of Manitoba. The first prototype of a full differential integrating detector signal chain was built and tested at MAMI (Mainzer Mikrotron). The results fulfill the requirements of the P2 parity violation experiment and will be presented in this talk.

HK 26.3 Wed 14:45 SCH/A117
The Data Acquisition for PANDA FAIR Phase-0 at MAMI — Nicolo Baldicchi[1], Luigi Capozza[1], Samet Katilmis[1], Dong Liu[1], Frank Maas[1,2,3], Julian Moik[1], •Oliver Noll[1,2], David Rodriguez Piñeiro[1], Paul Schöner[1], Christoph Rosner[1], and Sahra Wolff[1] — [1]Helmholtz-Institut Mainz, Mainz, Germany — [2]Institute of Nuclear Physics, Mainz, Germany — [3]PRISMA+ Cluster of Excellence, Mainz, Germany
The PANDA FAIR Phase-0 experiment at the Mainz Microtron Facility (MAMI) is set to determine the double-virtual transition formfactor (TFF) of the pion. As a result, the uncertainty in the hadronic light-by-light (HLbL) calculation can be reduced. Consequently, the experiment will give new input to the hadronic corrections of the anomalous magnetic moment of the muon (g_μ-2 puzzle). The detector system for the experiment is a modified version of the PANDA backward calorimeter, which was developed by the electromagnetic process group (EMP) at HI-Mainz. In contrast to the PANDA experiment, the detector will operate in forward direction within a strong electromagnetic environment. Thus, new challenges arise in terms of radiation load of the components and the handling of high event rates for the electronics. The talk addresses the developments for the data acquisition system to cope with the demanding experiment environment.

HK 26.4 Wed 15:00 SCH/A117
Digital Signal Processing with FPGAs using Modern C++ and HLS — •Thomas Janson and Udo Kebschull for the ALICE Germany-Collaboration — IRI, Goethe-Universität Frankfurt am Main, Max-von-Laue-Straße 12, 60438 Frankfurt am Main, Germany
In this talk, we discuss the use of Modern C++ and HLS to implement digital signal processing (DSP) algorithms on FPGAs for embedded systems. We introduce common design patterns for some simple algorithms that are suitable for continuous streaming data. The focus of this discussion is how modern C++ helps to control FPGA resource usage by applying compile-time C++ language features compared to traditional VHDL implementations. Furthermore, tests with common SOC systems and their implementation are presented.

HK 26.5 Wed 15:15 SCH/A117

Status of the Front-End-Electronics for the CBM-TRD detector at FAIR — •Dennis Spicker for the CBM-Collaboration — Institut für Kernphysik, Max von Laue Straße 1, 60438 Frankfurt am Main

At the future Facility for Antiproton and Ion Research (FAIR) the Compressed Baryonic Matter experiment (CBM) is supposed to measure particles from heavy-ion collisions at very high interaction rates. For this purpose, the data acquisition will run in a free-streaming mode without a hierarchical trigger system.

For the Transition Radiation Detector (TRD) the readout system is based on the Self-triggered Pulse Amplification and Digitization ASIC (SPADIC). It features a charge-sensitive amplifier, a continuously sampling ADC, a programmable digital filter and a hit detection logic. The latest version introduces new switchable features such as a low-gain mode, an additional shaping order and digital baseline tracking.

This contribution presents the latest progress towards a final version of the SPADIC chip, as well as a slow-control software framework, including a GUI, that enables the operator to easily configure the SPADIC via the underlying communication protocol "IPbus". The software offers an automated testing routine that helps to assure the quality of the front-end-electronics before installing them on the detectors.

Supported by the German BMBF-grant 05P21RFFC3

HK 27: Heavy-Ion Collisions and QCD Phases V

Time: Wednesday 14:00–15:30 Location: SCH/A216

Group Report HK 27.1 Wed 14:00 SCH/A216

The CBM Experiment at FAIR - towards commissioning in 2027 — •Christian Sturm for the CBM-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

The Compressed Baryonic Matter experiment (CBM) is under construction at the Facility for Antiproton and Ion Research (FAIR). It aims to explore the phase structure of strongly interacting (QCD) matter at large net-baryon densities and moderate temperatures by means of heavy-ion collisions. The CBM experiment is designed as a fixed-target experiment, being equipped with fast and radiation-tolerant detector systems read out by a free-streaming data acquisition system. Performing online 4D reconstruction and selection CBM will measure with unprecedented interaction rates of up to 10 MHz. Hence, rare and penetrating probes like multi-strange hadrons, $\Lambda\Lambda$-hypernuclei, di-electrons/muons as well as charm production will be measured with high statistics in this region of the QCD phase diagram for the first time. This opens the opportunity to search for structures in the excitation functions and thus obtain experimental evidence for a first order phase transition and critical end point recently predicted to be present in the FAIR (SIS100) energy range. The presentation will summarize the preparation status of the CBM experiment on the way towards commissioning in 2027 including latest results of the mCBM experiment, a CBM demonstrator and full-system test-setup running within the FAIR phase-0 program.

HK 27.2 Wed 14:30 SCH/A216

Improving the CBM RICH lepton reconstruction — •Pavish Subramani, Christian Pauly, and Karl-Heinz Kampert — Bergische Universität Wuppertal

The Compressed Baryonic Matter experiment (CBM) is a heavy ion fixed target experiment, designed to probe the QCD phase diagram near the critical point at high μ_B and medium temperatures. The Ring Imaging Cherenkov Detector (RICH), situated directly behind the Micro Vertex Detector (MVD) and Silicon Tracking System (STS), is designed to distinguish electrons from pions, being the most abundantly produced particles in heavy ion collisions in the momentum range up to 10 GeV/c. One major source of background in the dilepton analysis is contamination by pions arising from false ring track matching in the RICH. Moreover, electrons from photon conversion inside the target and detector material are partly undetected by the STS tracking system, but cause additional Cherenkov rings in the RICH. If these rings are falsely matched to pion tracks they lead to electron misidentification, and thus can increase the combinatorial background and reduce the signal-to-background ratio.

This talk will focus on possible improvements in the efficiency of primary electron identification and pion suppression, for example by using additional information from the Transition Radiation Detector (TRD) situated directly behind the RICH.

* supported by BMBF (05P19PXFCA, 05P21PXFC1) and GSI.

HK 27.3 Wed 14:45 SCH/A216

CBM performance for the measurement of (multi)strange hadrons' anisotropic flow in Au+Au collisions at FAIR — •Oleksii Lubynets[1,2] and Ilya Selyuzhenkov[1] for the CBM-Collaboration — [1]GSI Helmholtzzentrum für Schwerionenforschung — [2]Goethe-Universität Frankfurt am Main

The main goal of the CBM experiment is to study highly compressed baryonic matter produced in collisions of heavy ions. The SIS-100 accelerator at FAIR will enable investigation of the QCD matter at temperatures up to about 120 MeV and net baryon densities 5-6 times larger than that of the normal nuclear matter. Hyperons produced during the dense phase of a heavy-ion collision provide information about the equation of state of the QCD matter. The measurement of (multi)strange hyperons' anisotropic flow is important for understanding the dynamics and evolution of the QCD matter created in the collision.

Performance studies for strange hadrons anisotropic flow measurement with the CBM experiment at FAIR will be presented. Strange hadrons are reconstructed via their decay topology using Kalman Filter algorithm methods. Directed flow of strange hadrons is calculated as a function of rapidity, transverse momentum and collision centrality. The effects due to non-uniformity of the CBM detector response in the azimuthal angle, transverse momentum and rapidity are corrected using the QnTools analysis package. The CBM performance is compared with that of the STAR experiment and projections for statistical uncertainties with high statistics data at CBM are presented.

HK 27.4 Wed 15:00 SCH/A216

Σ^0 reconstruction in Ag+Ag collisions at $\sqrt{s_{NN}}$ = 2.55 GeV with HADES — •Marten Becker for the HADES-Collaboration — Justus-Liebig-University Giessen

The HADES experiment at GSI investigates the moderate temperature and high density regime of the QCD phase diagram created by A+A collisions at a few AGeV kinetic beam energy. Besides leptons and photons, strangeness directly transports measurable information of the created dense matter to the laboratory. In 2019 HADES collected Ag+Ag collisions at 2.55 GeV center of mass energy which is of great interest since the energy is right at the strangeness production threshold. For the first time, the newly installed electromagnetic calorimeter allows direct photon detection. The RICH detector was upgraded in addition, which strongly improves electron identification and the detection of conversion-pairs.

This contribution shows work in progress results on the Σ^0 baryon reconstruction, decaying electromagnetically into $\Lambda + \gamma$. Feasibility studies in simulations prove the reconstruction methods in the $\Lambda + \gamma$ channel as well as the Λ+lepton channel where the photon converted and at least one low energetic $e^{\pm}$ is identified in the RICH. The Σ^0 yield is extracted and the resulting Λ/Σ^0 ratio is compared to statistical-thermal model calculations.

HK 27.5 Wed 15:15 SCH/A216

First measurements of Σ^+ and $\bar{\Sigma}^-$ with ALICE — •Benedict Heybeck for the ALICE Germany-Collaboration — Institut für Kernphysik, Johann Wolfgang Goethe-Universität Frankfurt, Frankfurt, Germany

The first measurements of Σ^+- and $\bar{\Sigma}^-$-baryons with ALICE in pp collisions at $\sqrt{s}$ = 13 TeV will be presented.

Σ^+ baryons decay into a proton and a neutral pion via the weak interaction with a branching ratio of 51.57%. The neutral pion decays electromagnetically almost exclusively into two photons which are challenging to measure with the ALICE apparatus. In particular, since these photons have low momenta. However, Σ baryons are an important probe to study the strangeness production in pp collisions. Furthermore, the reconstructed Σ baryons can be used for correlation measurements with protons to improve the understanding of the interaction between nucleons and hyperons.

HK 28: Heavy-Ion Collisions and QCD Phases VI

Time: Wednesday 14:00–15:30 Location: SCH/A315

Group Report HK 28.1 Wed 14:00 SCH/A315

Transport Model Evaluation Project for Intermediate-Energy Heavy-Ion Collisions — •Hermann Wolter — University of Munich (LMU), unich, Germany

Transport models describing the evolution of a heavy-ion collision are indispensable to extract information on the equation-of-state of nuclear matter and medium properties of hadrons from such experiments in the intermediate energy range from several 100 MeV to a few GeV per nucleon. Of particular interest today is the high-density behavior of the nuclear symmetry energy, which is of great relevance for the understanding of astrophysical objects and processes. However, the highly complex and non-linear transport equations are commonly solved by simulations, which involve choices of strategies, which are not necessarily determined by the underlying equations. Thus it has occurred that studies using different transport models have deduced differing conclusions from the same data. In order to understand these differences and to reduce the systematical uncertainties of transport analyses of heavy-ion collisions, we have, within the TMEP collaboration, undertaken an extensive project of comparing many transport codes in different set-ups under controlled conditions (a review is given in H. Wolter et al., Progr. Part. Nucl. Phys. 125 (2022) 103962), also providing benchmark calculations. Here we will discuss the present status and future projects of this undertaking.

HK 28.2 Wed 14:30 SCH/A315

Mapping the quark-gluon plasma properties in Pb-Pb and Xe-Xe collisions at the LHC with FluiduM — •Luuk Vermunt[1,2], Yannis Seeman[1], Lukas Kreis[2], Christian Sonnabend[1], Andrea Dubla[2], Ilya Selyuzhenkov[2], and Silvia Masciocchi[1,2] — [1]Physikalisches Institut, Heidelberg, Deutschland — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Deutschland

Fundamental properties of strongly-interacting matter under extreme conditions become accessible with ultra-relativistic collisions of heavy ions. We will present a phenomenological analysis of the experimental data for transverse momentum spectra of identified charged hadrons and (multi-)strange hyperons in Pb-Pb and Xe-Xe collisions at the LHC. The analysis is based on the relativistic fluid dynamics description implemented in the numerically efficient FluiduM approach. We separate in our treatment the chemical and kinetic freeze out, and incorporate the partial chemical equilibrium to describe the late stages of the collision evolution. We determine key parameters of the quark-gluon plasma evolution and its properties including the shear and bulk viscosity to entropy ratios, the initialisation time, initial density, and freeze-out temperatures. The physics parameters and their posterior probabilities are extracted using global search in multidimensional space with modern Machine Learning tools, such as ensembles of neural networks.

HK 28.3 Wed 14:45 SCH/A315

Global angular momentum generation in heavy-ion reactions within a hadronic transport approach — •Nils Sass[1], Oscar Garcia-Montero[1,2], Marco Müller[1], and Hannah Elfner[1,3,4] — [1]Goethe University Frankfurt — [2]University Bielefeld — [3]GSI — [4]FIAS

In 2017, the STAR collaboration at the Relativistic Heavy Ion Collider (RHIC) has measured finite global spin polarization of Λ hyperons. This measurement revealed a high angular momentum of the heavy ions and provided experimental evidence for vorticity in the quark-gluon plasma for the first time. In order to investigate the underlying mechanisms, a dynamic description of the transfer of angular momentum is required. In this work, the microscopic non-equilibrium transport approach SMASH is applied to study the generation of global angular momentum by the interaction of two nuclei. As SMASH provides access to the whole phase-space evolution of every particle at any given time, it allows to assess the fraction of angular momentum generated in the fireball by all participants. We confirm the previous modeling by Becattini within a geometric Glauber model approach, which found that the angular momentum transfer reaches a unique maximum in mid-central Au-Au collisions during time evolution. Even though angular momentum is not conserved locally in the transport approach a priori, we identify the contributions to the conservation violation and propose optimal setups for different energy regimes that recover conservation, based upon the test particle method and the treatment of Fermi motion.

HK 28.4 Wed 15:00 SCH/A315

First dielectron measurements in pp collisions at 13.6 TeV with ALICE in Run 3 — •Florian Eisenhut for the ALICE Germany-Collaboration — Goethe-Universität Frankfurt am Main

With the new and upgraded detectors of ALICE, the experiment is capable to read out collision data in a continuous mode. With a data acquisition rate 100 times larger than before, an integrated luminosity of more than 10 nb^{-1} is expected to be collected for Pb–Pb collisions during the Run 3 and 4 (2022-2032) data taking periods. Not only the improved readout of the detectors but also the reduced material budget, as well as the improved pointing resolution of the detectors, are crucial for the dielectron analysis. They will help to control the background from photon conversions and heavy-flavor hadron decays within the dielectron spectra.

This talk will give an overview of the first performance studies for dielectron analyses with the ALICE experiment based on data of pp collisions at 13.6 TeV in Run 3. It will summarize the techniques used to track, identify and select electrons and positrons. First results of the dielectron spectra and their corresponding signal-to-background ratios and significances will be presented together with a comparison to the results in Run 2.

HK 28.5 Wed 15:15 SCH/A315

Prompt and non-prompt J/ψ with machine learning and Kalman filter techniques with ALICE in Run 3 — •Pengzhong Lu for the ALICE Germany-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany — University of Science and Technology of China, Hefei, China

Quarkonium production offers an effective way to study the properties of the quark-gluon plasma (QGP) created in ultra-relativistic heavy-ion collisions. While the prompt J/ψ production provides information on suppression and (re-)generation mechanisms in the QGP, the non-prompt J/ψ component (from b-hadron decays) allows one to study heavy quark energy loss in the medium. J/ψ meson production measurements in pp collisions, besides providing a reference for the corresponding measurements in p-Pb and Pb-Pb collisions, are also crucial to better understand quantum chromodynamics.

In this talk, the performance of the combined usage of KFParticle and machine learning (ML) for the measurement of prompt and non-prompt J/ψ production will be presented. The KFParticle package, based on the Kalman filter algorithm, shows good performances in the reconstruction of particle decays. Combining it with ML techniques will significantly improve the signal reconstruction efficiencies and signal-to-background ratios. Results from the commissioning of this new methodology in Pb-Pb collisions at $\sqrt{s_{\rm NN}}$ = 5.02 TeV from Run 2 will be shown, followed by the study of the first Run 3 data from pp collisions at $\sqrt{s}$ = 13.6 TeV.

HK 29: Hadron Structure and Spectroscopy III

Time: Wednesday 14:00–15:30 Location: SCH/A316

Group Report HK 29.1 Wed 14:00 SCH/A316

Probing the hadron spectrum with the GlueX experiment at Jefferson Lab — •Annika Thiel — Helmholtz-Institut für Strahlen- und Kernphysik, Nussallee 14-16, 53115 Bonn

One of the primary goals of non-pertubative QCD is the understanding of the hadron spectrum. A particular interesting aspect is the question, if and where states containing gluonic excitations contribute to the spectra. This issue has been tackled by different experiments using various production mechanisms without conclusive answers. A complementary production mechanism is the use of photoproduction, which is utilized by the GlueX experiment at Jefferson Lab.

The GlueX experiment started data taking in 2017 and is focused on the measurement of neutral as well as charged final states at photon energies up to 12 GeV. An important tool is the use of linearly polarized photons, which allows to shed light on the question whether natural or unnatural exchange dominates in the production of different states. Various results have been extracted in recent years, ranging from the extraction of polarization observables for different final states over the investigation of excited Λ states to the determination of the J/Ψ cross section at threshold.

This presentation will show the current status of the GlueX experiment and give an overview about the published results as well as ongoing analyses.

HK 29.2 Wed 14:30 SCH/A316

Partial-wave analysis of $\tau^- \to \pi^-\pi^-\pi^+\nu_\tau$ at Belle* — •Andrei Rabusov, Daniel Greenwald, and Stephan Paul — Technical University of Munich, James Franck Str. 1, 85748 Garching

We present preliminary results of a partial-wave analysis of $\tau^- \to \pi^-\pi^-\pi^+\nu_\tau$ in data from the Belle experiment at the KEK e$^+$e$^-$ collider. We demonstrate the presence of the a$_1$(1420), a$_1$(1640), and π(1300) resonances in τ decay and measure their masses and widths. We also present validation of our findings using a model-independent approach. Our results can improve modeling in simulation studies necessary for measuring the τ electric and magnetic dipole moments and Michel parameters.

*This work is funded by the DFG under Germany's Excellence Strategy - EXC2094 - 390783311 and BMBF Verbundforschung (05H21WORD1 HighD, 05H21WOKBA BELLE2, 05P21WOCC1 COMPASS).

HK 29.3 Wed 14:45 SCH/A316

Diffractive resonance production in the reaction $\pi^- + p \to \pi^- K^0_S K^0_S + p$ at 190 GeV/c from COMPASS — •Mathias Wagner for the COMPASS-Collaboration — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

Understanding of the light-meson spectrum is a necessity for the search for exotic states such as hybrid mesons. Especially the $\pi^-\pi^+\pi^-$ system proved very fruitful in this respect by providing, among others, clear evidence of the spin-exotic $\pi_1(1600)$ meson. A possible supernumerous state, the $a_1(1420)$, is established by the COMPASS collaboration as an evidence for a triangle singularity in the 3π-πKK coupled interaction. Therefore, it is extremely interesting to look for both the $\pi_1(1600)$ and the $a_1(1420)$ in the πKK final state.

Since the identification of charged kaons in COMPASS is severely limited at high momenta, we investigate the $\pi^- K^0_S K^0_S$ system by reconstructing secondary K^0_S decay vertices. First results of the event selection and the $\pi^- K^0_S K^0_S$ mass spectrum in diffractive production at COMPASS are presented. Possible resonances are $a_{J\geq1}$ and $\pi_{J\geq0}$, and in the two-body subsystems we expect in the $K^0_S K^0_S$ system the f and ρ states with even and odd spin, respectively, and K^*_J in the $\pi^- K^0_S$ system. For these, the corresponding invariant-mass spectra as well as the Dalitz-plots are presented.

Supported by BMBF.

HK 29.4 Wed 15:00 SCH/A316

Partial-Wave Analysis of the $\pi\pi\omega$ Final State at COMPASS* — •Philipp Haas for the COMPASS-Collaboration — Physik-Department, Technische Universität München

The COMPASS experiment is a multi-purpose fixed-target experiment at the CERN SPS. One of its major goals is to study the light-meson spectrum with high precision. Of special interest is the search for so-called exotic mesons which cannot be described as quark-antiquark states. To this end, COMPASS has acquired large data samples on diffractive production of excited light mesons by scattering a 190 GeV/c π^- beam off a proton target. Using this data set, COMPASS studied the $\pi_1(1600)$, which is a promising candidate for a so-called spin-exotic hybrid meson in great detail in the $\eta\pi$, $\eta'\pi$, and $\rho\pi$ decay modes. However, lattice QCD predicts that the $\pi_1(1600)$ dominantly decays into $b_1(1235)\pi$.

The $b_1(1235)\pi$ decay mode has so far not been studied at COMPASS. As $b_1(1235)$ dominantly decays into $\omega(782)\pi$, a partial-wave analysis of $\omega\pi\pi$ including the $\omega \to 3\pi$ decay is necessary to access the $b_1(1235)\pi$ decay mode. We will present our development of a partial-wave analysis of the $\omega\pi\pi$ final state. We will focus on modeling the $\omega(782)$ decay in the partial-wave analysis.

* funded by the DFG under Germany's Excellence Strategy - EXC2094 - 390783311 and BMBF Verbundforschung 05P21WOCC1 COMPASS.

HK 29.5 Wed 15:15 SCH/A316

Investigation of the decays $\chi_{cJ} \to \eta'\pi^+\pi^-$ and search for the spin exotic meson π_1(1600) at BESIII — •Frederik Weidner, Salleh Ahmed, Anja Brüggemann, Nikolai in der Wiesche, Hannah Neuwirth, Ann-Christin Schluse, Anna Theimann, and Alfons Khoukaz for the BESIII-Collaboration — Westfälische Wilhelms-Universität, Münster, Germany

In recent years the search for exotic hadrons has produced more and more states which seem to be incompatible with the conventional classification as a two or three quark state. However, in most of these cases the classification of these particles is inconclusive. An interesting opportunity is given by states with quantum numbers which cannot be produced by the conventional quark model, such as $J^{PC} = 1^{-+}$ in case of the $\pi_1(1600)$, which was seen in multiple experiments.

With the BESIII experiment decays of the χ_{cJ} mesons can be investigated through their production in radiative decays of the $\psi(2S)$ meson. Here, a large number of events has been recorded by the BESIII detector and additional data taking is ongoing. When considering the decay of these charmonia into three pseudoscalar mesons, spin exotic quantum numbers like $J^{PC} = 1^{-+}$ can be accessed. Additionally, precision measurements of branching ratios of the χ_{cJ} states can help solidify our understanding of the charmonium system. In this talk the current status of the search for the $\pi_1(1600)$ in the decay $\chi_{c2} \to \eta'\pi^+\pi^-$ by the means of a partial wave analysis will be presented.

This work is funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - 269952272, 271236083 and 443159800.

HK 30: Nuclear Astrophysics III

Time: Wednesday 14:00–15:30 Location: SCH/A419

Group Report HK 30.1 Wed 14:00 SCH/A419

Science highlights from the shallow underground laboratory Felsenkeller Dresden — •Konrad Schmidt and Daniel Bemmerer — Helmholtz-Zentrum Dresden-Rossendorf

Underground accelerator laboratories are important instruments to measure nuclear reactions with low cross sections in experimental nuclear astrophysics. The reduced detector background due the shielding from cosmic rays allows the study of astronuclear reactions at energies relevant to Big Bang nucleosynthesis and stellar burning. The reactions 3He(a,g)7Be and 12C(p,g)13N have recently been studied at the shallow underground laboratory Felsenkeller Dresden, where a 5 MV accelerator provides several high intensity ion beams and an ultra-low background counting setup for activation measurements. In the talk, the latest scientific results from the Felsenkeller laboratory, its current capabilities and upcoming enhancements will be summarized.

HK 30.2 Wed 14:30 SCH/A419

The ^{58}Fe(p,n)^{58}Co activation experiment at the University of Cologne — •Pina Wüstenberg, Felix Heim, Martin Müller, Svenja Wilden, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics

The γ-process describes a large network of reactions that leads to the synthesis of proton-rich nuclei, the p nuclei. Not all of these reactions can be measured in the laboratory, therefore theoretical predictions are needed. These models can be tested and improved by comparing them to experimental data. This contribution deals with the determination of cross sections of the ^{58}Fe(p,n)^{58}Co reaction. The cross section of (p,n) reactions is mainly sensitive to the optical model potential that describes the interaction between a proton and a nucleus. For this purpose, highly-enriched ^{58}Fe targets were irradiated with protons with seven different energies in the energy range between 3.3 MeV and 5 MeV. The proton beam was delivered by the 10 MV FN Tandem accelerator of the Institute for Nuclear Physics at the University of Cologne. The total cross sections were derived by analyzing the emitted γ-rays during the decay of ^{58}Fe using a dedicated counting setup. The γ-ray spectra were recorded using two clover-type HPGe detectors in a face-to-face geometry. The resulting cross sections were compared to predictions from theoretical models.

Supported by the DFG (ZI 510/8-2)

HK 30.3 Wed 14:45 SCH/A419

Results of total and partial cross-section measurements of the ^{87}Rb(p,γ)^{88}Sr reaction — •Svenja Wilden, Felix Heim, Martin Müller, Pina Wüstenberg, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics

The existence of most of the proton rich stable nuclei - the p nuclei - cannot be explained via neutron-capture reactions. Therefore, at least one other process has to exist in order to describe their origin, the γ process. Since most photodisintegration reactions involved in the process are not directly accessible, reliable statistical model calculations are needed to predict cross sections and reaction rates. The cross sections include total cross sections describing the probability of the reaction itself and partial cross sections describing the decay to certain discrete states in the final nucleus. To improve the calculations the nuclear input parameters need to be constrained. This requires a large experimental database. Via comparison of experimental data to theoretical predictions different models can be excluded or constrained. In order to study the ^{87}Rb(p,γ)^{88}Sr reaction an in-beam experiment at the high-efficiency HPGe γ-ray spectrometer HORUS at the University of Cologne was performed. Proton beams with energies between $E_p = 2.0 - 5.0$ MeV were provided by the 10 MV FN Tandem accelerator. Final results on absolute cross sections and first results on partial cross sections will be presented as well as comparisons to theoretical model calculations.

Supported by the DFG (ZI 510/8-2).

HK 30.4 Wed 15:00 SCH/A419

The ^{205}Pb/^{205}Tl s-process chronometry and pp neutrino flux — •Riccardo Mancino[1,2], Rui Jiu Chen[2], Iris Dillman[3], Chris Griffin[3], Guy Leckenby[4], Yuri Litvinov[2], Gabriel Martínez-Pinedo[2,1], Shahab Sanjari[2,5], and Ragandeep Singh Sidhu[2,6] — [1]Institut für Kernphysik, Technische Universität Darmstadt, Darmstadt, DE — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, DE — [3]TRIUMF, Vancouver, CA — [4]University of British

Columbia, Vancouver, CA — [5]Aachen University of Applied Sciences, Aachen, DE — [6]University of Edinburgh, Edinburgh, UK

The bound-state beta decay of fully ionized ^{205}Tl has been measured at GSI. Combining this new experimental information and the known electron capture decay of ^{205}Tl we can compute the weak processes connecting these two nuclei. This includes electron capture and beta decay operating during the age phase of intermediate-mass stars. These processes determine the ^{205}Pb/^{205}Tl ratio produced by the s-process. The new experimental information favors a larger production of ^{205}Pb that may be observable in the early Solar System. Another important weak process is the conversion of ^{205}Tl to ^{205}Pb by solar neutrinos capture. This reaction has such a low Q-value that probes the pp solar neutrino flux. Using the new experimental data together with shell-model calculations we provide an update to the neutrino absorption cross section for solar neutrinos on ^{205}Tl. We highlight the necessity of a measurement of the Gamow-Teller strength by charge exchange reactions. This work is funded by SFB 1245 "Nuclei: From Fundamental Interactions to Structure and Stars".

HK 30.5 Wed 15:15 SCH/A419

Linearity and dark rate of SiPMs for large scintillator bars — •Thomas Hensel[1,2], Daniel Bemmerer[2], Konstanze Boretzky[3], Igor Gašparić[5,3,4], Daniel Stach[2], Andreas Wagner[2], and Kai Zuber[1] — [1]Technische Universität Dresden, Institut für Kern- und Teilchenphysik, 01062 Dresden, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), 01328 Dresden, Germany — [3]GSI Helmholtzzentrum für Schwerionenforschung, 64291 Darmstadt, Germany — [4]Technische Universität Darmstadt, Fachbereich Physik, Institut für Kernphysik, 64289 Darmstadt, Germany — [5]Ruđer Bošković Institute, Zagreb, Croatia

The NeuLAND (New Large-Area Neutron Detector) plastic scintillator based time of flight detector for neutrons is currently under construction at FAIR. NeuLAND will consist of 3,000 2.7 m long bars that are read out by photomultipliers. Here, data from a comprehensive study of an alternative light readout scheme using silicon photomultipliers (SiPM) are presented. For this purpose, a typical NeuLAND bar was instrumented on each end with a prototype of the same geometry as a 1" photomultiplier tube, including four 6×6mm* SiPMs, amplifiers, high voltage supply, and micro-controller. Using fast digitizers, time resolution and saturation tests were carried out at the 35 MeV electron beam from the ELBE superconducting linac with its ps-level time jitter with 1-60 electrons per bunch. It is found that the SiPM-instrumented NeuLAND bar shows ≤ 10% nonlinearity over a range of 10-300 MeV deposited energy. The dark rate due to random coincident triggers of SiPMs is lower than the cosmic ray induced rate in the NeuLAND bar.

HK 31: Structure and Dynamics of Nuclei V

Time: Wednesday 14:00–15:30 Location: SCH/A118

Group Report HK 31.1 Wed 14:00 SCH/A118

Real photon-scattering experiments for the study of dipole excitations — •Miriam Müscher[1], Johann Isaak[2], Florian Kluwig[1], Deniz Savran[3], Tanja Schüttler[1], Ronald Schwengner[4], and Andreas Zilges[1] — [1]University of Cologne, Institute for Nuclear Physics — [2]TU Darmstadt, Institute for Nuclear Physics — [3]GSI, Darmstadt — [4]Helmholtz-Zentrum Dresden-Rossendorf

Absolute photoabsorption cross sections of atomic nuclei can have great impact on reaction rates in nucleosynthesis processes. Hence, they are crucial to understand the nuclear abundances in our universe.

Real photon-scattering experiments are well suited to study the dipole response due to the small angular-momentum transfer of photons [1, 2]. Besides the determination of spin and parity quantum numbers of excited states in even-even nuclei, absolute and total photoabsorption cross sections can be extracted in a model-independent way by combining complementary (γ,γ') experiments. The most common photon sources are, on the one hand, energetically-continuous bremsstrahlung and, on the other hand, Laser-Compton Backscattering producing a linearly-polarized, quasimonoenergetic γ-ray beam.

In this contribution, the aforementioned complementary photon sources, examples for corresponding setups, and recent results will be presented.

This work is supported by the BMBF (05P21PKEN9).

[1] U. Kneissl *et al.*, Prog. Part. Nucl. Phys. **37** (1996) 349

[2] A. Zilges *et al.*, Prog. Part. Nucl. Phys. **122** (2022) 103903

Group Report HK 31.2 Wed 14:30 SCH/A118

Systematics of the dipole polarizability — •Isabelle Brandherm[1], Peter von Neumann-Cosel[1], Tobias Klaus[1], Hiroaki Matsubara[2], and Atsushi Tamii[2] — [1]Institut für Kernphysik, TU Darmstadt, Darmstadt, Germany — [2]RCNP, Osaka, Japan

Inelastic proton scattering at extreme forward angles has been established as a tool to probe the electric dipole response in nuclei. From that the electric dipole polarizability can be obtained, which is a key observable to set constraints to the symmetry energy parameters of the equation of state and neutron skin thickness of nuclei. Over the last decade the electric dipole response in numerous nuclei has been measured at the Research Center for Nuclear Physics in Osaka, Japan. In this talk new result about the dipole response and dipole polarizability of ^{58}Ni and ^{90}Zr will be presented. Also the now available systematics of of the dipole polarizability will be discussed.

Supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Project-ID 279384907, SFB 1245.

HK 31.3 Wed 15:00 SCH/A118

Investigation of low-lying dipole excitations in ^{144}Nd via real photon-scattering experiments — •Florian Kluwig[1], Miriam Müscher[1], Ronald Schwengner[2], Tanja Schüttler[1], and Andreas Zilges[1] — [1]University of Cologne, Institute for Nuclear Physics — [2]Helmholtz-Zentrum Dresden-Rossendorf

Since photons only transfer small angular momenta, they are a well-suited probe to investigate dipole excitations in atomic nuclei [1]. Therefore, the (γ, γ') or also called Nuclear Resonance Fluorescence (NRF) technique is an established method to study among others the so-called Pygmy Dipole Resonance (PDR). The PDR occurs as a concentration of electric dipole strength around and below the neutron separation energy. For the last decades, this excitation mode has been a research topic of great interest [2,3] and further systematic studies are crucial. Due to its wide range of stable, even-even isotopes, the Nd isotopic chain is well suited for this purpose. Thus, two complementary (γ,γ') experiments on the rare-earth nucleus ^{144}Nd have been performed using a continuous bremsstrahlung beam at the γELBE facility [4] and utilizing quasimonoenergetic γ rays at HIγS [5]. First results of these experiments will be presented in this contribution.

This work is partly supported by the BMBF (05P21PKEN9).

[1] A. Zilges *et al.*, Prog. Part. Nucl. Phys. **122** (2022) 103903

[2] D. Savran *et al.*, Prog. Part. Nucl. Phys. **70** (2013) 210

[3] A. Bracco *et al.*, Prog. Part. Nucl. Phys. **106** (2019) 360

[4] R. Schwengner *et al.*, Nucl. Instr. and Meth. A **555** (2005) 211

[5] H.R. Weller *et al.*, Prog. Part. Nucl. Phys. **62** (2009) 257

HK 31.4 Wed 15:15 SCH/A118

Photoexcitation of ^{76}Ge — Ronald Schwengner[1], Konrad Schmidt[1], Kai Zuber[2], •Hans F. R. Hoffmann[2], Marie Pichotta[2], and Steffen Turkat[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, 01328 Dresden, Germany — [2]Institute of nuclear and particle physics, TU Dresden, 01069 Dresden, Germany

The dipole strength of the nuclide ^{76}Ge was studied in photon-scattering experiments using bremsstrahlung produced with electron beams of energies of 7.8 and 12.3 MeV which were delivered by the electron linear accelerator of high brilliance and high brightness (ELBE).

In total, 210 levels up to an excitation energy of 9.4 MeV were identified and a spin $J = 1$ was assigned to most of them. The quasi-continuum of unresolved transitions was included in the analysis of the spectra and the intensities of branching transitions were estimated on the basis of simulations of statistical γ-ray cascades. The photoabsorption cross section up to the neutron-separation energy was determined.

The experimental procedure and results will be discussed including some implication on ^{76}Ge $0\nu\beta\beta$ experiments.

HK 32: Structure and Dynamics of Nuclei VI

Time: Wednesday 14:00–15:30 Location: SCH/A215

HK 32.1 Wed 14:00 SCH/A215

Probing the $N = 152$ neutron shell closure by laser spectroscopy of fermium isotopes — •Jessica Warbinek for the Fermium-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung, Germany — Johannes Gutenberg-Universität Mainz, Germany

Determining the limits of existence of the heaviest nuclides is a forefront topic in nuclear-physics research. Nuclei in this region are stabilized by shell effects that retard spontaneous fission and feature properties distinctly different from those of lighter nuclei. Experimental information on the deformed shell closures around the heavy actinides like fermium (Fm, $Z = 100$) can help to benchmark state-of-the-art theoretical models to improve their predictive power in the range of the heaviest elements.

Laser spectroscopy serves as a powerful tool to extract experimental information on nuclear parameters such as the change in the mean-square charge radius and nuclear moments in a nuclear-model independent manner. Recent studies in fermium allowed the determination of the isotope shift in an atomic transition for a long chain of eight isotopes ranging from the accelerator-produced ^{245}Fm to reactor-bred ^{257}Fm. Direct and indirect production methods were combined and associated on-line and off-line measurement techniques significantly advanced to access isotopes spanning well across the known deformed shell gap at $N = 152$. Results on the extracted changes in the mean-square charge radii revealing a discontinuity around the neutron shell closure will be discussed.

HK 32.2 Wed 14:15 SCH/A215

Proton-neutron interaction strength studies via accurate mass measurements far from stability — •Gabriella Kripkó-Koncz for the FRS Ion Catcher-Collaboration — Justus-Liebig-Universität Gießen, Gießen, Germany — Tel Aviv University, Tel Aviv, Israel

The average interaction strength between the last (highest energy orbitals) proton(s) and neutron(s) in a nucleus (denoted as δV_{pn}), may be derived from differences of accurate atomic masses, and in turn point empirically to various aspects of nuclear structure and interactions. The FRS Ion Catcher experiment at the in-flight fragment separator FRS at GSI enables highly accurate direct mass measurements ($\delta m/m \sim 10^{-8}$) with thermalized projectile and fission fragments by combining a cryogenic stopping cell and a multiple-reflection time-of-flight mass spectrometer. Confirmed by mass measurements at the FRS Ion Catcher, the detailed structure of δV_{pn} along the $N = Z$, $N - Z = 2$, $N - Z = 4$ lines near the $Z = 29 - 37$ region has been investigated [1]. These studies will be presented and an analysis of mass measurements via higher-order mass-difference indicators, the deviations of which from their expected trends may indicate questionable mass values in the Atomic Mass Evaluation and highlight distinctive nuclear structure effects, will be motivated.

[1] I. Mardor et al., Phys. Rev. C 103, 034319 (2021)

HK 32.3 Wed 14:30 SCH/A215

The search for double alpha decay of ^{224}Ra at the FRS Ion Catcher — •Heinrich Wilsenach for the Double Alpha IN2P3-CEA-GSI-Collaboration — Justus-Liebig-Universität Gießen, Gießen, Germany — Tel Aviv University, Tel Aviv, Israel

Double alpha decay has been predicted since the 1980s. The most probable scenario for this decay mode is the simultaneous tunnelling of two alpha particles through the coulomb barrier and their emission in opposite directions. Recent theoretical studies [1] have predicted a back-to-back double alpha decay branching ratio for ^{224}Ra of 1.8×10^{-7}%.

A project to measure this small branching ratio has been performed at the FRS (FRagment Separator) Ion Catcher at Gesellschaft für Schwerionenforschung (GSI). This project utilized the thermalization of ^{228}Th alpha recoils in a cryogenic stopping cell (CSC) and the preparation of a clean beam of ^{224}Ra by a radio-frequency-quadrupole (RFQ) beamline. Two double-sided silicon strip detectors (DSSD) were used to read out each alpha particle's position, time and energy coming from the implanted ^{224}Ra.

This talk will give insight into the design and setup of the experiment, including Monte Carlo simulations. It will conclude with preliminary results from the first 135 day long data taking run.

[1] F. Mercier *et al.*, PRL 127, 012501 (2021)

HK 32.4 Wed 14:45 SCH/A215

Precise measurement of the nn scattering length using a new neutron detector — •Meytal Duer[1], Thomas Aumann[1,2,3], Dominic Rossi[1,2], and Marco Knösel[1] for the SAMURAI-Collaboration — [1]Technische Universität Darmstadt — [2]GSI Helmholtz-Zentrum für Schwerionenforschung — [3]Helmholtz Forschungsakademie Hessen für FAIR

An accurate knowledge of the nucleon-nucleon (NN) scattering lengths, characterize the NN interaction at low energies, is fundamental for nuclear physics. The NN interaction is not only basis for the description of nuclei as a many-body systems, but the difference on the nn and pp interaction is also an important measure of charge symmetry breaking. For the nn scattering length, however, there is a systematic and significant discrepancy between values extracted from several measurements.

In this talk a new method will be presented to determine the nn scattering length with high accuracy. The basic idea of the measurement, which will take place at the SAMURAI experimental setup at RIBF in Japan, is to use a knockout reaction in inverse kinematics to produce a localized two-neutron system. By measuring the nn relative-energy spectrum after the reaction, the value of the nn scattering length can be extracted. To achieve sufficient precision, a newly developed high-resolution neutron detector HIME has been constructed. This work is supported by the DFG, Project-ID 279384907 - SFB 1245.

HK 32.5 Wed 15:00 SCH/A215

Fission Isomers studies at the FRS — •Nazarena Tortorelli for the S530-Collaboration — Ludwig-Maximilians-University, Munich, Germany — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

The potential energy landscape in actinide nuclei ($Z = 92 - 97$, $N = 141 - 151$) shows a super-deformed second minimum. The ground state in this minimum is called a fission isomer, as it will preferably decay via isomeric (delayed) fission. So far 35 fission isomers with lifetimes between 5 ps and 14 ms have been observed using only direct reactions (like (d,pf)). At the FRS the fragmentation mechanism (i.e., the collision of a heavy relativistic beam on a light target) can be exploited to offer rapid production, hence access to isomers with short half-lives, and most importantly, highly pure fragmented beams and event-by-event identification. Recently, fission isomer studies have been made with the FRS at GSI, where a 1 GeV/u ^{238}U beam on a Be target was used. Different detection methods by implanting into a fast plastic scintillator and in the cryogenic stopping cell at the FRS Ion Catcher were used, and technical provisions have been implemented to cover a half-life range from about 50 ns to 50 ms. In this talk, the technical improvements as well as the status of the ongoing analysis will be presented. This work was supported by GSI R&D via LMTHI2023.

HK 32.6 Wed 15:15 SCH/A215

Study of the dipole response of ^{242}Pu with nuclear resonance fluorescence — •M. Beuschlein[1], J. Birkhan[1], J. Kleemann[1], O. Papst[1], N. Pietralla[1], R. Schwengner[2], S. Weiß[2], V. Werner[1], U. Ahmed[1], T. Beck[1,3], I. Brandherm[1], A. Gupta[1], J. Hauf[1], K. E. Ide[1], P. Koseoglou[1], H. Mayr[1], C.M. Nickel[1], K. Prifti[1], M. Singer[1], T. Stetz[1], and R. Zidarova[1] — [1]Institute for Nuclear Physics, TU Darmstadt, Germany — [2]HZDR, Dresden, Germany — [3]FRIB, MSU, East Lansing, MI, USA

Nuclear resonance fluorescence (NRF) of a sample of ^{242}Pu was studied at the Darmstadt High-Intensity Photon setup. The superconducting Darmstadt linear electron accelerator S-DALINAC was used to produce bremsstrahlung up to an endpoint energy of 3.7 MeV to irradiate a sample of PuO_2, which had a total mass of about 1 g. It was highly enriched in the isotope of interest ^{242}Pu and kept in a special target container. Photons were detected with two high-purity Germanium detectors placed at different angles relative to the beam axis. NRF signals from the sample were identified by comparison with measurements using an empty target container and measurements of the sample's radioactivity. Evidence for NRF signals from ^{242}Pu was observed. This makes this isotope the heaviest nuclide for which NRF information is available. Details of the experiment will be described and γ-ray spectra will be presented and discussed.

We thank the Institute of Resource Ecology of HZDR for providing the ^{242}Pu-sample. This work was supported by the LOEWE research project 'Nukleare Photonik' by the State of Hesse.

HK 33: Fundamental Symmetries I

Time: Wednesday 14:00–15:30 Location: SCH/A252

Group Report HK 33.1 Wed 14:00 SCH/A252

τSPECT - A fully magnetic gradient trap to measure the free neutron lifetime — •Martin Fertl for the tauSPECT-Collaboration — Institut für Physik, Johannes Gutenberg-Universität Mainz

The free neutron lifetime τ_n critically influences the primordial nucleosynthesis and is indispensible to perform a CKM-matrix unitarity test without nuclear structure corrections related to the extraction of V_{ud} from $0^+ \rightarrow 0^+$ nuclear transitions. The τSPECT collaboration has implemented a 3D magnetic field gradient trap for ultracold neutrons (UCN) with the aim to determine τ_n with a statistical sensitivity below 1 s, complementary to the precision obtained with the current state-of-the-art magneto-gravitational UCN traps. Spin-polarized UCN are loaded into the storage volume via a double-spin-flip sequence and counted after a preset storage time with an in-situ UCN detector. This report will introduce the concept, the implementation and results from the commissioning runs at the UCN source facility at TRIGA Mainz.

Group Report HK 33.2 Wed 14:30 SCH/A252

Degaussing of a Magnetically Shielded Room for the ^{3}He-^{129}Xe Comagnetometer Experiment in Heidelberg — •Benjamin Brauneis[1], Fabian Allmendinger[1], Werner Heil[2], and Ulrich Schmidt[1] — [1]Physikalisches Institut, Universität Heidelberg — [2]Institut für Physik, Universität Mainz

The permanent Electric Dipole Moment (EDM) of ^{129}Xenon is an experimentally accessible signal for potential sources of CP-violation not described by the Standard Model. It can be measured in a clock comparison experiment using a gas mixture of free spin precessing nuclear polarized ^{3}He and ^{129}Xe. To reach the desired accuracy this experiment has to be performed at low frequencies (few Hz) and therefore within a Magnetically Shielded Room (MSR). Furthermore, very small field gradients (pT per cm) are required in order to reach a sufficiently large spin coherence time. Our MSR consisting of three layers of Mu-metal and one layer of copper-plated aluminum was constructed in Heidelberg 2021. Efforts are made to develop an advanced degaussing routine yielding to reproducible low residual magnetic fields within the MSR. We report on the current status of preparation for next Xe-EDM measurements in Heidelberg with special focus on the degaussing procedure and the performance for our MSR.

HK 33.3 Wed 15:00 SCH/A252

Tracking of the spatial magnetic field distribution for the Fermilab Muon g−2 experiment — •Mohammad Ubaidullah Hassan Qureshi, René Reimann, and Martin Fertl for the Muon g–2-Collaboration — Institute of Physics and Excellence Cluster PRISMA+, Johannes Gutenberg University Mainz, 55099 Mainz, Germany

The Fermilab Muon g−2 experiment E989 aims to measure the anomalous magnetic moment of the muon to a precision of 140 ppb. This experiment consists of muons stored in a ring-shaped quasi-penning trap within a uniform magnetic field of 1.45 T. The measurement is composed of a ratio of two frequencies, the anomalous spin precession frequency of the muons (ω_a) and the muon-weighted spin precession frequency of protons ($\tilde{\omega}_p$). $\tilde{\omega}_p$ is fundamentally the measure of the magnetic field experienced by these precessing muons, we measure this magnetic field using nuclear magnetic resonance (NMR) based probe systems. In this talk, I will be reviewing two of the sub-systems of the magnetic field measurement chain, namely, the trolley probe and the fixed probe systems which measure the magnetic field periodically and continuously, respectively. This will be followed by an overview of the procedure for synchronising the measurements of the two sub-systems in time and the independent cross-check performed on the procedure for removing the trolley system's magnetic signature in the fixed probe system.

HK 33.4 Wed 15:15 SCH/A252

The Search for Electric Dipole Moments of Charged Particles in Storage Rings — •Achim Andres for the JEDI-Collaboration — Institute for Nuclear Physics IV, FZ Jülich, Germany — III. Physikalisches Institut B, RWTH Aachen University, Germany

The matter-antimatter asymmetry in the universe cannot be explained by the Standard Model of elementary particle physics. According to A. Sakharov CP violating phenomena are needed in order to understand the matter-antimatter asymmetry. Permanent Electric Dipole Moments (EDMs) of subatomic elementary particles violate both time reversal and parity asymmetries and therefore also violate CP if the CPT-theorem holds. Storage rings offer the possibility to measure EDMs of charged particles by observing the influence of the EDM on the spin motion. The Cooler Synchrotron (COSY) at Forschungszentrum Jülich provides polarized protons and deuterons up to a momenta of 3.7 GeV/c and is therefore an ideal starting point for the JEDI - Collaboration (Jülich Electric Dipole moment Investigations) to perform the first direct measurement of the deuteron EDM. During this talk, recent results of the first deuteron EDM measurements are presented.

HK 34: Instrumentation X

Time: Wednesday 15:45–17:15 Location: SCH/A251

Group Report HK 34.1 Wed 15:45 SCH/A251

Status of the CBM Micro Vertex Detector* — •Benedict Arnoldi-Meadows for the CBM-MVD-Collaboration — Goethe-Universität Frankfurt am Main

The Compressed Baryonic Matter (CBM) Experiment will be a core experiment of the future FAIR facility. Its Micro Vertex Detector (MVD) will be composed of four stations, operating in the experiment's target vacuum. The 0.3 – 0.5% X_0 thin stations will be equipped with 50 μm thin, highly granular Monolithic Active Pixel Sensors called MIMOSIS. MIMOSIS is being developed by IPHC Strasbourg and will provide a spatial and temporal precision of 5 μm and 5 μs, respectively, with a peak rate capability of 80 MHz/cm^2.

The first full-size prototype MIMOSIS-1 was intensely tested for in-beam performance, radiation tolerance and robustness to Single Event Effects. The results of the tests will be summarized and the implications for the next and final prototype MIMOSIS-2, which has been submitted, will be discussed. Moreover, a status of the efforts with regard to integration and cooling in vacuum towards the final MVD will be given.

*This work has been supported by BMBF (05P21RFFC2), GSI, Eurizon, HGS-HIRe, and HFHF.

HK 34.2 Wed 16:15 SCH/A251

Characterization of APTS, a MAPS prototype fabricated in 65 nm CMOS technology for the ALICE ITS3 upgrade — •David Schledewitz for the ALICE Germany-Collaboration — Physikalisches Institut, Universität Heidelberg — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt — European Organization for Nuclear Research (CERN), Geneva, Switzerland

For the next detector upgrade of the ALICE experiment, an extensive R&D program is carried out for the vertex detector to minimize the material budget and reduce the distance to the interaction point. From the currently installed ALICE Inner Tracking System (ITS2), the innermost three out of the seven layers of Monolithic Active Pixel sensors (MAPS) will be replaced. The proposed upgrade (ITS3) is based on curved, wafer-scale, ultra-thin silicon MAPS with a truly cylindrical geometry. The foreseen technology for this upgrade is the 65 nm CMOS imaging process by TowerJazz Panasonic Semiconductor Company, allowing the production of wafer-scale pixel sensors on 300 mm diameter wafers using stitching.

One of the current prototypes to evaluate the detection performance and radiation hardness of the technology is the Analog Pixel Test Structure (APTS). In particular, a set of 4 x 4 pixel matrices with parallel, analog readout realized in various geometries are used to characterize the parameter space of the technology. This contribution intends to provide an overview of the APTS, covering performance results from testbeam campaigns and laboratory measurements.

HK 34.3 Wed 16:30 SCH/A251

Characterisation of irradiated Digital Pixel Test Structures produced in 65 nm TPSCo CMOS process — •Pascal Becht for the ALICE Germany-Collaboration — Physikalisches Institut Universität Heidelberg

The future upgraded ALICE Inner Tracking System (ITS3) features wafer-scale, ultra-thin and truly cylindrical Monolithic Active Pixel Sensors (MAPS) as its innermost three layers around the beampipe. New sensors for this effort are intended to be produced in 65 nm CMOS technology in order to benefit from the smaller feature size and the larger commercially available wafers.

With the goal of qualifying this technology for the application in MAPS, an extensive R&D programme is ongoing. In view of a new pixel sensor for the ITS3, a Digital Pixel Test Structure (DPTS) has been designed and produced. Multiple of these prototypes are characterized in laboratory measurements and beam test campaigns at DESY and CERN. In order to evaluate the effects of radiation damage, some sensors have been neutron irradiated to different levels ranging from 10^{13} 1 MeV $n_{eq}cm^{-2}$ to 10^{16} 1 MeV $n_{eq}cm^{-2}$. Furthermore, several prototypes have been subject to an X-ray source and thereby received doses up to 100 kGy.

Detection efficiency and position resolution of the DPTS sensors are presented to characterize their performance. The outcome of these studies demonstrates the feasibility of the 65 nm CMOS technology for the application in future MAPS-based detectors.

HK 34.4 Wed 16:45 SCH/A251

ALPIDE Monolitic Active Pixel Sensors at GSI — •Martin Bajzek[1,2], Oleg Kiselev[1], Ivan Mukha[1], Christoph Scheidenberger[1,2], Luke Rose[3], Bastian Löher[1], and Andrea Jedele[1,4] for the R3B-Collaboration — [1]GSI, Darmstadt, Germany — [2]JLU, Gießen, Germany — [3]University of York, York, United Kingdom — [4]TU Darmstadt, Darmstadt, Germany

Precise particle tracking is important for complete kinematic reconstruction which gives insight into decay modes, cross-sections and excited states of exotic particles. In particular, tracking is important for the purpose of in-flight decay spectroscopy and particle identification.

We discuss the results of the on-going integration and adaptation of the ALPIDE Monolitic Active Pixel Sensors to be used for vertex reconstruction and tracking of charged particles in nuclear physics experiment at R3B and Super-FRS EC at GSI. This work was supported by GSI Erasmus scholarship.

HK 34.5 Wed 17:00 SCH/A251

Simulation studies for the Forward Conversion Tracker of ALICE 3 in run 5 — •Casper van Veen for the ALICE Germany-Collaboration — Physikalisches Institut Heidelberg, Heidelberg, Germany

During the Long Shutdown 4 of the LHC (LS4), the ALICE experiment will be upgraded to ALICE 3. Along with an advanced silicon-based tracking system placed closer to the interaction point, ALICE 3 will also come equipped with a Forward Conversion Tracker (FCT) which will measure the transverse momentum of soft photons in the forward direction. In the soft photon regime, the bremsstrahlung spectrum can be computed in a model- and process-independent way by Low*s theorem. Most previous experiments have observed a soft photon excess on top of what is expected by Low*s theorem, but some did not observe this excess at all. This makes the experimental status of the existence of the excess unclear. The FCT, an array of silicon layers, will provide a way to measure these photons via the photon conversion method. The FCT will be provided with an unprecedented position resolution from these silicon trackers which should result in a very clean photon identification.

This talk will give an overview of the current studies of the FCT and provide an overview of the upcoming challenges.

HK 35: Instrumentation XI

Time: Wednesday 15:45–17:00 Location: SCH/A.101

Group Report HK 35.1 Wed 15:45 SCH/A.101

MAGIX group report — •Pepe Gülker for the MAGIX-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität, Mainz, Germany

The versatile, low energy electron scattering experiment MAGIX, located in Mainz at the new MESA accelerator, has switched gears and entered the construction phase. The design of the main components, e.g. the two magnetic spectrometers, their small-drift focal plane TPCs and the trigger-veto system, are fixed and production has already started.

The broad physics program, ranging from rare particle searches to electro-disintegration measurements, is scheduled according to the increasing energy and availability of the energy-recovering mode of the accelerator.

This group report will redraw the design process of the whole experiment, give an overview of finalized parameters and discuss the planned measurement campaign.

Group Report HK 35.2 Wed 16:15 SCH/A.101

Status of the CBM Time-of-Flight project — •Ingo Deppner and Norbert Herrmann for the CBM-Collaboration — Physikalisches Institut, Uni. Heidelberg

In order to provide an excellent particle identification (PID) of charged hadrons at the future high-rate Compressed Baryonic Matter (CBM) experiment the CBM-TOF group has developed a concept of a 120 m^2 large Time-of-Flight (ToF) wall (with 93000 channels) with a system time resolution below 80 ps based on Multi-gap Resistive Plate Chambers (MRPC). The MRPC detectors were extensively tested in several beam campaigns at particle fluxes of up to a 30 kHz/cm^2 and reached by now the close to final design. Prior to its destined operation at the Facility for Antiproton and Ion Research (FAIR), a preproduction series of MRPCs is being used for physics research at two scientific pillars of the FAIR Phase0 program. At STAR, the fixed-target program of the Beam Energy Scan II (BES-II) relies on 108 CBM MRPC detectors enabling forward PID for center of mass energies in the range of 3 to 7.7 AGeV Au+Au collisions. At mCBM, high-performance benchmark runs of Λ production at top SIS18 energies (1.5/1.9 AGeV for Au/Ni beams) and CBM design interaction rates of 10 MHz became feasible. Apart from the physics perspectives, these FAIR Phase-0 involvements allowed for high rate detector tests and long term stability tests. Observations and conclusions for the upcoming mass production will be discussed. The project is partially funded by BMBF contract 05P21VHFC1.

HK 35.3 Wed 16:45 SCH/A.101

The Endcap-Time-Of-Flight Detector at STAR and its implications for the CBM Time-Of-Flight-Wall — •Yannick Söhngen for the CBM-Collaboration — Physikalisches Institut Universität Heidelberg

The Endcap-Time-Of-Flight Detector (ETOF) at STAR was build with 108 MRPCs designed for the CBM Time-Of-Flight-Wall and successfully operated during the Beam-Energy-Scan II (BESII) from 2018 onwards. Its status in terms of operation, data acquisition and calibration will be presented and the conclusions that could be drawn for the design of the CBM Time-Of-Flight-Wall will be discussed.

HK 36: Computing I

Time: Wednesday 15:45–17:15 Location: SCH/A117

HK 36.1 Wed 15:45 SCH/A117

ALICE TRD: online-offline processing and electron identification in LHC Run 3 and 4 — •Felix Schlepper — Physikalisches Institut, Heidelberg, Deutschland

During the long shutdown 2 (LS2) of the LHC, the ALICE experiment was upgraded to exploit the full scientific potential. The upgrade was posed by the challenge of continuously reading out and online processing p-p and Pb-Pb collisions at rates of 1 MHz and 50 kHz, respectively. To meet these new requirements, the ALICE experiment developed a new online-offline software framework O2 for Run 3 and 4.

This talk will give an overview of the software, the calibration and particle identification (PID) strategies currently being implemented and commissioned for the Transition Radiation Detector (TRD). The TRD contributes to the electron identification capabilities of ALICE. In Run 1 and 2 a classical likelihood-based algorithm was used. Since the front end electronics (FEE) was upgraded, the data readout precision was notably reduced to cope with the higher rates. Hence, new algorithms for PID, including Machine Learning, will be used to recover and possibly improve the previous PID capabilities. First performance results will be shown as well.

HK 36.2 Wed 16:00 SCH/A117

Volunteer Computing for ALICE at CERN — •Felix Hoffmann and Udo Kebschull — Goethe Universität Frankfurt

The High Luminosity LHC era at CERN will require Monte Carlo simulations to be at an even higher level of accuracy in order for them be suited for tasks such as background subtraction and filtering of rare events. In order to be able to keep up with the required amount of computational power, distributed computing approaches such as the Worldwide LHC Computing Grid (WLCG) are combined with other measures such as frequent hardware upgrades.

This publication explores ideas of novel volunteer computing frameworks in the context of ALICE which aim to allow people from all around the world to donate available computational power to further help the experiment. In this publication, two fundamentally different approaches are described and their potential analyzed: The first approach is a traditional volunteer computing approach that builds on existing BOINC infrastructure. The second approach is blockchain-based and features a novel Proof-of-Useful-Work consensus algorithm which aims to both support real-world HEP experiments with the production of required MC data and to secure the underlying blockchain infrastructure at the same time. A prototype implementation of such an algorithm in the context of the Online-Offline simulation and analysis framework ALICE uses for Run 3 is currently being developed in C++.

HK 36.3 Wed 16:15 SCH/A117

Searching for Anomalous Hadronic Higgs Boson Decays at the LHeC — Subhasish Behera, •Manuel Hagelüken, and Matthias Schott — Johannes Gutenberg-Universität Mainz

The future Large Hadron electron Collider (LHeC) would allow collisions of an intense electron beam with protons or heavy ions at the High Luminosity-Large Hadron Collider (HL-LHC). Owing to a center of mass energy greater than a TeV and very high luminosity, the LHeC would not only be a new generation collider for deep-inelastic scattering (DIS) but also an important facility for precision Higgs physics, complementary to pp and electron-positron colliders. While anomalous hadronic decay signatures of the Higgs boson, e.g. to three or more partons, are difficult to probe at the LHC due to its enormous background rates, it might be possible to search for such decays at the LHeC. In this work, we present the expected sensitivity at the LHeC for $H \rightarrow 3jets$ and $H \rightarrow 4jets$ decay channels, assumed an integrated luminosity of 1ab^{-1}.

HK 36.4 Wed 16:30 SCH/A117

A language model based tracking algorithm for the Straw Tube Tracker of the PANDA experiment — •Jakapat Kannika[1,2], James Ritman[1,2,3], and Tobias Stockmanns[3] — [1]GSI Helmholtz Centre for Heavy Ion Research, Darmstadt, Germany — [2]Ruhr-Universität Bochum, Bochum, Germany — [3]Forschungszentrum Jülich, Jülich, Germany

The Straw Tube Tracker (STT) is designed for momentum reconstruction of charged particles in the PANDA experiment. This talk will present a tracking algorithm that can group measured hit positions of the STT into tracks of the particles based on the language model. The overall algorithm consists of two main parts, the language model which contains the probabilities for predicting the next hit point based on previous measurements, and the tracking algorithm, the program that uses the information from the language model to select the most probable track or filter possible track candidates. We performed track parameterizations perpendicular and parallel to the solenoidal magnetic field and compared the reconstructed tracks to the MC truth information. As a result, all the reconstructed parameters are shown to be reconstructed within the expected ranges according to the MC information. The algorithm is also being developed to include a branching algorithm that can select the best track out of multiple track candidates. The development involves improving the quality of hit information and creating a track selector. The talk will also present the efficiency and resolution of this algorithm to reconstruct tracks in the STT.

HK 36.5 Wed 16:45 SCH/A117

Implementation of the Acts tracking software into PandaRoot — •Ken Suzuki for the PANDA collaboration — Ruhr-Universität Bochun, Bochum, Germany — GSI Helmholtzzentrum für Schwerionenforschung GmbH

The PANDA experiment at FAIR[1] combines the stored high-precision antiproton beam from the HESR with a hydrogen/nuclear target from cluster-jet/pellet target and 4π universal detector system equipped with a modern high-rate DAQ. The unique setup allows it to provide precision data to low/middle energy hadron structures where the experimental inputs are mostly awaited. We test the Acts Common Tracking Software[2] for particle track reconstruction as an alternative to be implemented to our analysis framework, PandaRoot. We will show the status of implementation and performance comparison to our current version using Genfit.

[1] PANDA collaboration, Eur. Phys. J. A 57, 184 (2021).
[2] https://acts.readthedocs.io .

HK 36.6 Wed 17:00 SCH/A117

Dynamically assisted nuclear fusion — •Daniil Ryndyk — Helmholtz-Zentrum Dresden-Rossendorf

We consider nuclear fusion at kinetic energies in the keV regime. At such low temperatures nuclear fusion is exponentially suppressed as it occurs via quantum tunneling through the Coulomb barrier between the nuclei. Our research goal is to increase the overall tunneling probability employing short-pulsed, high-intensity electromagnetic fields thus avoiding the negative aspects of hot plasmas, e.g., heat loss.

Latest publications:

F. Queisser and R. Schützhold, PRC, 100(4), 2019
C. Kohlfürst, F. Queisser and R. Schützhold, PRR, 3:033153, 2021

HK 37: Heavy-Ion Collisions and QCD Phases VII

Time: Wednesday 15:45–17:15 Location: SCH/A216

HK 37.1 Wed 15:45 SCH/A216

Anisotropic flow generation with $\eta/s(T, \mu_B)$ in a hybrid approach — •Niklas Götz[1,2], Lucas Constantin[1], and Hannah Elfner[3,1,2,4] — [1]Institute for Theoretical Physics, Goethe University, Max-von-Laue-Strasse 1, 60438 Frankfurt am Main, Germany — [2]Frankfurt Institute for Advanced Studies, Ruth-Moufang-Strasse 1, 60438 Frankfurt am Main, Germany — [3]Helmholtz Research Academy Hesse for FAIR (HFHF), GSI Helmholtz Center, Campus Frankfurt, Max-von- Laue-Straße 12, 60438 Frankfurt am Main, Germany — [4]GSI Helmholtzzentrum für Schwerionenforschung, Planckstr. 1, 64291 Darmstadt, Germany

In this work, the origin of anisotropic flow in hybrid approaches, combining different initial conditions, viscous relativistic hydrodynamics as well as hadronic transport, is studied. Previous works largely disregard a non-constant $\eta/s(\mu_B)$ and focus mainly on a temperature dependence. Here instead, we study qualitatively the effect of a generalized $\eta/s(T, \mu_B)$ in the hybrid approach SMASH-vHLLE-hybrid. The parameterization takes into account the constraints of matching to the transport coefficients in the hadronic phase and recent Bayesian analysis results. In addition, we quantify the uncertainty due to different initial state profiles, including the SMASH initial conditions as well as TRENTo and IP-Glasma profiles. In order to investigate their interplay with the size of the transport coefficients and anisotropic flows as well as the impact of different initial state eccentricities, we compare the results with different inital conditions at $\sqrt{s_{NN}}$=200 GeV.

HK 37.2 Wed 16:00 SCH/A216

Flow Measurements of Λ, K_s^0 and K^+ in $\sqrt{s_{NN}}$ = 2.55 GeV Ag+Ag Collisions with HADES — •Tan Lu for the HADES-Collaboration — Institute of Modern Physics, Chinese Academy of Sciences — GSI Helmholtzzentrum für Schwerionenforschung GmbH

The collective motion of particles (flow) is driven by pressure gradients in fireballs created in heavy-ion collisions and shows patterns that reflect properties of the nuclear matter equation of states of QCD matter under extreme conditions. Due to its high rate capability the High-Acceptance Di-Electron Spectrometer (HADES) provides excellent conditions to study the flow patterns of the rarely produced strange hadrons. Since the strange hadrons are produced near to the free NN threshold at SIS18 beam energies, they are expected to be particularly sensitive to the in-medium potential.

In this talk, we report the measurements of directed and elliptic flow of Λ, K_s^0 and K^+ from $\sqrt{s_{NN}}$ =2.55 GeV Ag+Ag collisions. The dependence on collision centrality, rapidity and transverse momentum of the measured collectivity will compared to results from microscopic transport model calculations.

HK 37.3 Wed 16:15 SCH/A216

New publications on higher-order flow observables in ALICE — •Ante Bilandzic, Farid Taghavi, Marcel Lesch, and Anton Riedel for the ALICE Germany-Collaboration — Technical University of Munich

In this contribution, the results from the two new publications on higher-order flow observables in ALICE are presented.

The newly developed Gaussian Estimator for correlations between symmetry planes, which characterize the direction of the anisotropic emission of produced particles, is measured in Pb-Pb collisions with ALICE. This allows for the first time the study of these quantities without the influence of correlations between different flow amplitudes, and therefore the extraction of unique and independent information about initial conditions and properties of Quark-Gluon Plasma from symmetry plane correlations.

In the second publication, the correlations between different moments of two flow amplitudes are measured for the first time with the recently developed asymmetric cumulants, which generalize the previous studies using symmetric cumulants of flow amplitudes.

For both sets of observables, comparison to state-of-the-art hydrodynamic model calculations is presented.

This project has received funding from the European Research Council (ERC) under the European Unions Horizon182020 research and innovation programme (grant agreement No 759257). Fundedf by BMBF Verbundforschung (05P21WOCA1 ALICE).

HK 37.4 Wed 16:30 SCH/A216

Bayesian analysis by using higher-order flow measurements at the LHC — •Seyed Farid Taghavi[1], Jasper Parkkila[2], Anna Onnerstad[3], Cindy Mordasini[4], Maxim Virta[5], Ante Bilandzic[6], and DongJo Kim[7] for the ALICE Germany-Collaboration — [1]Technische Universität München, Munich, Germany — [2]CERN, Experimental Physics Department, Geneva, Switzerland — [3]University of Jyväskylä, University of Jyväskylä, Finland — [4]University of Jyväskylä, University of Jyväskylä, Finland — [5]University of Jyväskylä, University of Jyväskylä, Finland — [6]Technische Universität München, Munich, Germany — [7]University of Jyväskylä, University of Jyväskylä, Finland

As a consequence of the theoretical improvements and a wide range of accurate experimental measurements, our understanding of the collective phenomena in heavy-ion collisions has advanced significantly over the past years. The Global Bayesian analysis has a substantial role in this advancement. In this talk, we present a global Bayesian analysis to infer the transport properties of QGP using the latest CERN Large Hadron Collider Pb-Pb data at $\sqrt{s_{\rm NN}}$=2.76 and 5.02 TeV. We show that including the latest multi-harmonic flow measurements significantly improves the uncertainties of the inferred specific shear and bulk viscosities. This observation shows the necessity of accurate measurements of collective flow observables in the future. Based on: PLB., 835 (2022) 137485. Funded by BMBF Verbundforschung (05P21WOCA1 ALICE), ERC European Unions Horizon 2020 (No. 759257), Academy of Finland, the Centre of Excellence in Quark Matter (No. 346324).

HK 37.5 Wed 16:45 SCH/A216

Emission of abundant hadrons from Au+Au Collisions at $\sqrt{s_{NN}}$ = 2.42 GeV with HADES — •Simon Spies for the HADES-Collaboration — Goethe-Universität Frankfurt

In April 2012 we recorded 7.3×10^9 Au(1.23A GeV)+Au events with the HADES detector located at the *GSI Helmholtzzentrum für Schwerionenforschung* in Darmstadt, Germany. Based on these data the emission/production of protons, light nuclei, pions, hyperons and strange mesons have been studied as a function of transverse momentum/mass, rapidity and centrality, yielding the most precise data set on hadron emission currently available at this energy. In this contribution we discuss the challenges in confronting experimental data with predictions from various state-of-the-art transport models and present first preliminary results. These are put in context with available world data from other collaborations.

This work has been supported by the State of Hesse within the Research Cluster ELEMENTS (Project ID 500/10.006).

HK 37.6 Wed 17:00 SCH/A216

Quasi-deuterons as surrogate for two-particle correlations in nuclear matter — •Stefan Typel[1,2] and Stefano Burrello[3] — [1]TU Darmstadt, Germany — [2]GSI, Darmstadt, Germany — [3]LNS-INFN, Catania, Italy

Properties of dense nuclear matter are often described using energy density functionals with nucleons as degrees of freedom and effective phenomenological interactions. They usually lack in an explicit treatment of correlations that are responsible for the formation of nuclear clusters at sub-saturation densities. Two-body correlations are also essential to explain the high-momentum tails of single-particle momentum distributions that are deduced from two-nucleon knockout experiments with energetic electrons or hadronic probes. In this contribution, the concept of quasi-deuterons in nuclear matter is introduced in a relativistic density functional to effectively describe two-nucleon correlations in dense nuclear matter above saturation. It extends the description of clustering in dilute nuclear matter using the concept of medium-dependent mass shifts.

HK 38: Heavy-Ion Collisions and QCD Phases VIII

Time: Wednesday 15:45–17:15 Location: SCH/A315

HK 38.1 Wed 15:45 SCH/A315

Critical dynamics in the real-time functional renormalization group — •Johannes Roth[1], Leon Sieke[1], and Lorenz von Smekal[1,2] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität, 35392 Giessen, Germany — [2]Helmholtz Research Academy Hesse for FAIR (HFHF), Campus Giessen, 35392 Giessen, Germany

Real-time quantities such as spectral functions and transport coefficients can serve to examine the real-time evolution of a system close to equilibrium, as they encode the possible excitations in the medium and show universal static and dynamic scaling behavior near a critical point. The functional renormalization group (FRG) formulated on the Schwinger-Keldysh closed-time path provides an excellent calculational tool for such real-time correlations [1]. In this talk I will present a novel approach for the systematic construction of causal regulators for the FRG, which comply with the analytic structure of the propagators, and demonstrate that they can be interpreted as a coupling to a fictitious external heat bath with FRG scale dependent spectral distribution. As particular applications, I will discuss the relaxational Models A, B, and C according to the classification scheme by Halperin and Hohenberg, and show how they can be implemented in the real-time FRG. With this setup, I will then present results which demonstrate the generation of dynamic scaling behavior in spectral functions obtained from one and two-loop self-consistent truncation schemes.

[1] J. V. Roth, D. Schweitzer, L. J. Sieke, L. von Smekal, Phys. Rev. D **105** (2022) 116017.

HK 38.2 Wed 16:00 SCH/A315

A novel saturation-based 3+1D initial state model for Heavy Ion Collisions — •Oscar Garcia-Montero[1], Sören Schlichting[1], and Hannah Elfner[2] — [1]Fakultät für Physik, Universität Bielefeld — [2]GSI Helmholtzzentrum für Schwerionenforschung

We present a new 3+1D resolved model for the initial state of ultrarelativistic Heavy-Ion collisions, based on the $k_\perp$-factorized Color Glass Condensate hybrid approach. This new model responds to the need for a rapidity-resolved initial-state Monte Carlo event generator which can deposit the relevant conserved charges (energy, charge and baryon densities) both in the midrapidity and forward/backward regions of the collision. This event-by-event generator computes the gluon and (anti-) quark phase-space densities using the IP-Sat model, from where the relevant conserved charges can be computed directly. In the present work we have included the leading order contributions to the light flavor parton densities. As a feature, the model can be systematically improved in the future by adding next-to-leading order calculations (in the CGC hybrid framework), and extended to lower energies by including sub-eikonal corrections the channels included. We present relevant observables, such as the eccentricities and flow decorrelation, as tests of this new approach.

HK 38.3 Wed 16:15 SCH/A315

Extending the fluid dynamic description of heavy-ions collisions to times before the collision — •Andreas Kirchner[1], Federica Capellino[2], Alaric Erschfeld[3], Stefan Floerchinger[3], and Eduardo Grossi[4] — [1]ITP Heidelberg — [2]University Heidelberg — [3]TPI Jena — [4]Dipartimento di fisica e astronomia, Universita di Firenze and INFN Sezione di Firenze

It is well established that the late states of a high energy nuclear collision can be described in terms of relativistic fluid dynamics. An open problem in this context is how the actual collision and the early time dynamics directly after it can be described. Phenomenological models are currently employed here and they have several parameters that need to be fitted to experimental data. Using relativistic fluid dynamics of second order we develop a new approach which addresses the entire collision event, and which gets initialized in fact already before the collision. This is based on the droplet model for the incoming nuclei and a state-the-art equation of state including the first-order liquid-gas phase transition. The physics picture we propose assumes that the soft features of a high energy nuclear collision can be fully described through the dynamics of the energy-momentum tensor and other conserved currents.

This work is part of and supported by the DFG Collaborative Research Centre "SFB 1225 (ISOQUANT)".

HK 38.4 Wed 16:30 SCH/A315

Correlations in a Moat Regime — •Fabian Rennecke — Institut für Theoretische Physik, Justus-Liebig-Universität Giessen

The QCD phase diagram at large chemical potential is largely uncharted territory. Based on model studies, there are various phases that could occur in this regime. Among them are phases related to spatial modulations, such as inhomogeneous/crystalline phases, liquid crystals or a quantum pion liquid. A common feature of all these phases is that particles can have a moat dispersion, where the energy is minimized at nonzero momentum. This can directly affect particle production in the medium created by a heavy-ion collision and leads to characteristic signatures in particle correlations. I will discuss the underlying physics and present a formalism to study particle spectra on general hypersurfaces. Using this formalism, I will show that the correlations generated by the Hanbury-Brown–Twiss effect are promising probes for a moat regime in heavy-ion collisions.

HK 38.5 Wed 16:45 SCH/A315

Search for QCD Instantons with the ATLAS Detector — •Radek Vavricka and Matthias Schott for the ATLAS-Collaboration — Johannes Gutenberg University Mainz

The Standard Model of particle physics predicts the existence of quantum tunnelling processes across topological inequivalent vacua, known as Instantons. In the*electroweak sector, instantons provide a source of baryon asymmetry within the Standard Model. In Quantum Chromodynamics they are linked to chiral symmetry*breaking and confinement. So far, no direct experimental evidence of instanton-induced processes has been found. Recently, new calculations for QCD Instanton processes in proton-proton collisions became public, suggesting promising experimental signatures at the LHC. In this work, we give an update on the ongoing searches for instanton signatures with the ATLAS Detector.

HK 38.6 Wed 17:00 SCH/A315

Fate of critical fluctuations in an interacting hadronic medium — •Jan Hammelmann[1], Marcus Bluhm[2], Marlene Nahrgang[2], and Hannah Elfner[3,1] — [1]Frankfurt Institute for Advanced Studies (FIAS) — [2]SUBATECH UMR 6457 — [3]GSI Helmholtzzentrum für Schwerionenforschung

We study the evolution of critical fluctuations in an expanding system within a hadronic transport approach. The system is initialized with particle number distributions coupled to the critical mode and the hadron gas then evolves in time with realistic hadronic interactions.

The initialization of the system with critical fluctuations is achieved by coupling the ideal hadron resonance gas cumulants to the ones from the 3d Ising model and generating the net and total particle numbers from the maximum entropy probability distribution.

We systematically investigate the evolution of the critical fluctuations initialized at various temperatures and chemical potentials along a freeze-out line and the dependency of the final state cumulants as a function of $\sqrt{s}$ is presented. Additionally, the sets of particles which are coupled to the critical mode are modified such that the strength of the propagation of correlations through interactions can be assessed. We find that in the scaling region of the critical point correlations are propagated through the whole collisional history and are still present after the kinetic freeze-out of the matter.

HK 39: Hadron Structure and Spectroscopy IV

Time: Wednesday 15:45–17:15 Location: SCH/A316

Group Report HK 39.1 Wed 15:45 SCH/A316

The BGOOD experiment at ELSA - exotic structures in the light quark sector? — •Thomas Jude for the BGOOD-Collaboration — Physikalisches Institut, Universität Bonn

The discoveries of the pentaquark states and XYZ mesons in the charmed quark sector initiated a new epoch in hadron physics, where the existence of exotic multi-quark states beyond the conventional three and two quark systems has been unambiguously realised. Similar structure may be evidenced in the light, uds sector, where access to a low momentum exchange and forward meson production region is crucial to study such phenomena. The BGOOD photoproduction experiment is uniquely designed to explore this kinematic region; it is comprised of a central calorimeter complemented by a magnetic spectrometer in forward directions.

Highlighted results include the indication of a peak-like structure in the $\gamma n \to K^0\Sigma^0$ cross section consistent with a meson-baryon interaction model which predicted the charmed P_C states. The same $K^*\Sigma$ molecular nature of this proposed $N^*(2030)$ is also supported in our measurement of $\gamma p \to K^+\Lambda(1405) \to K^+\pi^0\Sigma^0$, where it is predicted to drive a triangle singularity mechanism. In the non-strange sector, coherent meson photoproduction off the deuteron enables access to proposed dibaryon states, including the recently discovered $d^*(2380)$. Results will be presented which support recent experimental claims of higher mass isoscalar and isovector dibaryons.

Supported by DFG projects 388979758/405882627 and the European Union's Horizon 2020 programme, grant 824093.

HK 39.2 Wed 16:15 SCH/A316

Acceptance studies with pseudo data of the diffractive reaction $\pi^- + p \to a_2^-(1320)(\to \eta\pi) + p$ at COMPASS — •David Spülbeck, Henri Pekeler, and Bernhard Ketzer for the COMPASS-Collaboration — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

The COMPASS collaboration has recorded large data samples of diffractively produced final states with a 190 GeV hadron beam. First analyses of the final states $\eta^{(\prime)}\pi^-$ showed that these are golden channels to investigate the spin-exotic hybrid candidate $\pi_1(1600)$ experimentally.

For a successful partial-wave decomposition of the data using an extended likelihood fit, acceptance effects have to be corrected for. The presence of both charged and neutral particles in these final states makes a very good understanding of the full apparatus mandatory for a reliable acceptance correction. Wrong or missing acceptance corrections would lead to artifacts in the partial-wave decomposition and hence to possibly wrong conclusions.

In our ongoing analyses of the $\eta^{(\prime)}\pi^-$ final states, we use GEANT4-based Monte Carlo software to simulate the acceptance of our apparatus. To test its performance independently from any fit, we compare the kinematic distributions of real data and pseudo data for the almost isolated resonance $a_2^-(1320)$ decaying into $\eta(\to \pi^-\pi^+\pi^0(\gamma\gamma))\pi^-$ that have been accepted by our detector simulation.

Supported by BMBF.

HK 39.3 Wed 16:30 SCH/A316

Search for exotic states in η_c decays at BESIII — •Anja Brüggemann[1], Salleh Ahmed[1], Nils Hüsken[2], Nikolai in der Wiesche[1], Hannah Neuwirth[1], Ann-Christin Schluse[1], Anna Theimann[1], Frederik Weidner[1], and Alfons Khoukaz[1] for the BESIII-Collaboration — [1]Westfälische Wilhelms-Universität Münster, Germany — [2]Johannes Gutenberg-Universität Mainz, Germany

The BESIII detector at the e^+e^- collider BEPCII in Beijing, China, provides the world's largest data sample of the charmonium J/ψ with more than 10 billion events taken from 2009 to 2019.

Resulting from the radiative J/ψ decay into $\gamma\eta_c$ we analyse the reactions $\eta_c \to \eta' hh$, where the hh system represents the K^+K^-, K_SK_S, $\pi^+\pi^-$, $\pi^0\pi^0$, $\eta\eta$ and $2\pi^+2\pi^-$ systems. Since the majority of these η_c decay modes are still unlisted in the particle data group database we determine the corresponding branching ratios. Furthermore, since these mesonic η_c decays constitute a gluon-rich environment they offer the opportunity to investigate possible exotic content in hh intermediate states, that lie in the mass region below 2 GeV/c^2, where the lightest glueball is predicted.

Incorporating all analysed η_c decay modes our study is based on a combined partial wave analysis approach, which gives access to the partial decay widths of contributing resonances decaying into the hh subsystems. These widths are directly comparable to theory predictions, that assume glueball admixtures carried by certain isoscalar scalar resonances. The current status of the analysis will be presented.

This work is funded by DFG - 269952272, 271236083 and 443159800.

HK 39.4 Wed 16:45 SCH/A316

Study of $e^+e^- \to K^+K^-\pi^+\pi^-\pi^+\pi^-$ at BESIII — •Sebastian Coen — Ruhr-Universität Bochum, Institut für Experimentalphysik I, 44801 Bochum

The BESIII experiment at the symmetric electron-positron collider BEPCII in Beijing has recorded large data samples at center of mass energies between 2.0 GeV and 4.9 GeV. This offers good opportunities for the spectroscopy of both charm and light hadrons. In the accessible mass range recent lattice QCD calculations predict a rich spectrum of glueball states.

In the reaction $e^+e^- \to K^+K^-\pi^+\pi^-\pi^+\pi^-$ at center of mass energies between 4.0 GeV and 4.9 GeV the production and decay of light mesons as well as the vector glueball, predicted at a mass of about 3.8 GeV/c^2 can be studied. Preliminary results and future prospects of the study will be presented.

Supported by DFG (CRC 110 / NSFC-DFG).

HK 39.5 Wed 17:00 SCH/A316

$K_S^0\Sigma^0$ photoproduction at the BGOOD experiment — •Adrian Sonnenschein and Katrin Kohl for the BGOOD-Collaboration — Physikalisches Institut, Nussallee 12, D-53115 Bonn

The BGOOD experiment at the ELSA accelerator facility uses an energy tagged bremsstrahlung photon beam to investigate hadronic excitations in meson photoproduction.

The associated photoproduction of K_S^0 and hyperons is of particular interest. A cusp-like structure observed in the $\gamma p \to K_S^0\Sigma^+$ reaction at the K^* threshold is described by models including multi-quark resonances through dynamically generated vector meson-baryon interactions. This is the same model which predicted the P_C pentaquark states observed at LHCb through D^*-Σ_c interactions. In analogy, in the s-quark sector a peak like structure in $K_S^0\Sigma^0$ photoproduction off the neutron is predicted, associated with a K^*-Σ type configuration.

The reaction $\gamma n \to K_S^0\Sigma^0$ has been measured at BGOOD from threshold to a beam energy of 2600 MeV. In this talk results will be presented using updated analysis techniques and improved statistical precision.

*Supported by DFG projects 388979758/405882627 and the European Union's Horizon 2020 programme, grant 824093.

HK 40: Nuclear Astrophysics IV

Time: Wednesday 15:45–17:00 Location: SCH/A419

Group Report HK 40.1 Wed 15:45 SCH/A419

Nuclear astrophysics deep underground at LUNA and LUNA-MV — •Eliana Masha, Daniel Bemmerer, and Axel Boeltzig for the LUNA-Collaboration — Helmholtz-Zentrum Dresden-Rossendorf (HZDR), 01328 Dresden, Germany

A precise knowledge of the cross sections of astrophysically relevant nuclear reactions is needed for understanding energy generation inside stars and the creation of the chemical elements. In stars, nuclear reactions take place at energies well below the repulsive Coulomb barrier. Hence, their cross-sections are often too small to be measured in laboratories at the Earth's surface, where the signal would be lost in the cosmic-ray-induced background. An efficient way to reduce the cosmic-ray-induced background is to perform experiments in underground laboratories. The Laboratory for Underground Nuclear Astrophysics (LUNA) is located deep underground at Gran Sasso National Laboratories (Italy). The reduced background achieved at LUNA allows to measure the nuclear cross sections directly at the relevant astrophysical energies. The presentation will give an overview of the recent results achieved at LUNA, and future perspectives on the LUNA experiment, including the new 3.5 MV LUNA-MV accelerator.

HK 40.2 Wed 16:15 SCH/A419

Low-background radioactivity counting at the most sensitive HPGe detector in Germany — •Steffen Turkat[1], Daniel Bemmerer[2], Axel Boeltzig[2], Jonas Koch[1,2], Till Lossin[1,2], Max Osswald[1,2], Konrad Schmidt[2], and Kai Zuber[1] — [1]Institut für Kern- und Teilchenphysik, TU Dresden, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

The contribution reports about the commissioning of an ultra low-level γ-ray counting setup in the shallow-underground laboratory Felsenkeller in Dresden, Germany. It includes a high-purity germanium detector of 163 % relative efficiency within passive and active shields. The passive shield consists of 45 m rock overburden (140 meters water equivalent), 40 cm of low-activity concrete, 15 cm of high purity lead, 10 cm of oxygen-free radiopure copper, and an anti-radon box. The active veto is given by five large plastic scintillation panels surrounding the setup. All together, these shieldings attenuate the remaining background rate down to $116(1)\,\mathrm{kg}^{-1}\mathrm{d}^{-1}$ in an energy interval of [40 keV;2700 keV]. This is the lowest background of any HPGe detector in Germany, among the lowest worldwide, and enables studies of samples well below 1 mBq. In addition to the design of the setup, the underlying analysis techniques will be presented.

HK 40.3 Wed 16:30 SCH/A419

The new gas target system at the shallow underground laboratory Felsenkeller Dresden — •Anup Yadav, Konrad Schmidt, and Daniel Bemmerer — Helmholtz-Zentrum Dresden-Rossendorf

In experimental nuclear astrophysics, reaction studies with low cross sections are of interest. To measure those reactions directly, feasible possibilities include underground facilities to shield against cosmic rays and hence reduce the detector background, high intensity ion beams, and highly pure and stable targets. All those features will be available at the currently constructed und tested gas target setup for the shallow underground laboratory Felsenkeller Dresden. This setup combines a highly localized gas wall jet and an extended, static, windowless gas target. A unique feature in nuclear astrophysics applications is the in-situ monitoring of the jet thickness by a laser interferometry system. The talk will report on the gas target setup, its first thickness measurements, and suitable science cases in nuclear astrophysics.

HK 40.4 Wed 16:45 SCH/A419

Materie ist ein Aggregatzustand des Feldes der Raum-Energie — •Günter von Quast — Winterweg 4; 76344 Eggenstein-Leopolshafen

In dem isotropen Feld der Raum-Energie gibt es Ausgleichs- Strömungen. Die kugelförmigen Voids sind mit verdichteter Raum-Energie ausgefüllt und bauen sich ab. Das hat energetische Strömungen zur Folge. In diesen Strömungskanälen, den Filamenten zwischen den Voids, ent-stehen die Galaxien. Die Galaxien selber strömen wieder in Richtung der Galaxienhaufen und lösen sich dort als Elliptische Galaxien wieder zu der Raum-Energie auf. Das Feld der Raum-Energie ist ein Medium und hat Trägheitseffekte. Bei sehr starken Strömungen bilden sich deshalb Strudelsysteme aus, vergleichbar wie Hurrikane in dem Medium der Luft. Das sind die Zentren der Galaxien. In den Randbereichen dieser Strudelsysteme entstehen die Quarks als Grenzwirbel. Die Quarks sind elektrostatische Wirbelsysteme als Torkado- Strudel und Toroid- Strudel. Die Strudelfelder haben ultrahohe Rotationszahlen und bilden als Ergosphäre die Elektrostatische Ladung in Wechselwirkung mit dem ruhenden Feld der Raum-Energie aus. Die Elektrostatischen Felder der Strudelsysteme schließen sich wechselpolig zu den Nukleonen als Protonen, Neutronen und Elektronen zusammen. Aus den Nukleonen bilden sich die ersten Atome aus. Die Elektrodynamischen Felder zwischen den Quarks und Nukleonen sind dann die Bindungskräfte der Starken und der Schwachen Wechselwirkungen in den Atomen. Die Materie entsteht kontinuierlich in den Zentren der jeweiligen Galaxien vor Ort. Der Urknall der Standard- Theorien ist abgeschafft.

HK 41: Structure and Dynamics of Nuclei VII

Time: Wednesday 15:45–17:15 Location: SCH/A118

Group Report HK 41.1 Wed 15:45 SCH/A118

Lifetime measurements via the coincidence Doppler-shift attenuation method in Cologne — •Anna Bohn, Christina Deke, Felix Heim, Sarah Prill, Michael Weinert, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, Germany

A powerful tool to determine nuclear level lifetimes in the sub-picosecond regime is the coincidence Doppler-shift attenuation method (DSAM) [1,2]. The target is positioned inside the combined particle-γ detector array SONIC@HORUS [3]. This allows reconstruction of the complete reaction kinematics for each event. Therefore, feeding contributions from higher lying states to the transition of interest are eliminated and specific transitions can be precisely selected. Hence, lifetimes of several dozens of excited states can be determined from a single experiment, using that the emission-angle dependent Doppler-shift of the deexciting γ-ray energy is linked to the attenuation time of the recoiling nucleus. Systematic studies were performed along isotopic chains [4-6], including Zr, Ru, Sn, and Te. Recent results obtained via the DSA method and by spectroscopy benefitting from coincidence measurements will be presented.

Supported by the DFG (ZI-510/9-1).

[1] A. Hennig *et al.*, NIM A **794** (2015) 171
[2] M. Spieker *et al.*, Phys. Rev. C **97** (2018) 054319
[3] S. G. Pickstone *et al.*, NIM A **875** (2017) 104
[4] S. Prill *et al.*, Phys. Rev. C **105** (2022) 034319
[5] A. Hennig *et al.*, Phys. Rev. C **92** (2015) 064317
[6] S. Prill *et al.*, Phys. Conf. Ser. **1643** (2020) 012157

HK 41.2 Wed 16:15 SCH/A118

Nuclear Structure Studies from Mass Spectrometry of Isomeric States — •Lukas Nies — CERN, Switzerland — University of Greifswald, Germany

The nuclear binding energy arises from various effects that govern a nuclei's properties. Different nucleon configurations within nuclear isomers lead to modified binding energies, often resulting in mass differences of tens to hundreds of kilo-electronvolts. These isomeric excitation energies can be directly accessed by measuring the difference in atomic masses of ground and isomeric states. Here, we present such measurements performed with the ISOLTRAP mass spectrometer located at ISOLDE/CERN. By evaluating the excitation energies of neutron-deficient indium isotopes down to the shell closure at N=50 against state-of-the-art shell model, DFT, and ab initio calculations, we contrast the performance of these theories applied to several nuclear properties. We further present evidence for shape-coexistences close to N=50 through the precise excitation energy measurement of the $(1/2)^+$ state in zinc-79, supported by accurate large-scale shell model calculations.

HK 41.3 Wed 16:30 SCH/A118

Lifetime measurement of excited states in ^{116}Xe — •Casper-David Lakenbrink[1], Marcel Beckers[1], Andrey Blazhev[1], Felix Dunkel[1], Arwin Esmaylzadeh[1], Christoph Fransen[1], Jan Jolie[1], Lisa Kornwebel[1], Claus Müller-Gatermann[2], and Franziskus v. Spee[1] — [1]IKP, Universität zu Köln, Deutschland — [2]Physics Division, Argonne National Laboratory, IL , USA

In the Sn, Te and Xe isotope chains, previous experiments showed a drop for the $B_{4/2} = B(E2; 4_1^+ \to 2_1^+)/B(E2; 2_1^+ \to 0_1^+)$ ratio of nuclei with mass $A \leq 114$. If this is caused by a shell effect, as is expected, the drop should correspond to the neutron number rather than the mass number and would be expected to happen at ^{116}Xe already. Transition strengths in ^{116}Xe have only once been measured using singles spectra, possibly suffering from undetected feeding. Thus, lifetimes in ^{116}Xe were evaluated using $\gamma\gamma$-coincidence data from a recoil-distance Doppler-shift experiment to investigate transition strengths without the need for assumptions on feeding. Excited states in ^{116}Xe were populated in the fusion-evaporation reaction ^{102}Pd(^{16}O,2n)^{116}Xe at the FN-tandem accelerator at the Institute for Nuclear Physics, University of Cologne. Lifetimes of the 2_1^+, 4_1^+ and 6_1^+ states were evaluated using the differential decay-curve method as well as the lifetime of the 7_1^- state using simulations of spectra considering Doppler-shift attenuation effects. The corresponding B(E2), B(E1) values were calculated. We will present the results and compare these to a previous measurement as well as IBM1 calculations. This work was supported by the DFG, grant Nos. FR 3276/2-1 and DE 1516/5-1.

HK 41.4 Wed 16:45 SCH/A118

First direct lifetime determination of the 2_1^+ state of ^{210}Pb — •C. M. Nickel[1], M. Beckers[2], D. Bittner[2], A. Blazhev[2], A. Esmaylzadeh[2], B. Falk[2], C. Fransen[2], J. Garbe[2], L. Gerhard[2], K. Geusen[2], A. Goldkuhle[2], K. E. Ide[1], P. R. John[1], J. Jolie[2], V. Karayonchev[2], R. Kern[1], E. Kleis[2], L. Klöckner[2], M. Ley[2], N. Pietralla[1], G. Rainovski[3], F. Spee[2], M. Steffan[2], T. Stetz[1], V. Werner[1], and J. Wiederhold[1] — [1]TU Darmstadt — [2]U Cologne — [3]U Sofia

The investigation of transitions from the 2_1^+ to the g.s. in nuclei close to the doubly-magic ^{208}Pb allows to constrain parameters from nuclear models, e.g. the effective charges of the shell model. Nuclei containing two valence nucleons, like ^{210}Pb, are of particular importance [1], as their fundamental excitations form the low-lying nuclear states. The 2_1^+ state of ^{210}Pb was directly populated in a two neutron transfer reaction at the 10 MV FN Tandem Accelerator at the IKP of the University of Cologne. Its lifetime was measured using the Cologne plunger device and the RDDS method. The gamma radiation was detected with HPGe detectors and the back-scattered beam-like particles with silicon detectors. Corrections for contaminants were performed and, thus, for the first time the lifetime of the 2_1^+ state of ^{210}Pb was directly determined, being consistent with, but considerably more precise than, the only existing literature value obtained from triton scattering [2].

[1] D. Kocheva et al., Eur. Phys. J. A 53, 175 (2017).
[2] C. Ellegaard et al., Nucl. Phys. A 162, 1 (1971).
*Supported by the BMBF under Grant No. 05P21RDCI2.

HK 41.5 Wed 17:00 SCH/A118

Evolution of the first mixed-symmetry 2^+ state in the N=80 isotones — •T Stetz[1], R Zidarova[1], R Kern[1], V Werner[1], N Pietralla[1], T Abraham[2], U Ahmed[1], G Colucci[2], K Hadyńska-Klek[2], K E Ide[2], G Jaworski[2], M Kisieliński[2], M Komorowska[2], M Kowalczyk[1], M Liliana Cortes[2], P Napiorkowski[1], C Nickel[2], M Palacz[3], G Rainovski[2], J Samorajczyk-Pyśk[2], J Srebrny[3], M Stoyanova[2], A Trzcińska[2], K Wrzosek-Lipska[2], and B Zalewski[1] — [1]TU Darmstadt — [2]HIL Warsaw — [3]U Sofia

The evolution of the first mixed-symmetry 2^+ state in the N=80 isotones from ^{132}Te to ^{142}Sm has been of great interest for the past two decades [1,2,3,4,5]. A recent CoulEx experiment to investigate the M1 strength of the $2^+_{\mathrm{ms},1} \rightarrow 2^+_1$ transition of ^{142}Sm has been performed at HIE-ISOLDE [6]. A complementary experiment to determine the multipole mixing ratio of the aforementioned transition was conducted at the HIL in Warsaw in 2021. Combined, these experiments will expand the understanding of the first mixed-symmetry 2^+ state in this isotonic chain.

[1] M. Danchev *et al.*, Phys. Rev. C **84** (2011) 061306(R)
[2] T. Ahn *et al.*, Phys. Lett. B **679** (2009) 1
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HK 42: Structure and Dynamics of Nuclei VIII

Time: Wednesday 15:45–17:15 Location: SCH/A215

Group Report HK 42.1 Wed 15:45 SCH/A215

Nuclear structure studies far from stability with the FRS Ion Catcher — •Christine Hornung for the FRS Ion Catcher-Collaboration — GSI, Darmstadt, Germany,

At the FRS Ion Catcher at GSI, projectile and fission fragments are produced at relativistic energies at the FRS, separated in-flight, range-focused, slowed-down and thermalized in a cryogenic stopping cell and transmitted to a Multiple-Reflection Time-of-Flight Mass Spectrometer (MR-TOF-MS) for high-accuracy (down to $\Delta m/m \sim 10^{-8}$) direct mass measurements. Mass measurements of projectile fragments in the vicinity of ^{100}Sn were performed, including the first direct mass measurement of the ^{98}Cd ground state and the discovery of isomeric states. The measured excitation energies are compared with large-scale shell model calculations; they indicate the importance of core excitation around ^{100}Sn. Light neutron-deficient lanthanides were investigated. In this measurement the potential to perform surveys covering a large region on the chart of nuclei using an MR-TOF-MS was shown. Additionally, mass measurements of neutron-rich nuclei revealed evidence for shape transitions in the $N \approx 90$, Z=56-63 region. These results, recent technical upgrades at the FRS-IC, news from the next-generation CSC for the Super-FRS at FAIR and an outlook to plans for future experiments will be presented.

HK 42.2 Wed 16:15 SCH/A215

Fragmentation cross-sections of 1 GeV/u ^{208}Pb on ^{9}Be measured at the FRS — •Suraj K. Singh for the S450-Collaboration — GSI, Darmstadt, Germany — Justus-Liebig-Universität Gießen, Germany

Studies of nuclei far from the valley of stability, where extreme proton-to-neutron ratios appear, are particularly interesting because they provide insight into the nuclear structure and astrophysical nucleosynthesis processes. The nuclei are important for studies of the nuclear-existence limit, and for the understanding of nuclear reaction mechanisms. For such studies of the exotic isotopes, production cross-section measurements are the basic step of any research. The knowledge of accurate production cross-sections is essential for further development of reaction models and every new experiment based on a certain reaction. In this contribution, the evaluation of production cross-sections of exotic nuclei close to N=126, produced in fragmentation of a 1 GeV/u ^{208}Pb beam on a ^{9}Be target and separated in-flight at fragment separator FRS at GSI will be presented.

HK 42.3 Wed 16:30 SCH/A215

^{12}C(p,2p)^{11}B Quasi-Free-Scattering in Inverse Kinematics at R^{3}B — •Tobias Jenegger, Philipp Klenze, Lukas Ponnath, and Roman Gernhaeuser — Technische Universität München, Germany

The advanced R^{3}B setup at GSI allows to investigate proton-induced-quasi-free one-nucleon knockout reactions of exotic nuclei in inverse kinematics. This technique gives direct access to the momentum distributions of the scattered off protons in the nucleus before as well as the recoil momentum of the remaining spectator nucleus. In addition to the correlated gamma spectrum it is a powerful tool to unveil individual states populated in the reaction. The CALIFA calorimeter, with its 2528 CsI scintillation crystals in its final design, is a key detector in quasi-free-scattering experiments at R^{3}B. It allows to detect both the two coincident protons from the quasi-free-scattering process and emitted γ-rays from de-excitation of the remaining nucleus with high angular resolution and precise Doppler correction.
For the heavy residues unique particle identification was performed with multi-sampling ionisation chambers and a high resolution tracking system before and after the GLAD magnet, resulting in a relative mass resolution of less than 0.5 percent.
We present the analysis of the S444 experiment performed in the FAIR Phase-0 campaign with relativistic ^{12}C beams at various energies focusing on the quasi-free-scattering process, and the reconstruction of the associated gamma ray spectra.

HK 42.4 Wed 16:45 SCH/A215

Search for near-threshold multi-neutron resonances in (p,2p) reactions with neutron-rich nuclei at R^{3}B — •Nikhil Mozumdar[1,3], Thomas Aumann[1,2,3], Olivier Sorlin[4], and Valerii Panin[2] for the R3B-Collaboration — [1]Technische Universität Darmstadt — [2]GSI Helmholtz-Zentrum für Schwerionenforschung — [3]Helmholtz Forschungsakademie Hessen für FAIR — [4]Grand Accélérateur National d'Ions Lourds

In order to constrain the largely unknown multi-neutron interactions, it is necessary to measure the relevant observables sensitive to them. In the current work we plan to investigate multi-neutron resonances close to the corresponding neutron removal thresholds in neutron-rich light nuclei. The objective is to search for and characterize the systematic appearance of narrow resonances related to multi-neutron cluster structures and correlations near the respective cluster thresholds, similar to the popular alpha cluster resonant states. For this purpose an experiment has been recently concluded at the R^{3}B Setup in GSI. The $(p, 2p)$ reactions are studied in inverse kinematics where a radioactive ion "cocktail" beam is impinged on a 5cm LH_2 target. The resulting reaction products are measured using a large combination of detector systems providing information of the full reaction kinematics. Of particular interest is the neutron detector NeuLAND, which thanks to its high resolution and granularity provides access to the detailed study of multi-neutron resonances aimed for in this work.
Supported by HFHF, the GSI-TU Darmstadt cooperation and the BMBF project 05P21RDFN2

HK 42.5 Wed 17:00 SCH/A215

Correlation Experiments in Photofission* — •Vincent Wende[1], Dimiter Balabanski[4], Joachim Enders[1], Sean W. Finch[2], Alf Göök[3], Calvin R. Howell[2], Ronald C. Malone[6], Maximilian Meier[1], Andreas Oberstedt[4], Stephan Oberstedt[5], Marius Peck[1], Norbert Pietralla[1], Jack A. Silano[6], Gerhart Steinhilber[1], Anton P. Tonchev[6], and Werner Tornow[2] — [1]Institut für Kernphysik, Fachbereich Physik, TU Darmstadt, Darmstadt, Germany — [2]Triangle Universities Nuclear Laboratory, Duke University, Durham, NC, USA — [3]Uppsala Universitet, Uppsala, Sweden — [4]ELI-NP, IFIN-HH, Magurele, Romania — [5]EC-JRC Geel, Belgium — [6]Lawrence Livermore National Laboratory, Livermore, CA, USA

Mass, total kinetic energy and polar as well as azimuthal angular distributions of fission fragments were measured simultaneously using a position-sensitive twin Frisch-grid ionization chamber [1]. We present results of a pioneering ^{238}U(γ,f) experiment at the High-Intensity γ-Ray Source (HIγS) facility at Triangle Universities Nuclear Laboratory (TUNL) at an excitation energy of 11.2 MeV [2] as well as the first data from follow-up ^{234}U(γ,f) and ^{232}Th(γ,f) experiments with excitation energies near the fission barrier.

*Supported by HMWK (LOEWE Cluster Nuclear Photonics)

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HK 43: Fundamental Symmetries II

Time: Wednesday 15:45–17:15 Location: SCH/A252

Group Report HK 43.1 Wed 15:45 SCH/A252

The search for Charged Lepton Flavour Violation with the Mu2e experiment — •Anna Ferrari[1], Stefano Di Falco[2], Valerio Giusti[3], Stefan E. Müller[1], Oliver Knodel[1], Vitaly Pronskikh[4], and Reuven Rachamin[1] for the Mu2e-Collaboration — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]INFN Pisa, Pisa, Italy — [3]University of Pisa, Pisa, Italy — [4]Fermi National Accelerator Laboratory, Batavia, IL, USA

The Mu2e experiment, currently under construction at Fermilab (USA), will search for the charged-lepton flavor violating neutrino-less conversion of negative muons into electrons in the field of an aluminum nucleus. A conversion signal would require physics beyond the Standard Model, and the aim of Mu2e is to reach a sensitivity four orders of magnitude better than previous experiments. To achieve such a goal, a reliable estimate of the relevant particle yields and a rigorous control of all backgrounds are mandatory, together with an accurate normalization of signal events.

An extensive campaign of Monte Carlo simulations has been therefore performed to investigate key yields and beam and cosmic rays-related backgrounds. In addition, at the Helmholtz-Zentrum Dresden-Rossendorf the pulsed Bremsstrahlung photon beam at the ELBE facility has been used to study the performance of the detector system that will monitor the rate of the stopped muons in the aluminum target.

The design and present status of the Mu2e experiment will be presented, together with the main results of the background and sensitivity studies, and a summary of the results of the ELBE campaign.

Group Report HK 43.2 Wed 16:15 SCH/A252

Status of the COMET experiment — •Andreas Jansen, Thomas Kormoll, Dominik Stöckinger, and Kai Zuber — TU Dresden, Institut für Kern- und Teilchenphysik, Germany

The COMET experiment, currently being built in Tokai, Japan, will search for the coherent neutrinoless transition of muons to electrons in the Coulomb field of atomic nuclei ($\mu^- + \mathrm{N} \rightarrow e^- + \mathrm{N}$). While the total lepton number L is conserved, with no out-going neutrinos the individual lepton flavors L_e and L_μ are violated by one unit.

This charged lepton flavor violation involving muons is one of the most promising Beyond Standard Model (BSM) fields currently under investigation. Not only do recent results regarding the muon anomalous magnetic moment (g-2) present a very strong motivation for muon BSM, but also current best experimental limits barely fall short of the predicted conversion rate in many widely acknowledged BSM theories (e.g. supersymmetric theories).

In order to realize stringent requirements on the detector system and muon beam, the COMET experiment will follow a staged approach. Phase-I aims to improve the current branching ratio limit of 7×10^{-13} by two orders of magnitude while also allowing data taking of beam dynamics and validation of Monte Carlo simulations. In Phase-II the branching ratio limit will be additionally improved by at least two orders of magnitude.

This talk will give an experimental overview of both phases, recent updates on the facility and the current detector development status.

HK 43.3 Wed 16:45 SCH/A252

Effect of magnet cycling on the magnetic field tracking uncertainties in the Fermilab g–2 experiment — •René Reimann, Mohammad Ubaidullah Hassan Qureshi, and Martin Fertl for the Muon g–2-Collaboration — Institute of Physics and Excellence Cluster PRISMA+, Johannes Gutenberg University Mainz, 55099 Mainz, Germany

The Muon g–2 Collaboration has presented the most precise measurement of the anomalous magnetic moment a_μ with an uncertainty of 460 ppb. To achieve the goal of 140 ppb uncertainty, more than a factor of nine times the published data have been recorded, but systematic uncertainties must also be reduced. A key parameter in determining a_μ is the precise value of the homogeneous 1.45 T magnetic field in which the muons are stored. Two systems using nuclear magnetic resonance (NMR) techniques are used to track the magnetic field in the muon storage ring. One system measures the spatial magnetic field distribution every few days in the storage region itself, and the other system measures the magnetic field drift continuously with probes in the walls of the vacuum chambers of the storage ring. Cycling the storage ring magnet introduces additional field drifts which are challenging for the tracking of the averaged magnetic field. In this talk, I will present the effect of magnet cycling on the tracking of the magnetic field and its uncertainty.

HK 43.4 Wed 17:00 SCH/A252

Upgrading antihydrogen production in AEḡIS — •Saiva Huck — CERN, Meyrin, Switzerland — University of Hamburg, Inst. f. Experimental Physics, Hamburg, Germany

The AEḡIS (Antimatter Experiment: Gravity, Interferometry, Spectroscopy) collaboration, based at CERN's Antiproton Decelerator (AD) complex, produces antihydrogen atoms in the form of a pulsed, isotropic source with a precisely defined production time. $\bar{\mathrm{H}}$ is formed by means of a charge exchange reaction: antiprotons are captured from the AD inside a Penning-Malmberg trap, further sympathetically cooled with electrons, and then combined with positronium atoms, which are previously laser-excited to Rydberg states.

The focus of research in AEḡIS is on the formation of a pulsed horizontal beam of $\bar{\mathrm{H}}$ atoms utilized to investigate their vertical deflection due to the influence of gravity, thereby probing the Weak Equivalence Principle for antimatter and providing a test of the CPT theorem.

Since the first $\bar{\mathrm{H}}$ formation in 2018, AEḡIS has undergone several significant upgrades aimed at improving the efficiency of antihydrogen production and fully benefiting from the newly added ELENA (Extra Low ENergy Antiproton) decelerator at the AD, which commenced operation in fall of 2021 and yields antiprotons in larger numbers at lower energies. Subsequently, work is being undertaken to re-establish $\bar{\mathrm{H}}$ production, in larger numbers, and move towards beam formation.

This contribution gives an overview of the improvements to the AEḡIS setup, results obtained during the first beam times with ELENA, and progress towards the formation of a pulsed $\bar{\mathrm{H}}$ beam.

HK 44: Instrumentation XII

Time: Wednesday 17:30–19:00 Location: SCH/A251

Group Report HK 44.1 Wed 17:30 SCH/A251

Status of the CBM Silicon Tracking System — •Marcel Bajdel for the CBM-Collaboration — Goethe-Universität Frankfurt am Main — GSI Helmholtz Centre for Heavy Ion Research

The Compressed Baryonic Matter (CBM) is one of the core experiments at the future Facility for Anti-proton and Ion Research (FAIR), Darmstadt, Germany. The Silicon Tracking System (STS) is a central detector system of CBM, placed inside a 1 Tm magnet and with an operation temperature of about -10 $^\circ C$ to keep low radiation-induced bulk current in the 300 μm double sided microstrip silicon sensors.

The STS comprises eight tracking stations with 876 modules. Each module is calibrated and tested in order to access its performance. Next steps involve mounting the module on a carbon ladder, and subsequently these objects are arranged horizontally on so-called C-frames.

The purpose of this contribution is to give an overview of the recent progress towards the STS detector. The first major milestone is the operation of the readout chain and detector control system of the miniaturized version of STS, which features 11 detector modules. The second accomplishment features the commissioning efforts of the thermal demonstrator which serves to validate the concept for crucial services of the STS (cooling, air drying, ambient conditions measurements). Lastly, the preproduction of the detector modules has started, and the first results collected.

HK 44.2 Wed 18:00 SCH/A251

Quantifying the Dual-Sided Silicon Strip Detectors at R3B — •Andrea Jedele[1,2], Dominic Rossi[1,2], and Thomas Aumann[1,2] for the R3B-Collaboration — [1]TU-Darmstadt, Darmstadt, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

Dual-sided silicon strip detectors allow for accurate position and charge determination of in-beam fragments for heavy-ion collisions with minimal spatial restraints. The X5 Micron silicon detectors have been used in the R3B set-up at GSI. Improvements have been implemented to the hardware of the detector and a new calibration method has been developed and tested for beams of primary and secondary Sn isotope experiments.

Supported in part by BMBF (05P21RDFN2), Helmholtz Forschungsakademie Hessen für FAIR and GSI-TU Darmstadt cooperation agreement

HK 44.3 Wed 18:15 SCH/A251

HI-TREX: Compact, high resolution particle detection system for ISOLDE — Roman Gernhäuser, •Sergei Golenev, and Robert Neagu for the MINIBALL-Collaboration — Technische Universität München, Germany

HI-TREX is a particle detection setup, developed for the HIE-ISOLDE facility at CERN, optimized for transfer reactions using radioactive ion beams. HI-TREX is based on a very thin double-sided silicon strip detector (DSSSD), high-resolution front-end electronics based on SKIROC ASICs, and a newly developed, custom made, FPGA based GEneric Asic Readout board GEAR for the TRB data acquisition system.

A full system test with an array of four detectors in a two arm geometry was performed at the Bronowice Cyclotron Center in Krakow using proton beams with energies ranging from 80 to 200 MeV.

With ancillary CsI(Tl) scintillation detectors behind the setup and a plastic fiber target a full 4-momentum reconstruction of the 12C(p,2p) reactions is performed. We will present first results on calibrations, the energy resolution and the event correlations to determine absolute efficiencies of the new detector elements.

(supported by BMBF 05P21WOCI1)

HK 44.4 Wed 18:30 SCH/A251

A new concept for the geometry of the Silicon Tracking System in the CBM Experiment — •Mehulkumar Shiroya — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

The Compressed Baryonic Matter experiment is a fixed target experiment planned to be built at the Future Facility of Anti-Proton and Ion Research at the GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany. The Silicon Tracking System is the main detector for tracking and momentum determination of the CBM experiment. It is designed to measure up to 700 charged particles produced in nucleus-nucleus collisions up to an interaction rate of 10 MHz, and achieve a momentum resolution in 1 Tm dipole magnetic field better than 2%. It uses double-sided micro-strips silicon sensors with a thickness of $320 \pm 15\ \mu$m arranged in 8 tracking stations. Since the CBM magnet cannot be realized as previously planned, the originally intended monolithic design which minimizes the detector dimensions can be replaced by a modular structure independently assembled, called STS-3 & STS-5, and a full separation of services (low/high voltage, front-end, cooling, etc). A ROOT based geometrical model for the new conceptual design of the STS, including a detailed description of the passive material, has been implemented. The performance for track reconstruction and momentum determination has been studied in comparison with the old design with Au+Au simulations at different colliding energies. Further detailed information will be presented during the conference.

HK 44.5 Wed 18:45 SCH/A251

Light-weight but dense: mechanics and integration of Silicon Tracking System of the CBM experiment — •Maksym Teklishyn[1,2] and Oleg Vasylyev[1] for the CBM-Collaboration — [1]GSI Helmholtzzentrum für Schwerionenforschung — [2]Kyiv Institute for Nuclear Research

Silicon Tracking System (STS) is a core tracking detector of the future heavy-ion CBM experiment at FAIR. Requirements to cope with unprecedentedly high beam-target interaction rate (up to 10 MHz), multiple low-momentum reaction products (up to 700 charge particles per central collision) challenge the detector technologies.

STS features fast light-weight detector modules of various form factors. They are made of the 300 μm thick 2×1024 channel double-sided double-metal silicon sensors connected to the dedicated read-out electronics by 32 thin aluminium-polyimide micro-cables of up to 500 mm length. The STS assembly features highly integrated unique components. The basic blocks of STS are 876 detector modules in 199 unique configurations. They are arranged on the light-weight carbon-fibre mechanical support structures forming ladders of 8 or 10 modules each. There are 106 ladders in 38 ladder types; they form 8 tracking layers on 18 aluminium supports. They also accommodate powering and back-end read-out electronics, and liquid cooling.

Recently, STS team altered the detector mechanical design: STS may be split in upstream and downstream parts with 3 and 5 tracking layers, respectively. This introduces flexibility for running scenarios ($2-11$ AGeV for Au ions) and facilitates upgrade.

HK 45: Instrumentation XIII

Time: Wednesday 17:30–19:00 Location: SCH/A.101

HK 45.1 Wed 17:30 SCH/A.101

Photon Detection with THGEMs — •Thomas Klemenz[1], Laura Fabbietti[1], Piotr Gasik[2], Roman Gernhäuser[1], and Berkin Ulukutlu[1] — [1]Techinsche Universität München, Garching, Germany — [2]FAIR/GSI GmbH, Darmstadt, Germany

Traditional devices for photon detection like the Photomultiplier Tube or more recent technologies such as Silicon Photomultipliers are not easily scalable and rather cost-intensive.. Therefore, especially with large area experiments in mind it is exciting to investigate new ways of detecting photons. In this project we are taking the approach of combining a photosensitive material with a Thick GEM (THGEM) to produce a gaseous photon detector. THGEMs are robust, low-cost devices, which can be easily implemented in large area applications. One side of the THGEM is coated with a photosensitive material and placed within an electrical field. Photons captured by the active surface lead to a release of electrons which drift into the THGEM hole where they undergo avalanche multiplication due to strong electric fields applied. Below the THGEM an anode is reading out the amplified electron signal. Depending on the gain of the THGEM this could enable single photon detection. We want to study the potential of this approach while trying different photosensitive materials. Ultimately, we aim to measure visible wavelength photons and to provide a low-cost, large area solution for neutrino observation in water and ice environments. In the talk the current status of the project is discussed.

This work is funded by the BMBF Verbundforschung (05P21WOCA1 ALICE) and the DFG Sachmittel FA 898/5-1.

HK 45.2 Wed 17:45 SCH/A.101

The novel XYU-Readout for ambiguity-reduced tracking — •Karl Jonathan Flöthner[1,2], Florian Brunbauer[1], Serge Ferry[1], Francisco García[3], Djunes Janssens[1], Bernhard Ketzer[2], Marta Lisowska[1], Hans Muller[1], Rui de Oliveira[1], Eraldo Oliveri[1], Giorgio Orlandini[1], Dorothea Pfeiffer[4], Leszek Ropelewski[1], Jerome Samarati[4], Fabio Sauli[1], Lucian Scharenberg[1], Miranda van Stenis[1], Antonija Utrobicic[1], and Rob Veenhof[1] — [1]CERN, Geneva, Switzerland — [2]University of Bonn, Germany — [3]HIP, Helsinki, Finland — [4]ESS, Lund, Sweden

Signals generated in gaseous detectors such as GEM-based detectors are often read out by strips providing one or two coordinates of a track. Such a strip-based readout (R/O) often suffers from ambiguities. For particle tracks, these are usually removed by pattern recognition. For the detection of photons, e.g. in a RICH detector, however, they have to be removed in a single detector. Solutions for this problem on the detector level are additional information about the signal amplitude, or a pixelated readout. The latter, however, results in a huge increase in the number of electronic channels and the material budget. Therefore, the XYU-R/O was proposed as a three-coordinate strip-readout. The fact that no vias are needed inside the active area is a novelty of the design and important for a reliable and simple production. The talk will cover results from X-ray measurements and will be complemented by test beam data from October 2022.

HK 45.3 Wed 18:00 SCH/A.101

Stabilized voltage divider for GEM detectors — •Oliver Adam, Philip Hauer, Christian Honisch, Dimitri Schaab, Dominik Schüchter, Marco Vogt, and Bernhard Ketzer — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

Multi-GEM detectors often use the simple principle of classic voltage dividers to supply their electrodes with high voltages. The problem with that kind of voltage supply (passive voltage divider) is that the voltages change when additional currents are produced inside the detector at high irradiation rates, which are taken up by the electrodes. In addition, the effect of occasional sparks inside the detector is traditionally minimized using high-ohmic bias resistors, which again modify the electrode potentials in case of non-negligible currents. Using active components (source follower) instead of passive resistors offers away to overcome these drawbacks. The resistor chain is stabilized with a transistor chain and has an active current limit. Simulations support these considerations. In measurements with X-ray and radioactive sources, we investigate the gain stability at high rates and the stability against discharges. This talk will cover the working principle of the stabilized voltage divider. Furthermore the results of simulations and measurements will be discussed.

HK 45.4 Wed 18:15 SCH/A.101

Studying the Impact of Humidity on the Performance of MPGDs — •Henrik Fribert[1], Piotr Gasik[2], Berkin Ulukutlu[1], and Laura Fabbietti[1] — [1]Technische Universität München, Garching, Germany — [2]FAIR/GSI GmbH, Darmstadt, Germany

MPGDs (Micro-Pattern Gaseous Detectors) are gaseous detectors used in high-energy physics experiments like ALICE or ATLAS at the LHC. Despite 30 years long experience in the production and successful operation of this type of detector, the effect of water contamination of the gas composition on their performance is still a subject of debate. We contribute to this topic with systematic studies using several MPGDs (GEMs, THGEMs, and Micromegas) operated with an Ar-CO2 mixture and introducing water content in a range of 0-5000 ppmV. Detector performance is evaluated while varying the humidity level for each type of MPGD under study. The water is introduced to the detector vessel by incorporating a water-filled bubbler into the gas system, through which gas can be flushed at different rates. It is observed that the presence of increased humidity does not degrade any of the studied performance criteria. On the contrary, our measurements suggest an improvement in discharge stability with increasing humidity levels, at the highest gains and fields. We conclude, that adding a small amount of water to the gas mixture may be beneficial for the stable operation of an MPGD. This work is funded by the BMBF Verbundforschung (05P21WOCA1 ALICE) and the DFG Sachmittel FA 898/5-1.

HK 45.5 Wed 18:30 SCH/A.101

Investigations on the Signal-to-Noise Ratio of the VMM Readout Chip with a GEM Detector — •Virginia Klapper[1], Karl Flöthner[1,3], Pascal Henkel[1], Michael Lupberger[1,2], and Bernhard Ketzer[1] — [1]Universität Bonn, Helmholtz- Institut für Strahlen- und Kernphysik, Bonn, Germany — [2]Universität Bonn, Physikalisches Institut, Bonn, Germany — [3]CERN, Geneva, Switzerland

Dedicated readout chips are required to collect, preamplify and further process the data generated by microstructured particle detectors. The VMM is an ASIC that was developed for the ATLAS New Small Wheel upgrade. It operates in a self-triggered mode, thus not requiring an external trigger signal for data readout, which gives much more flexibility for complex selection criteria in the high-level software trigger. This chip is a candidate to read out novel high-rate GEM detectors at the AMBER experiment at the CERN SPS. We are in particular interested in the Signal-to-Noise Ratio (SNR) and how it compares to the APV25 chip that has been used for GEM readout at COMPASS.

This presentation focuses on a setup to measure the SNR with cosmic muons. A GEM detector read out by VMM chips is sandwiched between two scintillators with photomultipliers. The coincidence signal is injected into a trigger board connected to a separate VMM frontend board. This way, the triggers are timestamped as belonging to data from the detector.

This contribution presents the SNR measurements for a variety of parameters like different gas gains or VMM thresholds.

HK 45.6 Wed 18:45 SCH/A.101

Data analysis of a GEM detector with VMM3a readout at the AMBER pilot run — •Pascal Henkel[1], Karl Jonathan Flöthner[3,1], Virginia Klapper[1], Michael Lupberger[1,2], and Bernhard Ketzer[1] — [1]Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany — [2]Universität Bonn, Physikalisches Institut, Bonn, Germany — [3]CERN, Geneva, Switzerland

In its first phase, the AMBER experiment at CERN SPS plans, among others, a measurement of the proton form factor at small Q2, using high-energy muon-proton elastic scattering. During a pilot run in October 2021 a GEM-based planar tracking prototype detector took data using the self-triggered VMM3a ASIC as readout chip. The purpose was a first test of the prototype detector in a high muon rate environment and in various configurations of the chip. The time-stamped VMM data has to be combined with the triggered data from the COMPASS spectrometer and other detectors in the pilot run setup. For synchronization, COMPASS trigger signals where injected into a dedicated VMM chip, such that they were timestamped.

In the ongoing analysis the obtained data is brought into temporal match with the external trigger which will make it possible to reconstruct particle tracks from the triggered detectors and correlate them with the signals measured by the prototype detector. The results should give insights that help optimizing the chip configurations in order to evaluate in future measurements how the VMM3a performs in comparison to the APV25 readout chip for COMPASS GEMs.

HK 46: Heavy-Ion Collisions and QCD Phases IX

Time: Wednesday 17:30–19:00 Location: SCH/A216

Group Report HK 46.1 Wed 17:30 SCH/A216

Open heavy-flavour hadron production from small to large collision systems at the LHC with ALICE in Run 2 and beyond — •Annalena Kalteyer for the ALICE Germany-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

This talk will present the latest measurements performed by the group for heavy-flavour baryon production at midrapidity in pp, p–Pb and Pb–Pb collisions at the LHC. Small collision systems, like pp, allow for precision measurements of rare particle species, and they can serve as a reference for heavy-ion collisions. Proton-lead collisions are in particular useful to study cold nuclear matter effects, and with Pb–Pb systems we study heavy-flavour production in heavy-ion collisions and their interaction with the quark-gluon plasma.

We will show the measurement of Λ_c^+ down to $p_T = 0$ in pp and p–Pb collisions, together with the obtained nuclear modification factor, thanks to the recently measured Λ_c^+ also in Pb–Pb collisions. Furthermore, due to sophisticated machine learning techniques, it was possible to gain indirect information on beauty baryon production by measuring Λ_c^+ coming from the decay of beauty hadrons, both in pp and p–Pb collisions. Finally, results of heavy charm baryons, such as $\Xi_c^{0,+}$ and Ω_c^0, will be discussed. Since data taking in Run 3 at the LHC started in July 2022, we will show a first look on Run 3 data, plus some studies on vertex determination with the KFParticle package and heavy-flavour triggers for rare particles and beauty hadrons.

HK 46.2 Wed 18:00 SCH/A216

Ω_c^0 production in pp collisions at $\sqrt{s}$ = 13 TeV with ALICE — •Tiantian Cheng for the ALICE Germany-Collaboration — Central China Normal University(CCNU), Wuhan, China — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

Recent measurements of the production of charm hadrons at midrapidity in pp collisions at $\sqrt{s} = 5.02$ TeV showed that the baryon-to-meson yield ratios are significantly higher than those measured in e^+e^- collisions for different charm-baryon species. These observations suggest that the charm fragmentation fractions are not universal and depend on the collision systems. In this talk, the new measurement of the p_T-differential cross section times branching ratio of the Ω_c^0 baryon measured in the decay channels $\Omega_c^0 \to e\Omega\nu$ and $\Omega_c^0 \to \pi\Omega$ in pp collisions at $\sqrt{s} = 13$ TeV will be reported. The measurement of the Ω_c^0 baryon, containing 2 strange quarks, gives further constraints on charm-quark hadronisation models. The final result will be compared with theoretical calculations.

HK 46.3 Wed 18:15 SCH/A216

Charm production in proton–proton collisions at $\sqrt{s}$ = 13 TeV measured with the ALICE detector — •Carolina Reetz for the ALICE Germany-Collaboration — Physikalisches Institut, Universität Heidelberg — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

Recent measurements of charm fragmentation fractions of single charm ground state hadrons at midrapidity in proton–proton (pp) collisions at $\sqrt{s} = 5.02$ TeV at the LHC significantly differ from the values obtained in e^+e^- and ep collisions. Therefore the assumption of universality of the charm-to-hadron fragmentation

fractions across different collision systems might not be fully supported.
New p_T-integrated cross section measurements of prompt D^0, D^+, D_s^+, D^{*+}, Λ_c^+ and Ξ_c^+ in pp collisions at $\sqrt{s}$ = 13 TeV are presented. The relative abundance of the different charm hadron species, which is sensitive to hadronization mechanisms, is shown and compared to model calculations. The presented charm hadron cross section measurements are used to evaluate the charm fragmentation fractions and the total charm production cross section at midrapidity in pp collisions at $\sqrt{s}$ = 13 TeV. The new measurement of the Ξ_c^+ production cross section down to low transverse momenta is extrapolated to p_T = 0 for the first time. The Ξ_c^+ fragmentation fraction is calculated and the contribution is included in the total charm production cross section.

HK 46.4 Wed 18:30 SCH/A216

Reconstruction of displaced decay vertices in an inhomogeneous magnetic field with a Kalman Filter based tracking algorithm at HADES — •Mirco Parschau for the HADES-Collaboration — Goethe University Frankfurt am Main

The high interaction rate, fixed target experiment HADES at GSI, located in Darmstadt, Germany, investigates collisions of heavy-ion, proton and secondary pion beams with a target material. Hyperons are one of the key observables for both heavy-ion and elementary collisions. The challenge is to detect displaced vertices with good accuracy without having a dedicated vertex detector, by employing state-of-the-art techniques.

In this contribution we discuss a newly developed tracking algorithm that uses a Kalman Filter to further boost the track reconstruction performance and the reconstruction of displaced vertices from hyperons.

This work has been supported by BMBF (05P21RFFC2), GSI, HFHF, the State of Hesse within the Research Cluster ELEMENTS (Project ID 500/10.006) and HGS-HIRe.

HK 46.5 Wed 18:45 SCH/A216

Performance test of the KF Particle vertexing package for open heavy flavour baryon reconstruction with the ALICE detector — •Phil Stahlhut for the ALICE Germany-Collaboration — Physikalisches Institut, Universität Heidelberg

The study of charm baryon production is crucial to understand charm hadronisation processes in a parton-rich environment. In order to extract signal even in low transverse momentum (p_T) regions where the signal-to-background ratio is rapidly decreasing, a precise vertex reconstruction is of upmost importance.

The Kalman Filter Particle package gives a fast reconstruction of complex decay topologies providing a full description of the decay particle both at its production and decay vertex. It is suitable even for high-density track environments. In addition to that, the KF Particle package supports the use of geometrical, mass and topological constraints in the reconstruction process and includes the complete treatment of tracking and vertexing uncertainties.

In this work, the KF Particle package was used to reconstruct the Ξ_c^+ baryon from its decay to $\Xi^-\pi^+\pi^+$ in simulated proton–proton collisions at a center-of-mass energy of $\sqrt{s}$ = 13 TeV. This contribution will demonstrate the effect of geometrical, mass and topological constraints on the secondary vertex, p_T and mass resolution of the reconstructed Ξ_c^+ baryon.

HK 47: Heavy-Ion Collisions and QCD Phases X

Time: Wednesday 17:30–18:45 Location: SCH/A315

HK 47.1 Wed 17:30 SCH/A315

Light Nuclei Emission in Ag+Ag Collisions — •Marvin Nabroth for the HADES-Collaboration — Institut fuer Kernphysik, Frankfurt, Deutschland

This contribution gives an overview of data on protons, deuterons and He3, emitted in Ag+Ag collisions at $\sqrt{s_{NN}}$ = 2.55 GeV measured at HADES. Covered is the procedure of particle identification based on a Bayesian ansatz as well as the process of acceptance and efficiency correction and extrapolation into uncovered phase space regions. The reconstructed transverse mass spectra and resulting rapidity density distributions as a function of the collision centrality are presented and a comparison of the 4π yield to the world data in the low energy regime, as a function of collision energy, is discussed.
Detailed knowledge of the production yields and phase space spectra is of special interest when it comes to test to what extent thermal models can describe the nature of a heavy-ion collision in the low-energy regime and to understand the mechanisms under which light nuclei are formed during a heavy-ion collision.
This work has been supported by BMBF (05P21RFFC2), GSI F&E and HGS-HIRe.

HK 47.2 Wed 17:45 SCH/A315

Testing coalescence by studying (anti)nuclei production in and out of jets in ALICE — •Chiara Pinto for the ALICE Germany-Collaboration — Technische Universität München, München, Deutschland

The production mechanism of (anti)nuclei in ultrarelativistic hadronic collisions is under intense debate in the scientific community. The description of the experimental measurements is currently based on two competing phenomenological models: the statistical hadronisation model and the coalescence approach. For the first time, the deuteron production in pp collisions at \sqrt{s}= 13 TeV is measured both in jets and in the underlying event. Due to the collimated emission of nucleons in a jet, the nuclear production by coalescence is expected to be enhanced. In this contribution, the results for the coalescence parameter B2 in and out of the jet are presented in comparison with predictions from the coalescence model and a recently developed reaction-based production mechanism implemented in PYTHIA 8.3.

This work is funded by DFG SFB1258 and by BMBF Verbundforschung (05P21WOCA1 ALICE).

HK 47.3 Wed 18:00 SCH/A315

Measurement of proton-deuteron correlations in Pb–Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV — •Michael Jung for the ALICE Germany-Collaboration — Institut für Kernphysik Frankfurt

The first measurement of p–d two-particle correlations measured with ALICE in central and semi-central Pb–Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV will be presented. This measurement enables the possibility to study three particle interactions as well as the formation mechanism of light nuclei in heavy-ion collisions. The particle identification, the procedure to obtain the correlation functions and a study of the source size will be shown. The measured correlations are then compared with theoretical predictions using the Lednický-Lyuboshitz approach. For these calculations measured scattering lengths of proton-deuteron pairs from scattering experiments are taken.

HK 47.4 Wed 18:15 SCH/A315

Sexaquark Search in ALICE — •Andrés Bórquez for the ALICE Germany-Collaboration — Universität Heidelberg, Germany

For many years, WIMPs have been the leading candidate for the phenomenon of dark matter in astronomy. However, despite extensive experimental research, no WIMP signal has been detected, leading to the exploration of other dark matter candidates. In 2017, G. Farrar proposed the sexaquark as a new candidate for dark matter, which is a neutral, compact, six-quark state with the quark content $uuddss$. This particle is consistent with our current understanding of Quantum Chromodynamics (QCD) and the dark matter relic abundance. In the ALICE experiment at the Large Hadron Collider (LHC), we plan to search for this exotic particle via its interaction with detector material after being produced in heavy-ion collisions.

In this presentation, we will discuss an overview of the sexaquark, some preliminary studies with specialized simulations, and the challenges and prospects of this search analysis.

HK 47.5 Wed 18:30 SCH/A315

Net-Proton Fluctuations in Pb-Pb Collisions with the ALICE Experiment — •Ilya Fokin for the ALICE Germany-Collaboration — Physikalisches Institut, Heidelberg

Fluctuations of conserved charges – such as the electric charge, baryon number or strangeness – in ultrarelativistic heavy-ion collisions provide insight into the QCD phase diagram. They are quantified using moments or cumulants of the distribution of the respective charge in a collision, which can be related to susceptibilities from lattice QCD calculations. These numerical calculations predict a second order phase transition from the quark-gluon plasma to the hadron gas close to the chemical freeze-out temperature for vanishing quark masses and baryon chemical potential, which is expected to turn into a continuous crossover for physical masses. Since the LHC provides heavy-ion collisions with almost vanishing baryon chemical potential, using the proton number as a proxy for the baryon number makes the lattice QCD results accessible in the experiment.

In this contribution, recent measurements of higher-order cumulants of the net-proton number in Pb-Pb collisions recorded with the ALICE detector are presented. Their dependence on the pseudorapidity acceptance and centrality and comparisons to models are discussed. Moments of the proton number distributions are measured probabilistically using the Identity Method, treating contamination of the proton sample in a natural way.

HK 48: Hadron Structure and Spectroscopy V

Time: Wednesday 17:30–19:00 Location: SCH/A316

HK 48.1 Wed 17:30 SCH/A316

Status report of the PANDA FAIR Phase-0 detector development and installation at MAMI — Nicolo Baldicchi[1], Luigi Capozza[1], Samet Katilmis[1], Dong Liu[1], Frank Maas[1,2,3], Julian Moik[1], Oliver Noll[1,2], David Rodriguez Piñeiro[1], •Christoph Rosner[1], Paul Schöner[1], and Sarah Wolf[1] — [1]Helmholtz-Institut Mainz, Mainz, Germany — [2]Institute of Nuclear Physics, Mainz, Germany — [3]PRISMA+ Cluster of Excellence, Mainz, Germany

The PANDA experiment will be one of the main pillars of the future FAIR facility in Darmstadt. In the scope of the PANDA FAIR Phase-0 project, the backward electromagnetic calorimeter (EMC) of Panda will be used at the Mainz Microtron (MAMI) accelerator to determine the neutral pion transition form factor, which is a crucial ingredient to reduce the uncertainty of the theoretical calculation of the muon anomalous magnetic moment. Together with an improved experimental uncertainty, this will allow to shed light on the muon g-2 puzzle.

In this contribution, the current status of the detector assembly for the PANDA Fair Phase-0 version of the backward EMC will be summarised. In addition, the first efforts to install the experiment at MAMI will be discussed.

HK 48.2 Wed 17:45 SCH/A316

Search for $J/\psi \to p\bar{p}e^+e^-$ decays at the BESIII experiment — •Saskia Plura, Achim Denig, and Christoph Florian Redmer for the BESIII-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

In 2016, the ATOMKI collaboration proposed the existence of a new neutral boson with a mass of 17 MeV to explain their observation of a significant enhancement in the angular correlations of e^+e^- pairs in nuclear transitions of ^{8}Be and ^{4}He. This new particle, referred to as the X17 boson, sparked interest in the particle physics community.

As the X17 should couple to nucleons, the decay $J/\psi \to p\bar{p}e^+e^-$ has been selected as a potential channel for X17 searches, where the (anti-)proton radiates off an X17, which subsequently decays to an e^+e^- pair. The concurrent QED process offers the possibility to measure the timelike proton form factor in the unphysical region. However, the decay has not yet been measured. The BESIII experiment, located at the BEPCII collider in Beijing, China, has collected a data sample of $10^{10}\,J/\psi$ events.

In this talk, the current status of the search for the decay of $J/\psi \to p\bar{p}e^+e^-$ at the BESIII experiment is presented.

Supported by PRISMA$^+$ Cluster of Excellence.

HK 48.3 Wed 18:00 SCH/A316

Luminosity Determination for the FAIR Phase-0 Beamtime to Study Hyperon Production with HADES — •Gabriela Perez Andrade[1,2], James Ritman[1,2], and Peter Wintz[2] for the HADES-Collaboration — [1]GSI, Helmholtzzentrum für Schwerionenforschung GmbH, Planckstraße 1, 64291 Darmstadt, Germany — [2]Wilhelm-Johnen-Straße, 52428 Jülich

New data on hyperon production have been measured with the upgraded HADES Spectrometer, including the new Forward Detector components (FD). These measurements used a proton beam of 4.5 GeV kinetic energy impinging onto a fixed liquid hydrogen target. Proton-proton elastic scattering with one proton going in the FD ($3^\circ < \theta_{FD} < 6^\circ$) and the other proton in the main HADES acceptance ($70^\circ < \theta_H < 79^\circ$) has a high differential cross-section. This reaction is used to calibrate the FD and determine the integrated luminosity. Event selection is based on the kinematic observables, and the integrated luminosity is calculated considering the elastics yield, the elastic scattering cross-section interpolated from measurements in other experiments, and a correction factor that accounts for the reconstruction efficiency in the FD. Preliminary results of the integrated luminosity for the beamtime will be presented in this talk.

HK 48.4 Wed 18:15 SCH/A316

Study of Elastic Muon-Electron Scattering as Energy Calibration Process for the Proton Radius Measurement at AMBER* — Christian Dreisbach, Karl Eichhorn, Jan Friedrich, •Simon Helbing, Igor Konorov, Martin Losekamm, Stephan Paul, and Thomas Pöschl — Technische Universität München, Physik-Department E18, Garching, Germany

The proton radius can be determined by measuring the slope of the electric form factor G_E at small squared four-momentum transfer Q^2. Numerous elastic scattering and laser spectroscopy measurements of the proton radius have been performed with contradicting results – the so-called proton radius puzzle. We propose to measure the proton radius in high-energy elastic muon-proton scattering at the M2 beam line of CERN's Super Proton Synchrotron in the year 2023. A high-precision measurement at low Q^2 implemented using a high-pressure hydrogen TPC can contribute to a solution of the puzzle, especially in view of the systematics of this approach compared to electron scattering. The kinematic relation in elastic muon-electron scattering is foreseen as calibration process for the momentum of the incoming muon. Data collected in a pilot run in 2021 is used to study the resolutions and methods under comparable conditions to the proposed setup. We present results of the ongoing analysis and developments towards a possible application in the final setup.

*funded by the DFG under Germany's Excellence Strategy - EXC2094 - 390783311

HK 48.5 Wed 18:30 SCH/A316

Study of η and η' Production in Double-Tagged Two-Photon Scattering — •Maurice Anderson, Achim Denig, Christoph Florian Redmer, and Max Lellmann for the BESIII-Collaboration — JGU Mainz

The g-2 puzzle describes a 4.2 σ discrepancy between the experimental measurements of the muon's magnetic moment and the Standard Model prediction. In order to determine whether this observed deviation is a significant discovery of possible Beyond the Standard Model physics, the measurement uncertainty must be reduced. The primary source of systematic error stems from the hadronic quantum fluctuations affecting the muon, specifically the hadronic vacuum polarization (HVP) and the hadronic light-by-light (HLbL) scattering contributions. The HLbL term is dominated by the exchange of pseudoscalar mesons.

In this talk, the production of η and η' mesons via two virtual space-like photons will be studied. Double-tagged measurements are conducted at the BESIII experiment in Beijing, China, in which both virtual photons possess nonzero momentum transfers (Q^2). The transition form factor needed for the calculation of the HLbL contribution is determined in dependence of both Q^2-values.

HK 48.6 Wed 18:45 SCH/A316

Study of neutral-pion pair production in two-photon scattering at BESIII — •Max Lellmann, Achim Denig, and Christoph Florian Redmer — Johannes Gutenberg-Universität Mainz

The anomalous magnetic moment of the muon, a_μ, is one of the most precisely measured observables of the Standard Model, yet it shows a discrepancy of about 4.2σ between Standard Model prediction and measurement. It is still under discussion whether this discrepancy is a hint for New Physics or a proof for the poor understanding of strong interaction at low energies. To get a better understanding of this discrepancy, one needs to reduce the uncertainty of both, the Standard Model prediction and the direct measurement. Since the uncertainty of the Standard model prediction is dominated by hadronic contributions, it is crucial to gather more information about the contributing hadronic processes.

Information on the production of pion pairs in two-photon fusion processes plays an important role in the calculation of the hadronic light-by-light scattering contribution to a_μ. The BESIII experiment, located at the institute of high energy physics in Beijing/China, offers a perfect testbed for the investigation of two-photon processes at small momentum transfers. The process $e^+e^- \to e^+e^-\pi^0\pi^0$ is measured at the BESIII experiment at centre-of-mass energies between 3.77 and 4.6 GeV with a total integrated luminosity of more than 10 fb^{-1}. This presentation will discuss the current status of the analysis.

HK 49: Structure and Dynamics of Nuclei IX

Time: Wednesday 17:30–19:00 Location: SCH/A118

HK 49.1 Wed 17:30 SCH/A118

Measurements of the reaction cross sections of neutron-rich Sn isotopes at R^{3}B setup. — •Eleonora Kudaibergenova[1], Thomas Aumann[1,2,4], Martina Feijoo Fontan[5], Andrea Horvat[1,3], Ivana Lihtar[3], Valerii Panin[2], and Dominic Rossi[1,2] for the R3B-Collaboration — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany — [3]Rudjer Boskovic Institute, Zagreb, Croatia — [4]Helmholtz Forschungsakademie HFHF — [5]IGFAE, Universidad de Santiago de Compostela, Spain

The equation of state (EoS) is fundamental for understanding the structure of nuclear matter.The study of asymmetric nuclear matter via properties of neutron-rich nuclei became a current focus of investigation.The asymmetry term of the nuclear EoS is expressed by the symmetry energy at saturation J and its slope L, which has not yet been constrained well experimentally. It has been identified that a precise determination of the neutron removal cross section of neutron-rich nuclei, which is directly related to the neutron skin, would provide a much better constraint on L. To this end, an experiment was performed with the neutron-rich tin isotopes in the mass range A=124-134 on ^{12}C targets at the R^{3}B setup at the GSI/FAIR facility in inverse kinematics with very large acceptance. In this report, the current detector calibration, analysis status is presented.

This project was supported by the BMBF project No. 05P21RDFN2, the Helmholtz Research Academy Hessen for FAIR, and the GSI-TU Darmstadt cooperation.

HK 49.2 Wed 17:45 SCH/A118

Investigation of γ-softness: Lifetime measurements in ^{104,106}Ru — •Arwin Esmaylzadeh[1], Andrey Blazhev[1], Kosuke Nomura[2], Jan Jolie[1], Marcel Beckers[1], Christoph Fransen[1], Rosa-Belle Gerst[1], Andreas Harter[1], Vasil Karayonchev[1,3], Lukas Knafla[1], Mario Ley[1], and Franziskus von Spee[1] — [1]Insitute for Nuclear Physics, University of Cologne — [2]Department of Physics, University of Zagreb — [3]TRIUMF, Canada

Lifetimes of the 2_1^+, 4_1^+, 6_1^+, 2_γ^+ and 3_γ^+ states in ^{104,106}Ru were measured using the recoil distance Doppler shift technique and the Cologne Plunger device. Low-lying excited states in both nuclei were populated in a ^{104}Ru(^{18}O, ^{18}O)^{104}Ru* inelastic scattering and in a ^{104}Ru(^{18}O, ^{16}O)^{106}Ru two-neutron transfer reaction using the Cologne FN Tandem accelerator. The experimental energy levels and deduced electromagnetic transition probabilities are compared in the context of γ-softness and the mapped interacting boson model with input from the microscopic self-consistent mean-field calculation using a Gogny interaction [1]. The newly obtained results for the γ band, give a more detailed insight about the triaxial behavior of ^{104,106}Ru. The results will be discussed in the context of γ soft and rigid triaxial behavior which is present in the neutron-rich Ru isotopes [2]. This work supported by BMBF erbundprojekt 05P2021 (ErUM-FSP T07) grant 05P21PKFN1.

[1] K. Nomura et al., Phys. Rev. C 94, 044314 (2016)
[2] A. Esmaylzadeh et al., Phys. Rev. C (accepted in PRC) (2022)

HK 49.3 Wed 18:00 SCH/A118

Lifetime measurement of neutron rich Xe isotopes applying Fast-Timing method — •Andi Messingschlager[1], Martin von Tresckow[1], Thorsten Kröll[1], Matthias Rudigier[1], Andrey Blazhev[2], Julia Fischer[2], Sorin Pascu[3], and Jonathan N. Wilson[4] for the nu-Ball2 N-SI-120-Collaboration — [1]TU Darmstadt — [2]U Cologne — [3]U Surrey — [4]IJCLab Orsay

^{142}Xe is a neutron rich even-even isotope which lies between the double shell closure N = 82 and Z = 50 and a region in which an increased quadrupole and octupole collectivity is expected [1,2]. The lifetimes of excited states of ^{142}Xe are located in the range of some picoseconds. In this time range the Fast-Timing method is suited to determine the lifetime of exited states. Since there are different results for the lifetimes of excited states of the Xe-isotopes in experiments using the Fast-Timing method [1] and Coulomb exitation [2]. Therefore, we are going to analyse the data taken following the fission of ^{238}U induced by a pulsed neutron beam of 1.7 MeV energy from the LICORNE neutron source. The nu-Ball2 multidetector array consisted of 24 HPGe Clover detectors and 20 $LaBr_3$(Ce) detectors which promise excellent energy and time resolution, respectively. The campaign was performed at IJCLab in Orsay, France. Preliminary results will be presented. Supported by BMBF under Verbundprojekt 05P2021 (ErUM-FSP T07) grant 05P21RDFN1 and ARIEL

[1] S. Ilieva et al., PRC 94, 034302 (2016).
[2] C. Henrich, Dissertation TU Darmstadt (2020)

HK 49.4 Wed 18:15 SCH/A118

Gamma-ray spectroscopy of neutron-rich ^{55,57,59}Sc isotopes — •Radostina Zidarova[1], Martha Liliana Cortés[2], Volker Werner[1], Pavlos Koseoglou[1], Norbert Pietralla[1], Pieter Doornenbal[2], and Alexandre Obertelli[1] — [1]TU Darmstadt, Germany — [2]RIKEN-RIBF, Japan

Experimental data have shown that far from the valley of stability new magic numbers can emerge and the traditional ones can disappear. In particular, two new magic numbers at N=32 and N=34 have been suggested in the vicinity of Z=20 based on gamma-ray spectroscopy and mass measurements. In order to assess the impact of a single valence proton outside of the Z=20 shell on the shell-evolution mechanism in this region, it is necessary to study the neutron-rich Sc isotopes around, and even beyond, neutron number N=34. Investigation of exotic nuclei in this region was the goal of the third SEASTAR campaign at RIKEN-RIBF. Neutron-rich isotopes in the vicinity of ^{53}K were produced by fragmentation of a primary ^{70}Zn beam on a ^{9}Be target. Known and new γ-ray transitions of the isotope ^{55}Sc were observed and new γ-rays from ^{57,59}Sc identified for the first time. Observed γ spectra from ^{55,57,59}Sc will be presented together with preliminary level schemes. They will be discussed in the framework of the tensor-driven shell evolution.

Supported by BMBF under Grant Nos. 05P19/21RDFN1.

HK 49.5 Wed 18:30 SCH/A118

Lifetime measurements of excited states in ^{57}Mn — •Hannah Kleis, Peter Reiter, Konrad Arnswald, Maximilian Droste, Andrey Blazhev, Ramona Burggraf, and Cristoph Fransen — Institut für Kernphysik, Universität zu Köln

Previously, the $N = 32$ subshell closure was observed in the even-even Ca-, Ti-, and Cr-isotopes [1]. Adding more valence protons to the $\pi(f_{7/2})$ orbital reduces the shell gap at $N = 32$ which vanishes completely at $^{58}_{26}$Fe. Lifetime measurements in the odd-even ^{57}Mn nucleus were performed in order to close the gap between $Z = 24$ and $Z = 26$. Excited states of ^{57}Mn were populated via ^{55}Mn(^{18}O, ^{16}O)^{57}Mn two-neutron transfer reactions at a beam energy of 38 MeV employing the FN tandem accelerator at the University of Cologne. The Doppler-shift attenuation method is utilized to determine new lifetimes for the $11/2_1^-$ and $9/2_1^-$ states. The experimentally determined transition probabilities are confronted with results from the GXPF1A shell-model interaction along the Mn-isotopes. The experimental findings in ^{57}Mn are well reproduced by this interaction. The comparison of excitation energies and $B(E2)$ strengths is extended to all odd-even nuclei between Ca and Ni with neutron numbers $N = 26$ and $N = 36$ in order to discuss the nature of the $N = 32$ subshell closure.

[1] D. Steppenbeck *et al.*, Nature 502, 7470 (2013)

HK 49.6 Wed 18:45 SCH/A118

Lifetime measurements of neutron-rich Kr isotopes within the nu-Ball2 fission campaign — •J. Fischer[1], A. Blazhev[1], C. Hiver[2], J. Jolie[1], A. Messingschlager[3], S. Pascu[4], M. von Tresckow[3], N. Warr[1], and J. N. Wilson[2] for the nu-Ball2 N-SI-120-Collaboration — [1]U Cologne — [2]IJCLab Orsay — [3]TU Darmstadt — [4]U Surrey

Nuclei beyond the band of stability are crucial to our understanding of the atomic nucleus and nuclear forces. In recent years, neutron-rich krypton isotopes have been studied as part of various campaigns. New gamma-transitions and levels were discovered in the first nu-Ball and SEASTAR-2015 campaigns [1,2] which compared to theory indicated oblate-prolate shape coexistence already in ^{96}Kr [2]. However, the limited information on transition strengths did not allow for firm conclusions. Therefore lifetime measurements were performed at the IJCLab Orsay as part of the nu-Ball2 fission campaign. The nuclei of interest were produced with a fast-neutron-induced fission reaction ^{238}U(n,f). The improved multidetector-array (nu-Ball2), a novel hybrid γ-spectrometer consisting of HPGe and LaBr3(Ce) detectors provided excellent energy and timing information, respectively. The fast-timing method allows for lifetime determination down to about 10 ps and thus a possibility to determine transition strengths in the nuclei of interest. Preliminary results will be presented. *Supported by BMBF under Verbundprojekt 05P2021 (ErUM-FSP T07) grant 05P21PKFN1. / [1] R.-B. Gerst et al., PRC 102, 064323 (2020). ; [2] R.-B. Gerst et al., PRC 105, 024302 (2022).

HK 50: Structure and Dynamics of Nuclei X

Time: Wednesday 17:30–19:00 Location: SCH/A215

Group Report HK 50.1 Wed 17:30 SCH/A215

Measuring Photo-Absorption Cross Sections with Tagged Photons at NEPTUN — •Martin Baumann[1], Thomas Aumann[1,2], Maike Beuschlein[1], Isabelle Brandherm[1], Meytal Duer[1], Amrita Gupta[1], Phillip Imgram[1], Andrea Jedele[1], Liancheng Ji[1], Igor Jurosevic[1], Marco Knösel[1], Nikolina Lalic[1], Enis Lorenz[1], Hannes Mayr[1], Leandro Milhomens da Fonseca[1], Nikhil Mozumdar[1], Ann Rochele Netto[1], Oliver Papst[1], Thomas Pohl[1], Heiko Scheit[1], Gerhart Steinhilber[1], Sonja Storck-Dutine[1], Dmytro Symochko[1], Iyabo Usman[3], and Patrick van Beek[1] — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]GSI Helmholtzzentrum, Darmstadt, Germany — [3]University of the Witwatersrand, Johannesburg, South Africa

The photon tagger NEPTUN at the superconducting linear electron accelerator S-DALINAC has been upgraded to enable high precision measurements of nuclear photo-absorption cross sections in the energy region up to 35 MeV, covering the giant dipole resonance region using tagged bremsstrahlung with a single configuration. For this purpose a new focal plane detector LARISSA and

a rapid target changer PROTEUS have been commissioned. This setup has recently been used to measure the photo-absorption cross sections of the isotopes Sn-112,116,120,124,Ca-40 and Ca-48. In this talk the method will be outlined and performance characteristics of the setup will be shown as well as preliminary data from the recent beam time.
This work was supported by the Deutsche Forschungsgemeinschaft under Contract No. SFB 1245 (Project ID No. 279384907)

HK 50.2 Wed 18:00 SCH/A215

Self-absorption experiments with quasi-monochromatic photon beams: Model-independent level widths with high precision — •D. Savran[1], J. Isaak[2], A.D. Ayangeakaa[3,4], M. Beuschlein[2], S.W. Finch[4,5], D. Gribble[2], A. Gupta[2], J. Hauf[2], R.V.F. Janssens[3,4], S.R. Johnson[3,4], P. Koseoglou[2], T. Kowalewski[3,4], B. Löher[1], O. Papst[2], N. Pietralla[2], A. Saracino[3,4], N. Sensharma[3,4], and V. Werner[2] — [1]GSI, Darmstadt — [2]IKP, TU Darmstadt — [3]UNC, Chapel Hill, NC, USA — [4]TUNL, Durham, NC, USA — [5]Duke U., Durham, NC, USA

We have developed a novel variation of the relative self-absorption (RSA) technique in order to adapt this method to quasi-monochromatic photon beams produced via Laser-Compton Backscattering (LCB) [1]. The approach combines the advantages of LCB beams with the model-independent determination of level widths via the RSA method. In this contribution the method itself as well as preliminary results of its pioneering application to measure the B(E2, $0_1^+ \rightarrow 2_1^+$) transition strength of the first excited state in ^{12}C to a precision of better than 2% will be presented.
Supported by the State of Hesse, grant "Nuclear Photonics" (LOEWE program) and the Research Cluster ELEMENTS (Project-ID 500/10.006), the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Project-ID 279384907 - SFB 1245 and the U. S. DOE Grant No. DE-FG02-97ER41041 and No. DE-FG02-97ER41033.
[1] D. Savran and J. Isaak, Nucl. Inst. and Meth. A 899, 28 (2018).

HK 50.3 Wed 18:15 SCH/A215

Self-absorption experiments with quasi-monochromatic photon beams: A new approach to nuclear level densities — •J. Isaak[1], D. Savran[2], A.D. Ayangeakaa[3,4], M. Beuschlein[1], S.W. Finch[4,5], A. Gupta[1], D. Gribble[3,4], J. Hauf[1], R.V.F. Janssens[3,4], S.R. Johnson[3,4], P. Koseoglou[1], T. Kowalewski[3,4], B. Löher[2], O. Papst[1], N. Pietralla[1], A. Saracino[3,4], N. Sensharma[3,4], and V. Werner[1] — [1]IKP, TU Darmstadt — [2]GSI, Darmstadt — [3]UNC, Chapel Hill, NC, USA — [4]TUNL, Durham, NC, USA — [5]Duke U., Durham, NC, USA

The modeling of the elemental abundances in the universe requires, among others, information on the nuclear level density (NLD) of isotopes across the nuclear chart from stable to unstable nuclides. While it can be determined at the lowest excitation energies and from neutron resonances, it is a difficult quantity to access at intermediate excitation energies. In fall 2022, a pioneering experiment with ^{88}Sr was performed at HIγS exploiting the combination of the self-absorption technique with quasi-monoenergetic photon beams. A novel approach is introduced enabling the extraction of the NLD of dipole-excited states with photonuclear reactions and first results for the case of ^{88}Sr are presented.
Supported by the State of Hesse, grant "Nuclear Photonics" (LOEWE program) and the Research Cluster ELEMENTS (Project-ID 500/10.006), the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation - Project-ID 279384907 - SFB 1245 and the U. S. DOE Grant No. DE-FG02-97ER41041 and No. DE-FG02-97ER41033.

HK 50.4 Wed 18:30 SCH/A215

Lifetime measurements of excited states in ^{59}Ni and ^{57}Fe — •Ramona Burggraf, Erik Gassmus, Peter Reiter, Konrad Arnswald, Andrey Blazhev, Maximilian Droste, Christoph Fransen, and Hannah Kleis — IKP, Universität zu Köln

Lifetime measurements of excited states in nuclei along the $N = 31$ chain were used to corroborate the $N = 32$ sub-shell closure [1], as done previously in ^{55}Cr [2]. Systematic studies including the neighboring $N = 31$ isotones suffer from imprecise experimental values. Excited states in ^{59}Ni and ^{57}Fe have been populated in ^{51}V(^{12}C, $p3n$) and ^{51}V(^{12}C, $pn\alpha$) fusion-evaporation reactions at a beam energy of 55 MeV at the FN tandem accelerator of the University of Cologne. The Cologne plunger device, surrounded by an efficient γ-ray detector array was employed to determine lifetimes with the recoil-distance Doppler-shift method and the differential decay-curve method. Lifetimes and reduced transition strengths for several excited states in ^{59}Ni and ^{57}Fe were determined. Considerable deviations from previous experimental findings were observed. Comparison with results from new shell-model calculations employing the GXPF1A interaction show remarkable agreement with the present values.
[1] D. Steppenbeck et al., Nature 502, 7470 (2013)
[2] H.Kleis et al., Phys. Rev. C 104, 034310 (2021)

HK 50.5 Wed 18:45 SCH/A215

Lifetime Measurement of the 2_1^+ and 4_1^+ states in ^{60}Ni using the RDDS method — •Marcel Beckers[1], Claus Müller-Gatermann[2], Konrad Arnswald[1], Alfred Dewald[1], Felix Dunkel[1], Christoph Fransen[1], Lisa Kornwebel[1], Casper-David Lakenbrink[1], and Franziskus von Spee[1] — [1]Institut für Kernphysik, Universität zu Köln — [2]Argonne National Lab, USA

At ^{60}Ni and surrounding Ni isotopes one can find a quite confusing situation regarding the existing experimental results. There are several data sets giving quadrupole transition strengths for the $2_1^+ \rightarrow 0_1^+$ and the $4_1^+ \rightarrow 2_1^+$ transitions that are in disagreement with each other and would lead to different physical interpretations.
Therefore, a high-precision γ-γ coincidence Recoil Distance Doppler-Shift measurement has been carried out on ^{60}Ni to re-measure the lifetime of the 2_1^+ and 4_1^+ states. The new lifetime of the 2_1^+ state supports the adopted NNDC value but disagrees with the results of two more recent Doppler-Shift Attenuation Method measurements, which suggested a longer lifetime. The new result for the 4_1^+ state's lifetime is significantly shorter than the one recommended in the latest NNDC compilation while also reducing its uncertainty. It therefore resolves an unclear situation, where an unexpected drop in transition strength appeared from ^{58}Ni to ^{60}Ni. Both values match very well with recently applied shell model calculations using the GXPF1A interaction.
Supported by the DFG, grant Nos. FR 3276/2-1 and DE 1516/5-1.

HK 51: Fundamental Symmetries III

Time: Wednesday 17:30–19:15 Location: SCH/A252

Group Report HK 51.1 Wed 17:30 SCH/A252

Recent results of NA64 for Dark Matter searches at CERN — •Michael Hösgen and Bernhard Ketzer for the NA64-Collaboration — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

We report on the recent activity of the NA64 experiment at the SPS of CERN. The NA64 experiment uses an active beam-dump setup to conduct missing energy searches with high-intensity lepton beams (e or mu).

Since 2016 several dedicated searches for new mediators between standard model and dark sector were performed, most notably a light vector boson A' and a short-lived neutral boson X(17). The A' was proposed as a possible explanation for magnetic-moment anomalies of muons. At NA64 it could be created in electron-on-target reactions $e^-Z \rightarrow e^-ZA'$ and supposedly decay invisibly into lighter dark-sector particles ($A' \rightarrow \chi\bar{\chi}$). The X is motivated by an excess of e^+e^--pairs in ^{8}Be* excited state nuclear transitions. At NA64 it could be produced in bremsstrahlung interactions $e^-Z \rightarrow e^-ZX$ and decay into standard model leptons ($X \rightarrow e^+e^-$).

Starting in 2021, the search for a dark portal was expanded with a dedicated setup using a muon beam at the M2 beamline at the SPS of CERN. In 2022, a pilot run using an e^+ beam for resonant A' production in our active target was performed.

We present an overview over the experimental setups and analysis strategies, as well as the updated results until 2022.

Group Report HK 51.2 Wed 18:00 SCH/A252

The P2 experiment — Sebastian Baunack[1], Maarten Boonekamp[4], Boris Gläser[1], Rahima Krini[1], Frank Maas[1,2,3], Tobias Rimke[1], David Rodriguez Pineiro[2], and •Malte Wilfert[1] for the P2-Collaboration — [1]Institut für Kernphysik, Johannes Gutenberg-Universität Mainz — [2]Helmholtz-Institut Mainz, Johannes Gutenberg-Universität Mainz — [3]PRISMA+ Cluster of Excellence, Johannes Gutenberg-Universität Mainz — [4]IRFU, CEA, Université Paris-Saclay, Gif-sur-Yvette, France

The weak mixing angle $\sin^2\theta_W$ can be measured in parity violating elastic electron-proton scattering. The aim of the P2 experiment is a very precise measurement of the weak mixing angle with an accuracy of 0.15% at a low four-momentum transfer of $Q^2 = 4.5 \cdot 10^{-3}\,\mathrm{GeV}^2$. In combination with existing measurements at the Z pole with comparable accuracy, this comprises a test of the standard model with a sensitivity towards new physics up to a mass scale of 50 TeV. The experiment will be built at the future MESA accelerator in Mainz. In this talk, the motivation and challenges for this measurement will be discussed together with ideas for measurements at lower beam energies, which will be available at the start of MESA.

Group Report HK 51.3 Wed 18:30 SCH/A252

Light Dark Matter Searches at DarkMESA — •Maik Biroth for the MAGIX-Collaboration — Institute of Nuclear Physics, Johannes Gutenberg University, Mainz, Germany

The DarkMESA beam dump experiment will search for light dark matter particles. It will be placed behind the P2 experiment at the future MESA electron accelerator, where an unprecedented amount of electrons-on-target can result in the radiative production of dark photons. In various models, such a dark photon decays predominantly into a pair of dark matter particles in the sub-GeV range. These will be detected by a sophisticated setup based on a solid and reliable detection technology.

In this talk, the development status of the detector system and the estimated exclusion limits will be presented.

HK 51.4 Wed 19:00 SCH/A252

Search for axion-like particles from Higgs boson decays in the 4 electron final state using the ATLAS detector — •Georgios Lamprinoudis, Matthias Schott, and Kristof Schmeiden for the ATLAS-Collaboration — Johannes Gutenberg Universitat Mainz

Axion-like particles (ALPs) are motivated by numerous theoretical models, including the two-Higgs-doublet model (2HDM). ALPs can also couple to the Higgs boson and may decay to leptons. The coupling of ALPs to leptons defines their life-time and hence might lead to displaced decay vertices in the detector. While previous analyses assumed a negligible axion lifetime, a finite lifetime with displaced vertex signatures is studied in the present analysis of the h->aa->4e channel. The analysis covers a mass range of the axions from 0.5 GeV to 60 GeV. In the case that no signal is observed, the analysis will establish upper limits on the axion-Higgs coupling.

HK 52: AI Topical Day – Invited Talks (joint session AKPIK/HK/ST/T/AKBP)

Time: Thursday 11:00–12:30 Location: HSZ/AUDI

Invited Talk HK 52.1 Thu 11:00 HSZ/AUDI

AI Techniques for Event Reconstruction — •Ivan Kisel — Goethe University, Frankfurt, Germany

Why can we relatively easily recognize the trajectory of a particle in a detector visually, and why does it become so difficult when it comes to developing a computer algorithm for the same task? Physicists and computer scientists have been puzzling over the answer to this question for more than 30 years, since the days of bubble chambers. And it seems that we are steadily approaching the answer in our attempts to develop and apply artificial neural networks both for finding particle trajectories and for physics analysis of events in general.

This talk will present the basics of artificial neural networks in a simple form, and provide illustrations of their successful application in event reconstruction in high energy physics and heavy ion physics experiments. You will get an insight into the application of traditional neural network models, such as deep neural network, convolutional neural network, graph neural network, as well as those standing a little aside from traditional approaches, but close in idea of elastic network and even cellular automata.

Invited Talk HK 52.2 Thu 11:30 HSZ/AUDI

Accelerator operation optimisation using machine learning — •Pierre Schnizer — Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Berlin, Germany

Accelerators are complex machines whose many components need to be accurately tuned to achive design performance. Reliable operation requires frequent recalibration and tuning. Especially for large machines tools have been developed that facilitating this task.

Machine learning allows building such tools using simulations, archiver data or interaction with the real machine, thus making many tools now also available for smaller machines.

This talk will give an overview of different machine learning projects targeted to accelerators, which simplifies accelerator operation or even enable applications not been possible before.

Invited Talk HK 52.3 Thu 12:00 HSZ/AUDI

Is this even physics? – Progress on AI in particle physics — •Gregor Kasieczka — Universität Hamburg

Motivated by the large volume and high complexity of experimental data and mathematical structures, particle physics has a long tradition of employing state of the art computing and analysis techniques. Recent progress in machine learning and artificial intelligence have further pushed this trend, and these approaches are now ubiquitous in our field. This overview attempts to capture key developments such as the rise of unsupervised approaches and the quest for suitable neural network architectures for physics tasks; challenges like ultra-low latency inference and robust predictions; as well as promising new ideas looking forward.

HK 53: AI Topical Day – Computing II (joint session HK/AKPIK)

Time: Thursday 14:00–15:30 Location: HSZ/0103

HK 53.1 Thu 14:00 HSZ/0103

Exploiting Differentiable Programming for the End-to-end Optimization of Detectors — The MODE Collaboration[1] and •Anastasios Belias[2] — [1]mode-collaboration.github.io — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

Machine-learning Optimized Design of Experiments, the MODE Collaboration, targets the end-to-end optimization of experimental apparatus, by using techniques developed in modern computer science to fully explore the multidimensional space of experiment design solutions. Differentiable Programming is employed to create models of detectors that include stochastic data-generation processes, the full modeling of the reconstruction and inference procedures, and a suitably defined objective function, along with the cost of any given detector configuration, geometry and materials.

The MODE Collaboration considers the end-to-end optimization challenges in its generality, providing software architectures for machine learning to explore experiment design strategies, information on the relative merit of different configurations, with the potential to identify and investigate novel, possibly revolutionary solutions. In this contribution we present use cases, and highlight the potential for on-going and future experiment design studies in fundamental physics research.

HK 53.2 Thu 14:15 HSZ/0103

Klassifikation von Pulsdaten mit neuronalen Netzwerken auf einer FPGA Accelerator Card — •Robert Ufer, Bastian Auer, Helene Hoffmann, Oliver Knodel, Mani Lokamani und Stefan Müller — Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

Zur Analyse der entstehenden Detektordaten bei dem Mu2e Experiment am Fermilab soll die Datenauswertung mit Field Programmable Gate Array (FPGA) erfolgen. Diese übernehmen die notwendige Vorverarbeitung und Reduktion der Messdaten, noch während der Durchführung der Messung. Die dabei ausgeführten Anwendungen werden standardmäßig durch Algorithmen realisiert. Eine dieser Anwendungen führt die Klassifikation der ermittelten Pulsdaten durch. Mit den Testläufen an der gELBE Bremstrahlungs-Beamline am Helmholtz-Zentrum Dresden-Rossendorf (HZDR) konnte für das zukünftige Experiment eine große Menge dieser Datensätze erfasst werden. Diese dienen zur Charakterisierung des Detektorsystems und wurden mit einem Lanthanbromid (LaBr) Detektor gemessen. Für die Pulsdatenklassifikation wird auf der Basis des Algorithmus und der erfassten Datensätze, ein neuronales Netzwerk erstellt, trainiert und validiert. Um bei diesen Schritten etablierte Machine Learning Frameworks zu verwenden, wird für die Portierung des Netzwerks in eine High-Level Synthese (HLS) Sprache die Software hls4ml verwendet. Dabei werden verschiedene Konfigurationen genutzt, um unterschiedlich optimierte Implementierungen zu generieren. Zum Evaluieren erfolgt die Ausführung der Implementierungen auf einer Xilinx Alveo Accelerator Card.

HK 53.3 Thu 14:30 HSZ/0103

Pattern recognition using machine learning for the mCBM mRICH detector — •Martin Beyer for the CBM-Collaboration — Justus-Liebig-Universität Gießen

The Compressed Baryonic Matter experiment (CBM) is designed to explore the QCD phase diagram at high baryon densities using high-energy heavy ion collisions at high interaction rates. The Ring Imaging Cherenkov detector (RICH) contributes to the overall particle identification by reconstruction of rings from electrons with their respective radius, position and time. The miniCBM (mCBM) detector is the test setup for the CBM experiment, with the purpose of testing both hardware and software including the triggerless free-streaming data acquisition and data reconstruction algorithms. The miniRICH (mRICH) detector in the mCBM setup is a proximity focussing RICH detector with a photon detection plane consisting of 36 MultiAnode Photo Multipliers (MAPMTs). This setup results in charged particles passing directly through the MAPMTs resulting in quite some additional signals typically inside ring structures and reducing the overall ring finding efficiency based on the Hough Transformation.

In this talk a machine learning approach is presented to classify those signals in ring centers and thus improving the overall ring finding efficiency and precision.

HK 53.4 Thu 14:45 HSZ/0103

Machine Learning Algorithms for Pattern Recognition with the PANDA Barrel DIRC — •Yannic Wolf[1,2], Roman Dzhygadlo[1], Klaus Peters[1,2], Georg Schepers[1], Carsten Schwarz[1], and Jochen Schwiening[1] — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt — [2]Goethe-Universität Frankfurt

Precise and fast hadronic particle identification (PID) is crucial to reach the physics goals of the PANDA detector at FAIR. The Barrel DIRC (Detection of Internally Reflected Cherenkov light) is a key detector for the identification of charged hadrons in PANDA. Several reconstruction algorithms have been developed to extract the PID information from the measured location and arrival time of the Cherenkov photons. In comparison to other Ring Imaging Cherenkov detectors, the hit patterns observed with DIRC counters do not appear as rings on the photosensor plane but as complex, disjoint 3D-patterns.

Using the recent advances in machine learning (ML) algorithms, especially in the area of image recognition, we plan to develop new ML PID algorithms for the PANDA Barrel DIRC and compare the results to conventional reconstruction methods. In search for the best performance, different network architectures are currently under investigation.

HK 53.5 Thu 15:00 HSZ/0103

Optimization of the specific energy loss measurement for the upgraded ALICE TPC using machine learning — •Tuba Gündem for the ALICE Germany-Collaboration — Institut fuer Kernphysik, Frankfurt, Germany

The Time Projection Chamber (TPC) is the primary detector used in the ALICE experiment for tracking and particle identification (PID). PID is accomplished by reconstructing the momentum and the specific energy loss ($\mathrm{d}E/\mathrm{d}x$) of a particle. The $\mathrm{d}E/\mathrm{d}x$ for a given track is calculated using a truncated mean on the charge signals associated to the track. The readout plane, on which the signals are measured, is radially subdivided into four regions with different pad sizes. Since the measured signals depend on the pad size, an optimization of the $\mathrm{d}E/\mathrm{d}x$ calculation based on the pad size can be performed.

In this talk, a method for optimizing the $\mathrm{d}E/\mathrm{d}x$ calculation using machine learning (ML) algorithms will be presented. By performing realistic simulations of the generated signals on the pads, various effects such as the different pad sizes and track geometry are modeled. These simulations are used as inputs for the training of the ML model and are investigated using RootInteractive.

Supported by BMBF and the Helmholtz Association.

HK 53.6 Thu 15:15 HSZ/0103

Deep Leaning Based PID with the HADES detector — •Waleed Esmail[1] and James Ritman[1,2,3] for the HADES-Collaboration — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany — [2]Forschungszentrum Jülich, 52428 Jülich, Germany — [3]Ruhr-Universität Bochum, 44801 Bochum, Germany

The main purpose of a particle identification (PID) algorithm is to provide a clean sample of particle species needed to conduct a physics analysis. The conventional approach used in the HADES experiment is to apply the so-called "graphical cuts" around the theoretical Bethe-Bloch curves of the energy loss as a function of the particle momentum. However, this approach is not optimal, since the distributions resulting from the different particle species overlap. A better approach is based on deep learning algorithms. In our preliminary studies done with the p(4.5 GeV)+p data recently collected by HADES, we were able to improve the separation power of the particle species. The algorithm is based on Domain Adversarial Neural Networks (DANN) trained in a semi-supervised way to simultaneously look at simulated and real data to learn the discrepancies between the two data domains. In this talk we will present our preliminary results, which show that this technique significantly improves the classification of particle species in the experimental data.

HK 54: AI Topical Day – Heavy-Ion Collisions and QCD Phases XI (joint session HK/AKPIK)

Time: Thursday 14:00–15:30 Location: HSZ/0105

HK 54.1 Thu 14:00 HSZ/0105

Modelling charged-particle production at LHC energies with deep neural networks — •Maria Calmon Behling for the ALICE Germany-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt, Germany

Particle production at the Large Hadron Collider (LHC) is driven by a complex interplay of soft and hard QCD processes. Modelling these interactions across center-of-mass energies and collision systems is still challenging for Monte Carlo event generators. Concise experimental data is indispensable to characterize the final state of a collision. The ALICE experiment with its unique tracking capabilities down to low transverse momenta is perfectly suited to study the bulk particle production in high-energy collisions. During the data taking campaigns of LHC Run 1 and Run 2 (2009 - 2018), a large amount of data were collected of a variety of collision systems at different center-of-mass energies. A recent measurement of charged-particle production covering all of these collision systems provides a comprehensive set of fundamental observables like the charged-particle multiplicity distributions and transverse momentum spectra as well as their correlation.

In this talk, we discuss the possibility of extending this set of discrete experimental data points into unmeasured regions by means of machine learning techniques. Training deep neural networks with ALICE data gives the unique opportunity to measure the evolution of multiplicity dependent charged-particle production across collision system sizes and energies.

Supported by BMBF and the Helmholtz Association.

HK 54.2 Thu 14:15 HSZ/0105

Measurement of the Λ separation energy in hypertriton with ALICE using machine learning techniques — •Regina Michel for the ALICE Germany-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung — Technische Universität Darmstadt

Hypertriton ${}^3_\Lambda$H is the lightest hypernucleus, consisting of a Λ hyperon, a proton and a neutron. It is structured as a halo nucleus, where the Λ hyperon is very loosely bound to a "deuteron core". Measurements of the Λ separation energy can be used as a test for QCD, for some models of neutron stars and to constrain the possible difference of the lifetimes of ${}^3_\Lambda$H and Λ. The Λ separation energy can be measured via the invariant mass of the hypertriton decay products. The two-body-decay ${}^3_\Lambda\mathrm{H} \rightarrow {}^3\mathrm{He}+\pi$ is considered. Monte Carlo simulations are conducted to simulate the hypertriton interactions and decays while propagating through the detector. A data sample from Pb-Pb collisions at a center-of-mass energy of $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV recorded with ALICE at the LHC is analyzed using machine learning techniques.

HK 54.3 Thu 14:30 HSZ/0105

Physics performance studies on Ξ^- Baryon at CBM — •Lisa-Katrin Kümmerer[1,2], Andrea Dubla[2], and Ilya Selyuzhenkov[2] for the CBM-Collaboration — [1]Physikalisches Institut, Universität Heidelberg — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

The Compressed Baryonic Matter (CBM) experiment at FAIR will investigate the QCD phase diagram in the region of high net-baryon densities (μ_B > 500 MeV) in the collision energy range of $\sqrt{s_{NN}}$ = 2.7 – 4.9 GeV with high interaction rate, up to 10 MHz, provided by the SIS100 accelerator. The (multi)strange baryons are crucial in determining the chemical freeze-out and its connection to hadronization from deconfined QCD matter.

In this contribution the performance for Ξ^- selection in Au-Au collisions at $\sqrt{s_{NN}}$ = 4.93 GeV in the CBM experiment will be presented. The Ξ^- hyperon is reconstructed via the weak decay channel $\Xi^- \rightarrow (\Lambda \rightarrow p\pi^-)\pi^-$ using the Particle-Finder Simple package.

For the reduction of the data size, which is driven by the large combinatorial background, specific skimming pre-selection criteria are optimized in this work. To obtain an optimal and stable separation between signal and background candidates the machine learning tool XGBoost is used. Machine learning allows for efficient, non-linear and multi-dimensional selection criteria to be implemented in a heavy-ion collision environment, enabling to extract and correct the Ξ^- raw yield in different rapidity and transverse momentum intervals.

HK 54.4 Thu 14:45 HSZ/0105

Multi-differential Λ Yield Measurement in the CBM Experiment using Machine Learning Techniques — •Axel Puntke[1] and Shahid Khan[2] for the CBM-Collaboration — [1]Institut für Kernphysik, WWU Münster — [2]Eberhard Karls University of Tübingen

The Compressed Baryonic Matter (CBM) experiment at FAIR will investigate the QCD phase diagram at high net-baryon densities (μB > 500 MeV) with heavy-ion collisions in the energy range of $\sqrt{s}_{\rm NN}$ = 2.9-4.9 GeV. Precise determination of dense baryonic matter properties requires multi-differential measurements of strange hadron yields, both for the most copiously produced K^0_s and Λ as well as for rare (multi-)strange hyperons and their antiparticles.

The strange hadrons are reconstructed using methods based on a Kalman Filter algorithm that has been developed for the reconstruction of particles via their weak decay topology. The large combinatorial background needs to be suppressed by applying selection criteria according to the topology of the decay. This selection is optimized by training a boosted decision tree-based machine learning model with simulated data from two event generators, UrQMD and DCM-QGSM-SMM. After the signal has been selected, the yield of the strange hadron is computed.

In this talk, the analysis procedure for the most abundant Λ baryon is presented and the performance of the non-linear multi-parameter selection method is evaluated. A fitting routine is implemented to extract the Λ yield, on which the performance gain of training a separate model for each p_T-y interval will be discussed.

HK 54.5 Thu 15:00 HSZ/0105

Full beauty-hadron reconstruction with J/ψ: feasibility study for Run 3 with ALICE — •Guillaume Taillepied for the ALICE Germany-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

The study of the production of hidden and open heavy-flavour hadrons in proton-proton (pp) collisions provides an essential test of quantum chromodynamics, involving both the perturbative and non-perturbative regimes. The J/ψ meson allows to study both the charm sector, via the measurement of prompt J/ψ, and the beauty sector through the measurement of the non-prompt component, coming from the decay of beauty hadrons. With the recent upgrades of the ALICE apparatus, the full reconstruction of beauty hadrons in exclusive decay channels containing non-prompt J/ψ mesons is now possible, providing a new way to study beauty physics in hadronic collisions.

In this talk, a feasibility study of the $B^+ \to J/\psi\, K^+$, $J/\psi \to e^+e^-$ process in pp collisions at $\sqrt{s}$ = 13.6 TeV with ALICE will be presented. The analysis makes use of the KFParticle package for a precise reconstruction of the B^+ and non-prompt J/ψ decay chain. The package also provides important information for the training of a machine learning model, increasing the signal selection efficiency and signal-over-background ratio. Discussions on the perspectives in lead-lead collisions for Run 3, based on the results of this feasibility study, will be shown.

HK 54.6 Thu 15:15 HSZ/0105

Photon reconstruction in the Transition Radiation Detector of ALICE — •Peter Stratmann for the ALICE Germany-Collaboration — Institut für Kernphysik, Wilhelm-Klemm-Str. 9, 48149 Münster

The Transition Radiation Detector (TRD) of the ALICE detector at the Large Hadron Collider has the main purpose of identifying electrons and triggering on electrons and jets. Furthermore, it improves the resolution in track reconstruction at high transverse momenta. The working principle is based on transition radiation, which is produced by charged particles transversing boundaries of material with different dielectric constants.

In a rather new approach, the TRD should be used for measuring the photon production through the detection of conversion electrons. This is facilitated by the large material budget located in front and inside of the TRD. For this purpose, stand-alone tracking independent of the Inner Tracking System and the Time Projection Chamber had already been implemented. So far, this is achieved by a Kalman filter. As a new method, the photons are reconstructed in the TRD using Graph Neural Networks. These have the advantage that they operate well on the high-dimensional and sparse nature presented by the TRD data. In this talk, we will present the principles of the TRD, the direct photon reconstruction in the stand-alone tracking, and first results obtained with the Graph Neural Network.

Supported by BMBF within the ERuM framework, and DFG as part of the GRK 2149.

HK 55: Instrumentation XIV

Time: Thursday 14:00–15:30 Location: SCH/A251

Group Report HK 55.1 Thu 14:00 SCH/A251

Different applications of Low Gain Avalanche Detectors — •Felix Ulrich-Pur[1], Tetyana Galatyuk[1,2], Wilhelm Krüger[2], Sergey Linev[1], Jan Michel[3], Jerzy Pietraszko[1], Adrian Rost[4], Michael Traeger[1], Michael Traxler[1], and Christian Joachim Schmidt[1] — [1]GSI GmbH, Darmstadt, Germany — [2]Technische Universität Darmstadt, Darmstadt, Germany — [3]Goethe-Universität, Frankfurt, Germany — [4]FAIR GmbH, Darmstadt, Germany

Low Gain Avalanche Detectors (LGADs) are fast silicon detectors especially designed for high-rate environments. Due to their high spatial granularity ($\leq$ 100μm) and excellent intrinsic time resolution ($\leq$ 100ps), LGADs allow the reconstruction of single particle tracks even at very high track densities.

Within this contribution, we will present several applications of LGAD strip sensors, which were produced at Fondazione Bruno Kessler (FBK). This includes the reaction time (T0) detector for the High Acceptance Di-Electron Spectrometer (HADES) at GSI in Darmstadt, Germany, a beam-structure monitor for the Superconducting Darmstadt LINear Accelerator (S-DLINAC) at the Technische Universität Darmstadt and an ion imaging experiment conducted at the MedAustron cancer therapy and research centre in Wiener Neustadt, Austria.

After discussing first results, we will outline planned upgrades of the current systems and possible future projects at the GSI and FAIR facilities.

HK 55.2 Thu 14:30 SCH/A251

LGAD based Start Detector in HADES — Tetyana Galatyuk[1,2], Vadym Kedych[1], •Wilhelm Krüger[1], Sergey Linev[2], Jan Michel[3], Jerzy Pietraszko[2], Adrian Rost[4], Christian Joachim Schmidt[2], Michael Träger[2], Michael Traxler[2], and Felix Ulrich-Pur[2] — [1]Technische Universität Darmstadt — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt — [3]Goethe Universität Frankfurt — [4]FAIR GmbH

The High Acceptance Di-Electron Spectrometer (HADES) experiment has designed and used a Low Gain Avalanche Detector (LGAD) based in-beam detector for its high rate 4.5 GeV pp production beam time in February 2022. As LGADs offer high-precision timing measurements with high spatial granularity and high radiation hardness, they were the sensors of choice for the in-beam detector.

The detector consisted of two FBK LGADs with a form factor of 2 x 2 cm^2 and 96 half-strips each. It was used for beam monitoring purposes during the beam time and will assist in particle identification by providing a precise reaction time (T0).

This contribution will present the calibration procedure of the detector as well as its performance with respect to the reached timing precision.

HK 55.3 Thu 14:45 SCH/A251

Beam monitoring and T0 system for the CBM experiment at FAIR — •Adrian Rost for the CBM-Collaboration — Facility for Antiproton and Ion Research in Europe GmbH, Darmstadt, Germany

A beam detector system for the CBM experiment at the FAIR accelerator complex has been developed. The system will be used for T0 measurements with a precision in the order of 50 ps and for beam monitoring purposes i.e. beam halo particle measurements. The concept has been prepared and will consist of two detector stations, one used for beam monitoring and the second for the T0 measurement. Both detector stations are planned to utilize poly-crystal CVD diamond technology. But also new technologies like the Low Gain Avalanche Detectors (LGADs) are under investigation in collaboration with the HADES experiment at GSI. The sensors will be mounted on dedicated printed circuit boards, equipped with amplifier and shaping circuits. The detector stations are located in standard vacuum elements which are integrated into the CBM beamline. Two pcCVD diamond based prototype sensors have been prepared for tests at the mCBM experiment at the SIS18 accelerator. The read-out system will utilize the PADI discriminator and the GET4 TDC ASICs. In this contribution the BMON concept and the current status of the project will be presented.

*This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 87072.

HK 55.4 Thu 15:00 SCH/A251

Studies of the Unified Tracking Station for the Proton Radius Measurement in High-Energy Elastic Muon-Proton Scattering at AMBER* — •Christian Dreisbach, Karl Eichhorn, Jan Friedrich, Igor Konorov, Martin Losekamm, Stephan Paul, and Thomas Pöschl for the AMBER-Collaboration — Technische Universität München, Physik-Department E18, Garching, Germany

The proton radius can be determined by measuring the slope of the electric form factor G_E at small squared four-momentum transfer Q^2. Numerous elastic scattering and laser spectroscopy measurements of the proton radius have been performed with contradicting results – the so-called proton radius puzzle. We propose to measure the proton radius in high-energy elastic muon-proton scattering at the M2 beam line of CERN's Super Proton Synchrotron in the year 2023. A high-precision measurement at low Q^2 realized with a high-pressure hydrogen TPC can contribute to a solution of the puzzle, especially in view of the systematics of this approach compared to electron scattering. In addition to the precise measurement of the recoil proton provided by the TPC, novel unified tracking stations (UTS) are foreseen for an accurate measurement of the muon trajectory. Scintillating Fiber Hodoscopes joint with monolithic silicon-pixel detectors will be combined in this UTS. A first prototype was built and a beam test was performed in 2022. We present ongoing studies and results on the tracking capability of the UTS.

*funded by the DFG under Germany's Excellence Strategy - EXC2094 - 390783311

HK 55.5 Thu 15:15 SCH/A251

Scintillating Fiber Hodoscopes for the Proton Radius Measurement at AMBER — Christian Dreisbach, •Karl Eichhorn, Jan Friedrich, Igor Konorov, Martin Losekamm, Stephan Paul, and Thomas Poeschl for the AMBER-Collaboration — Technische Universität München, Physik-Department, Garching, Germany

The AMBER collaboration aims to measure the proton charge radius in an elastic scattering experiment using high energy muons provided by the M2 secondary beamline at CERN's Super Proton Synchrotron using an active hydrogen target. For muon tracking, novel Unified Tracking Stations equipped with monolithic active pixel silicon detectors in combination with a Scintillating Fiber Hodoscope (SFH) will be used. The SFH consists of 500 μm thin scintillating plastic fibers read out with SiPMs, covering an active area of (9x9) cm^2. We present ongoing studies and results from a test beam experiment performed in 2022 with a detector prototype.

Funded by the DFG under Germany's Excellence Strategy - EXC2094 - 390783311.

HK 56: Instrumentation XV

Time: Thursday 14:00–15:30 Location: SCH/A.101

Group Report HK 56.1 Thu 14:00 SCH/A.101

Performance of the upgraded HADES RICH in heavy ion collisions* — •Jörg Förtsch for the HADES-Collaboration — Bergische Universität Wuppertal

The 1.58A GeV Ag+Ag beamtime of the High Acceptance DiElectron Spectrometer (HADES) at GSI Darmstadt, Germany, in March 2019 marked the first use of the upgraded HADES RICH. At triggered event rates of up to 18 kHz the HADES RICH detector is the key component for efficient identification of electrons and positrons in hadronically dominated collision products.

The HADES RICH detector is a gaseous ring imaging Cherenkov detector with C_4H_{10} (isobutane) being used as radiator hence making the detector hadron blind for momenta up to approximately 2 GeV/c. A spherical mirror reflects Cherenkov photons on a staggered photon detection plane comprised of 428 MultiAnode Photo electron Multipliers (MAPMTs) of type Hamamatsu H12700. All 27392 different MAPMT channels are read out by the DIRICH readout electronic scheme measuring leading edge and time over threshold of each pulse down to sub-nanosecond precision.

In this talk we will present key features of our upgrade and lay out quantitatively how well the RICH performed throughout the full measurement campaign.

* Work supported by GSI and BMBF (05P19RGFCA, 05P21RGFC1, 05P19PXFCA, 05P21PXFC1), Hessen für FAIR (HFHF), GSI Helmholtzzentrum für Schwerionenforschung, Campus Gießen

HK 56.2 Thu 14:30 SCH/A.101

Design of a luminosity monitor for the P2 parity violating experiment at MESA — Sebastian Baunack[1], Boris Gläser[1], Rahima Krini[1], Frank Maas[1,2,3], •Tobias Rimke[1], David Rodriguez Pineiro[2], and Malte Wilfert[1] — [1]Institut für Kernphysik, Johannes Gutenberg-Universität Mainz — [2]Helmholtz-Institut Mainz, Johannes Gutenberg-Universität Mainz — [3]PRISMA+ Cluster of Excellence, Johannes Gutenberg-Universität Mainz

The P2 experiment at the future MESA accelerator in Mainz plans to measure the weak mixing angle $\sin^2(\theta_W)$ in parity violating elastic electron-proton scattering. The aim of the experiment is a very precise measurement of the weak mixing angle with an accuracy of 0.15% at a low four-momentum transfer of $Q^2 = 4.5 \cdot 10^{-3}$ GeV^2. In order to achieve this accuracy, it is necessary to monitor the stability of the electron beam and the liquid hydrogen target. Any helicity correlated fluctuation of the target density leads to false asymmetries.

Therefore, it is planned to install a luminosity monitor in forward direction close to the beam axis. The motivation and challenges for designing an air Cherenkov luminosity monitor will be discussed in this talk. Furthermore, I show promising results from prototype tests with the electron beam of the MAMI accelerator.

HK 56.3 Thu 14:45 SCH/A.101

Performance of the first mass production MCP-PMTs for the PANDA Barrel DIRC and lifetime of the latest MCP-PMTs — •Katja Gumbert, Merlin Böhm, Steffen Krauss, Albert Lehmann, and Daniel Miehling for the PANDA-Collaboration — Physikalisches Institut, Universität Erlangen-Nürnberg

In the PANDA detector at FAIR two DIRC detectors will be used for particle identification using Cherenkov light. Since the focal planes of both DIRCs are located inside magnetic fields of $\gtrapprox 1$ Tesla, Microcannel-Plate Photomultipliers (MCP-PMTs) will be used to detect the few Cherenkov photons. The Barrel DIRC, which will surround the beam line and the interaction point, will be equipped with 128 MCP-PMTs of the type XP85112-S-BA by PHOTONIS with an active area of 2x2 inch^2, 8x8 anode pixels and a pore diameter of 10 μm of the MCPs. As part of the quality controll process Erlangen will measure performance parameters like the efficiency, both quantum and collection efficiency, the gain distribution, the time resolution, the afterpulse probability and the rate capability of these sensors.

The quantum efficiency of former MCP-PMTs dropped after only a few hundred $\mathrm{mC/cm}^2$ integrated anode charge due to feedback ions produced in the residual gas. These ions are accelerated back to the photo cathode and may damage it. This aging problem was significantly reduced by applying an ALD coating (atomic-layer deposition) to the MCP pores. Both the lifetime performance of the latest tubes and the performance of the first Barrel DIRC MCP-PMTs will be shown in this talk. - Funded by BMBF and GSI -

HK 56.4 Thu 15:00 SCH/A.101

New "escalation" effect observed in recent MCP-PMTs — •Steffen Krauss, Merlin Boehm, Katja Gumbert, Albert Lehmann, and Daniel Miehling — Physikalisches Institut, Universität Erlangen-Nürnberg

Two DIRC-type Cherenkov detectors will be employed in the PANDA experiment at FAIR for pion/kaon separation. Since the focal planes of both DIRC detectors are located in a $\gtrsim 1$ Tesla magnetic field, Microchannel-Plate Photomultipliers (MCP-PMTs) are the only viable option to detect the few generated Cherenkov photons. To distinguish these single photons safely from the thermally emitted photo electrons a low darkcount rate is required in combination with a high gain of $> 10^6$. In some of the latest MCP-PMTs a new and completely unexpected effect was observed recently. At high gains and sometimes in combination with high illumination levels the MCP-resistance drops significantly, the gain drops, and a high amount of photons are created inside the tube, which causes a drastic increase of count rate. Inside a magnetic field this behavior seems to be significantly suppressed.

To study this effect in more detail several measurements of current, gain, and count rate were performed and compared for different MCP-PMTs. The rate of the produced photons were measured in an oppositely placed additional MCP-PMT. The results of these measurements are presented in this talk for older and the most recent MCP-PMT generations of different manufacturers.

- Funded by BMBF and GSI -

HK 56.5 Thu 15:15 SCH/A.101

Prototype studies towards the CBM RICH air cooling system* — •Gianluca Boccarella, Christian Pauly, Dennis Pfeifer, and Karl-Heinz Kampert for the CBM-Collaboration — Bergische Universität Wuppertal, Gaußstraße 20, 42119 Wuppertal

The Compressed Baryonic Matter (CBM) RICH detector is a CO_2 based gaseous Ring Imaging Cherenkov detector using MultiAnode PhotoMultipliers (MAPMT) for Cherenkov photon detection. It is placed beam downstream directly behind the CBM superconducting magnet and serves the precise electron identification and pion suppression. The photon detector is split into two separate cameras each including 30k channels DIRICH frontend readout electronics. Both cameras are enclosed by an iron shielding box in order to protect the MAPMT sensors from the magnetic stray field of the nearby CBM magnet. This shielding enclosure poses a major challenge for the cooling of the electronics dissipating approximately 3 kW heat inside each camera module. In order to achieve reliable cooling of all ~1000 readout modules per camera we plan to use a closed-cycle enforced air cooling system.

In the talk, we present the cooling concept of the CBM RICH detector together with first measurements obtained using a full scale prototype of one of the camera modules.

* supported by BMBF (05P19PXFCA, 05P21PXFC1) and GSI.

HK 57: Hadron Structure and Spectroscopy VI

Time: Thursday 14:00–15:30 Location: SCH/A316

Group Report HK 57.1 Thu 14:00 SCH/A316

Multi-meson photoproduction off the proton - recent results from the CBELSA/TAPS experiment — •Philipp Mahlberg for the CBELSA/TAPS-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn, Deutschland

The nucleon excitation spectrum is dominated by mostly broad resonances, so partial wave analyses (PWA) are needed to extract the overlapping resonances from the experimental data. In order to find an unambiguous solution, the measurement of polarization observables is indispensable.

Meson photoproduction experiments have provided an extensive database which in turn let different partial wave analyses converge to similar results. The findings fit surprisingly well in an ordering scheme imposed by a non-relativistic quark model. Within the higher mass regime, the PWA solutions are less constrained and not all model-predicted states have been confirmed by experiments. Here, multi-meson decay channels gain importance and sequential decay chains can be studied.

The Crystal Barrel/TAPS experiment is, due to its good energy resolution, high photon detection efficiency and its almost complete solid angle coverage, ideally suited to measure such multi-meson final states in which neutral mesons decay into photons.

For the $p\pi^0\pi^0$ and $p\pi^0\eta$ final states, recent results – obtained with a linearly polarized photon beam at different coherent edge positions (up to 1850 MeV), impinging on an either transversely polarized or unpolarized target – will be presented.

HK 57.2 Thu 14:30 SCH/A316

Sensitivity study for baryon resonances searches in pion-proton collisions with HADES — •Jan Gollub[1], Ahmed Foda[2], Johan Messchendorp[2], and James Ritman[2] for the HADES-Collaboration — [1]Ruhr-Universität Bochum, 44801 Bochum, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany

Pion-induced reactions provide unique opportunities for a description of baryonic resonances and their coupling channels. The two-pion production in $\pi^- - p$ reactions at pion beam momenta between 0.650 GeV/c and 0.786 GeV/c was already analysed. The next step is to investigate these reactions at center of mass energies up to $\sqrt{s} = 1.76$ GeV with the HADES detector in 2024.

In this work, a sensitivity study of the expected results using the Bonn-Gatchina partial wave analysis framework has been performed. In this talk MC simulated invariant mass spectra and angular distributions will be presented.

HK 57.3 Thu 14:45 SCH/A316

Study of the Δ++ baryon at BESIII — •Dong Liu[1,2], Christoph Rosner[1], and Frank Maas[1,3,4] for the BESIII-Collaboration — [1]Helmholtz Institute Mainz, Mainz, Germany — [2]University of Science and Technology of China, Hefei, China — [3]Institute of Nuclear Physics, Mainz, Germany — [4]PRISMA+ Cluster of Excellence, Mainz, Germany

The common baryons are the baryon octet and the baryon decuplet states. The wave functions of baryons in the octet are antisymmetric under quark exchange, and they have been extensively studied in electron-positron collision experiments, including proton, neutron, Λ, Σ, Ξ, etc. The wave functions of decuplet baryons are symmetric under quark exchange and there are few studies on them, including Δ, Σ*, Ξ*, Ω, etc. Among them, Δ particles are the lightest ones and have the highest cross section in electron-positron collisions. The measurement of the Δ production cross section at the BESIII experiment is a complement to the study of baryons and provides an experimental basis for theoretical studies of the intrinsic structure of baryons. The analysis of the Δ++ baryon pair production process is carried out at the BESIII experiment, giving the upper limit of the cross section for the process in the energy range from the threshold up to 2.645 GeV, which constrain the theoretical prediction for the decuplet pair production process. Meanwhile, the cross section and error for the Δ++p-π- process at a centre-of-mass energy of 2.645 GeV is also reported.

HK 57.4 Thu 15:00 SCH/A316

Determination of the polarization observables T,P and H in the reaction γp → pπ^0 — •Sebastian Ciupka for the CBELSA/TAPS-Collaboration — HISKP, Uni Bonn

It is experimentally and theoretically challenging to determine the exact number of exited nucleon states and their properties, since the short lifetime of these exited states leads to strongly overlapping resonances. Using a polarized beam, a polarized target or using the polarization of the recoil nucleon helps to measure single or double polarization observables, that are needed for an unambiguous partial wave analysis solution.

The CBELSA/TAPS experiment in Bonn provides a polarized photon beam as well as a longitudinally or transversely polarized target, allowing for the determination of single and double polarization observables. The Crystal Barrel (CB) calorimeter, together with the MiniTAPS calorimeter in forward direction, give the opportunity for close to 4π coverage for the measurements.

This talk will present preliminary results of the determination of the polarization observables T, P and H, for energies between 600MeV and 3200MeV, using data collected after the recent upgrade of the CB calorimeters readout electronics and these results are compared to previous data and model predictions.

HK 57.5 Thu 15:15 SCH/A316

Resonance Regions: Partial Wave Analysis in the HADES Experiment — •Ahmed Marwan Foda — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt

The High Acceptance Di-lepton Spectrometer (HADES) collaboration uses a pion beam to study features of baryonic resonances and their decay channels. This allows the production of baryonic resonances at a fixed center of mass energy, i.e. in the s-channel, thus giving these beams a significant advantage relative to proton proton reactions. Partial Wave Analysis (PWA) techniques are used to study the coupling of the resonances to different final states. Analysis of the baryonic resonances decays to ρN and ωN final states will provide insight into baryon-vector meson couplings essential for the understanding of the melting of the ρN meson in a dense baryonic matter and description of dilepton emissions from Heavy Ion collisions.

A new implementation of the Bonn-Gatchina framework is being developed in preparation for a more detailed mapping of the resonance regions in pion-proton collisions. Example fits will be presented showing current status and the potential of the new framework.

HK 58: Hadron Structure and Spectroscopy VII

Time: Thursday 14:00–15:30 Location: SCH/A419

Group Report HK 58.1 Thu 14:00 SCH/A419

Understanding the dynamics of three-body systems using femtoscopy at the LHC — •Raffaele Del Grande for the ALICE Germany-Collaboration — Technical University of Munich, Garching, Germany

Three-body forces among hadrons are necessary for the theoretical description of nuclear bound objects and for modeling the equation of state of neutron stars. Direct measurements of three-body interactions are currently missing and represent one of the current challenges for experimental nuclear physics. The ALICE Collaboration has recently extended the femtoscopy technique to explore the strong interaction in three-particle systems, exploiting both three-hadron and hadron-nucleus correlation studies. The present contribution provides an overview of the milestones reached by ALICE in the study of three-body systems, using the femtoscopy technique in pp collisions at $\sqrt{s} = 13$ TeV. The main highlights are the first experimental measurements of three-baryon correlations, p–p–p and p–p–Λ, and the first study of three-body systems with kaons, p–p–K^+ and p–p–K^-. The contribution of genuine three-body effects in the measured correlation functions has been isolated using Kubo's cumulant expansion method. The interpretation of such measurement and the possible implications on the equation of state of neutron stars and bound state formation will be discussed.

This research was funded by DFG SFB1258 and BMBF Verbundforschung (05P21WOCA1 ALICE).

HK 58.2 Thu 14:30 SCH/A419

Understanding the particle emitting source of π–π correlations from measurements in MB pp of ALICE at 13 TeV — •Maximilian Korwieser for the ALICE Germany-Collaboration — TU München, Physik Department E62, Excellence Cluster 'Universe', Garching

The ALICE collaboration recently published a plethora of results obtained from femtoscopic measurements, studying the interaction between many exotic combinations of particles, most notably Ω–p. In general these studies depend on a precise understanding of the particle emitting source, which is constructed employing the resonance source model (RSM). In the RSM, deviations of a Gaussians source distribution, due to the effects of short lived resonances, are modeled via a Monte Carlo procedure. For two particle correlations between baryons (p–p and Λ–p) the RSM was already validated with great success. The goal of this work is to validate whether the RSM can also be applied to constrain the source in the mesonic sector. A differential study of the source functions spatial extension is presented, in bins of m_T and multiplicity classes, by analysing MB pp collisions at $\sqrt{s}$ = 13 TeV obtained by ALICE. An m_T scaling behaviour of the source is observed and found to be compatible with previous results in the baryonic sector. This measurement supports the scenario of a common source for mesons and baryons in small colliding systems, allowing to employ the RSM to constrain the source for meson–baryon and meson–meson.

This research was supported by the BmBf.

HK 58.3 Thu 14:45 SCH/A419

Investigating p–π^+ and p–π^- femtoscopic correlations with ALICE at the LHC — •Marcel Lesch for the ALICE Germany-Collaboration — TUM, James-Franck-Straße 1, 85748 Garching bei München

The modelling of neutron stars is deeply linked to the understanding of the nuclear equation of state (EoS). It was recently proposed that the QCD axion might impact the EoS of neutron stars and that its properties at large baryonic densities can be related to the in-medium properties of pions. Constraining the latter is thus crucial for the study of the QCD axion and its impact on the description of neutron stars. By employing recently developed three-body femtoscopic techniques, the in-medium properties of pions can be inferred from correlation measurements between pions and many nucleons in pp collisions at the LHC. These small systems produce particles at distances of ~ 1 fm, mimicking a large-density environment. However, to understand the experimental three-body correlations, the lower-order two-body correlations between p–π^+ and p–π^- must be constrained. In this talk, we present the first measurement of p–π^+ and p–π^- correlations using two-body femtoscopy. The results have been obtained by analysing high-multiplicity pp collisions at $\sqrt{s}$ = 13 TeV measured by ALICE.

This research was funded by the DFG under Germany's Excellence Strategy - EXC2094 - 390783311 and the BMBF Verbundforschung (05P21WOCA1 ALICE).

HK 58.4 Thu 15:00 SCH/A419

ALICE determines the scattering parameters of open charm mesons with light-flavor hadrons — •Daniel Battistini for the ALICE Germany-Collaboration — Technical University of Munich, Munich, Germany

The strong interaction among D mesons and light-flavor hadrons was completely out of experimental reach until recently. The lack of experimental constraints on the scattering parameters of D-proton/pion/kaon poses strong limitations not only to the search of molecular states composed of charm and non-charm hadrons, but also to the study of the rescattering of charm mesons in the hadronic phase of ultrarelativistic heavy-ion collisions. The knowledge of the scattering parameters of charm hadrons with non-charm hadrons would be a crucial ingredient for models based on charm-quark transport in a hydrodynamically expanding QGP to describe the typical observables of heavy-ion collisions.

In this talk, we will report on the first measurement of the scattering parameters of open charm mesons with light-flavor hadrons. The study is carried out by the ALICE Collaboration, in high-multiplicity proton-proton collisions at $\sqrt{s}$ = 13 TeV. The scattering parameters are measured employing correlation techniques and the final-state strong interaction is found to be shallow in all the channels under study.

* Funded by BMBF Verbundforschung (05P21WOCA1 ALICE).

HK 58.5 Thu 15:15 SCH/A419

Studying the pΛ interaction in small collision systems using a common emission source — •Jaime Gonzalez and Dimitar Mihaylov — Technical Unverisity of Munich

This work introduces a new framework (CECA) to model the source function that represents the spatial and kinematic properties of a particle emission in small collision systems. The properties of the source have been fixed within CECA by using an existing ALICE measurement of the pp source size in pp collisions. Under the assumption of a common source, a simulation of the kinematic properties of the pΛ system is performed and compared to existing measurements. Utilizing several parameterizations of the chiral effective field theory, used to model the pΛ interaction, allowed to study the properties of the hyperon-nucleon interaction, which is an important ingredient for the nuclear Equation of State and the modeling of the structure of neutron stars. Funded by BMBF Verbundforschung (05P21WOCA1 ALICE).

HK 59: Structure and Dynamics of Nuclei XI

Time: Thursday 14:00–15:30 Location: SCH/A118

Group Report HK 59.1 Thu 14:00 SCH/A118

Commissioning of Miniball@HIE-ISOLDE and first results from Coulomb excitation of ^{130}Sn — •Maximilian Droste[1], Peter Reiter[1], and Thorsten Kröll[2] for the MINIBALL IS702-Collaboration — [1]IKP, Universität zu Köln, Germany — [2]Institut für Kernphysik, TU Darmstadt, Germany

The high-resolution Miniball germanium array has been recommissioned at the HIE-ISOLDE facility at CERN in 2022. After successful campaigns at RIKEN, Japan and PSI, Switzerland the cryostats and capsules of the HPGe crystals have been redesigned and rebuilt. A new data acquisition system, based on FEBEX digitizers, was used for the commissioning of the array. Coulomb excitation of ^{130}Sn was the first experiment after LS2 at CERN. A beam of 4.4 $\frac{\mathrm{MeV}}{\mathrm{u}}$ was delivered onto a ^{206}Pd target. Dexciting γ-rays from target and projectile nuclei were recorded in coincidence with scattered particles. The experiment aims to investigate the evolution of nuclear structure around the magic-shell closure at N=82 tin isotopes by determining the $B(E2; 0^+_{\mathrm{g.s.}} \rightarrow 2^+_1)$ value. Most advanced SM calculations using realistic interactions predict enhanced collectivity in the neighbouring isotopes of ^{132}Sn [1]. Moreover, a puzzling discrepancy between previous measurements in ^{130}Sn and latest theoretical results [2] needs to be resolved.

[1] D. Rosiak *et al.* Phys. Rev. Lett. 121, 252501 (2018)
[2] T. Togashi *et al.* Phys. Rev. Lett. 121, 062501 (2018)

Supported by BMBF Projects 05P18PKCI1, 05P21PKCI1 and European Unions Horizon Europe Framework research programm (Grant Agreement No. 101057511)

HK 59.2 Thu 14:30 SCH/A118

Investigation of SRC in exotic nuclei at R3B/GSI — •Enis Lorenz[1,2], Thomas Aumann[1,2], Meytal Duer[1,2], Anna Corsi[3], Or Hen[4], Julian Kahlbow[4], Aldric Revel[3], Andrea Jedele[1,2], Andrea Lagni[3], Manuel Xarepe[5,1], Hang Qi[4], Nikhil Mozumdar[1,2], and Antoine Barriere[6] for the R3B-Collaboration — [1]Technische Universität Darmstadt — [2]GSI Helmholtz Zentrum — [3]CEA Saclay — [4]Massachusetts Institute of Technology — [5]University of Lisbon — [6]Grand Accélérateur National d'Ions Lourds

Short-Range Correlations (SRC) are two-body components of the nuclear wave function with high relative momentum and low center-of-mass momentum relative to the Fermi momentum. These high-momentum states are overpopulated relative to a simple free-Fermi gas. During the nuclear reaction, SRC pairs are temporarily formed due to the presence of high-density fluctuations between 2-5 times the saturation density. The formation of the SRC pairs gives an unique opportunity to explore the interaction of cold nuclear matter at extreme densities. The first measurement of SRCs in inverse kinematics with radioactive ion beams has been performed at R3B as part of the FAIR Phase-0 experimental program in Spring 2022. In this talk I will give an overview on the status of the analysis.

This work is funded and supported by the State of Hesse within the Research Cluster ELEMENTS (Project ID 500/10.006), by the German Federal Ministry for Education and Research (BMBF) under contract number 05P21RDFN2 and the GSI-TU Darmstadt cooperation.

HK 59.3 Thu 14:45 SCH/A118

Overview of CALIFA in FAIR-Phase-0 Experiments at R^{3}B — •Leyla Atar[1], Christian Sürder[1], Thorsten Kröll[1], Roman Gernhäuser[2], and Philipp Klenze[2] for the R3B-Collaboration — [1]Institut für Kernphysik, Technische Universität Darmstadt, Germany — [2]Technische Universität München, Germany

CALIFA (the CALorimeter for In Flight detection of γ-rays and light charged pArticles) is one of the key detectors of the R^{3}B experiment at the GSI/FAIR facility. CALIFA is highly segmented and currently consists of 1528 scintillation CsI(Tl) crystals surrounding the reaction target area to facilitate measurement of the emission angle and energy of reaction products. CALIFA covers a large dynamic range to allow a simultaneous measurement of γ-rays down to 100 keV and scattered protons up to 300 MeV. A special feature of CALIFA is the digital Quick Particle Identification (QPID) enabling γ-rays and charged particle identification through Pulse Shape Analysis (PSA) of the scintillation light output.

I will shortly introduce the CALIFA calorimeter and its auxiliary detector systems and give an overview of the performance of CALIFA in the frame of FAIR-Phase-0 experiments performed at the R^{3}B/FAIR setup. First results from specific reaction channels will be presented.

This work is supported by BMBF contracts (05P19RDFN1) and (05P21RDFN2).

HK 59.4 Thu 15:00 SCH/A118

Lifetime measurements of excited states of ^{132}Te after 2n transfer — •H. Mayr[1], T. Stetz[1], V. Werner[1], T. Beck[5], M. Beckers[2], A. Blazhev[2], R. Borcea[4], S. Calinescu[4], C. Costache[4], I. Dinescu[4], A. Esmaylzadeh[2], B. Falk[2], J. Fischer[2], R.-B. Gerst[2], K. Gladnishki[3], A. Ionescu[4], V. Karayonchev[6], E. Kleis[2], H. Kleis[2], L. Klöckner[2], P. Koch[2], D. Kocheva[3], P. Koseoglou[1], R. Mayer[1], R.-E. Mihai[4], C. M. Nickel[1], C.-R. Nita[4], A. Pfeil[2], N. Pietralla[1], G. Rainovski[3], F. Spee[2], L. Stan[4], M. Stoyanova[3], S. Toma[7], and R. Zidarova[1] — [1]TU Darmstadt — [2]U Cologne — [3]U Sofia — [4]IFIN-HH Bucharest — [5]MSU — [6]TRIUMF Canada — [7]UP Bucharest

The proton-neutron symmetry of low-lying nuclear states is characterized by the mixing of respective configurations to their wave functions, dominated by few two-nucleon configurations near shell closures. Located closely to the doubly-magic ^{132}Sn, ^{132}Te is therefore well suited to study mixed-symmetric configurations and their fragmentation. By applying the Doppler Shift Attenuation Method, following a two-neutron transfer reaction to ^{132}Te, the location and fragmentation of mixed-symmetric states has been studied through the measurement of excited-state lifetimes. Results for the 2^+ mixed-symmetric states will be presented. A complementary experiment has been performed using the Recoil Distance Doppler Shift method, in order to access lifetimes of longer-lived states. With the resulting lifetimes, transition strengths to lower lying states have been determined and compared to theoretical approaches. *Supported by the BMBF 05P21RDCI2-TP1.

HK 59.5 Thu 15:15 SCH/A118

Development of a new γ-γ angular correlation analysis method using asymmetric ring of clover detectors — •Lukas Knafla[1], Arwin Esmaylzadeh[1], Andreas Harter[1], Jan Jolie[1], Ulli Köster[2], Mario Ley[1], Caterina Michelagnoli[2], and Jean-Marc Régis[1] — [1]Institut für Kernphysik, Universität zu Köln — [2]Institut Laue-Langevin, Grenoble, Frankreich

A new method for γ-γ angular correlation analysis using a symmetric ring of HPGe clover detectors is presented. Pairwise combinations of individual crystals are grouped based on the geometric properties of the spectrometer, constrained by a single variable parameterization. The corresponding effective interaction angles between crystal pairs, as well as the attenuation coefficients are extracted directly from the measured experimental data. Angular correlation coefficients, parameter uncertainties and parameter co-variances are derived using a Monte-Carlo approach, considering all sources of statistical uncertainty. The general applicability of this approach is demonstrated by reproducing known multipole mixing ratios in ^{177}Hf, ^{152}Gd and ^{116}Sn, populated by either β-decay or (n, γ)-reactions, measured at the Institut Laue-Langevin, using the EXILL&FATIMA spectrometer and different configurations of the FIPPS instrument. The derived mixing ratios are in excellent agreement with adopted literature values with comparable or better precision [1].

[1] L. Knafla et al., Nucl. Instrum. Methods Phys. Res. A 1042 (2022)

HK 60: Structure and Dynamics of Nuclei XII

Time: Thursday 14:00–15:30 Location: SCH/A215

HK 60.1 Thu 14:00 SCH/A215

Electron scattering off ^{10}B under 180° — •M. Spall, M. Singer, J. Birkhan, I. Brandherm, M. L. Cortés, F. Gaffron, K. E. Ide, J. Isaak, I. Jurosevic, P. von Neumann-Cosel, F. Niederschuh, N. Pietralla, G. Steinhilber, and T. Stetz — Institut für Kernphysik, Technische Universität Darmstadt

Electron scattering experiments under 180° are an excellent tool to study transversal form factors of magnetic excitations due to the suppression of longitudinal excitations by several order of magnitudes with respect to the transversal excitations and the associated radiative tail background from elastic scattering at this angle. A measurement was performed with the 180° system [1] at the S-DALINAC, in order to investigate the M3 transition of the 3^+ ground state to the excited 0^+ state at 1.74 MeV in ^{10}B which is the analogue to the second-forbidden beta-decay of ^{10}Be. The measurement will extend existing data towards lower momentum transfer allowing to improve the precision of the determined transition strength. The combined information from electron scattering and beta-decay will serve as a precision test of the unified description of electroweak observables in ab-initio models. First results of the new ^{10}B(e,e') data will be presented.

*Supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Project-ID 279384907 - SFB 1245.

[1] C. Lüttge et al., Nucl. Instrum. Meth. A 366, 325-331 (1995).

HK 60.2 Thu 14:15 SCH/A215

^{16}O(n,α_0)^{13}C Cross Section Normalization based on a new Time-of-Flight measurement using a Frisch Grid Ionisation Chamber — Sebastian Urlass[1], •Arnd Junghans[1], Roland Beyer[1], and Arjan Plompen[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Bautzner Landstraße 400, 01328 Dresden, Germany — [2]European Commission, Joint Research Center (JRC), Retieseweg 111 2440 Geel, Belgium

The ^{16}O(n,α)^{13}C reaction plays an important role in nuclear technology. Oxygen is a major component of the fuel and in the water coolant of nuclear power reactors. This reaction influences criticality through the removal of neutrons and produces helium in the fuel which may lead to swelling. A new reaction cross section measurement was carried out at the time-of-flight facility GELINA using a Frisch-gridded ionization chamber. Between the reaction threshold and a neutron energy of 9 MeV, ^{16}O(n,α_0)^{13}C events on the CO_2 admixture in the counting gas could be well identified. The cross sections were determined relative to relative to the neutron-induced fission cross section standard of ^{235}U using the H19 fission chamber of PTB and compared to recent evaluations. Special care was taken to quantify all sources of systematic uncertainties based on measurements. The integral over the data from 4 to 5.3 MeV allows the normalization of evaluated ^{16}O(n,α_0)^{13}C reaction cross sections and data in the literature to about 6% uncertainty. The new cross section normalization is compared with results deduced from thin target measurements of the inverse reaction ^{13}C(α,n)^{16}O and thick target yields.

HK 60.3 Thu 14:30 SCH/A215

Energy-dependence of the γ-decay branching ratio of the Giant Dipole Resonances of ^{154}Sm and ^{140}Ce — •K. Prifti[1], J. Kleemann[1], V. Werner[1], N. Pietralla[1], P. Koseoglou[1], M. Beuschlein[1], U. Friman-Gayer[1,2,4], S. W Finch[2,3], T. Beck[1], K. Ide[1], J. Isaak[1], O. Papst[1], M.L. Cortes[1], D. Gribble[2,3], D. Savran[5], and W. Tornow[2,4] — [1]IKP, TU Darmstadt — [2]TUNL, Durham, NC, USA — [3]UNC, Chapel Hill, USA — [4]Duke University, Durham, NC, USA — [5]GSI, Darmstadt

The giant dipole resonance (GDR) is a fundamental nuclear excitation that dominates the dipole response of all nuclei. The present work aims at quantifying the branching ratio of the decay of the GDR of ^{154}Sm and ^{140}Ce, via emission of γ-rays or neutrons as a function of excitation energy. Simultaneously to a nuclear resonance fluorescence (NRF) measurements an activation measurement has been performed at the HIγS facility. The targets used for the activation measurements were comprised of natural samarium, natural cerium and gold foils. By determining the activation of these targets and then comparing to the GDR-NRF events that are observed, we will determine the γ- to neutron-decay branching ratio. The data, their analysis and first results will be presented and discussed.

This work is supported by the LOEWE program under grant *Nuclear Photonics* and within the Hessian cluster project *ELEMENTS*.

HK 60.4 Thu 14:45 SCH/A215

γ-decay Behavior of the Giant Dipole Resonances of ^{154}Sm and ^{140}Ce — •J. Kleemann[1], U. Friman-Gayer[2,3,4], J. Isaak[1], N. Pietralla[1], V. Werner[1], A. D. Ayangeakaa[2,5], T. Beck[1,6], M. L. Cortés[1], S. W. Finch[2,3], M. Fulghieri[2,5], D. Gribble[2,5], K. E. Ide[1], X. James[2,5], R. V. F. Janssens[2,5], S. R. Johnson[2,5], P. Koseoglou[1], FNU Krishichayan[2,3], O. Papst[1], D. Savran[7], and W. Tornow[2,3] — [1]IKP, TU Darmstadt — [2]TUNL, Durham, NC, USA — [3]Duke University, Durham, NC, USA — [4]ESS, Lund, SE — [5]UNC, Chapel Hill, NC, USA — [6]FRIB, MSU, East Lansing, MI, USA — [7]GSI, Darmstadt

The giant dipole resonance (GDR) is one of the most fundamental nuclear excitations and dominates the dipole response of all nuclei. Recently, novel data on the γ-decay of the GDR of the well-deformed nuclide ^{154}Sm and the spherical nuclide ^{140}Ce were obtained through photonuclear experiments at the HIγS facility. Individual regions of the GDR were selectively excited by HIγS' intense, linearly-polarized and quasi-monochromatic γ-ray beam. The regions were chosen to highlight distinct features of the double-humped GDR of ^{154}Sm. The obtained data allow for a first experimental test of the commonly accepted K-quantum-number assignments to the GDR of ^{154}Sm. First results of the analysis will be presented and discussed with respect to the textbook interpretation of the GDR in deformed nuclei.

This work is supported by the State of Hesse under the LOEWE research grant *Nuclear Photonics* and the cluster project *ELEMENTS*, and by the U.S. Department of Energy, Office of Nuclear Physics.

HK 60.5 Thu 15:00 SCH/A215

Status report on the progress on the analysis of the NewSUBARU data — •Nikolina Lalic[1], Thomas Aumann[1,2], Takashi Ariizumi[3], Martin Baumann[1], Patrick van Beek[1], Ioana Gheorghe[4], Heiko Scheit[1], Dmytro Symochko[1], and Hiroaki Utsunomiya[3] for the NewSUBARU-Collaboration — [1]Technische Unitversität Darmstadt, Germany — [2]GSI Helmholtzzentrum, Germany — [3]Department of Physics, Konan University, Japan — [4]"Horia Hulubei" National Institute for R & D in Physics and Nuclear Engineering (IFIN HH), Romania

The photoneutron cross sections of ^{112}Sn, ^{116}Sn, ^{120}Sn and ^{124}Sn were measured in (γ, xn) reactions, where $x \in [1, 4]$, using a quasi-monochromatic laser Compton-scattering γ-ray beam at the NewSUBARU facility. The goal of the experiment is to resolve the long-standing discrepancy of the total and partial cross sections measured by the Livermore and the Saclay groups. Measurements were done with γ energies from 8 MeV to 38 MeV. As a neutron counter a detector with a flat efficiency was used to take advantage of the direct neutron-multiplicity sorting technique. The (γ, xn) cross sections $x \in [1, 4]$ will be determined as well as the total photo absorption cross sections.
In this report the experiment and the current state of the ongoing analysis will be presented.
Suported by HMWK (LOEWE centre "Nuclear Photonics") and DFG (SFB 1245).

HK 60.6 Thu 15:15 SCH/A215

Systematic investigation of the low-energy electric dipole response in ^{116,118}Sn using the $(d, p\gamma)$ reaction — •Markus Müllenmeister, Michael Weinert, Florian Kluwig, Miriam Müscher, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics

The so-called Pygmy Dipole Resonance (PDR) has been a research topic of great interest in recent decades. While the general properties of this excitation is well known [1], there are still questions about its structure. For the study of this underlying structure, experiments sensitive to different aspects of the nucleus are vital [2]. The $(d, p\gamma)$ reaction has been shown to be a selective probe for the microscopic character of certain states. The tin isotopic chain in particular is an interesting subject for this kind of investigation, as its magic proton number ($Z = 50$) provides several isotopes accessible for this reaction. As the $(d, p\gamma)$ reaction was already studied in depth for ^{119}Sn$(d, p\gamma)^{120}$Sn [3], similar experiments were performed at the SONIC@HORUS setup [4] in Cologne on the other two available isotopes ^{115,117}Sn to study excitations in ^{116,118}Sn. The results of these experiments will be shown. Supported by the DFG (ZI 510/10-1).

[1] A. Bracco *et al.*, Prog. Part. Nucl. Phys. **106** (2019) 360
[2] D. Savran *et al.*, Phys. Lett. B **786** (2018) 16
[3] M. Weinert *et al.*, Phys. Rev. Lett. **127** (2021) 242501
[4] S. G. Pickstone *et al.*, Nucl. Instr. and Meth. **875** (2017) 104

HK 61: Structure and Dynamics of Nuclei XIII

Time: Thursday 14:00–15:15 Location: SCH/A117

HK 61.1 Thu 14:00 SCH/A117

Reconstructed gamma-ray spectra by CALIFA after proton knockout reactions (experiment s467) — •Christian Sürder[1], Ryo Taniuchi[2], Luke Rose[2], Leyla Atar[1], Marina Petri[2], Stefanos Paschalis[2], and Thorsten Kröll[1] for the R3B-Collaboration — [1]Institut für Kernphysik, TU Darmstadt, Darmstadt, Germany — [2]School of Physics, Engineering and Technology, University of York, York, United Kingdom

An experiment to study single-particle properties of isotopes around the Ca isotopic chain was performed with the R^{3}B setup at GSI, Darmstadt, Germany. This experiment was part of the Phase 0 program at FAIR. A cocktail beam was produced via fragmentation of a ^{86}Kr primary beam impinging on a ^{9}Be target at a beam energy of 580MeV/A. One goal is to extract exclusive reaction cross sections in proton knockout (p,2p) reactions. Therefore it is essential to detect the knocked out protons and the coincident gammas from a de-excitation of the residual nucleus. CALIFA is a highly segmented CsI(Tl) detector which is capable of this task. To show the performance of CALIFA a strongly populated isotope is selected as a benchmark and the corresponding protons and gammas are reconstructed. The status of the analysis will be presented.

This work is supported by BMBF under contract 05P19RDFN1 and 05P21RDFN2 and the Helmholtz Research Academy Hesse for FAIR - HFHF.

HK 61.2 Thu 14:15 SCH/A117

"Comparison of the probability of Bi-209 (γ, p5n) Pb-203 reaction at 60 MeV and 80 MeV " — •Jelena Bardak[1], Miodrag Krmar[2], and NIkola Jovančević[2] — [1]GSI Helmholtz Centre for Heavy Ion Research, Darmstadt, Germany and Faculty of Sciences, University of Novi Sad, Serbia — [2]Faculty of Sciences, University of Novi Sad, Serbia

In several recently published papers, photonuclear reactions with a target of natural bismuth were studied. Irradiation of some heavy elements by the photons having energies up to 80 MeV, will give several products of (γ,xn) reactions. The emission of protons or other charged particles is less probable due to the Coulomb barrier. In this paper, an attempt was made to gain experimental evidence of Bi-209(γ,p5n)Pb-203 nuclear reaction by comparison of intensities of gamma lines following EC decay of Bi-203 and Pb-203. Pb-203 can be formed by (γ,p5n) nuclear reaction, but it is certainly created after the decay of Bi-203, obtained in Bi-209(γ,6n)Bi-203 reaction. After activation of the target from natural bismuth in photon beams of maximum energies of 60 MeV and 80 MeV, several gamma spectra were successively measured. Based on selected gamma lines from the measured spectra, the activities of Pb-203 and Bi-203 were monitored to assess the probability ratio for the occurrence of (γ,6n) and (γ,p5n) nuclear reactions. Furthermore, quantitative data concerning the probability of the mentioned reactions is extracted and compared to theoretical predictions.

HK 61.3 Thu 14:30 SCH/A117

Investigation of the internal conversion lifetime of $^{229\mathrm{m}}$Th in a solid — •Lilli Löbell[1], Sandro Kraemer[1], Daniel Moritz[1], Kevin Scharl[1], Benedict Seiferle[1], Lars von der Wense[2], Florian Zacherl[1], and Peter Thirolf[1] — [1]LMU München — [2]Max-Planck-Institut für Quantenoptik, Garching

The first excited nuclear state of ^{229}Th has an exceptionally low excitation energy of 8.338 ± 0.024 eV ($\lambda = 148.71 \pm 0.42$ nm), allowing potentially a laser excitation of the nuclear transition. Consequently, ^{229}Th is the so far only candidate for a nuclear clock, which can possibly outperform optical atomic clocks and be used amongst a manifold of other applications to investigate variations of fundamental constants. For the decay of the thorium isomer to the ground state, the dominant decay channel in neutral $^{229\mathrm{m}}$Th atoms is internal conversion (IC), in which the nuclear transition energy is transferred to an electron of the atomic shell. The lifetime of the IC decay was measured on a metallic surface as 7 ± 1 μs, but there are indications of a dependence on the electronic environment surrounding the thorium atom. A possible way to investigate the IC lifetime within a solid state environment is the implantation of $^{229\mathrm{m}}$Th atoms into the depletion region of a semiconductor detector, where the IC electrons can be detected. This could be a scenario for a solid-state nuclear clock where the clock transition would occur via IC in an active detector medium. The talk will present ongoing experiments using VUV-sensitive silicon photomultipliers for the IC electron detection. This work was supported by the European Research Council (ERC): ERC Synergy Grant 'ThoriumNuclearClock'.

HK 61.4 Thu 14:45 SCH/A117

Investigations of the internal conversion lifetime of ^{229m}Th on various metal surfaces — •Daniel Moritz[1], Sandro Kraemer[1], Lilli Löbell[1], Kevin Scharl[1], Benedict Seiferle[1], Lars von der Wense[2], Florian Zacherl[1], and Peter G. Thirolf[1] — [1]LMU München — [2]Max-Plank-Institut für Quantenoptik

With its exceptionally low energy of the isomeric first excited nuclear state, which has most recently been constrained to 8.338(24) eV (i.e. λ=148.71(42) nm) [1], ^{229m}Th is in the focus of current research as the only suitable candidate to build a nuclear clock based on it. One of the isomer's properties to be further investigated is its internal conversion (IC) lifetime when IC is triggered by neutralization of ^{229m}Th on a metallic catcher surface. After first hints on its dependence on the electronic environment of ^{229m}Th [2], the IC lifetime of ^{229m}Th$^{2+,3+}$ ions will now be evaluated systematically for various metal surfaces with different work functions. This talk presents the current status of these investigations at LMU.
This work was supported by the ERC Synergy Grant "ThoriumNuclearClock", Grant agreement No. 856415.

[1] S. Kraemer et al., arXiv:2209.10276 (2022)
[2] B. Seiferle, Diss., LMU (2019)

HK 61.5 Thu 15:00 SCH/A117

Benchmark of proton detection using CALIFA at R3B — •Luke Rose[1], Stefanos Paschalis[1], Ryo Taniuchi[1], Valerii Panin[2], Leyla Atar[2,3], Christian Suerder[3], and Marina Petri[1] for the R3B-Collaboration — [1]University of York, York, United Kingdom — [2]GSI, Darmstadt, Germany — [3]TU-Da, Darmstadt, Germany

Quasi-free scattering (p,2p) experiment of the Calcium isotopic chain $^{38-50}Ca$ at 450 MeV/u were performed by the R3B collaboration as part of FAIR phase 0. We performed a systematic study on the dependency of the quenching of spectroscopic factors to the isospin asymmetry by employing quasi-free scattering reactions in inverse kinematics, extending our previous investigation [Atar et al.] towards this medium-mass region. CALIFA has been used to measure the momentum of both the recoil and the knocked-out proton. In this contribution, we will discuss the simulations that were performed to study (p,2p) reactions using the CALIFA detector to quantify the detector efficiency for protons. This is a critical step in extracting the measured cross sections for the quasi-free scattering (p,2p) process.

HK 62: Astroparticle Physics I

Time: Thursday 14:00–15:15 Location: SCH/A252

Group Report HK 62.1 Thu 14:00 SCH/A252

Probing the Standard Model in Free Neutron Decay — •Karina Bernert, Max Lamparth, and Bastian Märkisch — Technische Universität München, Germany

(For the PERKEO and PERC consortia) Measurements of free neutron decay enable a variety of tests of the Standard Model of particle physics. Among the observables are the parity-violationg beta asymmetry A, and the Fierz interference term b. From precision measurements of A and the neutron lifetime, the CKM matrix element V_{ud} is determined without nuclear corrections. It serves as input for the first-row unitarity test of the CKM matrix and the current Cabibbo-angle anomaly. A non-zero Fierz term b would signal the existence of novel scalar and tensor interactions.

With its unique measurement technique, PERKEO III delivers the currently most precise values of A and b using a polarized neutron beam. We present the status of the data analysis of the most recent campaign at the ILL PF1b beam line in Grenoble, France, with the aim to extract an improved limit for the Fierz term b from the electron spectrum.

Meanwhile, the new PERC (Proton Electron Radiation Channel) facility is being set up at the research reactor FRM II of the Heinz Maier-Leibnitz Zentrum in Garching, with the aim to measure correlation coefficients one order of magnitude more precisely.

HK 62.2 Thu 14:30 SCH/A252

Measurement of the nuclear transition energies of ^{83m}Kr using the condensed krypton source of KATRIN — •Matthias Böttcher and Benedikt Bieringer for the KATRIN-Collaboration — Institut für Kernphysik, WWU Münster

The KATRIN experiment aims to measure or exclude the effective electron neutrino mass m_ν down to 0.2 eV/c^2 (90 % C.L.) by measuring the tritium beta spectrum near its endpoint E_0, and performing a fit including the parameters E_0 and m_ν^2. Since these are highly correlated, a systematic shift influencing the obtained neutrino mass would be visible in the endpoint and thus the tritium Q value. The KATRIN Q value can be determined by absolute calibration with ^{83m}Kr conversion electron lines. This is however limited by the nuclear gamma transition energy uncertainties of ^{83m}Kr to 0.5 – 0.6 eV accuracy. The excited nucleus of ^{83m}Kr decays in a two-step cascade of 32.2 eV and 9.4 eV highly converted gamma transitions. In a new four weeks measurement campaign performed at KATRIN, a large set of conversion electron lines including a new line was measured extensively with a condensed krypton source. Following the method described in ref. EPJ C 82 (2022) 700, the ^{83m}Kr nuclear transition energies can be determined, which can allow for a reduction of the Q value uncertainty to below 100 meV. In this talk the principle, measurements, and analyses for improving the ^{83m}Kr transition energy uncertainties are presented. This work is supported by BMBF under contract number 05A20PMA.

HK 62.3 Thu 14:45 SCH/A252

Towards the biggest germanium detectors ever grown — •Tommaso Comellato and Stefan Schönert — Technical University of Munich, Garching bei München, Germany

The Legend experiment searches for the neutrinoless double-beta decay of ^{76}Ge, a second order weak process which, if observed, would provide evidence of beyond the standard model physics. It is presently being commissioned in the upgraded Gerda infrastructure at LNGS (Italy) and in its first stage it will operate 200 kg of High Purity Germanium (HPGe) detectors. The baseline detector geometry is the inverted coaxial, which combines the excellent pulse shape discrimination performance of previous generation experiments with a up to a factor 4 larger mass per detector. This yields as a result a reduction of a similar factor of backgrounds from close-by parts as cables and holders. In this talk, detailed field modeling of big detectors will be given, and preliminary results on the experimental characterization of one of them will be presented. This work has been supported in part by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (Grant agreement No. 786430 - GemX)

HK 62.4 Thu 15:00 SCH/A252

Development of a cosmic muon and neutron veto system for IAXO and BabyIAXO — •Dhruv Chouhan, Elisa Ruiz-Chóliz, and Matthias Schott — Johannes Gutenberg University of Mainz, Germany

The International Axion Observatory (IAXO) experiment is a large-scale helioscope aimed at searching for axions and axion-like particles (ALPs) produced in the Sun. As a first step, the BabyIAXO was proposed as a smaller scale helioscope that will reach a sensitivity on the axion-photon coupling of 1.5*10-11 GeV-1 for masses up to 0.25 eV, covering a very interesting region of the parameter space. To detect the axion signal, a very low background x-ray detector design is required. This talk will focus on the development of the BabyIAXO veto system for cosmic rays based on light-guided organic plastic scintillators with Silicon Photo Mutiplier sensors.

HK 63: Instrumentation XVI

Time: Thursday 15:45–17:00 Location: SCH/A251

Group Report HK 63.1 Thu 15:45 SCH/A251

Der PANDA-Luminositätsdetektor — •Heinrich Leithoff[1], Achim Denig[1], Christof Motzko[2], Jannik Petersen[2], Florian Feldbauer[3], Gerhard Reicherz[3], Roman Klasen[3], Stephan Maldaner[3], Niels Boelger[3], Stephan Bökelmann[3], René Hagdorn[3] und Miriam Fritsch[3] — [1]Johannes-Gutenberg Universität Mainz — [2]Helmholtz Institut Mainz — [3]Ruhr-Universität Bochum

Das zukünftige PANDA-Experiment, welches im Antiprotonenring HESR als Teil der im Bau befindlichen FAIR Beschleunigeranlage bei Darmstadt entsteht, ist optimiert, um Fragen der Hadronenphysik zu untersuchen. Es bietet herausragende Voraussetzungen zur Suche nach neuen Zuständen sowie der präzisen Vermessung bekannter Zustände. In der dafür verwendeten Energie-Scan-Methode ist die exakte Kenntnis der Luminosität zur Normierung essentiell. Diese wird bei PANDA aus der Winkelverteilung der elastisch gestreuten Antiprotonen extrahiert. Für die geforderte absolute Messgenauigkeit von besser als 5% werden die Spuren der elastisch gestreuten Antiprotonen mit 4 Ebenen gedünnter Siliziumpixelsensoren (HV-MAPS) gemessen. Diese Sensoren mit integrierter Ausleseelektronik werden auf CVD-Diamantscheiben aufgeklebt in zwei verfahrbaren Halbdetektoren montiert und zur Reduktion der Vielfachstreuung im Vakuum betrieben. Präsentiert werden das Konzept des Luminositätsdetektors mit technischen Aspekten wie Vakuumsystem, Kühlung und Elektronik sowie Einblicken in die Datenanalyse.

HK 63.2 Thu 16:15 SCH/A251

Performance on the STS detector in Ni+Ni collisions at 1.93 AGeV with the mCBM setup at SIS18 — •Dario Alberto Ramirez Zaldivar for the CBM-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

The Compressed Baryonic Matter (CBM) is one of the experimental pillars at the FAIR facility. CBM focuses on the search for a signal of the phase transition between hadronic and quark-gluon matter, the QCD critical endpoint, new forms of strange-matter, in-medium modifications of hadrons, and the onset of chiral symmetry restoration. The Silicon Tracking System is the central detector for momentum measurement and charged-particle identification. It is designed to measure Au+Au collisions at interaction rates up to 10 MHz. It comprises approximately 900 double-sided silicon strip sensors arranged in 8 tracking stations, resulting in 1.8 million channels, having the most demanding requirements in terms of bandwidth and density of all CBM detectors. The mini-CBM (mCBM) project is a small-scale precursor of the full CBM detector, consisting of sub-units of all major CBM systems which aims to verify CBM's concepts of free-streaming readout electronics, data transport, and online reconstruction. In the 2022 beam campaign at SIS18 (GSI) Ni+Ni collisions at 1.93 AGeV were measured with an average collision rate of 400 kHz. The mini-STS (mSTS) setup for the campaign consists of 2 stations with 11 sensors. The results from data taken in the 2022 beam campaign will be presented focusing on the hit reconstruction and mSTS performance studies.

HK 63.3 Thu 16:30 SCH/A251

Characterization and test of STS modules for the E16 experiment — •Dairon Rodriguez Garces for the CBM-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

The J-PARC E16 experiment has the goal to search for signatures of the spontaneously broken chiral symmetry and its (partial) restoration, through di-electron detection from slowly moving vector mesons, particularly the phi meson, produced in proton-nucleus collisions. For this purpose, the experiment will use modules constructed using the same technology and procedures as the modules of the Silicon Tracking System (STS) of the CBM experiment.

A total of 10 modules were assembled at the Detector Lab in GSI. This is the first time a series of modules is produced with final components, and systematically tested. Each module has a double-sided silicon sensor, connected via a stack of microcables to a pair front-end boards (FEBs) with 8 ASICs (STS-XYTERv2) each. The characterization of the E16 modules was carried out through the STS testing procedure that includes the determination of the set of the operational parameters for each module (ADC calibration, etc.), testing the performance (ENC noise, the linearity of the ADC and the homogeneity of the channels response), and also the identification of the broken channels.

This work will show the results of testing and characterizing the E16 modules and the insights that we have gained from it for the upcoming series production of STS modules.

HK 63.4 Thu 16:45 SCH/A251

Dosimetry with test structures of the PANDA Micro-Vertex-Detector — •Nils Tröll — II. Physikalisches Institut, Giessen

Electrical characterization and radiation damage is carried out on double-sided silicon strip detectors and pin diodes representing a test structure with electrical properties for the Micro-Vertex-Detector (MVD), which will be the innermost tracking detector of the PANDA experiment.

Therefore, the silicon diodes of the MVD are used in a dosimeter con- cept for measurements of ionizing radiation dose. The energy calibra- tion is carried out at the Marburg Ion Beam Therapy Centre (MIT) and by various laboratory radiation sources. Signal generation by the sensors is observed to determine performance parameters for the MVD. Additionally, static electrical properties, like the depletion voltage, al- low a characterization of radiation tolerance of the silicon diodes. The work is supported by the BMBF.

HK 64: Instrumentation XVII

Time: Thursday 15:45–16:45 Location: SCH/A.101

Group Report HK 64.1 Thu 15:45 SCH/A.101

Status and production of the CBM Transition Radiation Detector — •Philipp Kähler for the CBM-Collaboration — Institut für Kernphysik, WWU Münster

The upcoming Compressed Baryonic Matter (CBM) experiment at FAIR will investigate the QCD phase diagram at high net-baryon densities and moderate temperatures. In these measurements, the CBM Transition Radiation Detector (TRD) will contribute to the excellent electron identification, enabling to study the hot and dense medium via di-electron analyses at intermediate masses. Furthermore, the TRD will serve as an intermediate tracking station as well as provide the identification of light nuclei in the hypernuclei programme of CBM.

This talk summarises the status of the CBM-TRD project. A report on the detector module (MWPC) production will be given, which has been started. Design details of the new intrinsically gas-tight cathode pad-plane are included. Moreover, the current plans for the periphery are covered as well as the participation in the FAIR phase 0 programme mCBM at the SIS18 accelerator. This work is supported by BMBF grants 05P21RFFC1 and 05P21PMFC1.

HK 64.2 Thu 16:15 SCH/A.101

Commissioning of the First Gas System Line for the CBM-TRD — •Felix Fidorra for the CBM-Collaboration — Institut für Kernphysik WWU Münster, Münster, Germany

The Compressed Baryonic Matter (CBM) experiment is a fixed target heavy-ion experiment which is currently under construction at FAIR in Darmstadt. It will explore the QCD phase diagram at high net-baryon densities. The Transition Radiation Detector (TRD) of the CBM experiment will be based on Multi Wire Proportional Chambers (MWPCs) filled with Xe/CO_2 85:15 as detector gas. This talk reports on the commissioning of the first regulated line of the future gas system for the CBM-TRD. During operation, the gas flow through the chambers has to be regulated such that the relative pressure in the detector volume stays within -0/+1 mbar. To ensure the gas quality, also continuous monitoring of O_2, CO_2 and H_2O content will be included. A part of the gas system, as, e.g., the main regulation valves, the circulation pump and the PLC layer will be located in a service level above the experiment. The first gas line, including already the final tube lengths and the PLC controls, has been set up in the laboratories in Münster for characterisation of, e.g., the timing characteristics of the pressure control and for commissioning. This work is supported by BMBF grants 05P19PMFC1 and 05P21PMFC1.

HK 64.3 Thu 16:30 SCH/A.101

New planar GEM detectors for AMBER — •Jan Paschek[1], Karl Flöthner[1,3], Dimitri Schaab[1], Christian Honisch[1], Michael Lupberger[1,2], Igor Konorov[4], Christian Honisch[1], Michael Hösgen[1], and Bernhard Ketzer[1] — [1]Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany — [2]Universität Bonn, Physikalisches Institut, Bonn, Germany — [3]CERN, Geneva, Switzerland — [4]Technische Universität München, Physik-Department, Garching, Germany

As a follow-up experiment to COMPASS at the M2 beamline of the CERN SPS, AMBER (NA66) is expected to make important contributions to unresolved questions related to the structure and spectroscopy of light mesons. In addition, a precision measurement of the proton formfactor by elastic muon-proton scattering at very low 4-momentum transfer will be performed over the next two years.

New large-format triple GEM detectors have been designed and built for tracking charged particles in close proximity to the primary beam. They have shorter strips split in the middle to handle higher particle rates without having to disable the central region. We also eliminated the use of spacer grids to minimize dead zones. The first new detectors were installed and operated during the COMPASS beam period in 2022. For AMBER, the APV-based readout electronics will be replaced by a self-triggering front-end chip. In addition, a stabilized voltage divider will provide constant gain independent of particle rate.

The talk will give an overview of the construction and commissioning of the new detectors and show first results from their operation.

HK 65: Heavy-Ion Collisions and QCD Phases XII

Time: Thursday 15:45–17:15 Location: SCH/A216

HK 65.1 Thu 15:45 SCH/A216

Reconstruction of neutral mesons via photon conversion method in Ag-Ag collisions at 1.58A GeV with HADES* — •Tetiana Povar for the HADES-Collaboration — Bergische Universität Wuppertal,Wuppertal,Germany

The High Acceptance DiElectron Spectrometer (HADES) situated at GSI Darmstadt, Germany, aims to measure nuclear matter at high densities and medium temperatures by means of heavy ion collisions. As leptons do not interact strongly with the formed medium in all stages of such collisions, electrons and positrons can provide information about the full fireball evolution. Hence, the study of virtual photons and their decay into electron pairs $(e^- + e^+)$ are one of the main goals in the HADES physics program.

The major background in the di-electron spectrum at low invariant masses are Dalitz-decays of light neutral mesons. Hence, precisely extracting the yields of neutral mesons produced in the collisions is necessary for proper background subtraction in all di-electron analyses.

In this talk we will present preliminary results on the transverse mass and rapidity resolved π^0- and η-production yields in Ag-Ag collisions measured with HADES via the photon conversion method at 1.58A GeV incident beam energy.

* Work supported by BMBF (05P19PXFCA, 05P21PXFC1), and GSI.

HK 65.2 Thu 16:00 SCH/A216

Measurement of neutral meson production with ALICE — •Nicolas Strangmann for the ALICE Germany-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

The ALICE experiment at CERN-LHC investigates the properties of hot and dense nuclear matter created in heavy-ion collisions. Measurements of identified particle production in pp collisions not only serve as reference for larger collision systems, but also help to study different aspects of hadronisation. This contribution will focus on the production of neutral mesons in different collision systems. A precise determination of the neutral meson production can help constrain theoretical models and provide vital input for direct photon analyses.

In ALICE, different detectors and detector combinations are used to reconstruct neutral mesons (π^0 and η) via their two photon decay channel. These photons can be detected in the calorimeters or via their conversion-electron tracks in ALICE tracking detectors. ω mesons can be reconstructed via their three pion decay $\omega \rightarrow \pi^+\pi^-\pi^0$.

In this talk, an overview of the π^0, η and ω measurements with ALICE will be presented. This includes a multiplicity dependent measurement of π^0 and η in pp collisions at $\sqrt{s}$=13 TeV as well as ω measurements in pp and p–Pb collisions.

Supported by BMBF and the Helmholtz Association.

HK 65.3 Thu 16:15 SCH/A216

Characterising the hot and dense fireball with virtual photons at HADES — •Niklas Schild für die HADES-Kollaboration — Technische Universität Darmstadt, 64289 Darmstadt, Germany

Electromagnetic probes (γ, γ^*) offer a unique opportunity to study the conditions in heavy-ion collisions throughout their whole evolution. Since they can escape the strongly interacting medium, they may bring direct information from their origins to a detector.

In this contribution, we present measurements of such dileptons from Ag+Ag collisions, collected at the High-Acceptance-DiElectron-Spectrometer (HADES), at $\sqrt{s_{NN}}$ = 2.55 GeV. A particular focus is set on the multidifferential analysis of the anisotropic flow in terms of centrality, rapidity, transverse momentum and invariant mass. Through the isolation of the in-medium contribution, this will allow insights into the flow at early stages of the collision, and therefore into the time evolution of the system's collectivity as a whole.

HK 65.4 Thu 16:30 SCH/A216

Measurement of photon and light neutral meson production in p–Pb collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV — •Stefanie Mrozinski for the ALICE Germany-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

The ALICE experiment at CERN-LHC is designed to study the characteristics of the hot and dense nuclear matter created in heavy ion collisions, the quark-gluon plasma (QGP). Since direct photons escape the medium unaffected during all collision states, they offer unique analysis opportunities. A necessary prerequisite for the direct photon measurement is the precise determination of the inclusive photon as well as the neutral meson production.

In ALICE, the measurements of photons is realized using electromagnetic calorimeters (EMCal or PHOS) and a photon conversion method (PCM). For the reconstruction of the mesons via their two-photon decay channel, photons from the same calorimeters or method as well as photons from a calorimeter and the PCM method can be used.

This talk will focus on the reconstruction of π^0 and η meson spectra as well as the measurement of the inclusive photon yield in p–Pb collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV using the PCM-PHOS reconstruction method. The current status of the analyses will be presented.

Supported by BMBF and the Helmholtz Association.

HK 65.5 Thu 16:45 SCH/A216

Topological separation of dielectron signals in Pb–Pb collisions with ALICE — •Jerome Jung for the ALICE Germany-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

Dielectrons are an exceptional tool to study the evolution of the medium created in heavy-ion collisions. In central collisions, the energy densities are sufficient to create a quark-gluon plasma (QGP). Thermal e^+e^- pairs with invariant mass around 1.5 GeV/c^2 can be used to estimate the temperature of the QGP.

At LHC energies, correlated HF hadron decays dominate the dielectron yield for invariant masses above 1.1 GeV/c^2. Their contribution is modified in the medium compared to elementary collisions to an unknown extent, leading to large uncertainties in the subtraction of known hadronic sources. The proper decay length of HF hadrons is of the order of $c\tau \approx 100 - 500$ μm, hence their reconstructed decay electrons do not point to the primary vertex of the collision. Therefore, a topological separation based on the distance-of-closest approach (DCA) to the primary vertex is a promising alternative approach to disentangle them from the prompt contribution of thermal dielectrons.

In this talk, the newest results on the DCA_{ee} spectra of dielectrons produced in Pb–Pb collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV with ALICE will be presented. The measurements are compared to reference distributions from simulations and expectations from theory. The presentation will conclude with a discussion of novel developments of the dielectron analysis.

HK 65.6 Thu 17:00 SCH/A216

Measurement of neutral pions in PbPb collisions in ALICE at sqrt(s_NN) = 5TeV — •Stephan Stiefelmaier for the ALICE Germany-Collaboration — Physikalisches Institut Heidelberg

Neutral pion and eta mesons are responsible for a large fraction of secondary photons in the measurement of direct photons what makes their measurement important. I present the current state of the measurement of neutral mesons with the photon conversion method with the 2018 PbPb data sample using the latest reconstruction and calibration methods.

HK 66: Heavy-Ion Collisions and QCD Phases XIII

Time: Thursday 15:45–17:15 Location: SCH/A315

HK 66.1 Thu 15:45 SCH/A315

Measurement of light neutral meson production inside jets in pp collisions at $\sqrt{s}$ = 13 TeV with ALICE — •Joshua König for the ALICE Germany-Collaboration — IKF, Goethe-Universität Frankfurt

Particle production in ultra-relativistic pp collisions can be factorized into the parton density function (PDF), the partonic cross-section and the fragmentation function (FF). While PDFs, accessible via deep inelastic scattering experiments, and the partonic cross section, calculable using perturbative QCD, are independent of the final state particle species, FFs need to be constrained by experimental data for each particle species. Measurements of the momentum fraction $z = p_{\mathrm{part}}/p_{\mathrm{jet}}$ of a particle species contained in a high energetic jet gives direct access to the FF of the species.

In this talk, the measurement of the p_{T} spectra of π^0 and η mesons inside jets as well as the measurement of the meson momentum fraction z in pp collisions at $\sqrt{s}$ = 13 TeV with ALICE will be presented. The measurement combines results from several partial independent meson reconstruction techniques available in ALICE, including calorimeter based photon detection as well as utilizing photon conversions in the central tracking detectors. Particle jets are reconstructed using charged tracks from the central tracking detectors as well as neutral clusters from the electromagnetic calorimeter. The results will be compared to theoretical model predictions.

Supported by BMBF and the Helmholtz Association

HK 66.2 Thu 16:00 SCH/A315

Jet-hadron correlations in PbPb collisions at $\sqrt{s_{\mathrm{NN}}}$=5.02 TeV with ALICE — •Luisa Bergmann for the ALICE Germany-Collaboration — Physikalisches Institut, Im Neuenheimer Feld 226, 69120 Heidelberg

In relativistic heavy-ion collisions, a deconfined medium with high energy density is created, the quark-gluon plasma. Amongst other observables, jets – originating from primordial hard scatterings – act as useful probes for the properties of this medium. As the initial partons traverse the quark-gluon plasma, they lose energy by interacting with the constituents of the medium. The study of this so called "jet quenching" yields insight into the properties of the medium.

By analyzing the angular correlations of jets with charged hadrons, one obtains information about the energy loss of jets in the medium. The study of these correlation functions for different orientations of the jet to the event plane allows for a measurement of the energy loss which is sensitive to the in-medium path-length of the jet. In this talk, first studies of event plane dependent jet-hadron correlations for data collected by the ALICE experiment in PbPb collisions at $\sqrt{s_{\mathrm{NN}}}$=5.02 TeV are presented.

HK 66.3 Thu 16:15 SCH/A315

Studies of jets in heavy-ion collisions at ALICE with a novel mixed-event approach — •Nadine Grünwald for the ALICE Germany-Collaboration — Physikalisches Institut Heidelberg, Im Neuenheimer Feld 226, 69120 Heidelberg

With heavy-ion collisions QCD matter is studied at very high temperatures and densities. The ALICE experiment is dedicated to measure heavy-ion collisions at the LHC. The Quark-Gluon Plasma (QGP) is produced in those collisions where quarks and gluons are deconfined and new physics phenomena emerge. The QGP can be studied using jets, which are produced in the early stage of the collisions. Depending on the structure of the QGP, the jets lose energy in various ways. A major difficulty in heavy-ion jet measurements is the huge amount of uncorrelated particles which distorted the jet measurements, especially at lower p_{T}. In order to perform low p_{T} jet measurements, a novel mixed-event technique is exploited. In this talk the mixed events as a new approach to describe the uncorrelated background in heavy-ion jet measurements at ALICE are presented. The description of the uncorrelated background by mixed events enables for the first time inclusive charged jet measurements down to low p_{T} at collision energies of $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV. In particular no cuts on the reconstructed jet energies are necessary.

HK 66.4 Thu 16:30 SCH/A315

Direct photon and χ_c performance studies for the ALICE 3 experiment — •Abhishek Nath for the ALICE Germany-Collaboration — Ruprecht Karl University of Heidelberg, Germany

Direct photons are one of the critical tools for studying hot QCD medium as their mean free path is much larger than the size of the system and they leave the medium without further interaction. As the ALICE 3 LOI received the LHCC recommendation to proceed with R&D, we try to perform more critical studies regarding photons. With much larger rapidity coverage and usage of bent Monolithic Active Pixel Sensors (MAPS), the ALICE 3 experiment aims to go much lower in p_T to explore the direct photons originating majorly from thermal contribution. Along with that, with the measurement of χ_c, χ_b, and other $L = 1$ states in the extended rapidity range in ALICE 3, a more accurate description of the dynamics of quarkonium interactions with the medium will be possible.

In this talk, we present performance studies and uncertainty projections in key direct photon measurements like R_γ, direct photon spectrum and corresponding inverse slope parameter, direct photon v_2 and possibly also HBT anticipated for Run 5 and 6. Along with this, the performance of χ_c measured through the radiative decay channel $\chi_c \to J/\psi + \gamma$ in Pb–Pb collisions is also presented.

HK 66.5 Thu 16:45 SCH/A315

Low p_T ω measurements in pp collisions at $\sqrt{s} = 5.02$ TeV with ALICE — •Merle Luisa Wälde for the ALICE Germany-Collaboration — Goethe University, Frankfurt, Germany

Measurements of hadron production cross sections in proton-proton (pp) collisions at high energies are important to test our understanding of QCD and as reference for heavy-ion studies. While the hard production of particles can be calculated in a perturbative approach, the production via soft scattering processes relies on phenomenological model approaches that require experimental input and suffer from sizeable uncertainties in their predictions. Therefore, the spectra of the ω meson needs to be measured down to the lowest transverse momentum (p_T) where the reach to low momenta is scarce at LHC energies and midrapidity.

In this talk, the first measurement of the ω meson down to $p_T = 0$ in pp collisions at $\sqrt{s} = 5.02$ TeV at midrapidity will be presented. The ω meson is reconstructed in the decay into e^+e^- pairs with ALICE. We will discuss the estimation of the combinatorial background as well as uncertainties related to the extraction of the signals. The final results will be compared to model calculations.

HK 66.6 Thu 17:00 SCH/A315

Charged Kaon and ϕ Production in Ag+Ag Collisions at 1.58A GeV with HADES — •Marvin Kohls for the HADES-Collaboration — Goethe-Universität Frankfurt

The investigation of strangeness production and propagation in heavy-ion collisions in the few GeV energy regime is a sensitive tool to study the microscopic structure of nuclear matter at high baryo-chemical potential [1]. For respective studies presented in this talk, a total of 6×10^9 central Ag(1.58 A GeV)+Ag events recorded with HADES in 2019 have been used. We focus on results concerning K^+, K^- and $\phi(1020)$.

The multiplicities of strange particles are compared with results obtained from statistical hadronization models. Special attention will be put on the non-strange $\phi(1020)$ meson and the double-strange Ξ^- hyperon. Furthermore, the centrality ($\langle A_{\rm part}\rangle$) dependence of strange-hadron multiplicities will be discussed, which was found to follow a universal scaling for the collision system Au(1.23 A GeV)+Au.

This work has been supported by BMBF (05P21RFFC2), GSI, HFHF, the State of Hesse within the Research Cluster ELEMENTS (Project ID 500/10.006) and HGS-HIRe.

[1] Che Ming Ko et al.; Ann.Rev.Nucl.Part.Sci. 47 (1997) 505-539

HK 67: Hadron Structure and Spectroscopy VIII

Time: Thursday 15:45–17:00 Location: SCH/A316

Group Report HK 67.1 Thu 15:45 SCH/A316

Recent and ongoing studies from the A2 Collaboration at MAMI — •Edoardo Mornacchi for the A2-Collaboration — Johannes Gutenberg-Universität, Mainz, Germany

The A2 Collaboration at the Mainz Microtron (MAMI) performs photoproduction experiments to investigate the internal structure of nucleons and mesons, gaining a better understanding of non-perturbative QCD.

It uses a circularly or linearly polarized Bremsstrahlung photon beam with energies up to 1.6 GeV, together with a variety of unpolarized and polarized targets. The resulting particles are then detected using the large acceptance Crystal Ball-TAPS detector system, which is perfectly suited for the detection of multi-photon final states.

An overview of the ongoing studies as well as recent results from the A2 Collaboration will be given, along with an outlook on current and future measurements.

HK 67.2 Thu 16:15 SCH/A316

Studies of Coherent Photoproduction off the Deuteron at the BGOOD Experiment — •Antonio Joao Clara Figueiredo for the BGOOD-Collaboration — Physikalisches Institut der Universität Bonn

The BGOOD photo production experiment [1] at the ELSA facility [2] is uniquely designed to explore kinematics where a charged particle is identified in the forward spectrometer and a recoiling hadronic system is reconstructed in the central calorimeter at low momentum transfer. Typically used to study strangeness photoproduction at low t, the setup also enables studies of coherent reactions off the deuteron where the deuteron takes the majority of the beam momentum.

Following a BGOOD publication on the $\pi^0\pi^0 d$ [3] photoproduction supporting the three isoscalar dibaryon candidates reported by the ELPH collaboration [4], the presented work uses an improved method of momentum reconstruction in the forward spectrometer and uses a kinematic fit to improve invariant mass resolutions. Preliminary results are presented of the analysis of the $pi^0\pi^0 d$ and $\pi^0\eta d$ final states.

Supported by DFG projects 388979758/405882627 and the European Unions Horizon 2020 programme, grant 824093.

[1] S. Alex et al., Eur. Phys. J. A 57 (2021) 80. [2] W. Hiller, Eur. Phys. J. A 28 (2006) 139. [3] T.C. Jude et al., Phys. Lett. B (2022) 137277. [4] T. Ishikawa et al., Phys. Lett. B 789 (2019) 413.

HK 67.3 Thu 16:30 SCH/A316

Evidence for a phi-N bound state — •Emma Chizzali for the ALICE Germany-Collaboration — Technical University of Munich, Munich, Germany

The possible existence of phi-mesic nuclei is widely discussed in the literature, however, experimental evidence so far is missing. The main ingredient for the study of such systems is the phi-N strong interaction, which is characterised by the two spin states S=1/2 and S=3/2 and can be accessed experimentally via momentum correlations. In this talk, a re-analysis of the p-phi correlation function, measured by the ALICE Collaboration in high-multiplicity pp collisions at sqrt(s)=13 TeV, is presented. The S=3/2 channel is constrained using the recently published lattice QCD potential. This makes it possible to study the unknown interaction in the S=1/2, which is modelled by an advanced phenomenological potential. The results of this study show evidence of a bound state in the S=1/2 channel, with sizeable binding energy, which is characterised by a potential strong enough that it results in negative scattering length.

Funded by BMBF Verbundforschung (05P21WOCA1 ALICE) and MPP IMPRS

HK 67.4 Thu 16:45 SCH/A316

Separation of protons and neutrons with the CBELSA/TAPS experiment — •Nadia Reinartz for the CBELSA/TAPS-Collaboration — HISKP, Uni Bonn

The ELSA accelerator can provide a polarised electron beam that together with the polarised target of the CBELSA/TAPS experiment makes it possible to determine single or double polarisation observables for various final states. The Crystal Barrel (CB) calorimeter in combination with the MiniTAPS calorimeter in forward direction, allows measurements in a full 4π coverage. In the past it was difficult to efficiently measure reactions with a neutron in the final state.

In the last years the CBELSA/TAPS experiment in Bonn has been improved in order to significantly boost the efficiency for detecting neutrons in the main calorimeter. The data taken after the upgrade was used to determine methods for identifying protons and neutrons with beam energies between 600 MeV and 3200 MeV. In this talk an overview about those results is presented.

HK 68: Hadron Structure and Spectroscopy IX

Time: Thursday 15:45–17:00 Location: SCH/A419

Group Report HK 68.1 Thu 15:45 SCH/A419

Exclusive Hyperon Reconstruction in pp Data at HADES — •Jenny Regina — GSI, Helmholtzzentrum für Schwerionenforschung GmbH, Planckstraße 1, 64291 Darmstadt, Germany

Hyperons are expected to play an important role in describing the dynamics of high-dense baryonic matter such as present in the interior of neutron stars. HADES (High Acceptance Di-Electron Spectrometer) offers excellent opportunities for studying hyperon production in pp and heavy ion collisions. In February 2022 HADES collected high statistics data of the reaction p(4.5 GeV)p. With this data set, the production and decay of single and double strange hyperons in inclusive and exclusive channels will be possible. In particular rare dielectron Dalitz decays of Σ^0 and Λ hyperons will investigated for the first time.

For this purpose, HADES was upgraded with straw tube trackers, which are a FAIR-Phase0 contribution from PANDA, and a timing detector, both of which cover polar angles below 7 degrees; a region where many hyperon decay products are emitted. As a result, they increase the efficiency of the hyperon reconstruction. A kinematic fitting library has been developed to improve the overall resolution. It is based on Lagrange multipliers and utilizes kinematic and geometric constraints.

This talk will address the exclusive hyperon reconstruction, for example of $pp \to pK^+\Lambda$, in the recent data, focusing on the new hyperon reconstruction tools; the straw tube tracker, the kinematic fitting, and how these are used in the analyses.

HK 68.2 Thu 16:15 SCH/A419

Hyperon-production studies in proton-proton collisions at 4.5 GeV with HADES — •Snehankit Pattnaik, Johan Messchendorp, and James Ritman for the HADES-Collaboration — GSI, Darmstadt, Germany

This work presents a preliminary analysis of the $\Lambda + K_S^0 + \mathrm{p} + \pi^+$ final state in recently collected proton-proton scattering data taken at 4.5 GeV using HADES at GSI Helmholtzzentrum für Schwerionenforschung in Darmstadt, Germany. The production of hyperons is of particular interest since it provides information about the role of N* resonances in strangeness production in NN interactions. Furthermore, this study could be relevant in describing the dynamics of high-dense matter such as that located at the core of neutron stars.

This talk will present some of the data-driven analysis procedures that have been used to select the final-state of interest. In particular, a particle identification method exploiting the relative time-of-flights and utilizing several vertex and kinematical observables have been used to obtain a strong signal for this exclusive state.

HK 68.3 Thu 16:30 SCH/A419

Photoproduction of $\Lambda(1520)$ at forward angles with BGOOD — •Emil Rosanowski for the BGOOD-Collaboration — Physikalisches Institut der Universität Bonn

The BGOOD experiment at the ELSA facility is used for photoproduction in the uds sector. It is uniquely designed to explore reactions where a meson is detected at forward angles, leaving a recoiling hadronic system at low momentum transfer, which could enable the observation of molecular structure.

Studies of the reaction $\gamma p \to K^+\Lambda(1520)$ at forward angles will be presented. The analysis required K^+ identification and the $\Lambda(1520)$ via the decay $\Lambda(1520) \to \pi^0\Sigma^0$. Progress in measuring preliminary differential cross sections at forward K^+ angles will be presented.

Supported by DFG projects 388979758/405882627 and the European Unions Horizon 2020 programme, grant 824093.

HK 68.4 Thu 16:45 SCH/A419

Hyperon Reconstruction with Realistic Track Finding for PANDA — •Anna Alicke[1], Tobias Stockmanns[3], and James Ritman[2,1,3] — [1]Ruhr-Universität Bochum, Experimentalphysik, Lehrstuhl I — [2]GSI Helmholtzzentrum für Schwerionenforschung — [3]Forschungszentrum Jülich, Institut für Kernphysik

One main research topic of the PANDA experiment is the spectroscopy of excited hyperon states. Hyperons, such as Ξ, have a large decay length of several cm and further decay into Λ particles, which have a similarly long lifetime. Consequently, hyperons have a distinctive decay pattern consisting of final state particles that have a displaced secondary vertex. These tracks, which do not originate from the primary interaction point (IP), make track reconstruction and the subsequent event reconstruction challenging. In contrast to primary track finders, which use the IP, secondary track finders have to deal with a much higher combination of hits and are lacking this additional constraint to the IP. Consequently, the track finding efficiency and the momentum resolution for secondary tracks is worse than for primary tracks and usually require more computational power. Up to now, the PANDA experiment was lacking a dedicated track finder for secondary particles. Therefore, hyperon reactions have only been investigated using ideal track finding in PANDA. This work presents the new secondary track finder and its application on the reaction $p\bar{p} \to \Xi(1820)^-\Xi^+$. The expected reconstruction rate to observe the $\Xi(1820)^-$ resonance will be shown.

HK 69: Structure and Dynamics of Nuclei XIV

Time: Thursday 15:45–17:15 Location: SCH/A118

HK 69.1 Thu 15:45 SCH/A118

Investigation of neutron-induced γ rays from Ge-nuclides in the region of interest of GERDA/LEGEND — •Marie Pichotta[1], Toralf Döring[1,2], Hans F. R. Hoffmann[1], Konrad Schmidt[2], Ronald Schwengner[2], Steffen Turkat[1], Birgit Zatschler[1,3], and Kai Zuber[1] — [1]Technische Universität Dresden (IKTP), Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Germany — [3]University of Toronto, Canada

GERDA has been a pioneering experiment in the search for the still undetected neutrinoless double beta ($0\nu\beta\beta$)-decay of ^{76}Ge and this will also hold for the successor experiment LEGEND. The discovery of this extremely rare process would prove the Majorana character of neutrinos and consequently physics beyond the Standard Model. For an explicit identification of a signal caused by the $0\nu\beta\beta$-decay, which correspond to an energy of 2039 keV for ^{76}Ge, a precise understanding of all background contributions in the ROI is crucial.

However, previous experiments indicated γ lines produced by neutron activation (n,p) and neutron scattering (n,n') processes on ^{76}Ge and ^{74}Ge but until now, their existence could not be confirmed adequately. In this experiment an enriched Ge-sample was alternately irradiated by 14 MeV neutrons from a DT generator and measured by an optimized HPGe detection setup. The γ spectrum of 51 irradiation cycles shows three peaks in the energy region around 2039 keV which means that germanium itself can contribute to potential background in all ^{76}Ge $0\nu\beta\beta$-decay experiments such as LEGEND and GERDA. The experimental procedure and the results will be presented.

HK 69.2 Thu 16:00 SCH/A118

Simulation of ordinary muon capture for nuclear matrix elements of $0\upsilon\beta\beta$ research — •Xianke He, Andreas Jansen, and Kai Zuber — Institute of Nuclear and Particle Physics, TU Dresden, Germany

The search for beyond the Standard Model neutrinoless double beta decay ($0\upsilon\beta\beta$) is currently one method of determining the Majorana nature of the neutrino. The decay requires a non-zero neutrino mass. The connection between any possibly measured half-life and the neutrino mass is provided by the nuclear matrix elements (NMEs).

Nuclear models aiming at the description of the NMEs of $0\upsilon\beta\beta$ decays at high-momentum-exchange could be tested with Ordinary Muon Capture. OMC is a semi-leptonic weak interaction process quite like electron capture but with 200 times the electron rest mass. This leads to a remarkably larger momentum exchange. The OMC process taking place in the mother nuclei produces multipolarities J^π states of daughter nuclei with large angular momenta and high excitation energies.

From an experimental point of view, the corresponding muon capture rates can be obtained by measuring the intensity of gamma rays emitted during the de-excitation of these excited state nuclei over time, which can be used to test the correctness of the model describing the NMEs.

This talk will show the proposed experimental design to measure gamma spectrum of OMC using cosmic muons.

HK 69.3 Thu 16:15 SCH/A118

Neutrinoless double-β decay in an effective field theory — •Catharina Brase[1,2,3], Javier Menéndez[4,5], and Achim Schwenk[1,2,3] — [1]Technische Universität Darmstadt, Department of Physics — [2]Max-Planck-Institut für Kernphysik, Heidelberg — [3]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [4]Departament de Física Quántica i Astrofísica, Universitat de Barcelona, 08028 Barcelona, Spain — [5]Institut de Ciències del Cosmos, Universitat de Barcelona, 08028 Barcelona, Spain

We study neutrinoless double-β decay in an effective field theory (EFT) for heavy nuclei, which are treated as a spherical core coupled to additional neutrons and/or protons. The low-energy constants for this unobserved decay are constrained through a correlation with double Gamow-Teller transitions. This correlation was recently found to hold for shell-model calculations, energy-density functionals, and other nuclear structure models. We therefore first calculate the nuclear matrix elements for double Gamow-Teller transitions in the EFT for heavy nuclei. The combination of the EFT uncertainty with the correlation uncertainty enables predictions of nuclear matrix elements for neutrinoless double-β decay for a broad range of isotopes with quantified uncertainties. Generally the EFT predicts smaller nuclear matrix elements compared to other approaches, but our EFT results are consistent with recent ab initio calculations.

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HK 69.4 Thu 16:30 SCH/A118

Lifetime measurements in ^{116,118}Sn — •Sarah Prill, Anna Bohn, Felix Heim, Michael Weinert, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics

The Doppler-shift attenuation method (DSAM) using particle-γ coincidences is a reliable technique to determine sub-picosecond lifetimes of excited nuclear levels without feeding contributions [1,2]. In recent years, it was used to determine level lifetimes of stable nuclei along isotopic chains around the Z=50 and N=50 and N=82 shell closures to study changes of nuclear structure phenomena along these chains.

For ^{112,114}Sn, lifetimes have already been determined with this method [3]. To continue the study across the semi-magic tin isotopic chain, inelastic proton and alpha particle scattering experiments have been performed on ^{116}Sn and ^{118}Sn at the SONIC@HORUS detector array [4] at the University of Cologne. The combined detector array can measure the backscattered projectiles in coincidence with the produced γ radiation. This enables the reconstruction of the reaction kinematics as well as the elimination of feeding by selecting the direct excitation of the level of interest from the particle energy.

From these experiments, numerous level lifetimes in ^{116,118}Sn could be determined.

Supported by the DFG (ZI 510/9-1).

[1] A. Hennig *et al.*, Nucl. Instr. Meth. A **758**, 171 (2015).
[2] S. Prill *et al.*, Phys. Rev. C **105**, 034319 (2022).
[3] M. Spieker *et al.*, Phys. Rev. C **97**, 054319 (2018).
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HK 69.5 Thu 16:45 SCH/A118

Lifetime determination in ^{99}Y, ^{99}Zr and ^{99}Nb via delayed γ-γ fast-timing spectroscopy — •Aaron Pfeil[1], Jean-Marc Régis[1], Jan Jolie[1], Arwin Esmaylzadeh[1], Mario Ley[1], Lukas Knafla[1], Ulli Köster[2] und Yung Hee Kim[2] — [1]Institute for Nuclear Physics, University of Cologne — [2]Institut Laue-Langevin, Grenoble, France

The experiment was performed in 2020 at the mass spectrometer Lohengrin at the Institut Laue-Langevin in Grenoble, France [1]. Lifetimes of the low-lying excited states in the nuclei ^{99}Y, ^{99}Zr and ^{99}Nb were determined using the fast-timing technique [2]. This region is of special interest because of a rapid shape transition, which occurs by going from N = 58 to N = 60 and is especially pronounced in the Zr isotopes, where ^{98}Zr is spherical and ^{100}Zr is strongly deformed [3]. Therefore, the results from ^{99}Zr provide crucial information about the spherical-deformed border at N = 59. Experimental values are compared to predictions calculated in the framework of the interacting boson-fermion model [4,5]. Work supported by DFG grant JO391/18.1 and the Institut Laue Langevin.

[1] P. Armbruster et al., Nucl. Instrum. Methods 139 (1976)
[2] J.-M. Régis et al., Nucl. Instrum. Methods Phys. Res. 726 (2013)
[3] K.L.G. Heyde and J. L. Wood, Rev. Mod. Phys. 83, 1467 (2011)
[4] N. Gavrielov et al., Phys. Rev. C 106, L051304 (2022)
[5] K. Nomura et al., Phys. Rev. C 102, 034315 (2020)

HK 69.6 Thu 17:00 SCH/A118

Investigation of the Nuclear Structure of ^{76}Ge Using Nuclear Resonance Fluorescence — •M. Heumüller, V. Werner, S. Bassauer, T. Beck, M. Berger, M. Beuschlein, I. Brandherm, K. Ide, J. Isaak, R. Kern, J. Kleemann, O. Papst, N. Pietralla, P. Ries, G. Steinhilber, M. Stoyanova, and R. Zidarova — IKP, TU Darmstadt

^{76}Ge is the heaviest stable of the Germanium isotopes, which have been discussed in terms of shape coexistence and triaxiality [1]. In addition, ^{76}Ge is the baseline isotope for experiments searching for neutrino-less double-beta decay, hence, especially its low-energy dipole response is of interest. The nuclear structure of ^{76}Ge was investigated previously by using the method of nuclear resonance fluorescence [2,3]. For minimizing systematic uncertainties for cross section measurements below 5 MeV, the energy region of the low lying scissors mode, a bremsstrahlung measurement with an endpoint energy of 5.5 MeV was performed. The photons were provided by the superconducting electron accelerator S-DALINAC, impinging the enriched target in the Darmstadt High Intensity Photon Setup (DHIPS) with three HPGe detectors for γ-ray detection. The data analysis and results will be presented in the talk.

[1]Y. Toh *et al.*, Phys. Rev. C **87**, 041304(R) (2013)
[2]A. Jung *et al.*, Nucl. Phys. A **584**, 103-132 (1995)
[3]R. Schwengner *et al.*, Phys. Rev. C **105**, 024303 (2022)

HK 70: Structure and Dynamics of Nuclei XV

Time: Thursday 15:45–17:15 Location: SCH/A215

Group Report HK 70.1 Thu 15:45 SCH/A215

Evolution of low-lying M1 modes in germanium isotopes — Stefan Frauendorf[1] and •Ronald Schwengner[2] — [1]University of Notre Dame, Indiana 46556, USA — [2]Helmholtz-Zentrum Dresden-Rossendorf, Germany

Magnetic dipole strength functions are determined for the series of germanium isotopes from $N = Z = 32$ to $N = 48$ on the basis of a large number of transition strengths calculated within the shell model. The evolution of the strength with increasing neutron number in the $1g_{9/2}$ orbital is analyzed. A bimodal structure comprising an enhancement toward low transition energy and a resonance in the region of the scissors mode is identified. The low-energy enhancement is strongest near closed shells, in particular at the almost completely filled $1g_{9/2}$ orbital, while the scissorslike resonance is most pronounced in the middle of the open shell, which correlates with the magnitude of the also deduced electric quadrupole transition strengths. The results are consistent with previous findings for the shorter series of iron isotopes [1] and prove the occurrence and correlation of the two low-lying magnetic dipole modes as a global structural feature [2].

[1] R. Schwengner, S. Frauendorf, B.A. Brown, Phys. Rev. Lett. **118**, 092502 (2017).
[2] S. Frauendorf, R. Schwengner, Phys. Rev. C **105**, 034335 (2022).

HK 70.2 Thu 16:15 SCH/A215

Coulomb excitation and lifetime measurements in $^{84-86}$Ge with relativistic radioactive ion beams — •U. Ahmed[1,2], V. Werner[1,2], F. Browne[3], M. L. Cortés[4], N. Pietralla[1], and K. Wimmer[5] for the HiCARI-Collaboration — [1]IKP, TU Darmstadt, Germany — [2]HFHF, GSI Darmstadt, Germany — [3]CERN, Geneva, Switzerland — [4]RIKEN, Wako, Japan — [5]GSI, Darmstadt, Germany

Coulomb excitation cross sections of $^{84-86}$Ge nuclei and level lifetimes were investigated through reactions of Ge and As beams on heavy and light targets. The cross sections of these reactions will be determined from the ratio of incoming and outgoing particles and de-excitation γ-ray peak areas as measured by the High-resolution Cluster Array (HiCARI) at RIKEN-RIBF in Japan. The ongoing gamma-ray analysis aims at the measurement of the $E2$ transition probabilities of the lowest excited 2^+ states to chart the evolution of collectivity in the Ge chain above the $N = 50$ neutron shell closure. First steps of the analysis will be presented, namely the particle identification for the incoming particles from the BigRIPS fragment separator and the outgoing particles in the ZeroDegree spectrometer. Additionally, Doppler-corrected gamma-ray spectra based on the reconstructed velocity of incoming ions will be presented.

Supported by BMBF under Grant No. 05P21RDFN1 and by HFHF

HK 70.3 Thu 16:30 SCH/A215

The isovector spin-$M1$ response of ^{90}Zr and ^{92}Mo — •A. Gupta[1], V. Werner[1], K.E. Ide[1], A.D. Ayangeakaa[2,3], M. Beuschlein[1], S.W. Finch[3,4], U. Friman-Gayer[3,4,5], D. Gribble[2,3], J. Hauf[1], J. Isaak[1], X. James[2,3], R.V.F. Janssens[2,3], S.R. Johnson[2,3], J. Kleemann[1], P. Koseoglou[1], T. Kowalewski[2,3], B. Löher[6], O. Papst[1], N. Pietralla[1], A. Saracino[2,3], and D. Savran[6] — [1]IKP, TU Darmstadt — [2]UNC, Chapel Hill, NC, USA — [3]TUNL, Durham, NC, USA — [4]Duke U., Durham, NC, USA — [5]ESS, Lund, SE — [6]GSI, Darmstadt

For the $N = 50$ isotones ^{90}Zr and ^{92}Mo, additional isovector spin-flip M1 (IVSM1) strength is expected for ^{92}Mo in comparison to ^{90}Zr because of the two additional protons in the proton $g_{9/2}$ orbital above the closed pf shell. In addition, the IVSM1 resonance is closely related to Gamow-Teller strengths and can serve to constrain the calculation of electron-capture rates in core-collapse supernova scenarios[1]. Using the newly available hybrid array of HPGe Clover and $LaBr_3$ detectors at the High Intensity γ-ray source (HIγS), we probed the dipole response of both isotopes in an integral-spectroscopy approach below neutron separation thresholds.The $E1$ and $M1$ strengths will be determined up to about 9 MeV by measuring the asymmetries resulting from the excitation of the target nuclei by the fully-polarized γ-ray beam. The experimental method and first results will be discussed.

Supported by DFG Project No.279384907-SFB 1245 and the U.S. DOE Grant No. DE-FG02-97ER41041 and No. DE-FG02-97ER41033.

[1] K. Langanke et al., Rep. Prog. Phys. **84**, 066301 (2021)

HK 70.4 Thu 16:45 SCH/A215

Lifetime measurement of low-lying states in ^{92}Mo via γ-γ fast-timing spectroscopy — •Mario Ley[1], Lukas Knafla[1], Andreas Harter[1], Arwin Esmaylzadeh[1], Jan Jolie[1], and Piet Van Isacker[2] — [1]Institut für Kernphysik, Universität zu Köln — [2]Grand Accélérateur National d'Ions Lourds, Caen

Lifetimes of the first excited states in ^{92}Mo were measured using the digital γ-γ fast-timing technique with a detector array consisting of $LaBr_3$(Ce) and HPGe detectors. States were populated in a ^{90}Zr(α,2nγ)^{92}Mo reaction using the FN-Tandem accelerator of the institute for nuclear physics at the university of Cologne. The symmetrised centroid shift method [1], which is suitable for the determination of lifetimes in the pico- to nanosecond regime, was used to determine the lifetimes. The experimental results are used in a semiempirical approach which uses a single shell ($1g_{9/2}$) orbit to predict the B(E2) values in the N = 50 isotones from ^{93}Tc up to ^{98}Cd.

Work supported by DFG grant JO391/18.1

[1] J.-M. Régis et al., Nucl. Instrum. Methods Phys. Res. A 897 (2018)

HK 70.5 Thu 17:00 SCH/A215

Electron-Gamma Coincidence Measurements at S-DALINAC — •Gerhart Steinhilber, Jonny Birkhan, Isabelle Brandherm, Juliane Buschinger, Bastian Hesbacher, Johann Isaak, Igor Jurosevic, Peter von Neumann Cosel, Norbert Pietralla, Maxim Singer, and Maximilian Spall — IKP, Technische Universität Darmstadt

Inclusive (e,e') electron scattering is an established tool in nuclear physics that provides insights in nuclear structure with high accuracy because of its pure electromagnetic nature. (e,e'γ) coincidence experiments preserve this strength of inclusive electron scattering while additional information, for example, γ-decay branchings of PDR/GDR and the interference of longitudinal and transversal components of low-lying electric dipole excitations are accessible. The existing (e,e') setup at S-DALINAC was extended by a detector array consisting of 6 $LaBr_3$:Ce detectors. In 2021 a successful (e,e'γ) measurement was conducted on a mid-heavy nucleus, ^{96}Ru, for the first time. The main goal of this measurement was to study the B(M1,$2^+_{ms}\rightarrow2^+_1$) and B(E2,$2^+_{ms}\rightarrow0^+_1$) decay transition strengths of the 2^+_{ms} state of ^{96}Ru. Data were taken at excitation energies below and above the neutron separation threshold allowing a variety of physics cases to be studied. This talk will present the (e,e'γ) coincidence setup and preliminary results of the ^{96}Ru measurement.

This work is supported by the Research Training Group GRK 2128 and the Hessian cluster project ELEMENTS.

HK 71: Structure and Dynamics of Nuclei XVI

Time: Thursday 15:45–17:15 Location: SCH/A117

Group Report HK 71.1 Thu 15:45 SCH/A117

Broken axial symmetry as essential feature for a consistent modelling of various observables in heavy nuclei — •Eckart Grosse[1] and Arnd R. Junghans[2] — [1]IKTP, Techn. Universität Dresden — [2]Helmholtz-Zentrum Dresden-Rossendorf, 01314 Dresden

Although most experimental data do not deliver accurate information on nuclear axiality the ad-hoc assumption of symmetry about one axis found widespread use in nuclear model calculations. In the theoretical interpretation of nuclear properties as well as in the analysis of experimental data triaxiality was considered - if at all - only for some, often exotic, nuclides. Allowing breaking of axial symmetry combined to a spin-independent moment of inertia results in a surprisingly simple heuristic triaxial parametrization of the yrast sequence in all heavy nuclei, including well deformed ones. No additional fit parameters are needed in detailed studies of the mass and charge dependence of the electric dipole strength in the range of and outside of giant dipole resonances. Allowing triaxiality also avoids the introduction of an arbitrary level density parameter ã to fit the accurate values observed in n-capture experiments. Predictions for radiative neutron capture yields as derived on the basis of non-axiality are improved as well. The broken axial symmetry experimentally favoured apparently is in accord to HFB and MC-shell model calculations already for nuclei in the valley of stability.

HK 71.2 Thu 16:15 SCH/A117

Eigenvector continuation for the pairing Hamiltonian — •Margarida Companys Franzke[1], Alexander Tichai[1,2,3], Kai Hebeler[1,2,3], and Achim Schwenk[1,2,3] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Plank Institut für Kernphysik, Heidelberg

The design of emulation techniques for the evaluation of many-body observables is attracting increasing attention over the past years. In particular the framework of eigenvector continuation (EC) has been identified as a powerful tool if the Hamiltonian admits for a parametric dependence. By training the emulator on a set of training data the many-body solution for arbitrary parameter values can be robustly predicted in many cases. Furthermore, it can be used to resum perturbative expansions. In this work, we apply EC to the pairing Hamiltonian and show that i) EC-resummed perturbation theory is in qualitative agreement with the exact solution and ii) EC-based emulators robustly predict the ground-state energy once the training data are chosen appropriately. In particular the phase transition from a normal to a superfluid regime is quantitatively predicted from a very low number of training points. Finally the use of approximate training data is discussed and how many-body truncations may affect the emulator's performance.

Funded by the ERC Grant Agreement No. 101020842.

HK 71.3 Thu 16:30 SCH/A117

Improved coalescence model for (anti)nuclei formation — •Maximilian Horst — Technical University Munich

In accelerator experiments, the production of light (anti)nuclei such as (anti)deuterons and (anti)helium-3 can be studied in a wide range of collision systems, from small (pp) to large (A–A) emission source sizes. However, the microscopic mechanism through which they are produced and how they survive such hot and turbulent conditions, are still unknown. The most commonly used models to describe this process are the statistical hadronization model and the coalescence approach. In this talk, a state-of-the-art coalescence model based on the Wigner function formalism to describe (anti)nuclear production on an event-by-event basis is presented. The model developed in this work is parameter-free and tuned on experimental measurements of nucleon production spectra and of the emitting source size measured with ALICE. Such a model would find application in astroparticle physics to predict (anti)nuclear fluxes in cosmic rays, which are a crucial ingredient for indirect Dark Matter searches. This work was supported by DFG SFB1258 and BMBF Verbundforschung (05P21WOCA1 ALICE).

HK 71.4 Thu 16:45 SCH/A117

Electromagnetic interactions as the source of all known four forces. — •Osvaldo Domann — Stephanstr. 42, 85077 Manching

The SM represents the space as empty with the subatomic particles moving in it. The proposed focal-point approach models the space as filled with Fundamental Particles (FPs) with longitudinal and transversal angular momenta that move from infinite to infinite. The different types of subatomic particles are formed by different configurations of FPs. Fermions are focal-points of rays of FPs with aligned angular momenta, photons are rays of FPs with alternating opposed angular momenta, and neutrinos are pairs of FPs with opposed angular momenta. Forces between subatomic particles are the result of the interactions (scalar and vector product) of the angular momenta of their FPs. No fictitious force carriers are required. All four forces are due to electromagnetic interactions and described by QED. An important finding of the approach is that the interaction between two charged SPs tends to zero for the distance between them tending to zero. Atomic nuclei can thus be represented as swarms of electrons and positrons that neither attract nor repel each other. As atomic nuclei are composed of nucleons which are composed of quarks, the quarks can also be seen as swarms of electrons and positrons. The charge quantum number Q of a quark is now interpreted as the relative charge of electrons and positrons. No fractional charges Q are required and the charge of an electron or positron is thus the unit charge of nature. More at: www.odomann.com

HK 71.5 Thu 17:00 SCH/A117

Simulations for the ASY-EOS II experiment — •Leandro Milhomens da Fonseca[1,3] and Igor Gašparić[2,3] for the R3B-Collaboration — [1]Technische Universität Darmstadt, Fachbereich Physik, Institut für Kernphysik, 64289 Darmstadt, Germany — [2]Ruđer Bošković Institute, 10000 Zagreb, Croatia — [3]GSI Helmholtzzentrum für Schwerionenforschung, 64291 Darmstadt, Germany

The ASY-EOS II experiment aims to place new and more stringent constraints on the density dependence of the symmetry energy at supra-saturation densities. The system proposed for the study is Au+Au at 250, 400, 600 and 1000 AMeV, which can only be performed nowadays at the GSI/FAIR facilities. The experiment is based on the NeuLAND detector to measure neutrons, protons and light-charged clusters emitted from mid-rapidity. To discriminate between neutrons and charged particles, it is the intention to use a VETO detector in front of the NeuLAND detector. It is a proposal to use a double plane of the R3B TOFD detector in front of the NeuLAND due to its ability to detect charged particles efficiently and let neutrons pass through without leaving any signal. As a proof of concept for this apparatus, this work aims to show simulations performed to determine detection efficiencies for the particles of interest and to assess the possibility of distinguishing the differently charged light particles coming from the reaction. This project was supported by the BMBF project No. 05P21RDFN2, and the GSI-TU Darmstadt cooperation.

HK 72: Astroparticle Physics II

Time: Thursday 15:45–17:00 Location: SCH/A252

HK 72.1 Thu 15:45 SCH/A252

Measurement of Pion-Carbon Interactions with NA61/SHINE — •Johannes Bennemann for the NA61/SHINE-Collaboration — Karlsruhe Institute of Technology, Institute for Astroparticle Physics, Karlsruhe, Germany

For the measurement of ultrahigh-energy cosmic-rays it is crucial to understand the evolution of air showers in the atmosphere. Air showers initiated by cosmic ray particle consist mostly of pions, thus studying the interaction between pions and air molecules is of utmost importance. Fixed target experiments with pions from accelerators like the SPS at CERN are suitable for pion interaction studies. As a proxy for nitrogen, the dominant component of air, carbon is used as a target material. The produced particles and their spectra are measured by the NA61/SHINE detector at the CERN North Area. The detector consists of multiple time projection chambers which allow momentum measurements and particle classification.

In this talk we will present the analysis of a new pion-carbon dataset, including meson spectra and resonance cross sections. Furthermore predictions of hadron interaction models used for air shower simulations are compared with the new data.

HK 72.2 Thu 16:00 SCH/A252

krypton level measurement in XENONnT and beyond — •ying-ting lin, steffen form, matteo guida, robert hammann, hardy simgen, and jonas westermann for the XENON-Collaboration — Max-Planck Institut fur Kernphysik, Heidelberg, Germany

The XENONnT experiment is in search of dark matter and other rare physical phenomena via a ton-scale liquid-xenon detector. To reach its target sensitivity, competing background has to be suppressed to unprecedented level. One main internal background is the pure beta-emitter, ^{85}Kr. With dedicated purification system in XENONnT, the krypton concentration over xenon can be reduced down to 100 ppq (parts per quadrillion 10^{-15}). Precisely quantifying the ^{85}Kr remnant in this ultra pure xenon detector is therefore an important and challenging task. The rare gas mass spectrometer (RGMS) at MPIK Heidelberg is capable of performing such measurement by a two stage process: applying a gas-chromatographic separation of krypton from xenon and tracing the amount of Kr gas using a mass spectrometer. For future low-background liquid-xenon detectors, a fully automatic rare gas mass spectrometer (AutoRGMS) is under development. The AutoRGMS will be a major improvement in reducing the complexity and duration of its operations, and thus allow frequent krypton monitoring. The highlight will cover both the results from RGMS and the progress toward AutoRGMS.

HK 72.3 Thu 16:15 SCH/A252

Experiments with the MuonPi Cosmic Particle Detector — Simon Glennemeier-Marke[1], •Kai-Thomas Brinkmann[1], Hans-Georg Zaunick[1], Lara Dippel[1], Marvin Peter[1], Lukas Nies[2], and Katharina Dort[1] — [1]Justus-Liebig-University — [2]EP Department, CERN

The MuonPi project is an open-community research project dedicated to the investigation of cosmic particle showers. Its goal is to establish a wide-spanning network of detector units for measuring muons originating from shower cascades. Nanosecond time synchronization for all stations is achieved using navigation satellites. By aggregating the individual detections and analyzing their timestamps, the shower geometry and energy can be reconstructed. However a single detector unit can already be used for some interesting experiments, enabling students, teachers, makers and otherwise interested individuals to study the field of high energy physics. In this presentation we will showcase some of these experiments as well as the results of a stratospheric balloon launch. *supported by ELJEN Technology

HK 72.4 Thu 16:30 SCH/A252

Photon identification and their uncertainties for the displaced production vertices in search for ALPs with ATLAS — Peter Krämer, Kristof Schmieden, Matthias Schott, and •Olivera Vujinović for the ATLAS-Collaboration — Johannes Gutenberg University, Mainz, Germany

Some puzzling questions in particle physics, such as the strong CP problem or the discrepancy of the muon magnetic moment could be solved by introducing light scalar or pseudo-scalar axion-like particles (ALPs). Theoretical models allow a wide range of ALP-masses and couplings to SM particles such as photons and the Higgs boson. Therefore, parts of the ALP parameter space could be investigated with collider experiments like the ATLAS experiment at the LHC.

In this analysis, we search for the SM Higgs boson decaying into a pair of ALPs further decaying into two photons each. Depending on ALP properties such as mass and their coupling to photons, the signal is expected to form different final states, ranging from 2 to 4 photons, with a special focus on the photons originating from displaced vertices. This resulted in developing a dedicated approach in estimating the systematic uncertainties for this case. In this talk, the preliminary analysis results will be presented.

HK 72.5 Thu 16:45 SCH/A252

Neural network based identification of collimated photon pair signatures in a search for axions in SM Higgs boson decays with the ATLAS detector — •Peter Krämer, Kristof Schmieden, Matthias Schott, and Olivera Vujinović for the ATLAS-Collaboration — Johannes Gutenberg University, Mainz, Germany

Some puzzling questions in particle physics, such as the strong CP problem or the discrepancy of the muon magnetic moment could be solved by introducing light scalar or pseudo-scalar axion-like particles (ALPs). Theoretical models allow a wide range of ALP-masses and couplings to SM particles such as photons and the Higgs boson. Therefore, parts of the ALP parameter space could be investigated with collider experiments like the ATLAS experiment at the LHC.

In the ongoing analysis, we search for the SM Higgs boson decaying into a pair of ALPs further decaying into two photons each. For low mass ALPs, the decay photons can appear strongly collimated. These collimated photon pairs are reconstructed as a single photon only differing in the shape of the electromagnetic shower. In this talk it will be discussed how these collimated photon pair signatures can be identified using neural networks and how the corresponding uncertainties can be estimated.

HK 73: Outreach Diverse (joint session T/HK)

Time: Thursday 15:50–17:20 Location: HSZ/0204

HK 73.1 Thu 15:50 HSZ/0204

Z0-Versuch im Jupyter notebook — •Gianni Di Paoli, Guenter Duckeck und Nikolai Hartmann — LMU München

Der 'Z0-Versuch' mit OPAL/LEP Daten ist an der LMU München seit vielen Jahren ein klassischer Versuch im Fortgeschrittenen Praktikum und wird in verschiedenen Varianten auch an anderen Universitäten verwendet. Er illustriert exemplarisch Analysemethoden in der Teilchenphysik und erlaubt die Bestimmung fundamentaler Parameter wie Z0-Masse, -Breite und Zahl der Neutrino-Generationen. Im Rahmen einer Bachelor Arbeit wurde die bisherige Root-basierte Analyse auf die Python data-science Umgebung und jupyter notebooks umgestellt. Das erleichtert zum einen den Studierenden die Versuchsdurchführung, weil die meisten schon mit der Python/Jupyter Umgebung vertraut sind. Zum anderen lernen sie anspruchsvolle Filter-techniken, komplexe Visualisierungen und Fit-Verfahren kennen, die über die Standard-Beispiele in den einschlägigen Kursen und Tutorials hinausgehen.

HK 73.2 Thu 16:05 HSZ/0204

Forschung trifft Schule @home - Digitale Teilchenphysik-Fortbildungen für Lehrkräfte — •Philipp Lindenau[1], Carolin Gnebner[2], Niklas Herff[1], Michael Kobel[1], Frank Siegert[1] und Steffen Turkat[1] für die Netzwerk Teilchenwelt-Kollaboration — [1]Technische Universität Dresden — [2]DESY Zeuthen

Häufig unter den Herausforderungen der Covid-19-Pandemie entstanden, haben digitale Angebote mittlerweile einen festen Platz in der Bildungslandschaft. Auch die von Netzwerk Teilchenwelt dank der Förderung durch die Dr. Hans Riegel-Stiftung durchgeführte Fortbildungsreihe "Forschung trifft Schule" wurde um in der Regel halbtägige digitale Formate erweiterte, die nun unter dem Titel "Forschung trifft Schule @home" zum permanenten Veranstaltungsportfolio gehören. Das digitale Angebot beinhaltet insbesondere Fortbildungen zur Forschungsmethodik in der Teilchenphysik unter dem Motto "Von der Kollision zur Entdeckung" sowie Veranstaltungen zur Astroteilchenphysik und deren Behandlung im Schulunterricht unter Nutzung des Online-Tools Cosmic@Web. Die Veranstaltungen wurden bundesweit beworben und von Lehrkräften aus fast dem gesamten Bundesgebiet sowie von deutschen Schulen im Ausland besucht. Im Vortrag werden sowohl die bisher umgesetzten als auch geplante Formate sowie das Feedback der teilnehmenden Lehrkräfte vorgestellt und diskutiert.

HK 73.3 Thu 16:20 HSZ/0204

Physik der kleinsten Teilchen in der Schule - Eine multiperspektivische Tagungsreihe zur kohärenten Vermittlung — Stefan Heusler[1], Christian Klein-Bösing[1], Michael Kobel[2], •Philipp Lindenau[2], Oliver Passon[3] und Thomas Zügge[4] — [1]Westfälische Wilhelms-Universität Münster — [2]Technische Universität Dresden — [3]Bergische Universität Wuppertal — [4]Universität Greifswald

Es existiert eine Vielzahl von Unterrichtsentwürfen für die Vermittlung der Teilchenphysik, Hadronen- und Kernphysik sowie Astroteilchenphysik. Engagierte Physiker:innen aus Outreach, Schulpraxis, Fachwissenschaft und Fachdidaktik, aber auch populärwissenschaftliche und Schulbuchverlage konzipierten Vermittlungskonzepte – häufig unabhängig voneinander. Mit zunehmender Aufnahme der Themen in die Lehrpläne stieg das Bedürfnis nach Austausch der Akteur:innen. Einige für die kohärente Vermittlung zentrale Fragen erwiesen sich als nur gemeinsam bearbeitbar, etwa jene nach der verwendeten Nomenklatur, den bildenden Inhalten, Bezügen zur aktuellen Forschungspraxis und Verknüpfung mit den in den Lehrplänen ausgedrückten Kompetenzerwartungen. So fand 2018 ein interdisziplinäres Symposium in Wuppertal statt. Weitere Tagungen folgten in Münster und Dresden. Sukzessive trug der kollegiale Austausch dazu bei, Unschärfen in unseren Vermittlungspraxen zu erkennen und bildende Gelegenheiten der Themen zu identifizieren. Die nächste Tagung ist 2023 in Greifswald mit dem Schwerpunkt "Nature of Science" geplant. Im Vortrag werden die Tagungsreihe sowie einige ihrer bisherigen Ergebnisse vorgestellt.

HK 73.4 Thu 16:35 HSZ/0204

Bausteine der Materie – ein Mitmachexperiment für Schüler:innen — •Luisa Faber für die Netzwerk Teilchenwelt-Kollaboration — Institut für Kernphysik, WWU Münster

Das Projekt „Bausteine der Materie – Ein Mitmachexperiment für Schüler:innen“ soll Schüler:innen durch die Vermittlung von Inhalten der Kern- und Teilchenphysik für Natur und Technik begeistern. Als Kernelement wurden die weitverbreiteten Klemmbausteine gewählt, um eine aktive Beteiligung und selbstständiges Arbeiten der Schüler:innen zu ermöglichen.

Inhalte des Buchs „Particle Physics Brick by Brick“ von Dr. Ben Still dienen als erster Kontakt der Schüler:innen mit den Elementarteilchen des Standardmodells – den Bausteinen der Materie. Der Nachbau des ALICE-Detektors aus LEGO® in verschiedenen Maßstäben ist ein zentraler Bestandteil des Projekts. Dabei soll der gemeinschaftliche Charakter der wissenschaftlichen Arbeit vermittelt werden.

Ziel der Arbeit ist die Einbindung der beschriebenen Komponenten in einen Workshop. Dieser soll in unterschiedlichem Umfang in Schulklassen und bei verschiedenen Events durchgeführt werden können. Beim Bau eines ALICE-Modells aus 18.000 LEGO®-Teilen in einer AG an einem Gymnasium in Münster werden bereits erste Elemente des Workshops angewendet.

In dem Vortrag wird über den aktuellen Stand des Projekts und bereits erfolgte Events, die in Zusammenarbeit mit dem Netzwerk Teilchenwelt durchgeführt wurden, berichtet. Gefördert durch die Joachim Herz Stiftung.

HK 73.5 Thu 16:50 HSZ/0204

Cosmic Watch - Bau eines Myonendetektors für Schulkinder — •Sebastian Laudage — Argelander-Institut für Astronomie, Universität Bonn

Sekundäre Teilchen der kosmischen Strahlung, insbesondere Myonen, erreichen zu hoher Zahl jede Sekunde unsere Erdoberfläche und sind ohne dass wir es merken, Teil unseres alltäglichen Lebens. Sie sind ein unsichtbares, aber höchst interessantes Phänomen astronomischen Ursprungs. Im privaten Kontext oder an Schulen war die Untersuchung dieses Bereichs der Physik bislang nur rudimentär möglich, da zuverlässige Detektoren komplex und teuer in der Herstellung sind. 2017 wurde das Projekt Cosmic Watch durch einen PhD-Studenten am MIT (Spencer N. Axani) entwickelt, welches den Bau eines bezahlbaren ($\approx$ 120 Euro), zuverlässigen und mobilen Myonendetektors beschreibt. Der fertige Detektor ist nur etwa 8x7x4cm groß, ist leicht zu bedienen und kann autark die lokale Rate, Energie und Richtung von passierenden Myonen messen. Damit ist er sehr gut geeignet um Schüler:innen oder Fachfremden einen Einblick in die Welt der Astroteilchenphysik zu geben. Neben spannenden experiementellen Möglichkeiten bietet der Detektor die Möglichkeit Erfahrungen im löten und mit elektrischen Schaltungen zu sammeln, da er nach Anleitung selber zusammengebaut werden kann. Der Vortrag beschreibt den Aufbau des Detektors, die Umsetzbarkeit des Baus als Projekt für Schüler:innen oder Hobbybastler:innen und gibt Ausblick auf Anwendungmöglichkeiten in der Lehre.

HK 73.6 Thu 17:05 HSZ/0204

Die Selbstbau-Nebelkammer als Hands-On Exponat für Events und Ausstellungen — •David Borgelt und Christian Klein-Bösing für die Netzwerk Teilchenwelt-Kollaboration — Wilhelm-Klemm-Str. 9 48149 Münster

Diffusions-Nebelkammern sind ein beliebtes Exponat für physikbezogene Ausstellungen. Beispielsweise verfügen sowohl die Dauerausstellung des FB Physik der WWU, das ExperiMINTum, als auch das Universum in Bremen über solche Nebelkammern. Allerdings sind diese wie klassische Exponate in Museen zu bestaunen und besitzen keine Hands-On Charakteristika.

In zahlreichen Workshops für Schulen sowie in Masterclasses (siehe Netzwerk-Teilchenwelt) erweist sich das Konzept der Hands-On Exponate in Form von Selbstbau-Nebelkammern des Netzwerk Teilchenwelt als überaus beliebt. Auch für Ausstellungen oder Events mit naturwissenschaftlichem Schwerpunkt können diese von Bedeutung sein. Die Selbstbau-Nebelkammern sind wie die Diffusions-Nebelkammern hervorragend dazu geeignet, die Relevanz von Teilchenphysik im Alltag zu zeigen. Darüber hinaus kann mit der Selbstbau-Nebelkammer zusätzlich das Experimentieren als Bestandteil der Physik vorgestellt und Aspekte von Nature of Science diskutiert werden.

In diesem Vortrag werden die Hands-On Charakteristika der Selbstbau-Nebelkammer vorgestellt und Erfahrungsberichte über ihren Nutzen in Ausstellungen und auf Events präsentiert.

HK 74: Poster

Time: Thursday 17:30–19:00 Location: HSZ EG

HK 74.1 Thu 17:30 HSZ EG

Mimicking an Fe55 Source with X-Ray Fluorescence — •Philip Hauer, Alexander Rachev, and Bernhard Ketzer — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn

With its low-energetic and well-known X-ray spectrum, Fe55 is a commonly used radioactive source to calibrate particle detectors. The X-ray spectrum does not originate from the radioactive decay directly. Instead, Fe55 decays via electron capture into the excited state Mn55*. This excited state lacks one electron (typically from the K-shell) which is filled by an electron from an outer shell (typically the L- or M-shell) and an X-ray photon is emitted.

This process can be mimicked by X-ray fluorescence. If pure manganese (which consists to 100% of the isotope Mn55) is irradiated with X-rays, the excited state Mn55* is created as well (if the energy of the X-rays exceed the binding energy of the K-shell). In the relaxation process, the same spectrum as the one of an Fe55 source is emitted.

In order to confirm these considerations with measurements, we set up an X-ray tube which irradiated a piece of manganese. Two different detectors were used to analyse the emitted spectra. The first one is a semiconductor detector and the second one is a gaseous detector. With the performed measurements, we could show that a clean Fe55 spectrum can be observed with the X-ray fluorescence method.

On this poster, the measurements of X-ray fluorescence at manganese compared to Fe55 spectra are shown. Furthermore, the advantages and disadvantages of this method are discussed.

Supported by BMBF.

HK 74.2 Thu 17:30 HSZ EG

Laser Spectroscopy of Thulium-169 — •Hendrik Bodnar, Julian Palmes, Wilfried Nörtershäuser, and Kristian König — Institut für Kernphysik, TU Darmstadt

Laser spectroscopy is an established way to obtain information about the charge radius and the electromagnetic moments of a nucleus and has been applied to many isotopes all across the nuclear chart. In preparation for the investigation of short-lived Tm isotopes at the proton dripline [1], the stable 169-Tm was investigated at the Collinear Apparatus for Laser Spectroscopy and Applied Physics (COALA) at the Institute of Nuclear Physics at TU Darmstadt. Singly charged thulium was produced with a surface ionization source. Several transitions from the ionic ground state in the wavelength range between 340 nm and 425 nm have been studied and the hyperfine structure was analyzed. This allowed the selection of a suitable transition for efficient studies of rare isotope beams. Funding from the BMBF under contracts 05P21RDCI1 and 05P21RDFN1 is acknowledged. [1] B. Cheal et al., CERN-INTC-2022-041 / INTC-1-245 (2022)

HK 74.3 Thu 17:30 HSZ EG

Towards the Establishment of an Electrofission Experiment at the S-DALINAC — •Gerhart Steinhilber[1], Michaela Arnold[1], Jonny Birkhan[1], Michael Block[2], Martha Liliana Cortès[1], Tetyana Galatyk[1], Pavlos Koseoglou[1], Norbert Pietralla[1], and Maximilian Spall[1] — [1]IKP, Technische Universität Darmstadt — [2]GSI Helmholtzzentrum für Schwerionenforschung

To account for the observed abundances of heavy elements, the rapid-neutron capture process is essential [1]. It was first proposed more than six decades ago but is still not completely understood. The r-process is thought to occur in very neutron rich environments such as neutron star mergers, where the fission yields play an important role in determination of the final abundances. The fission yields depend on the excitation energy of the compound nucleus, which is not well studied. To increase our understanding of fission processes, a new setup for electron-induced fission is in development at the S-DALINAC electron accelerator at TU Darmstadt. Combining the established large acceptance QCLAM electron spectrometer which provides the excitation energy of the nucleus with fission fragment detector modules (FFDM) allows for a coincident measurement of fission fragments with an excellent mass resolution as a function of the excitation energy. The FFDMs which will be placed around the actinide target will provide precise timing information and the kinetic energy of the fission fragments. This poster will present the design of the setup.

This work is supported by the Hessian cluster project ELEMENTS.

[1] J. J. Cowan et al., Rev. Mod. Phys. 93, 015002 (2021).

HK 74.4 Thu 17:30 HSZ EG

Analysis of the bremsstrahlung contribution in electron-gamma coincidence experiments at the S-DALINAC — •Bastian Hesbacher, J. Birkhan, I. Brandherm, J. Isaak, I. Jurosevic, N. Pietralla, M. Singer, M. Spall, and G. Steinhilber — IKP, Technische Universität Darmstadt

The all-electromagnetic $(e, e'\gamma)$ reaction had first been used for nuclear structure measurements in the 1980s [1]. Since then very few experiments were based on this reaction. One of the challenges of this measurement technique lies in the coincident bremsstrahlung, which - apart from the angular distribution - can not be distinguished from the γ-radiation of decaying nuclei after excitation by inelastic electron scattering. In 2021 a successful ^{96}Ru$(e, e'\gamma)$ measurement was performed at the S-DALINAC with 35 times improved resolution [2]. The scattered electrons were registered with the QCLAM spectrometer. The γ-radiation was detected by 6 $LaBr_3$:Ce detectors. The double differential cross section of the bremsstrahlung contribution is computed within PWBA and combined with GEANT4 simulations to model pure bremsstrahlung spectra. A subtraction of the bremsstrahlung background will be applied to the ^{96}Ru$(e, e'\gamma)$ data and allow for the extraction of ground-state γ-decays of excited states. Preliminary results on treating the bremsstrahlung contribution will be presented.

This work is supported by the Research Training Group GRK 2128 and the Hessian cluster project ELEMENTS.

[1] C. N. Papanicolas et al., Phys. Rev. Lett. 54 (1985).

[2] G. Steinhilber, Ph.D. thesis, TU Darmstadt (2022).

HK 74.5 Thu 17:30 HSZ EG

A distributed network of cosmic shower detectors — •Lara Dippel[1], Kai-Thomas Brinkmann[1], Hans-Georg Zaunick[1], Simon Glennemeier-Marke[1], Marvin Peter[1], Lukas Nies[2], and Katharina Dort[1] — [1]II. Physikalisches Institut, Giessen, Deutschland — [2]EP Department, CERN

The MuonPi project is a distributed network of Raspberry Pi-based Internet-of-Things (IoT) detector stations for measuring muon showers caused by the interaction of ultrahigh-energy particles of the primary cosmic rays with earth's atmosphere. By connecting the detectors to the global navigation network (GNSS), the individual events can be time-stamped with nanosecond-time accuracy. Thus, further information, such as shower geometry and possibly energy, can be obtained from the time correlations between the detectors. Among others, the project offers students, teachers, makers, HAMs and interested laymen an insight into the research field of astroparticle physics of the highest energies in the cosmos. The individual detector stations have also proven to be efficient in measuring charged particles on parabolic flights and stratospheric balloon missions.

*supported by ELJEN Technology

HK 74.6 Thu 17:30 HSZ EG

New Electronics for the HADES Drift Chambers — •Jan Michel[1], Ole Artz[1], Thomasz Gniadzdowski[3], Christian Müntz[1], and Christian Wendisch[2] for the HADES-Collaboration — [1]Goethe-Universität Frankfurt am Main — [2]GSI Helmholtzzentrum für Schwerionenforschung — [3]Warsaw University of Technology

The drift chambers (MDC) of the HADES Experiment at GSI, Darmstadt form the main tracking system of the spectrometer. Being designed more than twenty years ago, we are currently replacing the whole electronics read-out chain with state-of-the-art electronics.

The new analog signal processing is based on the PASTTREC ASIC, originally developed at AGH Krakow for the PANDA Straw Tube Tracker. The digitization of data happens in FPGA-based TDCs before data is sent on an optical link to the event server farm.

The main challenges of the project are the strict spatial constraints given by the experiment setup and the noise sensitivity of the large area gas detectors. In addition, the power consumption needed to be kept low to ease cooling of the electronics.

This work has been supported by bmbf (05P21RFFC2), gsi, and hfhf.

HK 74.7 Thu 17:30 HSZ EG

Evolution of the KATRIN energy scale measured with ^{83m}Kr — •Justus Beisenkötter for the KATRIN-Collaboration — Institut für Kernphysik, WWU Münster

The KATRIN experiment has the aim to measure or exclude the effective electron neutrino mass to 0.2 eV/c^2 (90% C.L.) by measuring the tritium beta spectrum near its endpoint. To study the energy scale of KATRIN, which is influenced by beamline workfunctions and plasma effects in the gaseous tritium source, ^{83m}Kr conversion electron lines are used. Gaseous ^{83m}Kr is inserted into the tritium source, which allows to measure energy shifts and broadenings that would also affect the beta spectrum. This poster gives an overview of the time evolution of the line position of the L_3-32 and N_{23}-32 lines, which were measured many times over the course of the KATRIN operation. This work is supported by BMBF under contract number 05A20PMA.

HK 74.8 Thu 17:30 HSZ EG

Studies on Alternative Sensor Carrier Concepts for the CBM MVD* — •Fabian Hebermehl for the CBM-MVD-Collaboration — Goethe-Universität Frankfurt

The Micro Vertex Detector (MVD), part of the Compressed Baryonic Matter (CBM) Experiment at the future FAIR facility, comprises four detector stations, of four 0.3 – 0.5% X_0 thin quadrants, respectively. As the MVD will be operating in vacuum, efficient thermal management by the carrier of the sensors is mandatory. For this reason, the carrier materials chosen are Thermal Pyrolitic Graphite (TPG) for the larger stations and pCVD diamond for the smallest, first station. Studies have been conducted on alternative concepts for the TPG stations to balance thermal performance, material budget and production yield. The station production yield is driven by the need to populate both carrier sides with large-area MIMOSIS sensors to minimize inactive areas inside the detector acceptance. The options to (i) integrate ladders rather then carrier plates and (ii) separate front and back side sensor integration have been studied. The contribution will summarize the findings and gives a recommendation of which design is best suited for refining MVD station concept accordingly.

*This work has been supported by bmbf (05P21RFFC2) and EURIZON.

HK 74.9 Thu 17:30 HSZ EG

Lifetime measurement of low-lying states of ^{170}W — •K.E. Ide[1], V. Werner[1], A. Goasduff[2,3], J. Wiederhold[1], P.R. John[1], D. Bazzacco[3], M. Beckers[4], J. Benito[5], M. Berger[1], D. Brugnara[2,3], M.L. Cortés[3], L.M. Fraile[5], C. Fransen[4], A. Gozzelino[3], E.T. Gregor[3], A. Illana[3], J. Jolie[4], L. Knafla[4], R. Menegazzo[3], D. Mengoni[2,3], C. Müller-Gatermann[4,6], O. Papst[1], G. Pasqualato[7], C.M. Petrache[8], N. Pietralla[1], F. Recchia[2,3], D. Testov[2,7], J.J. Valiente-Dobón[3], and I. Zanon[2,3,9] — [1]IKP, TU Darmstadt — [2]U Padova, Italy — [3]INFN, LNL, Italy — [4]IKP, U Köln — [5]U Madrid, Spain — [6]ANL, USA — [7]INFN, Padova, Italy — [8]U Paris-Saclay, France — [9]U Ferrara, Italy

Previous experiments in the region of the Hf and W isotopic chains have shown a change in the first 2^+ states' mean lifetimes in comparison to the literature values due to advancements in experimental techniques. A sudden increase of the $2_1^+ \rightarrow 0_1^+$ $E2$ transition strength in the W isotopic chain between $N = 96$ and $N = 98$ is significant and not seen in the neighboring isotopic chains. Therefore, a measurement of the low-lying level lifetimes of ^{170}W ($N = 96$) with the RDDS method was performed at LNL. The GALILEO array and the GALILEO plunger device were used. Lifetimes for the first 2^+, 4^+ and 6^+ state were obtained and the deduced $E2$ transition strengths compared to predictions of the CBS model.

*Supported by the BMBF under Verbundprojekt 05P2021 (ErUM-FSP T07) under Grant Nos. 05P21RDFN9, 05P21RDFN1 and 05P21PKFN1.

HK 74.10 Thu 17:30 HSZ EG

Evaluation of coincidence time resolution of YAG, LuAG, GAGG, YSO, LYSO, LSO, YAP and LuAP scintillators — •Dzmitry Kazlou, Valerii Dormenev, Kai-Thomas Brinkmann, Markus Moritz, Rainer Willi Novotny, and Hans-Georg Zaunick — 2nd Physics Institute, Justus Liebig University, Giessen, Germany

Development of new or optimization of already widely used scintillation materials for fast timing applications have become a very important research activity during the last decade. A significant progress with cerium doped inorganic materials has been made in the improvement of the timing characteristics of the scintillation pulse. Here we present test results of garnets YAG/LuAG/GAGG, lutetium-yttrium oxyorthosilicates YSO/LYSO/LSO and orthoaluminate perovskites YAP/LuAP with different types of doping. Samples have two types of dimensions: 3x3x3 and/or 3x3x20 mm^3. The main activity was concentrated on the measurements of the coincidence time resolution (CTR) with the help of an oscilloscope by offline analysis of recorded signals and the dependence on temperature and the sample shape. Measurements were performed inside a climate camber and done with SiPM readout and commercial evaluation kits from different producers as well as with own developments.

The work was supported by funding from BMBF Projects 05K2019, UFaCal, EFRE, the High-D consortium and in the spirit of the Crystal Clear Collaboration.

HK 74.11 Thu 17:30 HSZ EG

Influence of detector settings on the EPICAL-2 response — •Johannes Keul — Institut fuer Kernphysik Frankfurt

In context of the proposed ALICE-FoCal detector, a prototype of a digital electromagnetic pixel calorimeter, EPICAL-2, has been developed. EPICAL-2 consists of 24 layers with alternating tungsten absorbers and silicon sensors facilitating monolithic active pixel sensors (MAPS). The design features an active area of 30 x 30 mm^2 and a depth of 20 radiation lengths with a total of 25 million pixels.

An EPICAL-2 test-beam measurement has been performed at the CERN-SPS facility in September 2021, including measurements with different detector settings.

In this poster, an overview of the structure and functionality of EPICAL-2 is presented. Furthermore a study of the differences in detector response as e.g. the size of pixel clusters at different detector settings is presented.
Supported by BMBF and the Helmholtz Association.

HK 74.12 Thu 17:30 HSZ EG

Correlation of hit and particle densities in EPICAL-2 — •Jan Schöngarth — Institut für Kernphysik, Goethe Universität Frankfurt

A prototype of a digital electromagnetic pixel calorimeter, EPICAL-2, consisting of alternating tungsten absorber and silicon sensor layers has been developed. EPICAL-2 has been designed in the context of the proposed ALICE-FoCal detector. High granular ALPIDE sensors are employed in EPICAL-2 and will be utilized in two layers of the FoCal detector.

The measurement of the electromagnetic shower energy E with EPICAL-2 is based on the number N_{part} of charged shower particles. The number N_{hits} of pixel hits is considered as a measure of N_{part} and thus E, as long as the particle density is low. In order to understand the relation between N_{hits} and N_{parts} under varying density conditions, both observables have been investigated per local area, as well as their correlation, in Allpix^2 simulation, which includes the propagation of deposited charge carriers.

In this poster, the correlation of hit and particle densities is presented, aiming to provide input for EPICAL-2 to investigate saturation effects in areas of high particle density and for FoCal to circumvent detailed charge carrier propagation in simulation. The poster will present the current status of this analysis.

Supported by BMBF and the Helmholtz Association.

HK 74.13 Thu 17:30 HSZ EG

Triton Emission from Ag+Ag Collisions at 1.58A GeV — •Wojciech Trynda for the HADES-Collaboration — Goethe-Universität Frankfurt

Multi-differential emission rates of triton are part of the investigation of statistic data from Ag(1.58*A* GeV)+Ag collisions, measured in March 2019.

Triton candidates are selected out of all charged particle tracks by using the specific energy loss in the detector material.

The final count rates are extracted multi-differential in an m_t-y grid using the reconstructed particle mass. The background under the trition signal is estimated by an iterative interpolation method between the minimum of the signal peaks of other charged particle tracks and the tail of the triton signal peak. Based on full scale Geant-detector response simulation the extracted signals are corrected with response coefficients. The corrected triton signals are used to determine the multi-differential emission rate per event depending on center-of-mass rapidity and transverse mass. The obtained phase-space distribution of triton is put into context of available published data.

This work has been supported by BMBF (05P21RFFC2) and GSI.

HK 74.14 Thu 17:30 HSZ EG

Impact of the charm fragmentation fractions on the dielectron spectrum in pp collisions at the LHC — •Emma Ege for the ALICE Germany-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt, Germany

Charm and anti-charm quarks are produced abundantly in pp collisions at LHC energies. Until recently, it was assumed that the hadronization process, i.e. the formation of charm hadrons from the partonic matter, can be described by universal fragmentation functions. Measurements performed by the ALICE Collaboration have nevertheless shown an enhancement of the relative charm-baryon contributions with respect to the ones observed in e^+e^- collisions. This suggests a significant difference of the fragmentation fractions in hadronic collisions at the LHC compared to e^+e^- and ep collisions at lower energies. The PYTHIA event generator is able to reproduce part of these findings by including string fragmentation beyond the leading color approximation.

On this poster, we will discuss how sensitive the dielectron yield from correlated open-charm hadron decays is from the charm hadronization process. For this purpose, predictions with the PYTHIA generator using different tunes will be compared. Additionally, the consequences on the heavy-flavour cross section measurements via the dielectron channel will be shown.

HK 74.15 Thu 17:30 HSZ EG

Setup of high-precision voltage dividers for collinear laser spectroscopy experiments at TU Darmstadt and ISOLDE/CERN — •Finn Köhler[1], Kristian König[1], Johann Meisner[2], Wilfried Nörtershäuser[1], and Stephan Passon[2] — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]Physikalische Technische Bundesanstalt, Braunschweig, Germany

Collinear laser spectroscopy is a well-established technique to investigate ground-state properties of stable and short-lived isotopes. By accelerating an ion beam electrostatically to 20-60 keV, the Doppler width is drastically reduced to the order of the natural linewidth, which enables measurements with high resolution. To achieve a high accuracy in the isotope shift measurements, the acceleration voltage of the ions needs to be precisely known to account for the Doppler shift of the ions.

To determine this voltage, three high-voltage dividers inspired by precision dividers of the Physikalisch-Technische Bundesanstalt were set up and calibrated against a reference divider. With active temperature stabilization a relative accuracy of 5 ppm was achieved. At ISOLDE the voltage of the beam preparation trap and of the MIRACLS multi-reflection electrodes are measured and at TU Darmstadt, it is used to actively stabilize the voltage of the ion source. We additionally report on an upgrade of the 25m deep-UV laser-light transport to COLLAPS.
Support from BMBF under contract 05P21RDCI1 is acknowledged.

HK 74.16 Thu 17:30 HSZ EG

Silicon pixel sensors for the PANDA luminosity detector — •Niels Boelger, Stephan Bökelmann, Florian Feldbauer, René Hagdorn, Stephan Maldaner, Gerhard Reicherz, and Miriam Fritsch — On behalf of the PANDA Collaboration — Ruhr University Bochum AG Physics of Hadrons and Nuclei, 44780 Bochum

The PANDA experiment is one of the key experiments at the future FAIR accelerator facility in Darmstadt. Its purpose is to study the properties of hadronic states in detail and to search for exotic states of matter.

The PANDA detector will have a luminosity detector 11 meters downstream from the interaction point. This detector, consisting of two retractable half-detectors, uses silicon pixel sensors to measure the distribution of elastically scattered antiprotons as a function of the scattering angle, from which the luminosity is determined. The MuPix sensors intended for track reconstruction in the luminosity detector are High-Voltage Monolithic Active Pixel-Sensor (HV-MAPS), which offer two advantages over conventional pixel sensors: The active sensor part and the readout electronics are combined on the same chip. Secondly, due to the high voltage, the charge transport is much faster. The production of sensor modules consisting of several pixel sensors, as well as the data acquisition system prepared for this setup will be presented.
This project is supported by the BMBF - Gefördert durch das BMBF

HK 74.17 Thu 17:30 HSZ EG

A comparison of initial condition models for hydrodynamic evolutions in heavy ion collisions — •Lucas Constantin[1,2], Hannah Elfner[1,2,3], and Niklas Götz[1,2] — [1]Goethe Universität Frankfurt am Main — [2]Frankfurt Institute for Advanced Studies — [3]GSI Helmholtzzentrum für Schwerionenforschung

For a hydrodynamical description of the quark-gluon plasma created during a heavy ion collision, initial conditions of a thermalized system are needed. In this work, a comparison between three initial conditions models (SMASH, TRENTo, and IP-Glasma) is made. General quantities of the collision such as the number of participants and the number of binary nucleon collisions are determined, and the transverse plane energy densities from the different models are compared, along with their eccentricity distributions, for different collision systems at RHIC and LHC energies. The collisions in SMASH have slightly fewer participants and significantly fewer binary nucleon collisions. TRENTo not only produces lower eccentricities, but also has smaller event by event fluctuations. In addition, the elliptic flow from SMASH is shown, as well as the momentum anisotropy, found to be higher in SMASH than in IP-Glasma.

HK 74.18 Thu 17:30 HSZ EG

Feasibility studies for measuring electrical conductivity in heavy ion collisions with ALICE 3 — •Clara Peter for the ALICE Germany-Collaboration — Goethe University, Frankfurt, Germany

The ability of matter to transport electrical charges is described by its electrical conductivity. For the medium produced in heavy-ion collisions this fundamental property has, up to now, no experimental constraints, while theoretical predictions give a large range of possible values. This transport coefficient is not only of great interest in itself, but also an important input for the model calculations. The dielectron production rate in the hot partonic and hadronic phase of the collision is directly related to the electrical conductivity of the medium at vanishing mass and pair p_T. For this reason precise dielectron measurements in this phase space would be of great interest.

In this contribution we will explain the challenges to achieve such measurements focusing in particular on possible processes contributing to the irreducable physical background. Further we will discuss how the unique features of the ALICE 3 detector, planned at the LHC beyond 2030s, could enable dielectron measurements at very low invariant mass and pair p_T.

HK 74.19 Thu 17:30 HSZ EG

KATRIN like MINI MAC-E Filter with a tritium source for the advanced physics lab course — •Sarah Untereiner for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT), Wolfgang-Gaede-Str. 1, 76131 Karlsruhe, Germany

The KATRIN experiment at the Karlsruhe Intitute of Technology (KIT) aims to determine the effective neutrino mass using the kinematics of electrons from the tritium β-decay. The integral energy spectrum of the electrons is measured by an electro-static high-pass filter, using the MAC-E filter principle (Magnetic Adiabatic Collimation and Energy filter). Only electrons with energies above the retarding potential of the filter are counted at the detector at the end of the MAC-E spectrometer. In order to give students the opportunity to learn more about the experimental principles behind KATRIN, a smaller version of the MAC-E filter setup, called MiniMACE, has been built, which will be used in the advanced physics lab course at KIT. With a scale of approximately 1:20 the MiniMACE experiment includes all the major components of KATRIN: a tritium source, the spectrometer with adjustable high voltage, a high resolution detector and the magnetic guiding field. Other than KATRIN, the source uses two implanted disks with tritium and ^{83m}Kr that can be exchanged inside the ultra-high vacuum source chamber. This poster shows the design of the physics lab setup and reports on first results. This project has been supported by RIRO (Research Infrastructure in Research-Oriented teaching), which is part of the ExU project at KIT.

HK 74.20 Thu 17:30 HSZ EG

First pp correlation function with data taken by ALICE in Run 3 — •Anton Riedel and Georgios Mantzaridis for the ALICE Germany-Collaboration — Technical University of Munich (TUM), Garching, Germany

Femtoscopy has proven itself as a precise tool to constrain the strong interaction between hadrons in previously inaccessible sectors. When the source of particles in a collision is known, it is possible to probe the interaction potential between two particles. Already during Run 2 of the LHC an universal source of hadrons in pp collisions has been identified and benchmarked by studying the correlations of the produced proton-proton pairs. With this result as a foundation it was possible to probe the strong force between many different pairs of hadrons like p-Λ, p-Ω, p-ϕ and many more. With the recently started LHC Run 3 and the upgraded ALICE detector, femtoscopic studies can now be performed with an even greater precision and even more exotic interactions can be experimentally constrained for the first time. The proton-proton correlation function will be the starting point for gauging the universal hadron emission source in the new available data.

In this poster we present the first steps in the femtoscopy campaign of ALICE in Run 3, namely the proton proton correlation function, measured in pp collisions at $\sqrt{s}$ = 13.6 TeV at the ALICE experiment at the LHC.

This project has been funded by the DFG under Germany's Excellence Strategy - EXC2094 - 390783311 and by BMBF Verbundforschung (05P21WOCA1 ALICE).

HK 74.21 Thu 17:30 HSZ EG

Studying (anti)nuclei formation in heavy ions using an advanced coalescence model — •David Casado — Technical University Munich

Coalescence is a major model used to describe the formation of light (anti)nuclei in high energy collisions. It is based on the assumption that two nucleons close in phase-space can coalesce and form a nucleus. Antideuteron and antihelium nuclei have been proposed as a detection channel for dark matter annihilations and decays in the Milky Way, due to the low astrophysical background expected. In order to correctly interpret any future antinuclei measurement in space, the production of antinuclei has to be well understood. In this presentation a more advanced approach is employed combining event-by-event Monte Carlo simulations with a microscopic coalescence picture based on the Wigner function formalism. The antiproton production in the event generator EPOS 3 is compared to measurements from the STAR Collaboration.

This work was supported by BMBF.

HK 74.22 Thu 17:30 HSZ EG

Studying the strong interactions in proton-deuteron at LHC — •Bhawani Singh for the ALICE Germany-Collaboration — TUM, Munich Germany

In the journey to explore the strong interaction among hadrons, ALICE has for the first time extended its femtoscopic studies to nuclei. The large data sample of high-multiplicity pp collisions at $\sqrt{s}$ = 13 TeV allows the measurement of the proton-deuteron (p-d) momentum correlations. The femtoscopic study of such systems opens the door to investigate the interaction in three-body systems as well as formation mechanism of the light nuclei in hadron-hadron collisions. In this contribution, the measured momentum correlation function for p-d is presented. The measured p-d correlation shows a shallow depletion at low relative momenta while the model calculation which assumes the interaction of two point-like particles shows a clear discrepancy with respect to the data. This discrepancy can be resolved by employing a full three body wave function that accounts for the internal structure of the deuteron including all relevant partial waves and quantum statistical effects. This demonstrates that the study of correlations among light nuclei provides access to the details of the many-body system's wave function at the LHC. Funded by BMBF Verbundforschung (05P21WOCA1 ALICE).

HK 74.23 Thu 17:30 HSZ EG

Measurement of ^{3}H and ^{3}He production in pp collisions at $\sqrt{s}$ = 13 TeV with ALICE at the LHC — •Matthias Herzer for the ALICE Germany-Collaboration — Institut für Kernphysik, Goethe-University, Frankfurt

The production of (anti)nuclei in pp collisions at the LHC has become a major topic in the high-energy physics community. In fact, there is a huge overlap between different research directions, from astrophysics, particle and nuclear physics. For instance, the observation of antinuclei in space is considered as possible signature for dark matter, since they would originate from collisions of potential dark matter candidates among each other.

We show the study of the production of ^{3}H and ^{3}He in pp collisions at 13 TeV in two data sets that were taken in LHC Run 2, i.e. in high-multiplicity events and one from a dedicated online trigger on nuclei. Furthermore, we will show the measurement of the ratio of these nuclei. This is an important test of isospin symmetry, which is expected to hold at LHC energies, but can not be tested directly since neutrons are not accessible experimentally.

HK 74.24 Thu 17:30 HSZ EG

Collisional broadening in a transport model — Hannah Elfner[1,2,3,4], Renan Hirayama[1,2], and •Branislav Balinovic[2,3] — [1]Helmholtz Forschungsakademie Hessen für FAIR (HFHF), GSI Helmholtzzentrum für Schwerionenforschung, Campus Frankfurt — [2]Frankfurt Institute for Advanced Studies (FIAS) — [3]Institut für Theoretische Physik, Goethe Universität — [4]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

In this work, we study the effect of collisional broadening in different hadron species, for both resonances and stable particles, using different temperatures in the hadronic transport approach SMASH (Simulating-Many-Accelerated-Strongly-Interacting-Hadrons). In SMASH the information about the phase space and interactions is available at all times, which makes the lifetimes and mass distributions of particles directly accessible. Our set up simulates a thermalized hadron gas, used to study the absorption of particles in equilibrium. The collisional broadening is measured using effective widths, which are a measure for decay plus absorption probabilities. We also calculate the corresponding dynamical spectral functions, which are interesting from theoretical perspective, since they can be an indicator of chiral symmetry restoration. Moreover, we investigate the impact on collisional broadening of different assumptions for the mass dependence of vacuum decays, finding that a mass-dependent vacuum experiences a stronger collisional broadening than the mass-independent case.

HK 74.25 Thu 17:30 HSZ EG

Signal-to-noise ratio in the ALICE TPC with GEMs — •Janis Noah Jäger for the ALICE Germany-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

A major aspect of the recent ALICE upgrade is the upgrade of the Time Projection Chamber (TPC). The TPC is the main tracking and particle identification device of ALICE. By replacing the Multi-Wire Proportional Chambers (MWPC) with stacks of four Gas Electron Multiplier (GEM) foils, continuous readout of the TPC is achieved. Furthermore the installation of the GEMs implies specific design goals, such as the intrinsic noise of the electronics channels as well as the signal-to-noise ratio at the nominal gas gain of 2000. Different pad area and trace length result in variations of the properties. Additionally, external influences cause local variations of the noise.

In this poster the intrinsic noise together with the signal-to-noise ratio for minimum ionizing particles, measured in first pp collisions in LHC Run3, will be presented for the different pad regions of the TPC. The results will be compared with the design goals.

HK 74.26 Thu 17:30 HSZ EG

Background-Corrected Collinear Saturation Spectroscopy at COALA — •Julien Spahn, Phillip Imgram, Kristian König, Patrick Müller, and Wilfried Nörtershäuser — Institut für Kernphysik, TU Darmstadt

All-optical determinations of nuclear charge radii in He-like systems will come into reach with increasing accuracy in atomic structure calculations of He-like systems. To this end, the $1s2s\,^3\mathrm{S}_1 \rightarrow 1s2p\,^3\mathrm{P}_J$ transitions in He-like $^{12}\mathrm{C}^{4+}$ and $^{13}\mathrm{C}^{4+}$ were measured at the Collinear Apparatus for Laser Spectroscopy and Applied Physics (COALA) at the Institute of Nuclear Physics of TU Darmstadt. The C^{4+} ions are produced with an electron-beam ion source (EBIS) and collinear/anticollinear laser spectroscopy was performed using Doppler tuning. Variations in the background signal, caused by fluctuations in the collinear laser beam position, significantly contributed to the uncertainty of the measured transition frequencies, especially at high dwell times. Additionally, the residual Doppler broadening is still rather large compared to the natural linewidth of the transitions due to the initial energy spread of the ions inside the EBIS. This contribution will present and compare the improvements obtained by implementing a laser-beam position stabilization system and a voltage modulation of the fluorescence detection region. Moreover, a first attempt of background-corrected collinear saturation spectroscopy – a method that allows to overcome the limitations imposed by the residual Doppler broadening – will be presented.
This project is supported by DFG (Project-ID 279384907 - SFB 1245).

HK 74.27 Thu 17:30 HSZ EG

HYDRA: HYpernuclei Decay at R^{3}B Apparatus — •Simone Velardita[1], Hector Alvarez-Pol[2], Yassid Ayyad[2], Meytal Duer[1], Alexandru Enciu[1], Liancheng Ji[1], Alexandre Obertelli[1], and Yelei Sun[1] for the R3B-Collaboration — [1]Technische Universität Darmstadt, Fachbereich Physik, Darmstadt, 64289, Germany — [2]Universidade de Santiago de Compostela, Santiago de Compostela, E-15782, Spain

HYDRA is a physics program within the R^{3}B collaboration to study the decay spectroscopy of hypernuclei produced from heavy-ion collisions at GSI/FAIR. The program aims at measuring with high resolution the in-flight pionic decay of light and medium mass hypernuclei. To achieve that, a pion tracker is conceived as a time projection chamber inside the GLAD magnet of the R^{3}B setup.

The full experimental setup has been simulated within the R3BROOT framework, to optimize the geometry and define conditions for the forthcoming accepted experiment which will take place at R^{3}B in 2024. The first experiment aims at the mass-radius of hypernuclei such as the hypertriton, predicted to be halo, from measurements of its interaction cross-section. The experimental method developed for the measurement will be presented in the poster, together with first results from a tracking algorithm that will be used to reconstruct the decayed particle trajectories.

HK 74.28 Thu 17:30 HSZ EG

Characterization of prototypes of an active Transverse Energy Filter (aTEF) — •Kyrill Blümer[1,4], Kevin Gauda[1,4], Sonja Schneidewind[1,4], Christian Gönner[1,4], Volker Hannen[1,4], Hans-Werner Ortjohann[1,4], Wolfram Pernice[2,3], Lukas Pöllitsch[1,4], Richard Salomon[1,4], Maik Stappers[2], and Christian Weinheimer[1,4] — [1]Institute for Nuclear Physics, University of Münster — [2]CeNTech and Physics Institute, University of Münster — [3]Kirchhoff-Institute for Physics, University of Heidelberg — [4]KATRIN Collaboration

In the Karlsruhe Tritium Neutrino Experiment (KATRIN) the mass of the electron neutrino is intended to be measured directly by precision energy spectroscopy of the tritium β-decay electrons in its endpoint region. To achive the target sensitivity of 0.2 eV/c^2, a reduction of background electrons, assumed to be caused by Rydberg atoms and autoionizing states, is needed. An active transverse energy filter (aTEF, Eur. Phys. J. C 82, 922 (2022)) distinguishes electrons due to their angle to a magnetic field line. It preferentially detects signal electrons with a broad angular distribution rather than background electrons with a small angular distribution. This poster presents insight in the testing procedures and characterization of aTEF-prototypes in dedicated test environments.

This work is supported by BMBF under contract number 05A20PMA.

HK 74.29 Thu 17:30 HSZ EG

(Anti)nuclei production in ALICE — •Rafael Manhart for the ALICE Germany-Collaboration — Technische Universität München

High-energy hadronic collisions at accelerators create a suitable environment for the production of light (anti)(hyper)nuclei. Precise measurements of the antinuclei production at accelerators are essential to study the different sources of antinuclei in our Universe and to correctly interpret any future measurement of antinuclei in space. (Anti)nuclei production measurements are also interesting to investigate their production mechanisms, which are under intense debate in the scientific community. The description of the experimental measurements is currently based on two competing phenomenological models: the statistical hadronisation model and the coalescence approach. The production of (anti)nuclei, up to A=4, has been measured with ALICE in the last 10 years, from small collision systems (i.e., pp and p*Pb) to heavy-ion collisions (i.e., Xe*Xe and Pb*Pb). In 2022, LHC Run 3 has started and pp collisions at top centre-of-mass energy of $\sqrt{s}$ = 13.6 TeV have been recorded with the unprecedented luminosity of 18 pb^{-1}. In this contribution, new measurements of (anti)nuclei from Run 3 data will be shown, together with a review of (anti)nuclei results from Run 1 and 2.

This work is funded by BMBF Verbundforschung (05P21WOCA1 ALICE).

HK 74.30 Thu 17:30 HSZ EG

Machine Learning Approach to the Sexaquark Search in ALICE — •Sven Hoppner for the ALICE Germany-Collaboration — Physikalisches Institut, Heidelberg, Germany

The sexaquark was proposed by G. Farrar in 2017 to be a compact, stable and neutral particle consisting of six quarks with a quark content of *uuddss*. Its charge neutrality, stability, and expected production rate in the QCD phase transition in the early universe make it an interesting dark matter candidate within the standard model, while its similarity to the neutron in experimental settings could explain why it has not been discovered so far. A new search for the sexaquark S in heavy- ion collisions at the Large Hadron Collider (LHC) using the ALICE detector started in 2022 which will look for characteristic decay chains in the annihilation of the anti-S with the detector material. The search benefits from the excellent tracking and particle identification (PID) capabilities of ALICE, especially for low momenta. Based on Monte Carlo simulations it is investigated how the sexaquark search with ALICE can be improved with a decision tree based machine learning approach using XGBoost.

HK 74.31 Thu 17:30 HSZ EG

The ComPWA project: speeding up amplitude analysis with a Computer Algebra System — •Remco de Boer[1], Miriam Fritsch[1], Wolfgang Gradl[2], Stefan Pflüger[1], and Leonard Wollenberg[1] — [1]Ruhr-Universität Bochum — [2]Johannes Gutenberg Universität Mainz

In the ideal world, we describe our models with recognizable mathematical expressions and directly fit those models to large data samples with high performance. It turns out that this can be done with a CAS, using its symbolic expression trees as a template to computational back-ends like JAX. The CAS can in fact further simplify the expression tree, which can result in speed-ups in the numerical back-end.

The ComPWA project offers Python libraries that use this principle to formulate large expressions for amplitude analysis, so that the user has the flexibility to quickly implement different formalisms and can easily perform fast computations on large data samples. The CAS additionally allows the project to standardise and automatically document these formalisms as they are being implemented.

HK 74.32 Thu 17:30 HSZ EG

Detector response simulations for the CBM-TRD — •Lena Rossel for the CBM-Collaboration — Institut für Kernphysik, Goethe Universität, Frankfurt am Main

To ensure the best functionality of the Transition Radiation Detector (TRD) of the Compressed Baryonic Matter (CBM) experiment at the future Facility for Antiproton and Ion Research (FAIR), it is crucial to simulate the detector response as precisely as possible. Simulations are an instrument to optimize the detector design and account for possible challenges in the extraction of physics observables affected by design decisions.

After the event generation, the propagation of the particles through the detector setup is simulated with GEANT3. The detector behavior, including signal generation and collection, is simulated. This includes handling of transition radiation photons, energy deposition in the detector gas and signal-digitization.

In this contribution the general process of the detector response simulation is carried out with CbmRoot for the CBM-TRD. The focus lies on the reconstruction of the specific energy loss for charged particles. In addition, DESY test beam data of one TRD module will be compared to the simulation results. This work is supported by the BMBF-grant 05P21RFFC3.

HK 74.33 Thu 17:30 HSZ EG

Study of the $\pi^-\pi^+$ subsystem with $J^{PC} = 1^{--}$ in the diffractively produced $\pi^-\pi^-\pi^+$ final state at COMPASS * — •Martin Bartl for the COMPASS-Collaboration — Physik-Department E18, Technische Universität München

The COMPASS experiment is a fixed-target experiment at CERN fed by the SPS beam. The flagship spectroscopy analysis is based on the diffractive process $\pi^- p \rightarrow \pi^-\pi^-\pi^+ p$, for which a large data sample of 46×10^6 events has been collected.

This large data sample allows us to apply the so-called freed-isobar partial-wave analysis method, which extracts the amplitudes of the decay process with well-defined J^{PC} quantum numbers for the $\pi^-\pi^+$ subsystem, as well as for the 3π system. The $\pi^-\pi^+$ amplitudes are extracted in a quasi-model-independent way as a function of 2π mass, 3π mass, and squared four-momentum transfer. This highly detailed information allows us not only to test the assumptions of the isobar model, but also to perform in-depth studies of the 2π resonances that appear in the 3π system.

We study the 2π amplitudes with $J^{PC} = 1^{--}$. These 2π amplitudes are dominated by the well-known $\rho(770)$ resonance, but may also contain signals from excited ρ states, which are still elusive. The employed approach allows us to extract the pole positions, i.e. masses and widths, of these resonances and study their systematics.

*funded by the DFG under Germany's Excellence Strategy - EXC2094 - 390783311 and BMBF Verbundforschung 05P21WOCC1 COMPASS.

HK 74.34 Thu 17:30 HSZ EG

Reflectivity measurements with VUV light in xenon and vacuum — •Robert Braun, Lutz Althüser, and Johanna Jakob for the XENON-Collaboration — Institut für Kernphysik, WWU Münster

Rare event searches as performed with liquid xenon (LXe) detectors demand a precise knowledge of the employed materials. Measurements of optical properties at the xenon scintillation wavelength in the VUV regime are required for accurate simulations and detector characterization. The Reflectivity Setup in Münster has a focused light beam from deuterium lamp with a VUV monochromator to select the wavelength and as detector a PMT capable of 290° angular movement, allowing to study the reflectivity and transmission properties of a sample. The sample is placed in a quartz tube and can be studied in vacuum, in gaseous or in liquid xenon, which is kept stable by the built-in coldhead.

In the past, the setup was used for transmission measurements of polytetrafluorethylen (PTFE) (JINST 15 (2020) P12021), which is a common material to encapsulate the active volume in LXe detectors as used by the XENON dark matter project. In the near future, the setup will be used for reflectivity measurements of PTFE samples from the XENONnT experiment. This poster gives an overview of the Reflectivity Setup in Münster and the reflectivity and transmission measurements taken with it.

HK 74.35 Thu 17:30 HSZ EG

Correlation of flow coefficients measured in Au+Au collisions at 1.23 AGeV with HADES — •Laura Lauf for the HADES-Collaboration — Institut für Kernphysik, Frankfurt am Main, Deutschland

HADES has a large acceptance as well as excellent particle identification capabilities and therefore allows the study of dielectron, hadron, and light nuclei production in heavy-ion collisions with great precision. The harmonic flow coefficients v_n of the order $n = 1 - 6$ are measured with HADES as a function of centrality, transverse momentum, and rapidity in Au+Au collisions at 1.23 AGeV. Combining them allows to construct for the first time a complete, multi-differential picture of the emission pattern as a function of rapidity and transverse momentum.

The predictions of ideal hydrodynamic simulations, confirmed by transport model calculations, suggest a scaling between various flow coefficients. For protons at mid-rapidity the ratio v_4/v_2^2 is found to be close to 0.5. The correlations of flow coefficients are investigated based on an event-by-event selection of the mid-rapidity final state elliptic flow of protons. The correlations are compared to the results of transport models and to eccentricity calculations within the Glauber Monte Carlo approach.

This work is supported by the Helmholtz Forschungsakademie HFHF

HK 74.36 Thu 17:30 HSZ EG

Noise Calibration of the ALICE-TRD in Run03 — •Archita Rani Dash for the ALICE Germany-Collaboration — Westfälische Wilhelms- Universität Münster

The ALICE Transition Radiation Detector (TRD) provides excellent electron identification and is part of the global tracking in the central barrel of ALICE. The operation data taking and the calibration of the ALICE TRD is one of the important aspects of the experiment.While the TRD calibration procedure involves four basic parameters,namely time offset, drift velocity, gain, and noise, this poster presentation is chiefly focused on the noise aspects of the detector. Short pedestal/noise runs are taken roughly once per month during data taking period, recording the data without the usually-applied zero suppression. As a result, we determine the status of each of the more than 1 million readout channels, calculating the noise value for every channel. This is obtained by calculating mean and rms of the ADC valuesfor each channel. In this work, we look at the latest noise run data of December 2022, obtaining the noise map of the whole detector.

Supported by BMBF in the ErUM Framework and DFG GRK2149.

HK 74.37 Thu 17:30 HSZ EG

Stability Tests for a Pulsed LED Gain Monitoring System for CALIFA — •Carl Georg Boos, Christian Sürder, and Thorsten Kröll for the R3B-Collaboration — Institut für Kernphysik, TU Darmstadt

The CALIFA array is part of the R3B set-up used for kinematically complete measurements of nuclear reactions. Those measurements are conducted at GSI and later FAIR, Darmstadt. The CALIFA is one of the core elements, functioning both as a calorimetre and a spectrometre for gamma-rays and light charged particles. It is built out of over 2000 CsI(Tl) crystals connected to APDs. As the gain is not constant for these detector systems - e. g. through possible ageing of the scintillation crystals and the temperature dependencies of the APDs - an Pulsed LED Gain Monitoring System is currently tested. The stability is examined to understand, to which extend the LEDs shift and to identify the reasons. Parameters investigated are pulse lengths and frequencies, the mimicing of the spill structure of the beam as well as the coupling of the fibres. In addition to lab test, a long measurement was started at the CALIFA array at GSI for possible correlations with temperature. This work was supported by BMBF 05P19RDFN1 and 05P21RDFN2.

HK 74.38 Thu 17:30 HSZ EG

Constraining the interaction between Λ and Kaons with femtoscopy at LHC — •Emma Chizzali for the ALICE Germany-Collaboration — Technical University of Munich, Munich, Germany

The meson-baryon interaction among short-lived strange particles as Λ and kaons is very challenging to be accessed in scattering experiments. Recently, an alternative approach to access the strong interaction in these systems was provided by measuring of two-body momentum correlations. Of special interest is the ΛK- interaction, which is characterized by the presence of the Xi(1620) state, recently observed by Belle, which can couple to ΛK- and lies just above the threshold. The ΛK+,- correlation function, already studied by the ALICE Collaboration in Pb-Pb collisions, has now been measured in pp Collisions at sqrt(s)=13 TeV. The small size of the particle-emitting source produced in this colliding system makes it possible to study short-ranged strong potentials with much higher precision. The results show that the ΛK+ interaction is repulsive and dominated by elastic processes. The measured ΛK- correlation function indicates an attractive interaction composed of a resonant contribution, through the Xi(1620) resonance, and a non resonant one.

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HK 74.39 Thu 17:30 HSZ EG

Performance investigation of a DSSSD coupled to SKIROC2 ASICs — •Steffen Meyer[1], Thorsten Kröll[1], Roman Gernhäuser[2], Sergei Golenev[2], Corinna Henrich[1], and Han-Bum Rhee[1] — [1]TU Darmstadt — [2]TU Munich

Double-sided silicon-strip detectors (DSSSD) have been in use at the Coulomb excitation and transfer setup at the ISOLDE facility (CERN) for many years. Recently a new transfer setup, HI-REX, has been designed, which employs a FPGA-based GEAR platform to read out data of SKIROC2 ASICs [1].

Here, this new SKIROC ASIC-based DAQ is tested with a standard DSSSD. The TREX setup is known to face challenges with noise due to cabling and grounding. ASICs of the SKIROC family allow to minimize and eliminate such sources, because they are able to preamplify, filter, shape and digitize on-chip. To have comparable data, first tests with an MADC-32 module by Mesytec and FEBEX3 cards, designed at GSI, are performed.

The current status will be presented.

This work is supported by the German BMBF under contract 05P21RDCI2.

[1] C. Berner et al., Nuclear Inst. and Methods in Physics Research, A 987 (2021) 164827

HK 74.40 Thu 17:30 HSZ EG

Physics Performance Studies of K_s^0 with the CBM Experiment — •Felix Fidorra for the CBM-Collaboration — Institut für Kernphysik WWU Münster, Münster, Germany

The Compressed Baryonic Matter (CBM) is a fixed target heavy-ion experiment which is currently under construction at FAIR in Darmstadt. It will explore the QCD phase diagram at high net-baryon densities ($\mu B > 500$ MeV). A key element for the investigation of the dense baryonic matter are the measurements of the strange hadron yields, the most often produced K_s^0 and Λ as well as rare (multi-)strange hyperons and their antiparticles. To reconstruct the decays of these particles, a particle finder, based on the Kalman Filter, is used. A boosted decision tree machine learning model has been trained to distinguish between signal and background. Simulations using two different event generators, UrQMD and DCM-QGSM-SMM, are used for this study. Since K_s^0 decay with the highest probability symmetrically into two soft pions of opposite charge, their reconstruction gives insights into the performance of the CBM detector. This poster will be about the status of K_s^0 analysis. The aim is to maximize the signal significance of the K_s^0 decay candidates selection using the machine learning algorithms and validate the multi-step and multi-differential fitting routine for K_s^0 yield extraction.

HK 74.41 Thu 17:30 HSZ EG

CBM-TRD tracking performance studies for mCBM 2022 — •Axel Puntke for the CBM-Collaboration — Institut für Kernphysik, WWU Münster

The Compressed Baryonic Matter (CBM) experiment at the future Facility for Antiproton and Ion Research (FAIR) will explore the QCD phase diagram in the region of very high net baryon densities. The Transition Radiation Detector (TRD) is an important subdetector of the final CBM experiment and is used to identify electrons at high momenta, contributes to tracking of particles and supports the identification of light nuclei via their specific energy loss.

For commissioning and performance measurements, the TRD takes part in the mCBM high-rate beam measurement campaigns at the SIS18 accelerator, which are part of the FAIR-Phase 0 program. Together with the TOF, STS, RICH and MuCH detectors, also TRD is connected to the full CBM DAQ, making data available for common analysis.

In this poster, TRD data QA as, e.g., a first tracking approach using straight tracks is presented and its results are shown.

This work is supported by BMBF grant 05P21PMFC1.

HK 74.42 Thu 17:30 HSZ EG

Deuteron emission from Ag+Ag Collisions at 1.58A GeV — •Carl-Philipp Roy for the HADES-Collaboration — Goethe-Universität Frankfurt

A high statistics data sample of Ag(1.58A-GeV)+Ag events recorded in scope of the FAIR phase 0 program in March 2019 is used to study multi-differential emission rates of deuteron.

In this contribution, we discuss details of the extraction of deuteron signals from the bulk of reconstructed charged particle tracks. The extracted deuteron signals are corrected with simulated detector response coefficients and then used to calculate the multi-differential emission rate per event as a function of transverse mass and center- of-mass rapidity. The obtained phase-space distribution of deuteron yields is fitted with thermally motivated model functions and extrapolated to phase-space not covered by the detector geometry. The results are discussed in context of available world data.

*This work has been supported by BMBF (05P21RFFC2) and GSI.

HK 74.43 Thu 17:30 HSZ EG

Arduino-based readout electronics for particle detectors — •Markus Köhli[1], Jannis Weimar[1], Fabian Schmidt[2], Jochen Kaminski[2], Klaus Desch[2], and Ulrich Schmidt[1] — [1]Physikalisches Institut, Heidelberg University — [2]Physikalisches Institut, University of Bonn

Open Hardware-based microcontrollers, especially the Arduino platform, have become a comparably easy-to-use tool for rapid prototyping and implementing creative solutions. Such devices in combination with dedicated frontend electronics can offer low-cost alternatives for student projects, slow control and independently operating small scale instrumentation. The capabilities can be extended to data taking and signal analysis at decent rates. We present two projects, which cover the readout of proportional counter tubes and of scintillators or wavelength shifting fibers with Silicon Photomultipliers. With the SiPMTrigger we have realized a small-scale design for SiPMs as a trigger or veto detector. It consists of a custom mixed signal frontend board featuring signal amplification, discrimination and a coincidence unit for rates up to 200 kHz. The nCatcher board transforms an Arduino Nano to a proportional counter readout with pulse analysis - time over threshold measurement and a 10-bit analog-to-digital converter for pulse heights. The device is therefore suitable for low to medium rate environments, where a good signal to noise ratio is crucial - in case presented here to monitor thermal neutrons.

HK 74.44 Thu 17:30 HSZ EG

Ultra-clean magnetically-coupled piston pump for noble gas experiments. — •Andria Michael[1], Lutz Althüser[1], David Koke[1], Christian Huhmann[1], Michael Murra[1,2], Philipp Schulte[1], Henning Schulze Eissing[1], and Christian Weinheimer[1] for the XENON-Collaboration — [1]Institut für Kernphysik, Universität Münster, Germany — [2]Columbia University, New York, USA

The high performance magnetically-coupled piston pump is interesting for the usage in low background experiments dealing with noble gases as target. In such ultra-clean experiments, pumps are used for the circulation of the target material. Therefore, the reduction of radioactive emanating materials such as radon is of great importance. For this purpose, a radon-free, hermetically sealed, ultra-clean magnetically-coupled piston pump was developed (JINST 16 (2021) P09011) to be operated as a xenon gas compressor for the XENONnT experiment.

The magnetically-coupled piston pump is made of four cylinders connected in parallel, featuring a high flow by keeping high pressure differences for a good compression. The custom-made control gives the possibility to operate the system with different configurations and to monitor the status of each pump during the operation.

In this poster the function and the operation experience with this magnetically-coupled piston compressor is presented.

This research was partially supported by BMBF under contract 05A20PM1.

HK 74.45 Thu 17:30 HSZ EG

CBM-TRD Component Database — •Philipp Munkes for the CBM-Collaboration — Institut für Kernphysik WWU Münster, Münster, Germany

The Compressed Baryonic Matter (CBM) experiment is an upcoming heavy-ion physics experiment at the future Facility for Anti-proton and Ion Research (FAIR) which will investigate the low-temperature and high baryonic density region of the Quantum-ChromoDynamic (QCD) phase diagram.

The Transition Radiation Detector (TRD), one of the sub-detectors of the CBM experiment, will be used to provide particle identification information on electrons and pions at high momenta and light nuclei, as well as tracking information for charged particles.

For long-running experiments it is important to keep track of all of their components already during production of the detector, as soon as they have been assigned an identity. This enables not only full QA processes of those components, but also correlating the product behavior to the components and/or to the production process, if necessary at some point. For this reason, a long-term stable database for production data needs to be implemented, deployed, and tested.

In this poster, the design of the CBM-TRD Component Database concept and its current status will be presented.

This work is supported by BMBF grant 05P21PMFC1.

HK 74.46 Thu 17:30 HSZ EG

pp correlation in e^+e^- collisions at Belle to study the particle emitting source — •Maria Leibelt[1], Laura Serksnyte[1], Umberto Tamponi[2], and Laura Fabbietti[1] — [1]TU München, Garching, Germany — [2]INFN, Sezione di Torino, Turin, Italy

The light antinuclei cosmic rays are considered as a promising probe for the searches of Weakly Interacting Massive Particles (WIMPs) - one of the dark matter candidates. The antinuclei can be produced in dark matter annihilations and detected by experiments near Earth. Understanding the antinuclei fluxes requires knowledge about how light antinuclei are formed. One of the available models is coalescence which suggests that first antinucleons are formed as degrees of freedom and then they coalesce to antinuclei. The probability for the antinucleons to create a bound state depends on the relative momentum in the pair rest frame and the distance at which they are produced. The latter can be constrained with femtoscopic correlation measurements, currently available only for pp and heavy-ion collisions. As a proxy to constrain the source for antinuclei production in the dark matter annihilation, e^+e^- collisions are preferred since electrons are point-like particles and do not interact strongly. In this poster, we will show the first results on femtoscopic p-p correlations in e^+e^- collisions measured by Belle at the KEKB collider. The obtained correlation function is then modeled using well known interaction potentials and the size of the source for nucleon pairs is extracted.

HK 74.47 Thu 17:30 HSZ EG

A new TPC with a hybrid GEM-Micromegas detector — •Liancheng Ji[1], Meytal Duer[1], Alexandru Enciu[1], Bastian Löher[2], Alexandre Obertelli[1], Yelei Sun[1], Simone Velardita[1], Piotr Gasik[2], and Joerg Hehner[2] for the R3B-Collaboration — [1]Technische Universität Darmstadt, Institut für Kernphysik, 64289, Darmstadt, Germany — [2]GSI, Helmholtzzentrum für Schwerionenforschung, 64291 Darmstadt

HYDRA (HYpernuclei Decay at R^3B Apparatus), a physics program within the R^3B collaboration at GSI/FAIR, is dedicated to studying the production of light and medium mass hypernuclei in ion-ion collisions by measuring their pionic decay. With HYDRA day-one experiment in 2024 the mass radius of the hypertriton, the lightest hypernucleus will be extracted for the first time. The main tracking detector, a time projection chamber (TPC) is being developed and will be operated inside an inhomogeneous magnetic field of the GLAD large-acceptance dipole magnet at the R^3B setup.

As the first step, a prototype GEM-Micromegas hybrid TPC has been built to implement all the technologies proposed for the full TPC. It covers an active area of 256 x 88 mm^2 , with a 300 mm drift distance. A two-layer wired field cage holds up the electric field. Along with it, a laser system is employed to generate reference tracks with which the homogeneity of the drift field can be quantified and calibrated.

Currently the prototype is being tested at TU Darmstadt. Simulations and first test results will be presented in the poster.

HK 74.48 Thu 17:30 HSZ EG

A GEANT4 simulation of gamma clustering in CsI. — •Philipp Klenze[1], Leyla Atar[2], and Roman Gernhäuser[1] for the R3B-Collaboration — [1]Technische Universität München — [2]Technische Universität Darmstadt

With over 1500 CsI(Tl) crystals, the CALIFA calorimeter is one of the cornerstones of the upcoming R^3B experiment at the FAIR accelerator complex. One of its tasks will be the detection of gamma rays in the range from 100 keV to 30 MeV. Due to the high granularity of CALIFA, these energy deposit of gamma rays will generally be spread over multiple crystals. In this work a simplified geometry model in GEANT4 is used to study both the quantitative behavior of photons in CsI, cluster sizes and shapes, and energy and position reconstruction efficiency.

HK 74.49 Thu 17:30 HSZ EG

Pulse-shape analysis with the new Miniball triple-cluster detector — •Kai Henseler, Darius Luyken, Jasper Wehlitz, Rainer Abels, Jürgen Eberth, Herbert Hess, Rouven Hirsch, and Peter Reiter — IKP Universität zu Köln, Cologne, Germany

The Miniball (MB) array is a high-resolution γ-ray spectrometer used for low multiplicity experiments with low-intensity radioactive ion beams at HIE-ISOLDE, CERN. It consists of eight triple-cryostats, each housing three n-type six-fold segmented HPGe crystals. New preamplifier electronics was implemented in the cold part of the cryostat and the feedback loop is now coupled to the AGATA preamplifier [1]. The seven preamplifier outputs from one crystal are digitized at a rate of 100 MHz using 14-bit ADCs [2]. The new electronics yield comparable energy resolution results with respect to standard analog electronics and enable pulse-shape analysis of all channels simultaneously. Measurements with a collimated γ-ray source of ^{137}Cs were conducted to produce data sets of interactions along one line, so called 'pencil beams'. These pulses are filtered and analyzed with respect to the deposited energy, rise time and pulse shapes. Aim of the PSA is to identify the location of individual interaction points. Especially along the detector axis three dimensional position information is crucial for improved Doppler correction. First results will be presented and discussed. Supported by BMBF Projects 05P18PKCI1, 05P21PKCI1.

[1] S. Akkoyun *et al.*, Nucl. Inst. Meths. Phys. Res. A 668 (2012) 26
[2] A. Pullia *et al.*, IEEE NSS MIC Record (2012) 819-823

HK 74.50 Thu 17:30 HSZ EG

High-energy gamma calibration of CALIFA with a Pu-C source — •Phuong Nguyen, Leyla Atar, Christian Suerder, and Thorsten Kroell for the R3B-Collaboration — Institut für Kern- physik, TU Darmstadt, Darmstadt, Germany

CALIFA (CALorimeter for In-Flight detection of gamma-rays and high energy charged pArticles) is the scintillator based calorimeter of the R3B (reactions with relativistic radioactive beams) experiment at FAIR that surrounds the target. It currently consists of 1528 scintillation CsI(Tl) crystals and detects gamma-rays and light charged particles simultaneously. The energy calibration of CALIFA crystals is done using different sources, from low energy-gamma peaks (22Na) to high energy-gamma peaks (Pu-C) reaching from 511 keV up to 6.1 MeV. This is essential due to the high dynamic range (100keV to 300MeV) of CALIFA. To improve the calibration quality, various gamma sources are combined in the calibration procedure and automated by a Python script.

This work is supported by BMBF under contract 05P19RDFN1 and 05P21RDFN2 and the Helmholtz Research Academy Hesse for FAIR - HFHF.

HK 74.51 Thu 17:30 HSZ EG

New evidence for alpha clustering structure in the ground state band of ^{212}Po — •Martin von Tresckow for the IFIN212Po-Collaboration — IKP TU Darnstadt, Schlossgartenstraße 9, 64289 Darmstadt

^{212}Po has two-protons and neutrons outside the doubly-magic nucleus ^{208}Pb and it may be assumed that the nuclear structure can be well described within the shell-model. But various experimental properties, such as the short-lived ground state, are better described by an α-clustering model. The B(E2) values of the decays of the low-lying yrast states are an important finger print to describe the structure of ^{212}Po. Especially the missing B(E2; $4_1^+ \rightarrow 2_1^+$) value is important in this discussion. We have performed an α-transfer experiment to investigate excited states of ^{212}Po and determine the lifetimes using the ROSPHERE γ-ray detector array at IFIN-HH in Magurele, Romania. This array consisted of 15 HPGe detectors and 10 $LaBr_3$(Ce) scintillator detectors and was supplemented with the SORCERER particle-detector array. The combination of γ-ray and the particle detectors was an important tool to determine the mean lifetimes of all ground-state band levels up to the 8^+ state applying the fast-timing method [Ma. von Tresckow et al., PLB 821, 136624 (2021)]. I will present our lifetime analysis and discuss the results within the shell-model and α-clustering model. *Supported by BMBF under Verbundprojekt 05P2021 (ErUM-FSP T07) via grant 05P21RDFN1

HK 74.52 Thu 17:30 HSZ EG

CBM-TRD hit time extraction — •Philipp Kähler[1], Marius Kunold[2], and David Schledt[2,3] for the CBM-Collaboration — [1]Institut für Kernphysik, WWU Münster — [2]Institut für Kernphysik, Goethe-Universität Frankfurt — [3]Infrastruktur und Rechnersysteme in der Informationsverarbeitung, Goethe-Universität Frankfurt

The Transition Radiation Detector (TRD) of the upcoming CBM experiment will be based on Multi-Wire Proportional Chambers (MWPCs), which are read-out via their segmented cathode pad-planes. The incoming charge from hits is amplified and shaped in the analogue part of the read-out ASICs, i.e. the SPADIC chip. The resulting shaper signals are digitised directly in its integrated sampling ADC. As the transmission function of the shaper is well known, the signal arrival time can be extracted from the transmitted ADC samples with a precision well below the sampling frequency of 16 MHz.

This poster shows implementations of the time value extraction for measured signals, which is used in the chain to TRD hit reconstruction. Different methods, based on a look-up table approach as well as on direct calculation, have been tested on real data from mCBM measurements (FAIR phase 0 programme) at the SIS18 accelerator. Implementations for online application of the time extraction in the Common Readout Interface (CRI) FPGA of our system will be covered. This work is supported by BMBF grants 05P21RFFC1 and 05P21PMFC1.

HK 74.53 Thu 17:30 HSZ EG

Magnetic field dependence of dielectron measurements with ALICE 3 — •Zafar Momtaz for the ALICE Germany-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

Ultra-relativistic heavy-ion collisions are used to study strongly interacting matter under extreme conditions, i.e. high temperature and energy density, where a deconfined state of quarks and gluons is formed and chiral symmetry is expected to be restored. At the LHC, a next-generation heavy-ion experiment, called ALICE 3, is planned beyond the 2030s to address the remaining fundamental questions still open. In particular, ALICE 3 should enable precise measurements of the temperature evolution of the quark-gluon plasma created in heavy-ion collisions via dielectron analyses. Moreover it should allow us to study the mechanisms of chiral symmetry restoration from the spectrum of dielectron created in the medium in the vicinity of the transition temperature via the spectral function of the ρ - meson. In order to achieve these physics goals, the ALICE 3 detector setup would include an ultra-light tracker, covering the pseudorapidity range of of $|\eta| < 4$ and installed within a superconducting magnet system.

This poster will show the expected dielectron measurement performance with ALICE 3 for different magnetic fields. In particular, we will focus on the tracking and electron identification efficiencies for different detector configurations and explain how they influence the predicted uncertainties of the temperature measurements of the fireball.

HK 74.54 Thu 17:30 HSZ EG

Development of a Muon Tagger System for the future MuonEDM Experiment — •Dhruv Chouhan, Melike Akbiyik, Elisa Ruiz Choliz, Francesco Fallavolita, and Matthias Schott — Johannes Gutenberg University of Mainz, Germany

The future MuonEDM experiment aims to search for an electric dipole moment of the muon based on the frozen-spin technique. With the advent of the new high intensity muon beam, HIMB, and the cold muon source, muCool, at PSI the sensitivity of the search for the muon EDM could be improved by several orders of magnitudes. In this context, the latest developments on a muon-tagger system for the MuonEDM experiment are discussed. Special focus is drawn on a straw-tube based approach as well as a Micromegas based TPC detector.

HK 75: Members' Assembly

Time: Thursday 19:00–20:00 Location: HSZ/0002

All members of the Hadronic and Nuclear Physics Division are invited to participate.

HK 76: Invited Talks IV

Time: Friday 11:00–12:30 Location: HSZ/0002

Invited Talk HK 76.1 Fri 11:00 HSZ/0002

Thermalization of heavy quarks in the QGP — •Federica Capellino — Physikalisches Institut Heidelberg, Heidelberg, Germany

Heavy-ion collision experiments allow us to study the high-temperature deconfined phase of QCD, the quark-gluon plasma (QGP). Heavy quarks (i.e. charm and beauty) are powerful tools to characterize the transport properties of the QGP. Although they are initially produced out of kinetic equilibrium via hard partonic scattering processes, recent experimental measurements of charmed hadrons pose the question regarding the possible thermalization of heavy quarks in the medium. Exploiting a mapping between transport theory and fluid-dynamics, we will show how a fluid-dynamic description of the dynamics of charm quarks in the QCD plasma is feasible. Calculations for heavy-flavor observables which assume charm quarks to be in local thermal equilibrium with the plasma will be shown in comparison with experimental data. The model-to-data comparison is a fundamental step towards constraining the spatial- and momentum-diffusion coefficient of the QGP.

Invited Talk HK 76.2 Fri 11:30 HSZ/0002

Hadron structure in Lattice QCD — •Konstantin Ottnad — PRISMA+ Cluster of Excellence and Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Germany

Quantum chromodynamics (QCD) at low energies gives rise to a plethora of states as quark and gluons become bound in hadrons. Among these hadronic states are nucleons which account for the bulk part of visible matter in the universe. Due to their dynamical origin they are not pointlike particles but exhibit a rich and complex internal structure which is studied extensively in both experiment and theoretical studies.

Concerning the theoretical side, lattice QCD provides the obvious framework for ab initio hadron structure calculations as it is the only known method to deal with QCD in the non-perturbative regime from first principles. In recent years it has finally become feasible to obtain precise physical results with fully controlled systematics from such lattice calculations of hadron structure observables. Still, this remains a very challenging and computationally expensive endeavour as these calculations are always affected by a notorious signal-to-noise problem that hinders the extraction of groundstate matrix elements.

In this talk I will outline some of the essential methods used to carry out state-of-the-art hadron structure calculations within lattice QCD and discuss recent results from the Mainz group for nucleon matrix elements at zero and nonvanishing momentum transfer.

Invited Talk HK 76.3 Fri 12:00 HSZ/0002

LISA: LIfetime measurements with Solid Active targets — •Kathrin Wimmer — GSI Helmholtzzentrum für Schwerionenforschung GmbH

The coexistence of single-particle and collective degrees of freedom in atomic nuclei gives rise to various exotic phenomena. In nuclei with very asymmetric proton-to-neutron ratios, the strong nuclear interaction drives shell evolution which alters the orbital spacing, and in some cases even the ordering present in stable nuclei. In the absence of large gaps between orbitals, nuclei can take on non-spherical shapes and their excitations proceed through coherent and collective motion of many nucleons. Where and how collectivity emerges from the single-particle dynamics of protons and neutrons is an open question in nuclear structure physics that will be addressed with LISA in a unique way. The aim of the LISA (LIfetime measurements with Solid Active targets) project is to develop a novel method for lifetime measurements in atomic nuclei. Lifetimes probe the collectivity of a nucleus through its electromagnetic transition properties. The experimental approach is based on active solid targets and will dramatically enhance the scope of measurements of excited-state lifetimes and thus transition probabilities achievable in exotic nuclei. Coupled to state-of-the-art gamma-ray tracking detectors such as AGATA, this novel instrument will overcome the present challenges of lifetimes measurements with low-intensity beams of unstable nuclei. In this talk, I will present an overview of the LISA project and show the potential for future physics experiments at FAIR.

Theoretical and Mathematical Physics Division
Fachverband Theoretische und Mathematische Grundlagen der Physik (MP)

Johanna Erdmenger
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Overview of Invited Talks and Sessions

(Lecture halls ZEU/0250, HSZ/0003, and HSZ/0304; Poster HSZ OG3)

Plenary Talk of the Theoretical and Mathematical Physics Division

PV VIII	Wed	9:00– 9:45	HSZ/AUDI	**25 years of the AdS/CFT correspondence: Current status and future prospects** — •Koenraad Schalm

Invited Talks

MP 1.1	Mon	11:00–11:30	HSZ/0003	**Insights from random matrices on dissipative quantum dynamics** — •Pedro Ribeiro, Lucas Sá, Tomaz Prosen
MP 3.1	Tue	11:00–11:30	HSZ/0304	**Renormalization of singular stochastic partial differential equations** — •Pawel Duch
MP 3.2	Tue	11:30–12:00	HSZ/0304	**Integral decomposition of modular operators in QFT** — Henning Bostelmann, •Daniela Cadamuro, Ko Sanders
MP 3.3	Tue	12:00–12:30	HSZ/0304	**Emergence of gravity from conformal field theory** — •Nele Callebaut
MP 6.2	Wed	11:30–12:00	ZEU/0250	**Deep neural networks and the renormalization group** — •Ro Jefferson, Johanna Erdmenger, Kevin Grosvenor

Sessions

MP 1.1–1.4	Mon	11:00–12:30	HSZ/0003	**Quantum Dynamics and Quantum Information**
MP 2.1–2.4	Mon	16:30–18:00	ZEU/0250	**Quantum Field Theory I**
MP 3.1–3.3	Tue	11:00–12:30	HSZ/0304	**Quantum Field Theory II**
MP 4.1–4.3	Tue	10:30–14:00	HSZ OG3	**Poster**
MP 5.1–5.6	Tue	17:00–19:00	ZEU/0250	**Scattering Amplitudes and Conformal Field Theory**
MP 6.1–6.3	Wed	11:00–12:20	ZEU/0250	**AI Topical Day – Neural Networks and Computational Complexity (joint session MP/AKPIK)**
MP 7.1–7.4	Wed	14:00–15:20	ZEU/0250	**Classical and Quantum Gravity**
MP 8	Wed	16:00–17:30	ZEU/0250	**Members' Assembly**
MP 9.1–9.4	Thu	11:00–12:30	ZEU/0250	**AdS/CFT Correspondence and Hydrodynamic Transport**
MP 10.1–10.4	Thu	14:00–15:20	ZEU/0250	**AdS/CFT Correspondence II**
MP 11.1–11.3	Thu	16:00–17:00	ZEU/0250	**Quantum Field Theory III (QED and Particle Detection)**
MP 12.1–12.2	Thu	17:05–17:45	ZEU/0250	**Quantengravitation und Thermodynamik**

Members' Assembly of the Theoretical and Mathematical Physics Division

Wednesday 16:00-17:30 ZEU/0250

- Report
- Elections
- Any other business

Sessions

– Invited Talks, Contributed Talks, and Posters –

MP 1: Quantum Dynamics and Quantum Information

Time: Monday 11:00–12:30 Location: HSZ/0003

Invited Talk MP 1.1 Mon 11:00 HSZ/0003

Insights from random matrices on dissipative quantum dynamics — •Pedro Ribeiro[1], Lucas Sá[1], and Tomaz Prosen[2] — [1]CeFEMA, Instituto Superior Tecnico, Lisbon, Portugal — [2]University of Ljubljana, Ljubljana, Slovenia

Understanding the dissipative dynamics of complex quantum systems is essential to describe quantum matter at large time scales. However, even within a simplified Markovian description, studying the spectral and steady-state properties of Lindblad operators remains a challenging task.

In this talk, we present some novel insights into universal features of generic open quantum systems under Markovian dissipation by using ensemble averaging based on (non-Hermitian) random matrices. We will examine three representative cases: quadratic Liouvilians, dissipative SYK models, and fully random Liouvilian operators. For this last example, we will present a recent systematic classification of many-body Lindblad superoperators based on the properties of the Lindbladian under antiunitary symmetries and unitary involutions.

MP 1.2 Mon 11:30 HSZ/0003

Markovianity in Quantum Thermodynamics — •Frederik vom Ende[1], Emanuel Malvetti[2,3], Gunther Dirr[4], and Thomas Schulte-Herbrüggen[2,3] — [1]Dahlem Center for Complex Quantum Systems, Freie Universität Berlin, 14195 Berlin, Germany — [2]Department of Chemistry, Technische Universität München, Lichtenbergstr. 4, 85737 Garching, Germany — [3]Munich Centre for Quantum Science and Technology & Munich Quantum Valley, Schellingstr. 4, 80799 München, Germany — [4]Department of Mathematics, Julius-Maximilians-Universität Würzburg, 97074 Würzburg, Germany

In the first half of this talk – which is based on arXiv:2211.08351 – we characterize the generators of quantum-dynamical semigroups via Stinespring dilations. More precisely, we prove that the second derivative of Stinespring dilations with a bounded total Hamiltonian yields the dissipative part of some quantum-dynamical semigroup – and vice versa. As a byproduct we obtain that for semigroups which describe an open system, the evolution of the dilated closed system has to be generated by an unbounded Hamiltonian. The second half of this talk will deal with a natural application of these results to Markovianity in quantum thermodynamics, because the central object of the latter – the so-called thermal operations – are defined via their Stinespring form. This will yield a family of generators of Markovian thermal operations, and we conjecture that no further generators exist.

MP 1.3 Mon 11:50 HSZ/0003

The Thermomajorization Polytope and its Degeneracies — Frederik vom Ende[1] and •Emanuel Malvetti[2,3] — [1]Dahlem Center for Complex Quantum Systems, Freie Universität Berlin, 14195 Berlin, Germany — [2]Department of Chemistry, Technische Universität München, Lichtenbergstr. 4, 85737 Garching, Germany — [3]Munich Centre for Quantum Science and Technology & Munich Quantum Valley, Schellingstr. 4, 80799 München, Germany

In quantum thermodynamics thermal operations are considered free. We want to understand which states are reachable from a given initial state using thermal operations. We study the quasi-classical case of diagonal states, where the problem reduces to understanding the thermomajorization polytope. In particular we are interested in degeneracies of this polytope and its connection to the polytope of Gibbs-stochastic matrices.

MP 1.4 Mon 12:10 HSZ/0003

Particle Spin described by Quantum Hamilton equations — •Michael Beyer and Wolfgang Paul — Martin-Luther Universität Halle

The anomalous Zeeman effect made it clear that charged particles like the electron possess a magnetic dipole moment. Classically, this could be understood if the charged particle possesses an eigenrotation, i.e., spin. This classically motivated model of intrinsic rotation described in terms of a continuous stochastic process is revisited within the formalism of stochastic optimal control theory. Quantum Hamilton equations for spinning particles are derived, which reduce to their classical counterpart in the zero quantum noise limit. These equations enable the calculation of the common spin expectation values without the use of the wave function. They also offer information on the orientation dynamics of the magnetic moment of charged particles beyond the behavior of the spin averages.

MP 2: Quantum Field Theory I

Time: Monday 16:30–18:00 Location: ZEU/0250

MP 2.1 Mon 16:30 ZEU/0250

String-localized quantum field theory: the reverse side of the BRST coin — •Karl-Henning Rehren[1], Jens Mund[2], and Bert Schroer[3] — [1]Universität Göttingen — [2]Universidade Federal de Juiz de Fora, Brazil — [3]Freie Universität Berlin

Gauge symmetry is most successful at predicting the structure of all interactions among particles in the Standard Model. Yet, it addresses exclusively non-observable entities (gauge potentials and Fermi fields). One may ask how “fundamental” such a principle can be.

Quantum gauge symmetry can only be formulated on state spaces with indefinite metric (“negative probabilities”). The BRST method allows to return to a Hilbert space. Charged interacting fields are not defined on this Hilbert space, because they are not BRST-invariant.

An alternative is presented with the same (and in one instance even superior) predictive power on the structure of interactions. It proceeds directly on the physical Hilbert space, and allows to construct interacting charged fields. They exhibit a weaker localization than usual, while observables coincide with those in the BRST setup.

arxiv:2209.06133v2

MP 2.2 Mon 17:00 ZEU/0250

On the mass dependence of the modular operator for a double cone — •Christoph Minz[1], Henning Bostelmann[2], and Daniela Cadamuro[1] — [1]Institut für Theoretische Physik, Universität Leipzig — [2]University of York, Department of Mathematics

We present a numerical approximation scheme for the Tomita-Takesaki modular operator of local subalgebras in linear quantum fields, where the modular data are determined at one-particle level using time-0 formulation in position space. The technique is tested against the known results for the local subspace of a right wedge in 2-dimensional Minkowski spacetime, where one component of the modular operator is known to be a mass-independent multiplication operator. Applying the same technique to the unknown case of a double cone in 2 (and 4) dimensions, we find that the same component of the modular operator depends on the mass (and angular momentum).

MP 2.3 Mon 17:20 ZEU/0250

Information theoretic properties of soft photon clouds — •Henning Bostelmann[1], Daniela Cadamuro[2], and Wojciech Dybalski[3] — [1]Department of Mathematics, University of York, UK — [2]Institute for Theoretical Physics, University of Leipzig, Germany — [3]Adam Mickiewicz University, Poznań, Poland

In quantum field theories with massless particles, states which describe clouds of soft photons in front of the vacuum are macroscopically different from the vacuum state: in mathematical terms, they lead to inequivalent representations of the quasilocal observable algebra, and a global “photon charge” labels these representations.

Here we investigate this macroscopic difference from an information-theoretic perspective. In a massless free theory, we compute the relative entropy between a coherent photon cloud state and the vacuum with respect to the forward light-cone algebra. It turns out that this entropy is infinite if, and only if, the “photon charge” of the cloud is zero.

MP 2.4 Mon 17:40 ZEU/0250

Quantum energy inequality in the Sine-Gordon model — •Markus B. Fröb and Daniela Cadamuro — Institut für Theoretische Physik, Universität Leipzig, Germany

We consider the massless Sine–Gordon model in the finite regime $\beta^2 < 4\pi$ of the theory. We prove convergence of the renormalised perturbative series for the interacting stress tensor defined using the Bogoliubov formula in an arbitrary Hadamard state, even for the case that the smearing is only along a one-dimensional time-like worldline and not in space-time. We then show that the interacting energy density, as seen by an observer following this worldline, satisfies an absolute lower bound, that is a bound independent of the quantum state. Our proof employs and generalises existing techniques developed for free theories by Flanagan, Fewster and Smith.

MP 3: Quantum Field Theory II

Time: Tuesday 11:00–12:30 Location: HSZ/0304

Invited Talk MP 3.1 Tue 11:00 HSZ/0304

Renormalization of singular stochastic partial differential equations — •Pawel Duch — Adam Mickiewicz University, Poznan, Poland

Stochastic PDEs, i.e. partial differential equation with random terms or coefficient, play an important role in mathematical physics and have applications in areas such as quantum field theory, statistical mechanics and material science. Well-known examples of stochastic PDEs are the KPZ equation describing the motion of a growing interface or the stochastic quantization equation of the Φ^4 Euclidean QFT. Most of the interesting non-linear stochastic PDEs, including the ones mentioned above, are too singular to admit classical treatment. Solving such equations poses a formidable challenge and usually requires the regularization and renormalization of the equation.

After giving a brief overview of the tremendous progress in the area of singular stochastic PDEs in the past decade, I will present a novel approach to such PDEs proposed in my recent work. The approach uses the framework of the Wilsonian renormalization group theory and is based on a certain flow equation that plays an analogous role to the Polchinski equation in QFT. The approach allows to solve a large class of singular stochastic PDEs in a systematic manner and avoids algebraic and combinatorial problems arising in different approaches.

Invited Talk MP 3.2 Tue 11:30 HSZ/0304

Integral decomposition of modular operators in QFT — Henning Bostelmann[1], •Daniela Cadamuro[2], and Ko Sanders[3] — [1]Department of Mathematics, University of York, UK — [2]Institute for Theoretical Physics, University of Leipzig, Germany — [3]Department of Mathematics, FAU Erlangen-Nürnberg

The Tomita-Takesaki modular operator of local algebras (or, in linear field theories, of standard subspaces) is a structurally important concept in quantum field theory; unfortunately little can be said about its explicit form in most concrete situations. We develop a general decomposition theory for standard subspaces along direct integrals, making some new examples available to explicit treatment.

Invited Talk MP 3.3 Tue 12:00 HSZ/0304

Emergence of gravity from conformal field theory — •Nele Callebaut — Institute for Theoretical Physics, University of Cologne

I will discuss several mechanisms by which gravity emerges from conformal field theory: through holography, entanglement dynamics or irrelevant deformations.

MP 4: Poster

Time: Tuesday 10:30–14:00 Location: HSZ OG3

MP 4.1 Tue 10:30 HSZ OG3

Nonlinear Compton scattering and nonlinear Breit-Wheeler pair production including the damping of particle states — •Tobias Podszus[1], Victor Dinu[2], and Antonino Di Piazza[1] — [1]Max Planck Institute for Nuclear Physics, Heidelberg, Germany — [2]Department of Physics, University of Bucharest, Romania

In the presence of an electromagnetic background plane-wave field, electron, positron, and photon states are not stable, because electrons and positrons emit photons and photons decay into electron-positron pairs. This decay of the particle states leads to an exponential damping term in the probabilities of single nonlinear Compton scattering and nonlinear Breit-Wheeler pair production. We present analytical and numerical investigations for the probabilities of nonlinear Compton scattering and nonlinear Breit-Wheeler pair production including the particle states decay. For this we first give new spin- and polarization-resolved expressions of the probabilities, verify that they are gauge invariant, provide some of their asymptotic behaviors, and show that the results of the total probabilities are independent of the spin and polarization bases. In plots from numerical computations we observe that it is crucial to take into account the damping of the states in order the probabilities to stay always below unity and we show that the damping factors also scale with the pulse duration of the background field. In the case of nonlinear Compton scattering we show numerically that the total probability behaves like a Poissonian distribution for sufficiently low initial electron energies such that the photon recoil is negligible.

MP 4.2 Tue 10:30 HSZ OG3

Exploring anomalies by many-body correlations — •Klaus Morawetz — Münster University of Applied Sciences, Stegerwaldstrasse 39, 48565 Steinfurt, Germany — International Institute of Physics- UFRN, Campus Universitário Lagoa nova,59078-970 Natal, Brazil

The quantum anomaly can be written alternatively into a form violating conservation laws or as non-gauge invariant currents seen explicitly on the example of chiral anomaly. By reinterpreting the many-body averaging, the connection to Pauli-Villars regularization is established which gives the anomalous term a new interpretation as arising from quantum fluctuations by many-body correlations at short distances. This is exemplified by using an effective many-body quantum potential which realizes quantum Slater sums by classical calculations. It is shown that these quantum potentials avoid the quantum anomaly but approaches the same anomalous result by many-body correlations. A measure for the quality of quantum potentials is suggested to describe these quantum fluctuations in the mean energy. Consequently quantum anomalies might be a short-cut way of single-particle field theory to account for many-body effects. This conjecture is also supported since the chiral anomaly can be derived by a completely conserving quantum kinetic theory. [Eur. Phys. J. B 92 (2019) 176, Phys. Lett. A 383 (2019) 1362, Phys. Status Solidi B (2021) 2100316]

MP 4.3 Tue 10:30 HSZ OG3

Correlational entropy by nonlocal quantum kinetic theory — •Klaus Morawetz — Münster University of Applied Sciences, Stegerwaldstrasse 39, 48565 Steinfurt, Germany — International Institute of Physics- UFRN, Campus Universitário Lagoa nova,59078-970 Natal, Brazil

The nonlocal kinetic equation unifies the achievements of the transport in dense quantum gases with the Landau theory of quasiclassical transport in Fermi systems. Large cancellations in the off-shell motion appear which are hidden usually in non-Markovian behaviors [1]. The remaining corrections are expressed in terms of shifts in space and time that characterize the non-locality of the scattering process [2]. In this way quantum transport is possible to recast into a quasi-classical picture [3]. The balance equations for the density, momentum, energy and entropy include besides quasiparticle also the correlated two-particle contributions beyond the Landau theory [4]. The medium effects on binary collisions are shown to mediate the latent heat, i.e., an energy conversion between correlation and thermal energy. For Maxwellian particles a sign change of the latent heat is reported at a universal ratio of scattering length to the thermal De Broglie wavelength. This is interpreted as a change from correlational heating to cooling [5]. [1] Ann. Phys. 294 (2001) 135, [2] Phys. Rev. C 59 (1999) 3052, [3] "'Interacting Systems far from Equilibrium -Quantum Kinetic Theory"' Oxford University Press, (2017) ISBN 9780198797241, [4] Phys. Rev. E 96 (2017) 032106, [5] Phys. Rev. B 97 (2018) 195142

MP 5: Scattering Amplitudes and Conformal Field Theory

Time: Tuesday 17:00–19:00 Location: ZEU/0250

MP 5.1 Tue 17:00 ZEU/0250

One–loop six–particle Feynman integral to higher orders in dimensional regulator — Johannes M. Henn, •Antonela Matijašić, and Julian Miczajka — Max-Planck-Institut für Physik, Werner-Heisenberg-Institut, 80805 München, Germany

The state–of–the–art in current two–loop QCD amplitude calculations is at five-particle scattering. In contrast, very little is known at present about two–loop six–particle scattering processes. Computing two–loop six–particle processes requires knowledge of the corresponding one–loop amplitudes to higher orders in the dimensional regulator. In this talk, I will show the analytic results for the one–loop hexagon integral to higher orders in dimensional regulator obtained via differential equations. I will discuss the function alphabet for general D–dimensional external states, function space up to weight two and one–fold integral representation up to weight four for all integrals in the integral basis. Finally, I will discuss the difference between the conventional dimensional regularization and the four–dimensional helicity scheme at the level of the master integrals. With this, the one–loop integral basis is ready for two–loop amplitude applications.

MP 5.2 Tue 17:20 ZEU/0250

new results from computing planar and non-planar three-loop integrals for Higgs plus jet process — •Jungwon Lim — Max Planck Institute for Physics, Munich, Germany

We present new results for Feynman integrals relevant to Higgs plus jet production at three loops, including first results for a non-planar class of integrals. The results are expressed in terms of generalized polylogarithms up to transcendental weight six. We also provide the full canonical differential equations, which allows us to make structural observations on the answer. In particular, find a counterexample to previously conjectured adjacency relations, for a planar integral of the tennis court type. Moreover, for a non-planar triple ladder diagram, we find two novel alphabet letters. This information may be useful for future bootstrap approaches.

MP 5.3 Tue 17:40 ZEU/0250

Gravitational Waves from Worldline Quantum Field Theory — •Gustav Mogull — Institut für Physik und IRIS Adlershof, Humboldt Universität zu Berlin, Zum Großen Windkanal 2, 12489 Berlin, Germany — Max Planck Institute for Gravitational Physics (Albert Einstein Institute), Am Mühlenberg 1, 14476 Potsdam, Germany

Following the groundbreaking first detection by both LIGO observatories (Hanford/Livingston) of gravitational waves in 2015, a new era of gravitational wave astronomy has begun. The waves strong enough for us to detect on Earth are caused by the orbit, deceleration and eventual merger of pairs of extremely massive objects: primarily black holes, but also neutron stars. We aim to model these binary mergers mathematically, so that we may predict the gravitational waves emitted and thus learn about the black holes and neutron stars themselves - how they form, their internal composition - and Einstein's theory of gravity.

The Worldline Quantum Field Theory (WQFT) is a new formalism that we have developed, using tools and technologies from QFT to describe these gravitational merger events. The gravitational two-body problem is remarkably similar to our description of fundamental particles scattering in collider experiments such as CERN's Large Hadron Collider (LHC), and there is considerable overlap in our theoretical descriptions of these events. In this talk I will discuss the WQFT's fundamentals, its applications to gravitational wave physics and its supersymmetric extension to describe spinning black holes and neutron stars.

MP 5.4 Tue 18:00 ZEU/0250

Non-supersymmetric string backgrounds — •Ida Zadeh — Mainz Institute for Theoretical Physics, Mainz, Germany

New constructions of non-supersymmetric backgrounds arising from compactifications of superstring theories on Ricci-flat compact manifolds will be discussed. Such constructions give new insights on properties of theories of quantum gravity. I will discuss the problem within the framework of conformal field theories, namely the exact string worldsheet description. We will see how the conformal field theory formulation gives novel descriptions of the underlying semi-classical field theories and their associated moduli (parameter) spaces.

MP 5.5 Tue 18:20 ZEU/0250

Torus Conformal Blocks of 2D Conformal Field Theories — •Jakob Hollweck — Theoretisch-Physikalisches Institut, Jena, Germany

We compute higher point sl(2,R) conformal blocks on different topologies like the sphere and the torus. The usual methods, like the direct use of the Casimir equations, shadow operator representations, or successive use of the operator product expansion, quickly become complicated for higher point conformal blocks. The use of oscillator representations reproduces the known results and promises further insights, like the computation of (semi-classical) Virasoro conformal blocks, or conformal blocks in higher dimensions than two, which have recently spiked in interest.

MP 5.6 Tue 18:40 ZEU/0250

Quantum energy inequalities in integrable models with bound states and several particle species — •Jan Mandrysch[1], Daniela Cadamuro[1], and Henning Bostelmann[2] — [1]Institute for Theoretical Physics, Uni Leipzig — [2]Department of Mathematics, University of York, United Kingdom

In quantum theory negative energy densities appear and should be constrained in physically reasonable models. Otherwise, one expects instabilities and violations of the 2nd law of thermodynamics.

I present lower bounds of the time-smeared energy density, so-called quantum energy inequalities (QEI), in the class of integrable quantum field theory models. Our main results are a state-independent QEI for interactions which have a constant scattering function and a QEI at one-particle level for generic models including bound states and several particle species. Examples include the Bullough-Dodd, the Federbush, and the O(n)-nonlinear sigma model.

MP 6: AI Topical Day – Neural Networks and Computational Complexity (joint session MP/AKPIK)

Time: Wednesday 11:00–12:20 Location: ZEU/0250

MP 6.1 Wed 11:00 ZEU/0250

A universal approach to state and operator complexities — •Souvik Banerjee[1] and Mohsen Alishahiha[2] — [1]Julius-Maximilians-Universität Würzburg, Würzburg, Germany — [2]IPM, Tehran, Iran

In this talk, I shall present a general framework in which both Krylov state and operator complexities can be put on the same footing. In our formalism, the Krylov complexity is defined in terms of the density matrix of the associated state which, for the operator complexity, lives on a doubled Hilbert space obtained through the channel-state map. This unified definition of complexity in terms of the density matrices enables us to extend the notion of Krylov complexity, to subregion or mixed state complexities and also naturally to the Krylov mutual complexity. We show that this framework also encompasses nicely, the holographic notions of complexity and explains the universal late-time growth of complexity, followed by a saturation.

Invited Talk MP 6.2 Wed 11:30 ZEU/0250

Deep neural networks and the renormalization group — •Ro Jefferson[1], Johanna Erdmenger[2], and Kevin Grosvenor[3] — [1]Utrecht University — [2]University of Würzburg — [3]Leiden University

Despite the success of deep neural networks (DNNs) on an impressive range of tasks, they are generally treated as black boxes, with performance relying on heuristics and trial-and-error rather than any explanatory theoretical framework. Recently however, techniques and ideas from physics have been applied to DNNs in the hopes of distilling the underlying fundamental principles. In this talk, I will discuss some interesting parallels between DNNs and the renormalization group (RG). I will briefly reivew RG in the context of a simple lattice model, where subsequent RG steps are analogous to subsequent layers in a DNN, in that effective interactions arise after marginalizing hidden degrees of freedom/neurons. I will then quantify the intuitive idea that information is lost along the RG flow by computing the relative entropy in both the Ising model and a feedforward DNN. One finds qualitatively identical behaviour in both systems, in which the relative entropy increases monotonically to some asymptotic value. On the QFT side, this confirms the link between relative entropy and the c-theorem, while for machine learning, it may have implications for various information maximization methods, as well as disentangling compactness and generalizability.

MP 6.3 Wed 12:00 ZEU/0250

Analytic continuation of Greens' functions using neural networks — Johanna Erdmenger, René Meyer, Martin Rackl, and •Yanick Thurn — JMU Würzburg

In quantum many-body physics, the analytic continuation of Greens' functions is a well-known problem. The problem is ill-posed in the sense that the transformation kernel becomes chaotic for large energies and thus small noise creates huge differences in the resulting spectral density function. Some techniques in the field of machine learning, in particular neural networks, are known for handling this kind of problem. Using a neural network and for the problem-optimized loss functions and hyperparameters, a network is trained to determine the spectral density from the imaginary part of the Greens function given by quantum Monte Carlo simulations. The network is able to recover the overall form of the spectral density function, even without adding constraints such as normalization and positive definiteness. There is no need to encode these constraints as regularizations since they are reflected automatically by the solution provided by the network. This indicates the correctness of the inversion kernel learned by the neural network. In the talk, I will explain the structure of the methods used to train the network and highlight the central results.

MP 7: Classical and Quantum Gravity

Time: Wednesday 14:00–15:20 Location: ZEU/0250

MP 7.1 Wed 14:00 ZEU/0250

Geometry of charged rotating discs of dust in Einstein-Maxwell theory — •David Rumler — Friedrich-Schiller-Universität Jena, Germany

Within the framework of Einstein-Maxwell theory geometric properties of charged rotating discs of dust, using a post-Newtonian expansion up to tenth order, are discussed. Investigating the disc's proper radius and the proper circumference allows us to address questions related to the Ehrenfest paradox. In the Newtonian limit there is an agreement with a rotating disc from special relativity. The charged rotating disc of dust also possesses material-like properties. A fundamental geometric property of the disc is its Gaussian curvature. The result obtained for the charged rotating disc of dust is checked by additionally calculating the Gaussian curvature of the analytic limiting cases (charged rotating) Maclaurin disc, electrically counterpoised dust-disc and uncharged rotating disc of dust. We find that by increasing the disc's specific charge there occurs a transition from negative to positive curvature.

MP 7.2 Wed 14:20 ZEU/0250

A geometric view on local Lorentz transformations in teleparallel gravity — •Manuel Hohmann — University of Tartu, Estonia

Local Lorentz transformations play an important role in teleparallel gravity theories, in which a tetrad is conventionally employed as a fundamental field variable describing the gravitational field. It is commonly understood that modifications of general relativity in the teleparallel framework break a certain notion of local Lorentz invariance, which is present in the pure tetrad formulation of such theories, while another notion present in the covariant formulation is preserved. We illuminate these different notions from a geometric perspective, and distinguish them from what is commonly understood as breaking of local Lorentz invariance in the context of gravity phenomenology. Based on physical arguments, we present a geometric interpretation of the dynamical fields in teleparallel gravity, which unifies and refines the conventional approaches.

MP 7.3 Wed 14:40 ZEU/0250

Investigating Quantum Field Theory on Curved Spaces through Quantum Simulation — •Christian Friedrich Schmidt — Theoretisch-Physikalisches-Institut, Jena, Deutschland

In recent years, high-energy-phenomena like Hawking radiation or cosmological particle creation have been successfully simulated in laboratories by means of so-called quantum simulators. A prominent example among these are Bose-Einstein condensates, in which low-energetic (acoustic) fluctuations of the condensate wavefunction behave like a scalar quantum field on a curved spacetime. Excitations of this field are realized as phonons, which experience an effective, gravitational field set by the condensate background. The curved geometry is essentially realized through a time- and space-dependent speed of sound. In particular, a stationary background condensate yields an FLRW metric. Hence, this analogy gives an exciting opportunity to study phenomena of quantum fields in cosmological and also more general spacetimes in a controllable, experimental setup.

MP 7.4 Wed 15:00 ZEU/0250

Wilson Line approach to gravitational scattering of spinning particles — Domenico Bonocore[1], Anna Kulesza[2], and •Johannes Pirsch[2] — [1]Theoretische Elementarteilchenphysik, TUM, München, Germany — [2]Institut für Theoretische Physik, WWU Münster, Münster, Germany

Wilson lines provide a useful tool to reveal the all-order structure of scattering amplitudes. Recently it has been shown how a generalization that takes into account subleading eikonal effects (hence known as Generalized Wilson Line or GWL) clarifies the connection between the soft expansion in the Regge limit and the Post-Minkowskian expansion in the classical limit.

In this talk I will discuss the derivation of the spin 1/2 GWL starting from a N=1 supersymmetric worldline model. The resulting path integral expression exhibits a clear separation between purely classical and quantum contributions, which can conveniently be computed using Feynman diagrams in position space. Using this result, we are able to derive Low's soft theorem for off-shell gravitons and compute classical observables for spinning compact binaries.

MP 8: Members' Assembly

Time: Wednesday 16:00–17:30 Location: ZEU/0250

All members of the Theoretical and Mathematical Physics Division are invited to participate.

MP 9: AdS/CFT Correspondence and Hydrodynamic Transport

Time: Thursday 11:00–12:30 Location: ZEU/0250

MP 9.1 Thu 11:00 ZEU/0250

Ultraviolet-regulated theory of non-linear diffusion — •Matthias Kaminski[1] and Navid Abbasi[2] — [1]University of Alabama, Tuscaloosa, AL, U.S.A. — [2]School of Nuclear Science and Technology, Lanzhou University, Lanzhou, China

In a system with a single conservation law the inverse relaxation time plays the role of an ultraviolet (UV) regulator for the low energy diffusion of the conserved charge. In order to calculate renormalization effects through self-interactions stemming from fluctuations in such a system, we include the slowest non-conserved UV mode which relaxes at a system-specific relaxation time. Quantum fluctuations are computed in addition to statistical fluctuations for the first time in this framework. We show that the relaxation time is protected from renormalization while the diffusion constant is renormalized independent of the UV mode. Furthermore, the retarded Green*s function acquires four branch points, corresponding to threshold energies for generation of double-mode states from single diffusion or single UV modes. We report on the fate of long time tails in the current-current correlator, the dynamic susceptibility, and the conductivity. These results are relevant for the high temperature Hubbard model and also for the quark gluon plasma droplet near the critical point of quantum chromodynamics.

MP 9.2 Thu 11:30 ZEU/0250

Obtaining Transport Coefficients from Functional Renormalization Group Methods — •Tim Stötzel[1], Lars Heyen[2], and Stefan Flörchinger[1] — [1]Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, 07743 Jena, Germany — [2]Institut für Theoretische Physik, Universität Heidelberg, Philosophenweg 16, 69120 Heidelberg, Germany

The description of transport processes requires knowledge of their respective transport coefficients like viscosities or conductivities. Determining these quantities from a first principle approach can be done by the use of quantum field theories.

We make use of the well known Kubo formulas and apply them to a field theory at finite temperature in a non-perturbative approach. The transport coefficients can be derived by the use of renormalization group flow equations resulting in a flow equation for the near-equilibrium coefficients.

The method is applied to a massive, self-interacting scalar field and the shear viscosity is calculated for this toy model at finite temperature. We show a possible truncation ansatz for the Wetterich equation that generates a flow of the shear viscosity coefficient and comment on its relation to the properties of the microscopic theory.

MP 9.3 Thu 11:50 ZEU/0250

Critical and near-critical relaxation of holographic superfluids — •Mario Flory[1], Sebastian Grieninger[2], and Sergio Morales-Tejera[3] — [1]Institute of Theoretical Physics, Jagiellonian University, Lojasiewicza 11, 30-348 Krakow, Poland — [2]Center for Nuclear Theory, Department of Physics and Astronomy, Stony Brook University, NY 11794-3800, USA — [3]Instituto de Fisica Teorica UAM-CSIC, c/ Nicolas Cabrera 13-15, 28049, Madrid, Spain

We investigate the relaxation of holographic superfluids after quenches, when the end state is either tuned to be exactly at the critical point, or very close to it. By solving the bulk equations of motion numerically, we demonstrate that in the former case the system exhibits a power law falloff as well as an emergent discrete scale invariance. The later case is in the regime dominated by critical slowing down, and we show that there is an intermediate time-range before the onset of late time exponential falloff, where the system behaves similarly to the critical point with its power law falloff. We further postulate a phenomenological Gross-Pitaevskii-like equation that is able to make quantitative predictions for the behaviour of the holographic superfluid after near-critical quenches.

MP 9.4 Thu 12:10 ZEU/0250

Towards Explicit Discrete Holography: Aperiodic Spin Chains from Hyperbolic Tilings — Pablo Basteiro, Rathindra Nath Das, •Giuseppe Di Giulio, Johanna Erdmenger, Jonathan Karl, René Meyer, and Zhuo-Yu Xian — Julius-Maximilians-Universität Würzburg

The AdS/CFT correspondence is one of the most important breakthroughs of the last decades in theoretical physics. A recently proposed way to get insights on various features of this duality is achieved by discretizing the Anti-de Sitter spacetime. Within this program, we consider the Poincaré disk and we discretize it by introducing a regular hyperbolic tiling on it. The features of this discretization are expected to be identified in the quantum theory living on the boundary of the hyperbolic tiling. In this talk, we discuss how a class of boundary Hamiltonians can be naturally obtained in this discrete geometry via an inflation rule that allows constructing the tiling using concentric layers of tiles. The models in this class are aperiodic spin chains. Using strong-disorder renormalization group techniques, we study the entanglement entropy of these boundary theories, identifying a logarithmic growth in the subsystem size, with a coefficient depending on the bulk discretization parameters.

MP 10: AdS/CFT Correspondence II

Time: Thursday 14:00–15:20 Location: ZEU/0250

MP 10.1 Thu 14:00 ZEU/0250

Towards a Quantum Chaotic Dual of JT Gravity — •Fabian Haneder, Torsten Weber, Camilo Moreno, Juan Diego Urbina, and Klaus Richter — Universität Regensburg, Deutschland

Jackiw-Teitelboim (JT) quantum gravity is a two-dimensional model that has received a striking amount of attention in recent years as a simple example of holography, given its duality to the low-energy regime of the SYK model, as well as full perturbative equivalence to a matrix model found by Saad, Shenker and Stanford. We take first steps towards establishing a further duality between JT gravity and the chaotic quantum dynamics of a particle on a high dimensional compact manifold of constant negative curvature. The presence of a single system, instead of an ensemble, on the non-gravitational side of the duality allows us to identify possible degrees of freedom and corresponding mechanisms responsible for the quantum-chaotic features in JT gravity. We address key aspects of JT correlation functions by showing how the Schwarzian density of states, which bridges quantum gravity and disordered systems, such as SYK, is identical to the Weyl (smooth) term of the Selberg trace formula describing exactly the quantum spectrum on the compact manifold. Time permitting, we use periodic orbit theory to derive an effective trace formula over coarse-grained bundles of geodesics, and show that it admits a genus expansion structurally identical to the JT correlators.

MP 10.2 Thu 14:20 ZEU/0250

Aspects of Holography in Three-Dimensional Asymptotically Flat Space-times — •Michel Pannier — FSU Jena

A well-studied realisation of the Holographic Principle is provided by the AdS/CFT duality. However, Holography is expected to hold in rather general circumstances and should be extended to different examples, such as models containing asymptotically de Sitter or flat space-times. The latter is the idea of the talk, in particular focusing on the introduction of propagating, massive degrees of freedom to an otherwise purely topological three-dimensional theory of gravity. Particular emphasis is laid on the utilisation of techniques that are known from the study of higher-spin gravity as a Chern-Simons gauge theory.

MP 10.3 Thu 14:40 ZEU/0250

Geometric phases describing quantum systems with or without gravity — Souvik Banerjee[1,2], •Moritz Dorband[1,2], Johanna Erdmenger[1,2], and Anna-Lena Weigel[1,2] — [1]Institute for Theoretical Physics and Astrophysics, Julius-Maximilians-University Würzburg, 97074 Würzburg, Germany — [2]Würzburg-Dresden Cluster of Excellence ct.qmat

We discuss why the geometric phase is important to fully describe a quantum system, with or without gravity, by providing knowledge about the geometry and/or topology of its microscopic phase space. We illustrate this with several examples, ranging from a single spin in a magnetic field to Virasoro Berry phases and the geometric phase associated to the eternal black hole in AdS spacetime. We explain the relevance of this realisation with respect to the recent results on operator algebras in holography.

MP 10.4 Thu 15:00 ZEU/0250

On the Boundary Conformal Field Theory Approach to Symmetry-Resolved Entanglement — Giuseppe Di Giulio[1,2], René Meyer[1,2], Christian Northe[3,1,2], •Henri Scheppach[1,2], and Suting Zhao[1,2] — [1]Institute for Theoretical Physics and Astrophysics, Julius Maximilian University Würzburg, Am Hubland, 97074 Würzburg, Germany — [2]Würzburg-Dresden Cluster of Excellence on Complexity and Topology in Quantum Matter ct.qmat — [3]Department of Physics, Ben-Gurion University of the Negev, David Ben Gurion Boulevard 1, Be'er Sheva 84105, Israel

We study the symmetry resolution of the entanglement entropy of an interval in two-dimensional conformal field theories (CFTs), by studying the decomposition of the partition function into charge sectors of the respective symmetry in the presence of boundary conditions at the entangling points. Symmetry resolution provides a more refined entanglement measure and can therefore provide more information about the nature of quantum states in QFT. We demonstrate that the decomposition already provides the symmetry resolution of the entanglement spectrum of the corresponding bipartition. Considering the various terms of the partition function associated with the same charge sector the symmetry-resolved Rényi entropies can be derived to all orders in the UV cutoff expansion without the need to compute the charged moments. We apply this idea to the theory of a free massless boson with $U(1)$, $\mathbb{R}$ and $\mathbb{Z}_2$ symmetry. We find equipartition in the $U(1)$ and $\mathbb{R}$ cases to all orders in the cutoff expansion.

MP 11: Quantum Field Theory III (QED and Particle Detection)

Time: Thursday 16:00–17:00 Location: ZEU/0250

MP 11.1 Thu 16:00 ZEU/0250

Asymptotic Completeness and Particle Detectors in Quantum Field Theory — •Janik Kruse — Adam Mickiewicz University in Poznań, Poland

A quantum field theory is asymptotically complete if every quantum state is a scattering state (i.e. a state that allows a particle interpretation). A physical criterion that is known to be necessary and sufficient for asymptotic completeness is the detector criterion: A quantum field theory is asymptotically complete if and only if every quantum state causes a click in some particle detector. In this talk, I will explain why particle detectors do not detect non-scattering states and how this result could be used to characterise asymptotically complete theories by more fundamental criteria than the detector criterion.

MP 11.2 Thu 16:20 ZEU/0250

Electron-Positron Pair Production in High-Intensity Electromagnetic Fields — •Christian Kohlfürst[1], Naser Ahmadiniaz[1], Johannes Oertel[2], and Ralf Schützhold[1,3] — [1]Helmholtz-Zentrum Dresden-Rossendorf, 01328 Dresden, Germany — [2]Universität Duisburg-Essen, 47057 Duisburg, Germany — [3]Technische Universität Dresden, 01062 Dresden, Germany

In ultra-strong electric fields energy in terms of photons can be converted into electrons and positrons. We introduce a novel approach to calculate the mean particle number in collisions of short-pulsed laser fields. In this regard, we further discuss the different regimes of pair production in terms of their unique signatures in particle phase-space and relate our findings to currently ongoing experiments.

Reference: [1] Christian Kohlfürst, Naser Ahmadiniaz, Johannes Oertel, Ralf Schützhold, Sauter-Schwinger effect for colliding laser pulses, arXiv:2107.08741 [hep-ph], to appear in Physical Review Letters.

MP 11.3 Thu 16:40 ZEU/0250

Pair production spectrum in a space-time dependent field from worldline instantons — •Gianluca Degli Esposti[1] and Greger Torgrimsson[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstraße 400, 01328 Dresden, Germany — [2]Department of Physics, Umeå University, SE-901 87 Umeå, Sweden

The Worldline Formalism has proven to be an efficient tool for the computation of scattering amplitudes in a number of interesting cases. In the context of Strong-Field QED, it provides a useful representation of the full propagator in a background electromagnetic field, and in the present work, we use such representation in the LSZ reduction formula to compute the pair production spectrum in a space-time dependent electric field.

Unlike the closed-loop method that provides the total integrated probability from the effective action using unitarity, we work with the LSZ on the amplitude level, which allows us to obtain the spectrum. We use the saddle-point approximation to obtain a semiclassical result.

The instantons are the saddle points of the path integral. They represent tunneling near the turning point and free real particles asymptotically. We find such instantons numerically by solving the Lorentz force equation.

MP 12: Quantengravitation und Thermodynamik

Time: Thursday 17:05–17:45 Location: ZEU/0250

MP 12.1 Thu 17:05 ZEU/0250

Allgemeine Gastheorie vs. kinetische Gastheorie — •Grit Kalies[1], Steffen Arnrich[1] und Duong D. Do[2] — [1]HTW University of Applied Sciences, Dresden, Germany — [2]The University of Queensland, Brisbane, Australia

Die moderne Physik basiert auf Newtons Bewegungsgesetzen, welche die Wechselwirkung über Kräfte beschreiben. Durch Einführung der Impulsänderungsarbeit [1,2] schlagen wir eine vereinheitlichte Formulierung von Prozessgleichungen vor und schneiden Newtons Axiome auf Prozesse zu. Indem die elastische Kollision zweier Objekte als zeitliche Abfolge von jeweils zwei Simultanprozessen beschrieben wird, wird physikalisch erklärbar, dass die Energieerhaltung zu jedem Zeitpunkt gilt, auch bei v = 0 der Objekte am Umkehrpunkt der Bewegung. In der zweiten Hälfte des 19. Jahrhunderts nutzten Maxwell und Boltzmann Newtons Axiome, um das ideale Gas und dessen Druck und Temperatur mikroskopisch zu deuten. Nach der kinetischen Gastheorie (KGT) besitzt das ideale Gas nur kinetische Energie. Wir zeigen, dass die KTG den Energieinhalt des idealen Gases weit unterschätzt, und präsentieren die allgemeine Gastheorie (AGT) als experimentell bestätigt und als Grundlage für eine vereinheitlichte Wechselwirkungstheorie.

1. G. Kalies, Z. Phys. Chem. 236 (2022) 481-533. 2. G. Kalies, S. Arnrich, D.D. Do: Coherent process equations in mechanics and thermodynamics, submitted 11/2022.

MP 12.2 Thu 17:25 ZEU/0250

Konzept Dimensionale Physik: Konstruktion einer Raumzeitdichte zur Vereinigung von ART und QM — •Christian Kosmak — Working Group Dimensional Physics, Würzburg

Im Konzept Dimensionale Physik heben sich der Energie- Impuls-Tensor und der Einstein-Tensor auf. Daraus resultiert eine *Raumzeitdichte*, welche die Allgemeine Relativitätstheorie (ART) und die Quantenmechanik (QM) vereinigt. Es werden alle Prinzipien der ART aus dieser *Raumzeitdichte* abgeleitet Diese Raumzeitdichte ist in der eigenen Raumzeit nicht direkt feststellbar. Feststellbar ist die Raumzeitdichte nur in Verbindung mit nieder-dimensionalen Raumzeiten. Dies stellt die Verbindung zur QM her. Die verschieden dimensionalen Raumzeiten sind über den Raum (nicht Raumzeit) als Untermannigfaltigkeit verbunden. Die Raumzeitdichte wurde aus der höher-dimensionalen Raumzeit der nieder-dimensionalen Raumzeit aufgeprägt und besitzt in der nieder-dimensionalen Raumzeit keine Dynamik. In der Dimensionalen Physik stellen die Raumzeitdichten alle Objekte des Standardmodells, auf verschiedene nieder-dimensionale geometrische Abbildungen aufgeteilt, dar. Alle Quantenfelder werden durch die verschiedenen Kombinationen der Raumzeiten ersetzt. Damit sind alle Objekte und Grundkräfte des Standardmodells eine geometrische Abbildung in den Raumzeiten. Die Raumzeit ist nicht nur eine dynamische Bühne, sondern der einzige Akteur. https://dimensionale-physik.de/

Plasma Physics Division
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Liebe Kolleginnen und Kollegen,

nach drei Jahren Pandemie ist es mir eine große Freude, Sie alle wieder zu einer DPG-Tagung in Präsenz zu begrüßen. Es ist das erste Mal, dass wir als Fachverband mit der gesamten Sektion SMuK tagen, von der wir so freundlich und offen aufgenommen wurden. Dank der Vorschläge aus dem Fachbeirat und der zahlreichen Beitragsanmeldungen ist wieder ein interessantes Programm entstanden. Ich hoffe, Sie können – trotz der schwierigen Zeiten in der Welt – den Austausch untereinander, aber auch das wunderschöne Dresden genießen.

Ich verabschiede mich mit dieser Tagung als Sprecher aus dem Fachbeirat und übergebe die Aufgabe an Prof. Jan Benedikt von der Universität Kiel. Ich möchte mich an dieser Stelle bei allen Mitgliedern des Fachbeirates für die stets vertrauensvolle und konstruktive Mitarbeit bedanken.

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Dear colleagues,

after three years of pandemic, it is a great pleasure for me to welcome you all again to a DPG meeting in presence. It is the first time that we meet with the entire section SMuK, from which we were received so friendly and openly. Thanks to the suggestions from the advisory board and the numerous applications for contributions, an interesting program has again been created. I hope you can enjoy – despite the difficult times in the world – the scientific exchange and meetings but also the beautiful city of Dresden.

With this conference I retire as the speaker from the advisory board and hand over to Prof. Jan Benedikt from the University of Kiel. I would like to take this opportunity to thank all members of the advisory board for their ever trusting and constructive cooperation.

Ronny Brandenburg

Overview of Invited Talks and Sessions

(Lecture halls CHE/0089 and CHE/0091; Poster HSZ EG)

Invited Talks

P 1.1	Mon	11:00–11:30	CHE/0089	**Ion Beam Sputter Deposition – Fundamentals and Applications** — •Carsten Bundesmann
P 2.1	Mon	11:00–11:30	CHE/0091	**Deuterium-Tritium Plasmas at JET with ITER-like Wall and the Role of Isotope Mass and Transport for H-mode Access** — •Gregor Birkenmeier, JET Contributors
P 5.1	Tue	11:00–11:30	CHE/0089	**Diagnostics of metal-grid micro cavity plasma arrays** — •Marc Böke, David Steuer, Sebastian Dzikowski, Henrik van Impel, Volker Schulz-von der Gathen, Judith Golda
P 6.1	Tue	11:00–11:30	CHE/0091	**The physics of ELM-free regimes** — •Michael Dunne, Michael Faitsch, Georg Harrer, Lidija Radovanovic, Wolfgang Suttrop, Eleonora Viezzer, Matthias Willensdorfer, Elisabeth Wolfrum
P 8.1	Tue	17:00–17:30	CHE/0091	**Fuel retention and removal in the JET tokamak** — •Dmitry Matveev, David Douai, Tom Wauters, Sebastijan Brezinsek, JET Contributors
P 9.1	Wed	11:00–11:30	CHE/0089	**Modelling and analysis of single-filament dielectric barrier discharges at atmospheric pressure** — •Markus M. Becker, Ronny Brandenburg, Tomáš Hoder, Hans Höft, Aleksandar P. Jovanović, Detlef Loffhagen
P 10.1	Wed	11:00–11:30	CHE/0091	**Diagnosing the plasma edge with helium beam spectroscopy** — •Michael Griener, the ASDEX Upgrade Team
P 13.1	Thu	11:00–11:30	CHE/0089	**Acceleration of spin-polarized ion beams from laser-plasma interaction** — •Lars Reichwein, Markus Büscher, Alexander Pukhov

P 14.1	Thu	11:00–11:30	CHE/0091	**Experimental validation of turbulence codes** — •Klara Höfler
P 15.1	Thu	14:00–14:30	CHE/0089	**Tumor irradiation in mice with a laser-accelerated proton beam** — •Florian Kroll, Florian-Emanuel Brack, Elke Beyreuther, Thomas Cowan, Leonhard Karsch, Josefine Metzkes-Ng, Jörg Pawelke, Marvin Reimold, Ulrich Schramm, Tim Ziegler, Karl Zeil
P 16.1	Thu	14:00–14:30	CHE/0091	**Development of a Laser-based Diagnostic for in situ Monitoring of Fuel Retention in ITER and future fusion devices** — •Alexander Huber, M. Zlobinski, G. Sergienko, J. Assmann, D. Castano, S. Friese, I. Ivashov, Y. Krasikov, H. Lambertz, Ph. Mertens, K. Mlynczak, M. Schrader, A. Terra, S. Brezinsek, Ch. Linsmeier
P 19.1	Thu	17:30–18:00	CHE/0089	**Numerical and experimental investigations of a linear microwave plasma source for metal foil pumps for DEMO** — •Stefan Merli, Andreas Schulz, Matthias Walker, Yannick Kathage, Stefan Hanke, Christian Day, Günter Tovar
P 20.1	Thu	17:30–18:00	CHE/0091	**Laser-Induced Breakdown Spectroscopy (LIBS) for the detection of hydrogen isotopes stored in high-Z metals tungsten and tantalum** — •Steffen Mittelmann, Kévin Touchet, Xianglei Mao, Minok Park, Vassilia Zorba, Sebastijan Brezinsek, Georg Pretzler

Sessions

P 1.1–1.6	Mon	11:00–12:45	CHE/0089	**Low Pressure Plasmas and their Application I**
P 2.1–2.5	Mon	11:00–13:10	CHE/0091	**Magnetic Confinement I/HEPP I**
P 3.1–3.5	Mon	16:30–17:45	CHE/0089	**Astrophysical Plasmas**
P 4.1–4.5	Mon	16:30–18:35	CHE/0091	**HEPP II**
P 5.1–5.7	Tue	11:00–13:00	CHE/0089	**Atmospheric Pressure Plasmas and their Applications I**
P 6.1–6.5	Tue	11:00–12:50	CHE/0091	**Magnetic Confinement II/HEPP III**
P 7.1–7.8	Tue	17:00–19:00	CHE/0089	**Atmospheric Pressure Plasmas and their Applications III**
P 8.1–8.7	Tue	17:00–19:10	CHE/0091	**Plasma Wall Interaction I/HEPP IV**
P 9.1–9.7	Wed	11:00–13:00	CHE/0089	**Atmospheric Pressure Plasmas and their Applications III**
P 10.1–10.5	Wed	11:00–13:10	CHE/0091	**Magnetic Confinement III/HEPP V**
P 11.1–11.48	Wed	14:00–15:30	HSZ EG	**Poster I**
P 12.1–12.45	Wed	17:30–19:00	HSZ EG	**Poster II**
P 13.1–13.7	Thu	11:00–13:00	CHE/0089	**Laser Plasmas I**
P 14.1–14.5	Thu	11:00–13:10	CHE/0091	**Magnetic Confinement IV/HEPP VI**
P 15.1–15.5	Thu	14:00–15:30	CHE/0089	**Laser Plasmas II/Low Pressure Plasmas and their Applications II**
P 16.1–16.5	Thu	14:00–15:30	CHE/0091	**Plasma Wall Interaction II/Codes and Modeling I**
P 17.1–17.6	Thu	15:45–17:15	CHE/0089	**Complex Plasmas and Dusty Plasmas/Codes and Modeling II**
P 18.1–18.3	Thu	15:45–17:00	CHE/0091	**HEPP VII**
P 19.1–19.3	Thu	17:30–18:40	CHE/0089	**Magnetic Confinement V/HEPP VIII**
P 20.1–20.4	Thu	17:30–18:45	CHE/0091	**Laser Plasmas III/Codes and Modeling III**
P 21	Thu	19:00–20:00	CHE/0089	**Members' Assembly**

Members' Assembly of the Plasma Physics Division (Mitgliederversammlung P)

Donnerstag, 23.03.23 19:00–20:00 Raum CHE/0089

- Bericht
- Wahl neuer Fachbeiratsmitglieder
- Tagung 2024, Verschiedenes

Sessions

– Invited Talks, Contributed Talks, and Posters –

P 1: Low Pressure Plasmas and their Application I

Time: Monday 11:00–12:45 Location: CHE/0089

Invited Talk P 1.1 Mon 11:00 CHE/0089

Ion Beam Sputter Deposition – Fundamentals and Applications — •Carsten Bundesmann — Leibniz Institute of Surface Engineering (IOM), Leipzig

There is an increasing demand for thin films with tailored properties, which requires the use and control of adequate deposition techniques. Ion beam sputter deposition (IBSD) is a PVD technique that is capable of fulfilling the technological challenges. It is based on ion-solid interaction: A low-energy ion beam (Eion ~ 2000 eV) is directed onto a target and target particles get sputtered due to energy and momentum transfer [1]. These particles condense on a substrate and a film is growing (see Fig. 1). In addition, scattered primary particles and reactive background gas particles may contribute to thin film growth. In comparison to other PVD techniques, IBSD offers a unique opportunity to tailor angular-dependent energy and flux of the film-forming particles and, hence, thin film properties by changing ion beam parameters (ion species and ion energy) and geometrical parameters (ion incidence angle and emission angle).

Using selected examples, this talk describes the systematics, including pros and cons, of IBSD: The correlation between process parameters, properties of the film-forming particles, and thin film properties. The most important process parameters are the scattering geometry and the primary particle species. Depending on the material, different film properties can be influenced. Examples are adhesion, structural properties, composition, surface roughness, mass density, optical properties, stress, and electrical resistivity.

[1] C. Bundesmann, H. Neumann, J. Appl. Phys. 124 (2018) 231102.

P 1.2 Mon 11:30 CHE/0089

On the role of the Poisson-Boltzmann equation in the modeling of high-power magnetrons — Kevin Köhn, Dennis Krüger, Denis Eremin, Liang Xu, and •Ralf Peter Brinkmann — Ruhr University Bochum, Theoretical Electrical Engineering

The Poisson-Boltzmann equation is a nonlinear differential equation that describes equilibria of conducting fluids. Using a variation principle based on the balances of particle number, entropy, and electromagnetic enthalpy, it can also be justified for a wide class of unmagnetized technological plasmas [Köhn et al., PSST 30, 105014 (2021)].

This study aims to extend the variation principle to magnetized discharges as used in high-power pulsed magnetron sputtering (HiPIMS). The example in focus is that of a high power circular magnetron. The discharge chamber and the magnetic field are assumed to be axisymmetric; the plasma dynamics need not share this symmetry. The domain is divided into the region of confinement, where the electrons can escape from their magnetic field lines only by slow processes such as drift and diffusion, and the remainder where the electrons are effectively free. A distinction is made between a fast thermodynamic and a slow dissipative regime. A variational principle is established for the fast regime which is similar in logic to its counterpart for unmagnetized plasmas but accounts for magnetic confinement by treating the individual flux tubes of the confinement domain as separate thermodynamic units. The resulting solutions obey a generalized Poisson-Boltzmann relation; they are thermodynamic equilibria of the fast regime but must be interpreted as dissipative structures in the slow regime.

P 1.3 Mon 11:45 CHE/0089

Plasma-modified $NiCo_2O_4$ nanowires with abundant oxygen vacancies as electrocatalyst for the oxygen evolution reactions — •He Li[1], Sadegh Askari[2], and Jan Benedikt[1] — [1]Institute for Experimental and Applied Physics, Kiel University, Kiel, Germany — [2]Department of Fiber and Polymer Technology, KTH Royal Institute of Technology, Stockholm, Sweden

The development of highly active and stable electrocatalysts for the oxygen evolution reaction (OER) is critical for the applications such as water splitting or production of rechargeable zinc-air batteries. Oxygen vacancy engineering has demonstrated great promises to regulate the OER performances of transition metal compounds. However, the facile and effective generation of oxygen vacancies is still a challenge. Herein, we fabricated a $NiCo_2O_4$ nanowire catalyst by the hydrothermal method and generated oxygen vacancies with various concentrations by Ar or H_2/Ar plasma treatment. The reactive radicals generated by plasma reduce the valence of metal ions in the oxides and create oxygen vacancy defects with high electrocatalytic activity. The H_2/Ar plasma-treated $NiCo_2O_4$ presents more surface oxygen vacancies and thus better electrocatalytic performance for OER. Our work offers a facile and efficient route to design efficient OER electrocatalysts for zinc-air batteries.

P 1.4 Mon 12:00 CHE/0089

Experimental validation of a 0-D computational model for characterisation of double inductively coupled plasma — •J. Jenderny[1], M. Osca Engelbrecht[3], H. Hylla[1,2], I. Korolov[1], D. Filla[1], L. Schücke[1,2], C. P. Ridgers[3], P. Awakowicz[1], and A. R. Gibson[2] — [1]Chair of Applied Electrodynamics and Plasma Technology, Ruhr-University Bochum, Bochum, Germany — [2]Research Group for Biomedical Plasma Technology, Ruhr-University Bochum, Bochum, Germany — [3]York Plasma Institute, Department of Physics, University of York, York, UK

A double inductively coupled plasma is studied to be compared to 0-D plasma chemical kinetics simulations. A focus is placed on oxygen-containing gas mixtures due to their ability to produce large fluxes of reactive species such as atomic oxygen and UV photons. Various experimental diagnostic methods are applied. A multipole resonance probe is used to measure electron densities and electron temperatures radially resolved. Tuneable diode laser absorption spectroscopy is used to measure the absorption profile of the transition Ar ($1s_5 \rightarrow 2p_6$) at 772.376 nm to yield gas temperatures. Absolutely calibrated optical emission spectroscopy is used to determine the absolute intensities of different O transitions. These values are compared to those obtained from a 0-D computational model. The model includes electron densities and a collisional radiative treatment of excited states of O. It is then used to provide information on the flux of photons at 130 and 135 nm. This work was funded by DFG project "Plasma inactivation of microbial Biofilms", project number 424927143.

P 1.5 Mon 12:15 CHE/0089

Modeling electromagnetic phenomena in CCP VHF plasmas with an electromagnetic PIC-MCC code — •Denis Eremin[1], Thomas Mussenbrock[2], and Ralf Peter Brinkmann[1] — [1]Institute of Theoretical Electrical Engineering, Ruhr University Bochum, Bochum, Germany — [2]Institute of Applied Electrodynamics and Plasma Technology, Ruhr University Bochum, Bochum, Germany

Increasing the electrode radius and the driving frequency would be beneficial for industrial applications of the capacitively coupled plasma reactors operated at low pressures. Unfortunately, this leads to the emergence of various nonuniformities having detrimental effects on the processing quality. The underlying physics is related to the excitation of two types of surface modes interacting with electrons and energizing them through different mechanisms. The present work investigates this problem numerically with a novel implicit energy- and charge-conserving electromagnetic PIC code ECCOPIC2M. It is demonstrated that due to the observed complexity of the processes taking place in such devices, the particle-in-cell method seems to be the only means potentially suitable for predictive studies of the plasma uniformity in CCPs in the considered parameter range.

P 1.6 Mon 12:30 CHE/0089

Investigation of capacitively coupled radio frequency Ar/CF_4 discharges using a hybrid PIC/MCC simulation — •Katharina Nösges, Maximilian Klich, Sebastian Wilczek, and Thomas Mussenbrock — Ruhr University Bochum, Germany

Capacitively coupled radio frequency (CCRF) discharges are used in many dry etching processes in the semiconductor industry to realize micro- and nanometer-scale electronics. Low pressures of a few Pascal and voltages of about hundreds of volts are required to ensure anisotropic ion bombardment. Especially carbon tetrafluoride (CF_4) and mixed (Ar/CF_4) discharges are particularly important for etching. These discharges are investigated using a one-dimensional hybrid particle-in-cell/Monte Carlo collisions (PIC/MCC) simulation in the low-pressure regime (p = 6.67 Pa) with the inclusion of realistic particle-surface interactions. This approach considers the electrons kinetically and simultaneously solves the continuity equation based on the drift-diffusion approximation for all ion species. The transport coefficients, as well as the rate coefficients, can be determined with the help of swarm simulations. A closed group of particles moves in a background gas influenced by an externally applied constant electric field. The collective behavior gives information about transport features and collision probabilities. A variation of the electrode gap size and the applied voltage is then presented as a control tool to alter the discharge dynamics significantly. Additionally, it is shown that surface coefficients (i. e., electron reflection, and secondary electron emission) play a significant role.

P 2: Magnetic Confinement I/HEPP I

Time: Monday 11:00–13:10 Location: CHE/0091

Invited Talk P 2.1 Mon 11:00 CHE/0091

Deuterium-Tritium Plasmas at JET with ITER-like Wall and the Role of Isotope Mass and Transport for H-mode Access — •Gregor Birkenmeier[1,2] and JET Contributors[3] for the JET L-H Transition Team-Collaboration — [1]Max Planck Institute for Plasma Physics, Garching — [2]Physik-Department, Technical University Munich, Garching — [3]See J. Mailloux et al 2022 Nucl. Fus. 62 042026

More than 20 years after the last deuterium-tritium (D-T) experiments in magnetic confinement fusion research, the largest operating tokamak in the world, the Joint European Torus (JET) in Culham, UK, was operated with the reactor relevant D-T fuel mixture during the 2020/2021 experimental campaign. The experiments demonstrated that reactor relevant plasma scenarios can be successfully operated in metallic wall conditions and the record of controlled fusion energy production of 59 MJ was achieved in a steady plasma over five seconds. The experiments confirmed simulations of reactor-relevant plasma performance building confidence, that next step devices like ITER will perform as predicted. In addition to experiments maximizing the fusion power, further experiments in tritium containing plasmas allowed to study isotope effects in unprecedented detail. As one striking example, it was found that the power threshold to access the high confinement regime, which is considered as being mandatory for a sufficient performance of a reactor plasma, shows an unexpected isotope dependence in isotope mixtures. After the presentation of the highlights of recent D-T experiments, an explanation for the observed isotope effects is given and its impact on modelling is discussed.

P 2.2 Mon 11:30 CHE/0091

Experimental and numerical investigation of helium exhaust at the ASDEX Upgrade tokamak with full-tungsten wall — •Antonello Zito[1,2], Marco Wischmeier[1], Athina Kappatou[1], Arne Kallenbach[1], Francesco Sciortino[1], Volker Rohde[1], Klaus Schmid[1], Edward Hinson[3], Oliver Schmitz[3], Marco Cavedon[4], Rachael McDermott[1], Ralph Dux[1], Michael Griener[1], and Ulrich Stroth[1,2] — [1]Max-Planck-Institut für Plasmaphysik — [2]Physik-Department E28, Technische Universität München — [3]University of Wisconsin-Madison — [4]Dipartimento di Fisica "G. Occhialini", Università di Milano-Bicocca

An efficient removal of helium ash by active pumping in future fusion devices is necessary to avoid fuel dilution and not degrade plasma confinement. Therefore, a deep understanding of the underlying physics mechanisms is mandatory. Helium recycling and pumping has been experimentally investigated at the ASDEX Upgrade tokamak. The time evolution of helium following a small injection during otherwise steady-state deuterium discharges was measured spectroscopically both in the core plasma and in the neutral exhaust gas. The exhaust efficiency was found to improve with increasing divertor neutral pressures, but to degrade with detachment. A multi-reservoir particle balance model was developed to interpret the observed exhaust dynamics. The limited performance of the pumping system and an efficient helium storage capability of the tungsten wall were identified to have a strong impact on the exhaust dynamics. The SOLPS-ITER code was used to interpret the observed He transport towards the divertor.

P 2.3 Mon 11:55 CHE/0091

Introduction and Uncertainty Quantification of Kinetic Models in the Integrated Data Analysis Framework — •Michael Bergmann[1], Kislaya Ravi[2], Rainer Fischer[1], Clemente Angioni[1], Klara Höfler[1], Pedro Molina Cabrera[3], Tobias Görler[1], Roberto Bilato[1], and Frank Jenko[1,2] — [1]Max-Planck-Institute für Plasmaphysik — [2]TUM (CIT) — [3]École Polytechnique Fédérale de Lausanne, Switzerland

Using a combined analysis of multiple diagnostics as well as Bayesian probability theory the Integrated Data Analysis (IDA) infers elec- tron density and temperature profiles of ASDEX Upgrade plasmas and is the standard against which simulations are validated. As the diag- nostics do not cover the entire plasma or may be unavailable IDA con- siders a variety of non-physics-based priors. The resulting profiles may not be in accordance with theories best expectations e.g. may have gra- dients which drive too high turbulent transport. Using the transport solvers ASTRA coupled with the quasi-linear turbulence code TGLF we have created a loop in which simulated profiles are fed back into IDA as another prior thus providing constraints about the physically reasonable parameter space. For now the uncertainty of the simulation is given by the user, however we will discuss several ideas for a more complete uncertainty quantification such as input error propagation and comparison to the high-fidelity turbulence solver GENE.

P 2.4 Mon 12:20 CHE/0091

Analysis and modeling of momentum transport based on NBI modulation experiments at ASDEX Upgrade — •Benedikt Zimmermann[1,2], Rachael McDermott[1], Clemente Angioni[1], Basil Duval[4], Ralph Dux[1], Emiliano Fable[1], Antti Salmi[3], Ulrich Stroth[1,2], Tuomas Tala[3], Giovanni Tardini[1], Thomas Pütterich[1], and the ASDEX Upgrade Team[5] — [1]Max Planck Institute for Plasma Physics, 85748 Garching, Germany — [2]Physik-Department E28, Technische Universität München, 85747 Garching, Germany — [3]VTT, P.O. Box 1000, FI-02044 VTT, Finland — [4]EPFL, Swiss Plasma Center, CH-1015 Lausanne, Switzerland — [5]see the author list of U. Stroth et al. 2022 Nucl. Fusion 62 042006

Understanding momentum transport is crucial to reliably predict the plasma rotation profiles in future fusion devices. At ASDEX Upgrade, momentum transport studies are used to validate theoretical models and transport codes. An advanced momentum transport analysis framework uses NBI modulation to extract the contribution of diffusion, convection, and intrinsic torque to momentum transport within the core plasma. Recent work focused on a possible mass dependence by comparing hydrogen and deuterium plasmas. Both momentum transport coefficients were found to be the same within error bars indicating no significant mass dependence. Gyrokinetically predicted Prandtl number and pinch number agree with the experimental results. Furthermore, a robust error analysis quantified the uncertainties of the assessed coefficients and the uniqueness of the determined solution in the scanned parameter range.

P 2.5 Mon 12:45 CHE/0091

Neutral gas pressure gauges for current and future fusion devices — •Bartholomäus Jagielski[1,2], Uwe Wenzel[1], Dirk Naujoks[1], Felix Mackel[1], Thomas Sunn Pedersen[1], and and the W7-X team[1] — [1]Max Planck Institute for Plasma Physics, Germany — [2]Universität Greifswald, Institut für Physik, Greifswald, Germany

Pressure gauges emplyoing helical tungsten-wire emitters suffer from the Lorentz force in strong magnetic fields. In consequence, for fusion devices, conventional pressure gauges do not work reliably, or at all when operated within specified duration of plasma operation. As an alternative, rod shaped emitters are more robust in strong magnetic fields and may sustain long-pulse operation.

We report on the performance of the ionization gauges, equipped with lanthanum hexaboride, zirconium carbide or tungsten emitter, tested in a purpose built laboratory and operated in the stellarators W7-X and LHD. During the second Wendelstein 7-X campaign, 18 manometers equipped with LaB6 cathodes are used to measure the neutral gas pressure at different positions. Early experiments show robust operation up to 900s. The gauges reveal a magnetic field dependence of the ion current and sudden jumps of the electron- and ion current limit the operation over the whole pressure region from 10^{-7} mbar to 10^{-2} mbar. Along with a basic characterization of the latter, measurements under new record conditions and the impact of limitation on the design of the instruments are discussed. Operation in different magnetic field strengths and working gases are examined.

P 3: Astrophysical Plasmas

Time: Monday 16:30–17:45 Location: CHE/0089

P 3.1 Mon 16:30 CHE/0089

Energy conversion by magnetic reconnection in multiple ion temperature plasmas — •Jeremy Dargent[1], Sergio Toledo-Redondo[2], Andrey Divin[3], and Maria Elena Innocenti[1] — [1]Institut für Theoretische Physik, Ruhr-Universität Bochum, Bochum, Germany — [2]Department of Electromagnetism and Electronics, University of Murcia, Murcia, Spain — [3]St. Petersburg, Russia

Magnetic reconnection is one of the most efficient plasma process to convert magnetic energy into kinetic energy. In this work, we study the impact of the microscopic distribution function on the energy budget of symmetric magnetic reconnection in collisionless plasmas. We run two two-dimensional semi-implicit PIC simulations of symmetric reconnection with the same global parameters, but with different ion distribution functions: one simulation is loaded using Maxwellian distributions, while the other is the sum of two Maxwellian distributions, a hot one and a cold one, resulting in a very peaked distribution with large tails. We measure the evolution of the bulk and thermal kinetic energies in both simulations for each population and compare it to the loss of magnetic energy through a contour surrounding the ion diffusion region. We show that the global energy budget for ions and electrons does not change depending on the distribution function of the plasma, but also that, when focusing on sub-populations, the hot ion population gains more energy than the cold ion population and that the distribution of the energy gain between kinetic and thermal energy also depends on the initial temperature.

P 3.2 Mon 16:45 CHE/0089

Ionization and transport in partially ionized multicomponent plasmas: Atmospheres of hot Jupiters — Sandeep Kumar[1,2], Anna Julia Poser[1], Manuel Schöttler[1], Uwe Kleinschmidt[1], Wieland Dietrich[3], Johannes Wicht[3], Martin French[1], and •Ronald Redmer[1] — [1]Universität Rostock, Institut für Physik, D-18051 Rostock — [2]CASUS, D-02826 Görlitz — [3]MPI for Solar System Research, D-37077 Göttingen

We study ionization and transport processes in partially ionized multicomponent plasmas [1]. The plasma composition is calculated via a system of coupled mass-action laws. The electronic transport properties are determined by the electron-ion and electron-neutral transport cross sections. The electrical and thermal conductivities as well as the Lorenz number are calculated. For the thermal conductivity, we consider also the contributions of the translational motion of neutral particles and of the dissociation, ionization, and recombination reactions. We apply our approach to plasma conditions as typical for atmospheres of hot Jupiters such as HD 209458b. The electrical conductivity profile allows revising the Ohmic heating power related to the fierce winds in the planet's atmosphere in order to explain the observed inflation of HD 209458b. The model is also applied to study possible induction processes in the atmosphere of ultra-hot Jupiters like KELT-9b [2].

[1] S. Kumar et al., Phys. Rev. E 103, 063203 (2021)
[2] W. Dietrich et al., MNRAS 517, 3113 (2022)

P 3.3 Mon 17:00 CHE/0089

M^5 - Mars Magnetospheric Multipoint Measurement Mission: A multi-spacecraft plasma physics mission to Mars — •Cormac Larkin — Max Planck Institut fuer Kernphysik, Heidelberg, Germany — Astronomisches Rechen-Institut, Heidelberg, Germany

We propose the Mars Magnetospheric Multipoint Measurement Mission (M5), a multi-spacecraft mission to study the dynamics and energy transport of the Martian magnetosphere. Particular focus lies on the largely unexplored magnetotail region, where signatures of magnetic reconnection of the Interplanetary Magnetic Field (IMF) have been found. Further, to study the dynamics of the Martian magnetosphere depending on the upstream solar wind conditions, knowledge of those is needed. Finally, to resolve the three-dimensional structure of the Martian magnetosphere and make use of multipoint data analysis techniques, multipoint measurements are required. As a result, M5 is a five spacecraft mission, with one solar wind monitor orbiting Mars in a circular orbit, and four smaller spacecraft in a tetrahedral configuration orbiting Mars in an elliptical orbit. We present a detailed assessment not only of the scientific need for such a mission but also show the resulting mission and spacecraft design taking into account all aspects of systems engineering as well as spacecraft budgets like mass and data rate. The mission outlined in this abstract was developed during the ESA Alpbach Summer School 2022 on the topic of "Comparative Plasma Physics in the Universe".

P 3.4 Mon 17:15 CHE/0089

Berechnung elektronischer Transportkoeffizienten von Wasserstoffplasma mit Dichtefunktionaltheorie — •Martin French[1], Gerd Röpke[1], Maximilian Schörner[1], Mandy Bethkenhagen[1,2], Michael Desjarlais[3] und Ronald Redmer[1] — [1]Universität Rostock, Institut für Physik, D-18051 Rostock — [2]École Normale Supérieure, Université Lyon 1, Lyon, France — [3]Sandia National Laboratories, Albuquerque, USA

Dichtefunktionaltheorie (DFT) ist eine weit verbreitete Methode, um stark gekoppelte Coulombsysteme quantenmechanisch zu beschreiben. Die Berechnung von Transporteigenschaften erfolgt dabei über den Kubo-Greenwood-Formalismus [1]. Eine bislang kontrovers diskutiere Fragestellung ist, ob die Mean-Field-Beschreibung von Elektronen mit DFT den Einfluss von Elektron-Elektron-Stößen korrekt erfassen kann [2]. Diese Frage kann durch die Berechnung elektronischer Transportkoeffizienten im schwach gekoppelten und nicht entarteten Grenzfall beantwortet werden, für den exakte Grenzwerte aus der Spitzer-Theorie bekannt sind. Wir stellen entsprechende Ergebnisse von DFT-Rechnungen zur Thermokraft und Lorenz-Zahl vor und zeigen, dass Elektron-Elektron-Streuprozesse nicht mit dem Kubo-Greenwood-Formalismus in der DFT erfassbar sind [3].

[1] B. Holst, M. French, and R. Redmer, Phys. Rev. B 83, 235120 (2011). [2] M. P. Desjarlais et al., Phys. Rev. E 95, 033203 (2017); H. Reinholz et al., Phys. Rev. E 91, 034105 (2015). [3] M. French, G. Röpke, M. Schörner, M. Bethkenhagen, M. P. Desjarlais, and R. Redmer, Phys. Rev. E 105, 065204 (2022).

P 3.5 Mon 17:30 CHE/0089

Electron polarization in ultrarelativistic plasma current filamentation instabilities — •Zheng Gong, Karen Hatsagortsyan, and Christoph Keitel — Max Planck Institute for Nuclear Physics, Saupfercheckweg 1, 69117 Heidelberg, Germany

By utilizing particle-in-cell simulations, we investigate the plasma current filamentation of an ultrarelativistic electron beam impinging on an overdense plasma. The effect of the radiation-induced electron polarization is self-consistently studied. Here, three different regimes of the current filaments, namely, the normal filament, abnormal filament, and quenching regimes, are identified. We show that electron radiative polarization emerges during the instability along the azimuthal direction in the momentum space, which significantly varies across the regimes. We put forward a Hamiltonian model to trace the origin of the electron polarization dynamics. In particular, we discern the role of nonlinear transverse motion of plasma filaments, which induces asymmetry in radiative spin flips, yielding an accumulation of electron polarization.

P 4: HEPP II

Time: Monday 16:30–18:35 Location: CHE/0091

P 4.1 Mon 16:30 CHE/0091

CO_2 dissociation using a microwave plasma torch - a study on industrially relevant parameters — •Christian Karl Kiefer[1], Rodrigo Antunes[1], Ante Hecimovic[1], Arne Meindl[1], and Ursel Fantz[1,2] — [1]Max-Planck-Institut für Plasmaphysik, 85748 Garching, Germany — [2]University of Augsburg, 86159 Augsburg, Germany

Under laboratory conditions, microwave plasma torches are known to be an energetically highly efficient CO_2 conversion technology, for pressures ranging from 100 mbar up to atmospheric pressure. However, issues relevant for industrial application such as the wall-plug energy efficiency, including the energy consumption of peripheral equipment, the performance for impure CO_2 streams directly from carbon capture facilities and the stability at long-term operation are usually not addressed. To fill that gap, the wall-plug energy efficiency of a lab-scale microwave plasma torch was determined reaching values up to 17.9%, corresponding to an electrical power consumption of 19.6 kWh per produced Nm^3 of carbon monoxide. The effect of Ar, N_2, O_2 and air admixture to the CO_2 feed gas stream was investigated. Experiments show that small amounts of nitrogen can even increase energy efficiency whereas the most detrimental effect on CO_2 dissociation was found for air admixture. Finally, a durability test over 29 h was performed, demonstrating that microwave plasma torch operation is very reproducible and stable in all figures of merit with short ramp-up times, making it a promising technology for intermittent operation.

P 4.2 Mon 16:55 CHE/0091

3D Monte Carlo PIC modeling of particle extraction from negative ion sources — •Max Lindqvist[1,2], Dirk Wünderlich[1], Serhiy Mochalskyy[1], Adrien Revel[2], Tiberiu Minea[2], and Ursel Fantz[1] — [1]Max-Planck-Institut für Plasmaphysik, Garching, Germany — [2]Université Paris-Saclay, CNRS, LPGP, Orsay, France

Negative H^- or D^- ions for the ITER NBI system are produced in RF ion sources, mainly by surface production, and accelerated through a multi-aperture grid system. One of the main limiting factors during operation of such ion sources is the amount of co-extracted e^-, in particular during operation with D. For a correct description of the particle dynamics close to the Plasma Grid (PG) where a 3D magnetic field is present, self-consistent 3D PIC-MCC modeling is needed. The 3D PIC-MCC code ONIX has been used to simulate one PG aperture in the ELISE ion source, a half-size ITER-like ion source in IPP Garching. The impact of plasma parameters on the co-extraction of e^- is presented. A higher T_e has a strong impact on the amount of co-extracted e^-. The original code was improved by adding a plasma generation module that allows modeling the biasing of the PG w.r.t. the source walls. By increasing the PG bias above the floating potential, the amount and temporal instability of co-extracted e^- are strongly decreased, in agreement with experiments. ONIX was coupled with the beam code IBSimu to allow the correlation of particle properties from the plasma to the beam, and to study the extraction probability and beam divergence of negative ions during different configurations of PG biases and geometries to give insights into grid optimization.

P 4.3 Mon 17:20 CHE/0091

Non-local neoclassical PIC simulations for the radial electric field in stellarators. — •Michał Kuczyński, Ralf Kleiber, and Håkan Smith — Max-Planck-Institut für Plasmaphysik, Greifswald, Germany

Transport in fusion plasma devices can be classified as either turbulent or neoclassical. While turbulence is responsible for the majority of particle and heat losses in both, tokamaks and optimised stellarators the theory of neoclassical transport should not be disregarded. Its applications, for example the prediction of the bootstrap current, are of great importance in fusion research. This talk focuses on the neoclassical radial electric field in stellarators.

For a quasi-neutral plasma in a thermodynamic equilibrium, commonly, the electric field is negative throughout the plasma vessel. This is called an ion root. However, when electrons are much hotter than ions, the electric field takes a positive value. This electron root and can be achieved with, for example, ECRH heating. As correctly predicted by the local neoclassical transport theory, this is a consequence of the ambipolarity condition on the ion and electron fluxes. However, the theory meets its limitations when there is a transition between the two solutions. Moreover, since the electric field switches the sign during the transition, the strongly sheared ExB flow is likely to affect turbulence. To understand the physics of this phenomenon we must resort to simulations of global neoclassical transport. We present the first self-consistent global neoclassical radial electric field simulations performed using a particle-in-cell code - EUTERPE.

P 4.4 Mon 17:45 CHE/0091

Suppression of Diocotron Drift Modes and Increased Transfer in a Multicell Trap — •Martin Singer[1,3], James R. Danielson[2], and Lutz Schweikhard[3] — [1]IPP Greifswald, Germany — [2]Department of Physics, UCSD, USA — [3]Institut für Physik, Universität Greifswald, Germany

The A Positron Electron eXperiment (APEX) will accumulate large quantities of positrons for a positron-electron (pair) plasma which are an excellent candidate to test basic plasmas physics. To this end we have designed and constructed a new multicell Penning-Malmberg trap (MCT). It includes a master-cell, and three prototype storage cells (one on-axis, and two off-axis). With this device we will test and improve the plasma transfer to the off-axis cells and the stacking of multiple plasma pulses to create large space-charges. We will develop suitable protocols to achieve these key goals, for the use of a MCT at the NEPOMUC positron source in Munich.

In this contribution, we will discuss the dynamics during the transport to the off-axis cells. These are dominated by competing diocotron drift modes. We developed techniques to suppress these modes to mitigate losses and to center the plasma in the off-axis cells. Furthermore, we demonstrated an improved transfer and consecutive transfer to multiple off-axis cells. This enabled the first simultaneous confinement in two different off-axis storage cells. The work was funded by DFG (Grant Nos. SCHW 401/23-1, Hu 978/15-1 and PE 2655/1-1) and ERC (Grant No. 741322). JRD is funded by U.S. DOE (Grant No. DE-SC0019271).

P 4.5 Mon 18:10 CHE/0091

Characterization and identification of MHD-like fluctuations of core electron temperature transitions in W7-X plasmas — •Juan Fernando Guerrero Arnaiz[1,2], Andreas Dinklage[1,2], Axel Könies[2], Carolin Nührenberg[2], Alessandro Zocco[2], Matthias Borchardt[2], Christian Brandt[2], Neha Chaudhary[2], Joachim Geiger[2], Matthias Hirsch[2], Udo Höfel[2], Ralf Kleiber[2], Kian Rahbarnia[2], Sara Vaz Mendez[2], Alexei Mishchenko[2], Jonathan Schilling[2], John Schmitt[3], Henning Thomsen[2], Marco Zanini[2], and W7-X Team[2] — [1]Universität Greifswald, Greifswald, Germany — [2]Max-Planck-Institut für Plasmaphysik, Greifswald, Germany — [3]Auburn University, Auburn AL, United States

Previously unexpected spontaneous transitions to higher core-electron temperatures preserving plasma pressure were detected in low-iota configuration W7-X plasmas. Transitions occurred at stationary plasma conditions at fixed heating power and line integrated density but with evolving plasma currents. Here we report on low frequency activity preceding the transitions. To gain insight on the transition mechanism, this activity is characterized. This is done through experimental and numerical modelling, shedding light on the nature of the underlying MHD instability. The rational iota-values and the impact of radial electric fields on the mode activity and the transition to enhanced core electron temperature are examined. As for now, the instability is narrowed down to GAM oscillations and zonal flow activity, both of which were found to potentially exist according to systematic simulations.

P 5: Atmospheric Pressure Plasmas and their Applications I

Time: Tuesday 11:00–13:00 Location: CHE/0089

Invited Talk P 5.1 Tue 11:00 CHE/0089

Diagnostics of metal-grid micro cavity plasma arrays — •Marc Böke[1], David Steuer[2], Sebastian Dzikowski[1], Henrik van Impel[2], Volker Schulz-von der Gathen[1], and Judith Golda[2] — [1]Physics of Reactive Plasmas, Ruhr-University Bochum, D-44801 Bochum, Germany — [2]Plasma Interface Physics, Ruhr-University Bochum, D-44801 Bochum, Germany

Micro-structured plasma discharges offer great potential for a variety of applications, such as large-area treatment, catalytic conversion, or decomposition of volatile organic compounds. Therefore, they are of high relevance from a technical and scientific point of view. To understand the processes, fundamental knowledge about the discharge mechanisms and dynamics and generation of reactive species is necessary. Here, we investigate metal-grid micro cavity plasma arrays of well-defined microdischarges. They are modular in construction and allow stable operation and the use of catalysts. The plasma arrays are operated in helium with admixtures of reactive gases, typically in the percentage range, and excited by triangular voltage amplitudes of 400-800V at kHz frequencies. Diagnostics in these cavities are challenging due to their small dimensions in the range of 100μm and the limited access because of the encapsulation of the plasma cavities. Therefore, we apply optical emission-based methods to determine electric fields (Stark shift) or 2D resolved densities of reactive species (e.g. by state enhanced actinometry). The basic discharge behavior like discharge modes and spatial distribution, electrical characteristics and dynamics will be discussed. Supported by the DFG within SFB 1316.

P 5.2 Tue 11:30 CHE/0089

Modelling and experimental analysis of DBDs in Ar-TMS and Ar-HMDS mixtures — •Marjan Stankov[1], Markus M. Becker[1], Lars Bröcker[2], Claus-Peter Klages[2], and Detlef Loffhagen[1] — [1]Leibniz Institute for Plasma Science and Technology (INP), 17489 Greifswald — [2]Institute for Surface Technology (IOT), Technische Universität Braunschweig, 38108 Braunschweig

During the last two decades, plasma-enhanced chemical vapour deposition processes using atmospheric-pressure dielectric barrier discharges (DBDs) have become of great interest for fabricating various thin films and coatings. Here, fluid modelling and experimental analyses of such DBDs in argon with the addition of small amounts of tetramethylsilane (TMS) or hexamethyldisilane (HMDS) as precursors are reported. A plane-parallel and a single-filament discharge configuration are operated by sinusoidal voltages of few kV at frequencies of 86 and 19 kHz, respectively. A time-dependent, spatially one-dimensional fluid-Poisson model including an extensive reaction kinetic scheme for argon and the organosilicon presursors with about 90 species and 700 reactions is used for the modelling studies. Results for electrical discharge properties and relevant species in the DBD are represented and discussed. Penning ionization (PI) processes of excited argon species with the precursor gas are found to have a decisive impact on the discharge characteristics. In particular, it is found that cations generated due to PI processes are the dominant species for thin film formation.

Funded by the Deutsche Forschungsgemeinschaft (DFG) - project number 504701852.

P 5.3 Tue 11:45 CHE/0089

State enhanced actinometry in a micro cavity plasma array — •David Steuer, Henrik van Impel, Volker Schulz-von der Gathen, Marc Böke, and Judith Golda — Ruhr-University Bochum, D-44801 Bochum, Germany

In recent years, plasma catalysis as an application of atmospheric pressure plasmas has become a research. Suitable reactors for investigating the fundamental interaction between plasmas and catalytic surfaces are micro cavity plasma arrays. To understand the plasma catalytic processes, it is important to monitor the densities of reactive species. In the case of atomic oxygen, this is typically done using laser spectroscopic methods. Due to the small dimensions of micro cavities between 50-200μm this is very complex. Therefore, a new approach, helium state enhanced actinometry (SEA)[1], was used. 2D resolved measurements are performed by using an ICCD camera in combination with a tuneable bandpass filter. The discharge is operated in helium with an oxygen admixture of 0.1%. An argon admixture of 0.05% is used as actinometer gas. The triangular excitation voltage between amplitudes of 400-800V is varied at a frequency of 15 kHz. Very high dissociation degrees up to nearly complete dissociation are observed. The spatial resolution allows density distributions within individual cavities to be resolved. Time resolved measurements show significant differences in oxygen density between the increasing potential phase and the decreasing potential phase. This work is supported by the DFG via SFB 1316 (project A6). [1]Steuer et al 2022 PSST 31 10LT01

P 5.4 Tue 12:00 CHE/0089

CO_2 splitting in 3D-printed barrier discharge reactors — •Dimas Adrianto[1], Milko Schiorlin[1], Volker Brüser[1], Ronny Brandenburg[1,2], and Sven Grundmann[2] — [1]Leibniz Institute for Plasma Science and Technology, Greifswald, Germany — [2]University of Rostock, Rostock, Germany

First attempts to use Dielectric Barrier Discharges (DBDs) for the conversion of carbon dioxide (CO_2) date back to the 1990's, and found a renewed interest in the 2010's due to the energy transition, i.e., the demand for PtX technologies for the generation of fuels or chemicals. DBDs still lack on energy efficiency, but provide a simple and robust design for plasma reactors. In contrast to the studies of microwave discharges, the impact of gas flow distribution in DBDs reactors is still a rather unexplored field. In this study, a 3D printer is used to realize DBD discharge chambers with a predefined gas flow pattern. Thus, the high flexibility of rapid prototyping enables to correlate fluid dynamic simulations with the plasmachemical performance of CO_2 splitting. DBD reactors are made of methacrylic acid polymer and have an overall dimension of 120 x 120 mm, with a powered electrode size of 55 x 55 mm, placed in the center. The influence of flow mechanics is investigated in three DBD reactors with different gas flow patterns and velocity profiles. Besides CO_2 splitting in pure CO_2, ozone generation in air is studied. It is shown that CO or O_3 yield can be influenced by the flow pattern and gas flow rate.

P 5.5 Tue 12:15 CHE/0089

Gas Separation of O_2 in a CO_2 Plasma Membrane Reactor — •Katharina Wiegers[1], Andreas Schulz[1], Matthias Walker[1], Günter Tovar[1], Frederic Buck[2], Thomas Schiestel[2], and Stefan Baumann[3] — [1]University of Stuttgart IGVP, Stuttgart, Germany — [2]Fraunhofer IGB, Stuttgart, Germany — [3]Forschungszentrum Jülich IEK-1, Jülich, Germany

Mankind nowadays is strongly affected by ongoing climate change, mainly caused by the increasing emission of CO_2. CO_2, a very stable molecule, can be activated by a plasma process. It converts CO_2 into the value-added chemical molecule CO. In order for this method to become competitive with electrolysis, the simultaneously produced O_2 must be separated from the gas mixture. In order to do so, oxygen-conducting ceramic hollow fibers can be used. The first and well-investigated ceramic is $La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_{3-\delta}$ by Tereoka [1]. Changing the *A* site cations or using a dual-phase material can improve the temperature stability and chemical resistance against the CO_2 and CO atmosphere in the plasma membrane reactor.

In this work, $La_{0.6}Ca_{0.4}Co_{0.5}Fe_{0.5}O_{3-\delta}$ hollow fibers are investigated in terms of their oxygen separation ability. They are temperature stable up to 1200°C. To increase the viable region for O_2 separation in the plasma torch, new ceramic materials (e.g. 60 wt% $Ce_{0.8}Gd_{0.2}O_{1.9}$- 40 wt% $Gd_{0.85}Ce_{0.15}Fe_{0.75}Co_{0.25}O_3$) with higher temperature resistance have to be developed and investigated. The idea is that different fiber materials can be used depending on the local plasma temperature.

[1] Y. Teraoka et al., Chemistry Letters, 1985, 14 (11), 1743,17-46.

P 5.6 Tue 12:30 CHE/0089

Evaluation of an electron beam sustained atmospheric pressure plasma for the conversion of carbon dioxide — •Lars Dincklage[1], Burkhard Zimmermann[1], Gösta Mattausch[1], and Ronny Brandenburg[2,3] — [1]1Fraunhofer Institute for Org. Electr., EB and Plasma Technol. FEP, Dresden, Germany — [2]Leibniz-Institute for Plasma Science and Technology, Greifswald, Germany — [3]University of Rostock, Germany

Carbon dioxide (CO_2) conversion processes will play an important role in closed carbon cycles for zero carbon emission economies in the future. Even though plasmas exhibit numerous technical advantages, they are not yet economically feasible in terms of CO_2 conversion, since they struggle to simultaneously achieve high energy efficiency and high conversion degree for the splitting of CO_2 molecules and are often bound to sub-atmospheric pressures. Therefore, a new hybrid approach for the plasma-chemical conversion of CO_2 is presented, consisting of an atmospheric pressure glow discharge sustained by an electron beam. This hybrid approach potentially allows to transfer energy from the plasma mainly into vibrational dissociation pathways by working at low reduced electric field strengths (about 20 Td), while sufficient ionization in the plasma is ensured by the electron beam. Based on this principle a reactor for gas conversion processes was developed. Furthermore, preparatory electron beam dose measurements for estimating ionization rates in the plasma were conducted and power deposition by the electric field and the electron beam into the plasma were calculated for continuous and pulsed operation modes.

P 5.7 Tue 12:45 CHE/0089

Control of the gas flow by a surface barrier discharge — •Soad Mohsenimehr, Marc Böke, and Achim Von Keudell — Experimental Physics II, Ruhr-University Bochum, Bochum, Germany

Surface Dielectric Barrier Discharges (SDBD) are well-known plasma sources for gas stream purification and gas conversion due to their easy scalability in various applications. In addition, SDBDs are used as plasma actuators to generate thrust in a gas for flow control. The aim of this project is to combine plasma chemistry and plasma-based flow control concepts. The plasma-flow interaction and its contribution to the chemistry of transported species is evaluated. In this work, a twin SDBD is employed, which consists of an aluminium oxide plate (190x88x0.63 mm) that is covered by nickel metallic grid printed on both sides. The SDBD is generated at atmospheric pressure using damped sinusoidal voltage waveforms (G2000 Redline Technologies). To investigate the flow pattern, the Schlieren technique was carried out to visualize the refractive index gradients in the medium and to compare this with a fluid dynamic simulation in two dimensions performed by COMSOL. The fluid simulation uses the 2D Navier Stokes equations for compressible Laminar flow assuming small Reynolds numbers. This simulation model is used to predict the plasma aerodynamic and how it could influence the surrounding fluidic flow. The formation of distinct vortices in the flow pattern in both simulation and experiment is observed. The electrode design of the SDBDs is optimized to maximize the plasma-induced thrust on the species conversion.

P 6: Magnetic Confinement II/HEPP III

Time: Tuesday 11:00–12:50 Location: CHE/0091

Invited Talk P 6.1 Tue 11:00 CHE/0091

The physics of ELM-free regimes — •Michael Dunne[1], Michael Faitsch[1], Georg Harrer[2], Lidija Radovanovic[2], Wolfgang Suttrop[1], Eleonora Viezzer[3], Matthias Willensdorfer[1], and Elisabeth Wolfrum[1] — [1]Max-Plank Institute for Plasma Physics, Bolzmannstr. 2, 85748 Garching-bei-München, Germany — [2]Institute of Applied Physics, TU Wien, Fusion@ÖAW, Wiedner Hauptstr. 8-10, 1040 Vienna, Austria — [3]Dept. of Atomic, Molecular and Nuclear Physics, University of Seville, Avda. Reina Mercedes, 41012 Seville, Spain

High performance tokamak scenarios rely on an edge transport barrier (ETB) to reach the pressure and confinement time necessary for high fusion gain. The ETB is characterised by a steep pressure gradient, which provide energy for edge-localised modes (ELMs), quasi-periodic explosive instabilities, which are projected to cause significant damage to the walls of a fusion reactor. Ensuring the longevity of tokamak reactors requires, therefore, alternative operational scenarios where large ELMs are avoided. We present a general framework in which the occurrence of ELMs is understood as a combination of turbulent transport and magnetohydrodynamic (MHD) stability. Predicting and controlling ELM-free regimes is then a matter of increasing transport such that the MHD instabilities are avoided. Three ELM-free regimes are highlighted; the quasi-continuous exhaust (QCE), quiescent H-mode (QH-mode), and operation with magnetic perturbations (MPs). We present the current understanding of the physical mechanisms as well as projections to future devices.

P 6.2 Tue 11:30 CHE/0091

Gyrokinetic turbulence simulations in the pedestal — •Leonhard A. Leppin[1], Tobias Görler[1], Marco Cavedon[1], Mike Dunne[1], Elisabeth Wolfrum[1], Frank Jenko[1], and ASDEX Upgrade Team[2] — [1]Max Planck Institute for Plasma Physics, Boltzmannstraße 2, 85748 Garching b. München, Germany — [2]See author list of U. Stroth et al. 2022 Nucl. Fusion 62 042006

The theoretical investigation of relevant turbulent transport mechanisms in H-mode pedestals is a great scientific and numerical challenge. In this study we address this challenge by global, nonlinear gyrokinetic simulations of a full pedestal up to the separatrix, supported by a detailed characterization of gyrokinetic instabilities at pedestal top, center and foot. We present ASDEX- Upgrade pedestal simulations (and first comparisons to other experiments) using the gyrokinetic, Eulerian, delta-f code GENE (genecode.org). We investigate the differences in turbulence characteristics between the pedestal regions via local simulations and obtain global heat flux profiles employing a new code upgrade which enables stable simulations at experimental beta values. In agreement with experimental measurements [Viezzer, PPCF, 2020] our global GENE simulations reveal a complex structure with different radial transport regimes. The dominant drive of electron turbulent transport transitions from ion-scale TEMs at pedestal top to small-scale ETG modes in the steep gradient region. Ion turbulent transport is relevant at the pedestal top but suppressed towards the pedestal center. A combination of linear and nonlinear stabilization mechanisms is identified to contribute to this heat flux structure.

P 6.3 Tue 11:55 CHE/0091

Linear MHD stability studies of pedestals in magnetically perturbed Tokamak plasmas — •Jonas Puchmayr, Mike Dunne, Erika Strumberger, Hartmut Zohm, and Matthias Willensdorfer — Max Planck Institute for Plasma Physics, Boltzmannstr. 2, 85748 Garching, Germany

In H-mode Tokamak plasmas, edge localized modes (ELMs) limit the achievable pressure-gradient in the edge region and may cause severe damage in future fusion devices. For this reason, it is important to understand the onset conditions of ELMs and develop methods to avoid them. The ELM onset is well-described by the theory of peeling-ballooning (PB) modes which are magnetohydrodynamic (MHD) instabilities at the edge. This provides a framework to analyze the operational space of ELMs and their mitigation/suppression.

One method to suppress/mitigate ELMs is the application of magnetic perturbation (MP) fields. However, the impact of MPs on MHD stability is not well understood. In this talk, we use the CASTOR3D code for the numerical stability analysis of a range of plasmas. Results on the toroidal localization of PB modes in magnetically perturbed Tokamak plasmas are shown and successfully compared to experimental observations. We show that PB modes are predicted to appear only at selected toroidal locations when MP fields are applied and two different kinds of localization are distinguished. Finally, results on the effect of the MP fields on the linear MHD stability limit, i.e. the marginally stable edge pressure, are presented. In general, MP fields lead to a reduction of the stability limit, as experimentally observed.

P 6.4 Tue 12:20 CHE/0091

Experimental Evidence for the Drift Wave Nature of the Weakly Coherent Mode — •Manuel Herschel[1,2], Tim Happel[1], Daniel Wendler[1,3], Michael Griener[1], Joey Kalis[1,3], Peter Manz[4], Ulrich Stroth[1,3], and The ASDEX Upgrade Team[5] — [1]MPI für Plasmaphysik, Garching — [2]Universität Ulm — [3]Physik Department E28, TUM, Garching — [4]Institut für Physik, Universität Greifswald — [5]See Author list of "Stroth, U. et al., Nuclear Fusion 62 (2022) 042006"

Improved confinement regimes will play a key role in the operation of future fusion power plants. I-mode, one of these regimes, combines good energy confinement with the absence of ELMs. It features a characteristic edge transport barrier in energy but not in density. This selective transport reduction is not understood. An edge density fluctuation called the Weakly Coherent Mode (WCM) is often brought forward as a possible explanation

Measurements obtained from Doppler reflectrometry and thermal helium beam spectroscopy at ASDEX Upgrade (AUG) are combined to analyze the WCM in unprecedented detail. A phase velocity of the WCM consistent with the dispersion relation of a near ideal drift wave is found for the first time at AUG.

This marks a novel experimental verification of a specific mechanism for the WCM and sheds new light on a long-standing debate on the underlying physics.

P 6.5 Tue 12:35 CHE/0091

Numerical studies of the O-X mode conversion process in MAST Upgrade — •Alf Köhn-Seemann[1], Bengt E. Eliasson[2], Simon J. Freethy[3], Lou A. Holland[4], and Roddy G.L. Vann[4] — [1]IGVP, University of Stuttgart, Germany — [2]SUPA, Department of Physics, University of Strathclyde, Glasgow, U.K. — [3]Culham Centre for Fusion Energy, Culham, U.K. — [4]York Plasma Institute, York, U.K.

Microwaves in the GHz-range play an indispensable role for heating and current drive in plasmas. If, however, the plasma density exceeds the cut-off density of the injected microwave, it can no longer reach its electron cyclotron resonance layer. To overcome this limitation, heating at electron cyclotron harmonics is an often applied method. Another possibility is to couple to the electrostatic electron Bernstein wave which has no high-density cut-off and is very well absorbed at the electron cyclotron resonance layer. Spherical tokamaks can in particular benefit from EBWs as their current drive efficiency exceeds those of O- or X-mode. Here, we present numerical investigations of coupling to the EBW via the O-X-B mode conversion process in the spherical tokamak MAST Upgrade. These studies are to be understood as a feasibility study of an EBW heating system in MAST Upgrade.

P 7: Atmospheric Pressure Plasmas and their Applications III

Time: Tuesday 17:00–19:00 Location: CHE/0089

P 7.1 Tue 17:00 CHE/0089

Operation modes of the COST plasma jet — •Maximilian Klich, David Schulenberg, Máté Vass, Katharina Nösges, Sebastian Wilczek, and Ralf P Brinkmann — Ruhr University Bochum, 44780 Bochum, Germany

Discharges ignited at ambient pressure drive complex chemistry. This chemical variety offers plenty of applications; for example, wound healing. A commonly used plasma source at atmospheric pressures is the COST plasma jet, a capacitively coupled radio-frequency driven plasma jet. The main goal of this study is to demonstrate three distinct operation regimes of the COST jet and to indicate their relation. The work is conducted by applying a hybrid particle-in-cell/Monte Carlo collisions (PIC/MCC) simulation code between the jet's electrodes (i.e., a one-dim. setup) for He/N2 chemistry. The framework treats electrons kinetically via PIC/MCC and solves the continuity equation based on the drift-diffusion approximation for all ion species. We vary basic input parameters (e.g., the driving frequency or voltage) to control the discharge regimes. It shows that the scaling of the Debye length, the average sheath width, and the discharge length are comparable in magnitude. Depending on their exact values, the discharge enters one of three modes: (i) A quasi-neutral regime where distinguishable bulk and sheath areas exist. (ii) A non-neutral regime where no quasi-neutral bulk region is developed. (iii) All dynamics are constricted to tiny sheath regions shielding a vast, steady bulk region in the constricted mode. Overall, this work offers parameters for distinct operation modes that allow tailoring the discharge.

P 7.2 Tue 17:15 CHE/0089

A comparison of the spatial distribution of H_2O_2 in the effluent of the kINPen-Sci and the COST Reference Microplasma Jet — •Levin Krös[1], Ben Harris[2], Andy Nave[1], Erik Wagenaars[2], and Jean-Pierre van Helden[1] — [1]Leibniz Institute for Plasma Science and Technology (INP), Greifswald, Germany — [2]York Plasma Institute, Department of Physics, University of York, UK

Cold atmospheric plasma jets (CAPJs) are utilised in biomedical applications, as they provide important reactive oxygen and nitrogen species (RONS) for the plasma cell interaction, such as H_2O_2. There are still open questions in the physical and chemical field regarding the production of the RONS. Where are they formed and how does the jet-type has an influence on their production? As a first step to resolve that question, the production of H_2O_2 in humidified helium is compared between the kINPen-Sci and the COST Reference Microplasma Jet. The small sample length (about 4 mm) combined with low number densities are a challenge for established absorption spectroscopic techniques. Continuous-wave cavity ring-down spectroscopy (cw-CRDS) is applied in order to increase the path length through the sample. The difference in the spatial distribution of H_2O_2 in the effluent between the jets will be discussed.

P 7.3 Tue 17:30 CHE/0089

Gas temperature variations along the discharge channel in an atmospheric pressure RF plasma jet and their consequences on electron dynamics — •David A. Schulenberg[1], Maximilian Klich[1], Zoltán Donkó[2], Máté Vass[1,2], Jeldrik Klotz[1], Nikita Bibinov[1], Julian Schulze[1], and Thomas Mussenbrock[1] — [1]Ruhr University Bochum, German — [2]Wigner Research Center for Physics, Budapest, Hungary

The gas temperature increase along the discharge channel of a radio frequency micro-atmospheric pressure plasma jet is investigated by a combination of spectroscopic measurements and particle in cell (PIC) simulations. The jet is operated using Helium-Nitrogen mixtures of He:N2 ratios of 1000:0.5 to 1000:2. We find that under standard operating conditions, the increase in gas temperature depends on the nitrogen content of the jet gas, the driving voltage, and the driving voltage waveform. Depending on the exact combination of these parameters, the gas temperature increases approximately 80 K between the gas inlet and the nozzle of the jet. Phase Resolved Optical Emission Spectroscopy measurements reveal a change of the time- and space-dependent dynamics of the high energy electrons in the plasma under operating conditions at which the gas temperature determined by optical emission spectroscopy also changes. This behavior is reproduced by PIC simulations, in which the gas temperature is an input parameter. The dependence of the operation mode on the gas temperature might offer an additional degree of freedom in terms of controlling the plasma properties in order to match specific application requirements.

P 7.4 Tue 17:45 CHE/0089

Modeling and simulation of transport processes in capacitively coupled radio-frequency-driven micro atmospheric pressure plasma jets — •Lukas L. Vogelhuber, Katharina Nösges, Maximilian Klich, Thomas Mussenbrock, and Ralf Peter Brinkmann — Faculty of Electrical Engineering and Information Technology, Ruhr University Bochum, Bochum, Germany

Capacitively coupled radio-frequency-driven micro atmospheric pressure plasma jets (CCRF μAPPJ) are used in biomedical science and CO_2 conversion. Numerical methods offer a range of possibilities to investigate a μAPPJ's gas and plasma dynamics. A hybrid simulation code is implemented to investigate a CCRF μAPPJ that handles electrons kinetically in a particle-in-cell/Monte Carlo collisions (PIC/MCC) scheme and ions and other heavy particles in a fluid mechanical manner. The simulation cycle of charged and neutral particles is separated, accounting for their different time scales and to spare computational resources. A one-dimensional continuity equation for the charged heavy particles is solved based on the drift-diffusion approximation. For neutral heavy particles, the gas flow is modeled by Hagen Poisseuille's law, and a two-dimensional continuity equation is solved. The main goal of this work is implementing a scheme that can solve complex chemistry and gas transport and gives two-dimensional (2D) resolved data without evoking a full 2D-PIC scheme. With the exemplary chemistry of He/N_2 this work shows that the presented scheme is suitable for the communication between separate plasma and gas dynamics simulation that creates a multi-physics framework.

P 7.5 Tue 18:00 CHE/0089

Impact of feed gas humidity on the discharge dynamics in an Ar-operating atmospheric pressure plasma jet — •Sarah-Johanna Klose, Robert Bansemer, Ronny Brandenburg, and Jean-Pierre H. van Helden — Leibniz-Institut für Plasmaforschung und Technologie e.V. (INP), Greifswald, Deutschland

Cold atmospheric pressure plasma jets are often employed for biomedical purposes as they provide a large variety of reactive species remaining around room temperature, such as atomic and molecular radicals, and key species, such as H_2O_2. In particular, hydrogen, oxygen and nitrogen containing species have been proven beneficial for wound healing and cancer treatment. The formation of these species starts in general with the dissociation of molecular gases in the plasma zone of the plasma jet. It has been shown previously that by the addition of water to the feed gas, the composition of reactive species could be changed drastically. In this presentation, we will demonstrate the impact of feed gas humidity on the discharge dynamics of the kINPen-sci plasmajet, a cold atmospheric pressure plasma jet that is operating with Ar. By means of time-resolved laser atomic absorption spectroscopy (LAAS), absolute densities of $Ar(^3P_2)$ species have been determined as a function of the feed gas humidity and of the distance to the nozzle of the plasmajet. By analysing the quenching, conclusions on the dissociation of water have been drawn, which will also be presented.

P 7.6 Tue 18:15 CHE/0089

Impact of humidity on the OH distribution in the effluent of an atmospheric pressure plasma jet measured by laser induced fluorescence — •Judith Golda[1], Sebastian Burhenn[1], Maike Kai[1], Pia-Victoria Pottkämper[1], Volker Schulz-von der Gathen[2], and Marc Böke[2] — [1]Plasma Interface Physics, 44801 Bochum, Germany — [2]Experimental Physics II, Ruhr University Bochum, 44801 Bochum, Germany

For plasma sources operating in ambient atmosphere, such as the COST-Jet, the environmental conditions have a sensitive impact on the reactive species leaving the discharge zone. One important parameter is humidity: Water impurities in the feed gas or diffusion of moisture from the ambient atmosphere in the gas stream can contribute to an increase of humidity in the effluent. To study these effects, OH as a side-product from the dissociation of water by the plasma can be used as a tracer molecule. Therefore, we measured the 2D-distribution of OH produced in the COST-Jet by laser induced fluorescence. To control the influence of gas composition and humidity of the ambient atmosphere, the experiments were performed inside a closed vessel. By systematically varying the water content of the gas inside the vessel by a bubbler system, the influence of humidity on the OH density profile was studied. These results were then compared to profiles, which were obtained from the variation of humidity in the feed gas providing valuable information about the production channels of OH.

Funded by the DFG in the PlasNOW project 430219886.

P 7.7 Tue 18:30 CHE/0089

Photo-chemistry of organosilicon precursors initiated by VUV/UV-radiation from an atmospheric pressure RF plasma jet — •Tristan Winzer, Natascha Blosczyk, and Jan Benedikt — Institute of Experimental and Applied Physics, Kiel University, Kiel, Germany

Thin-film deposition using plasmas at atmospheric pressure is a topic of current research, because sources and setups are more simple and cost-effective when compared to their low-pressure counterparts. Furthermore, they enable continuous treatment of vacuum-sensitive substrates.

However, direct contact of the precursor with the plasma can lead to unwanted particle formation and ambient conditions influence the film via impurities from nitrogen, oxygen and water. To overcome these limitations, we use high purity noble gas in a setup that provides effective separation of plasma species and precursor gas and utilizes the VUV/UV-radiaton from the plasma to initiate photochemistry. Photo-chemistry products of different organosilicon precursors in dependence of plasma power and precursor gas flow will be analyzed using ion mass spectrometry with the goal of optimizing conditions for effective film deposition. Deposited films are analyzed using Fourier-transform infrared spectroscopy (FTIR).

P 7.8 Tue 18:45 CHE/0089

Anomalous $N_2^+(B^2\Sigma_u^+)$ population in the discharge and the afterglow of an APPJ in N_2 — •Nikita Lepikhin[1], Nikolay Popov[2], Dirk Luggenhölscher[1], Nader Sadeghi[3], and Uwe Czarnetzki[1] — [1]Institute for Plasma and Atomic Physics, Ruhr University Bochum, Bochum, Germany — [2]Moscow, Russia — [3]Laboratoire Interdisciplinaire de Physique, LIPhy, CNRS, UMR 5588, Laboratoire des Technologies de la Microélectronique, LTM, CNRS, UMR 5129, Université de Grenoble-Alpes, Grenoble, France

An anomalously high relative density of the $N_2^+(B^2\Sigma_u^+, v = 0)$ state is observed in the plasma bulk of a nanosecond near-atmospheric pressure plasma jet in nitrogen during its quasi-DC phase and afterglow. Additional population of $N_2^+(B^2\Sigma_u^+, v = 0)$ is confirmed by analyzing the rotational structure of the (0-0) transition of the First Negative System (FNS) of nitrogen. Numerical kinetic modeling is used to identify possible mechanisms of additional $N_2^+(B^2\Sigma_u^+, v = 0)$ formation. Kinetic calculations taking into account production of $N_2^+(B^2\Sigma_u^+, v = 0)$ in reaction between the $N_2(a^1\Pi_g)$ and $N_2(C^3\Pi_u)$ states as well as in reaction of the $N_2(a^1\Pi_g)$ state with the N_4^+ ion describe adequately the FNS(0-0) emission dynamics and the high relative density of the $N_2^+(B^2\Sigma_u^+, v = 0)$ state observed experimentally.

P 8: Plasma Wall Interaction I/HEPP IV

Time: Tuesday 17:00–19:10 Location: CHE/0091

Invited Talk P 8.1 Tue 17:00 CHE/0091

Fuel retention and removal in the JET tokamak — •Dmitry Matveev[1], David Douai[2], Tom Wauters[3], Sebastijan Brezinsek[1], and JET Contributors[4] — [1]Forschungszentrum Juelich GmbH, EURATOM Association, 52425 Jülich, Germany — [2]CEA Cadarache, IRFM, F-13108 Saint Paul Lez Durance, France — [3]ITER Organization, Route de Vinon-sur-Verdon, CS 90 046, F-13067 St Paul Lez Durance Cedex, France — [4]See the author list of J. Mailloux et al, Nucl. Fusion 62, 042026 (2022)

The control of fuel retention remains a critical issue for future fusion reactors due to tritium fuel self-sufficiency and related radiation safety requirements. This talk will cover fuel retention studies in the JET tokamak over the past decades, from the carbon wall configuration and the first deuterium-tritium experiment (DTE1) to the beryllium-tungsten ITER-Like Wall (ILW) configuration and the recent second deuterium-tritium campaign (DTE2). Fuel retention mechanisms, the aspects of long-term and short-term fuel retention, and post-discharge outgassing of hydrogen isotopes from tokamak wall materials, as well as wall cleaning techniques and respective fuel removal experiments will be addressed.

P 8.2 Tue 17:30 CHE/0091

Early stages of He cluster formation in pristine and displacement-damaged tungsten — •Annemarie Kärcher[1,2], Vassily V. Burwitz[2], Thomas Schwarz-Selinger[1], Lucian Mathes[2], Wolfgang Jacob[1], and Christoph Hugenschmidt[2] — [1]Max-Planck-Institut für Plasmaphysik, 85748 Garching, Germany — [2]Technische Universität München, 85748 Garching, Germany

In future fusion reactors, tungsten as plasma-facing material will be subjected to intense fluxes of helium (He). While the consequences of high He fluxes on the surface properties of tungsten have already been thoroughly studied, there are no experiments that could clarify the process of early He cluster formation. To understand the initial steps of the interaction of He with W, especially the impact of pre-existing defects, annealed, polycrystalline W samples were irradiation-damaged to various damage levels. Then, these samples were exposed to a low-temperature He plasma at fluxes between 10^{17} and 10^{19} He/m^{2}s and various fluences using implantation energies of 50 and 100 eV. The samples were measured by positron annihilation spectroscopy for defect characterization and elastic recoil detection analysis (ERDA) for quantification of the He retention. For the depth distribution of He, a novel method was applied: thin surface layers of the sample were subsequently removed followed by ERDA measurements in between the erosion steps. The removal was performed by by electrochemical oxidation and dissolution of the oxide in NaOH. The results show a higher He retention in pre-damaged samples by factors up to 10 and a deeper reaching distribution of He in undamaged samples.

P 8.3 Tue 17:55 CHE/0091

Low Energy Ion Scattering investigation of dynamic surface segregation of chromium in the WCrY SMART material — •Pawel Bittner, Hans Rudolf Koslowski, Andrey Litnovsky, and Christian Linsmeier — Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung, 52425 Jülich,Germany

Self-passivating Metal Alloys with Reduced Thermo-oxidation (SMART) are promising candidates for the first wall of the DEMOnstration power plant (DEMO). These materials should feature an increased oxidation resistance during accidental conditions and tolerate plasma loading during regular operation of the power plant. In this work, the effects of segregation, diffusion and sputter erosion on the surface Cr concentration of a tungsten-chromium-yttrium SMART alloy (WCrY - 68 at% of W, 31 at% of Cr and 1 at% of Y) are studied with low energy ion scattering (LEIS) measurements at 800 K, 900 K and 1000 K and numerical simulations. The LEIS is operated with He^+, Ne^+ and Ar^+ ions at 1 keV in sputter mode. The time resolved measurements show a build-up of Cr at the surface directly after increasing the temperature, followed by a slow decrease with evolving time. A comparison to a discrete layer model, in which the segregation enthalpy, entropy and atomic mobility are taken into account, indicates that this decrease is caused by a slower bulk diffusion rate compared to the rates of sputtering and surface segregation.

P 8.4 Tue 18:10 CHE/0091

Influence of the Microstructure of Tritium Permeation Barrier Layers on Hydrogen Isotope Retention and Permeation — •Jonah Lennart Book, Anne Houben, and Christian Linsmeier — Forschungszentrum Jülich GmbH, 52425 Jülich, Germany

For the safe and efficient operation of fusion reactors, tritium permeation barriers, or TPBs, are required to prevent fuel loss through first wall materials. Yttrium oxide is chosen as a TPB due its favorable neutron activation behavior compared to other candidates. Different Y_2O_3 layers several hundred nanometers thick are deposited onto a steel substrate using RF magnetron sputtering and studied using scanning electron microscopy. The samples are annealed at 550°C to obtain the favorable cubic phase of Y_2O_3, which is verified by X-ray diffraction. Permeation measurements are performed by gas-driven deuterium permeation experiments from 25 mbar to 800 mbar at 300°C to 550°C. The calculation of the single layer permeability is introduced to obtain a comparable value of the permeation reduction effect for the different coatings. In addition, in lag time measurements the diffusivity of the sample is determined separately from the permeability. The permeation results and layer permeabilities are compared for the different microstructures. Furthermore, the hydrogen isotope retention of the different layers is measured using nuclear reaction analysis and evaluated with their permeation reduction performance.

P 8.5 Tue 18:25 CHE/0091

Ex-Situ Ion Beam Analysis of ^{13}C on Plasma-Facing Components of Wendelstein 7-X — •Christoph Kawan[1], Sebastijan Brezinsek[1], Timo Dittmar[1], Sören Möller[1], and the W7-X team[2] — [1]Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung - Plasmaphysik, Partner of the Trilateral Euregio Cluster (TEC), 52425 Jülich, Germany — [2]See author list of T. Klinger et al. (2019) Nucl. Fusion 59 112004

At the end of OP1.2B 4.5 * 10^{22} ^{13}C - methane molecules were injected to study carbon transport in W7-X and generate benchmark data for material migration codes. Here we present the results of a dedicated NRA analysis using the ^{13}C(d, p_0)^{14}C reaction on 24 divertor target elements of different toroidal positions. The majority of the deposition was on the divertor half module where the carbon was injected (60%), with layers up to 100 μm in a 5 cm radius around the injection location. The reminder of the ^{13}C was deposited on the other divertor modules close to the strike line.

P 8.6 Tue 18:40 CHE/0091

Experimental Determination of Irradiation-Induced Stress Relaxation in Thin Tungsten Wires — •Alexander Feichtmayer[1,2], Max Boleininger[3], Raphael Colson[1,2], Bailey Curzadd[1,2], Sebastian Estermann[1,2], Till Höschen[1], Johann Riesch[1], Thomas Schwarz-Selinger[1], and Rudolf Neu[1,2] — [1]Max Planck Institute for Plasma Physics, Boltzmannstr. 2, 85748 Garching, Germany — [2]Technical University Munich, Boltzmannstr. 15, 85748 Garching, Germany — [3]Culham Centre for Fusion Energy, Abingdon, OX14 3DB, Oxfordshire, UK

The development of suitable materials for the highly loaded plasma facing components is a major challenge in the development of a future fusion power plant. The influence of neutron irradiation on the mechanical properties is particularly difficult to measure, since there is no suitable neutron source available. A widely used technique to simulate neutron irradiation is the use of high energy ions, since these can produce similar dislocation damage as neutrons. For this purpose, a dedicated device has been developed to allow simultaneous ion irradiation as well as mechanical testing. This device and the latest upgrades, as for example a laser-based strain measurement system, will be presented. The setup of a stress relaxation experiment on 16 μm tungsten wires, to study the synergistic effects between mechanical stress and irradiation damage, will also be presented. For this the wires were preloaded with up to 2 GPa and simultaneously irradiated with 20.3 MeV tungsten ions. The resulting force drop (10-30 mN) and the ion current across the sample (0.1-0.8 nA) was measured.

P 8.7 Tue 18:55 CHE/0091

First trials to regenerate the surface of plasma-facing components by wire based laser metal deposition — •Jannik Tweer[1], Robin Day[2], Thomas Derra[2], Daniel Dorow-Gerspach[1], Christian Linsmeier[1], Thorsten Loewenhoff[1], Ghaleb Natour[3,4], and Marius Wirtz[1] — [1]Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung - Plasmaphysik, 52425 Jülich, Germany — [2]Fraunhofer-Institut für Produktionstechnologie IPT, 52074 Aachen, Germany — [3]Forschungszentrum Jülich GmbH, Zentralinstitut für Engineering, Elektronik und Analytik (ZEA-1), 52425 Jülich, Germany — [4]Lehrstuhl und Institut für Schweißtechnik und Fügetechnik, RWTH Aachen University, 52074 Aachen, Germany

The harsh conditions inside a nuclear fusion reactor put high demands on the plasma-facing materials and components. Tungsten is the preferred material for lining the inner walls of future fusion reactors. It is considered as such due to its exceptionally high melting point, excellent thermal conductivity, low tritium retention and high erosion resistance during plasma exposure. However, even plasma-facing components made of tungsten get damaged during reactor operation, thereby limiting the lifetime of these components. It is envisioned to counteract these erosion losses by local deposition of tungsten using the wire based laser metal deposition process (LMD-w). During this process new material gets fused to the substrate, enabling in-situ repair of damaged plasma-facing components. Several experiments were conducted to find suitable process parameters and methods to create layers of new material by placing several melt tracks next to each other.

P 9: Atmospheric Pressure Plasmas and their Applications III

Time: Wednesday 11:00–13:00 Location: CHE/0089

Invited Talk P 9.1 Wed 11:00 CHE/0089

Modelling and analysis of single-filament dielectric barrier discharges at atmospheric pressure — •Markus M. Becker[1], Ronny Brandenburg[1], Tomáš Hoder[2], Hans Höft[1], Aleksandar P. Jovanović[1], and Detlef Loffhagen[1] — [1]Leibniz Institute for Plasma Science and Technology (INP), Greifswald, Germany — [2]Masaryk University, Brno, Czech Republic

This contribution gives an overview of research results of the last 10 years on the modelling of single-filament dielectric barrier discharges (DBDs). Two discharge configurations are used to highlight the possibilities and limitations of spatially one- (1D) and two-dimensional (2D) time-dependent fluid models. First, it is shown for a one-sided, sine-driven DBD in argon that 1D models are generally suitable to describe the discharge characteristics in periodic operation. Second, 1D models are found to be suitable for systematic determination of the influence of preionisation on repetitively pulsed, two-sided DBDs in nitrogen-oxygen gas mixtures up to time scales of milliseconds. However, 1D models lack the ability to correctly describe the appearance of striations (in argon) and the streamer breakdown phase (~ 1 ns). For this purpose, 2D models are applied, which show a very good agreement with measurement results. Since processes on longer time scales (μs to ms) can only be investigated in 2D with extreme computational effort, a smart combination of 1D and 2D models is most promising for a profound understanding of filamentary DBDs.

This work was partly funded by the DFG—projects 407462159 and 408777255, and Czech Science Foundation project 21-16391S.

P 9.2 Wed 11:30 CHE/0089

Kinetic modeling of the charge transfer across a negatively biased semiconducting plasma-solid interface — Kristopher Rasek, •Franz Xaver Bronold, and Holger Fehske — Institut für Physik, Universität Greifswald, 17489 Greifswald

We discuss the selfconsistent ambipolar charge transfer across a negatively biased semiconducting plasma-solid interface using a thin germanium layer with electron-phonon scattering sandwiched between an Ohmic contact and a collisionless argon plasma as a model system. The current-voltage characteristics of the interface is obtained from the distribution functions of the charge carriers on both sides of it. Due to quantum-mechanical reflection at the interface and collisions inside the solid, the characteristics differs substantially from the one obtained for a perfectly absorbing interface. The electron microphysics inside the solid affects thus the characteristics. In addition, the spatially and energetically resolved fluxes and charge distributions inside the germanium layer visualize the behavior of the charge carriers responsible for the charge transport. Albeit not quantitative, because of the crude model for the germanium band structure and the neglect of particle-nonconserving scattering processes, such as impact ionization and electron-hole recombination, which at the energies involved cannot be neglected, our results [1] clearly indicate (i) the current through the interface is carried by rather hot carriers and (ii) the perfect absorber model, often used for the description of charge transport across plasma-solid interfaces, cannot be maintained for semiconducting interfaces. [1] K. Rasek *et al.*, Phys. Rev. E **105**, 045202 (2022).

P 9.3 Wed 11:45 CHE/0089

Challenges during the design of a DC microplasma cell intended for *in situ* TEM — •Luka Hansen[1], Niklas Kohlmann[2], Lorenz Kienle[2], and Holger Kersten[1] — [1]Institute of Experimental and Applied Physics, Kiel University, Kiel, Germany — [2]Institute for Material Science, Kiel University, Kiel, Germany

In situ observation of plasma surface modifications are possible if a microplasma is inserted into a TEM as shown by proof of principle experiments in 2013 [1]. Still, multiple challenges have to be overcome for the development of a microplasma cell suitable for TEM integration. The electrodes have to be electron beam transparent and are therefore restricted to tens of nanometers in thickness. The microplasma itself has to be vacuum-proof encapsulated and operated in a stable regime.

A DC microplasma was designed and intensively studied to ensure its stable operation in the normal glow regime [2]. *Ex situ* performed measurements proved the possibility to setup the electrodes thin enough for TEM imaging and study the surface modifications [3]. Furthermore, the microplasma cell was successfully introduced into the TEM and first images without plasma could be taken. Electrical isolation problems prevented plasma ignition inside of the TEM, but will be solved by rebuilding the vacuum-proof encapsulation from ceramic.

This contribution summarizes the already overcome challenges and updates about the recent steps towards *in situ* TEM imaging.

[1] K. Tai *et al.*, 2013 *Scientific Reports* **3** 1325
[2] L. Hansen *et al.*, 2022 *Plasma Sources Sci. Technol.* **31** 035013
[3] L. Hansen *et al.*, *Thin Solid Films* **(Accepted)**

P 9.4 Wed 12:00 CHE/0089

Characterization of Sputtered Polyethylene Naphthalate-Foil for Flexible Surface DBD Plasma Generation — •Sandra Moritz[1], Roman Bergert[2], Martin Becker[1], and Markus H. Thoma[1] — [1]I. Physikalisches Institut, Justus-Liebig-Universität Gießen, Deutschland — [2]II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Deutschland

Plasma medicine demands for very specific plasma source configurations. Beside gasflow-driven jet-arrays, dielectrical barrier discharges (DBD) are commonly used to generate ambient air plasma at room temperature for sterilization. There, electrode and dielectric material limit its use in application. Especially, the sterilization of difficult, uneven or edged surface geometries with DBD can be rather challenging. Therefore, flexible polyethylene naphthalate-foil (PEN-foil) which was covered with electrode material by ion-beam sputtering is characterized regarding its electrical and bactericidal performance for different power and electrode thickness configurations. Operating temperature, ozone production capability and plasma parameters (electron temperature and density) were used as characterization parameters. Advantages as well as limitations of this new approach are presented.

P 9.5 Wed 12:15 CHE/0089

Study on interaction of two single-filament DBDs — •Hans Höft[1], Chiel Ton[2], Tom Huiskamp[2], and Torsten Gerling[1,3] — [1]Leibniz Institute for Plasma Science and Technology (INP), Felix-Hausdorff-Str. 2, 17489 Greifswald, Germany — [2]Department of Electrical Engineering, Electrical Energy Systems group, Eindhoven University of Technology, PO Box 513, 5600 MB Eindhoven, The Netherlands — [3]Competency centre for diabetes (KDK), Greifswalder Str. 11, 17495 Karlsburg, Germany

A dielectric barrier discharge configuration consisting of two identical single-filament arrangements with variable radial distance between them was investigated by means of synchronised, fast electrical and optical diagnostics. For that purpose, two single, alumina-covered electrode pairs featuring two 1 mm gaps were put in a stainless-steel chamber flushed with 0.1 vol% O_2 in N_2 at atmospheric pressure. A high-voltage pulse with ≈ 45 ns rise time was simultaneously applied to the electrode (10 kV amplitude and variable repetition frequencies). The diagnostics consisted of fast voltage and current probes, which were synchronised with an iCCD camera to record individual discharge structures. The current was measured at the grounded side for each single-filament to calculate the discharge power and transferred charge. The interaction between two adjacent discharges was investigated to better understand upscaling challenges and opportunities, e.g. by using an electrical circuit model and the synchronised single-shot data of the electrical measurements and the corresponding iCCD images.

Funded by the DFG – project number 466331904.

P 9.6 Wed 12:30 CHE/0089

Binary nanocrystal synthesis using atmospheric pressure plasmas — •Maren Dworschak[1], Martin Müller[2], Lorenz Kienle[3], and Jan Benedikt[1] — [1]Institue of Experimental and Applied Physics,Kiel University, Germany — [2]Institute of Physics, Czech Academy of Sciences, Czech Republic — [3]Faculty of Engineering, Kiel University, Germany

Nanocrystals of binary or multinary compounds with group IV semiconductors offer great flexibility in composition, morphology and structure. The resulting tunable band gap is associated with enhanced optical properties and tuneable luminescence ranging from the UV to the near-infrared region. The variety of possible nanocrystals offers a great selection of materials for energy conversion and storage application, yet the synthesis of such compounds on the nanometer scale is still challenging due to the complexity of the synthesis process. We report on possible methods that could facilitate the generation of metal-silicide nanocrystals while using atmospheric pressure plasmas as a tool. Silicon nanocrystals are generated in the plasma source from the reactive gas silane. An additional electrode inserted in to the plasma can be coated with the metal of choice. When the electrode is heated, the metal evaporates and gets incorporated in the produced nanoparticles downstream of the jet. A second possible method involves a post synthesis in-flight annealing stage. Particles synthesized in the plasma jet pass through a furnace at 1100°C, in which the desired metal is present in gaseous phase. Here, the high temperature has proven to facilitates the formation of crystalline polyelemental compounds.

P 9.7 Wed 12:45 CHE/0089

Modelling of self-pulsing discharges at atmospheric pressure — •Aleksandar P. Jovanović[1], Hans Höft[1], Detlef Loffhagen[1], Torsten Gerling[1,2], and Markus M. Becker[1] — [1]Leibniz Institute for Plasma Science and Technology (INP), Felix-Hausdorff-Str. 2, 17489 Greifswald, Germany — [2]Competency centre for diabetes KDK Karlsburg, Greifswalder Str. 11, 17495 Karlsburg, Germany

Non-thermal atmospheric-pressure plasmas are of considerable interest due to their wide relevance for technical and medical applications over the past decade. Self-pulsing discharges are a common way to generate these plasmas. Here, the discharge current is limited by a suitably designed electrical circuit to prevent thermalisation. Current oscillations observed in these discharges were attributed to the existence of ion acoustic waves (IAWs) and can be used for plasma diagnostics. Therefore, a detailed understanding of the electron and ion kinetics during the discharge evolution is of great interest. For this purpose, a time-dependent, spatially one-dimensional fluid-Poisson model coupled with an equation of electrical circuit has been applied to study a self-pulsing discharge in argon at atmospheric pressure. The characteristic phases governed by different charge carrier production and loss processes as well as the dominant ions produced during the discharge have been analysed. The two-cathode effect has been identified as a potential excitation mechanism of IAWs at atmospheric pressure.

Funded by the Deutsche Forschungsgemeinschaft (DFG) – project number 466331904.

P 10: Magnetic Confinement III/HEPP V

Time: Wednesday 11:00–13:10 Location: CHE/0091

Invited Talk P 10.1 Wed 11:00 CHE/0091

Diagnosing the plasma edge with helium beam spectroscopy — •Michael Griener and the ASDEX Upgrade Team — Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, 85748 Garching

The outer 5% of the plasma radius of magnetically confined fusion plasmas – the plasma edge region – plays a key role for reactor performance. It sets the boundary for the plasma core by establishing transport barriers and it distributes the power to the plasma facing components.

The power and particle transport at the plasma edge is influenced by coherent plasma modes and turbulent structures like convective filaments. To study these important physical phenomena, diagnostics with high spatiotemporal resolution are required as typical structures with a size of around 1 cm move with velocities of several km/s.

One diagnostic dedicated to this is active spectroscopy on a locally injected neutral helium beam, which gets excited mainly by plasma electrons. Dependent on temperature T_e and density n_e of the plasma electrons, the population densities of the neutral helium energy levels vary. Subsequently, n_e and T_e can be reconstructed out of measured line intensity ratios together with a collisional radiative model.

In this talk the diagnostic principle is explained and inventive measurements of plasma modes and filaments in fusion reactor relevant plasma scenarios are discussed.

P 10.2 Wed 11:30 CHE/0091

Determination of SOL filament cooldown at ASDEX Upgrade — •Daniel Wendler[1,2], Michael Griener[1], Gregor Birkenmeier[1,2], Elisabeth Wolfrum[1], Ulrich Stroth[1,2], and the ASDEX Upgrade team[3] — [1]Max-Planck-Institut für Plasmaphysik, Garching — [2]Physik-Department E28, Technische Universität München, 85747 Garching, Germany — [3]See author list of U. Stroth et al. 2022 Nucl. Fusion 62 042006

Filaments, alternatively called blobs, are coherent structures, appearing in the scrape-off layer (SOL) of magnetic fusion devices in all plasma scenarios. They have a higher pressure than the background plasma and a radial motion outwards, which also differs from the background. As a consequence, blobs cause convective transport, being correlated with phenomena like the density shoulder formation and in general the power deposition in the plasma vessel. To better estimate the power transported by the filaments, their temperatures, densities and velocities are measured. This is done by means of a two-dimensional grid of lines of sight at the ASDEX Upgrade thermal helium beam. Measured radiances of helium transitions are then converted into the plasma electron temperature and density by applying a collisional radiative model. Via the calculation of the temporal evolution of these quantities and the blob position, the convective power of the filament is determined. This shows a cooldown of the filament's temperature which is combined with a loss of density. These processes are compared to analytical models, allowing to determine the temporal evolution of the convective power.

P 10.3 Wed 11:55 CHE/0091

Experimental Exploration of a Two Point Model for the Island Divertor of Wendelstein 7-X via Helium Line Ratio Spectroscopy — •Erik Flom[1,3], Tullio Barbui[2], Oliver Schmitz[1], Maciej Krychowiak[3], Ralf König[3], Marcin Jakubowski[3], Sergei Bozhenkov[3], Valeria Perso[3], Felix Reimold[3], and The Wendelstein 7-X Team[3] — [1]UW-Madison, Madison, WI, USA — [2]PPPL, Princeton, New Jersey, US — [3]Max Planck Inst. for Plasma Physics, Greifswald, Germany

Understanding the basic plasma parameters of temperature and density, as well as their gradients in the scrape-off layer (SOL), is a topic critical for providing information about the performance of a divertor concept. The stellarator Wendelstein 7-X features a novel resonant island divertor with an adjustable rotational transform of $\iota = 2\pi$ (5/6, *, 5/4). In order to study the performance of this divertor concept, an active spectroscopy system on an atomic helium beam [1] was developed and installed on the stellarator [2]. The diagnostic was successfully operated in the first two divertor campaigns of the device in two magnetically connected modules. In this work, a database analysis of experiments from the operational phase OP1.2b is performed and systematic trends in divertor performance are discussed within the framework of a two-point, single-fluid model [3]. Particular focus is applied to separatrix vs. target density scaling and evidence for a *high-recycling* conduction limited regime, as well as an exploration of the validity of the helium beam as a downstream proxy given its displacement from the strike line poloidally.

P 10.4 Wed 12:20 CHE/0091

Low-collisionality extension of the edge turbulence fluid code GRILLIX — •Christoph Pitzal, Andreas Stegmeir, Kaiyu Zhang, Wladimir Zholobenko, and Frank Jenko — Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, 85748 Garching, Germany

Fluid models are yet the workhorse for plasma edge turbulence simulations, but the fluid assumptions have certain limitations. As one leaves the realm of validity, by decreasing collisionality, the most fragile quantity is the heat flux, as it represents usually the highest order fluid moment. These conditions can already be present in the near SOL of present day experiments and the commonly used Spitzer-Härm formula vastly overestimates the parallel heat conductivity. An approach to introduce Landau damping into fluid models and therefore predict the kinetic heat flux, is given in [1]. A method to translate this approach from k-space into configuration space, where most fluid codes act is presented in [2]. In this work the Landau-fluid closure is implemented into the edge turbulence fluid code GRILLIX [3]. This requires solving a set of elliptic equations along magnetic field lines. Turbulence simulations are performed to compare the Landau-fluid closure with the Spitzer-Härm formula. The aim is to find out whether this model is capable of predicting the parallel heat conductivity self-consistently and to investigate if non-local effects of the Landau-fluid closure can be seen. Finally, the performance of the model is assessed.

[1] G. Hammett et al., Phys. Rev. Lett., vol. 64, pp. 3019, 1990.
[2] A. Dimits et al. Physics of Plasmas, vol. 21, no. 5, 2014
[3] A. Stegmeir et al., Physics of Plasmas, vol. 26, no. 5, 2019.

P 10.5 Wed 12:45 CHE/0091

Gyrokinetic investigation of linear and non-linear excitation of energetic particle driven instabilities in ASDEX Upgrade — •Brando Rettino[1], Thomas Hayward-Schneider[1], Alessandro Biancalani[2,1], Alberto Bottino[1], Philipp Lauber[1], Ilija Chavdarovski[3], Markus Weiland[1], Francesco Vannini[1], and Frank Jenko[1] — [1]Max-Planck-Institut für Plasmaphysik, 85748 Garching, Germany — [2]Léonard de Vinci Pole Universitaire, Research Center, 92916 Paris la Défense, France — [3]Korea Institute of Fusion Energy, 34133 Daejeon, South Korea

Excitation of Alfvén Waves (AW) and Geodesic Acoustic Modes (GAM) by energetic particles (EPs) is an important topic of study for the physics of fusion reactors. In tokamaks, ions are injected with high energies to heat the plasma. These energetic particles are very weakly collisional and exist far from thermal equilibrium. We examine the effects of experimental-like anisotropic in velocity distribution functions of EPs on the excitation of such instabilities with the gyrokinetic particle-in-cell code ORB5. The growth rate of GAMs is found to be sensitively dependent on the phase-space shape of the distribution function as well as on the non-linear wave-wave coupling with AWs.

P 11: Poster I

Time: Wednesday 14:00–15:30 Location: HSZ EG

P 11.1 Wed 14:00 HSZ EG

Novel microwave interferometry approach for spatial plasma profile measurements — •Christos Vagkidis, Eberhard Holzhauer, Walter Kasparek, Alf Köhn-Seemann, Stefan Merli, Mirko Ramisch, and Andreas Schulz — IGVP, University of Stuttgart, Germany

Interferometry is widely used in plasma physics to obtain the line-integrated density of a plasma. Here, we present a method to obtain in addition information about the spatial profile of the plasma density from interferometry measurements with the help of accompanying full-wave simulations. For this purpose, a microwave-generated plasma torch is used, which is confined in a quartz tube. A high frequency (208 GHz) microwave beam is emitted by a horn antenna, perpendicular to the plasma, and used as a probing beam. The receiving antenna is placed behind the plasma and is aligned with the sending antenna. The reference beam is generated artificially from a network analyser, which measures the phase difference of the beams. In spite of the beam being scattered, the phase difference can still be used to calculate the line-integrated density of the plasma with reasonable accuracy. Furthermore, the intensity distribution of the probing beam, in the plane perpendicular to the plasma torch, is obtained by moving the receiving antenna with a stepping motor, which can be operated with submillimetre precision. Full-wave simulations (inhouse FDTD code and COMSOL Multiphysics) have been carried out with arbitrary plasma density profiles. Comparing the simulation results with experiments allows to deduce information on the actual density profile.

P 11.2 Wed 14:00 HSZ EG

Inverstigation on methanol synthesis with a microwave plasma torch — •Marc Bresser, Katharina Wiegers, Andreas Schulz, Matthias Walker, and Günter Tovar — IGVP, University of Stuttgart, Germany

Due to the increasing concentration of carbon dioxide (CO_2) in the atmosphere and the resulting impact on climate change, possibilities are being sought to remove CO_2 from air by direct air capturing and a subsequent reuse of CO_2. In addition, the chemical industry is heavily dependent on fossil fuels and is looking for new ways to generate sustainable base chemicals. A possible renewable way to form carbon-based products is to use CO_2 as a reactant for the production of the base chemical methanol. Renewable methanol synthesis could be achieved via a microwave plasma process using electricity from renewable sources and "green" hydrogen (H_2). A CO_2 plasma forms carbon monoxide (CO) and oxygen (O_2).The oxygen is extracted via ceramic hollow fibers from the plasma. The addition of H_2 to the CO_2 plasma leads to the formation of new molecules such as methanol. The methanol can be separated by condensation of the exhaust gas. In this work, the CO_2 conversion in a microwave plasma (2.45 GHz) is studied. In dependence of the gas flow and the microwave power (up to 6 kW) the exhaust gas composition is analyzed with a Fourier-transform infrared spectroscopy (FTIR). Optical emission spectroscopy (OES) in the range from UV to IR is used to investigate the influence of the added H_2 onto the plasma gas composition and the exhaust gas stream.

P 11.3 Wed 14:00 HSZ EG

Applying machine learning to the inverse scattering problem for experimental plasma profiles — •Ewout Devlaminck, Christos Vagkidis, Mirko Ramisch, and Alf Köhn-Seemann — IGVP, University of Stuttgart, Germany

This work proposes a novel method to study the spatially resolved electron density profile of experimental plasmas using machine learning. The approach, here applied to an atmospheric plasma torch, solves the so-called inverse scattering problem of recovering the plasma profile from non-invasive measurements of the scattered microwave field. The proposed multi-output neural network is trained on 1D scattered intensity profiles, obtained from full-wave FDTD simulations of a high-frequency microwave beam traversing the plasma torch setup with various plasma profile settings. As opposed to the conventional experimental diagnostic, which only provides information on the line-integrated plasma density, the neural network can use the same measurement data to predict multiple parameters describing the complete spatial density profile.

P 11.4 Wed 14:00 HSZ EG

Combining a nanosecond-pulsed DBD with an electrolytic cell to reduce CO_2 and N_2 — •Martin Leander Marxen[1], Luka Hansen[1], Gustav Sievers[2], Volker Brüser[2], and Holger Kersten[1] — [1]Plasmatechnology Group, Institute of Experimental and Applied Physics, Kiel University (CAU), Kiel, Germany — [2]Leibniz Institute for Plasma Science and Technology (INP), Greifswald, Germany

Plasma-catalytic approaches are promising for converting mixtures of CO_2 or N_2 with H_2 at mild conditions (ambient pressure and low temperatures) into higher-value gases or fuels such as syngas ($CO + H_2$), methanol (CH_3OH) or ammonia (NH_3)[1]. Activation of the strong chemical bonds in CO_2 and N_2 is achieved by collisions of the molecules with energetic electrons present in the discharge.

In a polymer electrolyte membrane (PEM) cell[2], oxygen ions (O^{2-}) and protons (H^+) are produced in the anode space. The protons permeate the membrane and adsorb on the cathode. By locating a custom nanosecond-pulsed DBD in the cathode space (as proposed in this contribution), the adsorbed hydrogen can directly be utilized for reducing activated CO_2 or N_2 species. This has two major advantages compared to other plama-catalytic approaches: First, hydrogen is produced in place. Second, the power supplied to the plasma is mainly used to activate the CO_2 or N_2 bonds instead of activating H_2 bonds as well.

[1] A. Bogaerts et al., J Phys D Appl Phys 53 (2020) 443001

[2] S. Shiva Kumar, V. Himabindu, Mater Sci Energy Technol 2 (2019) 442-454

P 11.5 Wed 14:00 HSZ EG

Investigation of OH and H2O2 distribution in aqueous solution treated by a humid atmospheric pressure plasma jet — •Steffen Schüttler, Emanuel Jess, Marc Böke, Volker Schulz-von der Gathen, and Judith Golda — Ruhr-University Bochum, Universitätsstraße 150, 44801 Bochum, Germany

Biological enzymes are suitable to convert a substrate into a valuable product in presence of H2O2 without producing heavy metal waste. Atmospheric pressure plasma jets can produce H2O2 under very good control so that a stable environment can be maintained. This work investigated the delivery of reactive species from an atmospheric pressure plasma jet into a liquid. The capillary plasma jet used is comparable to the COST reference jet and was operated in humid He. Spectrophotometric diagnostics by use of ammonium metavanadate and terephthalic acid were performed to measure the concentrations of H2O2 and OH in the liquid, respectively. The distribution of reactive species at the liquid surface was visualise by the chemiluminescence of luminol. Our work showed that a H2O2 concentration of up to 1 mM was achievable while the OH concentration was a factor of 40 lower. Both species could be controlled by the dissipated plasma power and by the humidity of the feed gas. The transport process could be used to achieve a higher selectivity towards H2O2. Pulsing the RF jet at low frequencies of up to 2 kHz increased the energy efficiency of H2O2 production while reducing the OH concentration in the liquid. This work is supported by the DFG within CRC1316 (Subproject B11, project number 327886311).

P 11.6 Wed 14:00 HSZ EG

Time-resolved characterization of a micro cavity plasma array using a multi-photomultiplier setup — •Henrik van Impel[1], David Steuer[1], Volker Schulz-von der Gathen[2], Marc Böke[2], and Judith Golda[1] — [1]Plasma Interface Physics, Ruhr-University Bochum, D-44801 Bochum, Germany — [2]Physics of Reactive Plasmas, Ruhr-University Bochum, D-44801 Bochum, Germany

Dielectric barrier discharges (DBDs) have many applications, such as ozone generation or treating volatile organic compounds (VOCs). To understand the underlying processes, fundamental knowledge about the generation of reactive species is necessary. Here we investigated atomic oxygen production as a model system in a micro cavity plasma array, a customized surface DBD confined to geometrically arranged cavities of micrometer size. We studied the behavior and the plasma chemical processes using optical emission spectroscopy methods. The discharge is operated in helium with a molecular oxygen admixture of about 0.1% at atmospheric pressure using a 15 kHz and about 600V triangular excitation voltage. With helium state enhanced actinometry (SEA) [1] high atomic oxygen densities could be observed. Using a multi-photomultiplier setup with synchronous narrow bandwidth detection of characteristic transitions and SEA, we measured the temporal evolution of the atomic oxygen density and the effective mean electron energy over the first ignitions, which are affected by a memory effect due to residual charges on the dielectric surface.

The project is funded within project A6 of the SFB 1316.

[1] David Steuer et al 2022 Plasma Sources Sci. Technol. 31 10LT01

P 11.7 Wed 14:00 HSZ EG

Development of plasma reactors for plasma-assisted catalysis — •Kerstin Sgonina, Alexander Quack, and Jan Benedikt — Institute of Experimental and Applied Physics, Kiel University, Kiel, Germany

The energy efficient and decentralized performance of catalytic reactions, such as for the production of ammonia, has become even more important nowadays. Plasma-assisted catalysis can help to achieve these goals as it is available on demand and works without enormous external heating. Non-equilibrium atmospheric pressure plasmas are used to dissociate gaseous molecules, which can then react at the surface of the catalyst to form the desired products. Plasma-assisted catalysis reactors at atmospheric pressure are often realized by packed bed reactors, in which the catalyst is packed into or deposited on millimeter-sized spheres. However, these millimeter-sized spheres are not feasible for all types of possible catalysts.

Therefore, different plasma reactors for plasma-assisted catalysis were developed and tested with and without different catalysts for in-plasma catalysis, where the catalyst is in direct contact with plasma, and post-plasma catalysis, where only reactive species from the plasma are reaching the catalyst. Dielectric barrier discharges operated at kHz- or radio-frequencies are used for ammonia synthesis using N_2 and H_2 as working gas as well as for methane formation experiments using CO_2 and H_2. Depending on the reactor-type and working gas, the gas temperature during plasma operation ranges from room temperature up to 200 °C.

P 11.8 Wed 14:00 HSZ EG

Coaxial dielectric barrier discharge for plasma catalysis in N_2 and H_2 — •Roland Friedl[1], David Rauner[1], and Ursel Fantz[1,2] — [1]AG Experimentelle Plasmaphysik, Universität Augsburg, 86135 Augsburg — [2]Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, 85748 Garching

Dielectric barrier discharges (DBDs) are frequently utilized for plasma catalytic systems, due to their advantages regarding several crucial aspects: due to the repetitive filamented discharge, gas heating is avoided and distinctive non-equilibrium conditions are maintained at atmospheric pressure. In addition, if operated in a so-called packed-bed configuration, where the catalyst is coated on or embedded in the dielectric material, a large interaction area between the plasma and the active catalyst surface can be exploited.

In this contribution, a recently commissioned coaxial DBD setup is introduced, which is targeted towards the investigation of nitrogen and hydrogen discharges together with catalytic materials in a packed-bed configuration, e. g. in view of ammonia production. First investigations in view of an electrical and spectroscopical characterization are presented.

P 11.9 Wed 14:00 HSZ EG

Active Flux for Vlasov-Maxwell I: Application of the Linear Advection scheme to the Vlasov System — Lukas Hensel, •Gudrun Grünwald, and Rainer Grauer — Ruhr-Universität Bochum, Universitätsstraße 150, 44801 Bochum, Germany

The Vlasov-Maxwell system for the kinetic description of collisionless plasmas is numerically challenging due to its high dimensionality (3 dimensions in position and velocity space, respectively, plus the time) as well as the coupling of the particle trajectories to the EM-fields, resulting in extreme computational expense. Thus, there is an ongoing demand for efficient low-dissipation conservative schemes suitable for this system. The Active-Flux (AF) Method is a finite-volume method for hyperbolic conservation laws with additional degrees of freedom on the cell interfaces. It hereby allows achieving 3rd order while keeping a compact stencil in space and time. This can facilitate the bulk coupling. The point values on the cell interfaces are evolved independently of the conservation update, with the former step not having to be conservative. For the Vlasov equation, being a linear transport equation, this allows for the use of semi-Lagrangian techniques. We present first results on the numerical error of the method for the cases of 1 and multidimensional linear advection and the 1D electrostatic limit, considering the case of Landau-damping. AF showed lower dissipation than other 3rd order schemes and performed better particularly at low resolution, encouraging its application to the full 3D Vlasov-Maxwell problem.

P 11.10 Wed 14:00 HSZ EG

Active Flux for Vlasov-Maxwell II: Application of the Linear Advection scheme to the Vlasov System — •Lukas Hensel, Gudrun Grünwald, and Rainer Grauer — Ruhr-Universität Bochum, Universitätsstraße 150, 44801 Bochum, Germany

The Vlasov-Maxwell system for the kinetic description of collisionless plasmas is numerically challenging due to its high dimensionality (3 dimensions in position and velocity space, respectively, plus the time) as well as the coupling of the particle trajectories to the EM-fields, resulting in extreme computational expense. Thus, there is an ongoing demand for efficient low-dissipation conservative schemes suitable for this system. The Active-Flux (AF) Method is a finite-volume method for hyperbolic conservation laws with additional degrees of freedom on the cell interfaces. It hereby allows achieving 3rd order while keeping a compact stencil in space and time.

The point values on the cell interfaces are evolved independently of the conservation update. For the Vlasov equation, being a linear transport equation, this allows for the use of non-conservative semi-Lagrangian techniques. We present first results on the application of AF to the full three-dimensional Vlasov-Poisson system. Different possible strategies for directional splitting that allows the solution of the six-dimensional equation with lower dimensional substeps are discussed. The multidimensionality of AF furthermore allows for the solution of the three-dimensional velocity space in a single steps, encouraging its future application to the relativistic Vlasov-Maxwell equations.

P 11.11 Wed 14:00 HSZ EG

Efficient GPU implementation of 2D Particle-in-Cell Simulations for capacitively coupled plasmas — •Christian A. Busch and Uwe Czarnetzki — Institute for Plasma and Atomic Physics, Ruhr University Bochum, D-44780 Bochum, Germany

Particle in cell (PIC) simulations are an indispensable tool for the study of low-pressure plasmas, in which a correct description of the particle transport can only arise from kinetic theory. However, the great ability of PIC simulations to model such systems has the drawback of being extremely expensive computationally.

In recent years, the development of general purpose graphics processing units (GPGPUs), provided cards with thousands of cores for computations different from graphics processing. This highly parallel hardware allows significant speedups in PIC simulations up to around a factor of 100 compared to CPUs, enabling the simulation of large multidimensional discharges.

Presented here are details for the efficient implementation of all components of a 2d3v PIC/MCC simulation on the GPU. The focus is on data management across the different types of memory on the GPU. Since data transfer is one of the main bottlenecks for high speed computation, optimization of the data storage and processing strategy is key to a successful implementation of PIC codes on the GPU.

P 11.12 Wed 14:00 HSZ EG

Control of the angular distribution of incident ions by tailoring electromagnetic fields in the sheath region — •Elia Johannes Jüngling, Neil Unteregge, David Klute, Marc Böke, and Achim von Keudell — Experimental Physics II - Reactive Plasmas, Ruhr-University Bochum, Bochum, Germany

The angular distribution of ions impinging on a surface in contact with a plasma plays a key role in various applications like anisotropic plasma etching or glancing angle film growth for the fabrication of microstructure devices. Here, we investigate ways to influence and ultimately control the ion incident angle and the angular distribution of the impinging ions to enable a true 3d manufacturing of microstructure devices. The ion incident angle can be controlled by applying additional local electric and magnetic fields in the sheath region of a plasma. Here, the electric field is modified by including a grid system (mask) in front of the surface which can be either on the floating potential of the plasma or externally biased; a magnetic field parallel to the surface is introduced to induce an asymmetry in the angular distribution of incident ions. A combination of both methods has been tested for reactive ion etching of carbon films in an argon-oxygen plasma and for deposition of copper in a HIPIMS plasma. The resulting etching or deposition profiles have been compared with a 2d3v particle-in-cell code (PIC) to simulate the ion trajectories in the sheath region/mask region in front of the substrate surface. A very good agreement has been found.

P 11.13 Wed 14:00 HSZ EG

Studies of low temperature radio-frequency discharges using a velocity moment analysis — •Tim Bolles, Maximilian Klich, Thomas Mussenbrock, Ralf Peter Brinkmann, and Sebastian Wilczek — Ruhr University Bochum, 44780 Bochum, Germany

Plasmas are complex systems in terms of their physics and chemistry. Thus, a fundamental understanding of the underlying mechanisms is crucial. The solution of the Boltzmann equation (BE) offers insight into the full spatio-temporal dynamics of the plasma. Single particle simulations such as the kinetic particle-in-cell/Monte Carlo collisions scheme (PIC/MCC) are a feasible way to obtain this information. This work aims to generate a fundamental understanding of a low-temperature plasma by the means of an analysis of velocity moments of the electron energy distribution function. By doing so, the particle generation can, for example, be related to plasma heating. Since the PIC/MCC scheme gives a stochastic solution to BE, arbitrary moments can be calculated and interpreted without approximations and truncation. Many considerations stop the analysis after the first moment, known as momentum balance. We, however, include the energy balance equation (i.e., the second moment) in our evaluation. For our work, we run simulations at varied parameters for pressure, background gas and driving frequency. The conservation equations, especially the energy balance equation, then provides insight into energy dissipation mechanisms. Overall, this work establishes the second moment of the BE as valuable diagnostics and contributes to a fundamental understanding.

P 11.14 Wed 14:00 HSZ EG

High-efficiency machine learning approach for nanoparticle 2D size characterization via kinetic Mie polarimetry — •Alexander Schmitz, Andreas Petersen, and Franko Greiner — IEAP, Kiel University, 24118 Kiel, Germany

In a nanodusty plasma, the determination of the size of the nanoparticles is crucial to their diagnostics. In the Mie regime, in situ polarization measurements of light scattered by the particles (polarimetry), have proven to be an effective, non-invasive technique.

This method holds a number of challenges. The polarization state depends not only on the particle size, but also on its complex refractive index. Furthermore, the inverse mapping from the measured polarization state to the time dependent particle size and refractive index in a reactive plasma exhibits a strongly non-linear relationship. To resolve this, a customized kinetic fitting algorithm has been introduced in the past [1]. However, that method, based on Least-Square Fits, is highly sensitive to the time series length and requires considerable computing time.

We present a new deep-learning approach to the mapping problem via our High-Efficiency Refractive index MappIng NEural network (HERMINE). With this, the error rate of automated data evaluation, as well as computing time was significantly reduced. This paves the path for future data-intensive, real-time imaging of the particle's growth dynamics in nanodusty plasmas [2].

[1] S Groth et al, J. Phys. D: Appl. Phys., 2015.
[2] S Groth et al, Plasma Sources Sci Technol, 28 (11), 2019.

P 11.15 Wed 14:00 HSZ EG

3D machine-learning reconstruction techniques for particles in dusty plasmas — •Andre Melzer, Michael Himpel, Christina Knapek, Daniel Maier, Daniel Mohr, and Stefan Schütt — Institute of Physics, University Greifswald

Dusty plasmas provide an interesting system to study fundamental processes in many-particle systems since the particles can be imaged and followed on the kinetic individual-particle level.

We have performed experiments with dusty plasmas on parabolic flights using a stereoscopic camera system with four cameras. Under microgravity conditions the dust particles form a dense dust cloud, and a small fraction of the dust cloud is imaged by the four cameras.

In this contribution, techniques to reconstruct the three-dimensional position of the dust particles from the stereoscopic images with the help of machine-learning methods are reviewed and tested. This is important for a future application in the Compact facility planned for the ISS [1].

The work is supported by DLR under 50WM2161/50WM1962.

[1] C. Knapek et al., "COMPACT - A new complex plasma facility for the ISS", Plasma Phys. Control. Fusion 64 (2022) 12400

P 11.16 Wed 14:00 HSZ EG

What's the rheology of electro-rheological plasmas? — •Michael Kretschmer[1,2], Markus Thoma[1], Andreas Schmitz[1], Lukas Wimmer[1], Thomas Nimmerfroh[1], and Christian Schinz[1] — [1]Justus Liebig University, 1st Institute for Physics, Giessen — [2]Technische Hochschule Mittelhessen, Abt. EI, Giessen, Germany

Negatively charged micron-sized particles inside a low-temperature plasma interact with each other and form strongly coupled Coulomb systems. In such so-called complex plasmas structure formation can be observed, from crystalline states ('plasma crystal') to dynamical fluids, depending on the plasma parameters. Since gravity is a disturbing factor many experiments with complex plasmas are performed in microgravity, e.g. on parabolic flights or aboard the International Space Station ISS.

We report here on experiments on so-called electro-rheological (ER) plasmas done on parabolic flights. ER plasmas are a model system of well-known and technically used ER fluids where immersed particles form strings when an electric field is applied. This drastically changes rheological properties, such as viscosity and elasticity of the fluid.

In a setup similar to PK-4 on the ISS we use a laser to manipulate strings of microparticles inside a polarity-switched DC discharge by applying a force (light pressure) in longitudinal as well as transversal direction. The behaviour between particles in strings and unbound particles is investigated to compare their rheology and to decide whether the labeling of a complex plasma as 'ER' is justified.

P 11.17 Wed 14:00 HSZ EG

Dust acoustic wave properties in varying discharge volumes — •Christina A. Knapek[1,4], Mierk Schwabe[2,4], Victoriya Yaroshenko[3,4], Peter Huber[4], Daniel P. Mohr[1,2,4], and Uwe Konopka[5] — [1]Institute of Physics, University of Greifswald, Greifswald, Germany — [2]Institut für Physik der Atmosphäre, DLR, Oberpfaffenhofen, Germany — [3]Institut für Solar-Terrestrische Physik, DLR, Neustrelitz, Germany — [4]Institut für Materialphysik im Weltraum, DLR, Köln, Germany — [5]Physics Department, Auburn University, Auburn, Alabama, USA

An ion flow through a cloud of microparticles suspended in a low-temperature plasma can induce an ion streaming instability and lead to the formation of dust acoustic waves. The properties of such self-excited dust acoustic waves under the influence of active compression of the dust particle system were experimentally studied. Ground based laboratory experiments show clearly that wave properties can be manipulated by changing the discharge volume and thus the dust particle density. Complementary experiments under microgravity conditions (parabolic flights) were less conclusive due to residual fluctuations in the planes acceleration indicating the need for a better microgravity environment. A theoretical model, using plasma parameters obtained from PIC (particle-in-cell) simulations as input, supports the experimental findings. It shows that the waves can be described as a new observation of the dust acoustic mode which demonstrates their generic character. This work is funded by DLR/BMWi (FKZ 50WP0700, FKZ 50WM1441).

P 11.18 Wed 14:00 HSZ EG

Dichromatic Mie scattering approach for particle size measurements — •Franziska Reiser, Sören Wohlfahrt, and Dietmar Block — Institute of Experimental and Applied Physics, Kiel University, Germany

Microparticles are an essential component in complex (dusty) plasmas. These microparticles are negatively charged in the plasma and levitate in the plasma sheath due to the sheath electric field. To understand structure as well as dynamical processes in dust clouds, a precise knowledge of the particle size is indispensable, as it determines charge as well as all forces acting on a particle. Recently, a suitable diagnostic based on Mie scattering was introduced [1]. It compares measured angular and polarization resolved intensity patterns of scattered light with predictions of Mie theory. However, Mie scattering is based on interference, the intensity patterns of particles which slightly differ in size and refractive index are selfsimilar and thus an ambiguity in the resulting particle size can occur. As this ambiguity is dependent on the wavelength it can be removed using two lasers with different wavelength. This contribution presents an enhanced setup using two lasers with different wavelength and discusses evaluation concepts.

[1] S. Wohlfahrt, D. Block, 2021 Phys. Plasmas 28

P 11.19 Wed 14:00 HSZ EG

COMPACT – the future complex plasma facility for the ISS — •Daniel P. Mohr and Christina A. Knapek for the COMPACT-Collaboration — University of Greifswald, Institute of Physics, Greifswald, Germany

Complex, or dusty, plasmas consist of micrometer-sized grains injected into a low temperature noble gas discharge. The grains become charged and interact with each other via a screened Coulomb potential. On ground, gravity compresses the system and prevents the generation of larger, three-dimensional particle clouds.

The future complex plasma facility COMPACT will allow the investigation of large three-dimensional complex plasmas under microgravity conditions on the International Space Station (ISS). Its technology is mainly based on pre-studies (Ekoplasma, PlasmaLab), including a novel plasma chamber with adaptive internal geometry, a four-electrode radio-frequency system for plasma generation, and a stereoscopic particle diagnostic that allows to record 3D particle dynamics in real-time.

We will present the scientific goals of COMPACT, scientific and technology results from the pre-studies, technologies currently under discussion, and the project status.

This work is funded by DLR/BMWi (FKZ 50WM2161).

P 11.20 Wed 14:00 HSZ EG

Comparison of HERMES-2 and EMC3 for the SOL transport of Wendelstein 7-X — •David Bold[1], Brendan Shanahan[1], Felix Reimold[1], and Benjamin Dudson[2] — [1]Max-Planck-Institut für Plasmaphysik, Greifswald, Germany — [2]Lawrence Livermore National Laboratory, Livermore, California, USA

The EMC3-EIRENE code is a well established tool for modelling of the scrape-off layer (SOL) of stellerator devices like Wendelstein 7-X. However EMC3 does not include drifts, which are expected to play a significant contribution to the transport in the SOL.

HERMES-2 is a hot-ion drift reduced SOL-model using the BOUT++ framework. A recent addition to BOUT++ is the inclusion of the flux coordinate independent (FCI) scheme for fully 3D geometries. The HERMES-2 model is currently modified to be able to handle the geometry of a stellerator using the FCI method. As a first step the results of the two codes are compared when solving the geometry of Wendelstein 7-X. For a direct comparison, only the terms in Hermes-2 which are similar to those found in EMC3 are used.

P 11.21 Wed 14:00 HSZ EG

Overview of MHD mode observations during the recent operational phase at the Wendelstein 7-X stellarator — •Kian Rahbarnia, Sara Vaz Mendes, Charlotte Bueschel, Christian Brandt, Henning Thomsen, Adrian von Stechow, Jan-Peter Baehner, Ralf Kleiber, Christoph Slaby, Axel Koenies, and Wendelstein 7-X Team — Max-Planck Institute for Plasma Physics, Wendelsteinstr. 1, 17491 Greifswald, Germany

In November 2022 the second operational phase (OP2) at Wendelstein 7-X (W7-X) started. Amongst many technical and diagnostic upgrades W7-X has been equipped with a fully water cooled high heat flux divertor, which in principle allows to operate high energy regimes for several minutes up to the envisaged half hour pulse. During the first part of the recent phase, OP2.1, a number of experiments have been conducted, specifically to investigate the role of magnetohydrodynamic (MHD) mode activity in high power heating scenarios involving neutral beam injection and electron cyclotron resonance heating. The obervation of various fluctuation diagnostics (Mirnov coils, soft X-ray tomography, phase contrast imaging, electron cyclotron emmission) are investigated and closely compared to findings of past operational campaigns. This contribution will mainly focus on Alfvén eigenmode activity, new insight concerning their driving mechanism and impact on high performance experiments.

P 11.22 Wed 14:00 HSZ EG

Neural Networks for the analysis of Langmuir probe characteristics — •Jasmin Joshi-Thompson and Mirko Ramisch — IGVP, University of Stuttgart, Germany

Developed in the early 1920s, Langmuir probes continue to be one of the most widely used plasma diagnostic tools. Theoretical curves are fitted to measured current-voltage (I-V) characteristics in order to obtain parameters such as electron density (n_e) and temperature (T_e). For extensive discharge conditions and comprehensive spatial profiles, measuring plasma parameters becomes more challenging and would best be addressed via automation, with manual checks for specific samples. In this work, deep neural networks are used for associating I-V characteristics to plasma parameters and are tested for robustness. Data is collected from the stellarator TJ-K for training and testing the networks, covering magnetized low-temperature plasmas in a broad parameter space. These networks are assessed as an adaptable, automated plasma characterisation method without the need for further control processes.

P 11.23 Wed 14:00 HSZ EG

Mode analysis of high performance discharges at Wendelstein 7-X during OP 1.2 — •Charlotte Büschel, Kian Rahbarnia, Sara Vaz Mendes, Henning Thomsen, Christian Brandt, Ralf Kleiber, Axel Könies, and Wendelstein 7-X Team — Max Planck Institute for Plasma Physics, Wendelsteinstr. 1, 17491 Greifswald, Germany

During the last operational phase, the optimized stellarator Wendelstein 7-X achieved so-called high performance up to 1.1 MJ of diamagnetic energy. In most experiments the high energy phase only lasted for about 200 ms following a series of pellet injections. During the discharges Alfvén Eigenmodes (AEs) were recognized which show dynamic behaviour throughout the pulse. The AE activity is investigated in detail to determine the type of the AEs and their possible impact on the often abrupt ending of the high energy phase. To identify relevant frequencies with high precision the parametric model stochastic system identification is used. Additionally poloidal mode number spectra are calculated with the use of a nonuniform Fourier Transformation. Experimental findings are compared to theoretical predictions of Alfvén continua calculated by the 3D ideal MHD code CONTI.

P 11.24 Wed 14:00 HSZ EG

ITG simulations with a fully-kinetic Semi-Lagrangian code — •Aleksandr Mustonen[1], Felipe Nathan de Oliveira[2], Ken Hagiwara[2], Sreenivasa Thatikonda[2], Daniel Told[2], and Rainer Grauer[1] — [1]The Ruhr Univeristy Bochum — [2]Max Planck Institute for Plasma Physics

Gyrokinetic framewrok has become a standart tool to research the phenomena occuring in the nuclear fusion devices. However, steep gradients in the edge region of tokamaks violate the the assumptions used to derive the gyrokinetic theory. Thus, we want to investigate the practical limits of the gyrokinetic theory with a model containing complete physics of the system. We develop a fully kinetic code employing semi-Lagrangian schemes to simulate the slab ion temperature gradient (ITG) mode with various setups, in order to learn the new physical effects that could be present only in the 6D model. Adiabatic electron approximation used to both verify the results with the analytical linear solution and to perform simulations. However, due to the smalness of the electron Larmor radius with comparison to the ion one, we can employ driftkinetic model for electrons to obtain a hybrid electrostatic description for the ITG simulations.

P 11.25 Wed 14:00 HSZ EG

Investigation of the influence of nanosecond pulsed plasmas in water on surfaces and on nanoparticle formation — •Pia-Victoria Pottkämper, Katharina Laake, Elia Jüngling, Oliver Krettek, and Achim von Keudell — Ruhr-Universität Bochum

One application of in-liquid plasmas is the formation of nanoparticles both in the treated liquid and on a surface in contact with the liquid. Plasmas in liquids ignited by voltage pulses with fast rise times and nanosecond pulse lengths applied to an electrode cause a dissociation of the molecules in the liquid. The reactive species created by the in-liquid plasma can propagate through the liquid and are able to modify surfaces in direkt contact with it. For instance it is possible to initiate surface growth of nanoparticles. In this project the modification of copper surfaces by in-liquid plasma treatment is investigated. On copper surfaces nanoparticles can be found in the shape of CuxO nanocubes which can act as catalysts e.g. in the reduction of CO2. The activity of these catalysts decreases over time. The plasma in water causes the formation of reactive oxygen species from the water molecules which can react with the surface to re-oxidize the material, leading to the formation of new CuxO nanocubes. It is postulated that by an in-situ in-liquid plasma treatment a re-activation of the surface could be achieved, thereby extending the lifetime of the catalytic surface. Furthermore the in-liquid plasmas can also yield particles through erosion of the electrode material itself. These particles dissolved in the liquid and their production is also investigated in this project.

P 11.26 Wed 14:00 HSZ EG

Influence of atmospheric microplasma jet treatment on self-organised submicrometer surface structures generated by short pulsed laser irradiation — •S. Chur[1], L. Kulik[1], R. Labenski[1], V. Schulz-von der Gathen[2], M. Böke[2], and J. Golda[1] — [1]Plasma Interface Physics, Ruhr-University Bochum, D-44801 Bochum, Germany — [2]Physics of Reactive Plasmas, Ruhr-University Bochum, D-44801 Bochum, Germany

Catalyst efficiency is strongly dependent on catalytic surface characteristics. Key features are the morphology and chemical composition. The combination of reactive species provided by an atmospheric pressure microplasma jet and energy input by laser irradiation can lead to very effective functionalisation of surfaces. Self-organising surface structures were generated on copper (Cu) layers deposited through High Power Impuls Magnetron Sputtering (HiPIMS) on silicon wafers via the Pulsed Laser-Induced Dewetting (PLID) effect. The nanoparticles were investigated using a Scanning Electron microscope (SEM). Cu samples were treated simultaneously with the effluent of a micro atmospheric plasma jet (He/O2 admixture) and laser irradiation in a controlled atmosphere. Treated surfaces were investigated using Xray Photon Emission Spectroscopy (XPS).
A trade-off between high atomic oxygen fluxes and nanoparticle formation was found. Preliminary XPS measurements showed that plasma treatment can influence the oxidation state of copper, namely increase the percentage of CuO compared to an untreated surface.
Supported by the SFB 1316 within project B2

P 11.27 Wed 14:00 HSZ EG

Electric probe measurements inside and outside of magnetic islands in the SOL of Wendelstein 7-X. — •Dario Cipciar[1], Carsten Killer[1], Olaf Grulke[1], Jiri Adamek[2], and W7-X Team[1] — [1]Max Planck Institute, Greifswald, Germany — [2]IPP of the CAS, Prague, Czech Republic

We report on electric probe measurements in the Scrape-Off Layer (SOL) plasma of the W7-X stellarator. In this device, the SOL is formed by a chain of magnetic islands that separate the SOL into different topological regions and furthermore contain regions of closed magnetic field lines around the island centers ("O-points"). Measurements inside and outside of magnetic islands are performed using the multipurpose manipulator equipped with a probe head carrying 27 Langmuir and 2 ball-pen probes (BPPs). One of the BPPs is floating and measures the electron temperature and plasma potential and is used to cross-validate of the newly installed BPPs against triple probe measurements. The second BPP is in a swept regime for ion temperature measurements and will be compared to RFA results from similar discharges. The probe head also features poloidal and radial measurements of key fluctuating parameters (floating potential V_{fl} and ion saturation current I_{sat}) and, inferred from these are the turbulent radial particle fluxes, radial and poloidal electric fields. With these measurements we aim to assess the SOL plasma profiles and turbulence.

P 11.28 Wed 14:00 HSZ EG

Study of fast electrons population in the TJ-K stellarator. — •EdgardO Villalobos Granados and Alf Köhn-Seemann — IGVP, University of Stuttgart, Germany

Microwaves provide one of the most widely used methods for heating plasmas. If the plasma density becomes too high, the microwave is in cut-off, it cannot propagate any further and is reflected. Such plasmas are often referred to as over-dense. The stellarator TJ-K is typically operated with over-dense plasmas. Preliminary studies in TJ-K have shown that during these kinds of scenarios a component of fast electrons can be detected.

In this work, a pulse-height analyzer including a semiconductor detector being sensible in the soft X-ray range was used to measure the spectral distribution of the soft X-rays emitted by the plasma. Part of this radiation is generated by a hot electron component whose energy can be determined after calibrating the diagnostic against known X-ray sources. The occurrence of the hot electron component is studied under different discharge conditions to identify their generation mechanism.

P 11.29 Wed 14:00 HSZ EG

Properties of Metal Droplets Ejected During Arcing — •Alberto Castillo Castillo[1,2], Martin Balden[1], Volker Rohde[1], Peter Siemroth[3], Michael Laux[3], Heinz Pursch[3], Juergen Sachtleben[3], and Rudolf Neu[1,2] — [1]Max-Planck-Institut für Plasmaphysik, 85748 Garching, Germany — [2]Technische Universität München, 85748 Garching, Germany — [3]retired, was with Arc-Precision GmbH, 15711, Germany

Droplet generation by arcing is one of the mechanisms that can generate dust in a fusion device. Metal droplets expelled by arcs can potentially introduce impurities in the plasma and influence operation. The diameter and velocities of droplets determine their capacity to penetrate the outer layers and, therefore, the measurement of their distributions allows prediction of the impact on plasma operation.

In order to investigate the properties of the droplets produced by arcs a dedicated laboratory device is used based on time of flight detection by light scattering. Additionally, a high speed camera has been added for the observation of expelled droplets in larger quantities than the time of flight system. Tracking software obtains trajectories from video recording to complement the statistics obtained from the time of flight system and allow back-tracking of the droplets point of origin as well as calculating the velocity distribution. Video recording reveals the existence of explosive droplet emission events that could potentially be the source of larger diameter droplets. Microscopy observations of the remaining origin craters provide insight on the emission process of different fusion relevant materials, focusing on tungsten.

P 11.30 Wed 14:00 HSZ EG

First Measurements of the Imaging Heavy Ion Beam Probe at ASDEX Upgrade — •Hannah Lindl[1,2], Gregor Birkenmeier[1,2], Pablo Oyola[3], Jose Rueda Rueda[3], Balazs Tal[1], Joey Kalis[1,2], and The ASDEX Upgrade Team[1] — [1]Max Planck Institute for Plasma Physics, Garching, Germany — [2]Physics Department E28, Technical University Munich, Garching, Germany — [3]Department of Atomic, Molecular and Nuclear Physics, Universidad de Sevilla, Sevilla, Spain

The imaging Heavy Ion Beam Probe (i-HIBP) is a new diagnostic developed at the tokamak ASDEX Upgrade in order to measure perturbations of the magnetic field, density and electrostatic potential at the plasma edge. The i-HIBP is based on launching neutrals into the plasma, where they are ionized and deflected by the Lorentz force due to the tokamak magnetic field onto a scintillator detector placed in the limiter shadow inside the vacuum vessel. The light pattern created by the scintillator contains information about the above mentioned quantities. First measurements have been obtained recently and are now evaluated. In order to obtain a quantitative understanding of the results, the simulation code iHIBPsim is used. The code solves the equation of motion for 3D fields including ionization and attenuation models for a beam with finite width and divergence.

Results will be shown demonstrating the agreement of simulation and experiment as well as the ability to observe perturbations in the edge plasma quantities. The ability of the i-HIBP to measure filaments, edge current densities and zonal flows is discussed in this contribution.

P 11.31 Wed 14:00 HSZ EG

Influence of beam profile on ion-driven permeation experiments — Philipp Sand and •Armin Manhard — Max Planck Insitute for Plasma Physics, 85748 Garching, Germany

Ion-driven permeation experiments can be used to determine e.g. solubility, diffusivity, defect binding energies and surface/interface transport in materials relevant for wall components in nuclear fusion devices. Especially under conditions where surface processes or trapping of hydrogen isotopes at defects play a significant role, such experiments are influenced by the distribution of the ion flux density across the irradiated surface. In suitable energy and ion flux ranges, the beam profile can be quantified by measuring the height profile across the sputter erosion crater of a bulk Cu sample. In this contribution, the beam profile in the high-current, ion-driven permeation setup TAPAS was determined. A 200 eV/D beam with a total current of 80 μA of D_3^+ ions was characterised and exhibits an averaged ion flux densitiy of 8x10^{19} D/m^{2}s, while local values vary from 1x10^{19} to 3x10^{20} D/m^{2}s. A calculation scheme was implemented in the diffusion trapping code TESSIM-X. Permeation data for tungsten annealed at 2000 K was measured at 600 K and compared to simulations using the averaged ion flux as well as the detailed histogram of ion flux density. The relevance of the ion flux histogram is shown for 600 K, where trapping appearantly still plays a significant role. The best agreement between simulations and experiment was obtained for a trap concentration of 1.2x10^{-4} and a binding energy of 1.45 eV. For high temperatures, where most traps are empty, both calculated solutions converge.

P 11.32 Wed 14:00 HSZ EG

Experimental characterization of the quasi-coherent mode in EDA-H and QCE plasmas — •Joey Kalis[1,2], Gregor Birkenmeier[1,2], Peter Manz[3], Ridhesh Goti[1,4], Michael Griener[1], Elisabeth Wolfrum[1], Thomas Eich[1], and Ulrich Stroth[1,2] — [1]Max-Planck-Institut für Plasmaphysik, Garching — [2]Physik-Department E28, TUM, Garching — [3]Institut für Physik, Universität Greifswald, Greifswald — [4]Ludwig-Maximilians-Universität, München

For future reactors based on the tokamak concept, it is necessary to establish high confinement modes without type-I ELMs. In the past years, several natural ELM-free operation scenarios, such as EDA-H-mode or quasi-continuous exhaust (QCE), have been achieved in ASDEX Upgrade. A quasi-coherent mode (QCM) appears in both scenarios at the plasma edge and may be the key feature for the stabilization of ELMs and thus the better confinement. In order to understand and extrapolate a possible EDA-H or QCE scenario at large-scale machines like ITER or DEMO, it is necessary to determine different spectral properties of the QCM. Due to its high spatial and temporal resolution, the He-beam diagnostic and magnetic pick-up coils are used for this purpose. The results include frequency scaling and coherency behaviour, poloidal and radial wavenumber analysis and radial localization as well as a link of the QCM to other higher harmonic modes (HHMs) appearing in the magnetic coils, and are compared with theoretical predictions.

P 11.33 Wed 14:00 HSZ EG

GPU development of the Gyrokinetic Turbulence Code GENE-X with Native Fortran/C++ Interface — •Jordy Trilaksono[1], Philipp Ulbl[1], Andreas Stegmeir[1], and Frank Jenko[1,2] — [1]Max Planck Institute for Plasma Physics, Boltzmannstraße 2, 85748 Garching, Germany — [2]University of Texas at Austin, Austin, TX 78712, USA

Turbulence plays a significant role in plasma confinement inside of magnetic confinement fusion devices. A gyrokinetic turbulence model is used in the GENE-X code [1-3] to simulate turbulence anywhere within magnetic confinement fusion devices from the core to the edge and scrape-off layer. GENE-X leverages hybrid MPI+OpenMP parallelization to meet its expensive computational demands. Here, our effort extends this to GPUs for extensive scalability towards simulations of larger reactor-relevant devices which currently are not feasible with a reasonable amount of computing resources. The abstraction of several GPU backends via native Fortran/C++ interfaces provides portability and non-invasive development parallel to the main Fortran layer. Our Fortran/C++ hybrid approach overcomes compiler limitations that often hinder GPU development of Fortran legacy codes. The current build configuration of GENE-X supports GPU backends such as OpenACC, OpenMP offload and CUDA. Directive-based OpenACC and OpenMP offload are prioritized in the C++ layer of GENE-X.

[1] D. Michels, et. al., Comput. Phys. Commun. 264, 107986 (2021)
[2] D. Michels, et. al., Phys. of Plasmas. 29, 032307 (2022)
[3] P. Ulbl, et. al., Contrib. Plasma Phys., e202100180 (2021)

P 11.34 Wed 14:00 HSZ EG

Helium exhaust and impurity transport in W7-X — •Thilo Romba, Felix Reimold, Thomas Klinger, and W7-X team — Max-Planck-Institut for Plasmaphysik, 17491 Greifswald, Deutschland

The precise monitoring of the impurity content and the understanding of the transport mechanisms is crucial for future fusion reactor operation due to the associated restrictions to the operational parameter space via dilution and increased radiative losses.

This work aims to analyze the transport of impurities in the confined region of the optimized stellarator Wendelstein 7-X (W7-X) [1] with focus on the fusion ash helium. Local impurity densities are measured using charge exchange recombination spectroscopy (CXRS) [2]. While CXRS allows to measure profiles of densities of individual impurity charge states, it has a low sensitivity to the transport coefficients in steady state scenarios [3]. To increase the sensitivity to the transport coefficients in those scenarios, modulated impurity sources outside the confined region are used.

The impurity transport will also be assessed in transient phases of neutral beam heated plasmas. In these scenarios it was found that impurity transport is dominated by inwards directed neoclassical convection and impurity density peaking is observed [4]. This work aims to extend this analysis to different magnetic configurations and impurity species.

[1] Erckmann 1997, [2] Fonck 1985, [3] Romba, in preparation [4] Romba, in preparation

P 11.35 Wed 14:00 HSZ EG

Automated workflow for energetic particle stability — •Virgil - Alin Popa, Philipp Lauber, and Thomas Hayward-Schneider — Max Planck Institute for Plasma Physics, Garching, Germany

EPs (Energetic Particles) driven instabilities are a concern for present (AUG, JET) and future (ITER, DEMO) fusion devices. These particles can come from Neutral Beam Injection or be generated from fusion reactions (alpha particles). Their impact on electromagnetic instabilities in tokamak plasmas can lead to energetic particle transport which affects the heating efficiency of the plasma. Different codes that can study predictive scenarios and/or experimental results are emerging and with them the need of automatic analysis and management of the data they produce. In order to study the linear/non-linear, local/global effects, a workflow that manages the work of several codes is necessary and has been developed using the IMAS framework (Integrated Modelling & Analysis Suite). In addition, several techniques for reducing the dimensionality of the physics results have been implemented, such as: using statistical methods to improve analytical formulas and splitting of the workload in relevant/non-relevant data.

P 11.36 Wed 14:00 HSZ EG

Quasi-Neutral Multi-Fluid Models: A Variational Principle and Numerical Methods — •Sayyed Amin Raiessi Toussi, Omar Maj, and Tomasz Tyranowski — Max Planck Institute for Plasma Physics, D-85748 Garching, Germany

Quasi-neutral multi-fluid models are commonly used to describe particle and energy transport in the edge and scrape-off layer (SOL) of magnetically confined fusion plasmas [R. Schneider, Contrib. Plasma Phys., 46, 2006]. In this work we present a generalization of the variational principle for incompressible Euler equations [V. Arnold, Ann. Inst. Fourier 16, 319-361 (1966)] to quasi-neutral multi-fluid models, including only ideal processes. Also some preliminary considerations on appropriate numerical methods are offered.

P 11.37 Wed 14:00 HSZ EG

Towards Laboratory Astrophysics in Wakefield Accelerators — •Erwin Walter[1], John P. Farmer[2], Martin S. Weidl[1], Patric Muggli[2], and Frank Jenko[1] — [1]Max Planck Institute for Plasma Physics, 85748 Garching, Germany — [2]Max Planck Institute for Physics, 80805 Munich, Germany

From supernovae in distant galaxies to wakefield accelerators in laboratories, the interaction of relativistic particles with plasma is relevant to many physical scales. The electromagnetically dominant current filamentation instability (CFI), which transversely breaks the beam into narrow filaments, may generate a sufficiently strong magnetic field to form collisionless shocks. By changing the operating parameters of beam-driven wakefield accelerators, it may be possible to access this regime relevant to astrophysics.

Due to the large difference in scales, numerical studies with quasistatic particle-in-cell (PIC) methods greatly reduce computational overhead compared to fully electromagnetic PIC. A quasineutral fireball beam consisting of positrons and electrons is simulated to determine to what extent the physics of CFI can be modelled by quasistatic codes and how different numerical methods affect the instability.

This work potentially paves the way to provide insight into analogous astrophysical scenarios in a laboratory setup.

P 11.38 Wed 14:00 HSZ EG

Integrated modelling of impurity transport in ASDEX Upgrade — •Daniel Fajardo[1], Clemente Angioni[1], Giovanni Tardini[1], Emiliano Fable[1], Pierre Manas[2], Rachael McDermott[1], and the ASDEX Upgrade Team[1] — [1]Max-Planck-Institut für Plasmaphysik, Garching, Germany — [2]CEA/IRFM, Saint-Paul-les-Durance, France

A database of experimentally measured boron (B) density profiles at ASDEX Upgrade (AUG) [R.M. McDermott *et al* 2022 *Nucl. Fusion* **62** 026006] is studied via 1.5D integrated modelling with ASTRA. An additional tungsten (W) impurity is evolved and the profile predictions are compared to experiments, which feature variations of the NBI–ECRH heating power mixture. The turbulent transport is calculated with the quasilinear codes TGLF and QuaLiKiz, allowing us to validate the impurity transport predictions of these models. The neoclassical component of B is calculated with NCLASS, whereas the FACIT model is used for W due to the stronger effects of rotation-induced poloidal asymmetries on heavy impurities. The correlation between the predicted logarithmic impurity density gradients and the main plasma gradients is discussed, also in comparison with gyrokinetic results. Moreover, in an additional set of simulations STRAHL is used for the self-consistent calculation of radiated power profiles, which are compared to experimental bolometry estimations.

P 11.39 Wed 14:00 HSZ EG

ECRH in early plasma formation — •Carl Albert Vilhelm Johansson and Pavel Aleynikov — IPP Greifswald, Wendelsteinstraße 1, Germany

The usage of electron cyclotron resonant heating (ECRH) is important in current operation of, amongst other devices, Wendelstein 7-X (W7-X) stellarator, and for future fusion devises. ECRH in the quasi–linear limit is theoretically well understood. However, because the ECRH system is used for plasma breakdown, there exists an interest in understanding the non–linear limit.

In this work, we consider the pre–ionization state. We show the energy gain of a single-electron interacting with the gyrotron beam once. For this interaction, we consider different magnetic field configurations. The interaction between electron and gyrotron beam yield a stronger coupling when located at the slope of the background magnetic field. The slope of the magnetic field dominates the effect for third harmonic interaction, whereas the second harmonic is less affected by the slope.

P 11.40 Wed 14:00 HSZ EG

Modeling of runaway electrons in disruption mitigation scenarios with DREAM — •Peter Halldestam[1], Gergely Papp[1], Hannes Bergström[1], Mathias Hoppe[2], Oskar Vallhagen[3], István Pusztai[3], and Tünde Fülöp[3] — [1]Max Planck Institute for Plasma Physics, Garching, Germany — [2]Swiss Plasma Center, Lausanne, Switzerland — [3]Department of Physics, Chalmers University of Technology, Göteborg, Sweden

One of the main issues threatening the success of future reactor-scale tokamaks is disruptions. It is the sudden loss of confinement where the plasma rapidly dissipates its energy onto the surrounding structures, exposing the device to excessive mechanical stress and heat loads. In addition, an electric field is induced that can accelerate a significant fraction of the electrons to relativistic energies, giving rise to runaway electrons (REs). Unmitigated disruptions could potentially cause severe damage to the device and, thus, modeling such events is crucial for being able to assess the effectiveness of various mitigation techniques.

Using the numerical RE modeling framework DREAM [Hoppe CPC 2021], we study the effects massive material injection (MMI) of deuterium and neon has on disrupting plasma representative of ITER, particularly the RE generation and the dissipation of its energy content. We self-consistently evolve the electric field, ion charge state densities, thermal electron temperature and density as well as the RE density in a flux surface-averaged fluid description of the plasma. This model is used together with a Bayesian optimisation tool to find suitable MMI parameters that minimise potential damage to the device.

P 11.41 Wed 14:00 HSZ EG

Electromagnetic flutter in the full-f edge turbulence fluid code GRILLIX — •kaiyu zhang, wladimir zholobenko, andreas stegmeir, christoph pitzal, konrad eder, and frank jenko — Max Planck Institut für Plasmaphysik, Boltzmannstr.2, 85748 Garching, Germany

Electromagnetic flutter has been implemented and verified in GRILLIX, a full-f turbulence code for the edge and scrape-off layer in tokamaks. Simulations for L-mode ASDEX Upgrade are performed with electromagnetic flutter. We particularly investigate how flutter transport contributes to the density advection and heat conduction perpendicular to the magnetic flux surfaces.

An issue arising during the computation of flutter is that a large-scale magnetic shift will be double-counted in the fixed background magnetic equilibrium and in the full-f turbulence. Commonly, the toroidal average of magnetic potential was stripped to remove this shift. However, this method is found to cause a spurious reduction of the perpendicular flutter turbulent transport in GRILLIX. Two refined methods are explored: (1) removing the time averaged magnetic field; (2) tracing the evolution of Pfirsch-Schluter currents analytically and removing the corresponding induced magnetic field. The new methods seem superior in preserving the amplitude of the perpendicular flutter turbulence transport.

P 11.42 Wed 14:00 HSZ EG

Engineering tool for the robust optimization of a full-W divertor in W7-X — •Antara Menzel-Barbara[1,2], Joris Fellinger[1], Rudolf Neu[2,3], Dirk Naujoks[1], and Thomas Pedersen[1] — [1]Max Planck Institute for Plasma Physics, 17491 Greifswald, Germany — [2]Technische Universität München, 85748 Garching, Germany — [3]Max Planck Institute for Plasma Physics, 85748 Garching, Germany

High levels of fuel retention due to co-deposition make C-based materials such as CFC, currently used on the W7-X divertor, incompatible for a fusion reactor. As part of an ongoing investigation into a W-based divertor for W7-X, an engineering tool for the robust optimization of leading edges is being developed. Leading edges, resulting from assembly tolerances and deformation during operation, lead to very high incidence angles and to strongly increased heat fluxes. Compared to a C-based divertor, leading edges in a W design are more problematic because of W melting. Since manufacturing and assembly tolerances are major cost drivers, relaxing them is another priority for a new divertor. Because particles in W7-X can come from opposite directions on the target surface in different magnetic configurations, the usual strategy of entirely shadowing divertor plates to avoid leading edges is not possible. Instead, a more refined approach that optimizes the divertor surface while considering all major magnetic configurations simultaneously is necessary. A variety of tools, including the code EMC3-Lite and Ansys, is used to rapidly evaluate a modified surface, and identify the problematic areas. Strategies to effectively explore the design space of geometric modifications are currently being investigated.

P 11.43 Wed 14:00 HSZ EG

Validation of theoretical upper bounds on local gyrokinetic instabilities — •Linda Podavini, Per Helander, Gabriel Plunk, and Alessandro Zocco — Max-Planck-Institut für Plamsaphysik, Wndelsteinstraße 1, 17491 Greifswald

Turbulence in magnetic confinement fusion devices is driven by the presence of gyrokinetic microinstabilities. In the last decades these instabilities have been extensively studied considering various assumptions about plasma parameters and magnetic geometry, thus hampering a desirable unified theory.

Only recently, it was shown by Helander and Plunk [1] that it is possible to obtain universal upper bounds on the growth rates of local gyrokinetic instabilities via thermodynamic considerations. These bounds are valid for all possible microinstabilities and they are independent of the magnetic field configuration and some plasma parameters, such as the number of particle species, beta and collisions.

In this work, we compare the theoretical upper bounds on growth rates with numerical and analytical results in different geometries, including stellarator, tokamak and z-pinch. For the numerical results, linear, flux-tube simulations are obtained using the gyrokinetic code stella.

[1] P. Helander and G. G. Plunk, Physical Review Letters, 127, 155001, (2021)

P 11.44 Wed 14:00 HSZ EG

Experimental impurity transport analysis for the tokamak plasma edge — •Tabea Gleiter[1,2], Ralph Dux[1], Francesco Sciortino[1], and the ASDEX Upgrade Team[3] — [1]Max-Planck-Institut für Plasmaphysik, Garching, Germany — [2]Physik-Department E28, Technische Universität München, Garching, Germany — [3]Authors of U. Stroth et al. 2022 Nucl. Fusion 62 042006

Impurity transport in the pedestal and SOL region impacts energy confinement and radiative power exhaust in tokamaks. However, thorough understanding is lacking for many confinement modes. This includes promising regimes for future reactor scenarios without type-I ELMs, such as the quasi-continuous exhaust (QCE) mode.

A series of impurity seeded (Ne, Ar or N) discharges in various confinement modes was conducted at ASDEX Upgrade. Their experimental setup was tailored for high resolution charge exchange recombination spectroscopy (CXRS) measurements at the plasma edge. From the observed line radiation, density profiles of multiple impurity charge states are derived, making use of a neutral beam model, the beam attenuation code COLRAD and ADAS atomic rates. Fitting the charge state distribution with a diffusive-convective transport model such as STRAHL or Aurora, insight can be gained about the impurity transport. Both a Levenberg-Marquardt fit as well as a Bayesian nested sampling algorithm are used for this inverse inference.

Current work focuses on the QCE plasmas in our dataset, comparing them to H-mode with type-I ELMs. In particular, discharges with a stepwise transition between both regimes are evaluated.

P 11.45 Wed 14:00 HSZ EG

ASDEX Upgrade shattered pellet injection experiments — •Paul Heinrich[1], Gergely Papp[1], Matthias Bernert[1], Pascal de Marné[1], Mathias Dibon[1], Stefan Jachmich[2], Michael Lehnen[2], Tobias Peherstorfer[3], Umar Sheikh[4], Jakub Svoboda[5], The ASDEX Team[6], and The MST1 Team[7] — [1]Max-Planck-Institut für Plasmaphysik, Garching, Germany — [2]ITER, St. Paul-lez-Durance, France — [3]Institute for Applied Physics, Wien, Austria — [4]EPFL, Lausanne, Switzerland — [5]IPP CAS, Prague, Czech Republic — [6]See author list of U. Stroth et al. 2022 Nucl. Fusion 62 042006 — [7]See author list of B. Labit et al. 2019 Nucl. Fusion 59 086020

In December 2021, the shattered pellet injection (SPI) system was successfully installed on the tokamak ASDEX Upgrade (AUG). Hereby, large amounts of material are injected into the plasma, radiating strongly and thereby spreading the previously confined energy over a larger area in comparison to unmitigated disruptions. The AUG SPI system allows a large variation in pellet parameters – such as pellet size, velocity or composition – and different shatter geometries. The ultimate goal is to assist the design of the ITER disruption mitigation system (DMS). In the 2022 campaign at ASDEX Upgrade around 240 discharges were performed for the SPI experiments. Different shatter heads were installed at the end of each of the three independent guide tubes. The focus of the analysis presented here is to find the optimal pellet parameters and shatter geometries for maximizing the radiated energy, while reducing localized heat loads.

P 11.46 Wed 14:00 HSZ EG

Investigation of Tearing Modes in ASDEX Upgrade — •Magdalena Bauer, Louis Giannone, Anja Gude, Felix Klossek, Marc Maraschek, Bernhard Sieglin, Wolfgang Suttrop, Hartmut Zohm, and The ASDEX Upgrade Team — Max Planck Institute for Plasma Physics, Garching

Tearing modes with toroidal mode number n=1 are precursors of and significantly involved in disruptions, especially when they are locked to the vessel. While rotating modes can be observed by many Mirnov coils measuring the time derivative of the poloidal magnetic perturbation field, locked modes require a radial field measurement. In addition to the saddle coils on the high field side, toroidally distributed radial field coils at two different poloidal positions on the low field side can be used to gain information on slowly rotating and locked modes. A 3D finite element model, simulating the field generated by a single helical perturbation current in all coils, has been improved by considering the detailed coil geometry and a better description of conducting in-vessel parts in which mirror currents affecting the local perturbation field are induced. Coupling of n=1 modes with different poloidal mode numbers is believed to play a large role in the disruption process. The projection of the measured complex amplitudes in all coils on the modelled perturbation amplitudes with single helicities allows to determine the contribution of different poloidal mode numbers for rotating modes. For locked modes, only the three poloidal positions of the radial field coils are available. The opportunities and limitations of the poloidal mode structure analysis are investigated.

P 11.47 Wed 14:00 HSZ EG

Power balance analysis and predictive modelling using the codes neotransp and NTSS — •Markus Wappl, Marc Beurskens, Sergey Bozhenkov, Hakan Smith, and Yuri Turkin — Max-Planck-Institute for Plasma Physics, Greifswald, Germany

One effect seriously limiting the plasma performance of the stellarator Wendelstein 7-X is ion temperature clamping, which restricts ion temperatures to about 1.5 keV in a wide range of scenarios. Empirical scaling laws such as ISS04 predict the performance of stellarators. However, no first-principle models offering a physical understanding or a clear explanation for the clamping are available. It has been shown that turbulent flux losses limit the achievable performance of a stellarator. ITG modes are thought to be the dominating turbulent process for ion heat losses and might be the cause for the ion temperature clamping observed at W7-X.

Power balance analysis allows a physics-motivated understanding of plasma performance including ion temperature clamping. Detailed modelling of neoclassical and turbulent heat fluxes is critical for this approach. A novel webtool for the power balance analysis of Wendelstein 7-X plasma discharges is presented. It employs the codes neotransp and NTSS for neoclassical calculation as well as Monte Carlo sampling for reliable error propagation. Predictive modelling of ion temperature profiles is performed in the code NTSS using a dummy density profile and ECR heating deposition profile. Ion temperature clamping is reproduced with simplified model assumptions which indicates that ITG modes might not be the primary reason for clamping.

P 11.48 Wed 14:00 HSZ EG

Non-Axisymmetric Generalization of the Gyrokinetic Turbulence Code GENE-X — •Marion Smedberg[1], Andreas Stegmeir[1], Philipp Ulbl[1], and Frank Jenko[1,2] — [1]Max Planck Institute for Plasma Physics, Boltzmannstraße 2, 85748 Garching, Germany — [2]University of Texas at Austin, Austin, TX 78712, USA

For optimized stellarators, edge plasma turbulence both sets the boundary condition for core performance and determines the heat fluxes onto the plasma-facing components. Thus realistic simulations of plasma turbulence in the edge and scrape-off layer (SOL) are a key step towards a stellarator power plant. The gyrokinetic turbulence code GENE-X [1] is well-equipped to simulate edge and SOL turbulence due to the use of a flux-coordinate independent (FCI) coordinate system [2]. However, until now the code has only simulated in axisymmetric geometries, such as tokamaks. Here progress towards a non-axisymmetric upgrade of the GENE-X code is presented. The focus will be on the implementation of stellarator magnetic fields, the development of numerical methods for representing the shape of three-dimensional flux surfaces, and simulating simple diffusion and advection models in a fully three-dimensional geometry.

[1] D. Michels, et. al., Comput. Phys. Commun. 264 (2021)
[2] F. Hariri, et. al., Comput. Phys. Commun. 184 (2013)

P 12: Poster II

Time: Wednesday 17:30–19:00 Location: HSZ EG

P 12.1 Wed 17:30 HSZ EG

Laser-induced charge ablation in surface DBD — •Robin Labenski, David Steuer, Henrik van Impel, Volker Schulz-von der Gathen, Marc Böke, and Judith Golda — Ruhr-University Bochum, D-44801 Bochum, Germany

In the emerging field of plasma catalysis, atmospheric pressure plasmas turned out to be promising candidates. Especially micro cavity plasma arrays allow for fundamental investigation of the interaction between the plasma and catalytic surfaces. As this reactor is a surface DBD, the used dielectric (e.g., catalyst) plays a crucial role in its discharge behavior since it can be charged during ignition. To visualize these charges and investigate their impact on catalysis, the array (15kHz, 400-800V) is irradiated using a nanosecond Nd:YAG-laser (20Hz, 532nm/1064nm) to ablate the charges during/after ignition. The impact of the laser is detected using global (and eventually local) electrical measurements as well as optical emission spectroscopy. While global electrical measurements involve current and charge measurements (i.e., Lissajous- figures), local measurements are planned to be performed using a Picoamperemeter directly picking up the ablated charges. Measurements show a lower/higher ignition voltage in the consecutive (half-) cycle and a decrease of charge in the Lissajous-figure immediately after laser irradiation.

This work is supported by the DFG via SFB 1316 (project A6).

P 12.2 Wed 17:30 HSZ EG

Characterization of the atmospheric plasma source HelixJetS: generation of silicon nanoparticles — •Leonie Mohn, Maren Dworschak, and Jan Benedikt — Institut of Experimental and Applied Physics, Kiel University, Germany

Silicon nanoparticles are of interest in developing new technologies such as next generation solar panels. Low-pressure discharges can produce silicon nanoparticles reliably but the cost effective and modular nature of atmospheric discharges makes them compelling to study. The atmospheric plasma source HelixJetS is analyzed to determine its ability to produce such silicon nanoparticles. The HelixJetS, a scaled down version of the HelixJet, has two electrodes that form a double helix, one of which is driven by RF power. The jet is operated with gas mixtures consisting of He, Ar, H_2 and SiH_4. To minimize the material deposition, there are two spatially separated gas inlets for He/H_2 on the outer diameter and for He/Ar/SiH_4 on the jet axis. The flow rates are simulated with Comsol to find those that achieve laminar flow. The Jet is characterized by varying the gas composition and the power deposited into the plasma and analyzing the resulting plasma by means of optical emission spectroscopy. The resulting nanoparticles are analyzed in regards to size, composition and photoluminescence. A Scanning mobility particle sizer is used to obtain the size distributions. FTIR and *in situ*-FTIR are used to determine the chemical composition of the particles. If the silicon nanoparticles crystallize, they exhibit photoluminescence, which is also qualitatively analyzed.

P 12.3 Wed 17:30 HSZ EG

Deposition of thin films from organosilicon precursors by means of photochemistry with VUV-radiation from an atmospheric pressure plasma jet — •Christina Reiser, Tristan Winzer, and Jan Benedikt — Institute of Experimental and Applied Physics, Kiel University, Kiel, Germany

Deposition of thin films using atmospheric pressure plasma (APP) is still limited due to the high collision rates and in the case of many precursors (C_2H_2, SiH_4) also due to fast formation of particles in the gas phase, resulting from the fast polymerization of negative molecular ions. Activation of these precursors with VUV-photons should avoid the formation of the negative ions and, therefore, also particles.

In this work, a high purity noble gas plasma is used for producing intense VUV-radiation from noble gas excimer species. The gas flow through the plasma is guided in such a way, that the plasma and the effluent have no contact with the precursor gas flow, while the emitted radiation produces ions and radicals in the precursor gas flow directly in front of the treated surface. For optimizing deposition rates and film quality, parameter variations are carried out in which the photochemistry of organosilicon precursors is analyzed by ion mass spectrometry. Deposited films are characterized using Fourier transform infrared spectroscopy (FTIR).

P 12.4 Wed 17:30 HSZ EG

Numerical modeling of CO_2 microwave discharges: first verification steps of electromagnetics — •Pirmin Almanstötter[1], Dominikus Zielke[1], and Ursel Fantz[1,2] — [1]Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, 85748 Garching — [2]AG Experimentelle Plasmaphysik, Universität Augsburg, 86135 Augsburg

To optimize the efficiency of CO_2 conversion processes, microwave plasmas (2.45 GHz) are very promising. Examples are the plasma torch (pressure 20-1000 mbar, power: 0.3-3 kW, flow: 3-100 slm), which can even operate at atmospheric pressure and the surfaguide (pressure 0.3-100 mbar, power: 0.3-1.2 kW, flow: 0.3-10 slm). To accompany experimental optimization efforts and for a systematic investigation, a numerical model is needed that describes the electromagnetics and plasma self-consistenly. Before the model can be applied with confidence verification and validation is necessary. This is done for the electromagnetics and the discharge part separately, which consequently will be coupled. The contribution covers the verification of the electromagnetics part. As a first example, solutions of waveguides in cylindrical and rectangular geometries with either dielectric or conducting walls are investigated. It is shown that the solutions obtained by the numerical model match the analytical results.

P 12.5 Wed 17:30 HSZ EG

Durability of metal-organic-frameworks (MOFs) in non-equilibrium atmospheric pressure plasmas — •Alexander Quack[1], Kerstin Sgonina[1], Hauke Rohr[2], Norbert Stock[2], and Jan Benedikt[1] — [1]Institute of Experimental and Applied Physics, Kiel University — [2]Institute of Inorganic Chemistry, Kiel University

Metal-organic-frameworks (MOFs) have a large surface area and different metallic structures, which gives them good catalytic properties. Nevertheless, MOFs mostly can not withstand high temperatures, which are needed for their activation in classical catalytic reactions. Non-equilibrium atmospheric pressure plasmas provide reactive and internally excited particles and allow for plasma assisted catalysis at lower temperatures. For these processes MOFs can be used as a catalyst, if they withstand the plasma conditions.

We have developed a dielectric barrier discharge (DBD) reactor (21 kHz, up to 17 kV_{pp}) to determine the stability and suitability of different MOFs for plasma assisted catalysis. Reactive plasmas using gas mixtures based on N_2, H_2 and CO_2 gases and post- and in-plasma treatment under externally controlled temperature up to 200 °C have been applied to several MOFs including Zif-8, Zif-67 and MAF-6. Structural MOF analysis (XRD, FTIR) allows us to judge the stability of the MOF in the applied plasma treatments.

P 12.6 Wed 17:30 HSZ EG

Space resolved temperature measurements in an atmospheric pressure argon methane microwave plasma — •Simon Kreuznacht, Marc Böke, and Achim von Keudell — Experimental Physics II, Ruhr University Bochum, Germany

Hydrogen is often envisioned as the energy carrier and green fuel of the future. However, new energy efficient and greenhouse gas free production methods are needed to utilize hydrogen as energy carrier on larger scales. A promising production method is the pyrolysis of methane in a microwave plasma. Here, we present a microwave plasma torch operated in an argon methane mixture (60 slm total flow rate, up to 35 % methane admixture) at atmospheric pressure. Microwaves with a frequency of 2.45 GHz and up to 6 kW of forward power are used to sustain the plasma. The methane is converted to hydrogen, solid carbon, acetylene and ethylene inside the plasma. The emission spectrum from the plasma is dominated by black body radiation from hot carbon particles and the dicarbon Swan bands. Broadband spectra of the black body radiation and high-resolution spectra of the dicarbon Swan bands are used to estimate the space resolved gas temperature from the black body temperature and the dicarbon rotational temperature. In the center the plasma reaches temperatures of up to 4600 K with large gradients of about 500 K in radial direction and 50 K in axial direction.

P 12.7 Wed 17:30 HSZ EG

Exploration of New Use Cases of Cold Atmospheric Plasma in Medicine, Surface Decontamination and Astronautics — •Alisa Schmidt and Markus H. Thoma — Justus-Liebig-Universität, Gießen, Deutschland

Wound healing, the corona pandemic and manned spaceflight - how can a connection be drawn between all these different areas via physics?

All of these three areas have their own problems: the healing of chronic wounds, for example, can be inhibited by wound healing disorders and infections, in the corona pandemic there were supply shortages of protective equipment and respiratory masks - which led to the reusability of protective equipment becoming a subject of discussion - and finally manned space flight, according to NASA, aims to bring humans to the moon again in 2025 and even fly them to Mars by 2040 - however, there is the problem of keeping the closed life support systems on space vehicles and future lunar or even planetary stations clean.

We have approached these problems with a common solution approach - treatment with physical cold atmospheric plasma. Experimental design and results will be presented in this contribution.

P 12.8 Wed 17:30 HSZ EG

Research data management in plasma science — •Markus M. Becker[1], Kerstin Sgonina[2], and Marina Prenzel[3] — [1]Leibniz Institute for Plasma Science and Technology (INP) — [2]Institute of Experimental and Aplied Physics, Kiel University (CAU) — [3]Research Department Plasmas with Complex Interactions, Ruhr-University Bochum (RUB)

Implementation of data management standards and adoption of the FAIR data principles are more and more requested by funding agencies in recent years. This results in several new challenges for the scientific community. Research in low-temperature plasma physics is characterized by table-top experiments and a large variety of plasma sources and measurement devices, which are often first developed in the course of the research. Therefore, there are usually no established research data management (RDM) standards. Moreover, the documentation of research results is extremely heterogeneous. This not only complicates the implementation of structured RDM, but also reduces the comparability and reusability of data. To overcome this challenges, research groups at INP, RUB and CAU have joined forces to develop common RDM standards and tools. In monthly workshops, local requirements are discussed and gradually transformed into proposals for community standards, see https://www.plasma-mds.org. The poster reports on the status of the activities and presents how everyone can contribute and use the already developed tools for their own work.

The work was supported by grants 16QK03A (BMBF) and 327886311 (DFG).

P 12.9 Wed 17:30 HSZ EG

Dust flows around an obstacle under microgravity — •Stefan Schütt, Christina Knapek, Daniel Maier, Daniel Mohr, and André Melzer — University of Greifswald, Greifswald, Germany

Dust flows around an obstacle in three-dimensionally extended dusty plasmas have been investigated on parabolic flights. A fixed tungsten wire has been installed in the plasma chamber perpendicular to the observation plane of a video microscopy setup and serves as an obstacle. Three different situations were created. First, the dust flow around the wire was investigated during the pull-out phase at the end of each parabola, when gravity sets in and the dust cloud moves downward past the wire. Second, a dust motion with respect to the fixed wire was generated by modulation of the electrode bias. And third, the wire was electrically biased and the reaction of the dust to bias voltage changes was studied. In this contribution, a first evaluation of all three situations will be presented.

This work was supported by DLR under grant no. 50WM1962.

P 12.10 Wed 17:30 HSZ EG

Development of a holographic optical trap design — •Christian Theden, Natascha Blosczyk, and Dietmar Block — Institute of Experimental and Applied Physics, Kiel University, Germany

In the research focus of dusty plasmas, a controlled manipulation of dust particle position is considered a major challenge. Especially in the field of binary mixtures, there is great interest in being able to control the positions of the particles to create binary crystals or liquids with periodic particle arrangement. First experiments show that optical tweezers can manipulate single particles in a dusty plasma [1, 2]. The problem here is that only one particle can be moved at a time. This is different for holographic-optical tweezers. Here the basic idea is to generate digitally a hologram and displayed on a spatial light modulator (SLM). Laser illumination of the SLM can create arbitrary light field and thus realize multiple tweezers at once. In this way, several tweezers can be projected at the same time. In addition, the hologram can be varied dynamically. The aim of this work and the first step towards such a powerful device is a single tweezer setup with a SLM. To determine the forces in the plasma that a holographic-optical tweezer exerts on a particle, the radiation pressure and the gradient forces are examined. This allows to develop a trap design and implement the holographic-optical tweezers in a dusty plasma experiment.

[1] V. Schneider, H. Kersten, 2018 Rev. Sci. Instrum. 89
[2] J. Schablinski, F. Wieben and D. Block, 2015 Phys. Plasmas 22

P 12.11 Wed 17:30 HSZ EG

Influence of the ion focus on diagnostics and simulations in 2D dusty plasmas — •Natascha Blosczyk, Yang Liu, and Dietmar Block — Institute of Experimental and Applied Physics, Kiel University, Germany

Evaluating dust particle properties is an important part in the field of dusty plasmas as properties such as charge can strongly influence the behaviour of single particles and, because of their coupling, of the entire system. A current interest is the description and evaluation of wave propagation in a 2D cluster, especially in clusters of binary mixtures. For this purpose, phonon dispersion relations and configurational temperature can be used as diagnostics to evaluate wave frequencies and charge respectively. These methods rely on a full and correct description of the interaction forces. Until now it has been mostly assumed to be a purely repulsive Yukawa interaction, disregarding the influence of a positive ion focus charge. Based on MD simulations, this poster will discuss the importance of the ion focus in simulations and diagnostics and wether it can really be disregarded.

P 12.12 Wed 17:30 HSZ EG

Creating nanodust clouds with different electrode geometries — •Franko Greiner, Andreas Petersen, and Alexander Schmitz — Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität Kiel

In a radio-frequency driven parallel plate reactor, nanodusty plasmas are created by means of reactive argon acetylene or argon silane plasmas. Switching off the reactive gas admixture creates a pure dusty plasma, consisting only of electrons, ions, and dust with a predeterminable radius. Using Mie polarimetry, Video aided extinction measurements (VAEM), and dust density wave diagnostic (DDW-D), the nanodusty plasma can be fully diagnosed [1]. For our standard setup of 60 mm circular electrodes with a 32 mm electrode gap we found dust densities of up to $6 \cdot 10^{13} m^{-3}$, creating a strongly electron-depleted plasma. We investigate the impact of different electrode geometries on the dust and plasma parameters of the created nanodusty plasmas. [1] A. Petersen et al, Communications Physics (2022), https://doi.org/10.1038/s42005-022-01060-5 (open access)

P 12.13 Wed 17:30 HSZ EG

Anaylsis of microparticle trajectories during free fall — Andreas S. Schmitz[1], •Luisa Hanstein[1], Michael Kretschmer[1], Christoph Lotz[2], and Markus H. Thoma[1] — [1]I. Physikalisches Institut, Justus-Liebig-Universität Gießen, Germany — [2]Instititut für Transport- und Automatisierungstechnik, Gottfried Wilhelm Leibniz Universität Hannover, Germany

In a radiofrequency plasma chamber microparticles were placed in a low-pressure plasma, where they became charged and levitated against gravity by an electric field. The argon-filled chamber was installed in the University of Hannover's drop tower, the Einstein Elevator. As the setup fell, the microparticles spread into the bulk plasma due to the electric field and were imaged with a CCD camera. The trajectories of the microparticles, which were determined by image analysis, were used to determine the electric forces acting on the microparticles. Considering fluid dynamic simulations, we were able to determine the electric field acting on the microparticles.

P 12.14 Wed 17:30 HSZ EG

Investigation of Screw-Like Wave Phenomena in DC-Discharged Plasma with PK-4 — •Lukas Wimmer and Markus H. Thoma — Justus-Liebig-University Gießen, Germany

If micrometer to nanometer-sized microparticles are introduced into a plasma, it is referred to as dusty or complex plasma. The Plasmakristall-4 facility (PK-4) is the fourth and latest version of a successful series of experiments for the fundamental research of complex plasmas. If PK-4 is operated at low pressure, p < 25 Pa, as well as at low energy, and the dust particle size falls below a certain limit, screwed-like wave phenomena appear in ground-based experiments. Local system properties show that the wave structure is caused by the two-stream instability of ions and dust particles, assigned to the regime of dust-acoustic waves, and the superposition of longitudinal and transversal waves causes the curvature of the waves. Deeper analysis gives us information about the ion drag force in the low-pressure regime and the local electric field in the boundary region.

P 12.15 Wed 17:30 HSZ EG

Particle Chains in Dusty Plasmas under microgravity — •Daniel Maier, Michael Himpel, Stefan Schütt, and André Melzer — Institut für Physik der Universität Greifswald, Greifswald, Deutschland

Chain-like structures of charged dust particles have been observed in dusty plasmas under microgravity conditions. These structures appear near the midplane and around the particle free zone (void) of the plasma. The previous 2-dimensional investigations of the chains have difficulties in separating chains from each other, proofing their authenticity or observing them at full length. The described experimental set-up, containing four high speed cameras allows a stereoscopic, 3-dimensional observation and investigation of these structures and the interaction of the included particles with high temporal resolution (up to 200 fps). Here a simple model to identify chains and first results of the stereoscopic investigations will be shown.

P 12.16 Wed 17:30 HSZ EG

Ion emission of various materials from laser plasmas using a pre-pulse — •Qëndresa Ibraimi, Lars Torben Schwabe, Jan Riedlinger, and Georg Pretzler — Institut für Laser- und Plasmaphysik, Heinrich-Heine-Universität Düsseldorf

Plasmas generated by ultra-short, intense laser pulses have high density and temperature, are far from equilibrium, and their dynamics is dominated by several transient processes. Therefore, the ion dynamics in the early phase of these plasmas is difficult to predict. Here, we present experimental data of the ion emission driven by single-digit-fs laser pulses with intensities up to 10^{17} W/cm^2 focused on various solid targets. The ions reach kinetic energies of several tens of keV and were characterized in terms of species, direction, and energies by a Thomson parabola spectrometer. The differences of the spectra for distinct materials and pre-plasma conditions may allow conclusion on processes during and after laser-surface interaction. These findings are presented and discussed.

P 12.17 Wed 17:30 HSZ EG

Influence of a pre-pulse on ultra-short laser-induced plasma emission — •Timo Wenier, Steffen Mittelmann, and Georg Pretzler — Institut für Laser- und Plasmaphysik, Heinrich-Heine-Universität Düsseldorf

In the versatile field of Laser-Induced Breakdown Spectroscopy (LIBS), ultrashort laser pulses in the femtosecond range are promising tools for detecting impurities and material composition with very high lateral and depth resolution. It has been shown that double-pulse or pre-pulse systems may significantly enhance the emission of the detected spectral lines of atoms and ion species present in the laser-induced plasma. This effect is systematically studied in this work: We investigate the influence of a pre-pulse on the emitted spectral lines in a vacuum LIBS setup with laser pulses of durations in the sub-10-fs range. The main pulse delay is varied up to 800ps and the influence on plasma parameters and ablation yield is examined on polished copper and silicon samples. First results give evidence that there are regimes where higher ionization degrees and temperatures can be achieved. Significantly decreased ablation yield is observed at the same time, which is attributed to plasma shielding effects. These results path the way for further optimization of ultra-short pulse LIBS with even higher spatial resolution.

P 12.18 Wed 17:30 HSZ EG

Experimental determination of the phase shift upon reflection — •Johanna Köchling, Nico Potzkai, and Georg Pretzler — Institut für Laser- und Plasmaphysik, Heinrich-Heine-Universität Düsseldorf

Interferometry can determine the expansion of laser plasmas in their early stage with a temporal resolution down to 10 fs. However, with measurements in the reflection geometry, the phase shift of the light reflected at the surrounding undisturbed material must be known precisely as a reference. In this contribution, we present experimental results for this reflective phase shift for a series of thin metal layers of different thickness. The results are compared with with theory and extrapolated to other regimes.

P 12.19 Wed 17:30 HSZ EG

Interplay of turbulent density and momentum transport in TJ-K plasmas — •Ralph Sarkis and Mirko Ramisch — IGVP, University of Stuttgart, Germany

Turbulent fluctuations of the potential and density in the magnetically confined plasma at the TJ-K stellarator are coupled as to give rise to radial turbulent cross-field transport of particles and poloidal momentum. Both transport phenomena have mutually exclusive prerequisites, being a strong density-potential cross-coupling for the Reynolds stress and decoupling for the particle transport. A poloidal Langmuir probe array is used to understand the turbulent transport phenomena in dependence of the geometry. This also allows to examine temporal alternations in the density-potential cross-coupling as a possible explanation for their coexistence. Conditional sampling and cross-correlation of transport with respect to the occurrence of zonal-potential events is used to establish a temporal and spatial relation, unravelling the dependence and coupling factors at play in both turbulent processes. Spectral analysis is also applied to address the interplay and to distinguish amplitude from phase modulations.

P 12.20 Wed 17:30 HSZ EG

The sticking machine: measuring electron sticking coefficients using dusty plasmas — •Armin Mengel and Franko Greiner — Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität zu Kiel

A central property of (micro-)particles in laboratory plasmas is the strong negative charge they accumulate. It is, among other things, dependent on the electron sticking coefficient of the particle material. In many descriptions of plasma-surface interaction, the electron sticking coefficient is, due to lack of better knowledge, assumed to be 1. However, recent quantum-mechanical calculations[1] hint at significantly smaller values for dielectric surfaces at low energies, while metallic surfaces are known to have a sticking coefficient very close to unity. Subsequent excitation and long-distance-microscopy measurements with SiO_2 and metal-coated particles under the same plasma conditions allow for the determination of the ratio of the particles' charge and sticking coefficient. We present a study comparing metal-coated particles with SiO_2 particles in order to obtain the sticking coefficient of the latter. This enables us to determine the low-energy sticking coefficient of dielectric materials using dusty plasma.

[1] F.X.Bronold et al., Plasma Phys. Cont. Fusion **59** (2017) 014011, https://iopscience.iop.org/article/10.1088/0741-3335/59/1/014011

P 12.21 Wed 17:30 HSZ EG

Characterization of low-pressure plasmas in highly porous and lightweight aeromaterials — •Karin Hansen[1], Lena M. Saure[2], Rainer Adelung[2], and Franko Greiner[1] — [1]Institute of Experimental and Applied Physics, Kiel University, Kiel, Germany — [2]Institute for Materials Science, Kiel University, Kiel, Germany

Plasma catalysis is a research field of growing interest due to the ongoing challenges in environmental protection. For the understanding of plasma catalysis, the interaction between the plasma and the catalyst surface plays an important role. Highly porous materials are used to provide a large surface area for a catalytic reaction processes. As the interplay of a plasma with porous material is not well studied, but crucial for further research, we investigate aeromaterials, micron-sized frameworks with nano-sized walls, in low-pressure plasmas. Highly porous (> 99.9 %) and lightweight ($< 2\,\mathrm{mg\,cm^{-3}}$) aeromaterials are developed in the group of R. Adelung at Kiel University and can be generated from different materials and with different porosity and conductivity.

In this work we explore the interaction of aeromaterials with low-pressure argon plasmas. To this end, a radio-frequency argon plasma is ignited in cylindrical cavities in aeromaterial cylinders. The impact of the aeromaterial wall interfaces on the plasma is studied with optical emission spectroscopy (OES) and electrostatic probes.

P 12.22 Wed 17:30 HSZ EG

Effect of magnetic islands on fast ion confinement in toroidal devices — •David Kulla[1], Samuel Lazerson[2], Athina Kappatou[1], Robert Wolf[2], and Hartmut Zohm[1] — [1]MPI für Plasmaphysik, Garching — [2]MPI für Plasmaphysik, Greifswald

Fast ion transport and confinement is an important area of fusion research: the fast ions have to heat the thermal plasma collisionally to reach self-sustaining conditions, and must not be lost e.g. to the vessel wall beforehand. Tokamaks are largely axisymmetric, but suffer from magnetic perturbations which can break this property and lead to increased fast ion transport. Stellarators are intrinsically three-dimensional in their magnetic configuration, but are generally less prone to transient perturbations in their field. In present experiments, one of the main methods of generating fast ions is neutral beam injection (NBI). Magnetic islands arise from helical perturbations of the background magnetic field, either internally from the plasma or externally from magnetic coils.

BEAMS3D is a Monte Carlo code that simulates NBI deposition and collisional slowing down in stellarator and also tokamak plasmas. We present results of verification against NUBEAM as well as validation against experimental data at the ASDEX Upgrade tokamak using fast-ion D-alpha light (FIDA). The results show good agreement between the codes and to experimental data both in on- and off-axis NBI heating phases, demonstrating the capability of BEAMS3D. Additionally, first results comparing simulations and experimental data of plasmas with internal islands are presented.

P 12.23 Wed 17:30 HSZ EG

Towards non-linear hybrid simulations of the interaction between energetic particles and the plasma in realistic tokamak geometry — •Felix Antlitz, Xin Wang, and Matthias Hoelzl — Max Planck Institute for Plasma Physics, Garching b. M., Germany

Future burning plasma experiments will feature a high supra-thermal particle pressure which strongly interact with magneto-hydrodynamic instabilities. To describe these dynamics accurately in simulations, realistic tokamak geometry, the self-consistent evolution of the plasma equilibrium, and a full-f treatment of the energetic particle population are needed. This contribution describes developments towards this goal based on the non-linear MHD code JOREK, in which a hybrid mode for energetic particles had recently been introduced based on a pressure coupling and tested linearly. The non-linear evolution of fishbone instabilities is foreseen as one of the first applications.

P 12.24 Wed 17:30 HSZ EG

Thermal equilibrium for non-neutral plasma in a magnetic dipole trap — •Patrick Steinbrunner[1], Matthew R. Stoneking[2], Thomas M. O'Neil[3], and Daniel H. E. Dubin[3] — [1]Max Planck Institute for Plasma Physics, Greifswald, Germany — [2]Lawrence University, Appleton, USA — [3]University of California San Diego, La Jolla, USA

The confinement of a non-neutral plasma in a thermal equilibrium state is known to be possible in the uniform magnetic field of a Penning-Malmberg trap. We generalize the theory of these states to include inhomogeneous magnetic dipole fields. We present computational results for local thermal equilibria along magnetic field lines as well as global thermal equilibria and there respective zero-temperature limits. The distribution function of a global thermal equilibrium state is obtained by maximizing the plasma entropy subject to fixed values for the total number of particles, total energy and total canonical angular momentum. If a non-neutral plasma arrives in this state, there is no conceptual limit on the confinement time. Such a configuration also confines a quasi neutral plasma for a finite amount of time, making it an attractive candidate for the creation of an electron-positron pair plasma as planned by the APEX collaboration.

P 12.25 Wed 17:30 HSZ EG

Influence of Radial Electric Field and Ideal Ballooning Stability on the Pedestal Width — •Lidija Radovanovic[1], Elisabeth Wolfrum[2], Mike Dunne[2], Marco Cavedon[3], Georg Harrer[1], Friedrich Aumayr[1], and ASDEX Upgrade Team[4] — [1]Institute of Applied Physics, TU Wien, 1040 Vienna, Austria — [2]Max Planck Institute for Plasma Physics, 85748 Garching, Germany — [3]Universit'a di Milano-Bicocca, 20126 Milano, Italy — [4]see author list of U. Stroth et al. 2022 Nucl. Fusion 62 042006

Understanding the physical processes which govern the pedestal is crucial for reliable prediction and control of the plasma conditions and for its stability. The first experimental method investigates if the ideal ballooning modes at the pedestal top could cause additional transport and limit the pedestal width. A variation in the plasma stability is achieved by modifying the shape of the plasma. Increasing the triangularity of the plasma widens the electron pressure pedestal at a fixed gradient, which correlates with the minimum ballooning stability. The second method assumes that the turbulence in the plasma edge is suppressed due to the presence of a critical shear flow originating from radial electric field gradients. The radial electric field is varied by changing the density in discharges which use different heating systems to achieve the same total power, but which apply a different amount of torque to the plasma. It is shown that the electron density changes with shaping and the ion temperature with torque of heating method. Therefore it seems as if there is no clear actuator for the pedestal width, but each component is influenced individually by different physical processes.

P 12.26 Wed 17:30 HSZ EG

Causal coupling between small-scale fluctuations and zonal flows at the stellarator TJ-K — •Nicolas Dumérat and Mirko Ramisch — IGVP, University of Stuttgart, Germany

Convergent cross mapping (CCM) is a causality inference technique used to identify causal links and directions of influence between variables. In this work, Langmuir probe measurements of plasma potential and density fluctuations across TJ-K's whole poloidal cross section are used as input for the CCM to map causal links between turbulent phenomena across distant flux surfaces.

Thus, zonal potential (ZP) structures are found to be causally related to density fluctuations in the core, which could reflect equilibrium density modulation via transport regulation by ZP through the shearing of drift-wave structures. Causal coupling between plasma potential and ZP fluctuations has been found to exhibit a strong bi-directional relation around the region of both maximum Reynolds stress and turbulent particle transport. Moreover, ZP is found to be caused by small-scale density and potential fluctuations with density dominating over potential. This is in line with vortex tilting and subsequent zonal flow drive in consequence of strong density-potential coupling drift-wave turbulence. The expected predator-and-prey relationship between background turbulent structures and zonal flows is unveiled with CCM and further analysis concerning its poloidal locality is under investigation.

P 12.27 Wed 17:30 HSZ EG

Divertor spectroscopy during Detachment in Wendelstein 7-X — •Frederik Henke, Maciej Krychowiak, Ralf König, Felix Reimold, Erik Flom, and Dorothea Gradic — Max Planck Institute for Plasma Physics, Wendelsteinstr. 1, 17491 Greifswald, Germany

Detachment is a mandatory regime for running long discharges with high power in W7-X in order to not reach the power load material limits of the walls. As a future stellarator reactor will run steady state, the detachment regime has to be investigated. In this work, the mainly used diagnostic system is divertor spectroscopy. Various important aspects during this regime can be assessed using different spectroscopic methods. One challenging aspect is the density build up in detachment as high pressures are needed to have good impurity and density control via pumping. To measure this in the SOL, the Stark broadening of Balmer lines is analysed. Another important aspect is the composition of the SOL plasma. Radiation of a large fraction of the input power is necessary to enter the detachment regime. For reaching these radiation levels, hydrogens radiation capabilities are insufficient. Therefore, the intrinsic impurity carbon or seeded impurities nitrogen, neon or argon are needed. As carbon is no reactor relevant wall material, it is crucial to understand the behaviour of the seeded impurities. Only very low concentrations of impurities can be tolarated in the core plasma of future reactor because of fuel dilution and radiation, while they are needed at the edge. This aspect is investigated via line ratio divertor spectroscopy combined with CXRS in the core.

P 12.28 Wed 17:30 HSZ EG

Measurement and Modeling of radiation losses in the stellarator TJ-K — •Izel Gediz and Alf Köhn-Seemann — IGVP, University of Stuttgart, Germany

In the stellarator TJ-K cold plasmas of up to 20 eV are routinely produced. An 8-channel gold-foil bolometer is used to observe the radiation emitted by the plasma. Following the principle of a "camera obscura" the 8 channels observe the plasma through a small slit, allowing for reconstruction of the spatial profile of the emitted radiation. In this manner line integrated power profiles can be recorded, giving information about the absolute numbers of radiated power as well as the relative spatial distribution of the radiation. This diagnostic was recently reestablished and newly calibrated to aid parameter studies, including plasma density and temperature measurements. Line radiation is the major contributor to the radiation losses of typical plasmas in TJ-K. Information about the absolute loss term due to radiation will give further insights in the efficiency of confined plasmas as well as increase the accuracy with which other loss-terms (e.g. diffusion terms) in energy- and particle-balance equations can be estimated. Furthermore the spatial radiation profiles can reveal interesting parameter regimes where e.g. fast electrons in the plasmas edge regions could be observed. The radiation profiles are also being calculated and compared with the measurements, enabling adjustments of the model used to estimate the radiative loss term so far.

P 12.29 Wed 17:30 HSZ EG

Machine Learning Applications in Control at ASDEX Upgrade — •Johannes Illerhaus[1,2], Wolfgang Treutterer[1], Alexander Bock[1], Rainer Fischer[1], Paul Heinrich[1], Frank Jenko[1,2], Ondrej Kudlacek[1], Gergely Papp[1], Tobias Peherstorfer[1,4], Bernhard Sieglin[1], Udo von Toussaint[1,5], Hartmut Zohm[1,3], and the ASDEX Upgrade Team[6] — [1]Max-Planck-Institut für Plasmaphysik, Garching, Germany — [2]Technische Universität München, Garching, Germany — [3]Ludwig Maximilian Universität, Munich, Germany — [4]Technische Universität Wien, Vienna, Austria — [5]Technische Universität Graz, Graz, Austria — [6]see the author list of U. Stroth et al. 2022 *Nucl. Fusion* 62 042006

Plasma control is essential for the operation of fusion devices. The individual control tasks depend on high-dimensional and possibly noisy input data and typically have a latency requirement of milliseconds to be real-time capable. Machine learning (ML) models are well suited for this application. While they are often computationally expensive to train, they generally have a cheap, low-latency inference process. Additionally, deep learning models have been shown to be capable of extracting complex hidden interactions in high-dimensional, noisy data. This contribution will illustrate two ML applications in plasma control: real time capable approximations of high-fidelity offline models for kinetic profiles, and deep-learning-based augmentations to the accuracy of the pellet fragment analysis used in the development of the shattered pellet injection disruption mitigation system tested on ASDEX Upgrade for use in ITER.

P 12.30 Wed 17:30 HSZ EG

Non-linear free boundary simulations of resonant magnetic perturbations in ASDEX Upgrade — •Verena Mitterauer[1], Matthias Hoelzl[1], Matthias Willensdorfer[1], and ASDEX Upgrade Team[2] — [1]Max Planck Institute for Plasma Physics, Boltz- mannstrasse 2, 85748 Garching - Germany — [2]See author list of U. Stroth et al. 2022 Nucl. Fusion 62 042006

Resonant Magnetic Perturbations (RMPs) are used routinely in tokamaks to control type-I Edge Localized Modes (ELMs). To improve the understanding of the effect of the helical magnetic field perturbations, numerical simulations of their penetration into the plasma are carried out using the free boundary non-linear MHD code JOREK-STARWALL. The use of free boundary conditions allows a self-consistent development of the plasma response within the complete computational domain.

Several aspects of RMP physics are investigated in simulations based on ASDEX Upgrade discharges with fully realistic plasma parameters and profiles. The comparison of the field line corrugation to experimental measurements shows that a valid representation of the plasma response is achieved. In subsequent simulations, the transition from ELM mitigation to suppression is shown, which allows the investigation of hypotheses concerning RMP-ELM suppression mechanisms, including the role of magnetic island positions relative to the pedestal, mode coupling and the impact of profile evolution on plasma stability. An extension of the fluid model to kinetic effects is on its way, which will allow the inclusion of the neoclassical toroidal viscosity.

P 12.31 Wed 17:30 HSZ EG

Enabling GENE for Exascale Computing via Modern Data Science — •Luciana Tanzarella[1], Tilman Dannert[2], Tobias Görler[1], and Frank Jenko[1] — [1]Max Planck Institute for Plasma Physics, Garching — [2]Max Planck Computing and Data Facility, Garching

The GENE (Gyrokinetic Electromagnetic Numerical Experiment) code represents the state-of-the-art in turbulence simulation in plasma physics, based on the Eulerian approach. Since these codes solve differential equations in 5 or 6 dimensions, over a very large parameter space, they require a very considerable computational power. Higher speed, lower communication and energy costs are all benefits of lower precision arithmetic, but the outputs must be accurately assessed. GENE allows for either single or double precision computations. The national DaREXA project's specific objective is to develop methods and architectures that will decrease the amount of data required for fusion research. The first steps in this direction, in particular, entail the creation and application of lower precision methods in selected operations performed by GENE. The precision must be scaled using existing libraries in addition to assessing how it impacts calculations as not every hardware supports arbitrary*precision. To ascertain how much the discretization order influences the outputs on grids, this must be done on each of GENE's several sections. The operation will be done on the stencil part first. In order to accurately evaluate the gain from implementing this reduced precision, an error model for the estimation of stencil and moments must be written.

P 12.32 Wed 17:30 HSZ EG

Enabling GENE for Exascale Computing via Modern Data Science — •Luciana Tanzarella[1], Tilman Dannert[2], Tobias Görler[1], and Frank Jenko[1] — [1]Max Planck Institute for Plasma Physics, Garching — [2]Max Planck Computing and Data Facility, Garching

Theoretical plasma turbulence studies are typically based on numerical solutions of integro-differential equations in 5 or 6 dimensions over a very large parameter space. So the required computational power is huge. Higher speed, lower communication and energy costs are all benefits of lower precision arithmetic, but the outputs must be accurately assessed. Particular focus is put on the world-leading gyrokinetic plasma turbulence code GENE, based on the Eulerian approach. GENE allows for either single or double precision computations.The national DaREXA-F project's specific objective is to develop methods to reduce the amount of data for transfer operations and leverage the power of reduced precision arithmetics on modern architectures. The first steps in this direction entail the creation and application of lower precision methods in selected operations performed by GENE. The precision must be scaled using existing libraries in addition to assessing how it impacts calculations as not every hardware supports arbitrary precision. To ascertain how much the discretization order influences the outputs on grids, this must be done on each of GENE's several sections. The operation will be done on the stencil part first. In order to accurately evaluate the impact of implementing this part with reduced precision, a respective error model has to be developed.

P 12.33 Wed 17:30 HSZ EG

Modeling of diagnostics for radiated power studies in Wendelstein 7-X — •G. Partesotti[1], F. Reimold[1], A. Demby[2], G. Wurden[3], and D. Zhang[1] — [1]IPP, HGW, DE — [2]UW-Madison, WI, US — [3]LANL, NM, US

In the field of magnetically confined fusion plasmas, stellarators like Wendelstein 7-X promise a more stable, steady-state operation, at the cost of increased, three-dimensional complexity of the magnetic field geometry. One of the many implications is the asymmetric distribution of impurities, which in turn causes radiative losses in the plasma to follow an inherently 3-D asymmetric pattern [1,2].

Given that radiation is a primary power dissipation mechanism, reliably estimating and predicting these patterns is crucial to accurately control the heat load on the divertor targets, so as to mitigate erosion and avoid exceeding material limits. For this purpose, it is therefore necessary to develop adequate 3-D signal post-processing techniques and diagnostic tools.

This contribution describes how the response of infra-red and resistive foil bolometer cameras was modeled with ray tracing [3], and how the so-obtained synthetic measurements can be combined to improve radiation tomography in W7-X. First, a set of emc3-calculated radiation patterns is studied to assess the 3-D aspects of the radiation distribution. Then, Gaussian Process Tomography is applied, combining physical and experimental constraints from multiple diagnostics and a newly designed Compact Bolometer Camera [4].

[1] Braun 2010, [2] Zhang 2021, [3] Carr 2018, [4] Moser 2020

P 12.34 Wed 17:30 HSZ EG

Overview of the neutral gas pressures in Wendelstein 7-X under boronized wall conditions — •Victoria Haak, Sergey Bozhenkov, Yuhe Feng, Amit Kharwandikar, Thierry Kremeyer, Dirk Naujoks, Valeria Perseo, Georg Schlisio, and Uwe Wenzel — Max-Planck-Institut für Plasmaphysik, Greifswald, Germany

Gas exhaust is a key requirement for density control in a fusion device and, apart from the pumping speed and the subdivertor geometry, strongly dependent on the neutral gas pressure in the subdivertor and in front of the pumps. 13 neutral gas pressure gauges measured the neutral gas pressure in different locations in the plasma vessel of the stellarator Wendelstein 7-X during the first test divertor campaign, allowing for a detailed analysis of the neutral gas pressures, the compression ratios and the particle exhaust rates via the turbomolecular pumps in the different magnetic field configurations. Neutral gas pressures on the order of few 10^-4 mbar were measured in the subdivertor region, while the highest neutral gas pressure of 1.75*10^-3 mbar was obtained in the so-called high iota configuration featuring 4 edge magnetic islands per cross section. While measurements are only available in specific locations of the subdivertor, finite element simulations provide a detailed picture of the pressure distribution in the subdivertor volume.

P 12.35 Wed 17:30 HSZ EG

Uncertainty Quantification for Multiscale Turbulent Transport Simulations — •Yehor Yudin, David Coster, Udo von Toussaint, and Frank Jenko — Max Planck Institute for Plasma Physics, Boltzmannstrasse2, 85748 Garching, Germany

One of the challenges in understanding the energy and particle transport processes in the core plasma of a magnetic confinement fusion device is to quantify how they are affected by turbulent dynamics. This work considers a multiscale approach to modelling this problem, where the numerical solution is obtained for coupled models describing processes on different spatial and temporal scales. Furthermore, we investigate epistemic and aleatoric uncertainties in the profiles of the quantities transported in this model. This work proposes an application of a surrogate modelling technique to reduce the computational cost of resolving a quasi-steady state solution on the microscale when it is sufficient to capture only statistics of the turbulent dynamics. We study a Multiscale Fusion Workflow that utilizes turbulent energy and particle fluxes computed with a gyrofluid turbulence code GEM in flux tube approximation to calculate the transport coefficients for core transport code ETS. In this work, a data-driven probabilistic surrogate model based on Gaussian Process Regression is used to infer flux values computed by a turbulence code for given core profiles and to calculate related uncertainties. We use the VECMA/SEAVEA toolkit to perform uncertainty quantification as well as to train, test, and utilize surrogate models.

P 12.36 Wed 17:30 HSZ EG

Self-consistent neutral gas description in the edge turbulence fluid code GRILLIX — •Konrad Eder, Andreas Stegmeir, Wladimir Zholobenko, and Frank Jenko — Max Planck Institute for Plasma Physics, Boltzmannstraße 2, 85748 Garching, Germany

The edge turbulence fluid code GRILLIX employs a diffusive neutral gas model to describe plasma-neutrals interactions arising from ionization, recombination, and charge exchange processes [1]. This inclusion of neutral gas physics has been found to significantly improve the agreement of simulated plasma profiles with experiment data [1,2,3].

Presently, the model requires prescribing the neutrals density at the divertor, introducing a new free parameter to the code. As we move toward simulations of detached plasmas, we seek to alter this boundary condition in order to self-consistently describe the recycling fluxes at the targets. For this purpose, a diagnostics framework has been developed to verify the implementation of recycling

boundary conditions and assess particle conservation properties of the code.
[1] W. Zholobenko et al., 2021 Nucl. Fusion, 61 116015.
[2] D.S. Oliveira and T.Body et. al., 2021 Nucl. Fusion 62 096001.
[3] K. Eder, 2022 Technical University of Munich, Master thesis.

P 12.37 Wed 17:30 HSZ EG

Simulation of electromagnetic turbulence in the stellarator W7-X — •Yann Narbutt, Aleksey Mischchenko, Alessandro Zocco, and Per Helander — Max Planck Institute for Plasma Physics, Wendelsteinstraße 1, 17489 Greifswald, Germany

Fusion plasmas need high $\beta = \langle p \rangle/(B^2/2\mu_0)$, i.e. the ratio of plasma pressure to magnetic pressure. Going from low to high β first weakens ion-temperature-gradient mode activity and then causes strong kinetic-ballooning-mode (KBM) activity [1], with the latter being inherently electromagnetic. This can lead to particle and energy fluxes [2] which degrade plasma confinement. It is therefore of great importance to understand KBM turbulence for attaining high-performance plasmas. This poster presents first results of linear and non-linear simulations of KBM activity in the geometry of the stellarator Wendelstein 7-X using the global gyrokinetic code Euterpe [3].

[1] K. Aleynikova et al. "Kinetic ballooning modes in tokamaks and stellarators". In: Journal of Plasma Physics 84.6 (2018), p. 745840602. doi: 10.1017/S0022377818001186.

[2] A. Mishchenko et al. "Gyrokinetic particle-in-cell simulations of electromagnetic turbulence in the presence of fast particles and global modes". In: Plasma Physics and Controlled Fusion 64.10 (Sept. 2022), p. 104009. doi: 10.1088/1361-6587/ac8dbc.

[3] E. Sánchez et al. "Nonlinear gyrokinetic PIC simulations in stellarators with the code EUTERPE". In: Journal of Plasma Physics 86.5 (Sept. 2020). doi: 10.1017/s0022377820000926

P 12.38 Wed 17:30 HSZ EG

Structure-preserving hybrid code, STRUPHY: energy-conserving hybrid MHD-driftkinetic models — •Byung Kyu Na[1,2], Stefan Possanner[1], Florian Holderied[1], and Yingzhe Li[1] — [1]Max Planck Institute for Plasma Physics, Garching, Germany — [2]Technical University of Munich, Garching, Germany

STRUPHY (STRUcture-Preserving HYbrid codes) is a Python package for the simulation of energetic particles (EPs) in plasma. The package features a collection of PDE solvers for hybrid fluid-kinetic systems in curved three-dimensional spaces where the bulk plasma is treated as a fluid and the EPs are described kinetically (Particle-In-Cell method). The discretization is based on the GEMPIC framework. We will introduce energy-conserving hybrid MHD-driftkinetic models which were newly implemented in STRUPHY. Existing hybrid MHD-kinetic models often suffer from not conserving the total energy, especially when reduced kinetic models are used to describe EPs such as driftkinetic or gyrokinetic. However, this property was recently recovered by adding additional terms derived from variational principles. The investigation of the conservation laws on the discrete level will be considered with some simulation results.

P 12.39 Wed 17:30 HSZ EG

Modelling the effects of geometry modifications on the divertor heat loads of W7-X — •Amit Kharwandikar, Dirk Naujoks, Felix Reimold, Ralf Schneider, Thomas Sunn Pedersen, and The W7X Team — Max Planck Institute for Plasma Physics, 17491 Greifswald, Germany

Wendelstein 7-X (W7-X) is an advanced stellarator device operated in Greifswald, Germany, to provide the proof of principle that the stellarator concept can meet the requirements of a future fusion reactor. It employs the island divertor concept to handle the heat and particle fluxes. In the recent experimental campaign OP1.2, unacceptably high heat loads limited the operation of the device. This immediate concern and the need to investigate a subsequent transition to fusion reactor relevant material (e.g. tungsten) for plasma facing components (PFCs) motivate the need for an improved divertor design. This poster discusses the investigation of such an optimized divertor via modelling. The simplified heat transport code, EMC3-Lite, is used as a fast tool to assess different design modifications of the current high-heat-flux (HHF) divertor. Moreover, using the functionalities of the code, a further reduced model for heat load calculations primarily depending on the inclination of magnetic field lines on the plasma-facing surface (PFS) and their connection lengths is derived. This new model introduces the possibility to gain insights into the main parameters determining heat loads and add more physics effects (e.g. radiation loss) in an attempt to fit with experiments. Finally, an iterative scheme for finding an optimum PFS is proposed.

P 12.40 Wed 17:30 HSZ EG

Characterisation of edge-SOL turbulence with `GRILLIX` in single null and advanced divertor configurations — •Jan Pfennig, Wladimir Zholobenko, Andreas Stegmeir, and Frank Jenko — Max Planck Institute for Plasma Physics, Boltzmannstraße 2, 85748 Garching bei München, Germany

Turbulent transport across the magnetic field in magnetic confinement fusion devices, especially in the plasma edge and scrape-off layer (SOL), where steep gradients are observed, is of key interest because of two main reasons:
i: It has a severe impact on the heat exhaust and hence on the energy confinement of the device
ii: It is also responsible for the exhaust of helium ashes produced by the fusion reaction
Turbulence phenomena remain difficult to analyze experimentally and are not fully captured by transport codes due to non-local drive of turbulence as well as intermittent, ballistic transport of filaments (blobs) into the SOL. Hence, high-fidelity global turbulence simulations in realistic diverted geometries represent an important tool in quantitative predictions of tokamak plasma turbulence. Here we present in-depth analysis of global turbulence simulations performed with the `GRILLIX` code, which implements the two-fluid Braginskii equations in the flux-coordinate indepented (FCI) approach. Thus, abirtrarily complex magnetic geometries can be investigated.

P 12.41 Wed 17:30 HSZ EG

Conceptualization of an EM-upgrade for the gyrokinetic full-f code picls — •Annika Stier and Alberto Bottino — IPP, Garching, Germany

The gyrokinetic particle-in-cell code picls is a full-f finite element tool to simulate turbulence in the tokamak scrape-off layer. Up until now however, picls is a purely electrostatic code with a constant background magnetic field. In order to adequately model the phenomena of the scrape-off layer, taking into account electromagnetic effects is a necessity. To this end, the contribution at hand identifies due changes in the theoretical foundation of picls and proposes suitable modifications in its field solver and particle pusher stages.

P 12.42 Wed 17:30 HSZ EG

Hybrid gyrokinetic simulations for weakly magnetized plasmas — •Sreenivasa chary Thatikonda, Felipe nathan De Oliveira lopes, Aleks Mustonen, Daniel Told, and Frank Jenko — Max planck institute for plasma physics, Garching, Germany

We aim to study instabilities, turbulence and reconnection phenomenon in weakly magnetized plasmas. Such conditions may found in natural plasmas such as the solar wind, but also in laboratory applications, e.g. in the edge of fusion plasmas. Due to steep gradients in the edge of fusion plasmas and high frequencies in space plasmas, the ordering assumptions of gyrokinetic theory (like low frequency or moderate gradients) may be challenged, particularly for ions. To overcome these limitations, the group derived equations for a hybrid model that includes fully kinetic physics for the ions, but gyrokinetic physics for the electrons. Thereby, only the slower ion gyration needs to be followed, while still benefitting from a faster treatment of the electrons and this approch also saves computation costs. The numerical implementation of the hybrid model for electrostatic version has been implemented into the existing simulation code ssV, ssV was developed initially at the department of Theoretical Physics I at RUB, Bochum. Semi-Lagrangian schemes (e.g. the PFC scheme) are employed in ssV. This approach tracks down characteristics from the mesh point backwards in time to get the new value of flutter. Ongoing work on ssV involves the addition of electromagnetic capabilities, which will enable application to space and astrophysical plasmas.

P 12.43 Wed 17:30 HSZ EG

Interaction of relativistic electrons with MHD activity during disruptions — •Hannes Bergstroem, Konsta Särkimäki, and Matthias Hoelzl — Max Planck Institute for Plasma Physics, Boltzmannstr. 2, 85748 Garching b.~M., Germany

In spite of all the promise that fusion energy holds, there are several obstacles that one must overcome before commercially viable fusion reactors can be realized. One issue that looks to be ever more prominent in future tokamak reactor designs such as ITER is the type of operational failure known as disruptions, triggered by a sudden loss of plasma confinement. During these off-normal events it is possible for electrons to be accelerated towards relativistic velocities. These highly energetic particles could then accumulate and strike the wall, causing subsurface melting which is difficult to repair. As such, disruption events could potentially put reactors out of commission for extended periods of time, which cannot be tolerated. In order to fully understand the evolution and consequences of disruptions it is vital that the dynamics of the relativistic electrons are studied in detail, which includes aspects such as how they are generated, to what extent they interact with the bulk plasma, what the transport looks like and where they eventually strike the wall. This work aims to answer these questions by extending the non-linear MHD code JOREK to kinetic particle-in-cell treatment for the phase-space evolution of relativistic electrons. In addition we use ray-tracing methods to determine where the particles intersect a 3D wall, allowing us to estimate localized heat loads.

P 12.44 Wed 17:30 HSZ EG

Tungsten-copper composites based on additively manufactured tungsten preforms for high heat flux applications — •Robert Lürbke[1,2], Alexander von Müller[2], Alexander Feichtmayer[1,2], Thomas Bareth[3], Armin Rieser[3], Georg Schlick[3], and Rudolf Neu[1,2] — [1]Max-Planck-Institut für Plasmaphysik, 85748 Garching, Deutschland — [2]Technische Universität München, 85748 Garching, Deutschland — [3]Fraunhofer IGCV, 86159 Augsburg, Deutschland

In future fusion reactors, plasma-facing components (PFCs) have to sustain high heat fluxes and neutron irradiation. This creates the need for advanced materials that can withstand such an environment. Tungsten (W) is considered the preferred plasma-facing material for use in fusion devices due to its low hydrogen retention, high melting point as well as its low physical sputtering yield. Against this background, additive manufacturing (AM) of W can be considered a useful tool to provide tailored W structures for reinforcing copper (Cu) based heat sinks due to a tailored thermomechanical behaviour. The present contribution will illustrate the possibilities of tailoring macroscopic properties of W-Cu PFC materials. In this context, basic observations like rules of mixture for composite materials will be discussed. Based on that, it will be shown how the exploitation of complex composite structures can open up new possibilities for material and component design.

P 12.45 Wed 17:30 HSZ EG

Analysis of Nonlinear Dynamics of Shear Alfvén Waves Driven by Energetic Trapped Particles — •Farah Atour — IPP Garching

In controlled fusion devices, shear-Alfven waves can be driven unstable by resonant interactions with energetic alpha particles. This results in many issues regarding the confinement of the particles and therefore can prevent the thermalization of the plasma core or increase the thermal load on the material's wall. The source of these particles is either the nuclear fusion reaction produced by the background plasma and/or external heating systems. Due to the importance of these issues, there exists an extensive literature on this topic. These studies mostly focus on the nonlinear dynamics of passing particles since they have more significant impacts. However, the nonlinear dynamics of shear-Alfven waves driven by energetic trapped particles deserves also depth analysis and will be the focus of this study. The overall goal of this work is to investigate on a deeper level the fundamental physical processes regarding both the linear stability properties and the nonlinear saturation mechanisms for single and multi modes. For this reason, to keep the context of the dynamical study simplified, these phenomena are investigated by HMGC code, which has a simple circular geometry and is based on the hybrid reduced MHD gyrokinetic model.

P 13: Laser Plasmas I

Time: Thursday 11:00–13:00 Location: CHE/0089

Invited Talk P 13.1 Thu 11:00 CHE/0089

Acceleration of spin-polarized ion beams from laser-plasma interaction — •Lars Reichwein[1], Markus Büscher[2,3], and Alexander Pukhov[1] — [1]Institut für Theoretische Physik I, Heinrich-Heine-Universität Düsseldorf, 40225 Düsseldorf, Germany — [2]Peter Grünberg Institut (PGI-6), Forschungszentrum Jülich, 52425 Jülich, Germany — [3]Institut für Laser- und Plasmaphysik, Heinrich-Heine-Universität Düsseldorf, 40225 Düsseldorf, Germany

Spin-polarized particles are of interest for a variety of applications such as fusion, where the use of spin-polarized reactants may increase the nuclear cross-section, or further investigation of the nucleon structure by means of deep inelastic scattering. In recent years, the acceleration of such polarized particles via laser-plasma interaction has gained traction in research due to the short acceleration distances needed compared to conventional accelerators. While several schemes for efficient proton and ion acceleration are generally known, many of them are not feasible for polarized beams since the target needs to be pre-polarized. In our talk, we give an overview of the current experimental and theoretical state-of-the-art for polarized ion beams. Two acceleration mechanisms, Magnetic Vortex Acceleration and Collisionless Shock Acceleration, will be studied by means of particle-in-cell (PIC) simulations. These schemes can be used to obtain highly polarized ion beams even in the regime of near-future laser facilities.

P 13.2 Thu 11:30 CHE/0089

Influence of plasma profile on injection dynamics in a proton-driven wakefield accelerator. — •Pablo Israel Morales Guzmán, Patric Muggli, and John Farmer — Max-Planck-Institut für Physik

Plasma wakefield accelerators (PWFA) have been proposed as a novel technique to accelerate particle bunches to high energies. Due to the high electric fields supported in plasma, this can be done in a shorter distance than in conventional accelerators. PWFA use a relativistic particle bunch to drive wakefields. When the bunch density is much larger than the plasma density, it induces a non-linear plasma response. For negatively charged bunches, there is blow-out of plasma electrons. For positively charged ones, plasma electrons flow towards the axis, creating a high-density filament. This filament sustains defocusing fields for negatively charged bunches.

A proton bunch much longer than the plasma wavelength drives high-amplitude wakefields only after undergoing self-modulation (SM). SM transforms it into a microbunch train that resonantly drives wakefields. An electron bunch can be injected to seed SM or be accelerated.

We present results of a numerical study using particle-in-cell simulations with parameters similar to those of the AWAKE experiment. We show that along the low density ramp leading to the plasma entrance, the proton bunch generates a filament of plasma electrons. These results indicate that the accelerator plasma of future experiments relying on self-modulation, and a drive and accelerated bunch of different charge, cannot have a density ramp.

P 13.3 Thu 11:45 CHE/0089

Relativistic High Harmonic Generation from solid density foils with a PW class short pulse laser. — •Milenko Vescovi[1], Marvin Elias Paul Umlandt[1,2], Stefan Assenbaum[1,2], Thomas Meric[1,2], Florian Kroll[1], Martin Rehwald[1], Radka Stefanikova[1,2], Thomas Püschel[1], Irene Prencipe[1], Stephan Kraft[1], Ulrich Schramm[1,2], and Karl Zeil[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, 01328, Dresden — [2]Technische Universität Dresden, 01062, Dresden

Relativistic High Harmonic Generation (HHG) from the interaction of high intensity lasers with over dense targets has become a topic of great interest in recent years because of its potential to achieve high energy, coherent short pulses of XUV emission. Several studies have shown the mechanism to be highly sensitive to the laser-plasma interaction conditions. Characterization of the high harmonic spectrum could then be used to probe the interaction during the high intensity fraction of the laser pulse, which is usually of most interest because of the extreme matter conditions but challenging to access experimentally. Measurements of the XUV harmonic spectrum have been conducted with the Draco PW laser (peak intensities up to $6\times10^{21} W/cm^2$ in 30fs FWHM). With the aim of using HHG to gain a better understanding about the interaction, different conditions were studied. Harmonics from 14nm to 17nm wavelength were measured from bulk SiO2 targets, metal foils and plastic foils, as well as driving laser energies. In this work, general features of this parameter scan are shown and its potential link to the laser plasma interaction is discussed.

P 13.4 Thu 12:00 CHE/0089

Setup and evaluation of a calibration free Thomson parabola spectrometer to study sub-MeV ions from laser plasmas — •Lars Torben Schwabe, Jan Riedlinger, and Georg Pretzler — Institut für Laser- und Plasmaphysik, Heinrich-Heine-Universität Düsseldorf

Since sub-MeV ions from laser pulse plasmas are only scarcely studied, we developed a special Thomson parabola spectrometer with a maximized dynamic range that maps these ions in a charge and energy dependent manner. Predictions for these types of ions tend to be inaccurate because of the amount of processes involved, acting on the particles on different time scales. The plasma is generated by a high-intensity ultrashort laser pulse with peak intensities up to 10^{17} W/cm^2 at pulse durations down to 8 fs focused on a solid. The emitted supra-thermal ions are investigated. These results are compared to simulations in terms of ionization state and energies. In this contribution, the design and construction of such a Thomson spectrometer is discussed, which allows us to detect ions over a wide energy range by utilizing variable fields. Furthermore, we present the multi-step evaluation process which eliminates the need for spectrometer calibration.

P 13.5 Thu 12:15 CHE/0089

Characterization of a laser driven supra-thermal ion source — •Jan Riedlinger, Lars Torben Schwabe, Qëndresa Ibraimi, and Georg Pretzler — Institut für Laser- und Plasmaphysik, Heinrich-Heine-Universität Düsseldorf

Today's laser systems achieve repetition rates up to 100 khz at pulse energies of 1 mJ and sub-10-fs durations. With these parameters, laser plasmas become viable ion sources for applications which require a small source size. We present the results of experiments performed with such a laser, reaching intensities up to 10^{17} W/cm^2 on the target surface. This interaction creates a high temperature plasma emitting bunched ions over a broad spectrum in the keV regime. Here, mostly bulk targets were used due to the nearly free choice of materials and high densities for an increased particle output. The talk gives an in-depth view into the ion emission in terms of its opening cone, ionization states and kinetic energies as well as the purposely designed diagnostics.

P 13.6 Thu 12:30 CHE/0089

Heating in Multi-Layer Targets at ultra-high Intensity Laser Irradiation and the Impact of Density Oscillation — •Franziska Paschke-Bruehl[1], Thomas Kluge[1], Motoaki Nakatsutsumi[2], Lisa Randolph[2], Tom Cowan[1], Ullrich Schramm[1], Lingen Huang[1], Mohammadreza Banjafar[2], and Brian Marré[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]European XFEL, Hamburg, Germany

We present a computational study of isochoric heating in multi-layered targets at ultra-high intensity laser irradiation(10^20W/cm^2). Previous studies have shown enhanced ion heating at interfaces, but at the cost of large temperature gradients. Here, we study multi-layered targets to spread this enhanced interface heating to the entirety of the target and find heating parameters at which the temperature distribution is more homogeneous than at a single interface while still exceeding the mean temperature of a non-layered target. Further, we identify a pressure oscillation that causes the layers to alternate between expanding and being compressed with non beneficial effect on the heating. Based on that, we derive an analytical model estimating the oscillation period to find target conditions that optimize heating and temperature homogeneity. This model can also be used to infer the plasma temperature from the oscillation period which can be measured e.g. by XFEL probing.

P 13.7 Thu 12:45 CHE/0089

K-alpha yield from laser-plasmas on thin layers — •Nico Potzkai and Georg Pretzler — Institut für Laser- und Plasmaphysik, Heinrich-Heine-Universität Düsseldorf

When intense sub 10-fs laser pulses create plasma on solid surfaces, they accelerate electrons into the vacuum as well as into the target. The latter electrons induce characteristic x-rays in the material, most of all characteristic K_α radiation, which constitutes a source of partly coherent x-rays due to the small source and narrow spectral line width. When optimizing the total radiation output of this source, we found that thin layers of aluminum on top of copper emit more K_α photons than expected. In our contribution, we present our experimental results and calculations describing this effect.

P 14: Magnetic Confinement IV/HEPP VI

Time: Thursday 11:00–13:10 Location: CHE/0091

Invited Talk P 14.1 Thu 11:00 CHE/0091

Experimental validation of turbulence codes — •Klara Höfler — Institut für Plasmaphysik, Greifswald, Germany

Turbulence is a main driver of heat transport, which deteriorates the performance of fusion reactors. Simulation codes aiming for identifying turbulence optimized devices need to be validated against experiments.

The comprehensive set of experimental turbulence data presented here is measured at the ASDEX Upgrade tokamak for two plasma scenarios. It includes wavenumber spectra, electron density and temperature fluctuation amplitudes and radial correlation lengths as well as the cross phase between density and temperature fluctuations. These quantities are measured for comprehensive code validation by Doppler reflectometers and an electron cyclotron emission radiometer. In this talk they are compared to the gyrokinetic code GENE because of its mature capabilities to assess and reproduce core turbulence. In addition synthetic diagnostic modeling is included to account for diagnostic effects on measurements.

The work presented in this talk shows the encouraging example of code validation where a remarkable number of measured physics quantities is successfully reproduced by the code. It comprises contributions of a variety of collaborators both on the experimental side – Institut für Plasmaphysik (IPP) in Garching, Plasma Science and Fusion Center of MIT in Cambridge and Laboratoire de Physique des Plasmas of the Ecole Polytechnique in Palaiseau – and on the theory side – IPP Garching and Institut für Grenzflächenverfahrenstechnik und Plasmatechnologie in Stuttgart.

P 14.2 Thu 11:30 CHE/0091

Turbulence in stellarators with GENE-3D — •Felix Wilms, Alejandro Banon Navarro, and Frank Jenko — Max-Planck-Institut für Plasmaphysik, Boltzmannstraße 2, 85748 Garching b. München, Germany

GENE-3D is a code that is capable of simulating gyrokinetic plasma turbulence in stellarators globally (Maurer et al., Journal of Computational Physics, 2020). It has recently been upgraded to an electromagnetic version, expanding the variety of turbulent features that can be studied with it (Wilms et al., Journal of Plasma Physics, 2021). In this work, we present an overview over the most recent achievements of the code, including the study of electromagnetic effects on global turbulence (Wilms et al., Journal of Plasma Physics, 2021) as well as the impact of a surface-global effects on turbulence stabilisation (Wilms et al., to be submitted to Nuclear Fusion).

P 14.3 Thu 11:55 CHE/0091

Gyrokinetic simulations of turbulent transport in the edge and scrape-off layer of TCV — •Philipp Ulbl[1], Andreas Stegmeir[1], and Frank Jenko[1,2] — [1]Max Planck Institute for Plasma Physics, Boltzmannstraße 2, 85748 Garching, Germany — [2]University of Texas at Austin, Austin, TX 78712, USA

Turbulence in the edge and scrape-off layer (SOL) region of magnetic confinement fusion devices is of high relevance for the feasibility of fusion energy. Two important properties of a future fusion reactor, confinement and heat exhaust, are largely affected by turbulence. This requires the development of predictive edge turbulence codes.

In this work, we present the latest improvements to the grid-based gyrokinetic turbulence code, `GENE-X` [1], with applications to the TCV tokamak [2]. `GENE-X` is specifically targeted for edge and SOL simulations, since it can perform simulations in realistic, diverted geometries. It features a full-f, electromagnetic, gyrokinetic turbulence model and recently, collisional effects were introduced.

We present the results of multiple `GENE-X` simulations using different collision models, which vary in their physics fidelity. We analyze the resulting plasma profiles and heat fluxes, and compare against the experiment. The code validation improves with the fidelity of the collision model. Based on this, we assess and discuss collisional effects on gyrokinetic turbulence in the edge and SOL.

[1] D. Michels, et. al., Comput. Phys. Commun. 264, 107986 (2021)
[2] D. S. Oliveira, T. Body, et. al., Nucl. Fusion 62, 096001 (2022)

P 14.4 Thu 12:20 CHE/0091

Investigation of driving mechanisms of dominant Alfvén eigenmodes at the Wendelstein 7-X stellarator — •Sara Vaz Mendes[1], Kian Rahbarnia[1], Henning Thomsen[1], Christoph Slaby[1], Charlotte Bueschel[1], Matthias Borchardt[1], Ralf Kleiber[1], Axel Könies[1], Jan-Peter Bähner[2], and Adrian von Stechow[1] — [1]Max-Planck-Institute for Plasma Physics, Wendelsteinstr. 1, 17491 Greifswald, Germany — [2]MIT Plasma Science and Fusion Center, Cambridge, MA 02139, USA

The basis for characterizing dominant Alfvén mode activity in the Wendelstein 7-X (W7-X) stellarator plasmas is presented with the investigation of possible driving mechanisms. In previous W7-X operational phases, Alfvén mode activity was frequently observed during plasmas operated solely with electron cyclotron resonance heating. A broad range of frequencies is observed in measurements of the fluctuating poloidal magnetic field, $\dot{B}_\theta$. An essential analysis was developed to track the dominant frequency bands (DFBs) from the spectrograms of $\dot{B}_\theta$ between $f = 100 - 450$ kHz. The DFBs studies allowed us to draw novel and integral analyses of the dynamics of Alfvén modes through the entire length of W7-X plasmas. Correlations between the modes dynamics with general plasma parameters are determined, and we present in which plasma conditions the spectral properties of the Alfvén DFBs show relevant changes. The amplitude of the DFBs shows a strong correlation to turbulent density fluctuations measured with the Phase contrast Imaging (PCI) diagnostic in most W7-X regimes.

P 14.5 Thu 12:45 CHE/0091

Model based optimization of Advanced Tokamak scenarios — •Raphael Schramm[1], Alexander Bock[1], Emiliano Fable[1], Jörg Stober[1], Simon van Mulders[2], Maximilian Reisner[1], Hartmut Zohm[1], and the ASDEX Upgrade Team[1] — [1]Max-Planck Institut für Plasmaphysik, Garching, Germany — [2]École Polytechnique Fédérale de Lausanne, Switzerland

Advanced Tokamak scenarios increase the plasma safety factor (q) profile via external actuators in order to increase the bootstrap current, thereby reducing the inductive current fraction. In order to avoid an intermittent drop in q the actuators need to be applied already during the current ramp-up. A model in the transport code ASTRA, capable of predicitvely designing such a scenario by calculating temperature and q profiles based on the actuator setup has been developed and validated on AUG.

A scenario, considerably different from the validation case has been analyzed. In order to increase magnetohydrodynamic stability, the q-profile has been optimized. This is done by using an optimizer, running on simpler model to propose changes, which are then double-checked in the ASTRA model. Effects of the plasma current on stability and the performance of different setups have been explored. Results of the last AUG campaign will be shown.

The model can also be applied on different devices with minor changes. Results for JET, based on data from previous shots will be shown. Using the model to design a scenario to show the flux-pumping phenomenon on a larger device for the first time is planned.

P 15: Laser Plasmas II/Low Pressure Plasmas and their Applications II

Time: Thursday 14:00–15:30 Location: CHE/0089

Invited Talk P 15.1 Thu 14:00 CHE/0089

Tumor irradiation in mice with a laser-accelerated proton beam — •Florian Kroll[1], Florian-Emanuel Brack[1], Elke Beyreuther[1,2], Thomas Cowan[1,3], Leonhard Karsch[1,2], Josefine Metzkes-Ng[1], Jörg Pawelke[1,2], Marvin Reimold[1,3], Ulrich Schramm[1,3], Tim Ziegler[1,3], and Karl Zeil[1] — [1]Helmholtz- Zentrum Dresden-Rossendorf, Dresden, Germany — [2]OncoRay - National Center for Radiation Research in Oncology, Dresden, Germany — [3]Technische Universität Dresden, Dresden, Germany

We report on establishing a laser-plasma-based proton research platform for user-specific small animal radiobiology studies. The Draco PW laser at Helmholtz-Zentrum Dresden-Rossendorf drives the laser-plasma accelerator (LPA). We discuss the findings that allowed us to operate our LPA proton source with unprecedented stability and long-term reliability, featuring proton energies regularly exceeding 60 MeV.

These capabilities allowed us to conduct the first radiobiological in vivo study using an LPA proton source. The pilot study was performed on human tumors in a mouse model, showing the concerted preparation of mice and laser accelerator, the dose-controlled, tumor-conform irradiation using the LPA as well as a clinical reference proton source, and the radiobiological evaluation of irradiated and unirradiated mice for radiation-induced tumor growth delay. The prescribed homogeneous dose was precisely delivered at the laser-driven source.

The presented results prove that LPA proton sources have reached a new level of applicability and now enable systematic radiobiological studies within an unprecedented range of beam parameters.

P 15.2 Thu 14:30 CHE/0089

Comparison between THz absorption spectroscopy and ps-TALIF measurements — •Jente R. Wubs[1], Laurent Invernizzi[2], Kristaq Gazeli[2], Guillaume Lombardi[2], Uwe Macherius[1], Klaus-Dieter Weltmann[1], and Jean-Pierre H. van Helden[1] — [1]Leibniz Institute for Plasma Science and Technology (INP), Greifswald, Germany — [2]Laboratoire des Sciences des Procédés et des Matériaux (LSPM), CNRS, Université Sorbonne Paris Nord, Villetaneuse, France

Terahertz (THz) absorption spectroscopy with quantum cascade lasers has recently been developed and implemented as a new diagnostic technique for investigating atomic oxygen densities in plasmas. It is based on the detection of the $^3P_1 \leftarrow {}^3P_2$ fine structure transition at approximately 4.75 THz. This allows for direct measurements (i.e. no calibration procedure required) of absolute ground-state atomic oxygen densities. A possible way to validate this method is by a comparison with two-photon absorption laser-induced fluorescence (TALIF), as this is currently the most established method for measuring atomic oxygen densities. TALIF measurements were done in this case with a picosecond (ps) laser system and using a streak camera for detection. Both ps-TALIF measurements and THz absorption spectroscopy were performed on the same low-pressure capacitively-coupled radio frequency plasma generated in pure oxygen, for a variation of the applied power (20–100 W) and gas pressure (0.7–1.3 mbar). A comparison between resulting atomic oxygen densities as obtained with the two different diagnostics is presented in this contribution.

P 15.3 Thu 14:45 CHE/0089

Characterization of the ion angle distribution function in low-pressure plasmas using a microelectromechanical system — •Marcel Melzer[1], Katja Meinel[1], Chris Stoeckel[1,2], Torben Hemke[3], Thomas Mussenbrock[3], and Sven Zimmermann[1,2] — [1]Center for Microtechnologies, Chemnitz University of Technology, Chemnitz, Germany — [2]Fraunhofer Institute for Electronic Nano Systems ENAS, Chemnitz, Germany — [3]Chair Electrical Engineering and Plasma Technology, Faculty of Electrical Engineering and Informationtechnology, Ruhr-University Bochum, Germany

It has been demonstrated for the first time that a microelectromechanical system (MEMS) can be used to characterize the ion angle distribution function (IADF) of a low-pressure plasma. The MEMS is piezoelectrically actuated. The piezoelectric AlN is used both to tilt a 30 μm thick silicon plate as well as to monitor the tilt angle. Holes with a diameter of 2 μm were etched into the tilting plate. These high aspect ratio holes allow selection of ion incidence angles depending on the tilt angle of the MEMS. Below the MEMS, the ions are detected by a metal electrode. A numerical method is presented to determine the ion angle distribution function based on the measured data for the resonant operation of the MEMS.

P 15.4 Thu 15:00 CHE/0089

Collisional radiative modelling for molecular hydrogen plasmas applying MCCC cross sections — •Richard Christian Bergmayr, Dirk Wünderlich, and Ursel Fantz — Max-Planck-Institut für Plasmaphysik, Garching, Germany

Molecular hydrogen (H_2) occurs in a variety of plasmas (e.g. negative ion source and fusion divertor plasmas). Collisional radiative (CR) models enable the characterization of these plasmas not only by their plasma parameters in combination with emission spectroscopy, but also to evaluate effective reaction rates (e.g. for molecular assisted recombination (MAR), a mechanism that may contribute to the detachment in divertors). CR models balance (de-)populating mechanisms of excited states in terms of coupled rate equations. Recent studies using a CR model for the triplet system of H_2 have shown that applying electron impact excitation cross sections calculated by the molecular convergent close-coupling (MCCC) method in the adiabatic-nuclei formulation show an improved agreement with measurements in low-pressure plasmas compared to models based on previously available cross sections. In this work a CR model for the electronic states of the singlet system of H_2 applying MCCC cross sections is presented showing likewise as the triplet model better agreement with measurements than previous models. Furthermore, the models for the singlet and triplet system are coupled. Thereby it is possible to estimate also the influence of (optically forbidden) spin-mixing processes. In a next step this knowledge can be used to create a (ro-)vibrationally resolved model for H_2, as (ro-)vibrational excitation is expected to enhance MAR.

P 15.5 Thu 15:15 CHE/0089

First-principles simulation of optical emission spectra for low-pressure argon plasmas and its experimental validation — Fatima Jenina Arellano[1], Márton Gyulai[2,3], Zoltán Donkó[1,3], Peter Hartmann[3], •Tsanko Vaskov Tsankov[4], Uwe Czarnetzki[4], and Satoshi Hamaguchi[1] — [1]Center for Atomic and Molecular Technologies, Osaka University, Osaka, Japan — [2]Eötvös Loránd University, Budapest, Hungary — [3]Institute for Solid State Physics and Optics, Wigner Research Centre for Physics, Budapest, Hungary — [4]Ruhr University Bochum, Faculty of Physics and Astronomy, Experimental Physics V, Germany

The emission intensity of various spectral lines are often used for the experimental characterization of low-temperature plasmas. However, the interpretation of the spectra requires knowledge of the electron distribution function and the population-depopulation kinetics of the emitting states. To investigate these relations and to test the suitability of numerical models for relating the measured emission spectra to the underlying plasma parameters, we perform here first-principle simulations for low-pressure radio-frequency driven capacitively-coupled argon plasmas via one-dimensional particle-in-cell/Monte Carlo collision (PIC/MCC) code coupled to a global collisional-radiative model. The model provides the emission intensities of various atomic lines which are compared with experimental data. The comparison shows good agreement for pressures up to about 20 Pa and increasingly notable deviations at higher pressures. Possible explanations for the deviations are discussed.

P 16: Plasma Wall Interaction II/Codes and Modeling I

Time: Thursday 14:00–15:30 Location: CHE/0091

Invited Talk P 16.1 Thu 14:00 CHE/0091

Development of a Laser-based Diagnostic for in situ Monitoring of Fuel Retention in ITER and future fusion devices — •Alexander Huber, M. Zlobinski, G. Sergienko, J. Assmann, D. Castano, S. Friese, I. Ivashov, Y. Krasikov, H. Lambertz, Ph. Mertens, K. Mlynczak, M. Schrader, A. Terra, S. Brezinsek, and Ch. Linsmeier — Institut für Energie- und Klimaforschung - Plasmaphysik, Forschungszentrum Jülich GmbH, Jülich

One of the most serious challenges for the operation of ITER and future fusion devices is the control of the inventory of tritium stored in the vessel walls which surround the plasma. For the operation of ITER and of a fusion reactor in general, the determination of the tritium inventory and the knowledge of its spatial distribution is essential. Its control without removal of wall tiles is also of paramount importance. A laser-based T-monitor diagnostic system is under development at Forschungszentrum Jülich (FZJ) to remotely provide information about the tritium content in the deposited layer on the inner divertor tiles of ITER. The T-inventory builds up through the interaction of wall erosion and co-deposition of hydrogen isotopes together with redeposited material. The limitation of the tritium content in the reactor is of course a safety requirement for the operation. The measurement concept is based on laser-induced desorption (LID) and detection of the released gases by Residual Gas Analysis (RGA).

The present contribution summarizes the results of an R&D programme on the LID method carried out at FZJ for the integration of this laser-based tool into ITER and future reactors.

P 16.2 Thu 14:30 CHE/0091

Multi-staged ERO2.0 simulation of material erosion and deposition in recessed ITER mirror assemblies — •Sebastian Rode[1], Juri Romazanov[1], Sebastijan Brezinsek[1], Andreas Kirschner[1], Sven Wiesen[1], Tom Wauters[2], Lucas Moser[2], and Richard Pitts[2] — [1]Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung, 52425 Jülich, Germany — [2]ITER Organization, 13067 St Paul Lez Durance, France

The Monte-Carlo code ERO2.0 traces impurity particles throughout the volume of fusion devices providing the local erosion and deposition fluxes at plasma-facing components or recessed objects, delivering important information about sputtering or layer growth on those components. In recessed areas, e.g. mirror assemblies in the diagnostic first wall (DFW) of ITER, the code is approaching its limits. The necessary resolution of information on mirrors more than 50 cm away from the LCFS cannot be achieved with standard simulations as only a tiny fraction of impurity test particles and a large fraction of charge exchange hydrogenic neutrals (CXN) reaches this volume. Multi-staged ERO2.0 simulations are employed to overcome this challenge: Impurity particles from a global ERO2.0 simulation with its boundary close to the DFW are collected and subsequently injected into local simulations. The number of test particles representing the fluxes is scaled up, achieving far superior resolution. The results show that the sputtering is largely dominated by high energy CXN, with the patterns indicating a strong influence by the geometry of the assembly. Overall neglible deposition is expected on the mirrors for the full ITER operation time.

P 16.3 Thu 14:45 CHE/0091

Separation of plasma species fluxes for investigating plasma-surface interactions — •Adrian Heiler[1], Roland Friedl[2], and Ursel Fantz[1,2] — [1]Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, 85748 Garching — [2]AG Experimentelle Plasmaphysik, Universität Augsburg, 86135 Augsburg

Low pressure plasmas are commonly applied for surface treatment processes. To investigate the role of the different plasma species in the plasma-surface interaction, a selective exposure is indispensable. Therefore, the separation of plasma species fluxes from an inductively coupled plasma source (27.12 MHz, 600 W max.) is demonstrated by using magnets and a MgF_2 window. The plasma source is operated in hydrogen at pressures of 4 – 10 Pa and is connected to a vacuum chamber in which surfaces can be installed at a sample holder. The impinging fluxes of hydrogen atoms, positive hydrogen ions and UV/VUV photons (up to 15 eV) are quantified by using optical emission spectroscopy, a Langmuir probe and a VUV diagnostic. The VUV diagnostic is based on a photodiode and optical filters for wavelength selection and is calibrated against a VUV spectrometer.

The influence of the UV/VUV photons, hydrogen atoms and positive hydrogen ions on surfaces is exemplarily demonstrated by applying work function measurements of in situ caesiated metal samples. By this, it is shown that each species can affect the surface separately. The impact of the selective exposure is compared to the full plasma-surface interaction by the generation of well-characterized inductively coupled hydrogen plasmas directly in front of the surface.

P 16.4 Thu 15:00 CHE/0091

Hyperfine structure splitting and the Zeeman effect of ^{83}Kr in laser absorption spectroscopy investigated at the linear plasma device PSI-2 — •Marc Sackers[1], Oleksandr Marchuk[1], FNU Dipti[2], Stephan Ertmer[1], Yuri Ralchenko[3], and Arkadi Kreter[1] — [1]Forschungszentrum Jülich GmbH - Institut für Energie- und Klimaforschung - Plasmaphysik, Partner of the Trilateral Euregio Cluster (TEC), 52425 Jülich, Germany — [2]International Atomic Energy Agency, Vienna, Austria — [3]National Institute of Standards and Technology - Atomic Spectroscopy Group, 20899 Gaithersburg, USA

Comparing Ar I and Kr I laser absorption spectra obtained at the linear plasma device PSI-2 indicate an additional line broadening in the case of Kr due to isotopic effects. The magnetic field configurations at PSI-2 provide weak field conditions for even numbered isotopes, i.e., a small perturbation on the energy level splitting. However, concerning ^{83}Kr, the magnetic field strength (B) is de facto intermediate. This condition substantially increases the complexity of the spectra since the energy shift is non-linear in B and the intensities of the magnetic sub-transitions depend on B as well.

The analysis is based on a model by C. G. Darwin of the Zeeman effect at all field strengths [1]. Overall, the experimental investigation at the linear plasma device PSI-2 is limited to laser absorption spectra (20.5 mT to 90 mT) from the Kr I 5s J=2 and J=0 metastable levels using the 760.15 nm and 785.48 nm lines, respectively.

[1] C. G. Darwin, Proc. R. Soc. Lond. A **115**, 1-19 (1927)

P 16.5 Thu 15:15 CHE/0091

Application of Laser Ablation Molecular Isotopic Spectroscopy on a-(^{12}C,^{13}C):H layers in double pulse mode — •Erik Wüst, Rongxing Yi, Christoph Kawan, Timo Dittmar, and Sebastijan Brezinsek — Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung - Plasmaphysik, 52425 Jülich

Following the injection of $^{13}CH_4$ into a Hydrogen plasma in Wendelstein 7-X, Laser Ablation Molecular Isotopic Spectroscopy (LAMIS) was utilised to quantify ^{13}C deposition patterns ex-situ on the graphite test divertor. LAMIS was applied in double pulse mode. The first pulse (355 nm, 35 ps, 1.1 J/cm^2) was applied for the production of a laser-induced plasma on the material's surface. A second laser pulse (1064 nm, 35 ps) followed typically 50 ns later. The second laser pulse was focussed into the laser-induced plasma plume of the first pulse in order to improve signal to noise ratio in the spectra and the sensitivity acquired from the emitted light.

In general a good agreement of the ^{13}C content and pattern with DP-LAMIS and the complementarily applied Nuclear Reaction Analysis was found for layers up to a few μm. Deviations were identified for thicker layers, therefore ablation process was investigated regarding the impact of the second laser pulse (2.3 J/cm^2, 50 ns after first pulse) on ablation rate per pulse pair and properties of the plasma plume. Results of these investigations and proposed ways to overcome the challenge of resolving ^{13}C content in thick mixed layers containing carbon and hydrogen are presented.

P 17: Complex Plasmas and Dusty Plasmas/Codes and Modeling II

Time: Thursday 15:45–17:15 Location: CHE/0089

P 17.1 Thu 15:45 CHE/0089

Size evolution and plasma-particle interaction of single MF particles in the plasma sheath — •Sören Wohlfahrt, Cassedyn Wirtz, and Dietmar Block — Institute of Experimental and Applied Physics, Kiel University, Germany

Complex (dusty) plasmas consist of micrometer sized particles in addition to the typical plasma species of ions, electrons and neutrals. It has been observed, that the particle size decreases for many materials during plasma exposure and that the particle surface is modified/roughened. This process is commonly referred to as 'etching', although in the context of dusty plasmas the detailed mechanism and surface reactions behind the decreasing size is not known yet and proposed explanations range from physical sputtering, over melting of the particle material to ion enhanced chemical reactions. We use an advanced light scattering diagnostic based on Lorentz-Mie theory to determine size and size evolution of single melamine formaldehyde (MF) particles in situ and with high temporal resolution. By adding small amounts of oxygen to the discharge, the etch process and plasma particle interaction become accessible [1]. In this talk, we will present precise measurements of the size evolution of single particles complemented with a reactive site model [2] that suggests an increase in surface reactions due to a roughening of the particle surface.

[1] S. Wohlfahrt, C. Wirtz, D. Block, Phys. Plasmas 29, 123702 (2022)
[2] R. Bray, R. Rhinehart, Plasma Chem. Plasma Process 21, 149-161 (2001)

P 17.2 Thu 16:00 CHE/0089

Ex situ measurement of dust size distribution of nanoparticle growth process and comparison with in situ measurements — •Andreas Petersen, Jakob Wötzel, and Franko Greiner — Institute of Experimental and Applied Physics, Kiel, Germany

We present the result of a size distribution analysis for plasma grown dust particles in their accretion phase. A multi-sample extraction process was used to prepare samples for analysis with SEM (ex situ measurement). This allowed for eight consecutive samples, without terminating the discharge. We find that a normal distribution is an adequate description of the particle distribution for the whole growth process. It is noteworthy, that the standard deviation of the distribution increases approximately linearly with average size. We also compare these results with those from a light scatter analysis, which was performed simultaneously and can determine average size and refractive index without opening the discharge chamber (in situ measurement).

P 17.3 Thu 16:15 CHE/0089

Characterization of a Pulsed Plasma and Macroparticles in an Industrial Scale ta-C Laser-Arc Coating System — •Mathis Klette[1], Martin Kopte[2], Wolfgang Fukarek[2], and Holger Kersten[1] — [1]Kiel University, Germany — [2]VTD Vakuumtechnik Dresden GmbH, Germany

Tetrahedral amorphous carbon (ta-C) coatings are commonly used in industry to improve tribological as well as corrosion and wear properties of treated objects. While ta-C can be deposited using various techniques, the Laser-Arc technology allows for a strong temporal and spatial control of the deposition process while providing high deposition rate and enabling up-scaling for industrial applications. A major limiting factor of this technology is the generation of macroparticles and the resulting defects in the coating. In this contribution we present measurements of plasma parameters, neutrals and macroparticles in dependance on arc parameters to get a better understanding of the impact on film growth and system upscaling. The carbon Laser-Arc system produces 100-300 us, 1-3 kA pulses, which are observed with a custom-tailored diagnostic setup. The Langmuir probes, retarding field analyzers, and the optical emission spectroscopy allow for spatially and time resolved measurements of electron and ion energy distribution functions, and estimates of neutral densities. Calorimetric probes monitor the energy influx to the substrate which is of special importance when forming tetrahedral bonds. The temporal and special macroparticle velocity distributions have been investigated with high-speed cameras.

P 17.4 Thu 16:30 CHE/0089

Viscosity of finite Yukawa liquids — •Yang Liu, Natascha Blosczyk, and Dietmar Block — IEAP, Christian-Albrechts-Universität, D-24098 Kiel, Germany

Viscosity is one of the basic characteristics to describe the dynamic behavior of a fluid. For dusty plasmas established methods exist to measure viscosity [1,2]. However, these methods are limited to large/infinite systems while in some experiments (e.g for binary mixtures) the system size is limited. Whether and how these methods can be adapted to measure the shear viscosity of a finite two-dimensional (2D) Yukawa liquid is presented in this contribution using non-equilibrium Langevin simulations. Two counter-propagating shear forces are used to push the particles, causing shear-induced melting of the cluster. Based on the Green-Kubo relation (which relies on the random thermal motion of individual particles of the liquids) we obtain a reliable shear viscosity by diminishing the effect of shear and boundary conditions. We find that the shear viscosity is in good agreement with the results in Refs. [1, 2] if an effective coupling parameter Γ^* is used. Surprisingly, the shear viscosity with this normalization follows a simple universal scaling. For $\Gamma^*>20$ and $0.5<\kappa<2$, the shear viscosity increases monotonously, and thermal motion positively affects the transport properties of dust particles.

References

[1] B. Liu and J. Goree, Physical review letters 94, 185002 (2005).
[2] Z. Donkó, J. Goree, P. Hartmann, and K. Kutasi, Phys. Rev. Lett. 96, 145003 (2006).

P 17.5 Thu 16:45 CHE/0089

Neural network based surrogate models for tokamak exhaust — •Stefan Dasbach and Sven Wiesen — Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung - Plasmaphysik, 52425 Jülich, Germany

For the design of future tokamak fusion reactors the heat transport in the scrape-off layer is a major challenge. A simulation can test only a single configuration at once and is computationally demanding, making it impossible to fully explore the high dimensional design parameter space with simulations alone. A promising approach to circumvent this is to use machine learning models trained on simulation data as surrogate models. After training such models can produce fast results for any configuration in the explored parameter space and could be used for rapid design studies of tokamak reactors or coupled with other models such as tokamak flight simulators or reactor control schemes. For the development of such models we created a dataset of 10.000 2D SOLPS-ITER simulations with reduced physical complexity. The simulations have eight varied parameters including a tokamak size scaling. Using this dataset neural networks are trained either to predict the electron temperatures in the whole 2D simulation domain or solely at the 1D divertor target. The accuracies of the network predictions in different physical regimes are evaluated and different network architectures are compared.

P 17.6 Thu 17:00 CHE/0089

Towards Machine-Learned Poisson Solvers for Low-Temperature Plasma Simulations — •Ihda Chaerony Siffa[1,2], Markus M. Becker[1], and Jan Trieschmann[2] — [1]Leibniz Institute for Plasma Science and Technology (INP), Felix-Hausdorff-Straße 2, 17489 Greifswald, Germany — [2]Kiel University, Kaiserstraße 2, 24143 Kiel, Germany

In multi-dimensional self-consistent low-temperature electrostatic plasma simulations, the computational effort for solving the Poisson equation can represent a large part of the overall evaluation runtime. Recently, it has been shown that by using machine learning (ML) techniques, in particular artificial neural networks (ANN), one can arrive to solutions of the Poisson equation faster (and with promising accuracy) than using the conventional numerical methods. However, the currently proposed ML-based Poisson solvers still fall short for being widely applicable in low-temperature plasma simulations, which may employ complex geometries, mixed boundary condition, etc. In this work, the requirements for making ML-based Poisson solvers applicable in low-temperature plasma simulations are discussed. Furthermore, a machine-learned Poisson solver that attempts to tackle these requirements is presented, with examples from dielectric barrier discharge (DBD) geometries. First results suggest that supervised training of an ANN with spatially dependent simulation properties and corresponding ground truth electric potential solutions allows for a machine-learned Poisson solver that generalizes well to various geometric and material configurations.

P 18: HEPP VII

Time: Thursday 15:45–17:00 Location: CHE/0091

P 18.1 Thu 15:45 CHE/0091

Electron kinetics in a high-Z plasmoid — •Alistair M. Arnold[1], Pavel Aleynikov[1], and Boris N. Breizman[2] — [1]Max-Planck-Institut für Plasmaphysik, Greifswald, Deutschland — [2]Institute for Fusion Studies, University of Texas at Austin, Austin, TX, USA

The problem of the electron dynamics on a closed magnetic field line passing through a high-Z plasmoid is considered. The electron kinetic equation is integrated over bounce motion and pitch-angle, reducing the independent variables to a single adiabatic invariant plus time. Integration of the full Landau self-collision operator is carried out exactly, resulting in a nonlinear integro-differential operator in the new invariant. Conservation laws and the H theorem of the integrated self-collision operator are proven. Numerical solutions of the integrated kinetic equation are obtained with a self-consistent quasineutral electric potential, given the initial condition of a cold plasmoid immersed in a hot ambient plasma. The fact that cold electrons are deeply trapped in a potential with a parabolic peak leads to exactly 3/4 the usual rate of collisional heating by the ambient plasma, independent of any other parameters.

P 18.2 Thu 16:10 CHE/0091

Grad-Zhdanov multi-ion collisional closure for fluid edge codes — •Sergei Makarov and David Coster — Max-Planck-Institut für Plasmaphysik, D-85748 Garching, Germany

Moments of the distribution function form an infinite sequence of fluid equations. For the specific cases, this system can be cut to the finite amount of equations. For doing this we use, so called closure. In collisonal plasmas, which can be observed in the Edge and Scrape-off layer (SOL) in fusion magnetic devices, a collisional closure can be applied. When the impurity mass is significantly larger than the mass of the main ions the multispecies extension of the single ion Braginskii approach can be applied. However, for ions with close masses the Grad-Zhdanov 21N-moment method should be used for the transport coefficients estimation. It is necessary, for example, when He plasmas or D-T plasmas are considered. This approach takes into account masses of ions for kinetic coefficients calculation. It is the major improvement in comparison to the previous approach applied for the SOLPS-ITER code. Only hydrogen isotope plasma with heavy impurities could be treated by SOLPS-ITER versions prior to 3.0.8. This approach is implemented into the SOLPS-ITER code for multiple ion parallel transport description in collisional plasmas. The particular approach is discussed in. The complete multi-ion generalization of the SOLPS-ITER code has been preformed without explicit separation between main and impurity species. The new code is tested for the He and D-T mixtures. The new effects coming from the improved multi-ion treatment are analyzed.

P 18.3 Thu 16:35 CHE/0091

AI based Larde Eddy Simulations for Turbulence in Fusion Reactors — •Robin Greif[1], Frank Jenko[1], and Nils Thuerey[2] — [1]Max-Planck Institute for Plasma Physics, Garching bei München, Germany — [2]TUM Department of Mathematics, Garching bei München, Germany

In this talk, we demonstrate the effectiveness of using hybrid AI and numerical methods to produce practically endlessly stable turbulence simulations conserving physical, spectral, and statistical properties. Specifically, we look at the two-fluid Hasegawa-Wakatani model discretized in two spatial dimensions used for simulating drift wave turbulence in fusion reactors. The presented hybrid AI predictor-corrector model in the large eddy domain allows for reducing complexity by three orders of magnitude with negligible losses.

P 19: Magnetic Confinement V/HEPP VIII

Time: Thursday 17:30–18:40 Location: CHE/0089

Invited Talk P 19.1 Thu 17:30 CHE/0089

Numerical and experimental investigations of a linear microwave plasma source for metal foil pumps for DEMO — •Stefan Merli[1], Andreas Schulz[1], Matthias Walker[1], Yannick Kathage[2], Stefan Hanke[2], Christian Day[2], and Günter Tovar[1] — [1]IGVP, University of Stuttgart, Stuttgart, Germany — [2]Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

In future fusion power plants like DEMO, minimizing the tritium fuel inventory is a critical design issue. Hydrogen isotopes have to be separated from the exhaust gas close to the diverter so that they can be immediately recirculated. At KIT a direct internal recycling system is being developed using a metal foil pump (MFP) which can selectively separate hydrogen isotopes by superpermeation even against a pressure gradient. For this process to work, the hydrogen must be in the form of atoms or ions, which is achieved with a linear microwave plasma source, the Duo-Plasmaline.

Since the Duo-Plasmaline is an integral part of the MFP, hydrogen plasmas from the Duo-Plasmaline are being investigated numerically and experimentally at the University of Stuttgart. In the numerical model the transport of electrons and heavy species are calculated self-consistently with the microwave el. field and a reduced set of plasma chemical reactions. Since the MFP will be in close proximity to the torus, the influence of strong magnetic fields up to 1 T is investigated. The results are compared to investigations in the experiment FLIPS with up to 250 mT. Results of the performance of the Duo-Plasmaline and the MFP from the HERMESplus experiment are presented as well.

P 19.2 Thu 18:00 CHE/0089

Physics-informed machine learning to approximate the ideal-MHD solution operator in Wendelstein 7-X configurations — •Andrea Merlo, Daniel Böckenhoff, Jonathan Schilling, Samuel Aaron Lazerson, Thomas Sunn Pedersen, and the W7-X Team — Max-Planck-Institute for Plasma Physics, 17491 Greifswald, Germany

The stellarator is a promising concept to produce energy from nuclear fusion by magnetically confining a high-pressure plasma. Magnetohydrodynamics (MHD) describes how plasma pressure, current density and magnetic field interact. In a stellarator, the confining field is three-dimensional, and the computational cost of solving the 3D MHD equations currently limits stellarator research and design. In this work, we present data-driven approaches to provide fast 3D MHD equilibria: we describe an artificial neural network (NN) that quickly approximates the ideal-MHD solution operator in W7X configurations. The model fulfils equilibrium symmetries by construction and the MHD force residual regularizes the solution of the NN to satisfy the ideal-MHD equations. The model predicts the equilibrium solution with high accuracy, and it faithfully reconstructs global equilibrium properties (e.g., magnetic well depth). We also optimize W7X magnetic configurations, where desiderable configurations can be found in terms of fast particle confinement. Moreover, preliminary results from solving the ideal-MHD equations for a generic stellarator geometry with a physics-informed model without any ground-truth data will be presented.

P 19.3 Thu 18:25 CHE/0089

Structure splitting at the transition to self-sustained turbulence in a magnetized cylindrical plasma — •Peter Manz[1], Stefan Knauer[1], Chanho Moon[2], Nils Fahrenkamp[1], and Akihide Fujisawa[2] — [1]Institut für Physik, Universität Greifswald, Greifswald — [2]Research Institution for Applied Mechanics, Kyushu University, Kasuga

When turbulent structures split more frequently before they decay, persistent turbulence forms in neutral fluid shear flows. Whether such behavior also occurs in magnetized plasmas is investigated in the experiment PANTA. With increasing control parameter the dynamics in the magnetized plasmas is known to undergo several changes from a quasiperiodic to a phase locked to a weakly turbulent regime. When the phase-locked regime breaks down, the splitting time approaches the decreasing lifetime reflecting self-sustained turbulence, as known from the pipe flow.

P 20: Laser Plasmas III/Codes and Modeling III

Time: Thursday 17:30–18:45 Location: CHE/0091

Invited Talk P 20.1 Thu 17:30 CHE/0091

Laser-Induced Breakdown Spectroscopy (LIBS) for the detection of hydrogen isotopes stored in high-Z metals tungsten and tantalum — •Steffen Mittelmann[1], Kévin Touchet[3], Xianglei Mao[3], Minok Park[3], Vassilia Zorba[3], Sebastijan Brezinsek[2], and Georg Pretzler[1] — [1]Institut für Laser- und Plasmaphysik, Heinrich-Heine-Universität Düsseldorf — [2]Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung - Plasmaphysik — [3]Laser Technologies Group, Lawrence Berkeley National Laboratory, Berkeley

Laser-Induced Breakdown Spectroscopy (LIBS) is a promising technology for insitu analysis of plasma facing components in confinement fusion experiments. It is of major interest to monitor the hydrogen isotope retention over many operation hours to guarantee the safety and lifetime of the facility. To be able to get full information of deuterium deposition in different surface layers, a LIBS setup with a high depth resolution is required. We present a comparison of such LIBS experiments with several laser systems of strongly differing parameters for optimizing the conditions. In our final study, ultra-short (ps- to fs-) UV-laser pulses were focused on tungsten and tantalum tiles that were exposed by a deuterium plasma in the linear plasma device PSI-2 at Forschungszentrum Jülich. We show that this concept can lead a Calibration-Free technique for quantitatively determining the amount of deuterium stored in the tiles under investigation without a-priori knowledge on the plasma.

P 20.2 Thu 18:00 CHE/0091

Acceptance Rates of Invertible Neural Networks on Electron Spectra from Near-Critical Laser-Plasmas: A Comparison — •Thomas Miethlinger[1,2], Nico Hoffmann[1], and Thomas Kluge[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, 01328 Dresden, Deutschland — [2]Technische Universitat Dresden, 01069 Dresden, Germany

While the interaction of ultra-intense ultra-short laser pulses with near- and overcritical plasmas cannot be directly observed, experimentally accessible quantities (observables) often only indirectly give information about the underlying plasma dynamics. Furthermore, the information provided by observables is incomplete, making the inverse problem highly ambiguous. Therefore, in order to infer plasma dynamics as well as experimental parameter, the full distribution over parameters given an observation needs to considered, requiring that models are flexible and account for the information lost in the forward process. Invertible Neural Networks (INNs) have been designed to efficiently model both the forward and inverse process, providing the full conditional posterior given a specific measurement. In this work, we benchmark INNs and standard statistical methods on synthetic electron spectra. First, we provide experimental results with respect to the acceptance rate, where our results show increases in acceptance rates up to a factor of 10. Additionally, we show that this increased acceptance rate also results in an increased speed-up for INNs to the same extent. Lastly, we propose a composite algorithm that utilizes INNs and promises low runtimes while preserving high accuracy.

P 20.3 Thu 18:15 CHE/0091

Magnetohydrodynamic Simulations of a Tapered Plasma Lens for Optical Matching at the ILC e^+ Source — •Manuel Formela[1], Gudrid Moortgat-Pick[1], Niclas Hamann[1], Gregor Loisch[2], Mathis Mewes[2], Maxence Thévenet[2], and Jens Osterhoff[2] — [1]University of Hamburg, Hamburg, Germany — [2]Deutsches Elektronen Synchrotron DESY, Hamburg, Germany

The International Linear Collider is a planned electron-positron linear collider with its positron source producing positrons by exposing a target to undulator radiation. The resulting, highly divergent positron beam requires optical matching to improve its luminosity and therefore the success of the collision experiments. Here, optical matching refers to capturing particles, i.e. making them available for downstream beamline elements. In the past, this has been done with sophisticated coils, but recently the usage of a current-carrying plasma, a plasma lens, has been proposed. For the International Linear Collider particle tracking simulations have already concluded with an optimal plasma lens design with respect to the captured positron yield. This design is characterized by a linearly widening radius in beam direction. Now further research and development is required, including both experiments with a prototype set-up as well as simulations modeling the hydrodynamics of the current-carrying plasma and the resulting magnetic field. The accuracy of the latter will benefit greatly from the former. First results of these magnetohydrodynamic simulations are discussed in this work.

P 20.4 Thu 18:30 CHE/0091

1D Vlasov simulations of the Windowless Gaseous Tritium source of the Karlsruhe Tritium Neutrino experiment — •Anna Josephine Schulze and Felix Spanier — University of Heidelberg

The aim of the Karlsruhe Tritium Neutrino (KATRIN) experiment is to precisely determine the neutrino mass by measuring the electron energy spectrum of the tritium-beta-decay. The high energy of this decay is also the reason for a plasma to develop inside the windowless gaseous tritium source (WGTS). Interactions between the plasma and metallic walls lead to the formation of a plasma sheath and with it an electrostatic potential arises. This can modify the resulting energy spectrum. Therefore, the behaviour of the plasma and especially its wall-interaction was estimated using a 1D simulation. It is based on solving the Vlasov-Poisson system with an Eulerian scheme to compute the electric potential along the middle axis of the tritium source. This technique allows for stronger density gradients as well as atomic processes to be considered. In general, however, it is more computationally expensive than a particle-in-cell method. Initial results yield a plasma potential of $\Delta\phi = 0.047$ V and show a backflow of electrons, leading to the development of a two-stream instability in the plasma. Currently, the code is further developed to simulate a larger area of the WGTS and to consider more effects, including recombination.

P 21: Members' Assembly

Time: Thursday 19:00–20:00 Location: CHE/0089

All members of the Plasma Physics Division are invited to participate.

Radiation and Medical Physics Division
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Overview of Invited Talks and Sessions

(Lecture hall ZEU/0146)

Plenary Talk of ST

See PV for details.

PV VII	Thu	9:00– 9:45	HSZ/AUDI	**The role of artificial intelligence in modern radiation therapy** — •Guillaume Landry

Invited Talks

ST 4.1	Wed	14:00–14:20	ZEU/0146	**Innovationen in die Praxis bringen – die EXIST Gründungsförderung** — •Antje Dewitz
ST 4.2	Wed	14:20–14:40	ZEU/0146	**Development and Certification of an IGRT system** — •Claus Promberger
ST 4.3	Wed	14:40–15:00	ZEU/0146	**Klinische Anwendung von Protonen-/Partikeltherapie** — •Esther Troost
ST 10.1	Thu	17:30–18:00	ZEU/0146	**Online-adaptive particle therapy: Current status and vision for the future** — •Christian Richter

Sessions

ST 1.1–1.6	Tue	11:00–12:30	GER/038	**Accelerators for Radiation Therapy (joint session ST/AKBP)**
ST 2.1–2.6	Tue	17:00–18:30	ZEU/0146	**Medical Imaging Concepts**
ST 3.1–3.3	Wed	11:00–12:30	ZEU/0146	**Poster Session**
ST 4.1–4.3	Wed	14:00–15:30	ZEU/0146	**DPG meets DGMP: Von der Idee bis zur klinischen Anwendung**
ST 5.1–5.6	Wed	15:50–17:20	ZEU/0146	**Physics and Technology for Radiation Detection**
ST 6	Wed	17:45–18:45	ZEU/0146	**Members' Assembly**
ST 7.1–7.3	Thu	11:00–12:30	HSZ/AUDI	**AI Topical Day – Invited Talks (joint session AKPIK/HK/ST/T/AKBP)**
ST 8.1–8.6	Thu	14:00–15:30	ZEU/0146	**AI Topical Day – AI in Medicine (joint session ST/AKPIK)**
ST 9.1–9.6	Thu	15:50–17:20	ZEU/0146	**Radiation Therapy**
ST 10.1–10.1	Thu	17:30–18:00	ZEU/0146	**Keynote: Online-Adaptive Particle Therapy**
ST 11	Thu	18:00–18:15	ZEU/0146	**Prize Ceremony and Closing Session**

Members' Assembly of the Radiation and Medical Physics Division

Wednesday 17:45–18:45 Location: ZEU/0146

Sessions

– Invited Talks, Contributed Talks, and Posters –

ST 1: Accelerators for Radiation Therapy (joint session ST/AKBP)

Time: Tuesday 11:00–12:30 Location: GER/038

ST 1.1 Tue 11:00 GER/038

Real-time analysis for a scintillating fiber-based ion beam profile monitor — •Liqing Qin, Qian Yang, and Blake Leverington — Physikalisches Institut, Heidelberg, Germany

For raster scanning of a pencil beam during ion beam therapy, it is necessary to monitor the beam in real-time for safety and quality reasons.

A scintillating fiber-based beam profile monitor developed from LHCb fiber winding techniques will offer real-time information of the pencil beam parameters, including position, width, and intensity, with a readout rate of up to 10 kHz.

The preliminary reconstruction algorithm for a Gaussian-like beam is being implemented on an FPGA. Preliminary results of the reconstruction algorithm performance on the FPGA will be presented.

ST 1.2 Tue 11:15 GER/038

Application of HV-CMOS sensor in a position monitoring system for therapeutic ion beams — •Bogdan Topko[1], Matthias Balzer[2], Alexander Dierlamm[1,2], Felix Ehrler[2], Ulrich Husemann[1], Roland Koppenhöfer[1], Ivan Perić[2], Martin Pittermann[1], and Alena Weber[2,3] — [1]Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT) — [2]Institute for Data Processing and Electronics (IPE), KIT — [3]now with Bosch AG

Cancer treatment with ion beams provides critical advantages compared to the photon irradiation approach. The Bragg peak of the ion energy deposition near the end of the particle range allows to deposit the maximum of energy to the tumor and minimize the damage of healthy tissue. The beam position and size can be precisely controlled by the beam delivery system. In order to provide effective and safe dose delivery to the tumor, a fast and reliable beam monitoring system is required. The studies presented in this talk are focused on the application of HV-CMOS sensors for such a beam monitoring system. This system should provide information about beam position, shape and fluence in real time. It should work under beam intensities up to 10^{10} s^{-1} and deliver fluence information every 1-2 μs. In order to fulfill the timing requirements, the HitPix chip family with counting electronics and frame based readout has been developed at the ASIC and Detector Lab (IPE, KIT). Recent measurements with ion beams and a multi-chip matrix as well as future developments are discussed.

ST 1.3 Tue 11:30 GER/038

Medical irradiation simulations for IBPT accelerators — •Katharina Mayer[1], Erik Bründermann[1], Alfredo Ferrari[3], Michael J. Nasse[1], Markus Schwarz[1], and Anke-Susanne Müller[1,2] — [1]IBPT, KIT, Karlsruhe — [2]LAS, KIT, Karlsruhe — [3]IAP, KIT, Karlsruhe

An important cancer treatment method used in oncology is radiation therapy, in which the tumor is irradiated with ionizing radiation. In recent years, the study of the beneficial effects of short intense radiation pulses (FLASH effect) or spatially fractionated radiation (Microbeam) have become an important research field. Systematic studies of this type often require non-medical accelerators capable of producing the requested short intense pulses. At KIT, the Ferninfrarot Linac- und Testexperiment (FLUTE) can produce ultra-short electron bunches and the KIT storage ring KARA (Karlsruher Research Accelerator) is a source of pulsed X-rays. Both can be used as pulsed high-energy radiation sources and compared to conventional X-ray tubes. In this contribution, first dose simulations for FLUTE using the Monte Carlo simulation program FLUKA are presented.

ST 1.4 Tue 11:45 GER/038

Dose Simulation of Ultra-High Energy Electron Beams for Novel FLASH Radiation Therapy Applications — •Kelly Grunwald, Klaus Desch, Daniel Elsner, Dennis Proft, and Leonardo Thome — Physikalisches Institut der Universität Bonn

The electron stretcher facility ELSA delivers up to 3.2 GeV electrons to external experimental stations. In a new setup the irradiation of tumor cells inside a water volume with doses of up to 50 Gy by ultra-high energy electrons (UHEE) in time windows of microseconds up to milliseconds (FLASH) is currently investigated. This technique may enable highly efficient treatment of deep-seated tumors alongside optimal sparing and protection of healthy tissue. Along the effort to measure the dose with a suitable detector, our approach is to determine the optimal dose distribution by simulations. Therefore, the electromagnetic shower process is simulated in Geant4, taking the extracted electron pulse properties into account. A virtual water volume is constructed of voxels of different sizes for precise investigation in the volume of interest. Various properties such as particle types, deposited energy and the energy spectra of the particle shower can be extracted and correlated to relative and absolute dose measurements at the real water phantom. The method and first results will be presented.

ST 1.5 Tue 12:00 GER/038

Evaluation of Measuring Techniques to Determine the Applied Dose of Ultra-High Energy Electorn Beams in Cell Samples for FLASH Therapy — •Leonardo Thome, Klaus Desch, Daniel Elsner, Dennis Proft, and Kelly Grunwald — Physikalisches Institut der Universität Bonn

The electron accelerator facility ELSA delivers up to 3.2 GeV electrons. Ultra-high energy electrons (UHEE) in short pulses of microseconds up to milliseconds (FLASH) are used to investigate the effect of UHEE on tumor cells. This may enable highly efficient treatment of deep-seated tumors due to the FLASH effect. Currently, in a preliminary setting the Booster-Synchrotron is used to deliver electrons of 1.2 GeV energy, to irradiate cell samples placed in a water phantom. A precise dose determination is necessary to monitor the efficacy of the biological effect. Therefore, the usability of different detector types for a precise dose determination is evaluated.

ST 1.6 Tue 12:15 GER/038

Dosimetry tests for FLASH RT at PITZ — •Felix Riemer, Zakaria Aboulbanine, Gowri Adhikari, Zohrab Amirkhanyan, Namra Aftab, Prach Boonpornprasert, Georg Georgiev, Anna Grebinyk, Andreas Hoffmann, Mikhail Krasilnikov, Xiangkun Li, Anusorn Lueangaramwong, Raffael Niemczyk, Houjun Qian, Chris Richard, Frank Stephan, Grygorii Vashchenko, Tobias Weilbach, and Steven Worm — Deutsches Elektronen-Synchrotron DESY, Platanenallee 6, 15738 Zeuthen, Germany

The Photo Injector Test facility at DESY in Zeuthen (PITZ) can provide unique beam parameters regarding delivered dose and dose rate. With an average dose rate of up to 10^7 Gy/s and peak dose rates of up to $4 \cdot 10^{13}$ Gy/s, PITZ is fully capable of FLASH radiation therapy. Nevertheless, dosimetry is a major challenge. Traditional detectors cannot provide reliable measurements and linearity up to such high dose rates. A new setup is being built to create a test infrastructure for all kinds of detectors. This includes a completely new beamline exclusively for FLASH RT and biology experiments. The goal is to develop and test detectors (also from external users) which cover the whole range of dose rates available at PITZ. First dosimetry experiments using Gafchromic films were done in air and water. Dose rate linearity and a limit test of the films were done. Beam parameters like beam profile, dose depth profile in water, homogeneity and dark current were measured. First detector tests will be done using silicon sensors utilized in high energy physics experiments.

ST 2: Medical Imaging Concepts

Time: Tuesday 17:00–18:30 Location: ZEU/0146

ST 2.1 Tue 17:00 ZEU/0146

Investigation of the prospects of BaF2 as a fast scintillator for TOF-PET — •Katrin Herweg, Vanessa Nadig, Volkmar Schulz, and Stefan Gundacker — Department of Physics of Molecular Imaging Systems, RWTH Aachen University, Aachen, Germany

Future time-of-flight positron emission tomography (TOF-PET) will be in need of ultra-fast scintillation, with potential seen in cross-luminescencent materials like BaF2, which shows a sub-100ps decay time with 300 photons produced per MeV. However, it poses challenges such as medium radiation length, low photofraction, moderate light yield and VUV emission around 200nm. A slow emission at 310nm presents an additional challenge, which has been addressed before by doping BaF2 with yttrium. Recent developments in UV-sensitive SiPMs (here manufactured by Hamamatsu) have the potential to establish cross-luminescence for ultrafast TOF in PET. In this work, we aim to study BaF2, read out by these new VUV SiPMs, as a viable alternative to LYSO:Ce:Ca. Comparing the coincidence time resolution (CTR) of air-coupled 2 x 2 x 20mm3 undoped and yttrium-doped BaF2 crystals to LYSO:Ce:Ca crystals of the same size, with high-frequency readout electronics, we reached 233ps with undoped BaF2 and 213ps with BaF2:Y. The performance of LYSO:Ce:Ca was 181ps with Hamamatsu SiPMs optimized for LYSO. Conducting measurements at different depth of interaction positions shows a pronounced impact on the CTR. Furthermore, we investigated the performance for systems of BaF2 with TOFPET2c ASIC measurements and Geant4 simulations for effective sensitivity comparisons to LYSO:Ce:Ca.

ST 2.2 Tue 17:15 ZEU/0146

Advancements in Energy Resolution for Positron Emission Tomography with light sharing Scintillation Crystals — •Matthias Bovelett[1], Florian Müller[1], Yannik Kuhl[1], Stephan Naunheim[1], David Schug[1,2], and Volkmar Schulz[1,2] — [1]Department of Physics of Molecular Imaging Systems, RWTH Aachen University — [2]Hyperion Hybrid Imaging Systems GmbH

Positron Emission Tomography (PET) is widely used in clinical and pre-clinical applications. Commercially available PET-detectors use arrays of segmented scintillators coupled to a SiPM matrix. Of current scientific interest are detectors using light sharing scintillators. In these, the scintillator covers multiple SiPM channels and, therefore, one gamma interaction shares the light among the optically coupled SiPM channels. Key parameters of the gamma interaction, i.e., interaction position, timing, and energy information, need to be reconstructed from the measured light distribution. To acquire a good energy resolution in PET it is necessary to filter out specimen scattered events, thereby reducing background, and improving the signal to noise ratio. This work presents a framework, in which a light sharing scintillator is divided in virtual voxels. For each voxel a dedicated energy calibration is performed. Different summation pattern of involved SiPM channels and their impact on the energy resolution are discussed, including events for which not all SiPM channels were read-out. For these "incomplete" light distributions (~ 15% of all) imputation strategies are presented. Overall, the presented strategies result in an improvement from 14% to below 12% for energy resolution of all events.

ST 2.3 Tue 17:30 ZEU/0146

Metamaterials for Magnetic Resonance Imaging — •Dennis Philipp — Fraunhofer Institute for Digital Medicine MEVIS, 28359 Bremen, Germany

Electromagnetic metamaterials (MTMs) offer manifold degrees of freedom in MRI applications. Most prominently, field homogeneity improvement and signal-to-noise ratio (SNR) enhancement are typical use cases. However, passive MTMs also have some drawbacks such as transmit field (Tx) deformations. Here, we pave the way towards dynamic and active MTMs, which overcome some of the open problems. Bluetooth-controlled, reconfigurable MTMs for signal-to-noise ratio (SNR) enhancement in MRI are presented. These metasurfaces allow to be wirelessly interfaced and tuned during an MRI scan by means of a digital capacitor (DCAP), which is connected to a low-power microcontroller with BLE capabilities. Two prototypes are manufactured, one of which is a metasurface with adjustable resonance frequency, and the second one is dynamically tunable at the meta-atom (unit cell) scale. It includes multiple DCAPS and, thus, is the first wirelessly reconfigurable MTM for MRI that offers field shaping capabilities, adjustable FoV, focal regions, sequence sync., and active Tx detuning. A MTM arrangement that encloses a volume "metaBox" is shown to yield a significant and volume-homogeneous SNR enhancement in 3T MRI. Due to the integration of non-linear components, the structure self-detunes in Tx whilst being resonant in Rx. Fine-tuning capabilities are included in two different prototypes via (i) a manually trimmable capacitor and (ii) a BLE controlled DCAP.

ST 2.4 Tue 17:45 ZEU/0146

Proton Radiography: An Overview and Outlook — Jana Hohmann, Kevin Kröninger, Isabelle Schilling, •Hendrik Speiser, and Jens Weingarten — TU Dortmund, department of physics

For years, proton therapy has been increasingly used to treat cancer because of its well-known advantages, such as the high dose precision of protons. However, exploiting this precision requires improved imaging techniques to ensure accurate patient positioning and dose delivery. This allows to reduce the safety margin around the target volume and protecting the surrounding healthy tissue.

One such enhanced imaging technique is proton radiography. It allows to take images whose properties are directly dependent on the proton interactions with the structures in the patient. Therefore, by measuring the residual energy of protons after passing through the patient, conclusions on the stopping power distribution in the patient can be drawn. Extending a proton radiogram to a CT allows to reduce the proton range uncertainty from the conversion of Hounsfield units into stopping power. However, even a single proton radiogram taken on the treatment day can be used to verify the predefined therapy plan and the correct patient positioning.

This talk will include an introduction into the topic of proton radiography followed by an overview of several proton radiography approaches. Subsequently, two new methods developed and investigated at the TU Dortmund University are presented and discussed.

ST 2.5 Tue 18:00 ZEU/0146

A Two-plane Spectral Proton Radiography System using Silicon Pixel Detectors — •Jana Hohmann, Kevin Kröninger, Isabelle Schilling, Hendrik Speiser, Jens Weingarten, and Jolina Zillner — TU Dortmund University, Germany

To take advantage of the locally high dose in proton therapy the irradiation must be planned precisely. X-Ray CT images are used for this purpose. However, when Hounsfield units are converted to the stopping power of the material, this entails a range uncertainty in the treatment plan, which can lead to unintentional radiation damage in healthy tissue or to missing dose in the tumor.

To avoid this, the stopping power of the protons can be determined via imaging techniques with protons themselves. This could be used to verify and adjust the existing irradiation plan.

One attempt is a two-plane system that is designed to measure the water equivalent thickness (WET) directly, from which the stopping power can be calculated. Two pixelated silicon detectors with an absorber in between track the deposited energies of individual protons. With a reference measurement and the initial proton energy, the WET of a phantom can thus be determined.

The detector design is simulated and optimized in GEANT4. This is then used to determine the 2D WET distribution of a known phantom. The talk summarizes the simulation results and provides a comparison to the single plane method.

ST 2.6 Tue 18:15 ZEU/0146

Experimental characterization and comparison of two Si-based compact setups for proton radiography and tomography of small animals for image-guided proton irradiation — •Angelica Noto[1], Guyue Hu[1], Katrin Schnürle[1], Matthias Würl[1], Franz Englbrecht[1], Johannes Gebhard[1], Julie Lascaud[1], Marco Pinto[1], Ze Huang[1], Jonathan Bortfeldt[1], Mateusz Sitarz[2], Per Poulsen[2], and Katia Parodi[1] — [1]Medical Physics Department, LMU, Munich, Germany — [2]Danish Center for Particle Therapy, Aarhus University Hospital, Aarhus, Denmark

In the project SIRMIO we develop advanced imaging for positioning and treatment planning to aid precise proton irradiation of small animals.In contrast to the widely adopted X-ray cone beam CT, the project integrates 3 solutions of proton imaging. Here, we compare 2 approaches that provide spatially resolved detection of individual or integral proton energy deposition relying on the commercial Timepix3 or Lassena Si-based pixelated detectors. Proton radiographs were acquired at the Danish Center for Particle Therapy for a calibration phantom housing inserts of well characterized relative stopping power values. We will compare the achievable spatial resolution and accuracy of water equivalent thickness retrieval in radiographic mode for different systems and imaging doses. Moreover, ongoing acquisitions of tomography with the Timepix3 will be presented for the calibration phantom and a dedicated mouse-like phantom. The work is supported by EU through the grant agreements 725539, 730983 and 101008548. The authors would like to thank Nordson and Advacam.

ST 3: Poster Session

Time: Wednesday 11:00–12:30 Location: ZEU/0146

ST 3.1 Wed 11:00 ZEU/0146

Large-area-diode based micro-dosimeter concept for a femto- satellite — Roman Bergert, •Nico Krug, Hans-Georg Zaunick, and Kai-Thomas Brinkmann — II. Physics Institute Justus-Liebig- University Giessen

A low-budget micro-dosimeter concept based on a large area diode (5×5 mm^2 sensitive area) and commercial of-the-shelf (COTS) components is designed and integrated to operate on an open-community femto-satellite platform provided by *AmbaSat Ltd.* The satellite platform is limited to a dimension of (3.5×3.5 cm^2) with a space of about 2×2 cm^2 for the dosimeter concept. Besides this challenge of space for the integration of the electronics on the platform, the challenge to operate in free harsh-space environment (radiation, vacuum, temperature) has to be overcome in the concept design. To target these challenges, several stress tests were performed, which will be presented with a performance mapping of the different components for their physical and electrical properties together with a discussion of the device performance.

ST 3.2 Wed 11:00 ZEU/0146

Systematic study of a large data set of CT scans with regard to diagnostic reference levels — •Hanna Eick[1], Lydia Bock[1], Jans Böing[1], Lennart Henkenherm[2], Norbert Lang[2], Christina Westphälinger[2], and Alfons Khoukaz[1] — [1]Institute for Nuclear Physics, Westfälische Wilhelms-Universität Münster — [2]Gesellschaft für Medizinische Physik und Strahlenschutz mbH, Münster

Diagnostic reference levels (DRL) for examinations on humans with ionizing radiation or radioactive sources are reviewed or updated if necessary every three years. These DRLs are determined and published by the Federal Office for Radiation Protection and are based on the data provided by the medical authorities. Each operator of a device with the mentioned types of radiation must provide review values to the medical authorities every two years. The collaboration of our working group from the WWU Münster with the 'Gesellschaft für Medizinische Physik und Strahlenschutz mbH' makes it possible, on the one hand, to analyze a large data set of CT examinations from different devices in various facilities and to shed more light on the DRLs and on the other hand, to develop an analysis program, which enables a fast and uncomplicated evaluation of the recorded data for every CT scanner. The results will be considered in particular in the context of the update of the DRLs published in November 2022 and to the reference levels valid until then. The analyses also make it possible to establish new DRLs for examinations that have not yet been considered.

ST 3.3 Wed 11:00 ZEU/0146

Cell irradiation experiments using a compact ultrafast electron source — •Bastian Löhrl[1], Leon Brückner[1], Julian Freier[1], Luitpold Distel[2], and Peter Hommelhoff[1] — [1]Department Physik, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), 91058 Erlangen — [2]Department Strahlenbiologie, Universitätsklinikum Erlangen, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), 91054 Erlangen

Dielectric laser acceleration (DLA) could provide new opportunities for radiotherapy [1]. The goal is to build a chip-based (electron) accelerator using nanophotonic structures driven by femtosecond laser pulses. Built into an endoscopic system, such a novel mini-accelerator could be used for highly localized cancer treatment, for example.

Motivated by this goal, we present the successful implementation of a cell irradiation experiment using pulsed electrons. The setup provides a custom-made, compact electron source with adjustable beam energies up to 30 keV. An integrated electrostatic lens enables focusing of the emitted electron beam. The source can provide several thousand electrons per laser pulse. Irradiation-induced DNA double-strand breaks are detected and visualized in different types of cells through γH2AX immunofluorescence staining. We report on the current status of the experiment and the results of the first measurements.

[1] England, R. Joel, et al. "Dielectric laser accelerators." Reviews of Modern Physics 86.4 (2014): 1337.

ST 4: DPG meets DGMP: Von der Idee bis zur klinischen Anwendung

Time: Wednesday 14:00–15:30 Location: ZEU/0146

Invited Talk ST 4.1 Wed 14:00 ZEU/0146

Innovationen in die Praxis bringen – die EXIST Gründungsförderung — •Antje Dewitz — Projektträger Jülich, Berlin, Germany

Seit 1998 fördert das EXIST-Programm des Bundesministeriums für Wirtschaft und Klimaschutz Existenzgründerinnen und -gründer aus der Wissenschaft, kofinanziert durch den Europäischen Sozialfonds. Durch Start-ups aus Universitäten und Forschungseinrichtungen gelangen Innovationen besonders schnell in die industrielle Praxis und die Gesellschaft. Außerdem entstehen so neue qualifizierte Arbeitsplätze. Wissenschaftlerinnen und Wissenschaftler können im eigenen Start-up auf Grundlage ihrer Forschungsergebnisse innovative Produkte oder Dienstleistungen entwickeln und in die Praxis bringen. Die finanzielle Unterstützung des EXIST-Programms mindert dabei das individuelle Risiko der Gründenden in der Anfangszeit. Außerdem stehen Sachmittel zur Verfügung, um die technische Machbarkeit zu belegen oder einen Prototypen zu bauen. Und durch betriebswirtschaftliche Beratungsangebote und individuelles Coaching wird unternehmerisches Handwerkszeug vermittelt. EXIST ist themenoffen und fördert wissenschaftlich basierte Gründungen von Agrarwissenschaft bis Zivilschutz. Fördervoraussetzung ist eine technische Innovation oder eine neuartige innovative Dienstleistung. Zudem muss erkennbar sein, dass die Idee vom Gründungsteam wirtschaftlich erfolgreich umgesetzt werden kann und grundsätzlich ein Markt vorhanden ist. Ein besonders anspruchsvolles Technologiefeld für Unternehmensgründungen stellt die Medizintechnik dar. Mehr Informationen zu EXIST: www.exist.de

Invited Talk ST 4.2 Wed 14:20 ZEU/0146

Development and Certification of an IGRT system — •Claus Promberger — Brainlab AG, München

As a mid-size company we decided several years ago to redesign a successful IGRT product line to follow current and upcoming regulations and standards in development, verification, validation and certification processes. The journey will be presented which ends again in a successful product and even in a nomination for the "Deutsche Zukunftspreis". The focus will be on the necessary tasks and timeline to bring a fully MDR certified product consisting of software and hardware components to the market in the EU and to keep it there.

Invited Talk ST 4.3 Wed 14:40 ZEU/0146

Klinische Anwendung von Protonen-/Partikeltherapie — •Esther Troost — OncoRay - National Center for Radiation Research in Oncology, Faculty of Medicine and University Hospital Carl Gustav Carus, Technische Universität Dresden, Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

Partikeltherapie, insbesondere Protonentherapie, wird aktuell an zahlreichen Zentren in Deutschland und Europa als Alternative zur herkömmlichen Photonentherapie angeboten. In diesem Vortrag werden die Unterschiede in der Dosisverteilung zwischen Photonen- und Protonentherapie, die Indikationen für eine Protonentherapie sowie der bisher bewiesene Mehrwert von Partikeltherapie dargestellt.

Round Table Discussion (30 min)

ST 5: Physics and Technology for Radiation Detection

Time: Wednesday 15:50–17:20 Location: ZEU/0146

ST 5.1 Wed 15:50 ZEU/0146

Measuring the beam energy at a proton therapy facility using ATLAS IBL pixel detectors — •Isabelle Schilling[1], Claus Maximilian Bäcker[1,2,3,4], Christian Bäumer[1,2,3,4], Carina Behrends[1,2,3,4], Marius Hötting[1], Jana Hohmann[1], Kevin Kröninger[1], Beate Timmermann[2,3,4,5], and Jens Weingarten[1] — [1]TU Dortmund University, Department of Physics, D-44221 Dortmund — [2]West German Proton Therapy Centre Essen, D-45122 Essen — [3]West German Cancer Center, D-45122 Essen — [4]University Hospital Essen, D-45122 Essen — [5]Clinic for Particle Therapy, University Hospital Essen, D-45122 Essen

The accurate measurement of beam range for quality assurance (QA) in proton therapy is important for optimal patient treatment. Conventionally used detectors mostly calculate the energy by detecting the depth dose distribution of the protons. In contrast to this, the ATLAS pixelated silicon detector measures the deposited energy in the sensor for individual protons, allowing the determination of the Linear Energy Transfer (LET). The restriction on the dynamic energy range of the measurement is given by the readout chip. Hence, there are different ways to use the detector whose applicability is being examined. An absorber with different thicknesses is used to investigate the variation of the charge production in the sensor and perform an energy calibration relative to the NIST PSTAR database. In comparison, this talk also presents measurements of the LET per pixel along the trajectory of individual proton, all performed at the West German Proton Therapy Centre Essen.

ST 5.2 Wed 16:05 ZEU/0146

Development of a Compton Camera with detection of electrons' interaction point and energy in the scattering layer using Cherenkov photons — •Kaveh Kooshk[1], Reimund Bayerlein[2], Ivor Fleck[1], Ulrich Werthenbach[1], and Michael Ziolkowski[1] — [1]Universität Siegen, NRW, DE — [2]University of California Davis, CA, US

A Compton Camera can be a great real-time imaging asset for Proton Beam Therapy cancer treatment and radio-immunotherapy. The main goal is imaging of gammas above 0.5 MeV, which cannot otherwise be resolved by conventional detectors such as SPECT with good efficiency. To that end, we designed an experimental setup which reconstructs Compton electron's energy and direction using coincident detection of Cherenkov photons. In order to calibrate the energy estimation, we built a device which separates electrons with energies up to 2.28 MeV from a 90Sr/90Y source to a very small spectrum using a magnetic field. The electrons subsequently undergo Cherenkov effect in a PMMA radiator, in contact with a 8x8 SiPM array with $3x3mm^2$ sized read-out channels. A separation resolution of 10 to 20% has been achieved for 7 different energy beams from 0.8 MeV to 2 MeV. The number of Cherenkov photons, detected in coincidence from SiPm's time-over-threshold signal within a time-window of 10 ns, is used to estimate the electron energy. The results are compared with a mean value available from theory.

ST 5.3 Wed 16:20 ZEU/0146

Neutron Detection With Coated Semiconductors — Kevin Alexander Kröninger, •Alina Johanna Landmann, Ruben Trimpop, and Jens Weingarten — TU Dortmund University, Department of Physics, Otto-Hahn-Str.4a, 44227 Dortmund

3He is a popular element in neutron detection. However, the world is suffering from an extreme 3He-shortage which increases the need for alternative detection methods. Coated semiconductors represent a promising alternative in high flux particle fields. Typical environments with high particle fluxes are found at (research) reactors. To make use of semiconductor detectors in lower particle flux environments, the detection efficiency has to be increased significantly. In Geant4 simulations, we investigated various neutron converting materials and possible detector layouts capable of increasing the detection efficiency. A first prototype with a single converter layer on top of a silicon sensor was built to investigate the detection principle. Further studies concerning the thin film coating process for the different converting materials have been performed and will be presented.

ST 5.4 Wed 16:35 ZEU/0146

Neutron dosimetry with diamont sensors — •Jennifer Schlüss, Kevin Kröninger, Jens Weingarten und Alina Landmann — Technische Universität Dortmund, Dortmund, Germany

Neutron dosimetry is becoming increasingly relevant in proton therapy. From to the neutrons released, conclusions can be drawn about the deposited energy in the body. However, neutron dosimetry is complicated because neutrons are electrically neutral particles and cannot ionize directly. Neutrons must therefore be converted to charged particles before they can be detected. One way to convert neutrons is with the help of diamond sensors. The natural carbon isotope ^{12}C captures fast neutrons ($E_{kin} > 5MeV$). This produces alpha particles which can be detected in the diamond detector itself. To make the detector more sensitive to thermal neutrons, an attempt is made to coat the detector with a converter material such as ^{6}LiF. The simulation tool Geant4 will be used to test carbon capture reactions as a tool for further detector development. A multi-spectrum will then be used to perform neutron dosimetry with the goal of implementing a multi-spectrum detector for neutron dosimetry. To characterize the detection of fast neutrons, the diamond sensor will be tested in a later step with a simple readout in a neutron field.

ST 5.5 Wed 16:50 ZEU/0146

Fast neutron detection in proton beam therapy using SciFi detectors — •Martin Lau, Justus Beckmann, Kevin Kröninger, Alina Johanna Landmann, Jennifer Schlüss, and Jens Weingarten — TU Dortmund University, Department of Physics, Germany

Proton beam therapy is a rapidly growing field, due to the precise dose distribution within the patient. There are however many uncertainties regarding the range of proton beams. A simulation study showed, that the proton beam depth in a water phantom could be reconstructed by tracking the fast neutron trajectories emitted along the beam during irradiation. Fast neutrons undergo less scattering in material. This leads to a more precise reconstruction of their trajectories. Due to the difficulty of fast neutron detection, the potential use of SciFi detectors from the LHCb upgrade are investigated to track fast neutrons in a clinical environment due to their high spatial resolution. To determine the applicability of scintillating fibres for fast neutron detection in a clinical setting, the neutron detection capabilities and the resulting light yields of these fibres are investigated through GEANT4 simulations. Parallel, we will be testing the actual SciFi detector matt for practical uses during irradiation.

This talk will present the first results of the simulations, necessary for the reconstruction of the beam. Additionally, first studies of the actual SciFi detector system were performed, which will also be presented.

ST 5.6 Wed 17:05 ZEU/0146

A novel silicon photomultiplier in 350 nm CMOS technology with virtual guard rings and improved geometric efficiency — •Jonathan Preitnacher[1], Wolfgang Schmailzl[1], Sergei Ageev[2], and Walter Hansch[1] — [1]Bundeswehr University Munich, Neubiberg, Germany — [2]The Moscow Engineering Physics Institute-Kashira Hwy, 31, Moscow, Russland, 115409

Silicon photomultipliers (SiPM) are solid-state detectors that can resolve single photons and that are used in various applications like high energy physics or the fields of medical imaging. The implementation of virtual guards is an established technique in full costume SiPM designs to increase the geometric efficiency and therefore the photon detection efficiency (PDE). We present a novel approach applying virtual guard rings in a standard CMOS 350 nm process, improving the geometric efficiency by up to 45% compared to a guard ring design of the same process. We compare both approaches, presenting PDE measurements and additional characteristics of the devices like the breakdown voltage or the dark count rate. In a third design, we coupled the SiPM on the same chip to a costume low-power integrated amplifier to improve the pulse height and the slew rate. Measurements are presented to compare the photon time resolution of the SiPM designs with and without the amplifier.

ST 6: Members' Assembly

Time: Wednesday 17:45–18:45 Location: ZEU/0146

All members of the Radiation and Medical Physics Division are invited to participate.

ST 7: AI Topical Day – Invited Talks (joint session AKPIK/HK/ST/T/AKBP)

Time: Thursday 11:00–12:30 Location: HSZ/AUDI

Invited Talk ST 7.1 Thu 11:00 HSZ/AUDI

AI Techniques for Event Reconstruction — •Ivan Kisel — Goethe University, Frankfurt, Germany

Why can we relatively easily recognize the trajectory of a particle in a detector visually, and why does it become so difficult when it comes to developing a computer algorithm for the same task? Physicists and computer scientists have been puzzling over the answer to this question for more than 30 years, since the days of bubble chambers. And it seems that we are steadily approaching the answer in our attempts to develop and apply artificial neural networks both for finding particle trajectories and for physics analysis of events in general.

This talk will present the basics of artificial neural networks in a simple form, and provide illustrations of their successful application in event reconstruction in high energy physics and heavy ion physics experiments. You will get an insight into the application of traditional neural network models, such as deep neural network, convolutional neural network, graph neural network, as well as those standing a little aside from traditional approaches, but close in idea of elastic network and even cellular automata.

Invited Talk ST 7.2 Thu 11:30 HSZ/AUDI

Accelerator operation optimisation using machine learning — •Pierre Schnizer — Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Berlin, Germany

Accelerators are complex machines whose many components need to be accurately tuned to achive design performance. Reliable operation requires frequent recalibration and tuning. Especially for large machines tools have been developed that facilitating this task.

Machine learning allows building such tools using simulations, archiver data or interaction with the real machine, thus making many tools now also available for smaller machines.

This talk will give an overview of different machine learning projects targeted to accelerators, which simplifies accelerator operation or even enable applications not been possible before.

Invited Talk ST 7.3 Thu 12:00 HSZ/AUDI
Is this even physics? – Progress on AI in particle physics — •Gregor Kasieczka — Universität Hamburg
Motivated by the large volume and high complexity of experimental data and mathematical structures, particle physics has a long tradition of employing state of the art computing and analysis techniques. Recent progress in machine learning and artificial intelligence have further pushed this trend, and these approaches are now ubiquitous in our field. This overview attempts to capture key developments such as the rise of unsupervised approaches and the quest for suitable neural network architectures for physics tasks; challenges like ultra-low latency inference and robust predictions; as well as promising new ideas looking forward.

ST 8: AI Topical Day – AI in Medicine (joint session ST/AKPIK)

Time: Thursday 14:00–15:30 Location: ZEU/0146

ST 8.1 Thu 14:00 ZEU/0146
Multimodal image registration with deep learning — •Alexander Ratke[1], Christian Bäumer[2], Kevin Kröninger[1], and Bernhard Spaan[1] — [1]TU Dortmund University, Dortmund, Germany — [2]West German Proton Therapy Centre Essen, Essen, Germany
In radiation therapy, precise localisation of tumour and risk structures is important for treatment planning. Medical imaging methods, such as computed tomography (CT) and magnetic resonance imaging (MRI), allow a differentiation between these structures. Planning systems typically align CT and MRI scans rigidly to compensate inaccurate immobilisation of the patient, but distortions in MRI or movement of organs still remain.

In this project, a data set of CT and MRI scans of the head and neck areas is used to study unsupervised deformable image registration with deep learning. First, the scans are pre-processed, which includes rigid registrations and the equalisation of the image formats. Then, deep learning is employed to filter structures of an image through multiple layers and to match them to a second image. The registration model strongly depends on the choice of its parameters. Therefore, variations of these parameters are investigated on the data set. The results are presented as well as the overall workflow including the preprocessing.

ST 8.2 Thu 14:15 ZEU/0146
Position reconstruction in proton therapy with proton radiography and machine learning — •Jolina Zillner, Carsten Burgard, Jana Hohmann, Kevin Kröninger, Florian Mentzel, Olaf Nackenhorst, Isabelle Schilling, Hendrik Speiser, and Jens Weingarten — TU Dortmund University, Department of Physics, Germany
In proton therapy precise patient positioning is essential for treatment quality. Current research in proton radiography (pRad) enables imaging of the patient immediately prior to irradiation. The idea is to use such pRad images to verify the patients position.

Therefore a 3D Convolutional Neural Network will be developed in order to predict pRad images depending on the CT image of an object and different translations and orientations. A minimization algorithm can then find the translation and rotation vector for which the predicted image has the smallest difference to a measured pRad image of the object, which can be used to correct the objects position. To predict pRad images, the CNN needs to be trained with pRad images and their related object translation and rotation and the CT-image.

This talk introduces the simulation used to generate these pRad training data. Simulations and reference measurements are performed with a primitive elbow phantom: a 3D-printed 3x3x3 cm^3 cube with a T-cavity for gypsum-inlays representing a stretched or bent elbow. The target is implemented in GEANT4 based on CT-data.

ST 8.3 Thu 14:30 ZEU/0146
Event identification in the SiFi-CC Compton camera for imaging prompt gamma rays in proton therapy via deep neural networks — •Alexander Fenger[1], Ronja Hetzel[1], Jonas Kasper[1], George Farah[1], Achim Stahl[1], and Aleksandra Wrońska[2] — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]M. Smoluchowski Institute of Physics, Jagiellonian University Kraków, Poland
One of the biggest challenges in proton therapy is ensuring that the dose is delivered to the right position. A promising approach for online monitoring of the beam range is the detection of prompt gamma rays using a Compton camera, as it provides the possibility to reconstruct the 3D distribution of the deposited dose.

The SiFi-CC (SiPM and scintillating Fiber-based Compton Camera) project is a joint collaboration of the RWTH Aachen University, the Jagiellonian University in Kraków and the University of Lübeck. The two modules of the SiFi-CC, the scatterer and the absorber, both consist of stacked LYSO fibres and are read out by SiPMs. Deep neural networks are employed to separate valid Compton events from background and reconstruct the direction and energy of prompt gamma rays. First implementations of neural networks show promising results in classification of Compton events as well as full reconstruction of the event topology and kinematics. The next step is to further optimize the current neural network implementation to gain sensitivity towards a detectable range shift in the source position. Different neural network designs as well as an evaluation of their performance are presented.

ST 8.4 Thu 14:45 ZEU/0146
Selection of Compton events in the SiFi-CC camera using convolutional neural networks — •George Farah[1], Ronja Hetzel[1], Jonas Kasper[1], Alexander Fenger[1], Achim Stahl[1], and Aleksandra Wrońska[2] — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]M. Smoluchowski Institute of Physics, Jagiellonian University Kraków, Poland
Proton therapy is a promising form of cancer treatment that uses charged protons to target and kill cancer cells. One of the main challenges in proton therapy is accurately determining the depth at which the protons will deposit their energy in the tumor.

The SiFi-CC (SiPM and scintillating Fiber-based Compton Camera) aims to enable range detection in proton therapy. It consists of multiple scintillating LYSO fibers generating signals that get read by SiPMs attached to both ends of the fibers. The camera utilizes the Compton effect and photoelectric effect to detect the prompt gamma rays produced in nuclear interactions of the protons with the nuclei in the tumor. This allows restricting the origin of the prompt gamma to a cone surface and by reconstructing many of such cones it is possible to reconstruct the source distribution of the prompt gammas.

The most recent SiFi-CC geometry has four fibers coupled to one SiPM in a shifted manner, so signals from multiple fibers get read by a single SiPM. In this talk, we present how three-dimensional neural networks can be advantageous by taking into consideration this new geometry. Hence improving the detection of Compton events, which improves the accuracy of range detection in proton therapy.

ST 8.5 Thu 15:00 ZEU/0146
Fast dose predictions for conformal synchrotron microbeam irradiations — •Marco Schlimbach[1], Micah Barnes[2], Kevin Kröninger[1], Florian Mentzel[1], Olaf Nackenhorst[1], and Jens Weingarten[1] — [1]TU Dortmund, Germany — [2]University of Wollongong, Australia
An important optimization goal of radiation therapy is to apply the prescribed dose to the tumor while minimizing the dose deposition to surrounding healthy tissue. The new preclinical irradiation method, called Microbeam Radiation Therapy (MRT), enables higher control for certain tumors by spatial fractionation of photon beams compared to conventional irradiation methods. At the same time, the exposure of normal tissue remains the same.

Currently, the dose for MRT is mostly calculated with time-consuming Monte-Carlo simulations. However, for transfer to clinical application, a fast dose calculation is essential, so that therapies can be planned in a sufficiently short time. Recent studies show that MRT doses can be predicted accurately within milliseconds using neural networks. These studies, however, are limited to predicting the dose from a fixed MRT field size.

This work presents a method to extend the developed machine learning model to predict the doses from MRT irradiation fields of variable size and shape. Since there is no data from the clinic for MRT compared to conventional irradiation methods, the models are trained using a Geant4 Monte-Carlo simulation of a rodent head irradiation at the Imaging and Medical beamline at the Australian Synchrotron.

ST 8.6 Thu 15:15 ZEU/0146
Thermoluminescence glow curve generation using generative adversarial networks (GANs) — •Evelin Derugin[1], Olaf Nackenhorst[1], Florian Mentzel[1], Jens Weingarten[1], Kevin Kröninger[1], and Jörg Walbersloh[2] — [1]Department of Physics, TU Dortmund University — [2]Materialprüfungsamt NRW
Personal dose monitoring is essential for a successful radiation protection program for occupationally exposed persons. The Materialprüfungsamt NRW (MPA NRW) provides thermoluminescence (TL) dosimeters based on LiF:Mg,Ti. Proof-of-concept studies to predict the day of irradiation have been successfully performed on measured TL glow curves using artificial neural networks (ANN). However, large data sets are required to train an ANN to predict the parameters of new measurements. Therefore the Department of Physics at TU Dortmund is developing multivariate methods for generating TL glow curves

using generative adversarial networks (GANs). These generated glow curves will be used as training data for the irradiation day prediction model. This study trains GANs to generate glow curves using a measured data set of 4100 glow curves with 28 irradiation dates. In this talk, we present the comparison of the simulated glow curves with the measured ones and provide information about the performance and optimization of the GAN.

ST 9: Radiation Therapy

Time: Thursday 15:50–17:20 Location: ZEU/0146

ST 9.1 Thu 15:50 ZEU/0146

Simulations of a combination of brachytherapy and X-ray irradiation for the treatment of intraocular tumors — •Michelle Stroth[1], Henning Manke[1], Dirk Flühs[2], Bernhard Spaan[1], and Johannes Albrecht[1] — [1]TU Dortmund University, Dortmund, Germany — [2]Department of Radiotherapy, Essen University Hospital, Germany

Brachytherapy with Ruthenium-106 Eye Applicators is an effective method for successfully treating ocular tumours. However, this treatment is contraindicated for intraocular tumours with an apex height above 7 mm due to insufficient irradiation of the tumor apex. To reduce side effects that can occur with alternative forms of therapy, an integrated concept consisting of brachytherapy with external X-ray irradiation is investigated for treating intraocular tumours.

For this purpose, the combined therapy modality is simulated using real patient data. The radiation sources' weights are adjusted by optimization through differential evolution, minimizing the dose to the organs at risk. Comparison of the dose-volume histograms of the combined form of therapy with the dose-volume histograms of brachytherapy only, confirms the advantages of integrating external X-ray irradiation using the ruthenium-106 applicator in terms of protection of the structures at risk and homogeneity of the dose profile in the tumour.

This presentation shows the results of the Monte Carlo simulations of the combined concept.

ST 9.2 Thu 16:05 ZEU/0146

A novel therapy concept for intraocular tumors — •Henning Manke[1], Michelle Stroth[1], Dirk Flühs[2], Bernhard Spaan[1], and Johannes Albrecht[1] — [1]TU Dortmund University, Dortmund, Germany — [2]Department of Radiotherapy, Essen University Hospital, Germany

To investigate the suitability of a new therapy concept for intraocular tumors consisting of both brachy- and radiotherapy a new phantom was developed and tested. Tumors with a height up to 7 mm are mostly treated with Ruthenium-106 plaques. Due to the steep dose gradient, tumors with a higher apex are irradiated insufficiently. A therapy modality for tumors that big is to use Iodine-125 plaques, but due to their isotropic gamma radiation healthy tissue is partly irradiated and damaged. The new concept consists of simultaneous therapy with Ruthenium-106 plaques and X-ray. Both the tumor base and apex can be irradiated sufficiently while sparing healthy tissue. The plaque may serve as an absorber for the X-rays.

A new phantom was constructed from the material Plastic Water Low Range to measure dose profiles of X-rays in front and behind a Ruthenium-106 plaque. Three different detectors can be used in the phantom to measure dose profiles: a soft X-ray chamber, radiochromic films and self-made scintillation detectors. Measurements have been performed with a X-ray therapy unit type T-105 distributed by BEBIG Medical GmbH.

This talk presents the first results which show an appropriate application of the combined therapy.

ST 9.3 Thu 16:20 ZEU/0146

Proton Therapy Dose Calculations with the Monte-Carlo Simulation — •Mariam Abuladze[2], Ronja Hetzel[1], Jonas Kasper[1], Revaz Shanidze[2], and Achim Stahl[1] — [1]RWTH Aachen University - Physics Institute III B, Aachen, Germany — [2]Kutaisi International University, Kutaisi, Georgia

Proton therapy is a high-quality radiation therapy that uses a proton beam to irradiate cancer tissue. The advantage of this type of treatment is a highly conformal dose deposition due to the presence of the Bragg peak. The results of the Geant4 simulation (version 10.6.3.) are presented. The dose distribution was studied in the phantom materials with proton beams of different geometry and intensity. Different geometric shapes are used for phantoms, which are filled with water and carbon. 3D phantom models are divided into voxels of different sizes. Obtained simulated data was used for calculations of dose-volume histograms for different proton beam parameters and different phantom models.

ST 9.4 Thu 16:35 ZEU/0146

Prompt gamma-ray timing for online proton range verification - status quo — •Krystsina Makarevich[1,2], Katja E. Römer[3], Sonja M. Schellhammer[1,2], Joseph A. B. Turko[3], Andreas Wagner[3], and Toni Kögler[1,2] — [1]Helmholtz - Zentrum Dresden - Rossendorf, Institute of Radiooncology - OncoRay, Dresden, Germany — [2]OncoRay - National Center for Radiation Research in Oncology, Faculty of Medicine and University Hospital Carl Gustav Carus, Technische Universität Dresden, Helmholtz - Zentrum Dresden - Rossendorf, Dresden, Germany — [3]Helmholtz - Zentrum Dresden - Rossendorf, Institute of Radiation Physics, Dresden, Germany

The prompt gamma-ray timing (PGT) technique is a promising candidate for proton therapy range verification as it is light-weighted, can be integrated into existing therapy systems, and introduces no additional dose to patients. This work explains the physical basics of the PGT method and gives an overview of a setup developed for future integration into clinical practice. Currently, the PGT technique undergoes extensive testing under close-to-clinical conditions so to prepare for the first in-human application. The latest measurements with an anthropomorphic head phantom irradiated with clinical treatment plans are delineated. The work sets out the main outcomes of this experiment such as the choice of the detector crystal size, the relationship between the detector load and the processed count rate, the influence of the range shifter on the PGT distributions, etc. An overview of the directions for future investigations is presented.

ST 9.5 Thu 16:50 ZEU/0146

First Results for Prompt Gamma Spectra measured by PETsys Electronics with 100-162 MeV Proton Beam at OncoRay TU Dresden — •Olga Novgorodova and Arno Straessner — IKTP TU Dresden, Dresden, Germany

Prompt gammas (PG) in proton therapy are one of the developing techniques for non-invasive measurements of in-vivo proton range. For the prompt gamma timing (PGT) application both time and spectral characteristics are important. Time and coincidence time resolution (CTR) studies showed already results below 100 ns. We concentrate now on the spectral properties of the system measuring PG in the range up to 8 MeV at OncoRay TU Dresden facility with proton energies between 100 to 162 MeV. A big challenge for PGT application is the data load due to the large number of photons hitting the crystal. By decreasing the size of the crystals and increasing the number of channels in the detector matrix the load to each channel can be reduced and more PGs can be detected. We are investigating $CeBr_3$ crystals of 5x5x20 mm^3 and 10x10x30 mm^3 size coupled with Sensl SiPM of 6x6 mm^2 with 35 μm microcells and Hamamatsu SiPM of 6x6 mm^2 with 25 and 50 μm microcells. The size of existing SiPMs is a limiting factor. For the readout electronics we optimized the PETsys electronics towards higher PG energies. It offers high photon detection efficiency, good time resolution, low bias voltage and can operate in magnetic fields. In the presentation we present first measurements of energy spectra with two different targets performed at OncoRay TU Dresden.

ST 9.6 Thu 17:05 ZEU/0146

Sub-Millimeter Relative Range Verification in Heavy-Ion Therapy using Filtered Interaction Vertex Imaging — •Devin Hymers[1,2], Eva Kasanda[2], Vinzenz Bildstein[2], Joelle Easter[2], Andrea Richard[3,4], Artemis Spyrou[3], Cornelia Hoehr[5], and Dennis Muecher[1,2,5] — [1]Institut für Kernphysik, Universität zu Köln, Köln, Germany — [2]Department of Phyiscs, University of Guelph, Guelph, ON, Canada — [3]National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, MI, USA — [4]Lawrence Livermore National Laboratory, Livermore, CA, USA — [5]TRIUMF, Vancouver, BC, Canada

The growing societal burden of cancer necessitates improvement in safety and efficacy of radiation therapy. Scanned heavy-ion therapy provides precise and highly conformal dose delivery, but inherent uncertainties make it difficult to ensure accuracy. Relative range verification via filtered Interaction Vertex Imaging could allow monitoring of beam depth spacing, to ensure full and consistent tumour coverage. To validate this method, twelve ^{16}O beams of differing energy irradiated a 40 mm poly-(methyl methacrylate) phantom, and external secondary particle yields were monitored with position-sensitive silicon detectors. These data were used to reconstruct sites of secondary particle origin. Comparison of logistic fits to the distal edges of these distributions via χ^2 minimization computed the range shift between any two beam depths with sub-millimeter precision, to a standard deviation of the mean of 220(10) μm. This result validates filtered Interaction Vertex Imaging as a candidate for high-performance clinical range verification.

ST 10: Keynote: Online-Adaptive Particle Therapy

Time: Thursday 17:30–18:00 Location: ZEU/0146

Invited Talk ST 10.1 Thu 17:30 ZEU/0146
Online-adaptive particle therapy: Current status and vision for the future — •Christian Richter — OncoRay - National Center for Radiation Research in Oncology, Faculty of Medicine and University Hospital Carl Gustav Carus, Technische Universität Dresden, Helmholtz-Zentrum Dresden - Rossendorf, Dresden, Germany — Department of Radiotherapy and Radiation Oncology, Faculty of Medicine and University Hospital Carl Gustav Carus, Technische Universität Dresden, Dresden, Germany — Helmholtz-Zentrum Dresden - Rossendorf, Institute of Radiooncology - OncoRay, Dresden, Germany

In this overview talk the following questions will be addressed: - What is the status concerning fast adaptations in particle therapy also in relation to photon therapy?

- Why we need online-adaptive particle therapy (OAPT)?
- What are different approaches also in relation to different adaption speed?
- What are the different imaging approaches for OAPT?
- How can we verify the treatment delivery when no pre-treatment phantom QA is performed?
- What is the role of AI-based decision support?
- What initiatives exist on national and international level? Where do we stand?

ST 11: Prize Ceremony and Closing Session

Time: Thursday 18:00–18:15 Location: ZEU/0146

In this last session we would like to take the opportunity to thank all participants for their attendance and contributions. We will announce the winner of this years award for the best contribution in the Radiation and Medical Physics Devision at the DPG Spring Meeting 2023. We welcome everyone to celebrate a successful conference with us, to provide some final feedback and to take the chance to meet other participants one last time at this meeting.

Particle Physics Division
Fachverband Teilchenphysik (T)

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Overview of Invited Talks and Sessions

(Lecture halls HSZ/AUDI, HSZ/0003, HSZ/0004, HSZ/0101, HSZ/0103, HSZ/0105, HSZ/0201, HSZ/0204, HSZ/0301, HSZ/0304, HSZ/0401, HSZ/0403, HSZ/0405, POT/0051, POT/0151, POT/0251, POT/0361, POT/0006, POT/0112, POT/0013, POT/0351, POT/0106, WIL/A317, WIL/A124, WIL/C133, WIL/A120, and WIL/C129)

Invited Talks

T 1.1	Mon	11:00–11:30	HSZ/AUDI	**What we learned about the Higgs Boson from the LHC so far** — •Duc Bao Ta
T 1.2	Mon	11:30–12:00	HSZ/AUDI	**QCD at the LHC – Precision for Discoveries** — •Malgorzata Worek
T 1.3	Mon	12:00–12:30	HSZ/AUDI	**The charm and beauty of flavour physics** — •Marco Gersabeck
T 24.1	Tue	11:00–11:30	HSZ/AUDI	**Searching for Long-Lived Particles at the LHC and Beyond** — •Juliette Alimena
T 24.2	Tue	11:30–12:00	HSZ/AUDI	**The Neutrino-Dawn of Galaxies** — •Wolfgang Rhode
T 24.3	Tue	12:00–12:30	HSZ/AUDI	**Galactic cosmic rays: What have we learned and what's next?** — •Philipp Mertsch
T 100.1	Thu	11:00–11:30	HSZ/AUDI	**AI Techniques for Event Reconstruction** — •Ivan Kisel
T 100.2	Thu	11:30–12:00	HSZ/AUDI	**Accelerator operation optimisation using machine learning** — •Pierre Schnizer
T 100.3	Thu	12:00–12:30	HSZ/AUDI	**Is this even physics? – Progress on AI in particle physics** — •Gregor Kasieczka
T 153.1	Fri	11:00–11:30	HSZ/AUDI	**The Standard Model on the test bench: What bosons and the top quark (will) tell us** — •Valerie Lang
T 153.2	Fri	11:30–12:00	HSZ/AUDI	**Gravitational wave observations: Current results & future expectations** — •Harald Pfeiffer
T 153.3	Fri	12:00–12:30	HSZ/AUDI	**Precise muon detection: novel technologies for the luminosity frontier** — •Kerstin Hoepfner
T 154.1	Fri	13:30–14:00	HSZ/AUDI	**ECN3: Experimental Opportunities at a Future High-Intensity Proton Facility at the CERN SPS (BDF/SHiP and HIKE+SHADOWS)** — •Annika Hollnagel

Invited Topical Talks

T 50.1	Wed	11:00–11:20	HSZ/AUDI	**Search for leptoquarks at the ATLAS experiment** — •Mahsana Haleem
T 50.2	Wed	11:20–11:40	HSZ/AUDI	**Making the most of Yukawa couplings: searching for Dark Matter accompanied by heavy quarks** — •Danyer Perez Adan
T 50.3	Wed	11:40–12:00	HSZ/AUDI	**Precision predictions for transverse momentum distributions of Higgs and vector bosons at the LHC** — •Maximilian Stahlhofen
T 50.4	Wed	12:00–12:20	HSZ/AUDI	**Axion fragmentation** — •Enrico Morgante
T 51.1	Wed	11:00–11:20	HSZ/0003	**LUXE – A new experiment to study non-perturbative QED in electron-laser and photon-laser collisions** — •Ruth Jacobs
T 51.2	Wed	11:20–11:40	HSZ/0003	**Precision timing with silicon sensors** — •Annika Vauth
T 51.3	Wed	11:40–12:00	HSZ/0003	**Recent advancements in Micro-Pattern Gaseous Detectors: Exciting research ahead towards future experiments** — •Michael Lupberger
T 51.4	Wed	12:00–12:20	HSZ/0003	**Recent Liquid Scintillator Developments for Astroparticle Physics** — •Stefan Schoppmann
T 52.1	Wed	14:00–14:20	HSZ/AUDI	**Commissioning of the new LHCb trigger system** — •Marian Stahl
T 52.2	Wed	14:20–14:40	HSZ/AUDI	**Alignment of the CMS Tracker: Automation is Key** — •Marius Teroerde
T 52.3	Wed	14:40–15:00	HSZ/AUDI	**ITk – ATLAS tracker upgrade** — •Dennis Sperlich
T 52.4	Wed	15:00–15:20	HSZ/AUDI	**Role of simulation in silicon tracker sensors R&D** — •Anastasiia Velyka
T 53.1	Wed	14:00–14:20	HSZ/0003	**LST-1: Initial scientific results from the first CTA telescope** — •Dominik Elsaesser

T 53.2	Wed	14:20–14:40	HSZ/0003	**Multimessenger astronomy with the Pierre Auger Obser- vatory** — •Marcus Niechciol
T 53.3	Wed	14:40–15:00	HSZ/0003	**Positron annihilation as an astrophysical messenger** — •Thomas Siegert
T 53.4	Wed	15:00–15:20	HSZ/0003	**The first results of the XENONnT experiment and an outlook to the future DARWIN observatory** — •Andrii Terliuk
T 101.1	Thu	14:00–14:20	HSZ/0003	**How to Study the Higgs Boson in its Bosonic Decays** — •Benedict Winter
T 101.2	Thu	14:20–14:40	HSZ/0003	**Measuring $H \to WW$ with the ATLAS Experiment** — •Carsten Burgard
T 101.3	Thu	14:40–15:00	HSZ/0003	**Belle II opportunities in B-decays with invisible signatures** — •Slavomira Stefkova
T 101.4	Thu	15:00–15:20	HSZ/0003	**Two Pieces of a Puzzle: Inclusive and Exclusive $\vert V_{cb}\vert$** — •Markus Prim
T 102.1	Thu	14:00–14:20	HSZ/0004	**Expanding the Frontiers of Galactic Neutrino Astronomy via Machine Learning*** — •Mirco Hünnefeld
T 102.2	Thu	14:20–14:40	HSZ/0004	**Enhancing the CMS Level-1 Trigger with real-time Machine Learning** — •Artur Lobanov
T 102.3	Thu	14:40–15:00	HSZ/0004	**Higgsino Hunting at ATLAS** — •Michael Holzbock
T 102.4	Thu	15:00–15:20	HSZ/0004	**New Ideas for Baryo- and Leptogenesis** — •Kai Schmitz

Sessions

T 1.1–1.3	Mon	11:00–12:30	HSZ/AUDI	**Invited Overview Talks I**
T 2.1–2.6	Mon	16:30–18:00	HSZ/0004	**Flavor I**
T 3.1–3.6	Mon	16:30–18:00	HSZ/0401	**Top I**
T 4.1–4.6	Mon	16:30–18:00	HSZ/0403	**Searches I**
T 5.1–5.6	Mon	16:30–18:00	HSZ/0101	**Higgs Searches**
T 6.1–6.6	Mon	16:30–18:00	HSZ/0103	**Other Exp., EW**
T 7.1–7.6	Mon	16:30–18:00	HSZ/0105	**Higgs, Di-Higgs I**
T 8.1–8.6	Mon	16:30–18:00	HSZ/0204	**Outreach Public/Teilchenwelt (joint session T/HK)**
T 9.1–9.6	Mon	16:30–18:00	HSZ/0301	**DAQ NN/ML – HW**
T 10.1–10.6	Mon	16:30–18:00	HSZ/0405	**ML Methods I**
T 11.1–11.6	Mon	16:30–18:00	POT/0051	**Neutrinos, Dark Matter I**
T 12.1–12.6	Mon	16:30–18:00	POT/0151	**Gamma Astronomy I**
T 13.1–13.6	Mon	16:30–18:00	POT/0251	**Neutrinos I**
T 14.1–14.6	Mon	16:30–18:00	POT/0361	**Neutrinos, Dark Matter II**
T 15.1–15.6	Mon	16:30–18:00	POT/0006	**Neutrinos, Dark Matter III**
T 16.1–16.6	Mon	16:30–18:00	POT/0112	**Neutrino Astronomy I**
T 17.1–17.6	Mon	16:30–18:00	POT/0013	**Cosmic Ray I**
T 18.1–18.6	Mon	16:30–18:00	POT/0351	**Exp. Methods, CTA, others**
T 19.1–19.5	Mon	16:30–17:45	POT/0106	**Detector Systems, Electronics**
T 20.1–20.5	Mon	16:30–17:45	WIL/A317	**Pixel ITk, Si-Strips/Other**
T 21.1–21.6	Mon	16:30–18:00	WIL/A124	**Si-Strips/CMS, Pixel/Sensor**
T 22.1–22.6	Mon	16:30–18:00	WIL/C133	**Calorimeter / Detector Systems I**
T 23.1–23.6	Mon	16:30–18:00	WIL/A120	**Gas-Detectors / Muon MDT**
T 24.1–24.3	Tue	11:00–12:30	HSZ/AUDI	**Invited Overview Talks II**
T 25.1–25.6	Tue	17:00–18:30	HSZ/0304	**Flavor II**
T 26.1–26.6	Tue	17:00–18:30	HSZ/0401	**Flavor III**
T 27.1–27.6	Tue	17:00–18:30	HSZ/0403	**Searches II**
T 28.1–28.6	Tue	17:00–18:30	HSZ/0101	**Forward Physics**
T 29.1–29.6	Tue	17:00–18:30	HSZ/0103	**Other Exp., EW**
T 30.1–30.6	Tue	17:00–18:30	HSZ/0105	**Higgs Charm, Di-Higgs**
T 31.1–31.5	Tue	17:00–18:15	HSZ/0201	**Theory Higgs, BMS**
T 32.1–32.6	Tue	17:00–18:30	HSZ/0204	**Di-Higgs, Higgs BSM**
T 33.1–33.6	Tue	17:00–18:30	HSZ/0301	**DAQ NN/ML – GRID I**
T 34.1–34.6	Tue	17:00–18:30	HSZ/0405	**ML Methods II**
T 35.1–35.6	Tue	17:00–18:30	POT/0051	**Neutrino Astronomy II**
T 36.1–36.6	Tue	17:00–18:30	POT/0151	**Gamma Astronomy II**
T 37.1–37.6	Tue	17:00–18:30	POT/0251	**Neutrinos, Dark Matter IV**
T 38.1–38.6	Tue	17:00–18:30	POT/0361	**Neutrinos, Dark Matter V**
T 39.1–39.6	Tue	17:00–18:30	POT/0006	**Neutrinos, Dark Matter VI**
T 40.1–40.4	Tue	17:00–18:00	POT/0112	**Astro Particle Theory**
T 41.1–41.6	Tue	17:00–18:30	POT/0013	**Cosmic Ray II**
T 42.1–42.6	Tue	17:00–18:30	POT/0351	**Exp. Methods, IceAct, Auger, RNO-G**

T 43.1–43.6	Tue	17:00–18:30	POT/0106	**Electronics, DAQ, Exp. Methods**
T 44.1–44.6	Tue	17:00–18:30	WIL/A317	**Pixel/LHCb, Si-Strips/CMS**
T 45.1–45.6	Tue	17:00–18:30	WIL/A124	**Si-Strips, Pixel**
T 46.1–46.6	Tue	17:00–18:30	WIL/C133	**Calorimeter / Detector Systems II**
T 47.1–47.6	Tue	17:00–18:30	WIL/A120	**Gas-Detecors, Detector Systems**
T 48.1–48.5	Tue	17:00–18:15	WIL/C129	**Exp. Methods I**
T 49.1–49.7	Tue	17:00–18:45	SCH/A252	**Outreach (joint session HK/T)**
T 50.1–50.4	Wed	11:00–12:20	HSZ/AUDI	**Invited Topical Talks I-A**
T 51.1–51.4	Wed	11:00–12:20	HSZ/0003	**Invited Topical Talks I-B**
T 52.1–52.4	Wed	14:00–15:20	HSZ/AUDI	**Invited Topical Talks II-A**
T 53.1–53.4	Wed	14:00–15:20	HSZ/0003	**Invited Topical Talks II-B**
T 54.1–54.6	Wed	15:50–17:20	HSZ/0304	**Flavor IV**
T 55.1–55.6	Wed	15:50–17:20	HSZ/0401	**Flavor V, Top-BSM**
T 56.1–56.6	Wed	15:50–17:20	HSZ/0403	**Searches EW I**
T 57.1–57.6	Wed	15:50–17:20	HSZ/0101	**Single Top – Higgs Top**
T 58.1–58.6	Wed	15:50–17:20	HSZ/0103	**Other Exp., $t\bar{t}$**
T 59.1–59.6	Wed	15:50–17:20	HSZ/0105	**QCD Theory and Experiment I**
T 60.1–60.5	Wed	15:50–17:05	HSZ/0201	**Theory BMS**
T 61.1–61.6	Wed	15:50–17:20	HSZ/0204	**Higgs I**
T 62.1–62.6	Wed	15:50–17:20	HSZ/0301	**DAQ NN/ML – GRID II**
T 63.1–63.6	Wed	15:50–17:20	HSZ/0405	**ML Methods III**
T 64.1–64.6	Wed	15:50–17:20	POT/0051	**Neutrino Astronomy III**
T 65.1–65.4	Wed	15:50–16:50	POT/0151	**Gamma Astronomy III**
T 66.1–66.6	Wed	15:50–17:20	POT/0251	**Neutrinos II**
T 67.1–67.4	Wed	15:50–16:50	POT/0361	**Neutrinos, Dark Matter VII**
T 68.1–68.4	Wed	15:50–16:50	POT/0006	**Neutrinos, Dark Matter VIII**
T 69.1–69.5	Wed	15:50–17:05	POT/0112	**Neutrinos, Dark Matter IX**
T 70.1–70.6	Wed	15:50–17:20	POT/0013	**Cosmic Ray III**
T 71.1–71.6	Wed	15:50–17:20	POT/0351	**Exp. Methods AP, PMTs**
T 72.1–72.5	Wed	15:50–17:05	POT/0106	**Exp. Methods II**
T 73.1–73.4	Wed	15:50–16:50	WIL/A317	**Pixel/CMS**
T 74.1–74.4	Wed	15:50–16:50	WIL/A124	**DetSys MAGIX, DetSys KATRIN**
T 75.1–75.3	Wed	15:50–16:35	WIL/C133	**Calorimeter / Detector Systems III**
T 76.1–76.4	Wed	15:50–16:50	WIL/A120	**Gas-Detectors**
T 77.1–77.6	Wed	17:20–18:50	HSZ/0401	**Flavor VI**
T 78.1–78.6	Wed	17:30–19:00	HSZ/0304	**Flavor VII**
T 79.1–79.5	Wed	17:30–18:45	HSZ/0403	**Searches III**
T 80.1–80.6	Wed	17:30–19:00	HSZ/0101	**Searches EW II**
T 81.1–81.6	Wed	17:30–19:00	HSZ/0103	**Single Top, Top Properties**
T 82.1–82.6	Wed	17:30–19:00	HSZ/0105	**Higgs, Di-Higgs II**
T 83.1–83.4	Wed	17:30–18:30	HSZ/0201	**Theory BSM**
T 84.1–84.6	Wed	17:30–19:00	HSZ/0204	**Theory EW**
T 85.1–85.5	Wed	17:30–18:45	HSZ/0301	**DAQ, Data Techniques**
T 86.1–86.6	Wed	17:30–19:00	HSZ/0405	**ML Methods IV**
T 87.1–87.6	Wed	17:30–19:00	POT/0051	**Neutrinos III**
T 88.1–88.6	Wed	17:30–19:00	POT/0151	**Gamma Astronomy IV**
T 89.1–89.6	Wed	17:30–19:00	POT/0251	**DM, Neutrino Theory**
T 90.1–90.6	Wed	17:30–19:00	POT/0361	**Neutrinos, Dark Matter X**
T 91.1–91.6	Wed	17:30–19:00	POT/0006	**Neutrinos IV**
T 92.1–92.6	Wed	17:30–19:00	POT/0013	**Cosmic Ray IV**
T 93.1–93.6	Wed	17:30–19:00	POT/0351	**Exp. Methods – Scint., HESS, Auger**
T 94.1–94.6	Wed	17:30–19:00	POT/0106	**DAQ, Exp. Methods**
T 95.1–95.6	Wed	17:30–19:00	WIL/A317	**Pixel, Det/Sys LHCb, HGT**
T 96.1–96.6	Wed	17:30–19:00	WIL/A124	**TestBeam, RadHard for Si and Pixel**
T 97.1–97.6	Wed	17:30–19:00	WIL/C133	**Calorimeter / Detector Systems IV**
T 98.1–98.6	Wed	17:30–19:00	WIL/A120	**Gas-Detecors, Detector Systems**
T 99	Wed	19:00–20:00	HSZ/0101	**Annual Meeting of Young Scientists in High Energy Physics (yHEP)**
T 100.1–100.3	Thu	11:00–12:30	HSZ/AUDI	**AI Topical Day – Invited Talks (joint session AKPIK/HK/ST/T/AKBP)**
T 101.1–101.4	Thu	14:00–15:20	HSZ/0003	**Invited Topical Talks III-A**
T 102.1–102.4	Thu	14:00–15:20	HSZ/0004	**Invited Topical Talks III-B**
T 103.1–103.6	Thu	15:45–17:15	HSZ/0004	**AI Topical Day – Simulation, Inverse Problems and Algorithmic Development (joint session AKPIK/T)**

T 104.1–104.6	Thu	15:50–17:20	HSZ/0304	**Flavor VIII**
T 105.1–105.6	Thu	15:50–17:20	HSZ/0401	**Flavor IX**
T 106.1–106.5	Thu	15:50–17:05	HSZ/0403	**Searches IV**
T 107.1–107.6	Thu	15:50–17:20	HSZ/0101	**Searches – Neutrino at accelerators**
T 108.1–108.6	Thu	15:50–17:20	HSZ/0103	**Top, EW I**
T 109.1–109.6	Thu	15:50–17:20	HSZ/0105	**Higgs, Di-Higgs III**
T 110.1–110.6	Thu	15:50–17:20	HSZ/0201	**Other Theory**
T 111.1–111.6	Thu	15:50–17:20	HSZ/0204	**Outreach Diverse (joint session T/HK)**
T 112.1–112.6	Thu	15:50–17:20	HSZ/0301	**DAQ Test/RO – GRID I**
T 113.1–113.6	Thu	15:50–17:20	HSZ/0405	**QCD Theory and Experiment II**
T 114.1–114.6	Thu	15:50–17:20	POT/0051	**Neutrinos V**
T 115.1–115.6	Thu	15:50–17:20	POT/0151	**Gamma Astronomy V**
T 116.1–116.6	Thu	15:50–17:20	POT/0251	**Neutrinos Legend, Neutrino Theory**
T 117.1–117.6	Thu	15:50–17:20	POT/0361	**Dark Matter I**
T 118.1–118.6	Thu	15:50–17:20	POT/0006	**Dark Matter II**
T 119.1–119.5	Thu	15:50–17:05	POT/0112	**Neutrino Astronomy IV**
T 120.1–120.6	Thu	15:50–17:20	POT/0013	**Cosmic Ray V**
T 121.1–121.6	Thu	15:50–17:20	POT/0351	**Cosmic Ray VI**
T 122.1–122.4	Thu	15:50–16:50	POT/0106	**DAQ Systems**
T 123.1–123.6	Thu	15:50–17:20	WIL/A317	**Pixel/Belle II, Si/Other**
T 124.1–124.6	Thu	15:50–17:20	WIL/A124	**Si-Strip/CMS, Pixel/DMAPS**
T 125.1–125.6	Thu	15:50–17:20	WIL/C133	**Calorimeter / Detector Systems V**
T 126.1–126.6	Thu	15:50–17:20	WIL/A120	**Gas-Detecors, Detector Systems**
T 127.1–127.5	Thu	15:50–17:05	WIL/C129	**Exp. Methods III**
T 128.1–128.6	Thu	17:30–19:00	HSZ/0004	**AI Topical Day – New Methods (joint session AKPIK/T)**
T 129.1–129.6	Thu	17:30–19:00	HSZ/0304	**Flavor X**
T 130.1–130.5	Thu	17:30–18:45	HSZ/0401	**Top II**
T 131.1–131.5	Thu	17:30–18:45	HSZ/0403	**Searches V**
T 132.1–132.6	Thu	17:30–19:00	HSZ/0101	**Searches VI**
T 133.1–133.6	Thu	17:30–19:00	HSZ/0103	**Top, EW II**
T 134.1–134.6	Thu	17:30–19:00	HSZ/0105	**Higgs, Di-Higgs IV**
T 135.1–135.6	Thu	17:30–19:00	HSZ/0201	**Top Mass, Top BSM**
T 136.1–136.6	Thu	17:30–19:00	HSZ/0204	**Higgs TH, VH**
T 137.1–137.6	Thu	17:30–19:00	HSZ/0301	**DAQ Test/RO – GRID II**
T 138.1–138.5	Thu	17:30–18:45	HSZ/0405	**QCD Experiment III**
T 139.1–139.6	Thu	17:30–19:00	POT/0051	**Neutrinos VI**
T 140.1–140.6	Thu	17:30–19:00	POT/0151	**Gamma Astronomy VI**
T 141.1–141.6	Thu	17:30–19:00	POT/0251	**Neutrino Astronomy V**
T 142.1–142.6	Thu	17:30–19:00	POT/0361	**Neutrinos, Dark Matter XI**
T 143.1–143.6	Thu	17:30–19:00	POT/0006	**Neutrinos VII**
T 144.1–144.6	Thu	17:30–19:00	POT/0013	**Cosmic Ray VII**
T 145.1–145.6	Thu	17:30–19:00	POT/0351	**Cosmic Ray VIII**
T 146.1–146.6	Thu	17:30–19:00	POT/0106	**DAQ Systems, Exp. Methods**
T 147.1–147.6	Thu	17:30–19:00	WIL/A317	**Pixel/HV-Maps, Si/Diamond**
T 148.1–148.6	Thu	17:30–19:00	WIL/A124	**Si/SiPM, Pixel/Other**
T 149.1–149.6	Thu	17:30–19:00	WIL/C133	**Detector Systems / Muon**
T 150.1–150.6	Thu	17:30–19:00	WIL/A120	**Gas-Detecors, Pixel/TANGERINE**
T 151.1–151.6	Thu	17:30–19:00	WIL/C129	**Exp. Methods IV**
T 152	Thu	20:00–22:00	HSZ/0003	**Members' Assembly**
T 153.1–153.3	Fri	11:00–12:30	HSZ/AUDI	**Invited Overview Talks III**
T 154.1–154.1	Fri	13:30–14:00	HSZ/AUDI	**Invited Overview Talks IV**

Members' Assembly of the Particle Physics Division

Thursday 20:00–22:00 HSZ/0003

Sessions

– Invited, Invited Topical, and Contributed Talks –

T 1: Invited Overview Talks I

Time: Monday 11:00–12:30 Location: HSZ/AUDI

Invited Talk T 1.1 Mon 11:00 HSZ/AUDI

What we learned about the Higgs Boson from the LHC so far — •Duc Bao Ta — Johannes Gutenberg-Universität Mainz

The Higgs boson in the Standard Modell of particle physics has a unique role as it is related to the mechanism that gives elementary particles their mass. Last year the large LHC experiments, ATLAS and CMS, released the most comprehensive overview of their results on the Higgs boson for the 10th year after its discovery. These results are based on the LHC run 2 dataset from 2015-2018, which constitutes only 5% of the ultimate dataset. However, it has already enabled us to study the Higgs boson properties in unprecedented detail. The two collaborations continue to study the dataset and explore more corners of the Higgs sector that might connect it to the open questions in particle physics, like the origin of CP violation or the nature of dark matter. In this presentation, I will review the current results of the Higgs boson from the LHC and give an outlook on what is planned and can be achieved with the data from the currently ongoing Run 3 or when the remaining 90-95% of the full dataset will have been collected and analysed in the future.

Invited Talk T 1.2 Mon 11:30 HSZ/AUDI

QCD at the LHC – Precision for Discoveries — •Malgorzata Worek — RWTH Aachen University

In this presentation, I will summarise the relevance of higher-order QCD effects to Standard Model processes at the Large Hadron Collider (LHC). Special emphasis will be placed on the physics of the top quark and QCD jets. Many models look at the production of top quarks as well as QCD jets as interesting channels to evidentiate signals of new physics. A good theoretical control of Standard Model backgrounds is, thus, a fundamental prerequisite for a correct interpretation of the possible signals of new physics that may arise in these channels. Since the top quark and QCD jets play an important role in virtually every LHC analysis, proper modeling of their production is essential both for SM measurements and for beyond the Standard Model searches. Such modelling will become even more important for high luminosity measurements and at future colliders.

Invited Talk T 1.3 Mon 12:00 HSZ/AUDI

The charm and beauty of flavour physics — •Marco Gersabeck — The University of Manchester, Manchester, UK

Precision flavour physics measurements have a long track record of providing some of the most powerful tests of the Standard Model, with sensitivity to scales of physics beyond the Standard Model well in excess of those directly accessible at colliders. This talk will review highlights among the latest set of results and report on the status of ongoing experiments. The recent discovery of CP violation in charm decays necessitates a range of further measurements to identify its origin and the latest analyses will be discussed. The talk will also include the most recent results on tests of lepton universality. The talk will further include an outlook on the next generation of flavour physics experiments.

T 2: Flavor I

Time: Monday 16:30–18:00 Location: HSZ/0004

T 2.1 Mon 16:30 HSZ/0004

Search for $^{3}\overline{\mathrm{He}}$ and $^{3}_{\overline{\Lambda}}\overline{\mathrm{H}}$ at LHCb — •Hendrik Jage[1], Razvan-Daniel Moise[1], Gediminas Sarpis[2], Valery Zhukov[1], and Stefan Schael[1] — [1]I. Physikalisches Institut B, RWTH Aachen University — [2]University of Edinburgh

In recent presentations, AMS-02 has reported the observation of several antihelium candidates in cosmic rays. In 2020, it has been suggested by M. Winkler and T. Linden that dark matter annihilation into b-quarks could produce a detectable $^{3}\overline{\mathrm{He}}$ flux in cosmic rays via $\overline{\Lambda}_b^0$ decays.

The LHCb detector at CERN is an experiment dedicated to the study of b-hadrons, which are abundantly produced in the proton-proton collisions at the Large Hadron Collider (LHC). Therefore, the large sample of Λ_b^0 decays, collected by LHCb until 2018, provides a unique opportunity to study the potential displaced production of ^{3}He via Λ_b^0 decays.

While prompt ^{3}He from proton-proton collisions as well as from $^{3}_{\Lambda}\mathrm{H} \to {}^{3}\mathrm{He}\pi^-$ decays has already been observed at the LHC by the ALICE Collaboration in the central region ($|y| < 0.5$), prompt and displaced ^{3}He has not previously been searched for at LHCb ($2 < \eta < 5$). In this talk, the possibility of identifying ^{3}He with the LHCb tracking system is discussed and the status of the on-going analysis is presented.

T 2.2 Mon 16:45 HSZ/0004

Taming New Physics in $b \to c\bar{u}d(s)$ with $\tau(B^+)/\tau(B_d)$ and a_{sl}^d — Alexander Lenz, •Jakob Müller, Maria Laura Piscopo, and Aleksey V. Rusov — Center for Particle Physics Siegen, Theoretische Teilchenphysik, Universität Siegen

Inspired by the recently observed tensions between the experimental data and the theoretical predictions, based on QCD factorisation, for several colour-allowed non-leptonic B-meson decays, we study the potential size of new physics (NP) effects in the decay channels $b \to c\bar{u}d(s)$. Starting from the most general effective Hamiltonian describing the $b \to c\bar{u}d(s)$ transitions, we compute NP contributions to the theoretical predictions of B-meson lifetime and of B-mixing observables. The well-known lifetime ratio $\tau(B^+)/\tau(B_d)$ and the experimental bound on the semi-leptonic CP asymmetry a_{sl}^d, provide strong, complementary constraints on some of the NP Wilson coefficients.

T 2.3 Mon 17:00 HSZ/0004

Flavour tagging, $B_s \to D_s K$, and $B^0 \to J/\psi K_S$ — Quentin Führing, Vukan Jevtic, Gerwin Meier, •Sophie Hollitt, and Johannes Albrecht — TU Dortmund University, Dortmund, Germany

The amount of CP violation in the Standard Model is insufficient to explain the universe's matter-antimatter asymmetry. Precision measurements of CP violation in decays–including measurements of the angles of the 'CKM triangle' to test for unitarity–are crucial to further understand CP violation in the Standard Model and reveal any possible hints of new physics. Determining the flavour of the B meson at the time of production with flavour tagging is a key part of this process.

In this talk we consider analyses for two of the three CKM angles: the angle γ using the decay $B_s^0 \to D_s K$, and the angle β using the channel $B^0 \to J/\psi K_S$. The LHCb experiment provides a large number of B_s meson decays with an excellent decay time resolution, that can be used to measure $B_s \to D_s K$ and provide an additional constraint on γ. For $\sin(2\beta)$, the statistical significance of previous measurements of $B^0 \to J/\psi K_S$ can be improved by including additional track reconstruction types and more decay channels in this updated analysis.

T 2.4 Mon 17:15 HSZ/0004

***CP* violation measurement in $B^0 \to D^+D^-$ and $B_s^0 \to D_s^+D_s^-$ decays at the LHCb experiment** — Johannes Albrecht, •Louis Gerken, Philipp Ibis, and Antje Mödden — TU Dortmund University, Dortmund, Germany

Time dependent measurements of *CP* violation are a major part of the research at the LHCb experiment. They provide access to important Standard Model parameters such as the *CP*-violating mixing phases $\sin 2\beta$ and ϕ_s. These can be measured in $B^0 \to D^+D^-$ and $B_s^0 \to D_s^+D_s^-$ decays, respectively. The *CP* violation in these decays arises in the interference between the direct decay and the decay after mixing. Due to the similarities of these decays, the two measurements are performed in parallel.

In this talk, the current status of the analysis is presented. The analysis uses data collected by the LHCb detector during 2015 to 2018 at a centre-of-mass energy of 13 TeV corresponding to an integrated luminosity of 6 fb^{-1}.

T 2.5 Mon 17:30 HSZ/0004

CP violation in $\tau \to K_S\pi\nu_\tau$ decays at Belle* — •Katarina Dugic, Daniel Greenwald, and Stephan Paul for the Belle II-Collaboration — Technical University Munich

In 2012, BaBar measured a CP-violating decay-rate asymmetry in $\tau \to \pi K^0_S(\geq 0\pi^0)\nu_\tau$ that deviates from the standard-model prediction by 2.8σ. We present initial studies for measuring the same asymmetry using data from the Belle experiment, which is twice as large.

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T 2.6 Mon 17:45 HSZ/0004

Minimal Models for Radiative Fermion Masses — •Zachary Wüthrich[1,2] and Andreas Crivellin[3,4] — [1]Universität Siegen — [2]ETH, Zürich — [3]PSI — [4]UZH

There has been a long history of attempts to generate fermion masses from loops of heavier particles. This would be an elegant theory, as it provides a simple and natural explanation of the observed fermion mass hierarchy through the loop hierarchy.

This work investigates a class of minimal renormalizable models using scalar leptoquarks and other new scalar particles to generate the fermion masses at the loop level. We provide for the first time a classification of the different representations of a scalar field that allows for a chirally enhanced radiative generation of fermion masses. Constraints from observables give bounds on the scalar particle masses and their couplings, with special emphasis given to the effect of the new models on the anomalous magnetic moment of the muon.

T 3: Top I

Time: Monday 16:30–18:00 Location: HSZ/0401

T 3.1 Mon 16:30 HSZ/0401

Top-beauty couplings at FCC-ee and synergies in global SMEFT interpretations — Kevin Kröninger[1], Romain Madar[2], Stéphane Monteil[2], and •Lars Röhrig[1,2] — [1]TU Dortmund University, Department of Physics — [2]Université Clermont-Auvergne, Laboratoire de Physique de Clermont

Experiments for the post-LHC era as proposed nowadays are aimed at precision measurements in the electroweak, flavor, Higgs and top-quark sector. The FCC-ee among other proposals offers unrivaled precision in these fields and allows to combine measurements within the Standard Model Effective Field Theory at energy scales ranging from 91 GeV up to 365 GeV.

This talk motivates the combination of the top- and the $Z \to b\bar{b}$ energy scale and possible synergies through a common set of dimension-six operators. The estimation of several top-quark observable sensitivites is highlighted, as well as challenges and prospects of a full reconstruction in an FCC-ee environment. Systematically limited measurements of EWPO at the Z-pole at FCC-ee are discussed and novel hemisphere tagging techniques are presented to reduce these uncertainties.

T 3.2 Mon 16:45 HSZ/0401

Search for same-sign top pair production with the Standard Model Effective Field Theory at the ATLAS experiment — Noemi Cavalli[1,2], Merve Nazlim Agaras[4], Maximiliano Sioli[2], Matteo Negrini[2], Kevin Alexander Kroeninger[1], Shalini Epari[4], Aurelio Juste Rozas Rozas[4], Stergios Kazakos[4], Javier Montejo Berlingen[3], Nicola Orlando[4], Tamara Vazquez Schroeder[3], and •Aaron van der Graaf[1,2] — [1]TU Dortmund — [2]Bologna — [3]CERN — [4]IFAE

Model-independent searches for new physics at high energies by using the Standard Model (SM) Effective Field Theory (SMEFT) are an important part of todays physics program. Same-sign top-quark pair production is highly suppressed in the SM while several models beyond the SM enhance the production. SMEFT is used obtain model-independent predictions for the production of the same-sign top pairs beyond the SM. Three EFT operators are considered to simulate the searched signal. The full Run 2 dataset collected by the ATLAS detector from proton-proton collisions is used for this search for same-sign top-quark pairs, in the dilepton final state. A Neural Network (NN) is employed to build separate signal regions (SR) enriched in same-sign top events resulting from different EFT operators. Within the defined SRs, a second NN is applied to perform a signal-background discrimination. In order to attain an accurate estimation of background contributions in the SRs, several Control Regions (CRs) are defined. The background estimation and the signal search are performed by using a maximum likelihood fit over all analysis regions.

T 3.3 Mon 17:00 HSZ/0401

Measurement of SMEFT parameters in $t\bar{t}+\gamma$ using Run 2 data with the ATLAS experiment — •Jan Joachim Hahn[1], Binish Batool[1], Beatrice Cervato[1], Markus Cristinziani[1], Carmen Diez Pardos[1], Ivor Fleck[1], Arpan Ghosal[1], Gabriel Gomes[1], Vadim Kostyukhin[1], Buddhadeb Mondal[1], Amartya Rej[1], Katharina Voss[1], Wolfgang Walkowiak[1], and Tongbin Zhao[1,2] — [1]Center for Particle Physics Siegen, Experimentelle Teilchenphysik, Universität Siegen — [2]Shandong University, China

In the Standard Model Effective Field Theory (SMEFT), the effects of physics phenomena beyond the Standard Model (SM) are modelled via higher dimension operators. Measurements of sensitive processes can be used to constrain the coefficients of operators that contribute to a process. The top quark is the heaviest known particle and the only quark that decays before hadronisation. It is expected to play a relevant role in many models of physics beyond the SM given its large mass. Final states including photons are sensitive to modifications in the electroweak sector, changing the photon energy spectrum. This talk will focus on a interpretation of the ongoing $t\bar{t}\gamma$ cross section measurement in terms of SMEFT. To constrain several EFT operators, $t\bar{t}\gamma$ events decaying semileptonically are studied. The study is performed using the full Run 2 data set collected by the ATLAS experiment corrosponding to 139 fb^{-1} at $\sqrt{s} = 13\ TeV$.

T 3.4 Mon 17:15 HSZ/0401

Kinematic Fit for Top-Antitop Production at LHC — •Constant Peeters, Patrick Connor, Johannes Lange, Hartmut Stadie, and Peter Schleper — Institut für Experimentalphysik, Universität Hamburg

The decay products of top quark pairs in proton-proton collisions at the LHC can be reconstructed independently of one another using the particle flow algorithm. A fit utilising physical properties of the event topology may be used in addition to further constrain their kinematics. This may be beneficial to measure fundamental quantities of the top quark, such as its mass. In this work, we present the general technique and investigate the impact of the jet energy resolution on the fit results. The kinematic fitting package KinFitter, commonly used within the CMS software framework, is utilized with the aim of ensuring usability independent of the CMS software stack.

T 3.5 Mon 17:30 HSZ/0401

Messung der Energieasymmetrie bei der Top-Antitop-Jet Produktion in der resolved Topologie am ATLAS — •Jessica Höfner, Alexander Basan, Asma Hadef, Lucia Masetti, Eftychia Tzovara und Doga Elitez für die ATLAS-Kollaboration — Universität Mainz

Das Top-Quark ist das schwerste Teilchen im Standardmodell der Elementarteilchen und das einzige Quark das zerfällt bevor es hadronisieren kann. Es eignet sich sehr gut dafür Physik jenseits des Standardmodells zu suchen, denn es könnten noch unentdeckte schwerere Teilchen mit dem Top-Quark wechselwirken.

Bei der Produktion eines Top-Antitop-Paares mit zusätzlichem Jet kann die Energieasymmetrie, eine Observable, die auf der Ladungsasymmetrie beruht, bestimmt werden, die besonders sensitiv auf Physik jenseits des Standardmodells sein kann. Daher ist es vom großem Interesse diese Observable zu messen. Nach einer ersten veröffentlichten Messung der Energieasymmetrie mit dem ATLAS Experiment in der Topologie mit einem kollimierten hadronischen Top-Quark Zerfall und einem semileptonischen Zerfall, ist es ebenfalls das Ziel die Observable in einem erweiterten Phasenraum zu bestimmen. Dazu wird zunächst die Eventrekonstruktion in der "resolved" Topologie, in der der hardonische Zerfall durch mehrere small-R Jets rekonstruiert wird, optimiert. In diesem Vortrag werden die bisher erzielten Fortschritte dieser Optimierung vorgestellt.

T 3.6 Mon 17:45 HSZ/0401

Machine learning approaches for parameter reweighting in MC samples of top quark production — •Valentina Guglielmi, Katerina Lipka, and Simone Amoroso — Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, D-22607 Hamburg, Germany

In particle physics, complex Monte Carlo (MC) simulations are needed to compare theoretical predictions to observables. Further MC samples have to be generated to account for all the systematic uncertainties. Therefore, the MC statistic becomes a limiting factor for most measurements. Moreover, the significant computational cost of these programs is a bottleneck in most physics analyses. Therefore, finding a way to reduce the number of MC samples is important to decrease the MC statistical uncertainties and lower the computational cost. In this contribution, an approach called Deep neural network using Classification for Tuning and Reweighting (DCTR) is evaluated. DCTR is a method, based on a Deep Neural Network (DNN) technique, to reweight simulations to different models by using the full kinematic information in the event. This methodology avoids the need for simulating the detector response multiple times by incorporating the relevant variations in a single sample. This way, the MC statistical uncertainties and the computational cost are reduced. Unlike the standard reweighting, in which the ratio in bins of two histograms at truth level is performed, multidimensional and unbinned information can be used as inputs to the DNN. This method is tested on MC simulations of top quark pair production within the CMS experiment.

T 4: Searches I

Time: Monday 16:30–18:00 Location: HSZ/0403

T 4.1 Mon 16:30 HSZ/0403

Search for long-lived particles decaying into displaced jets using a trackless and delayed jet tagger — •Lisa Benato and Gregor Kasieczka — Institute of Experimental Physics, Hamburg University

A search for long-lived particles decaying in the outer regions of the CMS silicon tracker or in the calorimeters is presented. A novel technique, using trackless and delayed jet information combined in a deep neural network discriminator, is employed to identify decays of long-lived particles. The results are interpreted in a simplified model of chargino-neutralino production, where the neutralino is the next-to-lightest supersymmetric particle, is long-lived, and decays to a gravitino and either a Higgs or Z boson. This search is most sensitive to neutralino proper decay lengths of ~1 m, for which neutralino masses from up to 1180 GeV are excluded at 95% confidence level.

T 4.2 Mon 16:45 HSZ/0403

Search for resonant lepton+jet production with the ATLAS experiment — •Jiyoung Kim, Adrian Fernandez, and Stefan Tapprogge — Institute for Physics, Johannes Gutenberg University, Mainz

The leptoquark (LQ) is a hypothetical particle, which carries both lepton and quark quantum numbers. Its existence could point to extended theories beyond the Standard Model. If such particles were to exist, their decays might be observable in high-energy pp collisions using the ATLAS detector at the LHC. In this contribution, the specific interest is single LQ production leading to a resonant structure in the lepton-jet invariant mass. The search strategy about the existence of the LQs will be presented, including optimization of the selection cuts and comparison with the run 2 data set from ATLAS (with an integrated luminosity of 139fb^{-1}at$\sqrt{s} = 13$TeV).

T 4.3 Mon 17:00 HSZ/0403

Search for Dark Matter in association with a single top quark at the CMS experiment - leptonic analysis and combination — •Sebastian Wieland, Ulrich Husemann, and Michael Wassmer — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

A promising production mechanism of Dark Matter at the Large Hadron Collider (LHC) is the associated production with a single top quark. Since the Dark Matter particles are not directly detected by the CMS detector the final state consists of a single top quark and missing transverse momentum, referred to as mono-top signature. The focus of this talk is the leptonic decay channel of the top quark, where the transverse W boson mass is utilized to discriminate between the mono-top signal and the standard-model backgrounds. In addition, the combination with the analysis targeting the hadronic decay of the top quark is presented. The analysis utilizes the full Run-2 dataset collected by the CMS experiment at the LHC. All results of this search are interpreted in the context of a simplified model introducing a flavor-changing neutral current at tree level by a spin-1 mediator and a Dirac Dark Matter particle.

T 4.4 Mon 17:15 HSZ/0403

Search for long-lived particles in the CMS muon system — •Joerg Schindler, Lisa Benato, Karim El Morabit, and Gregor Kasieczka — Universität Hamburg

Traditionally, searches for new physics at the LHC focused on already established objects, like photons, leptons, jets or missing energy. A different approach is to look for signatures in the detector which up until now were not considered. One example are long-lived particles, which can have a long lifetime leading to macroscopic flight distances ranging from a few micrometers up to several kilometers. In this talk, a search for long lived particles decaying in the CMS muon system is presented. The resulting signature is a large hadronic shower in the muon system with no inner detector activity, which can be observed with close to no background, but requires the development of new reconstruction and analysis tools. The status of the current searches for LLPs with decays in the muon system is shown, using data collected by the CMS detector in Run 2.

T 4.5 Mon 17:30 HSZ/0403

Substructure tagging with mass and p_T dependent variable-R jet clustering and a soft drop veto — •Anna Benecke[1], Anna Albrecht[2], and Roman Kogler[3] — [1]UCLouvain, Belgium — [2]Universität Hamburg, Germany — [3]DESY, Germany

The Heavy Object Tagger with Variable R (HOTVR) is an algorithm for the clustering and identification of boosted, hadronically decaying, heavy particles. The central feature of the HOTVR algorithm is a vetoed jet clustering with variable distance parameter R, that decreases with increasing transverse momentum of the jet. In this talk, we present improvements to the HOTVR algorithm, replacing the mass jump with a soft drop veto in the clustering. We study the performance of jet substructure tagging with HOTVR and ungroomed variable R jets, where we use machine learning techniques and energy flow polynomials to analyse the information loss from the soft drop veto. In addition, we show preliminary results of a distance parameter that changes with the jet mass and the transverse momentum, allowing to achieve an optimal value of R for W, Z, H bosons and top quarks simultaneously.

T 4.6 Mon 17:45 HSZ/0403

Search for Heavy Majorana Neutrinos in same-sign W Boson Scattering with the ATLAS experiment — •Jonas Neundorf for the ATLAS-Collaboration — Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg

Among the open question of particle physics is the origin of neutrino masses. While they are predicted to be zero by the Standard Model, oscillation measurements have shown that at least two of the three neutrino flavours observed in nature are massive. These masses can be explained by the "Seesaw Mechanism", which introduces Majorana neutrinos with a mass on the TeV scale. This talk will discuss the design and statistical evaluation of an ATLAS search for Heavy Majorana Neutrinos produced via same-sign W boson scattering.

T 5: Higgs Searches

Time: Monday 16:30–18:00 Location: HSZ/0101

T 5.1 Mon 16:30 HSZ/0101

An interference search for heavy Higgs bosons decaying to a top-antitop-quark pair with the ATLAS detector — •Nicola de Biase, Katharina Behr, and Eleanor Jones — Deutsches Elektronen-Synchrotron

New pseudoscalar (A) and scalar (H) states coupling strongly with $t\bar{t}$ states are predicted by many models with an extended Higgs sector, such as two-Higgs Doublet Models (2HDMs), which add a second Higgs doublet to the SM. In 2HDMs with fermion coupling structure of type II, these states decay predominantly to $t\bar{t}$, provided that they are massive enough (m>500 GeV) and that the ratio between the vacuum-expectation-values of the two Higgs doublets ($\tan\beta$) is small ($\tan\beta \lesssim 3$). To date, this parameter region is only little constrained by direct searches, as any search in the $t\bar{t}$ final state is complicated by the interference between the signal process (gluon-gluon initiated A/H production) and the dominant and irreducible background, which is the Standard Model production of $t\bar{t}$ pairs. This interference produces a characteristic peak-dip structure in the $t\bar{t}$ mass spectrum. In this talk, a search for pseudoscalar and scalar states decaying to a pair of top-quarks will be presented, using the full Run-II ATLAS dataset. Special attention will be given to the conceptual and technical challenges regarding the treatment of interference effects in the statistical analysis of the data.

T 5.2 Mon 16:45 HSZ/0101

Search for charged Higgs bosons in $H^+ \to W^+ h$ decays with the ATLAS detector — Dominik Duda, •Simon Grewe, Sandra Kortner, and Hubert Kroha — Max Planck Institut für Physik

Many theories beyond the Standard Model predict the existence of charged Higgs bosons. The main production mode of these new particles depends on their mass. For large masses ($m(H^+) > m(t) + m(b)$), the dominant mode of production is in association with a top quark and a bottom quark (tbH^+). In the alignment limit of the Two-Higgs-Doublet Model (2HDM), heavy charged Higgs bosons with $m(H^+) > m(t) + m(b)$ decay almost exclusively via $H^+ \to tb$. In other models such as the Georgi-Machacek model, however, significant branching ratios for $H^+ \to W^+ h$ are possible. This decay has so far not been studied by ATLAS or CMS.

A search for $H^+ \to W^+ h$ decays in association with a top and bottom quark is presented, based on the full Run-2 dataset of the ATLAS experiment. The analysis targets final states with resolved $h \to b\bar{b}$ decays containing five or more jets, one charged lepton and missing transverse momentum. The reconstruction of the charged Higgs boson decay, as well as the definition of the signal and control regions is based on boosted decision trees (BDTs). Limits on $\sigma(pp \to tbH^+) \times BR(H^+ \to W^+ h)$ are obtained by a maximum likelihood fit of the reconstructed H^+ mass spectrum.

This talk presents an overview of the analysis with special emphasis on the signal reconstruction and the development of the signal and control regions.

T 5.3 Mon 17:00 HSZ/0101

Search for inelastic Dark Matter with a Dark Higgs at Belle II — •Patrick Ecker, Giacomo De Pietro, Jonas Eppelt, Torben Ferber, and Pablo Goldenzweig — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

Belle II has a unique reach for a broad class of models that postulate the existence of Dark Matter particles in the MeV-GeV mass range. One highly motivated scenario is a model which involves inelastic Dark Matter, consisting of two Dark Matter states with a mass splitting between them and the presence of a Dark Higgs boson. This model has a signature of up to two displaced vertices, one from the resonant decay of the Dark Higgs and another non-resonant one emerging from the decay of the involved Dark Matter particles. This talk will present a way to search for such signatures, which is not only challenging due to the presence of displaced vertices but also because of the seven-dimensional parameter space of the model.

T 5.4 Mon 17:15 HSZ/0101

Search for non-resonant light axion-like particles with heavy vector bosons in the final state. — •Anna Albrecht[1], Steffen Albrecht[1], Andreas Hinzmann[2], and Ankita Mehta[1] — [1]Institut für Experimentalphysik, Universität Hamburg — [2]DESY, Hamburg, previously Universität Hamburg

Many extensions of the Standard Model (SM) propose axion-like particles (ALPs) that could solve the strong CP problem and are proposed as dark matter candidates. A non-resonant search for light off-shell ALPs as mediators between gluons and heavy bosons (ZZ, ZH) is presented. Only the hadronic decays of two vector bosons are considered. For the high invariant mass of the diboson system, the differential cross section via ALPs as mediator decreases slower than the SM production. To extract the signal a three dimensional maximum likelihood fit of the jet masses and the invariant mass of the diboson system is performed. The analysis is performed using pp collision data collected by the CMS experiment at $\sqrt{s} = 13\,\text{TeV}$ in the years 2016 - 2018.

T 5.5 Mon 17:30 HSZ/0101

Low Temperature MMC-based Muon Veto for IAXO — •Daniel Unger, Christian Enss, Andreas Fleischmann, Daniel Hengstler, Ashish Jadhav, and Loredana Gastaldo — Kirchhoff Institute for Physics, Heidelberg University, Im Neuenheimer Feld 227, 69120 Heidelberg, Germany.

An array of Metallic Magnetic Calorimeter (MMC) operated at a few mK in a dilution refrigerator is considered as a possible focal plane detector for the IAXO helioscope. For such an experiment, the background rate must be smaller than $10^{-6}\,\text{keV}^{-1}\text{cm}^{-2}\text{s}^{-1}$. However, we expect the rate of events related to cosmic muons to be two orders of magnitude larger. A traditional muon veto composed by scintillating panels would have to cover the full cryostat, a volume of about $3\,\text{m}^3$. A cryogenic muon veto surrounding the $150\,\text{cm}^3$ volume of the detector module could veto muon related events more efficiently. We present the development of a large-area MMC-based muon veto. Muons will be detected through their energy deposition while traversing a silicon wafer with thickness of 0.4 mm and an area of $30\,\text{cm}^2$. We discuss the design and the fabrication challenges of the muon veto in addition to the prototype setup for testing purposes. We aim to characterize the performance of the large silicon detector and at the same time study the spectrum of muon related events detected by the MMC array as well as of the residual background due to natural radioactivity. Finally, we evaluate the suitability of MMC arrays for low background measurements.

T 5.6 Mon 17:45 HSZ/0101

Recent Updates on the ALPS II Experiment — •Gulden Othman for the ALPS-Collaboration — Institut für Experimental Physik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg

The Any Light Particle Search II (ALPS II) experiment searches for axions and axion-like particles (ALPs) in an important parameter space that is relevant in understanding anomalous astrophysical phenomena, including stellar evolution. ALPS II takes advantage of the axion coupling to photons using a Light-Shining-through-a-Wall technique. Photons created using a strong laser may convert into ALPs in the presence of a strong magnetic field, traverse a light-tight barrier, reconvert into photons in another strong magnetic field, and be subsequently detected. By using two mode-matched optical resonators before and after the barrier, ALPS II aims to surpass the sensitivity of previous experiments by three orders of magnitude. In this talk, we will discuss the exciting recent progress and current status of ALPS II as we continue with our science program at DESY.

T 6: Other Exp., EW

Time: Monday 16:30–18:00 Location: HSZ/0103

T 6.1 Mon 16:30 HSZ/0103

High-p_T electron performance in proton-lead collisions in the ATLAS experiment at the LHC — •Patrycja Potepa for the ATLAS-Collaboration — Johannes Gutenberg-Universität Mainz, Germany

Electrons constitute an essential ingredient of final states from the leptonic decay channels of W and Z bosons. Their reconstruction and identification are especially challenging in heavy-ion collisions due to high detector occupancy. Therefore, the evaluation of electron performance is crucial for precision measurements of properties of quark-gluon plasma produced in heavy-ion collisions at the LHC energies. The presented measurement focuses on electron reconstruction, identification, isolation, and trigger efficiencies in proton-lead collisions collected at 8.16 TeV in 2016. The tag-and-probe method allows to derive electron efficiencies in data and MC simulation independently, and compare the results.

T 6.2 Mon 16:45 HSZ/0103

Towards a new test of lepton flavor universality using $B^0 \to K^{*0}e^+e^-$ decays in the high di-lepton invariant mass region — Martino Borsato and •Miguel Ruiz Díaz — Physikalisches Institut, Universität Heidelberg

Lepton Flavor Universality (LFU) tests using rare B-meson decays are amongst the most sensitive probes of the Standard Model (SM) flavor structure. They are mediated by a $b \to sl^+l^-$ transition which is loop suppressed in the SM. However, new physics (NP) processes involving new particles and interactions could lead to a measurable contribution.

Many NP models predict a sizable violation of LFU in $b \to sl^+l^-$ decays. A commonly used observable is the ratio $R_{K^{*0}} \equiv B(B^0 \to K^{*0}\mu^+\mu^-)/B(B^0 \to K^{*0}e^+e^-)$, defined within a given interval of the di-lepton invariant mass, q^2. This observable benefits from a clean theoretical prediction since most theoretical uncertainties cancel in the ratio in the SM.

This talk presents the current state of the analysis towards a new measurement of $R_{K^{*0}}$ in the experimentally more challenging high-q^2 region, using data from LHCb recorded between 2011 and 2018. It is the first measurement performed by the LHCb collaboration in this kinematic region. Being a relatively independent measurement it will serve to validate and cross-check the results obtained in lower-q^2 regions as NP effects are expected to be roughly q^2 independent.

T 6.3 Mon 17:00 HSZ/0103

Muon Momentum Calibration in ATLAS experiment — •Dionysios Fakoudis[1] and Stefan Tapprogge[2] for the ATLAS-Collaboration — [1]Johannes Gutenberg University, Mainz, Germany — [2]Johannes Gutenberg University, Mainz, Germany

In this contribution the momentum calibration of (anti-)muons for the ATLAS detector will be discussed. Precise measurements of the W and Z boson mass using the data from the full Run2 of LHC provide new challengeS for an even more accurate muon calibration. Firstly the overall method with the constraints, the systematics and the limits of the current calibration will be presented. The muon calibration scheme provides tools for reconstructed muons using information from the Inner Detector or the Muon Spectrometer and also using the so called combined muons, by comparing Monte Carlo generated events with ATLAS data using the well known 'standard candles' J/Psi and Z. Some of the major issues are going to be discussed (for example the extrapolation from the kinematic region of the J/Psi to the Z region) as well as their possible impact on precision measurements. Current solutions and further challenges will be presented.

T 6.4 Mon 17:15 HSZ/0103

Study of polarization fractions in same-sign W boson scattering — •Prasham Jain, Beate Heinemann, and Oleg Kuprash — Albert-Ludwigs-Universität Freiburg, Freiburg, Germany

Polarized same-sign W boson pair production is a crucial process to examine the electroweak symmetry breaking mechanism. A measurement of the fraction of longitudinally polarized W bosons, $W_L^{\pm}W_L^{\pm}$, directly probes the unitarization mechanism of the vector boson scattering amplitude through Higgs boson contributions, and is sensitive to potential new physics effects. This talk presents machine learning (ML) methods for classification of $W^{\pm}W^{\pm}$ polarization modes. Results are shown of applying the ML for the extraction of longitudinal polarization fraction.

T 6.5 Mon 17:30 HSZ/0103

Machine Learning Application for Single Boson Polarization Measurement in Same-Charged WW Scattering Within the Atlas Experiment — •Max Vincent Stange for the ATLAS-Collaboration — Institut für Kern- und Teilchenphysik, Technische Universität Dresden

In 2019, the scattering of same-charged W bosons was measured for the first time in the ATLAS experiment. This process provides a strong dependence on the exact mechanism of electroweak symmetry breaking. Since the W bosons obtain their mass and thus their longitudinal polarization directly from the Higgs mechanism, the longitudinal parts of the W boson scattering are particularly promising for studying the Higgs mechanism and finding physics beyond the Standard Model. Since the scattered W bosons decay into one charged lepton and one neutrino each, the original polarizations of the W bosons can no longer be reconstructed directly from the measurement. To be able to measure the contribution of WW scattering with at least one longitudinal boson, multi-variable analysis techniques are applied in the analysis. In this regard, this talk will demonstrate the application of neural networks trained to distinguish signal from background and polarizations. The focus is on comparing different methods to maximize the expected significance.

T 6.6 Mon 17:45 HSZ/0103

Same-sign WW scattering in the semi-leptonic channel at the CMS experiment — Thorsten Chwalek[1], Nils Faltermann[1], Abideh Jafari[2], Thomas Müller[1], and •Komal Tauqeer[1] — [1]Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT) — [2]Deutsches Elektronen-Synchrotron (DESY), Hamburg

Vector boson scattering (VBS) provides an opportunity for testing the Higgs mechanism in the electroweak sector of the standard model. At the LHC, the scattering of the weak gauge bosons can reveal the actual process by which they get their masses.

The most promising VBS channel for this type of study is same-sign WW scattering, which has a good balance between signal and backgrounds. In particular, the semi-leptonic decay channel provides a larger cross section than the fully leptonic decay channel; however, this channel faces large background contributions from V + jets and $t\bar{t}$ processes. Also, to study same-sign WW process, one needs to seperate it from processes like WZ, ZZ, and opposite-sign WW scattering. To do this in the semi-leptonic channel is very challenging because of very small W/Z reconstructed mass seperation.

To extract our signal, we have developed a ParticleNet based jet charge tagger to identify boosted W-jet charge. In this talk, I will discuss about the features and performance of this jet charge tagger and its implementation in this analysis. I will also discuss the overall analysis strategy and some important kinematic distributions for signal vs. background discrimination.

T 7: Higgs, Di-Higgs I

Time: Monday 16:30–18:00 Location: HSZ/0105

T 7.1 Mon 16:30 HSZ/0105

Strong first-order EWPTs in a Type-II 2HDM-EFT and their implications on Higgs pair production — Anisha[1,3], •Lisa Biermann[2], Milada Margarete Mühlleitner[2], and Christoph Englert[3] — [1]Indian Inst. Tech., Kanpur, India — [2]ITP, KIT, Karlsruhe, Germany — [3]Glasgow U., Glasgow, United Kingdom

We study the scalar dimension six effective field theory (EFT) extended 2HDM-Type-II in its possibility to promote the strength of the electroweak phase transition to a strong first-order electroweak phase transition (SFOEWPT). Therefore, a global minimization of the one-loop daisy-resummed effective potential at finite temperature is performed with the C++ code BSMPT. Our special focus lies on investigating the connection between Wilson coefficient constellations that enable an SFOEWPT and their phenomenological implications on Higgs pair production (resonant and non-resonant) in top final states.

T 7.2 Mon 16:45 HSZ/0105

Higgs Pair Production in a Composite 2HDM — Stefania De Curtis[1], Luigi Delle Rose[2], •Felix Egle[3], Stefano Moretti[4], Margarete Mühlleitner[3], and Kodai Sakurai[5] — [1]INFN sezione di Firenze and Dipartimento di Fisica e Astronomia, Università di Firenze, Via G. Sansone 1, I-50019, Sesto Fiorentino, Italy — [2]Dipartimento di Fisica, Università della Calabria, I-8703 Arcavacata di Rende, Cosenza, Italy — [3]Institute for Theoretical Physics, Karlsruhe Institute of Technology, 76131 Karlsruhe, Germany — [4]School of Physics and Astronomy, University of Southampton, Southampton, SO17 1BJ, United Kingdom — [5]Department of Physics, Tohoku University, Sendai, Miyagi 980-8578, Japan

In composite Higgs models the scalar particles in the Higgs sector are not elementary particles, but of composite nature, arising as pseudo Nambu-Goldstone bosons from higher broken symmetries. In a composite 2-Higgs-Doublet Model thus a 2HDM-like structure is generated but with couplings already predetermined by the composite nature of the model. In this talk we present Higgs Pair production in this model via gluon fusion. We give a brief introduction into the model and an overview over the calculation, highlighting the contributing couplings and diagrams. We apply current experimental limits for Di-Higgs production on our results and study differential distributions for specific benchmark scenarios.

T 7.3 Mon 17:00 HSZ/0105

The reconstruction of the $\tau\tau$ invariant mass in H $\to$ $\tau\tau$ decays as a machine learning task — •Moritz Molch, Ulrich Husemann, Nikita Shadskiy, Lars Sowa, Michael Wassmer, and Roger Wolf — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology

Analyses that deal with Higgs boson decays into a pair of τ leptons often rely on a good reconstruction of the $\tau\tau$ invariant mass. As the decay of two τ leptons involves at least two neutrinos, the reconstruction of $m_{\tau\tau}$ is a challenging part of such analyses.

In many analyses at the CMS experiment the SVfit algorithm, which is a likelihood method on an event-by-event basis, is utilized for that task. First studies have shown that $m_{\tau\tau}$ can also be reconstructed using a deep neural network.

In this talk the applicability of deep neural networks to reconstruct $m_{\tau\tau}$ is further investigated and a comparison to current methods is made.

T 7.4 Mon 17:15 HSZ/0105

Probing high p_T Higgs boson production in the di-τ decay channel — •Steffen Ludwig, Christopher Young, Karsten Köneke, and Karl Jakobs for the ATLAS-Collaboration — University of Freiburg, Institute of Physics, Freiburg im Breisgau, Germany

The Higgs boson was observed first in 2012 by the ATLAS and CMS experiments at the Large Hadron Collider at CERN. Even more than 10 years after its discovery, more precise measurements of the Higgs boson decay are desired to search for physics beyond the Standard Model.

One particularly interesting measurement is the transverse momentum (p_T) spectrum of the Higgs boson where deviations at high values could be a sign of new physics. I will discuss the prospects for selecting such events in the channel where the Higgs boson decays to τ leptons. At high p_T the two τ leptons are close to each other in $\eta - \phi$, making this a uniquely interesting final state.

T 7.5 Mon 17:30 HSZ/0105

Test of CP invariance in Higgs boson production via vector boson fusion exploiting the $H \to \tau_{\mathbf{had}}\tau_{\mathbf{had}}$ decay mode — •Daniel Bahner, Ö. Oğul Öncel, and Markus Schumacher — Albert-Ludwigs-Universität, Freiburg, Deutschland

In the universe, an asymmetry exists between the number of baryons and the anti-baryons. Three Sakharov conditions need to be fulfilled in order to explain this observed baryon asymmetry. One of those is the violation of the CP invariance. Its amount in the Standard Model is not enough to explain the asymmetry. The discovery of the Higgs boson has opened a new window to search for additional sources of CP violation. The vector-boson fusion (VBF) production of the Higgs boson is one of them. In the VBF production topology, it is possible to probe CP-violating contributions to the HVV coupling vertex.

In this talk the fully hadronic decay channel, where VBF-produced Higgs boson decays into two hadronically decaying tau leptons, is presented. The dominant background process in this decay channel is the irreducible $Z \to \tau\tau$ process. A data-driven Fake Factor method is used to estimate the sizeable contribution from events in which jets are misidentified as hadronically decaying tau leptons. A neural network is exploited to discriminate signal from background processes.

CP-odd observables are used in a profile-likelihood fit to perform a test of CP invariance and to constrain the strength of new CP-violating interactions. The talk will discuss the analysis strategy, CP-odd observables, and first results based on $\sqrt{s}$ = 13 TeV proton-proton collision data collected by the ATLAS detector with $\mathscr{L}_{\text{int}}$ = 139 fb^{-1}.

T 7.6 Mon 17:45 HSZ/0105

Precision measurements of the τ-identification efficiency of CMS — •Olha Lavoryk, Sebastian Brommer, Maximilian Burkart, Roger Wolf, Markus Klute, and Günter Quast — Karlsruhe Institute of Technology(ETP), Karlsruhe, Germany

τ-leptons play an important role in Higgs physics because the scalar coupling to the fermions is proportional to their mass. Standard model (SM) as well as Beyond the SM (BSM) analyses require precise reconstruction of the hadronic τ-lepton decays. Discriminators based on Deep Neural Networks (DNN) provide a fast and efficient solution to this task. In this talk, precision measurements of the τ-identification efficiency on the ultra-legacy Run-2 data taken from 2016–2018 are presented, and an appropriate uncertainty model for future Run-2+Run-3 measurements with τ-leptons in the final state is presented.

T 8: Outreach Public/Teilchenwelt (joint session T/HK)

Time: Monday 16:30–18:00 Location: HSZ/0204

T 8.1 Mon 16:30 HSZ/0204

The german LHC-Office for outreach, transfer and promotion of young talents — •Marius Hoffmann[1], Marie-Lena Dieckmann[2], Harald Appelshäuser[3], Johannes Haller[2], Stephanie Hansmann-Menzemer[4], and Arnulf Quadt[1] — [1]Georg-August-Universität Göttingen — [2]Universität Hamburg — [3]Goethe-Universität Frankfurt — [4]Universität Heidelberg

Communicating the scientific results to the public, fostering cooperation with partners in industry and the promotion of young talents are key tasks of the german LHC research groups. For this reason in 2020, the research focuses (”Forschungsschwerpunkte” short ErUM-FSPs) of the four LHC experiments have initiated a joint ”LHC-Office” which is funded by the Federal Ministry for Education and Research(BMBF). Since then, the LHC-office has been active in a multitude of areas, including a common broschure, a new joint website, the participation at major industry fairs as well as several workshops and events to promote young researchers. This talk will give an overview of the work of the LHC-office's work of the last two years and present an outlook into future activities.

T 8.2 Mon 16:45 HSZ/0204

KCETA event summer — •Katrin Link — Karlsruhe Institute of Technologie, KIT Center Elementary Particle and Astroparticle Physics KCETA, Karlsruhe, Germany

In the summer of 2022, the traveling exhibition "Code of the Universe" (codeoftheuniverse.eu) designed by CERN, was displayed for four weeks in the center of Karlsruhe. Accompanying this, the KIT Center for Elementary Particle and Astroparticle Physics (KCETA) organized a colorful program of events for a broad audience. The series of events included a vernissage, a lecture evening as part of the Karlsruhe EFFEKTE series and a panel discussion on the topic "Kommen große Forschungsinfrastrukturen an ihre Grenzen? Neue Energiekonzepte für die Forschung der Zukunft". The main focus was on "Science Afternoons", during which the individual working groups of KCETA presented their research with a small exhibition, hands-on experiments and short lectures. Additionally a special programm for pupils was offered, including masterclasses and "Physik am Samstag". In this talk we want to present the different formats we used to interact with a broad audience and report from our experiences.

T 8.3 Mon 17:00 HSZ/0204

Belle II - The Beauty goes public — •Johanna Häusler and Thomas Kuhr — LMU, München, Deutschland

Public outreach is an element feature of modern science. In particular, the large and internationally organized particle physics experiments have great potential to raise public awareness of physics - both in terms of the physics questions themselves and the technological developments associated with fundamental research. The Belle II experiment is a rather novel experiment based in Japan and involving worldwide collaboration. The German Belle II institutes - in close cooperation with partner organizations and supported by a BMBF *Forschungsschwerpunkt* - are in the process of building a network and developing a strategy to present Belle II particle physics research to the German public. This is particularly interesting in view of the important scientific results that are expected from Belle II in the coming years. The outreach strategy includes a corporate design, a strategy to present the Belle II institutes, scientific results and staff both on Twitter and on the Belle II homepage, basic outreach activities in education (such as Belle II Masterclasses, a Belle II coursework for students and the design of a Belle II model) and industry transfer to promote technological development and human potential in the broad field of industry.

T 8.4 Mon 17:15 HSZ/0204

Urknall unterwegs: eine mobile Ausstellung zur Teilchenphysik — Uta Bilow, •Sarah Kästner, Michael Kobel und Philipp Lindenau für die Netzwerk Teilchenwelt-Kollaboration — TU Dresden, Institut für Kern- und Teilchenphysik

Urknall unterwegs ist eine mobile Ausstellung, die von Weltmaschine bei DESY in Hamburg in Zusammenarbeit mit Netzwerk Teilchenwelt und Expert:innen aus der Teilchenphysik und Didaktik der TU Dresden entwickelt wurde. Besucher:innen erfahren bei einer kurzen Zeitreise in fünf Schritten, wie das Universum sich seit dem Urknall entwickelt hat. Außerdem können sie etwas über die Menschen erfahren, die in der Teilchenphysik wissenschaftlich tätig sind: Wie und warum geforscht wird und vor allem wie sich das auf ihren Alltag und die Gesellschaft auswirkt. Interaktive Elemente wie der Teilchen-Twister vervollständigen die Ausstellung. Studierende und Physiker:innen vermitteln als Urknall-Guides wissenschaftliche Inhalte. Im Juli 2022 wurde die Ausstellung zum 10jährigen Jubiläum der Higgs-Entdeckung gezeigt. Es folgten weitere Stationen bei der Langen Nacht der Wissenschaften in Dresden, der Mainzer Science Week und Stadtteilfesten in Hamburg. Für das Wissenschaftsjahr 2023 Unser Universum gibt es bereits Planungen für bundesweite Stationen. Die Ausstellung wird auch an die MS Wissenschaft andocken und in einigen Häfen vor dem schwimmenden Science-Center zu sehen sein. Der Vortrag zeigt Beispiele der bisherigen Ausstellungstour, stellt Erweiterungen vor und gibt eine Aussicht auf Entwicklungen. Urknall unterwegs kann während der Tagung vor dem Hörsaalzentrum angeschaut werden.

T 8.5 Mon 17:30 HSZ/0204

Nachwuchs für die Forschung gewinnen: Das Fellow-Programm von Netzwerk Teilchenwelt — •Andrea Mayer-Houdelet, Uta Bilow und Michael Kobel für die Netzwerk Teilchenwelt-Kollaboration — TU Dresden, Institut für Kern- und Teilchenphysik

Jedes Jahr kommen etwa 3.500 Jugendliche an den 30 Standorten von Netzwerk Teilchenwelt mit der Physik der kleinsten Teilchen in Kontakt. Die besonders Interessierten besuchen dann einen CERN-Workshop oder die Teilchenphysik-Akademie Mainz. Viele dieser Jugendlichen studieren danach Physik. Für diese vorgebildeten jungen Leute hat das Netzwerk Teilchenwelt das Fellow-Programm ins Leben gerufen. Ziel ist es sie möglichst früh mit den Forschungsgruppen zu vernetzen, sie fachlich weiter zu qualifizieren und so langfristig Nachwuchs für die Forschungsgruppen zu gewinnen. Wir stellen das Fellow-Programm vor, berichten von unseren bisherigen Erfahrungen und präsentieren die Ergebnisse einer Evaluation zu den vielfältigen Online- und Präsenz-Angeboten für Fellows.

T 8.6 Mon 17:45 HSZ/0204

Die Netzwerk Teilchenwelt Projektwochen: aktive Teilhabe an der aktuellen Forschung für Jugendliche am CERN — •Uta Bilow[1], Niklas Herff[1,2], Michael Kobel[1], Franziska Rauscher[3] und Sascha Schmeling[2] für die Netzwerk Teilchenwelt-Kollaboration — [1]TU Dresden, Institut für Kern- und Teilchenphysik — [2]CERN — [3]Gymnasium Olbernhau

Im Stufenprogramm von Netzwerk Teilchenwelt bilden die Projektwochen am CERN eine außergewöhnliche Möglichkeit für motivierte Jugendliche. Bis zu zehn Jugendliche, die durch ihr vorheriges Engagement bereits ein umfassendes Wissen und eine große Begeisterung für die ”Physik der kleinsten Teilchen” mitbringen, bekommen die Chance, selbst einmal richtig in die Forschung einzutauchen. Im Rahmen einer umfangreichen Forschungsarbeit, die von schulischer Seite und mit Unterstützung vom Netzwerk Teilchenwelt betreut wird, finden individuelle Projekte in verschiedenen Bereichen am CERN statt. Betreut von Wissenschaftler:innen arbeiten die Jugendlichen zwei Wochen in einem Team am CERN, in dem sie beispielsweise Daten analysieren oder Detektorkomponenten vermessen und auswerten.

In einem gemeinsamen Vortrag von Niklas Herff (der verantwortlichen Person am CERN) und Franziska Rauscher (einer Teilnehmerin der Projektwochen 2022) werden die besonderen Chancen dieses Programms genauer vorgestellt.

T 9: DAQ NN/ML – HW

Time: Monday 16:30–18:00 Location: HSZ/0301

T 9.1 Mon 16:30 HSZ/0301

Implementation of an improved Neural Network for identification of hadronically decaying τ leptons in the ATLAS trigger system for the LHC Run 3 — •Naman Kumar Bhalla, Ö. Oğul Öncel, and Markus Schumacher — Albert-Ludwigs-Universität Freiburg

The ATLAS detector employs a trigger system to reduce the large event rate by saving only interesting events on mass storage for further analyses. This is done via dedicated triggers for each observable physics object. Being the heaviest lepton in the Standard Model of particle physics, the τ lepton is highly unstable, allowing only its decay products to be directly observed. While the electron and muon triggers can be used for the leptonic decays of the τ lepton, separate triggers are necessary to differentiate between hadronically decaying τ leptons (τ_{had}) and jets, which are produced with significantly higher abundance. ATLAS uses a recurrent neural network (RNN) for τ_{had} identification, which exploits various track, cluster and high-level variables as inputs, and returns a single classifier as output. However, it needed to be retuned for operations in the ongoing Run 3 phase of the Large Hadron Collider (LHC) due to upgrades in the detector and the accelerator. Furthermore, new input variables were added to improve the performance of the RNN. An alternative architecture based on Deep Sets was tested in order to have a more efficient usage of computing resources. This talk presents the results of performance studies of the retuned RNN, and a comparison between the two network architectures in terms of efficacy and resource consumption.

T 9.2 Mon 16:45 HSZ/0301

Machine learning based triggers for VBF H → inv at the Level-1 trigger system of CMS — •Shahin Sepanlou, Johannes Haller, Gregor Kasieczka, Finn Labe, Artur Lobanov, and Matthias Schröder — Institut für Experimentalphysik, Universität Hamburg

At the CMS experiment, a two-level trigger system is used to decide which collision events to store for later analysis. The Level-1 trigger is subject to strict latency, resource and rate constraints. To handle the even more challenging High Luminosity-LHC environment, novel strategies in the trigger system are necessary. Therefore, in this talk studies towards a topological trigger algorithm using fast machine learning on FPGAs are presented. The vector boson fusion production of a Higgs boson decaying to invisible particles is used as an example process that is difficult to select with classical trigger strategies and would benefit from machine learning based approaches.

T 9.3 Mon 17:00 HSZ/0301

FPGA-based fast Machine Learning Triggers for Neutrino Telescopes — •Francesca Capel[1,3], Christian Haack[2,3], Lukas Heinrich[2,3], and Christian Spannfellner[2,3] — [1]Max-Planck-Institut für Physik — [2]Technische Universität München — [3]ORIGINS Excellence Cluster

Neutrinos provide valuable insight into the origin and acceleration mechanisms of cosmic particles. They are able to traverse vast distances and dense environments on their way to Earth unimpeded, but are also challenging to detect due to their weakly interacting nature. Earth itself is used as detector, where large volumes are equipped with photosensors to detect the Cherenkov light induced by astrophysical neutrino interactions. Neutrino telescopes are located deep underwater or in the Antarctic ice to reduce the background rate, inducing often strict limits on power and bandwidth available for the detector. Trigger algorithms are inevitable to reject background signals and reduce the data stream to manageable rates. In this contribution we will present the potential of fast, intelligent machine learning triggers implemented on low power FPGAs for the usage as online trigger in neutrino telescopes. Our main objectives are an improved signal to background discrimination and improved sensitivity for low energy events.

T 9.4 Mon 17:15 HSZ/0301

The MDT Trigger Processor for the ATLAS HL-LHC Upgrade of the Level-0 Muon Trigger — •Davide Cieri, Markus Fras, Oliver Kortner, and Sandra Kortner — Max-Planck-Institut für Physik, Munich, Germany

The novel MDT Trigger Processor (MDTTP) system is a fundamental part of the upgrade of the first-level (L0) muon trigger of the ATLAS experiment at the HL-LHC. The new system will be responsible for improving the muon momentum resolution and thus refining the muon selectivity, using for the first time at L0 the precision tracking information from Monitored Drift Tube (MDT) chambers in addition to the trigger chamber information. The system will also transmit the MDT hit data to the data acquisition (DAQ) system in the event of a trigger accept. Sixty-four MDTTP boards will be installed in ATLAS, one for each MDT trigger sector. The design of the MDTTP is highly challenging, requiring a high number of optical links and high-performance processing units.

We present here the recently fabricated MDTTP prototype and its testing plans. Based on an ATCA design, it is composed by two modules: the Service Module responsible for the powering and the infrastructure; and the Command Module, performing the trigger and DAQ processing and communicating with the other components of the ATLAS muon trigger. The Command Module mounts a powerful Xilinx Virtex Ultrascale+ FPGA XCVU13P, and ten 12-channel bidirectional optical transceiver modules with a link speed of up to 14 Gbps.

T 9.5 Mon 17:30 HSZ/0301

The ATLAS Forward Feature Extractor for the HL-LHC — •Adrian Alvarez Fernandez, Stefan Tapprogge, Ulrich Schaefer, Bruno Bauss, Julian Blumenthal, Marcel Weirich, and Dennis Layh — Johannes Gutenberg University (Mainz)

The ATLAS detector will undergo many upgrades to account for the more challenging running conditions of the High Luminosity LHC (HL-LHC). Some of these Phase-II upgrades will be focused on improving the trigger system, a crucial part to deal with the higher data rates and increased pile-up. Phase-I upgrades for Run 3 introduced the Feature EXtractors for a more refined processing of the calorimeter information and to better discriminate between jets, photons, electrons and taus. A Forward Feature EXtractor (fFEX) is being developed for the HL-LHC that will provide more flexible algorithms for the objects in the forward region (|eta|>2.5 for electrons/photons and |eta|>3.2 for jets). In contrast to the first level calorimeter trigger before HL-LHC, this system will have access to the full detailed calorimeter granularity in that region. The preliminary design of the fFEX has been recently reviewed and will be discussed in this presentation.

T 9.6 Mon 17:45 HSZ/0301

High-Speed Link Tests for the fFEX L1Trigger Module — •Dennis Layh, Stefan Tapprogge, Ulrich Schäfer, and Bruno Bauss — Johannes Gutenberg Universität

For the planned High Luminosity LHC upgrade the forward Feature EXtractor (fFEX), which will be a new component of the ATLAS first level trigger, will have an estimated input data rate of 2.2Tb/s. To achieve a data rate of this magnitude it is necessary to move to a higher line rate than previous modules, which were running at about 12Gb/s per link. The planned line rate of 25.7Gb/s per link will require thorough testing to make sure that signal integrity and quality needs are met. One part along the path from the LAr calorimeters to the fFEX FPGAs are opto-electrical modules, which translate the data from incoming optical fibers to electrical signals and vice versa. For this purpose a PCB was designed, produced and utilized to test a new 12-channel unidirectional firefly module from Samtec which runs at line rates of up to 28Gb/s.

T 10: ML Methods I

Time: Monday 16:30–18:00 Location: HSZ/0405

T 10.1 Mon 16:30 HSZ/0405

Fooling IceCube's Deep Neural Networks — •Oliver Janik, Markus Bachlechner, Thilo Birkenfeld, Philipp Soldin, Christopher Wiebusch, and Katharina Winkler for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

Deep neural networks (DNNs) find more and more use in the data analysis of physics experiments. In IceCube, such networks are used as classifiers for particle identification or as regressors to reconstruct the direction and energy of particles. In the context of adverserial attacks, it has been observed that imperceptible changes to the input of DNNs can alter the output drastically. Algorithms like DeepFool can calculate minimal changes of the input in order to obtain a wrong output, thus fooling the network. This talk will focus on testing the robustness of IceCube's DNNs to such minimal changes.

T 10.2 Mon 16:45 HSZ/0405

Generating Calorimeter Showers as Point Clouds — •Simon Schnake[1,2], Kerstin Borras[1,2], and Dirk Krücker[1] — [1]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [2]RWTH Aachen, Aachen, Germany

In particle physics, precise simulations are necessary to enable scientific progress. However, accurate simulations of the interaction processes in calorimeters are complex and computationally very expensive, demanding a large fraction of the available computing resources in particle physics at present. Various generative models have been proposed to reduce this computational cost. Usually, these models interpret calorimeter showers as 3D images in which each active cell of the detector is represented as a voxel. This approach becomes difficult for high-granularity calorimeters due to the larger sparsity of the data. In this study, we use this sparseness to our advantage and interpret the calorimeter showers as point clouds. More precisely, we consider each hit as part of a hit distribution depending on a global latent calorimeter shower distribution. A first model to learn calorimeter showers as point clouds is presented. The model is evaluated on a high granular calorimeter dataset.

T 10.3 Mon 17:00 HSZ/0405

DeepTreeGAN: Fast Generation of High Dimensional Point Clouds for Calorimeter Simulation — •Moritz Scham[1,2,3], Dirk Krücker[1], and Kerstin Borras[1,2] — [1]Deutsches Elektronen-Synchrotron, Hamburg, Germany — [2]RWTH Aachen University - III. Physikalisches Institut A, Aachen, Germany — [3]Institute for Advanced Simulation - Jülich Supercomputing Centre, Juelich, Germany

In high energy physics, detailed and time-consuming simulations are used for particle interactions with detectors. To bypass these simulations with a generative model, the generation of large point clouds in a short time is required, while the complex dependencies between the particles must be correctly modeled. Particle showers are inherently tree-based processes, as each particle is produced by decays or detector interaction of a particle of the previous generation.

In this work, we present a novel GNN model that is able to generate such point clouds in a tree-based manner. We show that this model is able to reproduce complex distributions, and we evaluate its performance on the public JetNet Dataset.

T 10.4 Mon 17:15 HSZ/0405

Particle identification at Belle II using Neural Networks — •xavier simo[1,2], daniel greenwald[1], stefan wallner[2], and stephan paul[1,2] — [1]Techincal University Munich (TUM) — [2]Max Planck Institute for Physics (MPP)

We will present improvements to the charged-particle identification algorithms used by the Belle II experiment located at KEK, Japan. So far, different approaches have been used to tackle the challenge of combining the information from each subdetector into a single variable for particle identification in an optimal way. We will present evaluations of the performance of a Neural Network based approach that combines information such as the likelihood values from each subdetector and the measured momentum of the particle track.

funded by the DFG under Germany's Excellence Strategy - EXC2094 - 390783311 and BMBF Verbundforschung (05H21WOKBA BELLE2)

T 10.5 Mon 17:30 HSZ/0405

Reconstruction of Full Decays using Transformers and Hyperbolic Embedding at Belle II — •Boyang Yu, Hosein Hashemi, Nikolai Hartmann, and Thomas Kuhr — Ludwig-Maximilians-Universität München

In analyses at Belle II, it is often helpful to reconstruct the whole decay process of each electron-positron collision event using the information collected from detectors. The reconstruction is composed of several steps which require manual configurations and suffers from high uncertainty as well as low efficiency.

In this project, we are developing a software with the aim to reconstruct B decays at Belle II automatically with both high efficiency and high accuracy. The well trained models should be tolerant to rare decays that have very small branching ratio or are even unseen during the training.

To ensure high performance, the project is separated into several stages: particle level embedding, event level embedding and decay reconstruction. Inspired by the recent achievements in computer science, transformers and hyperbolic embedding are employed as building blocks with pre-training-fine-tuning framework, contrastive metric learning and knowledge transfer serving as training tools.

T 10.6 Mon 17:45 HSZ/0405

The Federation - A novel machine learning technique applied on data from the Higgs Boson Machine Learning Challenge — •Maximilian Mucha and Eckhard von Törne — Universität Bonn, Physikalisches Institut, Bonn, Germany

The Federation is a new machine learning technique for handling large amounts of data in a typical high-energy physics analysis. It utilizes Uniform Manifold Approximation and Projection (UMAP) to create an initial low-dimensional representation of a given data set, which is clustered by using Hierarchical Density-Based Spatial Clustering of Applications with Noise (HDBSCAN). These clusters can then be used for a federated learning approach, in which we separately train a classifier on the high-dimensional data of each individual cluster. By doing so, the computational resource demands for the learning process is reduced. We additionally apply an imbalanced learning method to the data in the found clusters before the training to handle high class imbalances. By using a Dynamic Classifier Selection method, the Federation can then make predictions for the whole data set.

As a proof of concept for this novel technique, open data from the Higgs Boson Machine Learning Challenge is used and comparisons to results from established methods will be presented.

T 11: Neutrinos, Dark Matter I

Time: Monday 16:30–18:00 Location: POT/0051

T 11.1 Mon 16:30 POT/0051

Status and Prospects of the COBRA experiment — •Juliane Volkmer — Technische Universität Dresden, Deutschland

As many Beyond-Standard-Model theories predict the existence of the neutrinoless double beta decay ($0\nu\beta\beta$), this lepton-number-violating nuclear reaction is one of today's most examined processes in fundamental physics. Its observation could help to solve important questions as for the neutrino's mass or whether it is a Majorana particle, and thus shed light on physics beyond the Standard Model.

In 2011 the COBRA demonstrator was built with the objective of investigating the practicability of using CdZnTe semiconductor crystals for the decay's investigation. The CdZnTe crystals contain nine isotopes capable of different $0\nu\beta\beta$ decay modes, can be operated at room temperature and are commercially available. Additionally, the versatile detector material offers the possibility of investigating physics besides the $0\nu\beta\beta$ decay, like a potential quenching of g_A in nuclear processes – by measuring the spectrum shape of the strongly forbidden ^{113}Cd β decay – and exotic $\beta^+\beta^+$ decay modes.

Four years ago the demonstrator setup of $4 \times 4 \times 4$ 1 cm^3 CdZnTe crystals was upgraded based on the knowledge gained from the many years of operation. With nine additional larger detector crystals higher exposure rates as well as strongly reduced background levels can be achieved.

This talk shall give an overview of the status, plans and most recent experimental results of the COBRA collaboration.

T 11.2 Mon 16:45 POT/0051

Pulse shape analysis with quad coplanar grid CdZnTe detectors of the COBRA experiment — •Yingjie Chu — Institute of Nuclear and Particle Physics, TU Dresden

The COBRA experiment searches for double beta decays using CdZnTe room temperature semiconductor detectors operating at the Gran Sasso underground laboratory. The setup was upgraded in 2018 using nine large CdZnTe detectors with the novel electrode layout, a quad coplanar grid surrounded by a guard ring, which can veto surface contaminations intrinsically. Although the prominent surface α backgrounds identified in the previous setup are reduced with the new CdZnTe detector, nonphysical events and other background events are present in the $\beta\beta$ region of interest. Therefore, pulse shape discriminations are evaluated to identify the noise, distorted pulses, and multi-hit events, which enables further background suppression. After applying those discrimination cuts, significantly reduced background levels are observed. Furthermore, the pulse shape of the detector is simulated and used to investigate the efficiency of the cuts.

T 11.3 Mon 17:00 POT/0051

Status of the MONUMENT Experiment; ordinary muon capture as a benchmark for $0\nu\beta\beta$ decay nuclear structure calculations — •Elizabeth Mondragon for the MONUMENT-Collaboration — Technical University of Munich, 85748 Garching, Germany

Extracting particle physics properties from neutrinoless double-beta ($0\nu\beta\beta$) decay requires a detailed understanding of the involved nuclear structures. Still, modern calculations of the corresponding nuclear matrix elements (NMEs) differ by factors 2-3. The high momentum transfer of Ordinary Muon Capture (OMC) provides insight into highly excited states similar to those that contribute virtually to $0\nu\beta\beta$ transitions. The precise study of the γ-radiation following the OMC process makes this a promising tool to validate NME calculations and test the quenching of the axial vector coupling g_A. The MONUMENT collaboration is performing a series of explorative OMC measurements involving typical $\beta\beta$ decay daughter isotopes such as ^{76}Se and ^{136}Ba, as well as other benchmark isotopes. The experiment carried out at the Paul Scherrer Institute and the first results from the beam-time in 2021 will be presented.

This research is supported by the DFG Grant: 448829699 and RFBR-DFG with project number: 21-52-12040.

T 11.4 Mon 17:15 POT/0051

COSINUS: Cryogenic Search for Dark Matter With Scintillating NaI Calorimeters — •Martin Stahlberg for the COSINUS-Collaboration — Max-Planck-Institut für Physik, Föhringer Ring 6, 80805 München

COSINUS (Cryogenic Observatory for SIgnatures seen in Next-generation Underground Searches) is a cryogenic dark matter direct detection experiment that aims for a model-independent cross-check of the DAMA/LIBRA claim for dark matter. Since 1995, the DAMA/LIBRA experiment is measuring a yearly modulated signal with properties that fit well to a local dark matter halo in the Milky Way. The DAMA/LIBRA target mass consists of 250 kg of sodium iodide, and the experiment reaches a significance of 13.7 sigma for its claim of a modulation. COSINUS detectors will read out both the scinitllation light signal and the heat signal caused by particle interactions. Each detector will consist of a NaI absober crystal equipped with a transition edge sensor using the remoTES design and a silicon beaker surrounding the absorber. With the dual-channel readout, which is unique for NaI , different types of interacting particles can be discriminated on an event-by-event basis. This contribution will present the status of the COSINUS experiment and its detectors.

T 11.5 Mon 17:30 POT/0051

Magnetic shielding tests for the COSINUS experiment — •Maximilian Hughes for the COSINUS-Collaboration — Max Planck Institute for Physics Föhringer Ring 6, 80805 München

The COSINUS experiment is a dark matter search using cryogenic detectors . The readout of these detectors is sensitive to environmental parameters such as magnetic fields. Active and passive shielding are being investigated to counteract the fluctuations of these fields. Superconducting materials enclosing the detectors and employed inside the dilution refrigerator can be used to keep magnetic field values constant after cooling. The operating conditions of the detectors with an applied magnetic field and a superconducting shield has been investigated. This talk will be a description of the efforts for the optimization of passive and active shielding for cryogenic detectors.

T 11.6 Mon 17:45 POT/0051

Vibration decoupling in the COSINUS underground facility — •Moritz Kellermann for the COSINUS-Collaboration — Max-Planck-Institut für Physik, Föhringer Ring 6, 80805 München

COSINUS is a direct dark matter detection experiment that will utilize cryogenic calorimeters based on sodium iodide (NaI) to resolve the tension between the positive dark matter signal measured by DAMA/LIBRA and the null-result by other experiments. Currently, a modern cryogenic facility is set up at the Laboratori Nazionali del Gran Sasso (LNGS) and is expected to begin operation within 2023. The facility includes a large clean room area on top of a 270 cubic meter water tank equipped with ~30 Photo Multiplier Tubes (PMTs) acting as an active muon veto. Detectors will be mounted in a custom-made dry dilution refrigerator with a base temperature of 9 mK. A lifting system will lower the refrigerator into a passive copper shielding within the water tank. To reach the thermal stability necessary for operating cryogenic calorimeters in a dry dilution refrigerator, a multi-stage passive vibration-decoupling system is currently being tested. This contribution will present the COSINUS facility and the planned vibration decoupling system.

T 12: Gamma Astronomy I

Time: Monday 16:30–18:00 Location: POT/0151

T 12.1 Mon 16:30 POT/0151

Generation of IACT images using generative models — •Christian Elflein, Jonas Glombitza, and Stefan Funk for the H.E.S.S.-Collaboration — Erlangen Centre for Astroparticle Physics, Erlangen, Germany

The development of precise, fast, and computationally efficient simulations is a central challenge of modern physics. With the advent of deep learning, new methods are emerging from the field of generative models. Recent applications to the generation of calorimeter images showed promising results, which motivates the application in astroparticle physics. In this contribution, we introduce a deep-learning-based model for the generation of camera images of Imaging Air Cherenkov Telescopes (IACTs).

In our case study, we use simulations of the High Energy Stereoscopic System (H.E.S.S.) to train a Wasserstein generative adversarial network (WGAN) for the generation of IACT images. We examine basic image properties of the generated samples, discuss their physical properties, and outline possibilities for stereoscopic image generation.

T 12.2 Mon 16:45 POT/0151

A template-based air shower reconstruction method for SWGO — •Franziska Leitl, Vikas Joshi, and Stefan Funk for the SWGO-Collaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen Centre for Astroparticle Physics, Nikolaus-Fiebiger-Str. 2, D-91058 Erlangen, Germany

The Southern Wide-field Gamma-ray Observatory (SWGO) is a future ground-based gamma-ray detector that will be built in South America, extending current generation instruments to the Southern Hemisphere. Primarily, water Cherenkov detectors will be utilized to detect particles in an energy range from 100s of GeV to 100s of TeV. The instrument will possess a close to 100% duty cycle and an order steradian field-of-view. The detection area will consist mainly of a densely packed inner array of water Cherenkov detectors for detecting low energy events, while a large, sparse outer array of detectors is used mainly for higher energy showers. In this contribution, the current status of air shower reconstruction for SWGO with a template-based reconstruction method will be presented.

T 12.3 Mon 17:00 POT/0151

Event classification in Compton-Pair telescopes using Convolutional Neural Networks — •Jan Lommler and Uwe Oberlack — Institut für Physik und Exzellenzcluster Prisma+ Johannes Gutenberg-Universität Mainz

Low to medium energy gamma rays are shielded by the Earth's atmosphere and cannot be measured with on-ground facilities. Satellite based gamma-ray astronomy relies on photo absorption, Compton scatter and Pair creation as measurement channels. Among the biggest challenges are the poor signal to background ratio due to low signal fluxes from cosmic sources and the high background rates even in the comparatively moderate environment of Low Earth Orbits. An efficient event tagging reduces signal losses by preventing type-mismatching applications of reconstruction algorithms (e.g. performing a Compton reconstruction on a Pair event) and signal pollution (distinguishing events originating from background sources). We explore the feasibility of Deep Convolutional Neural Networks in the context of event classification for Compton-Pair telescopes on the example of the e-ASTROGAM design proposal and show improvements possible when using publicly available analysis tools.

T 12.4 Mon 17:15 POT/0151

eep-learning-based gamma/hadron separation for IACTs — •Jonas Glombitza, Vikas Joshi, Benedetta Bruno, and Stefan Funk for the H.E.S.S.-Collaboration — Erlangen Centre for Astroparticle Physics, Erlangen, Germany

Ground-based gamma-ray observatories have opened in the last decades a new window to the non-thermal universe by studying air showers initiated by cosmic particles. Imaging Air Cherenkov Telescopes (IACTs), like the High Energy Stereoscopic System (H.E.S.S.), are utilized to image the distribution of Cherenkov light emitted during the development of air showers. For the rejection of the hadronic background, many algorithms rely on a high-level parameterization of these IACT images and exploit their correlation. Recently, deep-learning-based approaches showed promising results by explolting the full images, which overcomes the limitation of the elliptical modeling.

In this contribution, we present a new approach to reconstruct IACT images using deep learning. We model the images as a collection of triggered sensors that can be described by a graph and analyzed using graph convolutional neural networks. We describe our new algorithm, trained using H.E.S.S. simulations, examine its performance, and compare it to various classification algorithms.

T 12.5 Mon 17:30 POT/0151

Characterization of the Response of large-area PMTs for SWGO. — •Frederik Wohlleben, Fabian Haist, Hazal Göksu, and Felix Werner for the SWGO-Collaboration — Max-Planck-Institut für Kernphysik, P.O. Box 103980, D 69029 Heidelberg, Germany

The SWGO collaboration aims at building a ground-based gamma-ray detector in the southern hemisphere. A promising approach to build a low-cost water Cherenkov detector with muon-tagging abilities is to deploy a two-chamber bladder containing two PMTs into an open body of water. This talk will give a short overview over the research done on large-area PMTs operated with a custom electronics chain which will be used in prototype SWGO detectors.

T 12.6 Mon 17:45 POT/0151

Actuators for the Medium-Sized Telescopes of the Cherenkov Telescope Array — •Heiko Salzmann for the CTA MST-Collaboration — Sand 1, 72076 Tübingen, Germany

The Cherenkov Telescope Array (CTA) is a future ground-based observatory for gamma-ray astronomy offering unparalleled sensitivity in the energy range from 20 GeV up to 300 TeV. One array will be located in the northern hemisphere (La Palma, Canary Islands), one in the southern hemisphere (Atacama, Chile).

Three different telescope types are foreseen. The Medium-Sized Telescope (MST) is covering the core energy range from 100 GeV up to 10 TeV and is currently the only type foreseen for both CTA sites in the Alpha configuration. It has a reflector with a diameter of 12 m and a tessellated mirror design of 86 mirror facets. Each mirror facet is mounted on the mirror support structure with two actuators that are adjustable in length to align the mirrors, and a freely rotating fixpoint. Image resolution and pointing accuracy constraints impose limits on the backlash and deformation of the actuators and the fixpoint under various weight and wind loads. After a short introduction into the MST mirror alignment procedure, this contribution will cover the mechanical design of the actuators, the limits on the positioning accuracy of the actuators and fixpoints as well as the verification thereof.

T 13: Neutrinos I

Time: Monday 16:30–18:00 Location: POT/0251

T 13.1 Mon 16:30 POT/0251

Core-Collapse Supernova detection with JUNO — •Alexei Coretzki, Thilo Birkenfeld, Markus Braun, and Achim Stahl for the JUNO-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

The Jiangmen Underground Neutrino Observatory (JUNO) is a liquid scintillator (LS) detector currently under construction in China. In addition to determining the neutrino mass ordering, JUNO is highly efficient for detecting neutrinos from Core-Collapse Supernovae. In particular, JUNO features the detection of inverse beta decay interactions. Due to its delayed coincidence signature this interaction is unique within the LS. We estimate the maximum distance of detectable supernovae using this interaction. For this we take into account backgrounds, elastic scattering, and other charged current interactions like neutrino-carbon interactions.

T 13.2 Mon 16:45 POT/0251

External Background in JUNO for Solar Neutrinos and DSNB Detection — •Simon Csakli[1], Lothar Oberauer[1], Simon Appel[1], Matthias Mayer[1], and Sebastian Zwickel[2] — [1]Technische Universität München, München, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

The Jiangmen Underground Neutrino Observatory (JUNO) is an upcoming 20 kt liquid scintillator detector. In this work, the impact of external backgrounds is studied with the goal of increasing the fiducial volume available for two specific neutrino measurements with JUNO. First, the periodic modulations in the solar neutrino flux are analysed. For this, the sensitivity for the detection of these modulations is determined for several fiducial volume cuts, taking the background caused by radioactive decays in various materials in and around the detector volume into account. The second part focuses on the diffuse supernova neutrino background (DSNB), the constant flux of neutrinos emitted by past core-collapse supernova in the entire visible universe. A crucial background for this signal are fast neutrons induced by spallation processes, which are simulated in this work. The fiducial volume is then determined from the obtained fast neutron data. This work is supported by the DFG research unit ”JUNO”, the DFG collaborative research centre 1258 ”NDM”, and the DFG Cluster of Excellence ”Origins”.

T 13.3 Mon 17:00 POT/0251

JUNO's sensitivity to 7Be, pep and CNO solar neutrinos and strategy for directional analysis of CNO solar neutrinos in JUNO — •Apeksha Singhal[1,3], Runxuan Liu[1,3], Livia Ludhova[1,3], Anita Meraviglia[2,3], Nikhil Mohan[2,3], Luca Pelicci[1,3], Mariam Rifai[1,3], and Cornelius Vollbrecht[1,3] for the JUNO-Collaboration — [1]Forschungszentrum Jülich GmbH, Institut für Kernphysik IKP-2, Jülich, Germany — [2]GSI Helmholtz Centre for Heavy Ion Research, Darmstadt, Germany — [3]III. Physikalisches Institut B, RWTH Aachen University, Aachen, Germany

JUNO Experiment is 20 kt multipurpose LS detector, under construction in China, with planned completion in 2023. Its main goal is Neutrino Mass Ordering determination, exploiting its large target mass and excellent energy resolution (3% at 1 MeV). Due to its unique properties, JUNO will have potential of real-time solar neutrino measurement with unprecedented levels of precision using multivariate (MV) fit. Sensitivity study is performed by considering all possible sources of background, including their various concentration level and full simulation of detector response. Performing directional analysis of CNO solar neutrinos via Correlated and Integrated Directionality method (developed by Borexino collaboration) in JUNO and using it as additional constraint in MV fit has potential to further improve precision of CNO solar neutrino measurement. This talk will summarize methods for sensitivity studies using MV fit and the final results. Investigation of Cherenkov and scintillation light properties using JUNO MC software and strategies of preliminary directional analysis will be shown.

T 13.4 Mon 17:15 POT/0251

Combined analysis of the first five KATRIN measurement campaigns with KaFit — •Stephanie Hickford[1], Leonard Köllenberger[1], and Weiran Xu[2] for the KATRIN-Collaboration — [1]Institute for Astroparticle Physics, Karlsruhe Institute of Technology — [2]Massachusetts Institute of Technology

The KATRIN collaboration aims to determine the neutrino mass with a sensitivity of 0.2 eV/c^2 (90 % CL). This will be achieved by measuring the endpoint region of the tritium β-electron spectrum. Combined analysis of the first two KATRIN measurement campaigns yielded a neutrino mass limit of $m_\nu \leq 0.8$ eV (90 % CL).

Analyses of data from the first five measurements campaigns are currently underway. One of the combined analyses is performed using the `KaFit/SSC` model within the `KASPER` software framework. In this analysis systematic uncertainties are propagated as additional fit parameters with constraints (the “pull term” method). An overview of the collected data and the expected combined sensitivity on the neutrino mass from these five measurement campaigns will be presented in this talk.

This work is supported by the Helmholtz Association, the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Initiative and Networking Fund (W2/W3-118).

T 13.5 Mon 17:30 POT/0251

A Look at General Neutrino Interactions with KATRIN — •Caroline Fengler for the KATRIN-Collaboration — Institute of Experimental Particle Physics, Karlsruhe Institute of Technology

The KATRIN experiment aims to measure the neutrino mass by precision spectroscopy of tritium β-decay with a target sensitivity of 0.2 eV. Recently, KATRIN has improved the direct upper bound on the effective electron-neutrino mass to 0.8 eV at 90 % CL [1]. However, the scientific potential of KATRIN extends well beyond the neutrino mass analysis. In particular, General Neutrino Interactions (GNI) [2] can be investigated through a search for potential shape variations of the β-spectrum. For this purpose, all theoretically allowed interaction terms for neutrinos are combined in one Effective Field Theory. This enables a model-independent description of novel interactions. Such potential modifications can then be identified in the β-spectrum measured with KATRIN by means of energy-dependent contributions to the rate. The talk will introduce the theory of GNI and present recent sensitivity studies on first year KATRIN data.

[1] The KATRIN Collab. *Nat. Phys.* 18, 160-166, 2022.
[2] I. Bischer and W. Rodejohann. *Nucl. Phys. B*, 947, 2019.

This work is supported by the Helmholtz Association, the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Initiative and Networking Fund (W2/W3-118).

T 13.6 Mon 17:45 POT/0251

Sensitivity of eV-scale sterile neutrino search with KATRIN using KaFit — •Shailaja Mohanty for the KATRIN-Collaboration — Institute for Astroparticle Physics, Karlsruhe Institute of Technology

KATRIN has recently reported a direct sub-eV upper bound on the neutrino mass from tritium beta-decay spectrum measurements. Along with the neutrino mass search, KATRIN has published recent results on searching for a fourth neutrino with a mass in the eV-range using the precision beta-decay spectra.

The fourth neutrino mass-eigenstate introduces an additional branch into the tritium β-spectrum which manifests as a kink in the differential spectrum. The position and amplitude of this kink correspond to the sterile neutrino mass m_4 and effective mixing angle $\sin^2(\theta) = |U_{e4}|^2$, respectively. In this work sensitivity studies to light sterile neutrinos based on new science runs and the effect of systematic uncertainties are presented. A grid scan is performed in the $[m_4^2, \sin^2(\theta)]$ 2-D plane using the fitting tool "KaFit" and sensitivity contours are calculated within this parameter space. Approach for a combined analysis of successive measurement campaigns are discussed.

This work is supported by the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3) and the Doctoral School "Karlsruhe School of Elementary and Astroparticle Physics: Science and Technology (KSETA)" through the GSSP program of the German Academic Exchange Service (DAAD).

T 14: Neutrinos, Dark Matter II

Time: Monday 16:30–18:00 Location: POT/0361

T 14.1 Mon 16:30 POT/0361

Nuclear Recoil modelling in XENONnT — •Luisa Hötzsch for the XENON-Collaboration — Max-Planck-Institut für Kernphysik, Heidelberg

The XENONnT detector is among the most sensitive dark matter experiments, aiming for the direct detection of WIMP dark matter with a multi-tonne xenon target in a dual-phase time projection chamber (TPC). WIMPs are expected to scatter elastically off the xenon nuclei in the target, resulting in a physical recoil of the nucleus. The energy that the recoiling nucleus imparts on neighboring xenon atoms leads to the creation of scintillation light and ionisation electrons, which are the two observables in the detector. A detailed understanding of the processes that govern the translation from deposited nuclear recoil (NR) energy into these two signal channels is therefore of utmost importance for the prediction of the signal shape of a potential WIMP interaction, as well as of NR background sources such as radiogenic neutrons.

In order to calibrate the detector response to NRs for the WIMP search, XENONnT uses neutrons from an external Americium-Beryllium source. In this talk, I will present the modelling and fitting of the liquid xenon response to the NR calibration data for the first WIMP search of the XENONnT detector.

T 14.2 Mon 16:45 POT/0361

Radon removal in the XENONnT experiment via cryogenic distillation — •Henning Schulze Eissing[1], Lutz Althüser[1], Christian Huhmann[1], David Koke[1], Andria Michael[1], Michael Murra[2,1], Philipp Schulte[1], and Christian Weinheimer[1] for the XENON-Collaboration — [1]Institut für Kernphysik, Universität Münster — [2]Columbia University, New York, USA

In order to reduce the dominant component of the electronic recoil background, Rn-222 and its progenies, in the XENONnT experiment a high flux radon removal system has been build by our group (Eur. Phys. J. C 82 (2022) 1104). Rn-222 continuously emanates from detector components and distributes homogeneously within the liquid xenon target due to the half-life of 3.8 days.

Our active radon removal system utilizes the vapor pressure difference between radon and xenon in the form of a cryogenic distillation column. With a xenon flow of 200 slpm the full 8.6 t of xenon are passed through the column within one mean lifetime of Rn-222 resulting in a radon concentration reduction by a factor two. An additional extraction flow of 25 slpm from the xenon gas phase provides a further reduction factor of about two. Combining both methods we achieved a radon activity concentration as low as 1 muBq/kg, the lowest value to date with a xenon-based Dark Matter experiment.

This talk will outline the working principle of the radon removal system and the performance within the XENONnT experiment.

This work is supported by BMBF under contract 05A20PM1 and by DFG within the Research Training Group GRK 2149.

T 14.3 Mon 17:00 POT/0361

Search for Sub-Relativistic Magnetic Monopoles in IceCube — •Silvia Latseva, Annika Wolf, Jakob Böttcher, Christian Dappen, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

The IceCube Neutrino Observatory at the South Pole is designed to detect high-energy neutrinos. It is also used for searches for exotic particles such as magnetic monopoles, which are predicted by Grand Unified Theories as relics from the very early Universe. A sub-relativistic magnetic monopole could catalyze nucleon decays in matter via the Rubakov-Callan effect. These decays result in small particle showers along the monopole's track with a spacing ranging from centimeters to tens of meters. IceCube detects the Cherenkov light produced in these processes and records potential monopole events by the so-called SLOw Particle (SLOP) trigger. For the separation of signal from background, we have developed an event selection algorithm based on Boosted Decision Trees (BDTs), which are trained on simulated monopole signals and data-driven backgrounds. This talk will give an update on the search for sub-relativistic monopoles in IceCube.

T 14.4 Mon 17:15 POT/0361

Paleo-detectors for Dark Matter — •Alexey Elykov — Karlsruhe Institute of Technology, Institute for Astroparticle Physics

Despite the recent advances in physics, Dark Matter (DM) still eludes detection by modern large-scale experiments and puzzles the minds of physicists. Paleo-detectors represent a drastically different approach to DM detection, which uses ancient samples of natural minerals to search for nm-sized damage tracks produced by DM-induced nuclear recoils, that will accumulate in the minerals for ~ 1 Gyr, while they reside in the depths of the Earth. Modern, state-of-the-art microscopy techniques can be used to read out these minute tracks with nm resolution, differentiating them from those produced by more energetic radioactive contaminants. Despite their small size the Gyr-scale lifetime of paleo-detectors provides them with enormous exposure, allowing them to probe DM-nucleon cross sections below current limits for DM masses greater than $30\,\mathrm{GeV/c^2}$. For lighter DM particles, with masses $< 10\,\mathrm{GeV/c^2}$, the sensitivity of paleo-detectors reaches many orders of magnitude below the current upper limits. In this talk, the latest research and developments towards the use of mineral-based paleo-detectors will be presented.

T 14.5 Mon 17:30 POT/0361

Construction of the JUNO pre-detector OSIRIS — •Tobias Sterr[1], Cornelius Vollbrecht[2], Oliver Pilarczyk[3], Jessica Eck[1], Tobias Heinz[1], Lukas Bieger[1], Marc Breisch[1], Benedict Kaiser[1], and Tobias Lachenmaier[1] — [1]Eberhard Karls Universität Tübingen, Tübingen, Physikalisches Institut — [2]Nuclear Physics Institute IKP-2 Forschungzentrum Jülich, Jülich, Germany — [3]Institute of Physics and EC PRISMA+, Johannes-Gutenberg University Mainz, Mainz, Germany

The Online Scintillator Internal Radioactivity Investigation System (OSIRIS) is a 20-ton liquid scintillator detector currently under construction at the Jiangmen Underground Neutrino Observatory (JUNO) in Kaiping, China. OSIRIS* main goal is the monitoring of the purity of the liquid scintillator during the filling phase of the JUNO main detector. The construction of OSIRIS was performed between September *22 to January *23 and involved both, Chinese and German personnel. During that time all auxiliary systems (e.g., liquid handling), (digital) infrastructure (e.g., network devices) as well as scientific equipment was installed. This talk will report on the procedures, systems, challenges, and results of this installation work. This work is supported by the Deutsche Forschungsgemeinschaft.

T 14.6 Mon 17:45 POT/0361

Optimisation of Light Concentrators in the OSIRIS Upgrade — •Marcel Büchner — Johannes Gutenberg-University Mainz

OSIRIS as the pre-detector of the JUNO reactor neutrino measurement, is meant to monitor the radio-purity of the scintillator used. When upgraded in the future, it is supposed to either be used as solar neutrino detector or to search for neutrino-less double-Beta decay. To provide a better energy resolution, the photon detection efficiency of OSIRIS needs to be increased. This is achieved by increasing the number of PMTs used along with adding Winston cones as light concentrators in front of them. Previous optimisations have shown that the optimal shape of these light concentrators depends heavily on the exact detector geometry. So the ideal arrangement for the PMTs needs to be found. This talk presents the on going work to optimise the light collection of the OSIRIS upgrade. During first tests an arrangement of 132 PMTs with light concentrators, on an almost equidistant triangular grid has been found, with an optical coverage that is at least 9 times higher then the current OSIRIS detector.

T 15: Neutrinos, Dark Matter III

Time: Monday 16:30–18:00 Location: POT/0006

T 15.1 Mon 16:30 POT/0006

The SNO+ Experiment: Current Status and future Prospects — •Johann Dittmer and Kai Zuber — IKTP, TU Dresden, Deutschland

Located at 2 km underground in a mine near Sudbury, Ontario, Canada, the SNO+ experiment has an excellent shielding against cosmic rays. Due to this fact, it is nicely suitable for low background measurements. SNO+ consists of a 12 m diameter acrylic sphere filled with 780 t of a liquid scintillator. The sphere is observed by 9400 photomultipliertubes mounted on support structure with 18 m diameter. The main goal is to search for the neutrinoless double beta decay ($0\nu\beta\beta$) of ^{130}Te. For this, the scintillator will be doped with 3.9 t of natural Tellurium. Owing to it's design as a general purpose neutrino detector, it is also possible to measure neutrinos from different sources (geo, reactor, solar, Supernova, etc). After a commissioning water phase ended in 2019, a phase with pure scintillator started in 2022 is currently running. During this phase, reactor neutrino oscillations, low energy ^{8}B solar neutrinos and geo neutrinos are studied. In addition, background components of the $0\nu\beta\beta$ deacay are investigated. The double beta phase is forseen to run for 5 years starting in 2025.

In this talk, the recent results and the broad physics program will be presented.

SNO+ is funded by the German Research Foundation (DFG).

T 15.2 Mon 16:45 POT/0006

Improved detector response modelling for single-charge sensitive SuperCDMS detectors — •Matthew Wilson and Alexander Zaytsev for the SuperCDMS-Collaboration — Karlsruhe Institute of Technology, Institute for Astroparticle Physics

Recently, R&D facilities within the SuperCDMS collaboration have developed and employed cryogenic, high-voltage, eV-scale (HVeV) detectors with single-charge sensitivity. For a typical event observed by one of these gram-sized, silicon crystal detectors, the total amount of phonon energy measured is proportional to the number of electron-hole pairs created by the interaction. However, crystal imperfections and surface effects can cause propagating charges to either trap inside the crystal or ionize additional charges, producing non-quantized measured energy as a result. Modelling these detector-response effects continues to be important for the HVeV R&D program in order to understand calibration data and apply these effects on potential signals for dark matter searches. This presentation showcases an improved, more robust model of these detector-response effects that has fewer limitations and is capable of modelling more effects compared to previous models. This model allows for more accurate characterization of HVeV detectors and may facilitate discrimination between potential dark matter signals and background sources.

T 15.3 Mon 17:00 POT/0006

Low-frequency noise classification for the SuperCDMS experiment using Machine Learning — •Sukeerthi Dharani for the SuperCDMS-Collaboration — Karlsruhe Institute of Technology, Institute for Astroparticle Physics — University of Hamburg, Institute for Experimental Physics

The SuperCDMS Soudan experiment was a direct dark matter search experiment that was operated from 2012 to 2015 at the Soudan Underground Laboratory in Minnesota, USA. It used germanium crystal detectors at cryogenic temperatures to search for dark matter-nucleon scattering events. The experiment was affected by broadband low-frequency (LF) noise due to vibrations from the cryocooler, which deteriorated the detector baseline resolution and increased the noise trigger rate. The LF noise events can have a similar pulse shape as the low-energy signal events, making it difficult to remove them at low energies. In the final low ionization threshold analysis, this has led to stronger event selection criteria to remove LF noise events which set a higher analysis threshold and thus reduced the sensitivity of the experiment to low-mass dark matter. Currently, an LF noise selection criterion using machine learning is being studied. Under investigation is a convolutional neural network that yields better signal purity while also retaining signal efficiency. This talk discusses the machine learning-based classification of LF noise and its preliminary results.

T 15.4 Mon 17:15 POT/0006

The LEGEND Experiment - Status of commissioning and outlook — •Simon Sailer for the LEGEND-Collaboration — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

The LEGEND experiment searches for the neutrino-less double beta ($0\nu\beta\beta$) decay of the germanium isotope 76Ge which would reveal the Majorana nature of neutrinos and prove lepton number non-conservation. The first stage of experiment (LEGEND-200) is built at the underground facility of LNGS in Italy. Here close to 200 kg of enriched high-purity germanium detectors (~ 88% 76Ge) are being deployed providing a discovery sensitivity for the half-life of the $0\nu\beta\beta$ decay of > 10^{27} yr. within 5 years of measurement. The detectors are emerged in a liquid argon cryostat which simultaneously provides the coolant, a gamma-radiation shield and active veto system. The cryostat itself is surround by a large water tank acting as an additional neutron shield and muon-veto. LEGEND-200 is ending it's commissioning phase and switches to standard operations. Meanwhile the preparations for the second stage (LEGEND-1000) increasing the detector mass to 1 tonne are making great strides which will increase the sensitivity to > 10^{28} yr. A non-observation would probe the effective Majorana neutrino mass $m_{\beta\beta}$ in the range of 10-20 meV and allow the exclusion of the inverted mass ordering.

T 15.5 Mon 17:30 POT/0006

Commissioning of the Liquid Argon Instrumentation of LEGEND-200 — •Rosanna Deckert, Patrick Krause, Laszlo Papp, Luigi Pertoldi, and Stefan Schönert — Technische Universität München

LEGEND (Large Enriched Germanium Experiment for Neutrinoless $\beta\beta$ Decay) is a ton-scale experiment to search for neutrinoless double beta ($0\nu\beta\beta$) decay using high-purity germanium detectors enriched in ^{76}Ge. An observation of $0\nu\beta\beta$ decay would prove the existence of lepton number violation and provide insight into the nature of neutrino masses. The first phase of the experiment LEGEND-200 will deploy 200 kg of enriched material and aims for a sensitivity of 10^{27} years on the $0\nu\beta\beta$ decay half-life. To achieve this, the germanium detectors are operated in liquid argon instrumented as an active detector to detect the scintillation light produced by backgrounds from trace radioactive contaminants. Commissioning of the liquid argon instrumentation, consisting of wavelength-shifting fibers, a wavelength-shifting reflector and silicon photomultipliers, took place during 2022 at the Laboratori Nazionali del Gran Sasso. In this talk, some of the main outcomes of the commissioning are presented.

This research is supported by the BMBF through the Verbundforschung 05A20WO2 and by the DFG through the Excellence Cluster ORIGINS and the SFB1258.

T 15.6 Mon 17:45 POT/0006

BSM physics searches beyond $0\nu\beta\beta$ decay with GERDA and LEGEND — •Elisabetta Bossio for the GERDA-Collaboration — Physik-Department E15, Technische Universität München, Garching, Germany

While searching for neutrinoless double-β ($0\nu\beta\beta$) decay, experiments collect huge statistics of the Standard Model (SM) two neutrino double-β ($2\nu\beta\beta$) decays. This is amongst the rarest nuclear processes ever observed. Beyond the Standard Model (BSM) physics, like the existence of new particles, Majorons, or light exotic fermions, or the violation of Lorentz symmetry, would affect the shape of the measured two-electron spectrum, originating detectable and characteristic signatures. The GERDA experiment, with its ultra-low background and excellent understanding of the experiment's response, set the best limits on the mentioned BSM double-β decays with ^{76}Ge [1]. In this contribution, the results of the GERDA experiment will be presented, and the sensitivity of the LEGEND experiment [2] to improve the current limits and to search for more exotic double-β decays involving non-standard interactions, like right-handed leptons currents or neutrino self-interactions, will be discussed. This research is supported by the BMBF through the Verbundforschung 05A20WO2 and by the DFG through the Excellence Cluster ORIGINS and the SFB1258.

[1] GERDA Collaboration, M. Agostini et al JCAP12(2022)012
[2] LEGEND-1000 pCDR, arXiv 2107.11462

T 16: Neutrino Astronomy I

Time: Monday 16:30–18:00 Location: POT/0112

T 16.1 Mon 16:30 POT/0112

Quasi-periodic oscillations in J1048.4+714 - comparison of hadronic and leptonic signatures* — •Tom Mianecki[1,2], Julia Becker Tjus[1,2], and Leander Schlegel[1,2] — [1]Theoretische Physik IV, Ruhr Universität Bochum, Bochum, Germany — [2]RAPP-Center at Ruhr Universität Bochum, Bochum, Germany

Active Galactic Nuclei belong to the most luminous known astrophysical sources of high energy radiation. They are assumed to produce charged particles as well as uncharged messengers as photons and neutrinos via leptonic as well as hadronic processes and show a strong time-variability in their corresponding light curves. The quasi-periodic behaviour of the recently analyzed light curve of the source J1048.4+714 especially raises the question of the creation of such temporal structures. One explanation is that the shape of the light curve stems from a precessing jet. In this work, we compare the photon flux produced via the $pp \to \pi^0 \to \gamma\gamma$ channel and the photon flux produced from synchrotron self-compton scattering in dependence of parameters of the emitting region. Furthermore, we investigate the differences of the flaring durations of the source defined by two methods, i.e. full-width at half-maximum method and the centroid method. Finally we evaluate the results with respect to the curvature parameter of the SEDs in the flaring phase. With these investigations we aim to reach a better understanding of the quasi-periodic oscillations in AGN and the interpretation of high-energy radiation signatures.

*Supported by DFG (SFB 1491)

T 16.2 Mon 16:45 POT/0112

Search for periodic low energy neutrino sources — •Maximilian Eff for the ANTARES-KM3NET-ERLANGEN-Collaboration — ECAP, Friedrich-Alexander Universität Erlangen-Nürnberg (FAU), Erlangen, Germany

Pulsars are rotating neutron stars that emit beams of electromagnetic radiation. Neutrino emission from pulsars has been the subject of phenomenological models during the last decades. So far, experimental data has not shown any neutrino emission at high energies. This contribution reports about the development of a novel search approach that aims at identifying low-energy (below 10 GeV) neutrinos from periodic sources with a neutrino telescope. This is done by applying a Fast Fourier Transformation to the PMT counting rate time series.

T 16.3 Mon 17:00 POT/0112

Study of high-energetic muon deflections * — •Pascal Gutjahr — TU Dortmund University, Dortmund, Germany

The analysis of incoming muon-neutrinos and muons relies on the reconstruction of the detected muons. In general, the energy and the direction of an incoming particle are estimated via likelihood methods. With new reconstruction algorithms and hardware optimizations, the direction of an incoming muon can be measured with an angular resolution lower than 1 degree.

However, high-energetic muons are able to travel many kilometers through dense media like ice and water. In these media, the muons interact very frequently with energy losses of up to 90% of the muon energy and even larger energy losses are possible. In each interaction, there is a momentum transfer which leads to a small deflection of the initial muon direction.

In this presentation, the lepton simulation framework PROPOSAL is used to estimate the accumulated muon deflection. Muons with different energies are propagated through ice and water over several distances. Data-Monte-Carlo comparisons as well as comparisons with the simulation tools MUSIC and Geant4 are shown. Finally, the impact of muon deflections for large scale neutrino telescopes is discussed. *Supported by DFG (SFB 876 and 1491) and BMBF

T 16.4 Mon 17:15 POT/0112

Image Recognition Algorithm for Deep Sea Bioluminescence — •Sophie Loipolder and Kilian Holzapfel for the P-ONE-Collaboration — Technical University of Munich, Munich, Germany

The Pacific Ocean Neutrino Experiment (P-ONE) is a planned, cubic-kilometer-scale neutrino telescope in the Pacific Ocean off the coast of Vancouver, Canada. Two pathfinder experiments have already been deployed: STRAW (STRings for Absorption length in Water) in 2018 and STRAW-b in 2020. Both pathfinder experiments are connected to the NEPTUNE deep-sea observatory, an initiative of Ocean Networks Canada (ONC). In the deep sea, light produced by bioluminescent organisms presents a particular background for neutrino detection, although the bioluminescence data obtained are valuable for interdisciplinary research. The cameras installed in STRAW-b allow a visual detection of the bioluminescence. In this contribution, we present an image recognition algorithm including a deep neural network to analyze the bioluminescence on the pictures.

T 16.5 Mon 17:30 POT/0112

Applications of an improved track reconstruction algorithm in IceCube — •Sofia Athanasiadou for the IceCube-Collaboration — DESY, Zeuthen, Germany

The IceCube Neutrino Observatory, the world's largest neutrino telescope, has detected neutrinos in spatial and time coincidence with AGN, providing strong evidence that these astrophysical objects can in fact be neutrino sources. Neutrinos of astrophysical origin can be discerned from the atmospheric background at energies above 100 TeV, and for point-source studies in particular, high-energy track-like events are preferred. In this energy regime, the stochastic energy losses of the neutrino-induced muons are the dominant source of Cherenkov light measured by the detector, thus it is essential to include them in our reconstruction methods. The SegmentedSpline reconstruction algorithm incorporates stochastic losses into the energy loss pattern while performing an energy fit as a first step, which significantly improves on the subsequent track reconstruction step and the angular resolution achieved. In this work we present our results when the algorithm is run on a subsample of simulated events for validation purposes, and our plans for implementation on IceCube data for a point-source search study.

T 16.6 Mon 17:45 POT/0112

Flavor differentiation for in-ice radio neutrino detectors — •Janna Vischer for the RNO-G-Collaboration — Erlangen Centre for Astroparticle Physics, Erlangen, Germany

Cosmogenic neutrinos (> PeV) can be detected via the Askaryan effect when they interact and induce particle showers in ice. The thereby created radio signals can be observed using large scale antenna arrays. This is currently done at the Radio Neutrino Observatory Greenland (RNO-G) and planned for the radio component of IceCube-Gen2. The capability to differentiate neutrino flavors would be an asset for such experiments. In the event of deep-inelastic scattering, neutrino interactions produce either an undetectable neutrino (neutral-current interaction) or an electron, muon, or tau lepton (charged-current interaction), both occasionally accompanied by measurable hadronic showers. In the second case extremely high energetic muons and taus themselves radiate secondary showers along their tracks. Particle showers with an energy above PeV can be detected. In this contribution we investigate how the signatures of these secondary showers can be used to deduce the flavor of the original neutrino in radio neutrino detectors.

T 17: Cosmic Ray I

Time: Monday 16:30–18:00 Location: POT/0013

T 17.1 Mon 16:30 POT/0013

Radio emission-mechanism of horizontal air showers measured with AERA at the Pierre Auger Observatory* — •Rukije Uzeiroska for the Pierre Auger-Collaboration — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal, Germany

The Pierre Auger Observatory is the world's largest detector measuring ultra high energy cosmic rays. The Auger Engineering Radio Array (AERA) is an ensemble of 153 antennas each with two polarization directions covering an area of 17 km^2 in order to detect the radio signal of the extensive air showers. These radio emissions consists of two components: the geomagnetic and the charge-excess emission. They can be disentangled by measuring the direction of the electric field vector.

This talk presents current efforts to determine the relative contributions of these two processes using the polarisation pattern of the antenna stations for events measured with AERA, which helps to understand the development of air showers.

**Gefördert durch die BMBF Verbundforschung Astroteilchenphysik (Vorhaben 05A20PX1)*

T 17.2 Mon 16:45 POT/0013

Directional Calibration of radio antennas by using a drone emitter and information field theory for interpolating measured data at the Pierre Auger Observatory — Matthias Boddenberg, Martin Erdmann, •Alex Reuzki, and Maximilian Straub — III. Physikalisches Institut A, RWTH Aachen University

Ultra-high-energy cosmic rays in the Earth's atmosphere induce extensive air showers. At the Pierre Auger Observatory those air showers are measured using various detection techniques including the type of Short Aperiodic Loaded Loop Antennas (SALLA) as part of the AugerPrime upgrade.

SALLA antennas have been calibrated in a limited solid angle using the galactic background together with simulations. Here we introduce a recently started drone campaign to enable the relative directional calibration over the full sphere. Following pilot measurements with a small drone, we use a well defined biconical antenna mounted to a sizable drone. With that we will be able extract the antenna pattern from any direction and distance. Furthermore we will use an additional GPS unit to measure the drone's position to cm accuracy such that the positional uncertainty is strongly reduced.

Finally we will interpolate the discrete measurements using information field theory (IFT) to obtain the full antenna pattern for all directions and frequencies.

T 17.3 Mon 17:00 POT/0013

Development of a Signal Model for the Radio Emission of Inclined Air Showers for GRAND — •Lukas Gülzow, Jelena Petereit, Tim Huege, and Markus Roth — Karlsruhe Institute of Technology (KIT), Institute for Experimental Particle Physics, Karlsruhe, Germany

Ultra-high energy (UHE) neutrinos induce particle cascades in the atmosphere after interacting with the Earth's crust. With its unprecedented sensitivity, the Giant Radio Array for Neutrino Detection (GRAND) will be able to consistently detect the radio signals emitted by extensive air showers caused by UHE neutrinos and UHE cosmic rays. GRAND plans to cover a detection area of 200 000 km^2 with a spacing of one radio antenna per square kilometre. The radio array will be optimised for the detection of inclined air showers and cover a wide frequency band from 50 to 200 MHz. In contrast to existing arrays, GRAND will operate autonomously, i.e. on radio events alone, hence efficient radio triggering techniques need to be developed.

We use CORSIKA air-shower simulations to develop a more advanced signal model of the radio emission with an emphasis on the high frequencies GRAND will utilise. The model will be instrumental for the development of the novel autonomous trigger* as well event reconstruction for large-scale detector systems.

This talk gives an overview on the radio emission of extensive air showers, the details of the signal model, and how it can be used for trigger development and event reconstruction.

** NUTRIG project, ANR-DFG Funding Programme (HU 1830/6-1)*

T 17.4 Mon 17:15 POT/0013

Cosmic ray radio detection with the IceCube Surface Array Enhancement — •Megha Venugopal for the IceCube-Collaboration — Institute of Astroparticle Physics (IAP), Karlsruhe Institute of Technology, Germany

The IceCube Neutrino Observatory has been recording neutrino events and cosmic rays at the South Pole for more than a decade. The cosmic ray observatory of this experiment, IceTop with 162 Cherenkov tanks, has played an important part in understanding the high-energy universe. A Surface Array Enhancement(SAE), made up of scintillators and radio antennas, is planned to address the rising uncertainties from IceTop measurements due to snow accumulation and to improve measurement capabilities. A prototype station was deployed in January 2020 and has taken measurements which have been correlated with reconstructed events from IceTop. This contribution focuses on the current status of radio detection of cosmic rays at the SAE. The calibration and characterization of hardware components were performed and prepared for deployment. Reconstruction of Xmax, the atmospheric depth of the shower maximum, was done with initial measurements and with data from IceTop. The main goal is to characterize uncertainties and to prepare the experiment to do physics.

T 17.5 Mon 17:30 POT/0013

A new approach to efficiency estimation of radio arrays — •Vladimir Lenok — Bielefeld University, Germany

The progress of in the field of radio detection of air showers in the last decades paved the way for the large-scale radio observatories of cosmic rays and neutrinos. One of the remaining challenges regarding this kind of instrumentation is estimation of their efficiency, which is a complicated problem due to high computational complexity of the required large Monte-Carlo libraries. We developed a new approach to this problem that is based on explicit probabilistic treatment or each of the components of the detection process. With this approach we built an efficiency model for the Tunka-Rex radio array as for example. The model uses a parametrization of the air-shower radio footprint and probability densities for signal detection on the antenna level and shower detection on the array level. The model was validated against full-fledged Monte-Carlo simulations and against the observational data that showed that it is suitable for selection of the full-efficiency regions usually used in all cosmic-ray studies. In the talk we will present the details of the approach and the results of its application to the Tunka-Rex array.

T 17.6 Mon 17:45 POT/0013

First Radio Measurements of an IceCube Surface Enhancement Station at the Pierre Auger Observatory — •Carmen Merx for the Pierre Auger and IceCube-Collaboration — Institute for Astroparticle Physics, Karlsruhe Institute of Technology

Radio detection of air showers has become a powerful method to measure cosmic rays at energies of several 10 PeV and above. IceTop, the surface array of the IceCube Neutrino Observatory at the South Pole as well as the Pierre Auger Observatory in Argentina are being upgraded with antenna stations to improve the accuracy of air-shower measurements.

A prototype station of the surface enhancement of IceCube has recently been installed at the Pierre Auger Observatory. This station comprises eight scintillation panels and three SKALA antennas. The frequency band of the SKALA antennas reaches up to 350 MHz, which is significantly higher than the 30-80 MHz currently used at Auger.

During my presentation, I will discuss first measurements of this prototype station at the Auger site.

T 18: Exp. Methods, CTA, others

Time: Monday 16:30–18:00 Location: POT/0351

T 18.1 Mon 16:30 POT/0351

Characterization of PMTs for the FlashCam project — •Oleg Kalekin for the CTA FlashCam-Collaboration — Erlangen Centre for Astroparticle Physics, FAU Erlangen-Nürnberg, Nikolaus-Fiebiger-Str. 2, 91058 Erlangen, Germany

High quantum efficiency PMTs of type R12199-100-5 from Hamamatsu have been selected for the cameras of telescopes of the Cherenkov Telescope Array (CTA). The FlashCam group has developed a camera design suitable for installation in Medium-Sized Telescopes of CTA.

Using PMTs delivered in 2017, an advanced FlashCam prototype was produced and installed in the central CT5 telescope of the H.E.S.S. experiment in Namibia in fall 2019. Since then the PMTs are in field operation for more than 2 years already, and provide very stable performance. To control the quality of the PMTs, sub-samples delivered in 2017 and 2021-2022 have been characterized in laboratory for timing parameters, gain, afterpulsing and Quantum Efficiency (QE). The results on spectral shape of QE and homogeneity of QE over photocathode area as well as an evolution of these parameters with time will be presented.

T 18.2 Mon 16:45 POT/0351

Performance of SiPM test pixel operation in the MAGIC IACT PMT camera — •Alexander Hahn[1], Razmik Mirzoyan[1], Antonios Dettlaff[1], David Fink[1], Daniel Mazin[1,2], and Masahiro Teshima[1,2] — [1]Max Planck Institute for Physics, Munich, Germany — [2]Institute for Cosmic Ray Research, The University of Tokyo, Kashiwa City, Japan

All currently operating large Imaging Atmospheric Cherenkov Telescopes (IACTs), such as MAGIC, H.E.S.S., or VERITAS, or such as CTA's LST presently being commissioned, use photomultiplier tubes (PMTs) as primary light detectors. It has been shown that smaller IACTs such as FACT and ASTRI can operate with Silicon photomultipliers (SiPMs) instead. However, it is an open research question whether SiPMs may also be suitable as light detectors for large-scale IACTs. To address this question, we have built several SiPM-based prototype detector modules at the Max Planck Institute for Physics. The first module, based on SiPMs from Excelitas, was installed in the PMT-based MAGIC-I imaging camera in May 2015, while two more modules, one using SiPMs from Hamamatsu and another one from SensL, were installed in 2017. Since then, all these modules have been operated in parallel with the PMT camera. Here we present a multi-year in situ study of SiPMs and PMTs in an operational IACT and present a direct performance comparison between the two detector types.

T 18.3 Mon 17:00 POT/0351

nsb2: an open source tool for simulating Imaging Atmospheric Cherenkov Telescope Night Sky Background — •Gerrit Roellinghoff[1], Samuel Spencer[2,1], and Stefan Funk[1] for the H.E.S.S.-Collaboration — [1]Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen Centre for Astroparticle Physics, Nikolaus-Fiebiger-Str. 2, 91058 Erlangen, Germany — [2]Department of Physics, University of Oxford, Keble Rd, Oxford OX1 3RH, United Kingdom

As a result of being exposed to the night sky, Imaging Atmospheric Cherenkov Telescopes (IACTs) are sensitive to background illumination; all sources of illumination that are not Cherenkov light. This Night Sky Background (NSB) limits the operational time of IACTs, introduces systematic uncertainty and is a source of Data/Monte-Carlo mismatch. Building on software previously developed for H.E.S.S., we present an open source tool for the pixel-wise prediction of NSB in IACTs, simulating contributions from a variety of sources, such as starlight, moonlight and atmospheric glow. It allows for the computationally efficient prediction of NSB rates for a variety of IACT types, thus improving on Data/Simulation mismatch and enabling users to plan observations for IACTs during partial moonlight observations.

T 18.4 Mon 17:15 POT/0351

IceCube-Gen2: Optical module prototyping and performance studies — •Markus Dittmer and Alexander Kappes for the IceCube-Collaboration — Westfälische Wilhelms-Universität Münster

As the progression of IceCube continues, a novel optical module (OM) for IceCube-Gen2 is being developed, that incorporates lessons learned from the development of modules for IceCube Upgrade while adapting to the reduced borehole diameter. The presentation will provide a brief introduction to four (of many) aspects involved in the development of the Gen2OM prototype: The gel pad concept, which is key for performance and integrity, and related prototyping; photomultiplier studies; simulation studies for OM performance; and a method for estimating the module background caused by radioactive scintillation in the pressure vessel.

T 18.5 Mon 17:30 POT/0351

Acceptance Tests of 10,200 Photomultiplier Tubes for the mDOMs of the IceCube Upgrade — •Lasse Halve[1], Philipp Behrens[1], Erik Büchau[1], Maja Freienhofer[2], Tara Haji Azim[1], Joëlle Savelberg[1], Lars Schmidt[1], Lydia von der Weiden[2], Johannes Werthebach[2], and Christopher Wiebusch[1] for the IceCube-Collaboration — [1]RWTH Aachen University - Physics Institute III B, Aachen, Germany — [2]Astroparticle Physics WG Rhode, TU Dortmund University, Germany

More than 10,000 3-inch Photomultiplier Tubes (PMT) will be deployed in multi-PMT Digital Optical Modules (mDOM) of the IceCube Upgrade. Prior to integration of the PMTs into the modules, they need to be tested for compliance with specifications agreed upon with the manufacturer. For this purpose, two dedicated testing facilities have been constructed at RWTH Aachen University and TU Dortmund University. These facilities have been optimized for a large throughput of PMTs using highly automized and parallelized testing routines. All PMTs have undergone extensive acceptance tests including single-photon response and detection efficiency, time-resolution, background rates, high-voltage dependence and more. During testing, several deviations from the specifications were identified and could be mitigated prior to the mDOM production. We describe the design of the facilities, testing procedures, and results of the acceptance tests.

T 18.6 Mon 17:45 POT/0351

Validation Tests of 10,200 Photomultiplier Tubes for the IceCube Upgrade — •Tara Haji Azim, Philipp Behrens, Erik Büchau, Lasse Halve, Joëlle Savelberg, Lars Schmidt, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

The Upgrade of the IceCube Neutrino Observatory incorporates the installation of Photomultiplier Tubes (PMTs) as parts of advanced multi-PMT Digital Optical Modules (mDOMs). For this purpose, 10,200 of 3-inch PMTs were quality controlled prior to the commissioning phase at two facility sites, one at RWTH Aachen University and the other one at TU Dortmund University. All PMTs have undergone extensive acceptance tests including single-photon response, detection efficiency, time-resolution, background rates, high-voltage dependence, and more. In this talk, we will review selected results of the survey.

T 19: Detector Systems, Electronics

Time: Monday 16:30–17:45 Location: POT/0106

T 19.1 Mon 16:30 POT/0106

Development of a high temperature superconducting magnet for applications in space. — •Christian von Byern[1], Laurenz Klein[1], Daniel Louis[1], Tim Mulder[1,2], Irfan Özen[1], Stefan Schael[1], Thorsten Siedenburg[1], and Michael Wlochal[1] — [1]Physics Institute 1B, RWTH Aachen University — [2]CERN

While AMS-02 is currently operated on board of the International Space Station, the next generation of cosmic particle detector is already planned. AMS-100 will be operated at Lagrange Point 2 and will feature a geometric acceptance of 100m*sr. With this large acceptance and improved momentum resolution a measurement of cosmic rays up to the PeV scale will be possible and an improvement of factor 1000 regarding the sensitivity of anti-matter measurements is expected.

The magnetic field of the spectrometer will be generated by a High Temperature Superconducting (HTS) solenoid. This coil will include several layers of individual HTS tapes. The coil is operated at 55K, and it will produce a field of 0.5T at 10kA current. To reduce the material budget in terms of mass and interaction length the HTS tapes will be stabilized using few millimetres of aluminium. As an intermediate step a small demonstrator coil is in preparation. In this R&D phase multiple samples, including straight cable samples, meteoroid impacts samples as well as coil samples with a few windings are prepared and teste. In this talk measurement results of the different samples will be presented and discussed.

T 19.2 Mon 16:45 POT/0106

Development of a quench detection system based on optical fibres for the AMS-100 high temperature superconducting solenoid. — •Clemens Dittmar[1], Markus Gastens[2], Caroline Girmen[3], Stefan Schael[1], Thorsten Siedenburg[1], and Michael Wlochal[1] — [1]Physics Institute I B, RWTH Aachen, Germany — [2]Institute of Structural Mechanics and Lightweight Design SLA, RWTH Aachen, Germany — [3]Fraunhofer Institute for Production Technology IPT, Aachen, Germany

The magnetic spectrometer AMS-100, which includes a high temperature superconducting coil, is being designed to measure cosmic rays and detect cosmic antimatter in space. This extreme environment requires a suitable sensing solution to monitor critical changes in the solenoid structure, for example the beginning of a quench in the superconducting coil. Rayleigh scattering-based distributed optical fibre sensors (DOFS) fulfil the high requirements for these extreme conditions, as they are small and lightweight, can be used under cryogenic temperatures, are immune to electromagnetic interference and have sub-millimetre spatial resolution over long distances. The established application of using this system only allows a coupled measurement of mechanical and thermal signals, based on knowledge of the thermomechanical behaviour of the structure being measured. A precise calibration of the temperature and strain response of the optical fibre in the range of 77K to 350K was achieved and a measurement principle was developed to decouple the mechanical and thermal signals.

T 19.3 Mon 17:00 POT/0106

Development of a High-Current, Low-Voltage Remote Power Supply for the P2 Tracking Detector — •Lars Steffen Weinstock for the P2-Collaboration — PRISMA+ Cluster of Excellence and Institute of Nuclear Physics, Johannes Gutenberg University Mainz

The P2 experiment is planned for the Mainz Energy recovering Superconducting Accelerator (MESA), which is currently under construction. The goal of P2 is to determine the electroweak mixing angle with an unprecedented precision at low energy scales with by measuring the parity violating asymmetry in proton-electron scattering at low momentum transfer. A key parameter for the analysis, the electron momentum transfer during scattering, is measured by the P2 tracker, which is placed inside the 0.6 T solenoid spectrometer. The tracker utilises over 4000 High-Voltage Monolithic Active Pixel Sensors (HV-MAPS) each drawing about 500 mA at a supply voltage of 2 V. Due to the high amount of radiation as well as thermal and noise constraints, the power conversion was shifted from the front-end to the counting room at a distance of 30 meters to the detector using a remote-sense technique.

This talk gives an overview of the P2 experiment and the powering scheme of its tracking detector, as well as the current state of development of the remote power supply using a combination of physics (COMSOL) and electronics simulation (SPICE) to estimate the performance and stability of the supplied power.

T 19.4 Mon 17:15 POT/0106

DC-DC Converter Development for the Mu3e Experiment — •Sophie Gagneur for the Mu3e-Collaboration — Institut für Kernphysik , JGU Mainz

The Mu3e experiment under construction at the Paul Scherrer Institute, Switzerland, aims to search for the lepton flavour violating decay of a muon into one electron and two positrons with an ultimate sensitivity of one in 10^{16} muon decays. The Mu3e detector consists of High-Voltage Monolithic Active Pixel Sensors (HV-MAPS) for an accurate track and vertex reconstruction combined with scintillating tiles and fibres for precise timing measurements. The entire detector and front-end electronics are located in the 1m diameter bore of a 1T superconducting magnet. A compact power distribution system based on custom DC-DC converters provide the detector ASICs and readout FPGAs with supply voltages of 1.1V to 3.3V with currents up to 30A per channel. 126 converters are placed as close as possible to the detector and provide 9kW of power in total. The talk presents the development process of the Mu3e DCDC converters and the results of recent prototype tests.

T 19.5 Mon 17:30 POT/0106

FPC prototype tests and results for the ATLAS High Granularity Timing Detector Demonstrator — •Maria Soledad Robles Manzano[1], Andrea Brogna[2], Jan Ehrecke[1], Atila Kurt[2], Lucia Masetti[1], Jigar Patel[1], Binh Pham[2], Fabian Piermaier[2], Steffen Schoenfelder[2], Quirin Weitzel[2], and Patricia Theobald[2] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz — [2]PRISMA Detektorlabor, Johannes Gutenberg-Universität Mainz

The ATLAS detector requires upgrades to face the challenges of the new High Luminosity LHC, in particular the increase of pile-up interactions. The High-Granularity Timing Detector (HGTD) will be built in order to mitigate the effects of pile-up in the ATLAS forward region, providing time information with a resolution of about 30 ps per track. The active area consists of 2-double-sided disks per end-cap. The HGTD basic unit, so-called module, is made up of two 2x2 cm^2 Low Gain Avalanche Detectors bump-bonded to two ASICs and glued to a flexible PCB. The modules are connected to the Peripheral Electronics Boards, surrounding the active area, via a Flexible Printed Circuit (Flex tail) that serves as interconnection for power, communication signals and HV bias. A prototype of different lengths of the flex tail for a small scale, but full chain HGTD demonstrator has been produced and tested. The tests results of both electrical and mechanical performance of the prototype are presented.

T 20: Pixel ITk, Si-Strips/Other

Time: Monday 16:30–17:45 Location: WIL/A317

T 20.1 Mon 16:30 WIL/A317

ITk-Pixel Pre-production Sensor QA Measurements Including Testbeam — Jörn Grosse-Knetter, Arnulf Quadt, •Yusong Tian, and Hua Ye — II. Physikalisches Institut, Georg-August-Universität Göttingen

In the ATLAS detector upgrade for the High-Luminosity LHC (HL-LHC), the current Inner Detector will be upgraded to an all-silicon Inner Tracker (ITk), to operate under higher occupancy (instantaneous luminosity 7.5×10^{34} cm^{-2} s^{-1}, corresponding to approximately 200 inelastic $p\bar{p}$ collisions per bunch crossing) and radiation damage (fluence 2×10^{16} n_{eq}/cm^2). The data taking is planned to start in 2029 and last for 10 years. The pixel detector is the inner-most layer of the ITk, it consists of modules equipped with planar or 3D sensors, and is currently in the pre-production stage. To be assured that specifications will be met during production, sensors from different vendors were sent to different ITk sites for testing, and some modules were assembled for beam test. This talk shows ITkPix pre-production planar sensor quality assurance (QA) measurements and testbeam.

T 20.2 Mon 16:45 WIL/A317

ATLAS ITk Module Testing Quality Control — •Yannick Dieter, Fabian Hügging, Florian Hinterkeuser, Hans Krüger, Maximilian Mucha, Matthias Schüssler, Thomas Senger, and Jochen Dingfelder — Physikalisches Institut der Universität Bonn

With the upgrade of the Large Hadron Collider (LHC) to the High-Luminosity LHC (HL-LHC), the instantaneous luminosity will increase by a factor of 5 with respect to its design value from 2029 onward. The resulting unprecedented hit rates and radiation levels require major upgrades of the detectors located at the HL-LHC to meet the new challenging requirements.

For the upgrade of the ATLAS detector, a new all-silicon inner tracking detector (ITk detector) consisting of silicon strip and pixel modules will be installed to replace the currently operated Inner Detector. In total, approximately 10 000 new pixel detector modules have to be built and tested carefully to ensure that only fully functional detector modules are installed. Approximately 1000 pixel detector modules will be built and tested at the Forschungs- und Technologiezentrum Detektorphysik (FTD) in Bonn during the production of the ATLAS ITk pixel detector. For testing the electrical functionality of the detector modules an intensive quality control (QC) with dedicated testing setups was developed.

This talk gives an overview of the electrical QC for ATLAS ITk pixel detector modules in Bonn, with a focus on the newly developed test setup and first testing results.

T 20.3 Mon 17:00 WIL/A317

Status update of the Cell Integration Site for ATLAS ITk Pixel Detector in Bonn — •Alexandra Wald, Klaus Desch, Matthias Hamer, Florian Hinterkeuser, Fabian Hügging, and Hans Krüger for the ATLAS-Collaboration — Physikalisches Institut, University of Bonn, Germany

In conjunction with the high luminosity upgrade of the Large Hadron Collider (HL-LHC) at CERN, the current tracking system of the ATLAS experiment will be replaced by the Inner Tracker (ITk), an all-silicon detector consisting of 5 layers of pixel detectors and 4 layers of strip detectors. More than 8000 modules are installed in the pixel layers, which together have an active area of approx. 13m^2 and cover a pseudorapidity of up to 4. In order to built such a large detector in time, the integration of the ITk Pixel modules on their local support structures, as well as the quality control of individual loaded local supports will be distributed over many institutes. One of the assembly lines for loaded local supports will be setup at the University of Bonn. Due to the powering scheme of the ITk Pixel Detector, the quality control of a loaded local support is challenging in several aspects: loaded modules cannot be tested standalone, as the implemented serial powering scheme only allows for the simultaneous operation of a significant fraction of all modules on a loaded local support. In this presentation, the current status of the cell integration line in Bonn is presented, with a particular focus on the data acquisition infrastructure required for the QC setup, which is based on a FELIX server (Front-End LInk eXchange).

T 20.4 Mon 17:15 WIL/A317

Commissioning and Testing of a QC-Setup for the ATLAS ITK-Pixel Outer Barrel Bare Cell — •Nico Klein[1], Matthias Hamer[1], Klaus Desch[1], Florian Hinterkeuser[1], Diego Alvarez Feito[2], Alexandre Lacroix[2], and Nicola Pacifico[2] — [1]Universität Bonn — [2]CERN

The high-luminosity upgrade of the Large Hadron Collider at CERN requires a complete redesign of the current tracking detector of the ATLAS experiment. The new Inner Tracker, the ITk Detector, will consist of a silicon pixel detector and a silicon strip detector. The ITk Pixel Detector is divided into three subsystems, the Outer Barrel (OB), Outer Endcaps and Inner System. In the OB, modules are loaded on cells (pyrolytic graphic tiles that are glued to an aluminum-graphite cooling block) before they are mounted on the local supports. These cells play a crucial role in the thermal performance of the modules, as they provide the connection between the modules and the cooling system. In order to meet the demanding requirements that are placed on the cooling system of the ITk Pixel Detector, bare cells must be tested for their thermal conductivity before silicon modules are loaded onto them. In this contribution, a setup for the thermal quality control of the bare cells is presented, as well as measurements of the thermal performance of prototype cells with this setup.

T 20.5 Mon 17:30 WIL/A317

Humidity Studies on Silicon Strip Sensors — •Ilona-Stefana Ninca — Deutsches Elektronen-Synchrotron (DESY), Zeuthen, Germany

Silicon strip sensors for the ATLAS Upgrade showed a strong dependence of the breakdown voltage on varying levels of relative humidity. This study aims to investigate the same behavior on test structures that are produced on "half moons" of the same wafers as the sensors. The test structures are first imaged in breakdown conditions: high bias voltage and 20% - 50% relative humidity. Using an infrared camera the location of the avalanche breakdown on the surface of the test structures was captured. Afterwards, the test structures are investigated using the transient current technique (TCT). The region of the avalanche breakdown is investigated in the TCT setup by scanning a focused, pulsed 660 nm laser beam along the surface of the test structure and recording the resulting current transients. Using the TCT data, the electric field at the breakdown point can be estimated. In the future, hopefully with a better understanding of the origin of the humidity sensitivity we wish to be able to propose changes for new sensors reducing the humidity impact.

T 21: Si-Strips/CMS, Pixel/Sensor

Time: Monday 16:30–18:00 Location: WIL/A124

T 21.1 Mon 16:30 WIL/A124

Stress testing optical readout components for CMS 2S modules — Max Beckers[2], •Christian Dziwok[2], Lutz Feld[1], Katja Klein[1], Alexander Pauls[1], Oliver Pooth[2], Nicolas Röwert[1], Martin Lipinski[1], Vanessa Oppenländer[1], Felix Thurn[1], and Tim Ziemons[2] — [1]I. Physikalisches Institut B, RWTH Aachen University, D-52056 Aachen — [2]III. Physikalisches Institut B, RWTH Aachen University

New detector modules will be installed for the upcoming CMS Phase-2 Outer Tracker upgrade. There are two general types of modules, one consisting of two co-planar silicon strip sensors (2S) and one of a macro pixel and a strip sensor (PS). The communication and the auxiliary support are supplied by a so-called SErvice Hybrid (SEH) in the case of a 2S module. It houses a two-stage DC-DC converter and a Low-Power Gigabit Transceiver (lpGBT). At the RWTH Aachen University, the SEHs are qualified regarding power and communication stability in a so-called test board setup, where the SEHs will undergo additional thermal cycling while being tested. A Field-Programmable Gate Array (FPGA) firmware was developed for the integrated testing routines, like a Bit Error Rate Testing (BERT) of the lpGBT's connections. This talk will focus on the data tests of this setup.

T 21.2 Mon 16:45 WIL/A124

Thermal Measurements of 2S Modules with an evaporative CO_2 Cooling System for the CMS Phase-2 Outer Tracker Upgrade — Christian Dziwok[2], Lutz Feld[1], Katja Klein[1], Martin Lipinski[1], •Vanessa Oppenländer[1], Alexander Pauls[1], Oliver Pooth[2], Nicolas Röwert[1], Michael Wlochal[1], and Tim Ziemons[2] — [1]1. Physikalisches Institut B, RWTH Aachen — [2]3. Physikalisches Institut B, RWTH Aachen

The new operating conditions of the future HL-LHC require a replacement of the complete silicon tracking system of the CMS experiment as part of the CMS Phase-2 Upgrade. For the Phase-2 Outer Tracker new silicon strip modules, so-called 2S modules, are being developed that consist of two silicon sensors stacked on top of each other. The high radiation conditions of the HL-LHC lead to a higher leakage current in the silicon sensors, which is exponentially dependent on the sensor temperature. An evaporative CO_2 cooling system will be used to cool the modules and ensure a successful operation. In an unstable cooling scenario it is possible that the module enters an uncontrolled self-heating loop called thermal runaway. Therefore it is crucial that the thermal properties and performance of the 2S modules and the cooling structure are tested and characterized. In this talk measurements with a test setup of 2S modules on a cooling structure using a custom CO_2 cooling system will be presented.

T 21.3 Mon 17:00 WIL/A124

Integration Tests with 2S Module Prototypes for the Phase-2 Upgrade of the CMS Outer Tracker — •Lea Stockmeier, Bernd Berger, Alexander Dierlamm, Ulrich Husemann, Markus Klute, Roland Koppenhöfer, Stefan Maier, Hans Jürgen Simonis, and Pia Steck — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

To deal with the increased luminosity of the HL-LHC, the CMS experiment will be upgraded until 2028. During this Phase-2 Upgrade, the CMS Outer Tracker will be equipped with modules each assembled with two silicon sensors. Depending on the position in the tracker, these silicon sensors are pixel or strip sensors. The modules with two strip sensors are called 2S modules. In the barrel region, they are placed on mechanical structures called ladders. A fully equipped ladder contains twelve modules.

During the prototyping phase of the modules, integration tests are performed with the purpose to test the module functionality on the final detector structures. Investigations focus on the cooling performance as well as on electrical performance of the modules on the supporting structures.

This talk summarizes integration tests with 2S modules on ladders performed at CERN and Institut Pluridisciplinaire Hubert Curien (Strasbourg) in cooperation with other CMS working groups.

T 21.4 Mon 17:15 WIL/A124

Investigations of a BiCOMS Pixel Sensor — André Schöning[1], Heiko Augustin[1], Ivan Peric[2], and •Benjamin Weinläder[1] — [1]Physikalisches Institut, Universität Heidelberg — [2]IPE, Karlsruher Institut für Technologie

In the field of particle physics, High Voltage Monolithic Active Pixel Sensors (HV-MAPS) are promising candidates to fulfil the high demands on spatial and time resolution of modern detectors. A new generation of sensors, which combines the HV-MAPS architecture with a BiCMOS technology, opens new possibilities for faster timing in the sub-nanosecond regime.

The BeBiPix is a small test chip to investigate the aforementioned potentials. It is a fully analog sensor featuring two 3×3 pixel matrices with pixel sizes of $41 \times 41\,\mu\mathrm{m}^2$ and $81 \times 81\,\mu\mathrm{m}^2$. During the ongoing testing phase several problems occurred, making an in-depth characterisation difficult. Identified problems such as an early break down at $\sim 10\,\mathrm{V}$ and a weak amplifier feedback are isolated and reproduced in simulations.

T 21.5 Mon 17:30 WIL/A124

Study of diffusion in small pixel sensors — •Amala Augusthy[1], Daniel Pitzl[2], Erika Garutti[1], Jörn Schwandt[1], and Tilman Rohe[3] — [1]Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Deutschland — [2]Deutsches Elektronen-Synchrotron, Notkestraße 85, 22607 Hamburg, Deutschland — [3]Paul Scherrer Institute, 5232 Villigen PSI, Switzerland

Pixel sensors are widely used in the CMS experiment for tracking. From 2025 to 2027, the LHC will undergo the high luminosity upgrade where the beam luminosity will be increased to about 7.5 x $10^{34} cm^{-2} s^{-1}$. To maintain high tracking efficiencies under such an extreme radiation environment, pixel sensors of smaller pitches will be used for tracking. However, as the pixel pitch is reduced, charge sharing effects like diffusion start to play an important role in determining the resolution of these sensors.

To investigate the effects of diffusion, measurements were performed on non-irradiated pixel sensors of sizes 50 x 50 μm^2 , 25 x 100 μm^2 and 17 x 150 μm^2 using 5.2 GeV electron beam at the DESY test beam facility. These sensors have a thickness of 285 μm and are bump bonded to low noise read-out chip ROC4SENS. From these measurements, the spatial resolution, cluster size and efficiency as a function of sensor bias and incidence angle of the beam were extracted. These results are then compared to simulation. The simulations were performed using PIXELAV and Synopsys TCAD. In this talk, the results of these measurements will be presented.

T 21.6 Mon 17:45 WIL/A124

guard ring optimisation for passive-CMOS pixel sensors — •Sinuo Zhang[1], Tomasz Hemperek[2], and Jochen Dingfelder[1] — [1]Physikalisches Institut, Universität Bonn, Germany — [2]Dectris, Switzerland

In high energy physics, the silicon pixel sensors manufactured in commercial CMOS chip fabrication lines have been proven to have good radiation hardness and spatial resolution. Along with the mature manufacturing techniques and the potential of large throughput provided by the foundries, the so-called "passive CMOS" sensor has become an interesting alternative to standard planer sensors.

High and predictable breakdown behaviour is a major design goal for sensors and the guard-ring structure is one factor to optimise. This is especially important for applications that require higher voltages.

In this talk we discuss the influence of the guard ring design on the breakdown voltage based on measurements and TCAD simulations. Results has shown that a more uniform potential distribution across the guard rings can be achieved by implementing deep n-well for guard ring structures, and reveals a higher breakdown voltage. Simulations has provided a potential way to reduce the size of the guard ring structures without limiting the breakdown performance.

T 22: Calorimeter / Detector Systems I

Time: Monday 16:30–18:00 Location: WIL/C133

T 22.1 Mon 16:30 WIL/C133

Bitwise Optimization of Artificial Neural Networks for the Energy Reconstruction of ATLAS Liquid-Argon Calorimeter Signals — •Alexander Lettau, Anne-Sophie Berthold, Nick Fritzsche, Christian Gutsche, Arno Straessner, and Johann Christoph Voigt — Institut für Kern- und Teilchenphysik, Dresden, Deutschland

The LHC will be upgraded to become the High-Luminosity-LHC, with significantly increased numbers of simultaneous particle collisions. With this upgrade, up to 200 pile-up events are expected within one bunch crossing. To cope with that, processing of the signals of the Liquid-Argon Calorimeter will need to be improved, because conventional algorithms are expected to lose performance. Artifical neural networks provide one way to deal with this. It has been shown, that convolutional neural networks are able to detect signals and reconstruct their energy with good performance. These networks are planned to be executed on Field Programmable Gate Arrays (FPGA) which have limited resources in signal, processing units, logic and memory. This talk will deal with the quantization of neural networks, a technique to reduce the resources needed for neural networks, by reducing the precision of the weights, biases and activations, while keeping the performance.

T 22.2 Mon 16:45 WIL/C133

Artificial Neural Networks for the Energy Reconstruction of ATLAS Liquid-Argon Calorimeter Signals — •Anne-Sophie Berthold, Nick Fritzsche, Christian Gutsche, Alexander Lettau, Arno Straessner, Johann Christoph Voigt, and Philipp Welle — Institut für Kern- und Teilchenphysik, Dresden, Deutschland

From 2029 on, the enhanced performance of the High-Luminosity LHC will increase the number of simultaneous proton-proton collisions at the ATLAS detector considerably. In order to cope with that, the so-called Phase-II upgrade is planned. Up to 200 pile-up events will emerge within one bunch crossing, which is why one important part of this upgrade will be the processing of the Liquid-Argon Calorimeter signals. It has been shown that the conventional, optimal filtering signal processing will loose its performance due to the increase of overlapping signals and a trigger scheme with trigger accept signals in each LHC bunch crossing. That is why more sophisticated algorithms such as neural networks come into focus. This talk deals with the application of convolutional neural networks, which on the one hand need to perform well under varying signal conditions and on the other hand need to satisfy tight resource restrictions. Different network architectures are compared. A scoring, which is visualized in a spider diagram, is introduced to evaluate the network performance with respect to different scenarios.

T 22.3 Mon 17:00 WIL/C133

Automated Photon Energy Resolution Calibration at Belle II — •Alexander Heidelbach and Torben Ferber — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

At the Belle II experiment in Tsukuba, Japan, the electromagnetic calorimeter is used to measure the energy of photons in e^+e^- collisions. The utilization of physical observables, like the invariant mass, from measured quantities, requires precise knowledge of the uncertainties on the components of the four-momentum. To account for uncertainties of these components, the determination of the full covariance matrix is crucial. This matrix stores the variances and covariances of the differences between reconstructed and generated four-momentum vector components for data, respectively MC. At Belle II, in the case of photons, the entries of the photon covariance matrix are determined with the help of radiative dimuon decays $e^+e^- \to \mu^+\mu^-\gamma$. This talk presents the studies on the radiative dimuon decay which are used to extract the photon energy resolution from data. Additionally, it discusses the current efforts to automatize the extraction procedure for run-dependent data and the implementation into the Belle II Analysis Software Framework.

T 22.4 Mon 17:15 WIL/C133

Testbeam Performance and Light Yields of Prototype Cell for the SHiP SBT — •Fairhurst Lyons for the SHiP-SBT-Collaboration — University of Freiburg

We present R&D towards a large-area detector for energy reconstruction and tracking, which consists of many individual cells filled with liquid scintillator. Each cell is equipped with two wavelength-shifting optical modules (WOMs) that capture scintillation light and transfer it to silicon photomultipliers. This design could serve as the surrounding background tagger (SBT) of the proposed Search for Hidden Particles (SHiP) experiment, a general-purpose detector housed at the CERN SPS accelerator to search for light, feebly interacting particles. One such cell was tested at the DESY e^- testbeam in October 2022; analysis of performance and light yields will be presented here. This work is funded by the Federal Ministry of Education and Research.

T 22.5 Mon 17:30 WIL/C133

Spatial information on particles crossing through a WOM-SiPM based liquid scintillator — •Constantin Eckardt for the SHiP-SBT-Collaboration — Humboldt Universität zu Berlin, Berlin, Germany

The proposed option of the SHiP surround background tagger is based on detector cells filled with liquid scintillator that are equipped with two wavelength-shifting optical modules (WOMs). A WOM is a light-guiding tube coated with a UV light-absorbing paint that emits secondary photons in the visible spectrum. By total internal reflection inside the tube walls, these photons are guided to the actual photon detector, which in this case is made of a ring array of silicon photomultipliers coupled to one end of the tube. We study the light yield distribution over the SiPMs in this ring array in a test detector equipped with one WOM as a function of the track position of cosmic muons. The possibility to obtain spatial information about this track position from the light yield distribution on the SiPM array with different optical coupling schemes between the WOM tube and the SiPM ring array is investigated.

T 22.6 Mon 17:45 WIL/C133

position reconstruction in a protoype cell of the SHiP surround background tagger — •Mahyar Jadidi for the SHiP-SBT-Collaboration — Albert Ludwigs Universität Freiburg, Freiburg im Breisgau, Germany

The future SHiP experiment at CERN aims for the discovery of long lived heavy neutral particles in a zero background experiment. To reach this challenging goal, its decay volume is surrounded by an active layer of the liquid scintillator (LAB), consisting of cells of about 1 square meter surface area. Each cell is equipped with two wavelength-shifting optical modules (WOMs) to collect the scintillation light. At each WOM, the collected light is detected by 40 silicon photomultipliers (SiPMs) arranged in a circle. With the help of a neural network, the time and the amplitude information from the SiPMs are used to reconstruct the position and possibly the direction of the particles passing the cell. First results on the position resolution measured in the test beam campaign at DESY in Fall 2022 and a comparison to Monte Carlo simulations will be presented.

T 23: Gas-Detectors / Muon MDT

Time: Monday 16:30–18:00 Location: WIL/A120

T 23.1 Mon 16:30 WIL/A120

Production and testing of Resistive Plate Chambers (RPCs) — •Timur Turkovic, Oliver Kortner, Daniel Soyk, and Hubert Kroha — Max Planck Institut für Physik

Resistive plate chambers (RPCs) with electrodes of high-pressure phenolic laminate (HPL) and small gas gap widths down to 1 mm provide a relatively low cost detector for large area tracking in ATLAS, that still grants high rate capability and fast response with an excellent time resolution of better than 500 ps. They can be operated up to γ background count rates of 10 kHz/cm2, which is five times the maximum rate these RPCs will encounter in the innermost layer of the barrel muon spectrometer of the ATLAS detector, where they will be installed in the phase-II upgrade for the HL-LHC operation. Production procedures that were previously developed in the lab have been transferred to several companies of which each produced first test samples. The quality of these samples was tested by measuring the voltage-current curves and the muon detection efficiency with cosmic muons.

T 23.2 Mon 16:45 WIL/A120

Study of the muon detection efficiency of thin-gap RPCs — •Nayana Bangaru, Oliver Kortner, Hubert Kroha, and Timur Turkovic — MPI für Physik, München, Deutschland

Resistive plate chambers (RPC) with small gaps between electrodes of high-pressure phenolic laminate offer excellent time resolution of better than 500 ps and cm position resolution . Thin-gap RPCs with a gas gap of 1 mm will be used for the phase II upgrade of the ATLAS muon spectrometer. The muon hit positions will computed from he signals induced on 30 mm wide pick-up strips. In order to obtain a muon detection efficiency >99%, very sensitvie amplifiers have to be used. We studied the dependence of the muon detection efficiency of thin-gap RPCs on the applied operating voltage with two different amplifier options: the ATLAS thin-gap RPCs and an alternative circuit using commercial high-performance transimpedance amplifiers from Texas Instruments. In this contribution we will introduce the two amplifiers and present the results of our efficiency measurements

T 23.3 Mon 17:00 WIL/A120

Finding eco-friendly alternatives for highly potent greenhouse gases in drift chambers — •Ines Hannen, Thomas Radermacher, Stefan Roth, David Smyczek, and Nick Thamm — RWTH Aachen University - Physics Institute III B, Aachen, Germany

Climate change poses an immense challenge to mankind. Drift chambers used in high-energy physics are often filled with highly potent greenhouse gases. To find an alternative to these, simulations on drift gas properties and energy deposition are performed. Important drift gas parameters, simulations and criteria to find eco-friendly alternatives are presented. The focus lies on Argon based drift gases as used for example in the time projection chambers of the T2K experiment.

T 23.4 Mon 17:15 WIL/A120

Quality Control in the Construction of new small-diameter Muon Drift Tube (sMDT) Chambers for the ATLAS Muon Spectrometer at the HL-LHC — •Daniel Buchin, Alice Reed, Marian Rendel, Patrick Rieck, Elena Voevodina, Oliver Kortner, and Hubert Kroha — Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), München

In order to improve the muon trigger efficiency and the rate capability of the ATLAS muon detectors for operation at the high luminosity upgrade of the Large Hadron Collider (HL-LHC), the Monitored Drift Tube (MDT) tracking chambers in the inner barrel layer of the ATLAS Muon Spectrometer will be replaced by small-diameter Muon Drift Tube (sMDT) chambers integrated with new thin-gap RPC trigger chambers.

The sMDT chambers are in serial production since January 2021. The serial production involves a stringent quality control program to assure the reliability and high mechanical precision of the chambers. In the talk, this program will be presented. It includes tests of the individual drift tubes and several mechanical measurements on the sMDT chambers. Also, the dedicated quality control database and monitoring web interface will be discussed.

T 23.5 Mon 17:30 WIL/A120

Construction of new small-diameter Monitored Drift Tube (sMDT) chambers for the HL-LHC upgrade of the ATLAS Muonspectrometer — •Alice Reed, Daniel Buchin, Marian Rendel, Patrick Rieck, Elena Voevodina, Oliver Kortner, and Hubert Kroha — Max Planck Institut für Physik (Werner-Heisenberg-Institut), München

In order to improve the muon trigger efficiency and the rate capability of the ATLAS muon detectors for operation at the high-luminosity upgrade of the Large Hadron Collider (HL-LHC), the Monitored Drift Tube (MDT) chambers in the inner barrel layer of the ATLAS Muon Spectrometer will be replaced by small-diameter Muon Drift Tube (sMDT) chambers integrated with new thin-gap RPC trigger chambers. The sMDT chambers fit, together with the RPCs, into the very tight available space and provide an order of magnitude higher background rate capability compared to the current detectors.

The sMDT chambers have been in serial production since January 2021. In this talk, the steps for the drift tube production and chamber construction will be presented, followed by a discussion of the cosmic muon tests used for the final chamber certification.

T 23.6 Mon 17:45 WIL/A120

Impact of environmental pressure and temperature variations on triple-GEM detector gas gain — •Francesco Ivone, Thomas Hebbeker, Kerstin Hoepfner, Giovanni Mocellin, and Shawn Zaleski — III. Physikalisches Institut A, RWTH Aachen University

The GEM (Gas Electron Multiplier) technology has been widely adopted for muon detection in high energy physics experiments, for both tracking and triggering, as well as in other application areas.

The GEM gas electron amplification factor depends on the gas properties: mainly the mixture, the temperature and the pressure. While the gas mixture is finely controllable, the gas temperature and pressure are influenced by the fluctuations of the environmental parameters. Correcting for such variations is therefore crucial to maintain stable operating conditions or to compare performance measured in different conditions. In this contribution we describe the dependence of triple-GEM gas gain on temperature and pressure for three different gas mixtures. The study is based on experimental data, supported by simulations.

T 24: Invited Overview Talks II

Time: Tuesday 11:00–12:30 Location: HSZ/AUDI

Invited Talk T 24.1 Tue 11:00 HSZ/AUDI
Searching for Long-Lived Particles at the LHC and Beyond — •Juliette Alimena — DESY, Hamburg
Particles beyond the standard model (SM) can generically have lifetimes that are long compared to SM particles at the weak scale. When produced at experiments such as the Large Hadron Collider (LHC) at CERN, these long-lived particles (LLPs) can decay far from the interaction vertex of the primary proton-proton collision. Such LLP signatures are distinct from those of promptly decaying particles that are targeted by the majority of searches for new physics at the LHC, often requiring customized techniques to identify, for example, significantly displaced decay vertices, tracks with atypical properties, and short track segments. In this talk, I will present the latest searches for LLPs at the LHC and other experiments and then give my view of where the field will go in the future.

Invited Talk T 24.2 Tue 11:30 HSZ/AUDI
The Neutrino-Dawn of Galaxies — •Wolfgang Rhode — Fakultät Physik, TU Dortmund
For decades, generations of underground detectors have been opening more and more the window to the neutrino sky. Quickly, the background shine of atmospheric neutrinos could be separated from the bright light of atmospheric muons. Ten years ago, astrophysical neutrinos' first faint isotropic glow was detected. After a brief gamma-flare of TXS 0506+056 in 2017, which coincided with a matching high-energy neutrino, it now appears that a time-independent neutrino signal from galaxies is finally arising: NGC 1068 in muon neutrinos and our Galaxy in cascading neutrino events of all flavors. The potential of neutrino telescopes is simultaneously being exploited to investigate several other important physical or methodological questions. The status of these questions will be reported. In addition, it is discussed what steps one needs to take in the future to look at the neutrino sky in detail - and to answer the fundamental physics questions involved.

Invited Talk T 24.3 Tue 12:00 HSZ/AUDI
Galactic cosmic rays: What have we learned and what's next? — •Philipp Mertsch — Institute for Theoretical Particle Physics and Cosmology (TTK), RWTH Aachen University, Sommerfeldstr. 16, 52074 Aachen, Germany
Cosmic rays constitute an important ingredient in the galactic ecosystem and hold lessons beyond the Milky Way, for instance in regulating galaxy formation and evolution. In addition, cosmic rays lend themselves to searches for new physics, like dark matter or primordial antimatter. All of these studies, however, require answering the century-old question of cosmic ray origin. Over the last ten years, there has been an abundance of new data from space-based experiments like AMS-02, CALET and DAMPE. Modelling of these data allow inferences on the various types of cosmic ray sources and the conditions determining their transport, for instance galactic magnetic fields. What emerges is a rather complex picture and thus existing models need to be revised, if not completely overhauled. I will highlight the lessons learned and discuss the open questions and what kind of instrumentation is required for answering them.

T 25: Flavor II

Time: Tuesday 17:00–18:30 Location: HSZ/0304

T 25.1 Tue 17:00 HSZ/0304
Observation of $B_s^0 \to D^{*+}D^{*-}$ and *CP* violation studies in $B^0 \to D^{*+}D^{*-}$ with the LHCb experiment — Johannes Albrecht, Sophie Hollitt, and •Jan Langer — TU Dortmund University, Dortmund, Germany
At the LHCb experiment, precision measurements are performed to search for physics beyond the Standard Model. One important area of interest is the field of CP violation. This includes direct measurements of CP violation in decays of neutral B mesons as well as the determination of branching fractions to constrain higher order effects in such measurements.

The $B_s^0 \to D^{*+}D^{*-}$ decay was observed with a high significance and its branching fraction was measured relative to the $B^0 \to D^{*+}D^{*-}$ decay. Further, the *CP* violation parameter $\sin(2\beta)$ can be measured by exploiting $b \to c\bar{c}d$ transitions in $B^0 \to D^{*+}D^{*-}$ decays, where the phases arise through the interference between the direct decay of the B^0 meson and the decay after mixing. Due to the topology of the decay, an angular analysis is required.

In this talk, the observation of the $B_s^0 \to D^{*+}D^{*-}$ decay and the current status of the *CP* violation measurement in $B^0 \to D^{*+}D^{*-}$ are presented.

T 25.2 Tue 17:15 HSZ/0304
Search for the $B^0 \to D^0\bar{D}^0$ decay with the LHCb experiment. — Johannes Albrecht, Sophie Hollitt, and •Jonah Blank — TU Dortmund University, Dortmund, Germany
With precise measurements of B-meson decays the LHCb experiment can test the integrity of the Standard Model. In particular $B \to DD$ decays are interesting to examine CP violation. While decays to charged $D^{\pm}$ mesons have already been well measured, the $B^0 \to D^0\bar{D}^0$ decay channel has not yet been observed by any experiment. The branching ratio of this decay mode is a key input to the theoretical prediction of its CP-asymmetry as well as the properties of other doubly charmed decays.
In the analysis presented in this talk, data collected by the LHCb experiment at $\sqrt{s} = 7, 8$ TeV and 13 TeV, corresponding to an integrated luminosity of 9 fb^{-1} is used to search for the $B^0 \to D^0\bar{D}^0$ decay. The $B^0 \to \bar{D}^0\pi^+\pi^-$ decay channel is used as a normalisation mode to cancel systematic uncertainties. The current status of the analysis will be presented.

T 25.3 Tue 17:30 HSZ/0304
Belle II measurement of $B^+ \to K^+\pi^0$ and $B^+ \to \pi^+\pi^0$ decays — •Justin Skorupa, Thibaud Humair, Hans-Günther Moser, Markus Reif, Oskar Tittel, and Benedikt Wach — Max Planck Institute for Physics, Munich, Germany
Charmless hadronic B-meson decays provide sensitive probes for physics beyond the Standard Model, since the contribution of penguin decay amplitudes to their decay is non-negligible. Exploiting isospin symmetry between charmless hadronic B-meson decays allows the construction of null tests of the Standard Model with an accuracy of better than 1%. Moreover, they allow to determine the angle α of the unitary triangle associated with B-meson decays. The Belle II experiment at the SuperKEKB e+ e- accelerator in Tsukuba, Japan, has the unique capability to measure all relevant final states to determine the angle α and to study all isospin-related decays necessary to set stringent limits on null tests. In this talk, a measurement of the decays $B^+ \to K^+\pi^0$ and $B^+ \to \pi^+\pi^0$ using Belle II data is presented.

T 25.4 Tue 17:45 HSZ/0304
On the contribution of the electromagnetic dipole operator to the $B_s \to \mu^+\mu^-$ decay amplitude — Thorsten Feldmann, Nico Gubernari, Tobias Huber, and •Nicolas Seitz — Center for Particle Physics Siegen, Theoretische Teilchenphysik, Universität Siegen
We report on the construction of a factorization theorem that allows to systematically include QCD corrections to the contribution of the electromagnetic dipole operator O_7 to the $\bar{B}_s \to \mu^+\mu^-$ decay amplitude. We elaborate on how the occurring endpoint divergences appearing in individual momentum regions cancel, and show how the resulting rapidity logarithms can be isolated by suitable subtractions applied to the corresponding bare factorization theorem. This allows to include in a straightforward manner the QCD corrections arising from the renormalization-group running of the hard matching coefficient, the hard-collinear scattering kernel, and the B_s-meson distribution amplitude. We estimate the effect numerically using a recently advocated parameterization of the B_s-meson light-cone distribution amplitude.

T 25.5 Tue 18:00 HSZ/0304
enhancing Bs to e+e- to an observable level — •Gilberto Tetlalmatzi-Xolocotzi — Siegen University, Siegen, Germany
As a result of the helicity suppression effect, within the Standard Model the rare decay channel $B_s\rightarrow e^+e^-$ has a decay probability which is extremely suppressed, being five orders of magnitude below current experimental limits. Thus, any observation of this channel within the current or forthcoming experiments will give unambiguous evidence of Physics Beyond the Standard Model. In this work, we present for the first time a New Physics scenario in which the branching fraction $\mathcal{B}r(B_s\rightarrow e^+ e^-)$ is enhanced up to values which saturate the current experimental bounds. More concretely, we study the general Two-Higgs-Doublet Model (2HDM) with a pseudoscalar coupling to electrons unsuppressed by the electron mass. Furthermore, we demonstrate how this scenario can arise from a UV-complete theory of quark-lepton unification that can live at a low scale.

T 25.6 Tue 18:15 HSZ/0304

Analysis of $B \rightarrow \mu\nu$ with inclusive tagging at Belle II — Florian Bernlochner, Jochen Dingfelder, •Daniel Jacobi, Peter Lewis, and Markus Prim for the Belle II-Collaboration — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

$B\overline{B}$ meson pairs are the dominant decay products of the $\Upsilon(4S)$ resonance, which is produced in large amounts in e^+e^- collisions at the SuperKEKB collider in Japan, and their decays are measured by the Belle II experiment. Leptonic B meson decays such as $B \rightarrow \mu\nu$ are highly CKM- and helicity-suppressed. In a two-body decay like $B \rightarrow \mu\nu$, the muon momentum is exactly known in the rest frame of the signal-side B meson. By boosting the signal-side muon into that frame, a better signal resolution and improved sensitivity can thus be achieved compared to the center-of-mass frame. This requires a high-precision for the boost vector, which can be determined from the rest of the event that contains the decay products of the second B meson. At the same time, this information can be used to reconstruct the kinematics of the signal-side B meson. Boosted decision trees are trained to deal with model discrepancies, suppress background and increase signal purity. The hadronic $B^- \rightarrow D^0[\rightarrow K^-\pi^+]\pi^-$ decay can be used to validate different steps in the analysis of the $B \rightarrow \mu\nu$ decay. This talk will discuss the current status of the analysis for the measurement of the $B \rightarrow \mu\nu$ branching fraction with an integrated luminosity of 364 fb^{-1} at the Belle II experiment.

T 26: Flavor III

Time: Tuesday 17:00–18:30 Location: HSZ/0401

T 26.1 Tue 17:00 HSZ/0401

Multi-lepton B decays within the Standard Model and their impact on LHCb analysis — Johannes Albrecht, Emmanuel Stamou, Vitalii Lisovskyi, and •Jan Peter Herdieckerhoff — TU Dortmund University, Dortmund, Germany

Rare flavour-changing neutral current decays of hadrons to multi-lepton final states are sensitive probes of the Standard Model and thus among the target measurements at LHCb. A reliable Standard Model prediction of their rates is an essential input for the realistic simulation within the LHCb analyses and even more so when analysing decays with non-trivial angular and q^2 dependence.
One such analysis is the most recent search of $B^0_{(s)} \rightarrow \mu^+\mu^-\mu^+\mu^-$ performed by the LHCb experiment and published in 2022. The main systematic uncertainty in this search comes from the missing Standard Model prediction. So far, only a simplified phase-space approach was used to simulate signal candidates in the LHCb analysis.
In this talk, we present the computation and results of the Standard Model prediction of the decay $B^0_s \rightarrow \mu^+\mu^-\mu^+\mu^-$, and its implementation in the simulation framework `EvtGen`. The impact of this calculation on the LHCb analysis is also evaluated.

T 26.2 Tue 17:15 HSZ/0401

Tests of muon-electron universality at the LHCb experiment — •Alex Seuthe and Johannes Albrecht — TU Dortmund University, Dortmund, Germany

The LHCb experiment at the Large Hadron Collider (LHC) specialised in high-precision measurements of flavour physics with hadrons containing b and c quarks. Tests of lepton flavour universality are a sensitive and clean way to probe the Standard Model of particle physics. Any deviations from this universality would be a clear sign of new physics. In this talk, I will present the first simultaneous test of muon-electron universality using the full LHCb Run 1 and Run 2 dataset with the observables R_{K^*} and R_K. These observables are defined as ratios of the branching fractions of the decays $B^0 \rightarrow K^{*0}\mu^+\mu^-$ and $B^0 \rightarrow K^{*0}e^+e^-$, and $B^+ \rightarrow K^+\mu^+\mu^-$ and $B^+ \rightarrow K^+e^+e^-$, respectively. This result is the most sensitive test of lepton flavour universality with rare b decays to date.

T 26.3 Tue 17:30 HSZ/0401

Angular analysis of the decay $B^0 \rightarrow K^{*0}\mu^+\mu^-$ with LHCb — •Leon Carus[1], Thomas Oeser[1], Eluned Smith[2], and Christoph Langenbruch[1] — [1]I Physikalisches Institut B RWTH Aachen — [2]Massachusetts Institute of Technology

Flavor Changing Neutral Currents, such as $b \rightarrow s\ell^+\ell^-$ transitions, are forbidden in the Standard Model of Particle Physics (SM) at tree-level and may only occur at the loop-level. Angular analyses of $b \rightarrow s\ell^+\ell^-$ decays are thus very sensitive to New Physics contributions. A previous measurement of angular observables of $B^0 \rightarrow K^{*0}(\rightarrow K^+\pi^-)\mu^+\mu^-$ decays, performed by the LHCb collaboration using data collected during Run 1 and 2016, found tensions with SM predictions at the level of 3 standard deviations.

The analysis of the full Run 2 data sample of LHCb, along with improvements of the analysis strategy, is expected to increase the precision of this measurement significantly. This talk will present the status of an update of this analysis, including LHCb data collected in 2017 and 2018.

T 26.4 Tue 17:45 HSZ/0401

Isospin asymmetry in $B \rightarrow K\mu^+\mu^-$ decays — Johannes Albrecht, •Fabio De Vellis, Vitalii Lisovskyi, and Biljana Mitreska — TU Dortmund University, Dortmund, Germany

Isospin symmetry is a fundamental property of the Standard Model. It predicts a branching fraction that is almost the same for decays which differ only by one spectator quark, like $B^0 \rightarrow K^0\mu^+\mu^-$ and $B^+ \rightarrow K^+\mu^+\mu^-$. For these decays a quantity which describes differences in branching fraction, namely the asymmetry, can be defined. This is particularly convenient since it is theoretically clean and it allows to cancel some experimental uncertainties.

Previous measurements on these decays from LHCb and Belle, despite being compatible with expectations, suggested coherent deviations that could be interpreted as statistical fluctuations, or unaccounted theoretical uncertainties, or as a sign of New Physics. In this talk an update of the asymmetry measurement with the full LHCb dataset is presented. This means that data corresponding to an integrated luminosity of 6 fb^{-1} are added to the dataset used in the previous Run 1 analysis. Particular attention is given to the new strategy adopted to calibrate simulation samples to data.

T 26.5 Tue 18:00 HSZ/0401

Neutrino Cross-Section Measurements with the T2K Near Detector — •Liam O'Sullivan for the DUNE-Collaboration — Johannes-Gutenberg Universität Mainz

T2K is a long baseline neutrino oscillation experiment in Japan, measuring electron (anti-)neutrino appearance in a muon (anti-)neutrino beam. As a good understanding of neutrino-nucleus interactions is essential to enable precise oscillation measurements, the T2K near detector complex has been designed to measure neutrino interactions on a variety of nuclear targets for the T2K neutrino beam at a distance of 280m from the beam target. This talk presents an overview of the T2K cross-section measurement strategy in the context of both present and future neutrino oscillation measurements, together with select recent cross-section results.

T 26.6 Tue 18:15 HSZ/0401

Čerenkov ring counting using ensembles of CNNs in ANNIE — •Daniel Tobias Schmid, David Maksimović, Michael Nieslony, and Michael Wurm for the ANNIE-Collaboration — Johannes Gutenberg-Universität Mainz, Germany

The Accelerator Neutrino Neutron Interaction Experiment (ANNIE) is a 26-ton Gadolinium-doped water Čerenkov detector located at the Booster Neutrino Beam (BNB) at Fermilab. The scientific aim of ANNIE is the study of the cross-section and the neutron multiplicity of GeV neutrinos in the BNB.

These measurements will benefit next generation neutrino experiments through the reduction of systematics and understanding the underlying interactions.

This talk focuses on using ensembles of Convolutional Neural Networks (CNNs) to perform Čerenkov ring counting to discriminate single- and multi-ring events. The identification of single-ring events will be used in the ANNIE neutron multiplicity analysis to select an exclusive sample of CC-0π events which are predominantly composed of CC-quasielastic interactions, while simultaneously rejecting more inelastic pion-producing interaction types.

T 27: Searches II

Time: Tuesday 17:00–18:30 Location: HSZ/0403

T 27.1 Tue 17:00 HSZ/0403

CMS Dijet Anomaly Search with Substructure — Gregor Kasieczka, •Louis Moureaux, Tobias Quadfasel, and Manuel Sommerhalder — Institut für Experimentalphysik, Universität Hamburg

The extensive searches for physics beyond the Standard Model carried out at the LHC have so far yielded no positive result, despite the very large number of models that have been tested. This motivates the use of techniques based on machine learning that, unlike common search strategies, are capable of dynamically adjusting the event selection to the observed data. These "anomaly detection" methods are expected to feature broad coverage of potential new physics signatures and can thus fill the gaps between searches dedicated to specific models.

We present the application of such an anomaly detection method, CATHODE, in a search for resonant dijet events using substructure observables with the CMS experiment. CATHODE combines density estimation and weak supervision techniques to detect anomalous events in a signal region, interpolating the background from sidebands to achieve nearly optimal classification performance.

T 27.2 Tue 17:15 HSZ/0403

The LHC as Lepton–Proton Collider: Searches for Resonant Production of Leptoquarks — •Daniel Buchin, Michael Holzbock, and Hubert Kroha — Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), München

Searches for leptoquarks constitute an essential part of the physics programme at the ATLAS detector. These hypothetical particles couple to a lepton and a quark and are predicted by many extensions of the Standard Model such as Grand Unified Theories. The existing leptoquark searches at the LHC currently only consider production modes via quark and/or gluon interactions. The small but non-zero lepton content of the proton, however, allows also for the so far unexplored resonant leptoquark production.

This production mode gives rise to lepton-plus-jet signatures. Thus, leptoquarks would emerge as peaks over the smoothly falling Standard Model background in the invariant mass spectrum of the lepton-plus-jet system. The talk will introduce the search strategy and present the current status of the analysis, focusing on final states with fermions of the first and second generation.

T 27.3 Tue 17:30 HSZ/0403

Development of a new trigger for exotic particle searches with IceCube — •Timo Stürwald for the IceCube-Collaboration — Bergische Universität, Wuppertal, Deutschland

The IceCube Neutrino Observatory is a cubic kilometer scale Cherenkov light detector that also searches for signatures of particles beyond the standard model. The upcoming IceCube Upgrade and IceCube-Gen2 extension will improve the sensitivity for these searches due to an increased and partly denser instrumented sensitive volume. The better sensitivity allows for the detection of signatures of exotic particles including fractionally charged particles, which directly and indirectly produce light.

The development of a new trigger for faint signatures of exotic particles with the focus on fractionally charged particles is presented. The new trigger includes the analysis of isolated single hits that so far are not included in any IceCube trigger, because a large fraction of them originates from well understood noise sources. For simulated faint exotic signatures the isolated single hits become the dominant hit type. The improvement in signal efficiency and the estimated trigger rate for different trigger configurations will be presented. Furthermore, the results of running the new trigger at the IceCube test DAQ will be presented.

* Funded by BMBF-Verbundforschung Astroteilchenphysik

T 27.4 Tue 17:45 HSZ/0403

Axion-Like-Particle (ALP) search using ATLAS central and ATLAS Forward Proton (AFP) detectors — •Ondrej Matousek and Andre Sopczak — CTU in Prague

The latest results of the ALP search with the AFP detector are presented.

T 27.5 Tue 18:00 HSZ/0403

A TES for ALPS II - Status and Prospects — •José Alejandro Rubiera Gimeno for the ALPS-Collaboration — Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany

The Any Light Particle Search II (ALPS II) is a Light-Shining-through-a-Wall experiment operating at DESY, Hamburg. Its goal is to probe the existence of Axions and Axion Like Particles (ALPs), possible candidates for dark matter. In the ALPS II region of interest, a rate of photons reconverting from Axions/ALPs on the order of 10^{-5} cps is expected. This requires a sensor capable of measuring low-energy photons (1.165 eV) with high efficiency and a low dark count rate. We investigate a tungsten Transition Edge Sensor (TES) system as a photon-counting detector that promises to meet these requirements and is foreseen for a later science run of ALPS II. This detector exploits the drastic change in its resistance caused by the absorption of a single photon when operated in its superconducting transition region at millikelvin temperatures. In order to achieve the required sensitivity, the implementation of the TES into the ALPS II experiment needs to be carefully optimized. In this work, we present the progress on measurements for the characterization of dark noise, energy resolution, background rejection, efficiency and linearity of our sensor.

T 27.6 Tue 18:15 HSZ/0403

LUXE-NPOD background estimation — Torben Ferber, Alexander Heidelbach, Markus Klute, •Raquel Quishpe, and Nicolo Trevisani — Karlsruhe Institute of Technology, Karlsruhe, Germany

The proposed LUXE experiment at the European XFEL at DESY will produce high-intensity electron-laser interactions to study QED in the non-perturbative regime. These interactions have as a secondary product a large flux of photons with energy up to a few GeV. The photons are then directed onto a physical dump allowing the production of axion-like particles (ALPs) in a region of parameters never probed before. The ALPs produced will decay into pairs of photons detected by an electromagnetic calorimeter. One of the challenges for ALPs searches at LUXE is to reduce the background of neutrons and non-resonant photons reaching the calorimeter. We present a systematic simulation study with different dump materials and depths we carried out in the quest of the best balance between signal acceptance and background suppression.

T 28: Forward Physics

Time: Tuesday 17:00–18:30 Location: HSZ/0101

T 28.1 Tue 17:00 HSZ/0101

QCD cross-section measurements for astroparticle physics with the LHCb experiment — Johannes Albrecht, Hans Dembinski, and •Lars Kolk — TU Dortmund University, Dortmund, Germany

A long-standing issue in the field of cosmic-ray research is the discrepancy between the observed and simulated numbers of muons in cosmic-ray-induced hadronic showers in Earth's atmosphere, which are called air showers. This discrepancy is referred to as the Muon Puzzle, as the required changes to existing models in simulation would violate either data constraints or the consistency between air shower simulations and other air shower features. One explanation for this inconsistency lies in universal strangeness enhancement. Measurements from the ALICE and LHCb experiments show first evidence that this enhancement could truly be universal and thus potentially solve the Muon Puzzle. To further study the impact on forward produced hadrons and to test this universality, proton-ion data from the LHCb fixed target mode are analysed. Of particular interest are proton-oxygen collisions, as they are a good proxy for air showers. Since proton-oxygen data are not yet available, the first step is to bracket oxygen with helium and neon. The current status of this analysis is presented.

Supported by DFG (SFB 1491)

T 28.2 Tue 17:15 HSZ/0101

LHCb for astroparticle physics: Prompt production of identified charged hadrons — Johannes Albrecht[1], •Julian Boelhauve[1], Hans Dembinski[1], and Michael Schmelling[2] — [1]TU Dortmund University, Dortmund, Germany — [2]Max Planck Institute for Nuclear Physics, Heidelberg, Germany

A long-standing issue in the field of cosmic-ray research is the discrepancy in the number of muons produced in high-energy air showers between observations and simulation, referred to as the Muon Puzzle. Precision measurements of hadron production in the forward region are needed to validate and improve the hadronic-interaction models used in the simulation of air showers, with the aim of solving the Muon Puzzle. In this context, measuring the differential cross-section of prompt production of identified long-lived charged hadrons as a function of transverse momentum and pseudorapidity is of great importance.

An analysis in which this differential cross-section is determined for proton–proton and proton–lead collisions is presented in this talk. The corresponding data samples were recorded with the LHCb experiment at centre-of-mass energies of 13 TeV and 8.16 TeV in the nucleon–nucleon system, respectively. The focus of the talk is placed on the calibration of the particle-identification response of the detector, which is essential to an accurate measurement of the fractions of the three most commonly produced hadrons, i.e. pions, kaons and protons, present in the data.

Supported by DFG (SFB 1491).

T 28.3 Tue 17:30 HSZ/0101

Obtaining the Total Cross-Section and ϱ-Parameter from Elastic Proton-Proton Scattering at $\sqrt{s}$ = 900 GeV with the ATLAS Subdetector ALFA — Wolfgang Friebel[2], Karlheinz Hiller[2], •Mustafa Schmidt[1], and Hasko Stenzel[3] for the ATLAS-Collaboration — [1]Bergische Universität Wuppertal — [2]Deutsches Elektronen-Synchrotron DESY — [3]Justus-Liebig-Universität Gießen

ALFA (Absolute Luminosity for ATLAS) is a Roman Pot (RP) detector system in the LHC tunnel, located around 240 m away from the Interaction Point (IP) downstream in the forward region of ATLAS. The ALFA subdetector contains several layers of scintillating fibers for tracking elastically scattered protons in the outgoing beams. The RPs are used as a housing for the fiber trackers and can be moved in small steps close to the beam to ensure proton tracking at small scattering angles. In 2018, 12 runs were recorded at a center-of-mass energy of $\sqrt{s}$ = 900 GeV during several fills using special LHC beam optics with $\beta^* = 100/50$ m parallel-to-point focusing.

This combination makes it possible to probe various important physics parameters of pp interactions in the Coulomb-nuclear interference region, providing a unique evaluation of the underlying model predictions within the non-perturbative QCD regime. A fit describing the physics models to the elastic cross-section distribution, which is obtained from the calculation of the four-vector momentum transfer, allows the extraction of the nuclear slope parameter B, the total cross-section σ, and the ϱ-parameter, defined as $\varrho = \Re[f(0)]/\Im[f(0)]$. This talk covers the current status of the ongoing analysis and future steps.

T 28.4 Tue 17:45 HSZ/0101

Physics potential of a combined data-taking of the LHCf and ATLAS roman pot detectors — •Yusuf Can Cekmecelioglu[1], Clara Elisabeth Leitgeb[1], and Cigdem Issever[2] — [1]DESY, Zeuthen, Germany — [2]Humboldt University, Berlin, Germany

The study determines a common geometrical acceptance for the LHCf and ATLAS roman pot (ARP) detectors located in the forward regions of the ATLAS interaction point. In order to better understand the soft QCD processes and to improve pileup modelling for hadron accelerators and cosmic ray air shower modelling, a simultaneous analysis of central tracks (ATLAS), forward proton (ARP) and neutral particles (LHCf) could be beneficial. Analyses of single diffraction processes especially take advantage of these kind of setup, since the final state intact proton can be detected using ARPs and the neutral particles from the dissociated proton can be detected using LHCf and ATLAS Zero Degree Calorimeter (ZDC). Delta baryons produced in a pomeron exchange can lead to a similar signature with one neutral pion and one proton in the final state. This process, which effectively represents very low mass diffraction, is also taken into account in these studies.

In the end, a good common geometrical acceptance is found, yielding an acceptable event rate with the proposed joint data-taking between the detectors. Based on these studies, the ATLAS Forward Proton detector (AFP) joined the special run for LHCf in 2022, which results the very first combined data of LHCf, ZDC, ATLAS and AFP so far, with a recorded data of about 300 millions events.

T 28.5 Tue 18:00 HSZ/0101

Prospect studies for Proton-Oxygen Collisions at ATLAS, LHCf and AFP — Yusuf Can Çekmecelioğlu[2], •Erik Dieckow[1], Cigdem Issever[1,2], and Clara Elisabeth Leitgeb[2] — [1]Humboldt Universität zu Berlin, Germany — [2]DESY, Zeuthen, Germany

In astroparticle physics, ground based analysis is done by studying cosmic ray induced showers in the Earth's atmosphere. The phenomenological models used to simulate the interaction of cosmic ray particles with the atmospheric nuclei cause large systematic uncertainties and thus need improvement. In the past, LHC has conducted proton-proton and proton-heavy nucleus (lead) collisions. In LHC run 3 there will be the opportunity to study proton-Oxygen collisions. The cross-sections and particle energy spectra in the forward regions that will be measured with this data can provide invaluable and complementary input to the aforementioned models. The main focus of these studies is on the feasibility of a combined data taking of LHCf, ATLAS and AFP detectors during the proton-Oxygen collision run. This would allow for a better reconstruction of the event kinematics, as well as a purer selection of low mass single diffraction events than would be possible with LHCf data only.

T 28.6 Tue 18:15 HSZ/0101

Measurement of Fragmentation Cross Sections of Intermediate-Mass Nuclei with NA61/SHINE at CERN — •Neeraj Amin for the NA61/SHINE-Collaboration — Institute for Astroparticle Physics, Karlsruhe Institute of Technology, Karlsruhe, Germany

Cosmic-ray propagation in the galaxy can be constrained by modeling the secondary-to-primary cosmic-ray flux ratios, like the boron-to-carbon flux ratio that reaches Earth. While these fluxes are currently measured with higher precision($<5\%$) by space-based detectors like AMS, CALET, and DAMPE, insufficient knowledge of nuclear fragmentation cross sections hinders our inference of propagation parameters. Therefore, laboratory measurements of fragmentation cross section above 10 A GeV/c are essential. We remediate this situation by utilizing the NA61/SHINE experimental facility at CERN.

Pilot data on fragmentation was taken in 2018 with the main aim of probing the feasibility of performing fragmentation studies at SPS energies. Two fixed targets, polyethylene(C_2H_4) and graphite were employed to study C+p interactions at 13.5 A GeV/c beam momentum. In this contribution, we will present the isotopic production of boron including direct production of ^{10}B & ^{11}B as well as via indirect channels originating from the decay of ^{10}C and ^{11}C fragments. We also report on the feasibility of measuring light and intermediate-mass nuclei from Li to F relevant for cosmic ray propagation studies. A dedicated high statistics data-taking is scheduled in late 2023 to study the fragmentation of various primary nuclei like C, N, O & Si.

T 29: Other Exp., EW

Time: Tuesday 17:00–18:30 Location: HSZ/0103

T 29.1 Tue 17:00 HSZ/0103

Search for new physics in top quark production with an associated boson in the framework of the SMEFT — Arnulf Quadt, Baptiste Ravina, Elizaveta Shabalina, and •Sreelakshmi Sindhu for the ATLAS-Collaboration — II. Physikalisches Institut, Georg-August-Universität Göttingen, Germany

The Standard Model Effective Field Theory (SMEFT) provides a model independent approach to study beyond the Standard Model effects. A search for new physics using the framework of the SMEFT is performed using events with one or two top quarks in association with a boson ($t\bar{t}W$, $t\bar{t}Z$, tZ, $t\bar{t}H$, tH). The simultaneous analysis of these processes gives the opportunity to constrain a large number of dimension six SMEFT operators.

In this analysis, final states with two same sign or three isolated leptons are selected and classified into various regions based on the number of leptons, jets, b-jets and the total charge of the leptons. Using the event yields in these regions, limits are extracted on the SMEFT operators. This measurement is performed using the proton-proton collision data at $\sqrt{s}$ = 13 TeV with an integrated luminosity of 139 fb^{-1}, recorded from 2015 to 2018 with the ATLAS experiment at the Large Hadron Collider at CERN.

T 29.2 Tue 17:15 HSZ/0103

A neural network for beam background decomposition in Belle II at SuperKEKB — •Yannik Buch, Ariane Frey, Lukas Herzberg, and Benjamin Schwenker — II. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Deutschland

The Belle II detector investigates the b-sector by measuring the decays of the $\Upsilon(4S)$ resonance. These $\Upsilon(4S)$ decays are produced by the SuperKEKB accelerator at KEK in Tsukuba, Japan. The goal of SuperKEKB is to achieve an instantaneous luminosity of 6.5×10^{35} cm^{-2}s^{-1}, of which 4.7×10^{34} cm^{-2}s^{-1} has recently been reached.

The beam backgrounds at Belle II are mostly composed of storage and luminosity-induced backgrounds. Due to short beam lifetimes continuous top-up injections into both rings are necessary, resulting in injection-induced background spikes. BGNet is a neural network based diagnostic tool for real-time background decomposition and analysis. The training data for BGNet are 1 Hz time series of diagnostic variables describing the state of the SuperKEKB collider subsystems. Using feature attribution to explain the predictions, provides clues to identify the most relevant causes of changes in background levels.

T 29.3 Tue 17:30 HSZ/0103

Studies of ATLAS Forward Proton (AFP) ToF performance with Run-3 data — •Viktoriia Lysenko and Andre Sopczak — CTU in Prague

Performance studies of ATLAS Forward Proton (AFP) ToF with Run-3 data are presented.

T 29.4 Tue 17:45 HSZ/0103

Search for $\gamma\gamma$jj final states from Vector Boson Scattering at the ATLAS experiment — •Orcun Kolay — Technische Universität Dresden, Germany

Vector boson scattering (VBS) is a suitable process to observe triple and quartic gauge couplings. This rare processes provide us an avenue to examine electroweak (EW) symmetry breaking mechanism and to search for possible new physics effects. In this study, two photons along with two jets ($\gamma\gamma$jj) are taken into account as the final state. The measurement of the VBS $\gamma\gamma$jj process comes along with two main challenges as the background coming from QCD induced $\gamma\gamma$jj and misidentified jets as photon. In this talk, it will be presented an ongoing work which mainly covers the separation of EW $\gamma\gamma$jj from QCD $\gamma\gamma$jj, the signal-control region strategy for misidentified jets and the comparison of the different Monte Carlo event generators for the signal phase space.

T 29.5 Tue 18:00 HSZ/0103

Electroweak production of two jets in association with a Z boson in proton-proton collisions — •Keila Moral Figueroa — Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, D-22607 Hamburg

In recent years, the Large Hadron Collider (LHC) has played an important role in constraining extensions of the Standard Model (SM). One of the measurements which can contribute to it, is the electroweak production of the Z boson in association with two jets (EW Zjj). This process limits the anomalous weak-boson self-interactions, due to its sensitivity to the weak vector-boson scattering (VBS), an increasingly relevant process at the LHC.

So far, the theoretical predictions of the EW Zjj process diverge slightly among different Monte Carlo event generators. As a consequence, further studies are needed in order to obtain reliable model-independent measurements. The EW Zjj process is identified by imposing large invariant dijet mass and dijet pseudaripidty separation. First distributions are shown using the full Run 2 dataset.

T 29.6 Tue 18:15 HSZ/0103

A data-driven multijet background estimation method for the measurement of the electroweak Wjj production with the ATLAS experiment — •Lisa Marie Baltes — Kirchhoff-Institute for Physics, University Heidelberg, Germany

The observation and measurement of self-interactions of weak gauge bosons provide an indirect search for physics beyond the Standard Model. The electroweak production of a W boson in association with two jets includes the vector-boson-fusion (VBF) production of a W boson and is thus sensitive to the triple gauge boson vertices WWγ and WWZ. In proton-proton collisions, the characteristic signature of VBF includes two high-momentum jets at small angles with respect to the incoming beams and a centrally produced lepton-neutrino pair originating from the W boson decay. A significant background for this analysis is multijet production via the strong interaction where a jet is misidentified as a lepton. Monte-Carlo simulation generally do not provide a proper description of QCD backgrounds. Therefore, data-driven techniques are used to estimate this background. In this talk, the current status of the analysis including the multijet background estimation using the matrix method is presented.

T 30: Higgs Charm, Di-Higgs

Time: Tuesday 17:00–18:30 Location: HSZ/0105

T 30.1 Tue 17:00 HSZ/0105

Introduction of a new framework in the analysis of the Higgs boson decay to a charm-anticharm pair in the vector boson associated production mode at CMS — •Valentyn Vaulin[1], Annika Stein[1], Xavier Coubez[1,2], Alena Dodonova[1], Ming-Yan Lee[1], Spandan Mondal[1], Andrzej Novak[1], Andrey Pozdnyakov[1], Manuella Guirgues[1], and Alexander Schmidt[1] — [1]Physics Institute III A, RWTH Aachen University, Germany — [2]Brown University, USA

During the last years the analysis techniques to measure the Higgs boson coupling to charm quarks using the full Run-2 data of the CMS experiment have been established. The Higgs boson decay into charm- anticharm pair, where the Higgs boson is produced in association with the W or Z boson, has been analysed in a resolved topology with individually reconstructed jets and in a boosted topology with merged jets. In this talk a concept of a new analysis framework is presented with the intention to reproduce the known results of the VH search from Run-2 analysis by CMS. The Z → 2l decay channel of the associate vector boson and resolved jet topology of the H → $c\bar{c}$ decay are considered for this study. Furthermore, the results of the current state of ML-supported analysis in the new framework will be discussed.

T 30.2 Tue 17:15 HSZ/0105

Direct search for Higgs boson decay to a pair of charm quarks in the vector boson associated production mode at CMS — •Annika Stein[1], Bjorn Burkle[2], Xavier Coubez[1,2], Alena Dodonova[1], Manuella Guirgues[1], Luca Mastrolorenzo[1], Ming-Yan Lee[1], Spandan Mondal[1], Andrzej Novak[1], Andrey Pozdnyakov[1], Alexander Schmidt[1], and Valentyn Vaulin[1] — [1]III. Physikalisches Institut A, RWTH Aachen University, Aachen, Germany — [2]Brown University, Providence, USA

The search targets Higgs bosons produced in association with a vector boson (W, Z) and probes the coupling of the Higgs boson to charm quarks via the H → cc̄ decay, using full Run-2 data of the CMS experiment. Two topologies contribute to the full analysis, the "boosted" topology, where the two jets from a Higgs boson candidate are merged into one large-radius jet, and a "resolved" topology which utilizes two reconstructed small-radius jets. Compared to a previous search, the analysis techniques have been improved by exploiting a DNN-based charm jet tagging algorithm along with a new calibration method, improved jet-energy regression, and a "kinematic fit" to constrain momenta of the jets using leptons. The most stringent constraint on the Higgs-charm Yukawa coupling modifier, κ_c, at the observed (expected) 95% CL interval is set to $1.1 < |\kappa_c| < 5.5$ ($|\kappa_c| < 3.4$). A validation of the analysis is carried out with a search for Z → cc̄ in VZ events, which leads to its first observation at a hadron collider with a significance of 5.7 standard deviations. Further developments that feature novel machine learning methods will be discussed.

T 30.3 Tue 17:30 HSZ/0105

Search for boosted Higgs boson decays to a charm quark pairs — •Andrzej Novak, Xavier Coubez, Ming-Yan Lee, Luca Mastrolorenzo, Andrey Pozdnyakov, Annika Stein, and Alexander Schmidt — Physics Institute III A, RWTH Aachen

The Higgs boson decay to charm quarks (H → $c\bar{c}$) has the highest branching fraction of the yet unobserved decays. Moreover, it is predicted to be the strongest coupling to the second generation of fermions, which as of now remains unconfirmed. This talk presents a recent search by the CMS experiment for H → $c\bar{c}$ at high transverse momentum, primarily targeting the gluon fusion production mode. The method is validated with the Z → $c\bar{c}$ decay, which is observed for the first time in this channel and provides the strongest constraint yet at the LHC. The observed (expected) upper limit on H → $c\bar{c}$ process is set at 47 (39) times the SM prediction. The analysis was enabled by recent developments in deep learning tools for jet identification in such topologies.

T 30.4 Tue 17:45 HSZ/0105

Discrimination of Di-Higgs and Higgs-Z Boson Final States Using Neural Networks — •Lars Linden, Otmar Biebel, Christoph Ames, and Celine Stauch — Ludwig-Maximilians-Universität, München

Precise measurements of Higgs boson pair production are of significant importance for new physics searches and determining the Higgs potential's exact shape. These processes have small cross-section however, making them exceptionally rare. As a result, neural networks are used to improve the experimental sensitivity for these processes. The employed network uses general event jet information and specific variables sensitive to di-Higgs production for event classification. This talk presents a network structure for distinguishing $gg \to HH$ from the important background process $gg \to HZ$ and its respective sensitive variables.

T 30.5 Tue 18:00 HSZ/0105

Separation of HH and HZ processes in LHC events — •Celine Stauch, Otmar Biebel, Christoph Ames, and Lars Linden — LMU München

LHC Processes with HH final states and HZ final states are kinematically very similar due to H and Z boson being close in mass and both final states having similar cross sections in proton-proton collisons. While the H boson is a scalar particle, the Z boson has a spin of 1. The spin of the Z boson transfers to the jets in the final state leading to a correlation of the angles of these jets.

For HH or HZ final states resulting in at least 4 jets all possible combinations of the four energetically highest jets are calculated in order to find the combination closest in mass to a H or Z boson. A variable sensitive to the correlation of the angles of the final state jets is introduced, which is a modification of the Ellis-Karliner angle. This variable is investigated using generator simulation data for the best combination of jets in HH final states ans HZ final states.

T 30.6 Tue 18:15 HSZ/0105

A neural network based regression of the neutrinos in H→ $\tau\tau$ decays for a resonant HH→bb$\tau\tau$ analysis — Philip Keicher, •Tobias Kramer, Nathan Prouvost, Marcel Rieger, Peter Schleper, Jan Voss, and Bogdan Wiederspan — Universität Hamburg

The CMS resonant HH→bb$\tau\tau$ analysis searches for heavy spin 0/2 resonances decaying into two Higgs bosons which subsequently decay into bottom quarks and tau leptons. It uses the Run 2 data collected from 2016-2018 at a center of mass energy of $\sqrt{s} = 13$ TeV corresponding to an integrated luminosity of 138 fb^{-1}. As a wide range of resonance masses is covered, reconstructing the invariant mass of the HH system and therefore the individual Higgs bosons is crucial. Especially for the Higgs boson decaying into tau leptons a significant amount of information is lost in the form of neutrinos not being measured by the detector. This talk presents a study on how to regress the full HH system using deep neural networks in order to improve the mass resolution of a potential new heavy particle.

T 31: Theory Higgs, BMS

Time: Tuesday 17:00–18:15 Location: HSZ/0201

T 31.1 Tue 17:00 HSZ/0201

Higgs pair production in SMEFT at full NLO QCD: an investigation of truncation effects — •Jannis Lang — Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

We present results for Higgs boson pair production in gluon fusion at NLO (2-loop) QCD including operators in the Standard Model Effective Field Theory (SMEFT) framework. Contributions from subsets of higher order terms in $\frac{1}{\Lambda^2}$, such as squared dimension-6 operators at cross section level and double operator insertions at amplitude level, are used as a proxy for the study of truncation effects of the SMEFT expansion. The different truncation options are contrasted to the non-linear Higgs Effective Field Theory (HEFT) framework for selected phenomenological examples.

T 31.2 Tue 17:15 HSZ/0201

Precision test of the muon-Higgs coupling at a high-energy muon collider — •Nils Kreher[1], Tao Han[2], Wolfgang Kilian[1], Yang Ma[2], Jürgen Reuter[3], Tobias Striegl[1], and Keping Xi[2] — [1]Department of Physics, University of Siegen, Walter-Flex-Straße 3, 57068 Siegen, Germany — [2]Pittsburgh Particle Physics, Astrophysics, and Cosmology Center, Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh, PA 15206, U.S.A. — [3]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg, Germany

I will present a sensitivity test of the muon-Yukawa sector at a high-energy muon collider. While in the Standard Model this sector is described by a single parameter, effects of new physics that is not aligned with the Standard Model Yukawa interactions may introduce a more sophisticated parameter dependence, which can be understood either in SMEFT or a HEFT frameworks. With the accidentally small value of the muon Yukawa coupling and its subtle role in the high-energy production of multiple (vector and Higgs) bosons, I will show that it is possible to measure the muon-Higgs coupling to an accuracy of ten percent for a 10 TeV muon collider and a few percent for a 30 TeV machine by utilizing the three boson production, potentially sensitive to a new physics scale about $\lambda = 10 \sim 30$ TeV. In addition I will discuss effects of an extended Higgs sector to the same processes in both frameworks.

T 31.3 Tue 17:30 HSZ/0201

Projecting composite operators onto a unique basis — Robert V. Harlander, •Jakob W. Linder, and Magnus C. Schaaf — 1Institute for Theoretical Particle Physics and Cosmology, RWTH Aachen, Aachen

The Standard Model effective field theory (SMEFT) describes the low-energy effects of possible high-energy theories in terms of Standard Model fields. In a top-down approach, the effective Lagrangian can be obtained by constructing the effective action using a functional matching procedure, for example. However, this yields a non-unique action in general.

To restore the desired uniqueness, an algorithm is developed to decompose any operator with arbitrary mass dimension into operators free of redundancies due to equations of motion, integration-by-part identities or internal symmetries. For this purpose, the operators are converted into a redundancy-free basis, which can be constructed automatically for arbitrary mass dimensions. In this talk, I will report on such a basis and ProSMEFTion, our implementation of the algorithm.

T 31.4 Tue 17:45 HSZ/0201

Debye mass effects in the Dark Sector in the Early Universe — Simone Biondini[1], Nora Brambilla[2], •Andrii Dashko[3], Gramos Qerimi[2], and Antonio Vairo[2] — [1]Department of Physics, University of Basel, Klingelbergstr. 82, CH-4056 Basel, Switzerland — [2]Physik-Department, Technical University Munich, James-Franck-Str. 1, 85748 Garching, Germany — [3]Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany

We address the impact of the thermal Debye mass m_D scale on the bound-state formation and ionization (dissociation) in the dark sector in the Early Universe. We focus on heavy dark fermions (with mass m) charged under a $U(1)_d$ group coupling dark matter to dark photons and dark light fermions with the coupling constant $\alpha = g^2/4\pi$. We determine the effect of the HTL resummation on the bound state formation and dissociation rates of heavy dark fermions in presence of a hot (with temperature T), weakly coupled ($T \gg gT$) dark plasma, under the assumption that $m \gg m\alpha \gg T$. Our analysis is based on Non-Relativistic Effective Field Theory (NREFT) to address the dark matter threshold dynamics and on Thermal Field Theory to address the thermal scales. We obtain and solve coupled Boltzmann equations and show how our results affect the evolution of the dark matter density in the Early Universe. Working with this simplified model of the dark sector, we show that the effect of HTL resummation on the bound-state formation and thermal relic abundance is non-negligible (and of the same order as the NLO fixed order correction), which indicates the importance of further studies in more realistic scenarios.

T 31.5 Tue 18:00 HSZ/0201

Trilinear Higgs Self-Couplings at $\mathcal{O}(\alpha_t^2)$ in the CP-Violating NMSSM — •Christoph Borschensky[1], Thi Nhung Dao[2], Martin Gabelmann[3], Margarete Mühlleitner[1], and Heidi Rzehak[4] — [1]Karlsruhe Institute of Technology, Germany — [2]PHENIKAA University, Hanoi, Vietnam — [3]DESY, Hamburg, Germany — [4]Eberhard Karls Universität Tübingen, Germany

In supersymmetric theories the Higgs boson masses are derived quantities where higher-order corrections have to be included in order to match the measured Higgs mass value at the precision of current experiments. Closely related through the Higgs potential are the Higgs self-interactions. In addition, the measurement of the trilinear Higgs self-coupling provides the first step towards the reconstruction of the Higgs potential and the experimental verification of the Higgs mechanism sui generis.

In this talk, I will present the $\mathcal{O}(\alpha_t^2)$ corrections to the trilinear Higgs self-couplings in the CP-violating Next-to-Minimal Supersymmetric extension of the SM (NMSSM), calculated in the gaugeless limit at vanishing external momenta. The higher-order corrections turn out to be larger than the corresponding mass corrections, but show the expected perturbative convergence. The inclusion of the loop-corrected effective trilinear Higgs self-coupling in gluon fusion into Higgs pairs and the estimate of the theoretical uncertainty due to missing higher-order corrections indicate that the missing electroweak higher-order corrections may be significant.

T 32: Di-Higgs, Higgs BSM

Time: Tuesday 17:00–18:30 Location: HSZ/0204

T 32.1 Tue 17:00 HSZ/0204

Employing Matrix Elements with Neural Networks to Search for Higgs Self-coupling — •Christoph Ames, Otmar Biebel, Lars Linden, and Celine Stauch — Ludwigs-Maximilians-Universität, München

The Higgs boson was discovered in 2012 as predicted by the Standard Model (SM), however, not all of its predicted couplings have been measured yet. One such coupling is the Higgs self-coupling, in which a Higgs boson decays into two further Higgs bosons. By integrating over all possible initial states and by using the details of the end state, the matrix element method evaluates the weight of an event for the specific production cross section. In this work, machine learning is combined with the matrix element method to search for $HH \to b\bar{b}\ W^+W^-$ using simulated data. A neural network is trained to calculate the matrix element weight of an event and to use this to determine whether the event contains a signal or a background decay.

T 32.2 Tue 17:15 HSZ/0204

Prospects for measuring di-Higgs production at the ILC — •Julie Torndal[1,2], Jenny List[1], and Yasser Radkhorrami[1,2] — [1]Deutsches Elektronen-Synchrotron DESY, Hamburg — [2]Universität Hamburg, Hamburg, Germany

The Higgs mechanism is a central part of the Standard Model (SM). However, at this point in time, it has not been established experimentally which can only be done by reconstructing the Higgs potential. In the SM, the shape of the potential is determined by the Higgs self-coupling, which can be measured directly and model-independently at future linear e+e- colliders through di-Higgs production.

The Interntional Linear Collider (ILC) offers a clean experimental environment and a physics programme with sufficient energies to produce di-Higgs events. The measurement suffers from small production cross sections and large jet multiplicity, imposing high standards on the reconstruction tools. Modern reconstruction tools have seen a large improvement since the di-Higgs analysis was last visited almost 10 years ago. These improvements are foreseen to improve the precision, and an analysis strategy is presented focusing on an accurate event reconstruction and Z/H separation. Other aspects such as the the centre-of-mass energy and BSM effects might also influence the reachable precision and will be considered.

T 32.3 Tue 17:30 HSZ/0204

Prospects for constraints on light-quark Yukawa couplings from differential distributions of Higgs boson production in the diphoton decay channel — Johannes Erdmann and •Jan Lukas Späh — III. Physikalisches Institut A, RWTH Aachen University

More than ten years after the discovery of the Higgs boson, various production and decay channels have been explored experimentally. However, the constraints on couplings to the light quarks up, down, and strange are comparatively weak as they are challenging to probe experimentally.

In this talk, studies to constrain these couplings based on the production mode of quark-antiquark annihilation in the diphoton decay channel are presented. The focus lies on the discrimination of this $q\bar{q} \to H + X$ component against the dominant Standard Model contribution from gluon-gluon fusion. For this, the transverse momentum and the rapidity of the Higgs boson play an important role.

Expected upper limits on the Yukawa couplings to the three light quark species are presented. The potential for this interpretation in light of the large statistical power of the datasets collected with the High-Luminosity Large Hadron Collider is highlighted.

T 32.4 Tue 17:45 HSZ/0204

Search for heavy Higgs bosons in the t$\bar{t}$Z final state at CMS — Matteo Bonanomi, Yannick Fischer, Johannes Haller, •Daniel Hundhausen, and Matthias Schröder — Institut für Experimentalphysik, Universität Hamburg

All measurements of the properties of the Higgs boson at 125 GeV are compatible with a standard model-like behaviour. However, the observed resonance might well be part of an extended Higgs sector, which is predicted in various scenarios of new physics beyond the standard model. Two Higgs Doublet Models (2HDM) provide a generic description of the phenomenology arising in models with a second Higgs doublet. In this talk, we will present a search for a hypothetical CP odd heavy Higgs boson A decaying into a CP even heavy Higgs boson H and a Z boson, with the H decaying further into a pair of top quarks. This decay channel is particularly relevant in the high mass and low tan(β) regime. We will present the strategy and status of the analysis of data collected with the CMS experiment at a centre of mass energy of 13 TeV, targeting the fully hadronic t$\bar{t}$ decay.

T 32.5 Tue 18:00 HSZ/0204

Exotic Higgs Decays: ATLAS Search for Higgs Decays to Two Light Scalars — •Judith Höfer, Claudia Seitz, and Beate Heinemann — DESY, Hamburg, Germany

Extensions of the SM Higgs sector featuring one or several singlet scalar fields are realised in many BMS models. While several searches have been performed targeting decays of the SM Higgs boson to two light spin-zero particles of the same mass, the decay to two new scalars of different mass is largely unexplored. The successive decays of these particles can give rise to spectacular high-multiplicity collider signatures, including so-called cascade decays, where the heavier of the scalars decays into the lighter one. The talk discusses an analysis searching for scalar decays to multi-b final states with the ATLAS experiment at the Large Hadron Collider, CERN. The analysis focuses on the ZH production mode and the channel where the scalars decay to b-quarks, resulting in a challenging low-pT jet final state. Particular focus is put on the cascade decays that result in a 6b final state. The signatures motivate the use of novel reconstruction techniques, such as a newly developed low-pT X→bb tagger or the reconstruction of soft secondary vertices.

T 32.6 Tue 18:15 HSZ/0204

Domain walls in the N2HDM — Gudrid Moortgat-Pick, Mohamed Younes Sassi, and •Muriel Kaya Blenck — II. Institut für Theoretische Physik Luruper Chaussee 149 22761 Hamburg

In the next-to-two Higgs doublet model, the Higgs sector is extended by a second doublet as well as a singlet real scalar. These extra degress of freedom lead to the possibility of extending the symmetry group of the theory with additional discrete symmetries. In this talk, I will discuss the domain walls arising in this model due to the breaking of a discrete symmetry imposed on the singlet scalar and also discuss how to avoid the domain wall problem in such a model by allowing for soft breaking of this discrete symmetry.

T 33: DAQ NN/ML – GRID I

Time: Tuesday 17:00–18:30 Location: HSZ/0301

T 33.1 Tue 17:00 HSZ/0301

Track reconstruction with Graph Neural Networks on FPGAs for the ATLAS Event Filter at the HL-LHC — Sebastian Dittmeier and •Sachin Gupta — Physikalisches Institut, Universität Heidelberg

The High-Luminosity LHC (HL-LHC) will enhance the potential to discover new physics with the ATLAS experiment beyond its reach at the LHC. To cope with the increased pile-up foreseen during the HL-LHC, major upgrades to the ATLAS detector and trigger system are required. The trigger system will consist of a hardware-based trigger and an online server farm, called the Event Filter (EF), with track reconstruction capabilities. For the EF, a heterogeneous computing farm consisting of CPUs and potentially GPUs and/or FPGAs is under study, together with the use of modern machine learning algorithms such as Graph Neural Networks (GNNs).

GNNs are a powerful class of geometric deep learning methods for modelling spatial dependencies via message passing over graphs. They are well-suited for track reconstruction tasks by learning on an expressive structured graph representation of hit data. A considerable speed-up over CPU-based execution is possible on FPGAs.

In this talk, a study of track reconstruction for the ATLAS EF system at HL-LHC using GNNs on FPGAs is presented. The main focus is set on model size minimization using quantization aware training, as resource utilization is a key aspect in the application of GNNs on FPGAs.

T 33.2 Tue 17:15 HSZ/0301

Convolutional Neural Networks on FPGAs for Processing of ATLAS Liquid Argon Calorimeter Signals — •Johann Christoph Voigt, Anne-Sophie Berthold, Nick Fritzsche, Rainer Hentges, Christian Gutsche, and Arno Straessner — Institut für Kern- und Teilchenphysik, TU Dresden, Germany

The Phase-II upgrade of the ATLAS Liquid Argon Calorimeter allows for the energy reconstruction of all ~180000 readout channels at the LHC bunch crossing frequency of 40 MHz. Further challenges arise from the increased pile-up due to the planned higher number of simultaneous proton-proton collisions.

For the digital energy reconstruction, we propose the use of Convolutional Neural Networks (CNNs) instead of the previous Optimal Filter. The networks need be able to run on an FPGA with limited resources and are therefore limited in complexity to approximately 100 weight parameters.

This talk focuses on the firmware implementation of these networks in VHDL. The implementation is optimized for DSP usage and latency. To be able to process all readout channels on the available FPGAs, time domain multiplexing is used to process multiple channels per CNN instance. This reduces the number of required instances and increases the frequency the design needs to run at. A multiplexing factor of 12 at a frequency of 480 Mhz is demonstrated for a design processing 384 detector cells. The latest FPGA resource usage estimates are presented.

T 33.3 Tue 17:30 HSZ/0301

Implementation of neural networks for live reconstruction using AI processors — Klaus Desch[1], Jochen Kaminski[1], Michael Lupberger[1,2], and •Patrick Schwäbig[1] — [1]Physikalisches Institut, Universität Bonn, Deutschland — [2]Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn, Deutschland

For years, data rates generated by modern detectors and the corresponding readout electronics exceeded by far the limits of data storage space and bandwidth available in many experiments. The solution of using fast triggers to discard uninteresting and irrelevant data is a solution used to this day. Using FPGAs, ASICs or directly the readout chip, a fixed set of rules based on low level parameters is applied as a pre-selection. Only a few years ago, live track reconstruction for triggering was rarely possible but with the emergence of fast and highly parallelized processors for AI inference attempts to sufficiently accelerate tracking algorithms become viable. The Xilinx Versal AI Adaptive Compute Acceleration Platform (ACAP) is one such technology and combines FPGA and CPU resources with dedicated AI cores. Our approach is to utilize the unique combination of FPGA and AI cores to leverage neural networks for live triggering which will be relevant for future experiments and upgrades of already existing setups.

In this talk AI algorithms for track reconstruction, especially their quantized and non-quantized implementation on the Xilinx VC1902, will be shown. They will be used in an envisioned mid-size ultra-high rate fixed-target dark matter experiment (Lohengrin) at the ELSA accelerator at the University of Bonn.

T 33.4 Tue 17:45 HSZ/0301

Profiling of GPU-based neural network trainings — •Tim Voigtländer, Manuel Giffels, Artur Gottmann, Günter Quast, Matthias Schnepf, and Roger Wolf — Karlsruhe Institute of Technology, Karlsruhe, Germany

The training of neural networks has become a significant workload of particle physics analyses. To speed up these trainings and reduce their turnaround cycle, one or more accelerators, e.g. GPUs, are typically utilized. While the increase in computational capacity is greatly beneficial, the heterogeneous hardware also adds layers of complexity to an already opaque process. In order to improve the efficiency in the usage of the available hardware, suitable profiling to identify possible bottlenecks. In this talk, solutions to a number of commonly occurring challenges found in single- and multi-GPU neural network trainings are presented, using the DeepTau neural network training as a case-study.

T 33.5 Tue 18:00 HSZ/0301

Open Science in KM3NeT — •Rodrigo Gracia-Ruiz for the ANTARES-KM3NET-ERLANGEN-Collaboration — FAU-ECAP, Erlangen, Germany

The KM3NeT neutrino detectors are currently under construction at two locations in the Mediterranean Sea, with a first data taking of high-energy neutrino interactions already under way. This scientific data is valuable both for the astrophysics and neutrino physics communities as well as for marine biologists. In order to facilitate FAIR data sharing of the research results, the KM3NeT collaboration is actively working towards an open science infrastructure to provide high-level scientific data, software, and analysis pipelines in an interoperable research environment suited both for research and education. This contribution introduces the open science program of KM3NeT and gives an overview of its current architecture and implementation.

T 33.6 Tue 18:15 HSZ/0301

Towards JupyterHub as one point of entry for the PUNCH4NFDI computing infrastructure — •Luka Vomberg, Philip Bechtle, Oliver Freyermuth, and Peter Wienemann for the PUNCH4NFDI Consortium-Collaboration — Physikalisches Institut Bonn

PUNCH (Particles, Universe, NuClei and Hadrons) is a consortium of the NFDI (Nationale ForschungsDaten Infrastruktur) representing about 9000 physicists in Germany at the Ph.D. level. The goals of PUNCH are the setup of infrastructure that enables physicists to easily manage and publish their data and corresponding analyses in accordance to the FAIR principles. These are Findability, Accessibility, Interoperability and Reproducibility, which are desirable properties that publications and their underlying data should adhere to as much as possible. The infrastructure supplied by PUNCH is meant to make this as easy as possible for individual researchers and collaborations alike. This talk will describe the vision of accessing the PUNCH infrastructure with FAIRness in mind through a JupyterHub infrastructure built on the PUNCH AAI (Authorisation and Authentication Infrastructure).

T 34: ML Methods II

Time: Tuesday 17:00–18:30 Location: HSZ/0405

T 34.1 Tue 17:00 HSZ/0405

Equivariant Normalising Flows for Particle Jets — •Cedric Ewen — Institut für Experimentalphysik, Universität Hamburg

In high energy physics, current Monte Carlo simulations are time-consuming and the demand for fast computationally efficient simulations is rising. Therefore, generative machine learning models have become a major research interest due to their ability to speed up data generation. A data structure capable of describing collider events such as jets are variable-size point clouds. However, due to complex correlations between the points, a powerful architecture is needed for high generative fidelity. Continuously normalising flows (CNFs) can model these complex point processes while having traceable likelihood and straightforward sampling. We show an implementation of an architecture using CNFs with equivariant functions and compare its performance to multiple GAN approaches on benchmark datasets.

T 34.2 Tue 17:15 HSZ/0405

Identification of bb-Jets Using a Deep-Sets-Based Flavour-Tagging Algorithm with the ATLAS Experiment — •Joschka Birk[1,2], A. Froch[1], M. Guth[3], and A. Knue[1] — [1]University of Freiburg — [2]University of Hamburg — [3]University of Geneva

Jets that contain two b-hadrons (bb-jets) are usually not considered as an individual target class in flavour-tagging algorithms. Instead, these jets are included in an inclusive b-jet category which consists of single-b jets and bb-jets, making these two types of jets indistinguishable when they are processed with such an algorithm.

While this is sufficient for most physics analyses, an explicit identification of bb-jets could be promising for analyses like the search for the $t\bar{t}H(\rightarrow b\bar{b})$ signal, which suffers from the large irreducible $t\bar{t} + b\bar{b}$ background. This irreducible background contains the same final-state particles as the signal, including four b-quarks. In the background process, a radiated gluon can split into a b-quark pair, which might be contained in one single jet. In order to improve the rejection of these particular background events, the ATLAS DL1d algorithm, which is the b-tagging algorithm designed for ATLAS Run 3 analyses, is extended with an additional output class dedicated to bb-jets (bb-DL1d).

By applying a cut in a two-dimensional discriminant plane, bb-DL1d provides a proof-of-concept for a flavour-tagging algorithm that is capable of both inclusive b-tagging and bb-jet identification. The design of the bb-DL1d algorithm and its most important, Deep-Sets-based, low-level tagger bb-DIPS are discussed in this talk. Futhermore, performance studies for both algorithms are shown.

T 34.3 Tue 17:30 HSZ/0405

Improving the robustness of jet tagging algorithms with adversarial training — •Hendrik Schönen[1], Annika Stein[1], Judith Bennertz[1], Xavier Coubez[1,2], Alexander Jung[1], Summer Kassem[1], Ming-Yan Lee[1], Spandan Mondal[1], Alexandre de Moor[3], Andrzej Novak[1], and Alexander Schmidt[1] — [1]III. Physikalisches Institut A, RWTH Aachen University, Germany — [2]Brown University, USA — [3]Vrije Universiteit Brussel, Belgium

Neural network architectures have advanced over the last decade and are an important part of current jet flavour tagging algorithms. Since these algorithms rely on training the network with simulated events as input, they might have a worse performance on detector data due to data/MC deviations. A possible approach to address this issue is adversarial training, which uses distorted inputs for training. One possibility to distort the inputs is applying a FGSM attack, which shifts the inputs in a way that maximizes the loss with a fixed magnitude. This talk is about the impact of adversarial training on the model performance and robustness.

T 34.4 Tue 17:45 HSZ/0405

Binning high-dimensional classifier output for HEP analyses through a clustering algorithm — •Svenja Diekmann, Niclas Eich, and Martin Erdmann — III. Physikalisches Institut A, RWTH Aachen University

The usage of Deep Neural Networks (DNNs) as multi-classifiers is widespread in modern HEP analyses. In standard categorisation methods, the high-dimensional output of the DNN is often reduced to a one-dimensional distribution by exclusively passing the information about the highest class score to the statistical inference method. Correlations to other classes are hereby omitted. Moreover, in common statistical inference tools, the classification values need to be binned, which relies on the researcher's expertise and is often non-trivial. To overcome the challenge of binning multiple dimensions and preserving the correlations of the event-related classification information, we perform K-means clustering on the high-dimensional DNN output to create bins without marginalising any axes. We evaluate our method in the context of a simulated cross section measurement at the CMS experiment, showing an increased expected sensitivity over the standard binning approach.

T 34.5 Tue 18:00 HSZ/0405

Resonant anomaly detection without background sculpting — •Manuel Sommerhalder[1], Gregor Kasieczka[1,2], Tobias Quadfasel[1], Anna Hallin[3], and David Shih[3] — [1]Institut für Experimentalphysik, Universität Hamburg, 22761 Hamburg, Germany — [2]Center for Data and Computing in Natural Sciences (CDCS), 22607 Hamburg, Germany — [3]NHETC, Dept. of Physics and Astronomy, Rutgers University, Piscataway, NJ 08854, USA

Anomaly searches are a class of machine learning–based methods to search for new phenomena without relying on specific signal and background models. They provide a promising complement to the typically model-dependent searches for physics beyond the standard model at the LHC. Resonant anomaly detection methods, such as CATHODE, make use of the assumptions of a signal being localized in one feature and have demonstrated great performance in terms of classifying new physics signals on simulation-based studies. However, they are prone to background sculpting in the case of input features being correlated with the resonant one and thus can ultimately impair a background estimation via the bump hunt. We thus propose Latent CATHODE (LaCATHODE), a new technique for resonant anomaly detection, which moves the features into a decorrelated latent space. Using the LHC Olympics R&D dataset, we observe that LaCATHODE leaves the background unsculpted while retaining much of the signal extraction performance of the original CATHODE approach.

T 34.6 Tue 18:15 HSZ/0405

ANN for Pulse Shape Analysis in GERDA — •Vikas Bothe for the GERDA-Collaboration — Max-Planck-Institute for Nuclear physics, Heidelberg

The GERDA experiment searches for the neutrinoless double-beta decay of 76Ge using enriched high-purity Germanium diodes as a source as well as a detector. For such a rare event search, the sensitivity of the experiment can be improved by employing active background suppression techniques. The time-profile analysis of the signals, called pulse shape analysis (PSA), generated by energy deposits within the detectors is employed to discriminate signal and background events. An effective PSA with artificial neural networks can reject the background events like alpha particles and Compton scattered photons while preserving a high signal efficiency for double beta decay-like events.

Coaxial detectors due to their geometry have significantly homogenous weighting potential adding a spatial dependence to pulse shapes. This makes the signal-background differentiation difficult with the use of simple mono-parametric cuts and to overcome this, we employ a multi-variate analysis with artificial neural networks which are capable of modeling complex relationships.

I will give a review of the methodology in building these ANN and their performance for PSA in GERDA.

T 35: Neutrino Astronomy II

Time: Tuesday 17:00–18:30 Location: POT/0051

T 35.1 Tue 17:00 POT/0051

Simulation of Bioluminescence for the Pacific Ocean Neutrino Experiment — •Moritz Brandenburg and Christian Haack for the P-ONE-Collaboration — Technical University Munich, Germany

The Pacific Ocean Neutrino Experiment (P-ONE) is a planned cubic kilometer-scale neutrino telescope in the Pacific Ocean. The first prototype detector line, P-ONE-1, is currently under construction. It consists of multi-PMT optical modules that will measure Cherenkov light produced by high-energy charged particles that stem from neutrino interactions in water. The optical modules are very sensitive to photons in the optical range, thus studying the impact of luminescent bio-organisms in the deep sea is crucial to forecasting expected trigger rates and the impact on neutrino searches. In this contribution we present a simulation that models the expected water currents around the optical modules which lead to stress-induced light emission of bioluminescent organisms. In the next step, the simulation propagates individual photons from expected emission positions to a simulated optical module. Analyzing the photon hits and PMT coincidences helps in designing the trigger algorithm that filters noise and reduces the background data rate.

T 35.2 Tue 17:15 POT/0051

Optical Timing and Synchronization for the Pacific Ocean Neutrino Experiment — •Lea Ginzkey, Christian Spannfellner, Michael Böhmer, and Elisa Resconi for the P-ONE-Collaboration — Technical University of Munich, Garching bei München, Germany

The Pacific Ocean Neutrino Experiment (P-ONE) aims to instrument more than one cubic kilometer of the Northeast Pacific Ocean off Vancouver Island (Canada) as a non-invasive next-generation neutrino telescope. P-ONE will measure high-energy astrophysical neutrinos and characterize the nature of astrophysical accelerators. A sub-ns timing synchronization within the photosensors in the detector volume is necessary to reconstruct the direction and energy of such highly energetic particles. Between the individual components of the P-ONE detector point-to-point fiber connections are used. A special implementation of ethernet allows to proliferate a central clock and synchronization signals to all modules in the system in real time, while offering a high bandwidth data connection by established protocols. This approach reduces the complexity of the system and cable design and optimizes the power consumption within the detector. First results of on- and offline delay measurements will be presented.

T 35.3 Tue 17:30 POT/0051

Neutrino detection with new triggers at the Pierre Auger Observatory* — Srijan Sehgal and •Michael Schimp for the Pierre Auger-Collaboration — Bergische Universität Wuppertal, Wuppertal, Germany

The Pierre Auger Observatory apart from detecting ultra-high energy comic rays is also an excellent instrument to look for highly inclined neutrino-induced air showers using its Surface Detector (SD) array. To improve the detection efficiency and to decrease the energy threshold of the array, two new SD triggers, time-over-threshold-deconvolved (ToTd) and multiplicity of positive steps (MoPS) were added in 2014.

This talk presents the work done to evaluate the effect of new triggers on the neutrino search. Events with energies below 10^{19} eV and in the zenith angle range of $60^\circ < \theta < 75^\circ$ are selected for both data and simulated neutrino-induced showers. The particular focus is on the improvements with the new triggers, MoPS and ToTd, to the neutrino sensitivity in comparison to previous neutrino searches at the Pierre Auger Observatory.

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T 35.4 Tue 17:45 POT/0051

Novel approaches in multimessenger observation of core-collapse supernovae — •David Maksimović and Michael Wurm — Johannes Gutenberg University, Mainz, Germany

In the case of a nearby galactic core collapse supernovae (CCSN), large-scale neutrino observatories and gravitational wave interferometers are expected to provide a wealth of experimental data.

This contribution presents a novel machine learning approach in the field of multi-messenger astronomy by investigating possible correlation between features in gravitational waves (GW) and neutrino signals originating from such galactic CCSN. Overarching phenomena during the explosion process can be so better understood, such as the suspected standing accretion shock instability (SASI) or oscillation modes of the newly formed proto-neutron star. Applying machine learning on combined GW- and neutrino-detector outputs from simulated CCSN can enable us a potential reconstruction of these crucial moments and parameters such as the shock radius during the explosion.

T 35.5 Tue 18:00 POT/0051

Event selection and spectrum unfolding for Supernova burst neutrinos in JUNO — •Thilo Birkenfeld, Achim Stahl, Jochen Steinmann, and Christopher Wiebusch — RWTH Aachen University

No core-collapse supernova (CC-SN) exploded close enough to be observed by terrestrial neutrino telescopes since the first detection of neutrinos from SN 1987A. The Jiangmen Underground Neutrino Observatory (JUNO) is a next-generation liquid scintillator detector with a large target mass of 20 kt. It will provide valuable insight into the details of the SN mechanism by observing the neutrino burst of a galactic CC-SN with high statistics and an unpreceded energy resolution of 3 % @ 1 MeV. JUNO will be sensitive to signals from all neutrino flavors via different detection channels. The reconstruction of their respective energy spectra requires an effective event classification. In this talk, we will present the results of an event classification and a subsequent Bayesian-based energy spectrum unfolding.

T 35.6 Tue 18:15 POT/0051

Hunting Supernova neutrinos with dark matter detectors — •Melih Kara — Karlsruhe Institute of Technology, Institute for Astroparticle Physics

During a massive star's death, 99% of its energy is released in the form of neutrinos. Neutrinos of all flavors escape the core well before any light. If detected, they can provide crucial information on stellar core collapse and its mechanisms. Detection of the next galactic supernova will provide the first multimessenger signal from electromagnetic waves, gravitational waves, and neutrinos. While existing neutrino observatories mostly probe neutrinos of a single flavor, ton-scale dark matter detectors can provide information from all flavors through coherent elastic neutrino-nucleus scattering, CEνNs, in the low-energy (few keV) range.

In this talk, we will discuss the challenges and opportunities of using two-phase xenon dark matter detectors for supernovae neutrino detection, and we will review some of the recent results and future prospects in this exciting field of research. I am also going to introduce the supernova early warning system, SNEWS, and the integration of the XENONnT experiment to SNEWS.

T 36: Gamma Astronomy II

Time: Tuesday 17:00–18:30 Location: POT/0151

T 36.1 Tue 17:00 POT/0151

Status of the Medium-Sized Telescopes of the Cherenkov Telescope Array — •Florian Leitgeb for the CTA MST Project — Deutsches Elektronen-Synchrotron DESY, Platanenallee 6, D-15738 Zeuthen, Germany

The Cherenkov Telescope Array (CTA) is the next-generation ground-based observatory for gamma-ray astronomy at very high energies. In its initial Alpha Configuration, it will consist of 64 imaging atmospheric Cherenkov telescopes of different sizes and designs, which will be deployed in the form of two large arrays in the northern hemisphere at the Roque de Los Muchachos Observatory on La Palma (Canary Islands, Spain) and in the southern hemisphere at the Paranal Observatory in the Atacama Desert (Chile), respectively.

The core energy range (100 GeV to 10 TeV) will be covered by the Medium-Sized Telescopes (MSTs), which are planned to be deployed at both sites. An international collaboration of institutes and universities from various countries is responsible for the design, construction and commissioning of the MSTs. The MST effort is grouped into three subprojects: one for the telescope structure, and two for the Cherenkov cameras which differ in their camera design.

In this contribution, an overview of the MST telescope and the status of the MST project will be presented, including the plans for building one pre-production telescope, a so-called pathfinder, per site ahead of the bulk production.

T 36.2 Tue 17:15 POT/0151

Status of the Large-Sized Telescopes of the Cherenkov Telescope Array — •Martin Will for the CTA Consortium — Max-Planck-Institut für Physik, München

The Cherenkov Telescope Array (CTA), the next-generation ground based observatory for gamma-ray astronomy at very high energies, will consist of Imaging Atmospheric Cherenkov Telescopes of different sizes and designs. Two arrays are foreseen, one in the northern hemisphere at the Roque de Los Muchachos Observatory on La Palma (Canary Islands, Spain) and one in the southern hemisphere at the Paranal Observatory in the Atacama Desert (Chile).

The Large-Sized Telescope (LST) will be part of both arrays. With its reflective surface of 23 meter diameter, the LSTs are optimized to detect gamma-rays in the low energy range (20 GeV to 3 TeV). LST-1 in La Palma is close to finishing its commissioning phase and scientific data taking has started.

In this presentation, the status and plans for the LSTs in La Palma and Chile will be shown.

T 36.3 Tue 17:30 POT/0151

LST-1 observations of BL Lacertae flare in 2021 — •seiya nozaki[1], katsuaki asano[2], gabriel emery[3], juan escudero pedrosa[4], and chaitanya priyadarshi[5] for the CTA-Collaboration — [1]Max Planck Institute for Physics, Munich, Germany — [2]Institute for Cosmic Ray Research, Chiba, Japan — [3]University of Geneva - DPNC, Geneva, Switzerland — [4]Institute of Astrophysics of Andalusia - CSIC, Granada, Spain — [5]Institute for High Energy Physics, Barcelona, Spain

The Cherenkov Telescope Array (CTA) will be the next-generation very-high-energy gamma-ray observatory. Three different sizes of telescopes are planned to be built to cover a wide energy range. The Large-Sized Telescope (LST), with a 23-m diameter mirror dish, is designed to detect low-energy gamma-ray signals upwards from a few tens of GeV. This energy range plays a crucial role in the exploration of the extragalactic objects, especially transient sources. The first prototype of LST (LST-1) located at La Palma (Canary Islands, Spain) has been in a commissioning phase since 2018 and already started to observe gamma-ray sources. In 2021, LST-1 observed BL Lacertae and detected enormous gamma-ray flares with a large flux variability. In this contribution, we will report the results of LST-1 observations of BL Lacertae in 2021, including the energy spectrum down to around the energy threshold of LST-1 and sub-hour-scale fast flux variability.

T 36.4 Tue 17:45 POT/0151

Status and results of TAIGA — Michael Blank[1], Martin Brückner[3,4], Alaa Kuotb Awad[1], Razmik Mirzoyan[2], Andrea Porelli[3], •Martin Tluczykont[1], and Ralf Wischnewski[3] — [1]Institut für Experimentalphysik, Universität Hamburg, Deutschland — [2]Max Planck Institut für Physik, München, Deutschland — [3]Deutsches Elektronen Synchrotron, Zeuthen, Deutschland — [4]PSI, Zürich, Schweiz

TAIGA (Tunka Advanced Instrument for Gamma-ray and cosmic ray Astrophysics) is implementing a new, hybrid air Cherenkov observation technique to access the TeV to PeV gamma-ray regime, particularly important to spectrally resolve the cutoff regime of cosmic-ray pevatrons. The TAIGA complex consists of a distributed array of 120 wide angle (0.6 sr) air Cherenkov timing stations (TAIGA-HiSCORE) covering 1.1 square-km, three 4.2m imaging air Cherenkov telescopes (TAIGA-IACTs) with a field of view of 9.6deg, and a surface and underground scintillator-based muon detector array. For a proof-of-principle of the hybrid method, combining IACTs with a non imaging timing array, first the individual components were tested. Both the HiSCORE array and the IACTs were found to operate within expectations using simulations and comparisons to real data. Measurements of a light source onboard the international space station were used to verify the pointing of HiSCORE and IACTs. Recently, the Crab Nebula was detected using data from the first TAIGA-IACT in stand alone mode. In the beginning of March 2022, we froze the collaboration work, but the German team is continuing to work with the available data.

T 36.5 Tue 18:00 POT/0151

FACT - Ten Years of Operation — •Daniela Dorner[1], Bernd Schleicher[1], and FACT Collaboration[2] — [1]Universität Würzburg, Germany — [2]ww.fact-project.org

The First G-APD Cherenkov Telescope (FACT) started operation in October 2011. Designed for remote and automatic operation and using semiconductor photosensors, the duty cycle of the instrument is maximized and the gaps in the light curves minimized. Thanks to the unbiased observing strategy, a unique and unprecedented data sample has been collected. The physics program consists of monitoring of bright TeV blazars combined with follow-up observations of multi-wavelength and multi-messenger alerts. The presentation summarizes the lessons learned from ten years of operation and the results of this legacy data sample.

T 36.6 Tue 18:15 POT/0151

The MAGIC of VHE gamma-ray astronomy: 20 years, 200 peer-reviewed publications and beyond — •David Paneque for the MAGIC-Collaboration — Max Planck Institute fuer Physik, Muenchen, Deutschland

The MAGIC telescope system consists of two 17-m diameter mirror dish telescopes located at 2200m a.s.l. on the Canary Island of La Palma, in Spain. The year 2023 is the 20th anniversary of MAGIC, reaching the milestone of 200 peer-reviewed publications over a wide range of research areas, covering astrophysics with Galactic and extragalactic objects, dark matter searches, and studies of cosmology via the propagation of gamma rays from distant sources. MAGIC has become a world-wide leading instrument for gamma-ray astronomy in the energy range from 20 GeV to beyond 100 TeV, and an active participant in various multiwavelength and multimessenger observational campaigns. In the conference I will give a status report of this instrument, including the discussion of a few recent highlight results.

T 37: Neutrinos, Dark Matter IV

Time: Tuesday 17:00–18:30 Location: POT/0251

T 37.1 Tue 17:00 POT/0251

Characterisation of the first 166-pixel TRISTAN detector module in a MAC-E filter environment — •Christina Bruch — Technical University Munich, James-Franck-Straße 1, 85748 Garching bei München

One possible Dark Matter candidate is the keV-scale sterile neutrino, that would only interact via the mixing of sterile and active eigenstates. In a tritium beta decay spectrum, this mixing would lead to a characteristic, kink-like signature for sterile neutrinos with masses up to 18.6 keV. The KATRIN experiment will be upgraded with a novel TRISTAN multi-pixel silicon drift detector and readout system to search for this signature.

The final TRISTAN detector will consist of multiple 166 pixel detector modules. This presentation will give an overview of the first characterisation with electrons of one of this 166 pixel detector modules in the KATRIN Monitor Spectrometer, which is a KATRIN-like MAC-E filter environment.

This project has received funding from the European Research Council (ERC) under the European Union Horizon 2020 research and innovation program (grant agreement No. 852845). In addition, this work is supported by BMBF (05A17PM3, 05A17PX3, 05A17VK2, 05A17WO3), KSETA, the Max Planck society, and the Helmholtz Association.

T 37.2 Tue 17:15 POT/0251

Search for Light Sterile Neutrinos with the KATRIN Experiment — •Xaver Stribl for the KATRIN-Collaboration — Chair for Dark Matter E47, Technical University of Munich

Light sterile neutrinos with a mass on the eV-scale could explain several anomalies observed in short-baseline oscillation experiments. The Karlsruhe Tritium Neutrino (KATRIN) experiment is designed to directly determine the effective electron anti-neutrino mass by measuring the tritium beta decay spectrum. The measured spectrum can also be investigated for the signature of light sterile neutrinos.

In this talk we present the status of the light sterile neutrino analysis of the KATRIN experiment. To handle the increasing computational challenge, a neural network is adapted for the analysis and its applicability is validated. This neural network is then used on Monte Carlo data sets to study the sensitivity of the first five measurement campaigns as well as the impact of individual systematic uncertainties. The obtained sensitivity is compared to current results and anomalies in the field of light sterile neutrinos.

T 37.3 Tue 17:30 POT/0251

Penning trap induced background in the KATRIN experiment — •Florian Fraenkle for the KATRIN-Collaboration — Institute for Astroparticle Physics (IAP), Karlsruhe Institute of Technology (KIT)

The KArlsruhe TRItium Neutrino (KATRIN) experiment is a largescale experiment with the objective to determine the effective electron anti-neutrino mass with an unprecedented sensitivity of 0.2 eV/c^2 at 90% CL in a model-independent way based on precision β-decay spectroscopy of molecular tritium. KATRIN is currently in the middle of several physics measurement campaigns and so far has improved the upper bound on the effective electron-neutrino mass to 0.8 eV at a 90% confidence level.

A Penning trap located between the KATRIN spectrometers, in combination with a large flux of β-decay electrons in this area, produces a scan-step-duration-dependent background which is one of the leading systematic uncertainties of KATRIN. This background was successfully mitigated with an optimized configuration of the voltages in the KATRIN beamline and is not present anymore in recent measurement campaigns. This talk will present measurements and a background model to describe the Penning trap induced background.

This work is supported by the Helmholtz Association, the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Initiative and Networking Fund (W2/W3-118).

T 37.4 Tue 17:45 POT/0251

WISPLC: Search for Dark Matter with LC Circuit — •Zhongyue Zhang[1], Oindrila Gosh[2], and Dieter Horns[1] — [1]Institut für Experimentalphysik, Universität Hamburg, Luruper Chausseee 149, 22761 Hamburg — [2]I. Institute of Theoretical Physics, Universität Hamburg, Notkestraße 9-11, 22607 Hamburg

The focus on dark matter search has expanded to include low-mass particles such as axions or axion-like particles (ALPs). Assuming dark matter is composed of axions, in presence of a strong magnetic field, they induce a displacement current that generates a magnetic field detectable by state-of-art superconducting quantum interference devices (SQUIDs). The Weakly Interacting Slender Particle detection with LC circuit (WISPLC) is a precision direct detection experiment that will search for light dark matter candidates such as ALPs in part of the parameter space previously unexplored. The key facility is a large cryogen-free magnetic system that can produce a maximum solenoidal magnetic field of 14 Tesla at the center of the bore, inducing an axion-sourced toroidal magnetic field which can be captured by a superconducting pickup loop. We present two detection scheme: a broadband detection with up to 2 MHz bandwidth, and a resonant scheme where a LC circuit is used to enhance the signal with an expected Q factor $\sim 10^4$. Taking into account the irreducible flux noise of SQUIDs, we estimate the sensitivity of the experiment in the axion mass range between 10^{-11} eV and 10^{-6} eV to reach a detectable axion-photon coupling of $g_{a\gamma\gamma} \approx 10^{-15}$ GeV^{-1}, making it possible to probe mass ranges corresponding to ultralight axions motivated by string theory.

T 37.5 Tue 18:00 POT/0251

Towards direct neutrino mass measurement with the Project 8 experiment — •Larisa Thorne for the Project 8-Collaboration — Johannes Gutenberg University Mainz

There have been significant gains in characterizing neutrino properties in recent years, however the absolute neutrino mass scale continues to be elusive. The Project 8 collaboration seeks to probe this quantity directly via kinematic analysis of tritium beta decay, using the novel cyclotron radiation emission spectroscopy (CRES) technique with an atomic tritium source. CRES employs a frequency-based approach to measure tritium beta decay spectra in the endpoint region, where the spectral shape is most sensitive to distortions from the neutrino mass. Here we present a roadmap of Project 8 towards neutrino mass, with a design sensitivity of 40 meV. This includes recent results from our successful demonstrator experiment with tritium, as well as status updates on the components comprising the experiment's future full-scale version.

T 37.6 Tue 18:15 POT/0251

Precise Temperature Characterization of an Atomic Hydrogen Source — •Brunilda Muçogllava and Martin Fertl for the Project 8-Collaboration — Johannes Gutenberg Universität Mainz

In order to achieve a neutrino mass sensitivity of 40 meV, Project 8 aims to use the Cyclotron Radiation Emission Spectroscopy technique to analyze the tritium beta decay spectrum. To that end, a tritium atomic beam must be constructed and employed. Due to tritium's radioactive nature, initial measurements have been carried out using a Hydrogen Atom Beam Source (HABS) at the Mainz atomic test stand. The HABS produces hydrogen atoms via a 1 mm diameter tungsten capillary radiatively heated to ~ 2300 K by a filament. Precise capillary temperature measurements with low uncertainty at this high temperature are required for accurate characterization of the source. This is particularly important to understand the dissociation efficiency from molecular into atomic hydrogen, the key performance parameter for the atomic source. In this talk, the results of several temperature measuring devices will be discussed: a thermocouple inside the HABS, an optical spectrometer operated from outside the vacuum system, and a camera looking into the interior of the capillary.

T 38: Neutrinos, Dark Matter V

Time: Tuesday 17:00–18:30 Location: POT/0361

T 38.1 Tue 17:00 POT/0361

Understanding the RF response of the MADMAX experiment — •Juan Pablo Arcila Maldonado for the MADMAX-Collaboration — Max Planck Institute for Physics/ University of Bonn

The MADMAX collaboration aims to probe the parameter space of the QCD axion around the well-motivated range of 40-400 μeV, which is out of reach for conventional cavities, using a novel technique referred to as dielectric haloscope. This concept relies on the power enhancement by constructive interference of axion-induced microwave signals from multiple dielectric boundaries. A prototype to verify the sensitivity of this approach was built, which helped to understand the underlying physics and the dependency from parameters on the axion-generated signal power. This talk presents the first results and discusses the next steps toward a possible final MADMAX setup.

T 38.2 Tue 17:15 POT/0361

Fitting the reflectivity of the MADMAX booster — •David Leppla-Weber for the MADMAX-Collaboration — Institut für Experimentalphysik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg — Now at Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

The **MA**gnetized **D**isk and **M**irror **A**xion e**X**periment is a dielectric haloscope aiming to detect axions from the galactic halo by resonant conversion to photons in a strong magnetic field. It uses a stack of dielectric disks, called booster, to amplify the axion-photon conversion probability over a significant mass range dependent on the position of the adjustable disks. In the planned prototype, depending on the axion mass, amplifications of a factor of $\sim 10^4$ can be achieved. To calibrate the system, an optimization fitting measurements to simulation is needed. The main physical quantity of the booster that can be measured is its complex reflectivity. It is shown how the simulation parameters are optimized in a way to reproduce the measured reflectivity. Previously, instead of the reflectivity, the group delay was used. The new method improves the match between simulation and measurement by one order of magnitude.

T 38.3 Tue 17:30 POT/0361

In-place optimization of a dielectric haloscope for axion dark matter detection, MADMAX — •Dominik Bergermann for the MADMAX-Collaboration — RWTH Aachen University, Physics Institute III A

The axion is a promising candidate to explain cold dark matter and the absence of CP violation in strong interaction. The **MA**gnetized **D**isc and **M**irror **A**xion e**X**periment is a planned experiment which intends to probe axion dark matter in a mass range of 40 to 400 μeV. It is a dielectric microwave haloscope utilizing the axion photon conversion, consisting of multiple, consecutive and movable dielectric discs.

Covering this range with a single experimental setup, while simultaneously being able to finetune the resonance on potential signals, necessitates repositioning the experimental hardware continuously and automatically. In simulations the parameter-space (disc positions) can be optimized to produce desired signals. Prominent optimizers are Nelder-Mead or Quasi-Newtonian algorithms.

This talk focuses on the attempt of optimizing a physical, scaled-down MADMAX-like setup in-place based on it's electrical microwave responses. Challenges are the reduced set of information, the time requirement of the motor movement and the reliability of the algorithm.

T 38.4 Tue 17:45 POT/0361

Axion-Photon Coupling Distributions for Non-Minimal DFSZ-type Axion Models — •Johannes Diehl and Emmanouil Koutsangelas — Max Planck Institute for Physics, Munich, Germany

We systematically calculate anomaly ratios and thus axion-photon couplings for non-minimal DFSZ models. This allows us to classify every model and study the resulting distributions to make predictions for axion experiments like haloscopes, helioscopes or light-shining-through-a-wall experiments. Doing so we confirm the experimental importance of the values dictated by the minimal DFSZ models, while also extending the viable axion parameter space. We map this space by introducing a theoretical prior probability distribution for DFSZ-type axions under the assumption of equally probable numbers of Higgs doublets $n_D \leq 9$ and give 68% and 95% lower bounds on the axion-photon coupling. In contrast to the minimal DFSZ models, there is a large number of non-minimal DFSZ models with domain wall number of unity, thus avoiding the domain wall problem. We find a significantly enhanced axion-photon coupling compared to the minimal DFSZ models, adding to the experimental relevance of this subset.

T 38.5 Tue 18:00 POT/0361

Search for the DSNB in JUNO: Development of new Methods for Background Event Identification — •Matthias Mayer[1], Lothar Oberauer[1], Raphael Stock[1], Hans Steiger[2], Konstantin Schweizer[1], Ulrike Fahrendholz[1], David Dörflinger[1], Simon Appel[1], Carsten Dittrich[1], Korbinian Stangler[1], Simon Csakli[1], and Florian Kübelbäck[1] — [1]Technische Universität München, München, Germany — [2]Institute of Physics and EC PRISMA+, Johannes Gutenberg Universität Mainz, Mainz, Germany

The diffuse supernova neutrino background (DSNB) describes the constant flux of neutrinos from past core-collapse supernovae over the entire visible universe. The Jiangmen Underground Neutrino Observatory (JUNO), a 20 kton liquid scintillator detector, plans to detect the DSNB in the inverse beta decay (IBD) detection channel. While other electron anti-neutrino sources will cause irreducible IBD background, non-IBD backgrounds such as neutron-induced events and NC interactions of atmospheric neutrinos can be reduced by careful pulse-shape discrimination (PSD). In this talk, I compare the performance of different PSD techniques with the prospect of increasing the fiducial volume available for the DSNB search. Additionally, I discuss the influence of possible quenching of non-IBD pulseshapes on the available discrimination performance in the DSNB energy region of interest. This work is supported by the DFG research unit "JUNO", the DFG collaborative research centre 1258 "NDM", and the DFG Cluster of Excellence "Origins".

T 38.6 Tue 18:15 POT/0361

Characterisation measurements of LAPPDs for ν-detectors — •Benedict Kaiser, Lukas Bieger, Marc Breisch, Jessica Eck, Tobias Heinz, Tobias Lachenmaier, and Tobias Sterr — Universität Tübingen, Physikalisches Institut, Auf der Morgenstelle 14, 72076 Tübingen

Designed for use in future neutrino experiments, Large Area Picosecond Photodetectors (LAPPDs) are novel Microchannel Plate (MCP) based photodetectors. With a uniform gain of 10^6 to 10^7 over a large active area of more than 370 cm, an LAPPD is capable of single photon detection. It features a position resolution of better than 3 mm and an unprecedented time resolution of better than 70 ps. This performance is achieved by using a compact, evacuated glass case containing a multi-alkali photocathode, a chevron pair of MCPs for electron multiplication, and 28 individual anode strips for signal detection. Currently, we are analysing the performance of an LAPPD using a self-developed test setup. This talk will outline the working principle and characteristics of an LAPPD and the first measurement results will be discussed.

T 39: Neutrinos, Dark Matter VI

Time: Tuesday 17:00–18:30 Location: POT/0006

T 39.1 Tue 17:00 POT/0006

Constraining the $^{77(m)}$Ge Production with GERDA Data and Implications for LEGEND-1000 — •Moritz Neuberger[1], Luigi Pertoldi[1], Stefan Schönert[1], and Christoph Wiesinger[2] for the GERDA-Collaboration — [1]Physik-Department E15, Technische Universität München — [2]Physik-Department E47, Technische Universität München

The delayed decay of $^{77(m)}$Ge, produced by neutron capture on ^{76}Ge, is a potential background for the next-generation neutrinoless double-beta decay experiment LEGEND-1000 at the LNGS site. Based on Monte Carlo simulations, various mitigation strategies and suppression techniques have been proposed to identify and suppress this background [1,2,3]. In this talk, we will present the results to search for $^{77(m)}$Ge by exploiting the isomeric state in ^{77}As. Given the very similar configuration - bare germanium detectors in liquid argon - it serves as a benchmark for our LEGEND-1000 predictions. This research was supported by the BMBF through the Verbundforschung 05A20WO2 and by the DFG through the SFB1258 and Excellence Cluster ORIGINS.

[1] C. Wiesinger et al., Eur. Phys. J. C (2018) 78: 597 [2] LEGEND-1000 pCDR, arXiv 2107.11462 [3] M. Neuberger et al., 2021 J. Phys.: Conf. Ser. 2156 012216

T 39.2 Tue 17:15 POT/0006

Plans for the Muon Veto of LEGEND-1000 — •Gina Grünauer for the LEGEND-Collaboration — Physikalisches Institut, Eberhard Karls Universität Tübingen

The **L**arge **E**nriched **G**ermanium **E**xperiment for **N**eutrinoless $\beta\beta$ **D**ecay (LEGEND) is a ton-scale experimental program searching for the neutrinoless $\beta\beta$ ($0\nu\beta\beta$) decay of ^{76}Ge. LEGEND-1000 will have a total active mass of the detector of about 1000 kg, with the goal of a discovery sensitivity at half-life of more than 10^{28} years. To reach such a sensitivity, the background rate must be reduced to less than 10^{-5} cts/(keV·kg·yr). A Cherenkov Muon Veto is currently being developed for this purpose. The new Veto will further optimize the detection efficiency and the noise. The number and positions of the photomultiplier tubes (PMTs) are adapted to the requirements of the LEGEND-1000 Muon Veto.

T 39.3 Tue 17:30 POT/0006

ASIC-based front-end electronics for LEGEND-1000 — •Florian Henkes, Michael Willers, and Susanne Mertens for the LEGEND-Collaboration — Physik-Department, E47, Technische Universität, München, Germany

The **L**arge **E**nriched **G**ermanium **E**xperiment for **N**eutrinoless $\beta\beta$ **D**ecay (LEGEND) is a ton-scale, ^{76}Ge-based, neutrinoless double-beta ($0\nu\beta\beta$) decay experimental program with discovery potential at half-lifes greater than 10^{28} years.

Low-background and low-noise signal readout electronics in close vicinity to the HPGe-detectors are crucial in order to achieve the experiment's sensitivity on $0\nu\beta\beta$-decay. The close proximity to the detectors poses unique challenges to balance electronic performance with radiopurity requirements. In LEGEND-1000, the use of **A**pplication-**S**pecific **I**ntegrated **C**ircuit (ASIC) technology would allow to implement the entire charge sensitive amplifier into a single low-mass chip with ultimate electronic noise performance and signal fidelity while ideally further reducing backgrounds.

In this contribution, the current status of the LEGEND-1000 ASIC based readout development will be presented. It will focus on the design challenges of the CSA implementation and present first results of simulations and measurements of the chip.

T 39.4 Tue 17:45 POT/0006

Double weak decays of ^{124}Xe and ^{136}Xe in XENON1T and XENONnT — •Christian Wittweg for the XENON-Collaboration — Physik-Institut, Universität Zürich

The current generation of xenon-based dark matter direct detection experiments has reached large enough target masses and low enough background levels to probe rare double weak decays. Among these decays are the two-neutrino double electron capture (2νECEC) of ^{124}Xe as well as the neutrinoless double beta decay ($0\nu\beta\beta$) of ^{136}Xe. Observation of the hypothetical neutrinoless decay would provide definite proof of the neutrino's Majorana nature and indicate lepton number violation. The measurement of the Standard Model 2νECEC – first detected by XENON1T in 2018 – provides nuclear structure information that is a crucial input for the nuclear models used to interpret $0\nu\beta\beta$ experiments. This contribution will present the ^{124}Xe 2νECEC results and search for $0\nu\beta\beta$ of ^{136}Xe in XENON1T. Moreover, the sensitivity projection for a ^{136}Xe $0\nu\beta\beta$ search in XENONnT will be outlined.

T 39.5 Tue 18:00 POT/0006

Fast track simulations in XENONnT — •Jaron Grigat for the XENON-Collaboration — Albert-Ludwigs-Universität, Freiburg, Deutschland

We present the work on a fast, effective simulator for the XENONnT dark matter experiment, which bypasses the sophisticated - but resource-intensive - full simulation of waveforms, while remaining as accurate as possible. This talk focuses on the aspect of predicting the multi-scatter resolution in this 'fast track' simulation framework using machine learning techniques.

T 39.6 Tue 18:15 POT/0006

Light signal correction for the XENONnT experiment — •Johanna Jakob for the XENON-Collaboration — Institut für Kernphysik, WWU Münster

XENONnT, the latest stage of the XENON dark matter project, is currently taking science data with the science goals to detect WIMP-nucleus scattering and to search for other rare events. The detector is a dual-phase time projection chamber (TPC) filled with 8.5 tonnes of liquid xenon. The detector side walls reflect the scintillation light caused by energy deposition in the detector, which is registered at the top and bottom by photomultiplier arrays. Free electrons, additionally created by the energy deposition, are drifted to the gaseous phase at the top of the detector where they create a secondary scintillation light pulse by electroluminescence. The combination of light and charge signal allows for a 3-dimensional position reconstruction of the recorded events and a differentiation between electron and nuclear recoil events. This talk focuses on the light signal reconstruction, which requires a correction of the position dependent light collection efficiency. Based on calibration data from internal radioactive sources, light collection efficiency maps are derived and applied to the light signals.

This work is supported by BMBF under contract 05A20PM1 und by DFG within the Research Training Group GRK 2149.

T 40: Astro Particle Theory

Time: Tuesday 17:00–18:00 Location: POT/0112

T 40.1 Tue 17:00 POT/0112

Inferring the properties of the Solar magnetic field via the temporal evolution of Sun shadow and the produced secondaries — •Alex Kääpä — Ruhr-Universitaet Bochum D-44780 BOCHUM

The Sun shadow of cosmic rays (CRs) constitutes an unlikely intersection between Solar and CR physics. Previous work based on Monte-Carlo-based propagation studies has shown that properties of the Solar magnetic field (SMF) can be inferred from the temporal evolution of the size of the shadow. One main observation is the tempral correlation with the 11-year Solar cycle. During low activity, the SMF can be described as a dipole, whereas the structure of the field becomes exceedingly complex during high activity.

In this talk, we discuss follow-up and expansive simulation studies, based on these previous findings. Particular focus is put on the production of secondaries, i.e. photons and neutrinos. Our aim is to constrain the properties of the SMF during high activity and confirm or improve upon the dipolar description during low activity. We further discuss the prospects of experimentally testing said studies.

T 40.2 Tue 17:15 POT/0112

The radial field in the axion kinetic misalignment mechanisms — •Vera Butz — Institut für Astroteilchenphysik, Karlsruher Institut für Technologie (KIT), Germany

The axion kinetic misalignment mechanism introduces an initial velocity for the phase of a complex scalar field thereby creating axion dark matter with a lower decay constant. The introduction of a velocity in angular direction however gives rise to the question of what would happen if we also introduced a velocity in radial direction and allowed the radial field to change its value away from the PQ symmetry breaking scale f_a. In this work we study the behaviour of the radial field by solving the coupled equations of motion for the radial and angular fields at different times. We allow the radial field to decay into Standard Model particles, which damps the velocity in radial direction.

T 40.3 Tue 17:30 POT/0112

Neutrino fluxes from Z'-mediated Dark Matter annihilation in the Sun — •Miriam Neumann[1], Amin Aboubrahim[2], Luca Wiggering[2], Michael Klasen[2], and Alexander Kappes[1] — [1]Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, Germany — [2]Institut für Theoretische Physik, Westfälische Wilhelms-Universität Münster, Germany

While there is various experimental evidence for the existence of dark matter (DM), its nature remains unclear. If DM scatters from conventional matter, it can be gravitationally captured in the Sun, leading to a local overdensity and enhanced annihilation of DM into Standard Model particles. When the unstable particles from this interaction decay further this leads to a neutrino flux that can be searched for with the IceCube neutrino observatory. Thus, IceCube can be used for an indirect DM search, complementing direct DM searches. To describe the DM and its interactions, we use a minimal model that extends the Standard Model by only a few fields. We specifically investigate a Z'-mediated leptophobic model featuring Majorana DM. Due to the Majorana character, the DM nucleon scattering is completely spin-dependent, making this model particularly interesting for the search of neutrinos from the Sun with IceCube. We perform a scan of the model parameter space taking into account the recent constraints from DM direct and indirect detection experiments as well as LHC searches of a heavy Z' resonance. In this talk, we present some first results showing the parts of the parameter space that have evaded all constraints to date and can potentially be probed by IceCube.

T 40.4 Tue 17:45 POT/0112

Looking for massive ALPs from SN1987A with Cherenkov detectors — •Tim Kretz — KIT TTP, Karlsruhe, Deutschland

In this talk I will discuss the production of massive axion-like-particles (ALP) via nucleon Bremsstrahlung in supernova 1987A, and review the resulting exclusion limits for the nucleon-nucleon-ALP coupling in the large coupling regime. Following an earlier suggestion by Engel et al. for QCD axions, such ALPs may be absorbed by oxygen nuclei and lead to photon signals in the MeV regime induced by de-excitation. For massive ALPS the flux at Earth is essentially mono-energetic, due to the long time of flight from SN1987A that stretches out their spectral distribution. This allows to estimate the number of detectable events in water Cherenkov detectors like Super-Kamiokande or SNO+, which I will use to derive novel exclusion limits and motivate new dedicated searches for this signal.

T 41: Cosmic Ray II

Time: Tuesday 17:00–18:30 Location: POT/0013

T 41.1 Tue 17:00 POT/0013

Determination of the Energy Spectrum of UHECRs using Air Showers Detected by the Fluorescence and Surface Detector of the Pierre Auger Observatory — •Kathrin Bismark for the Pierre Auger-Collaboration — Karlsruher Institut für Technologie (KIT)

The origin, propagation and mass composition of ultrahigh-energy cosmic-rays (UHECRs) are still open questions. A precise measurement of the spectral features of the UHECR energy spectrum provides important clues to answer these questions.

In this contribution, we present an analysis of air shower data using a hybrid technique, i.e. the combination of surface (SD) and fluorescence detector (FD) measurements from the Pierre Auger Observatory. The high statistics of hybrid data available after more than 15 years of UHECR observations enable us to evaluate environmental influences on detection capabilities as well as to optimize selection criteria using measured rather than simulated data. We will show how previous estimates of the hybrid spectrum can be improved and present a preliminary calorimetric measurement of the energy spectrum of UHECRs.

T 41.2 Tue 17:15 POT/0013

Depth of Maximum of Air-Shower Profiles at the Pierre Auger Observatory — •Thomas Thomas for the Pierre Auger-Collaboration — Karlsruhe Institute of Technology, Institute for Astroparticle Physics, Karlsruhe, Germany

The Pierre Auger Observatory is the largest ultra-high energy cosmic ray observatory in the world. Using a hybrid technique (fluorescence telescopes and surface detectors) it is possible to estimate the mass composition of cosmic rays. The main mass-sensitive observable measured with fluorescence telescopes is the depth of maximum of air-shower profiles called X_{max}.

In this presentation, we will present the analysis of the most recent datasets for the standard eyes and also for the low energy measurements performed with the High Elevation Auger Telescope (HEAT). This low energy measurements allow to study the energy region where the transition between Galactic and extragalactic cosmic rays is expected.

T 41.3 Tue 17:30 POT/0013

A machine learning approach to mass composition studies of ultra-high energy cosmic rays with the AugerPrime upgrade of the Pierre Auger Observatory. — •Akash Parmar, Paulo Ferreira, and Thomas Hebbeker — RWTH Aachen University, Aachen, Germany

The Pierre Auger Observatory is the world's largest experiment to observe the extensive air showers produced by ultra-high energy cosmic rays. The observatory uses a hybrid detection method that combines 1600 ground-based water Cherenkov detectors covering an area of more than 3000 km^2 and 27 fluorescence detectors at four sites. The efficiency and measurement techniques of the Pierre Auger observatory are improved by the ongoing upgrade called AugerPrime. A part of the upgrade consists of deploying a scintillator detector on top of each water Cherenkov detector which provides additional information about the composition of the extensive air showers.

Currently, the understanding of cosmic rays at ultra-high energy is limited by low incoming flux and the available theoretical models for hadronic interactions. Precise measurement of the composition can help us understand the sources of cosmic rays and improve the current models.

The additional information provided by the combination of water Cherenkov detectors and scintillator surface detectors has been explored with a machine learning algorithm called random forest, to analyze the measurable properties of the shower and infer the mass composition of the primary particle.

T 41.4 Tue 17:45 POT/0013

Inferring Properties of Ultra-High-Energy Cosmic Ray Sources from Surface Detector Data of the Pierre Auger Observatory — Teresa Bister, Martin Erdmann, Merlin Klein, •Frederik Krieger, and Josina Schulte — III. Physikalisches Institut A, RWTH Aachen University

With the Pierre Auger Observatory, the energy spectrum and the distributions of the depths of the shower maximum X_{max} of ultra-high-energy cosmic rays (UHECRs) can be measured. The latter is correlated to the mass of the primary cosmic ray and can be directly measured by the fluorescence detector (FD). Using deep learning, X_{max} can also be extracted from the surface detector (SD) data which has the benefit of high event statistics. With these observables, characteristics of the sources of UHECRs can be inferred. Owing to the stochastic nature of interactions during propagation, simple inversion of the process from source to Earth is not possible. To this end, different inference methods can be used.

We present and compare two different inference methods and apply them to actual astrophysical scenarios: the Markov Chain Monte Carlo (MCMC) method and conditional invertible neural networks (cINNs). It has already been shown that cINNs perform similarly well to the frequently used MCMC method. We show the results of both methods on SD data of X_{max} and the energy spectrum.

T 41.5 Tue 18:00 POT/0013

Studying the properties of bursting UHECR sources in a multi-messenger approach* — •Leonel Morejon — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal

The study of Ultra-High Energy Cosmic Rays (UHECRs) via the multi-messenger approach is reaching a level that requires going beyond steady state sources. The exploration of bursting sources and the implications for multi-messenger detection is the goal of the French-German research project MICRO. Meeting this challenge requires improvements of the existing tools and defining new methods to accelerate the computations related to the propagation of UHECRs in extragalactic space and within the sources. The progress of MICRO in these aspects will be presented by discussing: a) a module to compute hadronic interactions within CRPropa, b) tools to fit the UHECR spectrum and composition with precomputed propagation tensors and corresponding propagation matrices, and c) the estimation of the impact that uncertainties of the latest models of Extragalactic Background Light (EBL) have on the precision in UHECR propagation.

* *Supported by the DFG through project number 445990517.*

T 41.6 Tue 18:15 POT/0013

Numerical investigation of bursting sources as potential accelerators of ultra-high-energy cosmic rays — •Leander Schlegel[1,2], Julia Becker Tjus[1,2], and Marcel Schroller[1,2] — [1]Theoretische Physik IV, Ruhr Universität Bochum, Bochum, Germany — [2]RAPP-Center at Ruhr Universität Bochum, Bochum, Germany

Since their discovery over a century ago, the origin of cosmic rays of the highest energies is still widely uncertain. While the observed constant flux suggests at first sight to analyze primarily steady state source models, the needed magnetic luminosities for potential sources seem to favor bursting sources, that appear in quiescent and flaring states, like the class of Active Galactic Nuclei (AGN). The goal of this work is trying to understand the detailed behaviour of bursting sources and their possible contribution to the UHECR flux, by simulating the time resolved propagation of a plasma blob inside the jet of an AGN and accounting for a temporal variability of the source. For this purpose, a tool for cosmic-ray propagation in relativistic plasmoids of AGN jets implemented into the open-source code CRPropa 3.1, is further improved. With this framework, we will predict the multimessenger signatures of flaring sources that are active for certain intervals in time, representing a flaring behaviour. With this investigation we aim to help providing a numerical AGN model, that can finally be tested against other source models by fitting to observed UHECR data.

T 42: Exp. Methods, IceAct, Auger, RNO-G

Time: Tuesday 17:00–18:30 Location: POT/0351

T 42.1 Tue 17:00 POT/0351

Construction of IceAct Telescopes — •Lea Schlickmann[1], Thomas Bretz[2], Lars Heuermann[1], Andreas Nöll[1], Merlin Schaufel[1], and Christopher Wiebusch[1] for the IceCube-Collaboration — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]GSI Helmholtzzentrum für Schwerionenforschung

IceAct is an array of Imaging Air Cherenkov Telescopes at the ice surface as part of the IceCube Neutrino Observatory. Each telescope features a 55cm diameter Fresnel lens and a camera with 61 Silicon Photomultiplier pixels resulting in a 12° field of view. The design is optimized for harsh environmental conditions, as in Antarctica. Since 2019, the first two telescopes are operating at the South Pole in a stereoscopic configuration. Seven telescopes can be combined in a fly's eye configuration, forming a so-called station which has a field of view of 36°. In the future, for IceCube-Gen2, an array of four stations is planned. The commissioning of a first full station is scheduled for the next years within the current surface upgrade. For this, six telescopes are being constructed. This talk will report on the construction and calibration of these telescopes.

T 42.2 Tue 17:15 POT/0351

Characterization and Optimization of the Readout Electronics for IceAct Telescopes — •Andreas Nöll[1], Thomas Bretz[2], Lars Heuermann[1], Merlin Schaufel[1], Lea Schlickmann[1], and Christopher Wiebusch[1] for the IceCube-Collaboration — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]GSI Helmholtzzentrum für Schwerionenforschung

IceAct is an Imaging Air Cherenkov Telescope array located at the South Pole as part of the IceCube Neutrino Observatory. The telescopes feature a 61 pixel camera based on Silicon Photomultipliers (SiPM). The camera signals are processed and digitized by the TARGET module, developed for the Cherenkov Telescope Array (CTA). The inherent high rate of ambient photons caused e.g. by stars, the Moon, and auroras combined with the high decay time of the SiPM signal results in a signal pile-up. The TARGET system provides an analog front-end for pulse shaping combined with a high sampling rate of 1GSa/s to accommodate the pile-up. Extensive tests are necessary to understand the complete signal chain from the SiPM to digitization. In this talk a characterization of the current system is presented. In addition design improvements, based on electronics simulations and tests with prototypes, will be proposed.

T 42.3 Tue 17:30 POT/0351

Three Years Performance of IceAct — •Lars Heuermann[1], Thomas Bretz[2], Oliver Janik[1], Silvia Latseva[1], Andreas Nöll[1], Merlin Schaufel[1], Lea Schlickmann[1], and Christopher Wiebusch[1] — [1]RWTH Aachen University - Physics Institute III B, Aachen, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung

IceAct is an array of Imaging Air Cherenkov Telescopes at the ice surface as part of the IceCube Neutrino Observatory. The telescopes, featuring a camera of 61 Silicon Photomultipliers and a fresnel lens based optic, are optimised to be operated in harsh environmental conditions, such as the South Pole. Since 2019, the first two telescopes operate in a stereoscopic configuration in the centre of IceCube's surface detector IceTop. The telescopes enable improved cosmic ray studies and cross calibrations of IceCube and IceTop by a hybrid measurement of air showers. This talk will review the performance and detector operations of the past 3 years of the telescopes as well as give an outlook for the future of IceAct.

T 42.4 Tue 17:45 POT/0351

A new network of electric field mills at the Pierre Auger Observatory — •Max Büsken for the Pierre Auger-Collaboration — Institute for Experimental Particle Physics, Karlsruhe Institute of Technology (KIT) — Instituto de Tecnologías en Deteccíon y Astropartículas, Universidad Nacional de San Martín (UNSAM)

The Pierre Auger Observatory is the largest ground-based instrument for the detection of ultra-high energy cosmic rays via extensive air showers. As part of the current detector upgrade, called AugerPrime, the new Radio Detector (RD) is being deployed, which will finally consist of 1661 radio antennas covering an area of more than 3000 km^2. A crucial ingredient for the interpretation of data taken with the RD is monitoring the atmospheric electric field over the observatory. Large atmospheric electric fields, typically in the presence of thunderstorms, can significantly alter the radio emission from air showers. Therefore, these kinds of conditions have to be flagged.

We present a new network of five electric field mills (EFM) that was installed at the Pierre Auger Observatory to tackle this task. The network is designed such that each EFM measures the electric field with an absolute calibration. The setup of the network and the deployment process are shown. First data are presented.

T 42.5 Tue 18:00 POT/0351

Nanosecond time synchronization of distributed detectors — •Yan Seyffert and Tim Huege — Karlsruhe Institute of Technology (KIT), Institute for Experimental Particle Physics, Karlsruhe, Germany

At the Pierre Auger Observatory, the surface detectors used to detect and measure cosmic-ray air showers are placed in a triangular ground pattern with a 1500 m spacing, covering a total area of about 3000 km^2. Time synchronization of such distributed detectors to very high accuracy on the nanosecond scale is challenging. Currently, ordinary GPS receivers are used, which simply and independently report the GPS-time/UTC-time at their current position. Achieving 1 ns relative time accuracy between detectors would prove very useful, for example in the context of the measurement of radio emissions from extensive air showers. Accurate timing information of an event recorded by an array of radio antennas would enable intriguing possibilities for radio-interferometric analyses of cosmic-ray air showers.

This talk will report on recent findings regarding wirelessly communicating GPS modules with currently non-standard capabilities, promising 3 cm accurate relative positioning and thus potentially 1 ns relative timing accuracy.

T 42.6 Tue 18:15 POT/0351

Study of the antenna response for the Radio Neutrino Observatory Greenland (RNO-G) — •Anna Eimer for the RNO-G-Collaboration — Erlangen Centre for Astroparticle Physics (ECAP), Erwin-Rommel-Str. 1, D-91058 Erlangen

Ultra high energy neutrinos can be detected via radio emission following a neutrino interaction in ice. The long attenuation length of radio signals in ice allows for a much sparser instrumentation than required for optical Cherenkov neutrino telescopes, hence making it possible to survey large volumes. The Radio Neutrino Observatory Greenland (RNO-G) is a project that will eventually consist of 35 stations (7 already deployed) with distances of about 1.25 km between neighbouring stations. Each station consists of 9 log-periodic dipole array (LPDA) antennas about 1.5 m below the ice surface and with up to 100 m deep in-ice strings, equipped with vertically and horizontally polarized dipole antennas.

Understanding the antenna properties and potential interferences between nearby antennas is important to operate the experiment to evaluate the recorded data and reconstruct neutrino properties. In this contribution, first results of lab studies with the RNO-G antennas with emphasis on interferences will be presented.

T 43: Electronics, DAQ, Exp. Methods

Time: Tuesday 17:00–18:30 Location: POT/0106

T 43.1 Tue 17:00 POT/0106

Turning an FPGA into a fast multi-channel ADC — •Dmitry Eliseev, Thomas Hebbeker, Markus Merschmeyer, Carsten Presser, and Erik Ehlert — III. Physikalisches Institut A, RWTH Aachen University, Germany

Electronics for particle detectors nowadays typically deal with a huge number of channels. In a typical detector read-out electronics, the front-end signals are passed through a multi-channel conditioning circuit and meet an FPGA chip at the other end. Modern FPGAs enable good time resolution for such multi-channel acquisition. However, the common solution remains to acquire information on the energy or amplitude of particular events using high-speed multi-channel ADCs. Using ADCs often results in more complex schematics and much higher costs of the electronics for signal acquisition. The presented method makes it possible to waive the ADCs and, to some extent, replace the ADC's functionality with FPGA's internal resources. The method requires a minimal number of additional low-cost external components and can be potentially interesting for many detector applications.

The talk provides a general overview of how to turn a commercially available FPGA device into a multi-channel high-speed ADC. Characterization measurements and calibration methods for the resulting FPGA-based ADC are also given. Possible technical difficulties and ways to overcome them are discussed in an example application: an 8-channel mezzanine PCB for signal acquisition from multiple SiPMs.

T 43.2 Tue 17:15 POT/0106

A Software-Scalable ADC in 28nm CMOS for Detector Readout — •Lukas Krystofiak — Forschungszentrum Jülich

Particle detector experiments rely more and more on advanced integrated circuits to achieve new discoveries. Their development is a lengthy and costly process, that poses a high threat to the overall success of a project. Using a pre-developed software-scalable ADC, adjustable in resolution and sample rate and ultimately in power consumption, catering to many different areas of applications, can decrease this risk substantially. While a generic approach will never reach the same performance as a dedicated development, it facilitates rapid prototyping and verification of readout methods prior to the building of the complete systems without the need to develop a dedicated chip. It also opens up possibilities for projects with smaller budgets. The key driver for this concept is the use of a bulk CMOS 28nm process technology, which allows incorporation of a powerful digital signal processor while analog performance and design is not too restricted. Here, the first iteration of a software-scalable ADC is shown. It features a high-precison mode with 11 Bit resolution and a maximum sample rate of 400 Megasample per second, and a low-power mode with 8 Bit resolution and 800 Megasample per second.

T 43.3 Tue 17:30 POT/0106

High-rate On-Board Drift Tube electronics testing — •Matej Repik, Dmitry Eliseev, Thomas Hebbeker, and Markus Merschmeyer — III. Physikalisches Institut A, Aachen, Germany

A general-purpose detector at the Large Hadron Collider (LHC), the Compact Muon Solenoid (CMS), undergoes changes that are summed up under the Phase 2 Upgrade. As one of the CMS muon-detecting subsystems, the drift tube chambers (DT) also require an upgrade. Among others, the plans foresee new On-Board Drift Tube (OBDT) electronics to replace the previous electronics. OBDTs congregate front-end signals from the DT chambers and stream the acquired data to the CMS back-end. Each OBDT also implements certain slow control routines. As for every complex device, quality assurance is essential for the new OBDT electronics. Consequently, a test system for OBDT is being developed by the DT collaboration with the following requirements: emulate drift tube front-end signals at the expected high hit rates and record the response of OBDT. This talk focuses on the aforementioned test system and its implementation at RWTH Aachen University.

T 43.4 Tue 17:45 POT/0106

Absolute luminosity calibration through van der Meer scans in ATLAS — •Cédrine Hügli for the ATLAS-Collaboration — DESY Zeuthen

Luminosity is a very important quantity for many physics analyses. Its precise knowledge is required for example in cross section measurements. In ATLAS, luminosity is measured by several detectors: the main luminometer is LUCID, located in the forward region and based on Cherenkov radiation. All luminosity detectors need to be absolutely calibrated through so-called van der Meer scans. These are scans where the two beams are scanned through each other, first in the horizontal and then in the vertical plane. In this work, the preliminary analysis of the run 3 13.6 TeV van der Meer scan from 2022 is presented. The analysis precisely measures the part of the inelastic proton-proton interaction cross section visible in the luminosity detectors, which is the absolute luminosity calibration constant. Its value is obtained by fitting the scan curves. During the van der Meer scan analysis several effects need to be corrected to get a precise calibration constant, for example the impact of the electromagnetic interaction of the beams on their separation. The obtained absolute calibration of luminosity is then transferred to physics conditions and used in the early run 3 ATLAS measurements.

T 43.5 Tue 18:00 POT/0106

Emittance Scans at the LHCb Detector in Run 3
— Johannes Albrecht, Elena Dall'Occo, Hans Dembinski, and •Jan Ellbracht — TU Dortmund University, Dortmund, Germany

Precise determination of the luminosity at the LHCb detector is needed for accurate measurements of cross-sections as well as in daily operations. The instantaneous luminosity at LHCb is levelled throughout the fill to optimise the detector performance, which is achieved by tuning the distance between the two colliding beams based on a real-time measurement of the luminosity. The luminosity calibration is performed once per year and per centre-of-mass energy in dedicated van-der-Meer scans. Here, particular beam conditions are used, leading to a maximum number of visible proton-proton interactions $\mu \sim 1$ when the beams are colliding head-on.

In Run 3 the LHCb detector operates at a five times higher instantaneous luminosity compared to the previous runs, with a μ of about 5.5. Therefore, it is planned to perform additional per-fill emittance scans in order to verify linearity from calibration to data taking conditions. This talk will focus on the emittance scan analysis, procedure and first results of Run 3 data.

Supported by DFG (SFB 1491)

T 43.6 Tue 18:15 POT/0106

Estimation of the van-der-Meer factorization bias using the Beam Imaging Method — •Konstantin Sharko and Andreas Meyer — Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

At the CMS Experiment at the LHC, van-der-Meer (vdM) scans are used to calibrate the luminosity measurement. The beam imaging (BI) data, a special type of vdM-scan data, are used to estimate and correct biases coming from the assumption of transverse factorization of the proton-bunch densities. In BI scans one of the beams is kept at rest while the other one moves along the x- or y-axis.

In this analysis, the four scans, one for each of the two transverse orientations and two beams, are fit using combinations of Gaussian functions to extract the van-der-Meer factorization bias for LHC Run-2 and Run-3 data.

T 44: Pixel/LHCb, Si-Strips/CMS

Time: Tuesday 17:00–18:30 Location: WIL/A317

T 44.1 Tue 17:00 WIL/A317

LHCb MightyPix - First measurements and ongoing developments — •Hannah Schmitz, Can-Deniz Arslan, Klaas Padeken, Niclas Sommerfeld, and Sebastian Neubert — Rheinische Friedrich-Wilhelms Universität Bonn

With the upgrade of the LHC to the HL-LHC in LS4, the instantaneous luminosity at the LHCb detector will be increased from $2 \times 10^{33}\mathrm{cm}^{-2}\mathrm{s}^{-1}$ to $1.5 \times 10^{34}\mathrm{cm}^{-2}\mathrm{s}^{-1}$. In order to enable fast and precise tracking in this environment, it is planned to upgrade the entire LHCb tracking system. The downstream tracking system, known as the Mighty Tracker, has to withstand the increased radiation and occupancy at a similar or lower material budget than the current detector. Thus, a hybrid solution consisting of silicon pixels, called MightyPix, with a size of 55x165μm in the inner and scintillating fibres in the outer region is under development. In order to fulfill the conditions beyond Run4, the pixels are based on the technology of HV-CMOS MAPS.

To characterize the MightyPix, a new readout system is currently developed in Bonn. Further, first characterization studies are ongoing and development chips as the ATLASPix3.1 have been characterized at testbeams.

This presentation covers an introduction into the newly developed readout system for the MightyPix, latest testbeam results and an overview of the current developments regarding the Mighty Tracker with focus on the MightyPix.

T 44.2 Tue 17:15 WIL/A317

Characterization of HV-CMOS sensors for the Mighty Tracker at LHCb — •Can-Deniz Arslan, Klaas Padeken, Hannah Schmitz, Niclas Sommerfeld, and Sebastian Neubert — Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

From Run 5 of the HL-LHC onwards the LHCb detector expects an instantaneous luminosity of $1.5 \cdot 10^{-34}\mathrm{cm}^{-2}\mathrm{s}^{-1}$.

The upgraded downstream tracker will be called the Mighty Tracker and it will be equipped with HV-CMOS sensors around the beamline and scintillating fibres in the outer regions. A development version of the MightyPix is currently characterized. For this purpose a newly developed readout system is used and commissioned.

A first characterization of the development chip will be shown. The status of further plans including an irradiation campaign at the isochronous cyclotron in Bonn will be reported.

T 44.3 Tue 17:30 WIL/A317

Development of a setup to measure the timing resolution of the upcoming Mighty Tracker — •Niclas Sommerfeld, Can-Deniz Arslan, Klaas Padeken, Hannah Schmitz, and Sebastian Neubert — Helmholtz-Institut für Strahlen- und Kernphysik Bonn

With the upgrade during LS4, the instantaneous luminosity at the LHCb experiment will increase by almost one order of magnitude to 1.5×10^{34} $\mathrm{cm}^{-2}\mathrm{s}^{-1}$. With this increased data rate the untriggered readout of the LHCb detector provides changeless for the tracking detectors. The downsteam tracker (Mighty Tracker) will be instrumented with HV-CMOS pixel sensors in the central part. To assign each hit to the correct bunchcrossing, a timing resolution of 3 ns is needed to contain 3 sigma of the hits in a 25 ns window.

To measure the timing resolution of the MightyPix in the lab, a timing setup is required. This ongoing development of a generalized timing layer will be presented within this talk. The setup will consist of fast plastic scintillators with SIPM readouts and configurable, standardized outputs. The modular design allows to use this setup in a variety of applications.

T 44.4 Tue 17:45 WIL/A317

High rate measurements of HV-MAPS for a future main tracker — Sebastian Bachmann, •Lucas Dittmann, Maja Lecher, and Ulrich Uwer — Physikalisches Institut, Heidelberg, Germany

The LHCb experiment plans to upgrade its detector during the long shutdown 4 of the LHC to cope with a further luminosity increase at LHCb's interaction point during Run 5. For this upgrade, the currently installed scintillating fiber tracker will be replaced by the MightyTracker. The MightyTracker consists of an inner part made from silicon pixels sensors and an outer part made from scintillating fibers.

For the silicon sensor part of the MightyTracker, dedicated High-Voltage Monolithic Active Pixels Sensors (HV-MAPS), which are called MightyPix, are proposed. HV-MAPS are produced in commercial High-Voltage CMOS technology, which allows the design of low cost, thin and radiation hard sensors.

The MightyPix sensors in the hottest regions of the MightyTracker will experience a mean particle rate of 125 kHz/mm^2. To determine possible hit rate limitations of existing HV-MAPS experimentally, rate measurements with ATLASPix3.1 sensors have been performed. The results are compared to theoretical expectations. The ATLASPix3.1 sensor is used as a proxy for the MightyPix sensor, since the pixel readout of both sensors will be structured similarly.

T 44.5 Tue 18:00 WIL/A317

Series Production of 2S Modules for the Phase-2 Upgrade of the CMS Detector in Aachen — Max Beckers[1], Christian Dziwok[1], Lutz Feld[2], Katja Klein[2], Martin Lipinski[2], Vanessa Oppenländer[2], Alexander Pauls[2], Oliver Pooth[1], Nicolas Röwert[2], Felix Thurn[2], and •Tim Ziemons[1] — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]I. Physikalisches Institut B, RWTH Aachen University, D-52056 Aachen

The CMS detector will be upgraded in the Phase-2 Upgrade for the operation at the HL-LHC. Among others, the silicon tracking system will be completely replaced by a new system providing an extended acceptance, an improved granularity and the feature to include tracking information into the first level hardware trigger. The new Outer Tracker will consist of 2S modules with two strip sensors and PS modules with a macro-pixel sensor and a strip sensor, specialized detector modules with onboard p_T discrimination.

Up to 1000 2S modules will be assembled and tested at RWTH Aachen University. In this talk, the module assembly process is summarized and the preparation of the series production is presented.

T 44.6 Tue 18:15 WIL/A317

Development of a database and web applications for the production of CMS 2S modules — •Max Beckers[2], Christian Dziwok[2], Lutz Feld[1], Katja Klein[1], Alexander Pauls[1], Oliver Pooth[2], Nicolas Röwert[1], Martin Lipinski[1], Vanessa Oppenländer[1], Felix Thurn[1], and Tim Ziemons[2] — [1]I. Physikalisches Institut B, RWTH Aachen University, D-52056 Aachen — [2]III. Physikalisches Institut B, RWTH Aachen University

For the CMS Phase-2 Outer Tracker upgrade, new silicon strip detector modules consisting of two silicon strip sensors, so-called 2S modules, are developed and produced. This process is distributed along multiple assembly centers worldwide. To ensure consistent module quality, many specifications need to be respected. This includes different kinds of tests and measurement results.

RWTH Aachen University will build around 1000 2S modules. The production requires well-organized procedures. To guarantee the transparency and traceability of the production conditions and module quality many data are recorded and analyzed.

This talk presents how production and testing are organized in Aachen with a focus on the processing of the acquired data during module assembly. This includes multiple web applications based on a central database. This database is compatible with the central CMS construction database. Exemplary measurements are shown.

T 45: Si-Strips, Pixel

Time: Tuesday 17:00–18:30 Location: WIL/A124

T 45.1 Tue 17:00 WIL/A124

Strip sensor characterization for the ATLAS ITk tracker — •Elizaveta Sitnikova — DESY, Hamburg, Germany

Before the start of High Luminosity LHC the Inner Detector of the ATLAS detector will reach the end of its operating life. It will be replaced by a new Inner Tracker (ITk), more suitable for high luminosity. Building the ITk requires a lot of effort from many institutes in the collaboration, and DESY is one of the main contributing institutes. One of the two strip ITk endcaps will be assembled at DESY. During production, the main sensing units of the tracker, the silicon microstrip sensors, have to pass a number of tests to ensure that they are suitable for becoming part of the detector. One of these tests is measuring the IV sensor characteristic. In this talk the importance and the procedure of measuring strip sensor IV curves at DESY Hamburg will be discussed, as well as a detailed study of whether the number of required IV testing can be reduced, done using high statistics provided by the current data stored in the ITk production database.

T 45.2 Tue 17:15 WIL/A124

Producing high quality and long-lasting modules for the ATLAS ITk strip detector — •Ben Brüers — Deutsches Elektronen-Synchrotron DESY, Zeuthen, Germany

For the high luminosity phase of the LHC, the ATLAS collaboration plans to upgrade its current tracking detector with a new, all silicon pixel and strip detector, referred to as Inner Tracker (ITk). Core components of the ITk strip detector are modules that consist of sensors and printed circuit flex boards carrying the read-out and powering chips. To ensure reliable operation of the ITk strip detector, all module components are extensively tested and characterised before module building. After and during module assembly, the quality of the modules is additionally assessed to verify that they fulfil the high standards determined to lead to the required quality by the ATLAS collaboration. This talk will give an overview of the means of ensuring this level of quality for the modules and their components. Special focus will be on stress-tests of ASIC stuffed printed circuit boards and on temperature cycling of modules. During the quality assessment of a module and its components it is paramount to not damage the wire-bonds connecting the ASICs and the printed circuit boards, e.g. through resonances induced by the cooling or vibrations. A new approach to determine the resonance frequency of the wire-bonds is presented in this talk. Knowledge of this frequency is also relevant to prevent damages due to wire-bond oscillations excited by currents through the wires in the 2 T magnetic field of the ATLAS detector.

T 45.3 Tue 17:30 WIL/A124

Characterisation and test beam data analysis of passive CMOS strip sensors — •Naomi Davis for the CMOS Strip Detectors-Collaboration — Deutsches Elektronen Synchrotron DESY, Hamburg, Germany

In high-energy physics, upgrades for particle detectors, as well as studies on future particle detectors are largely based on silicon sensors as tracking devices. The surface that needs to be covered by silicon sensors is constantly increasing so that they become an immense cost driver in particle physics experiments. Consequently, there is a need to investigate new silicon sensor concepts that can realise large-area coverage and cost-efficiency. A promising technology is found in passive CMOS sensors, based on CMOS imaging technology. They provide a lowered sensor cost by being produced in commercial chip processing lines. Since passive CMOS sensors do not contain any active elements they also allow for a large choice of possible vendors and easy portation from one CMOS process to another.

The passive CMOS project at DESY is investigating passive CMOS strip sensors fabricated at LFoundry in a 150nm technology. Two different strip formats of the n-in-p sensor are achieved by the process of stitching. An electrical sensor characterisation is realised by measuring the change in the sensor current and capacitance with the applied bias voltage. In addition, the sensor performance is evaluated based on test beam measurements conducted at the DESY II test beam facility. This presentation will provide a characterisation of passive CMOS strip sensors and results of the test beam data analysis.

T 45.4 Tue 17:45 WIL/A124

Test beam analysis of irradiated, passive CMOS strip sensors — •Fabian Lex for the CMOS Strip Detectors-Collaboration — Albert-Ludwigs Universität, Freiburg, Germany

Nearly all envisioned future high-energy particle detectors will employ silicon sensors as their main tracking devices. Due to the increased demand in performance, large areas of the detectors will have to be covered with radiation hard silicon, facilitating the need for silicon sensors produced in large quantities, reliably and cost-efficiently.

A possible solution to these challenges has been found in the utilization of the CMOS process, which is an industrial standard, offering the advantage of a large choice of vendors and reduced production costs. To create the larger sensor structures typical for silicon strip trackers, the stitching process has to be used.

Currently three variations of passive CMOS strip sensors, produced by LFoundry in a 150 nm process, are being investigated. In order to examine the radiation hardness of the design and any possible effect of the stitching on position resolution, detection efficiency or charge collection efficiency, a test beam measurement at the Test Beam Facility at DESY Hamburg has been conducted, using the ALiBaVa (Analogue Liverpool, Barcelona, Valencia) system for DUT (Device under test) readout. In the course of the analysis, a new module to process the ALiBaVa data in the Corryvreckan Test Beam Data Reconstruction Framework has been developed. A summary of the results of this test beam analysis will be presented in this talk.

T 45.5 Tue 18:00 WIL/A124

Tests of the first TRISTAN 166 pixel detector modules in a MAC-E filter environment — •Daniel Siegmann — Technical University Munich, James-Franck-Straße 1, 85748 Garching bei München

Sterile neutrinos are a natural extension of the Standard Model of particle physics. If their mass is in the keV range, they are a viable dark matter candidate. One way to search for sterile neutrinos in a laboratory-based experiment is via tritium beta decay. A sterile neutrino with a mass up to 18.6 keV would manifest itself in the decay spectrum as a kink-like distortion. The objective of the TRISTAN project is to extend the KATRIN experiment measurement range with a novel multi-pixel silicon drift detector and readout system to search for a keV-scale sterile neutrino signal. In this presentation will an overview of the first measurements of a 166 pixel TRISTAN detector module inside a KATRIN-like MAC-E filter environment at the Monitor Spectrometer using an implanted ^{83m}Kr source will be shown.

This project has received funding from the European Research Council (ERC) under the European Union Horizon 2020 research and innovation program (grant agreement No. 852845). This work is also supported by BMBF (05A17PM3, 05A17PX3, 05A17VK2, 05A17WO3), KSETA, the Max Planck society, and the Helmholtz Association.

T 45.6 Tue 18:15 WIL/A124

A hot cathode electron gun to test and characterize silicon drift detector arrays for the KATRIN experiment — •Korbinian Urban for the KATRIN-Collaboration — Technical University Munich, James-Franck-Straße 1, 85748 Garching bei München

The KATRIN (Karlsruhe Tritium Neutrino) experiment investigates the kinematic endpoint of the tritium beta-decay spectrum to determine the effective mass of the electron anti-neutrino. Its unprecedented tritium source luminosity and spectroscopic quality make it a unique instrument to also search for physics beyond the standard model such as sterile neutrinos. For these searches a new silicon drift detector array is being developed to replace the current silicon detector in KATRIN. Key features of the new detector are the high rate capability and good energy resolution for electrons. This talk presents a setup where these properties of the new detector modules can be tested with electrons of up to 20 keV kinetic energy from a hot cathode electron gun.

This project has received funding from the European Research Council (ERC) under the European Union Horizon 2020 research and innovation program (grant agreement No. 852845). This work is also supported by BMBF (05A17PM3, 05A17PX3, 05A17VK2, 05A17WO3), KSETA, the Max Planck society, and the Helmholtz Association.

T 46: Calorimeter / Detector Systems II

Time: Tuesday 17:00–18:30 Location: WIL/C133

T 46.1 Tue 17:00 WIL/C133

Fast Hadron Shower Simulation Methods with the CALICE AHCAL Prototype — •André Wilhahn, Julian Utehs, and Stan Lai for the CALICE-D-Collaboration — II. Physikalisches Institut, D-37077, Göttingen

Extensive simulations of particle showers are crucial for high energy physics experiments, since they allow for a sensible interpretation of recorded calorimeter data. As many calorimeters are designed with increasing granularity, while having to cope with higher energy deposits and higher luminosity conditions, the accurate simulation of particle showers in a computationally efficient manner is of utmost importance. This talk describes preliminary investigations into a data-driven fast calorimeter simulation that is meant to describe particle showers accurately, without simulating every individual particle interaction with the calorimeter material.

We start by investigating pion showers in the CALICE AHCAL (Analog Hadron Calorimeter) prototype, which is a highly granular hadronic calorimeter comprising a total of 38 active layers embedded in a stainless-steel absorber structure. Each active layer contains a grid of 24×24 scintillator tiles that are read out individually via silicon photomultipliers. Longitudinal energy distributions and correlation factors between these detector layers have been simulated with the help of kernel density estimators and compared with data. The results of this procedure are presented in this talk. In particular, current developments will be discussed and future plans for improving and expanding the fast calorimeter simulation will be outlined.

T 46.2 Tue 17:15 WIL/C133

Data-driven Fast Calorimeter Simulation with the CALICE AHCAL Prototype — •Julian Utehs, André Wilhahn, and Stan Lai for the CALICE-D-Collaboration — II. Physikalisches Institut, Georg-August-Universität Göttingen

High granularity calorimeters are foreseen to be an integral part of future particle physics detectors, for instance in detectors at a future e^+e^- collider. Therefore, there is an extensive research program dedicated to understanding how high granularity calorimeters can be exploited. For this purpose, the CALICE collaboration has developed a prototype, the Analog Hadron Calorimeter, which uses SiPM technology to read out highly granular scintillator tiles. The combination of highly granular calorimetry with a foreseeable higher luminosity will significantly increase the calculation time for MC simulations that simulate all particle interactions with the calorimeter material (as in GEANT4). Therefore fast simulation methods are also important, allowing the reduction of computational resources, while accurately describing the shape and correlations of the showers.

The aim is to parameterize showers in order to describe them via a probability density function, that can be used for the simulation of particle showers. This talk will focus on the description of radial and angular distributions of pion showers, based on test beam data taken with the AHCAL Prototype. The combined description of longitudinal, radial, and angular distributions is also discussed.

T 46.3 Tue 17:30 WIL/C133

Shower Separation in Five Dimensions using Machine Learning — •Jack Rolph and Erika Garutti — University of Hamburg, 22761, Luruper Chaussee 149, Hamburg, Germany

To fulfil the requirements for BSM physics searches and Higgs precision measurements at future linear colliders, a final state jet-energy resolution of 3-4 % for jet energies in the range 150-350 GeV is mandatory. Particle Flow Calorimetry (PFC) is a method expected to provide this resolution, which relies upon highly granular sampling calorimeters and sophisticated clustering techniques. In addition, the PFC technique requires excellent separation of single particles. This study presents the performance of three published neural network models to separate the energy deposited by a single charged and single pseudo-neutral hadron estimated from a charged shower, observed with the highly granular CALICE Analogue Hadronic Calorimeter (AHCAL). The neural networks use spatial and temporal event information from the AHCAL and energy information, which is expected to improve sensitivity to shower development and differences in the time development of the hadron shower. Neutral hadron showers with energy 5-120 GeV were separated from charged showers at a variable distance of 0.2-658 mm by the neural networks. It is found that the best-performing network reconstructed events with a Mean90 energy in agreement within 5% of the known shower energy and with an average RMS90 of 1.6 and 1.4 GeV without and with 100 ps timing information from AHCAL, respectively. The improvement due to timing information is attributed to the superior clustering of the hadron shower core.

T 46.4 Tue 17:45 WIL/C133

Track reconstruction of charged particles using a 4D quantum algorithm — Arianna Crippa[1,2], Lena Funcke[3,4], Tobias Hartung[5], Beate Heinemann[1,6], Karl Jansen[1], Annabel Kropf[1,6], Stefan Kühn[1], Federico Meloni[1], •David Spataro[1,6], Cenk Tüysüz[1,2], and Yee Chinn Yap[1] — [1]Deutsches Elektronen-Synchrotron DESY — [2]Humboldt-Universität zu Berlin — [3]Universität Bonn — [4]Massachusetts Institute of Technology — [5]Northeastern University, London — [6]Albert-Ludwigs-Universität Freiburg

Reconstructing tracks in future colliders can be challenging for several reasons. For example, there may be a large number of particle tracks or a high background rate. Therefore, new reconstruction techniques need to be developed and existing ones refined. Quantum algorithms are believed to offer an advantage in computation time in combinatorial tasks such as track reconstruction. By formulating the tracking task as Quadratic Unconstrained Binary Optimization (QUBO), the task can be solved with quantum computers. For the first time, a time component is integrated into QUBO to enable 4D tracking, reducing background rates effectively. Results of an initial implementation are presented for a setup similar to the positron tracking system of LUXE, an experiment planned at DESY and Eu.XFEL. Peak occupancies of up to 100 hits/mm^2 are expected in the initial phase of LUXE. To demonstrate the transferability of this approach, results are also presented for a barrel-shaped muon collider detector geometry, where lower peak occupancy but large background is expected.

T 46.5 Tue 18:00 WIL/C133

QUBO partitioning and choice of quantum device for charged particle track reconstruction at LUXE — •Annabel Kropf[1,2], Arianna Crippa[1,3], Lena Funcke[4,5], Tobias Hartung[6], Beate Heinemann[1,2], Karl Jansen[1,3], Stefan Kuehn[1], Federico Meloni[1], David Spataro[1,2], Cenk Tüysüz[1,3], and Yee Chinn Yap[1] — [1]DESY — [2]Albert-Ludwigs-Universität Freiburg — [3]Humboldt-Universität zu Berlin — [4]Universität Bonn — [5]MIT — [6]Northeastern University, London

LUXE (Laser Und XFEL Experiment) is a proposed experiment at DESY using the electron beam of the European XFEL and a high-intensity laser. The experiment's primary aim is to investigate the transition from the well-probed perturbative to the non-perturbative Quantum Electrodynamics regime. In LUXE's initial phase, positrons are produced that impinge on a four-layered pixel detector with occupancies of up to 100 hits/mm^2. Reconstructing positron trajectories is a combinatorial problem challenging for a classical computer to solve. Our group explores the novel approach of expressing the track pattern recognition problem as a quadratic unconstrained binary optimization (QUBO), allowing the algorithm to be mapped onto a quantum computer. Splitting the QUBO term into mappable subQUBOS is required because the size of the QUBO exceeds the number of qubits of state-of-the-art quantum computers. This talk investigates the influence of the QUBO splitting algorithm on the final track reconstruction efficiency. Additionally, the effectiveness of a gate-based quantum computer and a quantum annealer for applying the QUBO approach will be compared.

T 46.6 Tue 18:15 WIL/C133

Beam induced background identification in ATLAS by tracking system — •Marzieh Bahmani for the ATLAS-Collaboration — Humboldt-Universität, Berlin, Germany

It is important to study Beam Induced Background (BIB) since the BIB can significantly affect the data from ATLAS detector. Events with a large BIB component can produce a large hit occupancy in the sub-detectors and can affect the track reconstruction in the Inner Detector. The hits pattern in the Inner detector has been studied which allows to distinguish electronic noise hits form those generated by BIB and provides information on BIB characteristics at different locations in barrel and end-caps. For this study unpaired isolated bunches are exploited using BCM unpaired triggers. The ATLAS Run-II dataset has been used for this study.

T 47: Gas-Detecors, Detector Systems

Time: Tuesday 17:00–18:30 Location: WIL/A120

T 47.1 Tue 17:00 WIL/A120

First measurements with a gas monitoring chamber at subatmospheric pressures — Rebecca Fischer, Thomas Radermacher, Stefan Roth, David Smyczek, and •Nick Thamm — RWTH Aachen University - Physics Institute III B, Aachen, Germany

Time projection chambers (TPCs) are gaseous ionization detectors, which can instrument large volumes for particle tracking applications. By adjusting the internal gas-mixture and the operating pressure it is possible to fine-tune these detectors to have increased target mass for neutrino interactions or improved track resolution for low energies. For the precise operation of TPCs various electron swarm parameters are usually measured during runtime with a gas monitoring chamber (GMC), a small specialized TPC. These monitoring chambers can also be used for the verification of drift parameter simulations, which help predict the physics behavior of larger detectors. In this talk the hardware modification of a high pressure GMC (HPGMC) towards low pressure operation is addressed, the associated challenges are explained and first measurement results are shown.

T 47.2 Tue 17:15 WIL/A120

Development and Commissioning of Gas Flow Meters — Thomas Radermacher, Stefan Roth, David Smyczek, Jochen Steinmann, Nick Thamm, and •Hanja Wehrle — RWTH Aachen University - Physics Institute III B, Aachen, Germany

Gas flow meters will be installed in the new Gas Monitoring Chambers (GMCs) of the T2K time projection chambers. The flow meters measure the heat transfer caused by the gas flow using platinum resistors. This offers an efficient solution for monitoring the gas flow through the GMCs. The construction, calibration and performance of the flow meters are presented.

T 47.3 Tue 17:30 WIL/A120

Gas Monitoring Chambers for the T2K Near Detector Upgrade — Ines Hannen, Thomas Radermacher, Stefan Roth, •David Smyczek, and Nick Thamm — RWTH Aachen University - Physics Institute III B, Aachen, Germany

A new pair of Time Projection Chambers for high angle measurements (HATs) will be installed during the upgrade of the T2K near detector ND280. For their calibration the gas parameters will be continuously monitored using newly developed Gas Monitoring Chambers (GMCs). Systematic measurements of drift velocity and gas gain have been performed for different gas mixtures. These measurements are compared to simulations and previous measurements. The test setup and measurement results are presented.

T 47.4 Tue 17:45 WIL/A120

Commissioning of the large-scale LXe detector test platform PANCAKE — •Tiffany Luce — Physikalisches Institut, Universität Freiburg, 79104 Freiburg, Germany

As liquid xenon (LXe) detectors grow in size with each experiment, larger components have to be developed and tested. PANCAKE is a cryogenic detector test platform for components up to 2.6 m diameter as required for the future dark matter project DARWIN. PANCAKE's primary goal is to test the behavior of large scale detector components, such as TPC electrodes, in cryogenic conditions. A first commissioning run has been performed for two months at liquid argon temperature. The talk will present the results and discuss the strategy for future runs with cryogenic liquid xenon.

T 47.5 Tue 18:00 WIL/A120

Preparations for TPC Electrode Tests in a large LXe R&D-Platform — •Julia Müller — Albert-Ludwigs Universität, Freiburg

PANCAKE is a large-scale cryogenic platform to develop and test components for future LXe TPCs such as DARWIN. Over the past decades LXe TPCs continuously grew in size and became more sensitive, however, also the technical realization of its large TPCs got more and more challenging. Among the most crucial and also most complex detector components are the TPC electrodes, which need to feature a high optical transparency and high voltage resilience. PANCAKE allows testing the full-scale electrodes in an LXe-environment before they are installed into a final TPC. We here present preparations towards such an electrode test.

T 47.6 Tue 18:15 WIL/A120

Detector system and simulation of the 155 MeV Hydro-Møller polarimeter at MESA — •Michail Kravchenko for the P2-Collaboration — PRISMA+ Cluster of Excellence and Institute of Nuclear Physics, Johannes Gutenberg University Mainz

The Mainz Energy-recovering Superconducting Accelerator (MESA) is an electron accelerator, which is currently under construction at the Johannes Gutenberg University Mainz. One aim for the MESA is the precise measurement of the weak mixing angle $sin^2\theta_w$, an important parameter of the Standard Model, with a relative uncertainty of 0.14%. The measurement will be performed by the P2 experiment by measuring the parity-violating asymmetry in elastic electron-proton scattering at low momentum transfer Q^2. MESA will provide a 150 μA beam of alternatingly polarized 150 MeV electrons with excellent beam stability. In order to achieve the goal of the P2 experiment, the beam polarization must be measured online with a very low systematic error (< 0.5% relative). The 155 MeV Møller polarimeter using a polarized atomic hydrogen target, known as the Hydro-Møller polarimeter, as proposed by V. Luppov and E. Chudakov opens the opportunity for achieving these requirements. The current design of the detector system for the Hydro-Møller polarimeter and the results of the simulation with Geant4 are presented.

T 48: Exp. Methods I

Time: Tuesday 17:00–18:15 Location: WIL/C129

T 48.1 Tue 17:00 WIL/C129

Tau-lepton decay mode classification using machine learning in ATLAS — •Jonathan Pampel[1], Duc Bao Ta[2], Christina Dimitriadi[1], Jochen Dingfelder[1], Tatjana Lenz[1], and Eckhard von Törne[1] — [1]University of Bonn, Germany — [2]University of Mainz, Germany

The tau-lepton is the heaviest charged lepton with a mass of about twice the mass of the proton. It can decay leptonically into a neutrino and other leptons or hadronically into a neutrino and hadrons, the latter being mostly pions. In the ATLAS collaboration at CERN, there are already several algorithms for the decay mode classification of hadronically decaying tau-leptons (tau-jets).

This talk presents a novel technique based on convolutional neural networks to classify the hadronic tau-lepton decay modes. The goal is to count the number of neutral and charged pions in a tau-jet using calorimeter information. To do this, for each calorimeter layer, a 'picture' of the tau-jet is generated. These 'pictures' are used as input for a neural network built from several 2D convolution and pooling layers and flattening layer followed by a number of dense layers.

The preliminary results of this study will be presented based on ATLAS Run 2 Monte Carlo samples, i.e. pp-collisions at a center of mass energy of 13TeV. This includes an introduction into the problem as well as a visualization of the preprocessed data which is fed into the neural network. Finally, the best performing neural network's architecture and its performance will be presented.

T 48.2 Tue 17:15 WIL/C129

Photon identification efficiency measurement with the Matrix Method using 139 fb^{-1} of data collected by the ATLAS experiment at $\sqrt{s}$ = 13 TeV — •Nils Julius Abicht and Tomas Dado — Technische Universität Dortmund, Fakultät Physik

Photon identification (ID) is an integral part of many analyses, for example, measurements of Higgs boson properties or hypothetical pro cesses involving isolated photons in the final state. As the photon ID efficiency is not necessarily modeled well in Monte Carlo simulations, data-driven approaches are employed. One of these approaches is the Matrix Method, which estimates the efficiencies between a loose and a tight selection. For this selection, two sets of variables are used. The first set describes the longitudinal and lateral shape of the calorimeter shower and the second the topology of the center of the calorimeter shower. For calculating the photon ID efficiency, track isolation criteria that are weakly correlated with with the second set of variables are used. A description of the Matrix Method, the systematic uncertainties of the measurement as well as the resulting photon ID efficiencies and corrections to simulated efficiencies, calculated on full Run-2 samples, corresponding to 139 fb^{-1}, are presented.

T 48.3 Tue 17:30 WIL/C129

Improvement of Electron identification with the ATLAS detector and performance with first Run3 data — Asma Hadef and •Lucia Masetti for the ATLAS-Collaboration — Johannes Gutenberg Universität, Mainz, Germany

Electrons are important objects both for the search for new physics and for precision measurements. An algorithm to identify electrons in the ATLAS experiment based on a deep neural network was recently developed. Inputs to the network are high-level discriminating variables derived from the reconstructed electron track and cluster of energy depositions in the calorimeter system. The performance is estimated in simulated proton-proton (pp) collisions at $\sqrt{s}$=13 TeV and compared to the current identification algorithm which is based on a likelihood approach. Depending on the kinematics of the electron candidate, an increase in background rejection between 1.7 and 5.5 at the same signal efficiency can be observed. The performance of the electron identification algorithms is evaluated by measuring efficiencies using tag-and-probe techniques with large statistics samples of isolated electrons from $Z \to ee$ resonance decay. The first results of Run3 data recorded in 2022 from pp collisions at $\sqrt{s}$=13.6 TeV, corresponding to an integrated luminosity of 3.4 fb^{-1}, will also be presented.

T 48.4 Tue 17:45 WIL/C129

A Particle Identification Framework for Future Higgs Factories — •Ulrich Einhaus — Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg

The particle physics community has concluded that the next collider should be an e^+e^- Higgs factory. Such a collider would also enable many other precision measurements, e.g. of the top quark and in the electroweak sector, as well as searches for exotic particles. In the ongoing discussions it has become increasingly clear that particle identification including charged hadron ID is a key feature that enables a number of analyses and improves many. A number of different PID systems - from the simple muon ID to gaseous dE/dx and dN/dx to calorimeter shower shapes and time of flight (and more) - are being envisioned for the proposed future Higgs factory detector concepts. It is desirable to assess their impact and the effect of combining them in a common tool to enable fair comparisons.

This talk presents a new modular approach to a generic PID framework for the different possible future Higgs factories, embedded in the Key4HEP framework. It discusses implementation questions, performance measures and possible physics applications, exampling the International Large Detector (ILD) concept for the International Linear Collider (ILC).

T 48.5 Tue 18:00 WIL/C129

Time-of-flight particle identification at future Higgs factories — •Bohdan Dudar[1,2], Jenny List[1], Annika Vauth[2], and Ulrich Einhaus[1] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany — [2]Universität Hamburg, Hamburg, Germany

It is established that particle identification of charged hadrons with $\gtrsim$ 5 GeV momentum plays an important role at future e^+e^- Higgs factories to achieve outstanding precision in Higgs and electroweak physics, which can be covered by dE/dx (or dN/dx) in a gaseous tracker or RICH. However, at low momentum these methods become inefficient, while also some detectors don't have a gaseous tracker or RICH in their designs at all. Modern Si sensors technologies that can achieve time resolutions of 10 – 30 ps, such as LGADs, allow us to use the time-of-flight technique to identify $\pi^\pm$, $K^\pm$ and p at low momentum by placing fast timing layers in the ECAL or as an outer tracker. This should enhance the particle identification at the future Higgs factory. Thus, achievable time resolutions of the LGADs together with time-of-flight particle identification technique are interesting points to investigate for the future detector R&D.

In this talk, we present test beam measurements of time resolution of LGAD samples with an electron beam at the DESY II test beam facility, the latest developments of the time-of-flight technique as well as its realistic momentum reach and limitations of integrating it into the detector at a future e^+e^- Higgs factory, using the International Large Detector at the International Linear Collider as an example case.

T 49: Outreach (joint session HK/T)

Time: Tuesday 17:00–18:45 Location: SCH/A252

See HK 22 for details of this session.

T 50: Invited Topical Talks I-A

Time: Wednesday 11:00–12:20 Location: HSZ/AUDI

Invited Topical Talk T 50.1 Wed 11:00 HSZ/AUDI

Search for leptoquarks at the ATLAS experiment — •Mahsana Haleem for the ATLAS-Collaboration — Julius-Maximillian-Universität Würzburg, Germany

The leptoquarks predicted in the extensions of physics beyond the Standard Model can describe the similarities between the lepton and quark generations. In the past years, these particles have been the most popular explanations for the B-anomalies reported in low-energy data, and the searches for leptoquarks have been among the important goals of the ATLAS program. Recent results from the LHCb collaboration reporting the disappearance of lepton flavour anomalies in the B-meson decays into kaon and charged-lepton pairs do not affect the search program. They probe unique signatures at the LHC, as they provide direct transitions between leptons and quarks. I will review some of these searches with ATLAS Run-2 dataset and their prospects in Run-3, particularly focusing on the final states with third-generation quarks, which offer great potential to the SM background reductions but are also challenging in terms of the remaining background modeling.

Invited Topical Talk T 50.2 Wed 11:20 HSZ/AUDI

Making the most of Yukawa couplings: searching for Dark Matter accompanied by heavy quarks — •Danyer Perez Adan — Deutsches Elektronen Synchrotron (DESY), Hamburg, Germany

Among the foremost alternatives to unravel the mysteries of Dark Matter (DM) is the search for invisible particles at colliders. The main experiments at the Large Hadron Collider (LHC) are engaged in an intense search program to identify any evidence of non-standard unbalanced transverse momentum. Should this DM hunt be successful and the manifestation consistent with any of the various theoretical scenarios, it could be a first indication of the particle-like nature of this unknown matter. A large number of these models propose that the coupling between the DM mediators and the Standard Model (SM) fermions is of Yukawa type, thus favoring at the LHC the associated production of DM with top-quarks or b-quarks. Such consideration turns out to be one of the leading motivations for many of the analyses that have a particular focus on heavy flavour fermions accompanying the DM particles in the final state. The most recent experimental efforts and some of the prospects in this direction will be the primary topic of this talk.

Invited Topical Talk T 50.3 Wed 11:40 HSZ/AUDI

Precision predictions for transverse momentum distributions of Higgs and vector bosons at the LHC — •Maximilian Stahlhofen — University of Freiburg

The transverse momentum (p_T) spectra of Higgs and electroweak gauge bosons are among the most prominent observables measured at the LHC. The expected quality of their experimental data requires high precision theoretical predictions to enable maximally accurate physics analyses like Standard Model tests, new physics searches, or PDF fits. I will discuss recent developments and future prospects in the theoretical description of p_T spectra at small and large transverse momenta, which are largely based on effective field theory techniques. I will put a focus on bottom mass effects in the peak region of the Higgs transverse momentum distribution and third-order QCD calculations for direct photon production at large p_T.

Invited Topical Talk T 50.4 Wed 12:00 HSZ/AUDI

Axion fragmentation — •Enrico Morgante — Johannes Gutemberg Universität, Mainz, Deutschland

Axion-like particles are a key ingredient of many new physics scenarios, well motivated both from the theoretical and phenomenological point of view. In a number of recent proposals, the non-trivial dynamical evolution of an axion field in the early universe is used to solve many open problems of particle physics and cosmology, such as the hierarchy problem, Dark Matter, and others. An effect which was previously overlooked is the growth of quantum fluctuations when the axion rolls down a potential with multiple minima. This effect is particularly relevant for the relaxion mechanism and for the kinetic misalignment scenario. I will introduce this effect presenting analytic and lattice results, and then discuss the cosmological aspects of the scenario.

T 51: Invited Topical Talks I-B

Time: Wednesday 11:00–12:20 Location: HSZ/0003

Invited Topical Talk T 51.1 Wed 11:00 HSZ/0003
LUXE – A new experiment to study non-perturbative QED in electron-laser and photon-laser collisions — •Ruth Jacobs — Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany
The LUXE experiment (Laser Und XFEL Experiment) is a new experiment in planning at DESY Hamburg using the electron beam of the European XFEL. At LUXE, the aim is to study collisions between a high-intensity optical laser and up to 16.5GeV electrons from the Eu.XFEL electron beam, or, alternatively, high-energy secondary photons. The physics objectives of LUXE are to measure processes of Quantum Electrodynamics (QED) at the strong-field frontier, where QED is non-perturbative. This manifests itself in the creation of physical electron-positron pairs from the QED vacuum. LUXE intends to measure the positron production rate in a new physics regime at an unprecedented laser intensity. Additionally, the high-intensity Compton photon beam of LUXE can be used to search for physics beyond the Standard Model.

Invited Topical Talk T 51.2 Wed 11:20 HSZ/0003
Precision timing with silicon sensors — •Annika Vauth — Institut für Experimentalphysik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Deutschland
Precision timing with silicon is an important tool in many areas of particle physics, either by adding a dedicated timing layer for track timing to a detector, or full "4D-tracking" where precise space and time coordinates are assigned to each hit.

Intense R&D is taking place in the design and optimisation of different types of silicon sensors to achieve excellent timing performance. Two examples for promising technologies are Low Gain Avalanche Diodes, which have been shown to achieve time resolutions of 30 ps or better, as well as 3D sensors, which display excellent radiation hardness. In this contribution, the currently existing technological solutions and ongoing research addressing the remaining challenges are reviewed. Future applications for precision timing will be presented.

Invited Topical Talk T 51.3 Wed 11:40 HSZ/0003
Recent advancements in Micro-Pattern Gaseous Detectors: Exciting research ahead towards future experiments — •Michael Lupberger — Helmholtz-Institut für Strahlen- und Kernphysik — Physikalisches Institut — Forschungs- und Technologiezentrum Detektorphysik, Bonn, Germany
The invention of Micro-Pattern Gaseous Detectors (MPGDs), overcoming the limitation of wire-based devices, marked a new epoch in the field of gaseous detectors. MPGDs, as 2nd generation gaseous detectors, were installed with large sizes in LHC experiments within the Long Shutdown 2 upgrades - more than 20 years after their invention.

The RD51 collaboration supported this path from prototypes to large area detectors, and promotes further MPGD R&D.

Major advancements have been achieved recently, opening up novel opportunities for exciting research and future experiments: The long-standing timing limitation of planar detectors was overcome with the PICOSEC concept, achieving 17 ps time resolution. With the implementation of the VMM chip into RD51's general Scalable Readout System, R&D support for the next decade is secured as well as new high-rate mid-size experiments are enabled. The GridPix technology with its single electron detection capability allows imaging of the fundamental particle-gas interaction and its features at a microscopic level.

These highlights will be presented, taking the prospects of the ECFA Detector R&D Roadmap and the transition from RD51 to DRDC1 into account.

Invited Topical Talk T 51.4 Wed 12:00 HSZ/0003
Recent Liquid Scintillator Developments for Astroparticle Physics — •Stefan Schoppmann — Johannes Gutenberg-Universität Mainz, Exzellenzcluster PRISMA+, PRISMA Detektorlabor, Staudingerweg 9, 55128 Mainz, Germany
Liquid scintillators have been used for decades in many experiments. They are particularly suited for the detection of low-energy particles where energy and timing information is required. Liquid scintillators exhibit advantages such as high light yield, cost effectiveness, radiopurity, and more.

In recent years, various developments aim for improving the vertex and directional resolution as well as particle identification of liquid scintillators. These ideas include advanced detector instrumentations, fine-grained vertex reconstruction, hybrid scintillators, and more. These novel approaches open a rich physics programme reaching from reactor neutrinos and searches for Majorana particles to solar and astrophysical neutrinos and beyond.

In this presentation, the status of novel approaches to liquid scintillators is reviewed and their prospects and applications compared.

T 52: Invited Topical Talks II-A

Time: Wednesday 14:00–15:20 Location: HSZ/AUDI

Invited Topical Talk T 52.1 Wed 14:00 HSZ/AUDI
Commissioning of the new LHCb trigger system — •Marian Stahl — European Organization for Nuclear Research (CERN), Geneva, Switzerland
Since 2022 the upgraded LHCb experiment uses a triggerless readout system collecting data at an event rate of 30 MHz and a data rate of 4 Terabytes/second. A software-only heterogeneous High Level Trigger (HLT) enables unprecedented flexibility for reconstruction and selections. Compared to Run2 (2015-18), the amount of data to be processed by the HLT increased by a factor 60 due to operating at five times higher luminosity and the removal of the hardware trigger. The GPU-based first stage (HLT1) reduces the event rate to 1 MHz by selections based on charged particle tracking, vertexing, photon reconstruction and lepton identification. At the CPU-based second stage (HLT2), full offline quality event reconstruction and user-friendly configuration provides the flexibility that has allowed analysts to implement more than 1500 inclusive and exclusive selection algorithms. Real-time alignment and calibration directly after HLT1 ensures best detector performance in HLT2's full event reconstruction. I will describe how LHCb's Real-Time-Analysis project addresses performance and code portability challenges associated with heterogeneous computing at this scale and how the new trigger, alongside with the upgraded detector, have been commissioned in 2022.

Invited Topical Talk T 52.2 Wed 14:20 HSZ/AUDI
Alignment of the CMS Tracker: Automation is Key — •Marius Teroerde — 1. Physikalisches Institut B, RWTH Aachen, Germany
The inner tracker is the central part of the Compact Muon Solenoid (CMS) detector at the Large Hadron Collider (LHC). In order to ensure excellent physics performance, it is necessary to have precise knowledge of the tracker geometry, so that tracks and vertices can be accurately reconstructed.

The measurement of the tracker geometry using particle tracks, called 'alignment', is a very complex task. It involves tracking the time dependent position of about 15000 detector modules. Radiation damage to the modules influences the position measurements. The best data quality is therefore achieved if the tracker geometry is frequently updated based on recent data and if the granularity of the alignment is fine enough to account for biases in individual modules. An automated procedure, including automated quality control, is key to meet these requirements. In this talk, an introduction to tracker alignment strategies at CMS is given and recent developments of automatic alignment are discussed. Future prospects for the era of the High-Luminosity LHC are also touched upon.

Invited Topical Talk T 52.3 Wed 14:40 HSZ/AUDI
ITk – ATLAS tracker upgrade — •Dennis Sperlich — Albert-Ludwigs-Universität Freiburg
For the LHC Phase-II upgrade, the ATLAS Experiment needs to upgrade the new whole tracking system. ITk will be able to cope with the higher pileup up to 200 and integrated luminosities up to 4000 fb^{-1}. It will replace the current Pixel, SCT and TRT detector with an all silicon detector comprised of Pixel and Strip subdetectors. The Pixel detector will consist of five barrel layers and a number of endcap-region rings to provide hermetic coverate and tracking up to $|\eta| < 4$. The Strip detector will consist of four barrel layers and six discs per endcap. With the R&D concluding in the system tests of bigger Pixel and Strip structures and the production starting, this talk will show the current state of the two subprojects and gives and outlook towards production and integration.

Invited Topical Talk T 52.4 Wed 15:00 HSZ/AUDI
Role of simulation in silicon tracker sensors R&D — •Anastasiia Velyka — DESY Hamburg
Experiments at possible future colliders require, among others, lightweight detectors with a single-point resolution of a few micrometers. These requirements are addressed with various silicon tracker sensor R&D projects. Optimisation of the sensor design requires precise simulations, which can be achieved by combining computer-aided design (TCAD) and Monte Carlo methods. TCAD is used to simulate an accurate electric field of a sensor via static simulations. The

response of the sensor is simulated using the Monte Carlo software.

The examples of sensor optimisation are shown for the hybrid Enchanted Lateral Drift (ELAD) sensor and the monolithic small collection electrode CMOS sensor.

T 53: Invited Topical Talks II-B

Time: Wednesday 14:00–15:20 Location: HSZ/0003

Invited Topical Talk T 53.1 Wed 14:00 HSZ/0003
LST-1: Initial scientific results from the first CTA telescope — •Dominik Elsaesser for the CTA-Collaboration — Fakultät Physik, TU Dortmund
The Cherenkov Telescope Array (CTA) will lead the frontier of ground-based gamma-ray astronomy with its unprecedented sensitivity in the energy range between 20 GeV to 300 TeV. CTA will be composed of two telescope sites, in the northern hemisphere on the Roque de Los Muchachos Observatory in La Palma, Spain and in the southern hemisphere at the Paranal Observatory in the Atacama Desert in Chile, and of three telescope types: Large, Medium, and Small sized telescopes. The Large-Sized Telescopes (LSTs) are specially designed for low-energy and transient phenomena and will dominate CTA's sensitivity in the energy range from 20 GeV to 150 GeV. The northern CTA site at Roque de Los Muchachos, La Palma, will host an array of four LSTs, each with a mirror diameter of 23m. The prototype, LST-1, was inaugurated in October 2018 and has since been in its commissioning phase. In this talk, we report on the first results from scientific observations using LST-1. Finally, we will discuss prospects for LST 2-4.

Invited Topical Talk T 53.2 Wed 14:20 HSZ/0003
Multimessenger astronomy with the Pierre Auger Obser- vatory — •Marcus Niechciol for the Pierre Auger-Collaboration — Center for Particle Physics Siegen, Experimentelle Astroteilchen- physik, Universität Siegen
The Pierre Auger Observatory is the largest air-shower experiment in the world, offering an unprecedented exposure not only to charged cosmic rays, but also to neutral particles at the highest energies. The Observatory can therefore contribute significantly to current efforts in multimessenger astronomy. For example, the upper limits on the incoming flux of ultra-high-energy (UHE) photons and neutrinos de- termined from Auger data are the most stringent to date, severely con- straining current models for the origin of UHE cosmic rays. Follow-up searches for neutral particles in association with gravitational wave events and other transient events, such as the anomalous blazar TXS 0506+056, complement those performed by specialized instruments at lower energies, extending the energy range of current multimessenger studies to the UHE regime.

In the contribution, the various activities concerning multimessen- ger astronomy at the Pierre Auger Observatory are presented and the current results are summarized. In addition, future perspectives in the scope of the ongoing AugerPrime upgrade will be discussed.

Invited Topical Talk T 53.3 Wed 14:40 HSZ/0003
Positron annihilation as an astrophysical messenger — •Thomas Siegert — Institut für Theoretische Physik und Astrophysik, Julius Maximilians Universität, Würzburg, Germany
One of the major tasks of astrophysics is to understand the emission mechanisms of observed sources and regions in the sky. Only by pinpointing down these mechanisms, it is possible to derive physical parameters and learn about the evolution of astrophysical objects. Alas, many observations of high-energy phenomena are ambiguous, requiring more and orthogonal information. The nature of several sources, among others accreting X-ray binary systems, core-collapse and thermonuclear supernovae, cosmic-rays, stellar flares and potentially dark matter, all show signatures of positron production and annihilation. Utilising this underrated emission mechanism can shed light on unsolved problems in astrophysics and cosmology.

In this talk, I will show examples of how we can learn from these gamma-ray signatures already now, and what might be possible in the context of new gamma-ray satellite missions, such as the accepted NASA mission COSI.

Invited Topical Talk T 53.4 Wed 15:00 HSZ/0003
The first results of the XENONnT experiment and an outlook to the future DARWIN observatory — •Andrii Terliuk for the XENON-Collaboration — Universität Heidelberg, Heidelberg, Germany — Max-Planck-Institut für Kernphysik, Heidelberg, Germany
The nature of Dark Matter is one of the most important open questions in today's particle physics and cosmology. The XENONnT experiment at the Gran Sasso Laboratory in Italy aims to discover it using a dual-phase time projection chamber filled with 6 tonnes of liquid xenon. It was commissioned in 2021 and shows an excellent performance in terms of background and purity levels. In this talk we will present the status and results obtained with the first XENONnT science run. Furthermore, we will introduce the future DARWIN observatory that will have the mass of at least 50 tonnes of liquid xenon, while further improving background levels and purity.

T 54: Flavor IV

Time: Wednesday 15:50–17:20 Location: HSZ/0304

T 54.1 Wed 15:50 HSZ/0304
Systematic Parametrization of the B-meson Light-Cone Distribution Amplitude — Thorsten Feldmann[1], •Philip Lüghausen[1], and Danny van Dyk[2] — [1]Theoretische Physik 1, Universität Siegen, Walter-Flex-Straße 3, D-57068 Siegen, Germany — [2]Institute for Particle Physics Phenomenology, Durham University, Durham DH1 3LE, UK
The light-cone distribution amplitude (LCDA) of the B meson provides the essential non-perturbative input in the QCD factorization approach to calculate, for example, the $B \to \gamma \ell \nu$ decay amplitude.
While previous phenomenological analyses were based on specific model assumptions for the LCDA, we propose a systematic parametrization with suitable properties: (1) to extract information about the LCDA from experimental data, (2) to perform analytical calculations in QCD-based approaches, and (3) to obtain numerical estimates for observables with controlled theoretical uncertainties.

T 54.2 Wed 16:05 HSZ/0304
New Physics Studies in $B_q^0 - \bar{B}_q^0$ Mixing — Kristof De Bruyn[1,5], Robert Fleischer[1,2], •Eleftheria Malami[3,1], and Philine van Vliet[4] — [1]Nikhef, Science Park 105, 1098 XG Amsterdam, Netherlands — [2]Vrije Universiteit Amsterdam, 1081 HV Amsterdam, Netherlands — [3]Center for Particle Physics Siegn (CPPS), Theoretische Physik 1, Universität Siegen, D-57068 Siegen, Germamy — [4]Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany — [5]Van Swinderen Institute for Particle Physics and Gravity, University of Groningen, 9747 Groningen, Netherlands
Neutral $B_q - \bar{B}_q$ mixing (where $q = d, s$) is a powerful probe for testing the Standard Model and searching for New Physics. Focusing on the analyses of the different determinations of the Unitarity Triangle apex, we explore how much room for New Physics is left through the available experimental data. We discuss the discrepancies between inclusive and exclusive $|V_{ub}|$ and $|V_{cb}|$ CKM matrix elements and the determination of the angle γ. Presenting future scenarios, we discuss the application of our findings to leptonic rare B decays, allowing us to minimise the CKM parameters impact in the New Physics searches. We explore the impact of increased precision on key input measurements, performing future projections. It will be exciting to see how the data will evolve in the high-precision era of flavour physics.

T 54.3 Wed 16:20 HSZ/0304
Flavour Tagging in Run 3 at LHCb — •Micol Olocco[1], Claire Prouve[2], Biljana Mitreska[1], and Johannes Albrecht[1] — [1]TU Dortmund University, Dortmund, Germany — [2]University of Santiago de Compostela, Santiago, Spain
The knowledge of the B meson flavour at time of production is crucial for measurements of time-dependent CP violation and flavour oscillations. Flavour tagging algorithms exploit correlations between the B meson flavour and features of the global event in order to tag the candidate as B or $\overline{B}$ with a corresponding efficiency and mistag probability. Beside the information that is saved in real time, it is fundamental to optimize the tagging power of the algorithm since it heavily affects the uncertainty on the CP asymmetry factor.

In the Run 3 of the LHC, the LHCb experiment will operate at the average non-empty bunch crossing rate of 30 MHz with an upgraded detector and a solely software-based trigger. The current status and challenges in flavour tagging algorithms for Run 3 are presented, together with their estimated performance at trigger level.

T 54.4 Wed 16:35 HSZ/0304

Automation of the Flavor tagging calibration software in the ATLAS experiment — •Marawan Barakat for the ATLAS-Collaboration — Platanenallee 6, 15738 Zeuthen

Particle cascades originating from quarks and gluons decays (jets) are omnipresent in proton-proton collisions at the LHC. The identification of jet flavors is essential for many physics searches at the ATLAS experiment. This is achieved using machine learning algorithms (taggers) trained with simulated Monte Carlo events. Due to simulations imperfections, the taggers performance need to be measured in data in order to extract correction factors for the simulation predictions. ATLAS is using a set of calibration software for different jets flavors, which are complicated to use, specially for non-experts. In order to make the software easier, more flexible and more time efficient, automation workflows are defined. This study shows the framework used to automate the calibration of the flavor tagging software using REANA platform. The results are compared to the official results from ATLAS calibration with 139 fb^-1 of 13 TeV collisions data from ATLAS. Same technique can be extended to RUN III of ATLAS and other analyses beyond Flavor Tagging.

T 54.5 Wed 16:50 HSZ/0304

Light Separation with the Topological Track Reconstruction in an idealised water-based liquid scintillator detector as study for Theia — Daniel Bick, Caren Hagner, and •Malte Stender — Universität Hamburg, Institut für Experimentalphysik

In neutrino physics, large unsegmented liquid scintillator or water Cherenkov detectors are often the tool of choice. Where the scintillation type excels in energy reconstruction, shower identification via the $\mathrm{d}E/\mathrm{d}x$ and a low detection threshold, the water Cherenkov detectors perform very well in direction reconstruction, particle identification via the fuzziness of the Cherenkov rings and background reduction with the number of rings. Experiments like the proposed Theia plan to combine the detection capabilities of both detector types and use water-based liquid scintillator (WbLS) as active volume. In order to unlock the full potential of these new detectors, a successful separation of Cherenkov and scintillation photons is of vital importance.

The Cherenkov scintillation photon separation is the focus of this work. Different light separation algorithms are implemented and studied in the context of a simulated idealised WbLS detector, which has a maximum optical coverage of Large Area Picosecond Photodetectors. These photodetectors feature a good spatial resolution of ~ 1 mm and an excellent time resolution of ~ 0.1 ns compared to the few nanoseconds PMTs typically achieve.

This contribution introduces the detector simulation, discusses the used light separation algorithms including the Topological Track Reconstruction and shows first results.

T 54.6 Wed 17:05 HSZ/0304

Sensitivity Studies for the Theia Experiment at LBNF — •Wei-Chieh Lee, Caren Hagner, and Daniel Bick — Institut für Experimentalphysik, Universität Hamburg, Hamburg, Germany

Theia is a next-generation neutrino detector, which can achieve great precision in neutrino event reconstruction and background rejection by exploiting both Cherenkov radiation and scintillation light. With this type of detectors, the nature of neutrinos may be further investigated to provide answers to unsolved questions in physics, especially those considering the mass ordering and the possible CP violation of neutrinos. For this purpose, the detector is proposed to be constructed at the Long-Baseline Neutrino Facility (LBNF) in the United States, alongside the Deep Underground Neutrino Experiment (DUNE) far detectors. The General Long Baseline Experiment Simulator (GLoBES) software package is utilized for the detector performance simulation. In this talk, studies of Theia's ability to discover CP violation will be presented with details, including effects from variations in oscillation parameters and systematic uncertainties. With conservative assumptions and 7 years of data, Theia can ultimately have $> 3\sigma$ ($> 5\sigma$) sensitivity to CP violation for 60% (20%) of δ_{CP} parameter space in the case of normal (inverted) mass ordering.

T 55: Flavor V, Top-BSM

Time: Wednesday 15:50–17:20 Location: HSZ/0401

T 55.1 Wed 15:50 HSZ/0401

Measurement of the isospin asymmetry in $B \to K^*\mu^+\mu^-$ decays with LHCb — Christoph Langenbruch, •Thomas Oeser, and Stefan Schael — I. Physikalisches Institut B, RWTH Aachen

In the Standard Model (SM), $b \to s\ell^+\ell^-$ transitions are forbidden at tree level and can only occur via loop-level and higher-order processes. Precision measurements of these processes therefore constitute powerful tests of the SM, sensitive to various potential New Physics contributions.

The isospin asymmetry $\mathscr{A}_I$ between $B^0 \to K^{*0}\mu^+\mu^-$ and $B^+ \to K^{*+}\mu^+\mu^-$ has a clean SM prediction as many hadronic uncertainties cancel in the calculation. Previous measurements are consistent with SM expectations, within still large uncertainties.

This talk presents an overview of the analysis of the isospin asymmetry in $B \to K^*\mu^+\mu^-$ using the full LHCb dataset, recorded between 2011 and 2018 and corresponding to an integrated luminosity of approximately 9fb^{-1}.

T 55.2 Wed 16:05 HSZ/0401

Inclusive analysis of untagged $B \to Xl^+l^-$ decays at Belle II — •Arul Prakash Sivagurunathan, Sviatoslav Bilokin, and Thomas Kuhr — Ludwig-Maximilians-Universität München

Precision measurements of inclusive $B \to Xl^+l^-$ decays can provide invaluable complementary information to scrutinize anomalies observed in their exclusive $b \to sl^+l^-$ counterparts. However, limited tagging efficiency, small Standard Model signal and very high background rate make these measurements very challenging, with no results being published so far. In our work, we will assess the chances of a 5σ result with data from the Belle and Belle II experiments. We will apply machine learning algorithms to tackle background rejection. We will finally compute the lepton flavour universality ratio $R(X) = B(B \to X\mu^+\mu^-)/B(B \to Xe^+e^-)$ which, together with $R(K)$ and $R(K^*)$, will be key to constrain potential New Physics contributions.

T 55.3 Wed 16:20 HSZ/0401

Testing Lepton Flavour Universality with $B_s^0 \to \phi\ell^+\ell^-$ decays using LHCb data — Christoph Langenbruch, Stefan Schael, and •Sebastian Schmitt — I. Phys. Inst. B RWTH Aachen

In the Standard Model of Particle Physics (SM), $b \to s\ell^+\ell^-$ transitions are forbidden at tree-level and may only occur at the loop-level. The branching fractions of these so-called Flavour Changing Neutral Currents (FCNCs) can thus be significantly affected by New Physics (NP) beyond the SM. While in the SM, the coupling of the electro-weak gauge-bosons is Lepton Flavour Universal (LFU), this universality can be broken in NP scenarios. Ratios of branching fractions of semileptonic rare decays with muons and electrons in the final state constitute clean SM tests.

The LHCb detector is located at the Large Hadron Collider (LHC) at CERN and is optimised to study rare b-hadron decays. For this purpose LHCb features high trigger efficiencies, excellent track reconstruction, and particle identification.

This talk gives an overview of the measurement of lepton universality $R_\phi = \mathscr{B}(B_s^0 \to \phi\mu^+\mu^-)/\mathscr{B}(B_s^0 \to \phi e^+e^-)$, which benefits from the experimentally clean $B_s^0 \to \phi\ell^+\ell^-$ environment. The analysis uses the full Run 1 and Run 2 dataset collected by LHCb which corresponds to 9 fb^{-1} of integrated luminosity.

T 55.4 Wed 16:35 HSZ/0401

Measurement of the branching fractions and differential kinematic distributions of $B^{+/0} \to XJ/\psi$ with hadronic tagging — Florian Bernlochner[1], Jochen Dingfelder[1], Thomas Kuhr[2], •Martin Angelsmark[1], William Sutcliffe[1], and Sviat Bilokin[2] for the Belle II-Collaboration — [1]Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn — [2]Fakultät für Physik der Ludwig-Maximilians-Universität München

Using data from the Belle II experiment we perform the first measurements of the individual branching fractions $B(B^0 \to XJ/\psi)$ and $B(B^+ \to XJ/\psi)$. The Belle II experiment is located at the superKEKB e^+e^- collider in Japan. The collisions are performed at the $\Upsilon(4S)$ resonance leading to a large amount of produced $B\bar{B}$ pairs. One of the B mesons (tag B meson) is fully reconstructed using the Full Event Interpreter (FEI) algorithm, which then gives full kinematic information about the opposite B (signal candidate). Previous analyses measured the admixture of B^0 and B^+, but using the B tag we can separate B^0 and B^+ candidates. A tagged approach also makes it possible to measure the shape distributions of the kinematic variables X mass, J/ψ momentum and absolute helicity angle. This measurement is also an important background study for a future inclusive $B \to X\ell\ell$ analysis, where XJ/ψ is one of the major backgrounds. This talk will present the current status of the analysis and predicted systematics with 364 fb^{-1} integrated luminosity.

T 55.5 Wed 16:50 HSZ/0401

Search for flavour-changing neutral current couplings between the top-quark and the Higgs boson in the $H \to WW/ZZ$ decay channel with the ATLAS detector at the LHC. — Marvin Geyik, •Oliver Thielmann, and Wolfgang Wagner — Bergische Universität Wuppertal, Germany

A search for flavour-changing neutral current (FCNC) couplings between the top-quark and the Higgs boson in the $H \rightarrow WW/ZZ$ decay channel in the tri-lepton final state is presented. The search for FCNC couplings in the top-quark-Higgs-boson sector is a promising search for a theory beyond the SM. Proton-proton collision data produced by the LHC at a centre-of-mass energy of $\sqrt{s} = 13$ TeV and collected by the ATLAS experiment during the years 2015 - 2018, and corresponding to an integrated luminosity of $139 fb^{-1}$, are used. Data is analysed in different final states, characterised by three isolated electrons or muons, missing transverse energy and the number of jets where exactly one of them is identified as a b-jets. A machine learning analysis based on neural networks is conducted to improve the discrimination between the signal and the backgrounds. Preliminary results, interpreted in the context of an effective field theory for FCNC, are presented, where additional exclusion limits on the qtH effective coupling are derived.

T 55.6 Wed 17:05 HSZ/0401

Search for FCNC couplings between the top quark and the Higgs boson in dilepton same-charge final states — •Marvin Geyik, Oliver Thielmann, and Wolfgang Wagner — University of Wuppertal, Germany

Flavour-changing neutral current interactions are strongly suppressed in the Standard Model. Still, some extensions of the Standard Model predict tree-level FCNC couplings between the top quark, other up-type quarks and neutral bosons, including the Higgs boson. These anomalous couplings can be parametrised in the framework of effective field theories (EFT). The presented analysis searches for the production of a single top-quark in association with a Higgs boson and for top-quark-antiquark production with one of the top quarks decaying to an up quark or a charm quark and a Higgs boson. Higgs decays to WW*, ZZ* and two taus leading to leptonic final states are considered in the event selection. Two analysis channels are defined: one with two leptons (electrons or muons) of the same electric charge and a second channel with three leptons. This talk focuses on advancements in the dilepton final state and the combination with the trilepton channel. The sensitivity of the analysis in setting limits to relevant coefficients of EFT operators will be presented.

T 56: Searches EW I

Time: Wednesday 15:50–17:20 Location: HSZ/0403

T 56.1 Wed 15:50 HSZ/0403

Search for charged Higgs bosons in $H^+ \rightarrow Wh$ decays with the ATLAS detector — •Shubham Bansal, Jochen Dingfelder, and Tatjana Lenz — Physikalisches Institut, University of Bonn, Germany

After the discovery of the Higgs boson at a mass of 125 GeV, the last missing piece of the Standard Model (SM) was presumably found. However, various theories beyond the SM predict additional Higgs bosons, one of which could be the observed Higgs boson at 125 GeV. One such example is the Two-Higgs-Doublet Model (2HDM) that features an extended scalar sector including the existence of charged Higgs bosons (H^+). The H^+ production mechanism depends on its mass (m_{H^+}) and for $m_{H^+}> m_t+m_b$, the leading H^+ production mode is the associated production with a top and a bottom quark via $gg \rightarrow tbH^+$. In the alignment limit for 2HDM, the dominant decay mode is $H^+ \rightarrow tb$. However, in models like N2HDM and the Georgi-Machacek (GM) model, it is possible to obtain a sizable branching ratio for $H^+ \rightarrow Wh$.

This talk presents a search for charged Higgs bosons in $H^+ \rightarrow Wh(\rightarrow b\bar{b})$ decays. The analysis strategy is presented and a focus is put on the data-driven improvements of the modelling of the main background from $t\bar{t}$ production, the event classification technique to separate the leptonic and hadronic decay modes of the W boson from the H^+ decay. Finally, the fit model is discussed to derive the first estimate of the expected sensitivity for the full Run-2 ATLAS dataset.

T 56.2 Wed 16:05 HSZ/0403

Constraints on spin-0 dark matter mediators and invisible Higgs decays using ATLAS 13 TeV pp collision data with two top quarks and missing transverse momentum in the final state. — •Marco Rimoldi for the ATLAS-Collaboration — DESY, Hamburg, Germany

Results of a statistical combination of searches targeting final states with two top quarks and invisible particles, characterised by the presence of zero, one or two leptons, at least one jet originating from a b-quark and missing transverse momentum are presented.

The analyses are searches for phenomena beyond the Standard Model consistent with the direct production of dark matter in pp collisions at the LHC, using 139 fb^{-1} of data collected with the ATLAS detector at a centre-of-mass energy of 13 TeV.

The results are interpreted in terms of simplified dark matter models with a spin-0 scalar or pseudoscalar mediator particle. In addition, the results are interpreted in terms of upper limits on the Higgs boson invisible branching ratio, where the Higgs boson is produced according to the Standard Model in association with a pair of top quarks.

T 56.3 Wed 16:20 HSZ/0403

Search for a charged Higgs boson decaying to cs in the low mass region with the ATLAS detector at $\sqrt{s} = 13$ TeV — Jochen Dingfelder, Tatjana Lenz, and •Christian Nass — Physikalisches Institut, Universität Bonn, Deutschland

In the Standard Model (SM) electroweak symmetry breaking (EWSB) is introduced by a single complex scalar field. The consequence is the prediction of a scalar, neutrally charged particle, the Higgs boson, which was discovered at the LHC in 2012 at the LHC. A simple extension of the SM is to introduce EWSB through two complex scalar fields. Such two-Higgs doublet models (2HDM) are attractive because they offer the opportunity to include additional CP violation in the SM, which is needed for explaining baryogenesis. 2HDMs feature 3 neutral and 2 charged Higgs bosons. An observation of such a charged scalar particle would be a striking signal of physics beyond the SM.

In the low mass region, $m_H^{\pm} < m_t$, the dominant production mode is by a $t\bar{t}$ pair with one t-quark decaying to $H^{\pm}b$. At low masses, the search for $H^{\pm} \rightarrow cs$ decays is promising, as suggested in several theory papers. This talk presents the analysis strategy to define signal-enriched and -depleted regions as well as the expected sensitivity for the $H^{\pm} \rightarrow cs$ search, including a complete set of systematics uncertainties, with the full Run-2 ATLAS dataset.

T 56.4 Wed 16:35 HSZ/0403

Search for $A \rightarrow ZH \rightarrow \ell\ell t\bar{t}$ at $\sqrt{s} = 13$ TeV with the ATLAS detector — •Roman Kuesters, Tetiana Moskalets, and Spyros Argyropoulos for the ATLAS-Collaboration — University of Freiburg, Freiburg im Breisgau, Germany

The generation of the existing matter-antimatter asymmetry in the observable universe is one of the biggest open questions that cannot be explained with the standard model and therefore requires physics beyond the standard model.

Many models suggest that electroweak symmetry breaking can generate the matter-antimatter asymmetry, however an extended Higgs sector is needed to satisfy the conditions for baryogenesis.One of the simplest extensions are models with two Higgs doublets, which give rise to 5 Higgs bosons. In these models a large mass splitting between the heavy CP-odd boson A and the CP-even boson H is required for successful baryogenesis.

The analysis, which will be presented, searches for the decay of the A boson into a heavy H boson and a Z boson. The heavy H boson subsequently decays into two top quarks, while the Z boson decays leptonically. This final state will allow us to probe the the parameter space with $m_H > 350$ GeV, which remains so far unexplored. In the presentation the analysis optimisation and the setup for the statistical analysis will be shown. Finally the expected exclusion limits will be presented.

T 56.5 Wed 16:50 HSZ/0403

Search for photon-induced semileptonic WW production at the ATLAS Experiment — •Varsiha Sothilingam for the ATLAS-Collaboration — Kirchhoff-Institut für Physik, Universität Heidelberg

Due to the non-abelien nature of the electroweak sector of the Standard Model of Particle Physics (SM), direct interactions between gauge couplings are possible. Measurements of the cross sections of these interactions allow for validation of the SM and potential deviations from it opens possibilities for physics beyond the SM. This talk will focus on the coupling between W bosons and photons where the W bosons decay semileptonically. They interact via the triple ($\gamma \rightarrow WW$) and quartic ($\gamma\gamma \rightarrow WW$) gauge couplings of the SM. This process can be produced via Centrally Exclusive Production at the LHC, where non-colliding protons produce a non-linear electromagnetic field which creates a photon pair. The photons couple to the W bosons, providing the signal of interest while the protons remain intact. These protons can be detected using the ATLAS Forward Proton (AFP) spectrometers, which are located around 200m away from the ATLAS detector, on both sides. This talk will provide insight to the measurement of this rare process and the methods used to optimise its signal. It will provide an insight to the different models of the final state which take advantage of the boosted topology of such events.

T 56.6 Wed 17:05 HSZ/0403

Probing the use of advanced observables for measuring the electromagnetic dipole moments of the tau lepton — •Kartik Bhide, Valerie Lang, and Markus Schumacher — Albert-Ludwigs-Universität Freiburg

Precise measurements of the anomalous magnetic moments (a_ℓ) and the electric dipole moments (d_ℓ) of leptons are strong tests of the predictions of the Standard Model (SM), and can be used to constrain theories beyond the SM. Recent measurements of a_τ by the ATLAS and CMS Collaborations demonstrate the ability to perform such measurements in ultra-peripheral lead-lead collisions, via the $\gamma\gamma \to \tau\bar{\tau}$ process. Improving future measurements of a_τ and d_τ can be done by exploiting advanced observables instead of simple kinematic distributions. In this work, the use of observables inspired by matrix element methods is explored for measuring the electromagnetic moments of the tau lepton, in Monte Carlo events produced by the gamma-UPC event generator integrated with MadGraph5. Studies of the performance of these advanced observables at particle level, in particular regarding the extraction of a_τ will be presented.

T 57: Single Top – Higgs Top

Time: Wednesday 15:50–17:20 Location: HSZ/0101

T 57.1 Wed 15:50 HSZ/0101

EFT interpretation of a t-channel single top-quark production cross-section measurement in proton-proton collisions at a centre-of-mass energy of 13 TeV with the ATLAS detector — Benedikt Gocke[2], Dominic Hirschbühl[1], Joshua Reidelstürz[1], •Maren Stratmann[1], and Wolfgang Wagner[1] — [1]Bergische Universität Wuppertal, Wuppertal, Deutschland — [2]Technische Universität Dortmund, Dortmund, Deutschland

Effective field theories (EFTs) provide a model-independent approach for searches for physics beyond the Standard Model (SM). The impact of new physics at high energy scales is parameterized by higher-dimension operators extending the SM Lagrangian.

In this talk, an EFT interpretation of a t-channel single top-quark production cross-section measurement is presented. Constraints on the four-fermion operator $O_{qQ}^{(1,3)}$ are set. The impact of a non-zero contribution of $O_{qQ}^{(1,3)}$ is studied from dedicated samples with simulated events. Constraints on the operator strength are set from a fit to data collected by the ATLAS detector from 2015 to 2018 at a centre-of-mass energy of 13 TeV.

T 57.2 Wed 16:05 HSZ/0101

Constraining effective field theory coefficients with machine learning in top quark pair production at CMS — •andre zimermmane-santos, gilson correia, afiq anuar, alexander grohsjean, and christian schwanenberger — Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, D-22607 Hamburg

Effective Field Theories (EFT) provide a systematic way to look for physics beyond the Standard Model (SM) via indirect searches. Nevertheless even the most restrictive scenarios contain dozens of operators predicting subtle deviations from the SM. Such small effects could only be significantly measured over a high-dimensional space of observables. While this complex problem does not scale well with traditional analysis approaches, *likelihood-free inference* methods based on machine learning (ML) techniques can be combined with the knowledge of the EFT structure to perform test statistics efficiently using several EFT parameters as well as a high number of observables. In this study, we aim at applying recent developments in ML-based inference on the measurement of all QCD-like dimension-six EFT operators in the top quark pair production process at the LHC.

T 57.3 Wed 16:20 HSZ/0101

Search for the tWZ process in the boosted region with the CMS experiment — •Michele Mormile[1], Abideh Jafari[2,3], and Alessia Saggio[2] — [1]Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT) — [2]Deutsches Elektronen-Synchrotron (DESY) — [3]Isfahan University of Technology

Searching for rare processes is a fundamental instrument in testing our understanding of the universe. The high luminosity of proton-proton collisions delivered by the LHC in the 2016-2018 period (Run 2) allows us to search for processes with cross sections in the order of magnitude of 100 fb, such as the associated production of a single top quark with a W and a Z boson (tWZ). The tWZ process has never been observed and has been shown to be promisingly sensitive to new physics in the context of SM Effective Field Theory (SMEFT), especially in the high-p_T spectrum of the final state products. An ongoing search for tWZ in the boosted top quark regime is presented. The data has been collected by the CMS experiment during LHC Run 2 and amounts to 138 fb^{-1}. Final states with three leptons are explored, where the Z boson decays to two oppositely charged leptons, either the W boson or the top quark decays leptonically, the remaining one decays hadronically. A boosted leptonic top tagger was developed using a deep neural network to identify leptons and b-jets arising from the decay of a top quark. The tagger was validated in a phase space pure in events of top quark-antiquark pair production, with both tops decaying into leptons. The results are included in an inclusive tWZ search.

T 57.4 Wed 16:35 HSZ/0101

Search for *tWZ* production at CMS and its interpretation in the SMEFT — •Alberto Belvedere, Roman Kogler, and Katerina Lipka — DESY, Hamburg, Germany

The production of a single top quark t in association with a W and a Z boson in proton-proton collisions has not been observed so far. Its small predicted cross section of 115 fb^{-1} at $\sqrt{s}$ = 13 TeV and a large background from ttZ production make this process very challenging to study. However, tWZ production receives large contributions from beyond-the-standard-model (BSM) theories through the electroweak interaction of the top quark, making this process an important probe of BSM physics. In the context of the Standard Model Effective Field Theory (SMEFT), tWZ is sensitive to unitarity violating effects, leading to an anomalous growth of the cross section as a function of the energy.

A search using Run 2 and 3 data collected by the CMS experiment at $\sqrt{s}$ = 13 and 13.6 TeV offers the possibility to study tWZ with high significance. A status of the ongoing efforts is presented, including studies of the discriminating power of selected variables between tWZ and ttZ. Additionally, the sensitivity to different SMEFT dimension-6 operators is shown.

T 57.5 Wed 16:50 HSZ/0101

tbH$^+$ analysis with multileptons with Run-2 ATLAS data — •Martin Rames and Andre Sopczak — CTU in Prague

The latest results with Run-2 ATLAS data are presented for the search tbH$^+$ in the multilepton channel.

T 57.6 Wed 17:05 HSZ/0101

CP-violation, Asymmetries and Interferences in ttphi — •Duarte Azevedo[1,2], Rodrigo Capucha[3], António Onofre[4], and Rui Santos[3,5] — [1]Institute for Theoretical Physics, Karlsruhe Institute of Technology, 76128 Karlsruhe, Germany — [2]Institute for Astroparticle Physics, Karlsruhe Institute of Technology, 76344 Karlsruhe, Germany — [3]Centro de Fisica Teórica e Computacional, Faculdade de Ciências, Universidade de Lisboa, Campo Grande, Edificio C8 1749-016 Lisboa, Portugal — [4]Departamento de Fisica , Universidade do Minho, 4710-057 Braga, Portugal — [5]ISEL - Instituto Superior de Engenharia de Lisboa, Instituto Politécnico de Lisboa 1959-007 Lisboa, Portugal

We present the results of our paper, where we use the associated production of top-quark pairs (t\bar{t}\phi) with a generic scalar boson (\phi) at the LHC (pp \to t\bar{t}\phi) to explore the sensitivity of a large set of observables to the sign of the CP mixing angle (\alpha), present in the coupling between the scalar boson and the top quarks.

The mass of the scalar boson is set to m_\phi = 125 GeV (the Standard Model Higgs boson mass) and its coupling to top-quarks is varied such that \alpha = 0, 22.5, 45.0, 67.5, 90.0, 135.0 and 180.0. Dileptonic final states of the t\bar{t}\phi system are used, where the scalar boson is set to decay as \phi \to b\bar{b}.

The most sensitive CP-observables are selected to compute Confidence Level (CL) limits as a function of the sign of the top quark Yukawa couplings to the \phi boson.

T 58: Other Exp., $t\bar{t}$

Time: Wednesday 15:50–17:20 Location: HSZ/0103

T 58.1 Wed 15:50 HSZ/0103

Charge detection via proportional scintillation in a single-phase liquid xenon TPC — •Florian Tönnies — Albert-Ludwigs-Universität Freiburg

Dual-phase liquid/gas xenon TPCs are a well-established detector technology to search for WIMP Dark Matter. Nevertheless, the spatially uniform detection of the charge signal in the standard way, i.e., via proportional scintillation in the gaseous xenon, will be challenging at the scale of the next-generation detectors due to the size of the TPCs. The detection of the charge signal in the liquid phase of a single-phase TPC is a promising option to circumvent this issue. In Freiburg we successfully operated a single-phase TPC demonstrator which exploits proportional scintillation in the strong electric field around very thin wires. Some of the most recent results will be presented in this talk.

T 58.2 Wed 16:05 HSZ/0103

Luminosity measurements using the ATLAS Forward Proton (AFP) detector — •Petr Fiedler and Andre Sopczak — CTU in Prague

The latest results of luminosity measurements using the AFP detector are presented.

T 58.3 Wed 16:20 HSZ/0103

Measurement of the top-quark pair to Z-boson production cross-section ratio at a centre-of-mass energy of 13.6 TeV with the ATLAS detector — •Donna Maria Mattern, Tomáš Dado, and Kevin Kröninger — TU Dortmund, Fakultät Physik

The ratio of the top-quark-pair production cross-section to the Z-boson production cross-section is sensitive to the gluon-to-quark ratio of parton distribution functions and other parameters that allow to study the Standard Model, such as the strong coupling constant and the top-quark mass.

A measurement of the top-quark-pair and Z-boson production cross-section, as well as the cross-section ratio, using data collected in proton-proton collisions in 2022 during the early Run 3 of the Large Hadron Collider (LHC) at a center-of-mass energy of 13.6 TeV with the ATLAS experiment, corresponding to an integrated luminosity of 1.2 fb^{-1}, is presented.

Events with an oppositely charged electron-muon pair, as well as b-tagged jets, are used for the top-quark-pair production, while same-flavor dileptonic events are used for the Z-boson production cross-section measurement.

The probability to reconstruct and tag a b-jet is measured in-situ. A large cancellation of the luminosity uncertainty is achieved in the ratio, while this uncertainty is otherwise dominant in cross-section measurements in the early stages of the Run 3 of the LHC. This early result at the new center-of-mass energy at the LHC also serves to validate data quality, hardware and software updates.

T 58.4 Wed 16:35 HSZ/0103

top-Yukawa coupling extraction from $t\bar{t}$ cross-section using ATLAS data — •Supriya Sinha for the ATLAS-Collaboration — DESY Zeuthen

The aim of this analysis is to extract the top-Yukawa coupling (Y_t) from the $t\bar{t}$ cross-section close to the threshold. The presence of a virtual Higgs boson in the loop for the $t\bar{t}$ production process affects several kinematic distributions. This boson exchange mainly modifies the differential distributions near the $t\bar{t}$ production threshold energy. It becomes highly sensitive to Y_t, and hence, is used to extract its value.

This talk introduces the involved physics processes and gives an insight to the analysis strategy. It also highlights a method to reconstruct the $t\bar{t}$ mass efficiently with a minimal bias. The decay channel considered for this analysis is the lepton+jets final state. Full Run-II data with an integrated luminosity of 139 fb^{-1} taken by the ATLAS experiment at 13 TeV, is used.

T 58.5 Wed 16:50 HSZ/0103

First measurement of the top quark pair production cross section at $\sqrt{s}$ = 13.6 TeV at the CMS experiment — Maria Aldaya, Alexander Grohsjean, •Laurids Jeppe, Andreas Meyer, Evan Ranken, and Christian Schwanenberger — Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, D-22607 Hamburg

Recently, the Large Hadron Collider (LHC) at CERN reached a new, unprecedented center-of-mass energy of $\sqrt{s}$ = 13.6 TeV, starting LHC Run 3. This presents the opportunity to measure relevant physical quantities at the new energy frontier, thereby checking the predictions of the standard model.

In this talk, we present the first measurement of the top quark pair production cross section at $\sqrt{s}$ = 13.6 TeV, using data recorded at the CMS detector. The analysis uses a new method combining dilepton and lepton+jets decay channels, constraining several experimental uncertainties such as lepton selection and b jet identification efficiencies in situ. This result also constitutes a first validation of the new data taken by CMS in LHC Run 3.

T 58.6 Wed 17:05 HSZ/0103

Measurement of the dileptonic $\mathrm{t\bar{t}}$ differential cross section in a BSM phase space at CMS — Lutz Feld, •Danilo Meuser, Philipp Nattland, and Marius Teroerde — I. Physikalisches Insitut B, RWTH Aachen University

Measurements of the $\mathrm{t\bar{t}}$ production cross section yield important precision tests of the Standard Model (SM), while also probing scenarios for physics beyond the SM (BSM).

This analysis aims to measure the $\mathrm{t\bar{t}}$ cross section in a phase space where additional contributions from BSM scenarios could be present. It is based on the data set recorded by CMS in the years 2016 to 2018 at a center-of-mass energy of 13 TeV, corresponding to an integrated luminosity of 138 fb^{-1}. The BSM scenarios considered include supersymmetric and dark matter models, where, similarly to the dileptonic $\mathrm{t\bar{t}}$ channel, two leptons, b jets and undetected particles are produced.

Unlike previous measurements, where the differential cross sections were mainly measured as a function of kinematic variables of the leptons or top quarks, this analysis focuses on observables related to the neutrinos, like the missing transverse momentum and the angular distance between the missing transverse momentum and the nearest lepton, to separate BSM from SM $\mathrm{t\bar{t}}$ events. In order to increase the sensitivity of the analysis multivariant techniques are used which improve the resolution of the missing transverse momentum in SM $\mathrm{t\bar{t}}$ events. In this talk the analysis strategy will be presented and preliminary results on the improved missing transverse momentum resolution and on systematic uncertainties will be shown.

T 59: QCD Theory and Experiment I

Time: Wednesday 15:50–17:20 Location: HSZ/0105

T 59.1 Wed 15:50 HSZ/0105

Measurement and QCD analysis of inclusive jet production in deep inelastic scattering at ZEUS — •Florian Lorkowski — DESY, Hamburg, Germany

The measurement of cross sections of deep inelastic scattering processes at the electron-proton collider HERA is a well established tool to test perturbative QCD predictions. Additionally, they can be used to determine the non-perturbative parton distribution functions of the proton. Measurements of jet production cross sections are particularly well suited to also constrain the strong coupling constant.

In this talk, a new measurement of inclusive jet cross sections in neutral current deep inelastic scattering using the ZEUS detector at the HERA collider is presented. The data were taken during the HERA 2 period at a center of mass energy of 318 GeV and correspond to an integrated luminosity of 347 pb^{-1}. Massless jets, reconstructed using the $k_\perp$-algorithm in the Breit reference frame, are measured as a function of the squared momentum transfer Q^2 and the transverse momentum of the jets in the Breit frame $p_{\perp,\mathrm{Breit}}$.

The measured jet cross sections are compared to previous measurements as well as NNLO QCD theory predictions. The measurement is used in a QCD analysis at NNLO accuracy to perform a simultaneous determination of parton distribution functions of the proton and the strong coupling constant. A significantly improved accuracy is observed compared to similar measurements of the strong coupling constant.

T 59.2 Wed 16:05 HSZ/0105

Measurement of the 1-jettiness event shape observable in DIS — Daniel Britzger[1], Sook Hyun Lee[2], and •Johannes Hessler[1] — [1]Max Planck Institute for Physics — [2]University of Michigan

A first measurement of the 1-jettiness event shape observable τ_1^b in neutral-current deep inelastic scattering is presented. The data were taken by the H1 experiment at HERA from 2003 to 2007 at a centre of mass energy of $\sqrt{s}$ = 319 GeV. The triple-differential cross sections are presented as a function of the 1-jettiness τ_1^b, the virtuality of the exchanged boson Q^2 and the inelasticity of the event y. The data exhibit a sensitivity to the strong coupling constant and to resummation and hadronisation effects. The data are compared to selected predictions.

T 59.3 Wed 16:20 HSZ/0105

Fast simulations with NNLO QCD accuracy - new developments in the APPLfast project — •Lucas Kunz — Karlsruhe Institute of Technology, Karlsruhe, Germany

The calculation of theoretical predictions for hadron colliders at higher orders in perturbation theory involves computing time expensive iterative procedures. The same is true for the extraction of parton distribution functions (PDFs) from measured data. Hence, to produce results in reasonable time, a very efficient and flexible setup is needed. The APPLfast project fulfills these requirements by linking the parton-level Monte Carlo program NNLOJET with both the APPLgrid and fastNLO grid libraries, thereby allowing for an a posteriori choice of a set of PDFs or value of the strong coupling constant. This talk will give an overview of the project, focusing on an explanation of the general logic and on possible applications rather than technical details. We will further present some first results for NNLO dijet production at the LHC, both at leading and full color.

T 59.4 Wed 16:35 HSZ/0105

The NNLO beam function for jet-veto resummation — Guido Bell[1], •Kevin Brune[1], Goutam Das[2], Marcel Wald[1], and Ding Yu Shao[3,4] — [1]Theoretische Physik 1, Center for Particle Physics Siegen, Universität Siegen, Germany — [2]Institut für Theoretische Teilchenphysik und Kosmologie, RWTH

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The jet-veto beam function describes collinear initial-state radiation that is constrained by a veto on reconstructed jets. As the veto is imposed on the transverse momenta of the jets, the beam function is subject to rapidity divergences, and we use the collinear-anomaly framework to extract the perturbative matching kernels to next-to-next-to-leading order (NNLO) in the strong-coupling expansion. Our calculation is based on a novel framework that automates the computation of beam functions and provides the ingredients to extend jet-veto resummations to NNLL$'$ accuracy.

T 59.5 Wed 16:50 HSZ/0105

Numerical multi-loop calculations with pySecDec — •Anton Olsson — Karlsruhe Institute of Technology

We present new features of the program pySecDec, which can serve to calculate loop amplitudes numerically. Examples for 2-loop multi-scale integrals needed for LHC precision physics as well as 3-loop integrals relevant at a future lepton collider will be given.

T 59.6 Wed 17:05 HSZ/0105

The determination of r_0 on the CLS 2+1 ensembles — •Tom Asmussen, Roman Höllwieser, Francesco Knechtli, and Tomasz Korzec — University of Wuppertal, Wuppertal, Germany

We determine the scale r_0 for $2+1$ flavour QCD ensembles generated by CLS. This scale is determined from an improved definition of the static force which we measure using Wilson loops. Reweighting factors from the simulations are included in the analysis and mass derivatives have been calculated to correct for mistunings. In the end we present an analysis for r_0/a at several values of the lattice gauge coupling and perform chiral extrapolations. We also compare with the scale t_0.

T 60: Theory BMS

Time: Wednesday 15:50–17:05 Location: HSZ/0201

T 60.1 Wed 15:50 HSZ/0201

Domain walls in the 2HDM and their interactions with standard model fermions — •Mohamed Younes Sassi and Gudrid Moortgat-Pick — II. Institut für Theoretische Physik, Hamburg, Germany

Extended Higgs models such as the 2HDM can induce topological defects after spontaneous symmetry breaking. In this talk, I will discuss the formation of domain walls arising after the breaking of the discrete Z2 symmetry present in the 2HDM. I will, in particular, discuss the property of localized CP and charge violation inside the domain walls and finish with describing how standard model fermions interact with such types of domain walls.

T 60.2 Wed 16:05 HSZ/0201

Dark Matter Phenomenology in Z'2 broken Two Higgs Doublet Model with Complex Singlet Extension — •Julia Ziegler, Juhi Dutta, Cheng Li, Gudrid Moortgat-Pick, and Tabira Farah Sheikh — Universitaet Hamburg, Germany

Although the Standard Model is very successful, there are still open problems which it cannot explain, one of it being dark matter (DM). This has led to various Beyond Standard Model theories, of which Two Higgs Doublet models are very popular, as they are one of the simplest extensions and lead to a rich phenomenology. Further extensions with a complex singlet lead to a natural DM candidate.

The aim of this work is the exploration of the dark sector in a Two Higgs Doublet Model extended by a complex scalar singlet, where the imaginary component of the singlet gives rise to a pseudo-scalar DM candidate. Both, the doublets, and the singlet, obtain a vacuum expectation value (vev), where the singlet vev leads to additional mixing of the doublet and the singlet scalar sector. We examine the influence of the Higgs sector parameters on DM relic density and direct detection scattering cross sections. The results are then compared with constraints from experiments.

T 60.3 Wed 16:20 HSZ/0201

Leading Logarithmic 3-loop Corrections to $(g-2)_\mu$ in the Two-Higgs-Doublet Model — •Kilian Möhling — TU Dresden, Germany

The persistent deviation of the measured value of the anomalous magnetic moment of the muon $(g-2)_\mu$ from the prediction in the Standard Model provides us with one of the currently most tantalizing hints at physics beyond the Standard Model. In the near future, increased statistics and improved theoretical calculations will further reduce the uncertainty of this result which in turn puts stronger constraints on new physics models and motivates more precise calculations of the additional corrections.

In this talk I will focus on the Two-Higgs-Doublet Model as one of the promising explanations of the deviation. Here, the dominant contribution to the magnetic moment arises through two-loop Barr-Zee diagrams with large Yukawa couplings to heavy fermion loops. These diagrams bring with them a large uncertainty from QCD corrections at 3-loop order. I will discuss how this uncertainty can be reduced by including large logarithmic 3-loop contributions resummed in the renormalization group equation of an appropriate effective field theory.

T 60.4 Wed 16:35 HSZ/0201

Scalar Potential in SU(6) Gauge-Higgs Grand Unification — Andreas Bally, Florian Goertz, •Maya Hager, and Aika Marie Tada — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

Composite Grand Unified Theories unify the Standard-Model gauge symmetries and their breaking in a single structure while at the same time offering a solution to the hierarchy problem. In these scenarios, the corrections to the Higgs mass are expected to be at the order of the compositeness scale around a few TeV, significantly decreasing the necessary level of fine-tuning. In the recently proposed SU(6) Gauge-Higgs GUT (GHGUT) by Angelescu et al., the Higgs emerges as a pseudo Nambu-Goldstone boson of the coset SU(6)/SU(5) along with a scalar leptoquark and a scalar singlet. The scalar potential is generated radiatively through explicit symmetry breaking induced by the coupling to elementary fields. To describe the dynamics of the SU(6) GHGUT we work in a 4-dimensional framework using the AdS/CFT correspondence and we employ the Callan-Coleman-Wess-Zumino (CCWZ) mechanism to find the zero temperature potential. The 4D method enables a better analytical understanding of the scalar potential than the numerical study in five dimensions done previously. In addition, it can shed light on open problems such as baryogenesis, for which we include the finite temperature potential. A small hierarchy remains between the scales and we look at the fine tuning needed to achieve a realistic Higgs mass and vev. Furthermore, phenomenological aspects are investigated, such as the modification of couplings with respect to the SM, or the bounds on the lightest composite resonances.

T 60.5 Wed 16:50 HSZ/0201

Constraining BSM scalars with neural networks — Thomas Flacke[1], Jeong Han Kim[2], •Manuel Kunkel[3], Jun Seung Pi[2], Werner Porod[3], and Leonard Schwarze[3] — [1]Center for AI and Natural Sciences, KIAS, Seoul, Republic of Korea — [2]Department of Physics, Chungbuk National University, Chungbuk, Republic of Korea — [3]Institut für Theoretische Physik und Astrophysik, Julius-Maximilians-Universität Würzburg, Germany

We study a simple extension of the Standard Model motivated by composite Higgs models, in which a doubly charged scalar decays to $W^+ t\bar{b}$, resulting in a $4t$-like signature from pair production. We train a neural network to differentiate this BSM signal from the dominant SM backgrounds using jet images and kinematic data. We derive the discovery reach and expected exclusion limit at the LHC. A comparison with recasts of Run-2 analyses shows a significant improvement over cut-based analyses.

T 61: Higgs I

Time: Wednesday 15:50–17:20 Location: HSZ/0204

T 61.1 Wed 15:50 HSZ/0204

ttH analysis with two light leptons and one hadronically decaying tau lepton with Run-2 ATLAS data — •Vladyslav Yazykov and Andre Sopczak — CTU in Prague

The latest results on the analysis with Run-2 ATLAS data are reported on the ttH 2lSS1tau channel.

T 61.2 Wed 16:05 HSZ/0204

Measurement of the inclusive $t\bar{t}H$ Cross-Section in the 4ℓ Final State — •Stephen Eggebrecht, Steffen Korn, Arnulf Quadt, Baptiste Ravina, and Elizaveta Shabalina for the ATLAS-Collaboration — II Physikalisches Institut, Göttingen

The Higgs boson production in association with a top quark pair plays a key role for studying the Yukawa coupling between the Higgs boson and the top quark. The coupling can be determined by measuring the cross-section of the $t\bar{t}H$ production to various finial states. Multi-lepton final states are quite but pure since most backgrounds are significantly suppressed. The non-resonant $t\bar{t}H \rightarrow 4\ell$ process has low rate and is sensitive to various Higgs decay modes like $H \rightarrow WW$, $H \rightarrow \tau\tau$, and $H \rightarrow ZZ$. The dominant background arises from $t\bar{t}Z$ and ZZ events. A multiclass dense neural network (DNN) is trained to separate signal events from these backgrounds and to define analysis regions. Input features such as kinematic information of all final state particles, missing transverse energy, and other high level variables like invariant masses of lepton pairs and their distances are used. An Asimov fit is then performed to evaluate the signal sensitivity.

T 61.3 Wed 16:20 HSZ/0204

Multivariate techniques for measurements of Higgs boson production cross-sections in $H \rightarrow WW^* \rightarrow e\nu\mu\nu$ decays with the ATLAS experiment — •Ahmed Markhoos, Karl Jakobs, Karsten Köneke, and Benedict Winter — University of Freiburg, Germany

The $H \rightarrow WW^* \rightarrow e\nu\mu\nu$ channel provides a sizeable signal and moderate background yields, allowing for accurate measurements of the total and differential cross-sections. The measurements for gluon-fusion production are generally dominated by systematic uncertainties, except in the sparsely populated regions of the phase space, such as at large transverse momenta.

In this talk, Deep Neural Network models (DNN) are showcased as powerful tools in tackling this complex but highly sensitive channel. Enhancing the signal purity with respect to the current cut-based selection method, reduces systematic uncertainties from backgrounds and statistical uncertainties, as well as enables measurements of simplified template cross-sections with finer granularity. Additionally, DNNs facilitate the difficult measurement of vector boson fusion in the single jet channel.

T 61.4 Wed 16:35 HSZ/0204

Search for the Higgs plus charm quark production mode in the H→WW→2ℓ2ν channel — •Ming-Yan Lee[1], Spandan Mondal[1], Alena Dodonova[1], Alexander Schmidt[1], Annika Stein[1], Luca Mastrolorenzo[1], Andrzej Novak[1], Xavier Coubez[1,2], Andrey Pozdnyakov[1], Manuella Guirgues[1], and Valentyn Vaulin[1] — [1]RWTH III. Physikalisches Institut A, Aachen, Germany — [2]Brown University, Providence, USA

The Higgs plus charm production mode is another topology to probe Higgs-charm Yukawa coupling complementary to H→cc channels. This topology provides the possibility to access the Higgs-charm coupling via cleaner final states. In this analysis, we aim to consider the Higgs decay into W boson to dileptonic final states with additional charm-tagged jets. The expected upper limit to extract H-c coupling is demonstrated using the data-taking period 2017 of the CMS experiment at the LHC at $\sqrt{s}$ =13 TeV.

T 61.5 Wed 16:50 HSZ/0204

Higgs Boson Cross Section Measurement in the $H \rightarrow ZZ \rightarrow 4\ell$ Channel with Early Run 3 ATLAS Data — •Alice Reed and Sandra Kortner — Max Planck Institut für Physik, München

Run 3 of the LHC began in July 2022, starting a new period of data taking at a higher centre of mass energy of 13.6 TeV, compared to 13.0 TeV during Run 2. At this higher center of mass energy, the Higgs boson cross section is expected to increase by ~ 7% compared to Run 2.

An important process for the measurement of the Higgs boson properties is the Higgs boson decay into two Z bosons, which subsequently decay into a $\mu^+\mu_-$ or e^+e^- pair, $H \rightarrow ZZ \rightarrow 4\ell$. Due to its clear signature, this decay channel can already be studied with early Run 3 data. The precision of the fiducial and differential $H \rightarrow 4\ell$ cross section measurements was studied and optimized in preparation for the measurements with early Run 3 data from the ATLAS experiment.

T 61.6 Wed 17:05 HSZ/0204

Measurement of $pp \rightarrow WH \rightarrow WWW$ with the ATLAS Experiment — •Moritz Hesping, Volker Büscher, Ralf Gugel, and Christian Schmitt — Johannes Gutenberg Universität Mainz

The measurement of the couplings of the Higgs boson is of great scientific interest, since it has the potential of testing possible extensions to the Standard Model. The decay of a Higgs boson into a pair of W bosons after production in association with a W boson is especially useful, since in this process the Higgs boson exclusively couples to W bosons.

In this talk, the analysis of the $pp \rightarrow WH \rightarrow WWW$ using the full run 2 dataset of the ATLAS experiment will be presented, focusing on the three lepton Z-depleted channel. First preliminary results for this analysis will be shown. Finally, the extension of the analysis to the Simplified Template Cross Sections (STXS) scheme will be discussed. In the STXS scheme, the measurement is performed as a function of the momentum of the associated W boson, which gives improved sensitivity to possible contributions from physics beyond the standard model.

T 62: DAQ NN/ML – GRID II

Time: Wednesday 15:50–17:20 Location: HSZ/0301

T 62.1 Wed 15:50 HSZ/0301

Development of machine-learning based topological algorithms for the CMS level-1 trigger — •Finn Labe, Johannes Haller, Gregor Kasieczka, Artur Lobanov, and Matthias Schröder — Institut für Experimentalphysik, Universität Hamburg

At the CMS experiment, a two-level trigger system is used to decide which collision events to store for later analysis. Due to the large fraction of non-interesting, low-energy collisions, currently used triggers often rely on momentum thresholds, only selecting events containing at least one highly-energetic object. In many cases, such as searches for di-Higgs production, this can substantially reduce the signal efficiency of the trigger selection. Targeting the upgraded CMS detector for the High Luminosity LHC, novel techniques are presented that utilize machine learning inside the first hardware layer of the trigger, which is based on FPGAs. Instead of individual objects, these triggers rely on the full event topology to select previously inaccessible events. The usage of these algorithmns in the context of the second trigger layer and offline analysis is studied.

T 62.2 Wed 16:05 HSZ/0301

LHCb's Topological Trigger in Run 3 — Johannes Albrecht[1], Gregory Max Ciezarek[2], Blaise Delaney[3], Niklas Nolte[3], and •Nicole Schulte[1] — [1]TU Dortmund University, Dortmund, Germany — [2]CERN, Switzerland — [3]Massachusetts Institute of Technology, Massachusetts, USA

The data-taking conditions expected in Run 3 of the LHCb experiment present unprecedented challenges for the software and computing systems. Consequently, the LHCb collaboration is pioneering an entirely software-based trigger system to efficiently manage the increased event rate. The beauty physics programme of LHCb is heavily dependent on topological triggers. These are dedicated to the inclusive selection of b-hadron candidates based on the characteristic beauty decay topology and their expected kinematic properties.

We present the Run 3 implementation of the topological triggers using Lipschitz monotonic neural networks. This architecture offers robustness under varying detector conditions and sensitivity to long-lived candidates, opening the possibility of discovering New Physics at LHCb.

T 62.3 Wed 16:20 HSZ/0301

APEL accounting with AUDITOR — Michael Böhler, Stefan Kroboth, •Dirk Sammel, and Markus Schumacher — Albert-Ludwigs-Universität Freiburg

Institutions that are part of the Worldwide LHC Computing Grid (WLCG) offer computing resources to analyse the data recorded by experiments at the Large Hadron Collider (LHC), and to produce simulated samples. An important task is the accounting of the utilized resources. For this, the used CPU time among other information is reported to the APEL (Accounting Processor for Event Logs) server, which publishes it on the Accounting Portal of the European Grid Infrastructure (EGI).

In Freiburg, for example, the accounting to APEL is performed by ARC CE (Advanced Resource Connector Compute Element). The compute element accepts compute jobs from WLCG and submits them to the local batch system. In addition it can also report the utilized resources. An alternative approach, independent from ARC CE, is the use of AUDITOR (Accounting Data Handling Toolbox For Opportunistic Resources). AUDITOR uses a “collector” to gather job information from the local batch system. These “job records” are stored in a PostgreSQL database, which can be accessed by plug-ins.

This talk first gives a short overview of the accounting system of the ARC software, and then presents an AUDITOR plug-in for accounting to APEL. The plug-in receives job records from the AUDITOR database, formats them according to APEL specifications, and submits them to the APEL server.

T 62.4 Wed 16:35 HSZ/0301

Accounting opportunistic resources with AUDITOR — •Stefan Kroboth, Michael Boehler, Dirk Sammel, and Markus Schumacher — Albert-Ludwigs-Universität Freiburg

The increasing computational demand and concerns about energy efficiency in high performance/throughput computing are driving forces in the search for more efficient ways to utilize available resources. A measure for achieving high efficiency is the sharing of idle resources of under-utilized sites with fully occupied sites. The software COBalD/TARDIS can automatically, transparently, dynamically and opportunistically integrate and disintegrate such resources. However, sharing resources also requires accounting. In this work we present AUDITOR (AccoUnting DatahandlIng Toolbox for Opportunistic Resources), a flexible and extensible accounting system that is able to cover a wide range of use cases and infrastructure. AUDITOR gathers accounting data via so-called collectors which are designed to monitor batch systems, COBalD/TARDIS, cloud schedulers or other sources of information. The data is stored in a database and provided to so-called plugins, which take an action based on accounting records. Actions can range from creating a bill, computing the CO_2 footprint, adjusting parameters of a service (i.e. priorities in a batch system) to forwarding accounting information to other accounting systems. Depending on the use case, one simply selects a suitable collector and plugin from a growing ecosystem of collectors and plugins. To facilitate the development of collectors and plugins for yet uncovered use cases by the community, libraries for interacting with AUDITOR are provided.

T 62.5 Wed 16:50 HSZ/0301

Containerization of the ATLAS HammerCloud setup — •Benjamin Rottler, Michael Böhler, and Markus Schumacher — Universität Freiburg

HammerCloud (HC) is a testing service and framework for continuous functional tests, on-demand large-scale stress tests, and performance benchmarks. It checks the computing resources and various components of distributed systems with realistic full-chain experiment workflows.

The current deployment setup based on RPMs allowed a stable deployment and secure maintenance over several years of operations for the ATLAS and CMS experiments. However, the current model is not flexible enough to support an agile and rapid development process. Furthermore, we wanted to be more independent of software versions that are provided by the package manager of the host system.

Therefore, we have decided to use a solution based on containerization, and switched to industry-standard technologies and processes. Having an "easy to spawn" instance of HC enables a more agile development cycle and easier deployment. With the help of such a containerized setup, CI/CD pipelines can be integrated easily into the automation process as an extra layer of verification. Furthermore, the container-based setup allows for quick onboarding of new team members, as developers can now work locally with a quick turnaround without the need to set up a production-like environment first.

In this talk we present the container-based setup for HammerCloud and discuss the process that led to our containerized solution.

T 62.6 Wed 17:05 HSZ/0301

Sapphire - Small-file aggregation for the dCache tape interface — •Svenja Meyer[1], Krishnaveni Chitrapu[3], Dmitry Litvintsev[2], Paul Millar[1], Tigran Mkrtchyan[1], Lea Morschel[1], Albert Rossi[2], and Marina Sahakyan[1] — [1]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [2]Fermi National Accelerator Laboratory, Batavia, USA — [3]National Supercomputer Center, Linköping University, Sweden

dCache is an open source distributed storage system used to manage and store scientific data in the scale of hundreds of petabyte. Archiving data on tertiary storage, for example tape, is a main feature of this software. Unfortunately the performance of writing data to tape decreases for small sized files, which are produced more and more by experiments.

To circumvent this problem, *Sapphire*, an advancement of *SmallFiles* for *dCache*, was developed. Working as a plugin for *dCache*, these small files are bundled into bigger archives without needed intervention by the user. Flushing files to tape as well as staging them back works transparently to the user.

T 63: ML Methods III

Time: Wednesday 15:50–17:20 Location: HSZ/0405

T 63.1 Wed 15:50 HSZ/0405

Automated Hyperparameter Optimization of Neural Networks for ATLAS analyses — •Erik Bachmann — Institute of Nuclear and Particle Physics, Technische Universität Dresden, Germany

In recent years, artificial neural networks have become a standard tool in many analyses to increase the sensitivity of measurements and largely replaced other multivariate techniques. The hyperparameters of the neural network, e. g. the number of hidden layers in a multilayer perceptron, are however usually chosen based on intuition and experience without any optimization. Additionally, the absence of overtraining is often only verified by visually inspecting the network's output distributions.

In this talk, a framework to perform automated hyperparameter optimization with a special focus on directly including objective overtraining conditions as part of the optimization is presented. Furthermore, its first application in the ATLAS vector boson polarization analysis of $W^{\pm}W^{\pm}$ scattering is discussed.

T 63.2 Wed 16:05 HSZ/0405

Optimising inference with binning — Phillip Keicher, Marcel Rieger, Peter Schleper, and •Jan Voss — Institut für Experimentalphysik Universität Hamburg, Hamburg, Deutschland

In order to increase the sensitivity of searches for rare processes, neural networks are nowadays a widely-spread tool to construct powerful discriminators. These discriminators are usually optimized to separate physics-motivated classes, but not necessarily on an optimal statistical inference. Consequently, the results can depend on auxiliary effects such as the exact binning choice for the distributions of the final discriminants.

This study aims to construct a setup for optimising the sensitivity with respect to the binning choice in the context of a Di-Higgs in the $b\bar{b}\tau^+\tau^-$ final state. This setup is based on the python packages pyhf and JAX, which are used for the statistical modeling and the derivation of the inference with respect to the bin edges. This talk presents the current status of this on-going project and will highlight the challenges and possible applications of this novel technique.

T 63.3 Wed 16:20 HSZ/0405

Uncertainty aware training — Markus Klute, •Artur Monsch, Günter Quast, Lars Sowa, and Roger Wolf — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

As physics experiments continue their measurements, with the LHC Run-3 and the future High-Luminosity LHC as notable examples, the amount of data is steadily increasing. These continued measurements will lead to reduced statistical uncertianties of many analyses, emphasizing the importance of systematic uncertainties in analysis results. This talk presents a machine-learning (ML)-based data analysis strategy to obtain an optimal test statistic minimizing analysis-specific statistical and systematic uncertainties. To achieve this the training objective for the neural network is modified to take systematic variations into account, leading to an overall uncertainty reduction on the analysis objective. The method will be demonstrated on a simple example using pseudo data and on a reduced CMS dataset used for an ML-based analysis of the observed Higgs boson in the di-τ final state with the goal of differential measurements of Higgs boson production, with the CMS experiment.

T 63.4 Wed 16:35 HSZ/0405

Interpolating Antenna Calibration Data from Sparse Measurements with Information Field Theory — •Maximilian Straub, Martin Erdmann, and Alex Reuzki for the Pierre Auger-Collaboration — Physics Institute III A RWTH Aachen University

Extensive air showers are induced in the Earth's atmosphere by ultra-high-energy cosmic rays. These air showers are measured at the Pierre Auger Observatory using various detection techniques, including radio antennas. As part of the Pierre Auger Observatory's AugerPrime upgrade, so-called Short Aperiodic Loaded Loop Antennas (SALLAs) are currently being deployed. These antennas will be calibrated with a remotely-piloted aircraft that carries a known signal source to characterize the direction- and frequency dependent gain, the so-called antenna pattern. With this method, only a finite number of directions and frequencies is probed, limited by i.a. battery life of the aircraft. Information Field Theory (IFT) is a framework for reconstructing field-like structures using Bayesian statistics. With IFT it is possible to leverage local correlation structures to interpolate on the domain product $S^2 \times \mathbb{R}$, that is direction dependence and frequency dependence at the same time. The multidimensional interpolation is informed by physics and therefore performs better than e.g. a linear interpolation. Using Information Field Theory provides calibration uncertainties resulting from the calibration measurements. Furthermore, by operating directly on the sphere it avoids projection-related distortions and edge effects that stem from the angular periodicity.

T 63.5 Wed 16:50 HSZ/0405

Tau neutrino identification with Graph Neural Networks in KM3NeT/ORCA — •Lukas Hennig for the ANTARES-KM3NET-ERLANGEN-Collaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Erlangen Centre for Astroparticle Physics, Nikolaus-Fiebiger-Straße 2, 91058 Erlangen, Germany

One of the goals of the KM3NeT collaboration is to constrain the PMNS matrix elements associated with the tau neutrino flavour. The data needed to perform this task is taken with KM3NeT/ORCA, a neutrino detector currently under construction in the Mediterranean deep sea. To constrain the matrix elements, one needs to measure the tau neutrino flux produced by atmospheric muon and electron neutrinos oscillating into tau neutrinos. Selecting the tau neutrino events from the full neutrino event dataset is a notoriously difficult task because the final states of tau neutrino interactions look very similar to the final states of muon or electron neutrino events. This classification problem was tackled in my Master's thesis using Graph Neural Networks (GNNs), a type of neural network architecture that showed promising results, e.g., on the related task of jet tagging. This talk will discuss the different methods used to optimise the GNN's performance on this classification task, including a computation-intensive automated hyperparameter search, and present the performance gains achieved by each of these steps and the final performance of the tau event classifier.

T 63.6 Wed 17:05 HSZ/0405

Negative event weights in Machine Learning and search for heavy Higgs bosons in top quark pair events at CMS — •Jörn Bach[1,2,3], Christian Schwanenberger[1,2], Peer Stelldinger[3], and Alexander Grohsjean[1] — [1]Deutsches Elektronen Synchrotron DESY, Hamburg — [2]Universität Hamburg, Hamburg — [3]Hochschule für angewandte Wissenschaften (HAW) Hamburg

Sophisticated Monte-Carlo event generators are key to the LHC research program. When involving higher order predictions or interference effects, simulated events can be negatively weighted. To achieve correct results with maximum sensitivity, negative weights cannot simply be ignored when working with Machine Learning methods. In this talk, I will discuss the issues that arise in trainings of Deep Neural Networks through negatively weighted events and propose a solution on how to efficiently handle them. Additionally, I will discuss the application of these techniques in a search for heavy Higgs bosons and its potential for LHC data analyses in general.

T 64: Neutrino Astronomy III

Time: Wednesday 15:50–17:20 Location: POT/0051

T 64.1 Wed 15:50 POT/0051

KM3NeT status — •Alba Domi for the ANTARES-KM3NET-ERLANGEN-Collaboration — ECAP, Erlangen, Germany

KM3NeT is an underwater neutrino telescope under construction in the Mediterranean Sea. It is divided into two subdetectors: ORCA, whose main goal is the determination of the neutrino mass ordering, is optimised for neutrino oscillation studies in the GeV energy range and it is located 40 km off-shore Toulon (France), and ARCA, located 100 km off-shore Portopalo di Capopassero (Italy), is optimised for cosmic neutrino studies up to the PeV energy range. The construction and deployment of the telescope is modular and, to date, a fraction of the planned detection units is already taking data. This talk reviews the status of the KM3NeT neutrino telescope, and it presents the first analyses performed with collected data.

T 64.2 Wed 16:05 POT/0051

Exploring Prospects for Multi-Messenger Observations of Short Gamma-Ray Bursts with IceCube-Gen2 and the Einstein Telescope — •Sharif El Mentawi[1], Jakob Böttcher[1], Anna Franckowiak[2], Philipp Fürst[1], Erik Ganster[1], Lasse Halve[1], Xavier Rodrigues[2], Matthias Thiesmeyer[1], and Christopher Wiebusch[1] for the IceCube-Collaboration — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]Astronomisches Institut (AIRUB), Ruhr-Universität Bochum

After the coincident observation of a short gamma-ray burst (sGRB) in gamma rays and a neutron star binary merger in gravitational waves in 2017, sGRBs have become one of the most prominent sources for multi-messenger astronomy. Whereas photons provide insight into some of the radiative processes taking place in sGRBs and gravitational waves reproduce kinematics of progenitor neutron stars, neutrinos can traverse dense material and thus might probe the source environment or the merger process itself. With the new generation of multi-messenger experiments, such as IceCube-Gen2 for high-energy neutrinos and the Einstein Telescope for gravitational waves on our doorsteps, the sensitivity to both messengers will be greatly improved. We discuss a data-motivated simulation of sGRBs in neutrinos and gravitational waves, with the goal of estimating joint detection prospects with IceCube-Gen2 and the Einstein Telescope.

T 64.3 Wed 16:20 POT/0051

Investigations of hadronic vs electromagnetic cascade identification at the PeV energy scale. — •Yara Darras for the ANTARES-KM3NET-ERLANGEN-Collaboration — Nikolaus-Fiebiger-Str. 2 91058 Erlangen, Germany

KM3NeT/ARCA is an underwater Cherenkov detector located 100 km off-shore Portopalo di Capo Passero on the south-eastern coast of Sicily. Its main goal is the detection of high energy neutrinos from astrophysical sources such as gamma ray bursts or active galactic nuclei. Neutrino interactions with matter are detected as events of different topologies depending on the neutrino flavour and interaction type. The Glashow resonance is a particular type of neutrino interaction in which an electron antineutrino with an energy of about 6.3 PeV interacts with an electron producing a W-boson which can decay through different channels. In this contribution, the use of deep learning techniques to distinguish between hadronic and leptonic decay modes of the W boson produced in the Glashow resonance is described.

T 64.4 Wed 16:35 POT/0051

Optimization of the Forward-Folding Likelihood Fit for the Astrophysical Muon Neutrino Analysis with IceCube — •Matthias Thiesmeyer[1], Jakob Böttcher[1], Shuyang Deng[1], Philipp Fürst[1], Erik Ganster[1], Jonas Hellrung[1], Sharif El Mentawi[1], Richard Naab[2], and Christopher Wiebusch[1] for the IceCube-Collaboration — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]DESY, Zeuthen, Germany

One important detection channel for astrophysical neutrinos in IceCube is neutrino-induced muon tracks. The astrophysical flux parameters are estimated using a explicit forward-folding likelihood fit of the measured neutrino data. Here, the binned distribution of reconstructed zenith and energy is compared to the number of expected events from atmospheric and astrophysical neutrino fluxes by means of a profile likelihood. To maximize the sensitivity to the astrophysical neutrino flux properties we optimize and generalize the choice of binning. A particular challenge is limited Monte-Carlo statistics for the estimation of precise templates over the full parameter space. As an optimization metric we extend the simple Poissonian likelihood to an effective likelihood that includes the uncertainties of the bin predictions caused by limited Monte-Carlo statistics. By this we can balance between a limited measurement resolution in cases where the binning is too coarse, and a higher statistical uncertainty of the bin predictions in cases where the binning is too fine.

T 64.5 Wed 16:50 POT/0051

Search for collider neutrinos with FASER — Florian Bernlochner, Tobias Blesgen, •Tobias Böckh, Jochen Dingfelder, and Markus Prim — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

Although neutrinos are produced in large numbers at the LHC, such collider neutrinos have not been discovered yet since they interact weakly and neutrinos with high energies are dominantly produced along the beamline. Therefore FASER, the forward search experiment, is located on the beam collision axis line-of-sight 480m downstream from the ATLAS interaction point. In this talk, we will present the search for such collider neutrinos using the electronic detectors of the FASER detector.

T 64.6 Wed 17:05 POT/0051

ANNIE: The Accelerator Neutrino Neutron Interaction Experiment — •Marc Breisch for the ANNIE-Collaboration — Physikalisches Institut, Eberhard Karls Universität Tübingen

The Accelerator Neutrino Neutron Interaction Experiment (ANNIE) is a 26-ton gadolinium doped water Cherenkov detector on-axis of the Booster Neutrino Beam (BNB) at FermiLab. Its primary goal is to measure the final state neutron multiplicity of neutrino-nucleus interactions to improve the systematic uncertainties of next-generation long baseline neutrino experiments. An additional milestone will be the deployment of multiple Large Area Picosecond Photodetectors (LAPPD), of which the first one is already commissioned and deployed. These novel detectors feature a timing resolution less than 100 picoseconds and a sub-centimeter spatial resolution, thus improving the track reconstruction capabilities of the detector. This talk will give a general overview of ANNIE in general and the status of the LAPPD deployment.

T 65: Gamma Astronomy III

Time: Wednesday 15:50–16:50 Location: POT/0151

T 65.1 Wed 15:50 POT/0151

Towards searching for ultra-high energy photons from galactic PeVatrons — •Chiara Papior, Marcus Niechciol, Markus Risse, and Philip Ruehl — Center for Particle Physics Siegen, Experimentelle Astroteilchenphsik, Universität Siegen

Recently, photons from galactic sources with maximum energies in the PeV range have been discovered. Sources which are able to accelerate particles to these energies are referred to as PeVatrons. They do not only emit photons, but are also candidate sources of galactic cosmic rays. The only firmly identified PeVatron is the Crab nebula. However, through theoretical considerations and directional observations of PeV photon signals, several other potential PeVatron candidates have been proposed, including pulsars, supernova remnants and massive stars. In this contribution, the energy spectra of such source candidates are modelled and extrapolated to even higher energies reaching up to EeV scales. Photons of these energies are referred to as ultra-high-energy (UHE) photons. The results of the extrapolation can then be used to obtain information on the required sensitivity for the measurement of UHE photons from specific source candidates. The work presented in this contribution aims to evaluate the potential at present and future observatories to detect UHE photons from certain sources.

This work is supported by the Deutsche Forschungsgemeinschaft (DFG).

T 65.2 Wed 16:05 POT/0151

Indirect Search for scotogenic WIMP Dark Matter — •Laura Eisenberger — University of Würzburg

Weakly interacting massive particles (WIMPs) are one of the most promising candidates for dark matter. They are predicted for example by scotogenic models which implement an additional Z_2 symmetry under which all Standard Model particles are even while new particles, among them a stable dark matter candidate, are odd.

In our study, we use a scotogenic model (T1-2-A$'$) which can explain neutrino masses and the muon anomalous magnetic moment while fulfilling the current limits for charged lepton flavour violating processes simultaneously. In addition, it also incorporates a new WIMP dark matter type (m=1.1 TeV) consistent with limits from direct dark matter detection experiments.

We focus on the indirect search for this promising dark matter candidate via the detection of annihilation signals. For this, we predict multiwavelength spectral energy distributions (SEDs) reaching from very-high-energy photons from pion decay to secondary Inverse Compton and synchrotron emission. The results are compared to observational limits.

T 65.3 Wed 16:20 POT/0151

Machine Learning Methods for an Increased Understanding of AGN Flares* — •Yannick Hartych[1,2], Julia Becker Tjus[1,2], Wolfgang Rhode[2,3], and Marcel Schroller[1,2] — [1]Theoretische Physik IV, Ruhr Universität Bochum, Bochum, Germany — [2]RAPP-Center at Ruhr Universität Bochum, Bochum, Germany — [3]Experimentelle Physik 5, Technische Universität Dortmund, Dortmund, Germany

Blazars are some of the brightest known sources in the Universe and are considered possible sources of the highest energy cosmic rays (CRs). Hence they are of high interest to astronomers to understand the processes accelerating those CR. One of those blazars is TXS 0506+056, from which a gamma-ray flare arrived in temporal and spatial coincidence with a high-energy neutrino of high probability to be of astrophysical origin. For this reason, the source was brought into focus for further investigation to understand the underlying processes leading to this observation. It is crucial to physically model blazars thoroughly. In order to find the related parameters responsible for this behaviour, we set up simulations in CRPropa3 and develop theoretical flare templates that can be compared to observational signatures. With those templates, the next step would be to train a machine learner to search the galactic catalogues for other blazars with a high probability of showing behaviour similar to TXS 0506+056. In this talk, we will present first preliminary results of such simulations and evaluate their significance in the context of the parameter study.

* Financial support by the DFG (SFB 1941) is gratefully acknowledged

T 65.4 Wed 16:35 POT/0151

Unfolding the Crab Nebula Flux with Gammapy* — •Noah Biederbeck and Maximilian Linhoff — TU Dortmund University, WG Elsässer

In spectral analyses of astrophysical gamma-ray sources, a flux model is typically fitted. Unfolding has the advantage over fitting that it is model independent and correctly includes all known detector effects. Gammapy is a widely used open-source Python package for gamma-ray astronomy, but is lacking unfolding functionality. In this talk, we present the implementation of unfolding in Gammapy and its application to joint flux unfolding of the Crab Nebula using public data of multiple Imaging Atmospheric Cherenkov Telescopes.

*Supported by DFG (SFB 1491) and BMBF (ErUM).

T 66: Neutrinos II

Time: Wednesday 15:50–17:20 Location: POT/0251

T 66.1 Wed 15:50 POT/0251

Detection of solar pp-neutrinos with CID in SERAPPIS — •Tim Charissé, Marcel Büchner, Arshak Jafar, Kai Loo, George Parker, Oliver Pilarczyk, and Michael Wurm — Institute of Physics and EC PRISMA+, Johannes-Gutenberg University Mainz, Mainz, Germany

The OSIRIS detector, a pre-detector that monitors the radiopurity of the scintillator for the JUNO experiment, is planned to be used for the measurement of the solar pp-neutrino flux after fulfilling it's initial purpose. This upgrade is called SEarch for RAre PP-neutrinos In Scintillator (SERAPPIS). As these pp-neutrinos originate from the sun it is crucial to obtain the directional information to get a high sensitivity. This directional information is contained in the Cherenkov light which is hard to distinguish from the scintillation signal. While there are experimental efforts like slow scintillators to enhance the sensitivity for Cherenkov light in SERAPPIS, there is also a data-analytical method called Correlated and Integrated Directionality (CID) to obtain the directional information from the data. It uses the angular distribution between the direction of the neutrino and the detected light for the whole data set to gain information over the pp-neutrino flux.

This talk will present the status of the ongoing sensitivity study for CID in SERAPPIS based on Monte Carlo simulations. It is investigated if CID can have a valuable impact on the measurement of the solar pp-neutrino flux.

T 66.2 Wed 16:05 POT/0251

Column Density Determination for the KATRIN Neutrino Mass Measurement — Fabian Block[1], •Christoph Köhler[2], and Sonja Schneidewind[3] for the KATRIN-Collaboration — [1]Karlsruhe Institute of Technology — [2]Technical University of Munich — [3]Westfälische Wilhelms-Universität Münster

The KATRIN experiment aims to model-independently probe the effective electron anti-neutrino mass with a sensitivity of 0.2 eV (90 % CL) by investigating the endpoint region of the tritium beta decay spectrum. To achieve this goal the gas quantity of the windowless gaseous tritium source, characterized by the column density, has to be known with great accuracy.

We present in this talk the principle of measuring the column density with an angular resolved photoelectron source and describe the method to ensure continuous monitoring of the column density during measurement campaigns of KATRIN. The influence of the recent hardware upgrade of the photoelectron source is discussed in light of the column density determination accuracy.

This work is supported by the Technical University of Munich, the Helmholtz Association, the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, 05A17WO3, 05A20PMA), the Helmholtz Alliance for Astroparticle Physics (HAP), the Helmholtz Initiative and Networking Fund (W2/W3-118) and Deutsche Forschungsgemeinschaft DFG (Research Training Group GRK 2149).

T 66.3 Wed 16:20 POT/0251

Calorimetric methods for monitoring Atomic hydrogen beam for Project 8 — •Christian Matthé, Felix Wünsch, and Sebastian Böser for the Project 8-Collaboration — Johannes Gutenberg Universität Mainz

The Project 8 collaboration aims to determine the absolute neutrino mass with a sensitivity of 40 meV by measuring the tritium decay spectrum around the endpoint energy. For this level of precision it is necessary to use atomic tritium, since molecular tritium sensitivity is limited by the molecular final state distribution to about 100 meV.

A flux of $\approx 10^{19}$atoms/s from the source will be required to inject a beam with $\approx 10^{15}$atoms/s into the detection volume after cooling and state selection inefficiencies. For monitoring this beam, we have built a detector that uses a wire with a micrometer-scale diameter intersecting the beam on which a small fraction of the beam's hydrogen atoms recombine into molecules. The energy released heats the wire and produces a measurable change in its resistance. Such a detector is suitable for both development work and for minimally disruptive online monitoring in the final experiment.

Additionally, we are working on a calorimetrically estimating the fraction of molecules being split by measuring the surplus power our thermal atom source draws when dissociating hydrogen.

In this talk I will present results from tests of both methods.

T 66.4 Wed 16:35 POT/0251

Modeling of RF signals in large-volume antenna-array CRES detectors — •Florian Thomas and Sebastian Böser for the Project 8-Collaboration — Institut für Physik, Johannes Gutenberg-Universität Mainz

The Project 8 collaboration has established Cyclotron Radiation Emission Spectroscopy (CRES) as a novel frequency-based approach of measuring the tritium beta decay spectrum and determining neutrino mass with the endpoint method. To gather sufficient statistics for its design sensitivity of $m_\beta < 40$ meV the Project 8 experiment needs to be scaled up to a $\mathcal{O}(m^3)$ source volume.

In the large-volume case a possible detection scheme for the radio frequency radiation emitted by the decay electrons is an antenna array with $\mathcal{O}(100)$ independent readout channels. In order to reconstruct the electron tracks comprehensive simulations are required. For this large number of channels, numerical solutions of the electron trajectory, the electromagnetic fields and the antenna response are computationally challenging. In this contribution we present an alternative simulation approach which is based on analytic knowledge about cyclotron radiation and $\mathcal{O}(1000)$ faster than our full numeric baseline approach with a negligible impact on the simulation results.

T 66.5 Wed 16:50 POT/0251

Test setup for de-excitation of Rydberg atoms in KATRIN using THz radiation — •Enrico Ellinger — Bergische Universität Wuppertal

The majority of the background in the neutrino mass experiment KATRIN probably originates from the ionization of Rydberg atoms in the main spectrometer volume. The Rydbergs are formed by natural radioactive decay, followed by sputtering processes on the inner walls of the spectrometer vessel. The neutral Rydberg atoms can migrate through the spectrometer before they are ionized by thermal radiation. The resulting free electrons are eventually accelerated towards the main detector producing the background.

Terahertz radiation can stimulate $\Delta n = \pm 1$ transitions in Rydberg atoms to states from which spontaneous decay to the ground state is faster, significantly reducing the ionization probability. A set of 8 high intense THz sources, targeting subsequent transitions in the vicinity of $n = 30$ can reduce the background by up to 50 %, as shown by earlier simulations.

We developed an experimental test setup that serves as a proof of principle for this new method. The setup mimics the processes in the main spectrometer. The main components are an implanted ^{212}Pb source producing the Rydberg atoms and a 40 mW tuneable Thz source able to target two transitions (256.3 & 284.3 GHz) in Rydberg atoms.

The development of the test setup and first experimental results are presented.

T 66.6 Wed 17:05 POT/0251

Recent developments for an automated krypton assay in xenon at the ppq level — Steffen Form, •Matteo Guida, Robert Hammann, Ying-Ting Lin, Hardy Simgen, and Jonas Westermann — Max-Planck Institut für Kernphysik, Heidelberg, Germany

The beta-decaying isotope ^{85}Kr is one of the main intrinsic background components in liquid xenon (LXe) dark matter detectors. Via purification techniques, a krypton-in-xenon concentration below 100 ppq (parts per quadrillion) can routinely be achieved. The rare gas mass spectrometer (RGMS), at Max-Planck Institut für Kernphysik, provides a measurement of the krypton concentration of an extracted xenon gaseous sample taken directly from the experiment. First, krypton is separated from xenon using a cryogenic gas-solid chromatography system. Then, the amount of krypton is quantified using a mass spectrometer. The system has achieved a detection limit of 8 ppq. A fully automatic rare gas mass spectrometer (Auto-RGMS) is under construction for the krypton assay of future low-background LXe detectors. Without human effort, the automatic operation is going to enable more frequent krypton monitoring and provide more robust results. The plan is to introduce a novel adsorbent for the chromatography system to increase the xenon sample size and further push down the krypton detection limit. The new solutions show a large enhancement in the separation power at a given temperature and in the linearity of the adsorption isotherms. The progress to select a new adsorbent and optimize the working point of Auto-RGMS will be discussed.

T 67: Neutrinos, Dark Matter VII

Time: Wednesday 15:50–16:50 Location: POT/0361

T 67.1 Wed 15:50 POT/0361

Optimization of the remoTES design using silicon absorbers — •Kumrie Shera, Gode Angloher, Mukund Bharadwaj, Trosten Frank, Moritz Kellermann, Michele Mancuso, Federica Petricca, Franz Pröbst, Karoline Schäffner, Martin Stahlberg, Vanessa Zema, Antonio Bento, Lucia Canonica, and Abhijit Garai — Max-Planck-Institut für Physik, 80805 München, Germany

Transition Edge Sensors (TES) are sensors that can measure tiny increases of temperature of order μK and are widely used to read out cryogenic calorimeters. However, delicate materials (e.g. with low melting point and/or hygroscopicity) can not undergo the process of fabricating such a sensor on their surface. To deal with this, the COSINUS-experiment developed the remoTES readout design, where the TES itself is placed on a separate wafer and the coupling of the absorber crystal to the TES consists of a gold bonding wire connected to a gold pad on the absorber. In this talk studies done for the optimization of the remoTES design using silicon crystals as a benchmark are shown.

T 67.2 Wed 16:05 POT/0361

Particle Dependent Parameter Determination of Liquid Scintillators for Neutrino Experiments — •David Dörflinger[1], Lothar Oberauer[1], Hans Th. J. Steiger[1,2], Raphael Stock[1], Ulrike Fahrendholz[1], Lennard Kayser[1], Florian Kübelbeck[1], Korbinian Stangler[1], Michael Wurm[2], Dorina Zundel[2], and Manuel Böhles[2] — [1]Technische Universität München (TUM), Physik-Department, James-Franck-Straße 1, 85748 Garching bei München — [2]Institute of Physics and Excellence Cluster PRISMA+, Johannes Gutenberg-Universität (JGU) Mainz, Staudingerweg 9, 55099 Mainz

The Jiangmen Underground Neutrino Observatory (JUNO) aims to detect neutrinos using 20 kton of organic liquid scintillator based on LAB (Linear Alkyl-Benzene). In order to understand the detector response, a precise determination of particle dependent scintillation parameters is crucial. Compared to gamma radiation, neutrons have a different energy dissipation method in the detector material, which leads to a quenched light output. The quenching factors of the JUNO scintillator and other organic, as well as water based liquid scintillator samples have been studied using a particle accelerator driven neutron source at the INFN-LNL in Legnaro, Italy. The neutrons are produced quasi-monoenergetically by ^{7}Li(p,n) reaction with energies between 3.5 MeV and 5.5 MeV. This work is supported by the DFG Research Unit JUNO (FOR2319) and the clusters of excellence ORIGINS and PRISMA+.

T 67.3 Wed 16:20 POT/0361

Quenching Factor measurements with COSINUS NaI crystals — •Mukund Raghunath Bharadwaj for the COSINUS-Collaboration — Max-Planck-Institut für Physik, Föhringer Ring 6, 80805 München

NaI (Tl) based scintillation detectors have become a staple in the field of direct dark matter searches, with the DAMA-LIBRA experiment being the stand out for its reported dark matter observation which is in direct contrast with numerous other results. In order to accurately calibrate the energies of WIMP induced nuclear recoil signals and conclusively rule out the parameter space covered by DAMA/LIBRA, precise measurements of the quenching factor of the NaI crystals is essential for each of these experiments as it is well established that electron recoils and nuclear recoils have dis-similar scintillation light yields. In this study, we present first preliminary results of a systematic study that has been carried out by the COSINUS collaboration to measure the quenching factor values primarily in the low recoil energies of 1-30keV$_{nr}$ in order to better understand the discrepancies/uncertainities reported by various experiments. Five ultra-pure NaI crystals manufactured by the Shanghai Institute for Ceramics, each of which have varying Tl dopant concentration, were irradiated with a mono-energetic neutron beam to study its impact on the quenching factor values in the desired recoil energy range.

T 67.4 Wed 16:35 POT/0361

Precision Attenuation Length Measurement of Liquid Scintillators for Future Large Volume Neutrinos Experiments — •Korbinian Stangler[1], Florian Kübelbäck[1], Hans Steiger[2], and Lothar Oberauer[1] — [1]TUM, Physik-Department, James-Franck-Straße 1, 85748 Garching — [2]Cluster of Excellence PRISMA+, Detector Laboratory, Staudingerweg 9, 55128 Mainz

Upcoming large volume neutrino experiments (like JUNO or THEIA) place high demands on the purity of their scintillators. The optical properties are important to ensure that a large number of photons reach the light detectors. Therefore, scintillators require attenuation lengths >20m for the wavelengths of interest. Measurements of these optical properties have so far been carried out with UV/Vis spectrometers and cuvette lengths of 10cm which leads to overall un-

certainties of the same order of magnitude as the attenuation length. In order to obtain precise measurements, the Precision Attenuation Length Measurement (PALM) was developed with light path lengths of up to 2.8m. The setup aims to determine the attenuation length for a wavelength range between 350 and 1000nm with an uncertainty of less than ten percent. So far, initial calibration and test measurements have been performed on linear alkylbenzene (LAB) to ensure and optimize the performance of the setup.
This work was supported by the DFG Forschergruppe JUNO.

T 68: Neutrinos, Dark Matter VIII

Time: Wednesday 15:50–16:50 Location: POT/0006

T 68.1 Wed 15:50 POT/0006

Determination of electromagnetic fields in the shifted analyzing plane of the KATRIN main spectrometer — •Fabian Block and Alexey Lokhov for the KATRIN-Collaboration — Karlsruhe Institute of Technology

The KATRIN experiment aims to determine the effective electron antineutrino mass with a sensitivity of 0.2 eV (90 % C.L.) by high-resolution spectroscopy of the endpoint region of the tritium β decay spectrum. To reach the sensitivity goal, the experimental setup of KATRIN combines a windowless gaseous tritium source with a high-resolution MAC-E filter, called main spectrometer. The energy analysis of the β-decay electrons in the main spectrometer takes place via a complex interplay of electric and magnetic fields.
To improve the signal-to-background ratio in neutrino mass measurements, the electromagnetic field configuration in the main spectrometer is adapted to the so-called Shifted Analyzing Plane (SAP). The SAP fields need to be known with high precision in order for them to be taken accurately into account in the β-spectrum model applied in the fit of the data. We present in this talk the results of high-statistics SAP characterization measurements employing conversion electrons of Kr-83m as sensitive probes for electromagnetic fields.
This work is supported by the Helmholtz Association, the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Initiative and Networking Fund (W2/W3-118).

T 68.2 Wed 16:05 POT/0006

Observables of the Electrical Potential of the KATRIN Tritium Source from Calibration with a High-Intensity Krypton-83m Source — •Moritz Machatschek for the KATRIN-Collaboration — Institute for Astroparticle Physics, Karlsruhe Institute of Technology

The KArlsruhe TRItium Neutrino experiment currently provides the best neutrino-mass upper limit of 0.8 eV/c^2 (90 % C. L.) in the field of direct neutrino-mass measurements. Reaching the target sensitivity of 0.2 eV/c^2 at 90 % C. L. not only relies on the ongoing data taking, but also the detailed study of systematic measurement uncertainties.

One major uncertainty is linked to the electric potential inside the tritium source. Inhomogeneities of the potential lead to a distortion of the β-spectrum, which needs to be characterized in order to reduce the systematic bias in the neutrino-mass measurement.

To this end we use conversion electrons from ^{83m}Kr as nuclear standard. Traces of gaseous ^{83m}Kr are circulated alongside tritium in the 10 m long source, such that inhomogeneities of the potential are observable as a broadening of the selected mono-energetic ^{83m}Kr lines. In this talk we describe the result of a three-week long ^{83m}Kr campaign carried out in 2021 and its impact on the neutrino-mass determination.

This work is supported by the Helmholtz Association, the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Initiative and Networking Fund (W2/W3-118).

T 68.3 Wed 16:20 POT/0006

The XENONnT Gd-loaded water n-veto detector and purification system — •francesco Lombardi for the XENON-Collaboration — flombard@uni-mainz.de

The nuclear recoil scattering by Neutrons is the most dangerous background for the XENONnT experiment because they can mimic the expected Dark Matter signal: the single nuclear recoil scattering. To increase the Neutron tagging efficiency, the Muon Veto Water tank has been modified by introducing an additional neutron veto detector surrounding the XENON time projection chamber (TPC) and, in the next phase of the experiment, the 700 ton of water of the Cherenkov detector will be loaded with a solution at 0.48% of Gadolinium Sulfate Octahydrate salt ($Gd_2(SO_4)_3 \cdot 8H_2O$), corresponding to a percentage of 0.2% of Gadolinium of the total mass. In the next phase, the addiction of Gadolinium at 0.2%, will increase the neutron capture efficiency from the 74% of pure water to the 90% of the new solution. Together with the infrastructure of the neutron veto detector, we will also present the filtration plant for purification system and the relative automatic control.

T 68.4 Wed 16:35 POT/0006

Results and updates of the XENONnT neutron-veto — •Daniel Wenz for the XENON-Collaboration — Johannes Gutenberg-Universität Mainz

Nobel liquid time projection chambers (TPC) are playing a key role in the search for WIMP dark matter in the mass range of a few to a few hundred GeV/c^2. Neutrons, emitted by the detector material, pose a great danger for this type of experiments as they can mimic WIMP signals, by undergoing single-scatter nuclear recoils before leaving the sensitive region of the TPC. To mitigate this detector intrinsic background, the XENONnT TPC is enclosed by a water Cherenkov neutron-veto which tags these dangerous signals by measuring in a delayed coincidence the 2.22 MeV gamma-ray released from the neutron-capture on hydrogen. To get a precise calibration of the neutron-veto tagging efficiency, a novel coincidence technique, based on coincidentally emitted neutrons and gammas of an AmBe source, is used. The very same technique is also applied to conduct a very clean calibration of the XENONnT TPC nuclear recoils response.

In this talk, we are going to present the latest results of the XENONnT neutron-veto, including its tagging efficiency calibration as well as the calibration of the NR response of the XENONnT TPC.

T 69: Neutrinos, Dark Matter IX

Time: Wednesday 15:50–17:05 Location: POT/0112

T 69.1 Wed 15:50 POT/0112

Reconstruction of atmospheric neutrino events in JUNO using GCNs — •Rosmarie Wirth, Caren Hagner, Daniel Bick, and Vidhya Thara Hariharan — Universitaet Hamburg, Hamburg, Germany

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kt liquid scintillation detector, which will be completed in 2023 as the largest of its kind. JUNO aims to determine the neutrino mass ordering with 3 σ significance in about 6 years by observing the energy dependent oscillation probabilities of reactor antineutrinos.

Due to JUNO's large volume, it provides the opportunity to detect atmospheric neutrino events with lower energies than today's large Cherenkov experiments. This channel could deliver further measurements on the mass ordering, by observing the energy and direction dependent oscillation probabilities.

This talk presents reconstruction methods based on Graph Convolutional Networks (GCNs) to analyze these atmospheric neutrino events in JUNO.

T 69.2 Wed 16:05 POT/0112

Atmospheric neutrino reconstruction for the neutrino mass ordering measurement of JUNO — •Mariam Rifai[1,3], Runxuan Liu[1,3], Livia Ludhova[1,3], Anita Meraviglia[2,3], Nikhil Mohan[2,3], Luca Pelicci[1,3], Apeksha Singhal[1,3], and Cornelius Vollbrecht[1,3] — [1]Forschungszentrum Jülich GmbH, Institut für Kernphysik IKP-2, Jülich, Germany — [2]GSI Helmholtz Centre for Heavy Ion Research, Darmstadt, Germany — [3]III. Physikalisches Institut B, RWTH Aachen University, Aachen, Germany

The Jiangmen Underground Neutrino Observatory (JUNO) is a multipurpose liquid scintillator-based neutrino experiment with a target mass of 20 kt. The detector is currently under construction and expected to be completed by the end of 2023. Its main goal is the determination of the neutrino mass ordering (MO), through a measurement of the oscillation pattern of reactor anti-neutrinos over a 53 km baseline. As the largest liquid-scintillator detector, JUNO will also be able to observe atmospheric neutrinos events in the GeV region and down to sub-GeV. Therefore, the sensitivity of JUNO to the neutrino mass ordering can be enhanced from 3 to at least 4 sigma in 6 years via a combined analysis of reactor anti-neutrinos with atmospheric neutrinos. Such an analysis requires a precise knowledge on the track of atmospheric neutrinos, which is challenging in terms of reconstruction of the isotropic scintillation light emitted in JUNO. To achieve this target performance, a novel track reconstruction technique based on the voxelized distribution of optical photon emissions is being developed. The current status of this method will be presented in this talk.

T 69.3 Wed 16:20 POT/0112

Development of the first Detector Line for the Pacific Ocean Neutrino Experiment — Christian Spannfellner, •Niklas Retza, Elisa Resconi, Chiara Bellenghi, Mariia Sharshunova, and Lea Ginzkey for the P-ONE-Collaboration — Technical University Munich, Physics Department, James-Franck-Str. 1, Garching, Germany

The Pacific Ocean Neutrino Experiment (P-ONE) is a proposed multi-cubic-kilometre neutrino observatory off the coast of Vancouver Island, Canada. P-ONE will be connected to the NEPTUNE observatory, a deep-sea infrastructure in the Northeast Pacific Ocean hosted by Ocean Networks Canada (ONC). The NEPTUNE node at the Cascadia Basin, roughly 200 km offshore of Vancouver Island at a depth of 2660 m, has been probed for its optical properties by two pathfinder experiments, STRAW and STRAW-b, deployed in 2018 and 2020 respectively and was found to be suitable for a neutrino telescope. A first mooring line, called P-ONE-1, is planned to be deployed in 2024. P-ONE-1, consisting of 20 optical and calibration instruments distributed over a total vertical length of around one kilometre, shall serve as a prototype line for the detector, and ultimately be the blueprint for the following detector lines. In this contribution, we will present the design of P-ONE-1 and its optical instruments. The multi-PMT design of the latter allows to cope with the high background rates in the depths of the Northeast Pacific Ocean, while their modular and minimal mechanical design makes them easily scalable in vision of the construction of the full P-ONE detector.

T 69.4 Wed 16:35 POT/0112

DELight: Direct Search Experiment for Light Dark Matter with Superfluid Helium — •Francesco Toschi[1], Klaus Eitel[1], Christian Enss[1,2], Torben Ferber[1], Loredana Gastaldo[2], Felix Kahlhoefer[1], Sebastian Kempf[1], Greta Heine[1], Markus Klute[1], Sebastian Lindemann[3], Marc Schumann[3], Kathrin Valerius[1], and Belina von Krosigk[1] — [1]Karlsruhe Institute of Technology — [2]Heidelberg University — [3]University of Freiburg

The DM-nucleon scattering parameter space of Light Dark Matter (LDM) has been barely experimentally probed, as it requires an energy detection threshold down to a few tens of eV. The “Direct search Experiment for Light dark matter” (DELight) aims at using superfluid helium-4 as target, particularly suited because of its low nuclear mass and radiopurity, while providing both photon and quasi-particle signal channels valuable for event classification. DELight will deploy Magnetic Micro-Calorimeters (MMCs) operating at a temperature of 20 mK, promising high resolution and a threshold of a few eV. With an exposure of only 1 kg×d and an energy threshold of 20 eV, in its first phase DELight will be able to probe unexplored regions of the parameter space for LDM masses below 100 MeV with an expected sensitivity lower than 10^{-39} cm^2 at 20 MeV.

In this talk we will present the working principle of the detector technologies as well as an overview of the ongoing R&D towards the realization of DELight.

T 69.5 Wed 16:50 POT/0112

Design and Commissioning of the MainzTPC2 — •Constantin Szyszka, Christopher Hils, Jan Lommler, Uwe Oberlack, Daniel Wenz, and Alexander Deisting — Institut für Physik & Exzellenzcluster PRISMA$^+$, Johannes Gutenberg-Universität Mainz

The MainzTPC is an experimental dual-phase xenon time projection chamber (TPC) dedicated to the study of scintillation and ionization processes of liquid xenon for low-energy electronic and nuclear recoils. It features a signal readout with two PMTs and eight APDs, enabling 3D position reconstruction. The TPC also allows to study the influence of the drift field’s strength on the scintillation process. Its design has been optimized for the use as primary target in Compton scattering experiments to measure recoil energies in liquid xenon down to 1 keV.

The MainzTPC is being redesigned to accommodate a SiPM array instead of the top PMT and APDs to improve position resolution in x and y. To address known instabilities in the liquid level of the MainzTPC, we aim to improve the level meters and level control by observing the liquid gas interface with commercially available cameras. We report on the status of this work.

T 70: Cosmic Ray III

Time: Wednesday 15:50–17:20 Location: POT/0013

T 70.1 Wed 15:50 POT/0013

measurment of the cosmic ray electron flux with AMS02 — •Yasaman Najafijozani — RWTH Acchen University, Sammelbau Physik, Sommerfeldstr. 14, Turm 28, 52074 Aachen, Germany

The Alpha Magnetic Spectrometer (AMS-02) on the International Space Station has been performing precision measurements of cosmic rays in the GeV to TeV energy range since 2011. The fluxes of electrons and positrons are potential probes of dark matter or new astrophysical phenomena. With AMS-02, electrons and positrons are identified by two independent subdetectors, a transition radiation detector, and an electromagnetic calorimeter. I will present my analysis of the cosmic-ray electron flux from 0.5 to 1000 GeV.

T 70.2 Wed 16:05 POT/0013

3D modelling of the Galactic Center region — •Julien Dörner[1,2], Julia Becker Tjus[1,2], Paul-Simon Blomenkamp[1,2], Horst Fichtner[1,2], Anna Franckowiak[1,2], Mario Hoerbe[1,2], and Memo Zaninger[1,2] — [1]Ruhr-Universität Bochum, 44801 Bochum, Deutschland — [2]RAPP-Center at Ruhr University Bochum, Bochum, Germany

The Galactic Center (GC) region is a unique astrophysical environment, which has been intensively studied in the past decades. In the HE and UHE gamma-ray regime several point like sources and a diffuse emission have been discovered. In addition, observation in the emission with FermiLAT show an excess, which may hint to a population of unresolved sources. The detection of the first *PeVatron* by H.E.S.S. indicates that cosmic-rays (CRs) can be accelerated up to PeV energies in the GC. While 3-D transport models for the entire Galaxy do exist in well-advanced states, the GC region in these global models is not well-represented and dedicated 3-D models of this region are missing. We present the first model using a realistic 3D distribution of the gas and the magnetic field for the Central Molecular Zone. The magnetic field is composed by a large-scale structure, as well as a contribution from several molecular clouds and non-thermal filaments. We use an anisotropic diffusion tensor defined by the ratio of the perpendicular and the parallel diffusion coefficient with respect to the local magnetic field direction. In the end, we compare our model with the observation by H.E.S.S. and calculate synthetic 2D count maps with predictions for the observability by CTA and for the expected neutrino flux.

T 70.3 Wed 16:20 POT/0013

Modeling of the Galactic Cosmic-Ray Antiproton Flux — •Thomas Pöschl[1], Laura Fabbietti[1], Maximilian Horst[1], Laura Serksnyte[1], and Andrew Strong[2] — [1]Technische Universität München, Garching, Deutschland — [2]Max-Planck-Institut für extraterrestrische Physik, Garching, Deutschland

Cosmic-ray particles are an excellent probe to study processes in our galaxy and can hint at exotic sources of energetic particles, such as dark-matter annihilation. In particular, cosmic-ray antinuclei are informative since these particles are expected to be only rarely produced in conventional reactions. However, the interpretation of cosmic antinuclei measurements requires a good understanding of all involved processes of the creation and propagation of the antiparticles and a realistic estimate of the involved modeling uncertainties to distinguish potential exotic contributions from ordinary production.

In this contribution, we review the current understanding of the production and propagation of charged cosmic rays in our galaxy and the thereon-based modeling of galactic cosmic-ray fluxes, with a special focus on cosmic-ray antiprotons. We quantify systematic deviations of the modeled flux that arise due to inaccuracies of the numerical solution of the propagation equation, different models of propagation processes, and different models of the antiproton-production cross section. Based on the found systematic uncertainties, we comment on the agreement between the modeled fluxes and recent measurements.

This research is funded by the DFG under Germany’s Excellence Strategy - EXC2094 - 390783311.

T 70.4 Wed 16:35 POT/0013

Charge sign dependent modulation of protons and electrons during solar cycle 22 and 23 — Johannes Marquardt, •Bernd Heber, Carlotta Jöhnk, Marlon Köberle, and Lisa Romaneehsen — Christian-Albrechts-Universität Kiel, D

The cosmic ray electron and proton flux observed with the Kiel Electron Telescope (KET) onboard the Ulysses space probe varies with solar activity as well as with heliospheric position. Ulysses’ launched in 1990 completed its mission in 2009. The KET measured the electron, proton and helium flux during the declining phase of solar cycle 22 and during the full solar cycle 23 during an $A > 0$ and $A < 0$-solar magnetic epoch. In this contribution we discuss the flux variation of protons/anti protons and electrons/positrons at an averaged rigidity of 2.5 GV that were corrected for spatial gradients and compare our measurements with the ones from AMS 02 showing clear signatures of charge sign dependent modulation.

T 70.5 Wed 16:50 POT/0013

Measurement of the p-p cross section at $\sqrt{s} \geq 50$ TeV using cosmic-ray induced air showers detected with the Pierre Auger Observatory — •Olena Tkachenko for the Pierre Auger-Collaboration — Karlsruhe Institute of Technology, Karlsruhe, Germany

In this talk, we present a measurement of the proton-proton interaction cross sections from the distribution of the depth of air shower maximum, $X_{\max}$, measured by the fluorescence detector of the Pierre Auger Observatory. In previous analyses, the interaction cross section was obtained assuming the predominance of protons in the tail of the $X_{\max}$ distribution. Similarly, assumptions on hadronic interactions in air showers were needed to estimate the mass composition of cosmic rays. To get a self-consistent estimation of the interaction cross sections and cosmic-ray primary composition, we implement an algorithm for the combined measurement of the interaction cross sections and composition fractions. For this, we perform a standard binned maximum-likelihood mass composition fit with the varied proton-proton interaction cross sections. The conversion from the modified proton-proton to the corresponding nucleus-nucleus cross sections is done via the Glauber formalism. We include a shift in the $X_{\max}$ scale to account for systematic uncertainties of the data and theoretical uncertainties of the properties of particle production in air showers. The preliminary cross sections and composition fractions obtained using this novel self-consistent approach will be compared to the previous measurements and future improvements to the method will be discussed.

T 70.6 Wed 17:05 POT/0013

A new bound on Lorentz violation based on the absence of vacuum Cherenkov radiation in ultra-high energy air showers — •Fabian Duenkel, Marcus Niechciol, and Markus Risse — Center for Particle Physics Siegen, Experimentelle Astroteilchenphysik, Universität Siegen

In extensive air showers induced by ultra-high energy (UHE) cosmic rays, secondary particles are produced with energies far above those accessible by other means. These extreme energies can be used to search for new physics. We study the effects of isotropic, nonbirefringent Lorentz violation in the photon sector. In case of a photon velocity smaller than the maximum attainable velocity of standard Dirac fermions, vacuum Cherenkov radiation becomes possible. Implementing this Lorentz-violating effect in air shower simulations, a significant reduction of the calculated average atmospheric depth of the shower maximum $\langle X_{\max} \rangle$ is obtained. Based on $\langle X_{\max} \rangle$ and its shower-to-shower fluctuations $\sigma(X_{\max})$, we present a new bound on Lorentz violation sensitive to vacuum Cherenkov radiation from fundamental particles (electrons and positrons) in air showers.

This work is supported by the Deutsche Forschungsgemeinschaft (DFG).

T 71: Exp. Methods AP, PMTs

Time: Wednesday 15:50–17:20 Location: POT/0351

T 71.1 Wed 15:50 POT/0351

Performance Tests of the Acoustic Module for the IceCube Upgrade — •Charlotte Benning, Jan Audehm, Jürgen Borowka, Mia Giang Do, Oliver Gries, Christoph Günther, Dirk Heinen, Adam Rifaie, Joëlle Savelberg, Christopher Wiebusch, and Simon Zierke for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

The IceCube Neutrino Observatory is a one cubic kilometer particle detector consisting of 5160 Digital Optical Modules located in the ice at the geographic South Pole. During the IceCube Upgrade more than 700 additional modules will be deployed at the center of the existing detector with the purpose of calibrating and enhancing the detectors capabilities. Part of this upgrade will be ten specialized Acoustic Modules which are capable of receiving and transmitting acoustic signals from 5 to 40 kHz. Based on the principle of trilateration, the positions of acoustic and optical modules will be determined from the propagation times of these signals. With this system we aim to achieve an accuracy of a few 10 cm for the geometrical precision of the detector. In this talk the results of performance tests of the acoustic modules in the laboratory and at a local swimming pool are presented.

T 71.2 Wed 16:05 POT/0351

The Design of the Acoustic Module for the IceCube Upgrade — •Adam Rifaie, Jan Audehm, Charlotte Benning, Jürgen Borowka, Mia Giang Do, Oliver Gries, Christoph Günther, Lasse Halve, Dirk Heinen, Joëlle Savelberg, Christopher Wiebusch, and Simon Zierke for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

The IceCube Neutrino Observatory at the South Pole detects high energy neutrinos from astrophysical sources. With the upcoming IceCube Upgrade, more than 700 detector modules along with calibration devices will be deployed at the central core of IceCube, 2 km deep into the Antarctic ice. Ten Acoustic Modules (AM) will transmit and receive acoustic signals from 5 to 40 kHz. By means of trilateration of the propagation times of these acoustic signals, we determine the positions of the AMs with an accuracy of about 10 cm and thus calibrate the geometry of the detector. The AM consists of acoustic transducer, communication and signal generation power electronics, and receiver electronics, all embedded in a housing, withstanding the pressure in the ice. For the proper measurement of transit times between different modules a dedicated synchronization and timing protocol has to be implemented. This talk presents an overview of the functionality and technical design of the main components and describes the development of appropriate firmware.

T 71.3 Wed 16:20 POT/0351

Status of the implementation of "Event-Generator" in IceCube-Gen2 — •Francisco Javier Vara Carbonell and Alexander Kappes for the IceCube-Collaboration — Institut für Kernphysik WWU Münster, Münster, Germany

The success of large observatories such as the IceCube neutrino telescope is highly dependent on the accuracy of their reconstruction algorithms. In IceCube, traditional likelihood-based methods are limited by the lookup tables used for calculating the event hypotheses, since their complexity requires them to be simplified. Promising results have recently been obtained with "Event Generator", a generative neural network that can replace such tables and lead to an improvement in reconstruction performance since it does not require simplification. The success of this neural network lies in its design, which, unlike most machine learning applications, is able to explicitly exploit the information domain of IceCube event generation, such as symmetries and detector properties. In this talk, "Event Generator" will be introduced and the current status and future plans for its implementation in IceCube-Gen2 will be presented.

T 71.4 Wed 16:35 POT/0351

Photomultiplier simulation in COMSOL Multiphysics — •Willem Achtermann, Alexander Kappes, and Markus Dittmer for the IceCube-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, Münster, Germany

Photomultiplier tubes (PMTs) are used in water Cherenkov neutrino detectors such as IceCube and KM3NeT. They play a central role in the performance of the detector and therefore a deep understanding of their properties is crucial for the operation and improvement of the experiment. In this talk, I discuss some of the timing parameters, e.g., the transit time (spread) for a PMT, which I investigate using a COMSOL multiphysics simulation. The current state of simulation will be shown and some insights into the working principle of PMTs and simulation results will be given.

T 71.5 Wed 16:50 POT/0351

Characterizing Light Attenuation inside the Wavelength-Shifting Optical Module from Timing Distributions — •Yuriy Popovych, John Rack-Helleis, Martin Rongen, and Sebastian Böser — Johannes Gutenberg-Universität Mainz

The Wavelength Shifting Optical Module (WOM) makes use of wavelength-shifting paint to absorb UV-photons and re-emit them as visible light. These photons are captured via Total Internal Reflection inside a quartz tube and propagate to Photomultipliers at both ends. Due to its design the timing resolution of the WOM does not result not from the sensors, but from the photon propagation inside the tube. Further, one can measure the timing distribution to differentiate between scattering and absorption processes in the light propagation. Characterizing the timing lets us explore new use cases for the WOM-technology.

This talk will describe the modeling and measurement of the timing characteristics of the WOM and a method to deduce absorption and scattering properties of the wavelength-shifter coated WOM tube from it.

T 71.6 Wed 17:05 POT/0351

Investigation of photomultiplier photocathodes with an ellipsometer — •Berit Schlüter and Alexander Kappes — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, Münster, Germany

Photomultiplier tubes (PMTs) are a central component of today's neutrino telescopes such as IceCube and KM3NeT, and an accurate understanding and measurement of their properties is indispensable for further improvement of the detectors. In my talk I focus on the optical properties of the photocathode, which is only a few 10 nanometers thick and will be investigated using an ellipsometer. As part of my master's thesis, I set up the ellipsometer and used it to characterize flat samples. Currently, the setup is being extended for the measurement of curved photocathodes as part of my PhD thesis. This talk presents the idea of the measurement as well as the current status of the work.

T 72: Exp. Methods II

Time: Wednesday 15:50–17:05 Location: POT/0106

T 72.1 Wed 15:50 POT/0106

Soft b-hadron vertex reconstruction tool — •Beatrice Cervato[1], Binish Batool[1], Markus Cristinziani[1], Carmen Diez Pardos[1], Ivor Fleck[1], Arpan Ghosal[1], Gabriel Gomes[1], Jan Joachim Hahn[1], Vadim Kostyukhin[1], Buddhadeb Mondal[1], Amartya Rej[1], Katharina Voss[1], Wolfgang Walkowiak[1], and Tongbin Zhao[1,2] — [1]Center for Particle Physics Siegen, Experimentelle Teilchenphysik, Universität Siegen — [2]Shandong University, China

Several interesting physical processes lead to the production of low-energy (soft) b-quarks in the final state, that may fragment into a b-hadron without the creation of a reconstructable jet. Moreover, sometimes b-hadrons in jets are so soft that their decay products are distributed over a wider angular range than the standard jet cone (the typical cone size is 0.4). The tool described in this contribution is targeting b-hadrons without jets and soft-b-hadrons inside jets, which are not detectable by standard Flavour Tagging Algorithms. For this reason, it is very important to develop and optimize such a b-tagging tool, as will be described in the presentation. After defining the efficiency and the fake rate, we estimate the tool performance using a $t\bar{t}$ reference sample, and define three working points. Subsequently, we check the tool performance at those working points using a sample with soft b-hadrons and a b-hadron-free sample. We demonstrate that the efficiency (fake rate) varies in a range that goes from 27% (0.5%) to 44% (7.1%).

T 72.2 Wed 16:05 POT/0106

Graph Neural Network based Track Finding in the Central Drift Chamber at Belle II — •Lea Reuter, Philipp Dorwath, Torben Ferber, and Slavomira Stefkova — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

In many new physics extensions of the Standard Model, new mediator particles may decay into charged particles leaving a unique signature of a displaced vertex and charged tracks. These displaced decay products are an important signature in searches for dark sector candidates in collider experiments. The current Belle II trigger algorithm is not designed for events with displaced vertices and therefore insufficient to detect these events. Traditional tracking algorithms scale poorly with the high beam-background, which is expected to increase significantly in the upcoming data-taking of the Belle II experiment.

Therefore, we develop a Graph Neural Network (GNN) based approach to find particle tracks and displaced vertices in the Central Drift Chamber of Belle II, where we realize track measurements using a graph representation of detector hits. We use GNN-based object condensation for track finding to identify the varying number of tracks per event. The goal of this project is to improve the track finding for Belle II. Furthermore, we also implement track fitting simultaneously to the track finding, to investigate if this GNN approach can also be used in real-time application in the level 1 trigger system.

T 72.3 Wed 16:20 POT/0106

Graph building and input feature analysis for edge classification in the Central Drift Chamber at Belle II — •Philipp Dorwarth, Torben Ferber, Lea Reuter, and Slavomira Stefkova — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

Many extensions of the Standard Model, such as inelastic dark matter models, predict long-lived particles. They can manifest with two charged tracks originating from a vertex with a large displacement from the interaction point in collider experiments. Conventional tracking algorithms are insufficient to respond to those highly displaced vertices, and they also scale poorly with an increased beam background, as expected from SuperKEKB's increased luminosity.

Graphs are an intuitive representation of hits in a tracking detector as they provide high flexibility regarding input features and the length of input vectors. Therefore, we develop a Graph Neural Network (GNN) approach for hit and edge classification in the Central Drift Chamber (CDC) at Belle II. Eventually, the output will be used for GNN-based displaced vertex and tracking algorithms. We examine different methods of graph building and analyze their performance for the classification task. In addition, we study the feasibility of using detector-level information, such as digitized signal hits, as GNN input features in both data and simulation. We find that this information provides very good discriminatory power and should therefore be used as an additional input feature for the GNN to improve the efficiency of the edge classification.

T 72.4 Wed 16:35 POT/0106

Development of a Classifier for Simulated Secondary Decay Vertices in the CMS Experiment — •Tim Graulich[1], Xavier Coubez[1,2], Wahid Redjeb[1], and Alexander Schmidt[1] — [1]III. Physikalisches Institut A, RWTH Aachen University, Aachen, Germany — [2]Brown University, USA

Secondary decay vertices are important signatures which can indicate the presence of a long-lived particle such as a b hadron. These vertices provide important information to be used in higher level algorithms, most importantly b-tagging algorithms. In order to study the performance of secondary vertex reconstruction algorithms, the investigation of simulated vertices is necessary. A classifier to find and classify secondary decay vertices in simulated events is presented, with a focus on b and c hadron decays. Furthermore, the final state decay products of the vertex are associated with it to provide reliable training information to neural networks. This talk will showcase how event generator and detector simulation data can be combined to extract the secondary vertex information from simulated data.

T 72.5 Wed 16:50 POT/0106

Introduction to columnflow — Mathis Frahm, Philip Daniel Keicher, Tobias Kramer, •Nathan Prouvost, Marcel Rieger, Daniel Savoiu, Peter Schleper, Matthias Schröder, and Bogdan Wiederspan — Institut für Experimentalphysik, Universität Hamburg, Luruper Chaussee 149, Hamburg

In order to observe and measure rare processes in nature, a staggering amount of data needs to be produced and processed at particle colliders. With the advancement of the LHC towards Run 3 and HL-LHC, the flow of data as well as the complexity of the analyses will increase even more. In light of these challenges and the limited resources available, an efficient usage of computing power and disc usage is critical for future analyses.

In order to analyze data in an efficient way, a new columnar analysis tool, columnflow, has been developed. In this presentation, an introduction to columnflow is given, including an overview of the workflow and some examples of use cases.

T 73: Pixel/CMS

Time: Wednesday 15:50–16:50 Location: WIL/A317

T 73.1 Wed 15:50 WIL/A317

Measurements of the CMS Inner Tracker pixel assemblies for the Phase-2 upgrade — •Bianca Raciti, Massimiliano Antonello, Erika Garutti, Jörn Schwandt, and Georg Steinbrück — University of Hamburg, 22761, Luruper Chaussee 149, Hamburg, Germany

During Long Shutdown 3, the entire CMS Tracking System will be replaced to operate during the High Luminosity LHC running phase with considerably increased luminosity. The new pixel sensors will have to fulfill stringent requirements to operate in an extremely harsh radiation environment and cope with the high data readout rate.

An extensive campaign has taken place to characterize the first half-size pixel chip demonstrator (RD53A), which led to the submission and production of the first full-size prototype chip (RD53B-CMS).

The new sensor-readout chip modules have been extensively tested both in the laboratory and at the CERN and DESY testbeam facilities.

This study presents results on the performances of the two subsequent iterations of pixel assemblies with different irradiation levels, sensor designs and experimental conditions.

T 73.2 Wed 16:05 WIL/A317

Commissioning of a Burn-In Setup for PS and 2S Detector Modules for the Upgrade of the CMS Outer Tracker — •Ana Ventura Barroso, Paul Schütze, and Katerina Lipka — Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, D-22607 Hamburg

The high luminosity LHC Upgrade will increase the instantaneous luminosity by a factor of five. The CMS detector will be upgraded in the so called Phase-2 Upgrade in order to meet the new requirements, among others the level of radiation tolerance and coping with larger pileup and thus higher data rates, as well as to add triggering capabilities. The entire silicon tracker will be replaced. The Outer Tracker (OT), consisting of macro-pixel and strip detectors, will be based on silicon modules that must operate at low temperatures (−35°C) due to the exposition at high radiation levels. The probability for defective electronic components to fail is higher after few hours of operation. Moreover, temperature cycles can induce mechanical stress. Therefore a burn-in procedure as well as thorough quality control is needed to ensure the correct operation of each of the OT modules before installation.

For this, a burn-in system is being commissioned at DESY. This setup will perform thermal cycles from room to operation temperature and key measurements to ensure the good performance of the modules. In this talk, the status of the DESY burn-in setup as well as noise measurements and temperature test on a PS module will be presented.

T 73.3 Wed 16:20 WIL/A317

Optical Metrology for the PS module production — •Leonie Sommer[1,2] and Paul Schütze[1] — [1]DESY, Hamburg, Germany — [2]University of Wuppertal, Wuppertal, Germany

The High Luminosity LHC upgrade aims at increasing the instantaneous luminosity leading to various challenges for the detectors. The CMS detector will undergo an upgrade to cope with larger pileup, higher data rates and higher radiation dose. As the new Outer Tracker will contribute to the first trigger stage at 40MHz bunch crossing rate, on-module pT-discrimination is needed for data reduction. This is achieved by building dual-sensor modules, where the efficiency of the momentum discrimination depends on the alignment precision of the sensors which needs to be checked thoroughly during module assembly. Metrology systems are used by the assembly centers to monitor that the modules used in the final detector meet the required alignment precision. In this talk the optical metrology setup at DESY is introduced and measurement procedures are described. Measurement results of various prototype PS modules built and tested at DESY are summarized and the stability of the system is assessed.

T 73.4 Wed 16:35 WIL/A317

Position reconstruction of shallow angle tracks in irradiated pixel sensors for the CMS Inner Tracker Upgrade — •Lukas Eikelmann, Massimiliano Antonello, Erika Garutti, Bianca Raciti, Jörn Schwandt, Georg Steinbrück und Annika Vauth — Institut für Experimentalphysik Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

The position reconstruction of shallow angle tracks in the CMS Phase-II inner barrel layers is studied for its planned pixel pitch of 25 μm by 100 μm. These tracks have incident angles on the sensor of up to 84° with respect to vertical incidence. At such incident angles, the deposited charge is shared between over 13 pixels of 100 μm length. An algorithm attempts to cluster these pixels. It assigns the cluster position as the track hit position in this layer. Hits in the four layers are used to reconstruct the track. One of the effects of radiation damage in silicon is charge trapping. This leads to a reduction in the recorded signal of a pixel. If it is below the threshold of the readout chip, no signal is recorded. A missing pixel affects the proper cluster reconstruction resulting in a wrong hit position. In this study, irradiated and non-irradiated pixel sensors bump-bonded to the RD53A prototype chip are tested with shallow angle tracks in the DESY-II electron beam. The cluster breakage and the impact on the position reconstruction of different cluster algorithms are analyzed.

T 74: DetSys MAGIX, DetSys KATRIN

Time: Wednesday 15:50–16:50 Location: WIL/A124

T 74.1 Wed 15:50 WIL/A124

A sophisticated trigger veto system for the MAGIX experiment — •Sebastian Stengel for the MAGIX-Collaboration — Institute for Nuclear Physics, Johannes Gutenberg University Mainz

At the new electron accelerator MESA, the MAGIX setup will be used for high-precision scattering experiments including dark sector searches, the study of hadron structure and few-body systems, and investigations of reactions relevant to nuclear astrophysics.

Together with the MAGIX time projection chamber (MX-TPC), the MAGIX trigger veto system builds the sophisticated detector system inside the two high-resolution magnetic spectrometers. It will provide the fast and reliable signals essential for DAQ, coincidence time measurements, and PID, as well as the basic hit and position information for the triggered readout of the MX-TPC.

The MAGIX trigger veto system consists of one segmented trigger layer made of plastic scintillation detectors and a flexible veto system of additional scintillation detectors and lead absorbers mounted below the trigger layer.

The data readout uses the ultrafast preamplifier-discriminator NINO chip which encodes the signal amplitudes using the time-over-threshold method, followed by FPGAs programmed as TDCs.

T 74.2 Wed 16:05 WIL/A124

Scintillating active Transverse Energy Filter: a novel detector concept for low-energy electron background discrimination — •Joscha Lauer for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT)

One of the leading sensitivity limiting factors in the Karlsruhe Tritium Neutrino (KATRIN) experiment are background electrons from the main spectrometer. These electrons, presumably low in energy at their creation point, are currently indistinguishable from the tritium beta electrons. Since they arrive at the detector with predominantly small angles relative to the guiding magnetic field lines in contrast to the signal electrons, an angular selective detector has great potential in increasing the sensitivity of the KATRIN experiment by enhancing the signal-to-background ratio.

Micro-structured detector configurations which exhibit angular selectivity due to their 3D structure, so-called active Transverse Energy Filters (aTEF), have been proposed by Eur. Phys. J. C 82 (2022) 922. One approach is a scintillator-based aTEF (scint-aTEF). This presentation gives an overview of the aTEF principle and in particular the scint-aTEF detector, including *GEANT4* simulation-based studies and prototype micro-structures 3D printed via two-photon lithography.

This work is supported by the Helmholtz Association, the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2 and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP) and the Helmholtz Initiative and Networking Fund (W2/W3-118).

T 74.3 Wed 16:20 WIL/A124

Design of a scintillating active Transverse Energy Filter for Background Suppression at the KATRIN Experiment — •Nathanael Gutknecht for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT)

The **Ka**rlsruhe **Tr**itium **N**eutrino (KATRIN) experiment aims to determine the mass of the electron antineutrino with an unprecedented sensitivity of 0.2 eV/c^2 (90 % C. L.) by precise measurement of the energy spectrum of tritium β-electrons. The energy of the signal electrons are spectrometrically determined in a MAC-E-Filter setup. At the moment, one sensitivity limiting factor is the spectrometer background which consists of electrons that are generated in the main-spectrometer volume. Due to their small initial energy the background electrons have a different angular distribution than the signal electrons at the point of detection.

A scintillating structure acting as an angular selective detector (scint-aTEF) has potential to discriminate between β- and background electrons. This talk will discuss the geometrical concept of the scint-aTEF and its expected impact on the background reduction, based on simulations with *Geant4*.

This work is supported by the Helmholtz Association, the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Initiative and Networking Fund (W2/W3-118).

T 74.4 Wed 16:35 WIL/A124

PMT test stand simulations of first scintillator prototypes towards active Transverse Energy Filter — •Tom Geigle for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT)

The **Ka**rlsruhe **Tri**tium **N**eutrino (KATRIN) experiment has the goal of determining the neutrino mass scale with a sensitivity of 0.2 eV/c^2 (90%C.L.). One of the most important factors limiting the measurement is the background, originating from the main spectrometer which consists of mostly low energy electrons. These electrons are accelerated by the retarding potential and thus possess low transverse energy, resulting primarily in small angles relative to the guiding magnetic field. Therefore, a detector that allows angular sensitivity could greatly improve the sensitivity of the KATRIN experiment.

The concept of an **a**ctive **T**ransverse **E**nergy **F**ilter (aTEF) has been proposed (Eur. Phys. J. C 82 (2022) 922) which could use micro-structures to develop such an angular sensitive detector. For this purpose, one of two designs being considered consists of a plastic scintillator that is read out via CMOS **s**ingle-**p**hoton **a**valanche **d**iodes (SPADs). In this presentation, we discuss our first investigation of scintillator prototypes for 2-photon lithography using *Geant4* based simulations and measurements with a photomultiplier setup.

This work is supported by the Helmholtz Association, the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Initiative and Networking Fund (W2/W3-118).

T 75: Calorimeter / Detector Systems III

Time: Wednesday 15:50–16:35 Location: WIL/C133

T 75.1 Wed 15:50 WIL/C133

Neutron and Photon Tagging in Plastic Scintillators — Asma Hadef, Antoine Laudrain, •Asa Nehm, and Sebastian Ritter — JGU Mainz, ETAP

While neutron-photon separation using pulse shape discrimination with liquid scintillators and PMTs is a well-known technique, it represents a major challenge using plastic scintillators with SiPM readout. A setup using an AmBe source has been built in order to study the ability of the EJ-276G plastic scintillator optimized for pulse shape discrimination to distinguish between neutrons and photons. The design also includes a cosmic tagging which allows for the identification and rejection of the cosmic background.

The main approach for the discrimination method is to use the more frequent delayed scintillation photons for neutrons compared to the gammas for the events. Different analysis methods using the amount of delayed photon-electron peaks per event as well as their timing information are implemented and studied in detail.

This method could be used in the electromagnetic calorimeter that is part of the DUNE near detector complex, to provide neutron tagging capabilities and enable neutron energy reconstruction.

T 75.2 Wed 16:05 WIL/C133

Development of PEN as an Optically Active Structural Material for Low Background Experiments — •Brennan Hackett[1], Iris Abt[1], Felix Fischer[1], Béla Majorovits[1], Luis Manzanillas[1,2], and Oliver Schulz[1] — [1]MPI for Physics, Munich, Germany — [2]Synchrotron Soleil, Saint-Aubin, France

Neutrino physics and experiments searching for dark matter are pursuing novel low background and self-vetoing materials for components in order to improve their sensitivity. One material of interest is poly(ethylene-2, 6-naphatalate) (PEN) for its inherent scintillating and wavelength shifting properties, as well as its commercial availability and structural stability. Commercially available PEN films are limited in their applications and occasionally do not fulfill the stringent radiopurity and optical requirements of these experiments. As such, the PEN working group has developed a method to produce PEN components with excellent optical properties of thicknesses up to 5 mm, and with a specific activity of less than mBq/kg. PEN detector holders have been successfully installed in the LEGEND experiment and additional PEN structures are being evaluated to further expand the use of structural scintillators. Details of this R&D effort with commercial PEN and the progress on development of custom synthesized radio-pure PEN will be presented.

T 75.3 Wed 16:20 WIL/C133

Light yields and spatial resolution of a wavelength-shifting fibre structured plastic scintillator detector — Alessia Brignoli[1], Heiko Markus Lacker[1], Christian Scharf[1], •Ben Skodda[1], Valery Dormenev[2], Hans Georg Zaunick[2], and Martin J. Losekamm[3] — [1]Humboldt-Universität zu Berlin — [2]Justus- Liebig-Universität Gießen — [3]Technische Universität München

The "CheapCal" project aims to develop a low-cost and easy-to-build detector for charged particle detection with spatial resolution of about a centimeter. The detector principle is based on an extruded plastic scintillator material with a short light attenuation length, which is structured with parallel oriented wavelength-shifting fibres and a fibre-to-fibre distance of 1.5 cm. The fibres are read-out at each end by a SiPM. Using a Sr-90 beta source, we study the light yield of each fibre as a function of the beta-source position on the scintillator plate from which the particle's intersection point at the plastic scintillator plate is determined. We acknowledge the support from BMBF via the High-D consortium.

T 76: Gas-Detectors

Time: Wednesday 15:50–16:50 Location: WIL/A120

T 76.1 Wed 15:50 WIL/A120

Material Optimization for Photon Detection by Structured Converter Layers using Micro-Pattern Gaseous GEM Detectors — •Nick Schneider, Otmar Biebel, Valerio D'Amico, Florian Egli, Stefanie Götz, Ralf Hertenberger, Christoph Jagfeld, Eshita Kumar, Katrin Penski, Maximilian Rinnagel, Chrysostomos Valderanis, and Fabian Vogel — LMU München

Micro-Pattern Gaseous Detectors are heavily used for the detection of charged particles with excellent temporal and spatial resolution. Electrically neutral particles are detected with poor efficiency due to the low density in the active gas volume. By inserting solid converter layers of high-Z material this disadvantage can be mitigated. In our design multiple converter layers are placed perpendicular to the first GEM foil. Proper electric fields guide the electrons to the amplification region. In order to further increase the photon detection efficiency the material and structure of the converter layers need to be optimized to find the perfect balance between creation and extraction rate. For photon conversion copper plated layers are used with relatively thin FR4 as carrier material. Different thick combinations of FR4 and copper are tested in order to achieve high photon detection efficiencies. These results are compared to simulations for better understanding of the physical processes. This method increases the photon detection efficiency by a factor of about 2 and provides interdisciplinary possibilities in material research, medical physics or astrophysics.

T 76.2 Wed 16:05 WIL/A120

Photon Position Reconstruction using Structured Converter Layers in Micro-Pattern Gaseous Detectors — •Katrin Penski, Otmar Biebel, Valerio D'Amico, Florian Egli, Stefanie Götz, Ralf Hertenberger, Christoph Jagfeld, Eshita Kumar, Maximilian Rinnagel, Nick Schneider, Chrysostomos Valderanis, and Fabian Vogel — LMU München

Micro-Pattern Gaseous Detectors are high-rate capable with excellent spatial and temporal resolution. Developed for the detection of charged particles, the low density in the active gas volume of these detectors exhibit only a poor detection efficiency for electrically neutral particles. For photons the detection via the photoelectric effect can be increased using a solid converter cathode, which is made of high-Z materials. With our novel approach, the detection efficiency can be optimized by incorporating multiple converter plates quasi perpendicularly on top of the first GEM foil. Moreover, this technique aims to provide a full two-dimensional position reconstruction of the particle with a resolution of less than 100 μm within a converter plate. Using the two coordinates of the readout anode of the GEM detector enables this by mounting the converter layers at a specific angle that allows geometric position reconstruction. An optimized electric field, where the electric field lines are parallel to the amplification field, guides the electrons from the converter layers to the GEM foils. Detailed simulations on the influence of different parameters, such as the tilting angle or the drift gas, were performed to optimize the design. Simulation and measurement results are presented.

T 76.3 Wed 16:20 WIL/A120

Setup of a 5 m long Straw Tube prototype for the SHiP experiment — •Rishabh Moolya, Caren Hagner, and Daniel Bick — Hamburg University

The Search for Hidden Particles (SHiP) experiment is a proposed, general purpose fixed target beam-dump experiment utilising the 400 GeV Super Proton Synchrotron (SPS) proton beam at CERN. It is specifically designed to search for hidden particles, at the intensity frontier and to also study tau neutrino physics extensively for the first time. The SHiP hidden sector (HS) detector is designed to detect the decay products of hidden particles decaying inside its ~50 m long vacuum decay vessel. An essential role is to reconstruct the tracks and determine the momentum of the charged particles produced in these decays. This is the purpose of the Spectrometer Straw Tracker (SST), consisting of roughly 16000 straw tubes, each 4 m long and 2 cm in diameter.

A prototype consisting of four straw tubes has recently been set up at Hamburg University. The status of the commissioning and the first results will be presented.

T 76.4 Wed 16:35 WIL/A120

The Influence of Water defects and Mesh Geometry on Measurements with a MicroMegas Detector filled with an Ar-CO_2 Gas Mixture — •Burkhard Böhm, Anno Strobel, and Raimund Ströhmer — Universität Würzburg

In particle physics, Micro-Pattern Gaseous Detectors (MPGD) find high usage in different experiments like ATLAS, CMS or ALICE. In this study MicroMegas Detectors (MM) - a special type of MPGDs - are researched in terms of H_2O contamination. They are well known for their simple single-stage amplification, high and stable gain and excellent spatial and temporal resolutions. These detectors can be contaminated by H_2O from air which can have an effect on detector stability. H_2O can also act as a quenching gas similar to CO_2. The effect on the gas-gain and the amplification of the number of primary electrons are studied by precisely controlled inflowing of H_2O inside a resistive MM chamber. Even a small change in concentration of H_2O is expected to have an impact on the detector performance.

Also the influence of different mesh geometries like gap size and wire diameter in terms of contamination is researched. The geometry can have an influence on the electric field and therefore on the detector gain as well as on the transparency of the mesh. Studied mesh types are 70/30, 50/30 and 45/18 (pitch size/wire diameter in μm).

T 77: Flavor VI

Time: Wednesday 17:20–18:50 Location: HSZ/0401

T 77.1 Wed 17:20 HSZ/0401

Studies of lepton universality with $\Lambda_b \rightarrow pKl^+l^-$ decays at LHCb — Johannes Albrecht, Vitalii Lisovskyi, and •Jannis Speer — TU Dortmund University, Dortmund, Germany

In recent measurements of b-hadron decays, a pattern of consistent tensions with the Standard Model predictions is observed. This includes rare decays with $b \rightarrow s\ell^+\ell^-$ transitions, which play an important role in lepton flavor universality tests. Complementary to b-meson decays, lepton flavor universality can also be tested in b-baryon decays, which come with partly orthogonal experimental uncertainties. The first measurement of the ratio of branching fractions of the decays $\Lambda_b \rightarrow pKe^+e^-$ and $\Lambda_b \rightarrow pK\mu^+\mu^-$, R_{pK}^{-1}, was published by the LHCb Collaboration using proton-proton collision data corresponding to an integrated luminosity of $4.7\,\mathrm{fb}^{-1}$. The ratio was measured to be $R_{pK}^{-1} = 1.17^{+0.18}_{-0.16} \pm 0.07$ in the dilepton mass-squared range $0.1 < q^2 < 6.0\,\mathrm{GeV}^2/\mathrm{c}^4$ and the pK mass range $m(pK) < 2600\,\mathrm{MeV/c}^2$. The legacy measurement of R_{pK}^{-1} aims to reduce the uncertainties by analyzing the full $9\,\mathrm{fb}^{-1}$ dataset of LHCb experiment and implementing new selection techniques. In this talk, the recent developments of the ongoing measurement are presented.

T 77.2 Wed 17:35 HSZ/0401

Updated Search for Rare Electroweak Decay $B \rightarrow K^{(*)}\nu\bar{\nu}$ to Constrain New Physics Models — •Caspar Schmitt, Sviatoslav Bilokin, and Thomas Kuhr — LMU München, Am Coulombwall 1, 85748 Garching, Germany

Precision measurements of rare decays serve as indirect searches for new physics up to scales well beyond the collider energy, since Standard Model contributions are strongly suppressed. Multiple anomalies are seen in rare decays of B mesons, in particular of the type $B \rightarrow K^{(*)}l^+l^-$. We search hints for new physics in the neutral lepton channel $B \rightarrow K^{(*)}\nu\bar{\nu}$, which is closely related assuming an unbroken SU(2) Standard Model symmetry. This channel allows particularly precise theoretical predictions and can help reducing hadronic uncertainties in the charged lepton channel.

Experimentally the decay has not yet been detected and is challenging due to the two neutrinos in its final state. Belle II currently is the only experiment in operation that can infer the decay from missing energy and momentum searches. Current experimental limits are model-dependent and a factor 3 to 5 above the Standard Model expectations.

In subsets of new physics models, Wilson coefficients map onto observables and make clear experimental signatures for different new physics scenarios accessible. We explore possibilities for model-independent q^2-binned searches for new physics contributions in $B \rightarrow K^{(*)}\nu\bar{\nu}$ by employing novel untagged methods using machine learning.

T 77.3 Wed 17:50 HSZ/0401

Enhancing data exploitation with public likelihoods — •Lorenz Gaertner[1], Thomas Kuhr[1], Danny van Dyk[2], Lukas Heinrich[3], Méril Reboud[2], and Slavomira Stefkova[4] — [1]Ludwig-Maximilians-Universität, München, DE — [2]IPPP, Durham University, Durham, UK — [3]Technical University Munich, München, DE — [4]Karlsruhe Institute of Technology, Karlsruhe, DE

The results published using data from high-energy experiments have large scientific potential beyond initial publication. To maximize the scientific impact of the data and the corresponding likelihood of the results, facilitating reuse for combination, reinterpretation, and the generation of pseudo data should be made standard practice.

A channel with a potentially high benefit from reinterpretation in terms of new physics models is the rare $B^+ \rightarrow K^+\nu\bar{\nu}$ decay, for which a search is conducted by the Belle II collaboration. The observables arising from such decays are very sensitive to many new physics models. Due to the experimental challenge arising from two final state neutrinos, the analysis of this decay requires assumptions on the kinematic distribution. Consequently, the results feature a model dependency arising from both (beyond) standard model assumptions and from the description of the pertinent hadronic matrix element. This dependency makes reinterpretation complicated without reanalysing the underlying data. By exploring methods to perform result-level reweighting of published likelihoods according to new theoretical models, we want to study the effect on the likelihoods and interpret the physical significance.

T 77.4 Wed 18:05 HSZ/0401

Studies of angular and CP asymmetries in $D^+_{(s)} \rightarrow h^+l^-l^+$ decays at LHCb — Serena Maccolini, Dominik Mitzel, and •Luca Toscano — TU Dortmund University, Dortmund, Germany

LHCb has recorded the world's largest sample of charm hadron decays and takes a leading role in measurements of rare decays and searches for CP violation.

Rare semi-leptonic charm decays such as $D^+ \rightarrow \pi^+l^-l^+$ and $D_s^+ \rightarrow K^+l^-l^+$ are sensitive to beyond-standard-model effects in flavour-changing neutral current $c \rightarrow u\ell^+\ell^-$ transitions, where $\ell^+\ell^-$ is a pair of oppositely charged electrons or muons. Null test observables can be defined to test the Standard Model in angular or CP asymmetries, where new physics signals can be enhanced in the vicinity of intermediate hadronic resonances.

In this talk, an overview of the tentative analysis strategy to perform a first study of angular distributions and CP asymmetries in $D^+_{(s)} \rightarrow h^+l^-l^+$ decays is presented. The analysis uses data collected by the LHCb detector from 2016 to 2018 at a centre-of-mass energy of 13 TeV, corresponding to an integrated luminosity of $6\mathrm{fb}^{-1}$.

T 77.5 Wed 18:20 HSZ/0401

Measurement of the branching fraction of the rare decay $D^0 \rightarrow K^-\pi^+e^-e^+$ with the LHCb experiment — Daniel Unverzagt and •Stefan Blenkle — Physikalisches Institut, Heidelberg, Germany

The LHCb experiment at the Large Hadron Collider (LHC) is particularly suitable for studying decays of charm hadrons. This talk presents the branching fraction measurement of the four-body decay $D^0 \rightarrow K^-\pi^+e^-e^+$ using LHCb data collected in 2017 and 2018, corresponding to an integrated luminosity of $3.8fb^{-1}$. The analysis aims to measure the most precise value for the decay branching fraction using the world's largest data sample of charm decays.

T 77.6 Wed 18:35 HSZ/0401

New Physics at the $K \rightarrow \pi\nu\nu$ kinematic distributions — •Kai Sieja[1], Emmanuel Stamou[1], Mustafa Tabet[1], and Martin Gorbahn[2] — [1]TU Dortmund, Germany — [2]University of Liverpool, United Kingdom

The rare decays $K^+ \rightarrow \pi^+\nu\nu$ and $K_L \rightarrow \pi^0\nu\nu$ are among the strongest probes of Beyond-the-Standard-Model dynamics with new sources of quark-flavour violation. These decays are thus the main target for the dedicated experiments NA62 and KOTO. Working within the LEFT framework, we analyze the impact of dimension-six operators including lepton-number violating ones on the experimentally accessible distributions. Concrete New Physics models can induce operators with different chirality, i.e., vector-, scalar, tensor-type operators, and different neutrino flavour structure. Using published data from NA62, we assess the impact of a combined binned likelihood in constraining the New Physics parameter space and how this varies for different operator types.

T 78: Flavor VII

Time: Wednesday 17:30–19:00 Location: HSZ/0304

T 78.1 Wed 17:30 HSZ/0304

Completing the Heavy Quark Expansion — •Ilija Sibin Milutin[1], Thomas Mannel[1], and Keri Vos[2] — [1]Siegen University, Siegen, Germany — [2]Maastricht University, Maastricht, The Netherlands

The Heavy Quark Expansion (HQE) has become the major tool to perform precision calculations for inclusive rates and spectra of heavy hadron decays. The HQE is an expansion in powers of the inverse mass of the heavy quark $1/m_b$ and introduces HQE matrix elements which need to be extracted from data. Recently, moments of the dilepton spectrum of inclusive semileptonic $B \rightarrow X_c\ell\bar{\nu}$ have been used to extract the CKM matrix element V_{cb} with incredible percent-level precision and in agreement with the world's best determination of V_{cb}.

The HQE for the inclusive semileptonic $B \rightarrow X_c\ell\bar{\nu}$ decay is usually set up in such a way that one assumes that the charm quark is also a heavy quark. Therefore, one will also have contributions of order $\Lambda^n_{\mathrm{QCD}}/m_c^n$.

At dimension six, i.e. at $1/m_b^3$, a coefficient function behaving as $\ln m_c^2$ appears and at dimension eight, terms with $1/m_c^2$ appear. A consistent power counting therefore needs to be set up. Numerically, we find that $m_c^2 \sim m_b\Lambda_{\mathrm{QCD}}$ and therefore two powers of m_c should be counted as one power of m_b. Consequently, in order to complete the existing calculation at order $1/m_b^4$, we need to include contributions of order $1/m_b^3 \cdot 1/m_c^2$ that may be numerically relevant.

In this talk, we present how we determine these contributions and the results for the moments of the leptonic invariant mass spectrum.

T 78.2 Wed 17:45 HSZ/0304

Studies of hadronic tag reconstruction and muon identification efficiency for $B \to X_u \ell \nu$ decays at the Belle II experiment — •Merle Graf-Schreiber[1], Florian Bernlochner[2], Lu Cao[1], Marcel Hohmann[3], Munira Khan[2], Tommy Martinov[1], and Kerstin Tackmann[1] — [1]DESY, Hamburg — [2]Universität Bonn — [3]University of Melbourne

The Belle II experiment is located at the SuperKEKB e^+e^- collider where it collects collision data around the $\Upsilon(4S)$ resonance, which primarily decays into $B\bar{B}$ pairs. The clean experimental environment of e^+e^- collisions enables us to study the inclusive $B \to X_u \ell \nu$ decay with good resolution, where X_u can be any charmless hadronic final state. The measurement of the partial branching fractions of this decay can be used to extract the Cabibbo-Kobayashi-Maskawa matrix element $|V_{ub}|$, which is important for constraining the unitary triangle. In addition insights about the discrepancy between the $|V_{ub}|$ value measured in inclusive versus exclusive decays can be gained.

The lepton of the signal B decay and the second (tag) B meson of the $\Upsilon(4S)$ decay are crucial ingredients for reconstructing the kinematics of the X_u system and the undetected neutrino. The muon identification efficiency and its calibration to account for possible differences between data and simulation using the $ee \to \mu\mu\gamma$ process are going to be discussed in this talk. The tag B meson is reconstructed using a multivariate based tagging algorithm, the full event interpretation. The second part of this talk is going to focus on studying the tagging performance using variables related to the B_{tag} meson.

T 78.3 Wed 18:00 HSZ/0304

Fitting procedure for the inclusive measurement of $\mathrm{B} \to \mathrm{X_u} \ell \nu$ at Belle II — Martin Angelsmark[1], Florian Bernlochner[1], Lu Cao[2], Jochen Dingfelder[1], Merle Graf-Schreiber[2], Marcel Hohmann[3], •Munira Khan[1], Tommy Martinov[2], and Kerstin Tackmann[2] — [1]Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn — [2]DESY, Hamburg — [3]University of Melbourne

The discrepancy between the results of exclusive and inclusive measurements of the Cabibbo-Kobayashi-Maskawa matrix element $|\mathrm{V_{ub}}|$ remains an open question in flavor physics. The precise determination of $|\mathrm{V_{ub}}|$ proves to be difficult since it is CKM suppressed and therefore suffers from a high physics backgrounds originating from the CKM favored $\mathrm{b} \to \mathrm{c}$ transition. Phase space regions that allow clear separation of these two processes are heavily dominated by modeling uncertainties. We are preparing a new determination using data from the Belle II experiment. Belle II is a next-generation flavor factory with an anticipated data set of 50 ab^{-1} of collision events. In this talk we present the current status of the analysis and focus on a new fitting procedure for the signal extraction.

T 78.4 Wed 18:15 HSZ/0304

Measurement of the ratio of partial branching fractions of hadronicly tagged inclusive $B \to X_u \ell \nu$ to $B \to X_c \ell \nu$ decays at the Belle experiment. — •Marcel Hohmann[1], Phillip Urquijo[1], and Kerstin Tackmann[2] — [1]The University of Melbourne, Melbourne — [2]DESY, Hamburg

We present a measurement of the ratio of partial branching fractions of the semileptonic inclusive decays, $B \to X_u \ell \nu$ to $B \to X_c \ell \nu$, where $\ell = e, \mu$. The measurement is performed on the world leading sample of 772×10^6 $B\bar{B}$ pairs collected at the $\Upsilon(4S)$ resonance by the Belle experiment using the state-of-the-art Full Event Interpretation algorithm developed for the Belle II experiment to fully reconstruct the companion B-meson. Identifying inclusive $B \to X_u \ell \nu$ decays is difficult due to the abundance of Cabibbo–Kobayashi–Maskawa (CKM) favored $B \to X_c \ell \nu$ events which share a similar single lepton signature and whose composition are not fully understood. To minimize dependence on modeling of these channels a data-driven $B \to X_c \ell \nu$ description is employed. The ratio is measured via a two-dimensional fit to the lepton momentum, $p_\ell^{B_{sig}}$, and four-momentum transfer squared, q^2, in the regime $p_\ell^{B_{sig}} > 1.0\,\mathrm{GeV}$, covering approximately 86% and 79% of the $B \to X_u \ell \nu$ and $B \to X_c \ell \nu$ phase-space respectively. The determination of this ratio allows for direct extraction of $|V_{ub}|/|V_{cb}|$, corresponding to the length of one of the sides of the Unitarity Triangle. Precise knowledge of this side-length allows for powerful tests of the flavor sector of the standard model and to constrain beyond standard model physics.

T 78.5 Wed 18:30 HSZ/0304

Machine learning applications to the measurement of $|V_{ub}|$ at Belle II — •Tommy Martinov[1], Florian Bernlochner[2], Lu Cao[1], Merle Graf-Schreiber[1], Marcel Hohmann[1,3], Munira Khan[2], and Kerstin Tackmann[1] — [1]DESY, Hamburg — [2]University of Bonn — [3]University of Melbourne

The Belle II detector is located at the SuperKEKB collider in Japan and performs high-precision flavour physics studies through e^+e^- collisions at a center-of-mass energy of approximately 10.58 GeV. Using data collected by the Belle II experiment, new precision measurements of $|V_{ub}|$ will be performed using inclusive semi-leptonic decays to a hadronic system, a lepton and a neutrino ($B \to X_u \ell \nu$). This is particularly important for constraining the unitarity triangle, including potential insights in the long-standing discrepancy between $|V_{ub}|$ measurements from inclusive and exclusive semi-leptonic decays. However, this process is overwhelmed by the much more likely decay to a hadronic system containing a charm quark ($B \to X_c \ell \nu$). A multivariate classifier can be used to improve the signal-to-background separation compared to simple kinematic selections. However, the signal acceptance of such a classifier is usually not uniform as a function of the main parameters of interest (leptonic system invariant mass q^2, hadronic mass M_X...). Different methods exist to constrain the classifier and obtain more uniform signal efficiency. Two examples are the uBoost method for Boosted Decision Trees and the DisCo method for Neural Networks. In this presentation the applications of these methods on simulated $B \to X_{u/c} \ell \nu$ data will be discussed.

T 78.6 Wed 18:45 HSZ/0304

Semileptonic Charged Kaon Decays in NA62 — •Atakan Tugberk Akmete — Johannes Gutenberg University Mainz

The NA62 experiment at the CERN SPS was proposed and designed to measure the branching ratio of the ultra-rare $K^+ \to \pi^+ \nu \bar{\nu}$ using a decay-in-flight technique. NA62 took data of $K_{\pi\nu\nu}$ in 2016, 2017, 2018, 2021 and 2022.

In such Kaon experiments, it is also possible to measure the branching ratios of the semileptonic decays $K \to \pi^0 \ell \nu(\gamma)$ ($K_{\ell 3}$) with high precision. $K_{\ell 3}$ provides a very clean way to test the lepton universality and probe the first row of the unitary of the CKM quark mixing matrix $|V_{ud}|^2 + |V_{us}|^2 + |V_{ub}|^2 = 1$. The measurement is done by analyzing the charged single tracks to measure the six main decay modes at once without any specific PID. This strategy reduces the systematics and allows to measure of the branching fractions by using binned maximum-likelihood fit of each MC component to the data. In this talk, I will present my preliminary results using this method.

T 79: Searches III

Time: Wednesday 17:30–18:45 Location: HSZ/0403

T 79.1 Wed 17:30 HSZ/0403

A new algorithm for the identification of boosted $Z \to e^+e^-$ decays for heavy resonance searches with the ATLAS detector at the LHC — Duda Dominik, •Kiwit Florian, Kortner Sandra, and Kroha Hubert — Max-Planck-Insitut für Physik

The identification of W, Z and Higgs bosons with large transverse momenta is crucial in many searches for new heavy resonances. Thus far, the development of algorithms for the tagging of boosted bosons focuses on the reconstruction and identification of hadronic boson de- cays, while no dedicated algorithm to identify boosted $Z \to e^+e^-$ decays exists. The performance of the standard electron reconstruction and identification algorithms degrades with decreasing angular separation between the e^+e^- pairs and will eventually vanish once the angular separation between the e^+e^- pairs is too small to construct individual clusters in the calorimeter. To improve the reconstruction and identification of such highly boosted $Z \to e^+e^-$ decays, a dedicated algorithm for $Z \to e^+e^-$ tagging is being developed using a deep neural network.

Finally, the $Z \to e^+e^-$ identification and reconstruction approach is tested in the search for a Z' boson based on Monte Carlo simulations of the data taken with the ATLAS detector during the LHC Run 2. Expected exclusion limits on the production cross section times branching ratio at 95% confidence level are presented.

T 79.2 Wed 17:45 HSZ/0403

Exploring extentions of MUSiC with Machine Learning techniques — •Ana Rita Alves Andrade, Thomas Hebbeker, Yannik Kaiser, Arnd Meyer, and Felipe Torres da Silva de Araujo — III. Physikalisches Institut A, RWTH Aachen University

MUSiC - Model Unspecific Search in CMS - is a model-independent search used in the CMS experiment, serving as a complementary approach to model-specific searches. Unlike the latter approach, MUSiC neither constrains the search phase-space nor is restricted to a specific final state. To this end, MUSiC employs, per set of final state multiplicity, an automated search for the most discrepant phase-space region, considering a defined p-value. We report results on exploring the implementation of the New Physics Learning from a Machine (NPLM) algorithm, a machine learning (ML) approach for new physics searches, applied to simulated MUSiC-like data as well as CMS data pre-processed by MUSiC. Sensitivities for the nominal MUSiC and the ML modified approach are discussed.

Challenges to incorporate this or similar ML methods to the standard MUSiC procedure, are also considered.

T 79.3 Wed 18:00 HSZ/0403

Search for excited leptons in the contact interaction and Z decay channels with CMS — •Fabian Nowotny, Thomas Hebbeker, and Kerstin Hoepfner — III. Physikalisches Institut A, RWTH Aachen University

The Standard Model of particle physics does not provide a comprehensive explanation for the observed hierarchy of three generations of fermions, for both leptons and quarks. A possible explanation is delivered by models postulating that quarks and leptons themselves are composite objects. Their constituents are bound by an asymptotically free gauge interaction below a characteristic scale Λ. Such models of compositeness predict the existence of excited lepton (l^*) and excited quark (q^*) states at the characteristic scale Λ of the new binding interaction. The theory allows the production of excited leptons via contact interactions in conjunction with a Standard Model lepton. Furthermore, the leptons can decay into several final states.

This talk focuses on the contact interaction and Z-boson decay channels, both resulting in $l^* \to lq\bar{q}$ transitions where l represents e and μ. Preliminary results are presented on the Run 2 proton-proton dataset of CMS corresponding to a luminosity of 137.6 fb^{-1} at a center of mass energy of $\sqrt{s}$ = 13 TeV.

T 79.4 Wed 18:15 HSZ/0403

Search for high-mass resonances in dilepton final states with associated b-jets at the ATLAS experiment — Frank Ellinghaus and •Anna Vorländer for the ATLAS-Collaboration — Bergische Universität Wuppertal

A search for the Z' boson in high-mass dilepton (e,μ) final states in association with b-jets is presented. The considered Z' model is a candidate explanation for potential anomalies in B hadron decays and couples to b and s quarks in the production. The search is carried out using the dataset collected by the ATLAS detector in Run-2 of the LHC corresponding to an integrated luminosity of 139 fb^{-1}. Control, signal and validation regions are defined, and these regions are fitted in a profile-likelihood fit. Expected exclusion limits on the Z' mass are obtained based on the results of the fit.

T 79.5 Wed 18:30 HSZ/0403

Search for Dark Matter in association with a hadronically decaying top quark at the CMS experiment — •Michael Wassmer, Ulrich Husemann, and Sebastian Wieland — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

In this talk a search for the production of Dark Matter in association with a single highly-energetic top quark is presented. In the standard model such a final state can only be generated at loop level and is, in addition, CKM suppressed, making it a prime candidate to search for new physics. The search is based on the total Run-2 dataset collected by the CMS collaboration. The mono-top signature is characterized by large missing transverse momentum and the well-known top quark decay. This talk is focused on the hadronic decay of the top quark. Large-radius jets are used to reconstruct the decay products and multivariate methods are employed to distinguish these jets from purely QCD-initiated jets. The results of the search are interpreted in the context of a simplified model introducing a flavor-changing neutral current at tree level by a spin-1 mediator and a Dirac Dark Matter particle.

T 80: Searches EW II

Time: Wednesday 17:30–19:00 Location: HSZ/0101

T 80.1 Wed 17:30 HSZ/0101

Constraints on Supersymmetry from Collider Searches and Other Experiments — Samuel Bein Bein, •Malte Mrowietz, and Peter Schleper — Universität Hamburg, Institut für Experimentalphysik

Constraints from searches at the LHC and from other experiments on the minimal supersymmetric standard model (MSSM) are evaluated in the context of the 19-parameter phenomenological MSSM (pMSSM). For this purpose a large scan of the pMSSM parameter scan is performed. Complementarity and possible tension between the LHC data, the recent g-2 result, and direct detection experiments are examined.

T 80.2 Wed 17:45 HSZ/0101

Kaon Quenching Measurements for Proton Decay Search with JUNO — •Ulrike Fahrendholz[1], Carsten Dittrich[1], Meishu Lu[1], Sarah Braun[1], Lothar Oberauer[1], Hans Steiger[2], and Matthias Raphael Stock[1] — [1]E15, Physik-Dep., Technische Universität München, James-Franck-Str. 1, 85748 Garching — [2]Cluster of Excellence PRISMA$^+$, Staudingerweg 9, 55128 Mainz

Proton Decay is a main consequence of Baryon Number Violation and is predicted in several Grand Unified Theories (GUTs). It is one of the conditions to explain the asymmetry of matter and anti-matter in our universe. One of the main proton decay channels favored by supersymmetric GUTs is $p \to K^+ + \bar{\nu}$. By now, Super-Kamiokande has set a lower lifetime limit of $5.9 \cdot 10^{33}$ years for this channel. The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kton liquid scintillator detector currently under construction in China and is expected to reach the order of 10^{34} years after ten years of data taking. In this talk, I present a general strategy of JUNO for the search of the proton decay as well as an experimental setup to identify the still unknown quenching behavior of the K^+ in the scintillator of JUNO.

This work is supported by the Clusters of Excellence Origins and PRISMA$^+$.

T 80.3 Wed 18:00 HSZ/0101

Search for supersymmetry in final states with disappearing tracks in proton-proton collisions at 13 TeV — •Samuel Bein, Viktor Kutzner, Malte Mrowietz, Peter Schleper, Alexandra Tews, and Moritz Wolf — Universität Hamburg, Hamburg, Germany

We report the results of a search for charged, semi-stable, supersymmetric particles in final states with one or more disappearing tracks embedded within a range of final states characterized by varying numbers of jets, b-tagged jets, electrons, and muons. The transverse length of signal candidate tracks is used to target various lifetimes associated with wino-like and Higgsino-like charginos in the MSSM, as well as semi-stable charged particles with longer lifetimes. The hit-averaged deposited energy associated with signal candidates traversing the pixel tracker is used to increase sensitivity to particles with large mass or small boost. The search uses a sample of proton-proton collisions at sqrt(s)=13 TeV collected between 2016 and 2018, corresponding to an integrated luminosity of 136 fb^{-1}. Limits on the pair production of gluinos and squarks are obtained in the framework of simplified and full-spectrum SUSY models.

T 80.4 Wed 18:15 HSZ/0101

Diboson polarization measurement in a region enhanced in longitudinal-longitudinal $W^{\pm}Z$ events — •Jan-Eric Nitschke — Institute of Nuclear and Particle physics

In the Standard Model (SM), fundamental particles acquire their masses through the Higgs mechanism. These resulting Goldstone bosons are absorbed into the W and Z bosons and become their longitudinal components, consequently making these gauge bosons massive. Thus, studying the longitudinal components of the W and Z bosons allows the probing of one of the cornerstones of the SM theory.

Vector boson scattering (VBS) events are often used to study longitudinal-longitudinal vector boson interactions. However, VBS processes have low production cross sections and only in recent years all VBS processes were observed for the first time.

Instead, this talk focuses on a study of longitudinal-longitudinal WZ interactions using diboson $WZ \to \ell\nu\ell\ell$ events. Additionally the considered events are constrained to have $p_{\mathrm{T}}^{Z} > 200$ GeV to enhance the contribution of the s-channel production where the bosons directly interact as well as $p_{\mathrm{T}}^{WZ} < 70$ GeV to isolate leading-order like events that exhibit a radiation amplitude zero effect, reducing the contribution from doubly-transversely polarized events.

This phase space has a significantly increased fraction of direct longitudinal-longitudinal vector boson interactions, allowing for an important and unique test of the standard model and electroweak symmetry breaking.

T 80.5 Wed 18:30 HSZ/0101

A precision measurement of fiducial and differential cross sections of WW production with the ATLAS detector — •José Antonio Fernández Pretel, Beate Heinemann, and Oleg Kuprash for the ATLAS-Collaboration — Albert-Ludwigs Universität Freiburg

Measuring production of W boson pairs at particle colliders gives an important way to test the predictions of Standard Model (SM) of particle physics in both perturbative Quantum Chromodynamics and Electroweak domains. Production of WW is also a significant background source for Higgs measurements (especially $H \to WW$) and beyond SM searches. In this measurement, fiducial and differential cross sections are obtained using the full Run 2 dataset collected in proton-proton collisions at the LHC at center-of-mass energy of $\sqrt{s}$ =13 TeV with the ATLAS detector, corresponding to an integrated luminosity of 139 fb^{-1}. Multiple background contributions such as fake and non-prompt leptons are estimated using data-driven techniques. In contrast to most previous measurements that enhance the WW signal purity by vetoing hadronic jets in the final state, the first measurement of WW cross sections using a fully jet-inclusive selection is presented in this work, providing the most precise cross sections of WW production achieved in hadron-hadron collisions to date. The measurements are also performed in a dynamic jet-veto phase space. Additionally, detector level distributions are used to extract constraints on dimension-6 Wilson coefficients in the Standard Model Effective Field Theory. No deviations with respect to the SM are observed.

T 80.6 Wed 18:45 HSZ/0101

Measurement of $ZZ\gamma$ final states with the ATLAS detector at the LHC — •Anke Ackermann for the ATLAS-Collaboration — Kirchhoff-Institute for Physics, Heidelberg University

The Standard Model of Particle Physics (SM) predicts the rare production of triboson final states. Although suffering from small cross sections and hence a limited amount of signal events, such triboson states can be studied with the vast amount of data collected by the ATLAS detector in Run 2. In addition to validating the predictions of the SM for rare processes, sensitivity to New Physics is given via anomalous quartic couplings of e.g. four neutral gauge bosons. This talk will focus on the analysis of the simultaneous production of $ZZ\gamma$. In order to determine the cross sections of this process, it is crucial to separate signal events from events arising through background processes mimicking the signal topology. The most dominant background process contains fake photons, which are non-prompt photons within jets. Due to the limited statistics no conventional data-driven method can be used. Instead a new approach with jet ratios is applied to estimate the amount of fake photons in the signal region. After giving a general introduction about the triboson production of the $ZZ\gamma$ process, a short summary of the analysis, including the event selection and the background estimation, is presented.

T 81: Single Top, Top Properties

Time: Wednesday 17:30–19:00 Location: HSZ/0103

T 81.1 Wed 17:30 HSZ/0103

Measurement of the t-channel single top-quark production cross-section in proton-proton collisions at a centre-of-mass energy of 13 TeV with the ATLAS detector — Olga Bessidskaia Bylund[1], Dominic Hirschbühl[1], •Joshua Reidelstürz[1], Mohsen Rezaei Estabragh[1], Wolfgang Wagner[1], Johannes Erdmann[2], Benedikt Gocke[2], Lukas Kretschmann[1], Olaf Nackenhorst[2], and Maren Stratmann[1] — [1]Bergische Universität Wuppertal, Wuppertal, Deutschland — [2]Technische Universitaet Dortmund, Dortmund, Deutschland

The measurement of the single top-quark t-channel production cross sections σ_{tq} and $\sigma_{\bar{t}q}$ and their fraction R_t as well as the total cross section $\sigma_{tq,\bar{t}q}$ is presented. These measurements provide a precise test of the standard model and are sensitive to new-physics phenomena by probing the properties of the Wtb vertex and placing limits on the CKM matrix element $|V_{tb}|$. Data taken with the ATLAS detector from 2015 to 2018 corresponding to an integrated luminosity of $\mathscr{L} = 139\,\mathrm{fb}^{-1}$ at a center-of-mass energy of 13 TeV is analyzed using corresponding samples of simulated events. Requirements are applied to the data selecting events with the signature expected for the signal process. To further enhance the separation between signal and background events a neural network is trained using the Monte Carlo simulated data combining several kinematic variables. The neural network output distribution is then used in a binned profile maximum likelihood fit including all systematic uncertainties to determine the cross sections.

T 81.2 Wed 17:45 HSZ/0103

Differential cross-section measurement of the tZq process with the ATLAS detector — •Nilima Akolkar[1], Ian Brock[1], Lidia Dell'Asta[2], and Thomas Stevenson[3] for the ATLAS-Collaboration — [1]Physikalisches Institut, Universität Bonn — [2]University of Milano — [3]University of Sussex

The associated production of a single top-quark with a Z-boson (tZq) is a rare process that has been discovered by the CMS and ATLAS Collaborations. This process is of special interest, as it allows one to probe the couplings of the Z-boson to the quark sector and to the W-boson simultaneously.

This talk will focus on the differential cross-section measurement of the tZq process, analyzed in the trilepton decay channel. The data used was collected with the ATLAS detector during Run 2 of the LHC. The tZq differ- ential cross-section is measured using profile likelihood unfolding and the preliminary results will be presented in the talk.

T 81.3 Wed 18:00 HSZ/0103

first simultaneous differential measurement of tZq and ttZ with the CMS detector — •Federica Cecilia Colombina — Deutsches Elektronen-Synchrotron (DESY), Notkestraße 85, 22607 Hamburg

With the large dataset of proton-proton collisions recorded during LHC Run-2, several precise and differential measurements of both ttZ and tZq processes have been produced with the CMS experiment. These two processes are mutual backgrounds to one another. In previous measurements, background processes were assumed to follow the expectations of the standard model. In this measurement, for the first time, both processes ttZ and tZq are measured simultaneously and differentially. The measurement will therefore be more sensitive to new physics, and particularly suitable for effective field theory interpretations.

T 81.4 Wed 18:15 HSZ/0103

Measurements of observables sensitive to colour reconnection in $t\bar{t}$ events with the ATLAS detector at $\sqrt{s} = 13$ TeV — •Shayma Wahdan, Dominic Hirschbühl, and Wolfgang Wagner — Bergische Universität Wuppertal, Wuppertal, Germany

A measurement of observables sensitive to effects of colour reconnection in top-quark pair-production events is presented using 139 fb^{-1} of 13 TeV proton–proton collision data collected by the ATLAS detector at the LHC. Events are selected by requiring exactly one isolated electron and one isolated muon with opposite charge and two or three jets, where exactly two jets are required to be b-tagged. For the selected events, measurements are presented for the charged-particle multiplicity, the scalar sum of the transverse momenta of the charged particles, and the same scalar sum in bins of charged-particle multiplicity. These observables are unfolded to the stable-particle level, thereby correcting for migration effects due to finite detector resolution, acceptance and efficiency effects. The particle-level measurements are compared with different colour reconnection models in Monte Carlo generators. These measurements disfavour some of the colour reconnection models and provide inputs to future optimisation of the parameters in Monte Carlo generators.

T 81.5 Wed 18:30 HSZ/0103

Measurements of top-quark pair spin correlation in the ℓ + jets channel using the ATLAS experiment — •Oleksandr Burlayenko, A. Knue, and Z. Rurikova for the ATLAS-Collaboration — University of Freiburg

The top quark is the heaviest known fundamental particle and has a lifetime of $\mathcal{O}(10^{-25}s)$. This lifetime is shorter than the quantum chromodynamic (QCD) hadronization time scale $1/\Lambda_{QCD} \approx 10^{-24}$s, and much shorter than the spin decorrelation time scale $m_t/\Lambda^2_{QCD} \approx 10^{-21}$s. This gives an opportunity to study the spin properties of a bare quark, as top-quark spin information is preserved in the angular distribution of its decay products.

The Standard Model predicts the $t\bar{t}$ pairs to have correlated spins. The degree of this correlation is sensitive to the production mechanism. The most recent measurement performed by ATLAS uses 13 TeV data in the dilepton channel.

This work presents ongoing studies of the $t\bar{t}$ spin correlation in the ℓ + jet channel at $\sqrt{s} = 13$ TeV. While this channel provides a larger dataset to study, the analyzing power is reduced compared to the dilepton channel.

To improve the event reconstruction, machine learning techniques are employed and non-reconstructable events are removed. Studies of various observables on particle- and detector-level measured inclusively and as a function of mass of the $t\bar{t}$ system will be presented. In addition the impact of systematic uncertainties on these observables will be studied.

T 81.6 Wed 18:45 HSZ/0103

Measurement of top quark involved CKM matrix elements in single top-quark t-channel processes — •Benedikt Gocke[1], Dominc Hirschbuel[2], Kevin Kröninger[1], Olaf Nackenhorst[1], Joshua Reidelstürz[2], Maren Stratmann[2], and Wolfgang Wagner[2] — [1]TU Dortmund, AG Kröninger — [2]Bergische Universität Wuppertal

Measuring top quark properties is one of the main purposes of the ATLAS experiment at the LHC. Since the top quark is the heaviest quark and thus decays before it hadronises, it can be seen as a quasi free quark. Therefore, its properties and especially its couplings are crucial to test the Standard model.

In general, all flavour-changing quark couplings are described by the Cabbibo-Kobayashi-Maskawa (CKM) matrix. Furthermore, all CKM matrix elements are free parameters of the Standard model and thus need to be measured. For the three CKM matrix elements involved in top quark processes - V_{tb}, V_{ts} and V_{td} - this is especially challenging due to the very small magnitudes for the two latter ones.

The CKM interpretation of the single top-quark t-channel cross section measurement at $\sqrt{s} = 13$ TeV with the ATLAS experiment is presented, in which all possible top quark production and decay processes are considered. The aim is to set limits on each involved CKM element individually for the first time. For this purpose, a profile-likelihood scan is used for the interpretation.

T 82: Higgs, Di-Higgs II

Time: Wednesday 17:30–19:00 Location: HSZ/0105

T 82.1 Wed 17:30 HSZ/0105

Constraints on the Higgs boson self-coupling, κ_λ, and the di-vector boson di-Higgs boson coupling, κ_{2V}, via Higgs boson pair production with the ATLAS detector — Jochen Dingfelder[1], Tatjana Lenz[1], Christopher Deutsch[1], and •Fiona Ann Jolly[2] — [1]Physikalisches Institut, Universitat Bonn, Germany — [2]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg

After the discovery of the Higgs boson in 2012, searches for Higgs boson pair production have become valuable in probing the Higgs boson self-coupling, κ_λ. The dominant mode for Higgs boson pair production is gluon-gluon fusion (ggF) followed by vector boson fusion (VBF), which produces two additional jets in the final state. Both production modes provide access to κ_λ. In addition, the VBF mode provides access to two other couplings: the quartic $HHVV$ coupling (κ_{2V}) and the Higgs boson-vector boson coupling (κ_V) with $V = W, Z$.

In this talk, a search for Higgs boson pair production via ggF and VBF in the $bb\tau\tau$ final state (both τ leptons decay hadronically) using 139 fb^{-1} of proton-proton collisions at 13 TeV recorded with the ATLAS detector, is presented. Expected constraints on κ_λ and κ_{2V} are obtained after employing a categorisation strategy that separates the VBF and ggF modes in the statistical analysis. In addition, extrapolated results for an integrated luminosity of 3000 fb^{-1} are given.

T 82.2 Wed 17:45 HSZ/0105

Search for non-resonant Higgs boson pair production in the lepton+jets final state of the bbWW decay mode at CMS — •Mathis Frahm, Johannes Haller, Alexander Paasch, and Matthias Schröder — Institut für Experimentalphysik, Universität Hamburg

The Higgs boson self-coupling is an important parameter of the Standard Model (SM), since it is related to the shape of the Higgs potential. At the LHC, this parameter can be probed by measuring the Higgs boson pair production (HH) cross section. The sensitivity of current HH searches is limited by the small SM production cross-section of only 33 fb at 13 TeV. The analysis of data from Run 3 of the LHC promises a further leap in sensitivity.

In this talk, preparation studies towards a search for non-resonant HH production in the lepton+jets final states of the bbWW decay mode with Run 3 data of the CMS experiment are presented. They benefit from a new analysis framework that relies on the novel 'columnar analysis' paradigm.

T 82.3 Wed 18:00 HSZ/0105

NMSSM di-Higgs search in bb$\tau\tau$ final states — •Nikita Shadskiy, Ulrich Husemann, Moritz Molch, Michael Wassmer, and Roger Wolf — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

The Next-to-Minimal Supersymmetric Standard Model (NMSSM) introduces additional Higgs bosons with different masses next to the already known SM-like Higgs boson. A full CMS run II data analysis (JHEP 11 (2021) 057), which focuses on such a beyond Standard Model search, was previously performed for the decay of a heavy Higgs boson into two lighter Higgs bosons i.e. $\mathrm{H} \rightarrow \mathrm{h_S(bb)h_{SM}}(\tau\tau)$, with $\mathrm{h_{SM}}$ being the SM-like Higgs boson with a mass of 125 GeV.

The new analysis presented in this talk introduces some changes to the previous analysis to improve the results. One of the improvements is to consider both possible Higgs boson decay channels $\mathrm{h_S(bb)h_{SM}}(\tau\tau)$ and $\mathrm{h_S}(\tau\tau)\mathrm{h_{SM}(bb)}$, another is to improve the sensitivity of the measurement, especially in high mass regions of H, by considering boosted topologies. Besides that, the newest CMS reconstruction of run II data will be used, which also includes updates of the data-driven background estimation methods.

T 82.4 Wed 18:15 HSZ/0105

Search for a light CP-odd Higgs boson with ATLAS — •Tom Kresse, Arno Straessner, Manuel Gutsche, Hannah Jacobi, and Christian Schmidt — IKTP, Dresden, Germany

Even though theoretical predictions of the SM are corresponding to experimental results to an incredible degree, there are still some phenomena unexplained, for example the deviation of the measured anomalous magnetic moment, g-2, of the muon from SM calculations. This deviation could be explained by the flavor-aligned two-Higgs-doublet model. The introduction of a second Higgs doublet leads to four additional Higgs bosons, one of which being CP-odd and electrically neutral. The muon g-2 deviation is best explained with a light CP-odd Higgs boson which couples nearly exclusively to top quarks and tau leptons.

This talk presents the search of such a light CP-odd Higgs boson produced via gluon fusion. The decay into two tau leptons is analyzed by requiring one electron and one muon in the final state. The search is carried out in the mass range between 20 GeV and 110 GeV. It is based on 139 fb-1 of data collected by the ATLAS experiment at 13 TeV center-of-mass energy.

The analysis strategy as well as the various validation regions to check the background estimation are presented. An overview over the most relevant systematic uncertainties is given. Even though the analysis is still blinded, expected limits for the production cross-section and model-dependent coupling parameters can be calculated and the fits can be checked for consistency. An outline for the further steps towards the unblinding and the publication of the analysis is given.

T 82.5 Wed 18:30 HSZ/0105

Optimisation and systematic uncertainties in the search for a light CP-odd Higgs boson with ATLAS — •Hannah Jacobi, Tom Kresse, Manuel Gutsche, Christian Schmidt, and Arno Straessner — IKTP, Dresden, Germany

The Standard Model of particle physics is a very successful theory as its predictions are in most cases compatible with experimental results. One example for deviations between the Standard Model and experimental measurements is the value of the anomalous magnetic moment g-2 of the muon. To resolve this problem expansions to the Standard Model, like the 2HDM, are proposed. This theory predicts two Higgs doublets and therefore a total of five Higgs bosons, including the CP-odd and neutral A boson. Assuming the A boson has a light mass and couples strongly to leptons and top quarks it is possible to predict a value for the g-2 that is compatible with the measured one.

This talk focuses on the experimental search for such a light CP-odd Higgs boson with a mass between 20 GeV and 110 GeV produced via gluon fusion. It is examined by looking at final states that contain one electron and one muon, which originated from the decay of the A boson to two τ leptons. The analysis uses 139 fb^{-1} of data recorded by the ATLAS detector at a centre of mass energy of 13 TeV. Before being able to unblind the data in the signal region it is important to ensure the correct modelling of the relevant background processes, like Z bosons decaying into two τ leptons. This talk presents the investigation and correction of mismodelling between measured data and Monte Carlo predictions in dedicated validation regions.

T 82.6 Wed 18:45 HSZ/0105

Top background estimation in the search for a light CP-odd Higgs boson with ATLAS — •Christian Schmidt, Tom Kresse, Manuel Gutsche, Hannah Jacobi, and Arno Straessner — IKTP, Dresden, Germany

Even though predictions of the Standard Model correspond to experimental results to an incredible degree, there are some deviations, for example between the measured anomalous magnetic moment g-2 of the muon and SM calculations.

To resolve this problem expansions to the Standard Model, like the 2HDM, are proposed. This theory predicts two Higgs doublets and therefore a total of five Higgs bosons with one of them being the CP-odd and neutral A boson. Assuming the A boson has a light mass and couples strongly to leptons and top-quarks, the model can predict a value for g-2 compatible with the measured one.

This talk describes the experimental search for such a light CP-odd Higgs boson with a mass of 20 to 110 GeV. The analysis aims to detect this A-boson by its production from gluon fusion and its decay via two tau-leptons into a final state containing one electron and one muon.

To be able to spot the extra events caused by A-boson decay, it is necessary to know the rate of background events very precisely. Background events have the same detector signature as signal events, but are caused by Standard Model processes. Their rate can be estimated by the Monte Carlo method. The talk focuses on the background caused by the decay of top quark-antiquark pairs, and the associated uncertainties due to approximations in the Monte Carlo generator.

T 83: Theory BSM

Time: Wednesday 17:30–18:30 Location: HSZ/0201

T 83.1 Wed 17:30 HSZ/0201

Charge-Parity Asymmetries of Charmed Meson Decays to Pseudoscalar Mesons — •Emil Overduin and Maurice Schüssler — Institut für Theoretische Teilchenphysik, Karlsruher Institut für Technologie, 76131 Karlsruhe, Germany

Measurements at the Large Hadron Collider beauty experiment (LHCb) have seen larger than expected direct charge-parity (CP) asymmetries in the charmed meson decays $D^0 \to K^-K^+$ and $D^0 \to \pi^-\pi^+$, violating the Standard Model U-spin symmetry predictions at around 2σ. An attempt to explain the discrepancy will be made by postulating new physics in the decay amplitudes. The measured CP asymmetries hint at a stronger coupling to d quarks than s quarks motivating an interpretation in terms of $\Delta U = 1$ new physics, where U denotes the U-spin. New sum rules based on $SU(3)_F$ for CP asymmetries of D meson decays to pseudoscalar mesons to test the $\Delta U = 1$ model are shown, one of which holds in both the $\Delta U = 0$ and $\Delta U = 1$ cases. We propose new experimental tests for the new-physics sum rules.

T 83.2 Wed 17:45 HSZ/0201

Charge-Parity-Asymmetrien von Charmed Meson-Zerfällen in pseudoskalare Mesonen und Vektormesonen — •Maurice Schüssler und Emil Overduin — Institut für Theoretische Teilchenphysik, Karlsruher Institut für Technologie, 76131 Karlsruhe, Germany

Neuste Messungen der Charge-Parity-Asymmetrie (CP-Asymmetrie) in $D^0 \to K^+K^-$ und $D^0 \to \pi^+\pi^-$ Zerfällen stimmen nicht gut mit den Vorhersagen des etablierten Standardmodells der Teilchenphysik überein. Wir untersuchen die Hypothese, dass diese Spannung von Beiträgen jenseits des Standardmodells stammt, die den U-Spin um eine Einheit ändern. Zur Überprüfung dieser Hypothese mit künftigen Daten betrachten wir Zerfälle von D^0, D^+, D_s^+-Mesonen in Endzuständen aus einem pseudoskalaren Meson und einem Vektormeson. Im Vortrag werden Summenregeln zwischen CP-Asymmetrien vorgestellt, die die neuen $\Delta U = 1$-Beiträge erfüllen und somit Konsistenzchecks künftiger Messungen erlauben.

T 83.3 Wed 18:00 HSZ/0201

Corrections of the B meson baryogengesis model to lifetimes of B mesons. — •Ali Mohamed, Alexander Lenz, Maria Laura Piscopo, Aleksey Rusov, and Zachary Wüthrich — Siegen university

The framework of B meson Baryogenesis by Alonso-Álvarez, Elor, and Escudero aims at describing the matter-antimatter asymmetry and the existence of dark matter in the Universe by introducing new decay channels of the b quark. These new decay channels could also modify other observables, e.g. the lifetime ratio of B^+ and B_d mesons. We perform a study of the possible size of these new contributions to $\tau(B^+)/\tau(B_d)$ within the framework of the Heavy Quark Expansion.

T 83.4 Wed 18:15 HSZ/0201

Holographic Non-Abelian Flavour Symmetry Breaking — •Yang Liu[1], Werner Porod[1], Johanna Erdmenger[1], and Nicholas Evans[2] — [1]Universität Würzburg — [2]University of Southampton

Multiple AdS/QCD models have been constructed to explain the lowest QCD meson and baryon spectra. Albeit the action is formulated in a non-abelian way, the spectra are essentially abelian. To produce the non-abelian spectra as observed in QCD, our work starts with the non-abelian DBI action taken from a top-down model in string theory. In constructing a bottom-up version, we keep the spirit of the top-down model, i.e. extending the action to matrices in flavour space, which describes coincident N_f D-branes. The explicitly breaking of the flavour symmetry is realised by separating the branes. The fact that the metric and coupling constants are matrices in the flavour space marks the main difference from the other models. We computed the two- and three-flavour QCD spectra and show the validity of our model.

T 84: Theory EW

Time: Wednesday 17:30–19:00 Location: HSZ/0204

T 84.1 Wed 17:30 HSZ/0204

Polarized cross sections for vector boson production with Sherpa — •Mareen Hoppe[1], Frank Siegert[1], and Marek Schönherr[2] — [1]Institute of Nuclear and Particle Physics, Technische Universität Dresden — [2]Institute for Particle Physics Phenomenology, Durham University

Polarization of vector bosons started to become an extensively investigated topic in recent years due to its sensitivity to the concrete mechanism of electroweak symmetry breaking and to beyond standard model physics. The general-purpose Monte-Carlo event generator Sherpa is used for event simulation of various processes in the analysis of LHC data. In this talk, an implementation is presented which will enable the simulation of polarized cross sections for vector bosons in future releases of Sherpa. Special features like the simulation of all polarized contributions in a single run - including the bulk of their NLO QCD behavior - and the direct calculation of the interference between them are discussed. Validation data comparing the new implementation with literature studies and results from its first applications in phenomenological analyses will be shown for several processes.

T 84.2 Wed 17:45 HSZ/0204

Soft photon emission at the LHC and the LBK theorem — •Roger Balsach[1], Domenico Bonocore[2], and Anna Kulesza[1] — [1]Institute of Theoretical Physics, WWU Münster, D-48149 Münster, Germany — [2]Physik Department T31, Technische Universität München, D-85748, Garching, Germany

The emission of low energetic (soft) photons plays a fundamental role in the understanding of Quantum Field Theories. However, there appears to be a discrepancy between the experimental measurements and the calculations for one-photon emission observables. Furthermore, future improvements to the ALICE detector will result in better measurement of soft photon emission, necessitating increasing precision of theoretical predictions.

For those reasons, we compute the cross-section for processes with a single photon emission including NLP and one-loop QCD corrections.

T 84.3 Wed 18:00 HSZ/0204

Detection schemes for light-by-light scattering — Naser Ahmadiniaz, Thomas Cowan, •Sebastian Franchino-Viñas, Jörg Grenzer, Alejandro Laso-Garcia, Michal Smid, Toma Toncian, María Anabel Trejo, and Ralf Schützhold — Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

In the theory of Quantum Electrodynamics loop corrections induce nonlinear interactions for the electromagnetic fields, allowing for effects such as light-by-light scattering. One of the most promising scenarios for its experimental detection regards the quantum vacuum diffraction and birefringence of x-rays at the combined field of two optical lasers. In this talk, we will theoretically compare various scenarios; as a way to deal with experimental constraints, we analyze cases in which the initial and final x-ray photons differ not just in polarization, but also in propagation direction or energy.

T 84.4 Wed 18:15 HSZ/0204

NLO QCD predictions for polarised WZ production — •Christoph Haitz — Institut für Theoretische Physik 2, Julius-Maximilians Univerität Würzburg

The double-pole approximation allows the calculation of observables with polarised virtual particles in a gauge-independent way. One class of processes where this is particularly useful are gauge-boson pair-production processes. This method has been very successful for the study of vector bosons decaying into leptons. The natural step forward from this is the investigation of hadronically decaying bosons. In my talk I will discuss the NLO QCD predictions to the production of a polarised WZ pair where the W boson decays hadronically and the Z boson leptonically. In particular it will be explained what physical observables are best suited to discriminate between the different polarisation states of the resonant bosons. Furthermore the effects of the NLO QCD corrections on the differential cross-sections will be elaborated, as the corrections can become very large and fundamentally change the features of the distributions.

T 84.5 Wed 18:30 HSZ/0204

Two-loop Symmetry Restoration in a Chiral Abelian Gauge Theory in DReg with Non-Anticommuting γ_5 — •Paul Kühler — Institut für Kern- und Teilchenphysik, TU Dresden

Dimensional Regularization is a popular and powerful method for renormalizing gauge theories at the multiloop level. This is due not least of all to the fact that DReg preserves BRST symmetry for vector-like theories such as QCD and QED, which not only guarantees that the renormalized theories make sense as a quantum theory, but it also tremendously simplifies calculations.

This feature is unavoidably lost in the case of chiral theories like the electroweak sector of the SM. Technically, this manifests in inconsistencies arising from insisting on retaining certain relations valid for γ_5 in 4-dimensions in the formal D-dimensional space of DReg. One way out is the BMHV scheme which gives up anti-commutativity and recommends itself by its consistent treatment generalizable to the multiloop setting. BRST symmetry is intermediately broken but may be restored by adding finite, non-invariant counterterms.

In this talk we exemplify our approach to renormalizing chiral gauge theories in the BMHV scheme with the aim of applying it to the SM. Here we present a concrete two-loop calculation of a simple, chiral Abelian model (based on Belusca-Maito et al., JHEP, Vol. 11, 2021; 2109.11042) with its necessary counterterm structure, and we discuss the explicit restoration of well-known Ward identities like transversality of the photon self-energy. In this setting, they are an immediate test of the restoration (or lack thereof) of the classical symmetry.

T 84.6 Wed 18:45 HSZ/0204

Algebraic Renormalization of abelian chiral Gauge Theories with non-anticommuting γ_5 at the Multi-Loop Level — •Matthias Weisswange — Institut für Kern- und Teilchenphysik, TU Dresden, Dresden, Deutschland

Divergences emerging in quantum corrections need to be handled via regularization and renormalization. However, treating manifestly 4-dimensional quantities such as γ_5 and $\varepsilon^{\mu\nu\rho\sigma}$ naively within dimensional regularization (DReg) may lead to inconsistencies. This constitutes a problem in chiral gauge theories, such as the electroweak Standard Model. In order to avoid such inconsistencies, γ_5 needs to be treated rigorously as a non-anticommuting object using the Breitenlohner-Maison/'t Hooft-Veltman (BMHV) scheme within DReg. Employing the BMHV scheme, however, violates gauge invariance, which subsequently needs to be restored using symmetry-restoring counterterms guaranteed to exist by the methods of algebraic renormalization. These counterterms may be calculated via special Feynman diagrams with an insertion of the $\widehat{\Delta}$-operator, which reflects the breaking of chiral gauge invariance, using the regularized quantum action principle of DReg. In the case of an abelian chiral gauge theory this is consistently done at the multi-loop level, showing that the counterterm structure in the BMHV scheme may be written in a very compact form, suitable for computer implementations. Ultimately, this renormalization procedure will be needed for high-precision calculations of e.g. electroweak observables.

T 85: DAQ, Data Techniques

Time: Wednesday 17:30–18:45 Location: HSZ/0301

T 85.1 Wed 17:30 HSZ/0301

Simulation and Optimization of Particle Detector Signal Processing using Matlab and Simulink — •Florian Rössing[1], André Zambanini[1], Christian Grewing[1], and Stefan van Waasen[1,2] — [1]ZEA-2, Forschungszentrum Jülich — [2]NTS, Universität Duisburg-Essen

Matlab and Simulink are tools that are widely used in the field of engineering because they provide a flexible tool chain for mixed signal simulation that can be tailored to the specific needs of the user. With these, we model the sensors used in particle detectors and the attached read-out systems, creating a full system view on the electronics component in the chain. This enables studies on the influence of various parameters to obtain a better understanding of relevant factors and optimization potential, for instance for power efficient information extraction.

With this contribution, we will present our modeling approaches, split into three stages: The per channel event modelling, the sensor response to the incident energy, and the analog receiver chain with a front-end and corresponding pre-processing. We will demonstrate how we can model different characteristics in all three stages of the systems, including statistical fluctuations, bandwidth limitations, non-linearity and noise. These models are also used to develop approaches for the digital processing of the signals. The Simulink HDL Coder Toolbox allows us to directly convert the digital domain of our models into HDL, implementable into either an FPGA or an integrated circuit.

T 85.2 Wed 17:45 HSZ/0301

A Simulink Hardware-in-the-Loop Demonstrator Setup for Detector System Analysis — •Aravinda Lasya Indukuri[1], Florian Rössing[1], Christian Grewing[1], André Zambanini[1], and Stefan van Waasen[1,2] — [1]ZEA-2, Forschungszentrum Jülich — [2]NTS, Universität Duisburg- Essen

In our work, we study the influence of different parameters in read-out chains of particle detectors, alongside with studying digital processing methods for feature extraction. As described in our adjacent contribution, we are using Matlab and Simulink to model different aspects of the read-out chain. In order to verify the developed processing methods and setup a demonstrator , we are implementing the digital domain of the models on an FPGA in an FPGA-in-the-loop workflow. Matlab and Simulink provide tools like HDL Coder and HDL Verifier to automatically generate HDL code, select an external simulator to simulate the generated HDL code, implement it on an FPGA, and compare the results with the Simulink reference model. To verify the whole read-out chain model, we are setting up a hardware-in-the-loop model with an arbitrary waveform generator and an ADC along with an FPGA that will be stimulated and verified over Matlab and Simulink. We will also be working on automating the workflow for different event models and signal processing methods. In this contribution, we will present an automated Matlab-Simulink workflow for an FPGA-in-the-Loop demonstrator setup to verify simulink models in hardware, efficiency of HDL coder in comparison to a handwritten HDL code, and our progress on the Hardware-in-the-Loop demonstrator setup.

T 85.3 Wed 18:00 HSZ/0301

Firmware for the Mu3e Filter Farm — •Marius Köppel for the Mu3e-Collaboration — Institute for Nuclear Physics, Johannes Gutenberg University, Mainz Germany

The Mu3e experiment at the Paul Scherrer Institute searches for the decay $\mu^+ \to e^+e^+e^-$. This decay violates charged lepton flavour conservation - any observation would be a clear indication for Physics Beyond the Standard Model. The Mu3e experiment aims for an ultimate sensitivity of one in 10^{16} μ decays. The first phase of the experiment, currently under construction, will reach a branching ratio sensitivity of $2\cdot10^{-15}$ by observing 10^8 μ decays per second over a year of data taking. The highly granular detector based on thin high-voltage monolithic active pixel sensors (HV-MAPS) and scintillating timing detectors will produce about 100 Gbit/s of data at these particle rates.

Since the corresponding data cannot be saved to disk, a trigger-less online readout system is required which is able to sort, align and analyze the data while running. A farm with PCs equipped with powerful graphics processing units (GPUs) will perform the data reduction. The talk presents the developed firmware used to provide the detector data for the GPU reconstruction. The firmware runs on Field Programmable Gate Arrays (FPGAs), which hold Double Data Rate Synchronous Dynamic Random-Access Memory (DDR SDRAM) to buffer the data. It will also show insides of the online analyzer used to perform data quality checks and other system checks.

T 85.4 Wed 18:15 HSZ/0301

Handling systematic uncertainties with the new ATLAS analysis formats — Nikolai Hartmann, Günter Duckeck, Otmar Biebel, and •Alexander Mario Lory — Ludwig-Maximilians-Universität München

Evaluating systematic uncertainties is one of the main elements contributing to CPU usage and processing time of a physics analysis in ATLAS. Frequently, these uncertainties are variations applied during the calibration of physics objects. During Run 2 of the LHC, although a common infrastructure and set of tools were used, the calibration was performed by each analysis group individually. For Run 3, two new small-sized formats have been introduced in order to cope with the increasing amount of data that is expected to be recorded. In one of these formats, the stored physics objects are already calibrated, which allows for a fast processing downstream and potentially new workflows. However, systematic uncertainties need to be revisited in that context, as they can no longer be applied as variations during the calibration step, but need to alter the already-calibrated objects. Can correctionlib, a tool which was developed within CMS to handle the typical correction factors encountered in particle physics, be used for this purpose within ATLAS?

T 85.5 Wed 18:30 HSZ/0301

HS3 - A serialization standard for statistical models in high energy physics — Carsten Burgard[1], Cornelius Grunwald[1], •Robin Pelkner[1], and Oliver Schulz[2] — [1]TU Dortmund University, Department of Physics — [2]Max Planck Institute for Physics, Munich

An important aspect of experimental particle physics, and science in general, is to perform analyses in a reproducible way. In addition to providing the observational data, this also means that the statistical models, which are usually formulated in terms of likelihood functions, must be provided in an accessible form as well. Currently, sharing statistical models between different programs and communities can be cumbersome because there is no standardized exchange format. Different software packages and toolkits usually use fundamentally different ways for representing data and models. We present the "high energy physics serialization standard" (HS3), a proposed standard, which is a language-agnostic and software-independent format for saving statistical models in exchangeable files. HS3 makes it possible to share entire analyses and to use them across software frameworks and methods so results can be cross-checked and models can be reused in new contexts. We give a general introduction to the HS3 standard, its design philosophy and semantics. In addition, we focus on the ongoing implementation of HS3 in ROOT, in Python, and the Julia programming language for use in packages like BAT.jl.

T 86: ML Methods IV

Time: Wednesday 17:30–19:00 Location: HSZ/0405

T 86.1 Wed 17:30 HSZ/0405

EPiC-GAN: Equivariant Point Cloud Generation for Particle Jets — •Erik Buhmann — Institut für Experimentalphysik, Universität Hamburg

With current and future high-energy collider experiments' vast data-collecting capabilities comes an increasing demand for computationally efficient simulations. Generative machine learning models allow fast event generation, yet so far are largely constrained to fixed data and detector geometries. We introduce the Deep Sets-based equivariant point cloud generative adversarial network (EPiC-GAN) for the generation of point clouds with variable cardinality – a flexible data structure optimal for collider events such as jets. The generator and discriminator utilize multiple EPiC layers with an interpretable global latent vector and do not rely on pairwise information sharing between particles, leading to a significant speed-up over graph- and transformer-based approaches. We show that our GAN scales well to large particle multiplicities and achieves high generation fidelity for gluon, light quark, and top jets.

T 86.2 Wed 17:45 HSZ/0405

Development of novel machine learning algorithms for robust jet flavour classification for Run3 at CMS — •Annika Stein[1], Judith Bennertz[1], Xavier Coubez[1,2], Alexander Jung[1], Summer Kassem[1], Ming-Yan Lee[1], Spandan Mondal[1], Alexandre de Moor[3], Andrzej Novak[1], Alexander Schmidt[1], and Hendrik Schönen[1] — [1]III. Physikalisches Institut A, RWTH Aachen University, Aachen, Germany — [2]Brown University, Providence, USA — [3]Vrije Universiteit Brussel, Brussels, Belgium

Complex neural network architectures have been developed for jet tagging and play a crucial role for numerous analyses relying on this classification task. Recent advances exploit low-level information with convolutional layers, graph neural networks, or transformer models with attention mechanisms. While improving performance is one of the key components in tagger development, the capability to generalize to detector data imposes new challenges and can be probed through comparisons between the two domains, simulation and data, in different phase spaces. This talk will showcase how strategies like adversarial training can be used to improve robustness and data/MC agreement for state-of-the-art tagging algorithms. An overview of the upcoming generation of flavour tagging algorithms for Run3 will be given.

T 86.3 Wed 18:00 HSZ/0405

Deep Neural Networks for jet-flavor tagging based on different hadronization models — •Aritra Bal, Markus Klute, and Roger Wolf — Institute for Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

Differences between the samples of either quark- or gluon-initiated jets produced by the two Monte-Carlo event generators Pythia and Herwig have been reported in the literature. A neural network can be trained to perform jet-flavor tagging on samples from either MC generator, but the performance of the network is observed to depend on the sample to which it is applied, and a network applied to a Herwig sample performs better than when applied to a Pythia sample, irrespective of the sample it was originally trained on.

We train a neural network using simple kinematic, and high-level constructed variables for better discrimination, to tag jets based on their flavor (as quark or gluon). A thorough analysis of the dependence on the input space is performed, to examine how the network responds to samples generated using different hadronization models. We also identify the critical regions of the input space where the two generators differ in the neural network response, using a Taylor Series expansion of the output function (up to 2nd order) in terms of the input variables, which we then use to find one possible answer for the generator dependence observed in the neural network application.

T 86.4 Wed 18:15 HSZ/0405

Multi-parameter Conditioning of Generative Models for Fast Simulation of Highly Granular Calorimeter Showers — •Peter McKeown — Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

High fidelity detector simulation is crucial for modern high energy physics experiments. While traditional simulation tools based on Monte Carlo methods are powerful, they consume significant computational resources. For this reason at the upcoming high luminosity stage of the LHC and for future colliders, simulation is expected to produce a major computational bottleneck. Particle showers in calorimeters are particularly computationally intensive due to the many interactions that occur with the detector material. Given the vast increases in the granularity of these detectors for future experiments, a high degree of fidelity is required of a surrogate simulator.

Deep generative models hold promise to provide significantly faster, yet accurate, simulation tools. Significant progress has been made in the simulation of both electromagnetic and hadronic showers in highly granular calorimeters. However challenges remain when broadening the scope of these simulators. In particular, these tools must be able to accept multiple conditioning parameters, for example to be able to handle particles incident at arbitrary angles. This talk will review the development of such a simulation tool, with a particular focus on the high degree of physical fidelity achieved, as well as the performance after interfacing with reconstruction algorithms.

T 86.5 Wed 18:30 HSZ/0405

Super-resolution of photon calorimeter images using generative adversarial networks — Johannes Erdmann[1], Aaron van der Graaf[2], •Florian Mausolf[1], and Olaf Nackenhorst[2] — [1]III. Physikalisches Institut A, RWTH Aachen University — [2]TU Dortmund University, Department of Physics

Photons are important objects at collider experiments as, for example, the Higgs boson can be studied with high precision in the diphoton decay channel. For this purpose, it is crucial to achieve the best possible spatial resolution for photons and to discriminate against other particles which can mimic the photon signature.

In this talk, a method to generate photon calorimeter images at increased resolution is presented. The energy depositions of single photons and photon pairs from neutral pion decays are simulated in a lead tungstate crystal calorimeter. Each shower is obtained pairwise, for a calorimeter with a crystal width of 2.2 cm and for a calorimeter with higher resolution, where the number of crystals is increased by a factor of 16. Wasserstein generative adversarial networks are trained to estimate the high-resolution images from their low-resolution counterparts, with a deep residual convolutional neural network used as generator. The properties of the super-resolved calorimeter images are analysed and it is shown that their barycentres can be significantly better localised in the calorimeter. Moreover, classifiers are trained on either super-resolution or low-resolution images to separate single photons from neutral pion decays and their performances are compared.

T 86.6 Wed 18:45 HSZ/0405

Generative Modeling with Diffusion Neural Networks for Fast Simulation of Electromagnetic Showers in the International Large Detector — •Anatolii Korol — Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

In high energy physics, detailed and time-consuming simulations are used for particle interactions with detectors. For future experiments and the upcoming High-Luminosity phase of the Large Hadron Collider (HL-LHC), the computational costs of conventional simulation tools are expected to exceed the projected computational resources.

Generative neural networks (GNNs) have the potential to provide a fast and accurate alternative. So far most of the studies of GNNs for fast simulations have used data represented in the form of a regular grid since it is possible to apply modern machine learning algorithms from image processing that are well optimized and developed.

In fast simulations with GNNs, it is crucial to be able to place GNNs into the simulation pipeline, and since many of today*s detector systems are not regular in terms of the positions of the active cells, it*s very hard to represent the data in a form suitable for training the GNN.

This work focuses on the development of a GNN for speeding up the simulation of electromagnetic showers in the electromagnetic calorimeter of the International Large Detector (ILD). In particular, a Diffusion Model is trained on Geant4 steps, where the electromagnetic shower is presented as a 3D point cloud to avoid the irregularities of the detector geometry and thereby generate showers anywhere in the calorimeter.

T 87: Neutrinos III

Time: Wednesday 17:30–19:00 Location: POT/0051

T 87.1 Wed 17:30 POT/0051

The Taishan Antineutrino Observatory — •Hans Theodor Josef Steiger — Cluster of Excellence PRISMA+, Detector Laboratory, Mainz, Germany — Experimental Particle and Astroparticle Physics, Johannes Gutenberg University, Mainz, Germany

The TAO (Taishan Antineutrino Observatory) detector is aiming for a measurement of the reactor neutrino spectrum at very low distances (<30m) to the core with a groundbreaking resolution better than 2 % at 1 MeV. The TAO experiment will realize the unprecedented neutrino detection rate of about 2000 per day, which is approximately 30 times the rate in the JUNO main detector. In order to achieve its goals, TAO is relying on yet to be developed, cutting-edge technology, both in photosensor and liquid scintillator (LS) development which is expected to have an impact on future neutrino and Dark Matter detectors. In this talk TAO's design, physics prospects as well as the status of its construction will be presented, together with a short excursion into its rich R&D program with a special focus on the German contribution to the development of the novel gadolinium-loaded liquid scintillator. This work is supported by the Cluster of Excellence PRISMA+ at the Johannes Gutenberg University in Mainz and the DFG research unit JUNO.

T 87.2 Wed 17:45 POT/0051

Event Reconstruction in JUNO-TAO using Deep Learning — •Vidhya Thara Hariharan, Daniel Bick, Caren Hagner, and Rosmarie Wirth for the University of Hamburg-Collaboration — University of Hamburg

he primary goal of JUNO is to resolve the neutrino mass hierarchy using precision spectral measurements of reactor antineutrino oscillations. To achieve this goal a precise knowledge of the unoscillated reactor spectrum is required in order to constrain its fine structure. To account for this, Taishan Antineutrino Observatory (TAO), a ton-level, high energy resolution liquid scintillator detector with a baseline of about 30 m, is set up as a reference detector to JUNO. The 20% increase in the coverage of photosensors, the replacement of Photomultiplier Tubes (PMTs) with Silicon Photomultiplier (SiPM) tiles, the smaller dimension and the operating temperature at -50°C, would enable TAO to achieve a yield of 4,500p.e./MeV. Consequently TAO will achieve an energy resolution better than 2% @ 1 MeV.

The ability to accurately reconstruct reactor antineutrino events in TAO is of great importance for providing a model-independent reference spectrum for JUNO. This work aims to demonstrate the general applicability of Graph Neural Network (GNN) for event reconstruction in TAO. The dataset for model training and validation are Monte Carlo samples generated from the official TAO offline software. The network is trained on the features that are obtained from the information collected by SiPMs to predict the vertices and energy. The resolutions obtained from the model are presented in the talk.

T 87.3 Wed 18:00 POT/0051

Calibration of the JUNO pre-detector OSIRIS — •Moritz Cornelius Vollbrecht[1,2], Livia Ludhova[1,2], Runxuan Liu[1,2], Anita Meraviglia[2,3], Nikhil Mohan[2,3], Luca Pelicci[1,2], Mariam Rifai[1,2], Apeksha Singhal[2,3], and Tobias Richard Sterr[4] — [1]Forschungszentrum Jülich GmbH, Institut für Kernphysik IKP-2, Jülich, Germany — [2]III. Physikalisches Institut B, RWTH Aachen University, Aachen, Germany — [3]GSI Helmholtz Centre for Heavy Ion Research, Darmstadt, Germany — [4]Physikalisches Institut, Eberhard Karls Universität Tübingen, Tübingen, Germany

The 20-kton liquid scintillator detector (LS) of the Jiangmen Underground Neutrino Observatory (JUNO) experiment, currently under construction in southern China, has a huge potential for insights in several fields of particle physics. To achieve its many goals, stringent radiopurity requirements have to be fulfilled. In order to ensure these limits, the Online Scintillator Internal Radioactivity Investigation System (OSIRIS) was designed as a pre-detector for JUNO. During the months-long filling of JUNO, OSIRIS will closely assess the radiopurity of purified LS batches to allow fast countermeasures in case of contaminations. In OSIRIS, an array of 76 Large Photomultiplier Tubes (LPMTs) instruments a water-shielded 20-ton LS target. An Automatic Calibration Unit (ACU) from the Daya Bay experiment is used for the calibration of event and vertex reconstruction as well as LPMT timing and charge responses. A separate laser system is used for redundant LPMT timing and charge calibration. This presentation will summarize the current status of the calibration strategy of OSIRIS.

T 87.4 Wed 18:15 POT/0051

Tau appearance with KM3NeT/ORCA — •Nicole Geisselbrecht for the ANTARES-KM3NET-ERLANGEN-Collaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP

KM3NeT/ORCA is a water Cherenkov detector currently under construction in the Mediterranean Sea. It is optimised for the detection of atmospheric neutrinos with the main goal of determining the neutrino mass ordering.

Even though atmospheric neutrinos are produced as electron or muon neutrinos and thus initially do not contain tau neutrinos, these are expected to appear at Earth due to neutrino oscillations. In KM3NeT/ORCA, tau neutrinos can't be identified on an event-by-event basis but rather as a statistical excess of shower-like events. This measurement will allow KM3NeT/ORCA to measure the tau neutrino flux normalisation factor and provide insights into the unitarity of the PMNS matrix and hence the validity of the standard three-flavour neutrino oscillation model. This talk will cover the status of the tau appearance analysis with an early sub-array of KM3NeT/ORCA.

T 87.5 Wed 18:30 POT/0051

Search for quantum gravity effects with neutrino telescopes — •Alba Domi for the ANTARES-KM3NET-ERLANGEN-Collaboration — ECAP, Erlangen, Germany

The Standard Model of particle physics and General Relativity are expected to merge into a new theory of Quantum Gravity (QG) at energies approaching the Planck scale. However, none of the proposed QG approaches has been validated to date. In this context, several signatures of QG effects in accessible energy regimes, known as "Windows on Quantum Gravity", have been postulated. In particular, quantum decoherence (QD) or QG-induced violation of Lorentz invariance (LIV), could cause modifications in neutrino oscillation patterns accessible to observation with neutrino telescopes. Moreover, the phenomenon of QD will provide new possibilities to investigate the neutrino nature as a Dirac or Majorana particle, as well as to trace possible violations of CPT symmetry in neutrino oscillations. Such a phenomenon represents a totally new scenario where to test the real nature of neutrinos. This talk reviews the efforts made in neutrino physics to search for QD and LIV effects and their implications in terms of QG models.

T 87.6 Wed 18:45 POT/0051

Neutrino Generator Comparisons GiBUU/GENIE in KM3NeT — •Johannes Schumann for the ANTARES-KM3NET-ERLANGEN-Collaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg

The KM3NeT neutrino telescope is currently being deployed in the Mediterranean Sea. The detector comprises a three-dimensional array of digital optical modules, which detect faint Cherenkov light signals from secondary particles of neutrino interactions. Simulations of the neutrino interactions play an important role for the interpretation of the measurements and are performed by so-called neutrino generators, which employ different approximations in order to achieve a numerical solution with reasonable computing resources. This contribution describes the comparison between GENIE, the neutrino generator used by KM3NeT and the GiBUU generator. The comparisons are performed at the level of systematic uncertainties and their impact on sensitivity estimates.

T 88: Gamma Astronomy IV

Time: Wednesday 17:30–19:00 Location: POT/0151

T 88.1 Wed 17:30 POT/0151

Simulated galactic SNR populations compared to experimental data — •Rowan Batzofin[1], Kathrin Egberts[1], Constantin Steppa[1], and Pierre Cristofari[2] — [1]University of Potsdam, Potsdam, Germany — [2]Observatoire de Paris, PSL Research University, LUTH, France

For a long time it has been believed that supernova remnants are the primary source of galactic cosmic rays up to the knee although it has not been conclusively proven yet. Supernova remnants are expected to produce VHE gamma rays via hadronic interactions between the cosmic rays accelerated at the shock and the ambient gas in the interstellar medium. There are many supernova remnants detected in the radio energy range but very few of them have been identified at VHE.

To study the VHE emission of galactic supernova remnants we create a model for supernova remnant populations. The supernova remnant population model ingredients are: The acceleration physics of the supernova remnants, the matter distribution of the interstellar medium in the Milky Way and the source distribution for the supernova remnants in the Milky Way. We utilise population synthesis to optimise some of the parameters for the model to best fit the experimental data. We compare our simulated populations to experimental data by looking at the source distribution and the detectability of the simulated sources.

We test the simulated populations of galactic supernova remnants against the experimental observations to show whether supernova remnants could be the primary accelerators of cosmic rays.

T 88.2 Wed 17:45 POT/0151

What we can learn from blazar light curves — •Lea Heckmann, David Paneque, and Axel Arbet-Engels — Max-Planck-Institut für Physik, D-80805 München, Germany

Blazars are among the most energetic sources in our Universe. However, even though they have been studied for decades over a wide range of the electromagnetic spectrum, they are far from being understood.

In this contribution, we would like to give some insights into what we can learn from studying the multi-wavelength light curves of blazars. It includes on the one hand the features in each single waveband, such as the degree of variability or signs of potential periodicity. On the other hand, the the connection between different wavebands can also be investigated by studying the correlations between them. In addition to introducing the theory behind these characteristics, we will use a long-term data set of the archetypal blazar Mrk 501 to demonstrate their capabilities when applied to real data.

T 88.3 Wed 18:00 POT/0151

Intergalactic magnetic fields and Mkn 421 gamma-ray observations — •Matias Sotomayor Webar and Dieter Horns — Institut für Experimentalphysik, Universität Hamburg, Luruper Chausseee 149, D-22761 Hamburg

The existence of intergalactic magnetic fields as a relic of a phase transition in the early universe has so far not been confirmed through observations. While Faraday rotation measure provide an upper bound ($\lesssim 10^{-9}$ G), lower bounds have been proposed via the non-detection of gamma-ray emission produced in inverse Compton/pair production cascades. Sufficiently large magnetic fields ($\gtrsim 10^{-16}$ G are required to deflect the secondary electrons out of the line of sight and suppress the visible inverse Compton emission. The interpretation of these limits is however debatable, as oblique pair instabilities could be a dominating energy-loss mechanism, providing the long sought additional heating of the intergalactic medium to explain Ly$-\alpha$ forest data. In this contribution, we present the results for a search for a strongly suppressed cascade emission from the direction of the prominent nearby blazar Mkn 421 ($z = 0.031$) using *Fermi* LAT data. Preliminary results will be presented at the conference.

T 88.4 Wed 18:15 POT/0151

3D Shower Reconstruction with the Cherenkov Telescope Array* — •Stefan Fröse and Lukas Nickel for the CTA-Collaboration — TU Dortmund University, Dortmund, Germany

The Cherenkov Telescope Array (CTA) is the next-generation telescope array for high-energy gamma-ray astronomy. The Imaging Atmospheric Cherenkov Telescopes (IACTs) will be able to make precise measurements of the Cherenkov light induced by incident primary particles, such as photons or ions. To determine the direction and energy of these particles, the characteristics of the atmospheric shower have to be reconstructed.

One possible method is the reconstruction using a three-dimensional rotationally invariant Gaussian shower model, as introduced by the H.E.S.S. collaboration. This model is fitted directly to the images of the shower in the triggered cameras using a maximum likelihood approach. This talk will summarize the current implementation as part of the ctapipe analysis package and the initial results.

* Supported by DFG (SFB 1491)

T 88.5 Wed 18:30 POT/0151

MAGIC Event Reconstruction with Deep Learning — •Jarred Gershon Green for the MAGIC-Collaboration — Max Planck Institute for Physics, Munich, Germany

The Major Atmospheric Gamma Imaging Cherenkov (MAGIC) telescope is a stereoscopic system used for detecting gamma rays in the GeV to TeV range. When gamma rays and cosmic rays interact with the atmosphere, an air shower is initiated which itself emits Cherenkov photons detectable by MAGIC. After parametrizing the images of each shower, machine learning algorithms like random forests are used to reconstruct the properties of each primary particle, including their type, energy, and arrival direction. Convolutional Neural Networks offer a promising way to perform this reconstruction directly on pixelated camera images. In this contribution, we explore how deep learning algorithms like convolutional and graph neural networks can be used to reconstruct events, first by introducing architectures and then showing their performance as applied to real MAGIC data.

T 88.6 Wed 18:45 POT/0151

ctapipe – Prototype Open Event Reconstruction Pipeline for the Cherenkov Telescope Array — •Maximilian Linhoff, Lukas Nickel, and Noah Biederbeck for the CTA-Collaboration — Astroparticle Physics, TU Dortmund University, Germany

The Cherenkov Telescope Array (CTA) is the next-generation ground-based, very high energy gamma-ray observatory currently under construction. It will improve over the current generation of imaging atmospheric Cherenkov telescopes (IACTs) by a factor of five to ten in sensitivity and it will be able to observe the whole sky from its two sites: La Palma, Spain, and Paranal, Chile.

CTA will also be the first open ground-based gamma-ray observatory. Accordingly, the data analysis pipeline is developed as open-source software. The event reconstruction pipeline accepts raw data from the telescopes and processes it to produce suitable input for the high-level science tools. Its primary tasks include reconstructing the physical properties of each recorded shower and providing the corresponding instrument response functions.

ctapipe is a python framework to facilitate calibration of the raw data, image extraction, image parameterization and event reconstruction. Though the current focus has been the analysis of simulated data, the software has also been successfully applied to the data obtained with the first CTA prototype telescopes, such as Large-Sized Telescope (LST-1). A plugin system also allows processing of comparable data from other IACT facilities. Recent updates, new features and the planned roadmap towards a 1.0 release will be discussed.

T 89: DM, Neutrino Theory

Time: Wednesday 17:30–19:00 Location: POT/0251

T 89.1 Wed 17:30 POT/0251

A mobile neutron spectrometer for the LNGS underground laboratory — •Melih Solmaz[1], Klaus Eitel[2], Kathrin Valerius[2], and Uwe Oberlack[3] — [1]Karlsruhe Institute of Technology, Institute of Experimental Particle Physics — [2]Karlsruhe Institute of Technology, Institute for Astroparticle Physics — [3]Johannes Gutenberg University Mainz, Institute for Physics

Environmental neutrons are a source of background for various rare event searches (e.g., dark matter direct detection and neutrinoless double beta decay experiments) taking place in deep underground laboratories. Both the neutron flux and spectrum depend on location. Precise knowledge of this background is necessary to devise shielding and veto mechanisms, improving the sensitivity of the neutron-susceptible underground experiments.

Ambient neutrons have been measured previously at different locations of the underground laboratory LNGS in Italy. However, flux numbers vary considerably across the measurements and direct comparison between them is difficult owing to the use of different detector technologies and setups, each of which possesses characteristic systematics and energy windows. A project was launched to solve these issues and enhance the scientific infrastructure of LNGS.

In this talk, we present the design and the expected performance of a portable neutron detector based on capture-gated spectroscopy as well as first test measurements and give an outlook towards the deployment at LNGS. This project is funded by the German Federal Ministry of Education and Research (BMBF) under the grant number 05A21VK1.

T 89.2 Wed 17:45 POT/0251

Background characterisation of GeMPI detectors and shield design for improved GeMPI-neo detectors — •Nicola Ackermann[1], Matthias sLaubenstein[2], Jochen Schreiner[1], Christian Buck[1], Manfred Lindner[1], Gerd Heusser[1], Herbert Strecker[1], Werner Maneschg[1], Janina Hakenmüller[1], and Hannes Bonet[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [2]Laboratori Nazionali del Gran Sasso, L'Aquila, Italy

This talk presents Monte Carlo simulations of the background spectra of the 4 screening detectors GeMPI 1 - 4 at the Gran Sasso Underground Laboratory (LNGS) using the Geant4 based framework MaGe. The GeMPI detectors are low background Ge spectrometers located at a depth of 3500 m.w.e. and achieve extremely high sensitivites in material screening at a level of muBq/kg. They are used to test material samples on their suitability to use in rare event experiments.

In the simulations muons, neutrons and tiny radioactive contaminations of the detector and shielding materials are investigated as possible sources of background radiation. It was found that the Pb210 contaminations in the detector shield and the neutrons coming from radioactive decays in the surrounding rock have the highest impact on the background spectra. With this new found understanding, a possible shield design for a next generation GeMPI-like detector is proposed.

T 89.3 Wed 18:00 POT/0251

Towards a low-background SDD for IAXO — Joanna Bilicki, Frank Edzards, Susanne Mertens, Lucinda Schönfeld, Juan Pablo Ulloa Beteta, •Christoph Wiesinger, and Michael Willers — Physik-Department, Technische Universität München, Garching

The International Axion Observatory (IAXO) aims to detect solar axions as they are back-converted into X-rays along a strong magnet pointed towards the sun Excellent spectroscopic performance, high X-ray absorption efficiency at and below 10 keV and great potential for ultra-low background operations are features of silicon drift detectors (SSDs) that could facilitate this endeavour. Dedicated low-background detector designs, following a consequent passive shielding strategy and a novel all-semiconductor active shield approach, are under development. A background demonstrator has been installed at the Canfranc underground laboratory in Spain. In this talk, we will report on the latest achievement towards a low-background SDD for IAXO. This work has been supported by the DFG through the Excellence Cluster ORIGINS.

T 89.4 Wed 18:15 POT/0251

Some Cosmological Constraints on Many Species Theories — •Alan Zander[1], Philipp Eller[1], and Manuel Ettengruber[2] — [1]TUM, Garching, Deutschland — [2]Max-Planck-Institut für Physik, München, Deutschland

We consider the so-called Many Species Model introduced by Dvali and Redi, which postulates the existence of $N \sim 10^{32}$ particle species yielding a new mechanism to solve the well-known hierarchy problem. We study some possible extensions of the model allowing the electroweak vacuum expectation values of the Higgs bosons of the different Standard Model (SM) copies to break the permutation symmetry in the species space and we show how this renders the theory testable in the context of neutrino physics. These scenarios make also possible to address some of the other biggest questions in modern physics that remain open like the smallness of the active neutrino masses and the nature of dark matter, yielding a viable explanation for these two mysteries. That being said, we also analyze some of the cosmological implications of these extensions, obtaining the first constraints available in the literature for this sort of theories on the number of species that interact to some extent with the SM.

T 89.5 Wed 18:30 POT/0251

Phenomenological implications of neutrinos and axions in Many Species Theories — •Manuel Ettengruber[1], Philipp Eller[2], Emmanouil Koutsangelas[1], and Alan Zander[2] — [1]Max-Planck-Institut für Physik, München, Deutschland — [2]TUM, Garching, Deutschland

The framework of TeV scale gravity theories was originally invented to solve the hierarchy problem. One specific BSM model is the Many Species Theory in which the scale of quantum gravity gets lowered by the existence of many additional light states. In this talk we want to present how small neutrino masses can be generated in this infrared approach and how this modifies the oscillation pattern. Then we present how current neutrino data can be used to give a lower bound on the number of additional species. Moreover, we show how to get an upper bound from axion physics. These results give the first time a theoretically restricted parameter space which can be tested by current and future experiments.

T 89.6 Wed 18:45 POT/0251

Influence of a gravitationally induced phase on neutrino oscillation and Baryogenesis — •Sara Krieg — TU Dortmund, 44227 Dortmund, Germany

In view of the fact that there is still no uncontroversial theory of quantum gravity nor an experimental evidence for its existence it is well motivated to look for the latter in neutrino oscillations.

For this a general transition probability is derived for a neutrino interacting gravitationally with background neutrinos. Entanglement of the neutrinos and a garvitational quantum field induces a phase modifying the oscillation behavior which may be experimentally detectable. Therefore this could be a direct evidence for the quantum character of gravity.

Since there are theories that explain baryon asymmetry via neutrino oscillations the effect of the phase shift may also have an impact on the predictions of these models.

Extra dimensions are introduced to consider even larger effects.

T 90: Neutrinos, Dark Matter X

Time: Wednesday 17:30–19:00 Location: POT/0361

T 90.1 Wed 17:30 POT/0361

Estimate of the electronic and nuclear recoil background in DARWIN: — •Antoine Chauvin, Maike Doerenkamp, Andrii Terliuk, and Stephanie Hansmann-Menzemer — Universität Heidelberg

The DARWIN experiment is a proposed future Direct Dark Matter observatory that aims to detect WIMPs through WIMP-nucleus interactions, in a multi-ton liquid xenon TPC. Its goal is to become the most sensitive experiment to WIMP-nucleus interaction. To estimate this sensitivity, good models for signal and background generation, and of the detection processes are fundamental. In this talk, we will report on the simulation of the response of the DARWIN detector to different background sources, interacting both through Electronic Recoil and Nuclear Recoil. We compare these to the response of a WIMP signal and derive according estimates for the WIMP sensitivity of the DARWIN experiment.

T 90.2 Wed 17:45 POT/0361

Properties of the radiogenic neutron background in DARWIN — •Maike Doerenkamp, Antoine Chauvin, Andrii Terliuk, and Stephanie Hansmann-Menzemer — Universität Heidelberg

DARWIN is a proposed multi-ton liquid xenon experiment that aims to explore new parameter-space in the direct detection of WIMPs through nuclear recoil. A major source of background for this experiment are radiogenic neutrons, originating from detector materials. A good understanding and modelling of their properties is therefore necessary for sensitivity studies. This talk will discuss characteristics of this background and methods to reduce it, to ultimately improve the sensitivity.

T 90.3 Wed 18:00 POT/0361

Radon mitigation in current and future liquid xenon detectors — •Florian Jörg for the XENON-Collaboration — Max-Planck-Institut für Kernphysik Heidelberg, Germany

Dual-phase liquid xenon time projection chambers have become a leading technology for rare-event searches such as the direct detection of particle dark matter. The sensitivity of current experiments is limited by the xenon-internal background from ^{222}Rn. Therefore, techniques for radon mitigation are applied during all stages of the experiment.

The XENONnT detector belongs to the latest generation of liquid xenon detectors and has reached an unprecedented low radon concentration of $< 1\ \mu$Bq/kg. This achievement was driven by a thorough material pre-selection in combination with a novel radon removal system. In-situ measurements of its radon concentration during scientific data taking will be presented. Furthermore, recent results from a novel radon mitigation method using surface coatings will be discussed.

T 90.4 Wed 18:15 POT/0361

Liquid Handling System (LHS) of the OSIRIS Detector — Michael Wurm, Kai Loo, •Oliver Pilarczyk, Arshak Jafar, George Parker, Tim Charisse, and Marcel Büchner for the JUNO-Collaboration — Johannes Gutenberg-University Mainz

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20kt liquid scintillator (LS) detector currently being built in southern China. It will use the neutrino flux from 2 nuclear power plants in a distance of 53km to achieve its main goal of determining the neutrino mass hierarchy. During the filling of the main JUNO detector the LS will undergo several cleaning steps as well as a final monitoring by the Online Scintillator Internal Radioactivity Investigation System (OSIRIS) to ensure it meets the needed radiopurity requirements. This talk will present the Liquid Handling System (LHS) of the OSIRIS detector.

T 90.5 Wed 18:30 POT/0361

Towards an Online Radiopurity Analysis with BiPo coincidences in the JUNO Pre-Detector OSIRIS — •Konstantin Schweizer[1], Lothar Oberauer[1], Michael Wurm[2,3], and Kai Loo[3] — [1]Technische Universität München, Physik Department, James-Franck-Str., 85748 Garching, Germany — [2]Institute of Physics, Johannes Gutenberg University Mainz Staudingerweg 7, 55128 Mainz, Germany — [3]Institute of Physics and Excellence Cluster PRISMA+, Johannes-Gutenberg Universität Mainz, Mainz, Germany

The organic liquid scintillator based JUNO experiment (Jiangmen Underground Neutrino Observatory) is aiming to determine the neutrino mass hierarchy. This goal imposes strict requirements on the radiopurity of the scintillator.

The 20m^3 OSIRIS pre-detector is expected to monitor the level of radioactive contaminations in the purified scintillator as the last device after the purification plants. This way the scintillator's radiopurity will be checked just before it is filled into the JUNO main detector. The level of U/Th contaminations can be determined by exploiting the coincidence structure of a Bi β-decay to Po immediately followed by an α-decay to Pb. This talk presents the status of the development of an in-situ analysis of this method using pulse shape discrimination.

This work is supported by the DFG Research Unit "JUNO" (FOR2319).

T 90.6 Wed 18:45 POT/0361

Machine learning based event reconstruction for the OSIRIS detector — •Lukas Bieger, Marc Breisch, Jessica Eck, Tobias Heinz, Benedict Kaiser, Tobias Lachenmaier, and Tobias Sterr — Eberhard Karls Universität Tübingen, Physikalisches Institut

The Jiangmen Underground Neutrino Observatory (JUNO) is a multi-purpose neutrino experiment with a 20 kt liquid scintillator detector that is currently set up in southern China. The main goal of JUNO is determining the neutrino mass hierarchy, which is to be achieved by a precise measurement of the oscillated energy spectrum of electron antineutrinos from nearby nuclear power plants. The Online Scintillator Internal Radioactivity Investigation System (OSIRIS) will monitor the radio-purity of the liquid scintillator during the filling of JUNO, to ensure that the required contamination levels are met. OSIRIS itself is a 18 t liquid scintillator detector, which is instrumented with 64 20-inch PMTs to collect the light produced by events in the detector's sensitive volume. This talk will present an event reconstruction method based on machine learning which was developed for the application in the OSIRIS detector.

T 91: Neutrinos IV

Time: Wednesday 17:30–19:00 Location: POT/0006

T 91.1 Wed 17:30 POT/0006

Sensitivity studies of the KATRIN experiment with a differential detector — •Svenja Heyns for the KATRIN-Collaboration — Institute for Astroparticle Physics, Karlsruhe Institute of Technology

The Karlsruhe Tritium Neutrino Experiment (KATRIN) is designed to probe the neutrino mass with a sensitivity of 0.2 eV/c^2 (90% C.L.). The measurement principle relies on an integral measurement of the tritium beta spectrum at the kinematic endpoint of T_2 by a high-pass MAC-E-type filter. Switching to a differential measurement of the beta-electron spectrum with eV-scale resolution would increase statistics and allow improved discrimination of background events. This presentation outlines the potential modification to the setup with possible detector concepts and discusses their impact in first studies on neutrino mass sensitivity.

This work is supported by the Helmholtz Association (HGF), the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Young Investigator Group (VH-NG-1055).

T 91.2 Wed 17:45 POT/0006

Characterization of a TRISTAN detector with a laser system — •Christian Forstner for the KATRIN-Collaboration — Technical University Munich, James-Franck-Straße 1, 85748 Garching bei München

Sterile neutrinos are a minimal extension of the Standard Model of particle physics. These neutrinos are a dark matter candidate if their mass is in the keV range. They can be accessed experimentally in the tritium beta decay, if they have a mass of up to 18.6 keV and would manifest themselves as a kink-like distortion in the electron energy spectrum. For the KATRIN experiment, a novel silicon drift detector and read-out system is developed to search for this signal. In this presentation, the results of the characterization of a 7 pixel TRISTAN detector with a laser system will be presented and compared to simulations.

This work is supported by BMBF (05A17PM3, 05A17PX3, 05A17VK2, 05A17WO3), KSETA, the Max Planck society, and the Helmholtz Association. This project has received funding from the European Research Council (ERC) under the European Union Horizon 2020 research and innovation program (grant agreement No. 852845).

T 91.3 Wed 18:00 POT/0006

The other end of KATRIN – systematic effects by the rear wall — •Leonard Hasselmann, Max Aker, and Rudolf Sack — IAP, Karlsruher Institut für Technologie

In order to determine the neutrino mass with a sensitivity of 0.2 eV/c^2 (90% C.L.) the Karlsruhe Tritium Neutrino (KATRIN) experiment measures the β-decay endpoint spectrum of tritium using a MAC-E filter type spectrometer. In KATRIN's source 10^{11} β-decay electronss are emitted per second. They are magnetically guided to the spectrometer in one direction and to a gold coated stainless steel plate, named rear wall, to the other.

A comprehensive understanding of various background contributions, e.g. accumulated tritium on the rear wall, is paramount. Decays of absorbed tritium create an additional spectrum which superimposes that of the source. This results in a systematic uncertainty, which is mitigated either by modelling the additional spectrum or by removing the tritium from the rear wall and surrounding surfaces.

The talk presents an overview on a cleaning method using UV/ozone which has been performed three times so far in the KATRIN setup. Besides a good cleaning performance, an influence on the source potential was found. Additionally, results from a test setup further investigating the cleaning effect are discussed.

This work is supported by the Helmholtz Association (HGF), the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3).

T 91.4 Wed 18:15 POT/0006

OSIRIS Upgrade: Solar PP Neutrinos and Neutrinoless Double Beta Decay — •Arshak Jafar[1], Kai Loo[1,2], Michael Wurm[1], Marcel Büchner[1], Tim Charisse[1], George Parker[1], Oliver Pilarczyk[1], and Timo Enqvist[2] — [1]Johannes Gutenberg University Mainz, Germany — [2]University of Jyvaskyla, Finland

The Jiangmen Underground Neutrino Observatory (JUNO), under construction in southern China, will determine the neutrino mass hierarchy (MH) by observing neutrinos from nuclear reactors at a distance of 53 km. To reach the desired sensitivity ($> 3\sigma$) for MH, the radiopurity of the different detector components plays a crucial role. To ensure the purity of the 20 kt liquid scintillator (LS) target of JUNO, the Online Scintillator Internal Radioactivity Investigation System (OSIRIS) is being constructed. It will monitor the radiopurity of the LS during its production and the filling phase of the central detector of JUNO.

After the filling phase, a plan to repurpose OSIRIS as a standalone detector for studying physics has been put forward, as OSIRIS along with the existing JUNO infrastructure provides a unique chance for low-budget high precision measurements. The OSIRIS upgrade project aims at a precision measurement of the flux of solar pp neutrinos on the few-percent level as well as to test the Majorana nature of neutrinos through neutrinoless double beta decay. The upgrade relies on the use of 20 tons of slow scintillator, either low ^{14}C or loaded with $0\nu\beta\beta$ isotope, with excellent energy resolution (~2.5% at 1 MeV), low internal background and sufficient shielding from surrounding radioactivity.

T 91.5 Wed 18:30 POT/0006

JUNO's sensitivity to geoneutrinos using full Monte Carlo simulation — •Nikhil Mohan[1,3], Runxuan Liu[2,3], Livia Ludhova[2,3], Anita Meraviglia[1,3], Luca Pelicci[2,3], Mariam Rifai[2,3], Apeksha Singhal[2,3], and Cornelius Vollbrecht[2,3] — [1]GSI Helmholtz Centre for Heavy Ion Research, Darmstadt, Germany — [2]Forschungszentrum Jülich GmbH, Institut für Kernphysik IKP-2, Jülich, Germany — [3]III. Physikalisches Institut B, RWTH Aachen University, Aachen, Germany

JUNO is a multipurpose 20 kton liquid scintillator detector located in China, with planned completion in 2023. Its main physics goal is the determination of the Neutrino Mass Ordering via the measurement of the vacuum oscillation pattern of the reactor antineutrinos coming from two nuclear power plants, each at a 53 km baseline. JUNO is also an excellent candidate to investigate geoneutrinos thanks to its sizable active mass and unprecedented effective energy resolution (3% at 1 MeV). The sensitivity study is performed by producing all the energy reference shapes - signal and backgrounds - using the JUNO official Monte Carlo simulation with a full detector response as well as the reconstruction software. The reference shapes generated from the massive pseudo-experiments are then fitted with JUST (Juelich nUsol Sensitivity Tool), a software tool developed in our group. This study reveals the important role JUNO can have in detecting geoneutrinos. Even only after one year of data-taking, JUNO will be able to reach a 14% precision, thus improving the best current result given by the Borexino and KamLAND experiment.

T 91.6 Wed 18:45 POT/0006

Neutrino directionality: aims, methods and the reaction of inverse beta decay — •Yaroslav Nikitenko, Philipp Soldin, Achim Stahl, and Christopher Wiebusch — III. Physikalisches Institut B, RWTH Aachen University

Reconstructing the direction of neutrinos is of high interest for supernovae and geoneutrinos. We discuss existing experimental methods and focus on neutrino directionality using the reaction of inverse beta decay.

While the reaction of neutrino-electron scattering provides a better per-event angular resolution for supernova neutrinos, inverse beta decay usually has many more events. Its detection threshold for existing large detectors is lower than that for electron scattering, which is important for geoneutrinos.

The Double Chooz reactor neutrino experiment provides a good scientific basis to study neutrino directionality with the reaction of inverse beta decay. Its advantage is the neutrino source of a known direction and almost point-like structure.

T 92: Cosmic Ray IV

Time: Wednesday 17:30–19:00 Location: POT/0013

T 92.1 Wed 17:30 POT/0013

Modeling Diffusive Shock Acceleration with CRPropa* — •Sophie Aerdker[1,2], Lukas Merten[1,2], Julia Becker Tjus[1,2], Dominik Walter[1,2], Frederic Effenberger[1,2], and Horst Fichtner[1,2] — [1]Ruhr-Universität Bochum — [2]RAPP Center Bochum

Ultra high energy cosmic rays are most likely accelerated stochastically in time-dependent, turbulent magnetic field structures present in astrophysical sources and the interstellar medium. One of such processes is Diffusive Shock Acceleration: Diffusive particles gain energy by repeatedly crossing a shock front. The stochastic nature of this process leads to the characteristic power-law spectrum. We study Diffusive Shock Acceleration using a stochastic differential equation solver (DiffusionSDE) of the cosmic-ray propagation framework CRPropa3.2. We show that the expected spectra are reproduced for various configurations, from one-dimensional planar shocks to three-dimensional spherical shocks. The effect of anisotropic diffusion is discussed and how different injection spectra change the resulting spectrum. We clarify constraints for modeling Diffusive Shock Acceleration using stochastic differential equations.

*Supported by DFG (SFB 1491)

T 92.2 Wed 17:45 POT/0013

Untersuchung des Einflusses magnetischer Spiegel auf den Transport kosmischer Strahlung — •Seeliger Ines[1,2], Schlegel Leander[1,2] und Tjus Julia Becker[1,2] — [1]Theoretische Physik IV, Ruhr-Universität Bochum, Bochum, Germany — [2]RAPP-Center at Ruhr-Universität Bochum, Bochum, Germany

Seit den ersten Messungen der kosmischen Strahlungen bei den Ballonfahrten von Victor Hess im Jahre 1912, sind die Forschungen zu der Frage der Quellen der hochenergetischen Strahlung noch immer nicht abgeschlossen und Gegenstand laufender Untersuchungen. Numerische Betrachtungen des Transports ergeben, dass Teilchen des beobachteten Energiespektrums der kosmischen Strahlung in unterschiedlichen Transportregimen mit dafür charakteristischem Transportverhalten betrachtet werden können. Ziel dieser Arbeit ist es, insbesondere das Spiegelregime genauer zu untersuchen, indem der Einfluss von magnetischen Spiegeln hinsichtlich des Transportverhaltens relevant wird. Dazu wird numerisch das Verhalten der Teilchen an magnetischen Spiegeln durch analytisch implementierte magnetische Flaschen analysiert und es gilt den Einfluss der Spiegel bei der Simulation der Propagation von Testteilchen mit Hilfe der Software CRPropa zu bestimmen.

T 92.3 Wed 18:00 POT/0013

Unstable cosmic-ray nuclei constrain low-diffusion zones in the disk — •Hanno Jacobs, Philipp Mertsch, and Vo Hong Minh Phan — TTK RWTH Aachen

Gamma ray halos around pulsars indicate a locally suppressed diffusion coefficient. In the past the impact of those zones on galactic cosmic ray transport has been neglected due to their supposedly small filling fraction. Here we show that the determining factor is not the volume of the low diffusion zones, but the effective time spent in pockets of low diffusivity. We derive an averaged diffusion coefficient in the disc and implement it in a semi-analytical model of cosmic ray transport. Upcoming Beryllium data from the AMS-02 and HELIX experiments will be able to constrain the filling fraction of low diffusion zones at the percent level.

T 92.4 Wed 18:15 POT/0013

The CORSIKA 8 air shower simulation framework — •Alexander Sandrock for the CORSIKA 8-Collaboration — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal

Originally developed for the KASCADE experiment, the air shower simulation code CORSIKA is now used in the simulation chain of numerous experiments in astroparticle physics. The monolithic hand-optimized Fortran code, that has served the community for the last decades, becomes increasingly difficult to maintain and to expand. For this reason, a community effort has been started in 2018 to rewrite CORSIKA as a flexible air shower simulation framework, making use of the possibilities of modern C++ standards.

By now, CORSIKA 8 is capable of simulating both hadronic and electromagnetic components of an air shower, calculate the radio and Cherenkov emission, and offers a considerably increased flexibility in defining properties and geometries of the media, in which the shower is to take place. Several abilities already go beyond what is possible in earlier versions of CORSIKA, such as cross-media showers or full genealogy of particles.

This presentation discusses the status of the implementation and validation of this new air shower simulation framework.

T 92.5 Wed 18:30 POT/0013

High-energy lepton, photon and air shower simulations using PROPOSAL — •Jean-Marco Alameddine[1], Pascal Gutjahr[1], and Alexander Sandrock[2] — [1]Astroparticle Physics WG Rhode, TU Dortmund University, Germany — [2]Faculty of Mathematics and Natural Sciences, University of Wuppertal

In modern physics experiments, simulations are crucial to apply modern analysis methods to the obtained data. One prime example in astroparticle physics is the simulation of extensive air showers, whose signatures can either be signal or background for experiments that needs to be separated.

PROPOSAL is a customizable C++ and Python library, providing three-dimensional simulations of charged leptons and high-energy photons. One of many applications of PROPOSAL is within the currently developed shower simulation framework CORSIKA 8, the successor of the well-established software CORSIKA 7. For CORSIKA 8, PROPOSAL is used as a library to describe the electromagnetic and muonic shower component.

In this contribution, the basic concepts of PROPOSAL are introduced. Furthermore, validations of electromagnetic showers simulated with CORSIKA 8 are presented, which are obtained by comparing relevant shower parameters such as longitudinal and lateral profiles with CORSIKA 7 simulations.

Supported by the BMBF (ErUM) and by the DFG (SFB 1491, SFB 876).

T 92.6 Wed 18:45 POT/0013

Air shower genealogy — •Maximilian Reininghaus and Ralph Engel — Karlsruher Institut für Technologie (KIT), Karlsruhe, Deutschland

Experiments detecting ultra-high energy cosmic rays rely heavily on air shower simulations and models governing the hadronic interactions. These have to cover a vast phase-space (several combinations of projectile species and target nuclei, interaction energies ranging over many orders of magnitude, final-state kinematic distributions), but not all regions of it share the same relevance for air shower observables.

Using the air shower simulation framework CORSIKA 8 and its *particle history* feature, we investigate the relation between kinematic distributions of pseudorapidity, Feynman-x, and transverse momentum in hadronic interactions and muon distributions from air showers at ground. Additionally, we quantitatively study the energy transfer from the hadronic into the electromagnetic (EM) cascade and the impact of early hadronic interactions on the EM profile and its maximum X_{max}.

T 93: Exp. Methods – Scint., HESS, Auger

Time: Wednesday 17:30–19:00 Location: POT/0351

T 93.1 Wed 17:30 POT/0351

Design of a detector irradiation facility in Mainz — •Daniela Fetzer, Michael Wurm, Kai Loo, and Arshak Jafar — Johannes Gutenberg-University Mainz

Detectors for low-energy particles (MeV) are often calibrated using gamma rays to induce electron-like signals. This contribution describes Monte Carlo simulation for a new experimental array to be set up at the Detector Irradiation Facility in the Center for Fundamental Physics in Mainz. It will use a DD-neutron generator, PE moderator and a nickel (neutron,gamma) converter to produce fairly high-energy gamma rays of 9 MeV. This allows a calibration for a far wider energy range than is accessible with standard radioactive sources.

In the planned experiment, different scintillator targets will be irradiated with neutrons and gammas. In a secondary detector array, the scattered particles will then be detected and their scattering angle and energy will be compared to the incident particles and their energy deposition in the target. This talk gives an overview of the proposed experiment and its current status.

T 93.2 Wed 17:45 POT/0351

Development of a spatial resolving scintillator readout system - "MIP-Cube" — •Philippe Bruder[2], Thomas Huber[1], and Andreas Haungs[1] — [1]Karlsruhe Institute of Technology, Institute for Astroparticle Physics, Karlsruhe, Germany — [2]Karlsruhe Institute of Technology, Institute for Particle Physics, Karlsruhe, Germany

High-energy muons from extensive air-showers, originated in the interaction between cosmic rays and the Earth's atmosphere, can propagate to Earth or even into low-noise facilities, like underground research laboratories and contribute to the noise level of experiments. By measuring the flux and spatial distribution of these muons, systematic background effects can be studied. For this purpose, a monitoring system based on a net of crossed 20 cm long and 5 cm wide plastic scintillator bars is in development. The foreseen scintillator system presented here will be readout by Hamamatsu 64-channel Silicon Photomultiplier (SiPM) arrays and are based on detectors developed for the surface instrumentation of the IceCube Neutrino Observatory. The baseline design provides a highly mobile detector system, with an adequate power supply and signal where focus will be given on a plug-and-play setup for variable measuring locations. The CAEN Co. Ltd Front-End units DT5202 or DT5203 as SiPM array readout and trigger electronic unit is one of the candidates. This contribution includes R&D efforts towards an appropriate data acquisition (DAQ) system, the foreseen detector design and the concept for front-end readout electronics.

T 93.3 Wed 18:00 POT/0351

Intensity Interferometry at H.E.S.S. - Introduction and first Results — •Andreas Zmija[1], Naomi Vogel[1], Gisela Anton[1], Stefan Funk[1], Alison Mitchell[1], Frederik Wohlleben[2], and Adrian Zink[1] — [1]Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP — [2]MPG Heidelberg

It has been less than a decade since astronomers rediscovered the concept of intensity interferometry, originally developed by Hanbury Brown & Twiss in the late 1950s, but state-of-the-art electronics have led to tremendous progress in recent years. The technique of correlating photon streams rather than interfering electromagnetic waves between telescopes is almost insensitive to atmospheric effects, and thus promises an increase in angular resolution in the optical regime by an order of magnitude. Since large light collection areas are preferred to optical quality mirrors, Imaging Atmospheric Cherenkov Telescopes are optimally suited for being equipped as intensity interferometer. In April 2022 we performed first photon correlation measurements with two of the H.E.S.S. Phase I telescopes during the moonlight break. We give a brief introduction into the method intensity interferometry, and present the first results of angular diameter measurements of the two stars Lambda Scorpii and Sigma Sagittarii.

T 93.4 Wed 18:15 POT/0351

Intensity Interferometry at H.E.S.S. - Technical Setup — •Naomi Vogel[1], Andreas Zmija[1], Gisela Anton[1], Stefan Funk[1], Alison Mitchell[1], Frederik Wohlleben[2], and Adrian Zink[1] — [1]Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP — [2]MPG Heidelberg

Intensity Interferometers are used to determine the angular diameter of stars. Imaging Atmospheric Cherenkov Telescopes are provided with technical setups to perform intensity interferometry (II) measurements. Our developed II setup was designed to be mounted to the lid of the Phase I H.E.S.S. telescopes in Namibia. It includes a 45 degree angled mirror and an optical path with a 2 nm interference filter leading to two photomultipliers whose photo currents are measured and then correlated. This enables us to handle high photon count rates. The data is then transferred via optical fibres to our workstation where the analysis is done after the measurements. The setup is equipped with motors in order to move each element individually which enables us to have a live pointing correction. In this contribution we will present the structure of our technical setup, how to include it between gamma ray observations and our future plans.

T 93.5 Wed 18:30 POT/0351

Trigger Concept for the Detection of Photon Air Showers with the AugerPrime Radio Detector* — •Jannis Pawlowsky for the Pierre Auger-Collaboration — Bergische Universität Wuppertal, Gaußstr. 20, 42119, Wuppertal, Germany

The Pierre Auger Observatory is the largest Cosmic Ray (CR) observatory with a size of ≈ 3000 km^2. Its size makes it feasible to not only look for CRs but also for presumably rare primaries like photons at energies larger than 1 EeV. Strong upper limits on the diffuse photon flux have been set in the past using the Water Cherenkov Detector (WCD). Additionally, air showers with photon-like properties were detected. For these photon candidate events, however, an uncertainty remains regarding whether they are of photon origin or possibly misinterpreted hadrons. With the AugerPrime upgrade, the WCD is complemented by the Radio Detector (RD). The combination of both detectors yields new information about air showers and will improve primary identification. Here, inclined photon showers are of special interest. We will present a stand-alone RD trigger concept to detect photon air showers with negligible particle footprints. It will be shown that the trigger is compatible with given hardware limitations and the noise level at the Pierre Auger Observatory. The status and results of a first hardware implementation is discussed. We will quantify the trigger efficiency of photon air showers for different configurations of the trigger.

Gefördert durch die BMBF Verbundforschung Astroteilchenphysik (Vorhaben 05A20PX1)

T 93.6 Wed 18:45 POT/0351

Segmented scintillation tracking detector for space applications — •Roman Bergert, Hans-Georg Zaunick, and Kai-Thomas Brinkmann — II. Physics Institute Justus-Liebig-University Giessen

A 3D-resolving detector concept as a payload for an upcoming satellite mission, which is foreseen to reach a final medium earth orbit (MEO) and high radiation levels, is discussed. A precise measurement of fluences and dose rates of relativistic charged particles with energies above 100 MeV is targeted as the main goal of the concept. The determination of the momentum vector of charged particles combined with a precise timing of the events will be used to demonstrate the feasibility of the unprecedented experimental correlation between the primary particles events and triggered secondary particles in air showers on earth by a citizen science project (MuonPi muonpi.org). The steps to reach these goals and first concept results will be presented with a focus on the mechanical and electrical construction of the detector payload for deployment in space.

T 94: DAQ, Exp. Methods

Time: Wednesday 17:30–19:00 Location: POT/0106

T 94.1 Wed 17:30 POT/0106

Development of a Detector Response Model and an Autonomous Trigger for the Detection of Air-Shower Radio Emission — •Jelena Petereit, Tim Huege, Markus Roth, and Lukas Gülzow — Karlsruhe Institute of Technology, Germany

Radio detection of air-showers has proven to be very advantageous for the measurement of ultra-high energy cosmic rays. As a consequence, a new generation of radio detectors is now evolving at much larger scales. The Giant Radio Array for Neutrino Detection (GRAND) is planned as an array of wide-band radio antennas, which will cover a total area of 200 000 km^2. In order to reliably distinguish air-shower events from noise for such large arrays, an efficient and autonomous multi-level radio trigger is developed*. The first-level trigger selects an antenna signal according to expected signal shapes, whereas the second-level trigger refines this selection according to information of all antennas triggered during the same event.

While the deployment of GRAND is in progress, a digital detector model is being developed. It will include a sufficiently accurate instrument response and signal processing methods. It will then make it possible to analyze the detector response and determine significant parameters that are needed for building this novel trigger method. This talk will cover the approaches to build a realistic response model and the multi-level radio trigger needed for large-scale experiments like GRAND. ** NUTRIG project, supported by the ANR-DFG Funding Programme (RO 4165/2-1)*

T 94.2 Wed 17:45 POT/0106

Event builder and online monitoring of OSIRIS pre-detector of JUNO — •Runxuan Liu[1,2], Kai Loo[4], Livia Ludhova[1,2], Cornelius Vollbrecht[1,2], Anita Meraviglia[2,3], Nikhil Mohan[2,3], Luca Pelicci[1,2], Mariam Rifai[1,2], and Apeksha Singhal[1,2] — [1]Forschungszentrum Jülich GmbH, Institut für Kernphysik IKP-2, Jülich, Germany — [2]III. Physikalisches Institut B, RWTH Aachen University, Aachen, Germany — [3]GSI Helmholtz Centre for Heavy Ion Research, Darmstadt, Germany — [4]Cluster of Excellence PRISMA+, Johannes Gutenberg University Mainz, Mainz, Germany

JUNO is a 20 kt liquid scintillator detector under construction in Jiangmen, China. The installation is expected to be completed in 2023. Its main goal is to determine the neutrino mass hierarchy with the measurement of reactor antineutrinos from the two nuclear power plants in the proximity. This requires stringent limits on the radiopurity of the liquid scintillator. The OSIRIS (Online Scintillator Internal Radioactivity Investigation System) pre-detector is designed to monitor the liquid scintillator during the several months of filling the large volume of JUNO. OSIRIS will contain 18 tons of scintillator and will be equipped with 76 20-inch PMTs. It will be sensitive for the ^{238}U/^{232}Th decay rates via tagging of the Bi-Po coincidence decays in the ^{238}U/^{232}Th decay chain. This talk will present the trigger strategies of OSIRIS and its updated event builder software. The online monitoring software for OSIRIS is needed for a live measurement of scintillator radiopurity during filling and it will also be presented in this talk.

T 94.3 Wed 18:00 POT/0106

Writing photons to disk - The triggerless DAQ-System of XENONnT — •Robin Glade-Beucke for the XENON-Collaboration — Physikalisches Institut, Universität Freiburg, 79104 Freiburg, Germany

The XENONnT experiment is an ultra low-background liquid xenon TPC for WIMP direct detection which is taking data at LNGS (Italy). Its triggerless data acquisition (DAQ) system allows for fast and storage-efficient recording with a very low threshold, accepting signals as small as from individual photons. Custom-developed FPGA firmware on the read-out digitizers and on auxiliary logic boards, e.g., a high energy veto to remove high-energy events during detector calibration, makes the data-taking in the triggerless paradigm possible. In this talk, I will present the system and its performance.

T 94.4 Wed 18:15 POT/0106

Improving Particle Flow Reconstruction in the CMS HGCAL — •Abhirikshma Nandi[1], Wahid Redjeb[1,2], Felice Pantaleo[2], Marco Rovere[2], and Alexander Schmidt[1] — [1]III. Physikalisches Institut A, RWTH Aachen University, Aachen, Germany — [2]CERN, Geneva, Switzerland

The CMS calorimeter endcaps will be completely replaced by the High Granularity Calorimeter (HGCAL) as part of the Phase-2 upgrades. The large number of simultaneous collisions (pile-up) and the novelty of the detector makes physics object reconstruction a challenging task. A new, modular framework, called The Iterative Clustering (TICL), is under development for reconstruction in HGCAL. Its granularity and the capability to obtain 5D (x,y,z,t,E) measurements, make HGCAL an ideal candidate for particle flow reconstruction - where information from different parts of the detector are matched to improve the global event description. Moreover, accumulating separate objects reconstructed inside the calorimeter, from the secondary components of a particle shower, is also necessary. This talk discusses a linking algorithm that was introduced in TICL as a first attempt to solve these problems. A complementary approach of learning functions on a graph of clustered energy deposits and detecting communities in it, will also be presented.

T 94.5 Wed 18:30 POT/0106

The Heterogeneous TICL Framework — •Wahid Redjeb[1,2], Abhirikshma Nandi[1], Alexander Schmidt[1], Felice Pantaleo[2], Marco Rovere[2], and Antonio Di Pilato[3] — [1]III. Physikalisches Institut A, RWTH Aachen University, Aachen, Germany — [2]CERN, Geneva, Switzerland — [3]University of Geneva, Geneva, Switzerland

The High-Granularity Calorimeter (HGCAL) is a sampling calorimeter with both lateral and longitudinal fine granularity designed for the High-Luminosity LHC. The calorimeter will use silicon sensors, in the high radiation regions, providing high pile-up mitigation, and scintillators in the low radiations regions. For the physics object reconstruction a dedicated framework for HGCAL is currently under development: The Iterative Clustering (TICL), which utilizes the 5D (x,y,z,t,E) information from the reconstructed hits and returns particle properties and probabilities. Heterogeneous computing will play a fundamental role in the physics object reconstruction software to fully exploit the reach of the HL-LHC. Performance Portability libraries allow performance portability across different hardware architectures with a single code basis. In this talk we present and overview of the TICL framework and we show how heterogeneous computing has been integrated in the framework, exploiting the Alpaka library to achieve Performance Portability and being able to run core parts of the Framework on GPU and on CPU with a single source code.

T 94.6 Wed 18:45 POT/0106

Updated jet energy scale calibration using Monte Carlo samples for ATLAS — •Gediminas Glemža and Christian Sander — DESY, Notkestr. 85, 22607 Hamburg, Germany

An updated simulation-based jet energy scale calibration utilising the newest ATLAS software release version and updated Run-2 Monte Carlo samples is presented. The calibration restores the jet energy scale back to particle level jets. The jets are reconstructed using particle-flow objects and clustered using the anti-k_t jet algorithm with a radius parameter of 0.4. The presented calibration accounts for in-time and out-of-time residual pile-up effects, calibrates the absolute jet energy scale and pseudorapidity, as well as provides additional corrections based on global jet observables. The presented procedure is based on similar simulation-based calibrations carried out during the period of Run-2 and their performance comparison is discussed.

T 95: Pixel, Det/Sys LHCb, HGT

Time: Wednesday 17:30–19:00 Location: WIL/A317

T 95.1 Wed 17:30 WIL/A317

Providing YARR Software Support to Operate ATLAS-ITk Read-out Chips with BDAQ53 Hardware — •Wael Alkakhi, Joern Grosse-knetter, Arnulf Quadt, and Ali Skaf — II. Physikalisches Institut, Georg-August-Universität Göttingen

During the ATLAS HL-LHC upgrade, the current inner detector is going to be replaced by an all-silicon Inner Tracker (ITk), using prototype and pre-production read-out chips, referred to as RD53A and RD53B respectively.

YARR is a DAQ system developed for the ITk detector. It is composed of a software communicating originally with several PCI-e FPGA hardware (HW) platforms. It was developed to read out different front-end (FE) chips with, recently, an extended support to other HW platforms. This work reports on providing the support for BDAQ53 FPGA platform, which was developed as a part of the BDAQ DAQ system, with its Ethernet connectivity. This enables YARR to read out both RD53A and RD53B (ITkPix-V1) FE chips, while preserving the original existing BDAQ53 firmware. In particular, this would be most helpful for several institutions of the ATLAS collaboration, having already a purchased BDAQ DAQ system. The work required to develop specific Hardware Abstraction Library (HAL) controller software blocs. Different RD53A and RD53B scans were successfully performed, validating the added BDAQ53 support.

T 95.2 Wed 17:45 WIL/A317

Developments in the ITk Pixel OB Demonstrator DCS — •Anne Gaa, Stan Lai, and Hans Joos — II. Physikalisches Institut, Georg-August-Universität Göttingen

The ATLAS experiment is developing the new Inner Tracker (ITk) in preparation for the High-Luminosity LHC Upgrade. The ITk pixel Outer Barrel demonstrator, as a system prototype, is in its final design review phase in preparation of the construction of the finished detector. The Detector Control System (DCS) is responsible for monitoring and controlling the detector and its sub-systems. The DCS uses WinCC OA, a SCADA software by Siemens, in a distributed system.

This talk discusses various improvements to the ITk pixel OB demonstrator DCS in the scope of its system tests. These include new monitoring panels for the modules mounted on the loaded local supports, the implementation of an archiving system for monitored data points, and the calibration of temperature and voltage monitoring.

T 95.3 Wed 18:00 WIL/A317

Electrical Tests with the ITk Pixel Outer-Barrel Demonstrator — •Hans Joos[1,2], Benedikt Vormwald[1], Leyre Flores Sanz De Acedo[1], Brian Moser[1], Stan Lai[2], and Anne Gaa[2] — [1]CERN — [2]II. Physikalisches Institut, Georg-August-Universität Göttingen

For the upgrade of the LHC to the High-Luminosity LHC (HL-LHC), the ATLAS tracking detector will be replaced with an all-silicon detector, the Inner Tracker (ITk), as the higher luminosity requires radiation hard components that can deal with higher occupancies and radiation. Given the close proximity to the interaction point, the environment is especially challenging for the pixel detector. The Outer-Barrel layers of the pixel detector will comprise quad chip modules that are combined into serially powered (SP) chains and loaded on ring and stave shaped low mass carbon-fibre local supports to reduce the material budget of the detector.

The integration from individual detector components to a final detector is one of the big challenges of the HL-LHC detector upgrades. In order to test the loading procedure and performance of the modules after loading, prototype modules were mounted on a stave local support and connected with realistic services to form a smallest "feature-complete" functional building block and demonstrator of the ITk Pixel Outer-Barrel detector.

This talk will explain the demonstrator setup and present the results of electrical performance tests of the demonstrator modules after loading and their behavior in SP chains.

T 95.4 Wed 18:15 WIL/A317

Measurements with a serial powering prototype for the ATLAS ITk Pixel Detector — •Thomas Senger, Florian Hinterkeuser, Matthias Hamer, Fabian Huegging, Jochen Dingfelder, Klaus Desch, and Hans Krüger for the ATLAS-Collaboration — Physikalisches Institut Bonn Germany

The high-luminosity upgrade of the LHC at CERN requires completely new inner detectors for ATLAS and CMS experiments. A serial powering scheme has been chosen to cope with the constraints of the new pixel detectors. A prototype consisting of up to 8 quad modules, based on the new readout chips (ITkPixV1.1) developed by the RD53 collaboration in 65 nm CMOS technology has been set up in Bonn. This talk presents the results of measurements with a full ITkPixV1.1 serial powering chain to better understand and validate the requirements for all active components in the ITk Pixel System.

T 95.5 Wed 18:30 WIL/A317

First data from the LHCb Beam Conditions Monitor in Run III of the LHC — Johannes Albrecht[1], Elena Dall'Occo[1], •Martin Bieker[1], David Rolf[2,1], Holger Stevens[1], and Dirk Wiedner[1] — [1]TU Dortmund University, Dortmund, Germany — [2]CERN, Geneva, Switzerland

The LHCb experiment is a single-arm forward spectrometer at the LHC that focuses on measurements in the *b* and *c* quark sector. Due to its unique geometry, featuring a sensitive tracking system located as close as 3 mm to the LHC beams, the detector is at risk of damage from adverse beam conditions. For this reason, the particle flux near the beam pipe is monitored by eight diamond sensors in a circular arrangement on either side of and close to the interaction point.

In preparation for the ongoing Run III of the LHC this so-called Beam Conditions Monitor (BCM) has been overhauled as part of a comprehensive upgrade of the LHCb detector. Besides the safety-related functions, measurements of the particle flux near the interaction point can serve as an estimate for the instantaneous luminosity.

The talk will present the first data acquired during the initial months of LHC operation in Run III with the upgraded BCM readout system. In order to evaluate performance metrics, such as the linearity of the sensor response, the BCM output is compared to data from other LHCb subdetectors.

T 95.6 Wed 18:45 WIL/A317

Module assembly for the ATLAS High Granularity timing detector — •Hendrik Smitmanns[1], Andrea Brogna[2], Doğa Elitez[1], Theodorus Manoussos[1], Lucia Masetti[1], Fabian Piermaier[2], Maria Soledad Robles Manzano[1], Steffen Schoenfelder[2], and Quirin Weitzel[2] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz — [2]PRISMA Detektorlabor, Johannes Gutenberg-Universität Mainz

To meet the challenges of the High Luminosity-LHC, especially the increase of pile-up interactions, the ATLAS detector needs to be upgraded. One of the foreseen upgrades consists of the installation of the High-Granularity Timing Detector (HGTD). The HGTD will mitigate the effects of pile-up in the ATLAS forward region, providing time information with a resolution of about 30 ps per track. The active area consists of 2-double-sided disks per end-cap. Two 2x2 cm^2 Low Gain Avalanche Detectors bump-bonded to two ASICs and wire bonded to a flexible PCB form the HGTD basic unit, the so-called module. 8032 modules have to be built in total. During the HGTD R&D phase, module prototypes are assembled and tested in order to optimize the procedures and be integrated for system level tests in the HGTD demonstrator. The module assembly procedure in Mainz and the results of the very first assemblies are presented.

T 96: TestBeam, RadHard for Si and Pixel

Time: Wednesday 17:30–19:00 Location: WIL/A124

T 96.1 Wed 17:30 WIL/A124

Characterisation of a novel trigger and timing plane for the EUDET Telescopes — •Arianna Wintle[1], Lennart Huth[1], Francesca Maria Pofi[1], Felix Sefkow[1], Marcel Stanitzki[1], and Ivan Peric[2] — [1]DESY, Notkestraße 85, 22607 Hamburg — [2]Karlsruhe Institute of Technology (KIT)

The DESY Test Beam facility provides GeV beams for users and precise reference tracking systems, the EUDET telescopes. The telescope readout is triggered externally and multiple particles are recorded in one readout cycle, causing ambiguities as no time-stamping is provided.

TelePix is a 180 nm HV-CMOS sensor foreseen to be used in upgrades of the EUDET-style pixel beam telescopes allowing for fast timing and triggering on a region of interest. Here, characterisation results of TelePix are presented using the latest test beam results.

T 96.2 Wed 17:45 WIL/A124

Irradiation Studies on Silicon Sensors for the CMS Outer Tracker Sensor Production — •Umut Elicabuk, Tobias Barvich, Bernd Berger, Alexander Dierlamm, Ulrich Husemann, Markus Klute, Roland Koppenhöfer, Thomas Müller, Marius Neufeld, Hans Jürgen Simonis, and Pia Steck — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

With the upcoming Phase-2 Upgrade of the CMS Outer Tracker, silicon sensors will be used to reconstruct the tracks of charged particles. The detector material continuously accumulates radiation damage at the level of the crystal lattice during operation. Due to the increased demands on radiation hardness with the HL-LHC upgrade, a sufficiently radiation hard sensor material is necessary.

Both during and before ongoing sensor production, it is therefore necessary to monitor the efficiency of the detectors under radiation exposure and to draw conclusions about subsequent performance in the detector.

Among other things, the ETP is investigating the sensor characteristics of these silicon sensors as part of the Phase-2 Upgrade. The talk will give an insight into the used measurement setups, investigated sensor characteristics and give an overview of the concept of irradiation studies in general.

T 96.3 Wed 18:00 WIL/A124

A High-Precision Irradiation Site for Silicon Pixel Detectors — •Pascal Wolf[1], Reinhard Beck[2], Jochen Dingfelder[1], and Dennis Sauerland[2] — [1]Physikalisches Institut, University of Bonn, Germany — [2]Helmholtz-Institut für Strahlen- und Kernphysik, University of Bonn, Germany

An irradiation site for radiation hardness studies of silicon pixel detectors is in operation at the isochronous cyclotron at the University of Bonn. The accelerator provides protons as well as other light ions with energies ranging from 7 to 14 MeV per nucleon and beam currents of up to 1 μA to the setup. Devices Under Test (DUTs) are irradiated in a temperature-controlled box, minimizing annealing, while being moved through the beam in a well-defined pattern, ensuring homogeneity. On-site beam diagnostics facilitate online monitoring of the beam parameters and enable a beam-driven irradiation procedure resulting in highly uniform damage profiles with relative uncertainties of typically 2%. The setup provides extensive data acquisition, visualization and control of all components allowing for flexible irradiation plans (DUT powering & R/O, pausing, etc.), post-irradiation corrections and precise damage analysis. In this talk, the irradiation site and its operational parameters are introduced in detail. Energy simulations for light ions are presented, showing the total ionizing dose (TID) as well as non-ionizing energy loss (NIEL) damage capabilities. Measurements of the applied particle fluence, using different techniques, are presented and their precisions are compared. Furthermore, an overview of the recently performed irradiation campaigns is given.

T 96.4 Wed 18:15 WIL/A124

Radiation hardness studies of the ULTRASAT space mission — •Vlad Dumitru Berlea — DESY, Zeuthen, Germany

ULTRASAT (ULtraviolet TRansient Astronomy SATellite) is a wide-angle space telescope that will perform deep time- resolved surveys in the near ultraviolet spectrum. ULTRASAT is led by the Weizmann Institute of Science (WIS) in Israel and the Israel Space Agency (ISA) and is planned for launch in 2026. The telescope implements a backside-illuminated, stitched pixel detector. The pixel has a dual-gain 4T architecture with a pitch of 9.5 μm and is produced in the 180 nm process by Tower Semiconductor. As part of the space qualification for the sensors, radiation tests are to be performed on both test sensors provided by Tower and the final flight design of the sensor. One of the main contributions to sensor degradation due to radiation for the ULTRASAT mission is Total Ionizing Dose (TID). TID measurements on the test sensors have been performed with Co-60 gamma source at Helmholz Zentrum Berlin (HZB) and CC-60 facilities at CERN, and preliminary results are presented in this talk.

T 96.5 Wed 18:30 WIL/A124

Test-Beam Performance Results of the FASTPIX Sub-Nanosecond CMOS Pixel Sensor Demonstrator — •Justus Braach[1,2], Eric Buschmann[1], Dominik Dannheim[1], Katharina Dort[1,3], Thanushan Kugathasan[4], Magdalena Munker[1], Walter Snoeys[1], Peter Švihra[1], and Mateus Vicente Barreto Pinto[4] — [1]CERN (CH) — [2]Universität Hamburg (DE) — [3]Justus-Liebig-Universität Giessen (DE) — [4]Université de Genève (CH)

Within the ATTRACT FASTPIX project, a monolithic pixel sensor demonstrator chip has been developed in a modified 180 nm CMOS imaging process technology, targeting sub-nanosecond timing precision for single ionising particles. It features a small collection electrode design on a 25 μm-thick epitaxial layer and contains 32 mini matrices of 68 hexagonal pixels each, with pixel pitches ranging from 8.66 μm to 20 μm. Four pixels are transmitting an analog output signal and 64 are transmitting binary hit information. Various design variations are explored, aiming at accelerating the charge collection and making the timing of the charge collection more uniform over the pixel area. Signal treatment of the analog waveforms, as well as reconstruction of time and charge information, is carried out off-chip.

This contribution introduces the design of the sensor and readout system and presents performance results for various pixel designs achieved in recent test-beam measurements with external tracking and timing reference detectors. A time resolution below 150 ps is obtained at full efficiency for all pixel pitches.

T 96.6 Wed 18:45 WIL/A124

Reconstruction of high track density beams in beam tests — •Christopher Krause, Jens Weingarten, and Kevin Kröninger — TU Dortmund, Dortmund, Deutschland

The Inner Tracker of the ATLAS experiment requires the optimal performance of its pixel sensors. To test their efficiency, a reliable track reconstruction and analysis for testbeam data is necessary to ensure the precise detection of particles. The quality of data from testbeam campaigns are influenced by many factors, including high beam densities, which can impair the track reconstruction.

To analyse and evaluate the data taken at beam tests, the track reconstruction software Corryvreckan is used. It is now the predominant reconstruction framework for beam tests and was developed with the intention to reduce external dependencies without reducing the quality and versatility of track reconstruction in complex environments.

In beam tests, high density beams lead to many hits on the sensors in short periods of time. The reconstruction of particle tracks with too many hits becomes increasingly difficult due to the ambiguity of track fits. In order to differentiate between false and true reconstructed tracks, a machine learner is implemented, which is trained on simulated testbeam data, generated by the Allpix2 software.

This talk presents results of the track reconstruction of high track density using Corryvreckan and the performance of a machine learner for true track tagging. Both simulated data and real testbeam data is investigated.

T 97: Calorimeter / Detector Systems IV

Time: Wednesday 17:30–19:00 Location: WIL/C133

T 97.1 Wed 17:30 WIL/C133

Evaluation of the Performance of SiPM-on-Tiles at the End of Life of the CMS HGCAL Upgrade — •Malinda de Silva — Deutsches Elektronen-Synchrotron (DESY), Hamburg

For the HL-LHC phase, the calorimeter endcap of the CMS detector will be upgraded with a High Granularity Calorimeter (HGCAL), a sampling calorimeter that will use silicon sensors as well as scintillator tiles read out by silicon photomultipliers (SiPMs) as active material (SiPM-on-tile). The design of the SiPM-on-tile section was inspired by the CALICE AHCAL. The complete HGCAL will be operated at $-30^{\circ}C$.

The basic detector unit in the SiPM-on-tile section is the tile module, consisting of a PCB with one or two HGCROC ASICs, reading out up to 96 SiPM-on-tiles. Signals from MIPs passing through the SiPM-on-tiles are used to quantify the performance of SiPM-on-tiles. With irradiation, their performance degrades while increasing the noise. The ratio between the MIP signal and noise is known as the signal-to-noise ratio (SNR). In order to maintain an SNR>3 at end of the detector lifetime, SiPMs will be used in areas where the expected radiation dose during the lifetime of the detector is less than $5 \times 10^{13} n_{eq}/cm^2$.

A series of tests were conducted to quantify the performance of SiPM-on-tiles mounted on tile modules including beam tests and cold tests at $-30^{\circ}C$. These tests were also repeated using irradiated SiPMs mounted on the tile modules. These tests were then used to extrapolate the performance expectations at the detector's end of life.

T 97.2 Wed 17:45 WIL/C133

Quality control for SiPM-on-tile section of the CMS HGCAL at DESY — •Daria Selivanova — Deutsches Elektronen-Synchrotron (DESY), Hamburg

The new High-Luminosity era of the LHC challenges the detector development field to implement technology in a new way. A detector under construction, the High Granularity Calorimeter (HGCAL) for CMS, is based on two detection technologies: silicon sensors and SiPM-on-tile boards. The highly segmented structure of the two will allow both electromagnetic and hadronic showers to be utilised in the energy reconstruction and the identification of particles.

The SiPM-on-tile component of the HGCAL consists of scintillator tiles wrapped in a reflective foil and photodetectors (SiPMs), mounted on a board with HGCROC readout electronics. The ability of each individual scintillator component (a tile) to fulfil the performance requirements stands on a choice of methods of production, wrapping and placement. That is why quality control (QC) measures have been implemented in the Tile Assembly Center (TAC) at DESY to monitor parameters at every stage. Two test stands have been developed to measure the size of the wrapped tile and to measure its light yield. Several tests have been performed using the setups with a variety of tiles to ensure consistency of measurements and to measure tile-to-tile wrapping variation and light output.

T 97.3 Wed 18:00 WIL/C133

Results of the Megatile prototype for the CALICE AHCAL — •Anna Rosmanitz for the CALICE-D-Collaboration — Johannes Gutenberg-Universität Mainz

The CALICE collaboration develops several highly granular calorimeter concepts for a future e^+e^- collider, that are designed for Particle Flow Algorithms. The current design for the Analog Hadronic Calorimeter (AHCAL) consists of 3x3 cm^2 scintillator tiles read out by silicon photomultipliers (SiPM). Each tile is individually wrapped in reflective foil and glued to the boards. The final AHCAL detector would countain 8 million channels.

To facilitate the assembly process, the Megatile design is developed at the University of Mainz. It is made from a large scintillator plate which houses 12x12 channels at once. The channels are separated by tilted trenches filled with a mixture of glue and TiO_2 for reflectivity and optical insulation. Optical tightness is achieved by gluing reflective foil on both faces and varnishing the edges. Until now, ten prototypes have successfully been built, continuously monitored in a cosmic test-stand in Mainz and tested in several test beam campaigns at DESY and CERN.

This talk presents the latest technical developments, the results from long-term monitoring and measurements with cosmic rays and with beam, focusing in particular on light yield and cross talk performance of the Megatiles.

T 97.4 Wed 18:15 WIL/C133

Characterization of a wavelength-shifter coated polystyrene plastic scintillator detector — Alessia Brignoli, Constantin Eckardt, Heiko Lacker, •Christophe Mullesch, Christian Scharf, and Ben Skodda — Humboldt-Universität zu Berlin, Berlin, Germany

Plastic scintillator detectors are widely used in particle physics for detecting charged particles crossing the scintillating material, converting the excitation energy into fluorescence radiation. It has been recently shown that a pure polystyrene plate that is coated with a wavelength-shifting dye can be used as an easy-to-build cheap scintillator with a decent light output. In this work, we further studied the light-yield response of a rectangular polystyrene tile coated with a wavelength-shifting dye. It was coupled to a photomultiplier at each end of the strip and exposed to beta particles from a Sr-90 source. By analyzing the light-yield and signal arrival times as a function of the beta source position along the tile, we determined the time and spatial resolution of the detector, as well as the light signal speed and the effective attenuation length in the scintillator.

T 97.5 Wed 18:30 WIL/C133

Simulation studies for tomography with fast neutrons and gammas with a multi-pixel detector — •Aenne Abel, Nina Höflich, and Oliver Pooth — III. Physikalisches Institut B, RWTH Aachen University

Combined neutron and gamma tomography enables a new, non-destructive imaging procedure showing further material properties than a common CT scan.

At the RWTH Aachen University a portable measuring setup for fast neutrons is developed, which uses an Americium Beryllium source and 16 stilbene crystals coupled to an SiPM for detection. The organic scintillator stilbene allows the simultaneous detection and separation of neutrons and gammas. The detector pixels are arranged in a 4 x 4 grid with a pixel size of 6.2 x 6.2 mm.

In this talk the simulation procedure of the experimental setup using GEANT4 along with methods to determine the quality of the tomographic images is presented.

T 97.6 Wed 18:45 WIL/C133

Simultaneous fast neutron and gamma tomography with a stilbene-based multi-pixel detector — Aenne Abel, •Nina Höflich, and Oliver Pooth — III. Physikalisches Institut B, RWTH Aachen University

The neutron detectors group at the Physics Institute III B, RWTH Aachen University, develops a multi-pixel detector for a compact fast neutron imaging setup. Since the interactions of fast neutrons in matter differ from those of X-rays and gamma rays, imaging with fast neutrons in addition to X- or gamma ray imaging can provide complementary information about the object of interest.

Our current detector prototype uses cuboids of the organic scintillator stilbene as active material, coupled to a SiPM array. The pixel size is 6.2×6.2 mm^2 . The usage of stilbene allows to distinguish neutron- and gamma-induced signals in the detector. An Americium-Beryllium neutron source delivers fast neutrons of up to 11 MeV and gamma rays of 4.44 MeV for our measurements.

In this talk, tomographic measurements of different test objects will be discussed, combining information from neutron and gamma attenuation. The main focus will be on the spatial resolution and the material distinction capability of our setup. Furthermore, possible improvements of our setup and the tomographic reconstructions will be briefly discussed.

T 98: Gas-Detecors, Detector Systems

Time: Wednesday 17:30–19:00 Location: WIL/A120

T 98.1 Wed 17:30 WIL/A120

X-ray Polarimetry with GridPixes — Klaus Desch, •Markus Gruber, and Jochen Kaminski — Physikalisches Institut, Universität Bonn

In astrophysics and material science on synchrotron light sources the measurement of X-ray polarisation can be an useful instrument. Therefore, a direct measurement would be beneficial. It can be directly measured by tracking photoelectrons created in photoelectric interactions. This is possible because their emission angle depends on the direction of the electric field vector of the photons. Within a gaseous detector these electrons have a sufficiently long mean free path such that tracking is possible - if the granularity of the readout is high enough. For this a GridPix - a combination of a Timepix(3) ASIC with 55 μm pixel pitch and a photolithographically postprocessed amplification stage (integrated grid) can be used. Within the GridPix the holes of the grid are perfectly aligned with the pixels. Thus, it is possible to detect the avalanches of individual primary electrons.

The talk will focus on the working principle and the design of a GridPix based X-ray polarimeter. Based on testbeam data taken at PETRA III and simulations the performance of the detector at different X-ray energies as well as the dependence on different detector parameters like gas choice and geometry will be discussed. Additionally challenges and possible improvements of such a detector will be presented.

T 98.2 Wed 17:45 WIL/A120

Development of a GridPix detector for IAXO — •Johanna von Oy, Klaus Desch, Jochen Kaminski, Tobias Schiffer, Sebastian Schmidt, and Markus Gruber — Physikalisches Institut der Universität Bonn

To search for the yet undiscovered particle axion, the helioscope experiment International AXion Observatory (IAXO) and its intermediate experimental stage BabyIAXO have been proposed. In these experiments, axions coming from the sun are converted into X-rays in a magnet utilizing the inverse Primakoff effect.

The then focused X-rays can be detected with a gas-filled GridPix detector. The base of this detector is a pixelated readout chip with a perfectly aligned mash on top that acts as a gas amplificication stage. This allows individual electrons, produced by the X-rays in the gas volume to be detected.

Due to the low probability of axions converting into X-rays thanks to their small interaction strength, the detector background has to be very low. For that purpose, the materials used have to be as radiopure as possible. A first prototype, using the materials in their non-radiopure form has been build and is being tested.

This talk explains the detector in detail and discusses first test results.

T 98.3 Wed 18:00 WIL/A120

Prototype of a Cherenkov position sensitive Micromegas — •Maximilian Rinnagel, Otmar Biebel, Valerio D'Amico, Florian Egli, Stefanie Goetz, Christoph Jagfeld, Eshita Kumar, Katrin Penski, Nick Schneider, Chrysostomos Valderanis, Fabian Vogel, and Ralf Hertenberger — LMU München

Detectors utilizing the Cherenkov effect are well established for particle identification of charged particles in detector systems such as LHCb. In reverse it is possible to determine the momentum of a known particle by measuring the opening angle of the Cherenkov cone in Cherenkov media.Our goal with this D =100 mm prototype is a proof of principle using cosmic muons. A traversing muon creates around 1500 Cherenkov photons in our 19 mm thick ultra-violet transparent Lithium Fluoride crystal (diameter 50 mm; UV optical refractive index 1.5). The conversion to electrons happens in transmission in a photosensitive CsI layer evaporated onto a 5 nm Cr layer, both applied to the bottom of the radiator. High voltage of -300 V, at the Cr layer, guides the ionization and photoelectrons into the drift region of a Micromegas gaseous micro pattern detector with two dimensional position readout, spatial resolution below 100 μm and good timing resolution. This will allow to distinguish between muon and photon signals.

T 98.4 Wed 18:15 WIL/A120

Prototype of a Cherenkov detector for the LUXE Experiment — •Antonios Athanassiadis[1,2], Louis Helary[1], Ruth Magdalena Jacobs[1], Jenny List[1], Gudrid Moortgat-Pick[2,1], Evan Ranken[1], and Stefan Schmitt[1] — [1]Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany — [2]Universität Hamburg, Germany

The aim of LUXE (Laser Und XFEL Experiment based at DESY, Hamburg) is to measure strong-field QED effects with high precision. In order to create electric fields stronger than the so-called Schwinger limit, it is planned to collide a high-intensity laser pulse with either high-energy electrons up to 16.5 GeV or high-energy photons.

These two configurations either result in non-linear Compton scattering or Breit-Wheeler interactions which can be studied by measuring rates and kinematics of secondary particles created at the interaction point like high-energy electrons, positrons and photons.

For the detection of electrons, with expected fluxes of the order of 10^4 to 10^9 particles in an area of 15 cm × 1 mm per event, a Cherenkov detector in combination with magnetic deflection for high-precision spectrometry will be used. This contribution will present the simulation-based design of the Cherenkov detector, as well as first operation experience obtained with a prototype. Further optimisation of the various components as well as reconstruction algorithms will be discussed.

T 98.5 Wed 18:30 WIL/A120

Monte Carlo simulation studies of background contributions in the Mu2e experiment — •Reuven Rachamin[1], Stefano Di Falco[2], Anna Ferrari[1], Valerio Giusti[3], Stefan Müller[1], and Vitaly Pronskikh[4] for the Mu2e-Collaboration — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]INFN Pisa, Pisa, Italy — [3]University of Pisa, Pisa, Italy — [4]Fermi National Accelerator Laboratory, Batavia, IL, USA

The Mu2e experiment is currently being constructed at Fermilab to search for the direct conversion of muons into electrons in the field of a nucleus without the emission of neutrinos. The experiment aims at a sensitivity of four orders of magnitude higher than previous related experiments, which implies highly demanding accuracy requirements both in the design and during the operation. Hence, it is essential to estimate precisely the backgrounds that could mimic the monoenergetic conversion electron signal and the particle yields relevant to the experiment sensitivity. In that regard, Monte Carlo simulations were performed to investigate key yields and beam-related and cosmic rays-related backgrounds. The investigation includes: (I) an evaluation of the antiproton and charged pion yields from an 8 GeV proton pencil beam impinging on a tungsten cylindrical target, (II) an evaluation of the transmission of cosmic neutrons and neutral kaons in a block of concrete. The simulations were performed using the FLUKA2021, MCNP6, GEANT4, PHITS, and MARS15 codes. The presentation will show the simulation results with a focus on the prediction obtained from each code and their impact on the experiment.

T 98.6 Wed 18:45 WIL/A120

The Stopping Target Monitor of the Mu2e experiment — •Stefan E. Müller, Anna Ferrari, Oliver Knodel, and Reuven Rachamin for the Mu2e-Collaboration — Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

The Mu2e experiment, currently under construction at the Fermi National Accelerator Laboratory near Chicago, will search for the neutrinoless direct conversion of a muon to an electron in the field of an aluminum nucleus, aiming for a sensitivity four orders of magnitude better than previous experiments. The observation of a clear signal would imply Charged Lepton Flavor Violation, and hint at physics beyond the Standard Model.

The normalization of the signal events will be done by monitoring the rate of muons stopping on aluminum target discs. This will be accomplished with a detector system made of an HPGe detector and a Lanthanum Bromide detector, which detect the characteristic X- and γ-rays of energies up to 1809 keV produced when the muons are stopped or captured on the aluminum.

At the Helmholtz-Zentrum Dresden-Rossendorf, we have used a pulsed Bremsstrahlung photon beam at the ELBE radiation facility to study the performance of the detectors under conditions very similar to the ones expected at Mu2e.

In the presentation, a short overview of design and status of the Mu2e experiment and its detectors will be given, and results of the ELBE beamtime campaigns will be presented.

T 99: Annual Meeting of Young Scientists in High Energy Physics (yHEP)

Time: Wednesday 19:00–20:00 Location: HSZ/0101

Annual Meeting of Young Scientists in High Energy Physics (yHEP) Hosts: Afzal, Peña, Morejon, Lupberger, Niknejadi, Krönert, Sehgal, Lang

T 100: AI Topical Day – Invited Talks (joint session AKPIK/HK/ST/T/AKBP)

Time: Thursday 11:00–12:30 Location: HSZ/AUDI

Invited Talk T 100.1 Thu 11:00 HSZ/AUDI
AI Techniques for Event Reconstruction — •Ivan Kisel — Goethe University, Frankfurt, Germany
Why can we relatively easily recognize the trajectory of a particle in a detector visually, and why does it become so difficult when it comes to developing a computer algorithm for the same task? Physicists and computer scientists have been puzzling over the answer to this question for more than 30 years, since the days of bubble chambers. And it seems that we are steadily approaching the answer in our attempts to develop and apply artificial neural networks both for finding particle trajectories and for physics analysis of events in general.

This talk will present the basics of artificial neural networks in a simple form, and provide illustrations of their successful application in event reconstruction in high energy physics and heavy ion physics experiments. You will get an insight into the application of traditional neural network models, such as deep neural network, convolutional neural network, graph neural network, as well as those standing a little aside from traditional approaches, but close in idea of elastic network and even cellular automata.

Invited Talk T 100.2 Thu 11:30 HSZ/AUDI
Accelerator operation optimisation using machine learning — •Pierre Schnizer — Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Berlin, Germany
Accelerators are complex machines whose many components need to be accurately tuned to achive design performance. Reliable operation requires frequent recalibration and tuning. Especially for large machines tools have been developed that facilitating this task.

Machine learning allows building such tools using simulations, archiver data or interaction with the real machine, thus making many tools now also available for smaller machines.

This talk will give an overview of different machine learning projects targeted to accelerators, which simplifies accelerator operation or even enable applications not been possible before.

Invited Talk T 100.3 Thu 12:00 HSZ/AUDI
Is this even physics? – Progress on AI in particle physics — •Gregor Kasieczka — Universität Hamburg
Motivated by the large volume and high complexity of experimental data and mathematical structures, particle physics has a long tradition of employing state of the art computing and analysis techniques. Recent progress in machine learning and artificial intelligence have further pushed this trend, and these approaches are now ubiquitous in our field. This overview attempts to capture key developments such as the rise of unsupervised approaches and the quest for suitable neural network architectures for physics tasks; challenges like ultra-low latency inference and robust predictions; as well as promising new ideas looking forward.

T 101: Invited Topical Talks III-A

Time: Thursday 14:00–15:20 Location: HSZ/0003

Invited Topical Talk T 101.1 Thu 14:00 HSZ/0003
How to Study the Higgs Boson in its Bosonic Decays — •Benedict Winter — Physikalisches Institut, Universität Freiburg
Measurements of the Higgs boson are means to probe electroweak symmetry breaking and the generation of the elementary particles' masses. Studies of Higgs boson decays to pairs of W and Z bosons and photons are cornerstones of the investigations by the ATLAS and CMS experiments at the LHC. This presentation illuminates how the Higgs boson's couplings as well as its mass and width are measured. It demonstrates how physics beyond the Standard Model is searched for in Higgs boson production and what opportunities will be provided by future LHC datasets.

Invited Topical Talk T 101.2 Thu 14:20 HSZ/0003
Measuring $H \to WW$ with the ATLAS Experiment — •Carsten Burgard for the ATLAS-Collaboration — TU Dortmund
The past year saw the 10th anniversary of the discovery of the Higgs boson - an excellent time to reflect on past achievements and look into the future. The decay of the Higgs boson to a pair of W bosons is one of the most sensitive channels to measure the total Higgs boson production rate, mostly due to the relatively large rate of leptonic W decays. This leptonic signature comes with some unique challenges and opportunities: it exposes a high rate of gluon-fusion produced Higgs bosons on top of the backgrounds, providing an opportunity for a powerful differential measurement, while the rarer VBF and VH decays allow direct experimental access to the coupling of the Higgs to vector bosons. Also for possible high-mass particles decaying to a pair of W bosons, this channel is a sensitive probe. While the reconstruction of the properties of the Higgs boson itself can be challenging due to the evanescent neutrinos, precise measurements are still enabled by the sheer statistical power of the channel. Finally, even the neutrinos can be exploited: the parity-violation-induced spin-entanglement of the leptons does not only provide a distinctive feature to reject continuum WW background, but could also allow to measure violation of Bell inequalities in Higgs physics in the future. Run 2 of the LHC has provided the ATLAS experiment with a powerful dataset to tackle these measurements, and the ongoing Run 3 will only add to this.

Invited Topical Talk T 101.3 Thu 14:40 HSZ/0003
Belle II opportunities in B-decays with invisible signatures — •Slavomira Stefkova for the Belle II-Collaboration — KIT, Karlsruhe, Germany
$B \to K\nu\bar{\nu}$ decays are excellent probes for finding new physics for two reasons. Firstly, many extensions to the Standard Model are expected to manifest themselves in these very decays. Secondly, they belong to the family of $b \to sll$ transitions, where tensions with SM have been measured. They are, however, experimentally challenging as not only are they rare but they contain two neutrinos leaving no signature in the detector. In this talk I will present the latest status of the measurements of observables in $B \to K\nu\bar{\nu}$ decays with the data collected by the Belle II experiment. I will also outline the prospects for future measurements of $B \to K\nu\bar{\nu}$ decays and similar processes using the growing Belle II dataset.

Invited Topical Talk T 101.4 Thu 15:00 HSZ/0003
Two Pieces of a Puzzle: Inclusive and Exclusive $|\mathbf{V_{cb}}|$ — •Markus Prim — Physikalisches Institut, Bonn, Germany
Over the last decade, the CKM matrix element $|V_{cb}|$ has been measured by various experiments, and the tension between the two experimental methods - the inclusive and the exclusive reconstruction of the final-state hadron system - persists to this day, despite the increasing precision of the experimental measurements and the higher-order corrections in the theoretical calculations. In this talk, we will review the current status of measurements and the implications of the ever-increasing Belle II data on the precision that can be achieved in the coming years.

T 102: Invited Topical Talks III-B

Time: Thursday 14:00–15:20 Location: HSZ/0004

Invited Topical Talk T 102.1 Thu 14:00 HSZ/0004
Expanding the Frontiers of Galactic Neutrino Astronomy via Machine Learning* — •Mirco Hünnefeld for the IceCube-Collaboration — TU Dortmund, Dortmund, Germany
IceCube has discovered a flux of astrophysical neutrinos and presented evidence for the first neutrino sources, a flaring blazar known as TXS 0506+056 and the active galaxy NGC 1068. However, the sources responsible for the majority of the astrophysical neutrino flux remain elusive. Within our Galaxy, high energy neutrinos can be produced when cosmic rays interact at their acceleration sites and during propagation through the interstellar medium. The Galactic plane has therefore long been hypothesized as a potential neutrino source.

In this contribution, results are presented for a new search of neutrino emission utilizing an improved dataset of cascade-like events that builds upon recent advances in deep learning based reconstruction methods. Enabled by these novel methods, the resulting dataset improves IceCube's sensitivity in the south-

ern neutrino sky and is thus particularly promising for the identification of neutrino production from the Galactic plane.
*Financial support by the BMBF and DFG (SFB 876, SFB 1491) is gratefully acknowledged.

Invited Topical Talk T 102.2 Thu 14:20 HSZ/0004
Enhancing the CMS Level-1 Trigger with real-time Machine Learning — •Artur Lobanov — Institut für Experimentalphysik, Universität Hamburg, Hamburg, Germany
The Level-1 Trigger (L1) is the first stage of the online event filter system of the CMS Experiment at the LHC. It reduces the event rate from 40 MHz to $\mathcal{O}(100)$ kHz by reconstructing, identifying and filtering collision events in real-time using dedicated processing hardware based on field-programmable gate arrays (FPGAs).

Following the success of machine learning (ML) in enhancing event selections in the offline analysis of recorded data, ML algorithms are finding their way into the real-time processing of the CMS L1 Trigger system. Contrary to current filters that rely on simple rule-based selection algorithms using the detected physics objects, ML allows to capture deeper correlations between and within the objects, improving the identification of the event.

In addition to the tight constraints on the processing latency of several microseconds, trigger algorithms also have to fit into the restricted processing resource budget of the FPGAs. This requires a dedicated optimisation of ML models for their use in hardware in these challenging conditions.

In this talk I will outline the basics of the CMS L1 Trigger system, the principles of ML inference in FPGAs, and present the current state-of-the-art developments of novel ML algorithms enhancing the trigger performance at the LHC and beyond.

Invited Topical Talk T 102.3 Thu 14:40 HSZ/0004
Higgsino Hunting at ATLAS — •Michael Holzbock — Max Planck Institut für Physik, München, Germany
Supersymmetry (SUSY) remains one of the best motivated candidates for physics beyond the Standard Model (SM) and predicts a new partner for each SM particle. The higgsino, the SUSY partner of the Higgs SM boson, has always been of particular interest due to its connection with the hierarchy problem and as a promising Dark Matter candidate when realized with masses near the weak scale. Intriguingly, (nearly) pure higgsino states can still escape the current constraints from colliders and direct Dark Matter searches, and hence they remain a prime target for new physics searches at the LHC.

In this talk the motivation and experimental challenges for higgsino searches at the LHC are reviewed, and the current results from ATLAS discussed. Finally, new techniques developed for accessing so far unprobed phase space in the search for higgsinos at the LHC are introduced.

Invited Topical Talk T 102.4 Thu 15:00 HSZ/0004
New Ideas for Baryo- and Leptogenesis — •Kai Schmitz — Institut für Theoretische Physik, WWW Münster
The baryon asymmetry of the Universe (BAU) cannot be explained by the Standard Model and hence represents important evidence for new physics. In this talk, I will review recent new ideas for the generation of the BAU in the early Universe that generalize or are complementary to conventional scenarios of baryo- and leptogenesis. Specifically, I will discuss the interplay between lepton number/flavor violation and the chemical transport in the Standard Model plasma at high temperatures, which provides the basis for new scenarios known as "wash-in leptogenesis" and "leptoflavorgenesis". I will highlight possible UV completions of these scenarios, notably cosmic inflation driven by an axion-like field, and outline their rich phenomenological implications for particle physics and cosmology. This will include the possibility that the generation of the BAU is in fact closely related to the generation of primordial magnetic fields, which in turn would have important consequence for the electroweak phase transition and the properties of intergalactic magnetic fields in the present Universe.

T 103: AI Topical Day – Simulation, Inverse Problems and Algorithmic Development (joint session AKPIK/T)

Time: Thursday 15:45–17:15 Location: HSZ/0004

T 103.1 Thu 15:45 HSZ/0004
Efficient Sampling from Differentiable Matrix Elements with Normalizing Flows — •Annalena Kofler[1,2], Vincent Stimper[2,3], Mikhail Mikhasenko[4], Michael Kagan[5], and Lukas Heinrich[1] — [1]Technical University Munich — [2]Max Planck Institute for Intelligent Systems, Tübingen — [3]University of Cambridge, UK — [4]ORIGINS Excellence Cluster, Munich — [5]SLAC National Accelerator Laboratory, Menlo Park, USA
The large amount of data that will be produced by the high-luminosity LHC imposes a great challenge to current data analysis and sampling techniques. As a result, new approaches that allow for faster and more efficient sampling have to be developed. Machine Learning methods such as normalizing flows, have shown great promise in related fields. There, access to not only the density function but also its gradient has proven to be helpful for training. Recently, software for accessing differentiable amplitudes, which serve as densities in particle scattering, have become available that allow us to obtain the gradients and benchmark these new methods. The described approach is demonstrated by training rational-quadratic spline flows with differentiable matrix elements of the hadronic three-body decays, $\pi(1800) \to 3\pi$ and $\Lambda_c^+ \to pK^-\pi^+$. To boost the ability to accurately learn and sample from complex densities whilst also reducing the number of training samples, we explore the use of the newly proposed method Flow Annealed Importance Sampling Bootstrap. Building on prior work, we plan to extend the approach to examples with more particles in the final state via the differentiable matrix elements provided by MadJax.

T 103.2 Thu 16:00 HSZ/0004
Generating Accurate Showers in Highly Granular Calorimeters Using Normalizing Flows — •Thorsten Buss — Institut für Experimentalphysik, Universität Hamburg, Germany
The full simulation of particle colliders incurs a significant computational cost. Among the most resource-intensive steps are detector simulations. It is expected that future developments, such as higher collider luminosities and highly granular calorimeters, will increase the computational resource requirement for simulation beyond availability. One possible solution is generative neural networks that can accelerate simulations. Normalizing flows are a promising approach in this pursuit. It has been previously demonstrated, that such flows can generate showers in low-complexity calorimeters with high accuracy. We show how normalizing flows can be improved and adapted for precise shower simulation in significantly more complex calorimeter geometries.

T 103.3 Thu 16:15 HSZ/0004
Introspection for a normalizing-flow-based recoil calibration — •Lars Sowa, Jost von den Driesch, Roger Wolf, Markus Klute, and Günter Quast — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)
Normalizing flows (NFs) are neural networks, that preserve the prob- ability between their input and output distributions. NFs can be promising candidates either as surrogates for the fast generation of new samples or as universal approximators of arbitrary probability density functions, based on which confidence intervals may be deter- mined, both of which are interesting properties in high-energy physics (HEP). This work presents the case study of recoil calibration on LHC Run- 3 data and Monte Carlo simulation with the goal to better understand the behavior of NFs. The result of the NF is compared to a deep ensem- ble of feed-forward neural networks created to compare the calibration results and the different coverage in the value space.

T 103.4 Thu 16:30 HSZ/0004
Normalising Flows for Parameter Estimation from Gravitational Wave Signals — Johannes Erdmann[1], •Jon Hoxha[1], and Shichao Wu[2,3] — [1]III. Physikalisches Institut A, RWTH Aachen University — [2]Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut) — [3]Leibniz Universität Hannover
The Einstein Telescope (ET) is a proposal for a next generation ground-based gravitational wave detector. Due to higher sensitivity, ET is expected to receive orders of magnitude more gravitational wave signals than the current 2nd generation detectors LIGO, Virgo and KAGRA. Additionally, these signals will also be in the frequency band of the detector for a longer time, which would cause overlaps of signals. The analysis methods currently in use, which are based on Markov Chain Monte Carlo (MCMC) nested sampling methods, are unsuitable for handling such data and would take up significant computing resources. Therefore, new efficient analysis methods are required. Deep learning methods form a promising approach for this task. Specifically, normalizing flows promise to provide a more efficient means for signal parameter estimation. We use mock data to estimate signal parameters through normalizing flows and compare them to the current standard approach.

T 103.5 Thu 16:45 HSZ/0004
A method for inferring signal strength modifiers by conditional invertible neural networks — •Mate Zoltan Farkas, Svenja Diekmann, Niclas Eich, and Martin Erdmann — III. Physics Institute A, RWTH Aachen

The continuous growth in model complexity in high-energy physics collider experiments demands increasingly time-consuming model fits. We show first results on the application of conditional invertible networks (cINNs) to this challenge. Specifically, we construct and train a cINN to learn the mapping from signal strength modifiers to observables and its inverse. The resulting network infers the posterior distribution of the signal strength modifiers rapidly and for low computational cost. We present performance indicators of such a setup including the treatment of systematic uncertainties. Additionally, we highlight the features of cINNs estimating the signal strength for a vector boson associated Higgs production analysis carried out at an LHC experiment on simulated data samples.

T 103.6 Thu 17:00 HSZ/0004

Reconstruction of SAXS Data using Invertible Neural Networks — •Erik Thiessenhusen[1], Melanie Rödel[1], Thomas Kluge[1], Michael Bussmann[2], Thomas Cowan[1], and Nico Hoffmann[1] — [1]HZDR, FWKT, Dresden, Germany — [2]CASUS, Görlitz, Germany

The understanding of laser-solid interactions is important to the development of future laser-driven particle and photon sources, e.g., for tumor therapy, astrophysics or fusion. Currently, these interactions can only be modeled by simulations which need verification within the scope of pump-probe experiments. This experimental setup allows us to study the laser-plasma interaction that occurs when an ultrahigh-intensity laser hits a solid density target. We employ Small-Angle X-Ray Scattering (SAXS) to image the nanometer-scale spatial- and femtosecond temporal resolution of the laser-plasma interactions. However, the analysis of the SAXS pattern is an ill-posed inverse problem meaning that multiple configurations of our target might explain the same measurement due to the loss of the phase information. We approach the ambiguities of the inverse problem by a conditional Invertible Neural Network (cINN) that is returning a probability density distribution over target parameters explaining a single SAXS pattern. We will show that the domain gap between generated training and experimental data can be approached by integrating perturbations of experimental data into the training workflow. We assess the applicability of our approach to a selected set of grating targets in terms of a comprehensive evaluation on simulation and experimental data.

T 104: Flavor VIII

Time: Thursday 15:50–17:20 Location: HSZ/0304

T 104.1 Thu 15:50 HSZ/0304

b->c decays at NNLO — •Manuel Egner[1], Matteo Fael[2], Kay Schoenwald[3], and Matthias Steinhauser[1] — [1]Karlsruhe Institute of Technology, TTP — [2]CERN, Department of Theoretical Physics — [3]University of Zurich, Physik-Institut

The decay of B mesons can be described in the heavy quark expansion as the decay of a free bottom quark plus corrections which are suppressed by powers of 1/m_b. In this talk I will present our NNLO calculations to the decay of free bottom quarks b->c with full charm mass dependence. For the semileptonic decay channel b->clv, we obtain analytic results which can be compared to previous known results obtained via expansions in the mass ratio m_c/m_b. I will also give an outlook on the ongoing calculation of the hadronic decay channels b->cud and b->ccs, where similar calculation techniques as in the semileptonic case are used.

T 104.2 Thu 16:05 HSZ/0304

Measurement of the branching fraction and q^2-spectrum of $B \to D^{**}\ell\nu$ decays at Belle II — •Eylül Ünlü, Thomas Lück, and Thomas Kuhr — Ludwig-Maximilians-Universität München

There is currently some tension between the measured value of $R(D^*) = \mathscr{B}(B \to D^*\tau\nu_\tau)/\mathscr{B}(B \to D^*\ell\nu_\ell)$ and the Standard Model prediction, hinting at lepton universality violation. Semileptonic B meson decays to D^{**} mesons are background to the $R(D^*)$ measurement, where D^{**} denotes the orbitally excited P-wave charm mesons: $D_1(2420)$, $D_2^*(2460)$, $D_0^*(2300)$, and $D_1^{'}(2430)$. These decays are not well understood, and there have been discrepancies between past measurements of their yields made by BaBar and Belle. Hence, improved understanding of these decays would reduce an important systematic uncertainty of $R(D^*)$ measurements.

The aim of the present study is to use simulation and data from the Belle II experiment to study these decays, in particular to determine the distribution of $q^2 = (p_B - p_{D^{**}})^2$ which is key to understanding these decays and an important input for theory.

We reconstruct one of the B mesons from the $\Upsilon(4S) \to BB$ decay in the signal channel, $B \to D^{**}(D^*\pi)\ell\nu$. The other B meson is reconstructed in various hadronic modes using the Full Event Interpretation algorithm, which provides a high purity tag B sample with well known kinematics. We identify signal decays by a peak at zero in the $M^2_{missing}$ (missing mass squared) distribution, and do a fit to the mass difference $M(D^*\pi) - M(D^*)$ to extract the D^{**} signal yield.

The current status of the analysis will be presented.

T 104.3 Thu 16:20 HSZ/0304

Studies of $B \to D^{**}\ell\nu$ at Belle II — Gerald Eigen[1,2], Ariane Frey[2], and •Noreen Rauls[2] — [1]Institutt for fysikk og teknologi, Bergen, Norway — [2]II. Physikalisches Institut, Georg-August-Universität Göttingen, Deutschland

To probe the Standard Model, various different measurements can be conducted. One test that can be performed is the determination of the ratio $R(D^{(*)}) = \frac{\mathscr{B}(B\to D^{(*)}\tau\overline{\nu})}{\mathscr{B}(B\to D^{(*)}\ell\overline{\nu})}$, where one limiting factor is the background arising from semileptonic $B \to D^{**}\ell\nu$ decays. Therefore, this analysis attempts to acquire a better understanding of the decay $B \to D^{**}\ell\nu$ as well as measure its branching ratio. This measurement is based on data collected at the Belle II experiment, which is situated at the asymmetric e^+e^- collider SuperKEKB in Japan, which operates at the $\Upsilon(4S)$ resonance. Thus, the B mesons are always produced in pairs. One of these B mesons is reconstructed employing the hadronic Full Event Interpretation (FEI), which reconstructs exclusive hadronic B decays. To reconstruct the other B meson, a charged, light lepton is combined with a D^{**}, where multiple hadronic decay modes are considered.

This talk will outline the selection procedure as well as explain a binned maximum likelihood fit to extract the branching ratio. Besides, a brief outlook on future plans will be given.

T 104.4 Thu 16:35 HSZ/0304

Untagged analysis of $B \to \pi\ell\bar{\nu}_\ell$ and $B \to \rho\ell\bar{\nu}_\ell$ and extraction of $|V_{ub}|$ at Belle II — Florian Bernlochner, Jochen Dingfelder, •Svenja Granderath, and Peter Lewis for the Belle II-Collaboration — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

One of the puzzles of current research in flavor physics is the persisting discrepancy between the results of exclusive and inclusive measurements of the CKM matrix element $|V_{ub}|$. The charmless semileptonic decays $B \to \pi\ell\bar{\nu}_\ell$ and $B \to \rho\ell\bar{\nu}_\ell$ belong to the most accessible and powerful channels for determining $|V_{ub}|$ in exclusive modes. Using data from the Belle II experiment, new precision measurements of $|V_{ub}|$ can be performed. In preparation for this, an untagged measurement method for simultaneously extracting $B \to \pi\ell\bar{\nu}_\ell$ and $B \to \rho\ell\bar{\nu}_\ell$ events is developed. An untagged measurement allows for sufficiently large samples of these rare decays already with the current Belle II dataset. In order to increase the signal purity, boosted decision trees are employed to suppress continuum and $B\overline{B}$ backgrounds. Once the signal events are extracted, $|V_{ub}|$ is determined using the measured partial branching fractions in combination with theory predictions of hadronic form factors. This talk will present the current status of the analysis and $|V_{ub}|$ extraction.

T 104.5 Thu 16:50 HSZ/0304

$B \to \rho\ell\nu_\ell$ Decays with Hadronic Tagging in Belle II Data — •Moritz Bauer, Torben Ferber, and Pablo Goldenzweig — Karlsruhe Institute of Technology (KIT)

Over the last 10 years, a 3σ tension between inclusive and exclusive measurements of the magnitude of the CKM matrix element $|V_{ub}|$ has become apparent in multiple experiments. Semileptonic decays involving $b \to u$ quark transitions present a unique opportunity to measure $|V_{ub}|$ with the current Belle II dataset due to their comparatively high branching fraction.

We present analyses of $B \to \rho\ell\nu_\ell$ decays in Belle II data as steps towards the extraction of this matrix element from exclusive decays. These analyses are conducted with hadronic tagging, an approach in which the second B meson in $\Upsilon(4S)$ decays is reconstructed in a wide variety of hadronic decay chains to increase the selection purity and obtain the recoil of the B-meson decay of interest. This is achieved using a multivariate analysis method, the Full Event Interpretation.

T 104.6 Thu 17:05 HSZ/0304

Leptoquarks at high and low energies — •Felix Wüst, Marco Fedele, and Ulrich Nierste — Institut für Theoretische Teilchenphysik (TTP), Karlsruher Institut für Technologie (KIT)

I consider the case that quarks and leptons are unified at some high scale. The so-called flavour anomalies, which have built up in the data of recent years, are usually interpreted in terms of leptoquarks (LQ) with masses in the multiple-TeV range. I present the renormalisation group equations which connect the LQ couplings at the fundamental high scale with those at the low scale probed in the flavour experiments and discuss phenomenological implications.

T 105: Flavor IX

Time: Thursday 15:50–17:20 Location: HSZ/0401

T 105.1 Thu 15:50 HSZ/0401

Search for the lepton flavour violating decay $B^0 \to \tau^\pm \ell^\mp$ — •Nathalie Eberlein, Thomas Kuhr, and Thomas Lück — Ludwig-Maximilians-Universität, München

Lepton flavour is conserved in the Standard Model, but violated in many new physics models. An observation of the $B^0 \to \tau^\pm \ell^\mp$ decay, where ℓ = e/μ, would be a clear sign for new physics. While an upper limit on the expected branching ratio would help constrain new physics models.

At B factories one can determine the kinematics of the signal B meson by fully reconstructing the accompanying B meson in $e^+e^- \to \Upsilon(4S) \to B\overline{B}$ events. In the rest frame of the signal B meson the mono-energetic lepton provides a clean signature to identify the signal decay. This talk presents the current status of the search for $B^0 \to \tau^\pm \ell^\mp$ decays with the full Belle data set using the Full Event Interpretation algorithm for the reconstruction of the accompanying B meson in hadronic decay modes.

T 105.2 Thu 16:05 HSZ/0401

Search for the lepton flavour violating decay $\tau^+ \to \mu^+\mu^-\mu^+$ with the LHCb experiment — •Giulia Frau[1], Flavio Archilli[2], and Rowina Caspary[1] — [1]Physikalisches Institut, Heidelberg University,Germany — [2]Università di Roma Tor Vergata, Rome, Italy

As lepton flavour violating, the $\tau^+ \to \mu^+\mu^-\mu^+$ decay is forbidden in the Standard Model (SM) at the tree level. The combination of the SM with neutrino oscillations predicts for this decay a branching ratio (BR) of the order of 10^{-55}, well below our current and foreseen experimental sensitivity. Improving the existing limit on the BR of this decay would allow to constrain theories of Physics beyond the SM. Especially lepto-quark models which are often discussed in the context of the recently observed flavor anomalies predict $\tau \to \mu\mu\mu$ BR which are testable with the current available data set. In this talk, I will show the different steps of the analysis performed to evaluate the limit on the BR using data collected by LHCb during Run 2, by focusing on the improvements introduced with respect to the previous LHCb analysis, which was conducted by analyzing Run 1 data. With the increasing luminosity and cross section of Run 2 and a more sophisticated analysis, we expect the LHCb limit to improve by at least a factor of two, making our results competitive with the current best experimental limit.

T 105.3 Thu 16:20 HSZ/0401

Restrictions on scalar leptoquark couplings from charged lepton flavor violation processes — •Uladzimir Khasianevich, Dominik Stöckinger, Hyejung Stöckinger-Kim, and Johannes Wünsche — Institut für Kern- und Teilchenphysik, TU Dresden, Zellescher Weg 19, 01069 Dresden, Germany

We derived the most conservative limits on the S_1 leptoquark model that comes from charged lepton flavour violation observables and magnetic moment of the muon, as they involve a similar diagrammatic structure. We apply the case study, where top-induced, charm-induced or mixed scenarios lead to an explanation of the $(g-2)_\mu$ and then further apply additional two- and three- body decay observables to restrict relevant couplings and their products. The $\mu - e$ conversion process in Au and Al is used to restrict the first row of couplings. As there are known restrictions from K- and D-meson decays, we incorporate them to further improve the bounds on the relevant coupling entries. The FlexibleSUSY program was used in this work to perform scans over various leptoquark coupling scenarios. We designed appropriate model files incorporating the parameterization of the couplings in the up-type mass diagonal basis. The expressions for the leptonic observables were generated with the help of the NPointFunctions extension of the FlexibleSUSY program.

T 105.4 Thu 16:35 HSZ/0401

Probing light New Physics in invisible rare charm decays — •Dominik Suelmann and Gudrun Hiller — TU Dortmund University, Department of Physics, Otto-Hahn-Str.4, D-44221 Dortmund, Germany

We analyze rare $|\Delta c| = |\Delta u| = 1$ charm decays with missing energy in the final state and study their potential to probe different scenarios of light New Physics (NP). We study three-body and two-body decays of baryons and mesons and probe the sensitivities of different observables for the various light NP models. We find that the $\Lambda_c \to p\,\nu\bar{\nu}$ missing energy distribution can distinguish between the scenario of only left-handed neutrinos and the scenario with additional light right-handed neutrinos. We also work out constrains from available experimental data for the two body decays $\Lambda_c \to p + nothing$ and $D \to \pi + nothing$ and point out the benefits of baryonic modes in rare decays.

T 105.5 Thu 16:50 HSZ/0401

Estimate of material effects on neutral charm mixing at the LHCb experiment — •Lennart Uecker[1], Adam Davis[2], Evelina Mihova Gersabeck[2], and Marco Gersabeck[2] — [1]Physikalisches Institut, Universität Heidelberg, Germany — [2]Department of Physics and Astronomy, The University of Manchester, United Kingdom

The LHCb experiment at the LHC is leading the precision measurements in the charm sector. The large charm production cross section and the unique vertex detector, with first detector compoments as close as 6mm to the interaction point, enable the LHCb experiment to measure a larger number of D^0 mesons passing through material

In this talk, we present a data-driven approach to estimate material effects on the mixing of neutral charm mesons using $D^0 \to K\pi$ decays recorded during Run 2 of the LHC, corresponding to an integrated luminosity of 5.6 fb^{-1}. Further, we explore the sensitivity of the upgraded LHCb detector for Run 3+4 to material effects on the charm mixing.

T 105.6 Thu 17:05 HSZ/0401

Constraining flavorful SMEFT operators with missing energy plus jet — Gudrun Hiller and •Daniel Wendler — TU Dortmund University, Department of Physics, Otto-Hahn-Str.4, D-44221 Dortmund, Germany

We consider the Drell-Yan process with final state neutrinos, where the experimental signature is given by "missing energy + jet", as a probe for new physics. The process $pp \to \nu\bar{\nu}$ + jet is analyzed, to constrain flavorful semileptonic four-fermion operators based on present LHC data ($\mathscr{L}_{int}$ = 139 fb^{-1}). Projections are derived for the High Luminosity Large Hadron Collider (HL-LHC). New physics scales probed are $\Lambda_{NP} \sim$ 3.5 TeV, 3.0 TeV, 2.6 TeV and 1.6 TeV for uc, ds, db and sb, respectively for four-fermion operators. The limits are complementary and competitive or better to those from Drell-Yan involving taus, and with low energy observables, such as from rare decays of kaons, charm and beauty hadrons.

T 106: Searches IV

Time: Thursday 15:50–17:05 Location: HSZ/0403

T 106.1 Thu 15:50 HSZ/0403

Using Density Estimation for Resonance Searches at the LHC — Thorben Finke, •Marie Hein, Michael Krämer, and Alexander Mück — Institute for Theoretical Particle Physics and Cosmology (TTK), RWTH Aachen University, Germany

We demonstrate an end-to-end application of model-agnostic weakly supervised machine learning methods improving a traditional resonant anomaly search. In particular we focus on the Cathode method and show its superior performance and its limitation at the example of the LHC Olympics R&D data set. For our specific search strategy, we discuss the treatment of systematic errors, however, the potential issue of background sculpting is absent. The method is powerful at present and will benefit substantially from increased statistics to be collected at the LHC.

T 106.2 Thu 16:05 HSZ/0403

Searches for new physics with MUSiC in pp collisions at $\sqrt{s}$ = 13 TeV — •Yannik Kaiser, Thomas Hebbeker, Arnd Meyer, Ana Rita Alves Andrade, and Felipe Torres da Silva de Araujo — III. Physikalisches Institut A, RWTH Aachen University

Besides the large effort of the LHC collaborations, no direct evidence for physics beyond the standard model (BSM) has been found. Considering several theory models available, which adress the inadequacies of the standard model (SM), many model-specific searches have been employed. Complementary to this approach is MUSiC - Model Unspecific Search in CMS - a model-independent search procedure in which data collected by the CMS experiment, with at least one identified lepton, is classified according to its final state multiplicities of well-reconstructed objects. For each class a search algorithm is used to determine the most stringent phase-space region, according to a defined p-value, with respect to an SM statistical model. The procedure also takes into account systematic and statistical effects. As an extension of the already published result using 2016 data, we report preliminary results of the MUSiC search on data collected by CMS during 2018, corresponding to 58.83 fb^{-1} of integrated luminosity.

T 106.3 Thu 16:20 HSZ/0403

Search for new physics in the final state with a lepton and $\vec{p}_T^{\,miss}$ — •Valentina Sarkisovi, Thomas Hebbeker, Kerstin Hoepfner, Sebastian Wiedenbeck, and Christoph Schuler — III. Physikalisches Institut A, RWTH Aachen University

Various Beyond the Standard Model (BSM) theories anticipate the existence of new particles that could decay into final states characterized by the presence of a charged lepton and missing transverse momentum ($\vec{p}_T^{\,miss}$) as their most distinctive experimental signature. The CMS detector at the CERN LHC is used to hunt for novel physics in the high mass region of final states containing a lepton (electron, muon, tau) and $\vec{p}_T^{\,miss}$. Achievement of a high mass resolution, rejection of the standard model backgrounds, and efficient identification and reconstruction of TeV leptons are crucial in a search for such phenomena. One of the main challenges of this search is represented by the high rate of QCD multi-jet background produced in the LHC proton-proton collisions, leading to the possible misidentification of a jet as a lepton. Data driven methods as well as advanced machine learning technologies are used to model the QCD contamination and to properly identify leptons. The latest CMS data, recorded in 2022 at unprecedented center-of-mass energy of 13.6 TeV, have been analysed. The key concepts of the analysis techniques employed in the search for new physics in the final state with a lepton and $\vec{p}_T^{\,miss}$ are addressed.

T 106.4 Thu 16:35 HSZ/0403

Leptoquark production in a single τ charm/bottom and met final state at the ATLAS detector — •Patrick Bauer, Philip Bechtle, and Klaus Desch for the ATLAS-Collaboration — Physikalisches Institut Bonn

At B-factories, anomalies were observed in decays of the B-hadrons into $D^{(*)}$ and $K^{(*)}$ plus leptons, which are consistent with the hypothesis of contributions from Leptoquarks in the high GeV to low TeV range.

Therefore, the direct search for leptoquarks (LQ) is a focus at high energy collider experiments. A very recent result, where CMS observes an excess of 3.4 sigma consistent with non-resonant LQ contributions, potentially provides an even stronger case.

This observation emphasizes the importance of exploiting all possible LQ production modes. For for LQ masses well above 1 TeV the single- and non-resonant production modes become an key ingredient for ongoing an future searches. With the single production into final states with one τ, bottom or charm jet with large missing transverse momentum, one can directly probe the couplings expected to be involved in the $B \to D^{(*)}\tau\nu$ anomaly. Furthermore the non resonant contributions to the same final state could give sizable sensitivity to higher masses for large coupling strengths from the LQ. For the inclusion of a non-resonant interpretation it is crucial to study the interference behaviour of LQ signal with the SM.

This talk will provide an overview over the ongoing search for singly produced LQ in the given final states, covering resonant, non-resonant and interference aspects.

T 106.5 Thu 16:50 HSZ/0403

Search for Beyond Standard Model particles with exclu- sive coupling to top quarks in four-top-quark final states — •Gabriele Milella[1], Freya Blekman[1], Matthias Komm[1], and Denise Müller[2] — [1]DESY, Hamburg, Germany — [2]VUB, Brussel, Belgium

Many Beyond Standard Model (BSM) theories predict new top-philic particles that couple exclusively with the top quark, as this coupling is the most favorable for new physics with respect to any other lighter quark.

This search is therefore focused on a heavy resonance decaying to a pair of top quarks. The resonance is produced in association with a top quark pair resulting in four top quarks in the final state.

The two top quarks from the resonance are expected to be highly boosted and their decay products can be found within large-radius jets. The signal region is constructed from events that contain also opposite-sign leptons and b-tagged jets.

The invariant mass distribution of the reconstructed pair of large-radius jets is studied. Various signal scenarios with different resonance masses and decay widths are tested by searching for local excesses in the reconstructed mass spectrum of the large-radius jets. Preliminary results are presented using the LHC Run 2 data taken with the CMS experiment.

T 107: Searches – Neutrino at accelerators

Time: Thursday 15:50–17:20 Location: HSZ/0101

T 107.1 Thu 15:50 HSZ/0101

Identification of displaced τ leptons for long-lived τ slepton searches at CMS — •Mykyta Shchedrolosiev — Deutsches Elektronen-Synchrotron DESY

Searches for the supersymmetric (SUSY) partner of the tau lepton are of high interest, since scenarios in which the tau slepton ($\tilde{\tau}$) is the next-to-lightest supersymmetric particle can lead to the observed relic density. In gauge mediated symmetry breaking scenarios, $\tilde{\tau}$ can have macroscopic lifetime. Direct searches of $\tilde{\tau} \to \tau\tilde{\chi}_0^1$, where $\tilde{\chi}_0^1$ is the lightest SUSY particle are limited by the reconstruction efficiency of displaced tau leptons at CMS, which are produced up to 50 cm away from the IP. In addition, the small cross-section of slepton production at the LHC makes such searches challenging. In our study, we explore a new displaced τ lepton tagger using a deep neural network.

T 107.2 Thu 16:05 HSZ/0101

Search for new physics in $t\bar{t}$+E_T^{miss} final states in pp collisions at 13 TeV with the ATLAS experiment — •Simran Gurdasani, Daniele Zanzi, and Christian Weiser for the ATLAS-Collaboration — Albert-Ludwigs-Universität Freiburg

This talk will present the recent developments of an ongoing search for Beyond Standard Model (BSM) signatures that can be probed using the $t\bar{t}$+E_T^{miss} final state at the Large Hadron Collider (LHC). The search is performed on proton-proton collision data at $\sqrt{s}$ = 13 TeV collected by the ATLAS experiment during the LHC Run 2, corresponding to a luminosity of 139 fb^{-1}. Targeted signatures include Dark Matter production via scalar or pseudo-scalar mediators and SUSY stop pair production. A machine learning approach via Neural Networks (NN) is used in two stages of the search (i) to reconstruct the hadronic decays of top quarks and (ii) to discriminate signal events from background events exploiting information on the full event kinematics. The presence of signal events is inferred via a template fit to the distributions of the NN output values in samples of events at different kinematic phase spaces. This talk will give an overview of the machine learning strategy developed, background modeling techniques and the expected sensitivity estimates.

T 107.3 Thu 16:20 HSZ/0101

Search for Compressed Elektroweakinos in Events with Two Soft and Displaced Leptons at the CMS Experiment — •Alexandra Tews — University of Hamburg, Hamburg, Germany

A variety of supersymmetric (SUSY) extensions of the Standard Model lead to light elektroweakinos with small differences in mass between the eigenstates.

One example is that of Higgsino-like electroweakinos, where the four states $\chi_1^{\pm}$, χ_2^0, and χ_1^0 are nearly mass degenerate. The production of two elecroweakinos followed by the decay of the semi-stable second neutralino through an off-shell Z boson can lead to a pair of same-flavor opposite-sign leptons. The leptons can have very low momentum if the mass spectrum of the SUSY particles is sufficiently compressed and be displaced from the primary interaction vertex.

Searches for new physics in events with two low-momentum opposite-sign leptons are particularly sensitive to such SUSY models. Scenarios with compressed Higgsinos with a mass splitting below 2 GeV with the CMS experiment are studied. We exploit new reconstruction and vertexing techniques for oppositely charged displaced lepton tracks with very low momentum of order of a few hundred MeV to extend the sensitivity of current searches to unexplored phase-space.

T 107.4 Thu 16:35 HSZ/0101

DUNE-PRISM: An innovative technique for neutrino oscillation predictions — •Ioana Caracas for the DUNE-Collaboration — JGU Mainz

As long baseline experiments are approaching the high precision era, an increased sensitivity towards constraining the oscillation parameter space is expected. Since the oscillation predictions are based on neutrino interaction cross sections, a classical approach is prone to systematic uncertainties, due to the incompleteness in the physical description of such models. This would in turn limit the capability to obtain the physics goals set for modern long baseline neutrino experiments, such as the Deep Underground Neutrino Experiment (DUNE).

An innovative technique, the Precision Reaction-Independent Spectrum Measurement (PRISM), has been proposed and investigated within the DUNE collaboration. This novel method is designed to measure neutrino oscillations based on a data-driven approach, eluding most theoretical modeling uncertainties. In this regard, the Near Detector (ND) is designed to move off the neutrino beam axis at several locations up to a distance of 33m, sampling thus several neutrino energy spectra. These ND off-axis results are used as a basis to predict the oscillated neutrino spectrum at the DUNE Far Detector, located at a baseline of 1300 km. The prediction obtained with the DUNE-PRISM analysis framework and the systematics impact on the oscillation parameters are presented. Additional studies needed to improve the overall sensitivity to the oscillation parameters and reduce their dependence on the interaction model uncertainties are also discussed.

T 107.5 Thu 16:50 HSZ/0101

Monoenergetic neutrino cross-section measurements with DUNE PRISM — •Lukas Koch for the DUNE-Collaboration — Johannes Gutenberg Universität Mainz

Next generation neutrino oscillation experiments like DUNE and Hyper-Kamiokande will require a precise understanding of systematic uncertainties to realise their physics goals. This includes a better understanding of neutrino-energy dependent cross sections of neutrino interactions with the target material. The DUNE near detector complex presents an opportunity to measure these cross sections using the PRISM approach. After recording interaction rates at different off-axis angles, and thus different neutrino energy spectra, we can make linear combinations of these measurements to create ”virtual neutrino fluxes”. These can be much narrower than the real fluxes, allowing for more precise cross-section measurements. This talk will explore the potential of the PRISM approach at the DUNE near detector complex and its potential implications for our understanding of neutrino cross sections.

T 107.6 Thu 17:05 HSZ/0101

The ESSνSB(+) design study: Achievements and Prospects — •Tamer Tolba — Institut für Experimentalphysik, Universität Hamburg, Hamburg, Germany

The European Spallation Source neutrino Super Beam (ESSνSB) is a long-baseline neutrino project that will be able to measure the CP-violation (CPV) in the leptonic sector at the second oscillation maximum, where the sensitivity of the experiment is close to three times compared to that at the first oscillation maximum. As shown in the recently published ESSνSB conceptual design report (CDR), the initially foreseen physics performance of the ESSνSB project has surpassed earlier expectations by covering, after 10 years of data collection, more than 70% of the range of possible CP-violating phase, δ_{CP}, values with a confidence level of more than 5σ to reject the no-CP-violation hypothesis. The expected measurement precision of the value of δ_{CP} is smaller than 8∘ for all δ_{CP} values, making it the most precise proposed experiment in the field by a large margin. The extension project, ESSνSB+ to be performed between 2023 and 2026, aims in addressing the challenging task of measuring the neutrino-nucleon cross-section, which is the dominant term of the systematic uncertainty, in the energy range from 0.2 to 0.6 GeV, using a Low Energy nuSTORM (LEnuSTORM) and an ENUBET-like Low Energy Monitored Neutrino Beam (LEMNB) facilities. With the successful end of the previous design-study program and the publication of the ESSνSB CDR, an overall status of the project, as well as the recently accepted, by the Horizon-Europe program, extension project, the ESSνSB+, will be presented.

T 108: Top, EW I

Time: Thursday 15:50–17:20 Location: HSZ/0103

T 108.1 Thu 15:50 HSZ/0103

Towards a WbWb differential cross-section measurement — •Eleonora Loiacono for the ATLAS-Collaboration — DESY Campus Zeuthen

The production of a top quark pair is extensively studied at the Large Hadron Collider (LHC). It constitutes a significant background in many searches for physics Beyond the Standard Model (BSM). The final state of this process, WWbb, interferes with the production of a single top quark in association with a W boson at Next Leading Order (tWb). In this contribution, I will focus on presenting different techniques that are used to correct the data for inefficiencies and limited geometric acceptance for the WWbb single lepton channel, with the goal of improving the modelling of Standard Model (SM) processes for BSM searches. First differential cross-section measurements in variables that are maximally sensitive to the interference, using data from second run of the LHC, will be presented.

T 108.2 Thu 16:05 HSZ/0103

Towards a WbWb differential cross-section measurement in a search-like phase space — •Thomas Mclachlan for the ATLAS-Collaboration — DESY

Top quark pair production is a widely studied process at the Large Hadron Collider (LHC) and is a significant background in many searches beyond the Standard Model (BSM). The WbWb final states of this process interfere with the production of a single top quark in association with a W boson and a b-quark (tWb). Inspired by searches for supersymmetry and dark matter, I will measure the WbWb production cross-section in a search-like phase space that is maximally sensitive to the interference effects. Performing such a measurement can allow for new constraints on new physics and improve the sensitivity of future searches through improved background modelling. An event selection using single lepton events has been developed and will be used on the entire Run 2 dataset. In this context, I will present a range of quantities and theoretical parameters that will be used in the differential cross-section measurement.

T 108.3 Thu 16:20 HSZ/0103

Measurement of differential cross sections in the process $pp \rightarrow W^+W^-bb$ — Stefan Kluth, Daniel Britzger, and •Johannes Hessler — Max-Planck-Institut für Physik

Precise measurements of differential cross sections in the process $pp \rightarrow W^+W^-bb$ offer an outstandingly rich physics potential at highest precision. Although the process is theoretically and experimentally well defined, dedicated measurements of W^+W^-bb production cross sections were not (extensively) performed in the past at the LHC. We will report on ongoing measurements in the single-lepton channel with Run-II data taken by the ATLAS experiment. Due to the high jet multiplicity of the final state the event reconstruction can be challenging. This talk will focus on the kinematic reconstruction of the hadronically decaying W-boson.

T 108.4 Thu 16:35 HSZ/0103

Measurement of the differential $W \rightarrow e\nu$ cross section at high transverse masses with the ATLAS detector and its combination with the $W \rightarrow \mu\nu$ channel — Frank Ellinghaus, Johanna Wanda Kraus, and •Tim Frederik Beumker — Bergische Universität Wuppertal

A measurement of the differential cross section of the process $W \rightarrow e\nu$ is shown. The data set used is based on pp-collision data corresponding to an integrated luminosity of $\mathscr{L}$ = 139 fb^{-1} at a center-of-mass energy of $\sqrt{s}$ = 13 TeV. It was recorded with the ATLAS detector during LHC Run-2. The measurement is done double-differentially in the transverse mass of the W boson and the absolute of the pseudorapidity of the electron. It focuses on the region of high transverse masses above 200 GeV. The results will allow constraints on effective field theories and parton distribution functions of the proton. An overview of the analysis with a focus on the determination of the multijet background will be given. In addition, a combination with the associated $W \rightarrow \mu\nu$ measurement using the HAverager tool will be presented.

T 108.5 Thu 16:50 HSZ/0103

Measurement of the differential $W \rightarrow \mu\nu$ cross section at high transverse masses at $\sqrt{s}$ = 13 TeV with the ATLAS detector — Frank Ellinghaus and •Johanna Wanda Kraus — Bergische Universität Wuppertal

The measurement of the differential cross section of the charged-current Drell-Yan process in the decay $W \rightarrow \mu\nu$ is presented. It is based on pp-collision data taken with the ATLAS detector during the LHC Run-2 at a center-of-mass energy of $\sqrt{s}$ = 13 TeV, corresponding to an integrated luminosity of $\mathscr{L}$ = 139 fb^{-1}. The cross section is measured double-differentially as a function of the transverse mass m_T^W and the pseudorapidity of the muon with a focus on the high transverse mass region above 200 GeV. This is done for the first time and will allow for constraints on the parton distribution functions of the proton and on effective field theories. A short overview of the complete analysis will be given with a focus on studies of the unfolding procedure via Iterative Bayesian Unfolding.

T 108.6 Thu 17:05 HSZ/0103

Measurement of the inclusive W and Z boson production cross sections in pp collisions at 13.6 TeV — •Jost von den Driesch, Markus Klute, Minseok Oh, and Xunwu Zuo — Karlsruhe Institute of Technology (KIT)

The measurement of the W and Z boson production cross sections and their ratios provides an important test of quantum chromodynamics and electroweak processes in the Standard Model. Such measurements have been previously performed by the ATLAS and CMS collaborations at LHC collision energies of $\sqrt{s}$ = 7 TeV, 8 TeV and 13 TeV.

This talk will provide an overview on the results of the W and Z production cross section measurement at CMS using Early Run3 data at the new collision energy of $\sqrt{s}$ = 13.6 TeV.

T 109: Higgs, Di-Higgs III

Time: Thursday 15:50–17:20 Location: HSZ/0105

T 109.1 Thu 15:50 HSZ/0105

Higgs-associated Top Quark Pair Production in the Bottom-Antibottom Higgs Decay Channel with ATLAS at 13 TeV — Arnulf Quadt, •Chris Scheulen, and Elizaveta Shabalina — II. Physikalisches Institut, Georg-August Universität Göttingen

The bottom anti-bottom Higgs decay channel of Higgs-associated top quark pair production offers direct access to measurements of the top Yukawa coupling and Higgs-p_T differential cross-section, which are sensitive to potential new physics. To incorporate improvements such as developments in b-tagging and Monte Carlo simulation of the dominant $t\bar{t}+b\bar{b}$ background, a legacy analysis of the $t\bar{t}H(H\to b\bar{b})$ process with the full ATLAS Run 2 dataset of $\mathscr{L}$ = 139 fb^{-1} is currently ongoing.

This talk will outline the general analysis strategy and provide an insight into the expected sensitivity of the analysis. Additionally, a focus will be placed on specific aspects of this round of analysis, such as the application of a muon-in-jet correction technique utilised to improve the Higgs mass and Higgs-p_T resolution.

T 109.2 Thu 16:05 HSZ/0105

Fake Estimation for the Search of the $t\bar{t}H(H\to b\bar{b})$ Process in the Single Lepton Channel — •Alexander Froch, Andrea Knue, and Ksenia Solovieva — Albert-Ludwigs-Universität Freiburg

The coupling of the Higgs boson to the standard model (SM) fermions, called Yukawa coupling, is one of the most basic but also most interesting properties in Higgs physics. In the standard model the top quark, with the largest mass of all SM fermions, should have the largest Yukawa coupling to the Higgs boson of approximately 1. To measure this property, the production of a top-antitop quark pair in association with a Higgs boson is studied. Due to its small production rate at the LHC, the most dominant decay of the Higgs boson (into a pair of b-quarks) is used. One of the top quarks is required to decay hadronically while the other one decays leptonically. This results in a final state with at least 4 b-quarks, a lepton and 2 additional non-b-quarks. The selected sample of events are split into signal- and background-dominated sub-samples called regions. While the signal region is not strongly affected by fake leptons, in dedicated control regions where additional correction are derived, the fake lepton contribution is not negligible.

In this talk, the current status of the fake estimation of the analysis in the single lepton channel will be discussed.

T 109.3 Thu 16:20 HSZ/0105

Measurement of the $ttH(b\bar{b})$ Cross Section in Events with High Higgs Boson Momentum at the ATLAS Experiment — •Doga Elitez, Lucia Masetti, Eftychia Tzovara, Asma Hadef, Alexander Basan, and Jessica Höfner for the ATLAS-Collaboration — Johannes Gutenberg Universität Mainz

The coupling of the Higgs boson to the top quark is very sensitive to effects of the physics beyond the Standard Model (BSM) and the most favorable production mode for direct measurement of the top Yukawa coupling is the Higgs production in association with a pair of top quarks, $t\bar{t}H$. The decay to two bottom quarks ($H\to b\bar{b}$) has the largest branching fraction of about 58%. This analysis aims at events where one of the top quarks decays semi-leptonically and produces an electron or a muon. The so-called boosted topology targets events containing a Higgs boson produced at high transverse momentum, whose decay products are contained in a large radius jet. In this talk, methods to improve background rejection, event reconstruction, and increase the sensitivity above the current p_T range are presented.

T 109.4 Thu 16:35 HSZ/0105

Search for Higgs boson pair production via vector-boson fusion in final states with four b-quarks in the boosted regime using data collected by the ATLAS detector at $\sqrt{s}$ = 13 TeV — •Marcus Vinicius Gonzalez Rodrigues, Janna Katharina Behr, and Kunlin Ran for the ATLAS-Collaboration — DESY, Hamburg, Germany

Searches targeting Higgs boson pair production via vector-boson fusion (VBF) provide unique access to the coupling of a Higgs boson pair to a vector boson pair (HHVV), and allow to set constraints on theories that predict resonant production of heavy particles that interact directly with the Higgs boson. The ultimate goal of this analysis is to improve the constraints on the HHVV coupling and search for heavy particles produced via VBF. For this purpose we consider the VBF di-Higgs pair production with final states containing four b-quarks in the boosted regime, where a pair of particle showers initiated by b-quarks from the decay of a high transverse momentum Higgs boson produces one single merged large-radius jet.

This analysis relies on data collected by the ATLAS detector at $\sqrt{s}$ = 13 TeV with an integrated luminosity of 139fb^{-1}. To improve the signal vs. background discrimination a Boosted Decision Tree (BDT) is used to define signal regions sensitive to the HHVV coupling, whereas a Parametric BDT is employed to define signal regions targeting resonant production in a wide range of masses. In this presentation the BDT performance will be shown with regard to the HHVV coupling constraints and to the limits on the resonant production.

T 109.5 Thu 16:50 HSZ/0105

Search for non-resonant Higgs Boson pair production in the decay channel bbWW at the CMS experiment — Martin Erdmann, •Peter Fackeldey, Benjamin Fischer, and Dennis Noll — III. Physikalisches Institut A, RWTH Aachen University

A measurement of the Higgs boson pair production can directly determine the trilinear Higgs coupling and probe the structure of the Higgs potential.

We present a search for Higgs boson pair production with one Higgs boson decaying into b quarks and the other Higgs boson decaying into W bosons. It includes final states with one or two leptons and resolved or boosted event topologies. The central challenge of this analysis is a tiny signal among a large amount of different backgrounds. To address this, we use physics process multiclass classification that is driven by a deep neural network.

We present results corresponding to the data recorded at the CMS experiment during Run 2.

T 109.6 Thu 17:05 HSZ/0105

Search for Higgs Boson Pair Production in Multi-Lepton Final States with the ATLAS Detector — Anamika Aggarwal, Janek Both, Volker Büscher, Antoine Laudrain, Christian Schmitt, •Niklas Schmitt, and Duc Bao Ta — Johannes Gutenberg-University, Mainz

After the discovery of the Higgs boson in 2012 at the LHC, many of its properties have already been determined precisely using 139 fb^{-1} of proton-proton collisions at $\sqrt{s}$ = 13 TeV. However, one of the biggest challenges in this field remains the measurement of the coupling of the Higgs boson to itself. It allows for a deep insight into the real shape of the Higgs potential and hence has a big impact on the understanding of fundamental interactions not only at the electroweak scale. In order to constrain the trilinear self-coupling, the Di-Higgs production cross section is measured. While decay modes including b-quarks typically have larger branching fractions, leptonic final states are generally much cleaner and have less SM background. Accordingly, probing this channel as a complement to $b\bar{b}$ analyses will be very promising.

Dedicated neural networks in the 2,3 and 4 lepton final states have been trained to distinguish all relevant signal processes against the sum of all SM backgrounds. This talk will highlight the performance of these multi-lepton channels compared to other HH decay modes and also introduces a regression network used for probing the sensitivity to the Higgs boson self-coupling. In addition, a first look into Run 3 data, as well as projections for the full Run 3 dataset, are presented.

T 110: Other Theory

Time: Thursday 15:50–17:20 Location: HSZ/0201

T 110.1 Thu 15:50 HSZ/0201

The use of Fierz identities beyond one loop — •Sophie Kollatzsch[1,2], Adrian Signer[1,2], Dominik Stöckinger[3], and Yannick Ulrich[4] — [1]Paul Scherrer Institut, CH-5232 Villigen PSI, Switzerland — [2]Physik-Institut, Universität Zürich, Winterthurerstrasse 190, CH-8057 Zürich, Switzerland — [3]Institut für Kern- und Teilchenphysik, TU Dresden, DE-01069 Dresden, Germany — [4]Institute for Particle Physics Phenomenology, University of Durham, South Road, Durham DH1 3LE, United Kingdom

EFTs typically contain dimension-six four-fermion operators. Different basis choices of such operators are possible by applying Fierz identities to rearrange four-fermion expressions. In d dimensions, such Fierz identities are not strictly valid; hence the question arises how such a basis change has to be treated at the (multi-)loop level. We discuss the treatment of so-called Fierz-evanescent operators, resulting in (finite) shifts of Wilson coefficients. Motivated by an abelian toy model, we show how the two-loop QED effects of specific Fierz-evanescent operators are absorbed into the renormalisation. As an example, we demonstrate how those basis changes affect the calculation of $\mu \to e\gamma$ at next-to-leading order.

T 110.2 Thu 16:05 HSZ/0201

Two-loop Treatment of a Simple Chiral Yang–Mills Model using Non-Anticommuting γ_5 — •Baibhab Ray — Deutsches Elektronen-Synchrotron DESY, Platanenallee 6, 15738 Zeuthen — TU Dresden, Institut für Kern- und Teilchenphysik, Zellescher Weg 19, 01069 Dresden

For practical calculations of loop diagrams in perturbative quantum field theory, Dimensional Regularization (DREG) is the most commonly applied regularization scheme. In this context, fields and integrals are transformed to D dimensions and one invariably needs to decide how intrinsically four-dimensional quantities like γ_5 should be treated in $D \neq 4$ dimensions. The original and to date most rigorous and universal HVBM scheme ('t Hooft–Veltman/Breitenlohner–Maison) forfeits anticommutativity of γ_5 with all other γ^μ and breaks BRST symmetry in intermediate steps. The latter can be restored by means of finite, symmetry-restoring counterterms.

In this talk, I shall discuss a simple chiral Yang–Mills model with only one SU(N) gauge group and without scalar fields, and present two-loop results in the HVBM scheme. Besides acquiring the two-loop counterterm structure (involving both singular and finite counterterms), I shall demonstrate methods of cross-checking by considering the Abelian special case (which can be compared with literature), as well as comparing with Ward identities (which are derived from the relevant Slavnov–Taylor identities encoding BRST symmetry). Time permitting, I shall provide insights into the implementation in `Mathematica`.

T 110.3 Thu 16:20 HSZ/0201

The phase structure of neutral three flavor quark matter — •Marco Hofmann, Gholami Hosein, and Buballa Michael — Institut für Kernphysik, Technische Universität Darmstadt, Schlossgartenstr. 2, 64289 Darmstadt

This talk explores the phase structure and equation of state of dense neutral quark matter at zero and finite temperature. As the equation of state and the speed of sound of neutron stars become more and more constrained by observations from gravitational waves and mass-radius measurements, the phenomenology of the quark matter phase structure is pivotal to understand the composition of stars with a quark matter core. We calculate the phase diagram from a three flavor Nambu Jona-Lasinio (NJL)-type model in the mean field approximation. Color superconductivity is included through the attractive scalar diquark channel. A repulsive vector interaction increases the stiffness of the matter. Furthermore, we address the systematic removal of cutoff artefacts within an renormalization group consistent approach.

T 110.4 Thu 16:35 HSZ/0201

Hybrid equation of state and mass radius relation — •Hosein Gholami, Marco Hofmann, and Michael Buballa — Institut für Kernphysik,Technische Universität Darmstadt, Schlossgartenstraße 2, 64289 Darmstadt

With the discovery of gravitational waves from neutron star mergers, investigating the structure of these objects using theoretical models has gained more importance. Matter at the highest densities reached in neutron star remnants is expected to be in a color superconducting state. To constrain the quark matter equation of state at these densities, we compare with constraints on hybrid star equations of state for isolated neutron stars at zero temperature. Here we explore the speed of sound and mass-radius relation for such hybrid equations of state. We also study these properties within a renormalization group consistent approach. Our calculation is based on a mean field approximation of three flavor Nambu Jona-Lasinio (NJL)-type models. A repulsive vector interaction is included to satisfy the 2 solar mass neutron star observations. Color superconducting phases are included through the attractive scalar diquark channel.

T 110.5 Thu 16:50 HSZ/0201

Notational Invariance of the standard model — •Lello Boscoverde — Istituto della Fava Pazza, Garching

We present current investigations into the notational invariance of the standard model as well as an introduction to the principles of notational invariance with pedagogical examples, a history of its study, and algorithms for implementing changes of notation.

T 110.6 Thu 17:05 HSZ/0201

Particle knowledge enhanced by a classical model — •Albrecht Giese — Taxusweg 15, 22605 Hamburg

According to today's understanding, the properties of elementary particles must be treated quantum mechanically - preferably according to the "Copenhagen Interpretation". In contrast, we present a particle model that classically provides the usual parameters; and what is more, it derives parameters that are only postulated by today's quantum mechanics.

This classic model initially refers to Louis de Broglie's approach and takes into account the relativistic behavior of particles. With these ingredients, not only standard properties such as spin and magnetic moment can be derived. In complete contrast to the Higgs model, it is possible to determine the particle mass very precisely; in the case of the electron by 1:300 000 without any adaption of parameters. It also allows the physical quantities h (Planck) and alpha not only to be postulated, but also to be derived from more fundamental elements. The additional understanding gained in this way leads to further properties such as the Pauli principle and the color codes of quarks, which are also only postulated to this day.

Further info: www.ag-physics.org/rmass

T 111: Outreach Diverse (joint session T/HK)

Time: Thursday 15:50–17:20 Location: HSZ/0204

T 111.1 Thu 15:50 HSZ/0204

Z0-Versuch im Jupyter notebook — •Gianni Di Paoli, Guenter Duckeck und Nikolai Hartmann — LMU München

Der 'Z0-Versuch' mit OPAL/LEP Daten ist an der LMU München seit vielen Jahren ein klassischer Versuch im Fortgeschrittenen Praktikum und wird in verschiedenen Varianten auch an anderen Universitäten verwendet. Er illustriert exemplarisch Analysemethoden in der Teilchenphysik und erlaubt die Bestimmung fundamentaler Parameter wie Z0-Masse, -Breite und Zahl der Neutrino-Generationen. Im Rahmen einer Bachelor Arbeit wurde die bisherige Root-basierte Analyse auf die Python data-science Umgebung und jupyter notebooks umgestellt. Das erleichtert zum einen den Studierenden die Versuchsdurchführung, weil die meisten schon mit der Python/Jupyter Umgebung vertraut sind. Zum anderen lernen sie anspruchsvolle Filter-techniken, komplexe Visualisierungen und Fit-Verfahren kennen, die über die Standard-Beispiele in den einschlägigen Kursen und Tutorials hinausgehen.

T 111.2 Thu 16:05 HSZ/0204

Forschung trifft Schule @home - Digitale Teilchenphysik-Fortbildungen für Lehrkräfte — •Philipp Lindenau[1], Carolin Gnebner[2], Niklas Herff[1], Michael Kobel[1], Frank Siegert[1] und Steffen Turkat[1] für die Netzwerk Teilchenwelt-Kollaboration — [1]Technische Universität Dresden — [2]DESY Zeuthen

Häufig unter den Herausforderungen der Covid-19-Pandemie entstanden, haben digitale Angebote mittlerweile einen festen Platz in der Bildungslandschaft. Auch die von Netzwerk Teilchenwelt dank der Förderung durch die Dr. Hans Riegel-Stiftung durchgeführte Fortbildungsreihe "Forschung trifft Schule" wurde um in der Regel halbtägige digitale Formate erweiterte, die nun unter dem Titel "Forschung trifft Schule @home" zum permanenten Veranstaltungsportfolio gehören. Das digitale Angebot beinhaltet insbesondere Fortbildungen zur Forschungsmethodik in der Teilchenphysik unter dem Motto "Von der Kollision zur Entdeckung" sowie Veranstaltungen zur Astroteilchenphysik und deren Behandlung im Schulunterricht unter Nutzung des Online-Tools Cosmic@Web. Die Veranstaltungen wurden bundesweit beworben und von Lehrkräften aus fast dem gesamten Bundesgebiet sowie von deutschen Schulen im Ausland besucht. Im Vortrag werden sowohl die bisher umgesetzten als auch geplante Formate sowie das Feedback der teilnehmenden Lehrkräfte vorgestellt und diskutiert.

T 111.3 Thu 16:20 HSZ/0204

Physik der kleinsten Teilchen in der Schule - Eine multiperspektivische Tagungsreihe zur kohärenten Vermittlung — Stefan Heusler[1], Christian Klein-Bösing[1], Michael Kobel[2], •Philipp Lindenau[2], Oliver Passon[3] und Thomas Zügge[4] — [1]Westfälische Wilhelms-Universität Münster — [2]Technische Universität Dresden — [3]Bergische Universität Wuppertal — [4]Universität Greifswald

Es existiert eine Vielzahl von Unterrichtsentwürfen für die Vermittlung der Teilchenphysik, Hadronen- und Kernphysik sowie Astroteilchenphysik. Engagierte Physiker:innen aus Outreach, Schulpraxis, Fachwissenschaft und Fachdidaktik, aber auch populärwissenschaftliche und Schulbuchverlage konzipierten Vermittlungskonzepte – häufig unabhängig voneinander. Mit zunehmender Aufnahme der Themen in die Lehrpläne stieg das Bedürfnis nach Austausch der Akteur:innen. Einige für die kohärente Vermittlung zentrale Fragen erwiesen sich als nur gemeinsam bearbeitbar, etwa jene nach der verwendeten Nomenklatur, den bildenden Inhalten, Bezügen zur aktuellen Forschungspraxis und Verknüpfung mit den in den Lehrplänen ausgedrückten Kompetenzerwartungen. So fand

2018 ein interdisziplinäres Symposium in Wuppertal statt. Weitere Tagungen folgten in Münster und Dresden. Sukzessive trug der kollegiale Austausch dazu bei, Unschärfen in unseren Vermittlungspraxen zu erkennen und bildende Gelegenheiten der Themen zu identifizieren. Die nächste Tagung ist 2023 in Greifswald mit dem Schwerpunkt "Nature of Science" geplant. Im Vortrag werden die Tagungsreihe sowie einige ihrer bisherigen Ergebnisse vorgestellt.

T 111.4 Thu 16:35 HSZ/0204

Bausteine der Materie – ein Mitmachexperiment für Schüler:innen — •Luisa Faber für die Netzwerk Teilchenwelt-Kollaboration — Institut für Kernphysik, WWU Münster

Das Projekt „Bausteine der Materie – Ein Mitmachexperiment für Schüler:innen“ soll Schüler:innen durch die Vermittlung von Inhalten der Kern- und Teilchenphysik für Natur und Technik begeistern. Als Kernelement wurden die weitverbreiteten Klemmbausteine gewählt, um eine aktive Beteiligung und selbstständiges Arbeiten der Schüler:innen zu ermöglichen.

Inhalte des Buchs „Particle Physics Brick by Brick“ von Dr. Ben Still dienen als erster Kontakt der Schüler:innen mit den Elementarteilchen des Standardmodells – den Bausteinen der Materie. Der Nachbau des ALICE-Detektors aus LEGO® in verschiedenen Maßstäben ist ein zentraler Bestandteil des Projekts. Dabei soll der gemeinschaftliche Charakter der wissenschaftlichen Arbeit vermittelt werden.

Ziel der Arbeit ist die Einbindung der beschriebenen Komponenten in einen Workshop. Dieser soll in unterschiedlichem Umfang in Schulklassen und bei verschiedenen Events durchgeführt werden können. Beim Bau eines ALICE-Modells aus 18.000 LEGO®-Teilen in einer AG an einem Gymnasium in Münster werden bereits erste Elemente des Workshops angewendet.

In dem Vortrag wird über den aktuellen Stand des Projekts und bereits erfolgte Events, die in Zusammenarbeit mit dem Netzwerk Teilchenwelt durchgeführt wurden, berichtet. Gefördert durch die Joachim Herz Stiftung.

T 111.5 Thu 16:50 HSZ/0204

Cosmic Watch - Bau eines Myonendetektors für Schulkinder — •Sebastian Laudage — Argelander-Institut für Astronomie, Universität Bonn

Sekundäre Teilchen der kosmischen Strahlung, insbesondere Myonen, erreichen zu hoher Zahl jede Sekunde unsere Erdoberfläche und sind ohne dass wir es merken, Teil unseres alltäglichen Lebens. Sie sind ein unsichtbares, aber höchst interessantes Phänomen astronomischen Ursprungs. Im privaten Kontext oder an Schulen war die Untersuchung dieses Bereichs der Physik bislang nur rudimentär möglich, da zuverlässige Detektoren komplex und teuer in der Herstellung sind. 2017 wurde das Projekt Cosmic Watch durch einen PhD-Studenten am MIT (Spencer N. Axani) entwickelt, welches den Bau eines bezahlbaren (≈ 120 Euro), zuverlässigen und mobilen Myonendetektors beschreibt. Der fertige Detektor ist nur etwa 8x7x4cm groß, ist leicht zu bedienen und kann autark die lokale Rate, Energie und Richtung von passierenden Myonen messen. Damit ist er sehr gut geeignet um Schüler:innen oder Fachfremden einen Einblick in die Welt der Astroteilchenphysik zu geben. Neben spannenden experimentellen Möglichkeiten bietet der Detektor die Möglichkeit Erfahrungen im löten und mit elektrischen Schaltungen zu sammeln, da er nach Anleitung selber zusammengebaut werden kann. Der Vortrag beschreibt den Aufbau des Detektors, die Umsetzbarkeit des Baus als Projekt für Schüler:innen oder Hobbybastler:innen und gibt Ausblick auf Anwendungmöglichkeiten in der Lehre.

T 111.6 Thu 17:05 HSZ/0204

Die Selbstbau-Nebelkammer als Hands-On Exponat für Events und Ausstellungen — •David Borgelt und Christian Klein-Bösing für die Netzwerk Teilchenwelt-Kollaboration — Wilhelm-Klemm-Str. 9 48149 Münster

Diffusions-Nebelkammern sind ein beliebtes Exponat für physikbezogene Ausstellungen. Beispielsweise verfügen sowohl die Dauerausstellung des FB Physik der WWU, das ExperiMINTum, als auch das Universum in Bremen über solche Nebelkammern. Allerdings sind diese wie klassische Exponate in Museen zu bestaunen und besitzen keine Hands-On Charakteristika.

In zahlreichen Workshops für Schulen sowie in Masterclasses (siehe Netzwerk-Teilchenwelt) erweist sich das Konzept der Hands-On Exponate in Form von Selbstbau-Nebelkammern des Netzwerk Teilchenwelt als überaus beliebt. Auch für Ausstellungen oder Events mit naturwissenschaftlichem Schwerpunkt können diese von Bedeutung sein. Die Selbstbau-Nebelkammern sind wie die Diffusions-Nebelkammern hervorragend dazu geeignet, die Relevanz von Teilchenphysik im Alltag zu zeigen. Darüber hinaus kann mit der Selbstbau-Nebelkammer zusätzlich das Experimentieren als Bestandteil der Physik vorgestellt und Aspekte von Nature of Science diskutiert werden.

In diesem Vortrag werden die Hands-On Charakteristika der Selbstbau-Nebelkammer vorgestellt und Erfahrungsberichte über ihren Nutzen in Ausstellungen und auf Events präsentiert.

T 112: DAQ Test/RO – GRID I

Time: Thursday 15:50–17:20 Location: HSZ/0301

T 112.1 Thu 15:50 HSZ/0301

Modular and Scalable Multi-Timepix3 Readout System — •Thomas Block, Klaus Desch, Markus Gruber, Jochen Kaminski, and Tobias Schiffer — Universität Bonn

The Timepix3 chip of the Medipix3 collaboration is a highly granular pixel chip. It can be used in combination with different detector components, e.g. with a bump bonded silicon pixel sensor, with a photolithographically postprocessed MicroMegas gas amplification stage (InGrid), or with a micro-channel plate (MCP). Therefore different detectors can be built, which can be used for various applications like beam telescopes, X-Ray detectors for axion search and polarimetry and neutron detectors. For these different detectors we are developing a fully open source solution: the Timepix3 readout system. It enables us to adapt to the different requirements (low- to high-rate events and single- to multi-chip design) efficiently. The system, which already has been used in test runs, supports different FPGA boards, which cover the different requirements. The Scalable Readout System (SRS), being one of them, together with of our own PCB designs, supports low- to medium-rate applications. Based on the basil framework, developed at SILAB Bonn, the firmware is written in Verilog and the software is written in Python. For the control system both a graphical user interface and a command-line interface have been developed.

In this talk I will present the readout and control system and the recent development from single-chip to multi-chip support. Also I will show the needed functionality like calibration, equalisation, readout and monitoring.

T 112.2 Thu 16:05 HSZ/0301

Scan Automated Testing for the ATLAS Pixel Detector — Marcello Bindi, Arnulf Quadt, and •Chris Scheulen — II. Physikalisches Institut, Georg-August Universität Göttingen

The ATLAS Pixel detector data acquisition system (DAQ) is distributed over several different physical components, such as front-end detector modules, read-out drivers, and PCs for operating and calibrating the detector. As a result, time-consuming manual tests are currently required to ensure the correct operation of the entire system after software or firmware changes in any one component. After the first year of detector operation during Run 3, this represents a bottleneck to the development work carried out during the end-of-year shutdown on the basis of the experience collected, such as observed dead-time desynchronisation instabilities.

To simplify software validation and free up manpower, a suite of automated tests is being developed for deployment in the DAQ software's continuous integration system on GitLab. Fully automated testing is only possible without involvement of the detector modules, whose operation requires some degree of manual supervision. Therefore, emulated detector responses are used for tests of read-out chain components under exclusion of the detector modules themselves.

This talk will provide a brief overview of required improvements to the Pixel detector's DAQ system based on the operational experience collected during the first data-taking year of Run 3. A special focus will be placed on the development of the automated testing framework being used to validate this firmware and software development.

T 112.3 Thu 16:20 HSZ/0301

Tests of the Mu3e DAQ in the Cosmic run 2022 — •Martin Müller for the Mu3e-Collaboration — Institute for Nuclear Physics, JGU Mainz

The Mu3e experiment will search for the lepton flavour violating decay $\mu^+ \to e^+e^-e^+$ and is aiming for a sensitivity of one in 10^{16} muon decays. Since this decay is highly suppressed in the Standard Model to a branching ratio of below $\mathcal{O}(10^{-54})$, an observation would be a clear sign for new physics.

In the Mu3e detector, four layers of silicon pixel sensors will be used to track electrons and positrons and a time resolution of $\mathcal{O}(100\ ps)$ will be provided by scintillating tile and fibre detectors. The overall detector is expected to produce a data rate from 80 Gbit/s (Phase I) to 1 Tbit/s (Phase II), which will be processed in a three-layer, triggerless DAQ system using FPGAs and a GPU filter farm for online event selection.

A prototype of the detector was operated in summer 2022 in the first Mu3e cosmic run with the intent to test and validate a variety of systems. The operated prototype included two cylindrical layers of pixel sensors, a scintillating fibre module and a vertical slice of the final data acquisition (DAQ) system. The talk will focus on the commissioning and validation of the DAQ in this run.

T 112.4 Thu 16:35 HSZ/0301

Integration of the Goettingen HPC resources to the WLCG Tier- 2 grid computing environment of GoeGrid — •Uday Saidev Polisetty, Arnulf Quadt, Daniel Schindler, and Sebastian Wozniewski — II. Physikalisches Institut, Georg-August-Universität Göttingen

The amount of data produced will significantly increase with the upcoming Run 4 of the LHC. To handle the incoming data there is a necessity to increase the computing resources for simulation, reconstruction and analysis in terms of storage and computing power. The important aspect of the solution is the integration of the High Performance Computing (HPC) resources. At Goettingen campus, there is both WLCG (Worldwide LHC Computing Grid) Tier-2 site (GoeGrid) and a large HPC cluster by National High Performance Computing (NHR) and North German Supercomputing Alliance (HLRN) supercomputer resources. In context of the FIDIUM project, the aim is to increase the computing resources by integrating the local HPC cluster to the GoeGrid. The unused quota from the external sources can be used to fill the shortage of computing resources required for the ATLAS experiment. This integration would lead to a solution to run all the job types provided by the ATLAS experiment.

T 112.5 Thu 16:50 HSZ/0301

Analysis benchmarking tests on selected sites — •David Koch[1], Thomas Kuhr[1], Günter Duckeck[1], Dennis Noll[2], and Benjamin Fischer[2] — [1]LMU München, Germany — [2]RWTH Aachen, Germany

A fast turn-around time and ease of use are important factors for systems supporting the analysis of large HEP data samples. We study and compare multiple technical approaches. This presentation will be about setting up and benchmarking the Analysis Grand Challenge (AGC) using CMS Open Data. The AGC is an effort to provide a realistic physics analysis with the intent of showcasing the functionality, scalability and feature-completeness of the Scikit-HEP Python ecosystem.

I will present the results of setting up the necessary software environment for the AGC and benchmarking the analysis' runtime on various computing clusters: the institute SLURM cluster at my home institute, LMU Munich, a SLURM cluster at LRZ (WLCG Tier-2 site) and the analysis facility Vispa, operated by RWTH Aachen. Each site provides slightly different software environments and modes of operation which poses interesting challenges on the flexibility of a setup like that intended for the AGC. Comparing these benchmarks to each other also provides insights about different storage and caching systems. At LRZ and LMU we have regular Grid storage (HDD) as well as and SSD-based XCache server and on Vispa a sophisticated per-node caching system is used.

T 112.6 Thu 17:05 HSZ/0301

Transparent extension of the Worldwide LHC Computing Grid to non-HEP resources — Manuel Giffels[1], •Alexander Jung[2], Thomas Kress[3], Thomas Madlener[4], Andreas Nowack[3], Alexander Schmidt[2], and Christoph Wissing[4] — [1]Institut für Experimentelle Teilchenphysik, Karlsruher Institut für Technologie, Deutschland — [2]III. Physikalisches Institut A, RWTH Aachen, Deutschland — [3]III. Physikalisches Institut B, RWTH Aachen, Deutschland — [4]Deutsches Elektronen-Synchrotron DESY, Deutschland

With the recently started Run 3 of the LHC, enormous amounts of data are expected. It is already foreseeable that the resources provided by the Worldwide LHC Computing Grid (WLCG) will be put under a lot of stress in the coming years, especially at the start of HL-LHC in Run 4. HEP computing is therefore increasingly developing in the direction of using external non-HEP dedicated resources and thus becoming more heterogeneous. This contribution reports on the work carried out as part of the BMBF (Bundesministerium für Bildung und Forschung) funded FIDIUM (Föderierte digitale Infrastrukturen für die Erforschung von Universum und Materie) project on the dynamic and transparent integration of non-HEP resources into the existing infrastructure of the WLCG and what challenges arise in the process. The currently ongoing integration of the high performance computing (HPC) resources at Jülich Supercomputing Centre (JSC) using the resource manager COBalD/TARDIS serves as an example.

T 113: QCD Theory and Experiment II

Time: Thursday 15:50–17:20 Location: HSZ/0405

T 113.1 Thu 15:50 HSZ/0405

Quark Masses in the Heavy Quark Expansion — •Anastasia Boushmelev[1], Thomas Mannel[1], and K. Keri Voss[2] — [1]Theoretische Physik 1, Center for Particle Physics Siegen Universität Siegen, D-57068 Siegen, Germany — [2]Gravitational Waves and Fundamental Physics (GWFP), Maastricht University, Duboisdomein 30, NL-6229 GT Maastricht, the Netherlands and Nikhef, Science Park 105, NL-1098 XG Amsterdam, the Netherlands

Many observables can be written in terms of an operator product expansion (OPE) which factorizes the expression in perturbative and non-perturbative parts. The examples to be studied in this talk are the Heavy Quark Expansion (HQE) for inclusive semi-leptonic $b \to u$ decays and the inverse moments of the cross section $e^+e^- \to$ hadrons.

In both cases the leading term of the OPE is given by the perturbatively calculated, partonic expression, which depends on the mass of the heavy quark. Calculating this using the pole mass one encounters the problem that this mass scheme suffers from so called renormalon induced ambiguities which spoil the convergence of the perturbative expansion.

However, we propose the following strategy: Since observables should be free of such ambiguities, we use an observable such as an inverse moment of the $e^+e^- \to$ hadrons cross section to eliminate the pole mass from the expression for the semi-leptonic $b \to u$ rate, obtaining a perturbative relation between two observables valid to leading order in the OPE.

T 113.2 Thu 16:05 HSZ/0405

Measurement of D^* meson cross sections in the full phase space for charm in CMS — •Yewon Yang[1], Achim Geiser[1], Nur Zulaiha Jomhari[1], Valentina Mariani[2], Josry Metwally[1], and Max Uetrecht[3] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, D-22607 Hamburg — [2]Università degli Studi di Perugia, Piazza Università, 106123 Perugia — [3]Technische Universität Dortmund, August-Schmidt-Straße 1, 44227 Dortmund

This is a summary talk about total, single- and double-differential cross sections for charm which are measured from the reconstruction of charm hadronic states in the CMS detector. Among all the hadronic states of charm, for this talk especially the reconstruction of D^* which decays into D^0 and a slow pion is introduced at proton-proton center-of-mass energies of 0.9, 5, 7, and 13 TeV. The measured cross sections for this final state show consistency compared to QCD theory and also to other LHC experiments. Then the D^* meson cross sections measured in the full phase space accessible with the CMS detector are extrapolated to extract the total charm cross section. For the first time, this extrapolation applies the p_T-dependent cross-section ratios between meson and baryon of charm, which are recently measured from LHC experiments.

T 113.3 Thu 16:20 HSZ/0405

Study of the X(3915) at Belle — •Yaroslav Kulii[1], Thomas Kuhr[1], and Boris Grube[2] — [1]Ludwig-Maximilians-Universität München — [2]Thomas Jefferson National Accelerator Facility

Many of the charmonium states, which consist of a charm and anti-charm quark, have been found and studied experimentally. Detailed theoretical predictions of the charmonium excitation spectrum agree well with the experimental data.

However, in recent years experiments discovered a growing number of charmonium-like states that do not fit into the predicted charm-anticharm excitation spectrum. One such state is $X(3915)$. It has been discovered by the BaBar and Belle collaborations in the two-photon reaction $e^+e^- \to e^+e^-X(3915) \to e^+e^-J/\psi\omega$, where the final-state electron and positron were not detected. The analysis of projections of angular distributions preferred the $J^{PC} = 0^{++}$ hypothesis, but other quantum numbers, in particular $J^{PC} = 2^{++}$, could not be excluded.

Because of this the $X(3915)$ was initially identified as the $\chi_{c0}(2P)$ charmonium state, although its mass and decay width were not in good agreement with the theory predictions. Following the Belle discovery of the $X^*(3860)$, which agrees much better with the $\chi_{c0}(2P)$ hypothesis, opinions shifted towards interpreting the $X(3915)$ as an exotic state. It could be, for example, a meson molecule or a so-called hybrid meson.

We will present research prospects and the status of the angular analysis to measure the quantum numbers of the $X(3915)$ in its $J/\psi\omega$ decay using Belle data.

T 113.4 Thu 16:35 HSZ/0405

Measuring the Drell-Yan Cross Section using Forward Electrons with the ATLAS Detector — •Craig Wells for the ATLAS-Collaboration — Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany

The full LHC Run-2 dataset offers an unparalleled opportunity to measure the complete decomposition of the Drell-Yan cross section in terms of the lepton decay angles in the rest frame of the incident quarks, rapidity of the dilepton system, and the transverse momentum of the vector boson. For this purpose, forward electrons (|eta| > 2.5) in the ATLAS detector present a unique opportunity to probe Z decays in extreme regions of phase space, which are sensitive to fundamental parameters of the Standard Model.

Forward electrons are, however, experimentally challenging objects to work with, due to large amounts of passive material in this region of ATLAS. This talk will present an overview of the analysis and calibration process for forward electrons, so that they are ready to be used for physics purposes.

T 113.5 Thu 16:50 HSZ/0405

Machine-learning off-shell effects in top quark production at the LHC — •Mathias Kuschick — Institut für Theoretische Physik, Münster

Measuring top quark processes at the LHC is an important test of the Standard Model of particle physics. As the heaviest of all quarks the investigation into its properties allows for tests of QCD and the electroweak interaction as well as tests of the Higgs mechanism, but also provides a window to new physics. Therefore, a precise determination of the top quark's fundamental properties is compulsory. Such determinations heavily rely on precise theoretical calculations. The most sophisticated of such calculations include improvements such as radiative corrections or off-shell effects, which make them extremely computational costly to evaluate. In my talk I will explore the use of modern machine learning techniques such as neural networks to learn how top pair production predictions change when finite width and interference effects are included in an effort to bypass the undesirable computational complexity of such calculations.

T 113.6 Thu 17:05 HSZ/0405

Automated NLO electroweak corrections to processes at hadron and lepton colliders — •Pia Bredt — U. Siegen, Siegen, Germany

The aim of this project was the completion of an automated framework calculating NLO corrections in the full SM for arbitrary processes at hadron and lepton colliders. This framework is an element of the Monte-Carlo program WHIZARD simulating cross sections and differential distributions. Specifically, it builds on the implemented FKS subtraction scheme for NLO QCD calculations, and extends it to automated NLO EW and QCD-EW mixed corrections. To that end, the implemented FKS scheme is generalised to systematically subtract QED and QCD infrared divergences in mixed coupling expansions. The automated computation of NLO contributions is validated for a set of benchmark processes at the LHC, including e. g. $t\bar{t}$ $(+H/W/Z)$ production. Cross-checks for e^+e^- processes likewise show that WHIZARD can be used for predictions at lepton colliders including fixed $\mathcal{O}(\alpha)$ corrections. This framework is applied to the study of multi-boson processes at a future multi-TeV muon collider.

T 114: Neutrinos V

Time: Thursday 15:50–17:20 Location: POT/0051

T 114.1 Thu 15:50 POT/0051

Characterization of the ECHo-100k detector response — •Raghav Pandey[1], Arnulf Barth[1], Sebastian Berndt[2], Holger Dorrer[2], Christoph E. Düllmann[2], Christian Enss[1], Andreas Fleischmann[1], Nina Kneip[3], Federica Mantegazzini[1], Klaus Wendt[3], and Loredana Gastaldo[1] — [1]Kirchhoff Institute for Physics, Heidelberg University — [2]Department of Chemistry - TRIGA Site, Johannes Gutenberg-Universität Mainz — [3]Institute of Physics, Johannes Gutenberg-Universität Mainz

In the ECHo-100 experiment high energy resolution and high statistics Ho-163 electron capture spectra will be acquired with more than 10000 single detector pixels that fully enclose implanted Ho-163. A well-understood and reliable detector response is at the basis for a precise analysis of the spectral shape in the endpoint region around 2.8 keV. We present the results obtained with ECHo-100k detectors containing Ho-163. We discuss the shape of the acquired spectrum with respect to the spectrum acquired with ECHo-1k detectors and with the spectrum acquired with the same ECHo-100k detectors but consisting only of the lower half of the absorber, meaning without complete Ho-163 enclosure.

T 114.2 Thu 16:05 POT/0051

First ^{7}Be Electron Capture Spectrum measured with MMCs — •Arnulf Barth[1], Karl Johnston[2], Federica Mantegazzini[1], Peter Rubovič[3], and Loredana Gastaldo[1] — [1]Kirchhoff-Institute for Physics, Heidelberg University — [2]ISOLDE, CERN — [3]Institute of Experimental and Applied Physics, Czech Technical University in Prague

^{7}Be, with a half-life of about 53 days and a Q-value of about 862 keV is the lightest nuclide to undergo electron capture. In nature, electron capture processes typically occur in atoms within a medium. ^{7}Be electrons provide very low screening from environment effects from the host material, causing a change in half-life and other atomic properties. This makes ^{7}Be an optimal candidate to study the effect of different host materials on the electron capture process and on the energy transferred to the nuclear recoil. We present the first measurement of the ^{7}Be spectrum using low temperature metallic magnetic calorimeters where ^{7}Be has been ion-implanted into gold. We achieved a baseline resolution of 4 eV FWHM and could observe the peak corresponding to the capture of the 1s electron, which includes the atomic de-excitation energy and the nuclear recoil energy. These very promising results demonstrate the possibility to perform a detailed study of the effect of the environment on the electron capture process by implanting ^{7}Be in different host materials.

T 114.3 Thu 16:20 POT/0051

Reducing temperature drifts and their effect on MMC detector response for the ECHo experiment — •Cicek Cihan, Arnulf Barth, Daniel Unger, Daniel Hengstler, Andreas Fleischmann, and Loredana Gastaldo — Kirchhoff Institute for Physics, Heidelberg University

In the ECHo experiment, large arrays of metallic magnetic calorimeters are mounted at the mixing chamber plate of a dilution refrigerator kept at a temperature below 20 mK. The temperature of the mixing chamber is regulated and shows average drifts at the level of 1 μK. Methods to improve the stability are presently under study.

Even if very small, these temperature fluctuations degrade the energy resolution of detectors optimized for the ECHo experiment. To cure this effect, each ECHo chip hosts two temperature sensors. For each triggered event in pixels on a chip, the signal of the temperature channels are also acquired and will be used for an off-line correction. We discuss methods which allow for identification and correction of temperature instabilities and present the effect of this correction on energy resolution.

T 114.4 Thu 16:35 POT/0051

Analysing KATRIN neutrino mass data using a neural network — Christian Karl[1,2], Susanne Mertens[1,2], •Alessandro Schwemmer[1,2], and Christoph Wiesinger[1,2] for the KATRIN-Collaboration — [1]Physik Department, Technische Universität München, Garching — [2]Max-Planck-Institut für Physik, München

The Karlsruhe Tritium Neutrino (KATRIN) experiment probes the effective electron anti-neutrino mass by a precision measurement of the tritium beta-decay spectrum near the endpoint. A world-leading upper limit of 0.8 eV c^{-2} (90 % CL) has been set with the first two measurement campaigns. Improvements w.r.t. the measurement configuration allowed for an enhanced signal-to-background ratio as well as a reduction of systematic uncertainties and a substantial increase in statistics. Subsequently the combined sensitivity of the first five datasets is estimated to be below 0.5 eV c^{-2} (90 % CL). In this talk we will present a novel approach for the analysis of these datasets using a neural network.

T 114.5 Thu 16:50 POT/0051

High voltage preparation and first measurement of a new ^{83m}Kr conversion line with the KATRIN experiment — •Benedikt Bieringer and Matthias Böttcher for the KATRIN-Collaboration — Institute for Nuclear Physics, University of Münster

The Karlsruhe Tritium Neutrino Experiment (KATRIN) is targeted to measure the neutrino mass with a design sensitivity of 0.2 eV at 90 % confidence level through electron spectroscopy of β^- decay electrons from a windowless gaseous tritium source. To determine the spectrometer properties and to calibrate the beamline work function, a Condensed Krypton Source (CKrS) can be inserted into the beamline, providing conversion electrons from ^{83m}Kr. For precision spectroscopy, the KATRIN experiment features a stabilized high voltage system up to −35 kV with ppm level precision. This talk presents the extention of the KATRIN high voltage system to support retarding potentials of up to −40 kV and a consecutive first measurement of a new ^{83m}Kr conversion line using the CKrS following the idea of EPJ C 82 (2022) 700.

The work shown in this talk is funded via BMBF contract number 05A20PMA.

T 114.6 Thu 17:05 POT/0051

Optimization-based Bayesian sensitivity on neutrino mass and constraints on cosmology with the KATRIN experiment — Stephanie Hickford[1], Leonard Köllenberger[1], and •Weiran Xu[2] — [1]Institute for Astroparticle Physics, Karlsruhe Institute of Technology — [2]Laboratory for Nuclear Science, Massachusetts Institute of Technology

The Karlsruhe Tritium Neutrino (KATRIN) experiment has pushed the direct bound of the neutrino mass down to sub-eV level in their first two scientific campaigns. The upcoming data release using a frequentist approach which includes the most recent three measurement campaigns is currently in preparation.

A comprehensive Bayesian analysis provides an alternative interpretation for the prior information and the neutrino mass results. Performing Bayesian sampling is computationally intensive and challenging when including all the systematic uncertainties, e.g. for the shifted analyzing plane configuration of the main spectrometer. New methods to optimize the model calculation will be presented, together with the Bayesian sensitivity for KATRIN's first five measurement campaigns. Constraints on cosmological models with the released data will also be presented within the Bayesian framework.

T 115: Gamma Astronomy V

Time: Thursday 15:50–17:20 Location: POT/0151

T 115.1 Thu 15:50 POT/0151

Quasi-periodic behavior of J1048+7143* — •Armin Ghorbanietemad[1], Ilja Jaroschewski[1], Emma Kun[1,2,3], and Julia Becker Tjus[1] — [1]Theoretical Physics IV, Ruhr University Bochum — [2]CSFK, MTA Centre of Excellence, Hungary — [3]Konkoly Observatory, ELKH, Hungary

Most blazars show short- and long-term variability in their electromagnetic emissions. Some of these have a gamma-ray light curve with a periodic pattern with a declining periodicity called quasi-periodic behavior, which is evident in observations using Fermi-LAT. Jet precession is a possible explanation for such a behavior. Supermassive binary back holes (SMBBHs) are characterized by the change in jet direction accompanied by jet precession close to an imminent merger, which makes them interesting candidates as the origin of quasi-periodic emission. A recent study on the multi-messenger behavior of the blazar J1048+7143 indicates a quasi-periodic behavior in the gamma-ray emissions from 2009 until now. The detected gamma-ray light curve is composed of three double-peak structures, each different in shape and symmetry, which makes conventional ways of signal assessment unsuitable.

In this talk, we analyze the gamma-ray light curve of J1048+7143 and use the centroid approach to find its characterizations, meaning duration and period. Furthermore, we apply our developed jet precession model on this blazar. Our findings show that its gamma-ray flares are compatible with an SMBBH at its center. Then, we use this model to predict its next gamma-ray flares and the time of merger based on its mass ratio. *Supported by DFG (SFB 1491)

T 115.2 Thu 16:05 POT/0151

Potential for detection of M31-like gamma-ray halos with CTA and Fermi-LAT — •Mario Engelmann, Alison Mitchell, and Katrin Streil — Erlangen Centre for Astroparticle Physics Nikolaus-Fiebiger-Str. 2 D-91058 Erlangen Germany

Recent evidence from the Fermi LAT satellite suggests that a gamma-ray halo exits around the Andromeda Galaxy. One explanation for the gamma-ray emission is, that in the inner region of the galaxy, buoyant bubbles of gas are created. These bubbles are pushed outwards and create a cosmic ray Halo around the galaxy. Consequently, the gamma rays are produced via proton-proton interaction of cosmic rays or inverse Compton scattering of cosmic ray electrons with the microwave background photons.

The sensitivity of the Fermi LAT satellite isn't sufficient to observe the whole spectrum in the GeV range. For this reason, observations with CTA can be used to search for emission at higher energies. With this information, the parameters for the spectrum can be fine-tuned. After this, potential candidate galaxies for similar halos will be chosen from the nearby galactic catalogue (maximum distance at 25 Mpc). In this contribution I will compare the sensitivity of CTA and Fermi-LAT to the gamma-ray emission from galaxies similar to the Andromeda galaxy.

T 115.3 Thu 16:20 POT/0151

Satellite trails in H.E.S.S. data — •Thomas Lang, Alison Mitchell, and Samuel Spencer for the H.E.S.S.-Collaboration — Erlangen Centre for Astroparticle Physics

The commercialization of space by private companies such as SpaceX and OneWeb has caused the number of satellites launched in low earth orbit to almost triple to over 4000 in the last three years. 17 constellations with over 400,000 total satellites are planned/proposed, which causes major concerns for ground based astronomy. The impact on Imaging Air Cherenkov Telescopes (IACTs) has been assumed to be low and apart from the brightest trails has not been considered as a significant problem.

This work aims to find and quantify satellite trails in data taken by the High Energy Stereoscopic System (H.E.S.S.), determine which observation times and directions are affected the most, giving a prediction for these effects depending on the satellite numbers and determine whether trails have an impact on the Hillas parameters used to reconstruct high energy particle events.

Trails are found in night sky background (NSB) maps of FlashCam data, the latest camera of the largest telescope (CT5) with a 0.1 s NSB mapping rate, and from this inferred for the other smaller telescopes (CT1-4). Comparisons of the distributions of Hillas parameters will be made of during and around satellite trail passing times.

T 115.4 Thu 16:35 POT/0151

Simultaneous TeV and X-Ray Observations of Markarian 421 in 2020 — •Bernd Schleicher for the MAGIC-Collaboration — University of Würzburg, Institute for Theoretical Physics and Astrophysics, Germany

The blazar Mrk 421 is one of the brightest and most studied sources in very-high-energy (VHE) gamma rays. As the underlying processes of the production of these gamma rays are still under debate and different models predict correlations between X-rays and gamma rays and some hadronic models for example predict specific features in the hard X-ray regime. Therefore, regular multi-wavelength (MWL) campaigns have been carried out since 2009. In late 2020, simultaneous observations were performed with the X-ray satellites XMM-Newton, the International Gamma-Ray Astrophysics Laboratory (INTEGRAL), and the Major Atmospheric Gamma Imaging Cherenkov Telescopes (MAGIC) to check if these hadronic signatures can be found. Two INTEGRAL observations with an long exposure of 165 ks were performed during the time range of 21. November to 24. November and the time range of 12. December to 15. December and data were taken simultaneously with XMM-Newton and MAGIC. The results of this MWL campaign will be presented.

T 115.5 Thu 16:50 POT/0151

Evidence of hadronic origin of the gamma-ray emission from the nova RS Oph by the MAGIC telescopes — •David Green[1], Vandad Fallah Ramazani[2], Francesco Leone[3], Rubén López-Coto[4], Alicia López-Oramas[5], and Julian Sitarek[6] for the MAGIC-Collaboration — [1]Max Planck Institute for Physics, Munich, Germany — [2]Astronomisches Institut (AIRUB) Ruhr-Universität Bochum, Bochum, Germany — [3]National Institute for Astrophysics, Rome, Italy — [4]IAA-CSIC, Granada, Spain — [5]Instituto de Astrofísica de Canarias, Tenerife, Spain — [6]University of Lodz, Faculty of Physics and Applied Informatics, Department of Astrophysics, Lodz, Poland

RS Ophiuchi (RS Oph) is a symbiotic recurrent nova that shows eruptive events roughly every 15 years. On August 8th, 2021, RS Oph erupted with its latest outburst. This event was detected by a wide range of multi-wavelength (MWL) instruments from radio up to very-high-energy (VHE) gamma rays. The MAGIC telescopes followed up on optical and high-energy triggers and initiated an observation campaign from August 9th till September 1st. RS Oph is the first nova detected in the VHE gamma-ray energy range. We report on the detection of VHE gamma rays at a significant level of 13.2σ during the first 4 days of RS Oph with the MAGIC telescopes. We combine the VHE emission detected by MAGIC with optical and high-energy observations and conclude RS Oph accelerated hadrons during its eruption. We will present the MWL modeling revealing this hadronic emission, and its further implications for Galactic cosmic-rays.

T 115.6 Thu 17:05 POT/0151

Performance of joint observations with LST-1 and MAGIC — •Alessio Berti[1], Yoshiki Ohtani[2], Julian Sitarek[3], Federico Di Pierro[4], Yusuke Suda[5], and Elli Jobst[1] for the MAGIC-Collaboration — [1]Max Planck Institute for Physics, Munich, Germany — [2]Institute for Cosmic Ray Research, Tokyo, Japan — [3]University of Lodz, Lodz, Poland — [4]INFN Torino, Torino, Italy — [5]Hiroshima University, Hiroshima, Japan

The next generation ground-based instrument for very high energy gamma rays observations will be the Cherenkov Telescope Array (CTA). In one of the two planned sites, La Palma (Canary Islands, Spain), the first prototype of a Large Sized Telescope, LST-1, is already operational and is currently under commissioning. The proximity of the two MAGIC telescopes offers a unique opportunity to perform joint observations with LST-1. This three-telescope system provides a better reconstruction of the events, both in angular and energy resolution, and discrimination between showers initiated by gamma rays and cosmic rays, which turns into an improvement in sensitivity with respect to LST-1 or the two MAGIC telescopes separately. In this contribution, we will report on results from Crab Nebula data with a pipeline developed for the analysis of joint LST-1 and MAGIC observations, and show the performance estimated both from real and simulated data.

T 116: Neutrinos Legend, Neutrino Theory

Time: Thursday 15:50–17:20 Location: POT/0251

T 116.1 Thu 15:50 POT/0251

Polyethylene-Naphthalate-Based Wavelength Shifting Reflectors for LEGEND-1000 — •Andreas Leonhardt, Maximilian Goldbrunner, and Stefan Schönert for the LEGEND-Collaboration — Physik Department, Technische Universität München, Garching, Germany

The next-generation experiment LEGEND-1000 will search for the neutrinoless double-beta decay ($0\nu bb$) of Ge-76 with unprecedented discovery potential covering the inverted neutrino mass ordering. To this end, 1000 kg of enriched germanium is employed bare in a segmented liquid Argon (LAr) volume. Particle interactions in LAr produce vacuum-ultraviolet (VUV) light flashes peaking at 128 nm, which are converted to longer wavelengths by wavelength shifters (WLSs). To efficiently instrument the LAr volume in LEGEND-1000, a large-scale wavelength shifting reflector (WLSR) based on polyethylene naphthalate (PEN) will be lined on the inner cryostat wall. In this talk, we describe the custom VUV spectrofluorometer used for the optical characterization of PEN-based WLSRs at VUV excitation and cryogenic temperatures. We present the first measurement of the wavelength-resolved photoluminescence yield of PEN for VUV excitation at cryogenic temperatures and compare it to the commonly used wavelength shifter tetraphenyl butadiene (TPB). This research is supported by the DFG through the Excellence Cluster ORIGINS and the SFB1258.

T 116.2 Thu 16:05 POT/0251

Trace gas analysis of unpurified and purified liquid argon by mass spectrometry for LEGEND — •Christoph Vogl, Martin Guevara, Alice Ortmann, and Stefan Schönert — Physics Department, TU-Munich

Liquid argon is commonly used as a medium for particle detection in rare event searches and particle physics experiments. Its performance is heavily impaired in the presence of electronegative impurities, typically oxygen, nitrogen, and water. The chemical purity of liquid argon can be assessed indirectly by measuring its scintillation properties. A complementary and direct way of determining purity is through mass spectrometry. In this talk, we will present our new quadrupole mass spectrometer setup (IDEFIX) and discuss the main challenges and solutions. Results are shown regarding the assessment of the chemical composition of commercial and in-house purified liquid and gaseous argon. This research is supported by the BMBF through the Verbundforschung 05A20WO2 and by the DFG through the Excellence Cluster ORIGINS.

T 116.3 Thu 16:20 POT/0251

Set Up and Run of a Cherenkov Test Detector — •Ivana Nikolac — Physikalische Institut, Eberhard Karls Universität Tübingen, Tübingen, Germany

High-energy particles, like muons, can cross many kilometres of rock and penetrate even the deepest underground laboratories, causing a non-negligible background in rare-event experiments. Muons can also produce neutrons, which mimic dark matter signals. This makes the muon veto an integral part of any rare-event underground experiment. To test the properties of a muon veto system, at the University of Tübingen a small volume water Cherenkov veto is being set up. The instrument (DODI) is a dodecahedron-shaped steel tank with a capacity of 700 litres, lined inside with highly reflective foil, and equipped with eleven photomultiplier tubes (PMTs). Due to its relatively small size and easy access to both its exterior and interior parts, DODI offers the opportunity to probe the muon veto system and its efficiency in real-time. This can be achieved, for example, by introducing different reflective materials in the tank or changing the PMT types. For future experiments, DODI will be further tested as a neutron tagger, first with water and then by introducing different Gadolinium arrangements into the water to improve the efficiency.

T 116.4 Thu 16:35 POT/0251

Neutrino Decay in JUNO — •George Parker, Marcel Büchner, Tim Charisse, Arshak Jafar, Joachim Kopp, Kai Loo, Oliver Pilarczyk, and Michael Wurm — Johannes Gutenberg Universität Mainz, Mainz, Germany

The decay of the neutrino mass eigenstates are well-constrained using astrophysical neutrinos, with the exception of neutrino mass eigenstate $\nu 3$, which has a much less stringent lifetime bound. In this work, we explore the sensitivity of the Jiangmen Underground Neutrino Experiment (JUNO) to $\nu 3$-decay. JUNO is a next-generation reactor neutrino liquid-scintillator detector with enhanced flavour sensitivity, exceptional energy resolution and high statistics, which operates on a medium-baseline and could be uniquely tuned to uncover evidence of neutrino decay. We consider the signature of $\nu 3$-decay on the neutrino oscillation spectrum in the case of (1) invisible decay, where the daughter states are not observable; and (2) visible decay, where the daughter states are active neutrinos. We comment on how neutrino decay models can be embedded into larger consistent theories.

T 116.5 Thu 16:50 POT/0251

Decoherence Effects of Reactor Neutrinos — •Raphael Krüger — Theoretical Astroparticle Physics at IAP, Karlsruhe Institute of Technology, Karlsruhe, Germany

In the most common theoretical formulation of Neutrino Oscillations neutrinos are described by plane waves. Although this formulation gives the correct oscillation formula verified by experiments it must be considered physically wrong. Several conceptual problems of the plane wave treatment, i.e. violated Lorentz invariance, can be avoided if one uses the QFT with external wave packets approach. There decoherence effects automatically emerge from the formalism. These decoherence effects depend on the localizations of the external particles and are negligible for the standard mass splittings.

This work focuses on reactor neutrino experiments and whether decoherence effects may play a role for the mixing with a potential light sterile neutrino. First, the localizations of the external particles are estimated on physical grounds. Using these results, the decoherence effects on the spectrum of the measured positron in the detector are analysed. Here this work makes use of a consistent treatment of the problem starting from basics feynman rules and without the use of normalizations introduced by hand. The results give no observable decoherence effects.

T 116.6 Thu 17:05 POT/0251

Light new particles in tritium beta decay — •Philipp Goller, Syuhei Iguro, and Ulrich Nierste — Institut für Theoretische Teilchenphysik (TTP), Karlsruhe Institute of Technology (KIT)

A hypothetical new light particle S interacting with neutrinos can be produced in the tritium beta decay studied in the KATRIN experiment. Near the kinematic endpoint the presence of various small energy scales (neutrino mass and energy, mass of S) require a careful treatment of the phase space integral. I present the prediction for the differential decay rate in the region probed by KATRIN and discuss the shape of the electron energy spectrum for different mass scenarios.

T 117: Dark Matter I

Time: Thursday 15:50–17:20 Location: POT/0361

T 117.1 Thu 15:50 POT/0361

Investigating Dielectric Loss in Travelling Wave Parametric Amplifiers for MADMAX — •Georg Monninger[1], Gwenael Le-Gal[2], Giulio Cappelli[2], Béla Majorovits[1], and Nicolas Roch[2] for the MADMAX-Collaboration — [1]Max-Planck-Institut für Physik, Munich, Germany — [2]Institut Néel, 38000 Grenoble, France

MADMAX is an experiment for the search of dark matter axions. In order to have the required senstivity, preamplifiers are required that operate at or close to the quantum limit. To reach standard quantum limit, a major open challenge is to improve the added noise in TWPA. One of the main phenomena, which could contribute to the noise, is capacitive dielectric loss. Losses become especially large when going to higher frequencies, as we are looking for when probing the axion mass in the range of 40 – 400 μeV at MADMAX. To investigate their origin, $\lambda/2$-Josephson resonators were built to measure $\tan(\delta)$ via extraction of quality factors. Two geometries were compared. This talk shows the measurement procedure and the obtained results.

T 117.2 Thu 16:05 POT/0361

Bead pull method on an open dielectric haloscope — •Jacob Egge for the MADMAX-Collaboration — Institut für Experimentalphysik, Universität Hamburg, Luruper Chaussee149, 22761 Hamburg

The **MA**gnetized **D**isk and **M**irror **A**xion e**X**periment is a dielectric haloscope that aims to search for axionic dark matter. It uses a stack of movable dielectric disks, called a booster, to enhance the weak axion signal. In order to calibrate the setup, the electromagnetic field inside the booster needs to be known. This is a difficult challenge as the complex design and open nature of the booster do not permit a simple mode analysis as in the traditional, closed cavity haloscopes. However, having an open and tunable setup also provides unique opportunities for additional measurements of the electromagnetic field of the booster. In this talk, I will present the first results of so-called bead pull measurements on a minimal dielectric haloscope and how they can be used to calibrate the setup.

T 117.3 Thu 16:20 POT/0361

Measurements of dielectric properties of single crystal sapphire (Al2O3) for the axion dark matter search experiment, MADMAX — •Haotian Wang, Alexander Schmidt, and Erdem Oez for the MADMAX-Collaboration — III. Physikalisches Institut A ,RWTH, Aachen, Germany

Axions are one of the candidates for cold dark matter and will be searched in the range of microwave frequencies from 10 to 100 GHz in the magnetized disk and mirror axion (MADMAX) experiment. Multiple dielectric disks will be used to amplify the axion signal. The dielectric properties, dielectric constant and loss tangent, of the disk materials affect the boost factor, so precise knowledge of them is crucial for the detection of axion. Here we present measurement results of dielectric properties of sapphire (Al2O3), a candidate material for the dielectric disks, at room temperature (295-297 K) and at 18 K. The measurements are done in the 10 to 40 GHz range using a microwave resonator.

T 117.4 Thu 16:35 POT/0361

Further dark matter searches using ALPS II's TES detector — •Christina Schwemmbauer for the ALPS-Collaboration — Deutsches Elektronen-Synchrotron, Hamburg, Germany

The elusive **D**ark **M**atter (DM), proposed due to its gravitational interaction with ordinary matter, supposedly makes up ~ 25% of our universe. Various models aim to explain the origin and properties of DM, many of these proposing beyond standard model particles to make up most of the DM in our universe. The ALPS II (**A**ny **L**ight **P**article **S**earch II) light-shining-through-walls experiment will use **T**ransition **E**dge **S**ensors (TESs) to detect low-energy single-photons originating from axion(ALP)-photon conversion with rates as low as 10^{-5} cps.

Even beyond ALPS II, these superconducting microcalorimeters, operated at cryogenic temperatures, could help search for further particle-DM candidates. Much of the work to ensure the viability of the TES detector for use in ALPS II, such as calibrating the detector and mitigating external sources of backgrounds, also leads to the ability to utilize the TES for an independent direct-DM search. For this purpose, the superconducting sensor, sensitive to sub-eV energy depositions, can be used as a simultaneous target and sensor for DM-electron scattering for sub-MeV DM. Hence, direct DM searches with TES could explore parameter space as-of-yet inaccessible by nucleon-scattering experiments.

T 117.5 Thu 16:50 POT/0361

Heterodyne detection of weak fields in ALPS II — •Isabella Oceano for the ALPS-Collaboration — Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

The Any Light Particle Search II (ALPS II) is a Light Shining through a Wall experiment at DESY in Hamburg, which will hunt for axions and axion-like particles in the sub-meV mass range with an axion-photon-photon coupling $g_{a\gamma\gamma} > 2 \times 10^{-11}$ GeV^{-1}. To do this, a high-power laser will be directed through a strong magnetic field where some of the photons can convert into a beam of axion-like particles. After this, the beam will cross a light-tight barrier and another strong magnetic field where some of the axion-like particles can convert back into photons and be detected. During the first data acquisition, planned for early 2023, a HETerodyne (HET) interferometer will be used to detect the reconverted photons. This very sensitive interferometer can detect very weak signals at the exact signal frequency.

The HET principle and its implementation in ALPS II will be discussed in this talk.

T 117.6 Thu 17:05 POT/0361

Impact of axion decay on the extragalactic background light — •Sara Porras Bedmar, Manuel Meyer, and Dieter Horns — Institut für Experimentalphysik, Universität Hamburg, Luruper Chaussee 149, D-22761 Hamburg

The Extragalactic Background Light (EBL) is an isotropic diffuse radiation field of extragalactic origin. Assuming that dark matter consists of axions with masses on the order of electron volts, we expect an additional contribution to the EBL due to their decay into two photons.

Here, we model the main light-emitting processes that constitute the EBL: stellar populations, intra-halo light, and dust. Utilizing the Starburst99 and SWIRE code libraries we create synthetic spectra to characterize the stellar components. Our model critically depends on structure formation and evolution, encoded in the star formation rate history, as well as star metallicity, and the distribution and composition of dust. We explore the dependencies of our model on these parameters, as measurements of these quantities are highly uncertain. In addition to these astrophysical EBL components, we include the contribution of decaying dark matter axions. Through a comparison of our model with the most recent direct and indirect EBL measurements, we are able to constrain the photon-axion coupling in the mass range from ~ 0.1 – 10 eV.

T 118: Dark Matter II

Time: Thursday 15:50–17:20 Location: POT/0006

T 118.1 Thu 15:50 POT/0006

R&D of large-scale electrodes for future generation TPCs — •Vera Hiu-Sze Wu, Alexey Elykov, and Francesco Toschi — Karlsruhe Institute of Technology, Institute for Astroparticle Physics

The DARk matter Wimp search with liquid xenoN (DARWIN) observatory is a future dark matter detector aiming at reaching the sensitivity for WIMPs at the neutrino floor and covering the mass range from 5 GeV/c2 to above 10 TeV/c2 [1]. The observatory uses the technology of a dual-phase time projection chamber (TPC) with a 40 t active volume of liquid xenon (LXe) [1].

The electrodes of the TPC are the vital components for 3D position reconstruction of the signal, benefiting the event selection processes. When designing the electrodes, we have to calculate and optimize the electrostatic. At the same time, the mechanical stability, the feasibility of manufacturing and treatment, as well as to minimization of spark and electron emission has to be ensured. Here we present our investigations of hexagonal mesh electrodes, including mechanical stability and handling as well as the first test of local high-voltage field emission.

[1] J. Aalbers et al., J. Cosmol. Astropart. Phys., 11, 017 (2016)

T 118.2 Thu 16:05 POT/0006

A high resolution scanning set-up for defect detection on electrodes — •Alexander Deisting[1], Jan Lommler[1], Shumit Mitra[1], Uwe Oberlack[1,2], Fabian Piermaier[2], Quirin Weitzel[2], and Daniel Wenz[1] — [1]Institut für Physik & Exzellenzcluster PRISMA+, Universität Mainz — [2]PRISMA Detector Laboratory, Universität Mainz

Achieving as low backgrounds as possible is key when operating time projection chambers (TPCs) for dark matter searches. One source of background signals is the (field) emission of electrons from the electrodes inside the detector. For dual phase TPCs, similar to XENONnT, these electrodes are meshes or grids with wire diameters of $200 - 300\,\mu$m, operated at a high voltage (HV) $\gg 1$ kV.

The scanning set-up at the PRISMA Detector Laboratory features a high resolution camera mounted to a gantry robot system. The camera's resolution of $1.4 \times 1.4\,\mu\text{m}^2$ provides detailed images of electrode wires. A 3D confocal microscope with a resolution better than 1 μm is used for studies on the μm scale. We will present results of mesh-scans.

The high resolution images uncover an abundance of microscopic "defects" but they do not show whether a found spot will enhance electron emission and thus the background signals in the TPC or not. To asses the defects' nature we extended the set-up with an overview camera and a HV supply. An electrode wire in a gas may emit electrons, resulting in a corona discharge, which the overview camera records. We present the set-up and report on our progress of matching regions of corona discharges with defects uncovered in the high resolution scan.

T 118.3 Thu 16:20 POT/0006

Understanding xenon scintillation properties — •Robert Hammann, Dominick Cichon, Luisa Hötzsch, Florian Jörg, Teresa Marrodán Undagoitia, and Mona Piotter — Max-Planck-Institut für Kernphysik

Xenon in gaseous and liquid form is a commonly used detector target material for rare-event searches like the direct detection of dark matter. The material has a number of beneficial properties for this application, one being that it is an excellent scintillator. Most xenon-based detectors rely on measuring the scintillation light component emitted in the vacuum ultraviolet range, however, light is also emitted in a wide spectrum of longer wavelengths. Exploring this parameter space could enable the construction of even more sensitive detectors in the future.

In this contribution, we present first measurements with a dedicated setup to extend our knowledge of the scintillation response in gaseous xenon to infrared light, which is so far not exploited in the field. In order to assess the usefulness of this wavelength range for rare-event searches, it is essential to characterize its response. We report measurements of the scintillation light yield for varying levels of electromagnetic impurities and as a function of the xenon gas pressure.

T 118.4 Thu 16:35 POT/0006

The CRESST-III Dark Matter Search: Status and Outlook — •Christian Strandhagen for the CRESST-Collaboration — Eberhard-Karls-Universität Tübingen, D-72076 Tübingen

The CRESST experiment (Cryogenic Rare Event Search with Superconducting Thermometers) operates an array of cryogenic detectors using different target materials in a well-shielded setup at the LNGS (Laboratori Nazionali del Gran Sasso) underground laboratory in Italy to search for nuclear recoils induced by scattering of dark matter particles in the detectors. With detection thresholds for nuclear recoils as low as 10 eV, CRESST is among the leading experiments in the search for low mass dark matter particles. The most recent measurement campaign, which started in summer 2020, was focused on investigating the origin of an unexplained event population at very low energies ("low energy excess") which is limiting the sensitivity of the experiment in the low mass region. We present the status of CRESST-III and report on observations of the low energy excess and dark matter results. Finally we show our plans for the coming years including the upgrade of the readout electronics.

T 118.5 Thu 16:50 POT/0006

A low-threshold diamond cryogenic detector for sub-GeV Dark Matter searches — •Anna Bertolini[1], Gode Angloher[1], Antonio Bento[1,2], Lucia Canonica[1], Nahuel Ferreiro Iachellini[1], Dominik Fuchs[1], Abhijit Garai[1], Dieter Hauff[1], Athoy Nilima[1], Michele Mancuso[1], Federica Petricca[1], Franz Probst[1], Francesca Pucci[1], Ahmed Abdelhameed[1], Elia Bertoldo[1,3], and Johannes Rothe[1,4] — [1]Max-Planck-Institut für Physik, München, Germany — [2]LIBPhys-UC, Departamento de Fisica, Universidade de Coimbra, Coimbra, Portuga — [3]Institut de Física d'Altes Energies (IFAE), Barcelona Institute of Science and Technology (BIST), Bellaterra (Barcelona) — [4]Physik-Department and Excellence Cluster Universe, Technische Universität München, D-85748 Garching, Germany

Recently the sub-GeV dark matter (DM) mass region has started to be probed. To explore this region, detectors with a low energy threshold are required. Recent developments in the production of diamond crystals allow for high-quality large-mass diamonds that can be used as DM detectors. Thanks to their superior cryogenic properties, diamond detectors can reach an energy threshold in the eV range. In this contribution the realization of the first low-threshold cryogenic detector that uses diamond as absorber for astroparticle physics applications will be reported. Two diamond samples instrumented with a W-TES have been tested, showing transitions at about 25 mK. The performance of the diamond detectors will be presented highlighting the best performing one, reaching an energy threshold of 16.8 eV.

T 118.6 Thu 17:05 POT/0006

ELOISE - Reliable Background Simulation at Sub-keV Energies — •Holger Kluck — Institut für Hochenergiephysik der Österreichischen Akademie der Wissenschaften, 1050 Wien, Österreich

$CaWO_4$ is a well-known target material for experiments searching for rare events like coherent elastic neutrino-nucleus scattering (CEνNS) with NUCLEUS or hypothetical dark matter-nucleus scattering with CRESST. Pushing the detection threshold down to sub-keV energies, experiments encounter new phenomena like an exponential rise of observed events towards lowest energies of yet unknown origin. This highlights the need for verified and reliable simulations of radioactive background components at sub-keV energies, e.g. based on the widely used Geant4 toolkit.

The ELOISE project aims to tackle this issue for electromagnetic particle interactions in $CaWO_4$ in a two-stage approach: First by a systematic evaluation of the current accuracy by comparing benchmark simulations with data from extended literature research and dedicated measurements. Second, if needed, ELOISE intend to develop bespoken simulation code for $CaWO_4$ to improve the accuracy at the sub-keV energy regime. Currently, ELOISE conduct a dedicated measurement of electronic energy loss in $CaWO_4$ via ionization.

In this contribution, I will first motivate the problem and outline the scope of ELOISE. Afterwards, I will report first results of ELOISE's reference measurements. Finally, I will discuss our preliminary findings and its implication for rare event searches with $CaWO_4$.

T 119: Neutrino Astronomy IV

Time: Thursday 15:50–17:05 Location: POT/0112

T 119.1 Thu 15:50 POT/0112

Search for neutrinos from AGN using a machine-learning-based source selection — •Sebastian Schindler for the IceCube-Collaboration — ECAP, University Erlangen-Nürnberg, Germany

The IceCube Neutrino Observatory is currently the world's largest high-energy neutrino detector. After the detection of a diffuse astrophysical neutrino flux in 2013, one of the main goals has been to associate parts of this flux with specific source classes. A few "hot spots" at or above the three-sigma level have been found and associated with certain classes of Active Galactic Nuclei (AGN). Most recently, the Seyfert II galaxy NGC 1068 was associated with a neutrino flux at a significance of 4.2 σ, and there is growing evidence for a neutrino flux from blazars. However, the underlying physical processes of neutrino production remain poorly understood. One problem for neutrino-source searches comes from the use of historically-driven class definitions of AGN, which are based on specific spectral properties that are not necessarily optimal for the selection of potential neutrino sources.

This talk will motivate a study that aims to address this problem in two stages. The first stage will use multi-wavelength data to define a source selection using modern machine-learning approaches in a way that emphasizes intrinsic physical properties and mostly disregards the general AGN classification. This will allow to identify potential neutrino sources similar in physical properties to those associated with the currently detected "hot spots". The second part will perform a statistical analysis in the form of a correlation analysis, for example a stacking search, using these previously defined source selections.

T 119.2 Thu 16:05 POT/0112

Searching for neutrino point-sources in the northern hemisphere with IceCube: recent results and outlook — •Elena Manao, Chiara Bellenghi, Martin Ha Minh, Tomas Kontrimas, and Martin Wolf for the IceCube-Collaboration — Technische Universität München

The IceCube Neutrino Observatory is a one cubic kilometer neutrino telescope deployed deep in the Antarctic ice at the South Pole. One of its main goals is to identify sources of the diffuse astrophysical neutrino flux, discovered by IceCube in 2013. In this talk we present the results of the search for neutrino point-sources in the northern hemisphere, which found evidence of astrophysical neutrino emission from the active galaxy NGC 1068 with a global significance of 4.2σ, and the prospects of an extension of this analysis with several additional years of data.

T 119.3 Thu 16:20 POT/0112

Solving the multi-messenger puzzle of the AGN-starburst composite galaxy NGC 1068 * — Bjoern Eichmann[1,2], Foteini Oikonomou[2], •Silvia Salvatore[1], Ralf Juergen Dettmar[1], and Julia Becker Tjus[1] — [1]Theoretical Physics IV, Ruhr University Bochum, Bochum, Germany — [2]Institutt for fysikk, Norwegian University for Science and Technology (NTNU), Trondheim, Norway

Multi-wavelength observations indicate that some starburst galaxies show a dominant non-thermal contribution from their central region. These active galactic nuclei (AGN)-starburst composites are of special interest, as both phenomena on their own are potential sources of highly-energetic cosmic rays and associated gamma-ray and neutrino emission. In our work, a homogeneous, steady-state two-zone multi-messenger model of the non-thermal emission from the AGN corona as well as the circumnuclear starburst region is developed and subsequently applied to the case of NGC 1068, which has recently shown some first indications of high-energy neutrino emission. We show that the entire spectrum of multi-messenger data - from radio to gamma-rays including the neutrino constraint - can be described very well if both, starburst and AGN corona, are taken into account. Using only a single emission region is not sufficient.

Supported by DFG (SFB|,1491)

T 119.4 Thu 16:35 POT/0112

Estimate of Galactic Neutrino emission — •Mohadeseh Ozlati Moghadam[1], Kathrin Egberts[1], Constantin Steppa[1], Rowan Batzofin[1], and Elisa Bernardini[2] — [1]University of Potsdam, Potsdam, Germany — [2]University of Padova, Padova, Italy

The origin of high-energy cosmic rays is an enduring mystery in science. As cosmic rays propagate through the universe, they interact with the environment, which eventually produces high-energy neutrinos as well as gamma rays.

High-energy Neutrinos are an unambiguous signal of hadronic interaction and, thus, provide valuable information about particle acceleration mechanisms and the origin of cosmic rays. On the other hand, identifying neutrino sources is a longstanding challenge. Exploiting the simultaneous production of neutrinos and gamma rays, neutrino sources are typically identified based on the tempo-spatial coincidence of variable emission of point-like objects. This has resulted in the detection of TXS 0506+056 as one extragalactic source for Neutrinos.

However, from VHE gamma-ray observation, we know there is a population of Galactic sources, some of which are expected to produce neutrinos as well. In this contribution, we use simulations of the*Galactic*population of*steady*VHE gamma-ray sources to estimate the Galactic neutrino flux. For this, a parametrization of the neutrino production for a given gamma-ray signal is used. We will present a galactic map of expected neutrino fluxes and will make a comparison with data.

T 119.5 Thu 16:50 POT/0112

Integration of the KM3NeT instrument response function with gammapy software — •Mikhail Smirnov for the ANTARES-KM3NET-ERLANGEN-Collaboration — Friedrich-Alexander-Universitat Erlangen-Nurnberg (FAU), Erlangen Centre for Astroparticle Physics, Erwin-Rommel-Straße 1, 91058 Erlangen, Germany

The instrument response function (IRF) contains all the necessary information about the physical properties of a neutrino telescope. It is an ideal tool for quick estimation of the sensitivity of the detector to an incoming neutrino flux from distant sources. Since a similar approach is used in gamma ray astronomy, both communities can benefit from using the same software tools and standards. Nowadays the gammapy python package is a standard tool used in the gamma ray community. Synergy between the KM3NeT IRF and gammapy will allow us to use the power of this package and at the same time to push forward the developments of combined analyses in the context of open science. In gammapy, the IRF consists of four main data domains and it is a part of the DL3 format along with the event list. In order to make KM3NeT data compatible with gammapy, the km3irf python package is being developed. This contribution covers in detail the km3irf package and the compatibility of the km3net data with gammapy.

T 120: Cosmic Ray V

Time: Thursday 15:50–17:20 Location: POT/0013

T 120.1 Thu 15:50 POT/0013

Unfolding the Atmospheric Muon Spectrum Using Stopping Muons in IceCube* — •Lucas Witthaus for the IceCube-Collaboration — TU Dortmund University

The IceCube Neutrino Observatory is a cubic kilometer neutrino detector located in the ice sheet close to the geographical South Pole. Its primary goal is the observation of neutrinos. However, the majority of detected events is caused by atmospheric muons produced in cosmic ray induced air showers in the upper layers of the atmosphere. Upon entering the antarctic ice, the muons are subject to significant energy losses due to interactions with the surrounding matter, resulting in a limitation of their propagation length. This talk presents the unfolding of the stopping muons depth intensity, providing information about the abundance of atmospheric muons in the South Pole ice. It is conducted on a subset of events, comprising single muons, which stop inside the IceCube detector. Deep neural networks are used to perform the event classification and reconstruction tasks.

* Supported by the BMBF and the DFG (SFB 1491)

T 120.2 Thu 16:05 POT/0013

Improved Measurements of Seasonal Variations of the Atmospheric Neutrino Flux with IceCube — •Shuyang Deng, Jakob Bötter, Hannah Erpenbeck, Philipp Fürst, Erik Ganster, Matthias Thiesmeyer, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B RWTH Aachen University

The IceCube Neutrino Observatory is proven to be highly efficient in detecting atmospheric neutrinos that originate from cosmic-ray induced air showers. The high statistics allow measuring the correlation between the atmospheric neutrino flux and atmospheric properties such as temperature. This correlation depends particularly on the early hadronic development of air showers in the upper atmosphere. In this talk we present the extension of a previous analysis from six years to about ten years of observations. Furthermore, we investigate improved descriptions of atmospheric temperature profiles, and test the prediction of different hadronic interaction models.

T 120.3 Thu 16:20 POT/0013

Searching for the Prompt Component of the Atmospheric Muon Flux — Pascal Gutjahr, Jean-Marco Alameddine, Mirco Hünnefeld, and •Ludwig Neste for the IceCube-Collaboration — Astroparticle Physics WG Rhode, TU Dortmund University, Germany

The muon is connected to many challenges in current physics, such as the muon puzzle in cosmic-ray induced air showers. The prompt component of the atmospheric muon flux has not been measured with high significance, yet. Understanding and measuring the prompt muon flux could help to better understand these challenges and help to test hadronic interaction models.

Atmospheric muons stem from the decay of particles created in hadronic interactions and their flux can be divided into a conventional and a prompt component. In the conventional part, muons originate from the decay of long-lived particles, mainly pions and kaons. In the prompt part, muons are produced by the decay of short-lived mesons. They consist of charmed mesons, strange mesons and unflavored ones.

In this talk, the current state of the analysis, which aims to confirm the existence of the prompt muon flux with the IceCube detector, is presented. Previous analyses suffered from statistical and systematic uncertainties in Monte Carlo simulations. Thus, we evaluate and create a new set of Monte Carlo simulations specialized to measure the prompt component.

Supported by BMBF (ErUM) and DFG (SFB 1491).

T 120.4 Thu 16:35 POT/0013

Sensitivity of IceCube-Gen2 for Cosmic-Ray Anisotropy Studie — •Wenjie Hou for the IceCube-Gen2-Collaboration — Institute for Astroparticle Physics, Karlsruhe Institute of Technology (KIT)

At which energy the transition from Galactic to extra-galactic cosmic rays (CRs) takes place is one of the major unresolved issues of cosmic ray physics. One expects to get strong constraints by studying the anisotropy in the cosmic-ray arrival directions. Recently, the cosmic ray anisotropy measurements in the TeV to PeV energy range were updated from IceCube using its 11 years of data. Moreover, IceCube-Gen2 is designed to achieve an exposure about 8 times larger than the IceCube area, as well as more statistics and capability to investigate the cosmic-ray anisotropy with higher sensitivity. The sensitivity of IceCube-Gen2 to anisotropy is in particular a matter of statistics. Taking into account the detector exposure of IceCube-Gen2 and the dipole input, we build a Monte Carlo toy model for IceCube-Gen2 and randomly generate the arrival directions for 10 years of measurements. In this case, the relative intensity maps, significance maps and angular power spectrum can be investigated. More importantly, by scanning the dipole declination and zenith threshold, we can determine under what conditions IceCube-Gen2 could achieve the highest sensitivity to observe the cosmic-ray anisotropy. In general, the current studies on the sensitivity of IceCube-Gen2 for CR anisotropy will also be discussed.

T 120.5 Thu 16:50 POT/0013

Studies on Monte Carlo generator tuning for cosmic-ray induced air shower simulations * — Kevin Kröninger, Salvatore La Cagnina, and •Michael Windau — TU Dortmund, Fakultät Physik

Monte Carlo (MC) generators are a fundamental tool in particle and astroparticle physics. To achieve a high-quality simulation of physical processes involving hadrons, the hadronic interaction model of the generator must be tuned efficiently. The free parameters of MC generators are optimized with the help of experimental data and Bayesian methods.

One area of application for MC generators is the simulation of cosmic-ray induced air showers in the Earth's atmosphere. Since hadronic interactions have a direct influence on the composition of secondary particles in the shower formations, tuning the parameters of these hadronic models has an impact on crucial observables such as the muon number.

In this talk, studies on the tuning of Monte Carlo generators for cosmic-ray induced air showers are presented.

* Supported by the DFG (SFB 1491)

T 120.6 Thu 17:05 POT/0013

Fixed-target $\pi^{\pm}$ C interactions at GeV energies simulated with PYTHIA8* — •Chloé Gaudu — Bergische Universität Wuppertal, Gaußstraße 20, 42119 Wuppertal, Germany

Understanding the properties of extensive air showers (EAS) is of prime importance for extracting the properties of ultra high-energy cosmic rays from data, such as collected by the Pierre Auger Observatory. Inferring their primary energy and, most importantly, their primary mass relies on detailed comparisons of EAS measurements with corresponding air shower simulations. The largest uncertainties in such simulations are caused by limited knowledge of hadronic interactions at high energies. To assess the effect of such uncertainties, different hadronic interactions are applied in EAS simulations, each of them being tuned to accelerator data. PYTHIA8 is a hadronic interaction model that is frequently used in the context of LHC experiments and is well suited to be tuned to accelerator data, but up to now has only rarely been used in EAS simulations. This contribution focuses on studying the production cross-sections and p_T-integrated particle spectra from charged pion-carbon fixed-target collisions at momenta between 3 and 350 GeV/c and comparing them against the newest version of the hadronic interaction model PYTHIA8. Three distinct datasets from the HARP, HARP-CDP, and NA61/SHINE collaborations are used for this purpose. The validity of the model to describe the experimental datasets is investigated using the RIVET interface. We discuss the results of this comparison as well as the effects to the uncertainties of EAS simulations. **Supported by DFG (SFB 1491).*

T 121: Cosmic Ray VI

Time: Thursday 15:50–17:20 Location: POT/0351

T 121.1 Thu 15:50 POT/0351

Detector Design Update for the AFIS Sattelite Mission — •Liesa Eckert[1], Peter Hinderberger[1], Martin J. Losekamm[1], Stephan Paul[1], Thomas Pöschl[1], and Sebastian Rückerl[2] — [1]Technical University of Munich, Department of Physics, Garching, Germany — [2]Technical University of Munich, Department of Aerospace and Geodesy, Garching, Germany

Radiation in space consists of charged particles, photons, and neutrons. We aim to measure the charged nuclear component of the radiation environment with CubeSat-sized detectors composed of scintillating-plastic fibers read out by silicon photomultipliers (SiPMs). With different detector versions, we study the radiation's composition for dosimetry with the RadMap Telescope and aim to measure the flux of antiprotons trapped in the Earth's magnetic field with the upcoming AFIS mission.

For the latter, we are currently improving the detector design and plan to verify the updated version as part of the In-Orbit Verification Experiment 1 (IOV-1) on the International Space Station.

In this talk, I will present the current detector design as used in the RadMap Telescope, as well as the opportunities for improvement we identified during production and calibration. Furthermore, I will show which changes we plan to apply to the current design to achieve a better performance and simplify production for future missions.

Our work is funded by the German Research Foundation (DFG, project number 414049180) and under Germany's Excellence Strategy - EXC2094 - 390783311.

T 121.2 Thu 16:05 POT/0351

Onboard Data Processing for the AFIS Satellite Mission — •Peter Hinderberger[1], Martin J. Losekamm[1], Stephan Paul[1], Thomas Pöschl[1], and Sebastian Rückerl[2] — [1]Technical University of Munich, Department of Physics, Garching, Germany — [2]Technical University of Munich, Department of Aerospace and Geodesy, Garching, Germany

The Antiproton Flux in Space (AFIS) satellite mission aims to measure the flux of antiprotons trapped in Earth's Van Allen radiation belts at energies of 20 to 100 MeV. The mission's central instrument is a charged-particle detector comprised of scintillating-plastic fibers and silicon photomultipliers. We are testing a range of processing approaches and hardware options to filter and analyze the recorded data in real time in order to reduce the amount of data that needs to be sent to ground. In this contribution, we present the technical motivation of these approaches, as well as early test implementations and simulations. Our work is funded by the German Research Foundation (DFG, project number 414049180) and under Germany's Excellence Strategy - EXC2094 - 390783311.

T 121.3 Thu 16:20 POT/0351

The RadMap Telescope — Ready for Flight — •Martin J. Losekamm[1], Liesa Eckert[1], Peter Hinderberger[1], Stephan Paul[1], Thomas Pöschl[1], and Sebastian Rückerl[2] — [1]Technical University of Munich, Department of Physics, Garching, Germany — [2]Technical University of Munich, Department of Aerospace and Geodesy, Garching, Germany

The RadMap Telescope will demonstrate new technologies for the characterization of the nuclear component of cosmic rays by measuring the radiation environment aboard the International Space Station (ISS). At the heart of the instrument is a tracking calorimeter made from scintillating-plastic fibers and silicon photomultipliers capable of recording particle-dependent energy spectra; several silicon-based dosimeters provide additional dosimetry information. RadMap will be deployed to the ISS in March 2023, with operations expected to begin a few weeks later. In this contribution, we present the instrument design, its capabilities, and our plans for on-orbit operations that shall lead to a full validation of the central detector and its read-out electronics. Our work is funded by the German Research Foundation (DFG, project number 414049180) and under Germany's Excellence Strategy - EXC2094 - 390783311.

T 121.4 Thu 16:35 POT/0351

Resolution limits in low-energy neutrino event reconstruction with IceCube — •Kaustav Dutta, Sebastian Böser, Martin Rongen, and Elisa Lohfink — Johannes Gutenberg Universität Mainz, Germany

The IceCube Observatory is a cubic-kilometer neutrino telescope built into the deep glacial ice at the South Pole. Low energy extensions to the detector include the existing DeepCore subarray and the upcoming IceCube Upgrade. These focus on neutrino oscillation physics using atmospheric neutrinos and are characterized by a denser instrumentation. These elusive particles are indirectly detected by collecting Cherenkov photons emitted by secondary charged particles produced as a result of neutrino-nucleon interactions inside the detector. The reconstruction of event information, in particular direction and energy of an incoming neutrino, is a crucial ingredient to the oscillation analyses. The accuracy of reconstruction is therefore affected by statistical fluctuations in the particle shower development as well as by photon propagation and detection efficiencies of sensors. Here we present first steps to identify the theoretically achievable resolution in the absence of modeling inaccuracies and computational limitations.

T 121.5 Thu 16:50 POT/0351

SkyLLH: A tool for using the public 10-year IceCube point-source data — •Martin Wolf and Chiara Bellenghi — TU-Munich, James-Franck-Straße 1, 85748 Garching, Germany

The IceCube collaboration has released 10 years of recorded data suitable for point-like neutrino source searches. In addition, the instrument response function is provided as well, making this data set usable for neutrino source searches by the public. In this contribution we highlight the tool "SkyLLH", a software framework for performing log-likelihood-ratio-based analyses on celestial data, and its interface to the public 10-year IceCube point-source data. Within the accuracy of the released binned instrument response function, the public data interface of SkyLLH allows to reproduce IceCube's results published in Phys. Rev. Lett. 124, 051103 (2020).

T 121.6 Thu 17:05 POT/0351

Reconstruction of proton showers using H.E.S.S. — •Benedetta Bruno, Jonas Glombitza, and Stefan Funk for the H.E.S.S.-Collaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen Centre for Astroparticle Physics, Nikolaus-Fiebiger-Str. 2, 91058 Erlangen, Germany

Imaging Atmospheric Cherenkov Telescopes (IACTs) - like the High Energy Stereoscopic System (H.E.S.S.) - observe extensive air showers initiated by gamma rays and cosmic rays (CRs) when interacting with the Earth's atmosphere. IACTs image the distribution of Cherenkov light emitted by air shower particles as they propagate toward the Earth's surface. The traditional reconstructions of the properties of the gamma rays rely on the Hillas parameterization, which reduces the measurement to a few characteristics using elliptical modelling of the image.

For the analysis of cosmic rays, which are usually considered background in gamma-ray astronomy, the reconstruction is more challenging. Since the development of hadronic-induced shower is subject to larger fluctuations, the detected IACT images feature deviations from the typical elliptical shape, making modifications necessary.

In this contribution, we utilize H.E.S.S. simulations to investigate the reconstruction of protons using the Hillas parametrization. In addition, we discuss the potential to use deep-learning-based reconstruction techniques to overcome the limits of the Hillas approach and outline the potential of H.E.S.S. data to measure the CR spectrum.

T 122: DAQ Systems

Time: Thursday 15:50–16:50 Location: POT/0106

T 122.1 Thu 15:50 POT/0106

Performance of the ATLAS Level-1 Calorimeter Trigger in Run 3 — •Thomas Junkermann — Kirchhoff-Institut für Physik, Heidelberg

The Phase-I Upgrade of the ATLAS Level-1 Calorimeter Trigger adapts the finer granularity of the spatial information of energy, provided by the upgraded front-end electronics of the Liquid-Argon calorimeter. To process the higher amounts of data a new digital trigger is installed. The new trigger has three feature extractors which each specialize on different calorimeter objects. They identify electrons, photons, taus, jets and missing energy.

The upgraded front-end components for the new digital trigger effect the old trigger system and re-calibration of it is needed as it will be run in Run 3 (started in July 2022) parallel to the new system.

The re-calibrated legacy trigger is the natural candidate to compare the new system to and offers many possibilities to compare and ultimately optimize the new system. Different calibrations are performed and eventually efficiencies and rates will give a deep insight into whether the re-calibration of the old system worked as expected and commissioning and calibration of the new system was succesful. The new trigger is being comissioned during Run 3 and took part in first data taking. With stable running making comparisons possible, the calibration as well as efficiency studies are presented.

T 122.2 Thu 16:05 POT/0106

Anomaly detection for the level 1 trigger system of the CMS experiment — •Sven Bollweg, Karim El Morabit, Lars Emmrich, Gregor Kasieczka, and Artur Lobanov — University of Hamburg, Germany

There exist strong hints for the existence of physics beyond the standard model (BSM). At the CMS experiment, the first event selection step is the Level 1 (L1) trigger system, which decides whether an event is stored for further analysis. Assuming that BSM events differ from standard model (SM) events, a trigger decision could then utilize this difference to detect anomalous event properties instead of being fully based on model specific criteria.

This talk discusses such an anomaly detection trigger based on neural networks. An autoencoder (AE) network is trained to reproduce typical collision events. It is found that the reconstuction quality of anomalous events, such as BSM events or rare SM events, is decreased. This decrease in reproduction quality can then be used as a basis for the trigger decision. Since the L1 trigger has a very limited time for the decision, the AE needs to be deployed on dedicated hardware in the form of field programmable gate arrays which presents additional challenges.

T 122.3 Thu 16:20 POT/0106

Online Track Reconstruction for the Mu3e Experiment — •Haris Avudaiyappan Murugan for the Mu3e-Collaboration — Institute of Nuclear Physics, Johannes Gutenberg University of Mainz, Germany

The Mu3e experiment aims to observe or exclude the rare decay of a positive muon into two positrons and an electron. Such an observation would be a violation of charged lepton flavour conservation and thus a clear signal of new physics. In the first phase, it will observe 10^8 muon decays per second using a thin pixel detector complemented by scintillating timing detectors. The data rate from the detector subsystems is estimated at about 100 Gb/s and is mostly comprised of background processes from other decay channels of the muon. To store the data for physics analysis, it needs to be reduced by a factor of 100. This can be achieved by selecting the potential signal events through online track and vertex reconstruction on graphics processing units (GPUs). The talk discusses the algorithm employed on the GPUs and the achieved performance.

T 122.4 Thu 16:35 POT/0106

Dilepton trigger selections for Run 3 at the LHCb Experiment — Johannes Albrecht, •James Gooding, and Biljana Mitreska — TU Dortmund University, Dortmund, Germany

Lepton flavour-violating processes in B decays are amongst the key curiosities studied at the LHCb Experiment. Measurements of such processes rely on high-quality selection of leptons, in particular of lepton pairs arising from B decays. These selections typically rely on cuts to essential kinematic and topological variables.

During the LHC Run 3 data-taking period, the LHCb Experiment will receive collisions at a rate of 30 MHz. The full detector readout at this rate produces 5 TB/s of data, though only 10 GB/s can be recorded. To reduce the amount of data recorded, LHCb will employ an entirely software-based trigger system to select events in real time. Within this framework, an inclusive cut-based trigger is being developed to select dilepton events (i.e. events containing a lepton pair).

In this talk, the status of the inclusive cut-based dilepton trigger is presented, and its performance is evaluated within the context of the Run 3 LHCb trigger system.

T 123: Pixel/Belle II, Si/Other

Time: Thursday 15:50–17:20 Location: WIL/A317

T 123.1 Thu 15:50 WIL/A317

Investigation of high backside currents in DEPFET pixel sensors for the Belle II experiment using dedicated test structures — Florian Bernlochner, Jochen Dingfelder, •Georgios Giakoustidis, and Botho Paschen — University of Bonn, Germany

For the Belle II experiment at KEK (Tsukuba, Japan) the KEKB accelerator was upgraded to deliver e^+e^- collisions at a center-of-mass energy of E_{CM} = 10.58 GeV with an instantaneous luminosity of up to $8 \cdot 10^{35}$ $cm^{-2}s^{-1}$. As the innermost part of the Belle II detector, the PiXel Detector (PXD), based on DEpleted P-channel Field Effect Transistor (DEPFET) technology, is most exposed to radiation from the accelerator. An unexpected steady increase of backside current with time and thus accumulated irradiation dose was observed in several modules during detector operation. Doping profile measurements and electric field simulations show that this is a consequence of (partially) shorted guard rings at the backside leading to high electric fields and avalanche current multiplication. Irradiation results of dedicated test structures to further investigate the mechanism will be presented.

T 123.2 Thu 16:05 WIL/A317

Development of the BDAQ-PXD laboratory readout system for the characterization of DEPFET pixel detector modules — Patrick Ahlburg, Florian Bernlochner, Jochen Dingfelder, Tomasz Hemperek, Hans Krüger, Botho Paschen, and •Jannes Schmitz for the Belle II-Collaboration — University of Bonn, Germany

The DEPFET PiXel Detector (PXD) is successfully operated in the innermost layers of the Belle II experiment at the SuperKEKB e^+e^- collider in Japan. The PXD data acquisition is optimized for the requirements of the full-scale pixel detector in Belle II. In this talk, the development of a laboratory readout system (BDAQ-PXD) for single PXD modules is presented. BDAQ-PXD provides a simple, flexible and expandable readout for measurements in laboratory, irradiation and test-beam environments. It thus facilitates studies to gain further insights into the behavior of the pixel detector modules and the DEPFET technology. The setup of the system and measurements for the characterization of PXD modules under laboratory conditions are presented in this talk.

T 123.3 Thu 16:20 WIL/A317

Simulation of power lines for the Investigation of the Emergency Shutdown system of the DEPFET pixel detector — •Paula Scholz[1], Florian Bernlochner[1], Jochen Dingfelder[1], Hans Krüger[1], Botho Paschen[1], Matthias Hoek[2], Jannes Schmitz[1], and Patrick Ahlburg[1] for the Belle II-Collaboration — [1]University of Bonn, Germany — [2]Institut für Kernphysik JGU Mainz, Germany

The Belle II Pixel Detector (PXD) is based on DEpleted P-channel Field Effect Transistor (DEPFET) matrices. To control the sensors, voltage levels have to be switched by 20 V within a few nanoseconds per readout cycle (50 kHz). The voltage switching is implemented in Application Specific Integrated Circuits (ASICs), the so-called switchers, on the detector modules. These switchers have been observed to be vulnerable to sudden irradiation bursts, which can occur during beam loss events in the SuperKEKB accelerator. To safeguard the modules from damage caused by beam loss events, the modules have to be switched off as fast as possible when a loss of beam control is imminent. Several beam monitoring systems are employed in the experiment to detect these situations. On PXD hardware side it is investigated how the vulnerable channels can be switched off fast and securely. Therefore, an electronics circuit simulation of the complex PXD power system is being set up to understand the limitations and conduct studies of possible hardware modifications. This talk will concentrate on the necessary steps for creating such a simulation.

T 123.4 Thu 16:35 WIL/A317

Investigation of high resistivity p-type FZ silicon diodes after ^{60}Co - γ irradiation — •Chuan Liao[1], Eckhart Fretwurst[1], Erika Garutti[1], Joern Schwandt[1], Anja Himmerlich[2], Yana Gurimskaya[2], Michael Moll[2], and Ioana Pintilie[3] — [1]Institute of Experimental Physics University of Hamburg, Hamburg, Germany — [2]European Organization for Nuclear Research (CERN), Geneva, Switzerland — [3]National Institute of Materials Physics, Bucharest, Romania

In this work, the macroscopic (I-V, C-V) and microscopic Thermally Stimulated Current (TSC) measurements were used to investigate the radiation effects in high resistivity p-type FZ silicon diodes induced by ^{60}Co γ-rays with dose values between 1×10^5 and 2×10^6 Gy. Two different types of diodes were manufactured using either p-stop or p-spray isolation between the pad and the guard-ring. The leakage current density development with dose was investigated and compared to standard float zone (FZ) n-type diodes. Frequency dependence of capacitance-voltage characteristics was only observed for p-stop diodes and showed a strong dose dependence. In the microscopic measurements, the development of radiation-induced defects (B_iO_i, C_iO_i, VO, I_P) with dose will be presented. To understand the thermal stability of these defects, isochronal annealing experiments from 80 ^{o}C up to 300 ^{o}C for 15 min were performed. The corresponding macroscopic and microscopic measurements will be presented and discussed.

T 123.5 Thu 16:50 WIL/A317

Compton imaging of undepleted regions of germanium detectors — •Felix Hagemann, Iris Abt, Chris Gooch, Lukas Hauertmann, David Hervas Aguilar, Xiang Liu, Oliver Schulz, and Martin Schuster — Max-Planck-Institut für Physik, München

Over the past three years, a novel experimental setup has been built, commissioned and operated at the Max-Planck-Institute for Physics in Munich to characterize the bulk of germanium detectors: the Compton Scanner. In this fully automated setup, a detector is irradiated with a collimated beam of 661.66 keV gammas from a ^{137}Cs source. A part of these gammas Compton scatter in the germanium detector and are detected by pixelated cameras placed nearby, allowing to reconstruct their interaction point in the detector.

If the germanium detector is operated below the depletion voltage, the undepleted volume of the detector cannot be used to register the energy left behind by the Compton scattered photon. By comparing regions with almost no reconstructed events, i.e. measured undepleted volumes for different bias voltages, to predictions based on different assumed impurity density profiles, an estimate of the real impurity density profile of the detector becomes possible.

In this talk, the Compton Scanner setup and its working principle will be presented. Images of the undepleted regions of a germanium detector will be shown and compared to predictions obtained with the open-source julia software package *SolidStateDetectors.jl.*

T 123.6 Thu 17:05 WIL/A317

Angle-selective electron detection with a silicon-based active Transverse Energy Filter (aTEF) — •Kevin Gauda[1,4], Sonja Schneidewind[1,4], Kyrill Blümer[1,4], Christian Gönner[1,4], Volker Hannen[1,4], Hans-Werner Ortjohann[1,4], Wolfram Pernice[2,3], Lukas Pöllitsch[1,4], Richard Wilhelm Julius Salomon[1,4], Maik Stappers[2], and Christian Weinheimer[1,4] — [1]Institute for Nuclear Physics, University of Münster — [2]CeNTech and Physics Institute, University of Münster — [3]Kirchhoff-Institute for Physics, University of Heidelberg — [4]KATRIN Collaboration

The active Transverse Energy Filter (aTEF) is a concept to discriminate electrons in a large magnetic field based on their pitch angle (EPJ-C 82, 922 (2022)). It is investigated as a background reduction measure in the KATRIN experiment, where low-energy electrons from ionisation of atoms in highly excited (Rydberg or autionising) states within the spectrometer impede the design sensitivity of 0.2 eV c^{-2} (90% C.L.). These electrons are practically indistinguishable from desired tritium beta electrons via kinetic energy, while their pitch angle distribution differs significantly. The aTEF for KATRIN may be realized as a microstructured detector – e.g., based on Si-PIN diodes – tailored to exclusively detect electrons with large pitch angles. Fabrication of prototypes is carried out via semiconductor processing technologies, for instance deep inductively coupled plasma etch (ICP-RIE). Production and performance of aTEF prototypes will be presented.

The work of the speaker for KATRIN is supported by BMBF under contract number 05A20PMA.

T 124: Si-Strip/CMS, Pixel/DMAPS

Time: Thursday 15:50–17:20 Location: WIL/A124

T 124.1 Thu 15:50 WIL/A124

Performance of the latest Service Hybrid prototypes for CMS silicon strip modules — Christian Dziwok[2], Lutz Feld[1], Katja Klein[1], Martin Lipinski[1], Daniel Louis[1], •Alexander Pauls[1], Oliver Pooth[2], Nicolas Röwert[1], Felix Thurn[1], Michael Wlochal[1], and Tim Ziemons[2] — [1]1. Physikalisches Institut B, RWTH Aachen — [2]3. Physikalisches Institut B, RWTH Aachen

The CMS Collaboration is developing silicon strip modules for the second phase of the CMS tracker upgrade. This upgrade will enable the CMS experiment to utilize the high luminosity provided by the future HL-LHC. The modules' Service Hybrids are responsible for the sensor bias voltage and low voltage distribution on the module and the data transmission via optical links to the back-end electronics. For the first time, final versions of the required ASICs were assembled and tested on Service Hybrid prototypes with materials and geometries as foreseen in the detector. The measurements were performed with setups similar to the foreseen production test system. The gained experience is crucial for the design validation and in taking the final choices in the design process before series production.

T 124.2 Thu 16:05 WIL/A124

Influence of High-Frequency Magnetic Fields on the Noise Behavior of CMS 2S Module Prototypes — Christian Dziwok[2], Lutz Feld[1], Katja Klein[1], Martin Lipinski[1], Alexander Pauls[1], Oliver Pooth[2], and •Nicolas Röwert[1] — [1]I. Physikalisches Institut B, RWTH Aachen University, Germany — [2]RWTH Aachen University - Physics Institute III B, Aachen, Germany

For the CMS tracker Phase-2 upgrade new modules with silicon strip sensors are being developed. Each module features a Service Hybrid (SEH), which is responsible for the distribution of low voltages to the module components using a two-stage DC-DC conversion scheme. For modules equipped with the latest generation of SEHs an increase in module noise has been observed. A setup for inducing radiative noise with external magnetic fields that are frequency- and location-dependent is presented. Measurements carried out on modules from different prototyping phases show that the sensitivity is similar across generations, which indicates that radiative coupling into the sensor or readout electronics is not responsible for the observed noise increase.

T 124.3 Thu 16:20 WIL/A124

Systematic tests of the testing infrastructure for CMS Outer Tracker Service Hybrids — Christian Dziwok[2], Lutz Feld[1], Katja Klein[1], Martin Lipinski[1], Daniel Louis[1], Alexander Pauls[1], Oliver Pooth[2], Nicolas Röwert[1], •Felix Thurn[1], Michael Wlochal[1], and Tim Ziemons[2] — [1]1. Physikalisches Institut B, RWTH Aachen — [2]3. Physikalisches Institut B, RWTH Aachen

The CMS Collaboration is developing so-called 2S modules for the Phase-2 upgrade of the CMS tracker. This upgrade will enable the CMS experiment to utilize the high luminosity provided by the future HL-LHC. A 2S module consists of two silicon strip sensors, two support bridges and three electronics hybrids. One of these hybrids is the Service Hybrid (SEH), which supplies the power to all other parts of the module, aggregates the data lines from both sides of the module and is responsible for the data transmission via optical links to the back-end of the detector. During the production roughly 20,000 SEHs will undergo a vigorous quality control procedure. The test card for testing the functionality of the SEH is developed by RWTH Aachen and around 100 test cards were manufactured. These will be distributed to the manufacturer and collaborating institutes of the SEHs. Before that they have been tested and the statistical fluctuations of the measurements have been analyzed. A crate with several test cards was set up in a climatic chamber and the whole testing procedure including thermal cycling was exercised. Selected results from the commissioning and quality control of the test cards are presented.

T 124.4 Thu 16:35 WIL/A124

Characterization of TJ-Monopix2 - A depleted monolithic active pixel sensor with column drain readout architecture — •Christian Bespin[1], Ivan Caicedo[1], Jochen Dingfelder[1], Toko Hirono[2], Hans Krüger[1], Konstantinos Moustakas[3], and Norbert Wermes[1] — [1]Universität Bonn, Bonn, Deutschland — [2]DESY, Hamburg, Deutschland — [3]Paul Scherrer Institut, Villingen, Schweiz

The increasing availability of commercial CMOS processes with high-resistivity wafers has fueled the R&D of depleted monolithic active pixel sensors (DMAPS) for usage in high energy physics experiments. One of these developments is a series of monolithic pixel detectors with column-drain readout architecture and small collection electrode facilitating low-power designs: the TJ-Monopix series.

The latest iteration TJ-Monopix2 is designed in a 180 nm TowerJazz CMOS process and features a pixel size of 33 um x 33 um. Results from laboratory measurements and test beam campaigns demonstrating threshold and noise performance as well as hit efficiency measurements will be presented to discuss the suitability of TJ-Monopix2 for use in high-radiation environments.

T 124.5 Thu 16:50 WIL/A124

Characterisation of a DMAPS prototype for BELLE II a proposed Vertex Detector Upgrade — •Marike Schwickardi[1], Benjamin Schwenker[1], Ariane Frey[1], Yannik Buch[1], Maximilian Babeluk[2], Bernhard Pilsl[2], Patrick Sieberer[2], Christian Irmler[2], and Jérôme Baudot[3] — [1]Georg-August-Universität Göttingen, Deutschland — [2]HEPHY, Wien, Österreich — [3]IPHC, Straßburg, France

The SuperKEKB collider in Japan is an asymmetric electron-positron collider at a center-of-mass energy of 10.58 GeV. A world record peak luminosity of $4.7 \cdot 10^{34}$ cm^{-2}s^{-1} was achieved during the last run period in June 2022. The peak luminosity is planned to be ramped up incrementally to the design value of $6.5 \cdot 10^{35}$ cm^{-2}s^{-1}. During the long shutdown tentatively scheduled for 2026/2027 an upgrade for the vertex detector is planned, to improve the detectors performance, robustness against beam-induced backgrounds and simplify servicing the system. Proposed is a fully pixelated 5 layer vertex detector (VXD) concept, based on the CMOS-DMAPS technology. The proposed chip is named OBELIX and is a further development based of the TJ-MONOPIX2 produced in the Tower 180 nm process, as a replacement of the current pixel-and-strip vertex detector concept.

To ensure the design specification for the OBELIX chip are met, the predecessor TJ-MONOPIX2, was characterised in laboratory measurements and during a beam test at DESY in June 2022. The results obtained from these measurements are implemented in simulations in the Belle II Analysis Framework for more realistic performance studies.

T 124.6 Thu 17:05 WIL/A124

Test-beam campaign and characterization of irradiated depleted monolithic active pixel sensors (DMAPS) designed in 150nm CMOS technology — •Lars Schall[1], Christian Bespin[1], Ivan Caicedo[1], Jochen Dingfelder[1], Tomasz Hemperek[2], Toko Hirono[1], Fabian Hügging[1], Hans Krüger[1], Piotr Rymaszewski[2], Tianyang Wang[3], and Norbert Wermes[1] — [1]University of Bonn, Germany — [2]Dectris, Switzerland — [3]Zhangjiang National Lab, China

Monolithic active pixel sensors with depleted substrates are a promising option for pixel tracking detectors in high-radiation environments. The use of a highly resistive silicon substrate and short drift paths enhance the radiation tolerance, while a careful guard ring design facilitates high biasing voltages to deplete the sensor.

LF-Monopix2 is the latest prototype of a DMAPS development in 150 nm CMOS technology. It features a fully functional column-drain readout architecture in a 2x1 cm^2 matrix. A reduced pixel pitch of 50x150 μm^2 compared to its predecessor results in a smaller detector capacitance and an improved spatial resolution. Each pixel's digital electronics are integrated within the large collection electrode.

LF-Monopix2 chips thinned down to 100 μm have been tested and found to work successfully after being irradiated to 1e15 neq/cm^2. In this talk, results from recent characterization measurements and test-beam campaigns are shown. Focus is put on measurements with irradiated sensors and the comparison to unirradiated sensors.

T 125: Calorimeter / Detector Systems V

Time: Thursday 15:50–17:20 Location: WIL/C133

T 125.1 Thu 15:50 WIL/C133

Developement of a SplitCAL Prototype — •Matei Climescu and Rainer Wanke — Johannes Gutenberg Universität Mainz

The SplitCAL is a mixed electromagnetic calorimeter designed to provide both energy reconstruction through layers of scintillating stripes read out by wavelength shifting fibres and shower direc tion information through high-precision layers. This can be used for fixed target experiments which require high geometrical precision (such as SHiP@ECN3 or SHADOWS@ECN3). The development needs to account for low rates but a large dynamic range. The status of the detector prototype as well as the readout electronics will be presented.

T 125.2 Thu 16:05 WIL/C133

A pointing Calorimeter for the SHADOWS Experiment — •Sebastian Ritter for the SHADOWS-Collaboration — Universität Mainz

The SHADOWS experiment is a proposed off-axis beam dump experiment on the 400 GeV/c proton beam from the CERN SPS aiming to measure the decay of Hidden Sector particles. To reconstruct particles that only decay into photons, the photon energies, and directions need to be measured. In this talk, a highly granular plastic scintillator-based electromagnetic calorimeter is presented, which aims to provide the necessary energy and pointing resolution to achieve this task in SHADOWS.

T 125.3 Thu 16:20 WIL/C133

Multi-layer tile modules test system using cosmic ray for the CMS HGCAL upgrade — •Jia-Hao Li — Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany

The CMS experiment plans to upgrade its calorimeter endcap for the high luminosity phase of the LHC with the High Granularity Calorimeter (HGCAL). The hadronic calorimeter (CE-H) part of the HGCAL in the lower radiation dose region is composed of scintillator-base tile modules using the SiPM-on-tile technology for particle detection. The tile module is equipped with HGCROC ASIC for data readout. The fast command and slow control signals from the counting room are also received by the HGCROC. To test and calibrate the tile modules, a cosmic ray measuring test with multi-layer tile modules parallel to each other is set up for quality control and a better understanding of the property and capability of the tile module. The presentation will discuss the idea and current status of the cosmic test setup at DESY.

T 125.4 Thu 16:35 WIL/C133

Testbeam Measurements with a Liquid Scintillator Detector Prototype for the SHiP Surrounding Background Tagger — •Annika Hollnagel for the SHiP-SBT-Collaboration — JGU Mainz

By introducing a segmented geometry, Liquid Scintillator [LS] detectors are able to offer a combination of large geometrical coverage and good spatial resolution. This approach can be employed to create a new generation of high-resolution particle detectors or to improve the performance of large-volume detectors commonly used in neutrino and low-background experiments.

As a frontrunner proposal of the CERN Physics Beyond Colliders initiative, SHiP aims to exploit the full potential of a future SPS Beam-Dump Facility and combine the Search for Hidden Particles [SHiP] with tau neutrino physics. The Hidden Sector detector of SHiP will consist of a large evacuated volume followed by magnetic spectrometer and Particle Identification system. To enable studying the decays of Feebly-Interacting Particles, the reduction of beam-induced background heavily relies on the Surrounding Background Tagger [SBT] enveloping the 50m-long decay vessel. Current baseline for the SBT is a segmented LS detector that is instrumented with Wavelength-shifting Optical Modules [WOM] and read out via SiPMs.

Supported by laboratory measurements and simulations, several testbeam measurements have already been conducted at CERN and DESY, proving the principle and allowing to improve detector design and performance. This talk will give an overview of the latest 2022 test exposure of a full-size detector cell to the DESY II electron beams.

T 125.5 Thu 16:50 WIL/C133

Development of the experiment control system for the Timepix4 telescope — Johannes Albrecht[1], Elena Dall'Occo[1], and •David Rolf[1,2] — [1]TU Dortmund University, Dortmund, Germany — [2]CERN, Geneve, Switzerland

Future high-energy physics experiments will require a very precise timing measurement, on top of a good spatial resolution. A precise timing will allow to not only reconstruct tracks in space, but also to separate them in time; this in turn allows for densely packed, almost simultaneous collisions to be reconstructed with high precision.

The Timepix4 telescope is designed to be a first demonstrator of track reconstruction in four dimensions, as well as a system to probe and characterise next generation devices in terms of space and time capabilities. The final version of the telescope aims to have a pointing resolution below 2 μm in space and around 30 ps in time. To achieve this, the telescope is built up from eight silicon sensors of 100 μm and 300 μm thickness, bump bonded to the newest generation of Timepix4 ASICs.

This talk will give a brief overview of the Timepix4 telescopes design, and then focus on its experiment control system. The control system is used to remotely operate the motion stages and power supplies of the telescope, and to monitor the environmental conditions. The focus of the talk will be on the development of the controlling software implemented in WinCCOA and its communication to the hardware.

T 125.6 Thu 17:05 WIL/C133

Upgrading the Cosmic Ray Facility for Tests Regarding the Phase-II Upgrade of the ATLAS Muon Spectrometer — •Florian Egli[1], Otmar Biebel[1], Henk Boterenbrood[2], Valerio D'Amico[1], Stefanie Götz[1], Ralf Hertenberger[1], Christoph Jagfeld[1], Eshita Kumar[1], Katrin Penski[1], Maximilian Rinnagel[1], Nick Schneider[1], Chrysostomos Valderanis[1], and Fabian Vogel[1] — [1]LMU München — [2]Nikhef, Amsterdam

The Phase-II Upgrade of the ATLAS Muon Spectrometer for the High Luminosity LHC (HL-LHC) includes the installation of a new and more efficient trigger and readout system for the Monitored Drift Tube (MDT) chambers. It is crucial that the Phase-II Upgrade can be tested on an MDT chamber outside of ATLAS, to detect errors and verify possible solutions, independent of the upgrade operations at CERN. The Cosmic Ray Facility in Garching could provide an ideal testsite, as it consists of two fully functional MDT chambers. However, its readout electronics and infrastructure are not compatible with the Phase-II Upgrade. As a first step, the infrastructure and electronics in the Cosmic Ray Facility are upgraded to the Phase-I standard of the ATLAS Muon Spectrometer. This includes the setup of a FELIX based readout system, which is compatible with both the Phase-I and the Phase-II electronics. Furthermore, new scintillators are installed on the top and on the bottom of the setup, in parallel to the MDTs, to allow preliminary tests of a path-based trigger. In this talk the current status of the project and first results are presented.

T 126: Gas-Detecors, Detector Systems

Time: Thursday 15:50–17:20 Location: WIL/A120

T 126.1 Thu 15:50 WIL/A120

Measurement Analysis of Micromegas detectors — •Eshita Kumar, Otmar Biebel, Valerio D'Amico, Florian Egli, Stefanie Götz, Ralf Hertenberger, Christoph Jagfeld, Katrin Penski, Maximilian Rinnagel, Nick Schneider, Chrysostomos Valderanis, and Fabian Vogel — LMU München

MICRO MEsh GAseous Structure (Micromegas) detectors are micro patterned gaseous detectors that have high rate capability due to the fast evacuation of positive ions and excellent spatial resolution due to a small scale readout strip pitch. These detectors are used for the track reconstruction of ionizing particles. To test the performance and resilience of such detectors under high background, multiple detectors are irradiated by a 10 GBq Americium-Beryllium neutron source: measurements with different shielding materials of varying thicknesses placed in front of the source are used to disentangle the detector response for gamma and neutron radiation. A Geant4 simulation to determine the interaction probability from the background radiation is carried out. Comparison of the analysis of the detector output to the simulation results for the final charge obtained from the gammas and the neutrons will be shown.

T 126.2 Thu 16:05 WIL/A120

Development of a Segmented GEM Readout (SGR) Detector — •Christoph Jagfeld, Otmar Biebel, Valerio D'Amico, Stefanie Götz, Ralf Hertenberger, Katrin Penski, Maximilian Rinnagel, Chrysostomos Valderanis, and Fabian Vogel — LMU, München

In Micromegas detectors the primary charges are amplified by electron avalanches between a planar anode and a mesh in 120 μm distance. For resistive Micromegas detectors the signal is read out via readout strips below the anode. A 2D position is reconstructed using two perpendicular readout strip layers below the resistive anode structure.

Using a standard 2D resistive Micromegas readout structure, a unique 2D particle position reconstruction is possible if the detector is hit by one particle at the same time. Ambiguities occur if multiple particles arrive at the same time. A unique X-Y assignment is not possible.

This issue can be solved by replacing the mesh with a GEM foil, which is segmented into 0.5 mm wide strips on both sides. The GEM strips must be turned by 45° with respect to the Micromegas readout strips. Thus the detector has four readout strip directions (X, Y, U, V).

A prototype of such a Segmented GEM Readout detector is built with GEM strips and readout strips perpendicular to each other. Test beam measurements with this detector were performed using 120 GeV muons. The GEM and Micromegas strips show a similar pulse height. For perpendicular incident particles a position reconstruction efficiency better than 90% is reached on both the GEM - and the readout strips. A resolution better than 80 μm for the GEM and readout strips is achieved.

T 126.3 Thu 16:20 WIL/A120

Efficiency and time resolution of a large-size WOM-SiPM-based liquid-scintillator detector — •Alessia Brignoli for the SHiP-SBT-Collaboration — Humboldt Universität zu Berlin

Within the BMBF-funded generic R&D consortium High-D, a multi-cell large area liquid-scintillator detector, where each cell is equipped with two wavelength-shifting optical modules (WOMs) viewed by a ring-array of silicon photomultipliers (SiPMs) is being developed. The aim is to reconstruct particles crossing the detector using the time and light-yield response. Such a detector type has been proposed for the Surround Background Tagger for the SHiP experiment proposal at the CERN SPS. In a first step, we are studying the characteristics of a one-cell detector using data taken during a testbeam campaign in October 2022 with a positron beam at the DESY testbeam facility in Hamburg. We will present results on the detector cell efficiency as well as on the time resolution of the detector as function of particle beam position at the detector cell.

We acknowledge the support from BMBF via the High-D consortium.

T 126.4 Thu 16:35 WIL/A120

Readout of Wavelength-shifting Optical Modules — •Johannes Alt for the SHiP-SBT-Collaboration — Albert-Ludwigs-Universität Freiburg

Wavelength-shifting optical modules (WOMs) are a low-cost way to capture the scintillation light produced in a liquid scintillator volume. These WOM tubes connected to Silicon Photomultipliers are proposed to be used in the large-area Surrounding Background Tagger (SBT) of the proposed general-purpose Search for Hidden Particles (SHiP) experiment. In this talk, the current status of the research and development on the WOM readout will be presented. This work is funded by BMBF.

T 126.5 Thu 16:50 WIL/A120

Photon exit angles of Wavelength-Shifting Optical Modules for the SHiP-SBT — •Florian Rehbein for the SHiP-SBT-Collaboration — RWTH Aachen University

This contribution will present simulations of the photon exit angle distributions of a Wavelength-Shifting Optical Module (WOM) for the SHiP experiment. These simulations are compared to first measurements taken with a DSLR camera on a laboratory test stand.

WOMs present a novel optical sensor for numerous applications, combining a well-designed light guide with a wavelength-shifting coating. They will be used as an integral part of the Surrounding Background Tagger (SBT) in SHiP (Search for Hidden Particles), a proposed general-purpose fixed target experiment at the SPS accelerator of the CERN facility. The SBT acts as a discriminator against external particle interactions and is composed of many cells utilizing liquid scintillator and tube-shaped WOMs made of PMMA to detect traversing particles. The coating of the WOMs absorbs the scintillation photons and re-emits wavelength-shifted photons, which are then detected by an array of SiPMs coupled to one end of the WOM.

T 126.6 Thu 17:05 WIL/A120

Reflective Coating for the SHiP Surround Background Tagger — •Patrick Deucher for the SHiP-SBT-Collaboration — Johannes Gutenberg Universität Mainz

The Surrounding Background Tagger (SBT) is a liquid scintillator-based detector in the SHiP Experiment. Divided into segments and embedded into the Corten steel structure of the Hidden Sector decay vessel, the SBT's main task will be the discrimination against beam-induced backgrounds. The efficiency of such a detector type can be increased by optimizing the light detection equipment, lowering the attennuation length of the scintillator (purification and addition of different fluorophores) and increasing the reflectivity of the inner detector walls. Following results of Photon Transport Simulations the application of a diffuse and highly reflective Bariumsulfate-based (OPRC by Berghof*Fluoroplastic*Technology*GmbH) coating to the inner detector walls is studied. After extensive reflectivity-, stability- and compatibility tests the reflective coating was applied to the SBT test cell for the test beam 2022 at the DESY facilities. This talk will discuss results of a first large scale application of the reflective coating in a liquid-scintillator detector cell.

T 127: Exp. Methods III

Time: Thursday 15:50–17:05 Location: WIL/C129

T 127.1 Thu 15:50 WIL/C129

A General Track Fit based on Hit Triplets — •Mohd Talha and André Schöning for the ATLAS-Collaboration — Physikalische Institute, Universität Heidelberg

Modern particle physics experiments often deal with high particle rates and therefore use silicon detectors for particle tracking. High hit occupancies, together with a relatively large amount of material in the tracking layers, pose a big challenge for track reconstruction.

For the High Luminosity ATLAS upgrade, it is planned to perform a full reconstruction of ~5000 tracks per event at the ATLAS Event Filter with a rate of about 100 kHz. The tracking algorithm has to run on commercial hardware. One option considered by our group is the implementation of a parallelizable track reconstruction algorithm on a farm of GPUs. The algorithm of choice is a general broken line fit based on hit triplets that was originally developed for applications with dominating multiple scattering uncertainties [N. Berger et al., JINST 9 P07007 (2014)] and has also been extended to include hit uncertainties. The latter is crucial for the reconstruction of high momentum tracks.

After motivating hit triplets as basic tracking elements for a general broken line fit, the general solution for a track fit of three hits (triplet) in a solenoidal magnetic field will be presented and discussed.

T 127.2 Thu 16:05 WIL/C129

Matrix inversion in the context of a novel track reconstruction algorithm for the ATLAS Event Filter — •Antara Paul[1] and Andre Schöning[2] for the ATLAS-Collaboration — [1]Physikalisches Institut, Universität Heidelberg, Germany — [2]Physikalisches Institut, Universität Heidelberg, Germany

The High Luminosity LHC project is expected to provide a tenfold increase of the integrated luminosity compared to the LHC. To cope with the resulting high pile-up from proton-proton collisions, the ATLAS detector, and its trigger and DAQ systems are undergoing major upgrades. As a part of the upgrade of the online event filter, a fast triplet track reconstruction algorithm is being developed based on a broken line fit. The track parameters are estimated by minimizing a χ^2 function, which includes the multiple scattering and spatial hit uncertainties at each layer. This minimization involves the inversion of a matrix.
In this context, the talk focuses on different algorithms of matrix inversion, including but not limited to LDL^T decomposition and the partition method. The speed and accuracy of each method will be presented and compared, in view of their implementation in the track reconstruction algorithm.

T 127.3 Thu 16:20 WIL/C129

Navigation and track parameter transport using a heterogeneous code design for CPUs and GPUs within the ACTS R&D project — Andreas Salzburger[1], •Joana Niermann[1,2], Beomki Yeo[3,4], Stephen Swatman[1,5], Attila Krasznahorkay[1], and Stan Lai[2] — [1]CERN — [2]II. Physikalisches Institut, Georg-August-Universität Göttingen — [3]Department of Physics, University of California — [4]Lawrence Berkeley National Laboratory — [5]University of Amsterdam

With the upcoming high luminosity era of the LHC, track reconstruction, in particular, will suffer from drastically increasing combinatorics. A promising perspective to meet these rising computing demands is the deployment of hardware accelerators which offer massive parallelism, like GPGPUs. Current state-of-the-art implementations of pattern recognition algorithms in track reconstruction are problematic to adapt to accelerator hardware architectures in several ways. For example, runtime-polymorphic geometry classes and pointer based data structures are commonly difficult to move to an accelerator device.

Within the ACTS parallelization R&D project, research is on-going to adapt a complete track reconstruction chain, from clusterization to track fitting, to run efficiently on GPUs. We show the implementation and performance of a core component of this chain: the propagation of track parameters and their associated covariances through an inhomogeneous magnetic field (*covfie* library), together with the application of material effects. The implementation is part of the *detray* library and makes use of its geometry description and navigation.

T 127.4 Thu 16:35 WIL/C129

Tracking efficiency studies for LHCb in Run 3 — Flavio Archilli[1], •Rowina Caspary[2], Giulia Frau[2], and Peilian Li[3] — [1]Università di Roma Tor Vergata, Rome, Italy — [2]Physikalisches Institut, Heidelberg University, Germany — [3]CERN

The LHCb detector is dedicated to the measurement of particles containing b- and c-quarks and has recently been upgraded, aiming to take data with an instantaneous luminosity of $2 \times 10^{33}\, cm^{-1} s^{-1}$ at $\sqrt{s} = 14$ TeV . The tracking system is completely renewed and a new reconstruction and trigger framework is implemented, in which all the tracking reconstruction algorithms are redesigned.

The correct evaluation of the tracking reconstruction efficiency is essential for many measurements of the LHCb experiment. However the precision of the simulation is limited, thus a data-driven approach is developed exploiting a tag-and-probe method on a sample of $J\psi \rightarrow \mu\mu$ events to cross-check the track reconstruction efficiency in data. The difference of track reconstruction efficiency between simulation and data is then evaluated and exploited as calibration parameters. In addition, the effect of hadronic interactions on the track reconstruction efficiency is estimated using $D^0 \rightarrow K\pi$ and $D^0 \rightarrow K\pi\pi\pi$ decays.

T 127.5 Thu 16:50 WIL/C129

Track reconstruction for the *Mu3e* experiment — •Alexandr Kozlinskiy — Institut für Kernphysik, JGU Mainz, Germany

The *Mu3e* experiment is designed to search for the lepton flavor violating decay $\mu^+ \rightarrow e^+e^-e^+$. The aim of the experiment is to reach a branching ratio sensitivity of 10^{-16}. The experiment is located at the Paul Scherrer Institute (Switzerland) and an existing beam line providing 10^8 muons per second will allow to reach a sensitivity of a few 10^{-15} in the first phase of the experiment. The muons with a momentum of about 28 MeV/c are stopped and decay at rest on a target. The decay products (positrons and electrons) with energies below 53 MeV are measured by a tracking detector consisting of two double layers of 50 μm thin high-voltage monolithic active pixel sensors. The high granularity of pixel detector with a pixel size of 80×80 μm together with the small material budget allows for a precise track reconstruction. The track reconstruction is optimized for low noise and high efficiency of tracking detector. This environment allows to efficiently remove incorrectly reconstructed tracks with minimal effect on tracks produced by real particles. This talk will present the details of the track reconstruction, the methods to reduce the number of fake tracks and suppress clones produced due to high hit densities.

T 128: AI Topical Day – New Methods (joint session AKPIK/T)

Time: Thursday 17:30–19:00 Location: HSZ/0004

T 128.1 Thu 17:30 HSZ/0004

Neural networks for cosmic ray simulations — •Pranav Sampathkumar[1], Tanguy Pierog[1], and Antonio Augusto Alves Junior[2] — [1]Institute for Astroparticle Physics (IAP), KIT, Germany — [2]Brazilian Synchrotron Light Laboratory (LNLS), CNPEM, Brazil

Simulating cosmic ray showers at high energies is memory and time intensive. Apart from the traditional methods such as thinning and cascade equations, novel methods are needed for the modern needs in astroparticle physics.

A hybrid model of generating cosmic ray showers based on neural networks is presented. We show that the neural network learns the solution to the governing cascade equation in one dimension. We then use the neural network to generate the energy spectra at every height slice. Pitfalls of training to generate a single height slice is discussed, and we present a sequential model which can generate the entire shower from an initial spectrum. Errors associated with the model and the potential to generate the full three dimensional distribution of the shower and detector footprints are discussed.

T 128.2 Thu 17:45 HSZ/0004

Transformer-Based Eventwise Reconstruction of Cosmic-Ray Masses at the Pierre Auger Observatory — Martin Erdmann, •Niklas Langner, and Dominik Steinberg — III. Physikalisches Institut A, RWTH Aachen University

As one aspect of the AugerPrime upgrade, scintillators (SSDs) will be added to the water Cherenkov detectors (WCDs) that form the surface detector of the Pierre Auger Observatory. This combined measurement offers the possibility to distinguish individual components of extensive air showers, potentially increasing the mass sensitivity. To efficiently exploit this new potential, novel methods are needed.

We introduce a Transformer-based neural network to reconstruct cosmic-ray masses from joint WCD and SSD measurements that outperforms both recurrent and convolutional networks. Efficient Transformers are employed to analyze and relate the two different sets of time traces on station level while ensuring a reasonable degree of computational demands. A Vision Transformer is then applied to the hexagonal grid of detector stations to process the whole shower footprint.

The Transformer network is trained to simultaneously reconstruct the depth of the shower maximum X_{max} as well as the shower's number of muons on ground R_μ. Both observables can be combined to estimate the primary cosmic-ray mass with an accuracy higher than what can be achieved individually.

T 128.3 Thu 18:00 HSZ/0004

Quantum Angle Generator for Image Generation — •Florian Rehm[1,2], Sofia Vallecorsa[1], Michele Grossi[1], Kerstin Borras[2,3], Dirk Krücker[2], Simon Schnake[2,3], Alexis-Harilao Verney-Provatas[2,3], and Valle Varo[3] — [1]CERN, Switzerland — [2]RWTH Aachen University, Germany — [3]DESY, Germany

The Quantum Angle Generator (QAG) is a new generative model for quantum computers. It consists of a parameterized quantum circuit trained with an objective function. The QAG model utilizes angle encoding for the conversion between the generated quantum data and classical data. Therefore, it requires one qubit per feature or pixel, while the output resolution is adjusted by the number of shots performing the image generation. This approach allows the generation of highly precise images on recent quantum computers. In this paper, the model is optimised for a High Energy Physics (HEP) use case generating simplified one-dimensional images measured by a specific particle detector, a calorimeter. With a reasonable number of shots, the QAG model achieves an elevated level of accuracy. The advantages of the QAG model are lined out - such as simple and stable training, a reasonable amount of qubits, circuit calls, circuit size and computation time compared to other quantum generative models, e.g. quantum GANs (qGANs) and Quantum Circuit Born Machines.

T 128.4 Thu 18:15 HSZ/0004

Photon identification at hadron colliders using graph neural networks — •Ali Malyali Choban[1], Johannes Erdmann[1], Florian Mausolf[1], and Christopher Morris[2] — [1]III. Physikalisches Institut A, RWTH Aachen University — [2]Fachgruppe Informatik, RWTH Aachen University

At hadron colliders like the LHC, photons are essential physics objects in a wide range of analyses. For example, they allow the study of the Higgs boson using the diphoton decay channel. At a typical particle detector, the main signatures of photons are energy depositions in the electromagnetic calorimeter. However, other objects can leave similar signatures in the electromagnetic calorimeter, leading to misidentification as photons. Jets are abundant at the LHC and they include a high number of light hadrons, most notably neutral pions decaying into two photons. The decay of pions produces photons that are often close to each other and they are likely to be reconstructed as a single photon. However, photon candidates from jets have different attributes that can help to discriminate them from real photons. Specifically, they tend to produce wider signatures in the calorimeter, and to be accompanied by more additional particles.

Graph neural networks (GNNs) are flexible neural architectures well suited for dealing with input data of irregular structure and variable shape. Hence, they are particularly suited for classifying photon candidates as often a variable number of particles surrounds them. In this talk, our study of the applicability of GNNs for photon identification and comparisons with convolutional neural networks are presented.

T 128.5 Thu 18:30 HSZ/0004

Data-driven Simulation of Target Normal Sheath Acceleration by Fourier Neural Operator — Jeyhun Rustamov[1,2], Thomas Miethlinger[1], Thomas Kluge[1], Michael Bussmann[1,3], and •Nico Hoffmann[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]TU Dresden, Dresden, Germany — [3]CASUS, Görlitz, Germany

Particle-in-Cell simulations are a ubiquitous tool for linking theory and experimen- tal data in plasma physics rendering the comprehension of non-linear processes such as Laser Plasma Acceleration (LPA) feasible. These numerical codes can be considered as state-of-the-art approach for studying the underlying physical processes in high temporal and spatial resolution. The analysis of experiments is performed by optimising simulation parameters so that the simulated system is able to explain experimental results. However, a high spatio-temporal resolution comes at the cost of elevated simulation times which makes the inversion nearly impossible. We tackle that challenge by introducing and studying a reduced order model based on Fourier neural operator that is evolving the ion density function of Laser-driven Ion acceleration via 1D Target Normal Sheath acceleration (TNSA). The ion density function can be dynamically generated over time with respect to the thickness of the target. We show that this approach yields a significant speed-up compared to numerical code Smilei while retaining physical properties to a certain degree promising applicability for inversion of experimental data by simulation-based inference.

T 128.6 Thu 18:45 HSZ/0004

RootInteractive tool for multidimensional statistical analysis, machine learning and analytical model validation — •Marian Ivanov[1] and Marian Ivanov jr.[2] for the ALICE Germany-Collaboration — [1]GSI Darmstadt — [2]UK Bratislava

ALICE, one of the four large experiments at CERN LHC, is a detector for the physics of heavy ions. In a high interaction rate environment, the pile-up of multiple events leads to an environment that requires advanced multidimensional data analysis methods.

Our goal was to provide a tool for dealing with multidimensional problems, to fit and visualize multidimensional functions including their uncertainties and biases, to validate assumptions and approximations, to easy define the functional composition of analytical parametric and non-parametric machine learning functions, to use symmetries and to define multidimensional "invariant" functions/alarms.

RootInteractive is a general-purpose tool for multidimensional statistical analysis. Its declarative programming paradigm makes it easy to use for professionals, students, and educators. RootInteractive provides functions for interactive, easily configurable visualization of unbinned and binned data and extraction of derived aggregate information on the server (Python/C++) and client (Javascript). We support client/server applications using Jupyter, or a standalone client-side interactive application/dashboard.

T 129: Flavor X

Time: Thursday 17:30–19:00 Location: HSZ/0304

T 129.1 Thu 17:30 HSZ/0304

New physics in $b \to c\tau\nu$ — Marco Fedele[1], Monika Blanke[1,2], Andreas Crivellin[3,4], Syuhei Iguro[1,2], Teppei Kitahara[5,6,7], •Ulrich Nierste[1], and Ryoutaro Watanabe[8] — [1]Institut für Theoretische Teilchenphysik (TTP), Karlsruhe Institute of Technology (KIT) — [2]Institut für Astroteilchenphysik (IAP), Karlsruhe Institute of Technology (KIT) — [3]Paul Scherrer Institut — [4]Physik-Institut, Universität Zürich — [5]Institute for Advanced Research & Kobayashi-Maskawa Institute for the Origin of Particles and the Universe, Nagoya University — [6]KEK Theory Center, IPNS, Tsukuba — [7]CAS Key Laboratory of Theoretical Physics, Institute of Theoretical Physics, Chinese Academy of Sciences, Beijing — [8]INFN, Sezione di Pisa

The branching fractions of the decays $B \to D\tau\nu$ and $B \to D^*\tau\nu$ have been measured by BaBar, Belle, and LHCb. The combination of these measurements indicates an enhancement of the $b \to c\tau\nu$ amplitude w.r.t. the Standard-Model prediction by 3.2σ. This finding is in in tension with the measurement of $B(\Lambda_b \to \Lambda_c\tau\nu)$, which is related to the former two branching ratios by a sum rule. I discuss the implications of this sum rule for future measurements and assess popular scenarios of new physics postulating either a charged Higgs boson or leptoquarks.

T 129.2 Thu 17:45 HSZ/0304

Measurement of $R(D^*)$ with inclusive B meson tagging at Belle II — •Stephanie Steinmetz, Thomas Lück, and Thomas Kuhr — Ludwig-Maximilians-Universität München

The measured ratio $R(D^*) = \mathscr{B}(B \to D^*\tau\nu)/\mathscr{B}(B \to D^*\ell\nu)$ of branching fractions, where $\ell = e, \mu$, has consistently shown an excess of $B \to D^*\tau\nu$ events. The deviation between Standard Model predictions and the current world average lies at 2.8σ, made even more interesting by the fact that many systematic uncertainties cancel in the ratio. In combination with the analogous $R(D)$, the discrepancy exceeds 3σ and has therefore attracted much attention as a possible hint towards new physics phenomena such as leptoquarks or a charged Higgs.

In this analysis at Belle II, we investigate the decay chains $B \to D^*\tau(\ell\nu\nu)\nu$ as the signal channel, and $B \to D^*\ell\nu$ as normalisation. As both provide the same final state (up to neutrinos), a D^* and a lepton are reconstructed in both cases. The other B meson ("tag B") in the $\Upsilon(4S) \to BB$ event is reconstructed ("tagged") inclusively, i.e. by assuming all particles not assigned to the signal B belong to the tag B without reconstructing intermediate particles. The resulting higher event yields are especially useful when only limited data is available, but come at the cost of higher background levels compared to previous approaches where specific tag B decay trees are reconstructed. The goal of this analysis is to determine the feasibility of applying the inclusive tagging approach to early Belle II data in order to gain competitive results w.r.t. other approaches. The current status of the analysis will be presented in this talk.

T 129.3 Thu 18:00 HSZ/0304

Measuring $\mathrm{R(D^*)}$ in hadronic one-prong τ decays at Belle II. — Florian Bernlochner, Jochen Dingfelder, Peter Lewis, and •Ilias Tsaklidis for the Belle II-Collaboration — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn, Nußallee 12, 53115 Bonn, Germany

Over the last years many experiments have hinted at the existence of lepton universality violating processes. In this work we probe these processes by measuring the $\mathrm{R(D^*)}$ ratio with hadronically decaying τ leptons. The Belle II experiment produces $\mathrm{B\bar{B}}$ pairs and it greatly benefits from the clean experimental environment of $\mathrm{e^+ e^-}$ collisions. In this study we tag one of the two B mesons using the Full Event Interpretation algorithm in fully hadronic modes, in order to kinematically constrain the second B meson. We further reconstruct $\mathrm{B} \to \mathrm{D}^*\tau\nu$ decays with a single charged hadron originating from the τ decay and two missing neutrinos in the event. This gives us a unique access to other quantities sensitive to New Physics, such as the polarization of the τ lepton in B-meson decays. In this talk the current status of the analysis and the expected sensitivity using 364 fb^{-1} of Belle II data will be presented.

T 129.4 Thu 18:15 HSZ/0304

Measurement of $R(D^{(*)})$ using $B \to D^{(*)}\tau\nu$ events with semileptonic tagging and leptonic τ decays — Florian Bernlochner, Jochen Dingfelder, Peter Lewis, and •Alina Manthei for the Belle II-Collaboration — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

The Belle II experiment at the SuperKEKB asymmetric-energy collider, where electrons and positrons are collided at the $\Upsilon(4S)$ resonance, collects a large number of events with $B\overline{B}$ pairs. The analysis of semitauonic decays of these B mesons allows for tests of lepton flavour universality. Existing experimental results on the ratios of the branching fractions $\mathscr{R}(D) = \mathscr{B}(\overline{B} \to D\tau^-\overline{\nu})/\mathscr{B}(\overline{B} \to D\ell^-\overline{\nu})$ and $\mathscr{R}(D^*) = \mathscr{B}(\overline{B} \to D^*\tau^-\overline{\nu})/\mathscr{B}(B^* \to D\ell^-\nu^-)$, where ℓ denotes an electron or muon, are in tension with the Standard Model (SM) predictions, which might hint at physics beyond the SM, such as the presence of charged Higgs bosons or leptoquarks. A combined analysis of $\mathscr{R}(D)$ and $\mathscr{R}(D^*)$ with measurements from Belle, BaBar and LHCb yields a divergence from the SM prediction of $> 3\sigma$. Thus, further investigations of these decays with the recently collected Belle II data are necessary. In order to exploit kinematic constraints in the $B\bar{B}$ decay, the second B meson in the event is reconstructed in semileptonic decay modes, a technique denoted as semileptonic tagging. In this talk, a signal extraction strategy for such a measurement will be presented and the current status and plans for the analysis will be outlined.

T 129.5 Thu 18:30 HSZ/0304

Probing lepton universality in inclusive semileptonic B-meson decays at Belle II — Florian Bernlochner, Jochen Dingfelder, •Henrik Junkerkalefeld, and Peter Lewis for the Belle II-Collaboration — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

Excesses in the ratios $R(D^{(*)}) = \mathscr{B}(B \to D^{(*)}\tau\nu)/\mathscr{B}(B \to D^{(*)}\ell\nu)$ measured by BaBar, Belle and LHCb have created large interest in recent years. Together with other measurements in the flavor sector they may hint at non-universality of lepton couplings. The Belle II experiment in Japan enables a complementary test of these measurements. Due to the precise knowledge of the initial state of the collision and the controlled production of $B\bar{B}$ pairs, an inclusive measurement of $R(X_{\tau/\ell}) = \mathscr{B}(B \to X\tau\nu)/\mathscr{B}(B \to X\ell\nu)$ as well as the light-lepton ratio $R(X_{e/\mu}) = \mathscr{B}(B \to Xe\nu)/\mathscr{B}(B \to X\mu\nu)$ becomes possible. Here, the hadronic system X is not constrained to specific final states, i.e., all possible B-meson decay modes contribute. In this talk, the results of the $R(X_{e/\mu})$ measurement based on a Belle II dataset of 189 fb^{-1} are presented and the current status of the $R(X_{\tau/\ell})$ measurement is discussed.

T 129.6 Thu 18:45 HSZ/0304

Flavour of the dark photon — •jordi folch eguren[1], emmanuel stamou[1], mustafa tabet[1], and robert ziegler[2] — [1]Fakultät für Physik, TU Dortmund, D-44221 Dortmund, Germany — [2]Physikhochhaus (Gebäude 30.23, 9. Stock) Wolfgang-Gaede-Str. 1 D-76131 Karlsruhe

In this work we analyse a BSM model in which an additional U(1) symmetry is added to the SM. We study how FCNCs might arise in this setup due to the new gauge field, the Dark Photon. We constrain the model by considering 2-body meson and baryon decays with different quark transitions, in which form factors play a crucial role.

Jordi Folch Eguren (TU Dortmund), Emmanuel Stamou (TU Dortmund), Mustafa Tabet (TU Dortmund) and Robert Ziegler (KIT).

T 130: Top II

Time: Thursday 17:30–18:45 Location: HSZ/0401

T 130.1 Thu 17:30 HSZ/0401

Measurement of the production cross-section of a W boson in association with $t\bar{t}$ — •Marcel Niemeyer, Arnulf Quadt, and Elizaveta Shabalina — Georg-August-Universität Göttingen

The top-quark pair production in association with a W boson is an important background to processes like $t\bar{t}H$ or 4-tops production. Due to higher order electroweak corrections, the process is difficult to model. In consequence, a tension of the predicted and observed rate of $t\bar{t}W$ surpassing 2σ has been observed in previous analyses. Thus, it is of high importance to increase our understanding of it.

This talk will give an overview of the measurement of the $t\bar{t}W$ cross-section in the multi-lepton channel with two same sign or three leptons (electrons or muons), using the full Atlas Run 2 dataset. In addition to a measurement in the inclusive phase space, the extraction of the cross-section in a fiducial phase space, as well as the measurement of the ratio $\sigma(t\bar{t}W^+)/\sigma(t\bar{t}W^-)$ will be discussed. The fit to extract the cross-section is performed simultaneously to a template fit estimating the main background contributions.

T 130.2 Thu 17:45 HSZ/0401

Measurement of the inclusive production cross section of a top quark pair with a Z boson in the trileptonic channel — •Steffen Korn, Arnulf Quadt, Baptiste Ravina, and Elizaveta Shabalina — II. Physikalisches Institut - Georg-August-Universität Göttingen

The strength and structure of the coupling of the top quark and the Z boson can be measured through the associated production of a top quark pair and a Z boson. It provides sensitivity to the top quark's weak isospin in the Standard Model (SM) framework. The measurement of this parameter also serves as a probe of the SM. The process was measured by ATLAS and CMS at $\sqrt{s}$ = 13 TeV with the full Run 2 dataset and a partial Run 2 dataset, respectively. In a new, refined analysis, multivariate techniques are used to improve the sensitivity of the measurement. The impact of using a multi-class deep neural network for event classification on the inclusive cross-section of $t\bar{t}Z$ final states with three charged leptons is presented.

T 130.3 Thu 18:00 HSZ/0401

Measurements of differential cross-sections of the $t\bar{t}\gamma$ production in the semileptonic and dileptonic channels in pp collisions at $\sqrt{s}$ = 13 TeV with the ATLAS detector — •Buddhadeb Mondal[1], Binish Batool[1], Beatrice Cervato[1], Markus Cristinziani[1], Carmen Diez Pardos[1], Ivor Fleck[1], Arpan Ghosal[1], Gabriel Gomes[1], Jan Joachim Hahn[1], Vadim Kostyukhin[1], Amartya Rej[1], Katharina Voss[1], Wolfgang Walkowiak[1], and Tongbin Zhao[1,2] — [1]Center for Particle Physics Siegen, Experimentelle Teilchenphysik, Universität Siegen — [2]Shandong University, China

The top quark being the heaviest fundamental particle in the Standard Model (SM) plays a very important role in the study of fundamental interactions. It has a very short lifetime and it decays before it hadronizes, passing its properties to its decay products. Top quark pair production in association with a photon ($t\bar{t}\gamma$) is a very important process for measuring the coupling between top quark and photon. A precise measurement of this coupling is necessary for testing the SM and is also a probe for new physics effects at very high energy scale. In this talk, measurements of $t\bar{t}\gamma$ differential cross-sections using 139 fb^{-1} of data collected by the ATLAS detector in proton-proton collisions at $\sqrt{s}$ = 13 TeV will be presented. They are performed in the semileptonic and dileptonic $t\bar{t}$ decay channels.

T 130.4 Thu 18:15 HSZ/0401

Measurement of $t\bar{t} + \gamma$ production with the full Run 2 ATLAS dataset — •Andreas Kirchhoff, Arnulf Quadt, Baptiste Ravina, and Elizaveta Shabalina — II. Physikalisches Institut, Georg-August-Universität Göttingen

The optimal way to measure the top-photon coupling would be an e^+e^- collider with sufficient energy. As such a collider does not exist, another possibility to measure it is the production of $t\bar{t}$ pairs in association with a photon. Unfortunately, such photons will mostly originate from the decay products of the top quarks and hence do not convey any information about the top-photon coupling. However, photons radiated from the top quarks themselves (and to some extent, from the initial state quarks) can be differentiated based on their kinematics and the topology of the event. The separation between 'production' and 'decay' modes is achieved for the first time in this ATLAS analysis, thanks to a dedicated MVA approach. In this talk, the measurement of the inclusive fiducial cross section of the $t\bar{t}\gamma$ process with photons originating from production and decay in single- and dilepton channels will be presented.

T 130.5 Thu 18:30 HSZ/0401

Search for $t\bar{t}\gamma\gamma$ production in pp collisions at $\sqrt{s}$=13 TeV with the ATLAS detector — •Arpan Ghosal[1], Binish Batool[1], Beatrice Cervato[1], Markus Cristinziani[1], Carmen Diez Pardos[1], Ivor Fleck[1], Gabriel Gomes[1], Jan Joachim Hahn[1], Vadim Kostyukhin[1], Buddhadeb Mondal[1], Amartya Rej[1], Katharina Voss[1], Wolfgang Walkowiak[1], and Tongbin Zhao[1,2] — [1]Center for Particle Physics Siegen, Experimentelle Teilchenphysik, Universität Siegen — [2]Shandong University, China

The top-quark pair production in association with one or more photons are important Standard Model processes that allow us to measure the strength of the electroweak coupling of the top quark with photon. While the production of $t\bar{t}\gamma$ is well-studied, the $t\bar{t}\gamma\gamma$ process has not been observed yet. The rare $t\bar{t}\gamma\gamma$ process is not only a good candidate for probing the top electroweak coupling but is also significant as an irreducible background process to the $t\bar{t}$ production with a Higgs boson decaying to two photons ($H \to \gamma\gamma$). New sources of CP-violation can appear as electric dipole moment terms in top-quark interactions, and their precise measurement is essential to determine the effects of new physics. Understanding the $t\bar{t}\gamma\gamma$ process can help set better bounds on these anomalous moments. The presentation will discuss the ongoing efforts in the search for the $t\bar{t}\gamma\gamma$ process in the semileptonic $t\bar{t}$ decay channel with a cut-and-count approach using the full Run 2 dataset collected by the ATLAS detector at $\sqrt{s}$ = 13 TeV.

T 131: Searches V

Time: Thursday 17:30–18:45 Location: HSZ/0403

T 131.1 Thu 17:30 HSZ/0403

Gamma-gamma collider with Energy < 12 GeV based on European XFEL — •Marten Berger — Universität Hamburg

The possibility of a Gamma-gamma collider extension to the Beam dump 17.5 GeV European XFEL has been discussed. This collider would be without competition in the region 5 – 12 GeV. In this range $b\bar{b}$ resonances, tetraquarks as well as mesonic molecules can be observed. Apart from these there are also BSM and dark matter processes that can be observed. In this talk we want to focus on possible BSM and dark matter observations with dark photon and ALPs.

T 131.2 Thu 17:45 HSZ/0403

SUPAX - A Superconducting Axion Search Experiment — •Tim Schneemann, Kristof Schmieden, and Matthias Schott — Johannes Gutenberg-Universität, Mainz

Supax is one of the first RF cavity based experiments in Germany to search for axions. Axions are hypothetical particles that could solve the well known strong CP problem in the standard model of particle physics. Furthermore axions could explain the dark matter content of the universe. Axions are expected to convert to photons in the presence of a strong magnetic field, where the photon frequency depends on the axions mass. For wavelengths in the microwave regime resonators are typically used to enhance the axion signal. We propose to use a superconducting radio frequency cavity with high quality factor. A Copper RF cavity has already been successfully tested probing for Dark Photons in the absence of a magnetic field whilst tune-able and superconducting RF cavities are currently being developed. With this innovative approach and by using an existing 14T magnet at the Institute of Physics at the Johannes Gutenberg University in Mainz, the largely unexplored mass region between 20 μeV to 50 μeV could be tested.

In this talk I will cover the experimental setup, data acquisition, analysis and current results of the experiment as well as future ideas of the experiment beside the search for axions.

T 131.3 Thu 18:00 HSZ/0403

BabyIAXO: prospects and status of a new generation axion helioscope — •Daniel Heuchel[1] and the IAXO-Collaboration[2] — [1]Deutsches Elektronen-Synchrotron (DESY) — [2]https://iaxo.desy.de

In order to search for solar axions and axion-like particles (ALPs) with unprecedented sensitivities, the International Axion Observatory (IAXO) aims to convert those particles via the interaction with virtual photons into X-rays in a strong magnet pointing towards the sun followed by high-precision focusing and ultra-low background and high-efficiency X-ray detectors.

The intermediate experimental stage, BabyIAXO, proposed to be sited at DESY Hamburg, will not only serve as a prototype-stage for all IAXO subsystems, but it will be a fully fledged helioscope with potential for discovery. Along with a 10 m long and about 2 T strong superconducting magnet hosting two 70 cm diameter bores, optics and detector systems very similar to the ones foreseen for IAXO will complete the two detection lines. Based on this setup, BabyIAXO will be able probe axion-photon couplings down to $1.5{\times}10^{-11}$ GeV^{-1} for axion masses of up to 0.25 eV.

In this contribution, the general prospects of BabyIAXO, the current status of the different BabyIAXO subsystems including the different X-ray detector technologies and the ongoing background simulation campaigns are presented and discussed.

T 131.4 Thu 18:15 HSZ/0403

Results from First Simulation Studies for a Dark Photon Search Experiment at the ELSA Electron Accelerator — Philip Bechtle, Klaus Desch, Oliver Freyermuth, Matthias Hamer, •Jan-Eric Heinrichs, and Martin Schürmann — Rheinische Friedrich-Wilhelms-Universität Bonn

The true nature of Dark Matter (DM) has long been of interest for scientists worldwide. Previous searches have so far been unsuccessful in finding proposed DM particles. A promising and not well explored family of DM models contains dark matter particles and a portal to the SM with masses below $\approx$ 1 GeV. Mainly two approaches are investigated by the community, namely beam dump and fixed targets experiments.

Lohengrin is a proposed experiment to search for a dark sector that couples to the SM through a dark photon at the ELSA accelerator in Bonn. In this presentation, the underlying theory and the proposed experiment strategy will be explained. The challenges for the proposed experiment are presented, as well as first steps towards the reconstruction of high level physics objects using a Geant 4 simulation.

T 131.5 Thu 18:30 HSZ/0403

QCD Generative Model Without Machine Learning — •Samuel Bein — Universität Hamburg, Hamburg, Germany

The Rebalance and Smear technique for the modeling of QCD backgrounds to searches for dark matter at the LHC is presented as a publicly available toolkit. Bayesian inference is carried out on real data events to estimate a latent space of the true jet energy values within each event. The latent space is sampled multiple times per event according to a known PDF of the detector response to the jet energy, and the resulting collection represents a high-statistics proxy for the true QCD background. This method, previously carried out at CMS and ATLAS for background estimation, can be further employed in the training of multivariate classifiers to optimally extend the sensitivity of searches to BSM scenarios with compressed mass spectra. An example future search probing pure Higgsino dark matter in gluino and squark simplified models, is a suitable application of this method in Run 3.

T 132: Searches VI

Time: Thursday 17:30–19:00 Location: HSZ/0101

T 132.1 Thu 17:30 HSZ/0101

Search for high mass lepton flavour violating processes with CMS — •Sebastian Wiedenbeck, Thomas Hebbeker, Arnd Meyer, and Swagata Mukherjee — III. Physikalisches Institut A, RWTH Aachen University

Lepton flavour is a conserved quantity in the standard model of particle physics, but it does not follow from an underlying symmetry. Neutrino oscillations imply that lepton flavour is not conserved in the neutral sector. Lepton flavour violating processes are common in several models of physics beyond the standard model (e.g. supersymmetry with R-parity violation, black hole production, and leptoquarks). Some models predict objects at the TeV mass scale that can decay into two standard model leptons of different flavours: electron + muon, muon + tau, or electron + tau. The challenges in a search for such phenomena are to achieve a high mass resolution, good rejection of standard model backgrounds, and efficient lepton identification at the same time. The status of the analysis, based on the CMS data taken in Run 2, and plans for Run 3 are presented.

T 132.2 Thu 17:45 HSZ/0101

Search for Leptoquarks in the multilepton channel with ATLAS Run-2 data — •Janik Böhm and Andre Sopczak — CTU in Prague

The latest results in the search for leptoquarks in the multilepton channel are presented using ATLAS Run-2 data.

T 132.3 Thu 18:00 HSZ/0101

Search for new particles decaying to top quark-antiquark pairs at CMS — •Henrik Jabusch[1], Ksenia de Leo[1], Johannes Haller[1], and Roman Kogler[2] — [1]Institut für Experimentalphysik, Universität Hamburg — [2]DESY, Hamburg

We present a model-independent search for new particles decaying to top quark-antiquark pairs ($t\bar{t}$) using 138 fb^{-1} of pp collision data at $\sqrt{s}$ = 13 TeV recorded with the CMS detector during LHC Run 2. The search targets both resonant and non-resonant signatures in the spectrum of the invariant mass $m_{t\bar{t}}$.

Focusing on lepton+jets final states, we use novel top-tagging techniques to identify the hadronic decay of highly Lorentz-boosted top quarks. We further employ a deep neural network for event classification. Reconstructed $m_{t\bar{t}}$-distributions are used to derive constraints on various physics models predicting new particles decaying to $t\bar{t}$, such as heavy resonances, Kaluza-Klein gluons, heavy Higgs bosons (including interference with the SM process), as well as non-resonant axion-like particles, extending the reach of earlier searches significantly.

T 132.4 Thu 18:15 HSZ/0101

Search for supersymmetry in single lepton events using angular correlations and heavy-object identification — Kerstin Borras[4,5], •Frederic Engelke[4,5], Kimmo Kallonen[3], Henning Kirschenmann[3], Pantelis Kontaxakis[1], Dirk Krücker[4], Isabell Melzer-Pellmann[4], Ashraf Mohammed[4,5], Paris Sphicas[1,2], Costas Vellidis[1], and Lucas Wiens[4] — [1]University of Athens — [2]CERN — [3]Helsinki Institute of Physics — [4]DESY — [5]RWTH Aachen IIIA

Results are presented from a search for supersymmetry in events with a single electron or muon, and multiple hadronic jets. The data corresponds to a sample of proton-proton collisions at $\sqrt{s}$ = 13 TeV with an integrated luminosity of 138 fb^{-1}, recorded by the CMS experiment at the LHC.

The search targets gluino pair production, where the gluinos decay into the lightest supersymmetric particle (LSP) and either a top quark-antiquark pair or a pair of light quarks in the final state.

We use the angular correlation between the lepton and the W boson's transverse momenta for a strong separation between the signal and the background region. The investigation of the two different signal models benefits from improved top and W tagging methods.

Furthermore, we also present current endeavors to prepare this analysis for the Run3 period using modern analysis tools.

T 132.5 Thu 18:30 HSZ/0101

Investigation of background processes for proton decay search in the JUNO experiment — •Carsten Dittrich[1], Ulrike Fahrendholz[1], Meishu Lu[1], Sarah Braun[1], Lothar Oberauer[1], Hans Steiger[2], and Matthias Raphael Stock[1] — [1]E15, Physik-Dep., Technische Universität München, James-Franck-Str. 1, 85748 Garching — [2]Cluster of Excellence PRISMA$^+$, Staudingerweg 9, 55128 Mainz

The Jiangmen Underground Neutrino Observatory (JUNO) is a large liquid scintillator detector, capable to search for the hypothetical proton decay $\mathrm{p} \rightarrow \mathrm{K}^+ + \bar{\nu}$, which is predicted by supersymmetric Grand Unified Theories (GUTs). As the momentum of the daughter kaon is below the Cherenkov threshold in water, JUNO will quickly be able to provide competitive results in comparison to the current lifetime limit of $\tau > 5.9 \cdot 10^{33}$ years by the Super-Kamiokande collaboration. The three-fold coincidence signature generated by the kaon and its daughter particles will be crucial to discriminate proton decay events from possible backgrounds produced by atmospheric neutrinos. This talk will present a brief overview on the proton decay search in JUNO, the different background processes and possible identification criteria to discriminate between the two.

This work is supported by the Clusters of Excellence Origins and PRISMA$^+$.

T 132.6 Thu 18:45 HSZ/0101

Search for Higgsinos in final states with a low-momentum, displaced track at the CMS experiment — Samuel Bein, Yuval Nissan, Peter Schleper, Alexandra Tews, and •Moritz Wolf — Universität Hamburg

Many supersymmetric extensions to the Standard Model predict the three lightest electroweakinos, χ_2^0, $\chi_1^\pm$, and χ_1^0, to be Higgsino-like with nearly degenerate masses around the electroweak scale. The lightest chargino can be produced alongside another electroweakino and then decay to the lightest neutralino. To search for these particles, the best strategy depends on the differences between the various masses. For $\Delta m(\chi_2^0, \chi_1^0) > \mathcal{O}(1\,\mathrm{GeV})$ lepton pairs from the decay of the second-lightest neutralino leave an experimentally distinct signature, whereas $\Delta m(\chi_1^\pm, \chi_1^0) \lesssim 0.3\,\mathrm{GeV}$ can lead to the chargino giving rise to a disappearing track. For mass splittings in the range of $\Delta m(\chi_1^\pm, \chi_1^0) = 0.3 - 1.0\,\mathrm{GeV}$, searches carried out so far at the LHC are lacking in sensitivity.

In this analysis, a slightly displaced track with small transverse momentum, corresponding to a pion originating from the chargino decay, is used to gain sensitivity to this challenging range of mass splittings.

T 133: Top, EW II

Time: Thursday 17:30–19:00 Location: HSZ/0103

T 133.1 Thu 17:30 HSZ/0103

Measuring mass and width of the W-boson with the ATLAS detector — Philip Bechtle[1], Klaus Desch[1], Oleh Kyvernyik[1], Jakub Kremer[2], •Philipp König[1], and Matthias Schott[2] — [1]Rheinische-Friedrich-Wilhelms-Universität Bonn — [2]2Johannes Gutenberg-Universität Mainz

In 2017, the ATLAS collaboration measured the W-boson mass using pp-collision data taken at $\sqrt{s}$ = 7 TeV in 2011, resulting in a precision of 19 MeV. We present a revised analysis of the same dataset, improving the fit methods and including a measurement of the width of the W-boson. A precise measurement of these quantities in the decay of the W-boson represent an excellent precision test of the Standard Model (SM). The recently released measurement of the W-boson mass using the full dataset recorded by the CDF collaboration is in significant tension with all previous measurements.

We will present the revised analysis of the ATLAS data including extensive cross-checks of the new profile likelihood fit approach. Detailed stability and consistency checks of the measurements will be discussed. Finally, a novel approach to validate fit models will be presented.

T 133.2 Thu 17:45 HSZ/0103

A direct measurement of the invisible width of the Z-boson with the ATLAS detector — •Martin Klassen — Kirchhoff-Institut für Physik, Heidelberg

The invisible width of the Z-boson, $\Gamma_Z(inv)$, is a fundamental parameter of the Standard Model. It is related to the number of light neutrinos that couple to the Z-boson, and its precise measurement allows for tests of the Standard Model. $\Gamma_Z(inv)$ has been indirectly measured at LEP with a precision of 0.3% and was in addition also directly determined using events with a photon and missing transverse energy to a precision of 3.2%.

At the ATLAS experiment, $\Gamma_Z(inv)$ can be obtained by measuring the ratio of $Z \rightarrow \nu\nu + jets$ to $Z \rightarrow ll + jets$ events (R^{miss}) as function of the Z boson's transverse momentum p_T. This approach is sufficient because the production cross section and the branching ratios can be decoupled leading to the relation $R^{miss} = \Gamma_Z(inv)/\Gamma_Z(ll)$ and the leptonic widths of the Z are already precisely measured. The ratio measurement benefits form a large degree of cancelation of many of the experimental and theoretical uncertainties. For this to work the phase spaces of selected $Z \rightarrow \nu\nu$ and $Z \rightarrow ll$ events need to be as similar as possible, and residual differences are corrected for using simulations.

In this talk the analysis strategy will be presented and it will be shown that the experiments at the Large Hadron Collider can obtain competitive results 30 years after the first direct measurement of $\Gamma_Z(inv)$ at LEP.

T 133.3 Thu 18:00 HSZ/0103

Measuring the Weinberg Angle at the Belle II Experiment * — •Lukas Grussbach, Daniel Greenwald, and Stephan Paul for the Belle II-Collaboration — Technical University Munich

The Weinberg angle is known precisely only at high energies around the Z^0 mass. At Belle II, we have the opportunity to measure it at a lower energy via $\mathrm{e}^+\mathrm{e}^- \rightarrow \mu^+\mu^-$, near to the energy where the NuTeV experiment has measured a discrepant value. We present preliminary studies of event selection criteria, muon identification performance and potential precision of such a measurement at Belle II.

*Funded by the DFG under Germany's Excellence Strategy - EXC2094 - 390783311 and BMBF Verbundforschung (05H21WOKBA BELLE2).

T 133.4 Thu 18:15 HSZ/0103

t$\bar{\mathrm{t}}$+heavy flavor classification at the CMS experiment — •Emanuel Pfeffer, Ulrich Husemann, Rufa Rafeek, Jan van der Linden, and Michael Wassmer — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

Processes in which a bottom quark-antiquark pair is produced in addition to the decay products of a top quark-antiquark pair are difficult to separate from each other. These processes include t$\bar{\mathrm{t}}$+b$\bar{\mathrm{b}}$, where the additional bottom quark-antiquark pair stems from a gluon splitting, as well as t$\bar{\mathrm{t}}$+H with $\mathrm{H} \rightarrow \mathrm{b}\bar{\mathrm{b}}$ and t$\bar{\mathrm{t}}$+Z with $\mathrm{Z} \rightarrow \mathrm{b}\bar{\mathrm{b}}$. New analysis techniques based on Graph neural networks are promising to improve the classification of these events. This talk sheds light on the current status of a simultaneous measurement of the production cross section of a top quark-antiquark pair in association with heavy flavor jets in the dileptonic channel at the CMS experiment. In this analysis, classification methods based on Graph neural networks are applied to separate processes in the t$\bar{\mathrm{t}}$+heavy flavor phase space.

T 133.5 Thu 18:30 HSZ/0103

Differential cross-section measurements of an hadronically decaying top-quark-antitop-quark pair produced in association with two b-jets with the ATLAS detector at $\sqrt{s}$ = 13 TeV — •Nina Wenke and Teresa Barillari — Max-Planck-Institut für Physik, München

The production of a top-quark-antitop-quark ($t\bar{t}$) pair in association with two b-jets ($t\bar{t}b\bar{b}$) is an important and insightful Standard-Model (SM) process to study at the LHC. It is the perfect playground to study the dynamics of multiple heavy quark production which is difficult to model precisely. It is also a major background in important SM measurements. In addition, precise $t\bar{t}b\bar{b}$ measurements could allow to catch glimpses of New Physics.

In this talk, preliminary results of the first ATLAS analysis targeting the hadronic decay channel of $t\bar{t}b\bar{b}$ production will be presented. It uses proton-proton collision-data recorded with the ATLAS detector at the LHC at a center-of-mass energy of 13 TeV, corresponding to an integrated luminosity of 139 fb^{-1}. The analysis uses a cut-based event selection with at least four b-jets. A likelihood-based algorithm is then used to reconstruct the hadronic decay of the $t\bar{t}$ pair in the event. The challenging large multijet background is modelled using a data-driven method. The final aim of the analysis is to perform fiducial differential cross-section measurements as a function of several variables and compare them to next-to-leading-order matrix-element calculations matched to a parton shower.

T 133.6 Thu 18:45 HSZ/0103

Simultaneous measurement of $t\bar{t}$+X($b\bar{b}$) processes in the semileptonic channel at the CMS experiment — •Rufa Kunnilan Muhammed Rafeek, Ulrich Husemann, Jan van der Linden, Emanuel Pfeffer, and Michael Wassmer — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

Top quark anti-quark pairs ($t\bar{t}$) are produced in association with other particles (X) where X can be the Higgs boson, Z/W boson or QCD-initiated heavy flavour jets ($b\bar{b}/c\bar{c}$). The measurement of $t\bar{t}+X$ is a direct probe of the coupling of standard model particles like the Higgs and Z boson to the top quark and may reveal new physics effects in modifications of these couplings.
The analysis is challenging as these processes, particularly when the bosons decay into heavy flavour quarks, like for example, $t\bar{t}+H(H\rightarrow b\bar{b})$ and $t\bar{t}+b\bar{b}$ or $t\bar{t}+Z(Z\rightarrow b\bar{b})$, share the same signature and kinematic features. These high jet multiplicity final states create ambiguities in the reconstruction and identification of these processes and thus, it is hard to differentiate them from each other. Due to this challenge, an attempt to simultaneously measure these $t\bar{t}+X$ processes is made by exploring multivariate analysis strategies.
In this talk, an overview of the ongoing analysis, designed with the full Run-2 data of the LHC using the single lepton channel, is given.

T 134: Higgs, Di-Higgs IV

Time: Thursday 17:30–19:00 Location: HSZ/0105

T 134.1 Thu 17:30 HSZ/0105

Differential measurement of the $H\rightarrow\tau\tau$ cross-section in the VBF production mode — •Lena Herrmann, Christian Grefe, Philip Bechtle, and Klaus Desch — Physikalisches Institut, Universität Bonn

Precision measurements of the Higgs boson properties are promising to show evidence of BSM physics. One aspect of interest is the Yukawa-interaction which can be directly investigated by the cross-section measurement of the di-τ final state. Detailed studies are performed in a combined maximum-likelihood fit of the di-τ mass in different p_T^H bins using the *"Simplified Template Cross Section"* framework (STXS). Orthogonal control regions are used to determine and to validate the contribution of important background processes. Multi-jet events which are misidentified as visible τ's (fakes), play an important role apart from the dominant $Z\rightarrow\tau\tau$ events. The fraction of fake events depends on the decay-mode of the hadronically decaying τ and has a less prominent contribution if no neutral pions are involved in the final state. In past analysis efforts, the estimated fake background events were only differentiated by 1- and 3-prong events which is why a more accurate, now decay-mode dependent fake background estimation is developed. It enables a loosened event selection for decay-modes without neutral pions and thus, an increased selection efficiency of signal events.

The method as well as the influence of the improved background estimation on the sensitivity of the measurement in different STXS bins will be discussed.

T 134.2 Thu 17:45 HSZ/0105

Charge-asymmetry measurement in WH($\tau\tau$) events — •Ralf Schmieder, Nicolo Trevisani, Nils Faltermann, Markus Klute, Roger Wolf, Xunwu Zuo, Sebastian Brommer, Maximilian Burkart, and Günter Quast — Karlsruher Institut für Technologie, Karlsruhe, Deutschland

At the LHC, an asymmetry in W^+H and W^-H production is expected as the parton distribution functions (PDFs) favour the production of positively-charged W bosons in proton-proton collisions. The measurement of the WH charge asymmetry provides a consistency test for the Standard Model (SM), as it is sensitive to enhanced Yukawa couplings to the first and more so to second generation quarks like the c quark. The production of an H in association with a W boson can happen through the exchange of a c quark in the t channel. Experimentally, the WH charge asymmetry measurement is independent of any challenging c jet tagging algorithms. This talk reports the status of this measurement in the channel where the Higgs boson decays into a pair of τ leptons.

T 134.3 Thu 18:00 HSZ/0105

Improved event cleaning for the τ-embedding method of CMS — •Christian Winter, Sebastian Brommer, Artur Gottmann, Roger Wolf, and Günter Quast — ETP, Karlsruhe Institute of Technology, Karlsruhe, Germany

In $H\rightarrow\tau\tau$ analyses a major source of background are genuine tau leptons, mostly originating from $Z\rightarrow\tau\tau$ decays. The τ-embedding method is a method to estimate this background from data, by replacing muons in an selected-event in data with simulated τ-decays. For this purpose, the muon signatures have to be removed from the original event record. This talk will focus on an improved cleaning, which takes electromagnetic muon showering in the muon detectors into account.

T 134.4 Thu 18:15 HSZ/0105

Measuring Higgs boson production cross sections in its decays into two tau leptons with the ATLAS detector — •baktash amini, christopher young, karsten köneke, and karl jakobs for the ATLAS-Collaboration — Albert-Ludwigs-Universität Freiburg, Freiburg, Germany

Since the Higgs boson discovery, probing the properties of it is an important physics program of the LHC. The significance of these studies originates from the fact that the Higgs boson is the only fundamental, point-like scalar which has been observed, and the precision measurement of the couplings of the Higgs boson through the production mechanisms and the decay modes might lead us to new physics. In this talk, the latest advances in Higgs boson measurements in its decays into two tau leptons, using data collected by the ATLAS detector, will be discussed.

T 134.5 Thu 18:30 HSZ/0105

Sensitivity to Triple Higgs Couplings via Di-Higgs Production in the 2HDM at the (HL-)LHC — Francisco Arco[1,2], Sven Heinemeyer[2], Margarete Muhlleitner[3], and •Kateryna Radchenko[4] — [1]UAM, Spain — [2]IFT (UAM-CSIC), Spain — [3]KIT, Germany — [4]DESY, Germany

The reconstruction of the Higgs potential is a major goal for experimental particle physics. This can be accomplished via the precise measurement of the Higgs mass and its self interactions. The first process that provides access to the trilinear self-coupling is Higgs pair production, which at the LHC happens dominantly trough gluon fusion. In this context, models with extended Higgs sectors are theoretically and experimentally allowed and can accommodate large deviations of the trilinear Higgs couplings while providing explanations to some of the shortcomings of the Standard Model.

We study the sensitivity to the triple Higgs couplings involved in Higgs pair production via gluon fusion in the framework of the Two Higgs Doublet Model. In particular, we focus on the contribution of the resonant diagram involving a heavy CP-even Higgs boson exchange to the total production cross section as well as the invariant mass distribution of two Higgses in the final state. We show that for the benchmark scenarios where the resonant production is dominant, there is significant sensitivity to the parameters of the extra scalar. Finally, we discuss the effects of experimental uncertainties by applying smearing and binning to our results.

T 134.6 Thu 18:45 HSZ/0105

A model-independent analysis of interference effects in the $t\bar{t}$ final state at the LHC involving two $\mathcal{CP}$-mixed Higgs bosons — Henning Bahl[1], •Romal Kumar[2], and Georg Weiglein[2,3] — [1]University of Chicago, Department of Physics and Enrico Fermi Institute, 5720 South Ellis Avenue, Chicago, IL 60637 USA — [2]Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany — [3]II. Institut für Theoretische Physik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

Various extensions of the Standard Model predict the existence of additional Higgs bosons. If these additional Higgs bosons are sufficiently heavy, an important search channel is the di-top final state. In this channel interference contributions between the signal and the corresponding QCD background process are expected to be important. If more than one heavy Higgs boson is present, besides the signal-background interference effects associated with each Higgs boson also important signal-signal interference effects are possible. We perform a comprehensive model-independent analysis of the various interference contributions within a simplified model framework considering two heavy Higgs bosons that can mix with each other, taking into account large resonance-type effects arising from loop-level mixing between the scalars. The interference effects are studied both in an analytic way at the parton level and with Monte Carlo simulations for proton-proton collisions at the LHC. The mapping of the general approach to a specific model is demonstrated for the case of a complex Two-Higgs Doublet Model.

T 135: Top Mass, Top BSM

Time: Thursday 17:30–19:00 Location: HSZ/0201

T 135.1 Thu 17:30 HSZ/0201

Measurement of the top-quark mass in the $t\bar{t} \to$ lepton + jets channel with a template method, using the full Run 2 dataset in ATLAS — •Dimbiniaina Rafanoharana and Andrea Knue for the ATLAS-Collaboration — Albert-Ludwigs-Universität Freiburg

The top-quark mass is a free parameter of the Standard Model (SM) and is playing a key role in the test of the consistency of the SM. Its precise determination is therefore of paramount importance. Several measurements of the top-quark mass in different final states using various methods were performed at the Tevatron and the Large Hadron Collider.

The combined measurement of the top-quark mass using different ATLAS Run 1 measurements achieved a relative overall uncertainty of 0.28%. The combination is limited by the systematic uncertainty as the relative statistical and systematic uncertainties are 0.14% and 0.23%, respectively.

The measurement of the top-quark mass with the template method in the $t\bar{t} \to$ lepton + jets channel using the full Run 2 dataset in ATLAS will be shown. Given the large amount of data collected during Run 2, the measurement is mainly limited by systematic effects. The presentation will discuss the dominating systematic uncertainties and studies aimed at reducing those uncertainties in the top-quark mass.

T 135.2 Thu 17:45 HSZ/0201

Messung der Masse des Topquark mit einer Likelihood-Anpassung mit Störparametern im vollhadronischen Kanal — •Yannek Gruel, Johannes Lange, Patrick Connor, Hartmut Stadie und Peter Schleper — Institut für Experimentalphysik, Universität Hamburg

Die Genauigkeit der Messung von der Masse des Topquarks hängt vor allem von unterschiedlichen systematischen Unsicherheiten ab. Um den Einfluss dieser Unsicherheiten auf die Masse zu verringern wird eine Likelihood-Anpassung angewendet, in der diese als freie Störparameter behandelt werden. Bisher wurde die Methode für die Messung im semileptonischen Zerfallskanal angewendet. Die hier präsentierten Ergebnisse zeigen die potentiellen Verbesserungen im vollhadronischen Kanal im Vergleich zur klassischen Messung ohne Störparameter.

T 135.3 Thu 18:00 HSZ/0201

Measurement of the jet mass distribution of boosted top quarks and the top quark mass with CMS — •Alexander Paasch[1], Johannes Haller[1], Roman Kogler[2], and Dennis Schwarz[3] — [1]Institut für Experimentalphysik, Universität Hamburg — [2]DESY, Hamburg — [3]Austrian Academy of Sciences, Wien

We present a measurement of the jet mass distribution in fully hadronic decays of boosted top quarks in pp collisions recorded by the CMS experiment in Run-2 of the LHC. The measurement is performed in the lepton+jets channel of top quark pair production. The top quark decay products of the all-hadronic decay cascade are reconstructed with a single large-radius jet with transverse momentum greater than 400 GeV. The top quark mass is extracted from the normalised differential top quark pair production cross section at particle level. The uncertainties arising from the calibration of the jet mass scale and modelling of the final state radiation in simulation are improved by dedicated studies of the jet substructure. This results in a significant increase in precision in the top quark mass with respect to an earlier measurement, now reaching a precision below 1 GeV.

T 135.4 Thu 18:15 HSZ/0201

Measurement of the top quark pole mass using $t\bar{t}$ +1 jet events with the CMS experiment — •Ana Ventura Barroso, Sebastian Wuchterl, Roman Kogler, and Katerina Lipka — Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, D-22607 Hamburg

The top quark is the most massive elementary particle known. Its mass,m_t, is a fundamental parameter of the Standard Model, and its value needs to be determined experimentally. However, direct top quark mass measurements suffer from ambiguities in their interpretation because of nonperturbative effects.

In this work, the pole mass of the top quark is extracted from a precise measurement of the distribution in ρ, in events where the $t\bar{t}$ system is produced in association with at least one additional jet. The variable ρ is defined as the inverse of the invariant mass of the $t\bar{t}$+jet system. This observable has been chosen due to strongest sensitivity to m_t at the threshold of the $t\bar{t}$+jet production. The analysis is performed using proton-proton collision data collected by the CMS experiment in 2016-2018 with $\sqrt{s}$=13 TeV, corresponding to a total integrated luminosity of 138 fb^{-1}. Events with two opposite-sign leptons in the final state are analyzed and the cross section is measured at the parton level using a likelihood unfolding method.

T 135.5 Thu 18:30 HSZ/0201

Prospects for a Measurement of Quantum Entanglement in Top Quark Pair Production in the Lepton+Jets Final State — Marcel Niemeyer, Arnulf Quadt, Baptiste Ravina, •Theresa Reisch, and Elizaveta Shabalina — II. Physikalisches Institut, Georg-August-Universität Göttingen

Quantum entanglement is a fundamental prediction of quantum mechanics. Experimental achievements with electrons and photons were recognised by the Nobel Prize in Physics 2022. At the LHC, quantum entanglement could be observed for the first time in quarks, testing quantum mechanics at high energies. Therefore, a sensitivity study for a possible measurement of quantum entanglement in the top quark pair production in the lepton+jets final state is presented. The angular separation between the decay products of the top quarks can act as a marker of quantum entanglement, when the two top quarks are produced near threshold. To take advantage of the presence of c-quarks in W decays in l+jets channel, c-tagging is used based on the working points of the current b-tagging algorithm. The result is then unfolded using Profile Likelihood Unfolding to remove detector effects. The study is performed with ATLAS Monte Carlo simulations under Run 2 conditions.

T 135.6 Thu 18:45 HSZ/0201

Search for heavy right-handed Majorana neutrinos in $t\bar{t}$ decays — •Tongbin Zhao[1,2], Binish Batool[1], Beatrice Cervato[1], Markus Cristinziani[1], Carmen Diez Pardos[1], Ivor Fleck[1], Arpan Ghosal[1], Gabriel Gomes[1], Jan Joachim Hahn[1], Vadim Kostyukhin[1], Buddhadeb Mondal[1], Amartya Rej[1], Katharina Voss[1], and Wolfgang Walkowiak[1] — [1]Center for Particle Physics Siegen, Experimentelle Teilchenphysik, Universität Siegen — [2]Shandong University, China

A search for heavy right-handed Majorana neutrinos is performed with the Run-2 dataset recorded from 2015 to 2018 with the ATLAS detector at the CERN Large Hadron Collider and is based on $\sqrt{s}$ = 13 TeV proton–proton collision data with an integrated luminosity of 139 fb^{-1}. The targeted process is $t\bar{t}$: one of the top quarks decays into a pair of same-sign same-flavour leptons (electrons or muons), a b-quark and two light quarks, while the other decays into a b-quark and two light quarks. The final states feature same-sign dilepton signatures. This analysis is the first search for heavy neutrinos using $t\bar{t}$ events.

A multivariate analysis is employed in order to improve the sensitivity. Several control regions are defined to estimate the main backgrounds. With profile likelihood fits using the ee and $\mu\mu$ channels, we expect to reach good sensitivities for the mixing parameters in the mass region 15–80 GeV.

T 136: Higgs TH, VH

Time: Thursday 17:30–19:00 Location: HSZ/0204

T 136.1 Thu 17:30 HSZ/0204

Associated production of a Higgs boson and a single top quark from t-channel production (tHq) in channels with hadronically decaying tau leptons at ATLAS — •Christian Kirfel, Ian C. Brock, Tanja Holm, and Oleh Kivernyk — Physikalisches Institut Bonn

A measurement of the single top-quark production in association with a Higgs boson and a spectator light-quark (tHq) gives insight into the properties of not only the top quark but also the Higgs boson. The associated production is uniquely sensitive to the relative sign of the top quark-Higgs boson Yukawa coupling. Additionally, the ditau decay of the Higgs boson, which successively decay hadronically, allows for precise reconstruction of the Higgs mass. The desired precision is limited by the plethora of background processes with higher cross sections.

This talk will discuss the search for this channel in the Run 2 LHC dataset by ATLAS.

T 136.2 Thu 17:45 HSZ/0204

Correlation studies on particle kinematics to improve mass reconstruction in single top quark associated H boson production (tHq) in the $H \to \tau\tau$ channel at ATLAS — •Mathias Weiss, Tanja Holm, and Ian Brock for the ATLAS-Collaboration — Universität Bonn

The associated production of a top quark and a H boson (called tHq) allows experimental tests of the relative phase between g_{HWW} and y_t, the coupling constants of the H boson to the W boson and to the top quark.

In the decay channel $H \to \tau\tau$ and $t \to l$ with one hadronic τ and two light leptons, l, in the final state, missing neutrinos are the main challenge to mass reconstruction. This talk approaches this challenge by exploiting correlations derived from Monte Carlo samples with truth information, which simulate events taken by the ATLAS detector during Run 2 of the LHC.

T 136.3 Thu 18:00 HSZ/0204

Associated production of a Higgs boson and a single top quark from t-channel production (tHq) in channels with hadronically decaying tau leptons at ATLAS — •Florian Kirfel, Tanja Holm, Christian Kirfel, and Oleh Kivernyk for the ATLAS-Collaboration — Physikalisches Institut der Universität Bonn, Deutschland

A measurement of the single top-quark production in association with a Higgs boson and a spectator light-quark (tHq) gives insight into the properties of not only the top quark but also the Higgs boson. The associated production is uniquely sensitive to the relative sign of the top quark-Higgs boson Yukawa coupling. In this talk the ditau decay of the Higgs boson, with one hadronically and one leptonically decaying tau, is investigated. The channel where the lepton from the top quark and the one from the Higgs boson have the same sign reduces the number of background events substantially. Techniques to treat the tau fakes as well as charge flip events present in this channel will be discussed in combination with applied TMVA methods and the fitting procedure.

T 136.4 Thu 18:15 HSZ/0204

Analysis of tH(bb) production with ATLAS Run-2 data — •Martin Vatrt and Andre Sopczak — CTU in Prague

The latest results on the analysis tH(bb) are presented with focus on machine learning optimization using ATLAS Run-2 data.

T 136.5 Thu 18:30 HSZ/0204

Comparison of different monte carlo generators for the simulation of ZH events in the gluon fusion production mode — •Manuella Guirgues[1], Xavier Coubez[1,2], Svenja Diekmann[1], Alena Dodonova[1], Ming-Yan Lee[1], Luca Mastrolorenzo[1], Spandan Mondal[1], Andrej Novak[1], Andrey Pozdnyakov[1], Alexander Schmidt[1], Annika Stein[1], and Valentyn Vaulin[1] — [1]III. Physikalisches Institut A, RWTH Aachen, Aachen, Germany — [2]Brown University, Providence, USA

The associated Higgs production via Higgsstrahlung from a Z boson originating from gluon fusion is a loop-induced process with destructive interference between the triangle and box contributions at leading order. This makes the process a sensitive candidate to probe new beyond the standard model pyhsics (BSM). Therefore, comparing different Monte Carlo generators and investigating their differences is important for the development of physics analyses to access the gg→ZH process in data. This talk will present the comparison of 4 generators for the process gg→ZH with the Higgs boson decaying via the H→bb channel. The comparison is done using simulated CMS Run 2 datasets at $\sqrt{s}$ = 13 TeV.

T 136.6 Thu 18:45 HSZ/0204

Extraction of the gluon-initiated component of the associated production of the Higgs boson and a vector boson with the CMS experiment — •Alena Dodonova[1], Alexander Schmidt[1], Xavier Coubez[1,2], Luca Mastrolorenzo[1], Andrey Pozdnyakov[1], Andrzej Novak[1], Spandan Mondal[1], Ming-Yan Lee[1], Annika Stein[1], Svenja Diekmann[1], Niclas Eich[1], and Martin Erdmann[1] — [1]III. Physikalisches Institut A, RWTH Aachen University, Aachen, Germany — [2]Brown University, Providence, USA

Associated Higgs boson production with a Z boson (ZH) contains quark- and gluon-initiated components. The gluon-initiated component ($gg \to ZH$) could be a good probe for the physics beyond the Standard Model (SM) since the effects of the new physics for the loop-induced processes would be of the same order as the SM process. Due to destructive interference between box and triangle contributions at the leading order, this component is suppressed with respect to the dominant quark-initiated contribution to ZH production.

In this talk, I will present the prospects to set an upper limit on the $gg \to ZH$ component in the $H \to b\bar{b}$ decay channel using DNN classifier. The study is performed with the full Run 2 dataset collected with the CMS detector at the LHC at $\sqrt{s} = 13\ TeV$.

T 137: DAQ Test/RO – GRID II

Time: Thursday 17:30–19:00 Location: HSZ/0301

T 137.1 Thu 17:30 HSZ/0301

Introducing Constellation - Development of a flexible DAQ Infrastructure Framework — •Stephan Lachnit — DESY, Hamburg, Germany

Test beam qualifications of new detectors are very volatile environments which require stable operation and synchronization of multiple devices while allowing for fast integration of new prototypes. For this purpose, a centralized run control software is usually used to distribute commands and to manage data recording and logging.

Constellation is an upcoming open-source DAQ infrastructure framework with the goal to implement such a run control software. The main aspect is the orchestration of different data acquisition "satellites" with the run control and other satellites for data storage.

In this talk several design concepts of Constellation will be presented, including for the Final State Machine, Messaging via ZeroMQ, zero-configuration networking, dynamic loading of DAQ modules and support for EUDAQ2 modules.

T 137.2 Thu 17:45 HSZ/0301

GUI framework and database for ATLAS ITk system tests — •Jonas Schmeing, Gerhard Brandt, Wolfgang Wagner, Marvin Geyik, and Maren Stratmann — Bergische Universtität Wuppertal

For the LHC Phase-2 upgrade, a new inner tracker (ITk) will be installed in the ATLAS experiment. It will allow for even higher data rates and will be thoroughly tested in the ATLAS ITk system tests. To operate these tests and later the final detector, a GUI and configuration system is needed. For this a flexible and scalable GUI framework based on distributed microservices has been introduced. Each microservice consists of a frontend GUI, a server running the python application, and a system-level backend.

The frontend GUI is a single-page application built with the React JavaScript library. The API for RESTful HTTP communication between the frontend and the Python app is defined via an OpenAPI specification. The Python app is the central part of each microservice. It connects to the microservices backend, such as a database or various DAQ applications. The OpenAPI and Python interfaces facilitate the maintainability and long-term upgradability of the system.

With this microservice framework, it is possible to serve specialized applications for different purposes: e.g., an API to access the data acquisition software or services to configure and monitor different hardware components. The system additionally includes multiple interfaces to a database used for storing configuration and connectivity data, data about the executed runs and their results.

T 137.3 Thu 18:00 HSZ/0301

ITk-Pixel FELIX read-out chain stress test preparations — •Matthias Drescher, Jörn Grosse-Knetter, Arnulf Quadt, and Ali Skaf — II. Physikalisches Institut, Georg-August-Universität Göttingen, Germany

The current ATLAS Inner Detector will be upgraded to an all-silicon Inner Tracker (ITk) for the experiment's phase 2 upgrade. The ATLAS ITk read-out system employs the FELIX hardware/software system for interfacing the optical fiber cables of the on-detector components to the higher level infrastructure. Each FELIX board has 24 high-speed fiber links. In the Pixel subdetector configuration, each uplink fiber is connected to an lpGBT aggregator chip, which itself bundles 7 Aurora 64b/66b data lanes at 1.28 Gbps. In our case, the Aurora data is the output of the RD53A prototype front-end chip. To ensure stable operation under full load before moving to the final large-scale read-out system, a stress test populating all 24 of these fibers is being prepared.

Due to limited hardware availability, we aim for carrying out stress tests with lpGBT and RD53A emulators implemented on several Xilinx FPGA development boards instead of the respective ASICs. The hit maps sent by the RD53A emulators are stored in fast local memory, which would be written from a central controller PC connecting to the FPGA boards via Gigabit Ethernet. In order to prepare our stress test, we had to develop a set of helping tools and procedures that might also be used independently. For example, a dedicated programmer GUI software was developed to be used with the existing CERN USB-I2C dongle.

T 137.4 Thu 18:15 HSZ/0301

Modelling Distributed Computing Infrastructures for High Energy Physics — •Maximilian Horzela[1], Henri Casanova[2], Robin Hofsaess[1], Manuel Giffels[1], Artur Gottmann[1], Günter Quast[1], Achim Streit[1], and Frederic Suter[3] — [1]Karlsruhe Institute of Technology, Karlsruhe, Germany — [2]University of Hawai'i at Manoa, Honolulu, USA — [3]Oak Ridge National Laboratory, Oak Ridge, USA

Designing distributed, heterogeneous computing-infrastructures is a challenging task. Since, due to their complexity and size, only a single design candidate can be feasibly deployed, building different prototypes is no option.

We therefore propose to simulate the behaviours of infrastructure candidates based on realistic simulation models as an accessible approach. This ansatz already proved to be successful, utilizing the MONARC simulator for the design of the original structure of the WLCG. In this spirit, a modern tool for simulation of high energy physics workloads executing on distributed computing infrastructures is presented. It is based on the SimGrid/WRENCH simulation framework, allowing to simulate complex infrastructures enhanced with models to simulate relevant data access and caching patterns.

T 137.5 Thu 18:30 HSZ/0301

Caching in Distributed Computing Infrastructures — •Robin Hofsaess, Maximilian Horzela, Manuel Giffels, Artur Gottman, and Matthias Schnepf — Karlsruher Institut für Technologie

With the steadily growing amount of data collected in several high energy physics experiments, new challenges occur when it comes to an efficient processing of the data. Besides storage, data transfers are becoming more and more limiting for the increasingly distributed computing infrastructure used by the HEP community. An efficient usage of the resources therefore make higher bandwidths necessary. However, it is often not possible to simply improve the connectivity of a resource provider leading to the necessity of other approaches. A first step here could be to reduce unnecessary data transfers by (local) caching. The talk will address the general ideas on coordinated caching within a distributed computing infrastructure - as given at KIT/GridKa - and briefly discuss its challenges. Furthermore, our future plans at KIT will be presented.

T 137.6 Thu 18:45 HSZ/0301

Belle II Grid Computing Developments in Germany — •Matthias Schnepf[1], Moritz Bauer[1], Günter Duckeck[2], Torben Ferber[1], Oliver Freyermuth[3], Andreas Gellrich[4], Manuel Giffels[1], Günter Quast[1], Michel Hernandez Villanueva[4], and Peter Wienemann[3] — [1]Karlsruhe Institute of Technology (KIT) — [2]LMU Munich — [3]Univertity of Bonn — [4]DESY Hamburg

The Belle II experiment studies B-meson decays with high precision and plans to record 50ab^{-1}, which corresponds to 50PB of recorded data. For reconstruction, simulation, and analysis, the Belle II collaboration uses several data centers around the world as a Grid, similar to the worldwide LHC Computing Grid.

To improve the global job throughput and support the local groups, several developments in Belle II Grid computing are being worked on and are applied in Germany or by German groups. In this presentation, we describe the challenges and the current development projects. These involve the Grid storage for local groups, caching techniques to increase dataset accessibility, GPU, and multicore support in the Grid for Belle II.

T 138: QCD Experiment III

Time: Thursday 17:30–18:45 Location: HSZ/0405

T 138.1 Thu 17:30 HSZ/0405

Triple differential cross-section measurement of Z($\mu\mu$)+jet events at 13 TeV — •Cedric Verstege, Robin Hofsaess, Maximilian Horzela, Günter Quast, and Klaus Rabbertz — Karlsruhe Institute of Technology, Karlsruhe, Germany

The differential cross-sections of Z($\mu\mu$)+jet events is presented using the data recorded at 13 TeV center-of-mass energy by the CMS experiment in the years 2016, 2017, and 2018. The cross-sections are measured as a function of the Z boson transverse momentum p_T^Z, the rapidity separation y^* of the Z boson and the leading jet, and the boost in rapidity y_b of their center-of-mass system in the lab frame. The observables y^* and y_b enhance the sensitivity to different parton initial-state and momentum contributions, and thus to the PDFs.

The measured cross-sections are unfolded for detector effects in all three dimensions simultaneously. The resulting cross-sections at stable particle level are compared to precise theory predictions calculated at next-to-next-to-leading order in perturbative QCD corrected for electroweak and non-perturbative effects.

T 138.2 Thu 17:45 HSZ/0405

Measurement of jet mass distribution of hadronic W and Z bosons — •Steffen Albrecht[1] and Andreas Hinzmann[2] — [1]Universität Hamburg — [2]DESY, Hamburg, previously Universität Hamburg

In this talk we introduce a new effort towards measuring the jet mass distribution of hadronically decaying W and Z bosons.

We study events in which the bosons have a large transverse momentum and thus produce strongly collimated decay products reconstructed as single fat jets. The substructure of such jets proves to be a useful handle in various procedures (e.g. jet calibration, jet tagging), but has room for improvement in its modelling. We aim to gain an in-depth understanding of the substructure by studying the unfolded jet mass distribution in dependence of the jet p_T and substructure tagger discriminants. While previous measurements of jet mass have been carried out for gluon, quark and top jets in dijet, Z(ll)+jet and $t\bar{t}$ samples, this is the first study of W and Z jet masses in the processes with $W(qq)$+jets, $Z(qq)$+jets as well as hadronic $t\bar{t}$ systems in the final states.

In addition the measurement of the difference $m_Z - m_W$ will be pursued, setting a first step towards a potential measurement of the W mass with jet substructure.

T 138.3 Thu 18:00 HSZ/0405

First results from inclusive jet measurement with Run2 data at CMS — •Valentina Guglielmi[1], Katerina Lipka[1], Simone Amoroso[1], Patrick Connor[2], and Roman Kogler[1] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, D-22607 Hamburg — [2]University Hamburg, Hamburg, Germany

We present preliminary results of the measurement and QCD analysis of double-differential inclusive jet cross sections in proton-proton collisions by using the full Run2 data collected by CMS experiment at a center of mass energy of s = 13 TeV. The higher accumulated luminosity, compared with the previous result, of full Run2 allows for an improved precision and opens up new corners of the phase space. This permits further testing of the Standard Model (SM) and facilitates indirect searches for physics beyond the SM. Our study addresses the high transverse momentum region, where possible contributions of new physics, e.g. different models of 4-quark contact interactions, are most significant. Furthermore, the precision of the parton distribution functions can be significantly improved and the strong coupling constant can be extracted. An overview of the current status of the measurement will be given, together with preliminary results of a simultaneous determination of alpha-s and PDFs at NNLO in QCD.

T 138.4 Thu 18:15 HSZ/0405

A novel method to measure the jet energy resolution from dijet events at CMS — •Yannick Fischer[1], Johannes Haller[1], Andrea Malara[2], Alexander Paasch[1], and Matthias Schröder[1] — [1]Universität Hamburg — [2]Université Libre de Bruxelles

The jet energy is a key observable for almost all analyses at the CMS experiment at the CERN LHC. A precise knowledge of the jet energy resolution (JER) is crucial for both measurements and searches. This talk will give a brief overview over JER measurements at CMS. A novel method based on the missing transverse momentum fraction (MPF) technique is introduced. The new approach provides a JER measurement complementary to existing methods and aims at avoiding several of their dominant uncertainties. In this talk, we will introduce the new method and show first results with the recent CMS data.

T 138.5 Thu 18:30 HSZ/0405

Production of interpolation grids for inclusive jet cross sections at ALICE — •Hector Pillot[1,2], Rachid Guernane[3], and Klaus Rabbertz[2] — [1]Grenoble Alpes University (UGA) — [2]Karlsruhe Institut of Technology (KIT) — [3]Laboratory of Subatomic Physics & Cosmology (LPSC)

The APPLfast project interfaces APPLgrid and fastNLO with the fixed-order cross section integrator NNLOJet. This produces interpolation grids that allow fast and accurate iterative computation of observables up to NNLO with different PDF sets or renormalization and factorization scales. This interface is employed in a workflow using the LAW and LUIGI packages for workflow management. As an example, differential cross sections of inclusive jet production from pp collisions at a center-of-mass energy of 5.02 TeV are computed within this workflow and are compared to experimental data from the ALICE collaboration. The cross sections are measured as a function of the jet p_T and jet size parameter R. The cross sections are also compared using different PDF sets including PDF uncertainties and renormalization and factorization scale variations.

T 139: Neutrinos VI

Time: Thursday 17:30–19:00 Location: POT/0051

T 139.1 Thu 17:30 POT/0051

Status of the NUCLEUS experiment — •Sebastian Dorer — Technische Universität Wien, Vienna, Austria

Coherent elastic neutrino nucleus scattering (CEvNS) is a well-predicted Standard Model process only recently observed for the first time. Its precise study could reveal non-standard neutrino properties and open a window to search for physics beyond the Standard Model.

NUCLEUS is a CEvNS experiment conceived for the detection of neutrinos from nuclear reactors with unprecedented precision at recoil energies below 100 eV. Thanks to the large cross-section of CEvNS, an extremely sensitive cryogenic target of 10g of CaWO4 and Al2O3 crystals is sufficient to provide a detectable neutrino interaction rate.

NUCLEUS will be installed between the two 4.25 GW reactor cores of the Chooz-B nuclear power plant in the French Ardennes, which provide an antineutrino flux of 1.7×10^{12} $\nu/(\mathrm{s\ cm}^2)$. At present, the experiment is under construction. The commissioning of the full apparatus is scheduled for 2023, in preparation for the move to the reactor site. In this talk we will discuss the NUCLEUS goals and sensitivity, as well as present the recent activities and progresses of the experiment.

T 139.2 Thu 17:45 POT/0051

Design and fabrication of MMC-based P2 detectors to be coupled to scintillating crystals at mK temperatures — •Ashish Jadhav, Christian Enss, Andreas Fleischmann, Daniel Hengstler, Daniel Unger, and Loredana Gastaldo — Kirchhoff Institute for Physics, Heidelberg University, Im Neuenheimer Feld 227, 69120 Heidelberg, Germany.

We present the development of high-energy resolution integrated photon and phonon detectors (P2), based on low-temperature Metallic Magnetic Calorimeters (MMC) to be coupled to a scintillating crystal operated at 20 mK. The present design of P2 is based on a 3 inch wafer. The central part, of area 15 cm^2 is connected to the rest of the wafer through 7 legs fabricated using deep silicon etching and is used for the detection of visible photons emitted after the interaction of a particle in the crystal. On the outer part of the wafer, three double meander MMC detectors are fabricated as phonon detectors. They will be connected to the crystal for monitoring the increase in temperature upon the interaction of a particle. We aim at demonstrating an energy resolution better than 1 keV for the phonon detectors and a time resolution better than 1 μs for the photon detector. This detector development is part of the R&D for the AMoRE experiment searching for $0\nu\beta\beta$ decay in ^{100}Mo. Demonstrating the expected performance for P2 will have a substantial impact on background reduction and influence the design of detector modules for the next stage of the AMoRE experiment.

T 139.3 Thu 18:00 POT/0051

CEvNS and searches for new physics with the CONUS experiment — •Sophie Armbruster for the CONUS-Collaboration — Max-Planck-Institut für Kernphysik, Heidelberg

The CONUS experiment (COherent elastic NeUtrino nucleus Scattering) aims to detect coherent elastic neutrino-nucleus scattering (CEvNS) of reactor antineutrinos on germanium nuclei in the fully coherent regime. The CONUS experiment - operated in the Brokdorf nuclear power plant (Germany) between April 2018 and December 2022- was located at 17m from the 3.9 GWth core. The possible CEvNS signature was studied with four 1 kg point-contact high-purity germanium (HPGe) detectors, which provided a sub keV energy threshold with background rates in the order of 10 events per kg, day and keV. The analysis of the final CONUS data set allows us to establish competitive limits on CEvNS from a nuclear reactor with a germanium target. The most recent results including constraints on beyond the Standard Model parameters will be presented together with future plans of the project.

T 139.4 Thu 18:15 POT/0051

CNO solar neutrinos measurement with Borexino detector: updated combined analysis with directionality constraint — •Luca Pelicci — Forschungszentrum Jülich GmbH, Institut für Kernphysik IKP-2, Jülich, Germany — Johanniterstrasse 22

Borexino was a large liquid scintillator experiment with an unprecedented level of radiopurity, designed for real-time detection of low-energy solar neutrinos. It was located at the underground INFN Laboratori Nazionali del Gran Sasso, in Italy. During more than ten years of data taking, it has measured the neutrino flux from each individual within the proton-proton-chain, i.e. the main fusion process accounting for 99 % of the energy production of the Sun, and in the CNO cycle, responsible for the remaining 1%. To disentangle neutrino-induced signals from residual background, a multivariate analysis was adopted, based on the fitting of the spectrum of Borexino events with Monte-Carlo simulated reference shapes. In recent years, through the method called ”Correlated and Integrated Directionality” (CID) Borexino has also provided a proof of principle for the exploitation of the sub-dominant Cherenkov information produced by sub-MeV solar neutrinos in a liquid scintillator detector. In this talk, the improvements and upgrades performed in recent years will be discussed. Furthermore, the combination of the two analysis approaches was recently exploited for a measurement of the CNO solar neutrinos with improved precision. The most recent results will be presented.

T 139.5 Thu 18:30 POT/0051

Looking for sterile neutrinos using the solar ^{8}B neutrino spectrum — •Simon Appel and Lothar Oberauer — Technische Universität München, München, Germany

Solar ^{8}B neutrinos are detected via elastic scattering on electrons in large radiopure detectors. The expected upturn in the survival probability of solar ^{8}B neutrinos is still not detected. Current generation detectors struggle with several challenges. Cosmic muons produce radiogenic isotopes that mimic the ^{8}B neutrino shape. Especially the long lived ^{10}C and ^{11}Be isotopes are problematic. External gamma background limits the fiducial volume.The expected upturn in the survival probability of solar ^{8}B neutrinos is still not detected. Current Besides the MSW effect there is more physics beyond the standard model that could affect the neutrino survival probability. Light sterile neutrinos $\Delta m^2_{01} \simeq (0.7-2)\cdot 10^{-7}\mathrm{eV}^2$ and flavor changing ν_e-ν_τ interactions affect the survival probability in the same energy region as the MSW effect. This talks focuses on the ability of future detector generations exploring this parameter space. This work is supported by the DFG collaborative research centre 1258 "NDM", and the DFG Cluster of Excellence "Origins".

T 139.6 Thu 18:45 POT/0051

Directionality measurement of CNO neutrinos in the Borexino detector — •Johann Martyn[1] and Apeksha Singhal[2,3] — [1]Johannes Gutenberg - Universtät Mainz — [2]Forschungszentrum Jülich GmbH, Nuclear Physics Institute IKP-2 — [3]III. Physikalisches Institut B, RWTH Aachen

Borexino has been a 280 t liquid scintillator detector situated at the INFN Laboratori Nazionali del Gran Sasso in Italy. With an unprecedetened level of radiopurity and a 3800 m.w.e. of rock shielding its main goal is the measurement of solar neutrinos. Previously the Borexino collaboration has provided the first directional measurment of sub-MeV ^{7}Be neutrinos using the so called "Correlated and Integrated Directionality" (CID). Here the known position of the Sun is correlated to the reconstructed photon direction, given by the hit PMT position and the reconstructed event position. Cherenkov hits from the neutrino recoil electrons show a correlation to the position of the Sun, while the isotropic scintillation and background events are not. The integrated angular distribution of the hits for a large number of events then allows for the statistical inference on the number of neutrino events. This talk presents the CID measurement of CNO neutrinos, using the full Borexino detector live time from May 2007 to October 2021.

T 140: Gamma Astronomy VI

Time: Thursday 17:30–19:00 Location: POT/0151

T 140.1 Thu 17:30 POT/0151

Signal extraction of raw simulated and laboratory data with the FlashCam camera for Medium Sized Telescopes in CTA. — •Clara Escanuela, Felix Werner, and Jim Hinton — Max-Planck Institut für Kernphysik, Heidelberg

The Cherenkov Telescope Array (CTA) is the next generation observatory for very high energy (VHE) gamma rays. The southern CTA site will consist of large, medium (MST), and small size telescopes to cover a wide range of photon energies. The FlashCam will be used for the southern site MSTs, and is a photomultiplier-tube based camera with a fully digital readout system. A FlashCam MST is expected to start taking data in Chile in 2024. This requires deep laboratory testing which includes the reproduction of shower-like illumination patterns and time profiles with an LED array, laser calibration, and night sky background simulation. We present first results from testing the signal extraction algorithm and performance verification in the laboratory.

T 140.2 Thu 17:45 POT/0151

Influence of varying pulse shapes on the response of FlashCam — •Fabian Leuschner for the CTA FlashCam-Collaboration — IAAT, 72076 Tübingen, Germany

FlashCam is a fully digital camera for Imaging Air Cherenkov Telescopes (IACTs) and is foreseen to be used for the Medium-Sized Telescopes (MSTs) at the southern site of the upcoming CTA Observatory. Since 2019, a fully functional advanced prototype is installed to CT5, the world's largest IACT that is part of the H.E.S.S. array in Namibia. Accurate reconstruction of the input light intensity in each individual pixel is key for correctly reconstructing air showers and consecutively for observations of very high energetic gamma rays. Extensive measurements with tuneable light-pulses from two pulsed lasers have been used to assess the performance of the reconstruction algorithms. The setup provides dual pulses, each with less than a nanosecond duration. Pulses are emitted either synchronously or with an adjustable time delay of multiples of 0.5 ns between each pulse.

After a short introduction into the FlashCam concept, I will discuss the influence of such pulses with varying length, shape, and intensity on the camera response. The results show that FlashCam is able to reconstruct the intensity of incoming light pulses over the required dynamic range with accuracies on the percent scale and meets the requirements for use in the CTA Observatory.

T 140.3 Thu 18:00 POT/0151

Muon Calibration of Dual-Mirror-Telescopes — •Henning Ptaszyk, Rune M. Dominik, and Maximilian Linhoff for the CTA-Collaboration — Astroparticle Physics, TU Dortmund University, D-44227 Dortmund, Germany

The Cherenkov Telescope Array (CTA) is being built at two sites on the northern and southern hemisphere respectively and will be the next generation ground-based very-high-energy gamma-ray observatory. Both arrays will consist of multiple Imaging Atmospheric Cherenkov Telescopes (IACT) in different sizes, built for the observation of gamma-ray induced air showers within different energy ranges. The southern array, currently being constructed in Chile, will include Small-Sized Telescopes (SSTs) utilizing a Schwarzschild-Couder design, that feature two reflectors instead of one. This optical design, which is also proposed for some of the MSTs, not only allows for a more compact construction, but also counteracts optical aberration.

To ensure precise reconstruction of the incoming gamma-ray's properties, calibra- tion methods are required. As for previous IACT experiments, ring-like images, generated by atmospheric muons, present an important calibration source for CTA. Since the aforementioned dual-mirror telescopes pose a novel introduction to IACT observatories, it is necessary to study the muon calibration process for Schwarzschild-Couder telescopes. The status and further proceeding of this research are the subject of this talk.

T 140.4 Thu 18:15 POT/0151

Reproducible Analysis of MAGIC Data with the Database-Driven Framework AutoMAGIC and the Open-Source Python Package Gammapy — •Simone Mender and Jan Lukas Schubert for the MAGIC-Collaboration — TU Dortmund University

The open-source Python package Gammapy is mainly developed for the high-level analysis of gamma-ray data of the future Cherenkov Telescope Array Observatory. It can also be used to analyze data from existing imaging air Cherenkov telescopes like MAGIC. Gammapy requires event-based data combined with the corresponding instrument response functions. In order to process this science-ready data (so-called DL3) for MAGIC, the new database-driven framework AutoMAGIC is developed. With AutoMAGIC it is possible to create DL3 data in an automated and reproducible way. It enables the possibility to perform very cumbersome analyses automatically, e.g. the low-level data reprocessing that is needed for observations with moderate to strong moonlight. In this talk, we present the analysis chain and its validation. For this, we analyzed Crab Nebula data, which was taken under different observational conditions.

T 140.5 Thu 18:30 POT/0151

Automatized Analysis of MAGIC Sum-Trigger-II Pulsar Data — •Jan Lukas Schubert and Simone Mender for the MAGIC-Collaboration — TU Dortmund University, Dortmund, Germany

The MAGIC telescopes are a stereoscopic system of Imaging Air Cherenkov Telescopes which is used for gamma-ray detection in the GeV to TeV range. Thanks to an analogue trigger system, dubbed Sum-Trigger-II, low-energy data with a threshold as low as ~25 GeV can be recorded, enabling the MAGIC telescopes to perform comparably low energetic analyses such as pulsar analyses.

This data requires a dedicated treatment adapted to the low energies. Since the analysis structure is complex, it is reasonable to automatize the analysis to save time for an analyzer and to deliver entirely reproducible results. The automatization of the analysis of Sum-Trigger-II data was implemented in the autoMAGIC project which aims to automatize the entire MAGIC analysis chain.

A workflow for the pulsar timing and the pulsar analysis based on the autoMAGIC output is currently designed and implemented. It delivers results comparable to manual pulsar analyses.

In the future, the automatization of the analysis of Sum-Trigger-II data could be used for further optimizations of the low-energy analysis as well as for comparisons of low-energy data from MAGIC and the LST. In combination with the automatic pulsar analysis, this will enable the possibility to perform long-term pulsar analyses with a comparably small amount of work.

T 140.6 Thu 18:45 POT/0151

Towards an automatic mode of operation of the MAM subsystem of MAGIC — •Angela Bautista for the MAGIC-Collaboration — Max Planck Institute for Physics, Munich, Germany

The MAGIC telescope system is sensitive to gamma rays in the very high energy range 20 GeV-100 TeV. Cherenkov light produced in extensive air showers is collected and used to estimate the primary gamma-ray energy. The atmosphere absorbs part of the Cherenkov light and the MAGIC LIDAR system is used to correct observations with zenith angles up to 60°. MAGIC observes sources above 60° using the Very Large Zenith Angle (VLZA) observation technique. The increased collection area during VLZA observations enables the study of PeVatron candidates with steep spectra extending to 100 TeV and beyond. At such large zenith angles, the column density of air exceeds the range covered by the LIDAR and a different atmospheric calibration technique is needed. The MAGIC Atmospheric Minion (MAM) was installed at the MAGIC site to correct for the atmospheric effects during VLZA observations. The task of MAM is to measure the atmospheric transmission in real-time either by using aperture photometry or spectroscopy of stars within the same sky region as the gamma-ray source of interest. Currently, a manual procedure for photometric calibration is already in place. This talk presents recent progress along with the next steps to advance towards an automatic mode of operation of the MAM subsystem.

T 141: Neutrino Astronomy V

Time: Thursday 17:30–19:00 Location: POT/0251

T 141.1 Thu 17:30 POT/0251

Study of the transport behaviour in blazars under the influence of hadronic and photohadronic interactions * — •Vladimir Kiselev[1,2], Marcel Schroller[1,2], Julia Becker Tjus[1,2], and Patrick Reichherzer[1,2] — [1]Theoretische Physik IV, Ruhr-Universität Bochum — [2]RAPP Center, Ruhr-Universität Bochum

Active Galactic Nuclei (AGN) are considered among the few possible sources of high-energy neutrino emission. Therefore, it is important to describe the temporal behaviour and their signal correctly in the multimessenger picture. The most commonly used approach to describe a blazar flare in the present work has been applied, where a population of high-energy primary protons enters a plasmoid, travelling along the jet axis. One such realisation is the modified version of the publicly available propagation framework CRPropa 3.2, which modular structure offers two different propagation approaches, i.e. the equation of motion (EoM) and the solution of the transport equation, under consideration of a broad network of interactions. Previously, it has been shown how, in the considered high-energy range of primary protons, a transition between ballistic and diffusive behaviour takes place, which influences the spectral energy distribution, as well as the light curve of flares. The present work is an extension of the aforementioned work, where the same energy range is considered. In this talk we investigate how the introduction of hadronic interaction modules influences the diffusive behaviour of protons and the transition between both propagation regimes. * Supported by DFG (SFB 1491).

T 141.2 Thu 17:45 POT/0251

Neutrino Cadence of TXS 0506+056 Consistent with Supermassive Binary Origin* — Julia Becker Tjus[1], •Ilja Jaroschewski[1], Armin Ghorbanietemad[1], Imre Bartos[2], Emma Kun[1,3,4], and Peter L. Biermann[5,6] — [1]Theoretical Physics IV, Ruhr University Bochum — [2]Dept. of Phys., Univ. of Florida, USA — [3]CSFK, MTA Centre of Excellence, Hungary — [4]Konkoly Observatory, ELKH Research Centre for Astr. and Earth Sciences, Hungary — [5]MPI for Radioastronomy, Bonn — [6]Dept. of Phys. & Astr., Bonn

In the past, two distinct flares of high-energy neutrinos have been detected by the IceCube neutrino observatory from the direction of the blazar TXS 0506+056. In de Bruijn et al. 2020, it was shown that these two neutrino emission episodes could be due to an ongoing supermassive binary black hole (SMBBH) merger where jet precession close to final coalescence leads to periodic emission. This model made predictions on when the next neutrino emission episode must occur. On September 18, 2022, a new alert by IceCube indicated that a high-energy neutrino arrived from the direction of TXS 0506+056, consistent with the model prediction.

In this work, we show that these three distinct flares of neutrino emission from TXS 0506+056 are consistent with a SMBBH origin and constrain the total mass as well as mass ratio for the binary. We make predictions on when the next neutrino flares should happen and, for the first time, calculate the characteristic strain of its gravitational wave emission. *Supported by DFG (SFB 1491)

T 141.3 Thu 18:00 POT/0251

Time and Density Dependent Modelling of Hadronic and Leptonic Processes in Blazar Jets* — •Marcel Schroller, Julia Becker Tjus, and Lukas Merten — Theoretical Physics IV, Ruhr University Bochum, Germany

Active galactic nuclei (AGN), and the accompanied jets, are some of the most luminous objects in the observable Universe. Both the active cores and their jets are candidates for the engine of ultra high-energy cosmic rays, gamma rays, and neutrinos with the highest energies measured on Earth. In 2017, IceCube recorded an extragalactic high-energy neutrino event with a strong hint of a directional coincidence with the position of a known jetted AGN TXS0506+056. A deep understanding of the processes related to jets will fuel the field of high-energy cosmic rays, fundamental plasma, astro, and particle physics. However, an AGN jet's physical and mathematical modelling is challenging, with ambiguous signatures that need to be understood by numerical simulations of cosmic ray transport and interactions. In this talk, we present a simulation framework for hadronic constituents and their interactions inside of a plasmoid propagating along the AGN jet axis, which is utilised to investigate the time- and density dependence of hadronic interactions in blazar jets and their effects on multi-messenger spectra. Furthermore, we will provide deeper insights into the results of such simulations and discuss how to include non-linear leptonic radiation processes into our test particle simulation framework for a more complete, physical description of processes in AGN jets. *Supported by DFG (SFB 1491).

T 141.4 Thu 18:15 POT/0251

Seasonal Variations of the Atmospheric Neutrino Flux measured in IcCube — •Karolin Hymon and Tim Ruhe for the IceCube-Collaboration — Technische Universität Dortmund, Germany

The IceCube Neutrino Observatory measures high energy atmospheric neutrinos with high statistics. These atmospheric neutrinos are produced in cosmic ray interactions in the atmosphere, mainly by the decay of pions and kaons. The rate of the measured neutrinos is affected by seasonal temperature variations in the Stratosphere, which are expected to increase with the particle's energy. In this contribution, seasonal energy spectra are obtained using a novel spectrum unfolding approach, the Dortmund Spectrum Estimation Algorithm (DSEA+), in which the energy distribution is estimated from measured quantities with machine learning algorithms. The seasonal spectral difference to the annual average flux will be discussed based on preliminary results from IceCube's atmospheric muon neutrino data.

T 141.5 Thu 18:30 POT/0251

Search for the Prompt Neutrino Flux with IceCube — •Jakob Böttcher, Philipp Fürst, Erik Ganster, Matthias Thiesmeyer, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Insitut b, RWTH Aachen University

For about a decade the IceCube Neutrino Observatory has been measuring a high-energy diffuse astrophysical neutrino flux. At these energies, an important source of background is prompt atmospheric neutrinos produced in decays of charmed mesons that are part of cosmic-ray-induced air showers. The production yield of charmed mesons in hadronic interactions, and thus the flux of prompt neutrinos, is not well known and has not yet been observed by IceCube. The analysis of up-going muon neutrino-induced tracks in IceCube provides a large sample of atmospheric neutrinos which likely includes prompt neutrinos. However, the measurement of a subdominant prompt neutrino flux strongly depends on the hypothesis for the dominating astrophysical neutrino flux. This makes the estimation of upper limits on the prompt neutrino flux challenging. We discuss the extent of this model dependency on the astrophysical flux and propose a method to calculate robust upper limits. Furthermore, a possible dedicated search of the prompt neutrino flux using multiple IceCube detection channels is outlined.

T 141.6 Thu 18:45 POT/0251

Search for up-going air showers and constraints of BSM particles with the Pierre Auger Observatory* — •Baobiao Yue for the Pierre Auger-Collaboration — Bergische Universität Wuppertal, Gaußstr. 20, 42119, Wuppertal, Germany

We report on the search for up-going air showers using data from the Pierre Auger Observatory. The observation of such kind of showers with energies above 10^{17} eV has been reported by the ANITA experiment but waits explanation. Using 14 years of available Auger data, the exposure to up-going showers after accounting for all cuts exceeds the one of ANITA by a large factor. Defining a data-blinded search strategy, only one event was found in the zenith angle range $[110^\circ, 180^\circ]$ to pass all cuts, which is consistent with a background expectation of 0.4 ± 0.2 events. The non-observation is used to derive stringent bounds on BSM particles that were discussed in the literature to explain the anomalous ANITA observation. These particles could be produced by high energy interactions within the atmosphere or the Earth and penetrate the Earth with only little absorption to eventually produce tau-particles initiating observable up-going air showers. We discuss the derived upper fluxes of such BSM particles as a function of their unknown cross section with matter and find the strongest bounds when it is at the level of 1% of the neutrino nucleon cross section at the same energy.

Gefördert durch die BMBF Verbundforschung Astroteilchenphysik (Vorhaben 05A20PX1)

T 142: Neutrinos, Dark Matter XI

Time: Thursday 17:30–19:00 Location: POT/0361

T 142.1 Thu 17:30 POT/0361

The finestructure in the reactor antineutrino spectrum and its implications on the JUNO NMO sensitivity — •Tobias Heinz, Lukas Bieger, Marc Breisch, Jessica Eck, Benedict Kaiser, Tobias Lachenmaier, and Tobias Sterr — Eberhard Karls Universität Tübingen, Physikalisches Institut

To determine the neutrino mass ordering (NMO) with the Jiangmen Underground Neutrino Observatory (JUNO) a precise knowledge of the antineutrino spectrum emitted by nuclear reactors is crucial. New model predictions of the reactor antineutrino spectra show the possible existence of a finestructure in the spectrum that has not been measured yet which can have an impact on the sensitivity of the NMO determination using a detector of unprecedented energy resolution of 3% @ 1 MeV like JUNO. This talk will focus on the study of those implications on the NMO sensitivity of JUNO as well as on the possibility to reduce this impact by measuring an unoscillated reactor antineutrino spectrum with high energy resolution by JUNO's satellite detector TAO as a reference.

This work is supported by the Deutsche Forschungsgemeinschaft.

T 142.2 Thu 17:45 POT/0361

Investigating atmospheric neutrino-antineutrino separation in JUNO — •Achilleas Patsias[1,2], Aachim Stahl[1], and Thilo Birkenfeld[1] for the JUNO-Collaboration — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]Physikalisches Institut, University of Bonn

The CP-violating nature of neutrinos has drawn a lot of attention after the discovery of neutrino oscillations. Atmospheric neutrinos appear in a broad energy range and with high flux of neutrinos and anti-neutrinos which makes them suitable candidates for the study of their CP properties. The Jiangmen Underground Neutrino Observatory (JUNO) will provide atmospheric neutrino data with high statistics and excellent energy resolution. In this study we investigate the required separation accuracy for neutrinos and anti-neutrinos to measure CP-violation with the JUNO detector.

T 142.3 Thu 18:00 POT/0361

UV-complete Dark-Matter models and the ATLAS missing-energy-plus-jets measurement — •Martin Habedank and Priscilla Pani — Deutsches Elektronensynchrotron (DESY) Zeuthen

In the Standard Model, the final state of missing energy and at least one jet (MET+jets) at colliders can be mostly attributed to the production of vector bosons in association with jets. Events with Dark Matter in the final state would however also contribute to this channel. It offers therefore a powerful handle in observing or constraining Dark-Matter models.

Traditionally, mostly simplified Dark-Matter models have been used to interpret the MET+jets final state at the LHC. UV-complete models like the two-Higgs-doublet-model with a pseudoscalar mediator to Dark Matter (2HDM+a) provide however a more complex phenomenology, offering many processes that can contribute to the MET+jets final state.

In this talk, insights into the ATLAS measurement of the MET+jets final state in 139 fb^{-1} of proton–proton collision at 13 TeV are given. Unfolding the measurement allows for direct comparisons to predictions of Standard-Model and beyond without having to take into account detector effects. This is demonstrated in interpreting the measurement with respect to the 2HDM+a and setting stringent parameter constraints on the latter.

T 142.4 Thu 18:15 POT/0361

Constraining the dark matter distribution of galaxy clusters — •Lukas Nickel — TU Dortmund University

Dark matter remains one of the unsolved mysteries of modern astrophysics. Many phenomena can only be explained under the assumption of an additional matter component, yet - despite searches in all channels - no clear detection was made so far.

One way dark matter could be found, is to look for an excess in gamma-rays from regions with high concentrations of dark matter. Assuming that the unknown particle(s) decay/annihilate into standard-model particles, they would produce gamma-rays even without direct electromagnetic interaction.

To estimate the expected signal, the distribution of dark-matter in an astrophysical object needs to be determined first. This talk will focus on constraining the dark-matter content of nearby galaxy clusters using the CLUMPY software package, presenting current results and discussing implications for gamma-ray observations.

T 142.5 Thu 18:30 POT/0361

Dark Matter Annihilation in NGC 1068 — •Alexandra Scholz and Li Ruohan — TU München

If Dark Matter (DM) is of particle nature, the Weakly Interacting Massive Particle (WIMP), with an expected mass in the range of some GeV to TeV, detectable by the IceCube telescope, would be a possible candidate. For the barred spiral galaxy NGC 1068 we calculated the neutrino flux from the spike of the super massive black hole (SMBH), and the disk, induced from DM self-annihilation into Standard Model (SM) particles. The calculation was performed for the DM masses 100 GeV, 1 TeV, and 10 TeV, and different Navarro-Frenk-White (NFW) density profile parameters. The annihilation branch ratios and neutrino energy spectra were simulated with the softwares Pythia and MadDM. Comparing IceCube data from NGC 1068 with the results for those three masses, the TeV Dark Matter annihilation scenario has no conflict with the spectrum shape from NGC 1068. Therefore, DM can be a potential explanation for the neutrino flux from NGC 1068.

T 142.6 Thu 18:45 POT/0361

multi-particle dark matter: how to get the hint — subhaditya bhattacharya[1], purusottam ghosh[2], •jayita lahiri[3], and biswarup mukhopadhyaya[4] — [1]Indian Institute of Technology, Guwahati, India — [2]Indian Association for the Cultivation of Science, Kolkata, India — [3]II. Institut für Theoretische Physik, Universität Hamburg, 22761 Hamburg, Germany — [4]Indian Institute of Science Education and Research Kolkata, Mohanpur, India

We investigate ways of identifying two kinds of dark matter component particles at high-energy colliders. The strategy is to notice and distinguish double-peaks(humps) in some final state observable. We carried out our analysis in various popular event topologies for dark matter search, such as mono-X and n-leptons+n-jets final state along with missing energy/transverse momenta. It turns out that an e^+e^- collider is suitable for such analyses. The observables which are best-suited for this purpose have been identified, based on the event topology. The implication of beam-polarization is also explored in detail. Lastly, a quantitative measure of the distinguishability of the two peaks has been established in terms of a few newly-constructed interesting variables.

T 143: Neutrinos VII

Time: Thursday 17:30–19:00 Location: POT/0006

T 143.1 Thu 17:30 POT/0006

Development of novel water-based liquid scintillator with pulse-shape discrimination capabilities — •Hans Theodor Josef Steiger[1,2], Matthias Raphael Stock[3], Manuel Böhles[2], David Dörflinger[3], Ulrike Fahrendholz[3], Daniele Guffanti[4], Meishu Lu[3], Lothar Oberauer[3], Andreas Steiger[3], Michael Wurm[1,2], and Dorina Zundel[2] — [1]Cluster of Excellence PRISMA+ — [2]Johannes Gutenberg-Universität Mainz — [3]Technische Universität München — [4]Università degli Studi di Milano-Bicocca

Future hybrid detectors in the field of neutrino physics have to combine high-resolution energy determination down to low thresholds by scintillation light detection and directional reconstruction with the help of Cherenkov radiation. The spectrum of potential applications is broad, ranging from long-baseline oscillation experiments to the measurement of low-energy solar neutrinos. One possible detector medium for these next-generation detectors is Water-based Liquid Scintillator (WbLS). Here, organic scintillators are dissolved colloidally in small quantities in highly pure water with the aid of surfactants. In this talk, a novel WbLS (based on Triton X-100) will be presented. Particular attention will be paid to its key properties, such as micelle size, scattering length and transparency. In addition, a study of its light yield as well as pulse-shape discrimination capabilities will be presented.

This work has been supported by the Clusters of Excellence PRISMA+ and ORIGINS, the DFG Sonderforschungsbereich 1258 as well as the Bundesministerium für Bildung und Forschung (Verbundprojekt 05H2018: R&D Detectors and Scintillators).

T 143.2 Thu 17:45 POT/0006

Development of novel organic liquid scintillators with slow light emission — •Manuel Böhles[1], Hans Theodor Josef Steiger[1,2], David Dörflinger[3], Lothar Oberauer[3], Matthias Raphael Stock[3], and Michael Wurm[1,2] — [1]Johannes Gutenberg-Universität Mainz — [2]Cluster of Excellence PRISMA+ — [3]Technische Universität München

One of the most promising approaches for the next generation of neutrino experiments is the realization of large hybrid Cherenkov/scintillation detectors made possible by recent innovations in photodetection technology and liquid scintillator chemistry.

This talk will focus on the development of such detector liquids with particularly slow light emission. Various attempts are currently underway, such as the use of special wavelength shifters or the use of blended multi-solvent cocktails. Several of these mixtures are compared with respect to their fundamental characteristics (scintillation efficiency, transparency, and time profile of light emission). In addition, the optimization of the admixture of wavelength shifters for a scintillator with particularly high light emission and pulse shape discrimination capability is presented. Newly developed purification methods based on column chromatography and fractional vacuum distillation for several candidate solvents are also discussed.

The work is supported by the Cluster of Excellence PRISMA+, the DFG Sonderforschungsbereich 1258 and the Bundesministerium für Bildung und Forschung (BMBF Verbundprojekt 05H2018: R&D Detectors and Scintillators).

T 143.3 Thu 18:00 POT/0006

Fluorescence Time Profiles of Slow Organic and Water-Based Liquid Scintillators using a Pulsed Neutron Beam — •Matthias Raphael Stock[1], Hans Steiger[2], Lothar Oberauer[1], David Dörflinger[1], Ulrike Fahrendholz[1], Manuel Böhles[2], Stefan Schoppmann[2,3], Luca Schweizer[1], Korbinian Stangler[1], and Dorina Zundel[2] — [1]Physik-Department, Technische Universität München — [2]Johannes Gutenberg University Mainz, Institute of Physics and Cluster of Excellence PRISMA+ — [3]University of California, Department of Physics, Berkeley, CA 94720-7300, USA

We performed two liquid scintillator (LS) characterization experiments using a pulsed neutron beam at the CN accelerator of INFN Laboratori Nazionali di Legnaro. At different energies ranging from 3.5 MeV to 5.5 MeV, one experiment measures the quenching factor of recoil protons while the other one measures the fluorescence time profile of recoil protons. This talk is about the time profile experiment, where we show studies of slow organic and water-based LS mixtures, which will be relevant for future neutrino detectors, e.g., Theia. Differences in the time profiles after gamma and neutron excitation would open the window to perform pulse shape discrimination and therefore advances the ability to distinguish the neutrino signal from background. This work is supported by the BMBF Verbundforschung 05H2018 ”R&D Detektoren (Szintillatoren)”, the DFG CRC 1258 ”NDM”, the DFG Clusters of Excellence ”PRISMA+” and ”Origins”.

T 143.4 Thu 18:15 POT/0006

Background investigations with passive transverse energy filters at KATRIN — •Dominic Hinz for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT)

The measurement of the absolute mass scale of neutrinos with an unprecedented sensitivity of 0.2 eV/c^2 is the key goal of the KATRIN experiment. This requires a detailed understanding of background processes in the large main spectrometer. Currently, the measured background level exceeds the design value by more than one order. An initial model assigned background events to originate from Rydberg H-states generated by the decay of traces of surface-implanted Pb-210. Highly-excited Rydberg states from the inner spectrometer surface are long-lived and can be ionised by thermal radiation. The resulting low-energy electrons on the meV-scale are then accelerated by the retarding potential, thus they only possess a very small transverse energy, which is in contrast to signal electrons. In a first step we have performed measurements with a passive transverse energy filter (pTEF) implemented as a micro-structured honeycomb gold plate. In this talk we present the measured transmission of background electrons through the pTEF and compare results at different magnetic field values with the initial and refined background models.

This work is supported by the Helmholtz Association (HGF), the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Young Investigator Group (VH-NG-1055).

T 143.5 Thu 18:30 POT/0006

Background reduction at the KATRIN experiment with an active transverse energy filter (aTEF) — •Sonja Schneidewind[1,4], Kevin Gauda[1,4], Kyrill Blümer[1,4], Christian Gönner[1,4], Volker Hannen[1,4], Hans-Werner Ortjohann[1,4], Wolfram Pernice[2,3], Lukas Pöllitsch[1,4], Richard Salomon[1,4], Maik Stappers[2], and Christian Weinheimer[1,4] — [1]Institute for Nuclear Physics, University of Münster — [2]CeNTech and Physics Institute, University of Münster — [3]Kirchhoff-Institute for Physics, University of Heidelberg — [4]KATRIN Collaboration

The KATRIN experiment aims at the direct measurement of the incoherent sum of neutrino masses via precision endpoint spectroscopy of the tritium β-decay. Despite advances in background reduction, the elevated background level prohibits to achieve the target sensitivity of 0.2 eV/c^2 (90% C.L.).

One option to reduce the background is the implementation of an active Transverse Energy Filter (aTEF, Eur. Phys. J. C 82, 922 (2022)), which makes use of the specific angular distribution of the background and discriminates electrons at the detector based on their pitch angle. The contribution presents studies concerning the potential background reduction and related sensitivity improvement from an implementation of an aTEF at KATRIN.

This work is supported by BMBF under contract number 05A20PMA and Deutsche Forschungsgemeinschaft DFG (Research Training Group GRK 2149) in Germany.

T 143.6 Thu 18:45 POT/0006

Investigation of electron backscattering for the TRISTAN project — •Daniela Spreng — Technical University Munich, James-Franck-Straße 1, 85748 Garching bei München

One open question in the field of neutrino physics is the existence of keV-sterile neutrinos, which would be a possible Dark Matter candidate. They are experimentally accessible through their mixing with the active neutrino flavours and would therefore lead to a kink-like distortion in the beta-decay spectrum. The KATRIN experiment aims to search for this kink-like structure in the tritium beta-decay spectrum by installing a new multi-pixel silicon drift detector named TRISTAN. To resolve the kink, the detector electron response has to be very well understood. In this talk the effect of the backscattering on the detected electron spectrum for different initial electron energies and incident angles will be presented. To analyse these effects, a dedicated test stand was build and measurements were compared to Geant4 simulations.

This project has received funding from the European Research Council (ERC) under the European Union Horizon 2020 research and innovation program (grant agreement No. 852845). This work is supported by BMBF (05A17PM3, 05A17PX3, 05A17VK2, 05A17WO3), KSETA, the Max Planck society, and the Helmholtz Association.

T 144: Cosmic Ray VII

Time: Thursday 17:30–19:00 Location: POT/0013

T 144.1 Thu 17:30 POT/0013

Effects of magnetic fields on anisotropies in a catalog based research — •Luca Deval, Ralph Engel, Thomas Fitoussi, and Michael Unger — Karlsruhe Institute of Technology, Karlsruhe, Germany

Ultra high energy cosmic rays (UHECRs) are charged particles which origins is still an open question in modern astrophysics. For the identification of valid sources, a key role is played by the Galactic magnetic field (GMF) which influences the arrival direction of charged particles.

Recent studies, by the Pierre Auger Collaboration, on the arrival direction of UHECRs showed the presence of anistropies above 40 EeV which indicates the contribution from nearby sources such as starburst galaxied (SBG) and active galactic nuclei (AGN). The likelihood analysis revealed a significance of 4.2σ for the starburst sample although the coherent deflections related to the GMF have not been considered.

In this work we focus our attention on the SBG catalog and we conduct the likelihood analysis on simulated datasets. The mock datasets are constructed by employing CRPropa3 for the extragalactic propagation and by adding an isotropic background. A lensing technique, considering the JF12 model for the GMF, is then applied to the simulated particles.

Our results show that the parameters as reported by the Pierre Auger Collaboration occur for 20% of all data sets. However, due to the neglected coherent deflections, the inferred anisotropy fraction is a biased estimator and the true anisotropic fraction is always larger than the one derived from the likelihood fit.

T 144.2 Thu 17:45 POT/0013

An all-sky search method for coherent magnetic field deflections of ultra-high-energy cosmic rays — •Josina Schulte[1], Teresa Bister[2], and Martin Erdmann[1] — [1]III. Physikalisches Institut A, RWTH Aachen University — [2]Institute for Mathematics, Astrophysics and Particle Physics, Radboud Universiteit Nijmegen

We present a method of searching for coherent deflection patterns in ultra-high-energy cosmic ray arrival directions induced by the Galactic magnetic field. These patterns are described by a variable magnetic field strength in combination with adaptable coefficients of a spherical harmonics expansion in our approach. The reconstruction of the free model parameters from the arrival directions is performed with a likelihood-free method in a Bayesian approach based on normalizing flows. This allows for a straightforward assessment of the uncertainty on the model prediction. We evaluate the sensitivity of the method to identify the presence of coherent magnetic field deflections on a realistic simulated astrophysical scenario.

T 144.3 Thu 18:00 POT/0013

The effects of a ΛCDM extension on the propagation of UHECRs — •Janning Meinert — Bergische Universität Wuppertal, Gaußstraße 20, 42119 Wuppertal, Germany

Current tensions in the cosmological parameters of ΛCDM (such as H_0, Ω_m, σ_8) motivate a possible extension. Treating the photon propagation in thermal equilibrium with an SU(2) gauge group instead of a U(1) gauge group gives the photon more degrees of freedom and thus changes the temperature redshift relation. This pushes the emergence of the CMB, recombination, to higher redshifts and dilutes the photon density. Since CMB photons interact with ultra-high energy cosmic rays (UHECRs), I will examine the effects of this particular ΛCDM extension on the interaction with UHECRs. In particular, the spectral shape of the cosmogenic neutrino flux is distorted and the GZK cutoff might be shifted to slightly higher energies.

*Supported by DFG (SFB 1491) and the Vector Foundation under grant number P2021-0102

T 144.4 Thu 18:15 POT/0013

Cosmic-ray signatures in dwarf galaxies: astrophysical foreground and dark-matter background* — •Athithya Aravinthan[1,2], Lukas Merten[1,2], Julia Becker Tjus[1,2], and Jurek Völp[1,2] — [1]Theoretische Physik IV, Ruhr-Universität Bochum, Bochum, Germany — [2]RAPP-Center, Ruhr-Universität Bochum, Bochum, Germany

Dwarf galaxies are a convenient testing ground in the search for Dark Matter (DM), owing to their low, astrophysical background in the radio and gamma-ray energies. Studying the multimessenger signatures of dwarf galaxies can lead to a more precise astrophysical background for DM searches, thereby improving the current limits on indirect DM detection. This motivates the study of nearby starburst galaxies like IC10, which produces non-thermal radio emission coupled to complex Cosmic Ray (CR) propagation.

The goal of this work is to understand the role of CRs in low-mass dwarf galaxies by modelling their propagation using the open-source tool CRPropa 3.2. First test results, starting with a general propagation environment in CRPropa, are pursued in a generic starforming-type magnetic field for IC10, and will later be modified for other low-mass galaxies. For the first time, the modelling is done in combination with astrophysical data on magnetic field structure and gas densities with the goal of pursuing a coherent understanding of the outflow produced in dwarf galaxies. *Supported by DFG (SFB 1491).

T 144.5 Thu 18:30 POT/0013

Stochastic modelling of cosmic ray sources for diffuse high-energy neutrinos — •Anton Stall and Philipp Mertsch — Institute for Theoretical Particle Physics and Cosmology (TTK), RWTH Aachen University, Aachen, Germany

Cosmic rays of energies up to a few PeV are believed to be of Galactic origin, yet individual sources have still not been firmly identified. Due to inelastic collisions with the interstellar gas, cosmic-ray nuclei produce a diffuse flux of high-energy gamma-rays and neutrinos. Fermi-LAT has provided maps of galactic gamma-rays at GeV energies which can be produced by both hadronic and leptonic processes. Neutrinos, on the other hand, are exclusively produced by the sought-after hadronic processes, yet they can be detected above backgrounds only at hundreds of TeV. To predict diffuse emission at these high energies, one can extrapolate from the GeV maps, but it is an open question to what extend this is justified. It can be expected that the consideration of individual cosmic-ray sources instead of a smooth density limits the correlation of the maps at TeV energies compared to the ones at GeV energies. Such a modelling of sources should be done stochastically. In a first step, we investigate the modelling of multiple point sources and the extension to a stochastic model.

T 144.6 Thu 18:45 POT/0013

Diffuse Emission of Galactic High-Energy Neutrinos from a Global Fit of Cosmic Rays — •Georg Schwefer[1,2,3], Philipp Mertsch[2], and Christopher Wiebusch[3] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Deutschland — [2]Institute for Theoretical Particle Physics and Cosmology (TTK), RWTH Aachen University, 52056 Aachen, Deutschland — [3]III. Physikalisches Institut B, RWTH Aachen University, 52056 Aachen, Deutschland

In the standard picture of galactic cosmic rays, a diffuse flux of high-energy gamma-rays and neutrinos is produced from inelastic collisions of cosmic ray nuclei with the interstellar gas. The neutrino flux is a guaranteed signal for high-energy neutrino observatories such as IceCube, but has not been found yet. Experimental searches for this flux constitute an important test of the standard picture of galactic cosmic rays. Both the observation and non-observation would allow important implications for the physics of cosmic ray acceleration and transport. In this talk, we present `CRINGE`, a new model of galactic diffuse high-energy gamma-rays and neutrinos, fitted to recent cosmic ray data from AMS-02, DAMPE, IceTop as well as KASCADE. We also discuss the uncertainties for the predicted emission from the cosmic ray model as well as from the choice of source distribution, gas maps and cross-sections and consider the possibility of a contribution from unresolved sources.

T 145: Cosmic Ray VIII

Time: Thursday 17:30–19:00 Location: POT/0351

T 145.1 Thu 17:30 POT/0351

Status of the production and calibration of the scintillation detectors for the IceCube Surface Array Enhancement — •Shefali Shefali for the IceCube-Collaboration — Institut für Astroteilchenphysik, Karlsruher Institut für Technologie (KIT), Karlsruhe, Germany

The surface array of IceCube, IceTop, operates as a veto for the astrophysical neutrino searches, as a calibration detector for the IceCube in-ice instrumentation, as well as a cosmic ray detector. However, the snow accumulation on top of these detectors results in an increased uncertainty in the number of detected particles and consequently, the air shower reconstruction. Enhancing IceTop with a hybrid array of scintillation detectors and radio antennas will lower the energy threshold for air-shower measurements, provide more efficient veto capabilities, enable the separation of the electromagnetic and muonic shower components and improve the detector calibration by compensating for snow accumulation. After the initial commissioning period, a prototype station at the South Pole has been recording air shower data and has successfully observed coincident events with the IceTop array. The production and calibration of the scintillation detectors for the full array has been ongoing. Additionally, one station each at Pierre Auger Observatory and Telescope Array have been installed for R&D of these detectors in different environmental conditions. This contribution will present the status of the scintillation detectors for the IceCube Surface Array Enhancement.

T 145.2 Thu 17:45 POT/0351

A new approach for the reconstruction of low-energy air showers at the IceCube Neutrino Observatory — •Federico Bontempo for the IceCube-Collaboration — Karlsruhe Institute of Technology, Institute for Astroparticle Physics, 76021 Karlsruhe, Germany

The IceCube Neutrino Observatory is an experiment located at the geographic South Pole. It is composed of two detectors: an array of ice-Cherenkov tanks at the surface called IceTop and an optical array deep in the ice. The combination of the two detectors can be exploited for the study of cosmic rays. This work will primarily focus on the IceTop response, mainly dominated by the electromagnetic component of cosmic-ray air showers, with the goal of developing a new reconstruction technique for low energy air-showers. Some preliminary plots of the reconstructed quantities will be shown, like the energy proxy, zenith and azimuth angle or core position.

T 145.3 Thu 18:00 POT/0351

A Two Component Lateral Distribution Function for the Reconstruction of Air-Shower Events with IceCube — •Mark Weyrauch for the IceCube-Collaboration — Karlsruhe Institute of Technology

The IceCube Neutrino Observatory, located at the geographic South Pole, consists of a surface detector comprised of ice-Cherenkov tanks, IceTop, and an optical in-ice array. With this combination, IceCube provides the unique possibility to perform coincident measurements of the low-energy ($\sim$ GeV) and high-energy ($\gtrsim$ 400 GeV) muon component in cosmic-ray air shower events. Since IceTop does not feature dedicated muon detectors, an estimation of the GeV muon component on basis of individual air showers is challenging. However, an event-by-event GeV muon estimator can constitute a useful tool for, amongst others, cosmic ray composition analyses and, in combination with the TeV muon component, strongly constrain hadronic interaction models. One possibility for an event-by-event estimation of low-energy muons is given by the Two Component Lateral Distribution Function (Two Component LDF), combining an analytical description for the electromagnetic and muon lateral distribution of the full detector signal. In this talk, I will discuss the main principle of the Two Component LDF and present first results of the reconstruction of simulated air-shower events.

T 145.4 Thu 18:15 POT/0351

Measurement and reconstruction of laser shots of the Aeolus satellite in the Pierre Auger Observatory — •Felix Knapp for the Pierre Auger-Collaboration — Karlsruher Institut für Technologie

The Pierre Auger Observatory is a large-scale experiment for the detection of ultra-high-energy cosmic rays. To this end, a combination of surface detectors as well as fluorescence telescopes is used to measure extensive air showers initiated by cosmic-ray particles in the atmosphere. Aeolus is a satellite, operated by the ESA, with the purpose of measuring global wind profiles. To achieve this, it uses a UV-lidar which emits laser beams towards the surface of the Earth. When the satellite passes over the Pierre Auger Observatory, light scatters off the laser beam in the atmosphere which can be detected by the Fluorescence Detector. The laser data taken by the Observatory allowed for a reconstruction of the laser tracks for several overpasses each year since its first appearance in 2019. The reconstructed laser tracks provide an interesting approach to study the aerosol content of the atmosphere above the Observatory, as well as a novel way to perform ground-truthing for space-based lidards.

In this presentation, we will explain the methods used to reconstruct laser tracks from the Fluorescence Detector data, show some results of this reconstruction and introduce a possible application of the data for the measurement of aerosols.

T 145.5 Thu 18:30 POT/0351

Radio Interferometry for extensive air showers using Information Field Theory — •Matthias Boddenberg, Martin Erdmann, Maximilian Straub, and Alex Reuzki for the Pierre Auger-Collaboration — III. Physikalisches Institut A, RWTH Aachen University

Ultra-high-energy cosmic rays induce extensive air showers (EAS) in the Earth's atmosphere. During its propagation through the atmosphere, radio waves are emitted by to the geomagnetic effect and the Askaryan effect, which can be observed by the ground based antenna array at the Pierre Auger Observatory.

In this contribution we apply an interferometry method for extensive air showers and and show its potential use in deriving the depth of shower maximum and the arrival direction of the cosmic ray. We will present a method to reconstruct the location of a point source in the atmosphere. Furthermore we discuss the impact of antenna positions and noise on the radio traces on the location reconstruction.

Finally, we will show an alternative interferometry method for the reconstruction using information field theory (IFT) and discuss its potential uses.

T 145.6 Thu 18:45 POT/0351

Nanosecond time synchronisation with GNNS antennas for application in autonomous astroparticle physics detectors. — •Qader Dorosti[1], Markus Cristinziani[1], Stefan Heidbrink[2], Noah Siegemund[1], Jens Winter[2], and Michael Ziolkowski[2] — [1]Center for Particle Physics Siegen, Experimentelle Astroteilchenphysik, Universität Siegen — [2]Elektronikentwicklungslabor des Departments Physik, Universität Siegen

The new generation of commercially available navigation satellite receivers, known as highly accurate multi-band GNSS timing modules, are designed to meet the requirements of the 5G mobile standard. They can achieve local time synchronisation with an accuracy of 5 ns (1 sigma) with respect to the Universal Time Clock. This accuracy is obtained by exploiting a dual-frequency technique that effectively compensates for the dominant source of error in signal propagation through the ionosphere without the need for additional correction data. The stricter requirements for the future mobile radio standard 6G will lead to a further significant improvement in time synchronisation with an expected accuracy of less than 1 ns. This is relevant for the instrumentation of future astrophysical experiments and is being pursued by our group through the testing and evaluation of novel GNSS products in the field. Here we present our investigations on the latest multiband GNSS receivers, where we achieved time synchronisation of clock signals of 3.5 ns from two GNSS receivers operating 40 m apart for several hours. Strategies for improving performance will be discussed.

T 146: DAQ Systems, Exp. Methods

Time: Thursday 17:30–19:00 Location: POT/0106

T 146.1 Thu 17:30 POT/0106

Real-time alignment and calibration for Run 3 at the LHCb experiment — •Biljana Mitreska and Johannes Albrecht — TU Dortmund University, Dortmund, Germany

The real-time alignment and calibration procedure is a fully automatic procedure at LHCb that is executed at the beginning of each fill of the LHC. The alignment estimates the position of detector elements and the correct alignment contributes to improving the data for offline analysis. Its importance in Run 3 is even more enhanced due to having a fully software trigger at LHCb. The procedure is implemented for the full tracking system at LHCb with the event reconstruction run as a multithreaded process. The operational and technical point of view of this procedure during the Run 3 data-taking is discussed with the focus on performance and optimisations done regarding the new computing framework and the new detectors.

T 146.2 Thu 17:45 POT/0106

Online data reduction with the FPGA-based DATCON track reconstruction system at the Belle II Detector — Florian Bernlochner, Bruno Deschamps, Jochen Dingfelder, •Ralf Farkas, and Botho Paschen for the Belle II-Collaboration — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

The DATCON system is a set of 15 FPGAs, deployed at the Belle II detector at the KEK facility in Tsukuba, Japan. Its purpose is the real-time reduction of the data stream of the two innermost PXD detector layers, by defining regions of interest (ROI) on them. Only the hit information of the pixels located inside these ROIs are to be further processed and saved. DATCON uses the information of the SVD layers of the detector, finds tracks using a Hough Transformation-based track reconstruction algorithm and extrapolates them towards the center of the detector, to the PXD layers. While the track reconstruction algorithm itself has already been validated both on Hardware and Software, further work is required to improve the stability and reliability of the system. This talk will highlight the recent changes and improvements of DATCON.

T 146.3 Thu 18:00 POT/0106

Techniques for the investigation of segmented sensors using the Two Photon Absorption – Transient Current Technique — •Sebastian Pape[1,2], Michael Moll[1], Esteban Curras[1], and Marcos Fernandez Garcia[1,3] — [1]CERN — [2]TU Dortmund University — [3]Instituto de Física de Cantabria

The Two Photon Absorption - Transient Current Technique (TPA-TCT) is a technique for the characterisation of radiation detectors with three dimensional resolution. The TPA-TCT setup at CERN is designed for the investigation of silicon based detectors and uses a 430 fs pulse fiber lasers, with a wavelength of 1550 nm, which is in the quadratic absorption regime of silicon. Highly focusing optics are used to only generate excess charge carriers in a small volume (approximately $1\mu m \times 1\mu m \times 20\mu m$) around the focal point of the laser beam, which enables a resolution in all three spatial directions. This three dimensional resolution is particular useful for the investigation and characterisation of segmented detectors. This talk introduces to the TPA-TCT and the setup at CERN. Further, the weighted prompt current method is presented, which allows to investigate the electric field of segmented sensors. The method is demonstrated on various segmented sensors: a HV-CMOS CCPDv3, a Micron strip detector, and a passive CMOS strip detector. Further, the mirror technique is presented, which exploits a reflection of the rear side, to probe below front surface metallisations.

T 146.4 Thu 18:15 POT/0106

Prototype studies of a liquid organic TPC for the detection of low energy antineutrinos — Malte Göttsche, •Niklas Herrmann, Thomas Radermacher, Stefan Roth, and Yan-Jie Schnellbach — RWTH Aachen University - Physics Institute III B, Aachen, Germany

Liquid organic time projection chambers, LOr-TPCs, can potentially be used to detect and measure low energy antineutrinos. One application would be monitoring antineutrinos from nuclear waste via inverse beta decay. Using an organic liquid as drift medium has the advantage of room temperature operation, but the measurement is very sensitive to impurities. Therefore, we set up a prototype including a purification system, which contains a turbomolecular pump, a boiler, a condenser and filters. The status of the prototype setup is presented.

T 146.5 Thu 18:30 POT/0106

Detection of Low-Energy Antineutrinos with Liquid-organic Time Projection Chambers — Marike Ellerbroek[1], Malte Göttsche[1,2], Niklas Herrmann[1], •Thomas Radermacher[1,2], Stefan Roth[1], and Yan-Jie Schnellbach[1,2] — [1]RWTH Aachen University - Physics Institute III B, Aachen, Germany — [2]RWTH Aachen University - Nuclear Verification and Disarmament, Aachen, Germany

The region of antineutrino energy of a few MeV is of special interest for physics research and for the application of antineutrino-monitoring in the nuclear safeguards regime. Typically, scintillation detectors are used to detect these low-energy antineutrinos via the inverse beta decay (IBD) by reconstructing the time-correlated light signals of the positron annihilation and the neutron capture. A novel detection concept utilizing a time projection chamber (TPC) filled with an organic liquid (LOr) could enable a background-minimized detection of the antineutrino since it allows the reconstruction of all final state particles in the IBD event. From the positron track the antineutrino's initial energy and its vertex can be determined. If the energy deposition of the neutron-induced proton recoils can be detected it offers the possibility to reconstruct the antineutrino direction on an event-by-event basis. We are investigating the IBD signature with a Geant4-based simulation together with a subsequent modelling of the electron drift. Additionally, we are working on prototype measurements and simulations to study the feasibility of such a LOr-TPC. This talk presents the status of our studies.

T 146.6 Thu 18:45 POT/0106

Stimulated de-excitation of Rydberg atoms in KATRIN using THz radiation* — •Shivani Ramachandran, Enrico Ellinger, and Klaus Helbing for the KATRIN-Collaboration — Bergische Universität Wuppertal (BUW)

The key requirement for the KArlsruhe TRItium Neutrino experiment (KATRIN) to reach its goal sensitivity of 200 meV at 90 % (C.L.) in measuring the effective electron anti-neutrino mass is minimal background. Several background suppression methods have already been implemented to achieve that and eliminate some known contributors. The most dominant contribution to the background in the measured signal is electrons produced by the thermal ionization of Rydberg atoms. They originate due to the sputtering of ^{210}Pb from inherent radioactivity from the walls of the KATRIN main spectrometer. A plausible method is using THz and microwave radiation (method developed by ASACUSA CERN) for dedicated stimulated de-excitation which can lead to a shorter lifetime of Rydberg atoms. The influence of THz light source in the main spectrometer along with the state and spatial evolution of the Rydberg atoms is presented via simulations. The effect of the properties of the ionization electrons on the de-excitation method is discussed.

*Gefördert durch die BMBF-Verbundforschung Astroteilchenphysik

T 147: Pixel/HV-Maps, Si/Diamond

Time: Thursday 17:30–19:00 Location: WIL/A317

T 147.1 Thu 17:30 WIL/A317

Measuring Large Energy deposition with HV-MAPS — •Danish Alam for the HD-HVMAPS-Collaboration — Physikalisches Institut, Heidelberg University

In high-energy physics experiments, the increasingly challenging physics demands high-rate detectors with excellent spatial and time resolution. High Voltage - Monolithic Active Pixel Sensor (HV-MAPS) fabricated in HV-CMOS processes provides fast charge collection via drift and enables the implementation of readout and the sensitive volume on the same die. Currently, the first tracking detector utilizing ultra-thin HV-MAPS chips is under construction for the Mu3e experiment.

At present, typical HV-MAPS detectors can measure energy depositions of the order of several 10 keV before the in-pixel charge-sensitive amplifier suffers saturation effects. The primary goal of the test chip Run2021V3 is to extend the measurable range and improve the precision of the measurements, which will allow detailed studies of the energy deposition of traversing particles, e.g., for particle identification. In the scope of this talk, the first characterization results of the Run2021V3 prototype will be presented.

T 147.2 Thu 17:45 WIL/A317

Charge Deposition and Charge Collection in HV-MAPS — •Ruben Kolb for the HD-HVMAPS-Collaboration — Physikalisches Institut Universität Heidelberg

Modern particle physics experiments have an ever growing demand on high rate detectors which combine precise spatial and time resolu- tion. These requirements are met by the High Voltage - Monolithic Active Pixel Sensor (HV-MAPS). It combines active detector volume and readout on one chip. Currently, the first tracking detector using ultra thin HV-MAPS is under construction for the Mu3e experiment. The Run2021V2 chip is an HV-MAPS test chip which includes in-pixel electronics such as an amplifier and comparator. It is the most advanced HV-MAPS chip presently available.

The charge deposition and charge collection process in this sensor is investigated to improve the further design of HV-MAPS. The signal was studied in dependency of high voltage for a 4 GeV electron beam, 5.9 keV photons from a ^{55}Fe and electrons from a ^{90}Sr source. A complementary study using a test circuit to inject charge directly into the amplifier was performed.

T 147.3 Thu 18:00 WIL/A317

Charge collection study of thin HV-MAPS — •David Maximilian Immig for the HD-HVMAPS-Collaboration — Physikalisches Institut Universität Heidelberg

High-voltage monolithic active pixel sensors (HV-MAPS) combine the advantages of MAPS with fast charge collection via drift in a reversely biased diode. The amount of collected signal charge is influenced by two factors, the applied bias voltage and a dependent unknown fraction due to diffusion from the undepleted region. The former, determines the depleted volume intended for charge collection, as well as the detector capacitance. In the case of ultra thin sensors (e.g. 50 um), the depletion depth is limited by the sensor thickness and a contribution by diffusion is no longer applicable at full depletion.

An measurement campaign with sensors of various thickness was performed to investigate and determine the size of these contributions. In this talk, first results extracted from this extensive data set are presented.

T 147.4 Thu 18:15 WIL/A317

Radiation damage studies of a HV-MAPS detector — •Maja Lecher, Lucas Dittmann, Sebastian Bachmann, and Ulrich Uwer — Physikalisches Institut, Heidelberg, Germany

As one cornerstone of the prospective LHCb upgrade during Long Shutdown 4 in 2033, the current Scintillating Fibre tracker is set to be replaced by the Mighty-Tracker, which combines scintillating fibres with radiation-hard silicon pixel detectors. The MightyPix sensor proposed as pixel detector employs the relatively new HV-MAPS technology. In preparation for the LHCb upgrade, the AtlasPix 3.1, a detector of similar build as the MightyPix, was studied with an emphasis on radiation damage.

While a number of studies investigating the damage sustained by HV-MAPS from radiation exist, irradiation campaigns to date were carried out using unpowered sensors. In a first proof-of-principle measurement, we irradiated a powered AtlasPix 3.1 with 14 MeV protons at the Bonn Isochronous Cyclotron. Specific sensor characteristics, most notably the leakage current, power consumption, and signal response, were tested before, during, and after the irradiation in an effort to evaluate the performance and viability of HV-MAPS in the radiation environment expected for the MightyPix. Results from these studies are presented and discussed.

T 147.5 Thu 18:30 WIL/A317

Diamond detector research — •Holger Stevens, Patrick Hoelken, and Johannes Albrecht — TU Dortmund University, Dortmund, Germany

The need for radiation-hard detectors is growing steadily. Compared to other semiconductor materials, diamond has a low leakage current, due to it's large bandgap and is very radiation-hard. This talk will present the experimental setups, which are developed for characterisation of diamond sensors. The radiation source used in these setups is Strontium (Sr90). In addition, the process to create gold contact surfaces in variable dimensions is described. The possible usage of diamond sensors for the precise dose profile measurement of large radiation fields is discussed and the option for spectrometric energy measurements is presented.

T 147.6 Thu 18:45 WIL/A317

implementation of diamond as detector material in AllPix Squared — •Faiz Ur Rahman Is-haqzai — TU Dortmund, Germany. Kabul University, Afghanistan

Monte-Carlo-based simulation of particle interactions with matter is a very important tool for detector development in high-energy physics and related fields since it allows testing of detector concepts in-silico before investing money and time in building the detectors. A widely used software framework in the high-energy physics community is Allpix Squared, based on GEANT4. It was started to simulate testbeam setups with silicon detectors but has garnered interest from a wider community by now. To extend the Allpix Squared framework and make it useful for further detector development, different sensor materials need to be implemented. My work is intended to implement the Diamond material. Diamond sensors are considered superior to others because of their faster signal generation, better radiation hardness, thermal properties, and ability to operate in harsh conditions. To test the implementation, given sensors are used in real test beam measurements where hits on the device under test (DUT) are extrapolated against a row of well-known detectors, called Beam Telescope. Implementation of Diamond sensor material will significantly contribute to the task of R&D of Diamond sensors by making the simulated prototype simply possible. I will present the status of the implementation of the diamond as detector material in Allpix Squared.

T 148: Si/SiPM, Pixel/Other

Time: Thursday 17:30–19:00 Location: WIL/A124

T 148.1 Thu 17:30 WIL/A124

Study of the self-heating in SiPMs — •Carmen Victoria Villalba Petro, Erika Garutti, Robert Klanner, Stephan Martens, and Jörn Schwandt — Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Deutschland.

The main effect of radiation damage in a Silicon-Photomultiplier (SiPM) is a significant increase in the dark current. For SiPMs irradiated at $\Phi_{eq} = 10^{13}$ cm^{-2} and operated at 2 V above breakdown voltage, V_{bd}, the leakage current leads to a power of 50 mW. Such power produces an instantaneous increase in the SIPM temperature, which needs to be cooled down by proper thermal contact to a cooling system. The performance of the SiPM changes with temperature (T). The V_{bd} increases with T. For a fixed bias voltage, this leads to a decrease in gain and PDE. A method has been developed to determine the SiPM temperature increase induced by the power dissipated in the SiPM multiplication layer. Heating studies were performed with a KETEK SiPM, glued on an Al_2O_3 substrate, which is either directly connected to the T-controlled chuck of a probe station, or through layers of material with well-known thermal resistance. The SiPM is illuminated by a LED operated in DC-mode. The SiPM current is measured and used to determine the steady-state temperature as a function of power dissipated in its multiplication region and of the thermal resistance, as well as the time constants for heating and cooling. The method is applied to MPPC samples before and after irradiation. The knowledge of the multiplication region temperature can be used to properly determine the working parameters of irradiated SiPMs.

T 148.2 Thu 17:45 WIL/A124

Integration time dependence of sipm performance parameters — •Katjana Neumann, Erika Garutti, Jörn Schwandt, and Jack Rolph — Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Deutschland

The research on Silicon Photomultipliers (SiPMs) and their characteristic parameters has increased strongly due to their advantages as photon detectors. The standard way to obtain these parameters from the charge spectra of SiPMs is to fit a model based on (generalized) Poisson distributed Gaussian functions to the low light intensity response spectra. However, this method has the disadvantage that it only describes the photo-electron peaks but not the regions between them, which means that a large amount of information is lost, for example about the dark-count rate (DCR) or after-pulsing. Thus a description of the whole spectrum in a single model is practical. The Python program PeakOTron is based on a model, that describes the entire spectrum. This program has been tested on the low light intensity spectra obtained by integrating the charge at various gate lengths, for two SiPM types operated at various overvoltage. The parameters and fitted spectra determined with this method are discussed and compared to those obtained with standard methods.

T 148.3 Thu 18:00 WIL/A124

Design and Production of Pixel Strips for the P2 Tracking Detector Modules — •Lucas Sebastian Binn for the P2-Collaboration — Institute of Nuclear Physics, Johannes Gutenberg-University Mainz, Germany

The P2 Experiment will make use of the new Mainz Energy-Recovering Superconducting Accelerator (MESA), currently under construction in Mainz, to measure the weak mixing angle in electron-proton scattering at low momentum transfer with unprecedented precision.

A key parameter for the analysis, the momentum transfer Q^2, is measured by a tracking detector consisting of 8 identical modules. Each module consists of two sensor planes, with pixel sensors glued and wire-bonded on rigid-flex strips. Commercially available and custom solutions for the production of the strip module design are currently being evaluated. With a total production of 260 strips, processes are semi-automated, with dedicated glue and bonding machines.

An overview of the P2 experiment with focus on the tracking detector will be given in this talk, as well as the current state of the development of the strip modules.

T 148.4 Thu 18:15 WIL/A124

Characterization of a Digital Silicon Photomultiplier — •Gianpiero Vignola[1,2], Inge Diehl[1], Doris Eckstein[1], Finn Feindt[1], Ingrid-Maria Gregor[1,2], Karsten Hansen[1], Stephan Lachnit[1], Frauke Poblotzki[1], Simon Spannagel[1], and Tomas Vanat[1] — [1]DESY, Hamburg, Germany — [2]Universität Bonn, Bonn, Germany

Silicon photomultipliers (SiPM) are increasingly used in high-energy physics, medical and commercial applications. Until now, most SiPMs are implemented as large arrays of Single Photon Avalanche Diodes (SPAD) in a parallel circuit, serving as photon counters. Recently, the possibility of using SPADs produced in commercial Complementary Metal-Oxide Semiconductor (CMOS) processes has opened up the possibility of combining their excellent performance in single photon detection and timing, with the possibilities offered by monolithic circuitry at a relatively low cost. The digital SiPMs, thanks to the per-pixel CMOS circuitry, extend the properties of standard SiPMs with features such as detailed event hit map, masking of noisy SPADs and in-chip trigger logic and digitalisation.

A prototype of a SPAD array with per-pixel CMOS circuitry was fully developed at DESY in a 150 nm CMOS technology offered by LFoundry. This talk will report the results of characterisations performed on the prototype in the laboratory and in the DESY II Test Beam facility. Studies on Dark Count Rate, MIPs detection efficiency and time resolution will be presented; along with an overview of planned future studies with a laser setup and scintillator coupling.

T 148.5 Thu 18:30 WIL/A124

Simulation of laser-TCT experiments with Allpix^2 — •Daniil Rastorguev for the Tangerine-Collaboration — Deutsches Elektronen-Synchrotron, Hamburg, Germany — Bergische Universität Wuppertal, Wuppertal, Germany

The Transient Current Technique (TCT) is a powerful yet flexible laboratory characterization technique for silicon sensors. By precisely injecting charges with laser pulses and analyzing waveforms, produced as deposited charge drifts in the sensor bulk, one may experimentally study different charge collection features of the sensor under test.

With the development of novel types of silicon sensors with complex internal structures, experimental results can be challenging to interpret. To investigate possible outcomes of such experiments and understand these in detail, computer simulations are often used.

This work focuses on Monte-Carlo simulations of TCT experiments, performed with the Allpix^2 framework. A dedicated Allpix^2 module, modeling absorption of laser light in silicon sensors, was developed to build a full pipeline that simulates processes occurring in a real experiment. An overview of the simulation technique is presented, as well as first simulation results and its comparison to experimental data.

T 148.6 Thu 18:45 WIL/A124

Simulations for High-Granularity LGAD Sensors using Commercial CMOS Technologies — •Saqlain Khan[1], Sinuo Zhang[1], Tomasz Hemperek[2], and Jochen Dingfelder[1] — [1]Physikalisches Institut, Universität Bonn — [2]Dectris, Switzerland

Low-Gain Avalanche Diode (LGAD) detectors can provide a time resolution an order of magnitude better than traditional silicon detectors. This enhancement is enabled by the implementation of controlled low gain in the detector response. One of the challenges in LGAD design is to achieve a high granularity. The granularity is constrained due to the design of an inter-channel protection structure referred to as "Junction Termination Extension" (JTE). This structure avoids breakdown between channels but also creates regions where charge collection is severely limited. An approach in the direction of improving the granularity is to have the gain layer of LGAD buried deep inside and below the readout surface. In this way, inter-channel breakdown is avoided and a high granularity could be achieved.

CMOS pixel sensors utilizing commercial processes are promising methods to be used in high energy particle physics experiments for high-precision charged particle tracking. In this talk, TCAD simulations to investigate the feasibility of the aforementioned approach using a commercial CMOS process will be presented.

T 149: Detector Systems / Muon

Time: Thursday 17:30–19:00 Location: WIL/C133

T 149.1 Thu 17:30 WIL/C133

The commissioning of the new SciFi tracking detector for LHCb — Johannes Heuel and •Jan-Marc Basels — I. Physikalisches Institut B, RWTH Aachen University

The LHCb Upgrade I detector at the Large Hadron Collider (LHC) at CERN includes a new and unique scintillating fibre tracker (SciFi) with a silicon photomultiplier (SiPM) readout system. The SciFi tracker is organised in 12 detector planes. Each, with an area of 30 m^2 and a radiation length of only 1 %, provides spatial measurements with a resolution of 0.07 mm and an efficiency of more than 98 %.

A real-time and offline monitoring system enables the optimisation of the detector performance and early detection of potential issues during operation. The signal detection efficiency is dominated by the time-alignments and the definition of the signal thresholds for the 4096 SiPM arrays, each with 128 channels. For long term operation, the expected degradation of the performance of the SiPMs due to radiation damages is of particular importance.

The detector assembly has been completed in 2022 and its commissioning is still ongoing. We present the status of the commissioning work.

T 149.2 Thu 17:45 WIL/C133

Understanding the alignment of LHCb's SciFi Tracker — •Nils Breer, Sophie Hollitt, and Johannes Albrecht — TU Dortmund, Germany

As part of the LHCb upgrade, the Scintillating Fibre Tracker (SciFi) replaces the previous Outer and Inner Tracker detectors. A well-aligned detector is crucial in order to measure the physics performance as precisely as possible. Understanding which constraints and which parts of the SciFi have the most impact on the overall alignment will be important for monitoring the reconstruction quality of each fill.

With the commissioning of the SciFi in 2022 we are able to perform misalignment tests on simulated samples and compare the results to the real misaligned detector. As part of the initial alignment of the SciFi, configuration tests on the best estimate for the detector position were performed. In particular, performance tests are used to compare alignments of the full length modules compared to half modules. An overview of the current preparation for further SciFi alignment commissioning in 2023 is presented in this talk.

T 149.3 Thu 18:00 WIL/C133

LHCb Upgrade II - Mighty Tracker Sci-Fi Readout — Thomas Kirn, Thomas Oeser, Stefan Schael, and •Sebastian Schmitt — I. Phys. Inst. B RWTH Aachen

The LHCb experiment at the Large Hadron Collider (LHC) at CERN is an experiment designed to perform precise measurements of CP-Violation and rare decays of b-hadrons. With its configuration during Run I and Run II of the LHC, many measurements are statistically limited, hence more data are required to improve their sensitivity.

The LHCb Upgrade II detector will operate with increased instantaneous luminosity, $\mathscr{L}_{\text{int}}$, in order to collect more data in a shorter time interval. This increases pile-up and the occupancy of the detector subsystems with respect to the current setup. As a result, the current detector needs to be upgraded in order to withstand the higher radiation damage and track multiplicity.

The downstream tracking stations will therefore be replaced by the Mighty Tracker, a tracker that comprises an inner silicon tracker and an outer Scintillating-Fibre (Sci-Fi) tracker. A design for the readout system of the Sci-Fi tracker is proposed that relies on coupling the Sci-Fi mats to a cryogenous chamber that houses Silicon Photomultipliers (SiPMs). This talk focuses on how to perform the coupling of the Sci-Fi mats to the cryogenous cooling chamber readout system.

T 149.4 Thu 18:15 WIL/C133

Impact of residual misalignment of the ATLAS' New Small Wheel on muon reconstruction performance — •Stefanie Götz[1], Otmar Biebel[1], Valerio D'Amico[1], Florian Egli[1], Ralf Hertenberger[1], Christoph Jagfeld[1], Eshita Kumar[1], Katrin Penski[1], Maximilian Rinnagel[1], Nick Schneider[1], Patrick Scholer[2], Chrysostomos Valderanis[1], and Fabian Vogel[1] — [1]LMU München — [2]Uni Freiburg

Highly accurate alignment of the ATLAS detector's New Small Wheel (NSW) is crucial to fully exploit the wheels precision tracking capability as required for the high luminosity upgrade of the Large Hadron Collider (LHC) at CERN. Therefore, precise information on the true NSW chamber positionings and shapes is included in the muon reconstruction software, but only with a certain degree of accuracy as caused by measurement uncertainties of the optical alignment sensors. This study investigates the impact of the NSW residual misalignment on the muon reconstruction performance in comparison to the ideal detector geometry. Translations, rotations and deformations described by specific alignment parameters are studied on Monte Carlo samples generated by the simulation software of the ATLAS experiment both at native detector geometry and with misaligned NSW detector components. Their effect is evaluated isolated for each alignment parameter and in a realistic scenario for which the residual chamber misalignment is determined using specific information on the alignment uncertainties. The final goal is to estimate the order of magnitude of the residual misalignment and its impact on the muon reconstruction performance.

T 149.5 Thu 18:30 WIL/C133

Reconstruction Performance of the ATLAS New Small Wheel — •Patrick Scholer — University of Freiburg

Before the start of the 2022 data-taking period, the innermost end cap of the ATLAS muon spectrometer was replaced by the so-called New Small Wheel (NSW). Micromegas and small-strip Thin Gap Chambers (sTGCs) detectors are used to maintain the precise particle tracking capabilities of the ATLAS muon spectrometer and to improve the rejection of false trigger signals at the rates expected after the high luminosity LHC upgrade.

This talk will discuss the tracking performance of the NSW for its first year of data-taking in ATLAS. First studies on the reconstruction of clusters and their properties on the individual detector layers will be presented for different settings of the detector working point and the readout system. This will be followed by a discussion of the track reconstruction performance using the 16 NSW detector layers and the combination of those tracks with the rest of ATLAS.

T 149.6 Thu 18:45 WIL/C133

Certification of sMDT chambers for the phase II upgrade of the ATLAS muon spectrometer — Oliver Kortner, Hubert Kroha, and •Nick Meier — MPI für Physik, München, Deutschland

For operation at the HL-LHC, the ATLAS experiments will upgrade the inner muon spectromater barrel layer with stations of thin-gap resistive plate chambers (RPCs) and small diameter muon drift-tube (sMDT) chambers in order to increase the acceptance of the first level muon trigger from current 80% to 95%. The MPI for Physics in Munich produced 49 sMDT chambers for this upgrade. The performance of all 49 chambers was measured with cosmic-ray muons: dark currents, electronics noise, muon detection efficiency, and the spatial resolution of all chambers were determined. The methods used for this certification and the results of the tests will be explained and shown in this presentation.

T 150: Gas-Detecors, Pixel/TANGERINE

Time: Thursday 17:30–19:00 Location: WIL/A120

T 150.1 Thu 17:30 WIL/A120

Cosmic test stand gas studies with a small-strip Thin Gap Chamber quadruplet — •Ksenia Solovieva, Jose Antonio Fernandez Pretel, Patrick Scholer, Vladislavs Plesanovs, and Ulrich Landgraf — Albert-Ludwigs University, Freiburg

The small-strip Thin Gap Chamber (sTGC) technology has been implemented in the New Small Wheel upgrade of ATLAS for improved triggering and tracking in a higher particle rate environment. For the purpose of investigating readout, trigger and gas parameters, a quadruplet was set up in a cosmic muon test stand in Freiburg and read out with the final ATLAS NSW readout system and the final gas mixture. With the unique opportunity of this setup to study analog signals before digitisation and to closely monitor various properties of the gas and HV, it lends itself to studies of the properties of the sTGC gas mixture. This presentation discusses the goals and challenges of the dedicated setup, as well as presenting the results of investigations into the behaviour of signals with varying gas mixtures. Some technical details of the mixing procedure to obtain the gas mixture (45:55 n-pentane: CO2) will be included as part of the results.

T 150.2 Thu 17:45 WIL/A120

Test of ATLAS Micromegas detectors with a ternary gas mixture at the CERN GIF++ facility — •Fabian Vogel, Otmar Biebel, Valerio D'Amico, Florian Egli, Stefanie Götz, Ralf Hertenberger, Christoph Jagfeld, Eshita Kumar, Katrin Penski, Maximilian Rinnagel, Nick Schneider, and Chrysostomos Valderanis — LMU München

The ATLAS collaboration at LHC has chosen the resistive Micromegas technology, along with the small-strip Thin Gap Chambers (sTGC), for the high luminosity upgrade of the first muon station in the high-rapidity region, the New Small Wheel (NSW) project. Achieving the requirements for these Micromegas detectors revealed to be even more challenging than expected. One of the main features being studied is the HV stability of the detectors. Several approaches have been tested in order to enhance the stability, among them the use of different gas mixtures. A ternary Argon-CO_2-iC_4H_{10} mixture has shown to be effective in dumping discharges and dark currents. It allows the operation of the Micromegas detectors at safe working points with high cosmic muon detection efficiency. The presence of Isobutane in the mixture required a set of aging studies, ongoing at the GIF++ radiation facility at CERN, where the expected HL-LHC background rate is created by a ^{137}Cs 14 TBq source of 662 keV photons. Preliminary aging results and muon reconstruction efficiencies under photon background of the ternary mixture will be shown.

T 150.3 Thu 18:00 WIL/A120

Measurement of the first Townsend coefficient using UV light — •Paolina Noll, Thomas Radermacher, Stefan Roth, David Smyczek, and Nick Thamm — RWTH Aachen University - Physics Institute III B, Aachen, Germany

In gaseous ionization detectors primary electrons are accelerated in high electric fields and hence generate secondary ion pairs. These electron avalanches are described by the first Townsend coefficient which is the number of electrons produced per unit path length per primary electron. In a test setup a UV LED produces primary electrons via the photoelectric effect. The Townsend coefficient is extracted from the anode current measured in relation to the voltage applied. The experimental setup and first results are presented.

T 150.4 Thu 18:15 WIL/A120

TANGERINE Project: Transient Simulation Studies — •Manuel Alejandro Del Rio Viera for the Tangerine-Collaboration — Deutsches Elektronen-Synchrotron (DESY)

The goal of the TANGERINE project is to develop the next generation of monolithic silicon pixel detectors using a 65 nm CMOS imaging process, which offers a higher logic density and overall lower power consumption compared to previously used processes. In order to understand the processes and parameters that are involved in the development in the new 65 nm technology, a combination of Technology Computer-Aided Design (TCAD) and Monte Carlo (MC) simulations are used. Transient simulations allow to study the response of the sensor over time, such as the signal produced after a charged particle passes through the sensor. The study of these signals is important to understand the magnitude and timing of the response from the sensors and improve upon them.

While TCAD simulations are accurate, the time required to produce a single pulse is large compared to a MC and TCAD combination approach, which reduces the simulation time and allows for high statistics studies. Electrostatic fields from TCAD are imported into the Allpix Squared framework, a simulation framework for semiconductor radiation detectors, and through the use of the Shockley-Ramo Theorem, the pulses induced from charges moving in the sensor are calculated.

In this talk, the advantages of this approach, the resulting pulses and the integrated charge obtained from the MC and TCAD simulations used as validation between the two methods will be presented.

T 150.5 Thu 18:30 WIL/A120

Monte Carlo Simulations of Detector Prototypes Designed in a 65 nm CMOS Imaging Process — •Sara Ruiz Daza for the Tangerine-Collaboration — DESY, Hamburg, Germany

Monolithic CMOS sensors enable the development of detectors with a low material budget and a low fabrication cost. Moreover, using a small collection electrode results in a small sensor capacitance, a low analogue power consumption, and a large signal-to-noise ratio. These characteristics have become very attractive in the development of new silicon sensors for charged particle tracking at future experiments. One of the goals of the Tangerine Project (Towards Next Generation Silicon Detectors) is to develop a telescope setup consisting of detector prototypes designed in a 65 nm CMOS imaging process. This contribution presents the Monte Carlo simulations of such detector prototypes using the Allpix Squared framework.

T 150.6 Thu 18:45 WIL/A120

Simulations and Test Beam Results of a MAPS in a 65 nm CMOS Imaging Technology — •Adriana Simancas for the Tangerine-Collaboration — Deutsches Elektronen-Synchrotron, Hamburg, Deutschland — Universität Bonn, Bonn, Deutschland

Monolithic CMOS sensors produced in a 65 nm imaging technology are being investigated for an application in particle physics for the first time. Their main characteristic is the integration of an active sensor and readout circuit in the same silicon wafer, which provides a reduction in material budget. Compared to the previously investigated 180 nm process, the 65 nm technology offers a significant improvement in the logic density of the pixels. The small collection electrode sensor is characterized by a low input capacitance, granting a high signal to noise ratio and a low power consumption. The Tangerine Project aims to use this technology for vertex detectors at future lepton colliders. TCAD Device and Monte Carlo simulations are used to develop an understanding of the sensor technology and provide important insight into performance parameters of the sensor. Testing prototypes in laboratory and test beam facilities allows to study their charge collection, spatial resolution and efficiency. Combining results from all these studies it is possible to optimize the sensor layout. This contribution will present the first comparison of simulation results to test beam data of a 65 nm CMOS sensor with a small collection electrode.

T 151: Exp. Methods IV

Time: Thursday 17:30–19:00 Location: WIL/C129

T 151.1 Thu 17:30 WIL/C129

Evaluating new triggers for ATLAS HH(4b) analysis in LHC Run 3 data — •Abdullah Nayaz[1], Teng Jian Khoo[2], and Cigdem Issever[3] — [1]Humboldt University, Berlin, Germany — [2]Humboldt University, Berlin, Germany — [3]Humboldt University, Berlin, Germany

The diHiggs (HH) study plays a central role in probing both the Standard Model and new Physics. The dominant higgs decay to a pair of b quarks (h->bb) makes the 4b final state one of the most significant signatures to look for a di-Higgs system.The small cross section of the process plus the existence of a huge QCD background make the trigger (selecting signature-relevant events) extremely challenging.

For Run 3, ATLAS has designed new triggers that use better reconstruction and selection, in order to improve the efficiency at which we record HH4b events. In this study, the efficiency of these triggers as well as the existing run-2 triggers are studied and compared using the hh4b MC samples and LHC run-3 data. Several factors such as improvement in jet calibration, b-tagging and optimized selection for hardware and software triggers are expected to boost the efficiency of over all run-3 triggers. The study, in particular, quantifies these improvements which is crucial for understanding the effectiveness of each trigger. In addition, since simulation is not a perfect reflection of real data, the measured detailed trigger performance in data and simulation will then help us to determine the parameterized correction factors needed to make simulation match the data.

T 151.2 Thu 17:45 WIL/C129

Prospects for machine-learning based unfolding techniques with a focus on the measurement of differential Higgs boson production cross sections — Johannes Erdmann, •David Kavtaradze, and Jan Lukas Späh — III. Physikalisches Institut A, RWTH Aachen University

In high-energy physics experiments, measured distributions are the result of Poissonian fluctuations around expectation values that are obtained from folding the underlying distribution with detector effects. The inference of the underlying distribution from the measurement in cases where no parametric form is available is known as "unfolding".

Traditional unfolding methods rely on a categorisation of events in a certain binning scheme. This limits the flexibility of the unfolding and does not allow for a simultaneous deconvolution of multiple observables.

An alternative approach, termed "Omnifold" in the literature, does not have these restrictions and benefits from machine-learning to take into account the whole information from each event. This approach is contrasted with the traditional approaches using a physically motivated example from a measurement of differential Higgs boson production cross sections in the diphoton decay channel.

T 151.3 Thu 18:00 WIL/C129

Studies on Monte Carlo tuning using Bayesian Analysis — •Salvatore La Cagnina[1], Andrii Verbytskyi[2], Kevin Kröninger[1], and Stefan Kluth[2] — [1]TU Dortmund, Fakultät Physik — [2]Max-Plank-Institut für Physik, München

Monte Carlo (MC) simulations are an essential aspect of data analysis at the LHC. One aspect of MC event generation involves hadronisation and parton shower models. Since these models are based on approximations, they introduce a number of parameters. These parameters cannot be inferred from first principles. Therefore, their values have to be optimized using numerical tools and experimental data (MC tuning). Generally, MC tuning is performed by choosing observables that are sensitive to the parameters. Afterwards, a fit of the parameters to data using a simplified MC response function derived from fits to MC events is performed. Though state-of-the-art methods for MC tuning exist, uncertainties are usually treated as uncorrelated. In this talk, MC tuning using a Bayesian approach will be discussed. The EFTfitter tool is used for fitting, which enables the implementation of correlations for different sources of uncertainties. In addition, the propagation of uncertainties with respect to the tune are discussed.

T 151.4 Thu 18:15 WIL/C129

Tuning Pythia8 for future e^+e^- colliders — •Zhijie Zhao[1,2], Mikael Berggren[1], and Jenny List[1] — [1]DESY, Hamburg, Germany — [2]Center for Future High Energy Physics, Institute of High Energy Physics, Chinese Academy of Sciences, Beijing, China

The majority of Monte-Carlo (MC) simulation campaigns for future e^+e^- colliders has so far been based on the leading-order (LO) matrix elements provided by Whizard 1.95, followed by parton shower and hadronization in Pythia6, using the tune of the OPAL experiment at LEP. In this contribution, we test and develop the interface between Whizard3 and Pythia8. As a first step, we simulate the $e^+e^- \to q\bar{q}$ process with LO matrix elements, and compare three tunes in Pythia8: the standard Pythia8 tune, the OPAL tune and the ALEPH tune. At stable-hadron level, predictions of charged and neutral hadron multiplicities of these tunes are compared to LEP data, since they are strongly relevant to the performance of ParticleFlow algorithms.

Then events are used to perform a full detector simulation and reconstruction of the International Large Detector concept (ILD), as an example for a ParticleFlow-optimised detector. At reconstruction level, a comparison of the jet energy resolution in these tunes is presented. We found good agreement with previous results that were simulated by Whizard1+Pythia6. This modern MC simulation chain, probably with matched NLO matrix elements in the future, should be introduced to ILC or other future e^+e^- colliders.

T 151.5 Thu 18:30 WIL/C129

Geant4 Optimizations in ATLAS — •Mustafa Schmidt for the ATLAS-Collaboration — Bergische Universität Wuppertal

Production of Monte-Carlo simulations for ATLAS usually require large amount of computation time and result in huge memory consumption. In order to minimize the required resources, a dedicated Geant4 optimization task force works on optimizing the performance of the integrated Geant4 version in the ATLAS offline software framework Athena. After being founded in 2020, many optimizations have been implemented, mainly related to improvements of various physics lists, stepping parameters, and detector descriptions.

Recent developments cover a Woodcock tracking algorithm for improving the CPU time for photons in the calorimeter, and a proposal for a particle killer that stops propagating unimportant secondary particles in ATLAS. In addition, a Geant4 toolkit called FullSimLight has been developed which can run with various geometries including the most recent ATLAS detector geometry description. It contains many useful tools, such as a clash detection or a generator for geantino maps of the imported geometry. This talk covers the current status of the ongoing projects as well as an overview of future work packages.

T 151.6 Thu 18:45 WIL/C129

Monte-Carlo Generator Validation in ATLAS with JEM/PAVER — Frank Ellinghaus, Dominic Hirschbühl, Johanna Kraus, Joshua Reidelstürz, Jens Roggel, and •Mustafa Schmidt for the ATLAS-Collaboration — Bergische Universität Wuppertal

Periodic validation of available Monte-Carlo (MC) generators is crucial for obtaining reliable physics simulations, especially for the ATLAS experiment. Its main idea is to spot the origin of possible problems and unwanted features in generated MC events by comparing the shapes of various observables between the generated samples and their references. For that purpose, the existing job execution monitor (JEM), originally designed for monitoring grid jobs, has initially been used. However, due to many missing features, a new validation system, PMG Architecture for Validating Evgen with Rivet (PAVER), was recently developed based on the JEM infrastructure. It uses the ATLAS official Rivet analysis routines for validating specific physics processes, providing an automated and central MC event generator validation procedure that allows a regular evaluation of new revisions and updates for commonly used MC generators in ATLAS. The result is a robust, flexible, and highly functional MC validation setup, that is constantly developed further, for efficiently detecting issues in generated samples within a restricted timescale. It turned out to be a very useful tool for determining several unexpected features related to MC generator behaviors that are regularly reported to the generator authors, which resulted in various bug-fix releases of external MC tools.

T 152: Members' Assembly

Time: Thursday 20:00–22:00 Location: HSZ/0003

All members of the Particle Physics Division are invited to participate.

T 153: Invited Overview Talks III

Time: Friday 11:00–12:30 Location: HSZ/AUDI

Invited Talk T 153.1 Fri 11:00 HSZ/AUDI
The Standard Model on the test bench: What bosons and the top quark (will) tell us — •Valerie Lang — Albert-Ludwigs-Universität Freiburg
The Standard Model of particle physics has been very successful at predicting the properties and interaction rates of particles since its formulation. The currently largest test bench for the Standard Model are the experiments at the Large Hadron Collider (LHC) at CERN. The supreme performance of both accelerator and detectors has allowed us to drive both, precision of measured properties and rarity of observed processes, into unprecendented areas. Particularly fascinating probes are the bosons of the Standard Model, which act as force carriers and can be produced directly at the LHC, as well as the top quark, the heaviest particle in the Standard Model and the only quark which we can observe as free particle. In this presentation, I will provide a glimpse at the insights we have gained so far, and at the possibilities that are still awaiting us with the current third running period of the LHC, and its upgrade - the high-luminosity LHC.

Invited Talk T 153.2 Fri 11:30 HSZ/AUDI
Gravitational wave observations: Current results & future expectations — •Harald Pfeiffer for the LIGO Scientific-Virgo-KAGRA-Collaboration — Max Planck Institute for Gravitational Physics, Am Mühlenberg 1, 14476 Potsdam
Gravitational Wave (GW) Astronomy has blossomed since the ground-breaking discovery in 2015 of a GW emitted by two merging black holes. The third observing run of the LIGO and Virgo observatories has increased the number of GW signals to nearly 100. Three types of compact object binaries have now been discovered: binary black holes, binary neutron stars and mixed systems with one neutron star and one black hole. This large set of GW signals enables ever more diverse conclusions about fundamental physics and astrophysics, with results including the equation of state at supernuclear densities, the mass-distribution of black holes, properties of gamma ray bursts, the nature of gravity and cosmology. This talk gives an overview of the observations and the wide variety of scientific results enabled by them. We close with an outlook to future observing runs and GW detectors.

Invited Talk T 153.3 Fri 12:00 HSZ/AUDI
Precise muon detection: novel technologies for the luminosity frontier — •Kerstin Hoepfner — RWTH Aachen, Phys. Inst. 3A, Aachen, Germany
Muons play an essential role in the discovery of new particles because of their potential to warrant a clean signature and low background. Outstanding examples from the past include the finding of the bottom quark as well as the tau lepton, and more recently the discovery of the Higgs boson. At present another type of signature is gaining importance: displaced muons as a probe for potential new BSM particles.

At the upcoming High-Luminosity LHC, muon detection as well as muon triggering face big challenges in terms of rate and precision. Consequently, modern muon systems evolve beyond being pure particle identification devices and rather turn into complex and high granularity trackers. High particle rates and densities also imply the requirement of increased radiation tolerance.

In anticipation of these challenges, new detection technologies were developed, largely based on micro-pattern gas detectors. These detectors provide a high spatial and time resolution. For the upcoming High-Luminosity LHC, the high-rate experiments ATLAS and CMS install large-scale systems of such detectors for muon detection. Their superior performance makes these detectors also good candidates for other applications in particle physics.

T 154: Invited Overview Talks IV

Time: Friday 13:30–14:00 Location: HSZ/AUDI

Invited Talk T 154.1 Fri 13:30 HSZ/AUDI
ECN3: Experimental Opportunities at a Future High-Intensity Proton Facility at the CERN SPS (BDF/SHiP and HIKE+SHADOWS) — •Annika Hollnagel — JGU Mainz
Within the framework of the CERN Physics Beyond Colliders (PBC) initiative and as an essential part of the European Strategy for Particle Physics, an upgrade of the existing ECN3 experimental hall will enable a diverse physics program at the CERN SPS and complement research at the energy frontier.

Competitive Letters of Intent have been submitted for experiments at the facility, focusing on either Kaon physics or the Hidden Sector:

BDF/SHiP aims to exploit the full potential of a dedicated Beam Dump Facility (BDF) in the Search for Hidden Particles (SHiP), covering a wide range of the Hidden Sector while also offering a rich neutrino physics program.

The combined approach of HIKE+SHADOWS - runnning part-time in beam dump or Kaon mode - on the other hand would allow to further pursue Kaon research by NA62-successor HIKE (High-Intensity Kaon Experiment), while also providing Hidden Sector sensitivity with off-axis experiment SHADOWS (Search for Hidden And Dark Objects With the SPS).

This talk will give an overview of the physics capabilities of the proposed experiments - all offering excellent options for research at a future high-intensity proton facility at ECN3. With significant German contribution and extensive efforts in R&D, further insight can be gained from the various talks at this conference.

Short Time-scale Physics and Applied Laser Physics Division
Fachverband Kurzzeit- und angewandte Laserphysik (K)

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Overview of Invited Talks and Sessions

(Lecture hall REC/C213; Poster HSZ OG2)

Invited Talks

K 1.1	Tue	11:00–11:35	REC/C213	**Information, Abstände und Gravitation ?** — •Rudolf Germer

Sessions

K 1.1–1.5	Tue	11:00–12:35	REC/C213	**Laser Applications and Laser-Beam Material Interaction**
K 2	Tue	12:35–13:00	REC/C213	**Members' Assembly**
K 3.1–3.2	Tue	16:45–17:45	HSZ OG2	**Poster**
K 4.1–4.4	Wed	11:00–12:00	REC/C213	**X-Ray Lasers**

Members' Assembly of the Short Time-scale Physics and Applied Laser Physics Division

Dienstag 12:35–13:00 Raum REC C213

- Bericht
- Verschiedenes

Sessions

– Invited Talks, Contributed Talks, and Posters –

K 1: Laser Applications and Laser-Beam Material Interaction

Time: Tuesday 11:00–12:35 Location: REC/C213

Invited Talk K 1.1 Tue 11:00 REC/C213

Information, Abstände und Gravitation ? — •Rudolf Germer — ITPeV und TU-Berlin, germer@physik.tu-berlin.de

Physikalische Experimente und Theorien vermitteln uns, dem Beobachter, Information und Erkenntnis. Ein Vergleich von Gravitations- und Coulombgesetz ermöglicht die Hypothese, daß die Verteilung von Massen im Universum Basis der "Gravitationskonstante" ist. Ausgang der Überlegungen ist die Frage nach kleinsten Informationseinheiten, kürzesten Zeitintervallen und Längen... Verstanden sind die Beziehungen zwischen den elektromagnetischen Quanten und zahlreichen Naturkonstanten, die sich, wie hier schon gezeigt, mit der Geometrie eines Quaders darstellen lassen. Kleinste Informationseinheiten lassen sich dann mit dem Planck'schen Wirkungsquantum h und einer beteiligten Energie E fassen. Bekannt ist die Abhängigkeit der Auflösung des Mikroskops von der Energie und Wellenlänge der Photonen. Der Zusammenhang bekannter elektromagnetischer Größen mit der Information über Abstände und Längen läßt sich am Beispiel des Wasserstoffatoms leicht demonstrieren. Viele Einzelheiten finden Sie im Wikibook "Die abzählbare Physik". Eine grobe Abschätzung läßt erwarten, daß diese Gedankenwelt auf die Gravitation übertragbar ist. Es sind dann lokal Abweichungen vom Mittelwert des Gravitationsfaktors zu erwarten.

K 1.2 Tue 11:35 REC/C213

Validation of two-temperature hydrodynamics modeling by in-situ metrology and ex-situ analysis of the microstructure of a thin gold film — •Markus Olbrich[1], Theo Pflug[1], Christina Wüstefeld[2], Mykhaylo Motylenko[2], Christiane Wächtler[2], David Rafaja[2], Stefan Sandfeld[3], and Alexander Horn[1] — [1]Laserinstitut Hochschule Mittweida — [2]Institute of Materials Science, TU Bergakademie Freiberg — [3]Institute for Advanced Simulation, Forschungszentrum Juelich GmbH

Irradiating a thin gold film (film thickness $d_z = 150$ nm, 20 nm adhesion layer of chromium, fused silica substrate) with single-pulsed ultrafast laser radiation (pulse duration $\tau_H = 40$ fs, wavelength $\lambda = 800$ nm, peak fluence $H_0 = 1.4$ J/cm^2) results in a flat ablation structure with a constant ablation depth, being replicable by two-temperature hydrodynamics modeling (TTM-HD). For validating the model, ultrafast imaging reflectometry is applied within a temporal range of up to 50 μs after the irradiation, resulting in a good agreement between the simulated electron temperature and the simulated dynamics of the ablated material with the measured change of reflectance. The modeling is further validated by comparing the calculated temperature and pressure distributions to the change of the microstructure and the diffusion depth of chromium into the gold film. The microstructure was investigated by electron backscatter diffraction (EBSD) and transmission electron microscopy (TEM). Concentration profiles of chromium were determined by energy dispersive X-ray spectroscopy (EDS) performed on cross-sections in the scanning transmission electron mode (STEM).

K 1.3 Tue 11:50 REC/C213

Laser-assisted atmospheric pressure plasma jet etching of optical glasses — •Robert Heinke[1,2], Martin Ehrhardt[1], Pierre Lorenz[1], Thomas Arnold[1,2], and Klaus Zimmer[1] — [1]Leibniz Institute of Surface Engineering, Permoserstr. 15, Leipzig, 04318, Germany — [2]Institute of Manufacturing Science and Engineering, Technische Universitat Dresden, 01062 Dresden, Germany

The increasingly demanding requirements for high-performance optics, e.g. EUV and free-form optics, necessitate progressive improvements in manufacturing techniques. Atmospheric pressure plasma jet (APPJ) processing provides a tool for the generation and correction of highly precise optical surfaces due to its high flexibility and depth precision. During APPJ processing of optical glasses such as N-BK7 and N-SF6, a residual layer of nonvolatile compounds is formed, resulting in rough surfaces or even the abortion of the etching process. Lasers are utilized to remove the residual layer without damaging the glass underneath. Therefore, a 248 nm excimer laser was used and fluences as well as pulse numbers have been varied to determine a parameter set with optimum selectivity. The resultant surface structures were measured by WLI and SEM. The results show a strong dependence on the processed glass type and the residual layer thickness. The incorporation of laser ablation into APPJ etching provides higher etching rates and lower surface roughness.

K 1.4 Tue 12:05 REC/C213

Laser-magnetization of $Fe_{60}Al_{40}$ investigated by pump-probe reflectometry — •Theo Pflug[1], Javier Pablo-Navarro[2], Markus Olbrich[1], Alexander Horn[1], and Rantej Bali[3] — [1]Laserinstitut Hochschule Mittweida, Hochschule Mittweida, Germany — [2]Instituto de Nanociencia y Materiales de Aragón, Universidad de Zaragoza, Spain — [3]Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf, Germany

Ultrashort pulsed laser irradiation enables the generation of ferromagnetism in initially non-ferromagnetic materials, such as B2-ordered $Fe_{60}Al_{40}$. The paramagnetic B2 phase, defined by atomic planes of pure Fe, separated by Al-rich planes is randomized due to irradiation leading to the formation of the disordered A2 $Fe_{60}Al_{40}$ being ferromagnetic. This phase transition has been reported to rely on melting and subsequent resolidification, estimated to occur within 5 ns. However, the physical dynamics during the B2-A2 transition have yet to be investigated. Here, we demonstrate the temporal evolution of the transient reflectance of $Fe_{60}Al_{40}$ during the B2-A2 transition measured by pump-probe reflectometry. The reflectance increases abruptly 5 ps after excitation with pulsed laser radiation (800 nm, 40 fs, 0.2 J/cm^2) which can be attributed to the disordering process. Ex situ observations (Kerr microscopy, HR-TEM, electron holography) confirm that the laser-irradiated areas possess a high magnetization and the A2 structure. Furthermore, materials whose phase transition does not necessarily rely on resolidification may lead to a further reduction in the time needed for generating ferromagnetism by laser irradiation.

K 1.5 Tue 12:20 REC/C213

Double-pulse irradiation of a thin gold film using ultrafast laser radiation — •Markus Olbrich, Theo Pflug, Nick Börnert, Philipp Lungwitz, Andy Engel, Peter Lickschat, Steffen Weissmantel, and Alexander Horn — Laserinstitut Hochschule Mittweida, Technikumplatz 17, 09648 Mittweida

Irradiating a thin gold film (film thickness $d_z = 150$ nm, 20 nm adhesion layer of chromium, float glass substrate) with a double-pulse of ultrafast laser radiation (pulse duration $\tau_H = 40$ fs, wavelength $\lambda = 800$ nm, temporal delay $\Delta t = 400$ ps, peak fluence per pulse $H_0 = 1.5\,H_{\mathrm{thr}}$, H_{thr} ablation threshold) results in a topology of the ablation structure deviating compared to the topology of the ablation structure induced by single-pulsed ultrafast laser radiation of the same total fluence ($H_0 = 3.0\,H_{\mathrm{thr}}$). We demonstrate that the origin of these different topologies is revealed by two-temperature hydrodynamics modeling (TTM-HD) and is confirmed by ultrafast imaging reflectometry. Herein, the first pulse induces an ablation of liquid material by spallation, being transformed nearly completely into a liquid-vapor mixture of high temperature by absorbing the energy of the second pulse. The omnidirectionally expanding mixture pushes the liquid non-ablated material, being a residual from the first pulse interaction, out of the interaction zone. Thus, setting the optimum delay between the two pulses can drastically increase the energy deposition and with it the material processing efficiency.

K 2: Members' Assembly

Time: Tuesday 12:35–13:00 Location: REC/C213

All members of the Short Time-scale Physics and Applied Laser Physics Division are invited to participate.

K 3: Poster

Time: Tuesday 16:45–17:45 Location: HSZ OG2

K 3.1 Tue 16:45 HSZ OG2

Organic distributed feedback lasers based on laser-inscribed periodic surface structures — •Tiange Dong, Tobias Antrack, Jakob Lindenthal, Markas Sudzius, Johannes Benduhn, and Karl Leo — Dresden Integrated Center for Applied Physics and Photonic Materials (IAPP) and Institute of Applied Physics, Technische Universität Dresden, 01062, Dresden, Germany

Laser ablation, as one of the well-approved alternative methods of photolithography in microfabrication, is limited in structuring resolution by the diffraction limit. However, it was observed that a laser-induced periodic surface structure (LIPSS) can be formed under ultrafast laser irradiation, and the periodicity resolution is significantly smaller than the wavelength of the incident laser ($\lambda/2$-$\lambda/10$). In this work, the periodic structure generated by LIPSS was utilized to build a distributed feedback (DFB) laser based on organic materials. The femtosecond laser (λ = 515 nm) was used to structure the SiO2 substrate, forming a surface grating with a periodicity of about 200 nm. Afterwards, an organic blend (Alq3:DCM, 450 nm thick) was evaporated on the top of the grating as an optically active waveguide. Photo-induced laser emission of the devices was measured under femtosecond optical pumping at 404 nm. We observed a narrow single peak laser emission at 620nm wavelength, which demonstrates optical feedback from the underlying 1st-order DFB structure. Our results show the potential of a laser-induced periodic surface structure to organic photonic devices and microlasers based on the artificially produced photonic structures on a subwavelength scale using laser micromachining techniques.

K 3.2 Tue 16:45 HSZ OG2

Spectroscopic Pump-Probe-Reflectometry of NIR Excited Silicon — •Philipp Lungwitz, Nick Börnert, Theo Pflug, and Alexander Horn — Laserinstitut Hochschule Mittweida, Technikumplatz 17, 09648 Mittweida

Ultrashort pulsed laser radiation with photon energies below the indirect bandgap of silicon enables the in-volume structuring of wafers due to multiphoton processes. Therefore, laser sources with wavelength in near infrared (NIR) spectral range are increasingly common for processing semiconductors. During laser mater interaction of ultrashort pulsed laser radiation ($\lambda_{\mathrm{pump}} = 1950\,\mathrm{nm}$, $\tau_{\mathrm{H}} < 50\,\mathrm{fs}$) with silicon, the resulting nonlinear excitation of electrons by NIR radiation also affects to the optical properties in the visual spectral range. Imaging pump-probe reflectometry enables the measurement of the transient reflectivity for different probe wavelengths ($420\,\mathrm{nm} \leq \lambda_{\mathrm{probe}} \leq 1000\,\mathrm{nm}$, $\tau_{\mathrm{H}} \approx 40\,\mathrm{fs}$) and time delays up to $\Delta t = 500\,\mathrm{ps}$ after irradiation. Assigning the spatial coordinates to local fluences allows a fluence dependent interpretation as well. Below the fluence for material modification H_{th}, a reduction of reflectivity was detected which become more and more significant with an increasing probe wavelength. For fluences above H_{th}, the reflectivity increases rapidly after irradiation and features a local minimum between $\Delta t = 2\,\mathrm{ps}$ and $\Delta t = 50\,\mathrm{ps}$ for all probe wavelengths.

K 4: X-Ray Lasers

Time: Wednesday 11:00–12:00 Location: REC/C213

K 4.1 Wed 11:00 REC/C213

Electron Optical Systems for High-Resolution Electron Time-of-Flight Spectrometer — •Niclas Wieland[1], Sara Savio[1], Lars Funke[1], Lasse Wülfing[1], Arne Held[1], Markus Ilchen[2], and Wolfram Helml[1] — [1]Fakultät Physik, TU Dortmund — [2]Deutsches Elektronen-Synchrotron DESY, Hamburg

Angular streaking allows resolving the sub-femtosecond temporal structure of SASE free-electron laser pulses. A circularly polarized infrared laser imprints a phase-dependent momentum shift onto the photoelectron spectra of a gas target. Time-of-flight spectrometers can be used to resolve these. The latter devices consist of electron optics, a drift section and a detector with good time resolution. Parameters such as energy resolution and energy-dependent transmission for the whole system can be determined by simulation. In this talk, we present the finalized simulation-motivated spectrometer design used inside our new chamber for the SpeAR_XFEL project. Furthermore, we will introduce the possibility of adaptive electron optics in our spectrometer to further increase the resolution and transmission by applying specific voltage sets to our optics.

Gaining insight into electron motion using precise simulations appears to be an efficient way to improve the overall performance of such experiments. We would like to present our progress in terms of electrode design and applied voltages for a 0-4 keV electron energy spectrum, to further develop spectrometer research in this field.

K 4.2 Wed 11:15 REC/C213

Angular streaking TOF spectrometer for ultrafast FEL pulse characterization — •Sara Savio[1], Niclas Wieland[1], Lars Funke[1], Lasse Wülfing[1], Arne Held[1], Markus Ilchen[2], and Wolfram Helml[1] — [1]Fakultät Physik, Technische Universität Dortmund, Maria-Göppert-Mayer-Straße 2, 44227 Dortmund, Germany — [2]Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany

Angular Streaking is a very successful and currently the only non-invasive tool used to measure the time-energy structure of X-ray pulses with sub-femtosecond resolution. A complete reconstruction of the ultrashort FEL pulses can be realized from the angle-resolved photoelectron momentum distribution due to the energy modulation by a circularly polarized optical laser. This work mainly evaluates the performance parameter like solid angle acceptance of the electron Time-of-Flight (eTOF) spectrometer with the help of SIMION software. A systematic investigation of the overall transmission and energy resolution while considering the pointing (displacement) of the beam in the interaction region is carried out using the charged particle optical simulation. Angle resolving photoelectron spectrometer is a potential candidate for polarization and short pulse measurements. The scope of the envisioned electron spectroscopy experiments is not only limited to pulse characterization but also includes measurements of ultrafast electron dynamics in gas-phase atoms, like the Auger-Meitner decay, and following electronic pathways in more complex molecules for ultrafast movies of photochemical reactions.

K 4.3 Wed 11:30 REC/C213

Mechanical design and implementation of high-resolution electron time-of-flight spectrometers for angular atreaking — •Lasse Wülfing[1], Sara Savio[1], Niclas Wieland[1], Lars Funke[1], Arne Held[1], Markus Ilchen[2], and Wolfram Helml[1] — [1]Fakultät Physik, Technische Universität Dortmund, Germany — [2]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

In order to reconstruct the stochastic temporal shapes of SASE FEL pulses in a non-destructive manner, a specialized *angular streaking* chamber is built at DESY and XFEL. Angular streaking superimposes the ultrashort X-ray beams with a circularly polarized infrared laser and correlates relative phases in the laser to the momenta of photoelectrons in a plane perpendicular to the beam. The energies of these photoelectrons can be obtained by Time-of-Flight spectrometers (eTOF).

In the SpeAR_XFEL project (Spectroscopy with Angular Resolution for ultrafast experiments at X-ray FELs) we develop a novel detector aimed at angular streaking. It consists of a specialized vacuum chamber, designed along with a new kind of eTOF, suitable to be implemented in the magnetic shield of the chamber. Special care has to be taken in order to create a robust and precise design compatible with the material stress resulting from the high temperature baking process of UHV components.

We present the newly developed concept for a UHV compatible installation of a Time-of-Flight spectrometer array inside a magnetically highly sensitive area.

K 4.4 Wed 11:45 REC/C213

Characterization of SASE FEL pulses with angular streaking — •Lars Funke[1], Kristina Dingel[2], Arne Held[1], Sara Savio[1], Lasse Wülfing[1], Niclas Wieland[1], Markus Ilchen[3], and Wolfram Helml[1] — [1]Fakultät Physik, Technische Universität Dortmund, Germany — [2]Intelligent Embedded Systems, Universität Kassel, Germany — [3]Deutsches Elektronensynchrotron DESY, Hamburg, Germany

SASE free-electron-laser pulses pose a challenge in terms of temporal diagnostics, due to their intrinsic stochastic structure. Few methods allow directly resolving the full spectro-temporal information. In *angular streaking*, photoelectron momenta are linked to their birth phase by superimposing a circularly polarized infrared laser pulse. This principle allows reconstructing a pulse spectrogram shot-by-shot, enabling “stochastic experiments” by evaluating measurements as a function of derived quantities such as pulse duration or delay in a (stochastic) double pulse.

The analysis of angular streaking data involves disentangling the spectral and temporal contributions to the measurement for a single shot. In this talk, we present a current adaptation of the iterative *Pacman* algorithm and further, advanced reconstruction methods.

Furthermore, we show the application of these methods to data measured using angular streaking at the SQS instrument of European XFEL in June 2022. Statistical analysis of the reconstructed spectrograms allows providing diagnostic feedback with regard to different short-pulse FEL modes.

Environmental Physics Division
Fachverband Umweltphysik (UP)

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Overview of Invited Talks and Sessions

(Lecture halls: MOL/0213, ZEU/0160 and HSZ/AUDI; Posters: HSZ OG1)

Plenary Talk of the Environmental Physics Division

PV V	Tue	9:45–10:30	HSZ/AUDI	**The European Destination Earth initiative – a paradigm change for weather and climate prediction** — •Peter Bauer

Invited Talks

UP 2.1	Wed	11:00–11:30	MOL/0213	**Volcanic radiative forcing: past and future** — •Anja Schmidt
UP 7.1	Thu	11:00–11:30	MOL/0213	**Towards monitoring of anthropogenic greenhouse gas emissions from satellites** — •Hartmut Bösch, Antonio Di Noia, Neil Humpage, Alex Webb, Harjinder Sembhi, Robert Parker, Michael Buchwitz, Max Reuter, Oliver Schneising, Stefan Noel, Heinrich Bovensmann
UP 8.1	Thu	14:00–14:30	MOL/0213	**Destabilization of carbon in tropical peatlands by enhanced weathering** — •Alexandra Klemme, Tim Rixen, Moritz Müller, Justus Notholt, Thorsten Warneke
UP 8.2	Thu	14:30–15:00	MOL/0213	**Widespread forest decline in central Europe following three extreme summers in 2018-2020** — •Ana Bastos

Invited Talks of the joint Symposium Strange Clouds – from the Earth to Exoplanets (SYSC)

See SYSC for the full program of the symposium.

SYSC 1.1	Tue	11:00–11:20	HSZ/0004	**Not all clouds are created equal – strange clouds in our solar system** — •Thomas Leisner
SYSC 1.2	Tue	11:20–11:45	HSZ/0004	**Clouds to the Edge of Space** — •Gerd Baumgarten, Ronald Eixmann, Jens Fiedler, Michael Gerding, Mykhaylo Grygalashvyly, Franz-Josef Lübken, Ashique Vellalassery, Christian von Savigny, Robin Wing
SYSC 1.3	Tue	11:45–12:10	HSZ/0004	**The dynamic clouds of Venus** — •Javier Peralta
SYSC 1.4	Tue	12:10–12:35	HSZ/0004	**Observational constraints of exoplanet clouds** — •Nicolas Iro
SYSC 1.5	Tue	12:35–13:00	HSZ/0004	**Gemstone clouds in JWST target exoplanets** — •Dominic Samra, Christiane Helling

Sessions

UP 1.1–1.5	Tue	16:45–18:00	ZEU/0160	**Clouds in Planetary Atmospheres (joint session EP/UP)**
UP 2.1–2.5	Wed	11:00–12:30	MOL/0213	**Volcanic Effects on Atmosphere and Climate**
UP 3	Wed	13:00–14:00	MOL/0213	**Members' Assembly**
UP 4.1–4.6	Wed	14:00–15:30	MOL/0213	**Aerosols & Hydrological Cycle**
UP 5.1–5.4	Wed	16:00–17:00	MOL/0213	**Measurement Techniques and Simulations**
UP 6.1–6.4	Wed	17:30–19:00	HSZ OG1	**Poster**
UP 7.1–7.4	Thu	11:00–12:15	MOL/0213	**Greenhouse Gases: Remote Sensing**
UP 8.1–8.3	Thu	14:00–15:15	MOL/0213	**Carbon Cycle & Climate Change**

Members' Assembly of the Environmental Physics Division

Wednesday 13:00–14:00 MOL/0213

- Report on last year's activities
- Election
- Any other business

Sessions

– Invited Talks, Contributed Talks, and Posters –

UP 1: Clouds in Planetary Atmospheres (joint session EP/UP)

Time: Tuesday 16:45–18:00 Location: ZEU/0160

UP 1.1 Tue 16:45 ZEU/0160

Wellen und Wolken in der Atmosphäre über den südlichen Anden gemessen mit einem Rayleigh-Lidar — •Natalie Kaifler, Bernd Kaifler, Andreas Dörnbrack und Markus Rapp — Deutsches Zentrum für Luft- und Raumfahrt e.V., Institut für Physik der Atmosphäre

Das CORAL-Lidar misst seit November 2017 in Tierra del Fuego, Argentinien (54°S) die Temperatur der Atmosphäre bis in 100 km Höhe. In der Stratosphäre treten über den südlichen Anden durch Gebirgswellen verursachte Temperaturstörungen von über 20 K Amplitude auf. In den kalten Phasen der Wellen können auf diese Weise polare Stratosphärenwolken auch in mittleren Breiten entstehen. In größeren Höhen, am oberen Rand der Mesosphäre, ist die Temperatur im Sommer kalt genug für die Bildung von Eiswolken, den sogenannten leuchtenden Nachtwolken. Sie werden durch die Gezeitenwinde beeinflusst, sind stark durch Schwerewellen moduliert, und treten in der Südhemisphäre nicht seltener auf als in der Nordhemisphäre, was man aufgrund der höheren Hintergrundtemperatur der südlichen polaren Mesosphäre erwarten könnte. Wir zeigen eine Übersicht und ausgewählte Beobachtungen von Wellen und Wolken in der mittleren Atmosphäre aus mehr als fünf Jahren Lidar-Messungen.

UP 1.2 Tue 17:00 ZEU/0160

Preferential adsorption of para and ortho water molecules on charged nanoparticles in planetary ice clouds — •Johanna Weidelt[1], Thomas Dresch[2], Denis Duft[2], and Thomas Leisner[2,3] — [1]Ultrafast Science Research Unit, University of Bielefeld, Germany — [2]Institute of Meteorology and Climate Research, Karlsruhe Institute of Technology, Germany — [3]Institute of Environmental Physics, University of Heidelberg, Germany

In the Earth mesopause, nanometer-size singly charged particles form by condensation of evaporated meteorite material. They exhibit an enhanced water adsorption cross section due to the strong charge-dipole-interaction. In this work, we study how the nuclear spin state of water molecules affects this enhancement and whether there are conditions that could lead to the formation of spin-polarized ice. Due to symmetry constraints on the total molecular wavefunction, ortho (proton spins parallel) and para (spins antiparallel) water occupy different rotational states, resulting in a different average dipole orientation in electric fields. Therefore, we expect ortho and para water to exhibit distinct adsorption enhancement factors onto charged nanoparticles. Based on Stark-shifts of individual rotational states of water, average dipole orientations of a molecular ensemble and the resulting collision cross section was calculated for various temperatures and particle sizes. We found that in the mesosphere of the Earth (T~150K) the adsorption enhancement of ortho- and para- water is approximately equal while at lower temperatures prevailing around ice giant planets and their moons, significant spin polarizations up to 15% occur.

UP 1.3 Tue 17:15 ZEU/0160

On the colour of noctilucent clouds — •Christian von Savigny[1], Anna Lange[1], Gerd Baumgarten[2], and Alexei Rozanov[3] — [1]Institute of Physics, University of Greifswald, Greifswald, Germany — [2]Leibniz Institute of Atmospheric Physics, Kühlungsborn, Germany — [3]Institute of Environmental Physics, University of Bremen, Bremen, Germany

Noctilucent clouds, also known as polar mesospheric clouds, are a polar summer mesopause phenomenon and they are typically characterised by a silvery-blue or pale blue colour. In this contribution, we investigate the reasons for this colour using the radiative transfer model SCIATRAN in combination with the CIE (International Commission on Illumination) colour-matching functions in order to the determine the resulting colour impression in an objective way. Different processes and parameters potentially affecting the colour of NLCs are investigated, i.e. the size of the NLC particles, the abundance of middle atmospheric O3 and the importance of multiply scattered solar radiation. We confirm earlier studies indicating that absorption of solar radiation in the O3 Chappuis bands can have a significant effect on the colour of the NLCs. It is, however, found that for sufficiently large NLC optical depths O3 plays only a minor role for the blueish colour. The simulations also show that the size of NLC particles affects the colour of the clouds. Cloud particles of unrealistically large sizes can lead to a reddish colour. Furthermore, the simulations show that the contribution of multiple scattering to the total scattering is only of minor importance, providing additional justification for the earlier studies on this topic, which were all based on the single-scattering approximation.

UP 1.4 Tue 17:30 ZEU/0160

Exoplanetary clouds: The potential of high-precision polarimetry — •Moritz Lietzow and Sebastian Wolf — Institute of Theoretical Physics and Astrophysics, Kiel University, Germany

The reflected flux from planets is polarized due to scattering in their atmosphere. While polarimetry is used to study objects in the Solar System, it has also been proposed for detection and characterization of extrasolar planets. In particular, the reflected polarized flux depends not only on the planetary phase angle and observed wavelength, but also on the atmospheric composition, allowing to distinguish between various cloud compositions. Given the accuracy of existing high-precision polarimeters, scattered light polarimetry indeed has the potential to become a powerful tool to characterize exoplanetary atmospheres. First measurements of planet-induced polarization were reported during recent years. To provide the basis for theoretical studies and the interpretation of dedicated polarization measurements, we developed a radiative transfer simulation software that contains all relevant continuum polarization mechanisms for the comprehensive analysis of the polarized flux resulting from the scattering in the atmosphere, on the surface, and in the local planetary environment. In addition, we investigated the impact of the cloud composition and exoplanetary rings on the scattered light polarization.

UP 1.5 Tue 17:45 ZEU/0160

Retrieval of cloud properties using spectropolarimetric simulations of Earthshine — •Orsolya Pari[1], Claudia Emde[1], Michael Sterzik[2], and Mihail Manev[1] — [1]Ludwig-Maximilians-Universität, München, Germany — [2]European Southern Observatory, Garching bei München, Germany

In order to be able to interpret future observations of the atmospheres of Earth-like planets and detect signatures of life, it is important to understand Earth's atmospheric and surface properties. Observations of Earthshine, which is sunlight scattered by Earth to the Moon, and then reflected back to Earth, make it possible to study Earth as an exoplanet.

We use the Monte Carlo radiative transfer model MYSTIC to simulate polarized spectra in the atmosphere of the Earth for Ocean and Lambertian surfaces. A water or an ice cloud layer is included and we vary the cloud parameters (cloud altitude, cloud optical thickness, effective droplet radius).

The focus is on the $O_2 - A$ and H_2O bands, where the degree of polarization can be higher or lower than the adjacent continuum. To quantify this behavior we use the equivalent width, which is the area in the passband between the absorption line and the simulated spectrum without absorption across a specific spectral region.

We find that the equivalent width is highly sensitive to cloud altitude and cloud optical thickness.The simulations are compared to the observations of Earthshine obtained by FORS2 at the VLT for different Sun-Earth-Moon phase angles.

UP 2: Volcanic Effects on Atmosphere and Climate

Time: Wednesday 11:00–12:30 Location: MOL/0213

Invited Talk UP 2.1 Wed 11:00 MOL/0213

Volcanic radiative forcing: past and future — •Anja Schmidt — Institute of Atmospheric Physics (IPA), German Aerospace Center (DLR), Oberpfaffenhofen, Germany — Meteorological Institute, Ludwig Maximilian University of Munich, Munich, Germany — Yusuf Hamied Department of Chemistry, University of Cambridge, Cambridge, United Kingdom

Volcanism is a major driver of climate variability and has played a critical role in the long-term evolution of Earth*s atmosphere and habitability through the release of gases including sulfur species, water, carbon dioxide, and halogens. In this talk, I will summarize my work on volcanic radiative forcing exerted by volcanic eruptions of different magnitudes in the past and in the future. The general mechanisms by which volcanic eruptions affect climate are well understood today. Until recently, research efforts have mainly been focused on the direct radiative, dynamical and chemical effects of sulfate aerosol particles formed by large-magnitude explosive eruptions such as Mt. Pinatubo in 1991. However, eruptions much smaller in magnitude than 1991 Mt. Pinatubo routinely decrease the transparency of the stratosphere to a degree that a cooling effect is discernible in upper tropospheric temperature measurements. I will make a case for the need to include these small-magnitude eruptions in climate model simulations. In addition, I will show that global warming can affect both eruptive column dynamics and the volcanic sulfate aerosol lifecycle and thus the radiative forcing and climate effects of future volcanic eruptions.

UP 2.2 Wed 11:30 MOL/0213

Reduction of average stratospheric aerosol size after volcanic eruptions — •Felix Wrana[1], Ulrike Niemeier[2], Sandra Wallis[1], and Christian von Savigny[1] — [1]Institute of Physics, University of Greifswald, 17489 Greifswald, Germany — [2]Max Planck Institute for Meteorology, 20146 Hamburg, Germany

The evolution of the size distribution of stratospheric aerosols after volcanic eruptions is still not understood very well, due to the temporal sparsity of in situ measurements, the low spatial coverage by ground based observations and the difficulties to derive aerosol size information from satellite measurements. To contribute to this ongoing research, we show data from our aerosol size retrieval using SAGE III/ISS solar occultation measurements. Using a three wavelength extinction approach the parameters of assumed to be monomodal lognormal particle size distributions are retrieved.

Surprisingly we find that some volcanic eruptions can lead to a decrease in average stratospheric aerosol size, in this case the 2018 Ambae eruptions and the 2019 Ulawun eruptions, while other eruptions have a more expected increasing effect on the average particle size, like the 2019 Raikoke eruption. We show how different parameters like the median radius, the absolute mode width and the number density evolve after the mentioned eruptions.

Additionally, as a part of our ongoing research to understand the underlying mechanisms controlling the observed aerosol size reduction, we show simulations of the aforementioned volcanic eruptions using the aerosol-climate model MAECHAM5-HAM.

UP 2.3 Wed 11:45 MOL/0213

A miniaturized chemiluminescence ozone monitor for drone-based measurements in volcanic plumes — •Maja Rüth[1], Ellen Bräutigam[1], Jonas Kuhn[1], Nicole Bobrowski[1], Ulrich Platt[1], and Christopher Fuchs[2] — [1]Institute for Environmental Physics, Heidelberg University, Germany — [2]ETH Zürich, Switzerland

Volcanic plumes contain reactive halogen species, especially bromine monoxide (BrO), which catalyzes ozone (O3) destruction. Therefore, local O3 depletion is commonly assumed inside volcanic plumes and has also been measured to varying degrees at different volcanoes in several studies. However, a calculation comparing atmospheric mixing with the rate of O3 destruction suggests no significant reactive halogen catalysed O3-loss (1% or less) in the plume. So far, O3 and its distribution in volcanic plumes have only been insufficiently determined since commonly used ultraviolet (UV) absorption O3 monitors show interference with sulphur dioxide (SO2), an abundant volcanic gas.

This problem can be overcome by using a chemiluminescence (CL) O3 monitor, which has no known interference from trace gases abundant in volcanic plumes. However, field measurements with former CL O3 monitors are challenging, as they were heavy and bulky.

Here we report on a lightweight version of the instrument (1 kg, shoebox size), which can be mounted onto a drone. In particular, we describe the design advances making the reduction in weight and size possible and present first test measurements. By allowing the instrument to be carried by a drone into the plume, this opens up completely new measurement strategies.

UP 2.4 Wed 12:00 MOL/0213

Highly resolved volcanic SO2 emission flux measurements with imaging Fabry-Perot interferometer correlation spectroscopy — •Jaro Heimann[1], Alexander Nies[1,2], Christopher Fuchs[1,3], Jonas Kuhn[1], Nicole Bobrowski[1,4], and Ulrich Platt[1] — [1]Institute of Environmental Physics, Heidelberg University, Germany — [2]CNRS/University Orleans, France — [3]ETH Zurich, Zurich, Switzerland — [4]INGV, Catania, Italy

Imaging Fabry-Perot interferometer (FPI) correlation spectroscopy (IFPICS) is a robust and mobile imaging technology, to study volcanic trace gas emissions with high temporal resolution and accuracy. The FPI provides a periodic transmission spectrum which is matched to the periodic narrowband absorption structure of the target trace gas (due to vibronic excitations in the UV). From the resulting data an image of trace gas column density can be inferred via an instrument model. Since the image acquisition takes about 2.4s for an image, it is possible to calculate emission fluxes on this timescale.

Here we present SO2 flux measurements from July 2022 at Mt. Etna with an IFPICS instrument with a detection limit of $\approx 5e17\, molec/cm^2$ at 4 Megapixel spatial and 2.4s temporal resolution, e.g. a mean flux of 418 ± 138 t/day^{-1} for the 15th of July 2021 between 08:17 and 10:13 UTC. We will furthermore discuss uncertainties and challenges of the technique.

UP 2.5 Wed 12:15 MOL/0213

Impact of a strong volcanic eruption on the summer middle atmosphere in UA-ICON simulations — •Sandra Wallis[1], Hauke Schmidt[2], and Christian von Savigny[1] — [1]University of Greifswald, Greifswald, Germany — [2]Max Planck Institute for Meteorology, Hamburg, Germany

Explosive tropical volcanic eruptions are able to inject large amounts of sulfur dioxide into the stratosphere. Sulfur dioxide mostly converts to sulfate aerosols that can increase the temperature of the lower stratosphere and subsequently alter the stratospheric circulation. This was directly observed after the strong Pinatubo eruption in 1991. The impact on the mesosphere is less well understood, mainly because of a lack of strong eruptions during the satellite era and sparse observations of the middle atmosphere before. Few measurements, however, hint to an increase in mesospheric temperatures after the Pinatubo eruptions. We investigate dynamical mechanisms that could explain such observations by simulating the response of the middle atmosphere to an idealized tropical eruption that emitted twice as much sulfur dioxide as the Pinatubo in 1991 using the upper-atmospheric icosahedral non-hydrostatic (UA-ICON) model. We focus on the first austral summer after the eruption and find a significant warming of the polar summer mesopause of up to 15-21 K. Our study indicates that this mesospheric warming is mainly due to vertical coupling through wave-mean flow interaction in the summer hemisphere and potentially enhanced by interhemispheric coupling (between the winter stratosphere and the summer mesosphere).

UP 3: Members' Assembly

Time: Wednesday 13:00–14:00 Location: MOL/0213

All members of the Environmental Physics Division are invited to participate.

UP 4: Aerosols & Hydrological Cycle

Time: Wednesday 14:00–15:30 Location: MOL/0213

UP 4.1 Wed 14:00 MOL/0213

Mineralstaub - Vom Feldexperiment ins Labor und zurück ins Feld — •Moritz Haarig, Ronny Engelmann und Albert Ansmann — Leibniz Institut für Troposphärenforschung, Leipzig

Mineralstaub stellt den größten (Massen-)Anteil des atmosphärischen Aerosols. Er wird von den großen Wüsten der Erde emittiert und über mehrere tausend Kilometer weit transportiert. Dabei beeinflusst er Wolken- und Niederschlagsbildung und den Strahlungshaushalt der Erde. Mittels Lidartechnologie können die Staubwolken höhenaufgelöst beobachtet werden. Das Leibniz Institut für Troposphärenforschung (TROPOS) betreibt Lidargeräte unter anderem auf den Kapverden, in Zypern und Tadschikistan. Die Messung des Depolarisationsverhältnisses erlaubt eine Trennung des Staubes von anderen Aerosolen, da Mineralstaubpartikel durch eine irreguläre Form gekennzeichnet sind. Die multispektrale Depolarisationsinformation enthält weitere Informationen über die Partikelform und Größenverteilung. Allerdings erschwert es die unregelmäßige Form eines Staubpartikels, seine Streueigenschaften zu modellieren und von optischen auf mikrophysikalische Eigenschaften zu schließen. Für ein besseres Verständnis sind Labormessungen dringend erforderlich, um so die optischen Partikelmodelle zu verbessern. Im Rahmen einer Leibniz Junior Research Group wird ein solches Labor am TROPOS aufgebaut. Größenselektierte Staubproben aus verschiedenen Wüsten sollen vermessen werden. Die Messung bei genau 180° Rückstreuung stellt große Herausforderungen an den optischen Aufbau, ist aber zwingend notwendig für ein besseres Verständnis der Lidarmessungen vom Boden und aus dem Weltraum.

UP 4.2 Wed 14:15 MOL/0213

50 Jahre Lidar-Messungen in Garmisch-Partenkirchen: Langzeit-Meßserie des stratosphärischen Aerosols — •Thomas Trickl, Helmuth Giehl, Horst Jäger und Hannes Vogelmann — Karlsruher Institut für Technologie, IMK-IFU, Kreuzeckbahnstr. 19, 82467 Garmisch-Partenkirchen

Bald nach der Erfindung des Lidars wurde 1973 am IFU in Garmisch-Partenkirchen das erste Aerosol-Lidar-System in Betrieb genommen. Ab 1976 wurde mit diesem eine Langzeit-Meßserie des stratosphärischen Aerosols erstellt, welche seit 2016 am Schneefernerhaus auf der Zugspitze fortgesetzt wird. Die verbesserte Empfindlichkeit des neuen Systems erlaubt es, Messungen nun bis in über 45 km Höhe durchzuführen. Das stratosphärische Aerosol reicht über Mitteleuropa meist bis in knapp 30 km Höhe. In Einzelfällen wurden jedoch schon Beiträge bis fast 40 km nachgewiesen. Die Partikel in der Stratosphäre stammen von starken Vulkanausbrüchen, massiven Waldbränden, Wüstenstaub, aber auch vom Flugverkehr. Im Falle von tropischen Eruptionen bleiben die Aerosole mehrere Jahre in der Stratosphäre, sonst nimmt die Belastung innerhalb eines Jahres stark ab. In den vergangenen Jahren haben die Beiträge von hochreichenden Pyro-Kumulonimbus-Ereignissen deutlich zugenommen. Die Ursachen hierfür sind noch nicht klar.

UP 4.3 Wed 14:30 MOL/0213

Aerosol measurements in the Tropo- and Stratosphere by spectral splitting of Rayleigh and Mie signals with mobile lidar system VAHCOLI. — •Ronald Eixmann[1], Gerd Baumgarten[1], Jan Froh[1], Josef Höffner[1], Alsu Mauer[1], Mense Mense[1], Bernd Jungbluth[2], Alexander Munk[2], Sarah Scheuer[2], and Michael Strotkamp[2] — [1]Leibniz Institute of Atmospheric Physics, Kühlungsborn, Germany — [2]Fraunhofer Institute for Laser Technology, Aachen, Germany

By combining a novel diode-pumped alexandrite ring laser with a narrow bandwidth (FWHM ~3 MHz) and a tuned interferometer (FWHM ~7.5 MHz), a separation of the atmospheric molecular and aerosol backscatter in the receiver of the mobile Lidar system (VAHCOLI) is possible. Matching the frequency of the pulsed laser from pulse to pulse with sub-MHz accuracy relative to the interferometer enables Doppler aerosol measurements with a largely reduced Rayleigh signal. This enables aerosol measurements from the ground up to an altitude of ~25 km as well as Doppler wind measurements from the Doppler shift. The technical specifications of the VAHCOLI Lidar system ($1m^3$) allow background-free measurements during the day and 24/7 measurement operation in the future.

UP 4.4 Wed 14:45 MOL/0213

Simulating green volcanic sunsets — •Christian von Savigny and Anna Lange — Institute of Phyics, University of Greifswald, Greifswald, Germany

Volcanic sunsets are usually associated with extended and enhanced reddish colors as well as purple colors higher up. Both of these effects are well understood and can be simulated with radiative transfer models based on appropriate assumptions. However, in some cases eyewitness accounts include reports of clear and distinct green colors in the evening sky. This was particularly the case after the 1883 eruption of Krakatoa. To our best knowledge no studies exist attempting to provide an explanation for this unusual phenomenon. In this contribution we employ radiative transfer simulations to provide an explanation for green sunsets. They can be explained with plausible assumptions by anomalous scattering on stratospheric aerosols having a suitable particle size distribution with sufficiently large mean particle size and a preferably narrow width. We investigate the sensitivity of the twilight colors to relevant parameters such as aerosol optical depth, the parameters of the particle size distribution and the amount of ozone. Apart from a specific particle size, a sufficiently large aerosol optical depth is required to explain green sunsets.

UP 4.5 Wed 15:00 MOL/0213

Sediment transport in Indian rivers high enough to impact satellite gravimetry — •Alexandra Klemme[1], Thorsten Warneke[1], Heinrich Bovensmann[1], Matthias Weigelt[2], Jürgen Müller[2], Tim Rixen[3], Justus Notholt[1], and Claus Lämmerzahl[4] — [1]Institute of Environmental Physics, University of Bremen, Germany — [2]Institute of Geodesy, Leibniz Universität Hannover, Germany — [3]Leibniz Center for Tropical Marine Research, Bremen, Germany — [4]Centre of Applied Space Technology and Microgravity, University of Bremen, Germany

Satellite gravimetry is used to study the global hydrological cycle. It is a key component in the investigation of groundwater depletion on the Indian subcontinent. Mass loss by sediment transport in rivers is assumed to be below the detection limit of current gravimetric satellites like GRACE-FO. Thus, it is not considered in the calculation of terrestrial water budgets from gravimetric data. However, the Indian subcontinent is drained by some of the world's most sediment rich rivers and mass loss by sediment transport will impact long term gravimetric anomalies. We estimate the impact of sediment mass loss within different river catchments on gravimetric estimates of trends in terrestrial water storage. For the Ganges-Brahmaputra-Meghna catchment, our results indicate that sediment transport could account for (6 ± 3) % of the gravity anomalies attributed to groundwater depletion. For erosion-prone Himalaya regions, we find an average sediment mass loss of $2\,\mathrm{kg\,m^{-2}\,yr^{-1}}$ which is almost 20 % of the observed gravity anomaly.

UP 4.6 Wed 15:15 MOL/0213

Validation potential for Remote Sensing soil moisture products using Cosmic-Ray Neutron Sensing — •Markus Köhli, Jannis Weimar, and Ulrich Schmidt — Physikalisches Institut, Heidelberg University

The novel method of Cosmic-ray neutron sensing (CRNS) allows for non-invasive soil moisture measurements at a hectometer scaled footprint. This technique relies on the measurement of neutrons originating from cosmic-ray induced air showers. The key characteristic of the method is the exceptionally high moderation strength of hydrogen. It slows down fast neutrons whereas other heavier elements independent of the chemical composition rather reflect them. The result is an inverse relation of the above-ground neutron intensity to soil moisture. Due to neutrons being transported over the air over hundreds of meters, the measurement is representative for an area on the scale of hectares. In the recent years the interest was set to understanding neutron transport by Monte-Carlo simulations for complex environmental topographies. Its remarkable performance in signal interpretation allows for a promising prospect of more comprehensive data quality. This especially addresses mobile applications, which is the current focus of development. With roving it is possible to cover the scale of one square kilometer per day with one instrument. Satellite-based products can specifically profit from data assimilation of CRNS-based representative measurements of soil moisture. With its large integral footprint and its penetration depth of several decimeters, high-quality data sets can be obtained as ground truthing for remote sensing products.

UP 5: Measurement Techniques and Simulations

Time: Wednesday 16:00–17:00 Location: MOL/0213

UP 5.1 Wed 16:00 MOL/0213

Concept of a Raman-based microfluidic system for measuring trace substances in the field of wastewater treatment — •Simon Jansen, Jan Berk, Sebastian Mammitzsch, and Martin Reufer — Hochschule Ruhr West, Institut Naturwissenschaften

In wastewater treatment plants, sewage is cleaned in various purification stages. But not all impurities are removed in this process. In particular, easily water-soluble substances and those that are difficult to biodegrade, such as pharmaceutical residues, are present in low but nevertheless environmentally harmful concentrations ($\sim \mu g/l$). To reduce the residual amount of these substances, an additional (fourth) purification stage is currently implemented in the wastewater treatment plants. The efficiency of this purification stage can be determined and controlled on the basis of the so-called lead substances with classical analytical methods like gas chromatography-mass spectrometry or indirectly by proof of a sum parameter. We demonstrate a measurement concept suitable for an inline approach, based on a microfluidic system. This concept provides for a concentration of the lead substances by specific binding to surface-activated magnetic beads and a subsequent determination of the concentration. The approach for concentration measurement is based on Raman spectroscopy, due to the distinguishable fingerprint of the different trace elements. This measurement concept is advantageous because the purification process will be monitored and optimised based on the concentration of the lead substances. First results of the particle concentration in the microfluidic system and the subsequent analysis are presented.

UP 5.2 Wed 16:15 MOL/0213

Optimization of excitation and detection windows for the optical detection of microplastics via photoluminescence — •Stefan Brackmann, Srumika Konde, Katharina Gejer, Marina Gerhard, and Martin Koch — Department of Physics and Material Sciences Center, Philipps-Universität Marburg, Renthof 5, 35032 Marburg, Germany

Current microplastics research utilizes subjective hand-picking of particles to identify plastic particles. Recently the first methods using visible photoluminescence to detect plastic particles have been publicized. Here, we investigate the excitation and detection wavelength range suitable to 12 common virgin polymer types. Based on our findings, we recommend a range from 270 to 320 nm for the excitation and 320-425 nm for the detection window. We further show that plastics have unique UV-PL signatures that may be suitable for identifying microplastic particles. This approach may lead to a low-cost alternative to the established methods.

UP 5.3 Wed 16:30 MOL/0213

Time-resolved simulations of wind speed fluctuations across atmospheric boundary layers using a stochastic forward model — •Marten Klein and Heiko Schmidt — BTU Cottbus-Senftenberg, Cottbus, Germany

Atmospheric boundary layers (ABLs) govern the atmosphere–surface coupling and are therefore of fundamental relevance for Earth's weather and climate system. Time-resolved numerical simulations of ABLs are challenging due to intricate interactions of inertial, Coriolis, buoyancy, and viscous forces on all relevant scales of the turbulent flow. Small-scale processes, albeit potentially nonuniversal, are typically not resolved due to cost constraints but modeled based on physically justified relations with the resolved scales, neglecting expensive backscatter. This lack in modeling is addressed here by utilizing a dimensionally reduced stochastic modeling approach. The model aims to reproduce turbulent cascade phenomenology by a stochastic process, respecting fundamental physical conservation principles. Momentary wind velocity and temperature profiles evolve autonomously in time for an ensemble of initial conditions. By comparison with available high-fidelity reference numerical simulations, reanalysis, and observations, it is shown that the model captures various relevant flow properties, exhibiting limitations mainly in a delayed relaminarization under very stable conditions. Forthcoming research aims to contribute to a better understanding of polar boundary layers, requiring predictive modeling capabilities, high resolution, and numerical efficiency to perform long-time simulations.

UP 5.4 Wed 16:45 MOL/0213

Simulated outdoor efficiency and performance ratio of a III-V-on-Si solar panel for direct solar hydrogen production — •Johannes Grabenstein[1,2], Moritz Kölbach[3], Matthias M May[3], Klaus Pfeilsticker[1], and Kira Rehfeld[1,2] — [1]Institut für Umweltphysik, Universität Heidelberg, Germany — [2]Geo- und Umweltforschungszentrum, Universität Tübingen, Germany — [3]Institut für Physikalische und Theoretische Chemie, Universität Tübingen, Germany

Tandem solar cells might play a substantial role in future energy systems and in negative emission technologies, both for electricity- and direct hydrogen generation. In a tandem solar cell, photocurrent mismatch between the absorber layers due to variation in the spectral irradiance distribution induces efficiency losses. Together with the temperature-related efficiency modulation, this effect gives rise to its sensitivity to climatic conditions. Here, the performance of an AlGaAs-on-Si tandem solar cell that is either used for electricity production or directly connected to an anion exchange membrane electrolyzer is evaluated for different locations on earth using numerical modeling. The ratio between the outdoor harvesting efficiency and efficiency at standard conditions [1] lies within 0.86 and 0.95 for electricity- and within 0.91 and 0.95 for hydrogen production. This study allows to improve performance predictions and highlights how tuning the top absorber band gap to the prevailing spectral irradiance composition can enhance the harvesting efficiency, depending on the location. [1] Kölbach et al., Sustainable Energy Fuels, 2022, **6** DOI:10.1039/D2SE00561A

UP 6: Poster

Time: Wednesday 17:30–19:00 Location: HSZ OG1

UP 6.1 Wed 17:30 HSZ OG1

Straylight characterization of airborne imaging remote sensing instruments of the MAMAP2D family for greenhouse gas observations — •Oke Huhs, Konstantin Gerilowski, Sven Krautwurst, Jakob Borchardt, Heinrich Bovensmann, and John P. Burrows — University of Bremen, Institute of Environmental Physics, Otto-Hahn-Allee 1, 28359 Bremen, Germany

Airborne measurements of atmospheric column enhancements of methane (CH_4) and carbon dioxide (CO_2) from anthropogenic point sources were performed with the Methane Airborne MAPer (MAMAP) since 2007, which delivers 1D spatial data by measuring the spectrum of backscattered solar radiation. To measure 2D spatial data from a single overflight, a new generation of passive airborne imaging remote sensing grating spectrometers is being developed and built by IUP Bremen. The MAMAP2D-Light instrument was already successfully flown during the COMET 2.0 Arctic campaign in Canada in summer 2022 measuring CO_2 and CH_4 enhancements in a short-wave infrared band around 1.6 μm. The MAMAP2D instrument, which has an additional near-infrared O2A-band channel and a higher spectral resolution, has delivered measurement data in a laboratory environment. For the characterization of remote sensing instruments, straylight is one important quantity. Straylight occurs due to reflections and scattering within the spectrometer and must be characterized well to establish a straylight correction. Therefore, straylight was characterized down to 7 orders of magnitude below the integrated incident illumination level for MAMAP2D and MAMAP2D-Light.

UP 6.2 Wed 17:30 HSZ OG1

Calibration of an Air Data Probe to complement airborne in-situ Flux Measurements — •Josua Schindewolf — Institut für Umweltphysik, Universität Bremen, Deutschland

Airborne in-situ measurements of greenhouse gases (GHG) contribute to the increasingly important task of monitoring the changing greenhouse gas emissions and attribution of the sources. For the quantification of GHG sources, not only observations of precise atmospheric concertation gradients are needed, but also accurate measurements of the corresponding wind fields. This is because, the computation of the emissions and their uncertainties have linear dependencies on wind speed and direction. In 2022 we installed and calibrated a new turbulence probe to the underwing pod of the research aircraft of the Jade University Wilhelmshaven to complement future airborne flux measurements with high accuracy wind data. A series of flights were conducted to carry out the in-flight calibration procedure recommended by the manufacturer. Additionally, a meteorological observation tower was used for a series of fly-by manoeuvres, providing ground-based reference wind data. The calibration exhibits a mean difference in wind speed of 0.3 m/s and in wind direction of 4° over ten such calibration flights. The tower comparison showed a mean difference in wind speed of 0.5 m/s and in wind direction of 20°. In summary, the results indicate that more calibration flights are required for a further evaluation, which will focus on the comparison with the ground based met tower observations. This is challenging, because of the high variability of the wind fields at low flight altitudes.

UP 6.3 Wed 17:30 HSZ OG1

On the twilight phenomenon of the green band — •Anna Lange[1], Alexei Rozanov[2], and Christian von Savigny[1] — [1]Institute of Physics, University of Greifswald, Germany — [2]Institute of Environmental Physics, University of Bremen, Germany

The twilight sky is usually characterised by the well-known reddish/orange colours close to the horizon and the blue colours above. However, in many cases a green or greenish band forms between the blue and reddish parts of the sky, and it is essentially not documented in the literature. In this study, the green band phenomenon is simulated using the radiative transfer model SCIATRAN and subsequent colour modelling based on the CIE colour matching functions and chromaticity values. Different parameters and processes that have a potential influence are investigated. In addition, a possible contribution by airglow emissions is discussed. The simulations show that it requires just the right intensities in the blue, green, and long-wave spectral regions to produce a green colour. The total ozone column has the comparatively largest influence. This study is, to the best of our knowledge, the first detailed investigation of the green band phenomenon.

UP 6.4 Wed 17:30 HSZ OG1

Investigation of a method to analyse OH(3-1) Mesopause temperature and two-dimensional imager data of the OH-airglow layer — •Lukas Depenthal[1], Christian von Savigny[1], Christoph Hoffmann[1], and Philipp Mattern[2] — [1]Institute of Physics, University of Greifswald, Greifswald, Germany — [2]Leibniz Institute for Plasma Science and Technology, Greifswald, Germany

The University of Greifswald operates two instruments to measure airglow emissions at an altitude of about 87 km. The Andor Shamrock SR-163 Infrared spectrometer is used to detect OH-Meinel bands at 1500 nm - 1600 nm as OH(3-1) rotational-vibrational spectroscopy. Based on the relative intensities of the OH(3-1)-lines, conclusions about the mesopause temperature are drawn and examined with regard to their variability. Based on these investigations, dynamic processes in the mesopause can be investigated. Since the spectrometer has a temporal resolution of 15 s, variations with periods of about 5-20 minutes can be determined. The ongoing measurements started in 2015.

In addition, a Xenics Cheetah 640CL infrared camera is used as an OH airglow imager to visualize spatial structures and gravity wave signatures within the OH airglow layer. With a resolution of 640 x 512 pixels, wavelengths of several kilometers can be observed. These measurements started in August 2020 and have continued since then. Using principal component analysis, it is possible to determine periods of about 5-20 minutes, as in the spectrometer data. Due to the side by side installation of the instruments, the data can be compared with each other.

UP 7: Greenhouse Gases: Remote Sensing

Time: Thursday 11:00–12:15 Location: MOL/0213

Invited Talk UP 7.1 Thu 11:00 MOL/0213

Towards monitoring of anthropogenic greenhouse gas emissions from satellites — •Hartmut Bösch[1,2], Antonio Di Noia[1], Neil Humpage[1], Alex Webb[1,3], Harjinder Sembhi[1], Robert Parker[1], Michael Buchwitz[2], Max Reuter[2], Oliver Schneising[2], Stefan Noel[2], and Heinrich Bovensmann[2] — [1]University of Leicester, Leicester, UK — [2]IUP, University of Bremen, Bremen, Germany — [3]Oklahoma University, Oklahoma, USA

To limit global warming to well below 2C compared to pre-industrial levels requires a decarbonization of the economy and many countries have pledged to reach net-zero emissions by 2050 but progress has been slow so far. Satellite observations of CO2 and CH4 will play a key role for tracking progress towards emission reduction targets and for verifying the effectiveness of mitigation policies. Satellites also provide information on natural sinks which store large amounts of carbon and play a potentially important role in the pathway towards net-zero emission.

In this presentation, I will introduce the key concepts for satellite observations of CO2 and CH4 and present examples how we use current, dedicated satellite missions to quantify regional surface fluxes of natural and anthropogenic sources. I will discuss how such dedicated missions can be complemented by hyperspectral satellites with high spatial resolution that allow constraining individual emission sources. The presentation will end with an outlook to the upcoming Copernicus CO2 Monitoring (CO2M) Mission, the space component of the European anthropogenic CO2 Monitoring & Verification Support Capacity.

UP 7.2 Thu 11:30 MOL/0213

Seasonal and Interannual Variability of Australian Carbon Fluxes Seen by GOSAT — •Andre Butz[1], Eva-Marie Metz[1], Sanam Vardag[1], Sourish Basu[2], Martin Jung[3], and Stephen Sitch[4] — [1]Institut für Umwetlphysik, Universität Heidelberg, Germany — [2]NASA Goddard Space Flight Center, University of Maryland, USA — [3]Max Planck Institute for Biogeochemistry, Jena, Germany — [4]University of Exeter, Exeter, UK

The semi-arid Australian continent significantly influences the interannual variability of the global terrestrial carbon sink. The sparsity of in-situ CO2 and flux measurements, however, leads to large uncertainties in estimated carbon fluxes for the continent. Satellite measurements of CO2 offer an independent and spatially extensive source of information about the Australian carbon cycle. Here, we examine the decadal data set (2009-2018) of atmospheric CO2 mole fractions delivered by the Greenhouse Gases Observing Satellite (GOSAT). We find previously undected CO2 pulses at the end of the dry season that we attribute to the quick onset of respiration after the dry period. These pulses dominate the seasonal and the year-to-year variability of Australia's carbon balance.

UP 7.3 Thu 11:45 MOL/0213

Emission estimates of carbon dioxide and methane with a ground-based imaging spectrometer — •Marvin Knapp[1], Leon Scheidweiler[1], Felix Külheim[1], Ralph Kleinschek[1], Jaroslaw Necki[2], Pawel Jagoda[2], and Andre Butz[1] — [1]Institute of Environmental Physics, Heidelberg University, Im Neuenheimer Feld 229, 69120 Heidelberg — [2]Faculty of Physics and Applied Computer Science, AGH University of Science and Technology, Krakow, Poland

Carbon dioxide (CO_2) and methane (CH_4) emissions into the atmosphere are the strongest anthropogenic drivers of global climate change. Mitigation strategies rely on precise knowledge of the strength and distribution of these greenhouse gas sources. Spectroscopic techniques emerge that enable imaging of atmospheric CO_2 and CH_4 plumes from strong point sources and thus, facility-scale emission estimates.

We show results of CO_2 and CH_4 emission plume images from ground-based observations with a NEO HySpex SWIR-384 hyperspectral camera. The camera takes images of sky-scattered sunlight in the shortwave-infrared range (1-2.5 μm) at kilometer distance to point sources. An adapted matched filter retrieval is used to calculate atmospheric enhancements of CO_2 and CH_4 from their 2 μm absorption bands. We present CO_2 emission plumes of a medium-sized power plant (>4.9 MtCO2/yr), which we detect reliably in hourly averaged spectral images. Furthermore, we successfully observed methane plumes from a coal mine shaft in Silesia, Poland, with a temporal resolution of roughly 1 minute, discovering emission dynamics on time scales from minutes to days.

UP 7.4 Thu 12:00 MOL/0213

Ozonmessungen auf der Zugspitze 1978-2020: Woher stammt der Ozonanstieg? — •Thomas Trickl[1], Cédric Couret[2], Ludwig Ries[2] und Hannes Vogelmann[1] — [1]Karlsruher Institut für Technologie, IMK-IFU, Kreuzeckbahnstr. 19, 82467 Garmisch-Partenkirchen — [2]Umweltbundesamt II 4.5, Schneefernerhaus, 82475 Zugspitze

Die Meßserie des troposphärischen Ozons auf der Zugspitze (2962 m) von 1978 bis 2011 zeigt bis 2003 einen deutlichen Konzentrationsanstieg auf, der im Vergleich mit anderen Langzeit-Serien besonders herausragt. Die Erklärung hierfür liegt an einer Zunahme des Absinkens von Stratosphärenluft, die mit einem Austrocknen der freien Troposphäre einhergeht. Kaum verzögert zum Rückgang der Sonnenaktivität seit ca. 20 Jahren hat der Ozonanstieg deutlich abgenommen. Die Messungen am 0.3 km tiefer gelegenen Schneefernerhaus (2660 m) haben die Trendänderung bis 2020 bestätigt. Ferner wurde eine klare Abnahme des troposphärischen CO gefunden, wohingegen der Trend für CO aus der untersten Stratosphäre leicht positiv ist. Die CO-Abnahme bestätigt die Verbesserung der Luftqualität in der Troposphäre.

UP 8: Carbon Cycle & Climate Change

Time: Thursday 14:00–15:15 Location: MOL/0213

Invited Talk UP 8.1 Thu 14:00 MOL/0213

Destabilization of carbon in tropical peatlands by enhanced weathering — •Alexandra Klemme[1], Tim Rixen[2], Moritz Müller[3], Justus Notholt[1], and Thorsten Warneke[1] — [1]Institute of Environmental Physics, University of Bremen — [2]Leibniz Center for Tropical Marine Research, Bremen — [3]Faculty of Engineering, Computing, and Science, Swinburne University of Technology Sarawak Campus

Southeast Asian peatlands represent a globally significant carbon store. Recent land use changes destabilize the peat, causing increased leaching of peat carbon into rivers. Despite resulting high river organic carbon concentrations, field data suggests only moderate carbon dioxide (CO2) emissions from rivers. We offer an explanation for this phenomenon by showing that carbon decomposition is hampered by the low pH in peat-draining rivers, and we find that enhanced input of carbonate minerals increases CO2 emissions by counteracting this pH limitation. One potential source of carbonate minerals to rivers is the application of enhanced weathering, a CO2 removal strategy that accelerates weathering-induced CO2 uptake from the atmosphere via the dispersion of rock powder. The effect of enhanced weathering on peatland carbon stocks is poorly understood. We present estimates for the response of CO2 emissions from tropical peat soils, rivers and coastal waters to enhanced weathering induced changes in soil acidity. The potential carbon uptake associated with enhanced weathering is reduced by 18 – 60 % by land-based re-emission of CO2 and is potentially offset completely by emissions from coastal waters.

Invited Talk UP 8.2 Thu 14:30 MOL/0213

Widespread forest decline in central Europe following three extreme summers in 2018-2020 — •Ana Bastos — Max Planck Institute for Biogeochemistry, Hans Knöll Str 10, 07745 Jena

Among the ten hottest summers in Europe since 1880, only two happened before 2010 (2003 and 2006). In Europe and other temperate regions, summers like 2003 and 2010 were extremely rare in the past, but are projected to happen every few years in the coming decades. Since they are stochastic to some extent, this means such extreme events do not necessarily happen at regular intervals, and they may cluster in time and/or space.

Together with that of 2003, the summers of 2018, and 2019 were exceptionally hot and dry in central Europe. In 2020, drought conditions persisted over a large region. Such a sequence of three exceptionally hot and dry summers is unprecedented in the observation-based record since 1950 and triggered a series of cascading effects that resulted in large-scale forest decline and tree mortality.

It is unclear to which extent this large-scale tree mortality event, driven by three consecutive extreme summers, reveals an anthropogenic fingerprint or whether these could have happened due to natural climate variability and disturbance interactions. This talk will discuss the conceptual and practical challenges of answering this question. Then, recent work addressing different aspects of this question from both data-driven and process-based modeling perspectives will be presented.

UP 8.3 Thu 15:00 MOL/0213

STEPSEC: Update und erste Ergebnisse — •Stefanie Falk für die STEPSEC-Kollaboration — Ludwig-Maximilians-Universität München (LMU)

Um sowohl nationale als auch internationale Klimaschutzziele einhalten zu können und den globalen Temperaturanstieg zu begrenzen, sind massive Reduktionen des CO_2-Ausstoßes notwendig. Da die bisherigen Maßnahmen zur Emissionsreduktion weltweit nicht ausreichend sind, müssen Wege gefunden werden, mehr Treibhausgase zu binden, als ausgestoßen werden. Wir führen eine robuste und vergleichende Bewertung der Potenziale der gängigsten Methoden landgebundener Kohlenstoffdioxidabscheidung (CDR_L) und ihrer Auswirkungen auf das Erdsystem unter der Annahme sozio-ökologischer Randbedingungen durch. Unter Verwendung von drei dynamischen globalen Vegetationsmodellen (DGVMs) vergleichen wir Aufforstung, Waldbewirtschaftung und Bioenergie mit Kohlenstoffabscheidung und -speicherung. Dies erlaubt es das CDR_L-Potenzial mit hohem ökologischen Realismus zu untersuchen. Da gesellschaftliche Zwänge wichtige Hindernisse für die Umsetzung von CDR_L darstellen können, werden auch sozio-ökonomische Gesichtspunkte, basierend auf sozio-ökonomischen Pfaden und agentenbasierten Modellen, für die Landnutzungsentscheidungen Eingang finden.

Diese umfassende und interdisziplinäre Untersuchung von CDR_L Methoden wird eine fundierte Entscheidungsfindung ermöglichen.

Working Group on Accelerator Physics
Arbeitskreis Beschleunigerphysik (AKBP)

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Overview of Invited Talks and Sessions

(Lecture halls HSZ/0304, CHE/0183, and CHE/0184; Poster HSZ OG3)

Sessions

AKBP 1.1–1.7	Mon	16:00–17:45	CHE/0183	**Particle and Photon Sources**
AKBP 2.1–2.7	Mon	16:00–17:45	CHE/0184	**Advanced Light Sources and their Instrumentation**
AKBP 3.1–3.6	Tue	11:00–12:30	GER/038	**Accelerator and Medical Physics (joint session ST/AKBP)**
AKBP 4.1–4.5	Tue	16:30–19:00	CHE/0183	**Plasmas and Lasers**
AKBP 5.1–5.6	Tue	16:30–18:00	CHE/0184	**Hadron Accelerators**
AKBP 6.1–6.3	Wed	11:00–12:30	HSZ/0304	**New Results from Accelerators for Hadron Physics**
AKBP 7.1–7.3	Wed	14:00–15:30	HSZ/0304	**Experiments for Advanced Light Sources**
AKBP 8.1–8.6	Wed	15:45–17:15	CHE/0183	**Advanced IT Tools**
AKBP 9.1–9.6	Wed	15:45–17:15	CHE/0184	**Beam Dynamics I**
AKBP 10.1–10.6	Wed	17:30–19:00	CHE/0183	**Instrumentation I**
AKBP 11.1–11.6	Wed	17:30–19:00	CHE/0184	**RF and SRF Research**
AKBP 12.1–12.3	Thu	11:00–12:30	HSZ/AUDI	**AI Topical Day – Invited Talks (joint session AKPIK/HK/ST/T/AKBP)**
AKBP 13.1–13.2	Thu	14:00–15:30	HSZ/0304	**Preisverleihung des AKBP Nachwuchspreises und des Horst-Klein Preises**
AKBP 14.1–14.7	Thu	15:30–17:15	CHE/0183	**Instrumentation II**
AKBP 15.1–15.7	Thu	15:30–17:15	CHE/0184	**New Accelerator Concepts**
AKBP 16.1–16.17	Thu	15:45–18:30	HSZ OG3	**Poster**
AKBP 17.1–17.5	Thu	17:30–18:45	CHE/0183	**Instrumentation III**
AKBP 18.1–18.5	Thu	17:30–18:45	CHE/0184	**Beam Dynamics II**
AKBP 19	Thu	19:00–20:00	CHE/0091	**Members' Assembly**

Members' Assembly of the Working Group on Accelerator physics

Thursday 19:00–20:00 CHE/0091

- Bericht
- Terminfindung für Symposium „Verleihung der AKBP-Preise 2023“
- Verschiedenes

Sessions

– Invited Talks, Prize Talks, Group Reports, Contributed Talks, and Posters –

AKBP 1: Particle and Photon Sources

Time: Monday 16:00–17:45 Location: CHE/0183

AKBP 1.1 Mon 16:00 CHE/0183

Design of a New Photo and Thermionic Hybrid Mode 50 kV Pulsed Electron Gun for ELSA — •Samuel Kronenberg, Klaus Desch, Daniel Elsner, Dennis Proft, and Philipp Hänisch — Physikalisches Institut der Universität Bonn

For the Linac travelling wave S-band injector at ELSA a new electron gun is being designed, to enhance the beam parameters obtained from the old gun. Furthermore, a new single bunch injection mode is to be realized alongside the standard long pulse (multi bunch) mode, enabling single bunch operations for accelerator research and development in addition to the use for normal operation serving the experimental program. For that a dual-use design is pursued utilizing a caesium dispenser cathode both as photo- as well as thermionic cathode. First steps including the design of the gun assembly and studies about its usability as a photoemitter are conducted. A preliminary design of the gun is presented.

AKBP 1.2 Mon 16:15 CHE/0183

Automated Activation Procedure for GaAs Photocathodes at Photo-CATCH* — •Maximilian Herbert, Tobias Eggert, Joachim Enders, Markus Engart, Yuliya Fritzsche, and Vincent Wende — Technische Universität Darmstadt, Fachbereich Physik, Institut für Kernphysik, Schlossgartenstr. 9, 64289 Darmstadt

Photo-electron sources using GaAs-based photocathodes are used to provide high-brightness and high-current beams of spin-polarized electrons for accelerator applications such as ERLs. Such cathodes require a thin surface layer consisting of Cs and an oxidant in order to achieve negative electron affinity (NEA) for efficient photoemission. The layer is deposited during a so-called activation procedure, whose performance greatly influences the resulting quantum efficiency η of the photocathode and robustness of the layer. An automatization of the activation procedure could simplify and accelerate this process, indipendent from expert input, for operational use in an accelerator. At TU Darmstadt, the dedicated test stand Photo-CATCH is available for GaAs photocathode research. The components of its activation chamber are remote-controlled using EPICS. This contribution will present recent proof-of-principle studies of a basic automated activation procedure at Photo-CATCH. Using a co-deposition scheme with Cs and O_2, several automated activations have been performed. A good reproducibility of η has been observed, with a slight reduction in mean η compared to manual activation.

*Work supported by DFG (GRK 2128 AccelencE, project number 264883531) and BMBF (05H18RDRB1)

AKBP 1.3 Mon 16:30 CHE/0183

Multi-alkali antimonide photocathodes for highly brilliant electron beams — •Chen Wang[1,2], Sonal Mistry[1], Julius Kühn[1], and Chen Wang[1,3] — [1]HZB, Berlin, Germany — [2]University of Siegen, Institute for Materials Engineering, Siegen, Germany — [3]Humboldt University of Berlin, Berlin, Germany

One important goal at the SEALab facility is to bring an innovative superconducting radio-frequency photoelectron injector into operation. As the electron source in the injector, a photocathode with high quantum efficiency (QE) and long operation lifetime is required. The family of multi-alkali antimonide photocathodes deposited on Mo substrate is chosen for this application due to its high QE (>1%) at visible wavelengths and good thermal conductivity. Currently, Na-K-Sb photocathodes are produced in a UHV preparation chamber at the photocathode lab of HZB. The influence of deposition parameters is studied to optimize the growth procedure and to achieve high stability at high operational temperatures as expected in the photoinjector. X-ray photoemission spectroscopy (XPS) and QE measurements are performed, and the correlation between chemical composition and QE value are presented in this contribution.

AKBP 1.4 Mon 16:45 CHE/0183

Development of Multi-alkali antimonides photocathodes for high brightness photoinjectors — •Sandeep Mohanty[1], Mikhail Krasilnikov[1], Anne Oppelt[1], Frank Stephan[1], Daniele Sertore[2], Laura Monaco[2], Carlo Pagani[3], and Wolfgang Hillert[4] — [1]DESY Zeuthen, Germany — [2]Istituto Nazionale di Fisica Nucleare - LASA, Segrate, Italy — [3]Università degli Studi di Milano & INFN, Segrate, Italy — [4]University of Hamburg

Multi-alkali antimonide photocathodes can have high quantum efficiency similar to UV-sensitive (Cs2Te) photocathodes, but with the advantages of photoemission sensitivity in the green wavelength and a significant reduction in the mean transverse energy of photoelectrons. In order to optimize and better understand the photo emissive film properties of KCsSb photocathodes, a batch of two photocathodes with different thicknesses was grown on molybdenum substrates via a sequential deposition method in a new preparation system at INFN LASA. During the deposition, a "multi-wavelengths" diagnostic, i.e. the measurements of the real-time photocurrent and reflectivity at different wavelengths (in the range from 254 nm - 690 nm) has been applied.The optical spectra of these semiconductors provide a rich source of information on their electronic properties.In this report, we present and discuss the experimental results obtained from the two different thickness KCsSb photocathodes, along with the effect of Sb thickness on the cathode's properties.

AKBP 1.5 Mon 17:00 CHE/0183

Investigation of structural changes in Ti-6Al-4V via high energy X-ray diffraction caused by fast cyclical heating — •Tim Lengler[1,2], Dieter Lott[2], Gudrid Moortgat-Pick[1,3], and Sabine Riemann[4] — [1]Universität Hamburg, Hamburg, Deutschland — [2]Helmholtz-Zentrum Hereon, Geesthacht, Deutschland — [3]DESY, Hamburg, Deutschland — [4]DESY, Zeuthen, Deutschland

For the planned International Linear Collider (ILC) a material for the positron source target is required which can withstand the high energy deposition needed for a high luminosity positron source. To distribute the load and keep the target at a reasonable temperature, the target is rotated with high velocity. Therefore, the material needs not only withstand the cyclical thermal load but also the simultaneous mechanical load. In this work, the behaviour of the material Ti-6Al-4V, which is considered as an appropriate target material, was studied via high energy X-ray diffraction during a cyclical heating process to gain information about changes in the crystal structure and consequently phase fractions. The material was heated homogeneously via induction to temperatures between 300 °C and 800 °C with heating rates of 100 °C/s and cooling rates in the range of 25 °C/s and 100 °C/s. Here, the influence of the maximum and minimum temperature as well as the cooling rate was investigated. The lattice parameter of the β phase turns out to be the most sensitive parameter that correlates to the changes in phase fractions at higher temperatures and thus provides a valuable reference for experiments at the Microtron MAMI, where Ti-6Al-4V targets will be irradiated by high energy electron beams.

AKBP 1.6 Mon 17:15 CHE/0183

Computational homogenisation of laminated yokes in finite-element models of fast-ramped orbit corrector magnets — Jan-Magnus Christmann[1], Moritz von Tresckow[1], •Herbert De Gersem[1], Alexander Aloev[2], Sajjad H. Mirza[2], Sven Pfeiffer[2], and Holger Schlarb[2] — [1]TEMF, TU Darmstadt, Germany — [2]DESY, Hamburg, Germany

Fast corrector magnets need to be equipped with iron yokes to keep their inductance sufficiently low. Even iron stacks with thin laminates suffer from relevant eddy-current losses at elevated frequencies, causing Joule losses and invoking a time delay between excitation current and aperture field. Resolving the individual laminates within a finite-element model is not feasible. Instead, computational homogenisation is applied. The lamination stack is modelled as a bulk part and represented by an anisotropic and frequency-dependent surrogate material. This contribution illustrates the validity of this approach. The correction magnets planned for the fast orbit feedback system of PETRA IV at DESY serve as an example.

AKBP 1.7 Mon 17:30 CHE/0183

The Merit of a Thomson backscattering based Gamma Source at MESA. — •Christoph Lorey[1] and Atoosa Meseck[1,2] — [1]Johannes Gutenberg Universität, Mainz, Germany — [2]Helmholtz Zentrum Berlin, Berlin, Germany

The Mainz Energy-recovering Superconducting Accelerator (MESA), currently under construction at the Johannes Gutenberg University (JGU) in Mainz, will offer two modes of operation, one of which is an energy-recovering (ER) mode in order to deliver electron beams of up to 155 MeV to two experiments. As an ERL, MESA, with it's high brightness electron beam, is a promising accelerator for supplying a Thomson back scattering based Gamma source. Furthermore, at MESA, the polarization of the electron beam can be set by the injector. We will present the first results of our performance studies for a Thomson backscattering based gamma source at MESA. Different polarization scenarios will be discussed considering a selection of laser and MESA configurations.

AKBP 2: Advanced Light Sources and their Instrumentation

Time: Monday 16:00–17:45 Location: CHE/0184

AKBP 2.1 Mon 16:00 CHE/0184

Powering test results of HTS undulator prototype coils for compact FELs at 4.2 K — •Sebastian C. Richter[1,2], Andreas W. Grau[3], David Saez de Jauregui[3], Amalia Ballarino[2], Axel Bernhard[1], and Anke-Susanne Müller[1,3] — [1]LAS, KIT, Karlsruhe — [2]CERN - 1211 Geneva 23 - Switzerland — [3]IBPT, KIT, Karlsruhe

Short-period and high-field undulators are crucial for the production of coherent light up to X-rays in compact free-electron lasers (FELs). Besides, future colliders like CLIC or FCC-ee demand high-field damping wigglers to reach a low beam emittance. Both applications may benefit from the use of high-temperature superconductors (HTS): magnetic field amplitudes in the range of 2 T become feasible for short periods of 15 mm and smaller with magnetic gaps of 6 mm at 4.2 K. Moreover, potential operation at higher temperatures may relax cryogenic requirements and reduce operational costs. This contribution presents and discusses the powering test results of several HTS undulator prototype coils, designed and manufactured at CERN, made from coated ReBCO tape superconductor. The coil set-up was already described in previous works and is based on non-insulated vertical racetracks with a period length of 13 mm, assembled with iron poles. Powering tests at 4.2 K were performed at KIT to explore the operation at high current densities (2 kA/mm^2) and the produced magnetic fields in the iron pole gap.

AKBP 2.2 Mon 16:15 CHE/0184

Spectro-temporal Properties of Coherently Emitted Radiation Pulses at DELTA — •Arjun Radha Krishnan[1], Benedikt Büsing[1], Shaukat Khan[1], Carsten Mai[1], Wa'el Salah[2], Zohair Usfoor[1], and Vivek Vijayan[1] — [1]Center for Synchrotron Radiation (DELTA), TU Dortmund, Dortmund, Germany — [2]The Hashemite University, Zarqa, Jordan

The short-pulse facility at the 1.5 GeV synchrotron light source DELTA, operated by the TU Dortmund University, employs the seeding scheme coherent harmonic generation (CHG) to produce ultrashort pulses in the vacuum ultraviolet and terahertz regime. Since the properties of the CHG radiation are based on the laser-induced energy modulation and the microbunching process, the spectral and temporal properties of the CHG pulses can be controlled by tuning the laser chirp and the strength of the dispersive chicane. The CHG spectra at several harmonics of the 800 nm seed laser were recorded using an image-intensified CCD camera and an XUV spectrometer for different seed laser chirps and chicane strengths. Convolutional neural networks were employed to fit the observed spectra with the simulations and extract the spectral phase information of the seed laser, taking the higher-order spectral phase of the seed pulse into consideration.

AKBP 2.3 Mon 16:30 CHE/0184

Highlights from seeded FEL@PITZ — •Georgi Georgiev — DESY Zeuthen

First results from a proof-of-principle experiment for a high-power accelerator-based THz source were obtained last year at the Photo Injector Test Facility at DESY in Zeuthen (PITZ). The THz source is an extension to the linac facility and it is based on a single LCLS-I undulator. A part of the research program includes studies on seeding methods for the FEL to improve the shot-to-shot stability of the THz pulses from what is expected from the self-amplified spontaneous emission (SASE) mode of operation. Several methods to achieve seeding are studied in simulation including pre-bunched electron beams, external radiation pulse and a super-radiant spike on top of the beam. Experimental measurements demonstrating the seeding effects from a pre-bunched electron beam are presented and discussed.

AKBP 2.4 Mon 16:45 CHE/0184

Wakefield Study for a PCB-Based Arrival-Time Pickup for Electron Accelerators — •Bernhard Erich Jürgen Scheible[1,2], Marie Kristin Czwalinna[3], Holger Schlarb[3], Wolfgang Ackermann[2], Herbert De Gersem[2], and Andreas Penirschke[1] — [1]Technische Hochschule Mittelhessen, Wilhelm-Leuschner-Str. 13, 61169 Friedberg, Germany — [2]Technische Universität Darmstadt, Karolinenplatz 5, 64289 Darmstadt, Germany — [3]Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany

Many scientific applications utilize large-scale electron accelerators, e.g., for imaging in free-electron laser facilities such as the European XFEL or FLASH. Precise timing information is necessary for stable operation or to control and evaluate experiments. With growing demands on the accuracy of beam diagnostics especially with smaller bunch-charges, it is unavoidable that monitoring concepts significantly affect the beam. To prevent this interaction from becoming intolerable, it is necessary to quantify and compare it with existing state-of-the-art structures. In this contribution the wake loss factor of a pickup structure based on a printed circuit board is determined in electromagnetic simulations and compared to the pickups of the European XFEL.

AKBP 2.5 Mon 17:00 CHE/0184

Towards Fiber-Optics-Guided Synchrotron Radiation-Based Longitudinal Beam Diagnostics at the KARA Booster Synchrotron — •Marvin-Dennis Noll[1], Johannes L. Steinmann[1], Dima El Khechen[2], Christian Goffing[1], Christina Widmann[1], Erik Bründermann[1], and Anke-Susanne Müller[1] — [1]IBPT, KIT, Karlsruhe — [2]LAS, KIT, Karlsruhe

Before injection into the Karlsruhe Research Accelerator (KARA), the electron storage ring of the KIT Light Source, the beam energy is ramped up from 53 MeV to 500 MeV by a booster synchrotron. The whole booster is located in a concrete enclosure inside the storage ring and thus not accessible during operation. For the study of longitudinal beam dynamics, a cost-effective solution to leverage the synchrotron radiation emitted at the booster bending magnets is desired. To ensure durability of the setup and to not obstruct the removable concrete ceiling of the booster enclosure, it is required to place the radiation-sensitive readout electronics outside of the booster enclosure and outside of the storage ring. In this contribution, a fiber-optic setup consisting of commercially available optical components, such as collimators, optical fibers and high bandwidth photodetectors are used. As a proof-of-concept, we present experimental results of different components characterized at the visual light diagnostics port of the storage ring KARA. In addition, we report on further improvements of the setup along with planned future experiments.

AKBP 2.6 Mon 17:15 CHE/0184

Simulation Studies on a High-Gain XUV FEL Oscillator at FLASH — •Margarit Asatrian[1], Georgia Paraskaki[2], Velizar Miltchev[1], and Wolfgang Hillert[1] — [1]University of Hamburg, 22761 Hamburg, Germany — [2]Deutsches Elektronen-Synchrotron DESY, 22607 Hamburg, Germany

Externally seeded high-gain FELs can generate fully coherent radiation with high shot-to-shot stability. With the application of harmonic conversion schemes, these qualities can be achieved at wavelengths down to the soft X-Ray range. However, at the moment, such FEL schemes aimed at the generation of short-wavelength radiation are limited in their repetition rate by the suitable seed laser sources and thus are unable to operate at the full repetition rate of superconducting machines. Cavity-based FELs have been proposed as a possible solution that would allow the generation of short-wavelength, fully coherent FEL radiation at high repetition rates. We present simulation studies for such a high-gain FEL oscillator, which is planned to be implemented at FLASH. The setup is aimed to operate at the repetition rate of 3 MHz, generating fully coherent radiation at the wavelength of 13.5 nm. The electron beam bunched at 13.5 nm can be further used in a harmonic conversion scheme to generate fully coherent radiation at much shorter wavelengths.

AKBP 2.7 Mon 17:30 CHE/0184

Advanced applications of laser heaters — •Linus Bölte[1], Philipp Amstutz[2], Christopher Gerth[2], Shaukat Khan[1], and Carsten Mai[1] — [1]Center for Synchrotron Radiation (DELTA), TU Dortmund University, Dortmund, Germany — [2]Deutsches Elektronen Synchrotron DESY, Hamburg Germany

Many FEL facilities use laser heaters to increase the electron energy spread and hence suppress microbunching instabilities. As part of the FLASH2020+ upgrade at DESY, a laser heater has been installed upstream of the first bunch compressor chicane. The goal of the FLASH Laser-Assisted Reshaping of Electron bunches (FLARE) project is to implement energy modulation schemes expanding the laser heater's basic purpose. This includes intentionally overheating regions of the electron bunch, as well as an up to now untested bunch compression method that will allow the generation of tunable few-femtosecond and possibly sub-femtosecond electron distributions. First studies on advanced applications of the laser heater will be presented.

AKBP 3: Accelerator and Medical Physics (joint session ST/AKBP)

Time: Tuesday 11:00–12:30 Location: GER/038

AKBP 3.1 Tue 11:00 GER/038

Real-time analysis for a scintillating fiber-based ion beam profile monitor — •Liqing Qin, Qian Yang, and Blake Leverington — Physikalisches Institut, Heidelberg, Germany

For raster scanning of a pencil beam during ion beam therapy, it is necessary to monitor the beam in real-time for safety and quality reasons.

A scintillating fiber-based beam profile monitor developed from LHCb fiber winding techniques will offer real-time information of the pencil beam parameters, including position, width, and intensity, with a readout rate of up to 10 kHz.

The preliminary reconstruction algorithm for a Gaussian-like beam is being implemented on an FPGA. Preliminary results of the reconstruction algorithm performance on the FPGA will be presented.

AKBP 3.2 Tue 11:15 GER/038

Application of HV-CMOS sensor in a position monitoring system for therapeutic ion beams — •Bogdan Topko[1], Matthias Balzer[2], Alexander Dierlamm[1,2], Felix Ehrler[2], Ulrich Husemann[1], Roland Koppenhöfer[1], Ivan Perić[2], Martin Pittermann[1], and Alena Weber[2,3] — [1]Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT) — [2]Institute for Data Processing and Electronics (IPE), KIT — [3]now with Bosch AG

Cancer treatment with ion beams provides critical advantages compared to the photon irradiation approach. The Bragg peak of the ion energy deposition near the end of the particle range allows to deposit the maximum of energy to the tumor and minimize the damage of healthy tissue. The beam position and size can be precisely controlled by the beam delivery system. In order to provide effective and safe dose delivery to the tumor, a fast and reliable beam monitoring system is required. The studies presented in this talk are focused on the application of HV-CMOS sensors for such a beam monitoring system. This system should provide information about beam position, shape and fluence in real time. It should work under beam intensities up to 10^{10} s^{-1} and deliver fluence information every 1-2 μs. In order to fulfill the timing requirements, the HitPix chip family with counting electronics and frame based readout has been developed at the ASIC and Detector Lab (IPE, KIT). Recent measurements with ion beams and a multi-chip matrix as well as future developments are discussed.

AKBP 3.3 Tue 11:30 GER/038

Medical irradiation simulations for IBPT accelerators — •Katharina Mayer[1], Erik Bründermann[1], Alfredo Ferrari[3], Michael J. Nasse[1], Markus Schwarz[1], and Anke-Susanne Müller[1,2] — [1]IBPT, KIT, Karlsruhe — [2]LAS, KIT, Karlsruhe — [3]IAP, KIT, Karlsruhe

An important cancer treatment method used in oncology is radiation therapy, in which the tumor is irradiated with ionizing radiation. In recent years, the study of the beneficial effects of short intense radiation pulses (FLASH effect) or spatially fractionated radiation (Microbeam) have become an important research field. Systematic studies of this type often require non-medical accelerators capable of producing the requested short intense pulses. At KIT, the Ferninfrarot Linac- und Testexperiment (FLUTE) can produce ultra-short electron bunches and the KIT storage ring KARA (Karlsruher Research Accelerator) is a source of pulsed X-rays. Both can be used as pulsed high-energy radiation sources and compared to conventional X-ray tubes. In this contribution, first dose simulations for FLUTE using the Monte Carlo simulation program FLUKA are presented.

AKBP 3.4 Tue 11:45 GER/038

Dose Simulation of Ultra-High Energy Electron Beams for Novel FLASH Radiation Therapy Applications — •Kelly Grunwald, Klaus Desch, Daniel Elsner, Dennis Proft, and Leonardo Thome — Physikalisches Institut der Universität Bonn

The electron stretcher facility ELSA delivers up to 3.2 GeV electrons to external experimental stations. In a new setup the irradiation of tumor cells inside a water volume with doses of up to 50 Gy by ultra-high energy electrons (UHEE) in time windows of microseconds up to milliseconds (FLASH) is currently investigated. This technique may enable highly efficient treatment of deep-seated tumors alongside optimal sparing and protection of healthy tissue. Along the effort to measure the dose with a suitable detector, our approach is to determine the optimal dose distribution by simulations. Therefore, the electromagnetic shower process is simulated in Geant4, taking the extracted electron pulse properties into account. A virtual water volume is constructed of voxels of different sizes for precise investigation in the volume of interest. Various properties such as particle types, deposited energy and the energy spectra of the particle shower can be extracted and correlated to relative and absolute dose measurements at the real water phantom. The method and first results will be presented.

AKBP 3.5 Tue 12:00 GER/038

Evaluation of Measuring Techniques to Determine the Applied Dose of Ultra-High Energy Electorn Beams in Cell Samples for FLASH Therapy — •Leonardo Thome, Klaus Desch, Daniel Elsner, Dennis Proft, and Kelly Grunwald — Physikalisches Institut der Universität Bonn

The electron accelerator facility ELSA delivers up to 3.2 GeV electrons. Ultra-high energy electrons (UHEE) in short pulses of microseconds up to milliseconds (FLASH) are used to investigate the effect of UHEE on tumor cells. This may enable highly efficient treatment of deep-seated tumors due to the FLASH effect. Currently, in a preliminary setting the Booster-Synchrotron is used to deliver electrons of 1.2 GeV energy, to irradiate cell samples placed in a water phantom. A precise dose determination is necessary to monitor the efficacy of the biological effect. Therefore, the usability of different detector types for a precise dose determination is evaluated.

AKBP 3.6 Tue 12:15 GER/038

Dosimetry tests for FLASH RT at PITZ — •Felix Riemer, Zakaria Aboulbanine, Gowri Adhikari, Zohrab Amirkhanyan, Namra Aftab, Prach Boonpornprasert, Georg Georgiev, Anna Grebinyk, Andreas Hoffmann, Mikhail Krasilnikov, Xiangkun Li, Anusorn Lueangaramwong, Raffael Niemczyk, Houjun Qian, Chris Richard, Frank Stephan, Grygorii Vashchenko, Tobias Weilbach, and Steven Worm — Deutsches Elektronen-Synchrotron DESY, Platanenallee 6, 15738 Zeuthen, Germany

The Photo Injector Test facility at DESY in Zeuthen (PITZ) can provide unique beam parameters regarding delivered dose and dose rate. With an average dose rate of up to 10^7 Gy/s and peak dose rates of up to $4 \cdot 10^{13}$ Gy/s, PITZ is fully capable of FLASH radiation therapy. Nevertheless, dosimetry is a major challenge. Traditional detectors cannot provide reliable measurements and linearity up to such high dose rates. A new setup is being built to create a test infrastructure for all kinds of detectors. This includes a completely new beamline exclusively for FLASH RT and biology experiments. The goal is to develop and test detectors (also from external users) which cover the whole range of dose rates available at PITZ. First dosimetry experiments using Gafchromic films were done in air and water. Dose rate linearity and a limit test of the films were done. Beam parameters like beam profile, dose depth profile in water, homogeneity and dark current were measured. First detector tests will be done using silicon sensors utilized in high energy physics experiments.

AKBP 4: Plasmas and Lasers

Time: Tuesday 16:30–19:00 Location: CHE/0183

Group Report AKBP 4.1 Tue 16:30 CHE/0183

Large Energy Depletion of a Beam Driver in a Plasma-Wakefield Accelerator — •Felipe Peña[1,2], Carl A. Lindstrøm[1,3], Judita Beinortaite[1,4], Jonas Björklund Svensson[1], Lewis Boulton[1,5,6], Severin Diederichs[1,2], James M. Garland[1], Pau González Caminal[1,2], Gregor Loisch[1,2], Sarah Schröder[1], Maxence Thévenet[1], Stephan Wesch[1], Jonathan Wood[1], Jens Osterhoff[1], and Richard D'Arcy[1] — [1]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [2]Universität Hamburg, Germany — [3]University of Oslo, Norway — [4]University College London, UK — [5]SUPA, University of Strathclyde, Glasgow, UK — [6]The Cockcroft Institute, Daresbury, UK

Beam-driven plasma-wakefield acceleration has the potential to reduce the size and construction cost of large-scale accelerator facilities, by providing accelerating fields orders of magnitude greater than that of conventional accelerating structures. Affordable running costs require demonstration of high energy-transfer efficiency from the wall-plug to the accelerated bunch. For this, drive bunches must be efficiently produced, strong decelerating fields must be sustained for the drive bunches until their energy is depleted, and the resulting accelerating fields must be strongly beam loaded by the trailing bunches. Here we address the second of these points, showing measurements using a 500 MeV drive bunch where (50±7)% of its total energy is deposited into a 20 cm long plasma. This level of energy-transfer efficiency demonstrates that plasma accelerators hold the potential to become competitive with conventional accelerators.

Group Report AKBP 4.2 Tue 17:00 CHE/0183

SPEED: Worldwide first implementation of the EEHG scheme at a storage ring — •Zohair Usfoor[1], Benedikt Büsing[1], Arne Held[1], Shaukat Khan[1], Carsten Mai[1], Arjun Radha Krishnan[1], Wa'el Salah[1,2], and Vivek Vijayan[1] — [1]Center for Synchrotron Radiation (DELTA), TU Dortmund University, Dortmund, Germany — [2]The Hashemite University, Zarqa, Jordan

At DELTA, a 1.5-GeV synchrotron radiation source at TU Dortmund University, the CHG (coherent harmonic generation) scheme is employed to generate ultrashort radiation pulses. In CHG, the interaction of electron bunches with laser pulses in a first undulator (modulator) causes a periodic electron energy modulation. A chicane then induces a density modulation, giving rise to coherent emission of ultrashort pulses at harmonics of the seed laser in a second undulator (radiator). A reconfiguration of the U250 device that incorporated the two undulators and the chicane went underway in summer 2022 to demonstrate EEHG (echo-enabled harmonic generation, originally proposed for linac-based free-electron lasers) at a storage ring and to enable the generation of higher harmonics. The coils of the U250 were rewired to create two modulators for a twofold laser-electron interaction, two chicanes for the manipulation of the electron density, and a radiator, with only a few undulator periods comprising each section. The produced EEHG pulses are detected by an in-vacuum grating spectrometer. Initial results are presented. To our knowledge, this is the first attempt worldwide to successfully apply EEHG at a storage ring.

Group Report AKBP 4.3 Tue 17:30 CHE/0183

High-temperature superconductor undulators and magnets for the future compact light sources — •Samira Fatehi, Axel Bernhard, and Anke-susanne Müller — Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

In this contribution, an overview of the ongoing projects at KIT on the high-temperature superconductor (HTS) undulators and magnets is given, and the research on beam dynamics and magnet design of a laser-plasma accelerator-based, miniature beam transport line using HTS novel periodic magnets is presented in detail. In laser-plasma accelerators (LPA), due to extremely high accelerating gradients, electron bunches are accelerated to high energies in only a few millimeters to centimeters of acceleration length. To efficiently capture and transport the LPA-generated bunches in a compact transport line, beam line designs employing high-strength combined-function magnets based on high-temperature superconductor technology have been studied. Moreover, to overcome coil winding challenges in fabricating miniature HTS magnets, novel periodic magnets have been designed, which can collimate and guide the electron beams in a well-controlled short-length transport line. The designed transport line has a length of 1.4 m matching the beam optics parameters of the LPA-generated electron beams to the transverse-gradient undulator (TGU) requirements.

Group Report AKBP 4.4 Tue 18:00 CHE/0183

Status Of Plasma Diagnostics On The Prototype Plasma Lens For Optical Matching At The ILC e+ Source — •Niclas Hamann[1], Gregor Loisch[2], Manuel Formela[1], Kai Ludwig[2], Jens Osterhoff[2], and Gudrid Moortgat-Pick[1,2] — [1]Uni Hamburg — [2]DESY Hamburg

In recent years, high-gradient, symmetric focusing with active plasma lenses has regained significant interest due to its potential advantages in compactness and beam dynamics compared to conventional focusing elements. A promising application could be optical matching of highly divergent positrons from the undulator-based ILC positron source into the downstream accelerating structures to increase the positron yield. In a collaboration between University Hamburg and DESY Hamburg a downscaled prototype for this application has been developed. Here, we present first plasma diagnostics results, such as discharge current stability, electron density distribution and reproducibility. Additionally, future plans for measuring the magnetic field distribution and a possible fullscale prototype will be discussed.

Group Report AKBP 4.5 Tue 18:30 CHE/0183

Multi-turn ERL mode of the S-DALINAC* — •Manuel Dutine, Michaela Arnold, Jonny Birkhan, Adrian Brauch, Jochim Enders, Marco Fischer, Ruben Grewe, Lars Juergensen, Maximilian Meier, Norbert Pietralla, Felix Schliessmann, Dominic Schneider, Merle Seeger, Alexander Smuskin, and Manuel Steinhorst — Institut für Kernphysik, Technische Universität Darmstadt

The superconducting Darmstadt linear accelerator S-DALINAC is a thrice-recirculating accelerator for electrons supporting a variety of experimental programs in nuclear physics and nuclear photonics. Besides the conventional acceleration scheme, it can also be operated as an energy-recovery linac (ERL) [1] and contributes to research on this exciting topic of technology development. The world-wide first successful operation as a superconducting multi-turn ERL has been demonstrated in August 2021 [2]. A variety of projects address further developments, for instance, dedicated diagnostics to measure the position of two beams in the same beamline, simultaneously, or to resolve its time structure, have been used for first measurements. This contribution gives an overview of their status. [1] M. Arnold et al., First operation of the superconducting Darmstadt linear electron accelerator as an energy recovery linac, Phys. Rev. Accel. Beams 23, 020101 (2020) [2] F. Schliessmann et al., Realization of a multi-turn energy-recovery accelerator, Nat. Phys. (in press). *Work supported by DFG (GRK 2128), BMBF (05H21RDRB1), the State of Hesse within the Research Cluster ELEMENTS (Project ID 500/10.006) and the LOEWE Research Group Nuclear Photonics.

AKBP 5: Hadron Accelerators

Time: Tuesday 16:30–18:00 Location: CHE/0184

AKBP 5.1 Tue 16:30 CHE/0184

Broadband laser cooling of stored relativistic bunched ion beams at the ESR — •Sebastian Klammes[1], Lars Bozyk[1], Michael Bussmann[2,3], Noah Eizenhöfer[4], Volker Hannen[5], Max Horst[4], Daniel Kiefer[4], Nils Kiefer[6], Thomas Kühl[1,7], Benedikt Langfeld[4,9], Xinwen Ma[8], Wilfried Nörtershäuser[4,9], Rodolfo Sánchez[1], Ulrich Schramm[3,10], Mathias Siebold[2], Peter Spiller[1], Markus Steck[1], Thomas Stöhlker[1,7,11], Ken Ueberholz[5], Thomas Walther[4,9], Hanbing Wang[8], Weiqiang Wen[8], Daniel Winzen[5], and Danyal Winters[1] — [1]GSI Darmstadt — [2]HZDR Dresden — [3]Casus Görlitz — [4]TU Darmstadt — [5]Uni Münster — [6]Uni Kassel — [7]HI Jena — [8]IMP Lanzhou — [9]HFHF Darmstadt — [10]TU Dresden — [11]Uni-Jena

High-precision experiments at heavy-ion storage rings strongly benefit from cold ion beams, i.e. beams with a small relative longitudinal momentum spread ($\Delta p/p$) and a small emittance (ϵ). Especially for the higher ion intensities and Lorentz factors (γ) at FAIR (SIS100), laser cooling has proven to be a powerful tool for cooling of relativistic bunched ion beams. The principle is based on resonant absorption (photon momentum & energy) in the longitudinal direction and subsequent spontaneous random emission (fluorescence & ion recoil) by the ions, combined with a moderate bunching of the ion beam. We will report on results from a 2021 laser cooling beamtime at the ESR, where we could demonstrate for the first time broadband laser cooling of relativistic bunched C^{3+} ions using a new pulsed UV laser system with a very high repetition rate, tunable pulse duration, and high power.

AKBP 5.2 Tue 16:45 CHE/0184

Tumor irradiation in mice with a laser-accelerated proton beam — •Florian Kroll[1], Florian-Emanuel Brack[1], Elke Beyreuther[1,2], Thomas Cowan[1,3], Leonhard Karsch[1,2], Josefine Metzkes-Ng[1], Jörg Pawelke[1,2], Marvin Reimold[1,3], Ulrich Schramm[1,3], Tim Ziegler[1,3], and Karl Zeil[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]OncoRay - National Center for Radiation Research in Oncology, Dresden, Germany — [3]Technische Universität Dresden, Dresden, Germany

Oncological studies identified beneficial properties of radiation applied at dose rates considerably exceeding the clinical standard of 1 Gy/min. At the Draco PW laser of Helmholtz-Zentrum Dresden-Rossendorf, a laser-driven proton research platform enables research on ultra-high dose rate effects for diverse user-specific small animal models.

Tunable single-shot doses are applied to mm-scale volumes on ns time scales, resulting in instantaneous dose rates around 10^9 Gy/s. Dose distributions that uniformly cover the sample volume were generated from individual broad-band proton bunches provided by our laser-driven source with unprecedented stability and long-term reliability. Maximum proton energies regularly exceeded 60 MeV.

We conducted the first radiobiological in vivo study with laser-driven protons using human tumors in a mouse model. We show the concerted preparation of mice and laser accelerator, the dose-controlled, tumor-conform irradiation using a laser-driven as well as a clinical reference proton source, and the radiobiological evaluation of irradiated and unirradiated mice for radiation-induced tumor growth delay.

AKBP 5.3 Tue 17:00 CHE/0184

Update on the Future Neutron Beam Line at the Bonn Isochronous Cyclotron — •Maximilian Loepke, Reinhard Beck, Dieter Eversheim, and Dennis Sauerland — Helmholtz-Institut für Strahlen- und Kernphysik Bonn

The Bonn Isochronous Cyclotron provides a beam of protons, deuterons, α-particles or other light ions with a mass-to-charge ratio $\geq 1/2$ with a kinetic energy ranging from 7 to 14 MeV per nucleon. Since 2019, a proton beam is utilized for irradiation of e.g. silicon pixel detectors for radiation hardness studies.

It is planned to extend the facility's irradiation and experimentation capabilities by providing a neutron beam in the near future. The neutrons are produced by splitting-up deuterons into protons and neutrons in a thick carbon or beryllium converter. Protons are stopped in the converter whereas the neutrons' flux and angular energy distribution is optimized by a subsequent copper/tungsten collimator. After collimation, the neutron beam can be utilized to irradiate a target.

The transversal dimension, yield and energy distribution of the neutron beam has been estimated for different collimator geometries using simulations with *Geant4* to optimize for radiation hardness tests.

This talk gives a conceptual overview of the future experimental area and results of the simulations are presented.

AKBP 5.4 Tue 17:15 CHE/0184

Standalone Readout for Mimosis-Sensors of the MVD. — •Benedikt Gutsche for the CBM-Collaboration — Goethe University Frankfurt

The Micro-Vertex-Detector (MVD) is a four-layer layer pixel detector and the first detector stage of the CBM experiment. Besides dedicated sensors (MIMOSIS), a fast and robust readout is necessary in order to handle the data in a proper way. In the prototyping phase of the detector and for sensor evaluation, a test system with smaller capabilities regarding the number of read-out sensors has been developed. This enables the use of a much simpler FPGA-based system. We chose the TRB platform and existing software framework, originally developed for HADES at GSI. We are going to show how automated tests of sensors can be implemented, in order to provide important information like the dead pixel count or the behaviour of DACs, using TRB-Software and root-based analysis applications (DABC, Go4) . This work has been supported by BMBF (05P21RFFC2) and GSI.

AKBP 5.5 Tue 17:30 CHE/0184

Upgrade of the Beam Preparation System of the Bonn Isochronous Cyclotron — •Béla Daniel Knopp[1], Reinhard Beck[1], Paul-Dieter Eversheim[1], Dennis Sauerland[1], and Pascal Wolf[2] — [1]Helmholtz-Institut für Strahlen- und Kernphysik — [2]SiLab, Physikalisches Institut, Universität Bonn

With the Bonn Isochronous Cyclotron either protons, deuterons, alpha particles or other light ions with a charge-to-mass ratio $\geq 1/2$ are accelerated to a kinetic energy ranging from 7 to 14 MeV per nucleon. The extracted beam is guided to one of five experimental sites via a high-energy beamline.

To ensure a controlled beam transport via this beamline, the beam is stabilized in angle and position by the beam preparation system after extraction from the cyclotron. This is achieved by fixating the beam position in two consecutive locations. Using pairs of adjustable scrapers which are symmetrically aligned horizontally and vertically around the design orbit one can deduce the relative beam position in the transversal plane. This is done by comparing the beam scrape-off current at the scrapers when the beam is passing between them. Using the relative beam position as feedback for a control loop, the respective beam deviation from the design orbit can be minimized by using dedicated corrector magnets.

In this talk, the design and development of a new digital readout and control of the beam preparation system, which replaces the current analog one, will be presented.

AKBP 5.6 Tue 17:45 CHE/0184

Kaon beam studies employing coventional hadron beam concepts at the CERN M2 beam line for the future AMBER experiment — •Fabian Metzger[1,2], Dipanwita Banerjee[2], Johannes Bernhard[2], Lau Gatignon[3], Alexander Gerbershagen[4], Bernhard Ketzer[1], Laurence James Nevay[2], and Silvia Schuh[2] — [1]Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany — [2]CERN, Geneva, Switzerland — [3]Lancaster University, Lancaster, United Kingdom — [4]University of Groningen, Particle Therapy Research Center, Netherlands

As a part of its rich proposed future physics programme, the AMBER (NA66) experiment aims to measure the inner structure and the excitation spectra of mesons with open strangeness with a high-intensity kaon beam at the CERN secondary beam line M2. One way to identify the small fraction of kaons in the available beam is tagging with the help of differential Cherenkov detectors (CEDARs), which are blind to other particles and whose detection efficiency depends critically on the beam parallelism.

In this contribution, we discuss possible improvements of the conventional beam optics to achieve a better performance of the CEDARs for the AMBER programme with hadron beams, in particular for the planned Drell-Yan and diffractive measurements. We focus on the investigation of multiple scattering in the present setup in the regions where the beam runs through vacuum windows and air at atmospheric pressure, and on the optimization of the beam optics.

AKBP 6: New Results from Accelerators for Hadron Physics

Time: Wednesday 11:00–12:30 Location: HSZ/0304

Group Report AKBP 6.1 Wed 11:00 HSZ/0304

Laser spectroscopy of Mg^+ at CRYRING@ESR — •Konstantin Mohr[1,2], Zoran Andelkovic[3], Volker Hannen[4], Frank Herfurth[3], Max Horst[1,2], Phillip Imgram[1], Kristian König[1,2], Claude Krantz[3], Michael Lestinsky[3], Yuri Litvinov[3], Bernhard Maass[1,5], Esther Menz[6], Patrick Müller[1], Wilfried Nörtershäuser[1,2], Simon Rausch[1,2], Rodolfo Sánchez[3], Ragandeep Singh Sidhu[7], and Ken Überholz[4] — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]Helmholtzforschungsakademie Hessen für FAIR HFHF, Darmstadt, Germany — [3]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Germany — [4]Institut für Kernphysik, WWU Münster, Germany — [5]ANL, Illinois, USA — [6]Helmholtzinstitut Jena, Germany — [7]University of Edinburgh, Scotland

The storage ring CRYRING@ESR at GSI/FAIR is dedicated to precision experiments with stored and cooled ions of energies down to few MeV. One of the first experiments at CRYRING@ESR was laser spectroscopy on the stable Mg isotopes, carried out to test a possible in-flight polarization buildup by optical pumping. Especially parity-non-conservation experiments would benefit from this technique. During the first attempts, we found an unexpectedly fast population transfer between the hyperfine ground states F=2,3 of $^{25}Mg^+$, which could be associated with the mixing of velocity classes caused by synchrotron oscillations in bunched-beam operation. We present the current status of the experiment and discuss the influence of dynamic effects. This work is supported by BMBF contract 05P21RDFA1.

Group Report AKBP 6.2 Wed 11:30 HSZ/0304

Laser-Driven Acceleration of Gold Ions — •Laura Desiree Geulig, Erin Grace Fitzpatrick, Maximilian J. Weiser, Veronika Kratzer, Vitus Magin, Masoud Afshari, Jörg Schreiber, and Peter G. Thirolf — Ludwig-Maximilians-Universität München

The efficient acceleration of gold ions is a first step towards the 'fission-fusion' reaction mechanism, which aims at investigating the rapid neutron capture process in the vicinity of the N=126 waiting point[1]. In our recent measurement at the PHELIX laser with a pulse length of 500fs, for the first time, the laser-based acceleration of gold ions above 7 MeV/u was demonstrated. Additionally, individual gold charge states were resolved with unprecedent resolution[2]. This has allowed the investigation of the role of collisional ionization using a developmental branch of the particle-in-cell simulation code EPOCH[3], showing a much better agreement of the simulated charge state distributions with the experimentally measured ones than when only considering field ionization. This work is continued at the Centre for Advanced Laser Applications (CALA), using the ATLAS3000 laser (800nm central wavelength, 25 fs pulse length).

[1] D. Habs et al., Appl. Phys. B 103, 471-484 (2011)
[2] F.H. Lindner et al., Sci. Rep. 12, 4784 (2022)
[3] M. Afshari et al., Sci.Rep. 12, 18260 (2022)

Group Report AKBP 6.3 Wed 12:00 HSZ/0304

Pure Copper and Stainless Steel Additive Manufacturing of an IH-Type Linac Structure — •Hendrik Hähnel, Adem Ates, and Ulrich Ratzinger — Institut für Angewandte Physik, Goethe Universität, Frankfurt am Main

Additive manufacturing ("AM") has become a powerful tool for rapid prototyping and manufacturing of complex geometries. A 433 MHz IH-DTL cavity has been constructed to act as a proof of concept for direct additive manufacturing of linac components. In this case, the internal drift tube structure has been produced from 1.4404 stainless steel, as well as pure copper using AM. The Prototype cavity, as well as stainless steel AM parts have been copper plated. We present results from low level rf measurements of the cavity with and without copper plating, as well as the status of preparations for high power rf tests with a 30 kW pulsed power amplifier.

AKBP 7: Experiments for Advanced Light Sources

Time: Wednesday 14:00–15:30 Location: HSZ/0304

Group Report AKBP 7.1 Wed 14:00 HSZ/0304

Seeded free-electron laser driven by laser-plasma accelerators - a quest to compact high-brilliance x-ray lasers — •Arie Irman[1], Amin Ghaith[1], Marie Labat[2], Eléonore Roussel[3], Jurjen Couperus-Cabadag[1], Alexandre Loulergue[2], Susanne Schöbel[1], Maxwell LaBerge[1], Patrick Ufer[1], Yen-Yu Chang[1], Nicolas Hubert[2], Moussa El Ajjouri[2], Anthony Berlioux[2], Mathieu Valléau[2], Philippe Berteaud[2], Fréderic Blache[2], Sébastien Corde[4], Alexander Debus[1], Carlos De Oliviera[2], Jean-Pierre Duval[2], Yannick Dietrich[2], Christopher Eisenmann[1], Julien Gautier[2], René Gebhardt[1], Simon Grams[1], Uwe Helbig[1], Christian Herbeaux[2], Charles Kitégi[2], Olena Kononenko[4], Michael Kuntzsch[1], Stéphane Lê[2], Bruno Leluan[2], Fabrice Marteau[2], Manh Huy Nguyen[2], Richard Pausch[1], Pascal Rousseau[4], Mourad Sebdaoui[2], Klaus Steiniger[1], Keihan Tavakoli[2], Cédric Thaury[4], Marc Vandenberghe[2], José Vétéran[2], Victor Malka[4], Driss Oumbarek-Espinos[2], Damien Pereira[2], Thomas Püschel[1], Jean-Paul Ricaud[2], Patrick Rommeluère[2], and Ulrich Schramm[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf e. V. (Germany); — [2]Synchrotron SOLEIL (France) — [3]Lab. de Physique des Lasers, Atomes et Molécules (France) — [4]Lab. d'Optique Appliquée (France);

Free-electron lasers (FELs) produce high-brilliance coherent light pulses, serving as versatile research tools in fundamental science and applications. The recent development of short-wavelength seeded FEL now allows for unprecedented levels of control on longitudinal coherence, opening new scientific avenues such as ultra-fast dynamics on complex systems and X-ray nonlinear optics. Although those devices rely on state-of-the-art large-scale accelerators, advancements on laser-plasma accelerators, which harness gigavolt-per-centimetre accelerating fields, showcase a promising technology as compact drivers for FELs. This talk will review the current status of global effort toward realization of compact FELs. In particular, we present the development of high-quality laser-plasma accelerated electron beams and the commissioning of the COXINEL - FEL beamline, as well as experimental demonstration of FEL lasing at 270 nm in a seeded configuration. Control over the radiation wavelength is achieved with an improved bandwidth stability. Furthermore, the appearance of interference fringes, resulting from the interaction between the phase-locked emitted radiation and the seed, confirms longitudinal coherence, representing a key feature of such a seeded FEL. We anticipate a navigable pathway toward smaller-scale free-electron lasers at extreme ultra-violet wavelengths.

Group Report AKBP 7.2 Wed 14:30 HSZ/0304

KIT accelerators and research highlights - an overview — •Härer Bastian — Karlsruhe Institute of Technology, KIT

The Institute for Beam Physics and Technology (IBPT) at the Karlsruhe Institute of Technology (KIT) operates the Karlsruhe Research Accelerator (KARA) and the short-bunch linear accelerator, Ferninfrarot Linac- und Test-Experiment (FLUTE). In addition, a new compact storage ring will be realised in the context of the cSTART project and a new laser plasma accelerator will be the stepping stone for R&D based on novel acceleration techniques. This contribution gives an overview of current and future facilities and highlight respective accelerator physics research activities.

Group Report AKBP 7.3 Wed 15:00 HSZ/0304

Recent Highlights at the Photo Injector Test Facility at DESY in Zeuthen (PITZ) — •Li Xiangkun — on behalf of the PITZ team, DESY, 15738 Zeuthen, Germany

The Photo Injector Test facility at DESY in Zeuthen (PITZ) develops high brightness photocathode RF guns, advanced diagnostics and applications of the high brightness electron beams, which currently can be accelerated up to 22 MeV. In this talk, we will focus on the two main experiments in 2022: the worldwide first high-power THz SASE free-electron laser (FEL) and a new R&D platform for FLASH radiation therapy and radiation biology. The THz SASE FEL aims at producing high power tunable narrow band THz pulses with an energy of hundreds of *J per pulse. This can be realized by transporting and matching an electron beam with a bunch charge of 2 to 4 nC and a peak current up to 200 A into an undulator. Methods have been developed at PITZ for the beam envelop and trajectory optimization of the strongly space charge dominated electron beam. Results from first lasing, seeding studies and even saturation at 3 THz will be presented. The R&D platform FLASHlab@PITZ for radiation biology and electron FLASH radiation therapy is being prepared at PITZ. PITZ can provide a uniquely wide parameter range for studying this newest modality of radiation treatment against cancer. A startup beamline has been installed, first successful experiments have been done and an upgrade plan for exploiting the full capability of PITZ was developed. All this will be summarized in the talk.

AKBP 8: Advanced IT Tools

Time: Wednesday 15:45–17:15 Location: CHE/0183

AKBP 8.1 Wed 15:45 CHE/0183

Image space reconstruction algorithm for LPS tomography at PITZ — •Namra Aftab[1], Prach Boonpornprasert[1], Georgi Georgiev[1], Matthias Gross[1], Andreas Hoffmann[1], Mikhail Krasilnikov[1], Xiangkun Li[1], Anne Oppelt[1], Christopher Richard[1], Frank Stephan[1], Grygorii Vashchenko[1], Wolfgang Hillert[2], and Andrew Reader[3] — [1]Deutsches Elektronen-Synchrotron, Zeuthen, Germany — [2]University of Hamburg, Institute for Experimental Physics, Hamburg, Germany — [3]School of Biomedical Engineering and Imaging Sciences, Kings College London, UK

At the Photo Injector Test facility at DESY in Zeuthen, longitudinal phase space (LPS) before the booster is determined by an iterative reconstruction method called Algebraic Reconstruction Technique (ART). Although ART is simple to implement with good convergence speed, the results show many artefacts and overestimate energy spread and bunch length. Recently LPS tomography was done via Image Space Reconstruction Algorithm (ISRA) which showed promising results owing to its assurance of non-negative solution. The weight matrix crucial for successive updates was improved by bilinear interpolation. The initial guess for iterations was established from low energy section momentum measurements. The aforementioned reforms resulted in reduced noise-like artefacts, better convergence speed and accurate longitudinal emittance. ISRA was tested on simulations as well as on experimental data. It can diagnose not only linear chirp in LPS but also higher order effects. Experiments with modulated laser beams were also designed to demonstrate the diagnostic capability.

AKBP 8.2 Wed 16:00 CHE/0183

Injection Optimization via Reinforcement Learning at the Cooler Synchrotron COSY — •Awal Awal[1,2], Jan Hetzel[2], and Jörg Pretz[1] — [1]RWTH Aachen University — [2]GSI Helmholtzzentrum für Schwerionenforschung

In accelerator facilities, it is important to have a particle beam with high intensity and small emittance in a timely manner for the successful operation of the experiments. The main challenges limiting the availability of the beam to the users and limiting the beam intensity in storage rings are the lengthy optimization process and the injection losses. The setup of the Injection Beam Line (IBL) depends on a large number of configurations in a complex, non-linear, and time-dependent way. Reinforcement Learning (RL) methods have shown great potential in optimizing various complex systems. However, unlike other optimization methods, RL agents are sample inefficient and have to be trained in simulation before running them on the real IBL. In this research, RL agents are trained to learn the optimal injection strategy of the IBL for the Cooler Synchrotron (COSY) at Forschungszentrum Jülich. The challenge of sim-to-real transfer, where the RL agent trained in simulation does not perform well in the real world, is addressed by incorporating domain randomization. The goal is to increase the beam intensity inside COSY while decreasing the setup time required. This method has the potential to be applied in future accelerators like the FAIR facility.

AKBP 8.3 Wed 16:15 CHE/0183

Beam Trajectory Control with Lattice-Agnostic Reinforcement Learning — •Chenran Xu[1], Erik Bründermann[1], Jan Kaiser[3], Anke-Susanne Müller[1,2], and Andrea Santamaria Garcia[2] — [1]IBPT, KIT, Karlsruhe — [2]LAS, KIT, Karlsruhe — [3]DESY, Hamburg

In recent work, it has been shown that reinforcement learning (RL) is capable of outperforming existing methods on accelerator tuning tasks. However, RL algorithms are difficult and time-consuming to train and currently need to be retrained for every single task. This makes fast deployment in operation difficult and hinders collaborative efforts in this research area. At the same time, modern accelerators often reuse certain structures within or across facilities such as transport lines consisting of several magnets, leading to similar tuning tasks. In this contribution, we use different methods, such as domain randomization, to allow an agent trained in simulation to easily be deployed for a group of similar tasks. Preliminary results show that this training method is transferable and allows the RL agent to control the beam trajectory at similar lattice sections of two different real linear accelerators. We expect that future work in this direction will enable faster deployment of learning-based tuning routines, and lead towards the ultimate goal of autonomous operation of accelerator systems and transfer of RL methods to most accelerators.

C. Xu acknowledges the support by the DFG- funded Doctoral School "Karlsruhe School of Elementary and Astroparticle Physics: Science and Technology".

AKBP 8.4 Wed 16:30 CHE/0183

Sensitivity Analysis and Online Surrogate Construction at the S-DALINAC Using Polynomial Chaos and Neural Networks — •Dominic Schneider, Michaela Arnold, Jonny Birkhan, Ruben Grewe, Norbert Pietralla, and Felix Schliessmann — Institut für Kernphysik, Technische Universität Darmstadt, Darmstadt, Germany

Particle accelerators are complex systems that coincide with their ideal design within the tolerances of its large number of technical components. Quantitative understanding of the beam dynamics and the analysis of their sensitivity to various components are challenging tasks. Machine learning methods provide the potential for the optimized operation of particle accelerators. In this contribution, the application of so-called surrogate models to the electron accelerator S-DALINAC will be discussed. This machine learning technique gives access to predict future behavior and an extensive set of characteristics that can be extracted by analyzing the trained model. The talk will include the presentation of a series of measurements performed in the injector section of the S-DALINAC to study the behavior of beam-influencing elements. Surrogate models, constructed and based on the acquired data, are being evaluated to reveal the behavior of these elements. Based on the information obtained, optimizations of the alignment of magnets as well as the beam dynamics simulations at the S-DALINAC will be discussed.

Supported by the State of Hesse and the Research Cluster ELEMENTS (Project-ID 500/10.006).

AKBP 8.5 Wed 16:45 CHE/0183

Generating synthetic shadowgrams with an in-situ plugin in PIConGPU — •Finn-Ole Carstens[1,2], Klaus Steiniger[1], Richard Pausch[1], Susanne Schöbel[1,2], Yen-Yu Chang[1], Arie Irman[1], Ulrich Schramm[1,2], and Alexander Debus[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf — [2]Technische Universität Dresden

Few-cycle shadowgraphy is a valuable diagnostic for laser-plasma accelerators for obtaining insight into the μm- and fs-scale relativistic plasma dynamics. To enhance the understanding of experimental shadowgrams, we developed a synthetic shadowgram diagnostic within the fully relativistic particle-in-cell code PIConGPU.

In the shadowgraphy diagnostic, the probe laser is propagated through the plasma using PIConGPU, and then extracted and propagated onto a virtual CCD using an in-situ plugin for PIConGPU based on Fourier optics. The in-situ approach circumvents performance limitations of a post-processing workflow, like storing and loading large output files that result from large-scale laser-plasma simulations.

In this talk we present the in-situ plugin and preliminary synthetic shadowgrams from laser wakefield accelerator simulations.

AKBP 8.6 Wed 17:00 CHE/0183

X-ray radiation transport in GPU accelerated Particle In Cell simulations — •Paweł Ordyna, Thomas Kluge, Thomas Cowan, and Ulrich Schramm — HZDR, Dresden, Germany

Ultra-high-intensity laser pulse interactions with solid density targets are of central importance for modern accelerator physics, Inertial Confinement Fusion(ICF) and astrophysics. In order to meet the requirements of real-world applications, a deeper understanding of the underlying plasma dynamics, including plasma instabilities and acceleration mechanisms, is needed. X-ray radiation plays a substantial role in plasma physics, either as an integral part of a physical system itself or as a useful diagnostic, hence it should be included in computational models. Therefore, we bring a Monte Carlo based X-ray radiation transport module into our Particle In Cell simulation framework PIConGPU. It allows, among others, for Thompson scattering, e.g. for small-angle X-ray scattering (SAXS), and Faraday effect calculation for X-ray polarimetry - as online, in-situ diagnostics.

AKBP 9: Beam Dynamics I

Time: Wednesday 15:45–17:15 Location: CHE/0184

AKBP 9.1 Wed 15:45 CHE/0184

A Simulation for Ultrafast Electron Scattering Applications — •Simon Barg — Helmholtz-Zentrum Berlin

The superconducting radio-frequency (SRF) photoinjector is a photoelectron driven linear accelerator located at the SEALab facility at Helmholtz-Zentrum Berlin. With the injector, very flexible beam parameters can be achieved enabling many scientific applications like performing ultrafast electron scattering, with diffraction and imaging modalities, which is this work's focus. Complex structures such as biological molecules, which are not suitable for conventional crystallographic methods, could be imaged and studied with this technique.

To assess the feasibility of ultrafast imaging, a numerical simulation is developed to model an electron pulse from the gun that is deflected by a stream of molecules running perpendicular to the pulse's path to then create a (motion-) blurred image of an individual particle after passing through a magnetic lens system. Considering the injector's spatial coherence, this work's first goal is to find optimal imaging conditions to differentiate between two molecule orientations.

After showing that a contrast between different images can be successfully obtained, the simulation is currently being refined to work as a tool for parameter optimization. Given the pulse features, the model is able to output suitable lens settings. It is also used to compare different techniques, such as dark and bright field imaging, with the overall goal to find the most promising setups for future experiments.

AKBP 9.2 Wed 16:00 CHE/0184

Determination of the Invariant Spin Axis in a COSY model using Bmad — •Maximilian Vitz — Institute for Nuclear Physics IV, FZ Jülich, Germany — III. Physikalisches Institut B, RWTH Aachen University, Germany

The matter-antimatter asymmetry might be understood by investigating the EDM (Electric Dipole Moment) of elementary charged particles. A permanent EDM of a subatomic particle violates time reversal and parity symmetry at the same time. A finite EDM would be, if discovered with the currently achievable experimental accuracy, an indication for further CP violation than established in the Standard Model.

The JEDI-Collaboration (Jülich Electric Dipole moment Investigations) in Jülich has performed a direct EDM measurement for deuterons with the so called precurser experiments at the storage ring COSY (COoler SYnchrotron) in Forschungszentrum Jülich by measuring the invariant spin axis.

In order to interpret the measured data and to disentangle a potential EDM signal from systematic effects in the radial part of the invariant spin axis, spin tracking simulations in an accurate simulation model of COSY are needed. Therefore a model of COSY has been implemented using the software library Bmad. Systematic effects were considered by including element misalignments, etc. These effects rotate the invariant spin axis in addition to the EDM and have to be analyzed and understood. The most recent spin tracking results as well as the methods to find the invariant spin axis will be presented.

AKBP 9.3 Wed 16:15 CHE/0184

Simulations of Beam Dynamics and Beam Lifetime for the Prototype EDM Ring — •Saad Siddique for the CPEDM-Collaboration — JEDI Collaboration — GSI Helmholtzzentrum für Schwerionenforschung Darmstadt Germany

The matter-antimatter asymmetry seen in the universe may be explained through CP-violation by observing a permanent electric dipole moment (EDM) of subatomic particles. An advanced approach to measure the EDM of charged particles is to apply a unique method of Frozen spin on a polarized beam in a storage ring. To increase the experimental precision step by step and to study systematic effects, the EDM experiment will be performed within three stages: the magnetic ring COSY (Cool Synchrotron Forschungzentrum Jülich Germany), a prototype EDM ring, and finally an all-electric EDM ring. The intermediate ring will be a mock-up of the final ring, which will be used to study a variety of systematic effects and to implement the basic principle of the final ring. Simulations of beam dynamics of the prototype EDM ring with different lattices are carried out to optimize the beam lifetime and minimize the systematic effects. The preliminary design of the prototype EDM ring helped to estimate the beam losses by using analytical formulas. Beam-target effects with more detailed simulations are being studied for beam losses and the application of stochastic cooling to control beam emittance growth is also being studied by using a simulation program. Further investigations to reduce systematic effects are also in progress.

AKBP 9.4 Wed 16:30 CHE/0184

Compton transmission polarimetry of LPA-accelerated electron beams — •Jennifer Popp[1,2], Simon Bohlen[1], Louis Helary[1], Felix Stehr[1,2], Gudrid Moortgat-Pick[2,1], Jenny List[1], Jens Osterhoff[1], and Kristjan Põder[1] — [1]Deutsches Elektronen-Synchrotron DESY, Hamburg — [2]Universität Hamburg

For the study of spin-dependent processes polarised particle beams are indispensable. The LEAP (Laser Electron Acceleration with Polarisation) project at DESY aims to demonstrate the production of polarised electron beams exploiting the extremely high acceleration gradients of laser plasma accelerators. In this proof of principle experiment, spin-polarised electron beams with energies of tens of MeV will be generated in a sub-millimetre long plasma source. For electron beams of such energies, Compton transmission polarimetry is the ideal method to measure the polarisation. Gamma rays produced by bremsstrahlung are transmitted through a magnetised iron absorber core depending on their polarisation direction and that of the electrons in the iron. The resulting transmission asymmetry is proportional to the initial electron polarisation. In this talk, an overview of the LEAP project will be given and a polarimeter design, as well as its implementation and commissioning status will be presented.

AKBP 9.5 Wed 16:45 CHE/0184

Simulation studies on longitudinal beam dynamics manipulated by corrugated structures under different bunch length conditions at KARA — •Sebastian Maier[1], Miriam Brosi[3], Hyuk Jin Cha[1], Akira Mochihashi[2], Michael J. Nasse[2], Patrick Schreiber[2], Markus Schwarz[2], and Anke-Susanne Müller[1,2] — [1]LAS, KIT, Karlsruhe — [2]IBPT, KIT, Karlsruhe — [3]MAX IV Laboratory, Lund, Sweden

In the KIT storage ring KARA (KArlsruhe Research Accelerator), two parallel plates with periodic rectangular corrugations are planned to be installed. These plates will be used for impedance manipulation to study and eventually control the beam dynamics and the emitted coherent synchrotron radiation (CSR). In this contribution, we present simulation results showing the influence of different corrugated structures on the longitudinal beam dynamics and how this influence depends on the machine settings in the low momentum compaction regime, which are related to the bunch length changes.

This work is supported by the DFG project 431704792 in the ANR-DFG collaboration project ULTRASYNC. S. Maier acknowledges the support by the Doctoral School "Karlsruhe School of Elementary and Astroparticle Physics: Science and Technology".

AKBP 9.6 Wed 17:00 CHE/0184

Design of a Solenoid Magnet for the S-DALINAC* — •Merle Seeger, Michaela Arnold, Lars Jürgensen, Norbert Pietralla, and Felix Schliessmann — Institut für Kernphysik, Technische Universität Darmstadt, Germany

For the electron accelerator S-DALINAC, new focusing components in the low-energy injector section are needed. Small solenoid magnets can be used to focus low-energy beams in both transverse planes simultaneously. For this purpose, a precise magnetic field is beneficial. The effect of a specific magnet geometry on the magnetic field, as well as on the particle beam, can be investigated using computer simulations. Main influences to the magnetic field that are largely independent from installation constraints include the magnet radius and the yoke shape and material. To find an optimum design for a solenoid magnet for the S-DALINAC, variations of these magnet parameters were considered. Further calculations were made regarding the wiring and cooling of the magnet. In this contribution we will present the results of the computer simulations leading to the final design of the solenoid magnet, as well as detailing the challenges of the magnet construction.

*Work supported by DFG (GRK 2128 AccelencE).

AKBP 10: Instrumentation I

Time: Wednesday 17:30–19:00 Location: CHE/0183

AKBP 10.1 Wed 17:30 CHE/0183

Development of a Thermal Conduction Instrument for Niobium at Cryogenic Temperatures — •Cem Saribal, Mark Wenskat, Cornelius Martens, Isabel Gonzáles Díaz-Palacio, and Wolfgang Hillert — Department of Physics, University of Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

Particle accelerators form an important tool in a variety of research fields including particle physics, material science, chemistry and medicine. In an effort to reduce operation costs while maintaining high energies, their accelerating structures, so-called superconducting radio-frequency (SRF) cavities, are steadily improved towards higher accelerating fields and lower RF losses. Stable operation of such a cavity generally requires Joule heating, generated in its walls, to be conducted to an outer helium bath. Therefore, it is of interest to experimentally evaluate how present and future cavity treatments affect thermal characteristics. We present an instrument for measuring the thermal performance of SRF cavity materials at cryogenic temperatures. Pairs of niobium disks are placed inside of a liquid helium bath and a temperature gradient is generated across them to obtain thermal transmission conductivity for temperatures ranging from 2 Kelvin to 4 Kelvin. To get an idea of the instrument's sensitivity and how standard cavity treatments influence thermal conductivity, samples are tested post fabrication, polishing and 800 degrees baking. These first tests serve as a baseline to study and evaluate new and promising cavity treatments such as ALD-coatings.

AKBP 10.2 Wed 17:45 CHE/0183

Status of the 5 MeV Mott polarimeter design for the MESA — •Rakshya Thapa — Institut für Kernphysik, Mainz, Germany

A high intensity polarised beam has to be delivered to the P2 experiment at Mainz Energy Recovering Superconducting Accelerator Facility (MESA). The absolute error of the beam polarisation should be ≤1%. To track the polarisation, a Mott polarimeter will be installed after the pre-acceleration of the polarised beam to 5 MeV energy and measurements will be done in quasi-online mode with beam current ≈150 μA at ≤1% precision. For that, the polarimeter scattering chamber and its assembly in the beam line is being designed which will be reported.

AKBP 10.3 Wed 18:00 CHE/0183

Teaching an old magnet new tricks — •Tasha Spohr — Helmholtz-Zentrum Berlin — Humboldt-Universität zu Berlin

For beam dynamics studies in the SeaLab SRF photoinjector, a dipole spectrometer built in 1993 and recycled from a decommissioned ion beamline was installed.

With this spectrometer, the beam energy and energy spread can be measured. The photoelectron beam will be bend by 60deg to a viewscreen in the dispersive section. For a precision energy analysis based on the beam size measurement at the viewscreen, it is necessary to know the beam transfer matrix of the dipole, as well as the relationship between magnetic field and coil current in the plane of all possible trajectories.

With this information about the dipole magnet, the transformation matrix of the beamline was determined and now can be applied for a large range of energy measurements.

AKBP 10.4 Wed 18:15 CHE/0183

Design and set-up of a spectrometer for the electro-optical far-field setup to monitor the CSR at KARA — •Ling Leander Grimm[1], Gudrun Niehues[2], Christina Widmann[2], Johannes Leonhard Steinmann[2], Micha Reissig[2], Erik Bründermann[2], and Anke-Susanne Müller[1,2] — [1]LAS, KIT, Karlsruhe — [2]IBPT, KIT, Karlsruhe

At the KIT storage ring KARA (Karlsruhe Research Accelerator), a new system to monitor the emitted coherent synchrotron radiation (CSR) is under commissioning aiming for single-shot measurements. The electro-optical (EO) far-field setup measures the time profile of the CSR employing electro-optical spectral decoding (EOSD). To achieve a sub-picosecond resolution for single-shot measurements, a high signal-to-noise ratio is crucial. Therefore, a spectrometer setup for balanced detection is developed. The ultra-fast line camera KALYPSO (KArlsruhe Linear arraY detector for MHz-rePetition rate SpectrOscopy) will be installed as a detector. This contribution discusses the development and setup of the spectrometer, including optics simulations and first experiments.

AKBP 10.5 Wed 18:30 CHE/0183

Low Gain Avalanche Detectors for beam monitoring — •Vadym Kedych[1], Wilhelm Krueger[1], Adrian Rost[4], Jerzy Pietraszko[2], Tetyana Galatyuk[1,2], Sergey Linev[2], Jan Michel[3], Michael Traxler[2], Michael Traeger[2], Christian Joachim Schmidt[2], and Felix Ulrich-Pur[2] — [1]Technische Universität Darmstadt, Darmstadt, Germany — [2]GSI GmbH, Darmstadt, Germany — [3]Goethe-Universität, Frankfurt, Germany — [4]FAIR GmbH, Darmstadt, Germany

The S-DALINAC at TU Darmstadt is a 3 GHz electron accelerator that allows the possibility to operate it in an energy recovery LINAC (ERL) mode. The multi-turn ERL operation mode was demonstrated in 2021. During the operation in this mode once accelerated and once decelerated beams share the same beamline which leads to the repetitive bunch rate of 6 GHz. A non-destructive beam monitoring tool is important for the simultaneous position measurement of both beams. For these purposes a setup based on Low Gain Avalanche Detectors (LGADs) is being developed for the beam time structure monitoring. LGADs are silicon detectors optimized for 4D-tracking with timing precision below 50 ps thanks to an internal charge amplification mechanism which makes it an ideal candidate for precise timing monitoring at S-DALINAC.

**This work has been supported by DFG under GRK 2128.*

AKBP 10.6 Wed 18:45 CHE/0183

Split-ring resonator experiments and data analysis at FLUTE — •Jens Schäfer, Matthias Nabinger, Michael J. Nasse, Robert Ruprecht, Thiemo Schmelzer, Nigel Smale, Bastian Härer, and Anke-Susanne Müller — IBPT, KIT, Karlsruhe

FLUTE (Ferninfrarot Linac- Und Test-Experiment) is a compact linac-based test facility for accelerator and diagnostics R&D located at the Karlsruher Institute of Technology (KIT). A new accelerator diagnostics tool, called the split-ring resonator (SRR), was tested at FLUTE, which aims at measuring the longitudinal bunch profile of fs-scale electron bunches. Laser-generated THz radiation is used to excite a high frequency oscillating electromagnetic field in the SRR. Electrons passing through the 20 *m x 20 *m SRR gap are time-dependently deflected in the vertical plane, leading to a vertical streaking of the electron bunch. During the commissioning of the SRR at FLUTE, large series of streaking attempts with varying machine parameters and set-ups were investigated in an automatized way. The recorded beam screen images during this experiment have been analyzed and evaluated. This contribution motivates and presents the automatized experiment and discusses the data analysis.

AKBP 11: RF and SRF Research

Time: Wednesday 17:30–19:00 Location: CHE/0184

AKBP 11.1 Wed 17:30 CHE/0184

Thin Films On HOM Antennas To Push The Limits For Higher Beam Currents at MESA(*)(**) — •Paul Plattner, Florian Hug, and Timo Stengler — Institut für Kernphysik (KPH), Mainz, Deutschland

The Mainz Energy-Recovering Superconducting Accelerator (MESA), an energy-recovering (ER) LINAC, is currently under construction at the Institute for Nuclear physics at the Johannes Gutenberg-Universität Mainz, Germany. In the ER mode continues wave (CW) beam is accelerated from 5 MeV up to 105 MeV. The energy gain of the beam is provided through 2 enhanced ELBE-type cryomodules containing two 1.3 GHz 9-cell TESLA cavities each. By pushing the limits of the beam current up to 10 mA, a quench can occur at the HOM Antennas. This is caused by an extensive power deposition within the antenna. Calculations have shown that a power transfer of 1 W must be assumed. To prevent a quench of the HOM antennas by high beam currents without mayor modification of the design, it is necessary to find suitable materials. Nb3Sn and NbTiN can be applied as a coating to the antennas and have higher critical parameters than Nb which provides than a higher power limit. As a further approach to improve the power transfer by changing to material from the antenna to OFHC Copper. The limit of the coated antennas will be tested with the cavities of a cryomodule from the decommissioned ALICE from STFC Daresbury. (*)The authors acknowledge the transfer of one cryomodule to Mainz by the STFC Daresbury. (**)The work received funding by BMBF through 05H21UMRB1.

AKBP 11.2 Wed 17:45 CHE/0184

Nb3Sn Co-Sputtering for Interlayer-Free High Performance Copper SRF Cavities — •Nils Schäfer, Carl Jung, Matthias Mahr, Carl Jung, Christian Dietz, Sebastian Bruns, Márton Major, and Lambert Alf — Technische Universitaet Darmstadt (TU Darmstadt) Institute of Materials Science FB 11

Nb3Sn thin film coatings are a promising candidate to replace bulk Nb to increase performance and energy efficiency of SRF cavities. Replacing niobium by Nb3Sn coated copper would not only reduce material*s cost, but would also allow optimal heat removal for higher cryogenic efficiency. The challenge is the detrimental interdiffusion of Cu into Nb3Sn at the typically high deposition temperatures conventionally used for Nb3Sn synthesis. We have recently introduced a novel kinetically driven low-temperature co- sputtering process that overcomes the copper diffusion challenge. In this break-through process, even a diffusion barrier layer is not needed, because the Cu diffusion is minimized to an extent where the superconducting properties of Nb3Sn are not negatively affected. Magnetization versus temperature measurements demonstrate the good shielding performance in parallel orientation of the Nb3Sn thin films on the copper substrate. Mechanical nanondentation and scratch tests demonstrate that even after thermal cycling of the sample, the adhesion properties the Nb3Sn thin film coatings are excellent. Work supported by the German Federal Ministry for Education and Research (BMBF) through grant 05H21RDRB1 and the German Research Foundation (DFG) via the AccelencE Research Training Group (GRK 2128).

AKBP 11.3 Wed 18:00 CHE/0184

low-temperature magnetron co-sputtering of Nb3Sn for SRF application — •Hamidreza Ghasemi[1], Nils Schäfer[2], Márton Major[3], Alexey Arzumanov[4], and Lambert Alff[5] — [1]Technical University of Darmstadt, Darmstadt, Germany — [2]Technical University of Darmstadt, Darmstadt, Germany — [3]Technical University of Darmstadt, Darmstadt, Germany — [4]Technical University of Darmstadt, Darmstadt, Germany — [5]Technical University of Darmstadt, Darmstadt, Germany

For the last decades, bulk niobium has been the material of choice for superconducting RF cavity applications. Nb3Sn thin films are another candidate for SRF cavities. The benefits of using Nb3Sn instead of Nb would be higher critical temperature and higher critical magnetic field, leading to significant cryogenics cost reduction. The Tc is maximal for about 25% tin content and decreases significantly for less than 23at%. Therefore, the big problem of Nb3Sn is the synthesis of the material. The most promising fabrication method of Nb3Sn is the tin vapor diffusion method. Control of the small stoichiometry range and Sn gradients are the challenges of this method. In single-target sputtering and multi-layer sputtering we have to deal with tin loss and surface segregation(due to high annealing temperature). Co-sputtering allows the tuning of the kinetic energy of both elements independently and offers high-performance thin films at low temperatures. This work presents recent results of Nb3Sn synthesis on Copper substrate by magnetron co-sputtering. This work supported by the German Federal Ministry for Education and Research (BMBF) through grant 05H21RDRB1.

AKBP 11.4 Wed 18:15 CHE/0184

Development of a system for the rapid RF characterization of superconducting samples — •Sebastian Keckert[1], Felix Kramer[1], Oliver Kugeler[1], and Jens Knobloch[1,2] — [1]Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Berlin — [2]Universität Siegen, Fachbereich Physik, Siegen

Niobium is currently the material of choice to produce superconducting radio frequency (SRF) cavities for applications in particle accelerators. These cavities are operated at temperatures of 2 K or lower to ensure manageable dynamic losses at high accelerating gradients. Presently, alternative materials to niobium and composite structures relying on thin film coatings are investigated in various R&D projects. Applied to SRF cavities such an advanced material or coating will allow performances beyond the fundamental limits of niobium and eventually operation temperatures of 4.2 K or higher. The development of such coatings requires RF characterization of superconducting samples and especially measurements of the RF surface resistance.

This contribution discusses the development and first commissioning results of a Rapid Superconductor Test Apparatus (RaSTA), a compact sample test cavity. In contrast to other test setups, RaSTA allows to distinguish BCS and residual resistance with high resolution but with far shorter turnaround times, enabling systematic studies of multiple samples and thus iterative optimization of materials production techniques.

AKBP 11.5 Wed 18:30 CHE/0184

Gobau-Line Measurements for In-Vacuum Undulators — •Paul Volz — Helmholtz-Zentrum Berlin für Materialien und Energie — Johannes Gutenberg-Universität Mainz

The in-vacuum elliptical undulator, IVUE32, is being developed at Helmholtz-Zentrum Berlin. The 2.5 m long device with a period length of 3.2 cm and a minimum gap of about 7 mm is to be installed in the BESSY II storage ring. The proximity of the undulator structure to the electron beam makes the device susceptible to wakefield effects which can influence beam stability. A complete understanding of its impedance characteristics is required prior to installation and operation. To understand and measure the IVU's impedance characteristics a Goubau-Line test stand is being designed. A Goubau-line is a single wire transmission line for high frequency surface waves with a transverse electric field resembling that of a charged particle beam out to a certain radial distance. First measurements from a prototype test stand, designed to measure IVUE32-components will be presented.

AKBP 11.6 Wed 18:45 CHE/0184

Influence of High-Pressure Rinsing on the Oxide-Layer Thickness and Oxygen-Concentration of Niobium Samples — •Rezvan Ghanbari[1], Marc Wenskat[1], Mona Kohantorabi[2], Heshmat Noei[2], Arti Dangwal Pandey[2], Detlef Reschke[2], and Wolfgang Hillert[1] for the University of Hamburg-Collaboration — [1]Institute of experimental physics, University of Hamburg, Germany — [2]Deutsches Elektronen-Synchrotron DESY, Germany

This study is devoted to investigate the effect of High Pressure Rinsing (HPR) on the outcome of annealing procedures of Niobium (Nb) superconducting radio-frequency cavities. Recently, a so-called "mid-T bake" treatment has exhibited very high-quality factors for Nb cavities. The complementary developed models assume that the quality factor severely depends on the oxygen concentration in the near-surface of niobium. On the other hand, based on our observation, we realize that HPR affects the thickness of oxide layers on the surface of niobium cavities, which is the dominant source of the oxygen diffusion during annealing. Thus, we have measured the oxide thicknesses after various HPR durations of Nb samples before and after applying mid-T bake treatment via X-ray Photoelectron Spectroscopy (XPS) and used Secondary Ion Mass Spectrometry (SIMS) to obtain the interstitial oxygen concentration after the annealing. The results of this investigation will be presented and discussed in the context of theoretical models.

AKBP 12: AI Topical Day – Invited Talks (joint session AKPIK/HK/ST/T/AKBP)

Time: Thursday 11:00–12:30 Location: HSZ/AUDI

Invited Talk AKBP 12.1 Thu 11:00 HSZ/AUDI
AI Techniques for Event Reconstruction — •Ivan Kisel — Goethe University, Frankfurt, Germany
Why can we relatively easily recognize the trajectory of a particle in a detector visually, and why does it become so difficult when it comes to developing a computer algorithm for the same task? Physicists and computer scientists have been puzzling over the answer to this question for more than 30 years, since the days of bubble chambers. And it seems that we are steadily approaching the answer in our attempts to develop and apply artificial neural networks both for finding particle trajectories and for physics analysis of events in general.

This talk will present the basics of artificial neural networks in a simple form, and provide illustrations of their successful application in event reconstruction in high energy physics and heavy ion physics experiments. You will get an insight into the application of traditional neural network models, such as deep neural network, convolutional neural network, graph neural network, as well as those standing a little aside from traditional approaches, but close in idea of elastic network and even cellular automata.

Invited Talk AKBP 12.2 Thu 11:30 HSZ/AUDI
Accelerator operation optimisation using machine learning — •Pierre Schnizer — Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Berlin, Germany
Accelerators are complex machines whose many components need to be accurately tuned to achive design performance. Reliable operation requires frequent recalibration and tuning. Especially for large machines tools have been developed that facilitating this task.

Machine learning allows building such tools using simulations, archiver data or interaction with the real machine, thus making many tools now also available for smaller machines.

This talk will give an overview of different machine learning projects targeted to accelerators, which simplifies accelerator operation or even enable applications not been possible before.

Invited Talk AKBP 12.3 Thu 12:00 HSZ/AUDI
Is this even physics? – Progress on AI in particle physics — •Gregor Kasieczka — Universität Hamburg
Motivated by the large volume and high complexity of experimental data and mathematical structures, particle physics has a long tradition of employing state of the art computing and analysis techniques. Recent progress in machine learning and artificial intelligence have further pushed this trend, and these approaches are now ubiquitous in our field. This overview attempts to capture key developments such as the rise of unsupervised approaches and the quest for suitable neural network architectures for physics tasks; challenges like ultra-low latency inference and robust predictions; as well as promising new ideas looking forward.

AKBP 13: Preisverleihung des AKBP Nachwuchspreises und des Horst-Klein Preises

Time: Thursday 14:00–15:30 Location: HSZ/0304

Prize Talk AKBP 13.1 Thu 14:00 HSZ/0304
TBA — •Carl A. Lindström — Universität Oslo/DESY — Laureate of the DPG-Nachwuchspreis für Beschleunigerphysik 2023
Details will be published online in a programme update.

Prize Talk AKBP 13.2 Thu 14:45 HSZ/0304
TBA — •Ferdinand Willeke — Brookhaven National Laboratory — Laureate of the Horst Klein-Forschungspreis 2023
Details will be published online in a programme update.

AKBP 14: Instrumentation II

Time: Thursday 15:30–17:15 Location: CHE/0183

AKBP 14.1 Thu 15:30 CHE/0183
System for Bunch Length Measurements behind the Injector of S-DALINAC* — •A. Brauch, M. Arnold, J. Enders, L. Jürgensen, and N. Pietralla — Technische Universität Darmstadt, Department of Physics, Institut für Kernphysik, Darmstadt, Deutschland
The estimation of the bunch length in accelerators is vital for monitoring and preserving the quality of the beam. At the S-DALINAC accelerating cavities are used for measuring this parameter at higher energies. However, values obtained by this method only serve as an upper estimate for the bunch length. A new setup involving a streak camera will be used to provide accurate evaluations of the small bunch lengths of < 2 ps at the S-DALINAC. An integrative measurement with a comparable resolution to the bunch length at different positions behind the injector is planned. This contribution will present the layout of this system, its current status and design considerations.

*Work supported by the State of Hesse within the Research Cluster ELEMENTS (Project ID 500/10.006).

AKBP 14.2 Thu 15:45 CHE/0183
Simulationen zur Optimierung von Vakuumsystemen für Beschleunigerstrahlführungen* — •Alexander Smushkin, Ruben Grewe, Michaela Arnold, Manuel Dutine, Marco Fischer, Lars Jürgensen, Felix Schliessmann und Norbert Pietralla — Institut für Kernphysik, TU Darmstadt, Darmstadt, Germany
Der S-DALINAC ist ein supraleitender, rezirkulierender Linearbeschleuniger. Im Rahmen der fortschreitenden Optimierungen der Systeme am S-DALINAC wurden Segmente der Strahlführung bezüglich ihrer Vakuumeigenschaften untersucht. Hierbei wurde der Einfluss verschiedener Geometrien und Pumpenkonfigurationen auf das Vakuum mit der Simulationssoftware Molflow untersucht, um eine Grundlage für weitere Entwicklungen zu schaffen. Insbesondere werden Verbindungen zwischen Bereichen mit unterschiedlichen Vakuumanforderungen untersucht, wie z.B. beim Übergang zu den Kryostatmodulen oder Experimentierplätzen mit hohen Vakuumanforderungen. In diesem Vortrag werden diese Simulationsergebnisse vorgestellt.
*Gefördert durch die DFG (GRK 2128 AccelencE)

AKBP 14.3 Thu 16:00 CHE/0183
An all-optical streak camera to measure the jitter between two beams in the single-digit femtosecond regime — •Marc Osenberg[1], Ahmad Fahim Habib[2], Lina Wübbena[1], Michael Stumpf[1], and Georg Pretzler[1] — [1]Institute of Laser- and Plasmaphysics, University Düsseldorf — [2]University of Strathclyde, Glasgow
We present a novel All-Optical Streak Camera (AOSC) based on the Kerr-effect which measures the relative temporal position of a laser pulse and a second short pulse of arbitrary constituents (e.g., electrons, protons, light, or x-rays) in a single shot. Many modern accelerator concepts rely on the coupling of an electron beam with a laser beam, which must overlap with ultra-high temporal precision down to the low fs-regime which will be shown quantitatively by simulation results. Our new device comes in at this point, measuring the temporal position of the electron pulse relative to the laser pulse for single shots, which will also show jitter or temporal drifts. We show proof-of principle experiments of this new device with an ultrashort laser pulse (6 fs FWHM) demonstrating resolution in the 10-fs regime.

AKBP 14.4 Thu 16:15 CHE/0183

controlling the transverse beam shape of the photoinjector laser via a spatial light modulator — •Stephan-Robert Kötter, Erik Bründermann, Matthias Nabinger, Michael Nasse, Andrea Santamaria Garcia, Chenran Xu, and Anke-Susanne Müller — KIT, Karlsruhe, Germany

In order to achieve unprecedented control over the phase space of electron beams in linear accelerators, the laser pulse of the photoinjector can be shaped by spatial light modulators (SLMs). Here, we use a convolutional neural network (CNN) from a proof-of-principle test with a visible diode laser on the TiSa-800-nm photoinjector laser system of the Ferinfrarot Linac- und Test-Experiment (FLUTE) at KIT to compensate the effects of compression and the non-linear process of third harmonic generation on the transverse laser profile.

AKBP 14.5 Thu 16:30 CHE/0183

First two-bunch measurements using the electro-optical near-field monitor at KARA — •Micha Reissig[1], Erik Bründermann[1], Bastian Härer[1], Akira Mochihashi[1], Gudrun Niehues[1], Meghana M. Patil[2], Robert Ruprecht[1], and Anke-Susanne Müller[1,2] — [1]IBPT, KIT, Karlsruhe — [2]LAS, KIT, Karlsruhe

The Karlsruhe research accelerator KARA is an electron storage ring, which features an electro-optical near-field monitor as a tool for longitudinal bunch profile measurements. The device performs well in single-shot turn-by-turn measurements during single-bunch operation and over the years, the design has been optimized to be prepared for measurements in multi-bunch operation. The ability to work with multiple bunches and short bunch spacing is an important step to make the device suitable for more application purposes, such as a diagnostics tool for the future electron-positron collider FCC-ee. This contribution provides first tests of the monitor during two-bunch operation with minimum 2 ns bunch spacing. Challenges like crystal heating due to an increased beam current are discussed and strategies for mitigation are presented.

AKBP 14.6 Thu 16:45 CHE/0183

Analytic formulation of the zero-crossing slope for a circular button-like pickup — •Stefano Mattiello, Bernhard Erich Jürgen Scheible, and Andreas Penirschke — Technische Hochschule Mittelhessen, Friedberg, Hessen

With the emerging demand of the experimenters for future experiments with ultra-short X-ray free-electron lasers (XFEL) shots, fs precision is required for the synchronization systems even with 1pC bunches using one or more button-like pickups in the Bunch Arrival Time Monitors (BAM). Because the sensitivity of the BAM depends in particular on the slope of the bipolar signal at the zero crossing and thus, also on the bunch charge, a precise theoretical prediction of the slope is a challenging and fundamental task. In this contribution the theoretical foundations of the pickup signal are presented in a systematic way, and we focus on a button-like pickup with circular active surface, that is the standard choice in the past. We present an exact general estimation of the zero-crossing slope and then discuss the results for ultra-short bunches. The comparison to the long-bunch case allows to achieve a deeper understanding of the features of these limiting cases as well as of the intermediate region.

AKBP 14.7 Thu 17:00 CHE/0183

Evaluation of a terahertz camera system for imaging, tomographic and diagnostic measurements at KARA — •André Schmidt[1], Stefan Funkner[1], Gudrun Niehues[1], Erik Bründermann[1], and Anke-Susanne Müller[1,2] — [1]IBPT, KIT, Karlsruhe — [2]LAS, KIT, Karlsruhe

With a short bunch operation mode, the KIT electron storage ring KARA (Karlsruhe Research Accelerator) features the creation of the so-called microbunching instability, which emits bright bursts of THz radiation.

The creation of an instability provides the opportunity to study complex beams dynamics by the investigation of properties from the emitted radiation. Furthermore, the emission of bright THz radiation bears the potential for many research applications in photon science.

In this contribution, we present an evaluation of a microbolometer-based THz-camera system, which is able to operate at 50 frames/s. In this regard, first results from tomographic measurements with a standalone THz illumination source and results from diagnostic beam measurements during the short bunch operation mode at KARA are shown.

AKBP 15: New Accelerator Concepts

Time: Thursday 15:30–17:15 Location: CHE/0184

AKBP 15.1 Thu 15:30 CHE/0184

Laser Transmission in the Relativistically Induced Transparency Regime for High Performance Proton Acceleration at PW Laser Systems — •Marvin E. P. Umlandt[1,2], Tim Ziegler[1,2], Nicholas P. Dover[3,4], Ilja Göthel[1,2], Thomas Kluge[1], Chang Liu[3], Thomas Püschel[1], Milenko Vescovi[1,2], Mamiko Nishiuchi[3], Josefine Metzkes-Ng[1], Karl Zeil[1], and Ulrich Schramm[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Technische Universität Dresden, Germany — [3]Kansai Photon Science Institute, QST, Japan — [4]John Adams Institute for Accelerator Science, Imperial College London, UK

Ion acceleration by laser-plasma sources promises many applications, but reaching the required beam quality parameters demands a high level of understanding and control over the interaction process. Several advanced schemes, including the Relativistically Induced Transparency (RIT) regime, have been proposed and investigated in search of a stable acceleration for proton energies beyond 100 MeV. In the RIT scheme, the absorption of the electromagnetic laser field by the target and the generated plasma is critical. In joint experiments at the DRACO PW (HZDR) and J-KAREN (KPSI) lasers, we use transmission diagnostics to study the onset of transparency and learn about the sensitivity of the laser input to improve the process's robustness. Using ultra-short pulses on thin solid density foil targets, we observe high performance proton beams in an expanded foil case. Our analysis of the effects on the transmission and its correlation with the acceleration performance indicates changes in the plasma interaction process.

AKBP 15.2 Thu 15:45 CHE/0184

Towards spin-polarised electron beams from a Laser Plasma Accelerator — •Felix Stehr[1,2], Simon Bohlen[1], Louis Helary[1], Jennifer Popp[1,2], Jenny List[1], Gudrid Moortgat-Pick[2,1], Jens Osterhoff[1], and Kristjan Põder[1] — [1]Deutsches Electronen-Synchrotron DESY, Hamburg — [2]University of Hamburg

Polarised beams are indispensable for many experiments in particle, atomic and nuclear physics where spin-dependent processes are to be studied. Unlike RF accelerators, the accelerating fields in Laser-Plasma-Accelerators (LPA) are not limited by material breakdown. LPAs can create beams of tens to hundreds of MeV in only a millimeter, making them a promising alternative to conventional accelerators.

The LEAP (Laser Electron Acceleration with Polarisation) project at DESY aims to generate and measure spin-polarised electron beams from a compact LPA for the first time. The generation of spin-polarised beams from an LPA relies on a pre-polarised plasma source, where hydrogen halide molecules are dissociated by a circularly polarised UV laser pulse. The dissociation of an HCl gas target requires a laser pulse with a wavelength of about 200 nm, which has to be synchronised with the LPA driver laser, as the depolarisation of the electrons in the gas occurs in the sub-nanosecond range. Therefore, the UV pulse will be generated by cascaded second harmonic generation of the fundamental 800 nm LPA driver pulse. This contribution will discuss the physics of spin-polarised LPA, the experimental progress of preparing a pre-polarised plasma source for LPA and will provide an overview of the polarisation measurement within the LEAP project.

AKBP 15.3 Thu 16:00 CHE/0184

Feasibility Study of a Low Energy Laser Driven Plasma Injector for ELSA — •Michael Switka and Klaus Desch — Physikalisches Institut der Universität Bonn

The injector of the 3.2 GeV ELSA storage ring consists of a 26 MeV linear accelerator and a 1.2 GeV booster synchrotron. The advent of functional plasma-based MeV electron accelerators may raise a prospective opportunity to replace the conventional Linac, which currently delivers electron pulses of up to 16 nC at a repetition rate of 50 Hz. We conduct a feasibility study of using a plasma based injector for the booster synchrotron. For this, we improve the diagnostic capabilities of the Linac transfer beamline and the injector synchrotron to obtain and verify acceptance parameters which are to be matched to beam properties from contemporary operated laser plasma accelerator setups. Possible facility operating modes using a plasma based injector are evaluated.

AKBP 15.4 Thu 16:15 CHE/0184

Better Atomic Physics for Laser Accelerator Plasmas — •Brian Edward Marre[1], Axel Huebl[2], Rene Widera[1], Sergei Bastrakov[1], Michael Bussmann[3], Thomas Cowan[1], Ulrich Schramm[1], and Thomas Kluge[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Berkley National Lab, Berkley, USA — [3]CASUS, Görlitz, Germany

Standard atomic physics models in PIC simulation either neglect excited states, predict atomic state population in post processing only, or assume quasi-thermal plasma conditions.

This is no longer sufficient for high-intensity short-pulse laser generated plasmas, due to their non-equilibrium, transient and non-thermal plasma conditions, which are now becoming accessible in XFEL experiments at HIBEF (EuropeanXFEL), SACLA (Japan) or at MEC (LCLS/SLAC). To remedy this, we have developed a new extension for our PIC simulation framework PIConGPU to allow us to model atomic population kinetics in-situ in PIC-Simulations, in transient plasmas and without assuming any temperatures. This extension is based on a reduced atomic state model, coupled to the existing PIC-simulation and solved explicitly in time, depending on local interaction spectra and with feedback to the host simulation. This allows us to model de-/excitation and ionization of ions in transient plasma conditions, as typically encountered in laser accelerator plasmas. This new approach to atomic physics modelling will be very useful in plasma emission prediction, plasma condition probing with XFELs and laser plasma accelerator performance prediction.

AKBP 15.5 Thu 16:30 CHE/0184

Plasma Density Evolution Background to the Ion-motion Recovery in a Beam-driven Plasma-wakefield Accelerator — •Judita Beinortaite[1,2], Jonas Björklund Svensson[1], James Chappell[3], Matthew James Garland[1], Harry Jones[1], Carl A. Lindstrøm[1], Gregor Loisch[1], Felipe Peña[1,4], Sarah Schröder[1], Stephan Wesch[1], Matthew Wing[2], Jens Osterhoff[1], and Richard D'Arcy[1] — [1]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [2]University College London, London, UK — [3]University of Oxford, Oxford, UK — [4]Universität Hamburg, Hamburg, Germany

Beam-driven plasma-wakefield acceleration is a promising avenue for the future design of compact linear accelerators with applications in high-energy physics and photon science. Meeting the luminosity and brilliance demands of current users requires the delivery of thousands of bunches per second: many orders of magnitude beyond the current state-of-the-art of plasma-wakefield accelerators, which typically operate at the Hz-level. As recently explored at FLASHForward, a fundamental limitation for the highest repetition rate is the long-term motion of ions that follows the dissipation of the driven wakefield (R. D*Arcy, et al. Nature 603, 58,62 (2022)). The duration of this ion motion could vary with the mass of the plasma ions, thus significantly decreasing in lighter gas species. To observe this, the understanding of the background processes, such as microsecond-level plasma density evolution of different gases in a capillary, is needed. Here we present the first steps of exploring this plasma evolution.

AKBP 15.6 Thu 16:45 CHE/0184

Laser-induced breakdown of targets for Laser-ion acceleration — •Stefan Assenbaum[1,2], Constantin Bernert[1,2], Martin Rehwald[1], Karl Zeil[1], and Ulrich Schramm[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstraße 400, 01328 Dresden, Germany — [2]Technische Universität Dresden, 01062 Dresden, Germany

After the interaction of ultra-short high intensity laser pulses with thin solid targets, strong electric fields within the resulting plasma can accelerate ions to energies of tens of MeV. The performance of such laser driven ion sources critically depends on the initial conditions of the target plasma at the arrival time of the driving laser pulse. Pre-pulses and pedestals in the intrinsic temporal laser contrast can cause dielectric breakdown of the target long before the arrival of the main laser pulse, causing the target to ionize and pre-expand uncontrolledly.

Here, we present a study of the laser-induced breakdown (LIB) threshold intensity of 300nm thin formvar foils as well as cryogenic solid hydrogen jets, which are both used as targets for ion accleration at the Draco laser facility at Helmholtz-Zentrum Dresden-Rossendorf. By stretching the pump laser pulse, the dependence of LIB threshold intensity on laser pulse duration is investigated. This helps to understand and model the pre-plasma formation during the rising flank of a high power laser pulse impinging on a thin dielectric target.

AKBP 15.7 Thu 17:00 CHE/0184

Laser Performance Monitoring at Centre for Advanced Laser Applications (CALA) — •Michael Bachhammer, Sonja Gerlach, Leonard Doyle, Felix Balling, Florian Schweiger, and Jörg Schreiber — Faculty of Physics, Ludwig-Maximilians-Universität München, Garching, Germany

One major interest of our research in the field of laser-driven ion acceleration is establishing a stable source of energetic ions. However, shot-to-shot fluctuations as well as long-term drifts of the PW-class Advanced Titanium Sapphire Laser ATLAS can cause instabilities and a significant degradation of the ion-beam performance. This prompted us to investigate and monitor the stability of our 1-Hz laser system. To this end, a 'Performance Report' has been implemented, which is automatically generated daily and summarizes the performance of the laser system throughout the day. This allows the detection of correlated fluctuations. The report is enabled by a Tango-Controls [1] based control system and comprises not only important laser parameters such as laser energy, spectrum and beam profile but also environmental factors like temperatures at different positions in the laser chain. In a next step we will implement diagnostics that enable more direct correlation of laser parameters with ion bunch parameters with the ultimate goal of enabling active control. This work was supported by the BMBF within project 01IS17048 and the Centre for Advanced Laser Applications.

[1] https://www.tango-controls.org/

AKBP 16: Poster

Time: Thursday 15:45–18:30 Location: HSZ OG3

AKBP 16.1 Thu 15:45 HSZ OG3

Beam-Based Characterization of a Non-Linear Injection Kicker at BESSY II — •Anny Gora, Markus Ries, Michael Abo-Bakr, Marc Dirsat, and Günther Rehm — Helmholtz-Zentrum Berlin, Germany

Top-up operation at BESSY II is performed with average injection efficiencies of 98 %. Howe- ver, the four kicker bump and the half-sine-wave septum pulser, that form the present injection system, both contribute to an injection distortion of the stored beam with an amplitude of a few millimeters for several thousand turns. A non-linear pulsed injection kicker (NLK) could be used to reduce the kicker induced distortion by a factor of approximately 30 and thus create a necessary condition for transparent injection. Studies with a NLK and optimized sextupole settings have shown that it is also possible to achieve injection efficiencies of up to 97 %. With regard to the application of the NLK for BES- SY II user operation and a possible injection method for BESSY III, the NLK was characterized beam-based and measurements and theory were reconciled.

AKBP 16.2 Thu 15:45 HSZ OG3

Spin-polarized electron beam generation in the colliding pulse injection scheme — •Zheng Gong[1], Michael Quin[1], Simon Bohlen[2], Christoph Keitel[1], Kristjan Põder[2], and Matteo Tamburini[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany

We studied the laser-wakefield acceleration of pre-polarized plasma electrons in the colliding pulse injection scheme. We found that the whole process is composed of two stages. In the first stage, the interaction between the plasma electrons and the transverse fields of the counterpropagating pulses leads to stochastic heating, which can substantially affect the longitudinal spin polarization of plasma electrons. As a result of the laser pulse collision, some plasma electrons gain a residue momentum in the longitudinal direction. The latter can result in the electrons being trapped and further accelerated by the forward-moving wakefield driven by the most intense laser pulse. The subsequent acceleration in the wakefield does not appreciably affect the longitudinal spin of the generated electron beam. Our theoretical model is supported by multi-dimensional particle-in-cell (PIC) simulations.

AKBP 16.3 Thu 15:45 HSZ OG3

Electro-stress-thermal analysis of quadrupole resonator designs — •Piotr Putek[1], Shahnam Gorgi Zadeh[2], Marc Wenskat[3], Simon Adrian[1], and Ursula van Rienen[1] — [1]Universität Rostock, Rostock, Germany — [2]CERN, Meyrin, Switzerland — [3]Hamburg, Hamburg, Germany

Exploring the fundamental properties of materials such as niobium or Nb3Sn, in terms of high-precision surface resistance measurements, is crucial for the further development of SRF technology. Quadrupole resonators (QPRs) are dedicated devices for determining superconducting materials' radio frequency properties using the so-called calorimetric measurement. Due to the electromagnetic radiation pressure (Lorentz detuning), microphoning, and geometrical deviations of cavity design uncertainties, measurements can substantially be distorted. Therefore, we address a stochastic multi-physical problem to study a significant measurement bias of the surface resistance, observed mainly for the third operating mode of the given HZB-QPR and all modes of CERN2-QPR. We explore the uncertainty quantification technique and sensitivity analysis to efficiently measure the impact of shape deformation on the QPRs' performance. The simulation results and their implication for the operational conditions of the QPR are discussed.

Founded by the German Federal Ministry for Research and Education BMBF under Contract No. 05H21HRRB1

AKBP 16.4 Thu 15:45 HSZ OG3

Design and Status of the Laser-Compton Backscattering Source at the S-DALINAC* — •Maximilian Meier, Michaela Arnold, Joachim Enders, and Norbert Pietralla — Technische Universität Darmstadt, Fachbereich Physik, Institut für Kernphysik, Darmstadt, Germany

Laser-Compton Backscattering (LCB) provides quasi-monochromatic highly polarized beams in the X-ray and gamma-ray regimes for a variety of applications. A powerful, stable, and well synchronized laser with a high repetition rate is essential for a high-flux Laser-Compton light source with narrow energy-bandwidth. This contribution presents the design of an LCB-based X-ray source at the Superconducting DArmstadt electron LINear ACcelerator (S-DALINAC), aimed at identifying optimum conditions for LCB photon sources for nuclear-photonics applications and accelerator science. At the LCB source a highly repetitive high-power laser beam will be scattered off the electron beam of the S-DALINAC. As a first step, the X-rays from LCB will be used as a diagnostic tool for determining the electron beam energy and the energy spread of the S-DALINAC. Later, combining LCB with the S-DALINAC's operation as an Energy Recovery Linac (ERL), is expected to yield X-rays at several 10s of keV with high brilliance.

*Supported by DFG (GRK 2128 'AccelencE' and Inst163/308-1 FUGG) and HMWK (cluster project ELEMENTS, ID 500/10.006, and research cluster LOEWE 'Nuclear Photonics')

AKBP 16.5 Thu 15:45 HSZ OG3

Development of a 6 GHz Cavity BPM for the Multi-Turn ERL Operation at the S-DALINAC* — •Manuel Dutine, Michaela Arnold, Aleksandar Dimitrov, Ruben Grewe, Lars Juergensen, Norbert Pietralla, Felix Schliessmann, and Manuel Steinhorst — Institut für Kernphysik, TU Darmstadt

The S-DALINAC is a thrice-recirculating electron accelerator operating in cw-mode at a frequency of 3 GHz. Due to the implementation of a path-length adjustment system capable of a 360° phase shift, it is possible to operate the accelerator as an Energy-Recovery LINAC [1]. The multi-turn ERL operation has been demonstrated in 2021 [2]. While operating the accelerator in this mode, there are two sets of bunches, the still-to-be accelerated and the already decelerated beam, with largely different absolute longitudinal coordinates in the same beamline. A 6 GHz resonant cavity Beam Position Monitor (cBPM) has been developed in order to measure the beam position of both, the accelerated and the decelerated beam simultaneously in the same beamline. A status update of the monitor will be given.

[1] M. Arnold et al., First operation of the superconducting Darmstadt linear electron accelerator as an energy recovery linac, Phys. Rev. Accel. Beams 23, 020101 (2020)

[2] F. Schliessmann et al., Realization of a multi-turn energy-recovery accelerator, Nat. Phys. (in press)

*Work supported by DFG (GRK 2128), BMBF (05H21RDRB1), the State of Hesse within the Research Cluster ELEMENTS (Project ID 500/10.006) and the LOEWE Research Group Nuclear Photonics.

AKBP 16.6 Thu 15:45 HSZ OG3

Design and first tests of a fast precision high voltage divider for the CRYRING electron cooler — •Ken Ueberholz, Timo Dirkes, Volker Hannen, and Christian Weinheimer — Westfälische Wilhelms-Universität Münster, Institut für Kernphysik

High-precision experiments performed on relativistic ions in storage rings and accelerators require a small momentum distribution of the ions. At the Cryring at ESR, electron cooling is the chosen technique, which overlaps the ion beam with a nearly mono-energetic electron beam. The electrons transfer their momentum via Coulomb interactions to the ions until the ion velocity has adjusted to the electron velocity. The energy of the ions is therefore set by the accelerating voltage of the electron cooler. Consequently, a precise knowledge of the voltage is needed for high-resolution spectroscopy and further experiments. These experiments include electron-ion collision experiments where the electrons of the cooler fulfill an additional function as a target for the ions. To conduct such experiments, the cooler voltage has to be stepped from the baseline cooling voltage to values differing by up to 1 kV during intervals of about 10 ms and still needs to be measured precisely. For this purpose, a fast precision divider has been developed, capable of measuring voltages up to 20 kV within a 10 ms interval with uncertainties in the 10 ppm range. The poster will present the design and construction of the new high-voltage divider and provide first results from test and calibration measurements.

This work is supported by BMBF under contract number 05P21PMFA1.

AKBP 16.7 Thu 15:45 HSZ OG3

Measurement of ω mesons in $\sqrt{s}$ = 13 TeV pp collisions at the LHC with ALICE — •Jens Lühder for the ALICE Germany-Collaboration — Institut für Kernphysik, Wilhelm-Klemm-Str. 9, 48149 Münster

Measurements of neutral mesons in small collision systems can serve as a baseline to understand modifications in heavy-ion collisions, where a QGP is formed. These measurements can also be used to test pQCD predictions and to constrain fragmentation functions as well as parton distribution functions. Furthermore, a precise knowledge of the ω-meson production improves the measurement of direct photons, as photons produced in ω meson decays represent the third largest contribution of decay photon background.

This poster presents the invariant cross section of the ω-meson in pp collisions at a center-of-mass energy of $\sqrt{s}$ = 13 TeV measured by ALICE via its dominant decay channel $\omega \rightarrow \pi^+\pi^-\pi^0$. While charged pions can directly be measured by the ALICE central barrel tracking detectors, neutral pions are reconstructed using their decay channel into two photons. This reconstruction is realized with several complementary methods using the ALICE calorimeters as well as the central barrel tracking detectors. The combined result covers an unprecedented p_T range with competitive statistical and systematic uncertainties.

AKBP 16.8 Thu 15:45 HSZ OG3

Aufbau und Inbetriebnahme eines optische Quellpunkt-Abbildungssystem für den BESSY II Booster — •Pauline Ahmels — Helmholtz-Zentrum Berlin

Das Ziel des Aufbaus ist die Messung der Elektronstrahlgröße im Booster. Dafür wird die Annahme getroffen, dass bei dem vorherrschenden Injecktor-Energielevel von 50 MeV bis 2GeV, die gestrahlten Photonen die Elektronenpakete darstellen.

Die Beamline besteht aus mehreren verstellbaren Linsen und Spiegeln und einer CCD-Kamera zur Messung der Normalverteilung der Photonen. Problemstellung ist, einen idealen Arbeitspunkt zu finden, wobei nach hoher Intensität und geringer Strahlgröße optimiert wird. Weiterhin soll dieser Zustand reproduzierbar sein.

Auf dem optischen Tisch steht noch eine Diode zur Messung der Bündellänge. Diese muss sehr genau und stabil getroffen, was mit Hilfe einem automatisierten Feedback-System realisiert wird.

AKBP 16.9 Thu 15:45 HSZ OG3

Characterization of an All-Optical Streak Camera (AOSC) by ultrashort laser pulses — •Lina Wübbena, Marc Osenberg, Michael Stumpf, and Georg Pretzler — Institute of Laser- and Plasmaphysics, University Düsseldorf

For experiments with two or more ultra-short particle or photon beams the mutual timing is crucial. In this poster we present an all-optical streak camera which is based on optical Kerr gating. The speciality of the setup is that it operates with single-shot measurements thus allowing shot-to shot jitter monitoring, for example. On our poster we will present a series of characterization experiments with sub-10-fs laser pulses. These experiments prove that the device's best temporal resolution is in the 10-fs regime, with a total time frame in the picosecond range which can be tuned by the angle of the gating beam in respect to the signal beam. We will also discuss various applications of this new technique.

AKBP 16.10 Thu 15:45 HSZ OG3

Characterization and optimization of laser-generated THz beam for THz based streaking — •Matthias Nabinger[1], Michael Johannes Nasse[1], Christina Widmann[1], Zoltan Ollmann[2], Erik Bründermann[1], and Anke-Susanne Müller[1] — [1]Karlsruher Institut für Technologie, Karlsruhe, Deutschland — [2]Universität Bern, Bern, Schweiz

At the Ferninfrarot Linac- Und Test-Experiment (FLUTE) at the Karlsruhe Institute of Technology (KIT) a new and compact method for longitudinal diagnostics of ultrashort electron bunches is being developed. For this technique, which is based on THz streaking, strong electromagnetic pulses with frequencies around 240 GHz are required. Therefore, a setup for laser-generated THz radiation using tilted-pulse-front pumping in lithium niobate was designed, delivering up to 1 microjoule of THz pulse energy with a conversion efficiency of 0.03 %.

In this contribution we study the optimization of the THz beam transport and environment.

AKBP 16.11 Thu 15:45 HSZ OG3

Investigations of two-dimensional laser polishing of niobium surfaces as a manufacturing process during the production of superconducting cavity resonators — •Florian Brockner and Dirk Lützenkirchen-Hecht — University of Wuppertal, Gauss-Str. 20, 42119 Wuppertal, Germany

Laser polishing (LP) has the potential to increase the electrical field gradients accessible in superconducting RF-cavities made of niobium, by substantially suppressing electron field emission. Thus extensive measurements were performed investigating which effects a planar LP has on the morphology and the microstructure of a niobium surface. Here we will report on a new experimental setup that allows LP under high vacuum conditions, with the capability to in-situ detect effects of the LP by measuring pressure changes, emitted electrical charges and the incident and reflected laser intensities, respectively. The change in surface properties as a result of the LP was subsequently investigated using SEM/EDX, optical profilometry and electron field emission measurements. The results show that moderate laser energies allow a cleaning of the Nb surfaces. Furthermore, local defects can be efficiently removed by LP. In addition, there is no direct relation between surface roughness and the onset fields for parasitic field emission after LP. Moreover, the orientation of individual grains within a large grain Nb sample seem to have a strong influence on the efficiency of the LP processes. This work was supported by the BMBF under grants no. 05H18PXRB1 and 05H21PXRB1.

AKBP 16.12 Thu 15:45 HSZ OG3

Recent Results from the Steady-State Microbunching Proof-of-Principle Experiment at the Metrology Light Source — •Arnold Kruschinski[1], Xiujie Deng[2], Jörg Feikes[1], Ji Li[1], Arne Hoehl[3], Roman Klein[3], and Markus Ries[1] — [1]Helmholtz-Zentrum Berlin, Berlin, Germany — [2]Tsinghua University, Beijing, China — [3]Physikalisch-Technische Bundesanstalt, Berlin, Germany

Steady-state microbunching (SSMB) has been proposed by Alex Chao and Daniel Ratner in 2010 to enable the generation of high-power coherent synchrotron radiation at an electron storage ring for wavelengths up to the extreme ultraviolet. The viability of the concept has been shown in a proof-of-principle (PoP) experiment at the Metrology Light Source (MLS) in Berlin. An enhanced detection scheme allows systematic studies of the conditions needed for the creation of microbunches within the continuing PoP experiment. It was found that the generation of coherent radiation from microbunches is favored in specific nonlinear longitudinal phase space structures, known as alpha buckets, which arise when the momentum compaction function becomes dominated by higher order terms. We present recent improvements to the experimental setup as well as newest results and their interpretation.

AKBP 16.13 Thu 15:45 HSZ OG3

Commissioning Status of the Frankfurt Neutron Source FRANZ LEBT and RFQ — •Hendrik Hähnel, Adem Ates, Christopher Wagner, Klaus Kümpel, Ulrich Ratzinger, and Holger Podlech — Institut für Angewandte Physik, Goethe Universität, Frankfurt am Main

The Frankfurt Neutron Source FRANZ will be a compact accelerator driven neutron source utilizing the $^7\mathrm{Li}(p,n)^7\mathrm{Be}$ reaction with a 2 MeV proton beam. Recent comissioning efforts showed succesful proton beam operation at the targeted RFQ injection energy of 60 keV up until the point of RFQ injection. The RFQ was retrofitted with new electrodes for the injection energy of 60 keV. We report on the status of comissioning of the beamline and RFQ

AKBP 16.14 Thu 15:45 HSZ OG3

Beamline Optimization for ELSA in Preparation for UHEE Flash Irradiation — •Miriam Lösgen, Daniel Elsner, Klaus Desch, Dennis Proft, and Michael Switka — Physikalisches Institut der Universität Bonn

The ELSA facility is optimized to deliver 3.2 GeV electrons to external experimental stations via slow resonance extraction. Research towards the usability of an intense ultra-high-energy electron beam (UHEE, Flash effect) for tumor cell irradiation requires an optimization of the ELSA storage ring operation mode. This includes adjustments of the extraction procedure, beam optics and extraction elements. The current status of investigation is presented.

AKBP 16.15 Thu 15:45 HSZ OG3

The Scraper System at S-DALINAC and ERL application — •M. Fischer, M. Arnold, M. Dutine, L. Jürgensen, N. Pietralla, F. Schliessmann, and D. Schneider — Institute for Nuclear Physics, Technische Universität Darmstadt, Germany

Scraper systems in particle accelerators are utilized for safely and efficiently removing undesired particles from the beam, e.g., those with too large momentum deviation or those belonging to the beam halo. They are of great importance for accelerators, in particular those with high energies and beam currents, where the risk of damage is high. In addition to the machine protection, the use of scraper systems can significantly improve the beam quality and reduce the experimental background. Also, such systems can be used for online beam diagnostics. Especially when operating an Energy Recovery Linac (ERL), it is important to prepare the beam for the return to the accelerator after the interaction with an experiment. In this contribution, we will present results of recent measurements with the High-Energy Scraper System of the S-DALINAC [1] and give an overview on the ongoing work. This work was supported by the state of Hesse within the cluster project ELEMENTS and within the LOEWE research project Nuclear Photonics

[1] N. Pietralla, Nuclear Physics News, Vol. 28, No. 2, 4 (2018).

AKBP 16.16 Thu 15:45 HSZ OG3

EXAFS study on role of grain boundaries and phase of Nb3Sn thin films — Nils Schäfer[1], Damian Günzing[2], Nail Karabas[1], Alexey Arzumanov[1], Debora Motta Meira[3], Katharina Ollefs[2], Philipp Komissinskiy[1], Stefan Petzold[1], •Márton Major[1], Dirk Lützenkirchen-Hecht[4], Heiko Wende[2], and Lambert Alff[1] — [1]Technical University of Darmstadt, Darmstadt, Germany — [2]University of Duisburg-Essen, Duisburg, Germany — [3]Argonne National Laboratory, Lemont, IL, USA — [4]University of Wuppertal, Wuppertal, Germany

In this contribution the low-temperature synthesis of Nb_3Sn, a promising material for superconducting radio frequency (SRF) application is presented. Theoretically Nb_3Sn is superior to Nb in surface resistivity, critical temperature and critical field, but in practice the performance is lacking behind due to early quenching at low fields. Co-sputtering at low sample temperature could overcome the microstructure-related limitations due to the high kinetic energy of the sputtered particles. Extended x-ray absorption fine structure analysis and x-ray absorption spectroscopy mapping were utilized to show the improved local order and elemental homogeneity of the Nb_3Sn films. Additionally, the presence of a grain-boundary network acting as Josephson-like junctions was found. Excellent elemental homogeneity and a good grain boundary state promoted by kinetic energy was demonstrated.

Work supported by BMBF through grant Nos. 05H21RDRB1, 05H21PXRB1 and DFG via the AccelencE Research Training Group (GRK 2128).

AKBP 16.17 Thu 15:45 HSZ OG3

Hydrodynamic plasma simulations of discharge capillary waveguides at FLASHForward for high-repetition-rate plasma-wakefield acceleration — •Advait Kanekar, G. Boyle, M. J. Garland, H. Jones, G. Loisch, S. M. Mewes, T. Parikh, S. Schröder, M. Thévenet, S. Wesch, J. Osterhoff, and R. D'Arcy — Deutsches Elektronen-Synchrotron (DESY)

Plasma-wakefield accelerators provide acceleration gradients several orders of magnitude larger than conventional accelerators, representing a promising technology for reducing the footprint of future particle accelerators. The luminosity in colliders and the brilliance in free-electron lasers scales with the repetition rate at which the accelerator operates. Therefore, high repetition rate is an important parameter to consider when developing plasma-based accelerators for these applications. FLASHForward is a beam-driven plasma-accelerator experiment at DESY that is unique in the field due to its ability to explore and develop concepts for MHz-repetition-rate operation. The capability to support such high repetition rates is strongly influenced by the functionality of the plasma source. Crucial physics effects including gas refill time and temporal evolution of 3D plasma profiles are in part determined by the cell geometry and gas/discharge properties. In this talk, 2D axisymmetric hydrodynamic plasma simulations of plasma cell designs are presented and compared. Through this a better understanding of current plasma-source designs and hints at how designs may be optimised in the future are revealed.

AKBP 17: Instrumentation III

Time: Thursday 17:30–18:45 Location: CHE/0183

AKBP 17.1 Thu 17:30 CHE/0183

Tracing Ionoacoustic Modulations of Broad Energy Distributions — •Alexander Prasselsperger, Felix Balling, Hans-Peter Wieser, Julia Liese, Anna K. Schmidt, Florian Schweiger, Ina Hofrichter, Katia Parodi, and Jörg Schreiber — LMU München, Fakultät für Physik - Medizinische Physik, Am Coulombwall 1, 85748, Garching

Modern laser-plasma based ion accelerators challenge particle detectors with very high beam intensities, strong EMP emission and tens of Hz repetition rates. This calls for new detector types for characterising ion-bunch characteristics. A first step towards this ambition is the ion-bunch energy acoustic tracing (I-BEAT) detector which measures the ionoacoustic signal generated by the energy deposition of energy-selected ion bunches in a water reservoir to reconstruct the incident energy spectrum [1]. Here we propose a new detector concept which expands the I-BEAT approach to arbitrary ion spectra by tracing ionoacoustic modulations of broad energy distributions (TIMBRE). By inserting modulator foils into the water reservoir the deposited energy distribution and the ionoacoustic wave are modulated which allows to reconstruct the ion spectrum on-line by measuring these modulations. The detector is placed within centimetre range behind the laser target to collect most of the accelerated particles. It inherently is EMP and saturation resistant and allows re-usability as the water reservoir does not suffer from major radiation damage. A minimum sensitivity to ion fluences of $\approx 10^4$ $protons/mm^2/bunch$ is predicted.

[1] D. Haffa et al. Sci. Rep. 9 (2019) 6714

AKBP 17.2 Thu 17:45 CHE/0183

Acoustic Measurement of the Energy Deposition of Heavy Ions in Water at 4°C — •Anna-Katharina Schmidt, Julia Liese, Alexander Prasselsperger, Felix Balling, Sonja Gerlach, Martin Speicher, Walter Assmann, and Jörg Schreiber — LMU München, Fakultät für Physik - Medizinische Physik, Am Coulombwall 1, 85748 Garching

Energy deposition of ions in water leads to the emission of a pressure, i.e. ionoacoustic wave. It is commonly described in the thermoacoustic approximation, that is, localized heating and volume change is considered as prime cause of the wave. If this was true, no pressure wave is expected at 4°C, which was indeed observed after localized absorption of light. Contrary, when initiated by protons, this minimum is shifted to significantly higher temperatures of around 4.5°C, hinting towards an additional, non-thermal excitation mechanism that has not yet been understood and is referred to as "charge effect" in the literature [1]. We want to investigate this effect, which as of today lacks an explanation, experimentally for femto-second laser induced water plasmas and heavy ions with higher charge than protons for the first time by measuring the polarity change of the pressure wave around the water anomaly at 4°C. Understanding the non-thermal effects has potential implications for completely new measurement principles, could open up new insights into the fast, pre-thermal processes and even help classifying the relevance of mechanically induced radiation damage.This work is supported by GSI-LMU F&E cooperation LMSCH2025.

[1] R. Lahmann et al. Astroparticle Physics 65 (2015): 69-79.

AKBP 17.3 Thu 18:00 CHE/0183

Characterization of low-density gas targets for wake driven plasma field using high harmonics — •Piet Leyendecker, Marc Osenberg, Dirk Hemmers, Bastian Hagmeister, and Georg Pretzler — Institute of Laser- and Plasmaphysics, University Düsseldorf

Low-density gas jets are a crucial part for wake driven plasma accelerators. Measuring the spatial and temporal density profile is challenging with common methods. Fortunately, the used gases have high and varying absorption rates in the XUV. Using high harmonics, we can detect the absorption for different wavelengths simultaneously. This method allows to determine the gas density even for hydrogen and helium down to the $10^{17}\,cm^{-3}$ regime. In this talk we will discuss the setup and challenges for this rarely used method, and we show actual results.

AKBP 17.4 Thu 18:15 CHE/0183

Time-Resolved Interferometric Measurement of Ultrasound Pulses in Water — •Julia Liese, Anna-Katharina Schmidt, Alexander Prasselsperger, Jens Hartmann, and Jörg Schreiber — LMU München, Fakultät für Physik - Medizinische Physik, Am Coulombwall 1, 85748 Garching

Current development in laser-driven ion acceleration demands for reliable techniques for ion beam monitoring. The ultra-short and intense ion bunches with a broad spread in energy are a challenge for conventional beam detectors. Our group recently presented a new approach for online detection of laser-accelerated ions referred to as Ion-Bunch Energy Acoustic Tracing (I-BEAT) [1]. This method is based on measuring the pressure pulse induced by ions stopping in water with piezoelectric transducers. Here, we investigate an optical method based on measurements of the refractive index change associated with the pressure pulse by femtosecond laser pulse probing. In contrast to transducer measurements, we can thus study the volume of the pressure pulse origin directly. To this end, an interferometric setup was tested in first experiments with ultrasound pulses generated by a piezoelectric transducer. Experimental results show temporally resolved images of the ultrasound pulse and reveal characteristics of the ultrasound pulse in agreement with theory. Within an ongoing project funded by the DFG (491853809), the pressure waves originating from laser-accelerated ions will be investigated optically to facilitate new insights into the fast dynamics of ion energy deposition.

[1] D. Haffa et al., Sci. Rep. 9 (2019), 6714.

AKBP 17.5 Thu 18:30 CHE/0183

Analysis of Real Materials for the RF Window of a GHz Transition Radiation Monitor — •Stephan Klaproth[1,2], Herbert De Gersem[2], and Andreas Penirschke[1] — [1]Technische Hochschule Mittelhessen, Friedberg, Hessen — [2]TU Darmstadt, Darmstadt, Hessen

State of the art measurement devices for longitudinal beam profiles typically include Feschenko monitors, Fast Faraday Cups, and field monitors. A novel approach of a GHz diffraction radiation monitor is able to non-destructively measure the longitudinal charge distribution of each micro-bunch within a bunch-train of a heavy ion beam. In this contribution, we compare several vacuum-grade, dielectric materials for the monitor's rf window aiming at signals as strong and well distinguishable as possible with beam energies of $\beta = 0.05$ to 0.75. To achieve this, numerical field simulations were performed with CST Particle Studio® to investigate the influence of different window materials on the signal strength.

AKBP 18: Beam Dynamics II

Time: Thursday 17:30–18:45 Location: CHE/0184

AKBP 18.1 Thu 17:30 CHE/0184

beam dynamics simulation and optimization of an electron beam for magnetic bunch compressor commissioning at PITZ — •Ekkachai Kongmon, Prach Boonpornprasert, Xiangkun Li, Mikhail Krasilnikov, Frank Stephan, Namra Aftab, Dima Dmytriiev, Grygorii Vashchenko, Georgi Georgiev, Christopher Richard, Anne Oppelt, and Matthias Gross — Deutsches Elektronen-Synchrotron DESY, Platanenallee 6, 15738, Zeuthen, Germany

A THz free electron laser (FEL) prototype has been developed at the Photo Injector Test Facility at DESY in Zeuthen (PITZ) for obtaining high intensity radiation for THz-pump-X-ray-probe experiments at the European XFEL. In this development, a magnetic chicane was recently installed to enhance the THz FEL performance. The aim of this study was to investigate the beam dynamics in the chicane for finding the optimum machine parameters for an electron beam transportation in the experiment. The simulation was performed via ASTRA software using a 3-dimensional magnetic field of the chicane simulated with CST-EM Studio. Furthermore, the influences of the Coherent Synchrotron Radiation (CSR) on the electron beam were studied by using the OCELOT code. The simulated results indicate the possibility of obtaining on-axis trajectory and zero-momentum dispersion of the compressed beam. The commissioning results are also reported in this presentation.

AKBP 18.2 Thu 17:45 CHE/0184

Measurement of emittance and spatial coherence for low intensity electron beams — •Benat Alberdi-Esuain — Helmholtz-Zentrum Berlin, 12489 Berlin — Humboldt-Universität zu Berlin, 12489 Berlin

The SRF-Photoinjector is a superconducting linear electron accelerator currently being commissioned in Helmholtz-Zentrum Berlin. It is able to provide a very broad range of beam parameters, which enables applications of the injector that go beyond its original operation purpose as an ERL technology demonstrator. The ultra-short bunch length, high repetition rate and low achievable emittances make the SRF Photoinjector an ideal candidate for Ultrafast Electron Diffraction (UED) and direct imaging experiments with the aim of imaging biological molecules in gas or liquid solutions. The first stage of the development of UED capabilities in HZB consists of a static UED experiment to prove that the spatial resolution required for UED experiments can be achieved. To monitor the performance of the experiment the diagnostics of transverse beam parameters is necessary, which is challenging to do with traditional techniques given the small emittances and low bunch charges. In this work we present the results of the measurement of transverse normalized emittance and spatial coherence length with appropriate methods for UED experimental conditions. The experiments were carried out at the UED user facility in KAERI, in South Korea, with the goal of developing the capabilities for beam monitoring for when the SRF Photoinjector in HZB becomes operational.

AKBP 18.3 Thu 18:00 CHE/0184

Influence of the Complex Filling Patterns on the Results of the Transverse Beam Size Measurements with the Interferometric Technique — •Irma Shmidt, Ji-Gwang Hwang, Gregor Schiwietz, and Andreas Jankowiak — Helmholtz-Zentrum Berlin

The transverse size of the electron beam in a storage ring can be measured using the synchrotron radiation of a bending magnet. Due to the diffraction limit, many facilities exploit beam size monitors in the X-ray regime. On the other hand, the visible part of the emitted radiation delivers spatial information via an interference pattern after passing through a double slit. Assuming a Gaussian beam distribution the size of the beam can be easily obtained with an analytical formula. If this assumption is not fulfilled, the calculated beam shape will vary from the real distribution. This can appear for instance in case of exotic beam optics settings or complicated filling patterns, that are widely used in modern storage-ring-based light sources. Influence of the additional electron distribution with larger emittance on the measurement of the transverse size of the multi-bunch train with the usual interferometric method will be discussed in this presentation.

AKBP 18.4 Thu 18:15 CHE/0184

Investigations of TRIBs in BESSY III design lattices — •Michael Etienne Arlandoo — Helmholtz-Zentrum Berlin — Humboldt-Universität zu Berlin

At HZB's BESSY II and PTB's Metrology Light Source (MLS), resonances and islands in transverse phase space are exploited in a special operation mode usually referred to as Transverse Resonance Island Buckets (TRIBs). This mode provides a second stable orbit well separated from the main orbit and one of its applications in photon science is the ultra-fast switching of the helicity of circularly polarized light pulses. In the context of the conceptual design study of BESSY III, investigations have already started to study the feasibility of the implementation of this special optics mode in the MBA lattice candidates. Here, we present some studies, fundamental and applied, regarding the implementation of TRIBs in the context of BESSY III lattice design.

AKBP 18.5 Thu 18:30 CHE/0184

Turn-by-turn Measurements of the Energy Spread at Negative Momentum Compaction Factor at KARA — •Christian Goffing[1], Erik Bründermann[1], Michele Caselle[1], Stefan Funkner[1], Gudrun Niehues[1], Marvin-Dennis Noll[1], Meghana Patil[1], Patrick Schreiber[1], Johannes Steinmann[1], Anke-Susanne Müller[1], Giovanni Paternoster[2], Maurizio Boscardin[2], and Matteo Centis Vignali[2] — [1]KIT, Karlsruhe, Germany — [2]FBK, Trento, Italy

The Karlsruhe Research Accelerator, the storage ring KARA at KIT, allows short electron bunch operation with positive as well as negative momentum compaction factor. For both cases, the beam dynamics are studied. Using the KALYPSO (KArlsruhe Linear arraY detector for MHz rePetition rate SpectrOscopy) linear array, based on TI-LGAD, the horizontal intensity distribution of the emitted visible part of the synchrotron radiation is measured at a 5-degree port of a bending magnet on a turn-by-turn time scale. Because the measurement is located at a dispersive section, the dynamics of the energy spread can be studied by measuring the horizontal bunch profile. The acquisition rate at MHz-frequencies and the low-charge sensitivity of the line camera allow the investigation of the microbunching instability. This contribution presents the results of the bunch profile measurements performed at positive and negative momentum compaction factor.

AKBP 19: Members' Assembly

Time: Thursday 19:00–20:00 Location: CHE/0091

All members of the Working Group on Accelerator Physics are invited to participate.

Working Group on Equal Opportunities
Arbeitskreis Chancengleichheit (AKC)

Agnes Sandner
Sprecherin des AKC
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Overview of Invited Talks and Sessions

(Lecture hall HSZ/0004)

Invited Talks

AKC 1.1	Wed	11:00–11:45	HSZ/0004	**What's wrong with me?** — •Pauline Gagnon
AKC 1.2	Wed	11:45–12:30	HSZ/0004	**Workplace cultures in physics as a game changer for equal opportunities** — •Martina Erlemann
AKC 1.3	Wed	12:30–13:00	HSZ/0004	**Belonging – a key to success in STEM?!** — Lennart Brademann, Denise Dörfel, •Barbara M. Gordalla, Anika Ihmels

Sessions

AKC 1.1–1.3	Wed	11:00–13:00	HSZ/0004	**AKC**

Sessions

– Invited Talks –

AKC 1: AKC

Time: Wednesday 11:00–13:00 Location: HSZ/0004

Invited Talk AKC 1.1 Wed 11:00 HSZ/0004
What's wrong with me? — •Pauline Gagnon — CERN, Geneva
Why are sexism, homophobia and racism still so prevalent in physics? I start from my personal experience to demonstrate that in fact the personal is political. CERN, the largest physics laboratory in the world, welcomes scientists from 118 nationalities but still 80% of them are white and 80% are male. I examine why this is so by reviewing many contributing factors and suggest a series of easily applicable measures that could greatly improve the situation. These measures would benefit all scientists, regardless of their gender, race, sexual orientation, physical ability or religion. It has been established that diversity benefits science by increasing the creativity potential, a key ingredient to in scientific research.

Invited Talk AKC 1.2 Wed 11:45 HSZ/0004
Workplace cultures in physics as a game changer for equal opportunities — •Martina Erlemann — FU Berlin, FB Physik
In recent decades there has been a growing awareness that a scientist's gender can have an impact on a career in physics, even though it should have no influence. This applies also for ethnicity or national background, social background, and other social characteristics which can have a detrimental impact on a career in science. The talk will present research on gender and diversity in physics, with a particular focus on studies of workplace cultures in physics and their impact on young scientists' sense of belonging to the physics community. It will be argued that improving the workplace cultures can be a game changer in combating discrimination and diversifying the physics community, which would also benefit physics research.

Invited Talk AKC 1.3 Wed 12:30 HSZ/0004
Belonging – a key to success in STEM?! — Lennart Brademann, Denise Dörfel, •Barbara M. Gordalla, and Anika Ihmels — Fakultät Psycholigie, Inst. Arbeits-, Organisations- und Sozialpsychologie, TU Dresden
Women continue to be underrepresented in science, technology, engineering or mathematics (STEM) fields as students and also in professional roles. What factors influence women's choice, persistence, and success?

In the US, studies evidenced that women do not feel like they belong in STEM community: they experience an impeding study climate (also called *chilly climate*) or suffer from stereotypical views on possible careers. This results in a decreased desire to choose a STEM carrier (for an overview see Shapiro & Sax, 2011). The probability to drop out of the program (Höhne & Zander, 2019b; Peters et al., 2015) is increased in the case of high *belonging uncertainty*, or when there is a conflict between an occupational stereotype and one's self-description.

The talk presents results from an online survey conducted among students, focusing on the field of physics. 122 physics students (40% female) completed it regarding success in studying physics (GPA, number of last attempts for an exam), turnover intention, chilly climate (e.g. exclusion, hostility), expectation of success (e.g. perceived potential, sense of belonging (e.g. belonging uncertainty), identification with physics, enjoyment, interest, a list of adjectives to describe oneself and to describe a *successful physicist*, and sociodemographic variables.

Results revealed lower social belonging and higher belonging uncertainty as well as a worse stereotype fit for women as compared to non-female students. Espepcially, social belonging turned out to be the most important predictor for GPA, identification, turnover intention, interest, enjoyment, perceived potential and self-efficacy. Social belonging hence was identified as an important influencing factor to enhance women's interest, persistence, and success in STEM. Therefore, this factor demands for more attention in the future, both in research and in actual working environments - for a continued success of Germany in STEM fields.

Working Group on Energy
Arbeitskreis Energie (AKE)

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Affordable, reliable and climate protecting energy supply is indispensable for a real sustainable development. Physics, engineering and many more sciences contribute to this objective. The following 3 sessions on concepts and technologies, energy supply, and perspectives for the future present three invited talks and 7 submitted contributions. They reflect needs for enhancing a sound energy system, including societal and political questions.

Overview of Invited Talks and Sessions

(Lecture hall GER/038)

Invited Talks

AKE 1.1	Mon	11:00–11:30	GER/038	**Zellulare Energiesysteme – Zukunft der Energietechnik ?** — •Joachim Seifert, Peter Schegner
AKE 2.1	Mon	16:30–17:00	GER/038	**The German primary energy consumption – status and trends** — •Larissa Breuning, Alexander von Müller, Andjelka Kerekeš
AKE 3.1	Tue	17:00–17:30	GER/038	**Activation calculations for decommissioning planning of NPPs** — •Reuven Rachamin, Jörg Konheiser, Marcus Seidl

Sessions

AKE 1.1–1.6	Mon	11:00–12:45	GER/038	**Konzepte und Technologien**
AKE 2.1–2.2	Mon	16:30–17:30	GER/038	**Energieversorgung**
AKE 3.1–3.3	Tue	17:00–18:15	GER/038	**Zukunftsperspektiven**

Sessions

– Invited and Contributed Talks –

AKE 1: Konzepte und Technologien

Time: Monday 11:00–12:45 Location: GER/038

Invited Talk AKE 1.1 Mon 11:00 GER/038

Zellulare Energiesysteme – Zukunft der Energietechnik ? — •Joachim Seifert[1] und Peter Schegner[2] — [1]TU Dresden, Institut für Energietechnik — [2]TU Dresden, Institut für Elektrische Energietechnik und Hochspannungstechnik

Energetische Systeme sind aktuell meist hierarchisch organisiert und bestehen aus großtechnischen Systemen die zentral unterschiedliche Primärenergien in Sekundärenergien wandeln, die dann den Verbrauchern über Leitungssysteme zugeführt werden. Durch die Energiewende wandeln sich diese unidirektionalen Systeme zu multidirektionalen Systemen. Consumer werden zu Prosumern, wodurch eine andere Systemarchitektur entsteht. Das Konzept der zellularen Energiesysteme besitzt zur Einbindung von dezentral erzeugten erneuerbaren Energien deutliche Vorteile, da auf lokaler Ebene schon versucht wird einen Ausgleich unterschiedlicher Verbrauchs- und Erzeugungswerte zu erreichen. Orientieren kann man sich hierbei an dem biologischen Konzept einer Zelle. Im energetischen Kontext ist die Zelle hierbei jedoch nicht scharf definiert. Sie kann als ein Gebäude, ein Quartier oder eine Region aufgefasst werden. Im Vortrag soll der Ansatz des zellularen Energiesystem detailliert erläutert werden. Die betrifft die systemischen Anforderungen, das Konzept von Energietrendbändern sowie die zum Betrieb notwendige Kommunikationstechnik. Abgerundet wird der Vortrag durch Praxisbeispiele.

AKE 1.2 Mon 11:30 GER/038

Numerical Simulation of the coating process for organic photovoltaics — •Fabian Gumpert[1], Annika Janssen[1,2], Andreas Distler[2], Christoph J. Brabec[2], Hans-Joachim Egelhaaf[2], and Jan Lohbreier[1] — [1]Nuremberg Institute of Technology, Nuremberg, Germany — [2]Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Germany

In various industrial applications, the doctor blading process is a well-established technique to coat thin films. In the context of organic photovoltaics, functional layers like electrodes, active materials, and interfacial layers are printed using this technique. For the performance and lifetime of the final photovoltaic devices, the thickness precision and uniformity of the individual layers is crucial.

Computational Fluid Dynamics (CFD) simulations and experiments are used to study the effect of various parameters on the film formation during doctor blading. For example, a numerically simulated correlation between coating speed and wet film thickness is established and found to match the experimental findings.

With the help of these CFD simulations, process parameters and resulting film thicknesses can be predicted based on simple fluid characteristics such as viscosity and surface tension. Furthermore, the observed decrease in the wet film thickness over printed distance, which relates to the decreasing volume in the meniscus, can be compensated by a calculated acceleration of the applicator during the coating process to drastically increase the distance range of homogeneous coating by doctor blading.

AKE 1.3 Mon 11:45 GER/038

Multiphysical simulation of the temperature distribution in a PEM-Fuel Cell — •Lara Kefer, Fabian Gumpert, Susanne Thiel, Maik Eichelbaum, and Jan Lohbreier — Nuremberg Institute of Technology, 90489 Nuremberg, Germany

Polymer electrolyte membrane fuel cells (PEM-FC) are a key technology for converting chemical energy from - ideally green - hydrogen into electrical energy. However, the electrochemical processes in a fuel cell also generate heat, which is crucial for the cell's performance and difficult to detect by experiments.

The heat generated in these exothermic chemical reactions and the external heating for the operating temperature were numerically simulated. The temperature field affects the relative local humidity, which has a strong influence on the local and global performance of the cell. Therefore, the three-dimensional temperature distribution was modelled, and the resulting voltage-current curves were computed. The latter are commonly used to characterize the properties of a fuel cell as a source of electric power.

The simulations show a temperature increase of the inner layers of the fuel cell due to the electrochemical reactions. The temperature of the cooler working gases (H_2, O_2) approaches the externally defined operating temperature of the fuel cell. This effect can also be seen in experimental data. The simulated U-I characteristics have the same overall shape as the experimentally determined characteristics and both reveal a decrease in the performance of the cell at higher temperatures.

AKE 1.4 Mon 12:00 GER/038

Photocatalytic conversion of carbon dioxide into methane for solar fuel production using a TiO2 functionalized thin-film micro-reactor — •Sebastian Thalheim — Fraunhofer ISE, Freiburg, Deutschland

The increasing concentration of greenhouse gases in the Earth's atmosphere is a major contributor to climate change. Carbon dioxide, a key greenhouse gas, is produced by fossil fuel combustion and industrial processes. The reverse combustion reaction offers a useful approach for converting carbon dioxide into hydrocarbons, such as methane, for use as a renewable fuel source and therefore contributing to a closed-carbon-dioxide cycle. However, the reverse combustion reaction requires significant amounts of energy for activation. Photocatalysis, which uses light to reduce the activation energy required, offers a potential solution to this challenge. By using renewable energy to drive the photocatalytic reaction, we can minimize the carbon footprint of the conversion process.

We propose a setup for the continuous conversion of carbon dioxide into methane using a photocatalytic TiO2 functionalized thin-film micro-reactor. We aim to identify the most influential parameters and optimize the reactor design and photocatalytic material to maximize Solar-To-Gas efficiency. This approach has the potential to make the conversion process more efficient and scalable. A life-cycle analysis will be performed to assess ecological sustainability, economic scalability, and the potential for carbon capture and usage of this emerging technology.

AKE 1.5 Mon 12:15 GER/038

Development of a loss model for dynamic inductive charging — Fabian Gumpert[1], •Michael Schmidt[1,2], Armin Dietz[1,2], and Jan Lohbreier[1] — [1]Nuremberg Institute of Technology, 90489 Nuremberg, Germany — [2]Institute ELSYS, Nuremberg, Germany

The electrification of vehicles is a promising approach to reduce the carbon footprint of the mobility sector. However, this approach still faces several challenges, for instance the limited range - or high battery weight - of electric vehicles. A possible solution to this limitation is an electrified road system (ERS) where coil segments are integrated into the road. An electric vehicle with a receiver module can charge inductively its battery while driving on these roads.

Analytical and numerical (Finite-Element-Method) simulations are used to model the ERS and the inductive charging of the vehicle to investigate the occurring losses. In detail, FEM simulations are used to investigate the efficiency of the power transfer from the transmitter coil within the ERS to the receiver coil, moving onboard the vehicle, under various conditions.

The coil segments in the ERS are supplied with a high-frequency square-wave voltage. To investigate all loses of the system it is necessary to develop a measurement device. The fundamental frequency of the voltage signal is roughly 90 kHz. The device can measure up to one MHz in order to detect high harmonics of the fundamental frequency. The concept of the measurement setup and first experimental results, which demonstrate the capability of the setup, are presented.

AKE 1.6 Mon 12:30 GER/038

Gigantisch große Hydrokavernenspeicher in Braunkohleabbaustätten zur nahezu verlustfreien Überbrückung von Kurzzeitschankungen in Energieerzeugung und Verbrauch — •Horst Schmidt-Böcking[1], Gerhard Luther[2] und Joachim Schwister[3] — [1]Institut für Kernphysik, Universität Frankfurt, Max-von-Laue Str.1, 60438 Frankfurt — [2]FSt. Zukunftsenergie (FZE), Experimentalphysik - Bau E26, Universität des Saarlandes, 66123 Saarbrücken — [3]Technischer Beigeordneter a.D., Berrenrather Str. 9, 50169 Kerpen

Die Energiespeicher-Technologie „Grüner Wasserstoff" alleine ist nicht in der Lage, bei nahezu 100%iger Erzeugung von der in Deutschland für die Energiewende benötigten elektrischen Energie die sogenannten Spitzen in der Energieerzeugung am Tage (wenn Sonne und Wind überdurchschnittlich viel Energie liefern) verlustfrei zu speichern oder nachts verlustfrei Strom zu liefern. In diesen Nachtflauten muss man dann Wasserstoff rückverstromen, wobei der Wirkungsgrad für die nutzbare Rückverstromung bezogen auf den primären Strom bei nur ca. 30% liegt. Durch eine Kombination von „Grüner Wasserstoff Technologie" mit einem Hydrokavernenspeicher (ca. 0,5 TWh pro Speicherzyklus oder größer) als Kurzzeitspeicher (Stunden, Tage), kann eine wesentlich verlustärmere Technologie zur Energiespeicherung in Deutschland aufgebaut kann, die die Verluste weitgehend eliminiert und damit Elektrizität von hunderten TWh/pro Jahr zu sehr niedrigen Kosten für die Industrie und auch für den kleinen Verbraucher nachhaltig bereit hält.

In den zu flutenden Braunkohleabbaustätten (z.B. Hambach, Garzweiler, Schleenhain, Cottbus etc.) kann man Hydrokavernenspeicher von gigantischer Kapazität (z.B. Hambach bis zu 0,5 TWh pro Zyklus) errichten. Das Prinzip und der Aufbau eines solchen Kavernenspeichers auf dem Boden einer gefluteten Braunkohleabbaustätte wird im Vortrag besprochen.

AKE 2: Energieversorgung

Time: Monday 16:30–17:30 Location: GER/038

Invited Talk AKE 2.1 Mon 16:30 GER/038

The German primary energy consumption – status and trends — •Larissa Breuning[1], Alexander von Müller[2], and Anđelka Kerekeš[1] — [1]Technical University of Munich (TUM), Lichtenbergstraße 4a, 85748 Garching, Germany — [2]Max Planck Institute for Plasma Physics (IPP), Boltzmannstraße 2, 85748 Garching, Germany

Like the gross domestic product (GDP), the primary energy consumption (PEC) is a highly aggregated indicator. The primary energy consumption characterizes the energy content of all energy sources used domestically. Energy sources like lignite, hard coal, mineral oil, or natural gas, are either used directly or converted into so-called secondary energy sources such as fuels, electricity, or district heating. In the longer term, PEC will be influenced by technological progress and the associated improvements in energy efficiency, by sectoral and intersectoral structural changes, but also by price-driven substitution processes.

This presentation summarizes the composition of PEC in Germany, how cross-border trade of primary energy is structured and which challenges in the field of energy supply Germany is likely to face in the future. In this context, the year 2019 - before the COVID-19 pandemic and the Russia-Ukraine war - serves as a reference year against which the current energy consumption is compared in order to point out changes resulting from these recent and disruptive developments.

AKE 2.2 Mon 17:00 GER/038

Das Windenergiepotenzial Deutschlands: Grenzen und Konsequenzen grossräumiger Windenergienutzung — •Axel Kleidon — Max-Planck-Institut für Biogeochemie, Jena, Deutschland

Die Windenergienutzung in Deutschland soll bis 2050 mit bis zu 200 Gigawatt ausgebaut werden, was in etwa einer Vervierfachung im Vergleich zu heute entspricht. Diese Windturbinen werden der Atmosphäre dabei Windenergie entziehen, um Strom zu produzieren, und damit die Atmosphäre beeinflussen. Dies wirkt sich auf die Effizienz der Windenergienutzung aus, weil die Windgeschwindigkeiten in den Regionen, wo Windenergie genutzt wird, sinken müssen. Sie lassen sich mithilfe der Impulsbilanz und den damit verbundenen kinetischen Energieflüssen abschätzen. Dies zeigt, dass die durch die Windturbinen reduzierten Windgeschwindigkeiten bei 200 GW Ausbau den Stromertrag um etwa 10 - 15% verringern werden. Der Effekt ist geringer, wenn die Windturbinen gleichmäßiger über mehr Fläche besser verteilt sind. Trotz dieser Effekte lässt sich mit der Windenergie sehr viel Strom erzeugen, die betrachteten Szenarien würden mehr als die Hälfte des gegenwärtigen Strombedarfs damit decken. Die Auswirkungen auf die Atmosphäre sind aber sehr gering. Die erzeugte Windenergie beträgt lediglich 2.4% des Verlusts an kinetischer Energie, die ganz natürlich durch Reibung in der unteren Atmosphäre verloren geht.

Discussion

AKE 3: Zukunftsperspektiven

Time: Tuesday 17:00–18:15 Location: GER/038

Invited Talk AKE 3.1 Tue 17:00 GER/038

Activation calculations for decommissioning planning of NPPs — •Reuven Rachamin[1], Jörg Konheiser[1], and Marcus Seidl[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]PreussenElektra GmbH, Hannover, Germany

By the middle of 2023, all German nuclear power plants (NPPs) will have been shut down. The final shutdown is followed by a post-operational phase in which measures can be carried out to prepare for the NPPs dismantling and decommissioning. One of the essential tasks in planning and preparing an NPP for decommissioning is to obtain precise knowledge of the activation levels in its reactor pressure vessel (RPV), the biological shielding, and other internal components. In that regard, a novel method based on the combined use of two Monte Carlo codes, MCNP6 and FLUKA2021, was developed to serve as a nondestructive tool for evaluating the activation in an NPP. The presentation will give an overview of the methodology and demonstrate its application through the activation calculations of selected components of a German pressurized water reactor (PWR), which is the most common NPP type in Germany.

AKE 3.2 Tue 17:30 GER/038

Ist eine globale Energiekrise noch zu verhindern und wenn ja, wie? — •Michael Düren — Zentrum für internationale Entwicklungs- und Umweltforschung, Univ. Gießen, Germany

Die globalen Klimaveränderungen werden verheerende Folgen insbesondere für die Welternährung haben, möglicherweise bis hin zum Kollaps der Zivilisationen. Um fatale Klima-Kipppunkte sicher zu verhindern, fordert die Wissenschaft eine schnelle Reduktion der Netto-CO2-Emission herunter bis Null im Jahr 2040. Ein Herunterfahren der fossilen Emittenten hat unausweichlich eine globale Primärenergielücke in der Größenordnung von 136 TWh/Jahr, also 15506 GW zur Folge.

Dazu kommen berechtigte Ansprüche der armen Länder ihren geringen pro-Kopf-Energieverbrauch in den kommenden Jahren dem unseren anzugleichen, sowie ein erhöhter Energieverbrauch durch die Produktion von neuen, nachhaltigen Kraftwerken, zur Reparatur von Klimaschäden und möglicherweise ein hoher Energiebedarf für das Einfangen von CO2 aus der Atmosphäre.

Werden wir es schaffen können mit extremer Geschwindigkeit innerhalb von 18 Jahren so viele neue Kraftwerke zu bauen oder Energie massiv einzusparen? Gibt es global abgestimmte Roadmaps für die Energiewende und welche Ansätze gelten als erfolgversprechend?

AKE 3.3 Tue 17:45 GER/038

Die Zeitenwende erfordert eine ideologiefreie Energiewende: Von der Grundlastdeckung zur Lückenlastdeckung — •Helmut Alt — FH Aachen

Die am 08.12.2021 im Regierungsamt vereidigte erste Ampel-Bundesregierung will die Erneuerbaren Energien zielstrebig mit festen Zielvorgaben ausbauen. Dazu sind folgende Randbedingungen vorgegeben:

Der Beitrag zur Deckung unseres Brutto-Strombedarfs bis 2030 durch regenerative Energieerzeugung auf der Basis von Wasserkraft, Biomasse, Solar- und Windenergie soll sich auf 80% erhöhen und damit gegenüber derzeit in 2021 mit etwa 233,6 Mrd. kWh (39,7%) verdoppeln, um die Klimaerwärmung auf 1,5 °C zu begrenzen. Bis 2050 werden 100 % Lastdeckung durch regenerative Energien angepeilt.

In diesem Beitrag wird auf die wetterabhängige Verfügbarkeit der dem Anlagenzubau zuzuordnenden Leistung der installierten Solar- und Windenergieanlagen explizit hingewiesen. Es wird gezeigt, dass die vorgenannten Zielvorgaben auf Basis kumulierter Arbeitswerte nur bei alternativ vorhandenen Kraftwerken auf der Basis speicherbasierter Primärenergien, wie dies bei Kohle- oder Kernenergie der Fall ist, zu realisieren sind. Um die gesicherte Leistung in der bisherigen Größenordnung der Leistungsverfügbarkeit von bisher 99,99999 % d.h. mit 7 Neunerstellen zu gewährleisten, ist eine Reservekapazizät von rd. 15 % über der zu ersetzenden Nennleistung vorzuhalten. Erwartungswerte in der Größenordnung von 99 %, wie oft vorgetragen, sind nicht zielführend. Dem ist leider so, es sei denn, man ist bereit, die Versorgungssicherheit dem "wetterbedingten Zufall von Wind und Sonne" unterzuordnen, da wettbewerblich bezahlbare Stromspeicher in der Größenordnung von rd. 8 TWh nicht verfügbar sind und es auch in denkbarer Zukunft aus physikalischen Gründen auch nicht sein werden.

Discussion

Working Group "Young DPG"
Arbeitskreis junge DPG (AKjDPG)

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Overview of Invited Talks and Sessions

(Lecture hall ZEU/0148)

Invited Talks

AKjDPG 1.4	Thu	16:00–16:45	ZEU/0148	**Open data and open-source tools throughout research data life cycle: KCDC example** — •Victoria Tokareva

Sessions

AKjDPG 1.1–1.5	Thu	14:00–17:30	ZEU/0148	**Hacky Hour (joint session AKjDPG/AGI)**

Sessions

– Invited Talks, Contributed Talks, and Posters –

AKjDPG 1: Hacky Hour (joint session AKjDPG/AGI)

Time: Thursday 14:00–17:30 Location: ZEU/0148

AKjDPG 1.1 Thu 14:00 ZEU/0148

Adamant: A JSON-Based Metadata Editor for Researchers — •Ihda Chaerony Siffa, Marjan Stankov, and Markus M. Becker — Leibniz Institute for Plasma Science and Technology (INP), Felix-Hausdorff-Straße 2, 17489 Greifswald, Germany

Adamant is a browser-based research data management (RDM) tool, specifically developed to systematically collect research metadata that is both machine- and human-readable. It utilizes the JavaScript Object Notation (JSON) schema specifications, where any valid schema can be rendered as an interactive and user-friendly web form. Users may create a JSON schema from scratch or provide an existing schema. Subsequently, users can provide inputs to the rendered form and generate a JSON document, which can be downloaded for further use. Adamant has found its usage in several research settings; namely, compilation of structured experiment metadata in conjunction with a generic electronic laboratory notebook, scientific instrument job requesting, and preparation of input data for plasma simulations. Overall, Adamant is an emerging generic RDM tool that eases day-to-day research activities as far as structured metadata is concerned.

AKjDPG 1.2 Thu 14:45 ZEU/0148

Hands-on data management with open-source software: CaosDB — •Florian Spreckelsen and Daniel Hornung — IndiScale GmbH, Göttingen, Germany

Data management involves the storing, searching, retrieving and analyzing of data sets and their connections and circumstances. Good data management makes valuable data reusable, for current and future users. It also makes data findable (*Where is the training data for sensor X of setup Y again?*) and adds real utility to data, because data can be embedded into context (*Which experimental settings were used for obtaining the data for project P, and how many failures were there?*).

The open-source toolkit CaosDB is a practical implementation of an agile data management approach designed to handle all these tasks, and much more: The structure of data can be modified later without losing old information and without the need to migrate existing data. This encourages agile implementation of data management workflows instead of delaying until the *perfect master plan* is ready. And CaosDB comes with a powerful Python client, so access is as easy as a few lines of code. This session consists of a short live demonstration of the CaosDB Python client, and participants are encouraged to follow along on their own machines. For this, they can install CaosDB's Python library and additional tools with `pip install caosdb caosadvancedtools` and make sure that they can load the library in Python with `import caosdb`. A Jupyter notebook will be made available online before the session.

AKjDPG 1.3 Thu 15:30 ZEU/0148

ELN integration into the open-source data management solution CaosDB — •Daniel Hornung, Florian Spreckelsen, Henrik tom Wörden, Timm Fitschen, and Thomas Weiss — IndiScale GmbH, Göttingen, Germany

Scientific research still often lacks professional data management, mostly because the dynamically evolving research environments lack suitable software tools. In contrast, standardized industrial processes can be integrated easily with existing data management software. Research work in the lab is increasingly documented with electronic lab notebooks (ELNs), which allow to conveniently enter device and experimental settings in a semi-structured way. This data is usually critical in the analysis of acquired raw data from instruments, e.g. for searching specific data sets or filtering by parameters. We successfully integrated the data management software CaosDB with the eLabFTW ELN, thus combining flexible lab input methods with an agile open source approach to data management.

We chose CaosDB over other solutions, because it allows to flexibly adjust the data model when necessary. This agility is required by the dynamic nature of scientific research activities and cannot be provided by rigid, SQL based approaches.

20 min. break

Invited Talk AKjDPG 1.4 Thu 16:00 ZEU/0148

Open data and open-source tools throughout research data life cycle: KCDC example — •Victoria Tokareva — Karlsruhe Institute of Technology, Institute for Astroparticle Physics, Karlsruhe, Germany

Open science essentials include open data, open source software, open access materials, open educational resources, etc. They provide substantial benefits to society like reproducibility of research, increased transparency and public acceptance of studies, simplified publication process, and enhanced public education. Ultimately, new opportunities become available for unique interdisciplinary studies performed by large diverse teams of specialists on publicly available datasets. Established in 2013, the KASCADE Cosmic Ray Data Centre (KCDC) exists simultaneously as an open archive for data of high-energy astroparticle physics experiments (such as KASCADE, KASCADE-Grande, LOPES, Maket-Ani, etc.), open source software and a web portal providing access to open educational resources. KCDC allows data selection with custom user data cuts using GUI or REST API and interactive online analysis of the selected data with integrated Jupyter Notebooks. From this talk, one can learn more about KCDC's functionality and get better understanding of open science and research data life cycle concepts. An example of machine learning based analysis employing the KCDC platform and deployment of the results as an application using Streamlit will be discussed. This work is partially supported by the DFG fund "NFDI 39/1" for the PUNCH4NFDI consortium.

AKjDPG 1.5 Thu 16:45 ZEU/0148

Interactive USB measurement device controlling with Python — •Benedikt Bieringer — Institute for Nuclear Physics, University of Münster

Although USB devices are central part of most lab experiments, in many cases their use is significantly limited by the provided manufacturers' software and drivers. This talk covers writing a (graphical) readout and controlling software in Python both by using proprietary drivers and by writing own user-space Python-based drivers in cases where the manufacturers' drivers limit the usage potential of the USB device. It gives an overview over writing Python modules for existing drivers in C++, writing USB drivers in Python using PyUSB by analyzing USB packets with Wireshark and writing an interactive plotting and controlling GUI with PyQt and PyQtGraph.

Working Group on Physics, Modern IT and Artificial Intelligence
Arbeitskreis Physik, moderne Informationstechnologie und Künstliche Intelligenz (AKPIK)

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Overview of Invited Talks and Sessions

(Lecture hall ZEU/0118; AI Topical Day HSZ/AUDI, HSZ/0004, and joint sessions; Poster HSZ OG2)

Plenary Talks of the AI Topical Day

PV XIII	Thu	9:00– 9:45	HSZ/AUDI	**The role of artificial intelligence in modern radiation therapy** — •Guillaume Landry
PV XIV	Thu	9:45–10:30	HSZ/AUDI	**Machine Learning Advances in Particle Physics** — •Lukas Heinrich

Invited Talks

AKPIK 6.1	Thu	11:00–11:30	HSZ/AUDI	**AI Techniques for Event Reconstruction** — •Ivan Kisel
AKPIK 6.2	Thu	11:30–12:00	HSZ/AUDI	**Accelerator operation optimisation using machine learning** — •Pierre Schnizer
AKPIK 6.3	Thu	12:00–12:30	HSZ/AUDI	**Is this even physics? – Progress on AI in particle physics** — •Gregor Kasieczka

Sessions

AKPIK 1.1–1.5	Mon	16:00–18:00	HSZ OG2	**Poster**
AKPIK 2.1–2.8	Tue	17:00–19:00	ZEU/0118	**Applications in Particle and Astroparticle Physics**
AKPIK 3.1–3.6	Wed	14:00–15:30	ZEU/0118	**Neural Networks I**
AKPIK 4.1–4.5	Wed	15:45–17:00	ZEU/0118	**Neural Networks II**
AKPIK 5.1–5.3	Wed	11:00–12:20	ZEU/0250	**AI Topical Day – Neural Networks and Computational Complexity (joint session MP/AKPIK)**
AKPIK 6.1–6.3	Thu	11:00–12:30	HSZ/AUDI	**AI Topical Day – Invited Talks (joint session AKPIK/HK/ST/T/AKBP)**
AKPIK 7.1–7.6	Thu	14:00–15:30	HSZ/0101	**AI Topical Day – Research Data Management and Medical Applications**
AKPIK 8.1–8.6	Thu	15:45–17:15	HSZ/0004	**AI Topical Day – Normalizing Flows and Invertible Neural Networks (joint session AKPIK/T)**
AKPIK 9.1–9.6	Thu	17:30–19:00	HSZ/0004	**AI Topical Day – New Methods (joint session AKPIK/T)**
AKPIK 10.1–10.6	Thu	14:00–15:30	HSZ/0103	**AI Topical Day – Computing II (joint session HK/AKPIK)**
AKPIK 11.1–11.6	Thu	14:00–15:30	ZEU/0146	**AI Topical Day – AI in Medicine (joint session ST/AKPIK)**
AKPIK 12.1–12.6	Thu	14:00–15:30	HSZ/0105	**AI Topical Day – Heavy-Ion Collisions and QCD Phases (joint session HK/AKPIK)**

Sessions

– Invited Talks, Contributed Talks, and Posters –

AKPIK 1: Poster

Time: Monday 16:00–18:00 Location: HSZ OG2

AKPIK 1.1 Mon 16:00 HSZ OG2

Learning Electron Bunch Distribution along a Beamline by Normalising Flows — •Anna Willmann[1], Jurjen Couperus Cabadağ[1], Yen-Yu Chang[1], Richard Pausch[1], Amin Ghaith[1,4], Alexander Debus[1], Arie Irman[1], Michael Bussmann[2], Ulrich Schramm[1,3], and Nico Hoffmann[1] — [1]Helmholtz Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Center for Advanced Systems Understanding, Görlitz, Germany — [3]Technische Universität Dresden, Germany — [4]Synchrotron SOLEIL, Saint-Aubin, Germany

Understanding and control of Laser-driven Free Electron Lasers remain to be difficult problems that require highly intensive experimental and theoretical research. The gap between simulated and experimentally collected data might complicate studies and interpretation of obtained results. In this work we developed a deep learning based surrogate that could help to fill in this gap. We introduce a surrogate model based on normalising flows for conditional phase-space representation of electron clouds in a FEL beamline. Achieved results let us discuss further benefits and limitations in exploitability of the models to gain deeper understanding of fundamental processes within a beamline.

AKPIK 1.2 Mon 16:00 HSZ OG2

Predicting volatile wind energy: Stochastic forward modeling and machine learning — Juan Medina, •Marten Klein, Mark Simon Schöps, and Heiko Schmidt — BTU Cottbus-Senftenberg, Cottbus, Germany

Forecasting power output from wind farms is a standing challenge due to complex dynamical processes in the atmospheric boundary layer that manifest themselves by a strong spatio-temporal variability of the wind field. Statistical post-processing of numerical weather prediction (NWP) ensemble data using machine learning, e.g., by multivariate Gaussian regression, has been utilized to estimate the probability of power ramp events for near-future power grid regulation. However, predictions on the scale of single turbines are not possible demonstrating that there is a lack in modeling for short-term forecasting. In this contribution, this lack is addressed by an economical stochastic modeling approach that autonomously evolves vertical profiles of the wind velocity and temperature. The model aims to reproduce turbulent cascade phenomenology by a stochastic process, respecting fundamental physical conservation principles in a dimensionally reduced setting. As a first step, standalone model predictions of wind field fluctuations in weakly and strongly stratified atmospheric conditions are analyzed by conventional and event-based statistics, including clustering and regression of model output. Forthcoming research aims at developing an economical tool for physics-informed downscaling of NWP data. Coupling with wind power plant models and abstraction by neural networks might hence provide additional physical details to power grid models.

AKPIK 1.3 Mon 16:00 HSZ OG2

Amortized Bayesian Inference of GISAXS Data with Normalizing Flows — •Maksim Zhdanov[1], Lisa Randolph[2], Thomas Kluge[1], Motoaki Nakatsutsumi[2], Christian Gutt[3], Michael Bussmann[5], Marina Ganeva[4], and Nico Hoffmann[1] — [1]HZDR, Dresden, Germany — [2]European XFEL, Germany — [3]University of Siegen, Siegen, Germany — [4]Forschungszentrum Jülich, Jülich, Germany — [5]CASUS, Görlitz, Germany

Grazing-Incidence Small-Angle X-ray Scattering (GISAXS) is a modern imaging technique used in material research to study nanoscale materials. Reconstruction of the parameters of an imaged object imposes an ill-posed inverse problem that is further complicated when only an in-plane GISAXS signal is available. Traditionally used inference algorithms such as Approximate Bayesian Computation (ABC) rely on computationally expensive scattering simulation software, rendering analysis highly time-consuming. We propose a simulation-based framework that combines variational auto-encoders and normalizing flows to estimate the posterior distribution of object parameters given its GISAXS data. We apply the inference pipeline to experimental data and demonstrate that our method reduces the inference cost by orders of magnitude while producing consistent results with ABC.

AKPIK 1.4 Mon 16:00 HSZ OG2

Control System for Autonomous Race Car — •Vadim Melnik — Bolshaya Semenovskaya str., 38, Moscow, Russia

Self-driving cars help significantly improve safety, universal access, convenience, efficiency, and reduced costs. In order to fulfill SAE level 4 autonomy, no driver must be required, even in emergency situations and under heavy weather conditions. Despite the fact that major part of autonomous driving on public roads will happen in standard situations, a critical aspect to reach full autonomy is the ability to operate a vehicle close to its limits of handling, i.e. in avoidance maneuvers or in case of slippery surfaces.

Testing such systems on closed tracks or in simulators reduces the risks of human injury.

The proposed system uses path planning algorithm based on the information received from cameras and LiDAR, estimates its position using IMU and linear algebra methods, and is controlled by Model Predictive Control technique. Successful completion of tests in simulator allows the system to be transferred to a real vehicle to proceed to live tests and data validation.

AKPIK 1.5 Mon 16:00 HSZ OG2

Quantum machine learning for calorimeter data generation — •Alexis-Harilaos Verney-Provatas[1,2], Kerstin Borras[1,2], and Dirk Krücker[1] — [1]DESY, Hamburg, Germany — [2]RWTH Aachen, Aachen, Germany

Rapid advances in Quantum Computing technology promise applications in a number of computational problems relevant to a wide range of scientific disciplines. Calorimeter simulation is crucial to Experimental High Energy Physics analyses. However, due to the rising computational cost of traditional simulation methods, machine learning has become a tool used to accelerate data generation. Calorimeter data exhibits strong correlations, which many classical machine learning models struggle to recreate. Properties of quantum states, such as entanglement, which directly imply strong correlations, may be a tool for capturing the full data complexity. Preliminary models, using hybrid Quantum-Classical machine learning architectures are presented and explored.

AKPIK 2: Applications in Particle and Astroparticle Physics

Time: Tuesday 17:00–19:00 Location: ZEU/0118

AKPIK 2.1 Tue 17:00 ZEU/0118

Studies of Machine Learning Inspired Clustering Algorithms for Jets — Amrita Bhattacherjee[1], Debarghya Ghoshdastidar[1], Stefan Kluth[2], and •Siddha Hill[2] — [1]Technical University of Munich — [2]Max Planck Institute for Physics, Munich

We study several machine learning inspired clustering algorithms to cluster the particles of hadronic final states in high energy e+e- and pp collisions into jets. We compare their performance against well known algorithms such as JADE or Anti-Kt. Performance indicators are physically motivated and study properties such as energy and angle differences of jets transitioning from parton to hadron level. In addition we also investigate the stability against pileup.

AKPIK 2.2 Tue 17:15 ZEU/0118

Providing GPU resources in a HEP analysis environment — Johannes Erdmann[1], Benjamin Fischer[1], Thomas Kress[2], Dennis Noll[1], Andreas Nowack[2], and •Roman Suveyzdis[1] — [1]III. Physikalisches Institut A, RWTH Aachen University — [2]III. Physikalisches Institut B, RWTH Aachen University

Graphics Processing Units (GPUs) have become a key computing resource for advanced physics analyses for example for training and evaluating machine learning models. The local research group's computing cluster is still often limited in GPU resources. Therefore, an efficient and fair use is crucial. HTCondor, a powerful batch job software system that is often used in the HEP physics community, offers the possibility to manage GPU resources. The basic installation of HTCondor only distributes entire GPUs on a per job basis, which leaves some potential resources unused. In this talk, we will present how HTCondor can be configured to cope with the users' need to use GPUs both interactively and in batch job mode. We will report on the first experiences with our setup.

AKPIK 2.3 Tue 17:30 ZEU/0118

Fast Columnar Physics Analyses of Terabyte-Scale LHC Data on a Cache-Aware Dask Cluster — Svenja Diekmann, Niclas Eich, Martin Erdmann, Peter Fackeldey, •Benjamin Fischer, Dennis Noll, and Yannik Rath — III. Physikalisches Institut A, RWTH Aachen University

The development of an LHC physics analysis involves numerous investigations that require the repeated processing of terabytes of data. Thus, a rapid completion of each of these analysis cycles is central to mastering the science project.

We present a solution to efficiently handle and accelerate physics analyses on small-size institute clusters. Our solution uses three key concepts: Vectorized processing of collision events, the "MapReduce" paradigm for scaling out on computing clusters, and efficiently utilized SSD caching to reduce latencies in IO operations. This work focuses on the latter key concept, its underlying mechanism, and its implementation.

Using simulations from a Higgs pair production physics analysis as an example, we achieve an improvement factor of 6.3 in the runtime for reading all input data after one cycle and even an overall speedup of a factor of 14.9 after 10 cycles, reducing the runtime from hours to minutes.

AKPIK 2.4 Tue 17:45 ZEU/0118

ProGamer: PROgressively Growing Adversarial Modified (transformer-)Encoder Refinement — •Benno Käch, Isabell Melzer-Pellmann, and Dirk Krücker — Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

Machine learning-based data generation has become a major research topic in particle physics due to the computational challenges posed by current Monte Carlo simulation approaches for future colliders, which will have significantly higher luminosity. The generation of collider data is similar to point cloud generation, but it is more difficult because of the complex correlations that need to be accurately modeled between the points. A refinement model consisting of normalising flows and transformer encoders is presented. The normalising flow is 3-dimensional, meaning that the generated particle cloud consists of independent and identically distributed objects. This output is then refined by a transformer encoder, which is adversarially trained against another transformer encoder discriminator/critic. As the model is able to produce an arbitrary number of particles, a progressively growing point cloud can be produced.

AKPIK 2.5 Tue 18:00 ZEU/0118

Machine Learning based defect detection for large-scale electrodes — •Sebastian Vetter — Karlsruhe Institute of Technology, Institute for Astroparticle Physics

Like every piece of hardware produced in an industrial setting, detectors in physics experiments are subject to material defects, introduced during the production or handling of individual components. This can greatly influence detector behavior and lead to unexpected experimental results, depending on the affected part and the extent of the defect. Detection and quantification of such defects is therefore an important step in constructing a successful experiment.

It is still quite common for defect inspection to be done by eye. However, recent developments in computer-based inspection methods provide the opportunity to relieve humans from this tedious task, to remove the susceptibility of human error from the inspection step, and to objectively quantify the extent of detected defects.

In this talk, I present the defect inspection of a large-scale electrode mesh, as used for example in liquid noble gas Dark Matter experiments. This inspection was carried out first by hand and then compared to various Machine Learning approaches, ranging from simple decision trees to variational autoencoders.

AKPIK 2.6 Tue 18:15 ZEU/0118

Interpolation of Instrument Response Functions for the Cherenkov Telescope Array — •Rune Michael Dominik and Maximilian Linhoff for the CTA Consortium — Astroparticle Physics WG Elsässer, TU Dortmund University, Germany

The Cherenkov Telescope Array (CTA) will be the next generation ground-based very-high-energy gamma-ray observatory, utilizing tens of Imaging Atmospheric Cherenkov Telescopes at two sites once its construction and commissioning is finished. Like its predecessors, CTA relies on Instrument Response Functions (IRFs) to relate the observed and reconstructed properties to the original properties of primary particles. IRFs are needed for the proper reconstruction of spectral and spatial information and are thus among the data-products issued to the observatory's users. They are derived from Monte Carlo simulations and depend on observation conditions like the telescope pointing direction or the atmospheric transparency. Producing a complete set of IRFs from simulations for every observation taken is a time consuming task and not feasible when releasing data-products on short timescales. Consequently, interpolation techniques on simulated IRFs are investigated to quickly estimate IRFs for specific observation conditions. However, as some of an IRFs constituents are given as probability distributions, specialized methods are needed. This talk summarizes and compares the feasibility of multiple approaches to interpolate IRF components. First results are shown and open challenges are discussed.

AKPIK 2.7 Tue 18:30 ZEU/0118

Estimation of prediction uncertainties for data from Imaging Atmospheric Cherenkov Telescopes — •Cyrus Pan Walther and Maximilian Linhoff — Technische Universität Dortmund, Germany

One main step in the low-level analysis of astroparticle physics data is the reconstruction of the properties of primary particles that induced extensive air showers.

Various methods are applied in different experiments and software packages. In general, these are multi-output and combined regression and classification tasks. The estimation of prediction uncertainties is of crucial importance for the later scientific exploitation of these events. However, most methods do not in themselves provide reliable uncertainty estimates. In this contribution, we want to apply a method that has been used successfully in a Deep Learning reconstruction for the IceCube experiment to data from Imaging Atmospheric Cherenkov Telescopes used for gamma-ray astronomy.

AKPIK 2.8 Tue 18:45 ZEU/0118

Testing Nested Machine Learning Models for the Cherenkov Telescope Array — •Lukas Beiske and Rune M. Dominik for the CTA-Collaboration — Astroparticle Physics, WG Rhode/Elsässer, TU Dortmund University, D-44227 Dortmund, Germany

The Cherenkov Telescope Array (CTA) will be the next-generation ground-based very-high-energy gamma-ray observatory covering an energy range from 20 GeV up to 300 TeV. It will operate tens of Imaging Atmospheric Cherenkov Telescopes (IACTs) on the Canary Island of La Palma (CTA North) and at the Paranal Observatory in Chile (CTA South) once construction and commissioning are finished.

Machine Learning techniques are currently being used to analyze data from IACTs. The tools are used to reconstruct the three main properties of the primary particle: its particle type, energy, and origin. A common approach is to train models on parameters extracted from the shower images observed by the telescopes which in turn give one prediction per telescope image. For events triggering multiple telescopes, these individual predictions can be averaged to obtain a single primary particle prediction for every shower event. However, it is possible to improve these averaged predictions by training a second set of machine learning models using all information available about the shower as seen by the whole telescope array. This talk will show the current results of testing such nested models for CTA.

AKPIK 3: Neural Networks I

Time: Wednesday 14:00–15:30 Location: ZEU/0118

AKPIK 3.1 Wed 14:00 ZEU/0118

"Ahead of Time compilation" of Tensorflow models — •Bogdan Wiederspan, Marcel Rieger, and Peter Schleper — University of Hamburg

In a wide range of high-energy particle physics analyses, ML methods have proven as powerful tools to enhance analysis sensitivity. In the past years, various ML applications were also integrated in central CMS workflows, leading to great improvements in reconstruction and object identification efficiencies.

However, the continuation of successful deployments might be limited due to memory and processing time constraints of more advanced models and central infrastructure. A new inference approach for models trained with Tensorflow, based on Ahead-of-time (AOT) compilation is presented that has the potential to drastically reduce memory footprints while preserving and even increasing computational performance.

AKPIK 3.2 Wed 14:15 ZEU/0118

A multi-layer approach and neural network architectures for defect detection in PBF-LB/M — •Michael Moeckel and Jorrit Voigt — TH Aschaffenburg, Würzburger Str. 45, 63743 Aschaffenburg

The substitution of expensive non-destructive material testing by data-based process monitoring is intensively explored in quality assurance for additive manufactured components. Machine learning show promising results for defect detection but require conceptual adaption to layer wise manufacturing and line scanning patterns in laser powder bed fusion. A multi-layer approach to co-register μ-computer tomography measurements with process monitoring data is developed and a workflow for automatic data set generation is implemented. The objective of this research is to benchmark the volumetric multi-layer approach and specifically selected deep learning methods for defect detection. The volumetric approach shows superior results compared to single slice monitoring. All investigated structured neural network topologies deliver similar performance.

AKPIK 3.3 Wed 14:30 ZEU/0118

Reconstructing jet characteristics using neural networks — •Arne Poggenpohl and Felix Geyer — Astroparticle Physics, TU Dortmund University, Germany

Active galactic nuclei (AGN) are among the most observed objects in the nocturnal sky. Several of these AGN have the capability to accelerate matter in their nuclei to relativistic velocities, resulting in jets. These are frequently studied sources of radio emission. Analysis of the kinematic characteristics of radio jets can provide information about physical properties of the host galaxy. Previously, this was mostly done by tracking Gaussian components of the jets manually, which is difficult to reproduce. Therefore, the goal of this work is to automatically detect Gaussian components in radio jets using a neural network and thus enable kinematic analysis. Big data sets can thereby be processed, because it is no longer necessary to concentrate on each individual image.

For the necessary object detection, an architecture based on YOLO is used. This architecture consists exclusively of convolutional layers and requires only one pass for the prediction. This allows it to be fast and accurate at the same time.

In this talk, the current state of the work is presented and improvements for the future are pointed out.

AKPIK 3.4 Wed 14:45 ZEU/0118

Deep-Learning based Estimation of the Ultra-High Energy Cosmic Ray Spectrum using the Surface Detector of the Pierre Auger Observatory — Ralph Engel, Markus Roth, Darko Veberic, Steffen Hahn, and •Fiona Ellwanger for the Pierre Auger-Collaboration — Karlsruhe Institute of Technology (IAP), Karlsruhe, Germany

To probe physics beyond the scales of human-made accelerators with cosmic rays demands an accurate knowledge of their energy. Ground-based experiments indirectly reconstruct the primary particle energy from measurements of the emitted fluorescence light or the time-dependent signal of the shower footprint.

At the Pierre Auger Observatory, the shower footprint is measured by a regular hexagonal grid of water-Cherenkov detectors. Since the shower development is a very intricate process, it non-trivial to find hidden patterns in the spatial and temporal distributions of signals. With large simulation datasets, we are able to train neural networks tackling such a problem.

In this work, we present a neural network that gives an estimate on the energy of the primary particle. The precision of the predictions is studied by evaluating the neural networks on a simulated test data set with particular regard to the mass-dependent bias. Systematic differences between simulations and measured data require special attention to possible biases, which are investigated. Methods to correct for these biases are presented. Furthermore, the energy spectrum from corrected neural network predictions is built and compared to published results.

AKPIK 3.5 Wed 15:00 ZEU/0118

Investigating Waveform Classification Using Neural Networks for the Einstein Telescope — Markus Bachlechner, •Philipp Otto, Oliver Pooth, and Achim Stahl — III. Physikalisches Institut B, RWTH Aachen

The Einstein Telescope (ET) is a proposed third-generation gravitational wave detector aiming to improve the sensitivity by more than an order of magnitude over the whole frequency band compared to the previous generation. Increased sensitivity yields a much higher event rate with overlapping signals, which will dramatically increase the computational resource requirements of conventional pattern matching methods. Neural networks are a promising approach to implement a fast and efficient waveform classification. Fast identification is also essential to allow for multi-messenger astronomy, by quickly alerting other observatories. This talk will present the investigation of a deep learning based waveform classification approach.

AKPIK 3.6 Wed 15:15 ZEU/0118

Estimating Uncertainties for Trained Neural Networks — •Sebastian Bieringer — Universität Hamburg, Hamburg, Germany

Uncertainty estimation is a crucial issue when considering the application of deep neural network to problems in high energy physics such as jet energy calibrations.

We introduce and benchmark a novel algorithm that quantifies uncertainties by Monte Carlo sampling from the models Gibbs posterior distribution. Unlike the established 'Bayes By Backpropagation' training regime, it does not rely on any approximations of the network weight posterior, is flexible to most training regimes, and can be applied after training to any network. For a one-dimensional regression task, as well as energy regression from calorimeter images, we show that this novel algorithm describes epistemic uncertainties well, including large errors for extrapolation.

AKPIK 4: Neural Networks II

Time: Wednesday 15:45–17:00 Location: ZEU/0118

AKPIK 4.1 Wed 15:45 ZEU/0118

Morphological Classification of Radio Galaxies with wGAN-supported Augmentation — •Janis Kummer[1,3], Florian Griese[1,4,5], Lennart Rustige[1,2], Kerstin Borras[2,6], Marcus Brüggen[3], Patrick Connor[1,7], Frank Gaede[2], Gregor Kasieczka[7], Tobias Knopp[4,5], and Peter Schleper[7] — [1]Center for Data and Computing in Natural Sciences (CDCS), Hamburg, German — [2]Deutsches Elektronen-Synchrotron DESY, Hamburg, German — [3]Hamburger Sternwarte, Hamburg, Germany — [4]University Medical Center Hamburg-Eppendorf, Hamburg, Germany — [5]Hamburg University of Technology,Hamburg, Germany — [6]RWTH Aachen University, Aachen, Germany — [7]Universität Hamburg, Hamburg, German

Supervised deep learning models for the morphological classification of radio galaxies are very important for processing the data of future large radio surveys. However, labelled training data for such models is limited. We demonstrate the use of generative models, specifically a Wasserstein Generative Adversarial Network (wGAN), to generate artificial data for different classes of radio galaxies. Further, we study the impact of augmenting the training data with images from our wGAN on different classification architectures. We find that it is indeed possible to improve models for the morphological classification of radio galaxies with this technique. In addition, fast simulations of radio galaxies with our wGAN are useful to validate new interferometric machine-learning algorithms.

AKPIK 4.2 Wed 16:00 ZEU/0118

Uncertainty estimations for deep learning-based imaging — •Felix Geyer, Arne Poggenpohl, and Kevin Schmidt — Astroparticle Physics WG Elsässer, TU Dortmund University, Germany

Radio interferometry is used to monitor and observe distant astronomical sources and objects with high resolution. Especially Very Long Baseline Interferometry (VLBI) allows for achieving the highest resolutions by combining the data of multiple telescopes. This results in an effective diameter corresponding to the greatest distance between two telescopes. The taken data consists of visibilities in Fourier space, which depend on the baselines between the telescopes. Because the distribution of these baselines is sparse, the sample of visibilities is incomplete. After transforming this sample to spatial space, this so-called "dirty image" is inadequate for physical inference and analyses.

In traditional methods, the image then undergoes an elongated and mostly manually performed cleaning process in order to remove background artifacts and restore the original source distribution. Contrary, a new and fast approach to reconstructing missing data reasonably is using neural networks. As an additional advantage, these networks can also be used to estimate the uncertainty of the prediction. This is done by not only predicting the mean value of the pixels but also the standard deviation by feeding the input and the prediction to a separate network. All of this is part of our framework called `radionets`, which is another focus of this talk.

AKPIK 4.3 Wed 16:15 ZEU/0118

Partition Pooling for Convolutional Graph Network Applications in Particle Physics — •Philipp Soldin, Markus Bachlechner, Thilo Birkenfeld, Achim Stahl, and Christopher Wiebusch — III. Physikalisches Institut B, RWTH Aachen University

Convolutional Neural Networks (CNN) are often used in particle physics applications for classification and reconstruction tasks. Since the individual sensors in a particle detector are often arranged in complex geometries, the information must be projected onto regular grids to use CNNs. Convolutional Graph Networks (CGN) can encode the individual sensor positions as a static graph to prevent projection effects. However, with the number of sensors in modern particle physics detectors, the CGN performance can be limited by the considerable number of parameters. A dimensionality reduction scheme analogous to conventional pooling on images that uses graph partitioning to create pooling kernels is presented. Different CGN architectures, including partition pooling, are presented with an exemplary vertex reconstruction in an idealized neutrino detector.

AKPIK 4.4 Wed 16:30 ZEU/0118

Gamma Source Detection using Deep Multitask Networks and Noisy Label Learning — •Lukas Pfahler — TU Dortmund University, Artificial Intelligence Group, Dortmund, Germany

Machine learning has been established as an effective tool for data analysis in modern high energy particle experiments. For the FACT telescope, we solve three supervised learning tasks - gamma-hadron separation, energy estimation, and origin estimation - using simulated training data and manual feature extraction. We outline how we can replace the manual feature engineering currently applied with a learned representation trained with multitask supervision. Our approach will train a shared representation that can solve all three prediction tasks with specialized prediction networks build on top of the shared representation. Furthermore, we look into an alternative source of supervision that reduces the burden of simulating training data by using real telescope recordings. We rely on the concept of noisy labels and introduce a novel method for learning under label noise where only one noise rate is known. We show how gamma-hadron separation can be framed in this setting and illustrate that the method allows us to train accurate classifiers.

AKPIK 4.5 Wed 16:45 ZEU/0118

Binary Black Hole Parameter Estimation using Deep Neural Networks — •Markus Bachlechner, David Bertram, Philipp Otto, Oliver Pooth, and Achim Stahl — III. Physikalisches Institut B, RWTH Aachen

As the first of the third-generation of gravitational wave detectors, the proposed Einstein Telescope is expected to be at least an order of magnitude more sensitive compared to current interferometers like LIGO and Virgo. On the one hand, the higher sensitivity increases the observable volume. On the other hand, high sensitivity in the low-frequency band leads to significantly earlier detection and observation for some coalescences like binary neutron stars. These early observations make it possible to send multi-messenger alerts before the merger. Applying a fast analysis handling event detection, classification, and estimation in real time is essential. This talk presents an approach for parameter estimation of binary black holes using deep neural networks.

AKPIK 5: AI Topical Day – Neural Networks and Computational Complexity (joint session MP/AKPIK)

Time: Wednesday 11:00–12:20 Location: ZEU/0250

AKPIK 5.1 Wed 11:00 ZEU/0250

A universal approach to state and operator complexities — •Souvik Banerjee[1] and Mohsen Alishahiha[2] — [1]Julius-Maximilians-Universität Würzburg, Würzburg, Germany — [2]IPM, Tehran, Iran

In this talk, I shall present a general framework in which both Krylov state and operator complexities can be put on the same footing. In our formalism, the Krylov complexity is defined in terms of the density matrix of the associated state which, for the operator complexity, lives on a doubled Hilbert space obtained through the channel-state map. This unified definition of complexity in terms of the density matrices enables us to extend the notion of Krylov complexity, to subregion or mixed state complexities and also naturally to the Krylov mutual complexity. We show that this framework also encompasses nicely, the holographic notions of complexity and explains the universal late-time growth of complexity, followed by a saturation.

Invited Talk AKPIK 5.2 Wed 11:30 ZEU/0250

Deep neural networks and the renormalization group — •Ro Jefferson[1], Johanna Erdmenger[2], and Kevin Grosvenor[3] — [1]Utrecht University — [2]University of Würzburg — [3]Leiden University

Despite the success of deep neural networks (DNNs) on an impressive range of tasks, they are generally treated as black boxes, with performance relying on heuristics and trial-and-error rather than any explanatory theoretical framework. Recently however, techniques and ideas from physics have been applied to DNNs in the hopes of distilling the underlying fundamental principles. In this talk, I will discuss some interesting parallels between DNNs and the renormalization group (RG). I will briefly reivew RG in the context of a simple lattice model, where subsequent RG steps are analogous to subsequent layers in a DNN, in that effective interactions arise after marginalizing hidden degrees of freedom/neurons. I will then quantify the intuitive idea that information is lost along the RG flow by computing the relative entropy in both the Ising model and a feedforward DNN. One finds qualitatively identical behaviour in both systems, in which the relative entropy increases monotonically to some asymptotic value. On the QFT side, this confirms the link between relative entropy and the c-theorem, while for machine learning, it may have implications for various information maximization methods, as well as disentangling compactness and generalizability.

AKPIK 5.3 Wed 12:00 ZEU/0250

Analytic continuation of Greens' functions using neural networks — Johanna Erdmenger, René Meyer, Martin Rackl, and •Yanick Thurn — JMU Würzburg

In quantum many-body physics, the analytic continuation of Greens' functions is a well-known problem. The problem is ill-posed in the sense that the transformation kernel becomes chaotic for large energies and thus small noise creates huge differences in the resulting spectral density function. Some techniques in the field of machine learning, in particular neural networks, are known for handling this kind of problem. Using a neural network and for the problem-optimized loss functions and hyperparameters, a network is trained to determine the spectral density from the imaginary part of the Greens function given by quantum Monte Carlo simulations. The network is able to recover the overall form of the spectral density function, even without adding constraints such as normalization and positive definiteness. There is no need to encode these constraints as regularizations since they are reflected automatically by the solution provided by the network. This indicates the correctness of the inversion kernel learned by the neural network. In the talk, I will explain the structure of the methods used to train the network and highlight the central results.

AKPIK 6: AI Topical Day – Invited Talks (joint session AKPIK/HK/ST/T/AKBP)

Time: Thursday 11:00–12:30 Location: HSZ/AUDI

Invited Talk AKPIK 6.1 Thu 11:00 HSZ/AUDI

AI Techniques for Event Reconstruction — •Ivan Kisel — Goethe University, Frankfurt, Germany

Why can we relatively easily recognize the trajectory of a particle in a detector visually, and why does it become so difficult when it comes to developing a computer algorithm for the same task? Physicists and computer scientists have been puzzling over the answer to this question for more than 30 years, since the days of bubble chambers. And it seems that we are steadily approaching the answer in our attempts to develop and apply artificial neural networks both for finding particle trajectories and for physics analysis of events in general.

This talk will present the basics of artificial neural networks in a simple form, and provide illustrations of their successful application in event reconstruction in high energy physics and heavy ion physics experiments. You will get an insight into the application of traditional neural network models, such as deep neural network, convolutional neural network, graph neural network, as well as those standing a little aside from traditional approaches, but close in idea of elastic network and even cellular automata.

Invited Talk AKPIK 6.2 Thu 11:30 HSZ/AUDI

Accelerator operation optimisation using machine learning — •Pierre Schnizer — Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Berlin, Germany

Accelerators are complex machines whose many components need to be accurately tuned to achive design performance. Reliable operation requires frequent recalibration and tuning. Especially for large machines tools have been developed that facilitating this task.

Machine learning allows building such tools using simulations, archiver data or interaction with the real machine, thus making many tools now also available for smaller machines.

This talk will give an overview of different machine learning projects targeted to accelerators, which simplifies accelerator operation or even enable applications not been possible before.

Invited Talk AKPIK 6.3 Thu 12:00 HSZ/AUDI

Is this even physics? – Progress on AI in particle physics — •Gregor Kasieczka — Universität Hamburg

Motivated by the large volume and high complexity of experimental data and mathematical structures, particle physics has a long tradition of employing state of the art computing and analysis techniques. Recent progress in machine learning and artificial intelligence have further pushed this trend, and these approaches are now ubiquitous in our field. This overview attempts to capture key developments such as the rise of unsupervised approaches and the quest for suitable neural network architectures for physics tasks; challenges like ultra-low latency inference and robust predictions; as well as promising new ideas looking forward.

AKPIK 7: AI Topical Day – Research Data Management and Medical Applications

Time: Thursday 14:00–15:30 Location: HSZ/0101

AKPIK 7.1 Thu 14:00 HSZ/0101

Federated Heterogeneous Compute and Storage Infrastructure for the PUNCH4NFDI Consortium — •Alexander Drabent[1], Jörn Künsemöller[2], Matthias Hoeft[1], Christoph Wissing[3], Manuel Giffels[4], Dominik Schwarz[2], Kilian Schwarz[3], and Andreas Henkel[5] — [1]Thüringer Landessternwarte Tautenburg — [2]Universität Bielefeld — [3]DESY, Hamburg — [4]Karlsruher Institut für Technologie — [5]Johannes Gutenberg-Universität Mainz

PUNCH4NFDI is the NFDI consortium of particle, astro-, astroparticle, hadron and nuclear physics.

Compute4PUNCH and Storage4PUNCH concepts are developed to meet the diverse needs of these communities to provide seamless and federated access to compute and storage systems. Those are being federated in a common infrastructure and transparently integrated with an overlay batch system. Both concepts comprise state-of-the-art technologies for resource access and to ensure scalable provisioning of community specific software. Furthermore, existing technologies for caching as well as metadata handling are being evaluated with the aim for a deeper integration. The combined Compute4PUNCH and Storage4PUNCH environment will allow a large variety of researchers to carry out resource-demanding analysis tasks.

In this contribution we will present the Compute4PUNCH and Storage4PUNCH concepts, the current status of the developments as well as first experiences with scientific applications, such as analysing radio-interferometric data, being executed on the available prototypes.

AKPIK 7.2 Thu 14:15 HSZ/0101

VISPA - Cloud Services for Modern Data Analysis — •Niclas Eich, Louis Christoph, Martin Erdmann, Peter Fackeldey, Benjamin Fischer, Leonard Lux, Dennis Noll, Mathilde Pöppelmann, and Malcom Steen — RWTH Aachen University

VISPA (VISual Physics Analysis) realizes a scientific cloud enabling modern scientific data analysis in a web browser. Our local VISPA instance is backed by a small institute cluster and is dedicated to fundamental research and university education. By hardware upgrades (656 CPU threads, 29 workstation GPUs), we have tailored the cloud services to accomplish both, rapid turn-around when developing O(TB) HEP analyses and deep-learning hands-on with O(100) participants through the web browser. With its latest software developments, VISPA now supports the interactive use of Jupyter notebooks on local as well as on batch resources. Additionally, users can optionally execute their analyses on any SSH reachable large-scale resource they desire. New tools such as an improved user management and a monitoring of the batch resources ensure seamless administration. We will present this major advance of the VISPA project and show how a wide range of scientific data analyses can be realized in the web browser.

AKPIK 7.3 Thu 14:30 HSZ/0101

Towards coherent metadata schema for the PUNCH4NFDI open science platform — •Victoria Tokareva for the PUNCH4NFDI Consortium-Collaboration — Karlsruhe Institute of Technology, Institute for Astroparticle Physics, Karlsruhe, Germany

PUNCH4NFDI is an NFDI consortium of particle, astro-, astroparticle, hadron and nuclear physics, which is addressing common challenges of data-intense physics at large research facilities: data volumes, data complexity, data rates, and data irreversibility, as well as the development and promotion of open science vision and required tools to achieve this. One of the core features in the development of a PUNCH4NFDI software infrastructure is a cloud-based platform and an open data portal, aimed at providing access to a wide range of digital research materials within the PUNCH4NFDI community and ensuring that the FAIR (findability, accessibility, interoperability, reusability) principles are applied for the community's data collections. This requires to navigate the landscape of different established metadata schemas and find common ground to access the data and run programs and workflows using data from different data collections. In order to achieve this goal, we have investigated core concepts and definitions in the field and analyzed user stories and use cases of several data platforms within the PUNCH4NFDI community. From these, essential requirements for the used metadata have been defined. The results will be presented in this contribution. This work is supported by the DFG fund "NFDI 39/1" for the PUNCH4NFDI consortium.

AKPIK 7.4 Thu 14:45 HSZ/0101

Datenanalytische Hilfestellungen für ein festgelegtes Modell zur Personenerkennung — •Jan Michael Bürger und Hans Dominik Werner — HowRyou GmbH, 24976 Handewitt

Für den Bereich der (Alten-)Pflege werten wir Videodaten mit einer Personenerkennung aus, um eine Videokommunikation genau dann zu ermöglichen, sobald sich die Person alleine im Raum aufhält. Insbesondere aus Datenschutzgründen sollte dabei eine Kommunikation nicht möglich sein, sobald sich mehr als eine Person im Raum aufhält. Gleichzeitig sollte die Person erkannt werden, selbst wenn sie zugedeckt im Bett liegt.

Für diese Aufgabe greifen wir auf bereits verfügbare Modelle zur Personenkennung zurück. Um unsere Anforderungen bestmöglich zu erfüllen, wäre es zunächst naheliegend, dass Modell anzupassen bzw. dieses mit geeigneten Trainingsdaten nachzutrainieren. Um vor allem mit einem kleineren Datensatz auszukommen, haben wir den Fokus auf einen anderen Ansatz gelegt: Wir haben eine systematische Datenanalyse der Personenerkennung auf Testdaten durchgeführt.

Auf Grundlage der Ergebnisse dieser Datenanalyse haben wir (einfache) Techniken implementiert, die die Videobilder im Vorfeld graphisch manipulieren und die Ergebnisse auf geeignete Weise verrechnen. Dazu zählt u.a. das Präsentieren des gleichen Bildes in verschiedenen Helligkeiten und ein virtuelles Drehen des Bildes. Diese Hilfestellungen führten zu zum Teil signifikanten Verbesserungen.

In diesem Vortrag werden die Erfahrungen und Ergebnisse zu von uns untersuchten und verwendeten Hilfestellungen dargestellt.

AKPIK 7.5 Thu 15:00 HSZ/0101

Interpretable Machine Learning and evidence-based decision support in clinical Digital Twins — •Carlos Andres Brandl, Anna Nitschke, and Matthias Weidemüller — Im Neuenheimer Feld 226, 69120 Heidelberg, Germany

Personalized medicine is based on including a vast variety of patient-specific data. The Digital Twin technology provides the opportunity for improved personalized patient care by monitoring the patient journey and predicting the best preventive and therapeutic decision options available. We developed a concept which fuses evidence-based methods with machine learning approaches into a single decision-support tool. Our method is independent on the parameter spaces and evidence-based tools being used, provides possibilities to include updated knowledge and is able to offer intuitively interpretable decision options to the clinician. The presentation introduces our architecture of the digital twin and provides details on the fusion approach.

AKPIK 7.6 Thu 15:15 HSZ/0101

Radiomics for two-dimensional prompt gamma-ray based proton treatment verification — •Sonja M Schellhammer[1,2], Theresa Lenk[1,3], Steffen Löck[1,3,4], and Toni Kögler[1,2] — [1]OncoRay – National Center for Radiation Research in Oncology, Faculty of Medicine and University Hospital Carl Gustav Carus, Technische Universität Dresden, Helmholtz-Zentrum Dresden - Rossendorf, Dresden, Germany — [2]Helmholtz-Zentrum Dresden - Rossendorf, Institute of Radiooncology – OncoRay, Dresden, Germany — [3]German Cancer Consortium (DKTK), Partner Site Dresden, and German Cancer Research Center (DKFZ), Heidelberg, Germany — [4]Department of Radiotherapy and Radiation Oncology, Faculty of Medicine and University Hospital Carl Gustav Carus, Technische Universität Dresden, Dresden, Germany

There is a growing need for on-line verification systems to further increase the safety and efficacy of cancer treatment with proton therapy. For this purpose, we propose a radiomics-based analysis of two-dimensional time-energy distributions of secondary prompt gamma-rays and apply it to realistic data measured in a proton therapy facility. In comparison to previously used methods based only on temporal gamma-ray distributions, we show that the accuracy of the range verification is improved by 38 % (1.5 mm). These results demonstrate that radiomics and machine learning are valuable tools to enhance proton treatment verification for cancer therapy.

AKPIK 8: AI Topical Day – Normalizing Flows and Invertible Neural Networks (joint session AKPIK/T)

Time: Thursday 15:45–17:15 Location: HSZ/0004

AKPIK 8.1 Thu 15:45 HSZ/0004

Efficient Sampling from Differentiable Matrix Elements with Normalizing Flows — •Annalena Kofler[1,2], Vincent Stimper[2,3], Mikhail Mikhasenko[4], Michael Kagan[5], and Lukas Heinrich[1] — [1]Technical University Munich — [2]Max Planck Institute for Intelligent Systems, Tübingen — [3]University of Cambridge, UK — [4]ORIGINS Excellence Cluster, Munich — [5]SLAC National Accelerator Laboratory, Menlo Park, USA

The large amount of data that will be produced by the high-luminosity LHC imposes a great challenge to current data analysis and sampling techniques. As a result, new approaches that allow for faster and more efficient sampling have to be developed. Machine Learning methods such as normalizing flows, have shown great promise in related fields. There, access to not only the density function but also its gradient has proven to be helpful for training. Recently, software for accessing differentiable amplitudes, which serve as densities in particle scattering, have become available that allow us to obtain the gradients and benchmark these new methods. The described approach is demonstrated by training rational-quadratic spline flows with differentiable matrix elements of the hadronic three-body decays, $\pi(1800) \rightarrow 3\pi$ and $\Lambda_c^+ \rightarrow pK^-\pi^+$. To boost the ability to accurately learn and sample from complex densities whilst also reducing the number of training samples, we explore the use of the newly proposed method Flow Annealed Importance Sampling Bootstrap. Building on prior work, we plan to extend the approach to examples with more particles in the final state via the differentiable matrix elements provided by MadJax.

AKPIK 8.2 Thu 16:00 HSZ/0004

Generating Accurate Showers in Highly Granular Calorimeters Using Normalizing Flows — •Thorsten Buss — Institut für Experimentalphysik, Universität Hamburg, Germany

The full simulation of particle colliders incurs a significant computational cost. Among the most resource-intensive steps are detector simulations. It is expected that future developments, such as higher collider luminosities and highly granular calorimeters, will increase the computational resource requirement for simulation beyond availability. One possible solution is generative neural networks that can accelerate simulations. Normalizing flows are a promising approach in this pursuit. It has been previously demonstrated, that such flows can generate showers in low-complexity calorimeters with high accuracy. We show how normalizing flows can be improved and adapted for precise shower simulation in significantly more complex calorimeter geometries.

AKPIK 8.3 Thu 16:15 HSZ/0004

Introspection for a normalizing-flow-based recoil calibration — •Lars Sowa, Jost von den Driesch, Roger Wolf, Markus Klute, and Günter Quast — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

Normalizing flows (NFs) are neural networks, that preserve the prob- ability between their input and output distributions. NFs can be promising candidates either as surrogates for the fast generation of new samples or as universal approximators of arbitrary probability density functions, based on which confidence intervals may be deter- mined, both of which are interesting properties in high-energy physics (HEP). This work presents the case study of recoil calibration on LHC Run- 3 data and Monte Carlo simulation with the goal to better understand the behavior of NFs. The result of the NF is compared to a deep ensem- ble of feed-forward neural networks created to compare the calibration results and the different coverage in the value space.

AKPIK 8.4 Thu 16:30 HSZ/0004

Normalising Flows for Parameter Estimation from Gravitational Wave Signals — Johannes Erdmann[1], •Jon Hoxha[1], and Shichao Wu[2,3] — [1]III. Physikalisches Institut A, RWTH Aachen University — [2]Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut) — [3]Leibniz Universität Hannover

The Einstein Telescope (ET) is a proposal for a next generation ground-based gravitational wave detector. Due to higher sensitivity, ET is expected to receive orders of magnitude more gravitational wave signals than the current 2nd generation detectors LIGO, Virgo and KAGRA. Additionally, these signals will also be in the frequency band of the detector for a longer time, which would cause overlaps of signals. The analysis methods currently in use, which are based on Markov Chain Monte Carlo (MCMC) nested sampling methods, are unsuitable for handling such data and would take up significant computing resources. Therefore, new efficient analysis methods are required. Deep learning methods form a promising approach for this task. Specifically, normalizing flows promise to provide a more efficient means for signal parameter estimation. We use mock data to estimate signal parameters through normalizing flows and compare them to the current standard approach.

AKPIK 8.5 Thu 16:45 HSZ/0004

A method for inferring signal strength modifiers by conditional invertible neural networks — •Mate Zoltan Farkas, Svenja Diekmann, Niclas Eich, and Martin Erdmann — III. Physics Institute A, RWTH Aachen

The continuous growth in model complexity in high-energy physics collider experiments demands increasingly time-consuming model fits. We show first results on the application of conditional invertible networks (cINNs) to this challenge. Specifically, we construct and train a cINN to learn the mapping from signal strength modifiers to observables and its inverse. The resulting network infers the posterior distribution of the signal strength modifiers rapidly and for low computational cost. We present performance indicators of such a setup including the treatment of systematic uncertainties. Additionally, we highlight the features of cINNs estimating the signal strength for a vector boson associated Higgs production analysis carried out at an LHC experiment on simulated data samples.

AKPIK 8.6 Thu 17:00 HSZ/0004

Reconstruction of SAXS Data using Invertible Neural Networks — •Erik Thiessenhusen[1], Melanie Rödel[1], Thomas Kluge[1], Michael Bussmann[2], Thomas Cowan[1], and Nico Hoffmann[1] — [1]HZDR, FWKT, Dresden, Germany — [2]CASUS, Görlitz, Germany

The understanding of laser-solid interactions is important to the development of future laser-driven particle and photon sources, e.g., for tumor therapy, astrophysics or fusion. Currently, these interactions can only be modeled by simulations which need verification within the scope of pump-probe experiments. This experimental setup allows us to study the laser-plasma interaction that occurs when an ultrahigh-intensity laser hits a solid density target. We employ Small-Angle X-Ray Scattering (SAXS) to image the nanometer-scale spatial- and femtosecond temporal resolution of the laser-plasma interactions. However, the analysis of the SAXS pattern is an ill-posed inverse problem meaning that multiple configurations of our target might explain the same measurement due to the loss of the phase information. We approach the ambiguities of the inverse problem by a conditional Invertible Neural Network (cINN) that is returning a probability density distribution over target parameters explaining a single SAXS pattern. We will show that the domain gap between generated training and experimental data can be approached by integrating perturbations of experimental data into the training workflow. We assess the applicability of our approach to a selected set of grating targets in terms of a comprehensive evaluation on simulation and experimental data.

AKPIK 9: AI Topical Day – New Methods (joint session AKPIK/T)

Time: Thursday 17:30–19:00 Location: HSZ/0004

AKPIK 9.1 Thu 17:30 HSZ/0004

Neural networks for cosmic ray simulations — •Pranav Sampathkumar[1], Tanguy Pierog[1], and Antonio Augusto Alves Junior[2] — [1]Institute for Astroparticle Physics (IAP), KIT, Germany — [2]Brazilian Synchrotron Light Laboratory (LNLS), CNPEM, Brazil

Simulating cosmic ray showers at high energies is memory and time intensive. Apart from the traditional methods such as thinning and cascade equations, novel methods are needed for the modern needs in astroparticle physics.

A hybrid model of generating cosmic ray showers based on neural networks is presented. We show that the neural network learns the solution to the governing cascade equation in one dimension. We then use the neural network to generate the energy spectra at every height slice. Pitfalls of training to generate a single height slice is discussed, and we present a sequential model which can generate the entire shower from an initial spectrum. Errors associated with the model and the potential to generate the full three dimensional distribution of the shower and detector footprints are discussed.

AKPIK 9.2 Thu 17:45 HSZ/0004

Transformer-Based Eventwise Reconstruction of Cosmic-Ray Masses at the Pierre Auger Observatory — Martin Erdmann, •Niklas Langner, and Dominik Steinberg — III. Physikalisches Institut A, RWTH Aachen University

As one aspect of the AugerPrime upgrade, scintillators (SSDs) will be added to the water Cherenkov detectors (WCDs) that form the surface detector of the Pierre Auger Observatory. This combined measurement offers the possibility to distinguish individual components of extensive air showers, potentially increasing the mass sensitivity. To efficiently exploit this new potential, novel methods are needed.

We introduce a Transformer-based neural network to reconstruct cosmic-ray masses from joint WCD and SSD measurements that outperforms both recurrent and convolutional networks. Efficient Transformers are employed to analyze and relate the two different sets of time traces on station level while ensuring a reasonable degree of computational demands. A Vision Transformer is then applied to the hexagonal grid of detector stations to process the whole shower footprint.

The Transformer network is trained to simultaneously reconstruct the depth of the shower maximum X_{max} as well as the shower's number of muons on ground R_{μ}. Both observables can be combined to estimate the primary cosmic-ray mass with an accuracy higher than what can be achieved individually.

AKPIK 9.3 Thu 18:00 HSZ/0004

Quantum Angle Generator for Image Generation — •Florian Rehm[1,2], Sofia Vallecorsa[1], Michele Grossi[1], Kerstin Borras[2,3], Dirk Krücker[2], Simon Schnake[2,3], Alexis-Harilao Verney-Provatas[2,3], and Valle Varo[3] — [1]CERN, Switzerland — [2]RWTH Aachen University, Germany — [3]DESY, Germany

The Quantum Angle Generator (QAG) is a new generative model for quantum computers. It consists of a parameterized quantum circuit trained with an objective function. The QAG model utilizes angle encoding for the conversion between the generated quantum data and classical data. Therefore, it requires one qubit per feature or pixel, while the output resolution is adjusted by the number of shots performing the image generation. This approach allows the generation of highly precise images on recent quantum computers. In this paper, the model is optimised for a High Energy Physics (HEP) use case generating simplified one-dimensional images measured by a specific particle detector, a calorimeter. With a reasonable number of shots, the QAG model achieves an elevated level of accuracy. The advantages of the QAG model are lined out - such as simple and stable training, a reasonable amount of qubits, circuit calls, circuit size and computation time compared to other quantum generative models, e.g. quantum GANs (qGANs) and Quantum Circuit Born Machines.

AKPIK 9.4 Thu 18:15 HSZ/0004

Photon identification at hadron colliders using graph neural networks — •Ali Malyali Choban[1], Johannes Erdmann[1], Florian Mausolf[1], and Christopher Morris[2] — [1]III. Physikalisches Institut A, RWTH Aachen University — [2]Fachgruppe Informatik, RWTH Aachen University

At hadron colliders like the LHC, photons are essential physics objects in a wide range of analyses. For example, they allow the study of the Higgs boson using the diphoton decay channel. At a typical particle detector, the main signatures of photons are energy depositions in the electromagnetic calorimeter. However, other objects can leave similar signatures in the electromagnetic calorimeter, leading to misidentification as photons. Jets are abundant at the LHC and they include a high number of light hadrons, most notably neutral pions decaying into two photons. The decay of pions produces photons that are often close to each other and they are likely to be reconstructed as a single photon. However, photon candidates from jets have different attributes that can help to discriminate them from real photons. Specifically, they tend to produce wider signatures in the calorimeter, and to be accompanied by more additional particles.

Graph neural networks (GNNs) are flexible neural architectures well suited for dealing with input data of irregular structure and variable shape. Hence, they are particularly suited for classifying photon candidates as often a variable number of particles surrounds them. In this talk, our study of the applicability of GNNs for photon identification and comparisons with convolutional neural networks are presented.

AKPIK 9.5 Thu 18:30 HSZ/0004

Data-driven Simulation of Target Normal Sheath Acceleration by Fourier Neural Operator — Jeyhun Rustamov[1,2], Thomas Miethlinger[1], Thomas Kluge[1], Michael Bussmann[1,3], and •Nico Hoffmann[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]TU Dresden, Dresden, Germany — [3]CASUS, Görlitz, Germany

Particle-in-Cell simulations are a ubiquitous tool for linking theory and experimen- tal data in plasma physics rendering the comprehension of non-linear processes such as Laser Plasma Acceleration (LPA) feasible. These numerical codes can be considered as state-of-the-art approach for studying the underlying physical processes in high temporal and spatial resolution. The analysis of experiments is performed by optimising simulation parameters so that the simulated system is able to explain experimental results. However, a high spatio-temporal resolution comes at the cost of elevated simulation times which makes the inversion nearly impossible. We tackle that challenge by introducing and studying a reduced order model based on Fourier neural operator that is evolving the ion density function of Laser-driven Ion acceleration via 1D Target Normal Sheath acceleration (TNSA). The ion density function can be dynamically generated over time with respect to the thickness of the target. We show that this approach yields a significant speed-up compared to numerical code Smilei while retaining physical properties to a certain degree promising applicability for inversion of experimental data by simulation-based inference.

AKPIK 9.6 Thu 18:45 HSZ/0004

RootInteractive tool for multidimensional statistical analysis, machine learning and analytical model validation — •Marian Ivanov[1] and Marian Ivanov jr.[2] for the ALICE Germany-Collaboration — [1]GSI Darmstadt — [2]UK Bratislava

ALICE, one of the four large experiments at CERN LHC, is a detector for the physics of heavy ions. In a high interaction rate environment, the pile-up of multiple events leads to an environment that requires advanced multidimensional data analysis methods.

Our goal was to provide a tool for dealing with multidimensional problems, to fit and visualize multidimensional functions including their uncertainties and biases, to validate assumptions and approximations, to easy define the functional composition of analytical parametric and non-parametric machine learning functions, to use symmetries and to define multidimensional "invariant" functions/alarms.

RootInteractive is a general-purpose tool for multidimensional statistical analysis. Its declarative programming paradigm makes it easy to use for professionals, students, and educators. RootInteractive provides functions for interactive, easily configurable visualization of unbinned and binned data and extraction of derived aggregate information on the server (Python/C++) and client (Javascript). We support client/server applications using Jupyter, or a standalone client-side interactive application/dashboard.

AKPIK 10: AI Topical Day – Computing II (joint session HK/AKPIK)

Time: Thursday 14:00–15:30 Location: HSZ/0103

AKPIK 10.1 Thu 14:00 HSZ/0103

Exploiting Differentiable Programming for the End-to-end Optimization of Detectors — The MODE Collaboration[1] and •Anastasios Belias[2] — [1]mode-collaboration.github.io — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

Machine-learning Optimized Design of Experiments, the MODE Collaboration, targets the end-to-end optimization of experimental apparatus, by using techniques developed in modern computer science to fully explore the multi-dimensional space of experiment design solutions. Differentiable Programming is employed to create models of detectors that include stochastic data-generation processes, the full modeling of the reconstruction and inference procedures, and a suitably defined objective function, along with the cost of any given detector configuration, geometry and materials.

The MODE Collaboration considers the end-to-end optimization challenges in its generality, providing software architectures for machine learning to explore experiment design strategies, information on the relative merit of different configurations, with the potential to identify and investigate novel, possibly revolutionary solutions. In this contribution we present use cases, and highlight the potential for on-going and future experiment design studies in fundamental physics research.

AKPIK 10.2 Thu 14:15 HSZ/0103

Klassifikation von Pulsdaten mit neuronalen Netzwerken auf einer FPGA Accelerator Card — •Robert Ufer, Bastian Auer, Helene Hoffmann, Oliver Knodel, Mani Lokamani und Stefan Müller — Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

Zur Analyse der entstehenden Detektordaten bei dem Mu2e Experiment am Fermilab soll die Datenauswertung mit Field Programmable Gate Array (FPGA) erfolgen. Diese übernehmen die notwendige Vorverarbeitung und Reduktion der Messdaten, noch während der Durchführung der Messung. Die dabei ausgeführten Anwendungen werden standardmäßig durch Algorithmen realisiert. Eine dieser Anwendungen führt die Klassifikation der ermittelten Pulsdaten durch.

Mit den Testläufen an der gELBE Bremstrahlungs-Beamline am Helmholtz-Zentrum Dresden-Rossendorf (HZDR) konnte für das zukünftige Experiment eine große Menge dieser Datensätze erfasst werden. Diese dienen zur Charakterisierung des Detektorsystems und wurden mit einem Lanthanbromid (LaBr) Detektor gemessen. Für die Pulsdatenklassifikation wird auf der Basis des Algorithmus und der erfassten Datensätze, ein neuronales Netzwerk erstellt, trainiert und validiert. Um bei diesen Schritten etablierte Machine Learning Frameworks zu verwenden, wird für die Portierung des Netzwerks in eine High-Level Synthese (HLS) Sprache die Software hls4ml verwendet. Dabei werden verschiedene Konfigurationen genutzt, um unterschiedlich optimierte Implementierungen zu generieren. Zum Evaluieren erfolgt die Ausführung der Implementierungen auf einer Xilinx Alveo Accelerator Card.

AKPIK 10.3 Thu 14:30 HSZ/0103

Pattern recognition using machine learning for the mCBM mRICH detector — •Martin Beyer for the CBM-Collaboration — Justus-Liebig-Universität Gießen

The Compressed Baryonic Matter experiment (CBM) is designed to explore the QCD phase diagram at high baryon densities using high-energy heavy ion collisions at high interaction rates. The Ring Imaging Cherenkov detector (RICH) contributes to the overall particle identification by reconstruction of rings from electrons with their respective radius, position and time. The miniCBM (mCBM) detector is the test setup for the CBM experiment, with the purpose of testing both hardware and software including the triggerless free-streaming data acquisition and data reconstruction algorithms. The miniRICH (mRICH) detector in the mCBM setup is a proximity focussing RICH detector with a photon detection plane consisting of 36 MultiAnode Photo Multipliers (MAPMTs). This setup results in charged particles passing directly through the MAPMTs resulting in quite some additional signals typically inside ring structures and reducing the overall ring finding efficiency based on the Hough Transformation.

In this talk a machine learning approach is presented to classify those signals in ring centers and thus improving the overall ring finding efficiency and precision.

AKPIK 10.4 Thu 14:45 HSZ/0103

Machine Learning Algorithms for Pattern Recognition with the PANDA Barrel DIRC — •Yannic Wolf[1,2], Roman Dzhygadlo[1], Klaus Peters[1,2], Georg Schepers[1], Carsten Schwarz[1], and Jochen Schwiening[1] — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt — [2]Goethe-Universität Frankfurt

Precise and fast hadronic particle identification (PID) is crucial to reach the physics goals of the PANDA detector at FAIR. The Barrel DIRC (Detection of Internally Reflected Cherenkov light) is a key detector for the identification of charged hadrons in PANDA. Several reconstruction algorithms have been developed to extract the PID information from the measured location and arrival time of the Cherenkov photons. In comparison to other Ring Imaging Cherenkov detectors, the hit patterns observed with DIRC counters do not appear as rings on the photosensor plane but as complex, disjoint 3D-patterns.

Using the recent advances in machine learning (ML) algorithms, especially in the area of image recognition, we plan to develop new ML PID algorithms for the PANDA Barrel DIRC and compare the results to conventional reconstruction methods. In search for the best performance, different network architectures are currently under investigation.

AKPIK 10.5 Thu 15:00 HSZ/0103

Optimization of the specific energy loss measurement for the upgraded ALICE TPC using machine learning — •Tuba Gündem for the ALICE Germany-Collaboration — Institut fuer Kernphysik, Frankfurt, Germany

The Time Projection Chamber (TPC) is the primary detector used in the ALICE experiment for tracking and particle identification (PID). PID is accomplished by reconstructing the momentum and the specific energy loss ($\mathrm{d}E/\mathrm{d}x$) of a particle. The $\mathrm{d}E/\mathrm{d}x$ for a given track is calculated using a truncated mean on the charge signals associated to the track. The readout plane, on which the signals are measured, is radially subdivided into four regions with different pad sizes. Since the measured signals depend on the pad size, an optimization of the $\mathrm{d}E/\mathrm{d}x$ calculation based on the pad size can be performed.

In this talk, a method for optimizing the $\mathrm{d}E/\mathrm{d}x$ calculation using machine learning (ML) algorithms will be presented. By performing realistic simulations of the generated signals on the pads, various effects such as the different pad sizes and track geometry are modeled. These simulations are used as inputs for the training of the ML model and are investigated using RootInteractive.

Supported by BMBF and the Helmholtz Association.

AKPIK 10.6 Thu 15:15 HSZ/0103

Deep Leaning Based PID with the HADES detector — •Waleed Esmail[1] and James Ritman[1,2,3] for the HADES-Collaboration — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany — [2]Forschungszentrum Jülich, 52428 Jülich, Germany — [3]Ruhr-Universität Bochum, 44801 Bochum, Germany

The main purpose of a particle identification (PID) algorithm is to provide a clean sample of particle species needed to conduct a physics analysis. The conventional approach used in the HADES experiment is to apply the so-called "graphical cuts" around the theoretical Bethe-Bloch curves of the energy loss as a function of the particle momentum. However, this approach is not optimal, since the distributions resulting from the different particle species overlap. A better approach is based on deep learning algorithms. In our preliminary studies done with the p(4.5 GeV)+p data recently collected by HADES, we were able to improve the separation power of the particle species. The algorithm is based on Domain Adversarial Neural Networks (DANN) trained in a semi-supervised way to simultaneously look at simulated and real data to learn the discrepancies between the two data domains. In this talk we will present our preliminary results, which show that this technique significantly improves the classification of particle species in the experimental data.

AKPIK 11: AI Topical Day – AI in Medicine (joint session ST/AKPIK)

Time: Thursday 14:00–15:30 Location: ZEU/0146

AKPIK 11.1 Thu 14:00 ZEU/0146

Multimodal image registration with deep learning — •Alexander Ratke[1], Christian Bäumer[2], Kevin Kröninger[1], and Bernhard Spaan[1] — [1]TU Dortmund University, Dortmund, Germany — [2]West German Proton Therapy Centre Essen, Essen, Germany

In radiation therapy, precise localisation of tumour and risk structures is important for treatment planning. Medical imaging methods, such as computed tomography (CT) and magnetic resonance imaging (MRI), allow a differentiation between these structures. Planning systems typically align CT and MRI scans rigidly to compensate inaccurate immobilisation of the patient, but distortions in MRI or movement of organs still remain.

In this project, a data set of CT and MRI scans of the head and neck areas is used to study unsupervised deformable image registration with deep learning. First, the scans are pre-processed, which includes rigid registrations and the equalisation of the image formats. Then, deep learning is employed to filter structures of an image through multiple layers and to match them to a second image. The registration model strongly depends on the choice of its parameters. Therefore, variations of these parameters are investigated on the data set. The results are presented as well as the overall workflow including the pre-processing.

AKPIK 11.2 Thu 14:15 ZEU/0146

Position reconstruction in proton therapy with proton radiography and machine learning — •Jolina Zillner, Carsten Burgard, Jana Hohmann, Kevin Kröninger, Florian Mentzel, Olaf Nackenhorst, Isabelle Schilling, Hendrik Speiser, and Jens Weingarten — TU Dortmund University, Department of Physics, Germany

In proton therapy precise patient positioning is essential for treatment quality. Current research in proton radiography (pRad) enables imaging of the patient immediately prior to irradiation. The idea is to use such pRad images to verify the patients position.

Therefore a 3D Convolutional Neural Network will be developed in order to predict pRad images depending on the CT image of an object and different translations and orientations. A minimization algorithm can then find the translation and rotation vector for which the predicted image has the smallest difference to a measured pRad image of the object, which can be used to correct the objects position. To predict pRad images, the CNN needs to be trained with pRad images and their related object translation and rotation and the CT-image.

This talk introduces the simulation used to generate these pRad training data. Simulations and reference measurements are performed with a primitive elbow phantom: a 3D-printed 3x3x3 cm^3 cube with a T-cavity for gypsum-inlays representing a stretched or bent elbow. The target is implemented in GEANT4 based on CT-data.

AKPIK 11.3 Thu 14:30 ZEU/0146

Event identification in the SiFi-CC Compton camera for imaging prompt gamma rays in proton therapy via deep neural networks — •Alexander Fenger[1], Ronja Hetzel[1], Jonas Kasper[1], George Farah[1], Achim Stahl[1], and Aleksandra Wrońska[2] — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]M. Smoluchowski Institute of Physics, Jagiellonian University Kraków, Poland

One of the biggest challenges in proton therapy is ensuring that the dose is delivered to the right position. A promising approach for online monitoring of the beam range is the detection of prompt gamma rays using a Compton camera, as it provides the possibility to reconstruct the 3D distribution of the deposited dose.

The SiFi-CC (SiPM and scintillating Fiber-based Compton Camera) project is a joint collaboration of the RWTH Aachen University, the Jagiellonian University in Kraków and the University of Lübeck. The two modules of the SiFi-CC, the scatterer and the absorber, both consist of stacked LYSO fibres and are read out by SiPMs. Deep neural networks are employed to separate valid Compton events from background and reconstruct the direction and energy of prompt gamma rays. First implementations of neural networks show promising results in classification of Compton events as well as full reconstruction of the event topology and kinematics. The next step is to further optimize the current neural network implementation to gain sensitivity towards a detectable range shift in the source position. Different neural network designs as well as an evaluation of their performance are presented.

AKPIK 11.4 Thu 14:45 ZEU/0146

Selection of Compton events in the SiFi-CC camera using convolutional neural networks — •George Farah[1], Ronja Hetzel[1], Jonas Kasper[1], Alexander Fenger[1], Achim Stahl[1], and Aleksandra Wrońska[2] — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]M. Smoluchowski Institute of Physics, Jagiellonian University Kraków, Poland

Proton therapy is a promising form of cancer treatment that uses charged protons to target and kill cancer cells. One of the main challenges in proton therapy is accurately determining the depth at which the protons will deposit their energy in the tumor.

The SiFi-CC (SiPM and scintillating Fiber-based Compton Camera) aims to enable range detection in proton therapy. It consists of multiple scintillating LYSO fibers generating signals that get read by SiPMs attached to both ends of the fibers. The camera utilizes the Compton effect and photoelectric effect to detect the prompt gamma rays produced in nuclear interactions of the protons with the nuclei in the tumor. This allows restricting the origin of the prompt gamma to a cone surface and by reconstructing many of such cones it is possible to reconstruct the source distribution of the prompt gammas.

The most recent SiFi-CC geometry has four fibers coupled to one SiPM in a shifted manner, so signals from multiple fibers get read by a single SiPM. In this talk, we present how three-dimensional neural networks can be advantageous by taking into consideration this new geometry. Hence improving the detection of Compton events, which improves the accuracy of range detection in proton therapy.

AKPIK 11.5 Thu 15:00 ZEU/0146

Fast dose predictions for conformal synchrotron microbeam irradiations — •Marco Schlimbach[1], Micah Barnes[2], Kevin Kröninger[1], Florian Mentzel[1], Olaf Nackenhorst[1], and Jens Weingarten[1] — [1]TU Dortmund, Germany — [2]University of Wollongong, Australia

An important optimization goal of radiation therapy is to apply the prescribed dose to the tumor while minimizing the dose deposition to surrounding healthy tissue. The new preclinical irradiation method, called Microbeam Radiation Therapy (MRT), enables higher control for certain tumors by spatial fractionation of photon beams compared to conventional irradiation methods. At the same time, the exposure of normal tissue remains the same.

Currently, the dose for MRT is mostly calculated with time-consuming Monte-Carlo simulations. However, for transfer to clinical application, a fast dose calculation is essential, so that therapies can be planned in a sufficiently short time. Recent studies show that MRT doses can be predicted accurately within milliseconds using neural networks. These studies, however, are limited to predicting the dose from a fixed MRT field size.

This work presents a method to extend the developed machine learning model to predict the doses from MRT irradiation fields of variable size and shape. Since there is no data from the clinic for MRT compared to conventional irradiation methods, the models are trained using a Geant4 Monte-Carlo simulation of a rodent head irradiation at the Imaging and Medical beamline at the Australian Synchrotron.

AKPIK 11.6 Thu 15:15 ZEU/0146

Thermoluminescence glow curve generation using generative adversarial networks (GANs) — •Evelin Derugin[1], Olaf Nackenhorst[1], Florian Mentzel[1], Jens Weingarten[1], Kevin Kröninger[1], and Jörg Walbersloh[2] — [1]Department of Physics, TU Dortmund University — [2]Materialprüfungsamt NRW

Personal dose monitoring is essential for a successful radiation protection program for occupationally exposed persons. The Materialprüfungsamt NRW (MPA NRW) provides thermoluminescence (TL) dosimeters based on LiF:Mg,Ti. Proof-of-concept studies to predict the day of irradiation have been successfully performed on measured TL glow curves using artificial neural networks (ANN). However, large data sets are required to train an ANN to predict the parameters of new measurements. Therefore the Department of Physics at TU Dortmund is developing multivariate methods for generating TL glow curves using generative adversarial networks (GANs). These generated glow curves will be used as training data for the irradiation day prediction model. This study trains GANs to generate glow curves using a measured data set of 4100 glow curves with 28 irradiation dates. In this talk, we present the comparison of the simulated glow curves with the measured ones and provide information about the performance and optimization of the GAN.

AKPIK 12: AI Topical Day – Heavy-Ion Collisions and QCD Phases (joint session HK/AKPIK)

Time: Thursday 14:00–15:30 Location: HSZ/0105

AKPIK 12.1 Thu 14:00 HSZ/0105

Modelling charged-particle production at LHC energies with deep neural networks — •Maria Calmon Behling for the ALICE Germany-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt, Germany

Particle production at the Large Hadron Collider (LHC) is driven by a complex interplay of soft and hard QCD processes. Modelling these interactions across center-of-mass energies and collision systems is still challenging for Monte Carlo event generators. Concise experimental data is indispensable to characterize the final state of a collision. The ALICE experiment with its unique tracking capabilities down to low transverse momenta is perfectly suited to study the bulk particle production in high-energy collisions. During the data taking campaigns of LHC Run 1 and Run 2 (2009 - 2018), a large amount of data were collected of a variety of collision systems at different center-of-mass energies. A recent measurement of charged-particle production covering all of these collision systems provides a comprehensive set of fundamental observables like the charged-particle multiplicity distributions and transverse momentum spectra as well as their correlation.

In this talk, we discuss the possibility of extending this set of discrete experimental data points into unmeasured regions by means of machine learning techniques. Training deep neural networks with ALICE data gives the unique opportunity to measure the evolution of multiplicity dependent charged-particle production across collision system sizes and energies.

Supported by BMBF and the Helmholtz Association.

AKPIK 12.2 Thu 14:15 HSZ/0105

Measurement of the Λ separation energy in hypertriton with ALICE using machine learning techniques — •Regina Michel for the ALICE Germany-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung — Technische Universität Darmstadt

Hypertriton ${}^3_\Lambda$H is the lightest hypernucleus, consisting of a Λ hyperon, a proton and a neutron. It is structured as a halo nucleus, where the Λ hyperon is very loosely bound to a "deuteron core". Measurements of the Λ separation energy can be used as a test for QCD, for some models of neutron stars and to constrain the possible difference of the lifetimes of ${}^3_\Lambda$H and Λ. The Λ separation energy can be measured via the invariant mass of the hypertriton decay products. The two-body-decay ${}^3_\Lambda\mathrm{H} \rightarrow {}^3\mathrm{He}+\pi$ is considered. Monte Carlo simulations are conducted to simulate the hypertriton interactions and decays while propagating through the detector. A data sample from Pb-Pb collisions at a center-of-mass energy of $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV recorded with ALICE at the LHC is analyzed using machine learning techniques.

AKPIK 12.3 Thu 14:30 HSZ/0105

Physics performance studies on Ξ^- Baryon at CBM — •Lisa-Katrin Kümmerer[1,2], Andrea Dubla[2], and Ilya Selyuzhenkov[2] for the CBM-Collaboration — [1]Physikalisches Institut, Universität Heidelberg — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

The Compressed Baryonic Matter (CBM) experiment at FAIR will investigate the QCD phase diagram in the region of high net-baryon densities (μ_B > 500 MeV) in the collision energy range of $\sqrt{s_{NN}}$ = 2.7 – 4.9 GeV with high interaction rate, up to 10 MHz, provided by the SIS100 accelerator. The (multi)strange baryons are crucial in determining the chemical freeze-out and its connection to hadronization from deconfined QCD matter.

In this contribution the performance for Ξ^- selection in Au-Au collisions at $\sqrt{s_{NN}}$ = 4.93 GeV in the CBM experiment will be presented. The Ξ^- hyperon is reconstructed via the weak decay channel $\Xi^- \rightarrow (\Lambda \rightarrow p\pi^-)\pi^-$ using the Particle-Finder Simple package.

For the reduction of the data size, which is driven by the large combinatorial background, specific skimming pre-selection criteria are optimized in this work. To obtain an optimal and stable separation between signal and background candidates the machine learning tool XGBoost is used. Machine learning allows for efficient, non-linear and multi-dimensional selection criteria to be implemented in a heavy-ion collision environment, enabling to extract and correct the Ξ^- raw yield in different rapidity and transverse momentum intervals.

AKPIK 12.4 Thu 14:45 HSZ/0105

Multi-differential Λ Yield Measurement in the CBM Experiment using Machine Learning Techniques — •Axel Puntke[1] and Shahid Khan[2] for the CBM-Collaboration — [1]Institut für Kernphysik, WWU Münster — [2]Eberhard Karls University of Tübingen

The Compressed Baryonic Matter (CBM) experiment at FAIR will investigate the QCD phase diagram at high net-baryon densities (μB > 500 MeV) with heavy-ion collisions in the energy range of $\sqrt{s}_{\mathrm{NN}}$ = 2.9-4.9 GeV. Precise determination of dense baryonic matter properties requires multi-differential measurements of strange hadron yields, both for the most copiously produced K^0_s and Λ as well as for rare (multi-)strange hyperons and their antiparticles.

The strange hadrons are reconstructed using methods based on a Kalman Filter algorithm that has been developed for the reconstruction of particles via their weak decay topology. The large combinatorial background needs to be suppressed by applying selection criteria according to the topology of the decay. This selection is optimized by training a boosted decision tree-based machine learning model with simulated data from two event generators, UrQMD and DCM-QGSM-SMM. After the signal has been selected, the yield of the strange hadron is computed.

In this talk, the analysis procedure for the most abundant Λ baryon is presented and the performance of the non-linear multi-parameter selection method is evaluated. A fitting routine is implemented to extract the Λ yield, on which the performance gain of training a separate model for each p_T-y interval will be discussed.

AKPIK 12.5 Thu 15:00 HSZ/0105

Full beauty-hadron reconstruction with J/ψ: feasibility study for Run 3 with ALICE — •Guillaume Taillepied for the ALICE Germany-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

The study of the production of hidden and open heavy-flavour hadrons in proton-proton (pp) collisions provides an essential test of quantum chromodynamics, involving both the perturbative and non-perturbative regimes. The J/ψ meson allows to study both the charm sector, via the measurement of prompt J/ψ, and the beauty sector through the measurement of the non-prompt component, coming from the decay of beauty hadrons. With the recent upgrades of the ALICE apparatus, the full reconstruction of beauty hadrons in exclusive decay channels containing non-prompt J/ψ mesons is now possible, providing a new way to study beauty physics in hadronic collisions.

In this talk, a feasibility study of the $\mathrm{B}^+ \rightarrow \mathrm{J}/\psi\,\mathrm{K}^+$, $\mathrm{J}/\psi \rightarrow \mathrm{e}^+\mathrm{e}^-$ process in pp collisions at $\sqrt{s}$ = 13.6 TeV with ALICE will be presented. The analysis makes use of the KFParticle package for a precise reconstruction of the B^+ and non-prompt J/ψ decay chain. The package also provides important information for the training of a machine learning model, increasing the signal selection efficiency and signal-over-background ratio. Discussions on the perspectives in lead-lead collisions for Run 3, based on the results of this feasibility study, will be shown.

AKPIK 12.6 Thu 15:15 HSZ/0105

Photon reconstruction in the Transition Radiation Detector of ALICE — •Peter Stratmann for the ALICE Germany-Collaboration — Institut für Kernphysik, Wilhelm-Klemm-Str. 9, 48149 Münster

The Transition Radiation Detector (TRD) of the ALICE detector at the Large Hadron Collider has the main purpose of identifying electrons and triggering on electrons and jets. Furthermore, it improves the resolution in track reconstruction at high transverse momenta. The working principle is based on transition radiation, which is produced by charged particles transversing boundaries of material with different dielectric constants.

In a rather new approach, the TRD should be used for measuring the photon production through the detection of conversion electrons. This is facilitated by the large material budget located in front and inside of the TRD. For this purpose, stand-alone tracking independent of the Inner Tracking System and the Time Projection Chamber had already been implemented. So far, this is achieved by a Kalman filter. As a new method, the photons are reconstructed in the TRD using Graph Neural Networks. These have the advantage that they operate well on the high-dimensional and sparse nature presented by the TRD data. In this talk, we will present the principles of the TRD, the direct photon reconstruction in the stand-alone tracking, and first results obtained with the Graph Neural Network.

Supported by BMBF within the ERuM framework, and DFG as part of the GRK 2149.

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Zur Abrüstung, der Verhinderung der Verbreitung von Massenvernichtungsmitteln und der Beurteilung neuer Waffentechnologien sind naturwissenschaftliche Untersuchungen unverzichtbar. Auch bei der Verifikation von Rüstungskontrollabkommen werden neue Techniken und Verfahren benötigt und eingesetzt. Schwerpunkte in diesem Jahr bilden Themen wie die nukleare Abrüstung, Verifikation bzw. die Detektion von Nuklearanlagen und Materialien, Raketenabwehr und Zerstörung von Nuklearsprengköpfen oder neue militärrelevante Technologien wie Drohnen. Die Fachsitzung wird von der DPG gemeinsam mit dem Forschungsverbund Naturwissenschaft, Abrüstung und internationale Sicherheit FONAS durchgeführt. Die 1998 gegründete Arbeitsgruppe Physik und Abrüstung ist für die Organisation verantwortlich. Die Sitzung soll international vorrangige Themen behandeln, Hintergrundwissen vermitteln und Ergebnisse neuerer Forschung darstellen.

Overview of Invited Talks and Sessions

(Lecture halls HSZ/0002 and HSZ/0004)

Max-von-Laue Lecture

PV XII	Wed	20:00–21:00	HSZ/AUDI	**Max-von-Laue Lecture: Risikokompetenz – informiert und entspannt mit Risiken umgehen** — •Gerd Gigerenzer

Invited Talks

AGA 1.1	Wed	14:00–14:45	HSZ/0004	**Acoustic, Seismic and Magnetic Detection of Banned Activities – 3.5 Decades of Physics-based Peace Research** — •Jürgen Altmann
AGA 4.1	Thu	14:00–14:45	HSZ/0002	**Mass Starvation? Impacts of Nuclear War on Climate Change and Food Security** — •Lili Xia
AGA 5.1	Thu	15:45–16:30	HSZ/0002	**Nuclear forensic science – when nuclear scientists and law enforcement meet** — •Maria Wallenius
AGA 5.2	Thu	16:30–17:15	HSZ/0002	**Applied Physics in the Alva Myrdal Centre for Nuclear Disarmament: Non-Proliferation and Safeguards Activities** — •Sophie Grape, Peter Andersson, Erik Branger, Cecilia Gustavsson, Vaibhav Mishra, Débora Montano Trombetta, Markus Preston
AGA 7.1	Fri	13:00–13:45	HSZ/0002	**Fireworks or Threat? – Recent Missile Developments in North Korea** — •Markus Schiller
AGA 7.2	Fri	13:45–14:30	HSZ/0002	**The Challenge of Nuclear-Powered Submarines to IAEA Safeguards** — •Tariq Rauf

Sessions

AGA 1.1–1.1	Wed	14:00–14:45	HSZ/0004	**Acoustic, Seismic and Magnetic Measurements**
AGA 2.1–2.4	Wed	14:45–16:25	HSZ/0004	**New Verification Concepts and Forensics**
AGA 3.1–3.2	Wed	16:25–17:05	HSZ/0004	**Simulation and Physics Teaching for Security and Disarmament**
AGA 4.1–4.3	Thu	14:00–15:25	HSZ/0002	**Nuclear Weapons and the Atmosphere**
AGA 5.1–5.2	Thu	15:45–17:15	HSZ/0002	**Applied Nuclear Physics**
AGA 6	Thu	17:30–18:30	HSZ/0002	**Members' Assembly**
AGA 7.1–7.3	Fri	13:00–14:50	HSZ/0002	**Proliferation Challenges**
AGA 8.1–8.1	Fri	14:50–15:10	HSZ/0002	**Mathematical Modelling of Conflicts**

Members’ Assembly of the Working Group on Physics and Disarmament

Thursday 17:30–18:30 HSZ/0002

1. Wahl der Versammlungsleitung und Protokollführung
2. Bericht der Sprecher
3. Wahl der Sprecher:in
4. Künftiger Arbeitsplan und Aktivitäten

Sessions

– Invited and Contributed Talks –

AGA 1: Acoustic, Seismic and Magnetic Measurements

Time: Wednesday 14:00–14:45 Location: HSZ/0004

Invited Talk AGA 1.1 Wed 14:00 HSZ/0004
Acoustic, Seismic and Magnetic Detection of Banned Activities – 3.5 Decades of Physics-based Peace Research — •Jürgen Altmann — Exp. Physik III, TU Dortmund University
Since 1988 we have done experimental research for verification and monitoring for disarmament, peacekeeping and nuclear safeguards, first at Ruhr University Bochum, from 1999 on at TU Dortmund University. The goal is to detect of movements of heavy land vehicles and aircraft or other activities that would violate an agreement or are relevant for peace in other ways. For outside, daylight and weather-independent sensing over short to medium distances (dozens of metres to kilometres) we focused on acoustic, seismic and magnetic signals. Field measurements were done at military training grounds and air bases, at an ambulance-helicopter base and at an exploratory mine for nuclear spent-fuel storage. The theoretical analyses included simulations. The talk will give an overview of the measurements, evaluations and findings. Problems and chances of such physics-based peace research will be discussed, too.

AGA 2: New Verification Concepts and Forensics

Time: Wednesday 14:45–16:25 Location: HSZ/0004

AGA 2.1 Wed 14:45 HSZ/0004
First Steps Towards a Muon Bunker Telescope to Verify the Absence of Nuclear Weapons — •Alexandra Datz[1] and Moritz Kütt[1,2] — [1]Institute for Peace Research and Security Policy at the University of Hamburg — [2]Program on Science and Security, Princeton University
Measurement approaches to verify the absence (or presence) of fissile materials are currently under intensive investigation. Through such measurements, one can demonstrate the absence of nuclear weapons. Previous measurements relied on particles emitted by the nuclear weapons themselves, photons and neutrons. We propose a new approach, using cosmic-ray-induced muons (muography), and a single detector to find hidden fissile material in potential nuclear weapon deployment sites (e.g. bunkers). Our contribution will present the possible framework for the application of this method to find hidden significant quantities of plutonium or highly-enriched uranium. Additionally, we show simulation results illustrating necessary detector properties and measurement times for a practical application.

AGA 2.2 Wed 15:05 HSZ/0004
Nuclear verification research – an integrated interdisciplinary approach — •Sophie Kretzschmar and Malte Göttsche — RWTH Aachen University
Verification is a key element for nuclear arms control. In today's global situation, it faces grave pressure: Increasing geopolitical change, rapid technological developments, and growing mistrust between states pose significant challenges to present and future verification regimes. The BMBF project *VeSPoTec – Verification in a complex and unpredictable world: social, political and technical processes* brings together researchers from physics, political sciences, and sociology to study verification in an interdisciplinary manner. This talk will introduce the project and demonstrate our integrated interdisciplinary approach on an example application case: verifying fissile material declarations using nuclear archaeology. On the technical side, questions remain on how to reduce uncertainties. For practical application, however, equally important questions persist that address a broader perspective: How can confidence be built when uncertainties remain? This talk will present first results on how social, political, and technical factors impact the success or failure of verification and discuss future challenges and potential solutions.

20 min. break

AGA 2.3 Wed 15:45 HSZ/0004
Anti-neutrino detector concepts for safeguarding spent nuclear fuel repositories — •Yan-Jie Schnellbach[1,2], Thomas Radermacher[1,2], Irmgard Niemeyer[3], Stefan Roth[1], and Malte Göttsche[2] — [1]RWTH Aachen University - Nuclear Verification and Disarmament, Aachen, Germany — [2]RWTH Aachen University - Physics Institute III B, Aachen, Germany — [3]Forschungszentrum Jülich, Jülich, Germany
Spent nuclear fuel (SNF) is an inevitable by-product of nuclear power generation and requires safeguarding, whether in interim storage or deep geological repositories. Anti-neutrino emissions from the ongoing beta decay of fission fragments could provide a complementary monitoring channel, as anti-neutrinos pass through shielding and geology unhindered and can be detected using inverse beta decay (IBD). This study investigates a novel anti-neutrino detection concept using a liquid organic (LOr) time projection chamber (TPC), combining scalability and particle reconstruction of TPCs with the hydrogen target atoms provided by organic compounds. Geant4-based simulations and electron drift modelling are used to study IBD event reconstruction in a container-sized concept detector for interim storage. The concept detector's expected signal rate, sensitivity and directionality are estimated for a representative example repository with varying deployment scenarios. The results are compared to other state-of-the-art anti-neutrino detection technologies proposed for monitoring. This ongoing comparison study will determine the feasibility anti-neutrino detection as complementary safeguards for SNF repositories.

AGA 2.4 Wed 16:05 HSZ/0004
Forensic Measurements for Nuclear Archaeology - A New Approach — •Lukas Rademacher and Malte Göttsche — Nuclear Verification and Disarmament, RWTH Aachen University
Nuclear archaeology is a field of study aiming to reconstruct the production and removal history of weapons-usable fissile materials and thus create estimates of existing stockpiles. A central method of nuclear archaeology is the deduction of a shut-down reactor's lifetime plutonium production using samples taken from within its core. Specific isotopic ratios are measured to assess neutron fluence and thus estimate plutonium production.

We will present a new approach aiming to strengthen the potential of the method by analyzing a larger set of measured isotopic ratios. This allows for the reconstruction of operational histories of the considered reactor in more detail, therefore also improving production estimates. The analysis required for this is however much more complex, so we developed a suitable procedure using mathematical and computational methods that we will present in the form of a first feasibility study.

This new analysis methodology can be used for various applications ranging from crosschecking fissile material declarations for international confidence building, to a combination with specially designed and installed reactor monitor tags to contribute to the verification of the proposed Fissile Material Cutoff Treaty, to reassessing potentially highly uncertain early plutonium production estimates on a purely national basis.

AGA 3: Simulation and Physics Teaching for Security and Disarmament

Time: Wednesday 16:25–17:05 Location: HSZ/0004

AGA 3.1 Wed 16:25 HSZ/0004

OpenMC für Anwendungen in sicherheitspolitischen Fragestellungen — •Olaf Schumann — Fraunhofer INT, Euskirchen

Strahlungstransportsimulationen sind ein wichtiges Instrument in vielen Gebieten der Kernphysik. Entweder dienen sie der Planung, Auswertung, Verbesserung oder dem tieferen Verständnis von experimentellen Messungen. Manchmal sind Simulationsrechnungen aber auch die einzige Möglichkeit, zu Ergebnissen zu kommen, sei es, weil eine Messung zu aufwendig oder undurchführbar ist, oder weil ein Messobjekt schlicht nicht zur Verfügung steht. Ein häufig genutztes Programm für diese Simulationen ist MCNP, welches umfangreich mit experimentellen Messungen validiert ist und in sehr vielen unterschiedlichen Bereichen eingesetzt wird. Es ist nur nach einer Aufwendigen Exportkontrollüberprüfung zugänglich, zudem ist eine Lizensierung nicht für jeden Anwendungszweck möglich. Hier hat sich in letzter Zeit OpenMC als Alternative etabliert, ein Programm, welches als Open Source Programm frei zur Verfügung steht und keinerlei Einschränkungen bezüglich der Nutzung unterliegt. OpenMC ist ursprünglich für Anwendungen der Reaktorphysik entworfen worden, daher bietet es einen darauf zugeschnittenen Funktionsumfang, der im Vergleich zu Programmen wie MCNP etwas eingeschränkt ist. Da es als quelloffenes Projekt angelegt ist, können fehlende Funktionen nachgerüstet und zur Aufnahme in die offizielle Version vorgeschlagen werden. Der Vortrag stellt dieses Programm vor und diskutiert Vor- als auch Nachteil gerade für Anwendungen im sicherheitspolitischen Bereich.

AGA 3.2 Wed 16:45 HSZ/0004

Teaching physics for Arms Control, Non-Proliferation and Disarmament — •Götz Neuneck — IFSH, Hamburg

Throughout the nuclear age, physicists played an important role to inform the public, advise the scientific community and influences politics. Teaching and education at universities and research groups form the basis for the discussion of future nuclear challenges. In the last decades much scientific-based materials, analytical papers and studies about the risk of nuclear use and non-proliferation dangers were elaborated and published by research groups and individual scientists. The talk intends to identify the most relevant topics, gives short introductions into current activities and literature and develops recommendations for relevant activities at universities and research centers. It gives an overview on active research groups, materials and interactions.

AGA 4: Nuclear Weapons and the Atmosphere

Time: Thursday 14:00–15:25 Location: HSZ/0002

Invited Talk AGA 4.1 Thu 14:00 HSZ/0002

Mass Starvation? Impacts of Nuclear War on Climate Change and Food Security — •Lili Xia — Rutgers University

The direct effects of nuclear war would be horrific, with blast, fires, and radiation killing and injuring many people. But in 1983, United States and Soviet Union scientists showed that a nuclear war could also produce a nuclear winter, with catastrophic consequences for global food supplies for people far removed from the conflict. Smoke from fires ignited by nuclear weapons exploded on cities and industrial targets would block out sunlight, causing dark, cold, and dry surface conditions, producing a nuclear winter, with surface temperatures below freezing even in summer for years. Climate change caused by smoke from fires ignited by nuclear weapons would limit the amount of food that could be grown on land our caught at sea. After stored food was consumed there would be mass food shortages in almost all countries. We used one climate model, one crop model, and one fishery model climate to estimate the impacts from six scenarios of stratospheric soot injection, predicting the total food calories available in each nation post-war after stored food was consumed. We estimated that more than 2*billion people could die from nuclear war between India and Pakistan, and more than 5*billion could die from a war between the United States and Russia.

AGA 4.2 Thu 14:45 HSZ/0002

Multi-technological analysis of the January 2022 Hunga Volcano explosive eruption from the perspective of CTBT monitoring — •Jens Ole Ross, Patrick Hupe, Andreas Steinberg, Stefanie Donner, Peter Gaebler, Johanna Lehr, Christoph Pilger, Thomas Plenefisch, and Lars Ceranna — Bundesanstalt für Geowissenschaften und Rohstoffe, BGR, B4.3 Erdbebendienst des Bundes / Kernwaffenteststopp, Hannover

For the detection of potential non-compliance with the Comprehensive Nuclear-Test-Ban Treaty (CTBT), the International Monitoring System (IMS) with 321 stations is nearly complete.

The huge explosive eruption of the Hunga Volcano (Tonga) on 15th January 2022 and its global observations were record-breaking in many aspects. All IMS infrasound stations measured the atmospheric Lamb wave and the following infrasound generated by the main eruption, which circumnavigated the globe several times. We also analysed the seismic and hydroacoustic signatures of the event series to characterize source processes and focused on methods for discriminating between earthquakes and explosions as demanded in the CTBT context. Atmospheric Transport Modelling assessed the sensitivity to the eruption for nearby radionuclide stations to estimate the detectability of hypothetical radionuclide releases in a fictitious nuclear explosion scenario.

The results show again the readiness of the CTBT-IMS and strengthen the value of the IMS data for scientific and civilian applications.

AGA 4.3 Thu 15:05 HSZ/0002

Test of a new radioxenon monitoring system for verification of the Comprehensive Nuclear-Test-Ban Treaty - What can be gained from higher sensitivities and shorter sampling periods? — •Sofia Brander[1], Sandra Baur[1], Roman Krais[1], J. Ole Ross[2], and Andreas Bollhöfer[1] — [1]Federal Office for Radiation Protection, Rosastr. 9, 79098 Freiburg — [2]Federal Institute for Geosciences and Natural Resources, GeoZentrum Hannover, Stilleweg 2, 30655 Hannover

For the verification of the Comprehensive Nuclear-Test-Ban Treaty (CTBT) an international monitoring system (IMS) of radioxenon measurement stations has been established. 26 of 40 planned noble gas stations now accommodate systems that automatically collect and analyze a minimum of 1 air sample per day for the nuclides Xe-133, Xe-131m, Xe-133m and Xe-135 in order to detect a possible nuclear weapons test. A new generation of systems, capable of shorter sampling cycles and lower detection limits, is being tested and implemented into the IMS. The German Federal Office for Radiation Protection tested one of these systems, Xenon International, from July 2021 to April 2022 at radionuclide station RN33 on Mount Schauinsland near Freiburg. The obtained activity concentrations are consistent with data from the current operational IMS system SPALAX at RN33, with sensitivities up to one order of magnitude higher for Xe-131m, Xe-133m and Xe-135.

In this talk, I will investigate multiple isotope detections and unusual single detections and explore the benefits of 6h time resolution considering source location capabilities via atmospheric transport modeling.

AGA 5: Applied Nuclear Physics

Time: Thursday 15:45–17:15 Location: HSZ/0002

Invited Talk AGA 5.1 Thu 15:45 HSZ/0002

Nuclear forensic science – when nuclear scientists and law enforcement meet — •Maria Wallenius — European Commission Joint Research Centre Directorate G - Nuclear Safety and Security Nuclear Safeguards and Forensics

Nuclear forensics is a discipline in which JRC Karlsruhe has a pioneering role: JRC was the first institution, which started to perform nuclear forensic analysis "in a routine manner" for seized nuclear materials 30 years ago. Starting as an ad-hoc analysis to respond safeguards and law enforcement authorities - questions on seized nuclear materials - what it is and where it comes from - nuclear forensics has now developed to a grown-up specialty.

Whereas nuclear forensics relies mostly on techniques used commonly in others fields, such as in nuclear safeguards, materials science or geochemistry, it has refined many of the methods and developed characteristic parameters (so-called nuclear forensic signatures) to response to the specifics required due to the criminal investigation.

This presentation will highlight some of the used methods, show newest developments and demonstrate their application by case studies.

Invited Talk AGA 5.2 Thu 16:30 HSZ/0002

Applied Physics in the Alva Myrdal Centre for Nuclear Disarmament: Non-Proliferation and Safeguards Activities — •Sophie Grape, Peter Andersson, Erik Branger, Cecilia Gustavsson, Vaibhav Mishra, Débora Montano Trombetta, and Markus Preston — Uppsala University

In 2020, the Swedish government announced the plans to start up a national competence centre on nuclear disarmament in Sweden. The objective was to highlight the importance of nuclear disarmament and to promote research, teaching and policy support on relevant topics. In mid-2021, the Alva Myrdal Centre (AMC) on nuclear disarmament was formally established at Uppsala University. The AMC combines competences from different disciplines such as peace and conflict research, applied nuclear physics, and international law, and organises the work into six different working groups. One of the working groups, led by the Division of Applied Nuclear Physics at Uppsala University, is focusing on technical aspects. In this division, research on nuclear safeguards has been performed for over 30 years, and competence exists on a number of applied physics applications ranging from nuclear reactions, nuclear power and detection of radionuclides. This presentation gives an overview of a number of different technical research projects that have been pursued within the technical working group under AMC.

AGA 6: Members' Assembly

Time: Thursday 17:30–18:30 Location: HSZ/0002

All members of the Working Group on Physics and Disarmament are invited to participate.

AGA 7: Proliferation Challenges

Time: Friday 13:00–14:50 Location: HSZ/0002

Invited Talk AGA 7.1 Fri 13:00 HSZ/0002

Fireworks or Threat? – Recent Missile Developments in North Korea — •Markus Schiller — ST Analytics GmbH, München, Germany

It seems that the North Korean missile program is now advancing at a pace unlike ever seen before. In the third quarter of 2022 alone, North Korea tested more missiles than it had in the first 30 years of its program under its previous leaders Kim Il Sung and Kim Jong Il. This presentation will try to shed some light on what is actually happening in the realm of Kim Jong Un in regard to missile developments and tests, and it will try to derive the underlying strategy by applying technical analyses of the observed activities.

Invited Talk AGA 7.2 Fri 13:45 HSZ/0002

The Challenge of Nuclear-Powered Submarines to IAEA Safeguards — •Tariq Rauf — Vienna

The decisions by Australia to import eight nuclear-powered submarines (SSNs) fueled with 97.3% highly-enriched uranium (HEU) from either the US or the UK, and by Brazil to develop its own SSNs fueled with low-enriched uranium (LEU) with technical assistance from France and Germany, have exposed fundamental weaknesses in the nuclear Non-Proliferation Treaty (NPT) and its related IAEA safeguards (verification) system. The NPT only covers "peaceful nuclear activities" while the IAEA safeguards system for NPT non-nuclear-weapon States (NNWS) includes an exemption from verification of "non-proscribed military activities". The IAEA Secretariat and the IAEA Board of Governors seemingly are deeply confused and divided over the safeguards implications of these SSN-acquisition programmes. This presentation will describe the problems and suggest possible ways of dealing with them and preserving the 50-year old nuclear non-proliferation regime.

AGA 7.3 Fri 14:30 HSZ/0002

The current Pollution and Contamination of the Biosphere and Humans with radioactive Isotopes through the Proliferation of Uranium used in Modern Weapon Systems - A Summary of critical Research Results — •Frank Klimaschewski — Uranium Medical Research Institute (UMRI), UK, www.umri.link

Uranium is a heavy metal with superior armour-penetrating properties. It can be found in bullets, tank rounds, precision-guided bombs and missiles, to name but a few. Thousands of metric tonnes of Uranium dust and shrapnel have been released by modern weapon systems during military conflicts in, for example, the following countries: Iraq and Kuwait during Gulf War I and II, Afghanistan during Operation Enduring Freedom, former Yugoslav states Serbia and Kosovo, and very likely Lebanon, Libya, Syria and the Gaza Strip among others. Mass spectrometric analysis of 24-hour urine samples of civilians and veterans returning from such areas shows that they were contaminated by uranic and transuranic isotopes suffering complex health issues and illnesses such as cancers, organ failures and premature deaths. Recent findings by UMRI also indicate health problems among clean-up workers from a military training site in Europe where uranium-containing weapons have been used. More thorough research at other training sites is urgently needed.

AGA 8: Mathematical Modelling of Conflicts

Time: Friday 14:50–15:10 Location: HSZ/0002

AGA 8.1 Fri 14:50 HSZ/0002

Increased Geopolitical Instability as a Consequence of Changed Equilibrium Country Size — •Richard Schubert — Blücherstr. 55, 10961 Berlin

In the proposed contribution an analogy is established between the equilibrium size of magnetic domains and the historically formed size of countries. The equilibrium size of magnetic domains is given by a minimum of the energy function consisting of different components obeying different scaling laws, e.g. scaling to the cube or the square of the domain size. Thus, different materials have different average domain sizes. The size of the historically formed countries as well depends on a cost/benefit equilibrium, which can also be described by a kind of energy function. As a consequence of digitization and other changes in technology the parameters of the material countries are made of have changed dramatically leading to a different equilibrium country size. As a consequence, the current geopolitical situation is in a thermodynamic sense highly unstable. In the contribution, it will be shown how the recent developments in the Yellow Sea, Ukraine, and Catalonia could also be interpreted in the framework of this model (ref to 2017). Trying to make suggestions on how to achieve a smooth transition from the old state of the system to a new state closer to equilibrium is, however, outside the scope of the proposed contribution. Part of the ideas are based on the author's long-standing experience in organizing political background discussions http://berlin-3d-art.de/politische_hintergrundgespraeche.htm

Working Group on Information
Arbeitsgruppe Information (AGI)

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Overview of Invited Talks and Sessions

(Lecture hall ZEU/0148)

Invited Talks

AGI 1.1	Thu	11:00–11:30	ZEU/0148	**Programming and Computational Physics Education in the Physics Curriculum at University of Göttingen** — •Fabian Heidrich-Meisner
AGI 1.2	Thu	11:30–12:00	ZEU/0148	**Integrating Digitalization and Research Data Management (RDM) into the Curricula of Bachelor and Master Students in Chemistry** — •Fabian Fink, Alexander Hoffmann, Sonja Herres-Pawlis
AGI 1.3	Thu	12:00–12:30	ZEU/0148	**News from PUNCH4NFDI: Education of students** — •Carsten Burgard, Kevin Kröninger

Sessions

AGI 1.1–1.3	Thu	11:00–12:30	ZEU/0148	**Data Literacy in the Physics Curriculum**
AGI 2.1–2.5	Thu	14:00–17:30	ZEU/0148	**Hacky Hour (joint session AKjDPG/AGI)**

Sessions

– Invited Talks, Contributed Talks, and Posters –

AGI 1: Data Literacy in the Physics Curriculum

Time: Thursday 11:00–12:30 Location: ZEU/0148

Invited Talk AGI 1.1 Thu 11:00 ZEU/0148

Programming and Computational Physics Education in the Physics Curriculum at University of Göttingen — •Fabian Heidrich-Meisner — Institut für Theoretische Physik, Georg-August-Universität Göttingen

Programming skills and expertise with computational physics are essential competences in the daily work of a physicist. Often, these skills are acquired on the flight, yet in view of qualification standards and evolving expectations from both students and prospective employers, graduates may benefit from standardized training elements in their physics education. Therefore, training in these skills are essential parts in the physics curriculum on the B.Sc. and M.Sc. level at the University of Göttingen. I will introduce our integrated approach, choice of programming languages, and the specific modules that are mandatory parts of our B.Sc. Physics programme. On the master's level, we offer a qualification direction in Theoretical Physics that encompasses a significant amount of training in Computational Physics. B.Sc. in Göttingen can also enroll in an Applied Computer Science track on the B.Sc. level and can specialize in Computational Physics.

Invited Talk AGI 1.2 Thu 11:30 ZEU/0148

Integrating Digitalization and Research Data Management (RDM) into the Curricula of Bachelor and Master Students in Chemistry — •Fabian Fink, Alexander Hoffmann, and Sonja Herres-Pawlis — RWTH Aachen University, Aachen, Germany

Ongoing and increasing digitalization is permanently changing the way research is conducted, experiments are documented, and data are stored. In general, this process requires the support of appropriate research data management (RDM) to enable sustainable research in the first place. [1] Currently, a rethinking takes place in academia focusing especially on the topic of RDM: working groups using electronic laboratory notebooks (ELNs) for documentation, publishers requiring authors to provide a data availability statement to describe how others can access their data, and scientists publishing their research data in repositories to ensure long-term storage and to meet the FAIR data principles (findable, accessible, interoperable, reusable). [2] However, despite the growing awareness of RDM, incorporation of the topic into curricula is largely nonexistent or, if at all, in its infancy.

In this talk, we showcase two initial examples of integrating RDM into bachelor and master studies in chemistry to raise students' attention at an early stage in their careers. Firstly, we present the implementation of an ELN in a bachelor lab course tracked with a survey among the students. Secondly, we show how we use case studies to combine a master lecture on sustainable chemistry with RDM content.

[1] *Angew. Chem. Int. Ed.* **2022**, *61*, e202203038; *Angew. Chem.* **2022**, *134*, e202203038. [2] *Sci. Data* **2016**, *3*, 160018.

Invited Talk AGI 1.3 Thu 12:00 ZEU/0148

News from PUNCH4NFDI: Education of students — •Carsten Burgard and Kevin Kröninger for the PUNCH4NFDI Consortium-Collaboration — TU Dortmund

The consortium Particles, Universe, NuClei and Hadrons (PUNCH) for the National Research Data Infrastructure (NFDI) joins forces of about 9000 scientists from various institutions to establish and promote a "FAIR" science data platform. One part of this initiative is to improve and develop the way we teach data literacy skills as part of the physics curriculum. Modern physicists are expected to have the required excellent data science skills. For this reason, a corresponding discussion must already take place during their studies. This results in a complex task for educators: staying up to speed with all that modern data science has to offer, while striking a balance with other important and demanding topics covered as part of a physics curriculum. Meeting these challenges requires educators of all types to coordinate, invent and exchange ideas on best practices in the field. One first step towards this goal is a detailed assessment and evaluation of existing strategies and methods. We at PUNCH4NFDI conducted a survey to get an overview. Collecting insights on what types of approaches exist and how they are received by the educators and the target audience alike will help to inform the future strategy and motivate advancing data literacy education in the context of physics curricula.

AGI 2: Hacky Hour (joint session AKjDPG/AGI)

Time: Thursday 14:00–17:30 Location: ZEU/0148

AGI 2.1 Thu 14:00 ZEU/0148

Adamant: A JSON-Based Metadata Editor for Researchers — •Ihda Chaerony Siffa, Marjan Stankov, and Markus M. Becker — Leibniz Institute for Plasma Science and Technology (INP), Felix-Hausdorff-Straße 2, 17489 Greifswald, Germany

Adamant is a browser-based research data management (RDM) tool, specifically developed to systematically collect research metadata that is both machine- and human-readable. It utilizes the JavaScript Object Notation (JSON) schema specifications, where any valid schema can be rendered as an interactive and user-friendly web form. Users may create a JSON schema from scratch or provide an existing schema. Subsequently, users can provide inputs to the rendered form and generate a JSON document, which can be downloaded for further use. Adamant has found its usage in several research settings; namely, compilation of structured experiment metadata in conjunction with a generic electronic laboratory notebook, scientific instrument job requesting, and preparation of input data for plasma simulations. Overall, Adamant is an emerging generic RDM tool that eases day-to-day research activities as far as structured metadata is concerned.

AGI 2.2 Thu 14:45 ZEU/0148

Hands-on data management with open-source software: CaosDB — •Florian Spreckelsen and Daniel Hornung — IndiScale GmbH, Göttingen, Germany

Data management involves the storing, searching, retrieving and analyzing of data sets and their connections and circumstances. Good data management makes valuable data reusable, for current and future users. It also makes data findable (*Where is the training data for sensor X of setup Y again?*) and adds real utility to data, because data can be embedded into context (*Which experimental settings were used for obtaining the data for project P, and how many failures were there?*).

The open-source toolkit CaosDB is a practical implementation of an agile data management approach designed to handle all these tasks, and much more: The structure of data can be modified later without losing old information and without the need to migrate existing data. This encourages agile implementation of data management workflows instead of delaying until the *perfect master plan* is ready. And CaosDB comes with a powerful Python client, so access is as easy as a few lines of code. This session consists of a short live demonstration of the CaosDB Python client, and participants are encouraged to follow along on their own machines. For this, they can install CaosDB's Python library and additional tools with `pip install caosdb caosadvancedtools` and make sure that they can load the library in Python with `import caosdb`. A Jupyter notebook will be made available online before the session.

AGI 2.3 Thu 15:30 ZEU/0148

ELN integration into the open-source data management solution CaosDB — •Daniel Hornung, Florian Spreckelsen, Henrik tom Wörden, Timm Fitschen, and Thomas Weiss — IndiScale GmbH, Göttingen, Germany

Scientific research still often lacks professional data management, mostly because the dynamically evolving research environments lack suitable software tools. In contrast, standardized industrial processes can be integrated easily with existing data management software. Research work in the lab is increasingly documented with electronic lab notebooks (ELNs), which allow to conveniently enter device and experimental settings in a semi-structured way. This data is usually critical in the analysis of acquired raw data from instruments, e.g. for searching specific data sets or filtering by parameters. We successfully integrated the data management software CaosDB with the eLabFTW ELN, thus combining flexible lab input methods with an agile open source approach to data management.

We chose CaosDB over other solutions, because it allows to flexibly adjust the data model when necessary. This agility is required by the dynamic nature of scientific research activities and cannot be provided by rigid, SQL based approaches.

20 min. break

Invited Talk AGI 2.4 Thu 16:00 ZEU/0148

Open data and open-source tools throughout research data life cycle: KCDC example — •Victoria Tokareva — Karlsruhe Institute of Technology, Institute for Astroparticle Physics, Karlsruhe, Germany

Open science essentials include open data, open source software, open access materials, open educational resources, etc. They provide substantial benefits to society like reproducibility of research, increased transparency and public acceptance of studies, simplified publication process, and enhanced public education. Ultimately, new opportunities become available for unique interdisciplinary studies performed by large diverse teams of specialists on publicly available datasets. Established in 2013, the KASCADE Cosmic Ray Data Centre (KCDC) exists simultaneously as an open archive for data of high-energy astroparticle physics experiments (such as KASCADE, KASCADE-Grande, LOPES, Maket-Ani, etc.), open source software and a web portal providing access to open educational resources. KCDC allows data selection with custom user data cuts using GUI or REST API and interactive online analysis of the selected data with integrated Jupyter Notebooks. From this talk, one can learn more about KCDC's functionality and get better understanding of open science and research data life cycle concepts. An example of machine learning based analysis employing the KCDC platform and deployment of the results as an application using Streamlit will be discussed. This work is partially supported by the DFG fund "NFDI 39/1" for the PUNCH4NFDI consortium.

AGI 2.5 Thu 16:45 ZEU/0148

Interactive USB measurement device controlling with Python — •Benedikt Bieringer — Institute for Nuclear Physics, University of Münster

Although USB devices are central part of most lab experiments, in many cases their use is significantly limited by the provided manufacturers' software and drivers. This talk covers writing a (graphical) readout and controlling software in Python both by using proprietary drivers and by writing own user-space Python-based drivers in cases where the manufacturers' drivers limit the usage potential of the USB device. It gives an overview over writing Python modules for existing drivers in C++, writing USB drivers in Python using PyUSB by analyzing USB packets with Wireshark and writing an interactive plotting and controlling GUI with PyQt and PyQtGraph.

Working Group on Philosophy of Physics
Arbeitsgruppe Philosophie der Physik (AGPhil)

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Overview of Invited Talks and Sessions

(Lecture halls JAN/0027 and HSZ/0304)

Invited Talks

AGPhil 5.1	Wed	14:00–14:45	JAN/0027	**Physical probability is relative frequency** — •Simon Saunders
AGPhil 5.2	Wed	14:45–15:30	JAN/0027	**Locality and the Metaphysics of Many Worlds Quantum Mechanics** — •Alyssa Ney
AGPhil 6.1	Wed	16:00–16:45	JAN/0027	**The structure of entangled properties: Distributional holism** — •Paul Näger
AGPhil 8.1	Thu	11:00–11:45	JAN/0027	**Interpreting Quantum Mechanics on an Informational Approach** — •Michael Cuffaro
AGPhil 8.2	Thu	11:45–12:30	JAN/0027	**Does science need intersubjectivity? The problem of confirmation in orthodox interpretations of quantum mechanics** — •Emily Adlam

Sessions

AGPhil 1.1–1.4	Mon	11:00–13:00	JAN/0027	**Quanten und Prozesse**
AGPhil 2.1–2.3	Tue	11:00–12:30	JAN/0027	**Space and Time**
AGPhil 3.1–3.3	Tue	17:30–19:00	JAN/0027	**Philosophy of Physics**
AGPhil 4.1–4.3	Wed	11:00–12:30	JAN/0027	**Quantum Foundations 1**
AGPhil 5.1–5.2	Wed	14:00–15:30	JAN/0027	**Quantum Foundations 2**
AGPhil 6.1–6.3	Wed	16:00–17:45	JAN/0027	**Quantum Foundations 3**
AGPhil 7	Wed	18:00–18:30	JAN/0027	**Members' Assembly**
AGPhil 8.1–8.2	Thu	11:00–12:30	JAN/0027	**Quantum Foundations 4**
AGPhil 9.1–9.4	Thu	14:00–16:00	JAN/0027	**Quantum Foundations 5**
AGPhil 10.1–10.3	Thu	16:15–16:45	JAN/0027	**Quantum Foundations Poster Session**
AGPhil 11.1–11.4	Fri	10:45–12:45	HSZ/0304	**Quantum Mechanics, Philosophy and Information**

Members' Assembly of the Working Group on Philosophy of Physics

Wednesday 18:00–18:30 JAN/0027

- Bericht
- Wahlen
- Planung 2023/24
- Verschiedenes

Sessions

– Invited Talks, Contributed Talks, and Posters –

AGPhil 1: Quanten und Prozesse

Time: Monday 11:00–13:00 Location: JAN/0027

AGPhil 1.1 Mon 11:00 JAN/0027

Vorgriff auf Quanten 2025 — Helmut Hille und •Helmut Hille — Fritz-Haber-Straße 34, 74081 Heilbronn

Da ich auf Grund meines Alters das Jahr 2025 wohl nicht mehr erleben werde, hier mein Vorsxhlag für die Theorie der Quantenphysik.

Durch die Einschätzung der Gravitation als ein von der Quantenmechanik her bekanntes Phänomen der Verschränkung, wird die pragmatische Quantenmechanik zur Theorie der Quantenphysik erweitert, zuständig für Materie und Kosmos. Die Heilbronner Deutung der Quantenphysik sieht dazu einerseits die allgemeine Verschränkung der Materie als Folge des gemeinsamen Ur-Sprungs unseres Kosmos im sog. "Urknall", deutet andererseits den Kosmos als einen von wahrscheinlich vielen im Universum, das selbst ohne Grenzen in Raum und Zeit ist. Unter dem durchgehenden Gesichtspunkt des Energieerhalts als oberstes Kriterium ergibt sich eine rationale Kosmologie, die keiner weiteren Begründung bedarf. Mit dieser Heilbronner Deutung ist die Einheit der Physik wieder hergestellt, und das ohne Hypothesen, nur mit Deutung des schon Bekannten. Man muss vor allem bereit sein, die Fakten als solche zu respektieren: verschränkte Teilchen und Körper verhalten sich nicht wie ungetrennte Einheiten, sondern sind solche! (Sie schauspielern nicht wie wir Menschen.)

AGPhil 1.2 Mon 11:30 JAN/0027

Raumzeitdichte in verschiedenen Dimensionen als gemeinsame Ontologie für ART und QM — •Christian Kosmak — Working Group Dimensional Physics, Würzburg

Es wird das Konzept Dimensionale Physik vorgestellt, welches alle Abbildungen des Standardmodells als eine geometrische Abbildung einer Raumzeitdichte ansieht. Gravitation und Raumzeitdichte sind gegensätzliche geometrische Abbildungen in der 4D-Raumzeit.Postulate aus der Allgemeinen Relativitätstheorie (ART) und der Quantenmechanik (QM) lassen sich auf dieselben drei Kernelemente zurückführen: Raumzeitdichte, Lichtgeschwindigkeit als nieder-dimensionale Grenze und Verbindung der nieder-dimensionalen Untermannigfaltigkeiten über den Raum. Entscheidend ist, dass niederdimensionale geometrische Abbildungen die Eigenschaften der Elementarteilchen erzeugen. In der Berechnung exakte aber in der Logik unverstandene Elemente wie Schwarze Löcher, die Verschränkung oder der Wellenkollaps erhalten in dem Konzept der Dimensionalen Physik eine klare physikalische Interpretation. Die Raumzeit ist nicht nur eine dynamische Bühne, sondern der einzige Akteur. https://dimensionale-physik.de/

AGPhil 1.3 Mon 12:00 JAN/0027

Prozesse statt Zustandsbetrachtungen — •Grit Kalies[1] und Duong D. Do[2] — [1]HTW University of Applied Sciences, Dresden, Germany — [2]The University of Queensland, Brisbane, Australia

Die moderne theoretische Physik beruht auf Zustandsbetrachtungen. Ihre zentrale Größe ist die Kraft F, die geheimnisumwittert geblieben ist [1]. In der Relativitätstheorie existiert keine Prozessgleichung [2]. Die Mechanik kennt nur eine Prozessgleichung $\delta W = Fdx$, die in abgewandelten Formen verwendet wird. Die Energieerhaltung gilt heute als verletzbar, z.B. in sogenannten Quantenfluktuationen des Vakuums oder in der Urknall-Hypothese. Mikro- und makroskopische Prozesse werden als reversibel beschrieben.

In der Natur und Thermodynamik ist der Prozess zentral. Panta rhei. Eine Prozessgleichung beschreibt eine Energieänderung und enthält ein unbeugsames Ursache-Wirkungs-Prinzip [1,2]. Folgt man diesem Prinzip auf fundamentaler mechanischer Ebene, lässt sich die Energieerhaltung als unbegrenzt gültig beschreiben und erklären. Sie gilt dann auch auf Quantenebene zu jedem Zeitpunkt. Quantenprozesse werden als irreversibel beschreibbar, d.h. sie sind nicht auf demselben Wege umkehrbar.

1. M. Jammer: Concepts of Force, Harper Torchbook, New York, 1962. 2. G. Kalies, Z. Phys. Chem. 236 (2022) 481-533. 3. G. Kalies, S. Arnrich, D.D. Do: Coherent process equations in mechanics and thermodynamics, submitted 11/2022.

AGPhil 1.4 Mon 12:30 JAN/0027

Three steps to a realistic foundation of quantum mechanics — •Ed Dellian — Bogenst. 5, 14169 Berlin, Germany.

1. Quantum mechanics currently presupposes the classical concept of energy. It emerges from calculating the faculty *work* of a moving system as a path integral; the time of motion plays no role here. This to ignore entails that in applications of the formalism there occur effects of seemingly timelessness interactions (instantaneous actions at a distance, etc.).

2. The Heisenberg relations presented by Bohr (the 1927 Como lecture) show the operators energy E, momentum p, time t and space s as an equation of products ($\Delta E \times \Delta t = \Delta p \times \Delta s$). Planck*s h works as an intermediate only that must not show up in the equation, which (rearranged) appears as a quaternate proportion: $\Delta E : \Delta p = \Delta s : \Delta t$. The proportionality factor is c [dimensions space over time]. What results is ΔE over $\Delta p = c$, or generally: $E/p = c$, or $E = pc$.

3. Replacing the classical energy concept $E = p^*/2m$ with the well-known $E = pc$, that is, $E/p = c =$ constant, removes mystical and weird implications of quantum mechanics, even gives it the status of a realistic theory of motion which Schrödinger*s equation is not.

AGPhil 2: Space and Time

Time: Tuesday 11:00–12:30 Location: JAN/0027

AGPhil 2.1 Tue 11:00 JAN/0027

Einstein's forgotten interpretation of GR: against geometrization and for the unification of gravity and inertia — •Dennis Lehmkuhl — Lichtenberg Group for History and Philosophy of Physics, University of Bonn

Almost every textbook on general relativity tells us that the main lesson of the theory is that gravity is not a force but that it can be reduced to space-time geometry, that gravity is the curvature of spacetime. Unbeknownst to most, Einstein himself actively opposed this interpretation of his theory. He thought that instead general relativity should be seen as a unification of gravity and inertia, analogous to the unification of electricity and magnetism in special relativistic electrodynamics. In this talk I am going to outline how this interpretation of general relativity originated in Einstein's work on a relativistic theory of gravity before he first embarked on a metric theory in 1913, and how his interpretation of the equivalence principle made him hold on to this interpretation even after more and more physicists and philosophers opted for a geometric interpretation of the theory. Finally, I will compare the geometric and the unificationist interpretation and discuss whether either or both of them can be upheld in the modern context.

AGPhil 2.2 Tue 11:30 JAN/0027

A dynamical perspective on the arrow of time — •Kian Salimkhani — University of Cologne

It is standardly believed that the generally time-reversal symmetric fundamental laws of physics themselves cannot explain the apparent asymmetry of time. In particular, it is believed that CP violation is of no help. In this paper, I want to push back against a quick dismissal of CP violation as a potential source for the arrow of time and argue that it should be taken more seriously for conceptualising time in physics. I first recall that CP violation is a key feature of our best physical theory which also has large-scale explanatory import regarding the matter-antimatter asymmetry of the universe. I then investigate how CP violation may help to explain the directionality of time. I argue that accounts a la Maudlin that posit an intrinsic fundamental direction of time are not convincing and instead propose to utilise recent results from work on the dynamical approach to relativity theory.

AGPhil 2.3 Tue 12:00 JAN/0027

Causal Theories of Spacetime — •Baptiste Le Bihan — University of Geneva

In the twentieth century, the causal theory of time was replaced by the causal theory of spacetime. Based on pioneering work by Hawking (1976), Malament (1977) and others, it was argued that special and general relativity were, at core, causal theories and the view that the metric structure of spacetime could be accounted for in terms of a causal topology started to gain momentum (Huggett and Wüthrich, forthcoming, ch2). But the theory was also subject to sustained attack in philosophical circles, especially by Smart (1969), Earman (1972) and

Nerlich (1982).

While interest in the causal theory ebbed within philosophy, the core motivations behind the theory never really went away in physics. The work by Malament and Hawking on causal structure in relativity gave birth to an important research programme in physics, culminating in what is now known as causal set theory.

To resolve the tension, we develop a new version of the causal theory of spacetime. Whereas traditional versions of the theory sought to identify spatiotemporal relations with causal relations, the version we develop takes causal relations to be more fundamental than spatiotemporal relations. We argue that this non-identity theory, suitably developed, avoids the challenges facing the traditional identity theory and offers a natural interpretation of causal set theory.

AGPhil 3: Philosophy of Physics

Time: Tuesday 17:30–19:00 Location: JAN/0027

AGPhil 3.1 Tue 17:30 JAN/0027

Realism Going Local: Stabilizing Quarks — •Nurida Lena Boddenberg — University of Bonn, Bonn, Germany

The aim of this talk is to present and defend a local realist position about stable phenomena and the traces leading towards them, called signatures, by acknowledging scientific practice and bottom-up data to phenomena inferences. For this endeavor, I will propose and justify a fourfold distinction into (raw) data, signatures, phenomena, and theories, utilizing a case study concerned with quarks.

I will show that jet events, or the scaling behavior of the structure functions in deep inelastic scattering, are signatures, and that their existence is independent of individual data sets and translatable across different experiments. Further, these signatures are also stabilized by their reliable reproducibility based on the different kinds of data. Nevertheless, they are not explicitly containing the entity, the quark, described in the theory of quantum chromodynamics. However, the (experimental) signatures can be traced back to a common origin, to a phenomenon. Referring to recent work on perspectival realism (Massimi 2022), I proceed to show that the more (experimental) signatures infer to one phenomenon, the more the latter is stabilized. Finally, I shall argue high-level theories or models can latch onto stabilized phenomena and provide further information, but the phenomena themselves can still exist independently.

AGPhil 3.2 Tue 18:00 JAN/0027

Feynman Diagrams providing understanding as Toy Models — •Karla Weingarten — Munich Center for Mathematical Philosophy, LMU Munich

Both in high school and undergraduate university courses, Feynman Diagrams are used to teach students about the mode of operation of elementary particle interactions. This is not for their mathematical rigor or theoretical beauty but for the accessibility and clarity of the pictorial representation. This decoupling of lower-order diagrams from the theoretical framework of perturbation theory is common practice in pedagogical settings, although they do not factually represent the underlying physical mechanisms. This raises the question of whether Feynman Diagrams, taken as literal graphical diagrams, can facilitate some form of understanding, which in most accounts requires the explanatory assumptions and models to be (at least approximately) true. This criterion can be weakened to design a concept of understanding that accommodates so-called toy models, highly idealised and simplified models intended to provide easier access to complex issues. I argue that the use of Feynman Diagrams as pictorial representations can be considered as a case of such a toy model. Although Feynman diagrams cannot (realistically) be considered to present how-actually understanding, I show that as toy models, they can indeed facilitate how-possibly understanding, emphasising their great use in learning particle physics.

AGPhil 3.3 Tue 18:30 JAN/0027

Suzanne Bachelard's Conceptualization of Mathematical Physics — •Ties van Gemert — Tilburg University, Tilburg, Netherlands

Suzanne Bachelard (1919-2007) was a French philosopher and historian of physics and mathematics. Although she was a longtime director of the prestigious l'Institut d'histoire des sciences et des techniques in Paris, she never acquired the same standing as many of her peers and her philosophy has received little to no attention. In this presentation, I will reconstruct her phenomenological epistemology through close-readings of her book The Consciousness of Rationality: A Phenomenological Study of Mathematical Physics (1958). First, I will give a general overview of her conceptualization of mathematical physics. After that, I will elucidate this overview by setting out her account of the history of three critical concepts in mathematical physics: (1) fluid objects, (2) potentiality, and (3) the principle of least action. In conclusion, I will reflect on what Bachelard's philosophy of physics can still teach us today.

AGPhil 4: Quantum Foundations 1

Time: Wednesday 11:00–12:30 Location: JAN/0027

AGPhil 4.1 Wed 11:00 JAN/0027

Supervaluationism, Determinacy, and the Completeness of Quantum Mechanics — •Samuel Fletcher and David Taylor — University of Minnesota, Twin Cities

Putative instances of quantum indeterminacy provide important test cases for theories of metaphysical indeterminacy such as metaphysical supervaluationism (MS). A theory that cannot faithfully model these types of cases is arguably inadequate. While MS has had notable success in modeling run-of-the-mill examples of indeterminacy, such as those which accompany vagueness, it faces a challenge in modeling the peculiar behavior of quantum systems. The challenge goes roughly as follows: (i) MS models indeterminacy via quantification over possible worlds; (ii) those possible worlds require a classically complete assignment of properties to individuals; (iii) there is no consistent, classically complete way of assigning properties to quantum systems; therefore (iv) MS cannot model indeterminacy in quantum systems.

We believe that this challenge has not yet been sufficiently understood and that, as a result, there is considerable confusion regarding its strength and scope. Accordingly, our aims are to: (i) present a version of the challenge that is stronger, more general, and more refined than those currently in the literature; (ii) clarify the role that EEL plays in the challenge, as this is a persistent source of confusion; and (iii) show that the primary disagreement between proponents of the challenge and its critics reduces to a disagreement regarding the (in)completeness of quantum mechanics.

AGPhil 4.2 Wed 11:30 JAN/0027

Classicality and Bell's Theorem — •Márton Gömöri[1] and Carl Hoefer[2] — [1]Eötvös Loránd University, Budapest, Hungary — [2]University of Barcelona, Spain

A widespread view among physicists is that Bell's theorem rests on an implicit assumption of "classicality," in addition to locality. According to this understanding, the violation of Bell's inequalities poses no challenge to locality, but simply reinforces the fact that quantum mechanics is not classical. The paper provides a critical analysis of this view. First we characterize the notion of classicality in probabilistic terms. We argue that classicality thus construed is not a mark of the validity of classical physics, nor of classical probability theory, contrary to what many believe. At the same time, we show that the probabilistic notion of classicality is not an additional premise of Bell's theorem, but a mathematical corollary of locality in conjunction with the standard auxiliary assumptions of Bell. Accordingly, any theory that claims to get around the derivation of Bell's inequalities by giving up classicality, in fact has to give up one of those standard assumptions. As an illustration of this, we look at two recent interpretations of quantum mechanics, Reinhard Werner's operational quantum mechanics and Robert Griffiths' consistent histories approach, that are claimed to be local and non-classical, and identify which of the standard assumptions of Bell's theorem each of them is forced to give up. We claim that while in operational quantum mechanics the Common Cause Principle is violated, the consistent histories approach is conspiratorial.

AGPhil 4.3 Wed 12:00 JAN/0027

On the Bell Notion of Beable: from Bohr to Primitive Ontology — •Federico Laudisa — Department of Humanities and Philosophy, University of Trento, Via Tommaso Gar 14, 38122, Trento (Italy)

There have been in more recent times comprehensive accounts of the Bell scientific developments, but in my talk I would like to focus on a rather specific point. I refer here to the Bell notion of beable, a term first introduced in his 1973 paper entitled *Subject and object*. The aim of my talk is to show that there are at least two different readings of the notion of beable in the development of Bell*s foundational analyses. First, the concept of beable emerges as the consequence of a Bohr-like view of the status of measurement in QM: Bell, across the succession of his papers devoted to the foundations of QM, refers to Bohr in different places and with different senses, often instrumental to supporting claims that in fact appear to be only partially consistent with a Bohrian view of quantum mechanics. Only later the notion of beable acquired the meaning which in retrospect motivated the so-called primitive ontology approach. It will also be shown that in neither of the two readings the use of the notion of beable commits Bell to assume any form of naive *realism*, especially with respect to the so-called *local realism* that, according to a widespread opinion, would be the alleged target of the Bell theorem.

AGPhil 5: Quantum Foundations 2

Time: Wednesday 14:00–15:30 Location: JAN/0027

Invited Talk AGPhil 5.1 Wed 14:00 JAN/0027
Physical probability is relative frequency — •Simon Saunders — Oxford University
Frequentism as a philosophy of probability is a perennial favourite among scientists, but for reasons I shall explain, has long been abandoned by philosophers of probability (physical probability, probability as something in nature). However, this consensus rests on the presupposition that there is only a single world. That assumption is challenged by the Everett interpretation of quantum mechanics, which is independently motivated. Understanding Everett's branches in terms of decoherence theory, there is a ready candidate for an ensemble even in the case of a single experiment: the equi-amplitude branches produced on any given trial. Relative frequencies for ensembles like these agree with the Born rule. As I shall show, for ensembles of this kind, the usual difficulties that render frequentism untenable no longer arise. Arguably, all physical probabilities are quantum probabilities, so the account is quite general.

The argument is strengthened by a recent result due to Tony Short, where given the possibility of swapping branch amplitudes, a probability measure over an ensemble of branches invariant under swapping must agree with the relative frequency rule, for it must treat equi-amplitude branches as equiprobable. It must therefore agree with the Born rule as well. I conclude with a critical evaluation of the invariance condition, and a limited defence. This work extends my https://arxiv.org/abs/2201.06087; The paper by Short is at https://arxiv.org/abs/2106.16145.

Invited Talk AGPhil 5.2 Wed 14:45 JAN/0027
Locality and the Metaphysics of Many Worlds Quantum Mechanics — •Alyssa Ney — UC Davis, Davis, California, USA
Those who defend the Many Worlds Interpretation (MWI) of quantum mechanics often argue it is to be preferred over other solutions to the measurement problem because it provides a local interpretation. However, some have argued that the locality of MWI depends on the way MWI is itself interpreted metaphysically. This paper defends the locality of several metaphysical interpretations of MWI against recent criticisms.

AGPhil 6: Quantum Foundations 3

Time: Wednesday 16:00–17:45 Location: JAN/0027

Invited Talk AGPhil 6.1 Wed 16:00 JAN/0027
The structure of entangled properties: Distributional holism — •Paul Näger — University of Münster, Germany
Which options does a wave function realist (GRW, Everett or other) have to understand entangled quantum states as referring to properties? Since entangled states cannot be reduced to the micro states, the denoted properties must be ontologically irreducible in some sense. There are three major proposals: Either an entangled state refers to an irreducible property of the macro object (as proposed by wave function monists), e.g. "having total spin 0"; or it refers to an irreducible relation between the micro objects (as proposed by some ontic structural realists), e.g. "having opposite spin to"; or, less well-known, it denotes a plural property of the micro objects, e.g. "having total spin 0" understood as a *collective* property of the micro objects. I argue that all three established proposals fail to properly fit with the structure of more general entangled states and develop a new proposal: An entangled state denotes what I call a "distributional property", establishing a specific kind of holism with a characteristic structure.

AGPhil 6.2 Wed 16:45 JAN/0027
The Self-Interaction Problem as the Measurement Problem of Classical Electrodynamics — •Mario Hubert — The American University in Cairo, New Cairo, Egypt
The self-interaction problem is the foundational problem of classical electrodynamics. Although it has been recognized for around 100 years, it has not been satisfactorily solved so far. I argue that the formulation of the problem actually determines how successful solutions may look like. Indeed, I show that the formulation of the self-interaction problem surprisingly parallels the formulation of the quantum mechanical measurement problem. Although Frisch (2005, Ch. 2) presents such a formulation, I criticize his list of assumptions, as well as his proof. The problem, as he sees it, relies on an inconsistency of energy conservation, while I argue that the problem is more severe: the fundamental equations of motion for a charge affected by its own electromagnetic field break down.

Having shown what the self-interaction problem actually is, I then present different strategies for its solution. My focus will be to retain the electromagnetic field with point charges. This strategy has not yet received sufficient attention.

AGPhil 6.3 Wed 17:15 JAN/0027
Quantum Theory Is Not As Strange As We Think (or is classical physics stranger than we think?) — •Fedde Benedictus — Utrecht University, the Netherlands — Amsterdam University College, the Neterlands
Quantum theory is conceptually closer to classical physics than is usually understood. I will discuss two of the characteristics of quantum theory that, at first sight, seem to set it apart from classical physics, but on closer scrutiny are not so different from their classical counterparts * locality and quantization.

To argue my point, I will show that:

1) While gravity in Newton*s theory is notoriously non-local, Einstein wanted nothing to do with this non-locality. However, Einstein's understanding of gravity as a metrical concept cannot fully do without non-locality: any interaction that is strictly local is restricted to a mathematical point (and therefore can never be between objects of finite size).

2) The atoms and molecules in classical physics are quanta of mass. Not only does this show that quantization plays a formative role in classical physics, it leads to the remarkable suggestion that the very idea of quantization (in the form of a fundamental symmetry) is essential for any description in terms of mathematical regularities.

AGPhil 7: Members' Assembly

Time: Wednesday 18:00–18:30 Location: JAN/0027

All members of the Working Group on Philosophy of Physics are invited to participate.

AGPhil 8: Quantum Foundations 4

Time: Thursday 11:00–12:30 Location: JAN/0027

Invited Talk AGPhil 8.1 Thu 11:00 JAN/0027
Interpreting Quantum Mechanics on an Informational Approach — •Michael Cuffaro — Munich Center for Mathematical Philosophy, LMU Munich, Germany
The traditional metaphysical picture of the world takes observation-independent properties as primary and to be the origin of values of dynamical quantities revealed in experiments. It is naturally suggested by classical mechanics, since the classical state fixes the values of all such quantities in advance. Famously this is not true of the quantum state. Although Everett is the most natural interpretation of quantum mechanics given the traditional metaphysical picture, in this talk I defend an informational interpretation. What we preserve from classical mechanics is not the metaphysical picture it suggests, but the empiricist methodology through which one reasons, from the probability distributions over the values revealed in experiments, to a global picture of the world that is anchored in the contextual models one gives of phenomena under the dynamical assumptions characterising each of them. A priori, the question of how to conceive of reality is, on our approach, open; but the answer suggested by the novel kinematical framework of quantum mechanics is that a description of the world that does not include a reference to the possibilities of observation is inadequate for physics. Since observers are represented schematically, our kinematical resolution of the measurement problem reveals the observation-independent structure of the world, but it is a mistake to interpret this structure in substantival terms.

Invited Talk AGPhil 8.2 Thu 11:45 JAN/0027
Does science need intersubjectivity? The problem of confirmation in orthodox interpretations of quantum mechanics — •Emily Adlam — University of Western Ontario
Any successful interpretation of quantum mechanics must explain how our empirical evidence allows us to come to know about quantum mechanics. In this talk I will argue that this vital criterion is not met by the class of orthodox interpretations, which includes QBism, neo-Copenhagen interpretations, and some versions of relational quantum mechanics. I will take a detailed look at the way in which belief-updating might work in the kind of universe postulated by an orthodox interpretation, and argue that observers in such a universe are unable to escape their own perspective in order to learn about the structure of the set of perspectives that is supposed to make up reality according to these interpretations. I will also argue that in some versions of these interpretations it is not even possible to use one's own relative frequencies for empirical confirmation.

AGPhil 9: Quantum Foundations 5

Time: Thursday 14:00–16:00 Location: JAN/0027

AGPhil 9.1 Thu 14:00 JAN/0027
Transcendental dimensions of epistemic networks in the foundations of quantum mechanics — •Alex Seuthe — TU Dortmund University, Dortmund, Germany
The tool of social network analysis has been translated into the history and philosophy of science as epistemic network analysis. According to Renn (cf. The evolution of knowledge, 2020), three dimensions can be assigned to these networks: the social, semiotic, and semantic. The social dimension encompasses social actors and structures, the semiotic dimension encompasses experiments, and representations. The semantic dimension encompasses cognitive structures, concepts, and mental models with two main aspects: 1) They gain meaning through their interpretation of experience and their relationships with one another. 2) They can only be inferred by the reconstructive analysis of social and physical representations. I want to discuss how this novel analysis strategy of epistemic complexes can be related to the philosophy of symbolic forms of Cassirer. This theoretical reflection can help to enrich the sole aggregation of empirical data, as it often can be seen in the social sciences, with theoretical and epistemological meaning. 1) I want to outline how Cassirer's functional concept formation is similar to Renn's understanding of networks of semantic structures. 2) According to Cassirer, the basic forms of thinking manifest themselves in the social and semantic expressions of culture. I will utilise studies about the foundations of quantum mechanics as a case study to develop and illustrate my arguments.

AGPhil 9.2 Thu 14:30 JAN/0027
Heterodox underdetermination: metaphysical options for discernibility and (non-)entanglement — •Maren Bräutigam — University of Cologne
There are largely three views on whether Leibniz‘s Principle of the Identity of Indiscernibles (PII) is violated by similar particles. According to the earliest view, PII is always violated (call this the no discernibility view). According to the more recent weak discernibility view, PII is valid in a weak sense. No and weak discernibility have been referred to as orthodoxy. Steven French has argued that although PII is violated, similar particles can still be regarded as individuals. However, as it is equally possible to regard them as non-individuals, French famously concluded that metaphysics is underdetermined by physics. Call this thesis orthodox underdetermination. Most recently, some authors have turned against orthodoxy by arguing that PII is valid in more than a weak sense. Call this the new discernibility view, also referred to as heterodoxy. As heterodoxy is backed up by physical considerations, metaphysics now seems to be determined by physics: physics indicates that PII is valid. In this talk, I argue that, despite appearances, heterodox metaphysics is just as underdetermined by the physics as orthodox metaphysics; in other words, I argue for heterodox underdetermination. Heterodox underdetermination is problematic because it leaves us with the choice between two crucially different understandings of entanglement, thereby preventing us from getting a clear metaphysical picture of this peculiar phenomenon.

AGPhil 9.3 Thu 15:00 JAN/0027
Perspectival Objectivity in Relational Quantum Mechanics — Noemi Bolzonetti and •Luca Gasparinetti — University of Italian Switzerland, Lugano, Switzerland
What if everything in the world we are living in could be defined only relative to something else? What if different observers might give different accounts of the same sequence of events? According to the relational interpretation of quantum mechanics (RQM) proposed by Carlo Rovelli (e.g., 1996), there is no "absolute", i.e., observer-independent, description of reality. On the contrary, as well as the notion of simultaneity in special relativity, values and states of quantum systems are always defined via a given perspective. Does this mean that RQM cannot be in any way objective? Very roughly speaking, objectivity can be established only when different observers ascribe their descriptions to their different perspectives. But what can be said to further articulate this rough sketch?

Based on recent development on this topic (Emily Adlam and Carlo Rovelli 2022), the aim of this talk is twofold: we (i) take into account Evans's notion of "intersubjective objectivity" (Peter W. Evans 2020) to better understand in which sense it is possible to recover objectivity in relational quantum mechanics and (ii) explore how perspectival objectivity can provide a philosophical foundation for RQM. Along with Evans, we conclude that we should "stop worrying and love observer-dependent reality" also in the context of relational quantum mechanics.

AGPhil 9.4 Thu 15:30 JAN/0027
The Foundations of the Measurement Problem — Diana Taschetto[1] and •Ricardo Correa da Silva[2] — [1]Philosophy Department, University of São Paulo — [2]Department of Mathematics, University of Erlangen-Nuremberg
The measurement problem is the most intensely investigated issue at the foundations of the quantum theory. Since what counts as a solution depends on how the problem is defined, a historical investigation of the development that has conditioned the standard formulation of the problem is most needful as a test of its adequacy. Quantum Mechanics is unique in the history of science in that it resulted from the axiomatized merging of two rival–yet putatively equivalent–theories, namely Matrix Mechanics and Wave Mechanics. In this talk, we shall present a new, detailed mathematical and conceptual analysis of the structures of Matrix and Wave Mechanics. It will follow that the measurement problem is a logical consequence of constructing Quantum Mechanics over a fabricated–and therefore fictitious–equivalence. Matrix and Wave Mechanics are not equivalent quantum theories, but their structures are related, in a way we shall demonstrate. The physical relevance of this relation, stated in exact mathematical terms, is that it gives us new insight into the nature of the measurement problem, enabling us to state it in a different, more general setting than it has been done heretofore, opening new paths in our search for solutions.

AGPhil 10: Quantum Foundations Poster Session

Time: Thursday 16:15–16:45 Location: JAN/0027

AGPhil 10.1 Thu 16:15 JAN/0027

The Limits of the $\hbar$-Limit — •Renzo Kapust — Institute of Philosophy, KU Leuven

It is often thought that the limit of $\hbar \to 0$ is a classical limit, meaning that it retrieves classical mechanics from quantum mechanics. Against this common belief, we argue that the $\hbar$-limit does not fully instantiate the relation between classical and quantum mechanics on its own and mostly serves anecdotal purposes.

Importantly, the conceptual analysis shows that "$\hbar \to 0$" expresses two different limits, which also has practical consequences. Firstly, the "classical idealization" tries to map the set of quantum formulas to the set of classical formulas by changing the constant $\hbar$; pictorially imagining other possible worlds with different $\hbar$-values. Secondly, the "classical approximation" remains in this actual world and tries to map quantum explanations to classical phenomena by letting a variable grow relative to the actual value of $\hbar$.

The problems of the classical approximation include the failure to be a limit in any proper sense and to necessarily neglect important effects of quantum composition. Moreover, it does not fully include other parameters necessary to wholly retrieve classical mechanics. The problems of the classical idealization include implausible convergences, the danger of divergences, the failure to tackle $\hbar$-independent quantum phenomena as well as the failure to apply to all required equations. Consequently, although the investigation of the $\hbar$-limit bears great insight into the quantum-classical relation, neither of its senses fully instantiates it.

AGPhil 10.2 Thu 16:15 JAN/0027

Measuring up to the measurement problem: Decoherence and Bohr's ideas through the lens of the measurement problem and quantum erasers — •Emilia Kjaersdam Telléus — University of Copenhagen

In this thesis, interpretations of the formalism of quantum mechanics are investigated in terms of their address to the classic measurement problem as well as the more modern quantum erasers. The main focus is on the interpretational insight provided by Niels Bohr and the concept of decoherence, but with an overview of other important interpretations as well. The measurement problem is described and strategies for its solution is divided into two main categories: solutions and dissolutions, which are associated with collapse and no-collapse interpretations respectively. Decoherence is found to require an interpretational basis in order to properly address the measurement problem, while Bohr's interpretation has some unresolved points, mainly relating to the understanding of Bohr's notion of context, which is central to his idea of quantum mechanics. By comparing Bohr's ideas and decoherence, I argue that each can be of use to the other; decoherence can formalise some of Bohr's concepts, while Bohr's ideas provides a constructive interpretational basis for decoherence. Lastly, I argue that quantum erasers provides a ground for discussions on interpretational questions, as the insight into the nature of quantum mechanics challenges several aspects of the aforementioned different interpretations, the understanding of the Bohrian context among them.

AGPhil 10.3 Thu 16:15 JAN/0027

Is reality mystical and weird? — •Ed Dellian — Bogenst. 5, 14169 Berlin.

Current quantum mechanics is represented by the Schrödinger equation. This algorithm allows to calculate states of a particle system's kinetic energy. The concept stems from classical mechanics. It is the space integral of the concept of force. Accordingly the Schrödinger equation, as it considers energy states only (indifferently whether time dependent or not), does not consider the time required to generate an energy state, and also not the time that may separate different energy states at different places in space from each other. Therefore all possible energy states in space apparently seem to exist at the same time. As a consequence it may seem that a moving system, or particle, could even arrive at different places in space at the same time, or instantaneously, that is, without consuming time. It was realized already by Galileo and Newton that this result evidently contradicts natural experience, according to which nothing happens but in time. Therefore, the mystical and weird instantaneous effects appearing in quantum mechanics are not the features of a specific microphysical reality but only result from ignorance as to the genesis and mathematical content of the Schrödinger equation.

AGPhil 11: Quantum Mechanics, Philosophy and Information

Time: Friday 10:45–12:45 Location: HSZ/0304

AGPhil 11.1 Fri 10:45 HSZ/0304

Entangled states explained locally — •Eugen Muchowski — Primelstrasse 10, 85591 Vaterstetten

The existence of entangled states (Bell states) forces us to reconsider our conception of physical reality. This is best done using a model. However, after Bell's theorem a local realistic model describing the quantum correlations should not exist. But Bell's theorem has been refuted by a contextual model. So we are able to concretely discuss terms like contextuality, indistinguishability, inseparability and counterfactual definiteness using a local realistic model. We introduce a model in which the indistinguishability of the entangled photons explains the physical states, but in which the photon pairs do not share the value of a statistical parameter. It is astonishing that a model of entangled quantum systems can be derived solely from the initial conditions and the assumption that the behaviour of quantum particles is determined in advance. No coupling of hidden parameters is required.

AGPhil 11.2 Fri 11:15 HSZ/0304

When and why did physicists start bashing philosophy? — •Alexander Unzicker — Pestalozzi-Gymnasium München

While in the first half of the 20th century physics was an integral part of philosophy, after World War II the latter became more and more an unwelcome appendix. The evolution of this role of philosophy is discussed with some key examples. Obviously, the different research traditions in Europe and America also contributed to this shift in significance.

AGPhil 11.3 Fri 11:45 HSZ/0304

Impacts, symmetries and decisions — •Basil Evangelidis — Eschwege, Germany

There is a great amount of research data accumulating by space exploration on the topics of impacts, symmetries, habitable zone, chemical syntheses, atmosphere, climate and geology. The related facts, sayings and relations need to be evaluated by a theory of decision based on strategies of cooperation. A logic of quantum space science and technology is being, therefore, continuously articulated and innovated though focusing on efficiency, computability, polyvalence, feedback control etc.

AGPhil 11.4 Fri 12:15 HSZ/0304

Everything is information: paradox or solution? — •Ewoud Halewijn — TU Delft, Netherlands

If we want to solve fundamental conceptual problems such as the "measurement problem", the "absence of absolute space", the multifaceted "problem of time" and "nonlocality", we should not regard matter, space and time as fundamental. Neither should we wait for reconciliation projects in highly mathematical fields such as loop quantum gravity or string theory. If reconciliation of quantum-mechanics and relativity theory succeeds at all, it might not provide conceptual solutions that we are looking for.

We should take the reconciliation challenge head-on without all the mathematics, and ask ourselves: Why are some scientific findings so hard to swallow? Which strong convictions do they clash with? Why are these convictions held by larger audiences at all?

In this talk I defend that the claim "everything is information" could resolve a number of conceptual problems, while not clashing with the convictions held by larger audiences. Except for maybe one paradox: While information seems to be everything, it doesn't appear to exist at all.

Index of Exhibitors

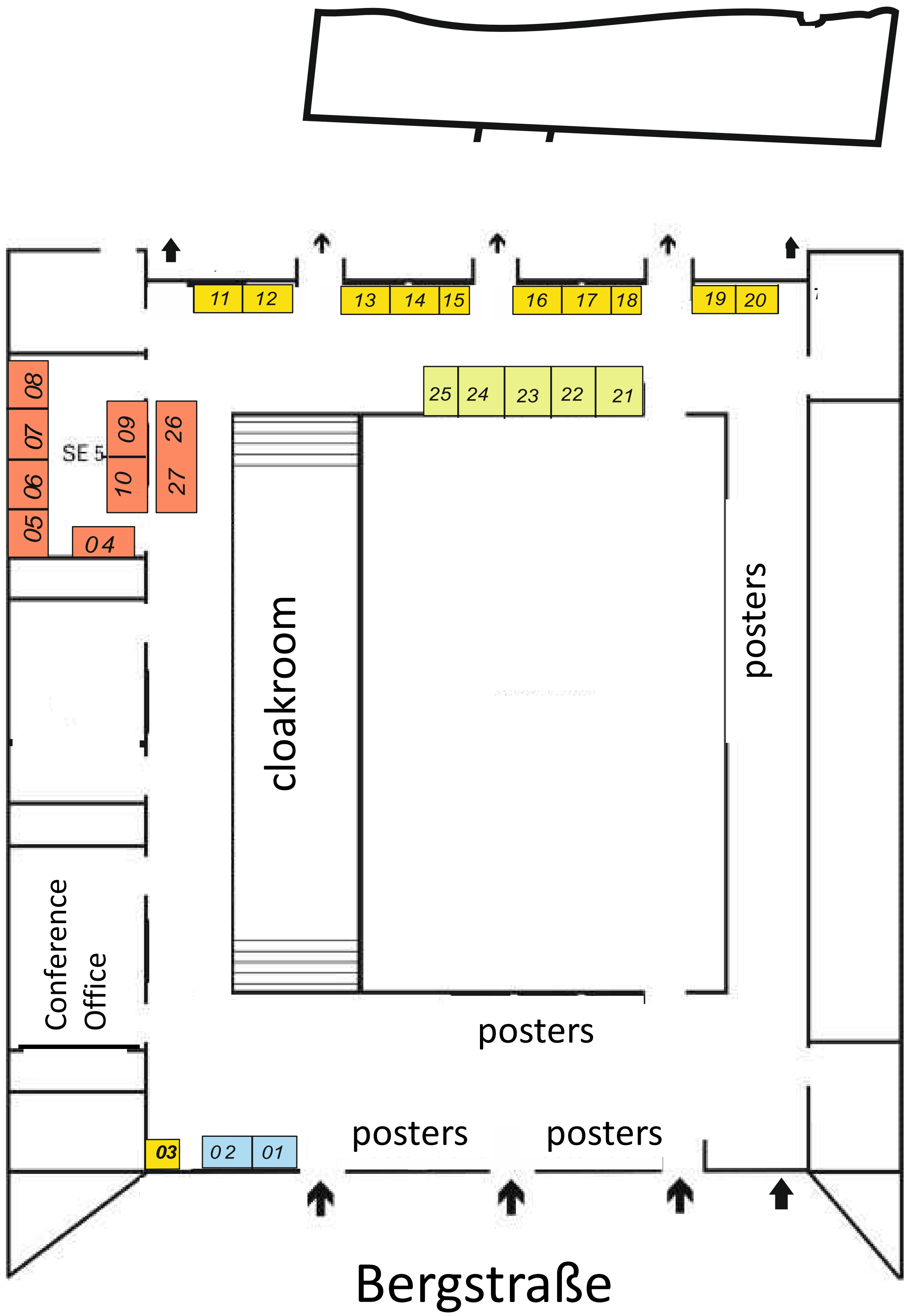
Exhibition Venue:
Technische Universität Dresden / Lecture Hall Centre (HSZ)
Campus Südvorstadt
01069 Dresden

Opening Hours Exhibition:

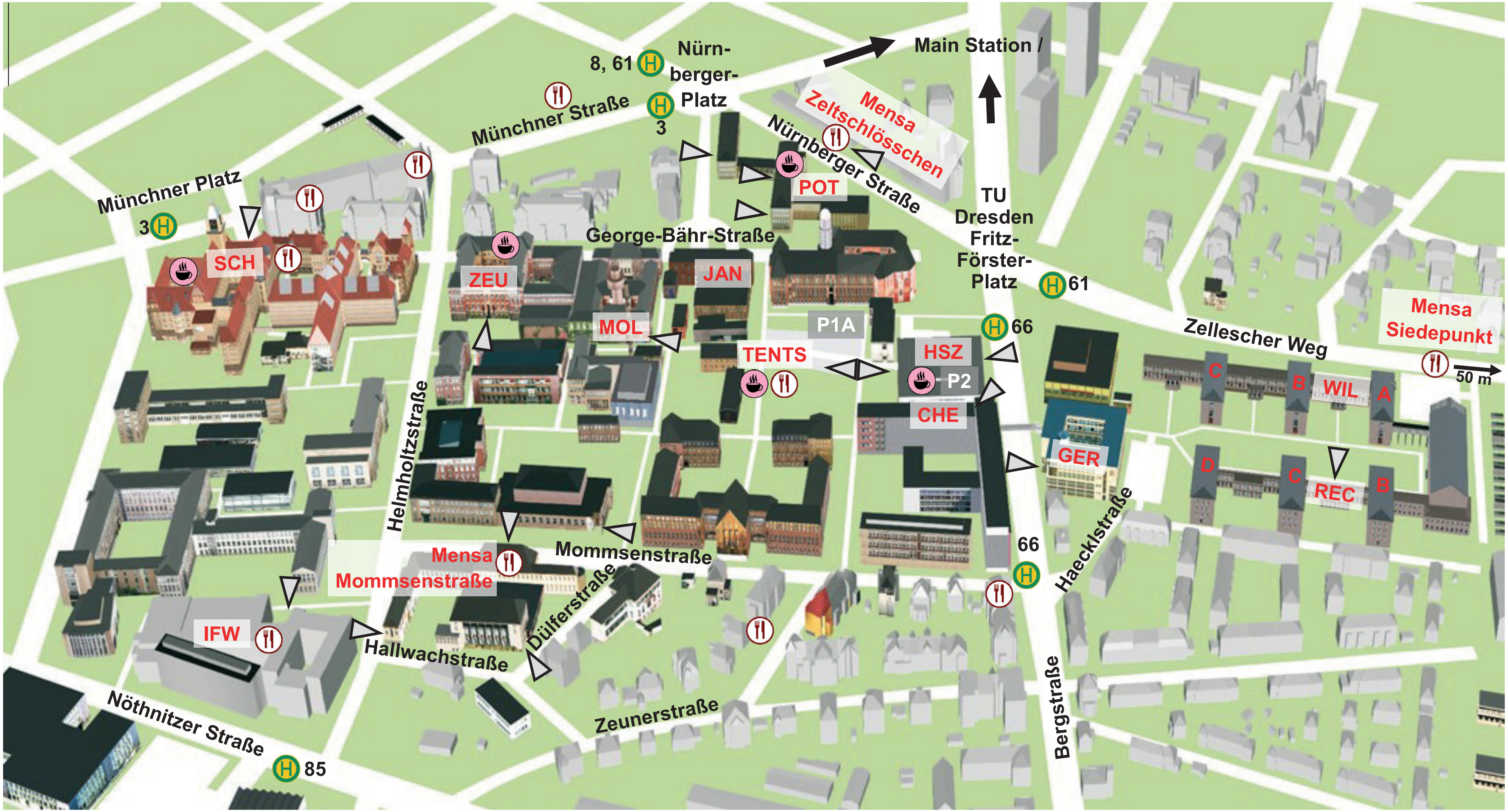
Tuesday, March 21	10:00 — 18:00
Wednesday, March 22	10:00 — 18:00
Thursday, March 23	10:00 — 18:00

Company	**Stand No.**
AMT Andreas Mattil - Technischer Vertrieb Talstraße 33, 67737 Frankelbach *Flanges and fittings, viewports, electrical feedthroughs, electronics and instruments, motion and manipulation, helium leak detectors, gauges, SEM coatings, titanium sublimation pumps and much more.*	**H 02**
CAEN ELS S.R.L. AREA Science Park — SS14 km 163,5, 34149 Basovizza, Trieste, ITALIEN *High Performance Power Supplies / High Precision 0-FLUCS Current Measurement Devices / Beamline Electronic Instrumentation / Components for FMC and MicroTCA*	**H 23**
CAEN GmbH Klingenstraße 108, 42651 Solingen *VME, NIM, CAMAC, High Voltage*	**H 24**
Hamamatsu Photonics Deutschland GmbH Arzbergerstraße 10, 82211 Herrsching *We are a manufacturer of optoelectronic components for highest demands. Small quantities, customization, or series production, whatever you need: We will find a solution. Talk to us at booth H25.*	**H 25**
ISEG Spezialelektronik GmbH Bautzner Landstraße 23, 01454 Radeberg / Rossendorf *Hochspannungsversorgungen, Hochspannungsnetzgeräte, HV-DC/DC- Konverter*	**H 18**
LHC ErUM-FSP **Office Georg-August-Universität Göttingen** Friedrich-Hund Platz 1, 37077 Göttingen *LHC ErUM-FSP Büro*	**H 13**
Owis GmbH Im Gaisgraben 7, 79219 Staufen i. Br. *Strahlführungs- und Positioniersysteme*	**H 03**
Springer-Verlag GmbH Tiergartenstraße 17, 69121 Heidelberg *Wissenschaftliche Bücher und Zeitschriften*	**H 01**

Exhibition Lecture Hall Center (HSZ)



SMuK campus map



Quelle: TUD

HSZ	Lecture hall name (abbreviation) https://navigator.tu-dresden.de		
	Entrance		
	Coffee		
	Mensa, Snacks		
	Tram or bus stop with number		

CHE	Chemiegebäude	Tent A, B	Coffee Breaks
GER	von-Gerber-Bau	WIL	Willers-Bau
HSZ	Hörsaalzentrum (Lecture Hall Center) Conference office, Plenary talks, Tutorials, Evening talks, Posters, Exhibition	ZEU	Zeuner-Bau
JAN	Jante-Bau		
MOL	Mollier-Bau		
POT	Gerhard-Potthoff-Bau		
REC	Recknagel-Bau		
SCH	Georg-Schumann-Bau		