

# TECHNOLOGY AND RESEARCH INITIATIVE FUND

FISCAL YEAR 2023





## **ABOUT THIS REPORT**

This report details Arizona’s public universities Technology and Research Initiative Fund (TRIF) expenditures in accordance with state law and the universities’ board approved three-year plans.

The report has four sections, one for each university and one for Arizona Board of Regents’ grants, initiatives, and operations. Each section provides an overview of the TRIF activity for the last fiscal year and an update for each TRIF supported project or initiative. Supporting material for each university initiative or project, including the original proposal, budget, and an update for this fiscal year, are available through the link included at the end of the executive summary.

### **ABOUT THE ARIZONA BOARD OF REGENTS**

The Arizona Board of Regents is committed to ensuring access for qualified residents of Arizona to undergraduate and graduate institutions; promoting the discovery, application, and dissemination of new knowledge; extending the benefits of university activities to Arizona’s citizens outside the university; and maximizing the benefits derived from the state’s investment in education.

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September 1, 2023



## INTRODUCTION

Proposition 301 established TRIF through an increase in state sales tax dedicated to K-12, community colleges and Arizona's public universities. Collection of the tax began on June 1, 2001, and the proposition was extended for another 20 years in 2018. Twelve percent of collections go to the Arizona Board of Regents to administer for the expansion of research, workforce development and increasing access to public higher education. TRIF monies are continuously appropriated to the board and do not lapse at the end of the fiscal year.

Since its inception in June 2001 the program has received over \$1.7 billion in TRIF funds. In FY 2023, the university system received over \$133.3 million in TRIF revenue. The university system carried over an additional \$9.6 million from FY 2022 to FY 2023 resulting in \$142.9 million in total TRIF revenues available for allocation in FY 2023.

Last year, the board allocated TRIF funding as follows:

### **University Research & Workforce Base Funding**

- Board Office Operating – \$2 million to the board office for operating expenditures in support of administrative oversight and reporting, specific board initiatives, programs and infrastructure, and activities designed to support and promote the board's TRIF goals and initiatives.
- Base Allocation Funds – \$84.8 million for the universities' board approved three-year TRIF plans. The base allocation awards 40 percent of funding to Arizona State University; 40 percent to the University of Arizona; and 20 percent to Northern Arizona University.

### **Arizona Board of Regents Grant Programs to Impact and Improve Arizona**

- Regents Community Grants Funds – \$ 900 thousand to a grant funding process designed to engage Arizona's local communities with university resources and talent to solve real world problems at the local level.
- Regents' Research Grants Funds – \$12 million to a grant funding process designed to address critical Arizona issues and problems by leveraging Arizona's public universities' research talent and assets.

### **Arizona Board of Regents Approved Initiatives**

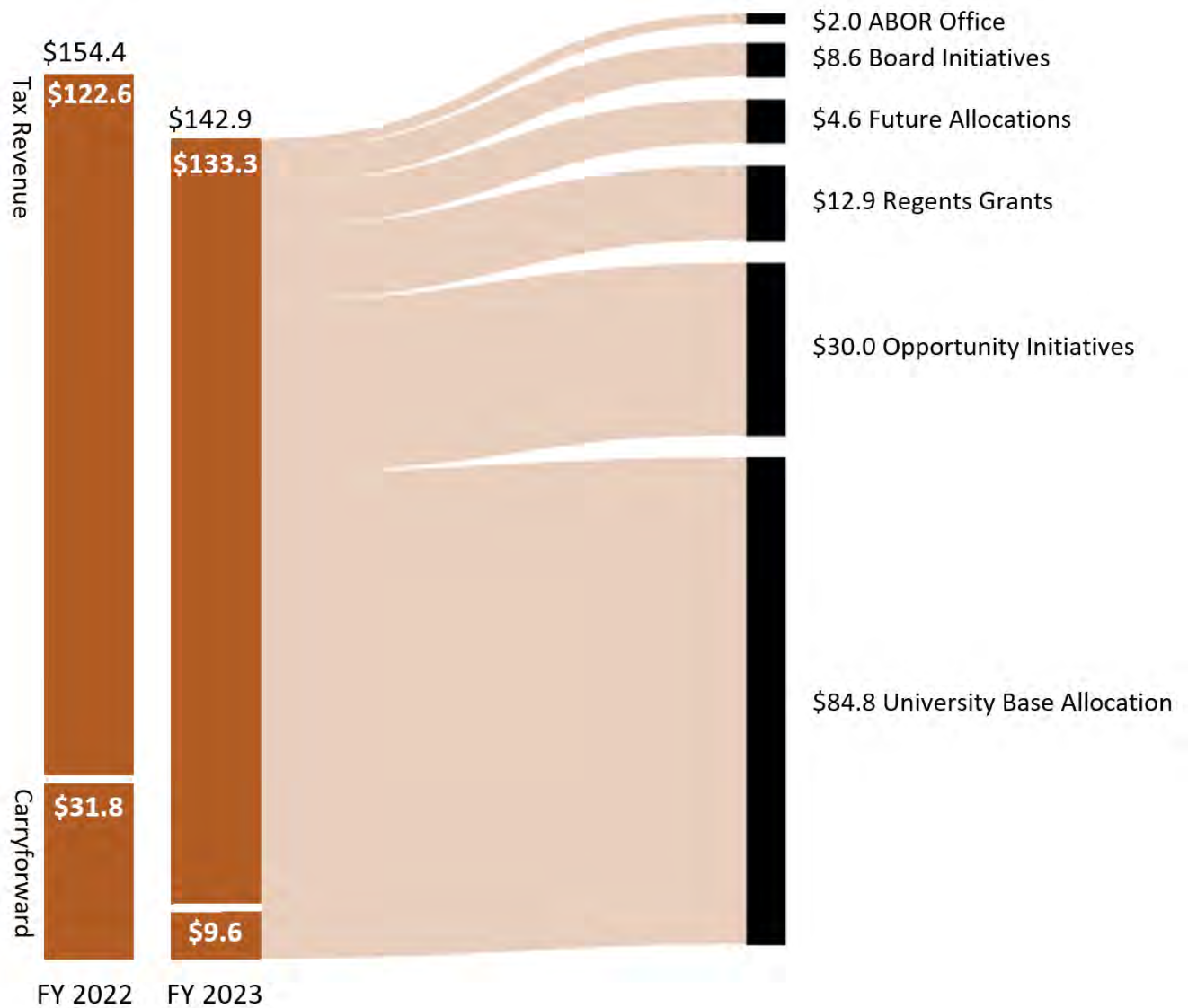
- Board approved initiatives, including:
  - Arizona Innovation Alliance – \$700,000 for the Arizona Innovation Alliance to support and improve access to higher education and student attainment.
  - General Education Assessment – \$300,000 to the board office and the universities to help design and administer the general education assessments to support and improve student and workforce outcomes.
  - Health Sciences and Workforce Analysis – \$3.5 million to analyze and identify factors that contribute to the success of the current structure/model and challenges that may limit its opportunities within Arizona's existing health care landscape and workforce.

- Phoenix Bioscience Core – \$1.0 million for the Phoenix Bioscience Core in support of its research, technology transfer and workforce development efforts.

**Regents’ Opportunity Grants Awarded to the Universities**

- Regents’ Opportunity Initiatives Funds – \$30 million to the universities to support board priorities in research and to improve Arizona workforce and higher education access. The board divided this year’s awards equally among the three Arizona public universities.
- Regents’ Future Opportunity Initiative Funds – \$7.5 million in reserve for the board to allocate on a year-by-year and university-by-university basis to support board priorities in research and improving Arizona workforce and higher education access.

In FY 2023, the board and universities spent TRIF dollars within these areas  
(See chart below, \$ Millions).



## Universities Three-Year Plans

The largest TRIF investments are in the base allocation funds awarded to each university for research, attainment, and workforce initiatives in accordance with the universities' board approved three-year TRIF plans. The universities develop the three-year plans in compliance with A.R.S. §15-1648(C).

The three-year plans' identified initiatives and projects must be in one or more of the following board-approved research investment areas:



Improving Health



Water, Environmental and Energy Solutions National



Security Systems



Space Exploration and Optical Solutions



Higher Education Access for Workforce Development

For TRIF supported research initiatives, the universities must categorize each project or initiative from a research pipeline and infrastructure perspective as:

- Basic Research (defined as 10 plus years to a potential commercial product development)
- Applied Research (defined as two to five years to a potential commercial product)
- Development (defined as less than two years to a commercial product)
- Infrastructure (defined as support resources and related services used to conduct research and technology transfer)

Each university's current three-year plan is available on the ABOR website [here](#).



Exhibit Enterprise.1: FY 2023 University Base Allocation Expenditure Summary

**\$79,551,484**

Proposal 2023

2023 Proposal vs Actual

● Proposal 2023 ● Actual 2023

**\$75,497,449**

Actual 2023



Proposal 2023 and Actual 2023 by Investment Area

● Actual 2023 ● Proposal 2023



Table Enterprise.1: FY 2023 TRIF Expenditures by Investment Area

InvestmentArea	Proposal 2023	Actual 2023	Budget Delta
Improving Health	\$23,286,197	<b>\$23,564,820</b>	(\$278,623)
National Security Systems	\$15,630,138	\$12,161,684	\$3,468,454
Space Exploration and Optical Solutions	\$7,369,969	\$5,349,972	\$2,019,997
Water, Environment and Energy Solutions	\$18,618,472	\$18,137,971	\$480,501
Workforce Development	\$14,646,708	<b>\$16,283,002</b>	(\$1,636,294)
<b>Total</b>	<b>\$79,551,484</b>	<b>\$75,497,449</b>	<b>\$4,054,035</b>

Exhibit Enterprise.1: FY 2023 Percent of Total TRIF Expenditures by Investment Area

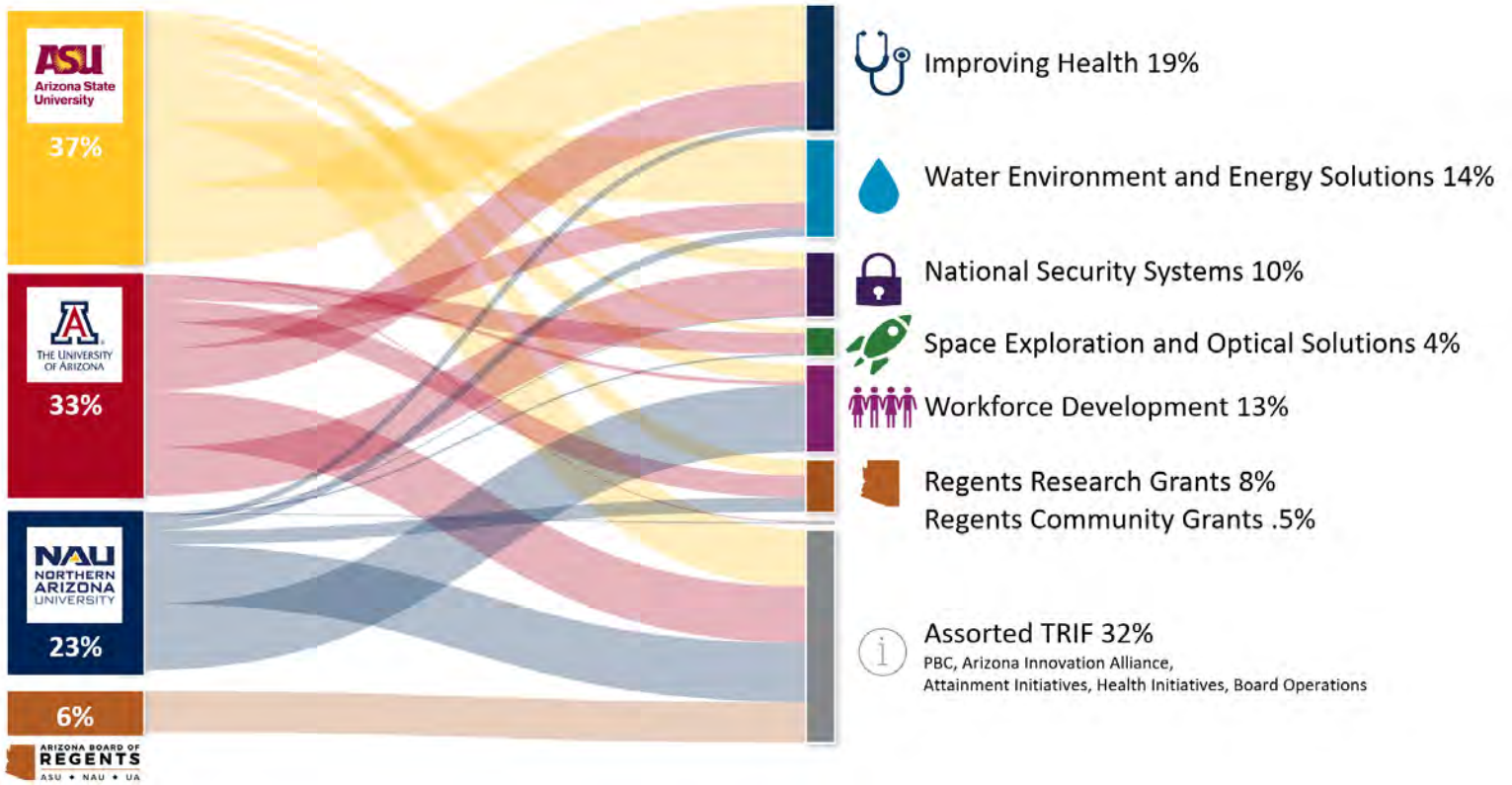
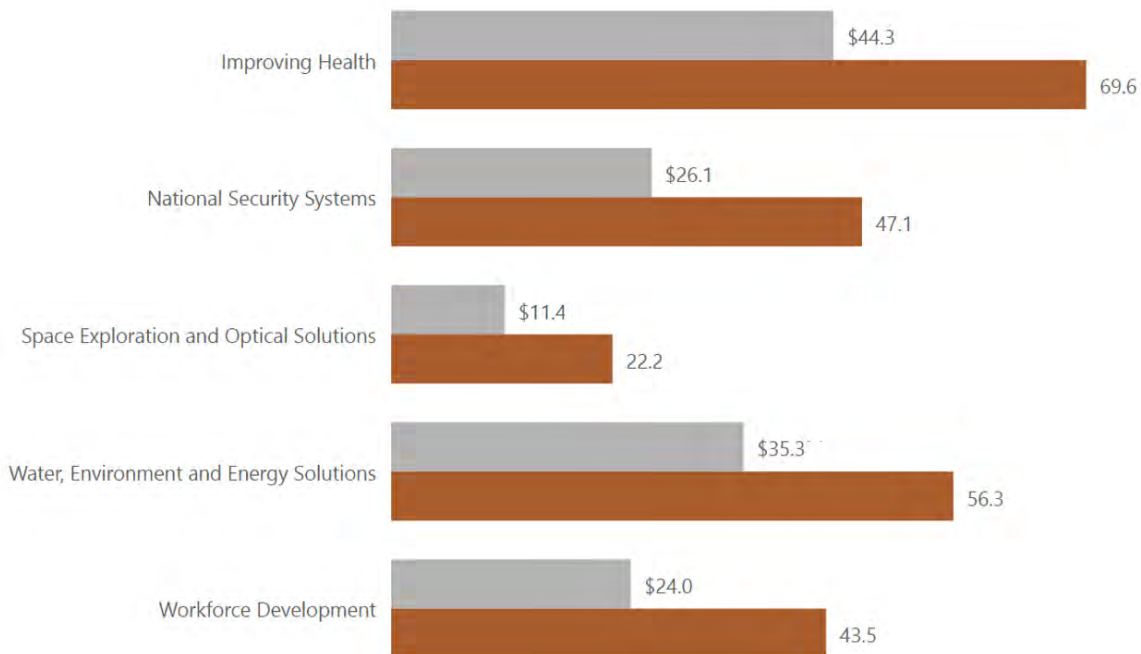


Exhibit Enterprise.3: FY 2023 – FY 2023 Cumulative Expenditures vs 3 Year Proposals

2023 Proposal vs Actual

● 2 Year Actual ● 3Yr Proposal







# TECHNOLOGY AND RESEARCH INITIATIVE FUND

ARIZONA STATE UNIVERSITY

FISCAL YEAR 2023





## EXECUTIVE SUMMARY

TRIF investment at Arizona State University has been fundamental to elevating ASU as a leading research and educational powerhouse. ASU leverages TRIF to advance programs and projects that are poised to bring the greatest return on investment to Arizona. Since TRIF began, ASU has more than quintupled its research expenditures, rising to #6 in the nation for research expenditures among institutions without a medical school. The university's solutions-focused approach to grand challenges led U.S. News & World Report to name ASU "#1 in innovation" for eight consecutive years. Currently, via TRIF, ASU is educating more than 14,000 students, providing the knowledge, skills and hands-on experience that 21st century employer's demand. During the current funding cycle, ASU is building on its foundation of TRIF-enabled expertise and infrastructure, developing novel solutions to challenges in our state and the skilled workforce needed to implement them.

Notable TRIF-enabled achievements in FY 2023 include:

- A \$90.8M award to build the world's first compact X-ray free electron laser. ASU's largest NSF award to date, the funds will support the construction of a room-sized instrument to explore the intricacies of complex matter at atomic length and ultrafast time.
- An expanded partnership between ASU and Applied Materials to create the Materials-to-Fab (MTF) Center. Representing a combined investment of \$270M, the MTF will provide researchers (including industry partners and students) access to state-of-the-art semiconductor tools.
- To address pressing energy concerns, the Center for an Arizona Carbon-Neutral Economy partnered on a multi-million-dollar NSF proposal to develop a regional clean hydrogen hub. Based at ASU with partnerships at the University of Arizona, Northern Arizona University and Arizona energy providers, the center will build on ASU's long-standing national expertise in hydrogen research.
- The launch of ASU's LunaH-Map CubeSat aboard NASA's inaugural Artemis I lunar flyby mission, where it successfully acquired lunar data and achieved the highest designation for technology readiness from NASA.
- Skysong Innovations secured 60 licensing deals and 160 new patents based on ASU innovations.
- ASU's recently launched supercomputer, Sol, was recognized by the Top500, ranking higher than esteemed academic institutions such as Harvard, NYU and Johns Hopkins.

TRIF investment creates an ecosystem that empowers businesses to succeed in our state. Arizona's long-term commitment to research attracts and generates companies that advance new technologies and helps them stay ahead of disruptive trends. Our universities provide the talent, knowledge and infrastructure companies need to be competitive. In turn, they create stable, high-wage jobs and invest in their communities — a virtuous cycle of economic growth and human well-being for generations to come.







ASU invested 78.4% of its FY 2023 TRIF funds toward research on improving health and finding solutions in water, environment, and energy. The research dollars were used mainly to support applied research and development.

These investments generated \$897.8 million in outside related sponsored project funding, resulted in 26 startups and supported 4,279 graduate and undergraduate students.

Exhibit ASU.1: FY 2023 ASU Base Allocation Expenditure Summary



Proposal 2023 and Actual 2023 by Investment Area



Table ASU.1: FY 2023 TRIF Expenditures by Investment Area

InvestmentArea	Proposal 2023	Actual 2023	Budget Delta
Improving Health	\$14,091,805	\$14,510,651	(\$418,846)
National Security Systems	\$2,953,895	\$3,074,948	(\$121,053)
Space Exploration and Optical Solutions	\$868,967	\$1,012,136	(\$143,169)
Water, Environment and Energy Solutions	\$10,898,498	\$11,761,735	(\$863,237)
Workforce Development	\$2,819,315	\$3,135,043	(\$315,728)
<b>Total</b>	<b>\$31,632,480</b>	<b>\$33,494,513</b>	<b>(\$1,862,033)</b>



Exhibit ASU.1: FY 2023 TRIF Revenue and Expenditures by Investment Area and Initiative (\$ Millions)

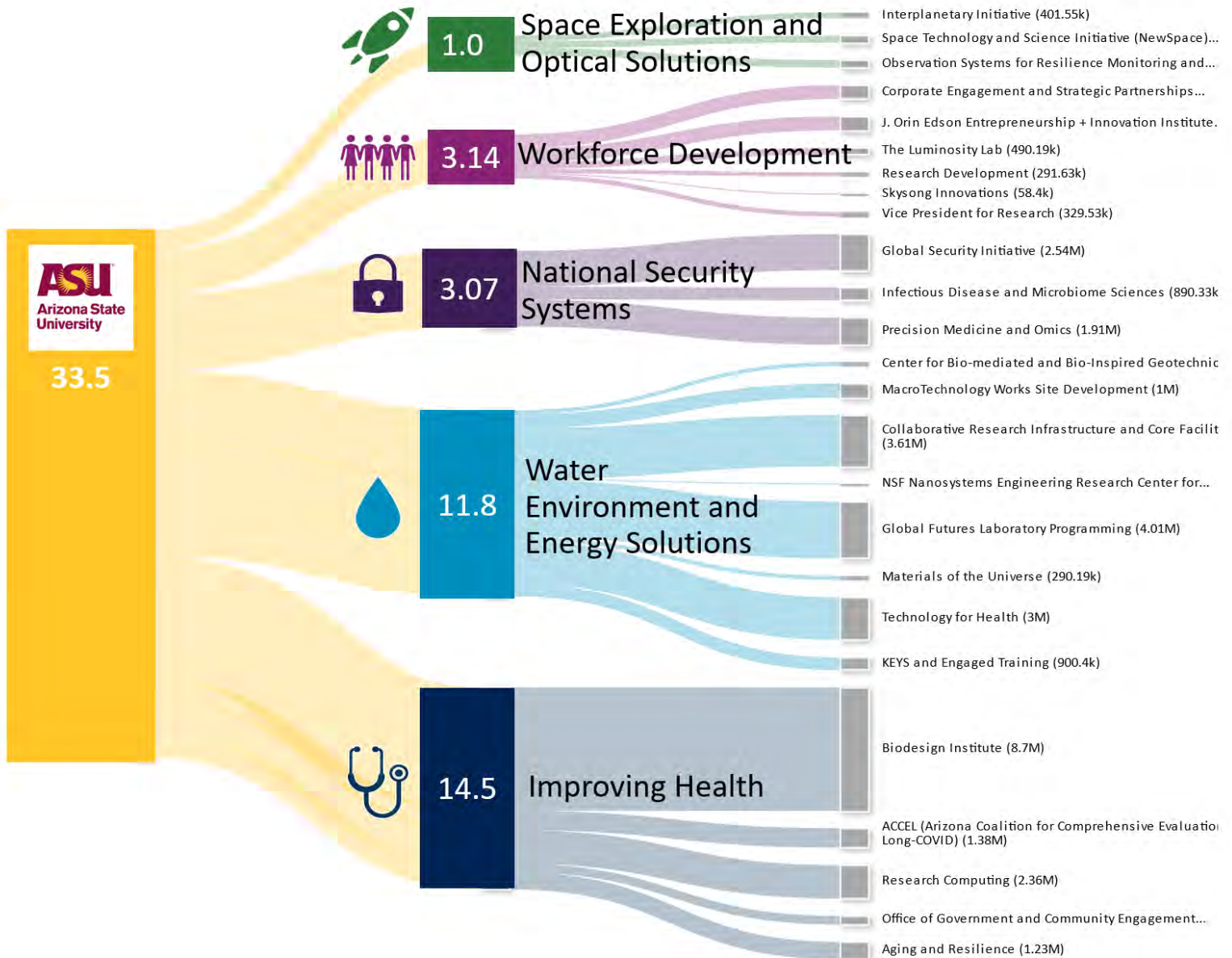


Table ASU.2: FY 2023 Performance Measures

Performance Measures	2023 Projections	2023 Actuals
Faculty Startup Package Expenses	0	0
Postdocs Supported	548	503
Graduate Students	2,814	2,911
Undergraduate Students	1,435	1,368
Sponsored Project Funding	\$468,285,900	\$897,766,937
Publications in Academic Peer-Reviewed Journals	1	1
Startups	48	26

Exhibit ASU.2: FY 2023 TRIF Expenditure by Research Category (in millions)

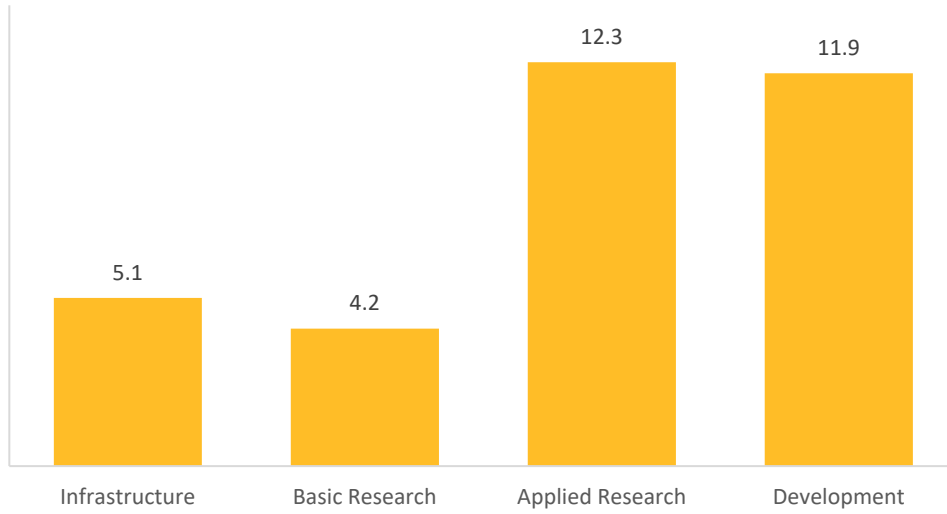
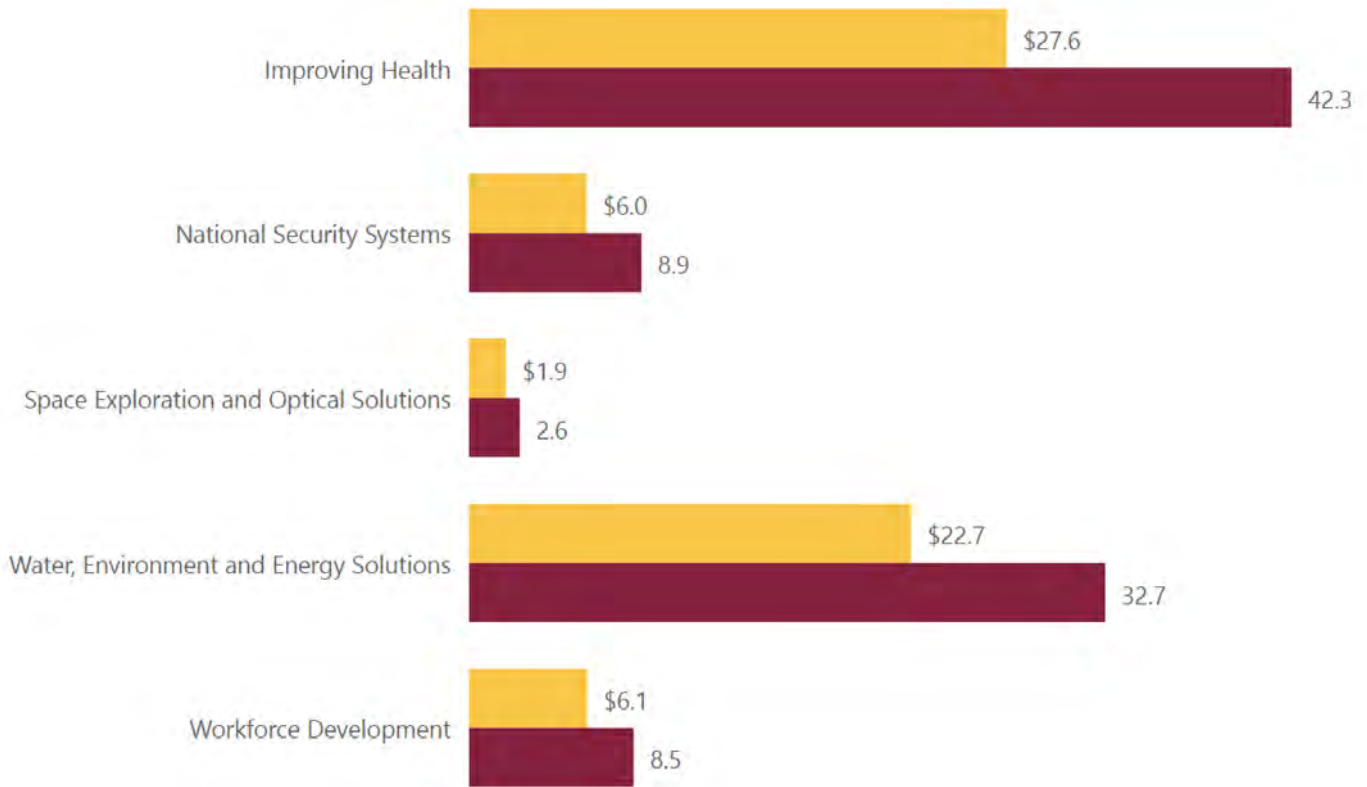


Exhibit ASU.3: FY 2023 – FY 2023 Cumulative Expenditures vs 3 Year Proposals

● 2 Year Actual ● 3Yr Proposal







# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	Improving Health			
Program Name	ACCEL (Arizona Coalition for Comprehensive Evaluation of Long-COVID)			
<b>Problem Statement</b>				
<p>There is growing recognition that survivors of COVID-19 infection are vulnerable to developing a wide range of post-infection problems (known as long-COVID) of unknown duration with implications for long-term care costs and disabilities affecting capacity to work. Long-COVID affects the cardiovascular system, lungs, joints, skin, GI tract and brain with widely differing effects in different individuals. There is an urgent need for new diagnostic tests and clinical assessment tools to predict which patients will develop Long-COVID and their prognosis.</p>				
<b>Program Description</b>				
<p>The Arizona Coalition for Comprehensive Evaluation of Long-COVID (ACCEL) is a multi-institution consortium led by ASU's Complex Adaptive Systems Initiative (CASI), in partnership with Abrazo Health, Dignity Health, Honor Health, Mayo Clinic, Valleywise Health, Veterans Administration, Arizona Department of Health Services, HealthCurrent, NAU, TGen-North and multiple units at ASU (Biodesign Institute, College of Health Solutions, Southwest Interdisciplinary Center (SIRC), College of Public Service and Community Solutions). Its goal is to establish collaborative research on COVID-19 immune responses to predict individuals at risk of severe COVID-19, death or development of long-COVID. CASI's role as founding sponsor of National Biomarker Development Alliance established protocols for biobanking of samples for multiOmics and standardized data formats for multi-institution data exchange that have been adopted by the ACCEL project.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>The scale of the patient population suffering from long-COVID and its statewide impact will benefit from mobilizing tri-university resources to generate the spectrum of clinical, research and computing skills required. Long-COVID is attracting major federal funding. ASU and the Institute for Future Health (a joint program of ASU and the University of Arizona) have strong competitive assets to pursue these funding sources and provide a robust return on investment.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>Over 1 million Arizonans have been infected with COVID-19. Over 70,000 have been hospitalized and 18,000 have died. Based on the incidence of long-COVID across the U.S. and undetected infections, the nation is potentially facing a formidable public health challenge of up to 1 million chronically ill individuals. Arizona will face a proportional burden and will need to mobilize new specialty clinics to meet the needs of these patients. Discovery of new diagnostic biomarkers as part of this project offers opportunities to develop intellectual property to promote collaborations with industry for commercialization and royalty revenues.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$712,323	\$712,323	\$712,323	\$2,136,970
Applied Research	\$712,323	\$712,323	\$712,323	\$2,136,970
Development	\$712,323	\$712,323	\$712,323	\$2,136,970
Total	\$2,136,970	\$2,136,970	\$2,136,970	\$6,410,910
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	54	56	59	15
Graduate Students	254	266	266	800
Undergraduate Students	110	116	121	347
Sponsored Project Funding	\$253,962	\$266,660	\$279,993	\$800,615
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	Improving Health			
Program Name	ACCEL (Arizona Coalition for Comprehensive Evaluation of Long-COVID)			
<b>Progress Summary</b>				
<p>IFH has made significant progress on the activities outlined in the FY 2022 progress report, including:</p> <ul style="list-style-type: none"> <li>• \$1.789M grant awarded by Defense Intelligence Agency to ASU and Crossbow Analytics to analyze technology trends and risks arising from advances in synthetic biology and development of new biowarfare threats.</li> <li>• Pilot program with Cowper LLC to accelerate design of vaccines against novel pathogens and predict mutations of known pathogens has led to a new spinout company, Epitope AI, with pending licensing of ASU patents.</li> <li>• Submitted proposal to Defense Threat Reduction Agency with Philips health care corporation to design wearable devices for early warning of infection up to 48 hours before symptoms start.</li> <li>• Hosted a Continuing Medical Education workshop on amyloidosis in congestive heart failure, with presentations by leading U.S. cardiologists and participants from all major AZ health providers. Additional funding has been secured to hold a seminar series on the role of primary care providers and to conduct a screening of at-risk Black veterans, among other projects.</li> <li>• George Poste continues to serve on the Bipartisan Commission on Biodefense in Washington, D.C.</li> </ul>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>Recent evidence indicates that variations in HLA (human leukocyte antigen) genes affect individual differences in our immune responses to vaccines and diseases, including whether a person develops dangerous cytokine storms in response to an infection and the likelihood of developing post-infection autoimmune disease. IFH has been developing a messenger RNA-based assay for HLA typing that is faster and lower cost than current methods, with support from the Virginia G. Piper Trust and the ASU-Dignity Health collaboration fund. The research will be presented at the 2023 American Association of Immunology meeting and a scientific paper is being prepared. Additionally, a patent application has been filed in preparation for future commercialization discussions with the private sector.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>A major goal for IFH is to enhance collaborations between ASU, UA and NAU. The COVID pandemic has highlighted the need for innovations in pandemic prevention, preparedness and response (3PR). In FY 2023, ASU, UA, NAU, TGen North and ADHS hosted a symposium with over 200 participants at ASU to inventory biosecurity expertise in AZ for building statewide capabilities in 3PR. ASU and UA are also collaborating on detection of highly pathogenic avian influenza as a pandemic threat. Additional discussions are underway on design of sensors for multi-pathogen detection in environmental samples (sewage, water, air). IFH is also participating in a \$7.99M CDC award to the Biodesign Institute to assess influenza and COVID-19 vaccine effectiveness in underserved populations. IFH submitted an additional \$3.5M proposal to the USDA for surveillance of COVID-19 in animal populations as potential pandemic reservoir hosts. IFH is playing a role in ASU's new Health Observatory, working to develop low-cost, rapid biosurveillance tools for monitoring diverse pathogens across AZ and the U.S. IFH is partnering with Creative Testing Solutions, which tests 38% of the U.S. blood supply, on a pilot project to profile antibodies to a range of pathogens to detect evidence of infections. IFH is also involved in discussions about curriculum for the new ASU Medical School and School of Public Health Technologies. IFH submitted a \$5.4M proposal to the National Science Foundation to reduce failure rates for new drugs in clinical trials. Current rodent disease models are unreliable in predicting efficacy and safety of drugs in humans. This project would conduct preclinical testing in canine diseases that have validated genetic homologies with human diseases, working with veterinary hospitals across AZ.</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$453,381	\$459,040		\$912,421
Applied Research	\$453,381	\$459,040		\$453,381
Development	\$453,381	\$459,040		\$912,421
Total	\$1,360,143	\$1,377,120		\$2,737,263
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	3	8		11
Graduate Students	26	51		77
Undergraduate Students	19	29		48
Sponsored Project Funding	\$2,169,262	\$2,660,919		\$4,830,181
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	Improving Health			
Program Name	Biodesign Institute			
<b>Problem Statement</b>				
Emergent global challenges in medicine, environmental sustainability and national security continue to threaten the health of our communities and our planet. The Biodesign Institute at Arizona State University is committed to solving such challenges by developing rigorous, collaborative, nature-inspired science for the benefit of all life on Earth. By leveraging TRIF investment, Biodesign improves health, ensures security, sustains the planet and provides access and workforce development opportunities.				
<b>Program Description</b>				
As the premiere scientific research institute in one of the nation's fastest-growing research universities, the Biodesign Institute addresses an expansive array of global challenges by creating nature-inspired solutions to address society's greatest challenges in biomedical health, environmental sustainability and national security. Biodesign is poised to promote workforce and leadership development with academic and hands-on, laboratory enrichment experiences and education to advance research, technology and thought leadership in the state of Arizona, and to elevate and expand Arizona's highly skilled workforce. Voter-supported investment in university research pioneered at Biodesign allocates resources to promote access to highly skilled experts and technologies in state-of-the-art laboratories for high-impact research of societal value. In this way TRIF funding is a powerful driver of scientific excellence and enables multiple pathways to enrich the economy through higher education access for workforce development, with ASU Biodesign-specific programs in impactful areas.				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
The ASU advantage for additional funding opportunities are many, including: 1. Expansion of COVID-19 testing success to a more generalized platform for developing new ways to rapidly diagnose and detect disease. 2. Expansion of the Neurodegenerative Disease Research Center (NDRC) under the leadership of Jeff Kordower. 3. In partnership with the ASU School for Complex Adaptive Systems, expand efforts in cybersecurity, artificial intelligence, deep learning and computational biology to reduce internet security threats and measure the impact of censorship on internet architecture. 4. Leverage TRIF funding to enable the formation of spinout companies. 5. Established the Biodesign Center for Sustainable Macromolecular Materials and Manufacturing (BCSM3) to focus on sustainable manufacturing and polymer chemistry, with goals of generation of sustainable, environmentally friendly materials.				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
Biodesign is committed to the creation, development and deployment of impactful programs to improve human health and economic opportunity in Arizona. TRIF funding to the Biodesign Institute would enhance the workforce and impact health in many areas, including: 1. Through Compact X-ray free electron laser/compact X-ray light source student internships, train the next generation of X-ray machinists, technologists and physicists. 2. Through internships and fellowships in the ASU Biodesign Clinical Testing Laboratory (ABCTL), train and educate workers to seek new technologies and solutions to respond to potential infectious viruses such as COVID-19 and its various strains. 3. Develop Biodesign workforce training opportunities in semiconductor science and sustainable manufacturing.				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$3,304,222	\$3,304,222	\$3,304,222	\$9,912,666
Basic Research	\$0	\$0	\$0	\$0
Applied Research	\$2,138,000	\$2,138,000	\$2,138,000	\$6,414,000
Development	\$2,138,000	\$2,138,000	\$2,138,000	\$6,414,000
Total	\$7,580,222	\$7,580,222	\$7,580,222	\$22,740,666
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	95	100	105	15
Graduate Students	415	436	436	1309
Undergraduate Students	159	167	176	502
Sponsored Project Funding	\$56,867,053	\$59,710,405	\$62,695,925	\$179,273,383
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	4	4	5	13

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	Improving Health			
Program Name	Biodesign Institute			
<b>Progress Summary</b>				
<p>With support from TRIF, the inception of the Biodesign Institute at ASU marked the beginning of a journey to become a globally acclaimed hub of research. Most notably, a project started with TRIF and private support, the ASU CXFEL Labs generated X-rays with the world's first compact X-ray light source, a milestone for a proof-of-concept device. Shortly after, the lab at racted \$90.8M — ASU's largest NSF award — to build the world's first compact X-ray free electron laser. This will be a room-sized instrument to explore the intricacies of complex mat er at atomic length and ultrafast time. In FY 2023 we also launched the Biodesign Center for Biomaterials, Innovation and Translation led by Kaushal Rege, whose research findings have had major implications for repair and regeneration of tissues.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>Key research findings include&amp;#58; • The body reacts differently to calories from high-fiber, whole foods compared to processed foods, which has implications for the growing obesity epidemic. • Choline that reduces levels of a neurotoxin holds promise to help defend the brain from neurodegeneration and decline. • Machine learning was used to unveil hallmarks of six neurodegenerative diseases. Targeting these could lead to new therapies. • A combined myxoma virus-immunotherapy treatment has potential to help immune cells identify and destroy tumors. • Modifications to an existing microbial biofilm reactor has created a way to remove dangerous PFAS that linger in our environment and in our bodies. Faculty excellence examples include&amp;#58; • Michael Lynch was named the 2022 Arizona Bioscience Pioneer Award for Lifetime Achievement for examining mechanisms of evolution at the cellular level. • Stephanie Forrest accepted the IEEE CIS Evolutionary Computation Pioneer Award for work on artificial immune systems that behave analogously to the natural immune system. • Methane expert Hinsby Cadillo-Quiroz was appointed to the Atmospheric Methane Removal Commit ee by the National Academies of Sciences.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<p>Expansion of the ASU Biodesign Clinical Testing Lab has slowed due to lower SARS-CoV-2 infection rates. We are growing capabilities to anticipate the state's future testing needs, including a recent award by the CDC, making us one of 7 U.S. centers to track vaccine response to COVID-19 and flu. Despite robust efforts and several near successes, at racting prominent scientists to form research centers — and faculty recruitment overall — has been challenging, as has retaining current staff.</p>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>Arizona will be home to the first CXFEL, which will enable observation of biology's molecular processes in detail. Such processes are key for developing medicines and advancing renewable energy, quantum and semiconductor technologies. CXFEL shrinks existing technology — currently requiring facilities 2km in length and \$2B+ to build, making it far less expensive and more accessible at 10m and under \$70M. The innovation will at ract experts from around the world to AZ. The team anticipates commercializing potential to bring CXFEL to other organizations. The Biodesign Center for Sustainable Macromolecular Materials Manufacturing opened a world-class shared instrument space available to the team's partners. The space will be a resource for Arizona in developing new materials. Biodesign's SM3 is developing model curriculum for new degrees in sustainable materials with one of five \$500K NIST Training for Improving Circularity grants. The effort will enhance workforce skills to help solve the plastic waste problem. Integral to Biodesign's success, students work alongside our world-renowned scientists on real-world science and engineering innovations. Biodesign offers Arizona students amazing training and at racts a highly skilled, global workforce.</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$3,270,007	\$3,792,941		\$7,062,948
Basic Research	\$0	\$0		\$0
Applied Research	\$2,115,861	\$2,454,226		\$2,115,861
Development	\$2,115,861	\$2,454,226		\$4,570,087
Total	\$7,501,729	\$8,701,393		\$16,203,122
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	121	123		244
Graduate Students	488	490		978
Undergraduate Students	212	221		433
Sponsored Project Funding	\$57,191,622	\$67,901,312		\$125,092,934
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	Improving Health			
Program Name	Office of Government and Community Engagement			
<b>Problem Statement</b>				
<p>Decisions to pursue solutions to most pressing human health challenges are often informed by select organizations and committees with limited access by the broader research community. Moreover, securing federal research funding is highly competitive and becoming more and more challenging. To participate meaningfully in relevant discussions and secure funding to support research, ASU must conduct creative, coordinated efforts to establish the university as a thought leader in policy setting areas and increase federal support for research and research-related activities.</p>				
<b>Program Description</b>				
<p>The Office of Government &amp; Community Engagement serves as the liaison to officials and agencies of the U.S. government, state of Arizona, Maricopa County, surrounding municipalities and communities, tribal nations, Mexico and cultural leaders. Our office establishes and maintains communication channels with policy-makers, sponsor agency officials and program staff to effectively represent our research capabilities, infrastructure and organizational strengths. We facilitate participation in priority-setting venues and recognition as a thought leader and valuable contributor to advances in science and technology in the national interest, enabling sustained growth in our research and development pursuits.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>ASU is developing new, cross-disciplinary teams and partnerships that position it well to participate in high-level discussions around use of novel technologies and analytical tools to address more complex health challenges than have been resolved to date. We are already seeing early evidence of realization of the need for such innovative approaches in recent funding opportunities, for which we are getting recognition. With appropriate outreach, ASU's Health Futures Center will provide facilities needed to increase our competitiveness in obtaining funding from the U.S. Department of Health and Human Services, including NIH, CDC, HRSA and PCORI. In addition, coupling our broad biomedical expertise with artificial intelligence and machine learning is already enhancing our ability to compete for large, new funding opportunities that require this interdisciplinarity.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>Growth of the microelectronics industry in Arizona and other advanced technologies will be the beneficiaries of increased research efforts that depend on access to these tools, with corresponding positive economic impacts. ASU will also be a source for a highly skilled workforce in these areas, thereby providing a magnet for future industry growth. Arizona is home to rural and urban communities experiencing disproportionate health disparities based on multiple factors, many of which may be identified using advanced analytical tools such as artificial intelligence, which requires increased federal funding.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$0	\$0	\$0	\$0
Applied Research	\$304,000	\$304,000	\$304,000	\$912,000
Development	\$304,000	\$304,000	\$304,000	\$912,000
Total	\$608,000	\$608,000	\$608,000	\$1,824,000
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	15
Graduate Students	0	0	0	0
Undergraduate Students	0	0	0	0
Sponsored Project Funding	\$7,000,000	\$7,350,000	\$7,717,500	\$22,067,500
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0



# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	Improving Health			
Program Name	Office of Government and Community Engagement			
<b>Progress Summary</b>				
<p>ASU has made significant progress accelerating health and clinical research in the Phoenix Bioscience Core (PBC) • Transitioning 2 college-level clinical recharge facilities to the university level; the Translational Research Laboratory (for sample processing) and the Clinical Research Hub (for biospecimen and other data collection/testing). The goal is to better support clinical research and scale capabilities by promoting and increasing access to these services to researchers across ASU. • Sponsoring Venture Café Phoenix, hosted in PBD. Over the next year, ASU will be involved in planning and organizing community and industry events to promote engagement and collaboration on topics such as AI, sustainability and health. • ASU was awarded \$1M from the Flinn Foundation to solve the health data paradox. Hospitals are sitting on mountains of data with little ability to leverage it for research/care delivery. Universities have tremendous data science capabilities but lack access to health data. ASU is partnering with Valleywise Health to embed dedicated health data research management support for the hospital into ASU's Research Technology Office, launching a doctoral twinning program, and analyzing their unique cultural health navigator model to determine why it is so effective and if it can be scaled to other vulnerable populations. Arizona is home to communities experiencing disproportionate health disparities that can benefit from advanced analytical tools such as AI and wireless measurement devices. ASU's Health Futures Center, next to Mayo Clinic's Phoenix campus, is home to the MedTech Accelerator, an ASU-Mayo Clinic initiative that helps medical technology companies bring their products and services to market. • 9 companies participated in this year's accelerator at the HFC and PBC buildings. 5 international companies were accepted from Spain, South Korea, UK, France, Kenya. • The Health Futures Center is integrating into the 228-acre Discovery Oasis, a Mayo Clinic-led effort to join clinical, academic and industrial expertise and create an environment where biomedical research and entrepreneurial activities thrive, improving health technologies and adding to economic growth in Arizona.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>ASU's Federal Research Engagement Office (FREO) supports development of facilities that will have a major positive impact on health in Arizona and beyond. Sophisticated facilities necessary to conduct clinical research on the impact of behavioral decision-making, precision nutrition, dietetics, genetic and other determinants of health are now coming to fruition. PBC will support inpatient clinical research in these areas as well as advanced technology for functional neuroimaging and computational neuroscience.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>• FREO provided information on NIH Climate Change and Health Initiative that led to a universitywide symposium addressing the impacts of Arizona's extreme heat and water challenges on health. • FREO is assisting on multiple project proposals that will benefit the health and wellbeing of Arizona's population and build on ASU's expertise and community relationships. • FREO is enhancing ASU's near and long-term funding opportunities through introductions to agency leadership, providing input on future funding opportunities and engaging faculty to identify promising future national research priorities. • Anticipating the launch of the Advanced Research Projects Agency for Health (ARPA-H), FREO coached faculty interested in applying for funding and followed up with briefing sessions once the agency was established. • FREO is leading ASU in a nationwide competition for a consortium that will house an ARPA-H hub dealing with investors who will bring promising products to the marketplace improving both health and economic wellbeing.</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$0	\$0		\$0
Applied Research	\$243,879	\$301,940		\$243,879
Development	\$243,879	\$301,940		\$545,819
Total	\$487,758	\$603,880		\$1,091,638
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	2	0		2
Graduate Students	11	0		11
Undergraduate Students	12	0		12
Sponsored Project Funding	\$5,566,531	\$4,503,005		\$10,069,536
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	Improving Health			
Program Name	Research Computing			
<b>Problem Statement</b>				
<p>The process of discovery is directly driven by the scale and pace of available simulation and analysis capacity on campuses. Research projects within Arizona increasingly rely on foundational and advanced research computing. Over 80% of the top-funded researchers at each of the state institutions are currently supported through research computing infrastructure and services. This percentage continues to increase as more research funding opportunities require not only research computing but also systematic support for data controls and regulations. Positioning our researchers for success in health, medical, defense and next-generation technologies research requires a scale of support only available at the statewide level, providing enhanced collaborative capability across all three universities.</p>				
<b>Program Description</b>				
<p>ASU Research Computing provides cutting-edge technology to support research and education while advancing the knowledge and understanding of deploying 21st-century cyberinfrastructure in a large public research university. Specifically, this program supports multidisciplinary research and education in science, technology, engineering and mathematics domains, including computational genomics, molecular dynamics, computational materials science, robotics and imaging. The program increases ASU's capacity for computationally enabled discovery and provides a federated access mechanism for extramural resource sharing across Arizona. Partnering with Dell Technologies, the ASU Research Computing Core Facility has established the ASU Center of Excellence in High Performance Computing and Artificial Intelligence. One of only three such centers in the United States, Research Computing currently enables nearly \$1 billion in proposals and nearly \$300 million in awards.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>Investment in Research Computing will unify, broaden and overarchingly lift all advanced computing capabilities across the state. Notably, investment of TRIF funds in this program will: - Directly enable ASU proposals totaling \$2 million per year. - Precipitate large-scale federal infrastructure awards. - Increase percent conversion of faculty who have consumed research computing resources. - Increase engagement via training events reaching over 1,000 participants per year. - Shorten the time to achieving transformational research and scientific discovery.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>Research Computing has developed capacities in advanced computing and data for initiatives in health, sustainability, space exploration, national security and workforce development that directly benefit Arizona industries and the well-being of Arizona citizens. Notably: - Federally regulated secure computing environment for the Global Security Initiative. - Advanced data movement network for the Lunar Reconnaissance Orbiter Camera. - Developing the Health Futures Computational Facility in partnership with Mayo Clinic. - Supporting artificial intelligence/machine learning-driven research in resilience science. - Exploring opportunities to engage our tribal communities in workforce development opportunities (e.g., data sciences) and identifying innovative solutions to accessing technological resources. - Developing innovative technology capabilities around hybrid cloud. - Training students and faculty on the latest technologies, emphasizing the use of this vital technology to undergraduate and graduate students, and creating a more competitive workforce in the future. - Partnerships with local industry innovators in developing novel cloud-based research-computing-as-a-service business models.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$765,000	\$765,000	\$765,000	\$2,295,000
Applied Research	\$765,000	\$765,000	\$765,000	\$2,295,000
Development	\$765,000	\$765,000	\$765,000	\$2,295,000
Total	\$2,295,000	\$2,295,000	\$2,295,000	\$6,885,000
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	110	116	121	15
Graduate Students	633	665	665	1996
Undergraduate Students	217	228	239	684
Sponsored Project Funding	\$47,441,365	\$49,813,433	\$52,304,105	\$149,558,903
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	3	3	3	9

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	Improving Health			
Program Name	Research Computing			
<b>Progress Summary</b>				
The robust progress of ASU Research Computing in FY 2023 is evidenced by the prestigious international recognition for the Sol supercomputer, the growth of the Quantum Collaborative, the acquisition of the Aloe Supercomputer, the significant increase in supercomputer utilization, the active pursuit of federal funding, and strong support for health initiatives in the state of Arizona.				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
ASU Research Computing facilitated groundbreaking research by supporting PIs with over \$175M in research expenditures. The breadth of disciplines utilizing these resources ranges from health sciences and materials design to engineering and computational science. ASU's supercomputer, Sol, was recognized by the Top500, ranking higher than esteemed academic peers such as Harvard, NYU and Johns Hopkins. This achievement has solidified Sol's pivotal role in catalyzing research at ASU. Sol and other Research Computing resources delivered an unprecedented 180 million CPU-hours of computing — nearly twice the computing delivered in FY 2022 — and continue to empower more than a fifth of principal investigators across various colleges, underscoring their role as crucial enablers of innovative research projects. The Quantum Collaborative has secured access to the IBM Quantum Osprey system, the largest quantum processor to date. The Collaborative also celebrated the notable achievement of ASU student Aradhita Sharma writing one of the top 3% of papers accepted at ICASSP 2023, the flagship conference of the fourth largest society of IEEE (Institute of Electrical and Electronics Engineers). The collaborative also celebrated advisory board member Houlong Zhuang's feature in Materials Today for pioneering work using quantum machine learning to discover new alloys. In FY 2023, ASU Research Computing submitted five federal funding proposals, including successful proposals of over \$2M for cyber workforce development, and infrastructure for ASU's \$90.8M compact X-ray free electron laser.				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
A vital acquisition of FY 2023 was the Aloe Supercomputer, designed for advanced computing on secure and regulated health data and adhering to HIPAA guidelines. This acquisition notably enhances ASU's ability to conduct crucial health-related research at scale while ensuring rigorous data security and compliance. By providing state-of-the-art supercomputing and AI systems, Research Computing also directly supports a grant from the Flinn Foundation to create a data-enabled research platform for Valleywise Health, focused on servicing refugees and other underserved or at-risk populations in Arizona. Research Computing also directly supports research and discovery for several ASU clinical partnerships focusing on "cyberinfrastructure for health," including efforts funded by the Arizona Department of Health Services to design a statewide public health genomics platform. Research Computing also plays a vital role in the long-running ASU-Mayo alliance, including providing the advanced networking, cloud computing access, and supercomputer capacity for ASU-led AI research with Mayo. Research Computing also supports the Arizona Health Information Exchange, a multi-year multi-phase project to evaluate data from over 700 providers and establish data governance and policies around its research use. Finally, Research Computing has also developed a secure private computing cloud to enable research on HIPAA-regulated data sets. Created to aid the ASU response to the COVID-19 pandemic, this secure cloud is now used for multiple research efforts on secure and regulated data, including data from the aforementioned ADHS honest broker.				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$765,000	\$785,548		\$1,550,548
Applied Research	\$765,000	\$785,548		\$765,000
Development	\$765,000	\$785,548		\$1,550,548
Total	\$2,295,000	\$2,356,644		\$4,651,644
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	137	126		263
Graduate Students	872	870		1742
Undergraduate Students	334	349		683
Sponsored Project Funding	\$47,601,576	\$67,903,303		\$115,504,879
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	Improving Health			
Program Name	Skysong Innovations			
<b>Problem Statement</b>				
<p>ASU researchers are tackling some of the world's biggest challenges, from sustainable resources and carbon capture to cancer detection and treatment. Their post-research challenge comes in finding the right partners, strategic investments and experienced entrepreneurial leaders needed to move those innovations into successful commercial application. Skysong Innovations (SI) identifies those technologies with broad potential and coordinates with the right partners to bring these innovations into the marketplace. From pulling water out of thin air to re-engineering a virus to attack cancer, ASU researchers have worked with Skysong Innovations to spin out dozens of companies that have the potential to revolutionize the way we navigate the global challenges of the 21st century.</p>				
<b>Program Description</b>				
<p>SI is ASU's exclusive intellectual property management and technology transfer organization (TTO). Since 2003, SI has provided the ASU research community with the support and expertise needed to turn their research discoveries into commercial opportunities. SI has long been one of the top-performing university TTOs in terms of researcher inventions disclosed, licensing deals signed and startups launched per research dollar. For the third consecutive year, ASU is in the top 10 for U.S. patents issued to U.S. universities — and 11th worldwide — according to an annual ranking of the top universities by the National Academy of Inventors (NAI) and the Intellectual Property Owners Association (IPO). In FY20, ASU researchers working with SI continued to set new benchmarks, submitting 306 invention disclosures and launching 19 new startups. ASU startups also raised more than \$120 million in external funding in FY20. Moreover, when the COVID-19 pandemic first emerged, SI began fast-tracking innovations to prevent, diagnose or treat the disease. To date, SI has licensed eight ASU-developed COVID technologies to companies.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>SI has worked for years to help ASU startups connect with investors. In that regard, SI regularly interacts with venture-capital firms, angel-investment groups, and other potential investors around the globe to showcase ASU startups and technologies. All told, ASU researchers working with SI have launched more than 170 startups, which in turn have attracted nearly \$1 billion in venture capital and other funding. Because experience has taught us that many investors are wary of giving money to companies led by inexperienced founders, we created a special program called the ASU Startup Mill. The ASU Startup Mill connects ASU companies with successful entrepreneurs and experienced corporate executives who can provide advice, support and — in some cases — even take positions running these startups. SI is also the ASU lead behind the ASU-Mayo MedTech Accelerator, which brings together the recognized world leader in patient care, education, and research.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$490,538	\$490,538	\$490,538	\$1,471,613
Applied Research	\$490,538	\$490,538	\$490,538	\$1,471,613
Development	\$490,538	\$490,538	\$490,538	\$1,471,613
Total	\$1,471,613	\$1,471,613	\$1,471,613	\$4,414,840
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	15
Graduate Students	0	0	0	0
Undergraduate Students	0	0	0	0
Sponsored Project Funding	\$0	\$0	\$0	\$0
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	5	5	5	15

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	Improving Health			
Program Name	Skysong Innovations			
<b>Progress Summary</b>				
<p>In FY 2023, SI continued its trend as a highly productive, impactful technology transfer organization. Namely, SI captured 315 new ASU innovations and secured 160 new U.S. patents in FY 2023. Additionally, SI closed 60 new licensing deals — not accounting for many other innovations licensed to industry partners in the context of research collaborations. Within these licensing activities, SI advanced the launch of 21 new startup companies founded on ASU innovations spanning the technological spectrum from high-precision, sustainability-focused polymer production to small-molecule therapeutics for neurodegenerative diseases. Of the 21 new companies, 11 are based in Arizona. Notably, these output levels for innovations, patents, licensing deals and startups have historically placed ASU within the top 10 (and in some instances the top 5) of universities without medical schools according to data published by the Association of University Technology Managers. According to FY 2021 data published in early 2023, ASU was one of only four such universities to rank in the top 10 across all four categories — ASU, Caltech, MIT, and North Carolina State. Compared to its ABOR-identified peer institutions on a per-\$10-million-in-research-expenditures basis, ASU ranked #1 in invention disclosures, #1 in patents, #3 in licensing deals and #1 in startups.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>In FY 2023, SI secured 135 new life science invention disclosures and 66 new life science U.S. patents, the vast majority of which are directed to improving health. Overall, SI's productivity in FY 2023 involved many innovations, patents, licensing deals and startups directed to improving health. Select FY 2023 examples include ASU startup Akeila Bio (next-generation therapeutics to treat a diverse set of diseases with unmet needs, including neurodegenerative diseases), ASU startup Neuroassessments (game that uses human movement to predict dementia progression and Alzheimer's disease at home), a U.S. patent covering methods for improved control and performance of surgically implanted devices that help restore hearing loss, and a non-exclusive license agreement with Center for Orthopedic and Research Excellence, Inc. (wearable heart rate assessment method for detecting adverse health conditions). SI also continues to play a highly active and important executive team role in growing the successful Mayo-ASU MedTech Accelerator. The accelerator's growing reputation continues to help shine a global spotlight on Arizona's accelerating life sciences and medical technology industries. The FY 2023 accelerator included participating companies from the United States, United Kingdom, France, Spain, Kenya and South Korea. Several of the companies are examining Phoenix as a potential location for their U.S. headquarters.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>SI commissioned Rounds Consulting Group to perform an economic impact analysis of ASU's technology transfer activities from FY 2014 through FY 2021. The report concluded that SI and ASU-linked companies generated nearly \$2B in economic activity in Arizona alone (including \$684.2M in labor income, \$66.8M in state and local tax revenues, and 10,727 job-years). By FY 2031, Rounds projects the Arizona economic impact will reach \$5.8B (including \$1.3B in labor income, \$133.6M in state and local taxes, and 20,393 job-years). Rounds reported, "The impact of Skysong Innovations reaches all employment industries in Arizona. For example, the 336 direct employees of Skysong Innovations affiliated companies create the demand for 144 manufacturing jobs, 102 information jobs, etc." Other industries expanded include retail (90 jobs), transportation and warehousing (70 jobs), and finance and insurance (58 jobs).</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$490,538	\$490,538		\$981,076
Applied Research	\$490,538	\$490,538		\$490,538
Development	\$490,538	\$490,538		\$981,076
Total	\$1,471,614	\$1,471,614		\$2,943,228
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	0	0		0
Undergraduate Students	0	0		0
Sponsored Project Funding	\$0	\$0		\$0
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	6	6		12

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	National Security Systems			
Program Name	Global Security Initiative			
<b>Problem Statement</b>				
<p>Today's national and global security challenges are highly complex and interconnected, including protecting information networks (such as those found in critical infrastructure), optimizing human-robot teams, combatting mis- and disinformation, leveraging massive amounts of complex data for effective decision making, and developing transition pathways to application. These challenges require both developing advanced mission-focused research capabilities and creating novel training environments.</p>				
<b>Program Description</b>				
<p>ASU's Global Security Initiative (GSI) brings together unique ASU research, education, and programming capabilities to address national and global security challenges. GSI has three pillars of activity: research, education and engagement. The research pillar establishes interdisciplinary teams to work on the most challenging problems in security. Currently, GSI has four centers: Center for Cybersecurity and Digital Forensics (CDF), Center for Human, AI, and Robot Teaming (CHART), Center on Narrative, Disinformation, and Strategic Influence (NDSI), and Center for Accelerating Operational Efficiency (CAOE), a U.S. Department of Homeland Security (DHS) Center of Excellence (COE). GSI also manages the Cybersecurity Education Consortium (CEC), an interface between industry and academia to facilitate a robust talent pipeline for cybersecurity jobs in Arizona and across the nation. In addition, GSI supports ASU's Center for Wireless Information Systems and Computational Architectures (WISCA), which builds novel computational architectures that require significantly less power while improving computational ability.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>GSI has strategically aligned ASU capabilities with national security needs in cybersecurity, human/AI teaming, analytics and narrative analysis, which has resulted in large-scale externally funded awards and recognition by government and academic partners of ASU's unique strengths in these areas. GSI is also creating a unique role for ASU in the education domain, addressing the need to expand STEM education to ensure our future national security. One of GSI's measures of impact is NSF HERD Department of Defense research expenditures ranking. In the last five years, largely through strategic investment in GSI focus areas, ASU's DoD HERD expenditures grew by more than 50%. Assuming the current investment level and other complimentary university activities, we expect the DoD HERD expenditures to continue to grow another approximately 20% by 2024.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>1. The Global Security Initiative is improving state and the national cyber-readiness by providing hands-on learning activities for all skill levels and age groups, including: - Free resources for Arizona's middle school and high school teachers to implement in their classrooms, such as a cybersecurity curriculum for middle school students and access for high school students to the U.S. Cyber Range. The U.S. Cyber Range is a virtual environment in which students can practice cybersecurity skills and learn how to better protect themselves and their information online. - A free educational platform, called pwn.college, aimed at college students but available to anyone. The platform guides emerging members of the cybersecurity community through increasingly sophisticated learning modules centered around real-world exercises to develop the cybersecurity skill set today's employers need. 2. Research done in GSI's cybersecurity center impacts and is informed by connections with Arizona-based industries, and helps protect the intellectual property of Arizona-based companies. Citizens of Arizona are also protected from cyber-threats more effectively due to this research, which ranges from Internet of Things (IoT) device security to browser security and beyond. 3. Research and national leadership in GSI's Center for Human AI Robot Teaming positions Arizona as a leader and innovator in creating and informing the future of work given increased adoption of autonomy by various industries. 4. A dedicated security entity within the university helps to establish Arizona as a forward-thinking, security-conscious state that can serve as a model for others, as the threats to our nation continue to evolve.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$0	\$0	\$0	\$0
Applied Research	\$1,249,000	\$1,249,000	\$1,249,000	\$3,747,000
Development	\$1,249,000	\$1,249,000	\$1,249,000	\$3,747,000
Total	\$2,498,000	\$2,498,000	\$2,498,000	\$7,494,000
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	42	45	47	15
Graduate Students	383	402	402	1207
Undergraduate Students	140	147	154	441
Sponsored Project Funding	\$39,723,704	\$41,709,889	\$43,795,383	\$125,228,976
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	2	2	2	6



# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	National Security Systems			
Program Name	Global Security Initiative			
<b>Progress Summary</b>				
In FY 2023, GSI worked with more than 140 faculty affiliates from across ASU to submit more than 70 proposals totaling over \$140M in potential funding. We also executed more than \$28M in expenditures of externally-funded research and training programs in defense-related priority technology areas. GSI also provided advanced cybersecurity and AI skills building to current Department of Defense (DOD) personnel, and engaged more than 300 Phoenix-area high school students to generate interest in STEM career paths.				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
GSI advanced transformational science and technology to meet defense, security and intelligence mission needs, leveraging ASU's unique strengths to create impact and drive growth in the Critical Technology Areas identified by the Department of Defense (DOD). In cybersecurity, GSI was awarded a \$3.7M contract from DARPA to automatically identify and fix flaws in computing systems that may allow unauthorized users to gain system access, and is working with an industry partner to transition the results of a multi-year research project into operation. As a trusted partner for the DOD on cybersecurity training, a GSI center secured a \$900K Navy award to systematically assess and improve cyber-training, and through another DOD award led three intensive, two-week training sessions for approximately 100 DOD personnel on advanced cybersecurity techniques. In another critical technology area, microelectronics research awards funded by DARPA are reinforcing the Phoenix area as a national hub for development and manufacturing of this vital technology. ASU received a \$1.5M award for a first phase project aimed at identifying new manufacturing methods for microchips, and \$5.4M to develop a new class of processor that can connect low earth orbit satellites with each other and earthbound operators.				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
ASU's need for a robust transition pipeline has never been greater. ASU has demonstrated the ability to execute large-scale research awards that result in unique technology ready for operationalization, and ASU continues to focus on effective transition.				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
As the conduit for ASU's national defense research, GSI contributes to Arizona's reputation as a leader in defense technologies and a hub for the defense industry. GSI focuses on the intersection of technology and national security, and uses its in-depth understanding of that landscape to anticipate future defense mission needs and position ASU to respond to them. One demonstration of this role was the creation of a generative AI working group over a year ago. GSI also provides technological development and hands-on training to the current and future workforce on defense priorities. Below are just a few of GSI's Arizona-focused engagements. <ul style="list-style-type: none"> <li>• A high school internship program introduced local high school students to a high-performing university research lab, partnering the students with graduate student mentors for 8 weeks.</li> <li>• Providing free biotechnology education to 15 Arizona high schools through a project funded by the DOD.</li> <li>• Generating interest in STEM career paths for high school students. GSI demonstrated its unique robot capabilities to more than 200 Arizona middle and high school students, as well as city leaders from Mesa, Gilbert and Chandler.</li> <li>• GSI has become a trusted partner of Global Ties Arizona, sharing expertise with more than 50 leaders from 20 countries through Global Ties events.</li> </ul>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$0	\$0		\$0
Applied Research	\$1,231,677	\$1,271,884		\$1,231,677
Development	\$1,231,677	\$1,271,884		\$2,503,561
Total	\$2,463,354	\$2,543,768		\$5,007,122
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	34	18		52
Graduate Students	342	316		658
Undergraduate Students	93	62		155
Sponsored Project Funding	\$27,998,805	\$41,711,737		\$69,710,542
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	National Security Systems			
Program Name	Research Development			
<b>Problem Statement</b>				
Increasing the diversity, reach, quality and impact of ASU's faculty, staff and student research activities contributes to the strength of our regional economy and improves our national standing in higher education.				
<b>Program Description</b>				
Research Development is responsible for increasing the size of ASU's research enterprise through a community of practice around early positioning and competitiveness of proposals for funding from federal agencies. This is accomplished through strategic intelligence of funding opportunities and improved teaming, outreach and training during research-related events, transparent and equitable management of limited funding opportunities and internal seed grants programs, and professional proposal management for large and complex funding proposals.				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
Research Development is responsible for dissemination of hundreds of limited funding opportunities to the university, providing hundreds of documents in support of strategic decision-making for leaders, bringing together hundreds of researchers to discuss competitive funding solicitations, and supporting millions of dollars' worth of proposals from ASU. This work increases the overall ability of ASU to reach aggressive goals for research expenditures.				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$41,010	\$41,010	\$41,010	\$123,030
Applied Research	\$41,010	\$41,010	\$41,010	\$123,030
Development	\$41,010	\$41,010	\$41,010	\$123,030
Total	\$123,030	\$123,030	\$123,030	\$369,089
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	15
Graduate Students	0	0	0	0
Undergraduate Students	3	3	3	9
Sponsored Project Funding	\$40,000,000	\$42,000,000	\$44,100,000	\$126,100,000
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	National Security Systems			
Program Name	Research Development			
<b>Progress Summary</b>				
Overall, Research Development supported almost \$527M across 27 proposals originating from the university. In addition, 103 graphics were produced for 27 proposals, with some of these overlapping with the proposal manager work. In the past year, Research Development hosted 38 events for ASU faculty, students and staff. These events had 1,603 registrations and 990 attendees. Fifteen events focused on highly competitive, national-level programs, while twelve covered best practices of preparing competitive proposals. Research Development also circulates federal funding opportunities via a weekly email newsletter with over 2,000 subscribers.				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
Research Development produced 77 analyses to inform decision-making and proposal strategy for ASU faculty and leadership. Two analyses were in support of national security. One delved into exploration of international opportunities for security and defense and another examined disinformation. Summary of national security systems activities • Submitted one proposal worth \$100,000 • Hosted four events relevant to national security with 122 registrations				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
Pandemic response is a key concern in national security, as population health is tied to successful governance and economies. A strong workforce creates a resilient economy that then creates a more secure nation. Research Development supported a proposal in which the Biodesign Institute partnered with Valleywise Health and Phoenix Children's Hospital to successfully secure a \$12.5M award evaluating the efficacy of flu and COVID-19 vaccinations in Arizona residents. Understanding how population health is affected by vaccinations year over year allows us to forecast efficacy of vaccination efforts. The proposal was submitted in the previous fiscal year and the award begins this coming fiscal year.				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$53,621	\$66,105		\$119,726
Applied Research	\$53,621	\$66,105		\$53,621
Development	\$53,621	\$66,105		\$119,726
Total	\$160,863	\$198,315		\$359,178
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	0	0		0
Undergraduate Students	0	0		0
Sponsored Project Funding	\$675,000	\$100,000		\$775,000
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	National Security Systems			
Program Name	Skysong Innovations			
<b>Problem Statement</b>				
<p>ASU researchers are tackling some of the world's biggest challenges, from sustainable resources and carbon capture to cancer detection and treatment. Their post-research challenge comes in finding the right partners, strategic investments and experienced entrepreneurial leaders needed to move those innovations into successful commercial application. Skysong Innovations (SI) identifies those technologies with broad potential and coordinates with the right partners to bring these innovations into the marketplace. From pulling water out of thin air to re-engineering a virus to attack cancer, ASU researchers have worked with Skysong Innovations to spin out dozens of companies that have the potential to revolutionize the way we navigate the global challenges of the 21st century.</p>				
<b>Program Description</b>				
<p>SI is ASU's exclusive intellectual property management and technology transfer organization (TTO). Since 2003, SI has provided the ASU research community with the support and expertise needed to turn their research discoveries into commercial opportunities. SI has long been one of the top-performing university TTOs in terms of researcher inventions disclosed, licensing deals signed and startups launched per research dollar. For the third consecutive year, ASU is in the top 10 for U.S. patents issued to U.S. universities — and 11th worldwide — according to an annual ranking of the top universities by the National Academy of Inventors (NAI) and the Intellectual Property Owners Association (IPO). In FY20, ASU researchers working with SI continued to set new benchmarks, submitting 306 invention disclosures and launching 19 new startups. ASU startups also raised more than \$120 million in external funding in FY20. Moreover, when the COVID-19 pandemic first emerged, SI began fast-tracking innovations to prevent, diagnose or treat the disease. To date, SI has licensed eight ASU-developed COVID technologies to companies.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>SI has worked for years to help ASU startups connect with investors. In that regard, SI regularly interacts with venture-capital firms, angel-investment groups, and other potential investors around the globe to showcase ASU startups and technologies. All told, ASU researchers working with SI have launched more than 170 startups, which in turn have attracted nearly \$1 billion in venture capital and other funding. Because experience has taught us that many investors are wary of giving money to companies led by inexperienced founders, we created a special program called the ASU Startup Mill. The ASU Startup Mill connects ASU companies with successful entrepreneurs and experienced corporate executives who can provide advice, support and — in some cases — even take positions running these startups. SI is also the ASU lead behind the ASU-Mayo MedTech Accelerator, which brings together the recognized world leader in patient care, education, and research.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$110,955	\$110,955	\$110,955	\$332,865
Applied Research	\$110,955	\$110,955	\$110,955	\$332,865
Development	\$110,955	\$110,955	\$110,955	\$332,865
Total	\$332,865	\$332,865	\$332,865	\$998,595
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	15
Graduate Students	0	0	0	0
Undergraduate Students	0	0	0	0
Sponsored Project Funding	\$0	\$0	\$0	\$0
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	5	5	5	15

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	National Security Systems			
Program Name	Skysong Innovations			
<b>Progress Summary</b>				
<p>In FY 2023, SI continued its trend as a highly productive, impactful technology transfer organization. Namely, SI captured 315 new ASU innovations and secured 160 new U.S. patents in FY 2023. Additionally, SI closed 60 new licensing deals — not accounting for many other innovations licensed to industry partners in the context of research collaborations. Within these licensing activities, SI advanced the launch of 21 new startup companies founded on ASU innovations spanning the technological spectrum from high-precision, sustainability-focused polymer production to small-molecule therapeutics for neurodegenerative diseases. Of the 21 new companies, 11 are based in Arizona. Notably, these output levels for innovations, patents, licensing deals and startups have historically placed ASU within the top 10 (and in some instances the top 5) of universities without medical schools, according to data published by the Association of University Technology Managers. According to FY 2021 data published in early 2023, ASU was one of only four such universities to rank in the top 10 across all four categories — ASU, Caltech, MIT and North Carolina State. Compared to its ABOR-identified peer institutions on a per-\$10-million-in-research-expenditures basis, ASU ranked #1 in invention disclosures, #1 in patents, #3 in licensing deals and #1 in startups. FY 2023 also saw continued growth for ASU startup fundraising efforts. The historical running total of venture capital investments and other funding reported by all ASU startups surpassed the \$1.3B mark in FY 2023.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>In FY 2023, SI secured 12 new invention disclosures and seven new U.S. patents covering innovations with potential application to national security systems. Overall, SI's productivity in FY 2023 involved innovations, patents, licensing deals and startups with direct or potential applications to national security systems. Select FY23 examples include a licensing deal that provided additional technology to ASU startup DENSEC ID (technologies that provide inexpensive, spoof-resistant, tamper-resistant, unique identifiers that can be placed directly on goods for supply chain security); new invention disclosures concerning systems for improving the efficiency of airport security screening checkpoints, cybersecurity within the autonomous driving field and more; and several U.S. patents covering cybersecurity and fake-news-detection technologies. SI also continued providing support to ASU programs such as the National Security Academic Accelerator (NSA2) and the Center for Accelerating Operational Efficiency (CAOE). NSA2 is a National Security Innovation Network (NSIN) program that connects university-oriented startups with Department of Defense customers and end users to create viable, U.S.-based, dual-use-solution companies.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>SI commissioned Rounds Consulting Group to perform an economic impact analysis of ASU's technology transfer activities from FY 2014 through FY 2021. The report concluded that SI and ASU-linked companies generated nearly \$2B in economic activity in Arizona alone (including \$684.2M in labor income, \$66.8M in state and local tax revenues, and 10,727 job-years). By FY 2031, Rounds projects the Arizona economic impact will reach \$5.8B (including \$1.3B in labor income, \$133.6M in state and local taxes, and 20,393 job-years). Rounds reported, "The impact of Skysong Innovations reaches all employment industries in Arizona. For example, the 336 direct employees of Skysong Innovations affiliated companies create the demand for 144 manufacturing jobs, 102 information jobs, etc." Other industries expanded include retail (90 jobs), transportation and warehousing (70 jobs), and finance and insurance (58 jobs).</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$110,955	\$110,955		\$221,910
Applied Research	\$110,955	\$110,955		\$110,955
Development	\$110,955	\$110,955		\$221,910
Total	\$332,865	\$332,865		\$665,730
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	0	0		0
Undergraduate Students	0	0		0
Sponsored Project Funding	\$0	\$0		\$0
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	5	3		8

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	Space Exploration and Optical Solutions			
Program Name	Interplanetary Initiative			
<b>Problem Statement</b>				
<p>Humankind is compelled to explore space and will have a space future. Most efforts to prepare for this space future are aimed toward incremental science in narrow disciplines. They struggle to cope with the larger picture or, alternatively, only look at the larger societal impacts without being connected to real scientific endeavors. However, humankind's space future requires fusing disciplines together for these efforts to succeed.</p>				
<b>Program Description</b>				
<p>The interplanetary Initiative is transforming both how we educate the next generation and how we fundamentally conduct research while finding common cause in an essential challenge for humanity: our space future. Space exploration is a compelling, freeing vehicle for ideation about the future of society and education. To build a positive space future, people will need to embrace and know how to tackle unsolved problems. ASU is uniquely prepared to create thoughtful, communicative, transdisciplinary teams including scientists, engineers, psychologists, sociologists, artists, public relations experts, historians and beyond. The interplanetary Initiative is creating and implementing novel pan-university learning programs centered on open inquiry and launching new research driven by interdisciplinary teams tackling some of the biggest questions about space exploration. The implementation and scaling of our unique teaming and learning processes will make problem-solving and knowledge creation accessible to all of society.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>The Interplanetary Initiative helps ASU drive forward (and ultimately scale) new models of learning and research that support an inclusive and sustainable space future. The program also explores new organizational models for advancing ASU's mission. The initiative's experimental processes and programs, in addition to the interdisciplinary and cross-sector community of thought leaders which it has nurtured and grown, puts ASU in a competitive position for high-impact partnerships and funding opportunities in the space sector, such as its partnership with XPRIZE.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>The initiative's novel learning programs, such as its Technological Leadership B.S. and the OpenCitizen program, will directly benefit learners and businesses based in Arizona. For example, OpenCitizen meets learners wherever they are — in the home or the workplace — and connects their learning experience to what matters most to them in their communities. OpenCitizen's local problem solving focus benefits Arizona by empowering its citizens to make positive changes in their community while gaining new skills. The Technological Leadership B.S., which has just completed its first year and offers a radically different learning experience in which students direct their own learning through research processes, enrolled 18 students living in Arizona. Moreover, the Interplanetary Initiative strengthens ASU's relationships with the robust aerospace industry in Arizona through workforce development and research partnerships.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$133,333	\$133,333	\$133,333	\$400,000
Applied Research	\$133,333	\$133,333	\$133,333	\$400,000
Development	\$133,333	\$133,333	\$133,333	\$400,000
Total	\$400,000	\$400,000	\$400,000	\$1,200,000
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	2	2	2	15
Graduate Students	6	6	6	18
Undergraduate Students	64	67	71	202
Sponsored Project Funding	\$5,089,714	\$5,344,200	\$5,611,410	\$16,045,324
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	Space Exploration and Optical Solutions			
Program Name	Interplanetary Initiative			
<b>Progress Summary</b>				
<p>Through a networked model, the Interplanetary Initiative advances positive space futures through external partnerships and programs dedicated to education and workforce development. We draw upon experts from across all of ASU and its many disciplines to accomplish this goal. In FY 2023, we engaged more than 19,000 people through 43 outreach events and public engagements. Our work was featured in 23 media stories across ASU News and third party publications. Our project portfolio since inception includes 53 projects including pilot studies, lab projects and other types of collaborations which together generated over \$9.5M.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>In FY 2023, we supported nine interdisciplinary, cross-sector pilot projects promoting a positive human space future. These projects included experts across 28 disciplines from the private, government and university sectors and engaged 35 external organizations and 107 team members, 44 of which were students. This pilot program has delivered a 6.5X return on investment in follow-on grants, contracts and royalties. One previously funded project secured a \$1.5M grant to create a Mars simulation habitat in Tucson. Our student-run Interplanetary Laboratory continued to support space hardware and software projects across the university and the greater community. This year the lab hosted 569 unique users, a majority of whom are students; seven hardware projects; five faculty collaborators and four industry partners. Now in its third year, our technological leadership degree program graduated seven students, the largest graduating class to date, and launched a new minor. We trained more than 40 local educators in OpenCitizen, our community problem-solving program, which led to a dozen pilots in Arizona this coming year. Participation in this program leads to credit-bearing degree programs at ASU. In collaboration with the Learning Enterprise, we created a new online upskilling certificate for the aerospace sector, the SciTech Space Leadership Program, set to launch soon. Our annual marquee event hosted in Arizona convened 80 thought leaders from 39 organizations spanning industry, government and academia and now has a cumulative alumni roster of 102 participants. Now in its second year, the Orbital Reef University Council is optimizing pathways for researchers to send experiments to low Earth orbit and disseminating vet ed microgravity curricula to teachers in underserved communities. The council is also creating frameworks to implement principles of responsible innovation as well as diversity, equity, inclusion and access in the space sector. We hosted the first Arizona Space Summit, which brought together 100 space leaders to highlight the state's talent, infrastructure and other strengths to explore opportunities to grow Arizona's commercial space sector. In addition, we hosted the first Space Career Fair at ASU.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>Our Interplanetary Lab serves faculty, students and startups primarily based in Arizona. All four startups that utilized this shared resource this past year are based here. The OpenCitizen program engaged Arizona middle and high school educators who will be implementing the program in their classrooms this fiscal year. This is a unique community-based problem solving program that creates ASU degree credit opportunities for participating students. The SciTech Space Leadership certificate will launch this fall and provide accessible upskilling courses to Arizona-based aerospace employees. The first Arizona Space Summit helped identify strategic opportunities for Arizona to strengthen its standing in the space sector.</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$133,272	\$133,851		\$267,123
Applied Research	\$133,272	\$133,851		\$133,272
Development	\$133,272	\$133,851		\$267,123
Total	\$399,816	\$401,553		\$801,369
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	1	1		2
Graduate Students	4	4		8
Undergraduate Students	18	18		36
Sponsored Project Funding	\$5,522,827	\$953,655		\$6,476,482
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	Space Exploration and Optical Solutions			
Program Name	Research Development			
<b>Problem Statement</b>				
Increasing the diversity, reach, quality and impact of ASU's faculty, staff and student research activities contributes to the strength of our regional economy and improves our national standing in higher education.				
<b>Program Description</b>				
Research Development is responsible for increasing the size of ASU's research enterprise through a community of practice around early positioning and competitiveness of proposals for funding from federal agencies. This is accomplished through strategic intelligence of funding opportunities and improved teaming, outreach and training during research-related events, transparent and equitable management of limited funding opportunities and internal seed grants programs, and professional proposal management for large and complex funding proposals.				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
Research Development is responsible for dissemination of hundreds of limited funding opportunities to the university, providing hundreds of documents in support of strategic decision-making for leaders, bringing together hundreds of researchers to discuss competitive funding solicitations, and supporting millions of dollars' worth of proposals from ASU. This work increases the overall ability of ASU to reach aggressive goals for research expenditures.				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$22,989	\$22,989	\$22,989	\$68,967
Applied Research	\$22,989	\$22,989	\$22,989	\$68,967
Development	\$22,989	\$22,989	\$22,989	\$68,967
Total	\$68,967	\$68,967	\$68,967	\$206,902
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	15
Graduate Students	0	0	0	0
Undergraduate Students	3	3	3	9
Sponsored Project Funding	\$40,000,000	\$42,000,000	\$44,100,000	\$126,100,000
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0



# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	Space Exploration and Optical Solutions			
Program Name	Research Development			
<b>Progress Summary</b>				
Overall, Research Development supported almost \$527M across 27 proposals originating from the university. In addition, 103 graphics were produced for 27 proposals, with some of these overlapping with the proposal manager work. In the past year, Research Development hosted 38 events for ASU faculty, students and staff. These events had 1,603 registrations and 990 attendees. Fifteen events focused on highly competitive, national-level programs, while twelve covered best practices of preparing competitive proposals. Research Development also circulates federal funding opportunities via a weekly email newsletter with over 2,000 subscribers.				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
Research Development submitted a proposal worth approximately \$5M related to exoplanet characterization. Although the proposal was not selected for funding at this time, the research would contribute to infrastructure related to scientific discovery in space, a vital and growing economic engine for Arizona. Research Development continues to identify current and emerging opportunities in the space sector and support researchers in pursuing them.				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
Research Development advances ASU and Arizona through support of large and strategic initiatives across our campuses and in partnership with other institutions of higher education in Arizona. We support individual faculty, faculty-led teams and ASU leadership in the development and execution of proposals for federal funding. We also offer a robust slate of events that connect interested individuals with competitive federal programs and provide information on the process for creating competitive applications for funding. Furthermore, the office provides timely, cogent analyses on the federal funding landscape and emerging trends relevant to the university's priorities. The office manages all institutionally limited solicitations, a variety of prestigious nomination competitions and several internal seed grant programs that foster preliminary research efforts.				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$30,059	\$37,057		\$67,116
Applied Research	\$30,059	\$37,057		\$30,059
Development	\$30,059	\$37,057		\$67,116
Total	\$90,177	\$111,171		\$201,348
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	0	0		0
Undergraduate Students	0	0		0
Sponsored Project Funding	\$300,000	\$5,000,000		\$5,300,000
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	Space Exploration and Optical Solutions			
Program Name	Space Technology and Science Initiative (NewSpace)			
<b>Problem Statement</b>				
<p>Morgan Stanley predicts that by 2040, the space economy will be over \$1 trillion. The exponential growth in the commercial space industry provides an enormous opportunity for universities to partner with commercial space companies. ASU's expertise in space science and technology and a growing commercial space industry presence provide multiple entry points for partners to engage and see mutual benefits. NewSpace works across the university on numerous commercial space projects, including satellite communication and ground stations, DOD space opportunities, continued growth in NASA funding, development of a spaceport in Arizona, space industry presence on campus, commercial remote sensing projects for Arizona, and ASU exposure at industry events.</p>				
<b>Program Description</b>				
<p>The ASU Space Technology and Science ("NewSpace") Initiative was established in 2013. The Initiative was designed to develop and integrate the commercial space industry with the space science and technology community at ASU. Leveraging heritage experts from ASU for space and space relevant science and technology growth, we have been successful in securing a number of new space-related projects on campus, including a NASA-funded deep space satellite mission to orbit the Moon for mapping of lunar polar hydrogen and other programs focused on space-related sensors, instruments and spacecraft systems. ASU NewSpace is supporting the growth of the Arizona space industry through ASU student capstone programs, the establishment of a space business entrepreneurship course for students, and partnerships with industry to enable access to the unique space-relevant facilities available on campus. We also focus on developing an ASU-led satellite communication and tracking ground station, smallsat instrument development and technology advancement, industry sponsored senior design/capstone course growth, and Arizona NASA Space Grant mentorship.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>ASU has over 300 investigators that submit proposals to NASA and other space-related funding sources. Leveraging and growing this space researcher cohort has been a focus at ASU NewSpace. Incorporating our 400+ industry partners into funding proposal development, we directly enabled the submission of over \$60 million in proposals to federally sponsored opportunities in FY21, leading to over \$1.5 million in awards last year. We forecast that through ASU NewSpace there will continue to be growth in proposals annually of \$40-\$75 million, along with an increase in our win rate on awards.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>Yes. ASU NewSpace has cultivated relationships with more than 60 Arizona-based companies or institutions in the space industry. These industry relationships have resulted in multiple sub-contracts to NASA-funded projects, multiple ASU senior design/capstone projects and multiple public-facing events through organizations like AZ Commerce Authority, the City of Tempe, the Greater Phoenix Economic Council, AZ Tech Council and others. These benefits and impact will continue to grow as ASU NewSpace expands its ability to assemble ASU experts and commercial space industry partners to pursue new funding opportunities. These efforts will enable deep relationships to benefit the students, faculty and facilities at ASU along with the growing Arizona space industry.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$0	\$0	\$0	\$0
Applied Research	\$200,000	\$200,000	\$200,000	\$600,000
Development	\$200,000	\$200,000	\$200,000	\$600,000
Total	\$400,000	\$400,000	\$400,000	\$1,200,000
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	1	15
Graduate Students	6	9	9	27
Undergraduate Students	40	42	44	126
Sponsored Project Funding	\$1,500,000	\$2,500,000	\$4,000,000	\$8,000,000
Publications in Academic Peer-Reviewed Journals	1	1	2	4
Startups	0	0	1	1

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	Space Exploration and Optical Solutions			
Program Name	Space Technology and Science Initiative (NewSpace)			
<b>Progress Summary</b>				
In FY 2023, ASU/NewSpace directly supported \$145M in proposals to 8 different agencies and partners led by 12 different ASU faculty principal investigators. In addition, ASU received \$3.3M in awards from 5 different funding agencies as a direct result of engagement and consultation with ASU/NewSpace, reaching an ROI of 4.6 from overall TRIF investments.				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
Our most notable success was the launch of the LunaH-Map CubeSat aboard NASA's inaugural Artemis I lunar flyby mission. Designed by Prof. Craig Hardgrove, the spacecraft and instrument successfully acquired lunar data and achieved the highest designation for technology readiness from NASA. Leveraging that success, Hardgrove went on to secure a \$3M award from NASA for his Lunar-VISE instrument, destined for a future lunar lander. Commercial space businesses supporting this project include Arizona-based Qwaltec. A NOAA award of \$120K led by ASU researchers will enable future models of Phoenix-metro air quality from sensors on new NOAA satellites. ASU/NewSpace worked directly with one of Jim Bell's graduate students to propose and win a NASA-funded project leveraging rover mission operations in analogue environments. This included a NASA mission simulation event on craters and lava flows near Flagstaff. This spring-boarded her to a postdoc position with a commercial space subcontractor to continue Mars/Lunar Rover Operations at NASA's Johnson Space Center.				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
ASU/NewSpace efforts focused this year on continuing to grow Arizona as a space industry destination. We advanced this goal through participation at leading industry trade shows. For example, with Arizona Commerce Authority (ACA), we hosted an Arizona Space Overview session for the ACA business development and strategy team. This became a precursor for the inaugural AZ Space Summit held on the Tempe campus in April and organized by ASU's Interplanetary Initiative, ASU/NewSpace, Thunderbird School of Global Management, the Fulton Schools of Engineering, and the School of Earth and Space Exploration. Around 100 participants attended from industry, government and all three Arizona universities. The event included a space-focused career fair that will repeat in 2024. Additional industry engagement included participation in the SmallSat (Logan, UT) and Space Symposium (Colorado Springs) space industry conferences as exhibitors, enabling exposure to thousands of attendees resulting in new proposal engagements in FY 2023 and planned for FY 2024. ASU continues to be the only Executive Member of the Commercial Spaceflight Federation (CSF), a leading voice for the commercial space industry in Washington. At the February member meeting, ASU/NewSpace was invited to introduce Senator Mark Kelly to address the 400 participants from across the country. This has enabled continued engagement of CSF members for workforce and funding opportunity collaborations. ASU/NewSpace will host the next CSF board and member meeting at the ASU Los Angeles Center in fall 2023. As an affiliate of the NASA AZ Space Grant Consortium, ASU/NewSpace worked closely with the ASU Space Grant Director and Coordinator Senior to implement a pilot internship program with the commercial space industry. The pilot intern worked at General Dynamics Mission Systems in Scottsdale and she obtained hands-on, real-world experience with environmental testing of actual space hardware in support of their programs. We anticipate continuing to work with the commercial space industry in FY 2024 on novel pilot programs that will engage ASU students with industry to support their workforce demands. In addition, LunaH-Map Operations were conducted by students and staff on the Tempe campus, providing invaluable career experience.				
<b>Additional Notes</b>				
0				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$0	\$0		\$0
Applied Research	\$200,101	\$249,706		\$200,101
Development	\$200,101	\$249,706		\$449,807
Total	\$400,202	\$499,412		\$899,614
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	8	11		19
Undergraduate Students	48	46		94
Sponsored Project Funding	\$1,211,333	\$3,219,408		\$4,430,741
Publications in Academic Peer-Reviewed Journals	0	1		1
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	Center for Bio-mediated and Bio-Inspired Geotechnics (CBBG)			
<b>Problem Statement</b>				
<p>Through the Center for Bio-mediated and Bio-Inspired Geotechnics (CBBG), Arizona State University is the international leader in applying the emerging field of biogeotechnics to develop sustainable and resilient geotechnical solutions for civil infrastructure systems. Through direct application of and by mimicking biological processes abiotically, CBBG seeks to reduce the life cycle costs and environmental and social impacts of construction, operation, and maintenance of infrastructure systems that build on, in, and with earthen materials.</p>				
<b>Program Description</b>				
<p>Led by ASU, CBBG is a National Science Foundation Gen-3 Engineering Research Center and includes three other leading public Universities: Georgia Institute of Technology, New Mexico State University and the University of California at Davis. CBBG has four technological thrusts: Geological Hazard Mitigation; Environmental Protection and Ecological Restoration; Infrastructure Construction Methods and Materials; and Subsurface Exploration and Excavation. CBBG also has a focus on Innovation, Diversity and Inclusion, and Education that includes a robust K-12 outreach program and a Research Experience for Teachers (K-14) program that has a strong emphasis on participants from underrepresented groups.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>ASU is uniquely suited to lead CBBG because of its emphasis on transdisciplinary and use-inspired research, sustainable development, local impact and social embeddedness, and global outreach. With its focus on bio-mediation, bio-inspiration and earthen (geologic) materials, CBBG research is by nature a transdisciplinary endeavor. Its progress is facilitated by ASU's ability to foster and support interdisciplinary work. All CBBG projects must be targeted towards sustainable development of civil infrastructure, i.e., must be use-inspired, whether it be focused on fundamental knowledge development or integration of a new technology into civil infrastructure systems. And all CBBG projects must be supported by a life cycle sustainability assessment (LCSA) that documents potential contributions of the project to the triple bottom line of social, environmental and financial benefit.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>TRIF support for CBBG has many direct and indirect benefits for Arizona. Direct benefits include research on problems of major importance to the health and well-being of Arizona citizens such as fugitive dust control and remediation of groundwater impacted by chlorinated solvents, education and training for Arizona's engineering workforce, training and curriculum development for local K-14 schools, and entrepreneurial opportunities for startup businesses. Indirect benefits for Arizona not only include contributions to sustainability and resilience of civil infrastructure systems across the U.S. and worldwide but also research on global problems of concern to major Arizona-based industries such as mitigation of the impacts of mining on groundwater and enhanced management of methane emissions at landfills.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$400,000	\$400,000	\$400,000	\$1,200,000
Basic Research	\$0	\$0	\$0	\$0
Applied Research	\$0	\$0	\$0	\$0
Development	\$0	\$0	\$0	\$0
Total	\$400,000	\$400,000	\$400,000	\$1,200,000
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	4	4	4	15
Graduate Students	19	20	20	60
Undergraduate Students	12	12	13	37
Sponsored Project Funding	\$2,205,548	\$2,315,826	\$2,431,617	\$6,952,991
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	Center for Bio-mediated and Bio-Inspired Geotechnics (CBBG)			
<b>Progress Summary</b>				
CBBG continued developing cost-effective and environmentally friendly biotechnologies for infrastructure development, soil and groundwater remediation, and geologic hazard mitigation. Technologies in development include bio-cementation to replace Portland cement in foundation construction and synthetic polymers in fugitive dust control, bioremediation of groundwater impacted by semiconductor production, and bio-desaturation of soil to mitigate earthquake-induced soil liquefaction. CBBG industry partners are collaborating on all of these efforts. CBBG also began strategic planning for the end of NSF core funding in July 2025. The four partner universities agreed to form the Consortium for Bio-mediated and Bio-inspired Geotechnics (retaining the CBBG brand) and continue to pursue opportunities for collaborative research, including funding for an Industry-University Collaborative Research Center (IUCRC).				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
In the last year, CBBG has made advancements across a range of nature-inspired geotechnologies to support infrastructure systems. We've progressed our biocementation technology to address the air quality issues of fugitive dust, improved methods of bioremediation to remove chlorinated solvents in contaminated groundwater, and advanced biocemented column reinforcements for building foundations to reduce greenhouse gas emissions. In addition, CBBG is pioneering bio-inspired solutions for bridge foundation erosion — the primary cause of bridge failure worldwide. TRIF funds also supported development of a geotechnical workforce schooled in the principles of sustainable development.				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
Two of the technologies evaluated for fugitive dust mitigation, MICP (Microbially Induced Carbonate Precipitation) and biopolymer stabilization, were not as technically sound or cost effective as desired. However, a third technology, EICP (Enzyme Induced Carbonate Precipitation), has advanced to the large-scale field trial stage. Adoption of CBBG technologies by industry has been somewhat slower than anticipated. We believe this resistance to embrace new technology is due to the conservative nature of the infrastructure industry, wherein owners are reluctant to be the first to embrace an innovative, if somewhat unproven technology (we're most commonly asked where our technology has been used before). To overcome this barrier requires large scale demonstrations, such as the one currently underway for fugitive dust mitigation.				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
Many of our developing biotechnologies have direct impact on issues facing Arizona, including poor air quality caused by fugitive dust, groundwater contamination due to semiconductor manufacturing, and greenhouse gas emissions from construction. CBBG is also working to establish an Arizona-based geotechnical workforce versed in sustainable development principles at the university level, and through our Research Experience for Teachers program we are helping to cultivate Arizona's future STEM workforce at the K-14 level. TRIF funding also supports our strategic planning to maintain CBBG and ASU's position as a world leader in cost-effective and environmentally protective nature-inspired geotechnologies.				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$195,572	\$281,075		\$476,647
Basic Research	\$0	\$0		\$0
Applied Research	\$0	\$0		\$0
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$195,572</b>	<b>\$281,075</b>		<b>\$476,647</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	2	2		4
Graduate Students	20	24		44
Undergraduate Students	17	18		35
Sponsored Project Funding	\$4,410,534	\$2,776,910		\$7,187,444
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	Collaborative Research Infrastructure and Core Facilities			
<b>Problem Statement</b>				
<p>As the state of Arizona positions itself to be a leader in the research areas targeted by TRIF, it is imperative that we maintain and enhance our core infrastructure that supports these initiatives. We have taken steps toward developing a statewide network to promote awareness of shared resources across the state. We have leveraged federal funding to the extent possible to secure advanced and highly specialized technologies. Just as important are our fundamental capabilities and personnel that form the backbone of our core infrastructure. TRIF funding is an essential component of our overall funding strategy to maintain an appropriate refresh rate of these broadly-impactful fundamental capabilities.</p>				
<b>Program Description</b>				
<p>Core Facilities mission: To facilitate the expansion and enhancement of ASU's research enterprise by providing technical and scientific services to support faculty research objectives and enable success. Strategy: 1. Maintain state-of-the-art facilities and expert staff to support technologies and applications aligned with ASU's strategic research goals. 2. Provide effective access (physical, financial, training, workflows) and maintain customer-focused orientation. 3. Increase awareness of capabilities through marketing, communications and promotional efforts. 4. Engage industry and non-profit partners to fully leverage resources and maintain fiscal sustainability.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>ASU is uniquely poised to advance research and secure external funding in key areas that are enabled largely by core facilities. Given federal funding initiatives, our geographical location, and strength in advanced materials, solar, power electronics and other related areas, there is significant opportunity for expanding partnerships within the semiconductor industry as companies establish a presence in the Phoenix metro area. These will be supported by our NanoFab, Eyring Materials Center, Advanced Electronics and Photonics, and Solar Fab facilities. In addition to funding in the semiconductor space, ASU's strong clinical partnerships with multiple health care organizations provides a unique opportunity to competitively pursue National Institutes of Health funding through the Clinical and Translational Science Award program. Funding of infrastructure to provide shared clinical support services will be instrumental to advancing this effort.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>By nature, core facilities train a high volume of university students, staff and faculty, as well as industry partners, and thereby contribute significantly to hands-on workforce development. Many of our student trainees move on to work in local industry as scientists and engineers, utilizing the skill sets they develop under our training programs.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$1,000,000	\$1,000,000	\$1,000,000	\$3,000,000
Basic Research	\$670,128	\$670,128	\$670,128	\$2,010,383
Applied Research	\$670,128	\$670,128	\$670,128	\$2,010,383
Development	\$670,128	\$670,128	\$670,128	\$2,010,383
Total	\$3,010,383	\$3,010,383	\$3,010,383	\$9,031,149
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	159	167	175	15
Graduate Students	696	731	731	2195
Undergraduate Students	332	349	366	1047
Sponsored Project Funding	\$61,072,281	\$64,125,895	\$67,332,189	\$192,530,365
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	5	6	6	17

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University
TRIF Investment Area	Water, Environment and Energy Solutions
Program Name	Collaborative Research Infrastructure and Core Facilities
<b>Progress Summary</b>	
Throughout FY 2023, ASU Core Research Facilities supported over 530 research projects with expenditures of nearly \$60M. Our experts, high-end equipment and customized services enabled the expansion of fundamental capabilities and technologies that have been crucial to the success of 1,813 ASU faculty, student and staff researchers. Overall, we have trained 861 graduate and undergraduate students and post-doctoral scholars, providing opportunities to develop key skills in technologies that will help them succeed in Arizona's new economy. In addition, Core Research Facilities provided support to 118 companies with a presence in Arizona.	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
TRIF funding continues to support our team of experts in enabling a broad range of research initiatives throughout ASU and among our partner organizations, both in industry and other ABOR institutions. We have coupled TRIF funds with other strategic funding sources such as the New Economy Initiative to develop a comprehensive strategy to enhance core capabilities, particularly in the areas of health and microelectronics research.	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
Due to supply chain challenges, we have experienced a number of setbacks on new equipment installations. This will delay access to some new capabilities that our TRIF-supported team is poised to support.	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
A significant amount of TRIF funding has supported training and development of student and industry users, strengthening the pipeline of talent in key areas of economic importance to Arizona, including solar energy, advanced materials and nanofabrication.	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$1,000,000	\$1,000,000		\$2,000,000
Basic Research	\$670,128	\$870,551		\$1,540,679
Applied Research	\$670,128	\$870,551		\$670,128
Development	\$670,128	\$870,551		\$1,540,679
<b>Total</b>	<b>\$3,010,384</b>	<b>\$3,611,653</b>		<b>\$6,622,037</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	139	142		281
Graduate Students	594	656		1250
Undergraduate Students	274	313		587
Sponsored Project Funding	\$61,102,505	\$76,391,393		\$137,493,898
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	Global Futures Laboratory Programming			
<b>Problem Statement</b>				
<p>The Emergence of the Julie Ann Wrigley Global Futures Laboratory at ASU is rooted in the conviction that we can and must make a meaningful contribution to ensuring a habitable planet and a future in which well-being is attainable for all mankind. This laboratory draws from ASU's deep commitment to use-inspired research, our ongoing work in sustainability and service to the global community in which we live. We are running out of time on many fronts, and need to address problems with urgency, sometimes within only a few years or decades. Water, Energy and Environmental Systems are key drivers to a more sustainable future.</p>				
<b>Program Description</b>				
<p>This laboratory draws from ASU's deep commitment to use-inspired research, our ongoing work in sustainability and service to the global community in which we live. TRIF funding supports multiple programs focused on new energy systems, decisions systems and water related research.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>The Julie Ann Wrigley Global Futures Laboratory leverages the tools and expertise of transdisciplinary research institutes, centers and facilities across ASU to generate new ideas and solve problems. We work in networks and in close exchange with the people affected by problems to combine knowledge and develop solutions on multiple scales. Our New Energy Systems efforts — carbon capture, synthetic fuels, energy transition — have funding opportunities from the Department of Energy (DOE), Carbon Collect and National Science Foundation (NSF). Our Decisions Systems project — complex systems thinking, convergence research, data visualization and modeling — may attract funding from State Department/USGS, Helios Foundation, Rockefeller Foundation and DOE. Our Water research — building on the Action for Water Equity (AWE) NSF award to create a center-level effort — may draw additional investment from the NSF.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>Multiple AZ specific benefits and impacts exist through this programming, including:</p> <ul style="list-style-type: none"> <li><b>New Energy Systems:</b> - Commercializing (manufacture and deployment) of the mechanical trees in Arizona. - Through federal grants and local funding, develop technology, partnerships and investment base to support hydrogen and synthetic fuels industry in Arizona. - Working through partnerships that include, Arizona Thrives, the Navajo Nation, APS, SRP, and local NGOs support the economic transition from coal to alternative energy sources including support to affected communities. - Grow the Just Energy Transition Center as the primary mechanism for creating opportunities for redevelopment in rural and tribal communities.</li> <li><b>Decision Systems:</b> - Leverage and expand recent Decision Theater work involving the integration and analysis of food, energy, and water supply chains to develop a scalable prototype initially focused on Maricopa County with the objective of building economic system reliance able to sustain the Continuity of the Economy (COTE) in the face of significant human-induced or natural disasters (e.g. the consequence of cyberattacks). - Partner with cognizant national topic leaders and integrate the perspectives and data of faculty, State, County, and industry leaders, with the goal to attract approximately \$10 million in funding while establishing Arizona as a U.S. leader in efforts to develop economic resilience and sustain continuity of the economy in the face of major disruptions.</li> <li><b>Water:</b> - Significantly expand ASU water initiatives including western water resilience and innovation ecosystem by engaging more than 100 faculty and attracting \$25 million in external funding with the goal of improving water sustainability and bringing jobs and greater water access and equity to urban and rural communities.</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$0	\$0	\$0	\$0
Applied Research	\$2,643,000	\$2,643,000	\$2,643,000	\$7,929,000
Development	\$1,321,500	\$1,321,500	\$1,321,500	\$3,964,500
<b>Total</b>	<b>\$3,964,500</b>	<b>\$3,964,500</b>	<b>\$3,964,500</b>	<b>\$11,893,500</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	44	46	49	15
Graduate Students	217	228	228	684
Undergraduate Students	148	156	163	467
Sponsored Project Funding	\$25,819,327	\$27,110,293	\$28,465,808	\$81,395,428



# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	Global Futures Laboratory Programming			
<b>Progress Summary</b>				
<p>The Julie Ann Wrigley Global Futures Laboratory has continued to develop and expand programs and initiatives that directly support Arizona communities by examining challenges relevant to our state. The Global Futures Laboratory conducts research, develops solutions and collaborates with state and local organizations as well as with national and global entities to ensure that all Arizonans can thrive, particularly in the face of challenges related to energy, water, food and heat.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>In December 2022, the Arizona Water Innovation Initiative was established with a \$40M investment from the state of Arizona and \$5M from the Virginia G. Piper Charitable Trust to help ensure a secure and resilient water supply for Arizona. This initiative brings together faculty and researchers from across ASU to work with industrial, municipal, agricultural, tribal and international partners to rapidly develop and deploy new approaches and technology for water conservation, infrastructure and reuse. The initiative is advancing this effort through four primary program areas. The Global Center for Water Technology is developing scalable solutions for industrial, municipal and agricultural sectors in Arizona, producing inventions, patents and related startup companies. Advanced Water Observatory and Decision Support Systems is revolutionizing water measurement, modeling and prediction to provide data necessary to identify critical risks and vulnerabilities in hydrologic systems. Impact Water - Arizona is catalyzing community understanding of, engagement and solutions for Arizona's water challenges. Arizona Water for All works with the state's most water-insecure households to improve water security and engagement in water decision-making using community-based participatory approaches. To address pressing energy concerns, the Center for an Arizona Carbon-Neutral Economy submitted a multi-million-dollar NSF proposal to develop a regional clean hydrogen hub. Based at ASU with partnerships at the University of Arizona, Northern Arizona University and Arizona energy providers, the center is reinforcing ASU as a national leader in hydrogen research. ASU has received multiple new grants for hydrogen-related projects, including the engineering of a promising new hydrogen-producing cyanobacterium, and this center is key to actualizing this important next step in clean energy development. As part of ASU's ongoing work in carbon capture technology, the first MechanicalTree(TM), developed in partnership with Carbon Collect LLC, was installed on the Tempe campus in March 2022. The device began field testing in FY 2023 to prove the efficacy of the carbon capture technology that was validated in the lab. Amidst rising temperatures, our Human Biometeorology Laboratory acquired an ANDI manikin (one of 10 in the world) to better study the impacts of heat on humans. This manikin is able to mimic the thermal functions of the human body with sensors and pores that allow it to sweat, generate heat, shiver and breathe. Decision Theater entered a new development phase under the direction of Manfred Laubichler called DT3.0 to expand the facility's ability to help stakeholders design policy decisions.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>Though the scope of the Global Futures Laboratory is truly worldwide, our placement in Arizona allows us the opportunity to identify challenges relevant to the state and not only create solutions but model better outcomes and strategies for the entire world. Our programs dealing with state-centric issues such as water security, energy, food and heat tolerance improve the lives of Arizonians and also contribute to expanding Arizona as a research and innovation destination that is tied to these essential needs.</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$0	\$0		\$0
Applied Research	\$2,768,412	\$2,670,554		\$2,768,412
Development	\$1,384,206	\$1,335,277		\$2,719,483
Total	\$4,152,618	\$4,005,831		\$8,158,449
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	40	55		95
Graduate Students	209	221		430
Undergraduate Students	136	148		284
Sponsored Project Funding	\$30,970,246	\$57,383,206		\$88,353,452
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	MacroTechnology Works Site Development			
<b>Problem Statement</b>				
<p>In developing a strategy for the MacroTechnology Works (MTW) site, we took on the mission "To become the engine of semiconductor and energy materials and device research in the US and a national resource for advancing new technologies to pilot scale." ASU has developed a model to realize this mission, leveraging the MTW site and the unique facilities and equipment available there to enable a collaborative university/startup/industry research model. Defining elements for this model include: strong core facilities for democratized research; small "proprietary" faculty and industry labs for unique toolsets; key corporate partners that enhance our capabilities and engage in joint research; a lease + user fees + research collaboration model that provides options that fit the scale of the partner; and undergraduate, graduate, and employee training.</p>				
<b>Program Description</b>				
<p>The 5 major components of the program are: 1. Strong core facilities provide users with access to capital equipment within the core. This allows industry partners to access non-proprietary toolsets on a fee for service basis, and allows startups and smaller companies access to industry-scale tools. 2. The MTW site has highly configurable space within cleanroom environments that allow small proprietary lab spaces to operate on site. These labs are available as leased spaces for industry partners and are required to also commit to funding research activities. 3. Key corporate partners provide opportunities to enhance access to state of the art tools for materials deposition, etch, and characterization and provide opportunities for industry relevant research activities. 4. Engaging with companies at various scales is enabled via a scalable model that engages partners in leased space, core facilities usage, and research collaboration that provides a win-win opportunity for ASU researchers to participate in value added research that aligns with industry needs. 5. Undergraduate, grad student, and post doc participation in research projects and training on industry relevant tools helps to prepare the next generation semiconductor workforce.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>With recent announcements of new semiconductor fabs being built in the valley, Arizona has an opportunity to become the hub of semiconductor research and innovation in the U.S. ASU has a robust pipeline of semiconductor research and has key partnerships in place to expand the ecosystem in Arizona. ASU researchers engaged in programs at MTW are currently funded at ~\$25 million per year, and we expect federal and industry funding for semiconductors to grow. Our projections are amplified by the federal requests for funding via the CHIPS act which addresses supply chain shortages in the wake of the COVID pandemic. ASU is expecting to participate in a number of large scale opportunities related to manufacturing and supply chain working with Arizona industry partners including a NIST-sponsored Manufacturing USA Institute and a DOD-sponsored National Network for Microelectronics Research and Development.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>There are several impacts to Arizona. Research activities at ASU can be tied directly in intellectual property (IP) generation and oftentimes to startup companies, jobs and wealth creation. ASU is engaged with eight Arizona-based startups at MTW already. Student engagement in research opportunities provides experiential learning and results in better trained employees. With recent announcements of new fab facility construction in the state there is a heavy demand for employees in the semiconductor industry, well beyond the needs within the fabs as suppliers across the supply chain also increase staffing.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$0	\$0	\$0	\$0
Applied Research	\$0	\$0	\$0	\$0
Development	\$1,000,000	\$1,000,000	\$1,000,000	\$3,000,000
Total	\$1,000,000	\$1,000,000	\$1,000,000	\$3,000,000
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	5	5	5	15
Graduate Students	20	20	20	60
Undergraduate Students	0	0	0	0
Sponsored Project Funding	\$30,000,000	\$33,000,000	\$37,000,000	\$100,000,000
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	9	11	12	32

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	MacroTechnology Works Site Development			
<b>Progress Summary</b>				
<p>We continue to work toward becoming a premiere semiconductor, energy materials and device research site in the U.S. and a national resource for advancing new technologies to pilot scale. Notable progress toward this goal includes an expanded partnership between ASU and Applied Materials to create the Materials-to-Fab (MTF) Center at MacroTechnology Works. Developed with the Arizona Commerce Authority, the MTF Center represents a combined investment of \$270M and will provide researchers (including industry partners) access to state of the art semiconductor tools. In addition, our Solar Fab (SF) and Advanced Electronics and Photonics (AEP) Core Facilities have seen continued growth this year. AEP increased overall sales to \$382,108 (32% year-over-year) and served 26 faculty labs at ASU and 16 external entities, with 78 faculty, staff and students using the facilities. SF achieved \$696,418 in sales revenue with 28 internal and 9 external partners. This more than \$1M in combined revenue is a testament to how our core facilities are enabling the innovation ecosystem in Arizona. The MTW site hosts industry lab spaces. This year one of our tenants, Applied Microarrays Inc., exited the facility after they were acquired. We also saw one of our startups graduate from MTW, moving into a larger space to accommodate growth. We currently host two medium- to large-scale enterprises and eight small enterprises.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>We support the ecosystem through a service model that includes access to capital equipment and skilled personnel alongside private leased space. We also partner with industry and academia to pursue research funding opportunities to expand the innovation pipeline, provide students with hands-on experience and bring jobs to Arizona. In addition to the creation of the Materials-to-Fab Center with Applied Materials, MTW has expanded our toolsets and capabilities to support additional partnerships with industry members. For instance, MTW's unique facilities provided the foundation for a new graduate-level electrical engineering class developed by ASU faculty, microelectronics testing equipment company Advantest and chip manufacturer NXP Semiconductors. The course was designed to help meet the increasing demand for semiconductor test engineers and bolster the growing semiconductor industry in Arizona.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<p>Construction delays and semiconductor supply chain challenges have slowed expansion and new capabilities coming online. With CHIPS and Science Act funding just beginning to become available, we are well positioned to take advantage of those opportunities and recently submitted the \$100M Southwest Advanced Prototyping (SWAP) Hub proposal to the DOD MicroElectronics Commons.</p>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>With Intel and TSMC chip plant expansions fueling the growth of the semiconductor industry in Arizona, there is a need for workforce expansion. ASU is leveraging MTW's facilities and capabilities to deliver student training with access to modern toolsets and industry-relevant research opportunities. Through industry partnerships we have also brought significant new investments to the state, such as Applied Materials' commitment of \$200M in new capital and ongoing operations and research commitments.</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$0	\$0		\$0
Applied Research	\$0	\$0		\$0
Development	\$1,001,818	\$1,000,000		\$2,001,818
Total	\$1,001,818	\$1,000,000		\$2,001,818
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	18	16		34
Graduate Students	217	232		449
Undergraduate Students	28	0		28
Sponsored Project Funding	\$17,406,135	\$18,535,741		\$35,941,876
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	8		8

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	Materials of the Universe			
<b>Problem Statement</b>				
Space exploration is now pursued actively in both the private and government sectors. The discovery of complexities in our solar system and of thousands of remarkably diverse exoplanets raises both fundamental and practical questions. To understand planets, we need to combine knowledge from fields ranging from astrophysics to geochemistry to materials science. We need to answer materials-based questions, such as determining the detailed structure, composition and evolution of distant planets based on a few observed properties. At the same time, we need better materials for space exploration — solving problems like finding more sensitive spectroscopic detectors, building more robust space vehicles, and extracting and utilizing extraterrestrial resources.				
<b>Program Description</b>				
The Navrotsky Eyring Center for Materials of the Universe (MotU) addresses the two challenges above — understanding planets and improving materials for space exploration — by an interdisciplinary program involving about 20 faculty from the School of Molecular Sciences (SMS), the School of Earth and Space Exploration (SESE) the Department of Physics, and the School for Engineering of Material, Transport, and Energy (SEMTE). A major thermodynamics and high-temperature materials laboratory has been established by the MotU director, Alexandra Navrotsky, who joined ASU in 2019, and further strengthened by the hire of Professor Hongwu Xu, arriving this fall. Four additional MotU faculty positions are planned in the College of Arts and Sciences, with two searches commencing imminently. A major NSF proposal for a high-pressure center has been submitted, thus adding emphasis to materials under extreme conditions relevant to planetary systems — high temperature, high pressure, radiation fields, etc. Faculty in different fields are co-supervising graduate students. Seminars, courses and workshops have been held and are being developed.				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
ASU has unique strengths in astrophysics, planetary exploration (both orbiters and landers), experimental geochemistry and thermodynamics, electron microscopy and fundamental theory, with a distinguished history of collaboration in solid state science. There are funding opportunities from NSF, DOE, NASA and DOD, and a number of proposals have already been submitted and some funded. A large private gift to support MotU, partly now and partly as a bequest, has been finalized.				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
With growing high tech and space related industries in Arizona, MotU will have increasing opportunities for collaboration with industry. The growing industrial sector will have access to ASU facilities and uniquely trained students who will function at the interface of space science, physical science and engineering.				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$106,667	\$106,667	\$106,667	\$320,000
Applied Research	\$106,667	\$106,667	\$106,667	\$320,000
Development	\$106,667	\$106,667	\$106,667	\$320,000
Total	\$320,000	\$320,000	\$320,000	\$960,000
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	2	2	2	15
Graduate Students	2	2	2	6
Undergraduate Students	0	0	0	0
Sponsored Project Funding	\$381,034	\$400,085	\$420,090	\$1,201,209
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	Materials of the Universe			
<b>Progress Summary</b>				
The Navrotsky Eyring Center for Materials of the Universe (MotU) has made great progress in FY23. The NSF-funded Facility for Open Research in a Compressed Environment (FORCE) center and facility has been established, the renovations of the facility are nearing completion and the first instruments for this one-of-a-kind facility have arrived. MotU also recruited more expert faculty to FORCE in FY23.				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
MotU's FORCE center, which focuses on high-pressure research using unique multi-anvil presses to create pressures that rival those found deep in the earth, provides unique research capabilities to both the ASU and the nation. FORCE is funded by a five-year, \$13.7 million implementation grant from the NSF Midscale Instrumentation Program. The new facility will enable principal investigator Kurt Leinenwebe (now promoted to research professor in the School of Molecular Sciences) and co-PIs Alexandra Navrotsky (promoted to Regents professor this year and this year's recipient of the Czochralski Medal from the European Materials Society), Thomas Sharp, David Smith and Dan Shim to drive transformation and innovation in high-pressure science and lead a research center unlike any other in the U.S., serving investigators at ASU, nationwide and worldwide. A research scientist with extensive multi-anvil press research, Kyusei Tsuno, was recruited, and another staff scientist, Kara Brugman, has also joined FORCE. A major workshop on this topic was held at ASU last January. The many publications produced by MotU in FY23 include important advances in materials for batteries, materials with unusual thermal characteristics, new types of zeolites (materials with cavities that are used industrially in catalysis and separation/purification processes), a deeper understanding of Perovskites (materials with great promise in efficient solar energy applications) and materials that could be useful in the development of new superconductors. In addition to the many practical applications of these materials, this research and particularly the research that will be carried out in FORCE will help us understand in much greater detail what planets are made of and how they form. The extreme pressures and temperatures involved in such processes can be simulated in the new instrumentation, enabling the creation of new models that can be applied to data obtained from planetary observation and analysis.				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
MotU has achieved considerable national and international prominence during its brief existence as evidenced by the awards bestowed upon Professor Navrotsky (including a new material named after her), the creation of FORCE as a national facility at ASU, and the ability to attract new faculty to the center of the highest caliber. This focuses the attention of the materials community, and the associated battery, solar and advanced materials industries on Arizona, making it an increasingly attractive place to locate such activity.				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$70,794	\$96,729		\$167,523
Applied Research	\$70,794	\$96,729		\$70,794
Development	\$70,794	\$96,729		\$167,523
Total	\$212,382	\$290,187		\$502,569
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	6	5		11
Graduate Students	5	7		12
Undergraduate Students	2	0		2
Sponsored Project Funding	\$444,000	\$772,643		\$1,216,643
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	NSF Nanosystems Engineering Research Center for Off-Grid Nanotechnology Enabled Water Treatment (NEWT)			
<b>Problem Statement</b>				
<p>The vision of the Nanosystems Engineering Research Center for Nanotechnology-Enabled Water Treatment Systems (NEWT) is to enable access to water of suitable quality almost anywhere in the world by developing next-generation, easy-to-deploy modular treatment systems enabled by nanotechnology. These efforts both protect human lives and support sustainable economic development.</p>				
<b>Program Description</b>				
<p>NEWT aims to develop new technologies to purify drinking and industrial waters. Initially funded in 2015, we are renewed through 2025. As NEWT approaches self-sufficiency, we are request funding to continue discovery of new treatment technologies that will stimulate the many industrial partners with breakthrough science. This compliments our strong success in industrial members then funding associated projects. Personnel time and material funds will be used to support multiple NEWT faculty on high-risk science that will collect preliminary data for new extramural funding proposals, and funds to demonstrate technology translation using our mobile testbed. The NEWT faculty and student team has been amazingly successful with new patents, start-ups and STTR awards – and having the ability to translate to the testbed has proven essential in these higher TRL endeavors. The NEWT team leads and participates in a broad range of outreach, education and diversity activities.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>ASU has lead recruitment and collaboration with over 25 industrial members of NEWT. Annually these industrial members fund an additional \$1 million at ASU in research through NEWT. The NEWT research has been leveraged to be part of a recent NIH MEMCARE Center with Harvard and Yale, and a new NSF Science and Technology Center to be launched in October 2021. Within NEWT we are on the verge of a new project with the Gates Foundation for reuse of greywater inside homes, and use of the reused water for sanitation. This is considered a high-risk, high-tech solution that Gates is providing to NEWT and considerable follow-on funding and industrial spinouts are expected.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>The industrial members increase visibility of ASU researchers, and are enabling us to recruit even more Arizona-based industrial members who are struggling with on-site water reuse challenges that they must address to meet corporate sustainability goals. Experience by the ASU team in working with industry is demonstrating our ability to solve real-world problems, rapidly, and provide actionable information for companies. Two start-up companies in Arizona related to NEWT technology have advanced funding from NASA and hire employees in Arizona. In addition to working with industry, our technologies are being integrated into water solutions for rural communities to provide clean drinking water. Annually we bring undergraduates from Arizona Community colleges and high school teachers from Arizona into our research labs for organized, paid, summer research experiences.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$35,000	\$35,000	\$35,000	\$105,000
Basic Research	\$0	\$0	\$0	\$0
Applied Research	\$0	\$0	\$0	\$0
Development	\$0	\$0	\$0	\$0
Total	\$35,000	\$35,000	\$35,000	\$105,000
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	4	4	4	15
Graduate Students	19	20	20	60
Undergraduate Students	12	12	13	37
Sponsored Project Funding	\$2,205,548	\$2,315,826	\$2,431,617	\$6,952,991
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	NSF Nanosystems Engineering Research Center for Off-Grid Nanotechnology Enabled Water Treatment (NEWT)			
<b>Progress Summary</b>				
At NEWT, we envision a world where affordable, adequately treated water is accessible to anyone, anywhere. We're working toward this goal by developing transformative, decentralized and modular water treatment systems powered by nanotechnology. Such technology not only protects and promotes human health, but supports economic development. NEWT continues to strive toward self-sufficiency in 2025 by securing government awards and industry funding and applying for patents.				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
Several NEWT technologies have birthed startup companies, most notably H2Optic Insights. The company secured three phases of funding from the NASA Small Business Technology Transfer program to develop optical fiber technologies for chemical-free water disinfection and distributed production of hydrogen or hydrogen peroxide. In addition, funding from the Gates Foundation for an exploratory effort led to a successful proposal for low-energy, chemical-free distributed greywater treatment. NEWT technology to cleanse water of nitrate and per- and poly-fluoroalkyl substances (PFAS) scaled up to pilot systems, which now serve as a catalyst for working with several private companies and the Department of Defense. The visibility and success in developing new water technologies has led to significant funding for the Global Center for Water Technology, part of the Arizona Water Innovation Initiative, which is now leveraging these investments with renewal of a DOE national-scale water center. Our team uses advanced computational techniques and artificial intelligence-based strategies to model and explore possible new material structures that have the potential to more cost-effectively treat pollutants in water.				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
Working with NEWT industry members, we have been exploring how air quality impacts chemicals in water extracted from the air using desiccant or condensation-based collection processes. While the water extracted from the atmosphere is nearly salt free, when used indoors there are considerable organic chemicals found in water — due to cooking and other indoor activities that emit organics into the air. Insights gained during this process are providing valuable feedback cycles to design and develop new atmospheric water extraction technologies that provide cleaner water and reduce the energy required for this process by more than tenfold.				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
The above and other examples demonstrate how fundamental atomistic modeling, material discovery, and integration of nanomaterials into functioning pilot-scale systems can be achieved, and are part of revolutionizing water purification and unlocking access to otherwise unusable water supplies to enable a resilient Arizona water future.				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$35,000	\$35,034		\$70,034
Basic Research	\$0	\$0		\$0
Applied Research	\$0	\$0		\$0
Development	\$0	\$0		\$0
Total	\$35,000	\$35,034		\$70,034
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	7	6		13
Graduate Students	25	22		47
Undergraduate Students	12	8		20
Sponsored Project Funding	\$1,461,643	\$1,326,696		\$2,788,339
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	Research Development			
<b>Problem Statement</b>				
Increasing the diversity, reach, quality and impact of ASU's faculty, staff and student research activities contributes to the strength of our regional economy and improves our national standing in higher education.				
<b>Program Description</b>				
Research Development is responsible for increasing the size of ASU's research enterprise through a community of practice around early positioning and competitiveness of proposals for funding from federal agencies. This is accomplished through strategic intelligence of funding opportunities and improved teaming, outreach and training during research-related events, transparent and equitable management of limited funding opportunities and internal seed grants programs, and professional proposal management for large and complex funding proposals.				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
Research Development is responsible for dissemination of hundreds of limited funding opportunities to the university, providing hundreds of documents in support of strategic decision-making for leaders, bringing together hundreds of researchers to discuss competitive funding solicitations, and supporting millions of dollars' worth of proposals from ASU. This work increases the overall ability of ASU to reach aggressive goals for research expenditures.				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$201,189	\$201,189	\$201,189	\$603,566
Applied Research	\$201,189	\$201,189	\$201,189	\$603,566
Development	\$201,189	\$201,189	\$201,189	\$603,566
Total	\$603,566	\$603,566	\$603,566	\$1,810,698
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	15
Graduate Students	0	0	0	0
Undergraduate Students	3	3	3	9
Sponsored Project Funding	\$40,000,000	\$42,000,000	\$44,100,000	\$126,100,000
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0



# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University
TRIF Investment Area	Water, Environment and Energy Solutions
Program Name	Research Development
<b>Progress Summary</b>	
Overall, Research Development supported almost \$527M across 27 proposals originating from the university. In addition, 103 graphics were produced for 27 proposals, with some of these overlapping with the proposal manager work. In the past year, Research Development hosted 38 events for ASU faculty, students and staff. These events had 1,603 registrations and 990 attendees. Fifteen events focused on highly competitive, national-level programs, while twelve covered best practices of preparing competitive proposals. Research Development also circulates federal funding opportunities via a weekly email newsletter with over 2,000 subscribers.	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
Research Development produced 77 analyses to inform decision-making and proposal strategy for ASU faculty and leadership. Fourteen of these analyses were related to water, energy and environment and directly supported the launch of the STCs/NEIs and the Water Initiative. Both of these programs impact Arizona's regional capacity to organize programs and individuals to diversify the economy and craft a sustainable future. Summary of water, environment and energy solutions activities • Submitted 13 proposals worth approximately \$441M • Won an award worth \$75M from the Department of Energy in support of electrification of manufacturing infrastructure • Hosted an event regarding water, environment and energy solutions with 15 registrations	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
Research Development supported the successful proposal for a \$25M award from the Department of Energy. This award created the Southwest Urban Integrated Field Laboratory, which is working to develop solutions for Arizona's most heat-vulnerable populations. The proposal was submitted in the previous fiscal year and the award begins this coming fiscal year.	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$263,058	\$324,302		\$587,360
Applied Research	\$263,058	\$324,302		\$587,360
Development	\$263,058	\$324,302		\$587,360
<b>Total</b>	<b>\$789,174</b>	<b>\$972,906</b>		<b>\$1,762,080</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	0	0		0
Undergraduate Students	0	0		0
Sponsored Project Funding	\$487,025,000	\$437,000,000		\$924,025,000
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	Skysong Innovations			
<b>Problem Statement</b>				
<p>ASU researchers are tackling some of the world's biggest challenges, from sustainable resources and carbon capture to cancer detection and treatment. Their post-research challenge comes in finding the right partners, strategic investments and experienced entrepreneurial leaders needed to move those innovations into successful commercial application. Skysong Innovations (SI) identifies those technologies with broad potential and coordinates with the right partners to bring these innovations into the marketplace. From pulling water out of thin air to re-engineering a virus to attack cancer, ASU researchers have worked with Skysong Innovations to spin out dozens of companies that have the potential to revolutionize the way we navigate the global challenges of the 21st century.</p>				
<b>Program Description</b>				
<p>SI is ASU's exclusive intellectual property management and technology transfer organization (TTO). Since 2003, SI has provided the ASU research community with the support and expertise needed to turn their research discoveries into commercial opportunities. SI has long been one of the top-performing university TTOs in terms of researcher inventions disclosed, licensing deals signed and startups launched per research dollar. For the third consecutive year, ASU is in the top 10 for U.S. patents issued to U.S. universities — and 11th worldwide — according to an annual ranking of the top universities by the National Academy of Inventors (NAI) and the Intellectual Property Owners Association (IPO). In 2020, ASU was issued 140 U.S. patents, tied with the University of Florida, up from 137 the previous year, and just one spot behind Harvard. Other U.S. universities in the top 10 include MIT, Stanford, and Caltech. Tsinghua University in Beijing was the only non-U.S. university to surpass ASU on the global list.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>SI has worked for years to help ASU startups connect with investors. In that regard, SI regularly interacts with venture-capital firms, angel-investment groups, and other potential investors around the globe to showcase ASU startups and technologies. All told, ASU researchers working with SI have launched more than 170 startups, which in turn have attracted nearly \$1 billion in venture capital and other funding. Because experience has taught us that many investors are wary of giving money to companies led by inexperienced founders, we created a special program called the ASU Startup Mill. The ASU Startup Mill connects ASU companies with successful entrepreneurs and experienced corporate executives who can provide advice, support and even take positions running these startups. In FY21, SI advanced sponsored research providing over \$30 million in funding for ASU, resolving IP and other substantive issues as part of the agreements.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$521,683	\$521,683	\$521,683	\$1,565,049
Applied Research	\$521,683	\$521,683	\$521,683	\$1,565,049
Development	\$521,683	\$521,683	\$521,683	\$1,565,049
Total	\$1,565,049	\$1,565,049	\$1,565,049	\$4,695,148
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	15
Graduate Students	0	0	0	0
Undergraduate Students	0	0	0	0
Sponsored Project Funding	\$0	\$0	\$0	\$0
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	5	5	5	15

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	Skysong Innovations			
<b>Progress Summary</b>				
<p>In FY 2023, SI continued its trend as a highly productive, impactful technology transfer organization. Namely, SI captured 315 new ASU innovations and secured 160 new U.S. patents in FY 2023. Additionally, SI closed 60 new licensing deals — not accounting for many other innovations licensed to industry partners in the context of research collaborations. Within these licensing activities, SI advanced the launch of 21 new startup companies founded on ASU innovations spanning the technological spectrum from high-precision, sustainability-focused polymer production to small-molecule therapeutics for neurodegenerative diseases. Of the 21 new companies, 11 are based in Arizona. Notably, these output levels for innovations, patents, licensing deals and startups have historically placed ASU within the top 10 (and in some instances the top 5) of universities without medical schools, according to data published by the Association of University Technology Managers. According to FY 2021 data published in early 2023, ASU was one of only four such universities to rank in the top 10 across all four categories — ASU, Caltech, MIT and North Carolina State. Compared to its ABOR-identified peer institutions on a per-\$10-million-in-research-expenditures basis, ASU ranked #1 in invention disclosures, #1 in patents, #3 in licensing deals and #1 in startups. FY 2023 also saw continued growth for ASU startup fundraising efforts. The historical running total of venture capital investments and other funding reported by all ASU startups surpassed the \$1.3B mark in FY 2023.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>In FY 2023, SI secured 13 new invention disclosures and four new U.S. patents covering energy innovations, nine new invention disclosures and five new U.S. patents covering water innovations, and 12 new invention disclosures and three new U.S. patents covering other environmental innovations. Overall, SI's productivity in FY 2023 focused on several innovations, patents, licensing deals and startups directed to water, environment and energy solutions. Select FY 2023 examples include ASU startup Precise Polymer (sustainability-focused 3D-printed precision polymers), U.S. patents covering methods of recovering precious metals from wastewater streams (licensed to ASU startup Precient Technologies), nanotechnologies for cleaning water, and energy storage systems; several new invention disclosures concerning innovations that analyze wastewater biomarkers to track disease prevalence, exposure and health at the population level; several new invention disclosures directed to bat ery storage innovations; and ongoing technology transfer activities related to ASU spinout Carbon Collect Ltd. (system that passively removes carbon from air); and multiple new patent applications directed to clean water and energy systems.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>SI commissioned Rounds Consulting Group to perform an economic impact analysis of ASU's technology transfer activities from FY 2014 through FY 2021. The report concluded that SI and ASU-linked companies generated nearly \$2B in economic activity in Arizona alone (including \$684.2M in labor income, \$66.8M in state and local tax revenues, and 10,727 job-years). By FY 2031, Rounds projects the Arizona economic impact will reach \$5.8B (including \$1.3B in labor income, \$133.6M in state and local taxes, and 20,393 job-years). Rounds reported, "The impact of Skysong Innovations reaches all employment industries in Arizona. For example, the 336 direct employees of Skysong Innovations affiliated companies create the demand for 144 manufacturing jobs, 102 information jobs, etc." Other industries expanded include retail (90 jobs), transportation and warehousing (70 jobs), and finance and insurance (58 jobs).</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$521,683	\$521,683		\$1,043,366
Applied Research	\$521,683	\$521,683		\$521,683
Development	\$521,683	\$521,683		\$1,043,366
Total	\$1,565,049	\$1,565,049		\$3,130,098
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	0	0		0
Undergraduate Students	0	0		0
Sponsored Project Funding	\$0	\$0		\$0
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	5	6		11

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	Workforce Development			
Program Name	Corporate Engagement and Strategic Partnerships			
<b>Problem Statement</b>				
ASU is an institution that prioritizes use-inspired research, student experiential learning, student success and community embeddedness. This requires a deep understanding of the needs of the external community and the agility, commitment and will to mobilize university resources to match and problem-solve in real time. ASU's Corporate Engagement and Strategic Partnerships team builds long-term, mutually beneficial partnerships that help Arizona's constituents and the entire U.S. economic ecosystem.				
<b>Program Description</b>				
Corporate Engagement and Strategic Partnerships advances university-wide research and education efforts in key sectors such as semiconductors, sustainability, health futures and workforce development. The program facilitates complex engagements to leverage the abilities of the community, the university and our business collaborators while supporting all stakeholders. Our work is individualized, transformative and impactful to best support all involved, especially Arizona. By expanding and diversifying the workforce, developing novel solutions to complex challenges, and finding innovative approaches to advancing research and development initiatives, Corporate Engagement and Strategic Partnerships infuses ASU's productivity and innovation into the economy through intentional engagement and partnership.				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
ASU's advantage is the university's vast resources and networks across Arizona. Through one-of-a-kind academic-corporate partnerships, corporate collaborators can access ASU's world-class faculty and student talent, cutting-edge research and development, and state-of-the-art facilities. Corporate Engagement and Strategic Partnerships provides partners with an institutional commitment to collaboration, growth and impact on a global scale, coupled with a response time that is required for industry engagement. Anticipated funding opportunities are broad given the different assets and clients we serve. Funding will come in the form of direct industry-sponsored research projects, consortium fees, corporate philanthropy, leases paid in Innovation Zones at ASU, fees for custom academic or non-credit programs and/or federally sponsored research, with corporate partners as supporters or subcontractors.				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
There are significant impacts and benefits to Arizona. The work performed by the Corporate Engagement and Strategic Partnerships team supports economic and community development groups to recruit companies to relocate or expand their business in Arizona. Recent examples include the \$20 billion Intel expansion, \$8 million investment by Applied Materials and the \$32 billion TSMC location to Arizona, creating over 3,000 jobs in the state. We will also create opportunities to increase technological access throughout the state through public-private partnerships with industry giants such as Dell and Verizon, organizations that have prioritized closing the digital divide and providing access to remote and rural areas.				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$0	\$0	\$0	\$0
Applied Research	\$500,000	\$500,000	\$500,000	\$1,500,000
Development	\$500,000	\$500,000	\$500,000	\$1,500,000
Total	\$1,000,000	\$1,000,000	\$1,000,000	\$3,000,000
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	1	1	1	15
Graduate Students	5	6	6	19
Undergraduate Students	2	2	2	6
Sponsored Project Funding	\$107,000	\$112,000	\$118,000	\$337,000
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	Workforce Development			
Program Name	Corporate Engagement and Strategic Partnerships			
<b>Progress Summary</b>				
<p>Corporate Engagement and Strategic Partnerships (CESP) continues to create complex and individual engagements, aligning the strengths inherent across the university, state and regional communities. The resulting workforce, economic and research opportunities benefit all stakeholders, including the broader community. Key highlights</p> <ul style="list-style-type: none"> <li>• The creation of a Materials-to-Fab (MTF) Center with Applied Materials at ASU's Macrotechnology Works, representing a \$270M investment.</li> <li>• Advocated for the ASU Health Technology Center to Phoenix City Council, resulting in approval of \$12M for 2023 Phoenix General Obligation Bond ballot measure.</li> <li>• Aided the \$100M Southwest Advanced Prototype (SWAP) Hub proposal by facilitating 80 letters of support from tribal communities, small businesses, industry giants, economic development organizations, university partners, and state and local governments.</li> <li>• Obtained 40 letters of support from businesses and organizations across Arizona, Utah and Nevada to bolster ASU's Sustainability Innovation Engine of the Southwest proposal. Part of the NSF Engines program, the proposal represents \$160M over ten years and was one of 34 semifinalists moving to the next phase out of 188.</li> <li>• The U.S. Department of Energy selected ASU for \$70M to establish a Clean Energy Manufacturing Innovation Institute to curb greenhouse gas emissions from industrial process heating.</li> <li>• Achieved complete building occupancy of 777 NOVUS at the ASU NOVUS Innovation Corridor with the addition of MSC Logistics, a leader in global supply chain, to the building.</li> <li>• Attracted Planet, a cube satellite and earth imaging company, to open an office at the ASU Walton Center for Planetary Health.</li> <li>• Hosted three New Economy Initiative Microelectronics Industry Council meetings for c-suite executives from local industry leaders. NEI Council advocates for continued investment in the new economy with a focus on workforce development, research and policy needs.</li> <li>• Supported the ASU and Mayo Clinic NIH REACH proposal to create a \$4M Arizona Center of Medical Entrepreneurship.</li> <li>• Facilitated the fourth ASU-Mayo Clinic MedTech Accelerator cohort to advance 9 health care companies from around the world.</li> <li>• Increased collaboration opportunities with two well-established venture capital firms, Plug and Play and Idealab.</li> </ul>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>The CESP team has built and expanded comprehensive and tactical partnerships with key industry partners, including TSMC, Applied Materials, Mayo Clinic and many others, with a focus on serving the people of Arizona and ASU students through projects that promote sponsored research and workforce development. The team has also become increasingly involved in large federal funding opportunities that will increase Arizona's competitiveness in the defense, microelectronics and health fields, which create additional workforce opportunities and economic impact in the state. Work on these federal funding opportunities has resulted in greater collaboration between CESP and the various state economic development organizations, expanding the scope and impact of our projects.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>The Corporate Engagement and Strategic Partnerships team has built a strong network of startups, industry partners, and local economic development organizations to contribute to ASU-led proposals throughout 2023, with a combined total bid amount of almost \$350 million. Comprehensive collaborations and relationships with these organizations will strengthen Arizona's overall competitiveness on the national and global stage. In FY22, the university generated an estimated economic impact of \$4.662 billion on the state's gross product, \$3.205 billion in labor income and 55,712 jobs. ASU also had 17 new company locates at Innovation Zones, including three major commercial tenants.</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$0	\$0		\$0
Applied Research	\$541,262	\$488,894		\$541,262
Development	\$541,262	\$488,894		\$1,030,156
Total	\$1,082,524	\$977,788		\$2,060,312
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	1	1		2
Graduate Students	7	3		10
Undergraduate Students	43	20		63
Sponsored Project Funding	\$174,994	\$5,116,196		\$5,291,190
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	Workforce Development			
Program Name	J. Orin Edson Entrepreneurship + Innovation Institute			
<b>Problem Statement</b>				
Funding is needed to stimulate new collaborations with academic units, provide entrepreneurial training and development opportunities, and to supply the related material resources needed to continue to strengthen Arizona's entrepreneurial community and ecosystem.				
<b>Program Description</b>				
The J. Orin Edson Entrepreneurship + Innovation Institute (Edson E+I) stimulates new collaborations with academic units to add dimension to both the student and faculty experience and development that lead to both personal and professional positive outcomes as well as economic and community development outcomes. Through TRIF funding, we have supported collaborations in business, creative arts enterprises, engineering, health innovation, and sustainability and piloted a number of new initiatives that have since led to additional funding.				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
Edson E+I believes in ASU's charter of excellence with inclusion and impact at scale and its design aspirations including valuing entrepreneurship. Edson E+I supports over 50,000 square feet of place-based innovation spaces across five locations. These spaces provide co-working, events and exhibitions, and amenities spaces for emerging ventures and community-based partners including entrepreneur support organizations to convene, network, and strengthen the entrepreneurial community and ecosystem. With academic collaborations, entrepreneurial training and development, and a place-based innovation spaces network as continued resources, Edson E+I has raised \$40.4 million in additional funding including two endowed funds of \$11.5 million over the last five years.				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$0	\$0	\$0	\$0
Applied Research	\$400,000	\$400,000	\$400,000	\$1,200,000
Development	\$400,000	\$400,000	\$400,000	\$1,200,000
Total	\$800,000	\$800,000	\$800,000	\$2,400,000
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	15
Graduate Students	2	2	2	6
Undergraduate Students	6	7	7	20
Sponsored Project Funding	\$3,508,580	\$3,684,009	\$3,868,209	\$11,060,798
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	Workforce Development			
Program Name	J. Orin Edson Entrepreneurship + Innovation Institute			
<b>Progress Summary</b>				
<p>The J. Orin Edson Entrepreneurship + Innovation Institute (Edson E+I) operates place-based Innovation Spaces across the greater Phoenix area, providing collaborative workspaces and programming for ASU and the greater community. TRIF funding supports operational needs across the five locations including 850 Phoenix Bioscience Core, 1951@SkySong in Scottsdale, ASU Chandler Innovation Center, Fusion on First in Phoenix, and The Studios @ Mesa City Center. In FY 2023, the institute supported 1,137 events and served 1,017 aspiring entrepreneurs and entrepreneurs. Signature events within the network include Pitch-In, a community pitch event, and Coffee+Conversations, a networking and idea sharing series. Additionally, our Community Managers developed a monthly newsletter that reaches over 1,400 subscribers.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>Our place-based network provides support to entrepreneurs at all stages through training, development and mentorship. Our five locations underpinned our efforts to strengthen entrepreneurship in Arizona in a variety of ways. 850PBC plays a significant role in supporting health care entrepreneurs, including hosting the Health Entrepreneurship Accelerator Lab and ASU Mayo MedTech Accelerator. These collaborative efforts across Edson E+I, Edson College of Nursing and Health Innovation, the College of Health Solutions and Mayo Clinic exemplify an interdisciplinary approach to entrepreneurship and innovation in healthcare. 1951@SkySong serves as the main hub for the Venture Devils program, with over 1000 engaged ventures. In FY23, the program has awarded a total of \$610K to 60 unique ventures. This funding has been made possible through the support of stakeholders, university partners and philanthropic funds. Collaborating with the City of Chandler, Edson E+I has supported local entrepreneurs through a series focusing on marketing and funding, culminating in a pitch competition. The success of these efforts has contributed to the anticipated Incubation program to be funded by the City of Chandler. Fusion on First, in collaboration with Education Outreach and Student Services and the Herberger Institute of Design and the Arts, hosted 9 Entrepreneurs in Residence. This program provided an immersive opportunity for industry leaders to provide development opportunities to students. The space also expanded its operational team to support increased activation and student-centered programming. The Studios @ Mesa City Center, since opening in August 2022, has held 166 programs with 37 programs initiated by Edson E+I surpassing the City of Mesa's initial goal of 25 Edson E+I-initiated programs. It has hosted 37 community organizations, creating an inclusive environment for entrepreneurial activities.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>Edson E+I provides its space network free of charge to ASU and our communities, resulting in increased engagement and activation. This has led to \$275K in incubator program funding, developing an ecosystem assessment for Downtown Mesa Innovation District, and submitting proposals to NIH and NSF totaling more than \$1M alongside academic partners. Working with music industry leaders, a need for commercial opportunities was identified. Licensing and distribution processes have been established, potentially allowing ASU and its students to collect performance royalties through a revenue sharing agreement. Edson E+I leaders actively engage with local organizations (AZ NASPA, ACA Venture Ready, National Association of Women Business Owners-Phoenix Chapter, Young Entrepreneurs Academy) and national consortiums (Global Consortium of Entrepreneurship Centers, National Commission for Competitiveness) to continue to identify opportunities and foster a thriving entrepreneurial community.</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$0	\$0		\$0
Applied Research	\$399,012	\$493,755		\$399,012
Development	\$399,012	\$493,755		\$892,767
Total	\$798,024	\$987,510		\$1,785,534
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	0	1		1
Undergraduate Students	53	65		118
Sponsored Project Funding	\$11,520,000	\$15,250,001		\$26,770,001
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	Workforce Development			
Program Name	Research Development			
<b>Problem Statement</b>				
Increasing the diversity, reach, quality and impact of ASU's faculty, staff and student research activities contributes to the strength of our regional economy and improves our national standing in higher education.				
<b>Program Description</b>				
Research Development is responsible for increasing the size of ASU's research enterprise through a community of practice around early positioning and competitiveness of proposals for funding from federal agencies. This is accomplished through strategic intelligence of funding opportunities and improved teaming, outreach and training during research-related events, transparent and equitable management of limited funding opportunities and internal seed grants programs, and professional proposal management for large and complex funding proposals.				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
Research Development is responsible for dissemination of hundreds of limited funding opportunities to the university, providing hundreds of documents in support of strategic decision-making for leaders, bringing together hundreds of researchers to discuss competitive funding solicitations, and supporting millions of dollars' worth of proposals from ASU. This work increases the overall ability of ASU to reach aggressive goals for research expenditures.				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
ASU's research portfolio directly impacts the regional economy and contributes to ASU's national ranking among institutions of higher education.				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$60,306	\$60,306	\$60,306	\$180,917
Applied Research	\$60,306	\$60,306	\$60,306	\$180,917
Development	\$60,306	\$60,306	\$60,306	\$180,917
Total	\$180,917	\$180,917	\$180,917	\$542,751
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	15
Graduate Students	0	0	0	0
Undergraduate Students	3	3	3	9
Sponsored Project Funding	\$40,000,000	\$42,000,000	\$44,100,000	\$126,100,000
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0



# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	Workforce Development			
Program Name	Research Development			
<b>Progress Summary</b>				
Overall, Research Development supported almost \$527M across 27 proposals originating from the university. In addition, 103 graphics were produced for 27 proposals, with some of these overlapping with the proposal manager work. In the past year, Research Development hosted 38 events for ASU faculty, students and staff. These events had 1,603 registrations and 990 attendees. Fifteen events focused on highly competitive, national-level programs, while twelve covered best practices of preparing competitive proposals. Research Development also circulates federal funding opportunities via a weekly email newsletter with over 2,000 subscribers.				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
Research Development produced 77 analyses to inform decision-making and proposal strategy for ASU faculty and leadership. Several of these analyses contributed to strengthening partnerships and increasing competitiveness for ASU-led teams applying to the Economic Development Authority's request for Technology Hub designation and to the National Science Foundation Regional Innovation Engine. ASU is currently a public finalist in the latter program, which is an opportunity worth \$160M. The team has also produced analyses on topics that are highly relevant to Arizona's regional economy and workforce, including community youth, Native American research centers, housing and homelessness, energy, water research, and the New Economy Initiative. Research Development events highlight how research funding can be used to promote workforce development for students and faculty, as well as beyond the walls of the university. These events include the National Science Foundation (NSF) Research Traineeship, multiple early career funding programs, NSF Mid-Career Advancement, NSF Major Research Instrumentation and NSF Major Research Infrastructure programs. ASU continues to win awards in these programs that support the training and education of the next generation of scientists, engineers and other highly skilled workers. Furthermore, these awards support facilities development; they directly increase the capacity and impact of ASU's Core Research Facilities, which also benefits Arizona's community of practitioners and companies. Summary of workforce activities • Submitted 11 proposals worth approximately \$81M were submitted • Won award worth almost \$6M to support the training of rural Arizona nurse educators • Hosted 32 events relevant to workforce development with 1,427 registrations				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
As a university-level office, Research Development works across all campuses to support development of strategy and proposals for funding. As part of that work, we work closely with representatives from local communities, government and industry to design and deliver compelling proposals that, when awarded, will cultivate expertise and expand resources for Arizona's continued benefit. Research Development supported a \$90.8M award from the National Science Foundation for the construction of the first compact X-ray free electron laser; parts of this award will be used to train the next generation of Arizona scientists and engineers.				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$78,851	\$97,209		\$176,060
Applied Research	\$78,851	\$97,209		\$78,851
Development	\$78,851	\$97,209		\$176,060
Total	\$236,553	\$291,627		\$528,180
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	0	0		0
Undergraduate Students	0	0		0
Sponsored Project Funding	\$212,078,593	\$84,895,000		\$296,973,593
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	Workforce Development			
Program Name	Skysong Innovations			
<b>Problem Statement</b>				
<p>ASU researchers are tackling some of the world's biggest challenges, from sustainable resources and carbon capture to cancer detection and treatment. Their post-research challenge comes in finding the right partners, strategic investments and experienced entrepreneurial leaders needed to move those innovations into successful commercial application. Skysong Innovations (SI) identifies those technologies with broad potential and coordinates with the right partners to bring these innovations into the marketplace. From pulling water out of thin air to re-engineering a virus to attack cancer, ASU researchers have worked with Skysong Innovations to spin out dozens of companies that have the potential to revolutionize the way we navigate the global challenges of the 21st century.</p>				
<b>Program Description</b>				
<p>SI is ASU's exclusive intellectual property management and technology transfer organization (TTO). Since 2003, SI has provided the ASU research community with the support and expertise needed to turn their research discoveries into commercial opportunities. SI has long been one of the top-performing university TTOs in terms of researcher inventions disclosed, licensing deals signed and startups launched per research dollar. For the third consecutive year, ASU is in the top 10 for U.S. patents issued to U.S. universities — and 11th worldwide — according to an annual ranking of the top universities by the National Academy of Inventors (NAI) and the Intellectual Property Owners Association (IPO). Other U.S. universities in the top 10 include MIT, Stanford, and Caltech. Tsinghua University in Beijing was the only non-U.S. university to surpass ASU on the global list. In FY20, ASU researchers working with SI continued to set new benchmarks, submitting 306 invention disclosures and launching 19 new startups. ASU startups also raised more than \$120 million in external funding in FY20.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>SI has worked for years to help ASU startups connect with investors. In that regard, SI regularly interacts with venture-capital firms, angel-investment groups, and other potential investors around the globe to showcase ASU startups and technologies. All told, ASU researchers working with SI have launched more than 170 startups, which in turn have attracted nearly \$1 billion in venture capital and other funding. Because experience has taught us that many investors are wary of giving money to companies led by inexperienced founders, we created a special program called the ASU Startup Mill. The ASU Startup Mill connects ASU companies with successful entrepreneurs and experienced corporate executives who can provide advice, support and — in some cases — even take positions running these startups. SI is also the ASU lead behind the ASU-Mayo MedTech Accelerator, which brings together the recognized world leader in patient care, education, and research.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>SI has annually commissioned the Seidman Research Institute to perform an economic impact analysis of ASU's tech transfer activities. The most recent report found that during the time period 2016-2020, as a result of the operations of SI and the Arizona-based ASU-linked companies, Arizona's economy gained a cumulative: • \$717.8 million in gross state product • \$477.9 million in labor income • 7,059 job years • \$64 million in state and local tax revenues By 2025, Seidman projects the economic impact of SI and these ASU-linked companies will exceed \$2.3 billion, with the vast majority of that impact in Arizona.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$19,466	\$19,466	\$19,466	\$58,397
Applied Research	\$19,466	\$19,466	\$19,466	\$58,397
Development	\$19,466	\$19,466	\$19,466	\$58,397
Total	\$58,397	\$58,397	\$58,397	\$175,192
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	15
Graduate Students	0	0	0	0
Undergraduate Students	0	0	0	0
Sponsored Project Funding	\$0	\$0	\$0	\$0
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	5	5	5	15

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	Workforce Development			
Program Name	Skysong Innovations			
<b>Progress Summary</b>				
<p>In FY 2023, SI continued its trend as a highly productive, impactful technology transfer organization. Namely, SI captured 315 new ASU innovations and secured 160 new U.S. patents in FY 2023. Additionally, SI closed 60 new licensing deals — not accounting for many other innovations licensed to industry partners in the context of research collaborations. Within these licensing activities, SI advanced the launch of 21 new startup companies founded on ASU innovations spanning the technological spectrum from high-precision, sustainability-focused polymer production to small-molecule therapeutics for neurodegenerative diseases. Of the 21 new companies, 11 are based in Arizona. Notably, these output levels for innovations, patents, licensing deals and startups have historically placed ASU within the top 10 (and in some instances the top 5) of universities without medical schools, according to data published by the Association of University Technology Managers. According to FY 2021 data published in early 2023, ASU was one of only four such universities to rank in the top 10 across all four categories — ASU, Caltech, MIT and North Carolina State. Compared to its ABOR-identified peer institutions on a per-\$10-million-in-research-expenditures basis, ASU ranked #1 in invention disclosures, #1 in patents, #3 in licensing deals and #1 in startups. In addition to marking the launch of 21 new ASU startups, FY 2023 also saw continued growth for ASU startup fundraising efforts. The historical running total of venture capital investments and other funding reported by all ASU startups surpassed the \$1.3B mark in FY 2023.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>Each year, SI advances several chains of events that generate Arizona economic impact from innovations created at ASU. Each chain of events begins with ASU creating innovations of potential benefit to society, the majority of which are conceived in Arizona. Next, SI secures patent protection for ASU innovations over a multi-year process before the U.S. Patent Office. While SI works to secure patent protection, it executes strategic marketing campaigns and closes licensing deals with industry partners. Those industry partners then attempt to bring ASU innovations to market. In today's technology commercialization landscape, new startup companies are a preferred vehicle for de-risking early-stage innovations by moving them deeper into product development. As a result, each year SI advances the launch of many new startup companies founded to commercialize ASU innovations. After doing so, SI helps connect the ASU startups with management candidates and fundraising opportunities. When a startup secures funding, the chain of events that began with ASU innovation culminates in local economic impact as the company creates new jobs and contributes to the Arizona economy.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>SI commissioned Rounds Consulting Group to perform an economic impact analysis of ASU's technology transfer activities from FY 2014 through FY 2021. The report concluded that SI and ASU-linked companies generated nearly \$2B in economic activity in Arizona alone (including \$684.2M in labor income, \$66.8M in state and local tax revenues, and 10,727 job-years). By FY 2031, Rounds projects the Arizona economic impact will reach \$5.8B (including \$1.3B in labor income, \$133.6M in state and local taxes, and 20,393 job-years). Rounds reported, "The impact of Skysong Innovations reaches all employment industries in Arizona. For example, the 336 direct employees of Skysong Innovations affiliated companies create the demand for 144 manufacturing jobs, 102 information jobs, etc." Other industries expanded include retail (90 jobs), transportation and warehousing (70 jobs), and finance and insurance (58 jobs).</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$19,466	\$19,466		\$38,932
Applied Research	\$19,466	\$19,466		\$19,466
Development	\$19,466	\$19,466		\$38,932
Total	\$58,398	\$58,398		\$116,796
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	0	0		0
Undergraduate Students	0	0		0
Sponsored Project Funding	\$0	\$0		\$0
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	3	3		6

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	Workforce Development			
Program Name	The Luminosity Lab			
<b>Problem Statement</b>				
<p>The current university systems within the United States lack effective student engagement models that provide undergraduate students with meaningful applied research and development opportunities. Opportunities, when they do exist for undergraduates, are often not relevant to the technical and real challenges of the 21st century. As a result, the United States stands to lose its position as the world leader in innovation and R&amp;D.</p>				
<b>Program Description</b>				
<p>Having designed and successfully launched The Luminosity Lab, a novel model of student-led research and development, Luminosity now aspires to launch a consortium, in which ASU-powered Luminosity labs will be chartered at academic institutions around the country. These labs, powered by ASU, will engage exceptional talent at each hosting institution within our unique model of student-led R&amp;D to focus on moonshot projects and impacting society. These labs will scale ASU's access to student talent, corporate partners and academic institutions across the globe.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>ASU will retain the IP generated throughout the network and serve as the prime recipient of all sponsored research that is executed within the consortium. This model, which is the first of its kind, will scale ASU's patent numbers and sponsored research dollars exponentially. This embedded model is net revenue generating and funded pilots are underway. Each new lab will bring in resources to offset its costs. However, the program will require initial investment to get established and support staffing requirements.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>This nationwide program will be powered by ASU and its home base will be established within Arizona. Arizona and ASU will benefit tremendously from the expansion of the brand, as well as the resulting IP, talent and corporate partnerships. Our hope is to make Arizona the home for all spinout companies that are generated from this national innovation network.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$166,667	\$166,667	\$166,667	\$500,000
Applied Research	\$166,667	\$166,667	\$166,667	\$500,000
Development	\$166,667	\$166,667	\$166,667	\$500,000
Total	\$500,000	\$500,000	\$500,000	\$1,500,000
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	15
Graduate Students	1	1	1	4
Undergraduate Students	12	13	13	38
Sponsored Project Funding	\$139,851	\$146,844	\$154,186	\$440,881
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	Workforce Development			
Program Name	The Luminosity Lab			
<b>Progress Summary</b>				
<p>During FY 2023, Luminosity experienced comprehensive expansion, achieved significant goals and delivered innovative solutions to both internal and external clients. We've extended our reach globally, with operational labs located in Ghana, Boston and a Historically Black College in Jackson, Tennessee. We've become one of the university's principal collaborators with corporate partners, providing research and development solutions to 10 major partners this year alone, and cumulatively serving the unique needs of over 40 corporate partners. Furthermore, our student achievements led to a \$15M endowment for a new scholarship program. Through our TRIF funding, Luminosity has grown and gained wider recognition, winning global innovation challenges, most recently including Red Bull's Global Innovation Challenge, and becoming finalists twice in NASA's highly competitive Big Idea Challenge. Furthermore, our students have collaborated with university faculty and provided solutions for and worked with top ASU units and departments, strengthening the interdepartmental ties within the university.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>Luminosity is addressing insufficient effective student engagement models and relevant research and development opportunities for undergraduates in a variety of ways. We provide funded undergraduate research opportunities, supporting about 100 student researchers and academic scholars. This year, our students were involved in more than 30 unique research and development efforts. These projects have mirrored the technical and real challenges of the 21st century, creating an authentic, impactful and useful learning environment. Furthermore, Luminosity has increased its global outreach with operational labs in various locations worldwide to engage students in international research collaboration. These global interactions also ensure that students are exposed to diverse perspectives and challenges, increasing the relevancy of their research. Engagement with industry has been another significant aspect of addressing the problem statement. Luminosity has served over 40 corporate partners to date, including 10 partners this year, providing students with exposure to industry-related challenges and career-relevant learning experiences. Lastly, Luminosity has prioritized creating tangible, innovative solutions, and has developed several unique software and analytics solutions and hardware systems. We filed provisional patents on some of these solutions, one of which has resulted in ASU's first commercial spinout in Large Language Models.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>Our work has led to a high-potential startup company that will be located in Arizona and which will work to hire local talent. Our work for corporate partners helped serve many local companies, including Axon Technologies, local startup TouchPoint Solutions, Blue Cross Blue Shield of Arizona, Bank of the West's regional office, DataVault, Phoenix Children's Hospital, Paradise Valley City Council and the Rodel Foundation. This work includes the development of a substantial Arizona Futures Simulator which will be able to simulate Arizona future outcomes through what-if analysis.</p>				
<b>Additional Notes</b>				
Doesn't include our funded work through foundation.				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$169,365	\$163,398		\$332,763
Applied Research	\$169,365	\$163,398		\$169,365
Development	\$169,365	\$163,398		\$332,763
Total	\$508,095	\$490,194		\$998,289
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	3	3		6
Undergraduate Students	33	47		80
Sponsored Project Funding	\$990,000	\$2,541,241		\$3,531,241
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Arizona State University			
TRIF Investment Area	Workforce Development			
Program Name	Vice President for Research			
<b>Problem Statement</b>				
When faculty are developing proposals, evaluation plans are often required, yet many faculty do not have the expertise to create a comprehensive and competitive evaluation component. However, having a well-developed evaluation plan aligned with educational and broader impact goals is an essential component needed to secure funding for sponsored projects.				
<b>Program Description</b>				
CREST (College Research and Evaluation Services Team) within the ASU Knowledge Enterprise provides technical assistance and evaluation planning at the pre-award stage at no cost to faculty members and staff. CREST includes three full-time evaluation professionals with advanced degrees, graduate level training in evaluation and global experiences in evaluation methods. Expertise includes quantitative and qualitative analysis data collection for needs assessments, implementation and impact evaluations. CREST currently supports the evaluation of 29 projects totaling over \$50 million in funding from the National Science Foundation, U.S. Department of Education, National Institutes of Health, the ASU Foundation, and state and national philanthropic organizations.				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
CREST completed evaluation sections of 59 grant proposals over FY21. This same level of work is expected in FY22. The total potential revenue generated through funding if all grants were awarded would be over \$25 million.				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
With the grant funding on projects, the overwhelming majority need to provide educational services to K-16 students. These students primarily reside within Arizona and receive free, high-quality educational outreach they may otherwise not have had available. K-12 teachers from Arizona also have opportunities to participate in paid professional development to increase their pedagogical skills and technical knowledge to bring back to their classrooms.				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$0	\$0	\$0	\$0
Applied Research	\$140,000	\$140,000	\$140,000	\$420,000
Development	\$140,000	\$140,000	\$140,000	\$420,000
Total	\$280,000	\$280,000	\$280,000	\$840,000
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	15
Graduate Students	0	0	0	0
Undergraduate Students	100	105	110	315
Sponsored Project Funding	\$362,414	\$380,535	\$399,562	\$1,142,511
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Arizona State University			
TRIF Investment Area	Workforce Development			
Program Name	Vice President for Research			
<b>Progress Summary</b>				
Over the course of FY 2023, CREST assisted with 60 proposals by providing evaluation plans free of charge to faculty. Proposals were submitted to the National Science Foundation, National Institutes of Health, USAID, U.S. Department of Education, U.S. Department of Energy, Department of Defense, National Oceanic and Atmospheric Administration, Arizona Department of Education, Arizona Governor's Office and internal ASU grants. Further, CREST supports the evaluation of 39 grants within ASU, three grants at other institutions (Mesa Community College, University of Pennsylvania and Stanford University), and one grant with a community partner.				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
CREST participated in the evaluation of multiple NSF grants, evaluating the broader impacts of their programs on K-12 students. Programs included an NSF-sponsored foldable robotics class for high school students (N=19), Department of Defense BioSense biotechnology program for high school students (N=52), NSF-funded YouthLeaders high school program examining global warming and gaming (N=12), and NSF-funded program ImageSTEAM examining artificial intelligence for middle school students (N=27).				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
CREST examined programs directly supporting undergraduate success in STEM programs by providing evaluation support. These programs are designed to provide students with hands-on research experiences, increasing their knowledge and skills in the field and their motivation to pursue a STEM career. Evaluation projects examining broadening impact for post-secondary Arizona students included NIH Environmental Health Sciences summer research programs (N=8), NSF Research Experiences for Undergraduates (N=14), and NSF International Research Experiences (N=12). CREST also worked with programs across campus that assist first-generation and high-financial-need college students with academic, social and financial support. These include the NSF Scholarships in Science, Technology, Engineering, and Math (S-STEM) (N=28), U.S. Department of Education's College Assistance Migrant Program (CAMP) (N=32), and the Work+ program (N=400). The evaluation work provides feedback that increases the effectiveness of programs that help first-generation college students to be retained and graduate from ASU. In addition, Arizona teachers participated in NSF Research Experiences for Teachers in summer labs across ASU (N=9), Department of Defense BioSense program for teaching biotechnology (N=14), and an NSF ImagineSTEAM artificial intelligence computing professional development program in coordination with the middle school program (N=6). Now in its second year, CREST oversaw the evaluation of the Presidential Scholars Graduate Assistantship (PGA) and Post-doctoral Fellowship (PPF) programs, a merit-based program to recruit and mentor BIPOC doctoral students who have great potential to move on to advanced academic and private sector careers. This initiative encourages career growth and professional development of underrepresented graduate-level students. The evaluation provided data back to the President's Office with recommendations for continuing best practices and decreasing barriers for the cohort.				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$0	\$0		\$0
Applied Research	\$126,753	\$164,763		\$126,753
Development	\$126,753	\$164,763		\$291,516
Total	\$253,506	\$329,526		\$583,032
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	10	0		10
Graduate Students	152	0		152
Undergraduate Students	62	24		86
Sponsored Project Funding	\$450,854	\$1,824,571		\$2,275,425
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

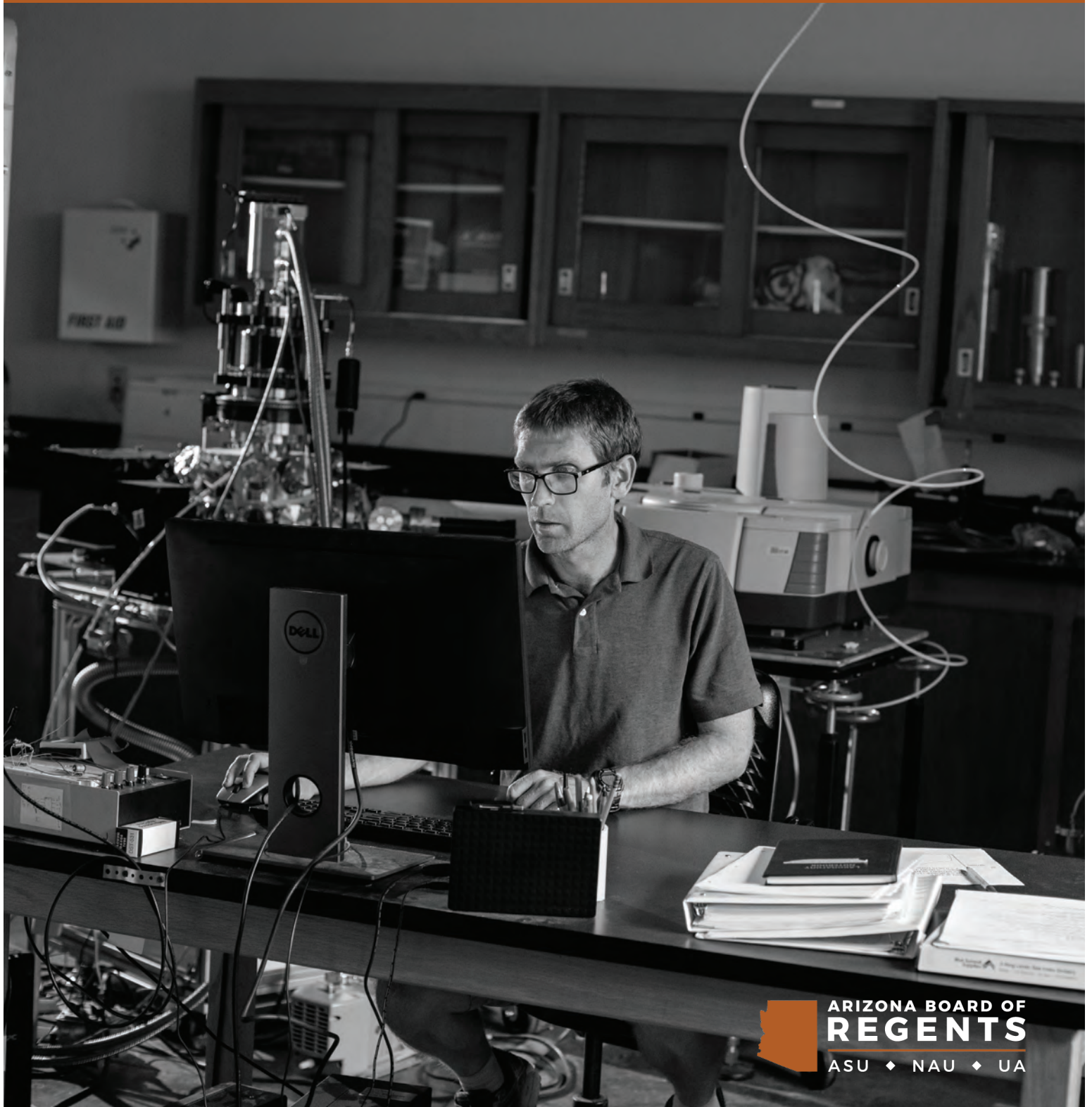




# TECHNOLOGY AND RESEARCH INITIATIVE FUND

NORTHERN ARIZONA UNIVERSITY

FISCAL YEAR 2023





## EXECUTIVE SUMMARY

Northern Arizona University has used TRIF to produce economic benefits through scientific advancements, workforce training and enabling access to higher education for all Arizonans. TRIF funding has provided the foundation for NAU to strategically invest in workforce development opportunities, attract new external research programs, and enable high impact experiential opportunities for students to conduct both basic and applied research. NAU's accomplishments in research enhance the reputation of the state while addressing critical issues facing the world today.

Through competitive externally funded grants, research remains a significant growth engine for NAU that supports the university's mission. At the same time, faculty-led research projects continue to offer a pathway for intellectual growth of students, provide learning opportunities that enable students to secure better jobs, generate economic growth for communities and improve the lives of Arizona's citizens.

TRIF has also enhanced NAU's educational programming and ability to prepare its students to be complex problem solvers, addressing the workforce needs of today and an increasingly diversified workforce for the future. NAU is dedicated to impactful research that expands opportunities for undergraduate learning.

Researchers in the Pathogen Genomics program joined with statewide partners to form the Arizona Valley Fever consortium and coordinated their research to understand, prevent, and treat this disease of concern, as well as mentoring over sixty undergraduates over the past year. Investigators in our Solar System Science and Exoplanets program conducted a student-led program which delivered a camera that was designed and built by undergraduates for inclusion on a future spaceflight to Mars.

Additionally, researchers in our Community Health Research program were awarded two center proposals (the Center for Native American Health Equity and renewal of the Southwest Health Equity Research Collaborative or SHERC), which together represent more than \$25M in new sponsored research funding to NAU and similarly provide experiential learning opportunities for many students. Investment into NAU's TRIF has consistently generated a positive impact for the state.

- The iHealth initiative has empowered NAU to make discoveries in the lab, in the clinic, and the public health arena that has elevated our translational research capabilities, enabling NAU researchers to better understand and be prepared for outbreaks of pathogens facing the world.
- The NSS initiative has established NAU as a leader in the critical areas of cybersecurity and cyber solutions, developing new technologies to protect Arizona's businesses and consumers.
- The AWD initiative supports online and in-person statewide programs and services, workforce training, and lifelong learning, with the aim of fostering students' economic mobility. It resulted in the identification, development, and in some cases delivery of degree



and certificate programs and workforce development programming, informed by regional business and industry needs and occupational outlook analyses. These high-quality programs are intentionally designed with learning outcomes responsive to the workforce needs of communities across Arizona.

- The WEES initiative leverages regional resources in Northern Arizona and historical strengths of the institution to pursue research of the environment and sustainability and has enhanced NAU's leadership position in forestry, land management, and climate science.
- The SPACE initiative leverages the wealth of astronomical resources in Northern Arizona and throughout the state at partner institutions to prepare a workforce that will strengthen Arizona's stature as a worldwide leader in this burgeoning area of research.





NAU invested 80% of its FY 2023 TRIF funds to access and workforce development projects. NAU also invested 17% of its TRIF funds in targeted research toward improving health and finding solutions in water, environment, and energy. The research dollars were used mainly (14 million) to support research infrastructure.

These investments generated \$50.6 million in outside related sponsored project funding, and supported 8,559 graduate and undergraduate students.

Exhibit NAU.1: FY 2023 NAU Base Allocation Expenditure Summary

**\$15,973,002**  
Proposal 2023

2023 Proposal vs Actual

● Proposal 2023 ● Actual 2023

**\$15,570,341**  
Actual 2023

Northern Arizona University



Proposal 2023 and Actual 2023 by Investment Area

● Actual 2023 ● Proposal 2023



Table NAU.1: FY 2023 TRIF Expenditures by Investment Area

InvestmentArea	Proposal 2023	Actual 2023	Budget Delta
Improving Health	\$1,836,923	\$1,128,021	\$708,902
National Security Systems	\$381,978	\$79,486	\$302,492
Space Exploration and Optical Solutions	\$715,467	\$416,060	\$299,407
Water, Environment and Energy Solutions	\$1,934,434	\$1,538,929	\$395,505
Workforce Development	\$11,104,200	\$12,407,845	(\$1,303,645)
<b>Total</b>	<b>\$15,973,002</b>	<b>\$15,570,341</b>	<b>\$402,661</b>

Exhibit NAU.1: FY 2023 TRIF Revenue and Expenditures by Investment Area and Initiative (\$ Millions)

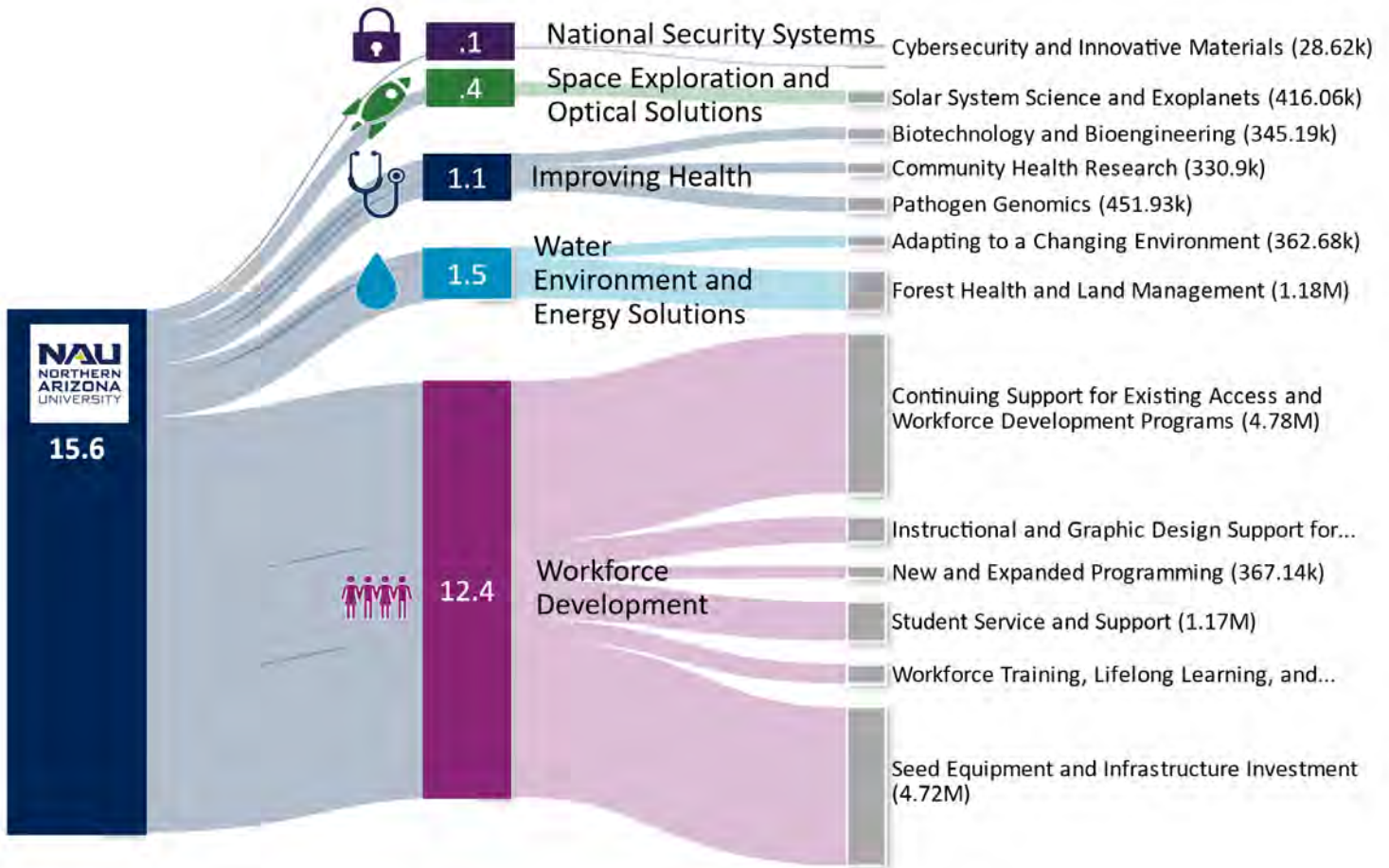


Table NAU.2: FY 2023 Performance Measures

Measures	2023 Projections	2023 Actuals
Faculty Startup Package Expenses	1,032,500	771,579
Postdocs Supported	38	32
Graduate Students	2,573	2,076
Undergraduate Students	5,367	6,483
Sponsored Project Funding	\$27,014,081	\$50,572,385
Publications in Academic Peer-Reviewed Journals	343	442
Startups	0	0

Exhibit NAU.2: FY 2023 TRIF Expenditure by Research Category (in millions)

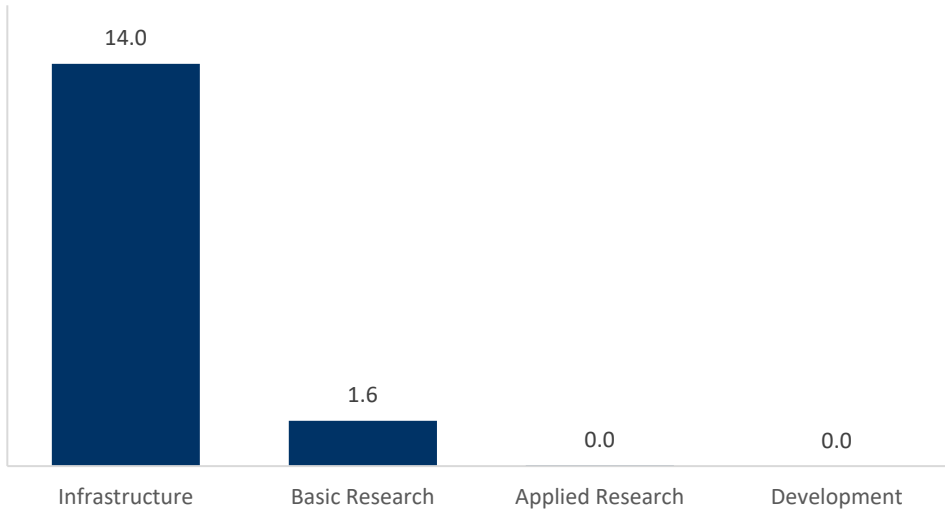
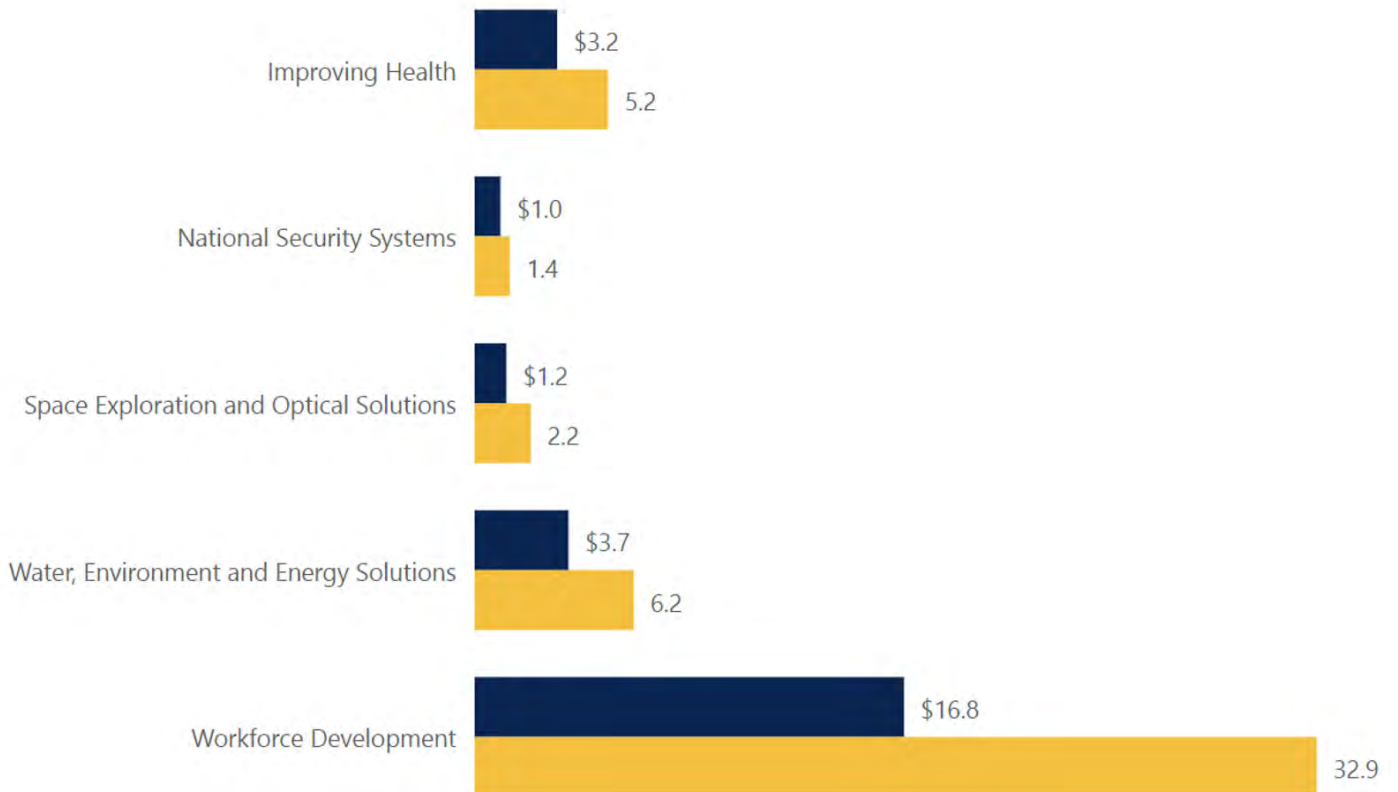


Exhibit NAU.3: FY 2023 – FY 2023 Cumulative Expenditures vs 3 Year Proposals

### 2023 Proposal vs Actual

● 2 Year Actual ● 3Yr Proposal







# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Northern Arizona University			
TRIF Investment Area	Improving Health			
Program Name	Biotechnology and Bioengineering			
<b>Problem Statement</b>				
<p>The Challenge: Developing new technologies to address critical medical needs of Arizona and the nation. The need for innovative solutions to medical problems is ever-present in society. Arizona has significant areas of medical need common to our civilian and veteran populations. As a single example, the NIH has dedicated programs to spur the development of tools and rehabilitation strategies to prevent ambulatory decline in aging populations, and the DoD has a need for similar technologies to aid human performance of service members and recovery of injured veterans. Technologies that respond to current and emergent needs of civilians that are also positioned to serve the needs of deployed military and injured veterans represent highly at ractive investment areas for the state.</p>				
<b>Program Description</b>				
<p>The Bioengineering and Biotechnology initiative is supported by a recently established PhD program in Bioengineering and by researchers in diverse departments, including Biological Sciences, Applied Physics &amp; Materials Sciences, Chemistry, Health Sciences, Athletic Training, and Mechanical Engineering, which form collaborative interdisciplinary groups to carry out basic and applied research in areas including personal bionics and wearable robotics, rehabilitation, hearing improvement, development of materials and devices for biocompatible implants, sensors, wound healing agents, and other medical devices. NAU researchers are positioned well to partner with faculty at other in-state institutions to further develop research programs and provide experiential learning opportunities for our students in this broader area.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>As the home of the medical devices division of industry pioneer W.L. Gore, Flagstaff is a center of innovation within the state for bioengineering and medical devices. Previous program investment enabled NAU to contribute to these fields while concurrently training students to meet the workforce needs of these industries. NAU will draw from expertise in the departments of Biological Sciences, Chemistry, Mechanical Engineering, and Applied Physics &amp; Materials Sciences to pursue external funding opportunities in Defense as well as NIH. Skills of NAU researchers participating in this program complement larger programs at our partner institutions in the state, and collaborative projects among universities are likely to yield further positive outcomes and expanded research opportunities for our students, in turn providing graduates strong fundamental skills for employment in the biotechnology or medical devices industries.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>Wearable technology and sensors, precision medicine, and medical device development are a focus of the Bioengineering and Biotechnology program, and NAU will continue to develop important intellectual property and licensable technology in these areas. Ongoing work within this program has fostered SBIR/STTR grants and start-up companies based on NAU technology, and further investment will continue to expand these opportunities. Arizona in general and Flagstaff in particular is home to many industries that require skilled workers in medical devices and translational biotechnology research. Investments in bioengineering and biotechnology are catalyzing discoveries that improve lives, foster economic growth and provide cutting-edge training for a diverse population of students who will join Arizona's workforce.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$416,500	\$512,500	\$0	\$929,000
Basic Research	\$263,704	\$128,489	\$153,267	\$545,460
Applied Research	\$117,450	\$0	\$0	\$117,450
Development	\$0	\$0	\$0	\$0
Total	\$797,654	\$640,989	\$153,267	\$1,591,910
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$416,500	\$0	\$0	\$929,000
Postdocs Supported	3	4	6	0
Graduate Students	18	19	19	59
Undergraduate Students	30	35	40	105
Sponsored Project Funding	\$1,502,864	\$1,552,940	\$1,587,303	\$4,643,107
Publications in Academic Peer-Reviewed Journals	22	24	26	72
Startups	0	0	1	1



# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Northern Arizona University			
TRIF Investment Area	Improving Health			
Program Name	Biotechnology and Bioengineering			
<b>Progress Summary</b>				
<p>NAU's investments into the bioengineering and biotechnology program have provided empowering training opportunities for undergraduates and graduate students and prepared them to join the biotechnology workforce. Research in this field aims to improve the lives of people inside and outside of Arizona, and involves a diverse suite of projects including those focused on personal bionics, wearable robotics, rehabilitation assistance devices, and design and implementation of improved medical devices. Program researchers in biomechanics have commercialized NAU technology in the area of robotic exoskeletons that help children who are limited in their ability to walk. Program researchers have also made substantial developments into new biocompatible materials and computational modeling algorithms that aid the design of treatments for cerebral aneurisms. Student training and mentorship is a strength of NAU and also remains a significant focus of faculty in the Biotechnology and Bioengineering program. In 2021, a new program that encourages students from underrepresented groups to enter into engineering and computer science careers was launched by faculty in engineering and it continues to draw new students into these career pathways. Previous TRIF investment into the initiative has enabled substantial follow-on funding from external sponsors and publications by researchers in top tier academic journals.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>In the area of biomechanics, wearable assistive technology was developed and patented by researchers in the initiative, and the technology demonstrated that it is capable of improving real-world walking performance in aging populations and individuals with Cerebral Palsy. In the previous year, NAU made several teacher-scholar faculty lines into the Bioengineering and Biotechnology program with the goal of expanding opportunities for research experiences for students. TRIF funds were used to support faculty startups for these hires, as well as seed projects to develop pilot data and instrument investments both designed to increase competitiveness of faculty applications to external programs. TRIF funding was also used to help defray costs associated with tech transfer activities in this program. Support for undergraduate and graduate researchers were provided either directly to the program or indirectly through awards from the Seed, Equipment and Infrastructure Investment program and funds were provided for general research infrastructure support utilized by program members.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<p>Development and growth of the research programs in this initiative is reliant on graduate student recruitment, and consistent growth of this population is an active area of focus for the program. The regional infrastructure for startups in biotechnology is nascent and remains relatively small. While development of technology that forms the basis of new companies in Flagstaff remains a goal of the program, the development of a skilled workforce for the biotechnology sector remains the larger statewide need.</p>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>The assistive mobility technology developed by researchers in the initiative has aided people with disabilities throughout the state and has made contributions to the local economy. The Biotechnology and Bioengineering program will continue to be an important resource for training students for Arizona's workforce, and expansion of training and experiential learning opportunities for students the diverse areas of our state.</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$80,908	\$164,754		\$245,662
Basic Research	\$478,478	\$180,437		\$658,915
Applied Research	\$85,288	\$0		\$85,288
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$644,674</b>	<b>\$345,191</b>		<b>\$989,865</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$95,521	\$170,178		\$265,699
Postdocs Supported	4	3		7
Graduate Students	37	24		61
Undergraduate Students	43	22		65
Sponsored Project Funding	\$2,467,362	\$3,353,368		\$5,820,730
Publications in Academic Peer-Reviewed Journals	52	27		79
Startups	1	0		1

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Northern Arizona University			
TRIF Investment Area	Improving Health			
Program Name	Community Health Research			
<b>Problem Statement</b>				
<p>The Challenge: Reducing health disparities in rural and underserved populations. Many prevalent diseases in America disproportionately affect minority and underserved/rural populations, and this trend is often magnified in the southwest. In Arizona, the mortality rates associated with diabetes are nearly eight-fold higher than the state average for Native American communities and two-fold higher for Hispanic/Latino populations. A 2020 CDC report also found that Native Americans have higher incident rates of many cancers compared to non-Hispanic White people (<a href="http://www.cdc.gov/cancer/dcpc/research/articles/cancer-AIAN-US.htm">www.cdc.gov/cancer/dcpc/research/articles/cancer-AIAN-US.htm</a>). The factors that contribute to health inequity are multifaceted and require a coordinated and interdisciplinary response.</p>				
<b>Program Description</b>				
<p>The Community Health Research program will further develop NAU's nationally recognized capacity to produce translational health research and discoveries in community-based healthcare research, precision and personalized medicine, infectious disease control, and partnership-based clinical research for the diverse populations of Arizona and beyond. The program supports a wide range of research into chronic health conditions such as cardiac disease, obesity, dental health, communicative disabilities, , cancer, health informatics, and wellness training research, among others. Faculty across departments in the College of Health &amp; Human Services, the College of Engineering, Informatics &amp; Applied Sciences, the College of the Environment, Forestry &amp; Natural Sciences, and the College of Social &amp; Behavioral Sciences work in collaborative, interdisciplinary groups to transform evidence-based bioscience and health care applications to improve lives and foster economic growth in Arizona and beyond.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>Previous investment into this program has paid dividends via the establishment of the Center for Health Equity Research (CHER) and the Southwest Health Equity Research Collaborative (SHERC); moreover, NAU has a longstanding focus on basic science impacting cancer health disparities, community health and student training through the Partnership for Native American Cancer Prevention (NACP), which is a partnership with the University of Arizona Cancer Center (UACC) funded by the National Cancer Institute. Achieving health equity, eliminating disparities, and improving population health is a of the goal of the Health People 2030 initiative set forth by the Department of Health and Human Services. Together, Community Health researchers equip Native American, Hispanic and other diverse students with high impact multidisciplinary training that prepares them for a wide variety of solutions-oriented jobs in critical areas of need.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>Investment into the Community Health Research program serves to help address health disparities in underserved populations throughout the state and trains diverse students for careers in health-related occupations. Program researchers and their mentees are spearheading interdisciplinary and culturally informed and appropriate efforts to find community-driven solutions to address health inequities wherever they exist in Arizona and beyond. By building valuable partnerships with local and regional healthcare providers, research institutions and tribal communities, program researchers are making important developments in community and behavioral health sciences, which are particularly important for rural Arizona communities that do not have the same access to public health resources as do individuals in Phoenix or Tucson.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$60,000	\$60,000	\$0	\$120,000
Basic Research	\$359,788	\$385,467	\$459,800	\$1,205,055
Applied Research	\$0	\$0	\$0	\$0
Development	\$0	\$0	\$0	\$0
Total	\$419,788	\$445,467	\$459,800	\$1,325,055
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	4	5	7	0
Graduate Students	22	27	27	77
Undergraduate Students	15	18	22	55
Sponsored Project Funding	\$3,539,802	\$3,381,061	\$3,217,860	\$10,138,723
Publications in Academic Peer-Reviewed Journals	40	44	48	132
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Northern Arizona University			
TRIF Investment Area	Improving Health			
Program Name	Community Health Research			
<b>Progress Summary</b>				
<p>The Community Health Research program serves the diverse populations of Arizona through its pursuit of translational health research, community-based healthcare research and partnership-based clinical research. Investment into this program supports research and workforce training to address healthcare disparities for underserved populations, including Native Americans, Hispanics, and rural communities. Researchers in this initiative have acquired a significant amount of external funding and have been highly productive in publishing their work in top-tier scientific journals. Student traineeships and graduate certificate programs are also offered within this program and they have provided additional opportunities for undergraduate and graduate students. Faculty in the Center for Health Equity Research (CHER) have stimulated research at NAU by using a team science approach to build strong research partnerships across disciplines and with external partners, to provide leadership to write and submit large interdisciplinary grant proposals, and through the mentorship of early-stage investigators to successfully write and receive awards.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>Research into health equity has immense impacts in the promotion of health and well-being for diverse communities throughout the state. TRIF funds directly supported several pilot and other initiatives over the previous year which led to significant accomplishments for the program. Among the most significant of these were two center proposals that were both awarded; the Center for Native American Health Equity and renewal of the Southwest Health Equity Research Collaborative (SHERC), together representing more than \$25M in new sponsored research funding to NAU. As part of the renewal, \$500,000 was allocated to provide crucial infrastructure upgrades to NAU's Information Technology Services research servers. Researchers also were awarded many new sponsored projects including two highly prestigious NIH "K Awards" to Native American investigators. TRIF-supported faculty were also instrumental in novel programs aimed at training the health workforce of the state, receiving continued funding for the Navajo NARCH Partnership, the ABRC Health Education Program, among others. Two graduate certificate programs at NAU are now fully functional and supporting students in the Masters of Public Health and Interdisciplinary Health PhD programs (over half of the students enrolled in these programs are Native American or Hispanic). The Navajo NARCH Partnership, a collaboration with Diné College has also led to the establishment of the Indigenous Health track of NAU's MPH program.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<p>Post-pandemic issues such as economic hardship related to long lock-down periods and on-going community- and family-level health challenges, especially in tribal communities, has led to difficulties in implementing some programs requiring face-to-face interactions.</p>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>The programs established by Community Health Research investigators are directed at improving the health and wellbeing of Arizona residents, and the TRIF investment has directly contributed to the growth and success of these initiatives. The Community Health Research program has continued its important outreach efforts into Native American and rural communities that are affected by health disparities. It has also provided an abundance of training programs and extramurally funded research opportunities for students. The Community Health Research program is a core component of NAU's research enterprise, and TRIF funding has enabled program researchers to continue to deliver upon this important mission for the state.</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$86,010	\$210,555		\$296,565
Basic Research	\$478,478	\$120,348		\$598,826
Applied Research	\$0	\$0		\$0
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$564,488</b>	<b>\$330,903</b>		<b>\$895,391</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	1	1		2
Graduate Students	24	18		42
Undergraduate Students	31	21		52
Sponsored Project Funding	\$10,068,685	\$6,465,580		\$16,534,265
Publications in Academic Peer-Reviewed Journals	42	45		87
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Northern Arizona University			
TRIF Investment Area	Improving Health			
Program Name	Pathogen Genomics			
<b>Problem Statement</b>				
<p>The Challenge: Rapidly characterize outbreaks of pathogens to inform and enable community response. The COVID-19 pandemic illustrated that rapid detection of microbial pathogens is critical to an informed community response. Although the pandemic illuminated the need for screening in the eyes of many Americans, rapid and reliable detection strategies are also crucial for doctors to prescribe appropriate antibiotic regimens and to identify emerging biothreats. In Arizona, environmental monitoring of pathogens found in soil or animal hosts (e.g. Valley fever, West Nile virus) is necessary to inform appropriate community responses. New detection and mitigation strategies will be a national priority and the need for skilled professionals to collect and interpret this data has never been more important.</p>				
<b>Program Description</b>				
<p>Northern Arizona University's program in Pathogen Genomics research is primarily carried out through the world-renowned Pathogen and Microbiome Institute (PMI), with complementary research in this area in the Department of Biological Sciences and School of Informatics, Computing &amp; Cyber Systems. Major focus areas include the evolution, ecology, and epidemiology of human and animal pathogens spanning those involved in hospital-acquired infections, to anthrax, plague, biological warfare agents, to virulent viral pathogens such as COVID-19. Research strengths encompass microbiology, high throughput genetics and genomics analysis, bioinformatics and drug development. Cutting-edge research efforts are also contributing to our understanding of the human microbiome through identification and characterization of the communities of microorganisms of the human gut, sinuses, and skin, for example, which are associated with human health and disease.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>NAU is uniquely equipped to address this challenge due to its core strength in microbial genetics, genomics and microbiome sciences, and its history of training undergraduate researchers to support the health-care and biotechnology industries. Anchored by PMI, which includes a state of the art BSL3 laboratory and vivarium, NAU will continue to maintain robust relationships with external clients at the DHS and DoD. Recent investment into PMI has enabled it to grow its portfolio to include expertise in virology and computational sciences. On average, Pathogen Genomics researchers have trained over forty undergraduate researchers annually over the previous five-year period and continue to provide exemplary training in the fundamentals of genomic research. These students go on to outstanding next steps after NAU, including medical school and top graduate programs.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>Researchers in the Pathogen Genomics program specialize in infectious disease that affect Arizona and the Southwest, such as Valley Fever, West Nile Virus, and COVID-19. The expertise of researchers in the program was instrumental to the community response to COVID-19 and they play important roles in continued environmental monitoring efforts. The program has proven to be outstandingly effective in training students for jobs in translational genetics and medicine. Program researchers are generating important intellectual property for licensing. In addition to researching pathogens with a significant presence in the state such as Valley Fever, NAU launched the COVID-19 Testing Service Center (CTSC) to grow the SARS-CoV-2 virus and test new drugs against it, giving Arizona an edge in responding to the crisis. NAU's TRIF investments in this program include basic, applied and translational research and will ensure that NAU researchers will continue to make discoveries and invent new technologies that have an immediate and long-lasting impact on the health and well-being of the diverse populations of Arizona.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$180,000	\$180,000	\$180,000	\$540,000
Basic Research	\$359,788	\$385,467	\$459,800	\$1,205,055
Applied Research	\$185,000	\$185,000	\$185,000	\$555,000
Development	\$0	\$0	\$0	\$0
Total	\$724,788	\$750,467	\$824,800	\$2,300,055
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	4	5	6	0
Graduate Students	17	22	22	63
Undergraduate Students	50	52	55	157
Sponsored Project Funding	\$6,000,300	\$6,493,946	\$6,890,261	\$19,384,507
Publications in Academic Peer-Reviewed Journals	52	57	62	171
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Northern Arizona University			
TRIF Investment Area	Improving Health			
Program Name	Pathogen Genomics			
<b>Progress Summary</b>				
<p>NAU continues to pursue impactful research into the ecology and evolution of human pathogens via its expertise in microbial genetics and the microbiome sciences. Program scientists work closely with students to train them for highly skilled jobs in the biomedical sciences. In particular, the Pathogen and Microbiome Institute functions as the home for over 100 NAU faculty, staff, and students to conduct research and advance their educations. These individuals are spread across three departments/schools and two colleges, representing a highly diverse and multi-disciplinary group of scientists. PMI provides a work and training environment for multi-disciplinary projects that includes laboratory, analytical instruments, and computational resources. TRIF funding was used to expand the genetic sequencing instrumentation at PMI, which is crucial to the work ongoing in the center and enables training of undergraduate and graduate students for high-tech jobs. Researchers in this initiative have focused on the problem of Valley Fever in Arizona as part of a collaborative statewide initiative that also includes partner laboratories at UA and ASU.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>NAU faculty have continued to develop rapid and reliable detection methods for pathogens in order to better inform a community response. Researchers continue work initiated in the COVID-19 pandemic to understand and develop countermeasure strategies for viral pathogens. NAU faculty play a role in advisory panels for long-covid research for the NIH and have developed immunological methods for SARS-COV2. The facilities and expertise developed in the pandemic response are now being leveraged into new and exciting arenas. The biosafety facilities that were dedicated to COVID-19 research are now being used to support large extramural awards for research on valley fever, melioidosis, and plague. NAU researchers have joined with partner faculty at UA and ASU to form the Arizona Valley Fever consortium and coordinate their research to understand, prevent, and treat this disease. Funding from the Chan Zuckerberg Initiative has provided opportunities for Native American students to receive training in bioinformatics and computational science. TRIF funds were also used to upgrade the laboratory infrastructure utilized by the COVID-19 Testing Center and invested into modern genetic sequencing instrumentation and data analysis tools. Funds were also used to help support for research projects into COVID wastewater screening and the role of the microbiome in the onset of neurodegenerative disease. Support for undergraduate and graduate researchers were provided either directly to the program or indirectly through awards from the Seed, Equipment and Infrastructure Investment program.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<p>Recruitment and retention of highly trained staff remains a challenge for the program, as well as the University on the whole, given the rising costs of living within the state and Flagstaff in particular.</p>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>By identifying new areas where the Valley Fever pathogen is found in the environment in Arizona, we will be able to update existing risk maps for Valley Fever in Arizona. This basic information is fundamental to educating the public and thereby preventing many infections before they occur. The work performed by researchers in the initiative will lead to more precise identification of environmental sources of human Valley Fever infections, leading to improved prevention of future disease. Pathogen Genomics is an area of historical research strength for NAU and the impacts of the research done here are recognized both nationally and internationally. Researchers in this initiative have continued to make discoveries that have an immediate and long-lasting impact on the health and well-being of the diverse populations in Arizona.</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$277,623	\$451,927		\$729,550
Basic Research	\$478,478	\$0		\$478,478
Applied Research	\$134,651	\$0		\$134,651
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$890,752</b>	<b>\$451,927</b>		<b>\$1,342,679</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	3	4		7
Graduate Students	24	37		61
Undergraduate Students	36	69		105
Sponsored Project Funding	\$6,734,981	\$3,771,546		\$10,506,527
Publications in Academic Peer-Reviewed Journals	90	76		166
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Northern Arizona University			
TRIF Investment Area	National Security Systems			
Program Name	Cybersecurity and Innovative Materials			
<b>Problem Statement</b>				
<p>The Challenge: Preventing cybercrime through the development of hacker-resistant security measures and novel materials. As of December 2020, global economic losses from cybercrime were estimated to be over a trillion dollars, and over half of companies that experienced a cyberincident admit ed to having no plan to respond to or prevent a future incident. The most pressing challenge is the need for cybersecurity that cannot be easily defeated. Novel approaches include embedded encryption in hardware, innovation in secure quantum computing, nanotechnology and robust microelectronics. The development of innovative materials to address these concerns also has practical applications spanning national security, the production of clean energy and water, and microelectronics.</p>				
<b>Program Description</b>				
<p>The Cybersecurity and Innovative Materials program addresses key challenges for secure computing and the development of microelectronics. Cybersecurity for information and communications systems, reconfigurable computing, remote sensing, and the internet are areas of major concern for industry operations, institutional protection of data, computer-to-computer communications, and other related applications. Every technology-oriented industry requires increasingly sophisticated approaches to computing systems operations, computing applications, and data protection. In addition to the need for cybersecure materials, the society of tomorrow will increasingly rely on bioelectronics and biosensors, quantum computing, nanotechnology, and those for novel energy storage. All of these will require fundamental research and translatable discoveries to forge these foundations for society. We see this growing need as a core national security priority in the coming decade, as is the effective training of participants in the computing systems and microelectronic industry workforce.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>The university will leverage expertise in the School of Informatics, Computing &amp; Cyber Systems, Mechanical Engineering and Applied Physics &amp; Material Science to develop technology modules that will enable new forms of protection across the landscape of cybersecurity needs. Furthermore, NAU researchers will leverage strengths in materials science across multiple academic units as well as the Center for Materials Interfaces in Research and Applications (iMIRA!), to develop and combine several new technologies, including innovations in microelectronics and the design of computer hardware, to improve the ability of computers to fend off cyberattacks. iMIRA! is a materials science center with research foci on quantum materials, active material and nanoclusters, materials for national security and maintains a mission for expanding opportunities for students from underserved groups in applied materials research.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>National security and the economic vitality of the United States depends on a stable, safe and resilient cyberspace. The cybersecurity and defense industries have long been one of the most important employers for the state, and coupled with the rapid expansion of job opportunities in semiconductors and microelectronic materials there is expected to be an immediate and pervasive need for skilled workers across these fields in the state of Arizona. Program researchers will provide important experiential opportunities for undergraduate and graduate students, thus in these disciplines to help meet the growing need for these important and rapidly growing Arizona industries.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$309,731	\$125,000	\$0	\$434,731
Basic Research	\$119,929	\$128,489	\$153,267	\$401,685
Applied Research	\$71,888	\$0	\$0	\$71,888
Development	\$71,887	\$0	\$0	\$71,887
Total	\$573,435	\$253,489	\$153,267	\$980,191
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$309,731	\$0	\$0	\$434,731
Postdocs Supported	6	8	8	0
Graduate Students	25	30	30	90
Undergraduate Students	30	35	40	105
Sponsored Project Funding	\$1,992,141	\$2,227,355	\$2,389,619	\$6,609,115
Publications in Academic Peer-Reviewed Journals	20	22	25	67
Startups	0	0	2	2

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Northern Arizona University			
TRIF Investment Area	National Security Systems			
Program Name	Cybersecurity and Innovative Materials			
<b>Progress Summary</b>				
<p>The Cybersecurity and Innovative Materials program leads NAU's efforts in cybersecurity and other innovative technologies that aim to serve businesses, industries and consumers within the state. Program researchers in the School of Informatics, Computation and Cyber Systems (SICCS) continue to be engaged in ongoing cybersecurity programs sponsored by the Air Force Research Laboratory and industrial partners to develop new approaches to identifying, authenticating, and protecting devices for enterprises and consumers. Faculty in SICCS and in the Department of Applied Physics and Materials Sciences (APMS) continue to participate in a multistate DoD-sponsored consortium which aims to improve cybersecurity education. Program researchers mentor graduate and undergraduate researchers in the laboratory and continue to foster opportunities for undergraduate and graduate students to develop skills they need to meet the need of Arizona employers. Community outreach is a focus of researchers in this program, particularly to reach potential students in rural and underserved communities within the state.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>TRIF funding was used to help defray costs associated with tech transfer activities and program support in the Cybersecurity and Innovative Materials program. The continued effort to develop advanced cybersecurity functions and materials has enabled program researchers to secure over \$2M in funding from the Department of Defense for the university. Program researchers also continue to work with statewide partners at UA and ASU for educational outreach programs in quantum science and materials development. Support for undergraduate and graduate researchers were provided either directly to the program or indirectly through awards from the Seed, Equipment and Infrastructure Investment program and funds were provided for general research infrastructure support utilized by program members.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<p>NAU researchers are best positioned to make impactful research contributions in the area of cybersecurity and materials research in partnership with teams in the established programs at other universities in the state. Increasing opportunities for students to engage in these areas, either through experiential or curricular learning, is a core component of NAU's strategic mission and a strength of our teacher-scholar faculty. Future TRIF investment into this program will reflect a renewed emphasis into traineeships and student-centered outcomes that enable entry into the technological workforce in the state.</p>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>Funds invested into the Cybersecurity and Innovative Materials program aided researchers' ability to continue to train the next generation of the research workforce in areas of critical need in Arizona. We have also begun to make TRIF investments to enable NAU researchers to participate in workforce training efforts for the expanding semiconductor industry in the state, and to be able to respond to opportunities arising from the CHIPS Act.</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$25,356	\$0		\$25,356
Basic Research	\$439,308	\$28,618		\$467,926
Applied Research	\$0	\$0		\$0
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$464,664</b>	<b>\$28,618</b>		<b>\$493,282</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$28,618		\$28,618
Postdocs Supported	6	3		9
Graduate Students	12	38		50
Undergraduate Students	13	12		25
Sponsored Project Funding	\$1,177,486	\$2,673,868		\$3,851,354
Publications in Academic Peer-Reviewed Journals	20	38		58
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Northern Arizona University			
TRIF Investment Area	National Security Systems			
Program Name	Supply Chain Management			
<b>Problem Statement</b>				
<p>The Challenge: Empower communities with tools to enable adaptation to unexpected events. Communities thrive when they have ready access to food, energy and water, but when disruptions to their supply occurs (through natural disasters, wildfires, extreme weather events, or even a global pandemic) the lives and livelihood of its citizens may be jeopardized. The ability to accurately model and visualize the supply chain and commodity transit pathways in real-time can provide powerful information for decision-makers and emergency managers in the resilient management of their food, energy and water systems for disaster relief and recovery. Knowledge of potential limitations to commodity distribution can help communities and states plan for and effectuate recovery as rapidly as possible.</p>				
<b>Program Description</b>				
<p>The Supply Chain Management program researchers work with very large datasets in partnership with economic forecasting data and analysis of social and behavioral trends in affected communities, to enable construction of models to develop effective responses to unexpected events. Effective community responses to catastrophic events is a priority global need that serves to protect people’s lives and livelihoods. Supply chain analysis will aid development of intelligently planned and sustainable smart cities, smart buildings and smart cars. Implementation of the program relies on interdisciplinary expertise from a suite of academic units, including the School of Informatics, Computing &amp; Cyber Systems, School of Earth &amp; Sustainability, College of Health &amp; Human Services, College of Social &amp; Behavioral Sciences, and the W.E. Franke College of Business. The strong focus on interdisciplinarity fosters technical innovations, economic development, and workforce training.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>NAU researchers are developing a nationally scalable protocol for public participation in research that leverages data science and visualization tools, and we anticipate this program will effectively complement work at our partner institutions in the state. FEWSION, which uses comprehensive data sets to map out domestic supply chains and resources, aims to develop a framework for deploying adaptation strategies for interdependent power, water, and transportation systems. The tool analyzes and extracts new information from public datasets describing the production, consumption, and flow of food, energy, and water. This program represents an at ractive path for students seeking careers in data analytics or information sciences. We anticipate opportunities for student engagement to increase as the program develops, and collaboration with researchers at programs in other statewide institutions will be pursued.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>The pandemic has shown how crucial effective management of supply chains are to modern society. When disruptions to the supply of food, energy or water occurs, be it through wildfires, extreme weather events, or even a global pandemic, the lives and livelihood of many may readily become jeopardized. Investment into the Supply Chain Management program will enable NAU researchers to develop unique algorithms from publicly-available datasets to describe the production, consumption, and flow of food, energy, and water. These tools will provide invaluable information to city planners, economic planners and emergency managers inside and outside of Arizona. Further, training of undergraduate, graduate and postdoctoral scientists in advanced data analytics will provide effective workers to meet the need of industry in the state.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$119,929	\$128,489	\$153,267	\$401,685
Applied Research	\$0	\$0	\$0	\$0
Development	\$0	\$0	\$0	\$0
Total	\$119,929	\$128,489	\$153,267	\$401,685
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	2	3	0
Graduate Students	2	6	6	17
Undergraduate Students	3	10	13	26
Sponsored Project Funding	\$1,559,548	\$1,456,649	\$1,355,663	\$4,371,860
Publications in Academic Peer-Reviewed Journals	18	20	22	60
Startups	0	0	0	0



# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Northern Arizona University			
TRIF Investment Area	National Security Systems			
Program Name	Supply Chain Management			
<b>Progress Summary</b>				
<p>TRIF investment into the Supply Chain Management program has enabled the development of advanced and adaptable supply chain models that can be deployed to aid users in the region, in the state, and also by the Federal government. These models take advantage of access to very large dataset, reconfigurable computing and machine learning approaches to aid community response to unexpected events. Program researchers continue to work closely with collaborators on campus, as well as with partner institutions both inside and outside of Arizona. NAU researchers partnered with Johns Hopkins Applied Physics Laboratory, Northeastern, ASU's Decision Theater and private companies to develop a platform for predictive supply chain analytics to the Department of Defense. Faculty in the program also collaborate to monitor and predict rain and floodwater flows in both urban and rural environments.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>TRIF funding was used to help defray costs associated with tech transfer activities and program support in the Supply Chain Management program. The continued effort to accurately model and visualize supply chain and commodity distribution pathways has enabled program researchers to secure over \$5M in funding from the Department of Defense for the university, and program researchers have begun to collaborate significantly with statewide partners to effectively execute on our deliverables. Support for undergraduate and graduate researchers was provided either directly to the program or indirectly through awards from the Seed, Equipment and Infrastructure Investment program and funds were provided for general research infrastructure support utilized by program members.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<p>This program requires significant participation from contract workers and the ability of this program to support student-focused training opportunities at NAU is somewhat limited. Additionally, NAU has a limited capacity to host research with significant defense-related data security requirements and less experience with complex DoD contracting processes than other institutions in the state, thus we have been actively partnering with ASU and UA to aid us in these efforts. The Supply Chain Management program is considered an area of opportunity for NAU to develop strong ties with established programs in the state to be collectively well positioned to respond to other opportunities that develop in this area.</p>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>Together with collaborators at our statewide partners, the Supply Chain Management program will help develop tools that use publicly available data to describe the flow of the critically important resources of food, energy and water. These tools will provide critical information to strategic planners both inside and outside of the state.</p>				
<b>Additional Notes</b>				
FEWSION				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$25,356	\$0		\$25,356
Basic Research	\$439,308	\$50,868		\$490,176
Applied Research	\$0	\$0		\$0
Development	\$0	\$0		\$0
Total	\$464,664	\$50,868		\$515,532
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	7	3		10
Undergraduate Students	4	1		5
Sponsored Project Funding	\$1,752,522	\$5,532,617		\$7,285,139
Publications in Academic Peer-Reviewed Journals	13	12		25
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Northern Arizona University			
TRIF Investment Area	Space Exploration and Optical Solutions			
Program Name	Solar System Science and Exoplanets			
<b>Problem Statement</b>				
<p>The Challenge: To understand the composition of objects in our solar system, and to pursue a spacecraft mission to explore an asteroid. The origins of the Solar system and its unexplored bodies remain among the most significant questions for space scientists. Research is performed through high-powered telescopes, in which signatures are assessed through measurement and analysis of large data sets. Data obtained from instrumentation delivered to the site of observation via a planned spaceflight is also necessary. Cutting-edge equipment must be made that is limited in size and weight, is robust and resilient, and is constructed in an economical fashion. Deployed instrumentation can acquire data inaccessible through telescope images and is critical to understand the composition of these bodies.</p>				
<b>Program Description</b>				
<p>TRIF funding has enabled recruitment of leading-edge faculty to NAU's Department of Astronomy and Planetary Sciences with experience on collaborative spacecraft missions, and program researchers aim to lead a spacecraft mission to an asteroid through the NASA SIMPLEx program. Currently, researchers and their students direct the daily tasks of the NASA Curiosity Rover on the surface of Mars from campus and have developed deployable instruments for other missions to the red planet. Researchers specializing in exoplanets have access to powerful telescopes, as well as unique equipment capable of replicating and measuring phenomena in the environments of these distant planets. NAU researchers will engage with our partner institutions in the state, and with the aerospace industry in Arizona. In addition to yielding valuable scientific information, this project will also provide industry contacts and unique training opportunities for undergraduate and graduate researchers, strongly serving current needs of this cornerstone industry in Arizona.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>Northern Arizona was the site of a transformative finding in planetary science when Pluto was discovered at Lowell Observatory, and NAU is positioned to build on this rich tradition. Previous investment grew the department of Astronomy &amp; Planetary Science, created a top-tier doctoral program, and enabled important discoveries, such as the evidence of Farfarout, which was recently confirmed as the most distant object in the Solar System by the International Astronomical Union. NAU researchers access important telescopes and have developed valuable collaborations (Lowell Observatory, USGS) to pursue new funding opportunities at NASA, the DoD, and the NSF. Finally, program researchers are collaborating with other areas of university strength to understand seasonal variations of biosignatures using remote sensing, both on Earth and potentially those detectable on astrobiological targets of interest.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>Arizona is host to a thriving aerospace and defense technology industry. According to the Arizona Commerce Authority, the state is home to over 1300 manufacturers and suppliers of the aerospace industry and employs over 58,000 workers. Astronomy and planetary sciences is also an important employer for the state, which houses numerous internationally recognized research facilities and observatories. A study conducted by the Arizona Arts, Sciences and Technology Academy estimates Astronomy and Planetary Sciences contribute over a quarter of a billion dollars annually to the state revenue. Investment into the Solar Systems Sciences and Exoplanets program will allow NAU researchers and students to engage with our partner institutions in the state, and with the aerospace industry in Arizona. In addition to yielding valuable scientific information, this project will also provide strong industry contacts and unique training opportunities for undergraduate and graduate researchers, strongly serving current needs of this cornerstone industry in the state. In addition to the crucial scientific information this program is poised to provide, it will also facilitate strong industry contacts and unique experiential learning opportunities for undergraduate and graduate researchers, strongly serving current needs of this industry in Arizona.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$0	\$0	\$0
Basic Research	\$689,788	\$715,467	\$789,800	\$2,195,055
Applied Research	\$0	\$0	\$0	\$0
Development	\$0	\$0	\$0	\$0
<b>Total</b>	<b>\$689,788</b>	<b>\$715,467</b>	<b>\$789,800</b>	<b>\$2,195,055</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	1	1	0
Graduate Students	7	8	8	25
Undergraduate Students	10	13	16	39
Sponsored Project Funding	\$3,465,529	\$3,919,541	\$4,297,490	\$11,682,560
Publications in Academic Peer-Reviewed Journals	40	44	48	132
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Northern Arizona University			
TRIF Investment Area	Space Exploration and Optical Solutions			
Program Name	Solar System Science and Exoplanets			
<b>Progress Summary</b>				
<p>The Solar System Science and Exoplanets program continues to facilitate impactful discoveries and the development of cutting-edge technology by faculty in the areas of astronomy and planetary science. This program leverages the wide range of astronomical resources found throughout Arizona and within our partner institutions, and ultimately aims to prepare a workforce that meets the needs of the state and strengthens Arizona's recognized leadership position in this area of research. Over the course of the last year TRIF funding continued to aid efforts to increase participation in astronomy and astrophysics by underrepresented minority students via a pipeline of students transferring from community college. A researcher in this program served as the lead author for the report communicated by the NASA "DART" mission, which successfully redirected an asteroid for the purpose of planetary defense. NAU researchers also concluded a student-led program (VISIONS) which delivered a camera that was designed and built by undergraduates for inclusion on a future spaceflight to Mars. This effort engaged a cohort of thirty undergraduate and five graduate students in all aspects of design, construction and operation of spaceflight hardware. TRIF funds were also used to support student travel to southwestern Kansas to observe a rare occultation event where the Jupiter asteroid Polymele passed in front of a distant star.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>TRIF funds were used to provide access to high powered telescopes for program researchers, infrastructure modifications and the acquisition of research instrumentation. Funds were also used to support undergraduate engagement within the VISIONS program and the Polymele occultation campaign as well as material support for items needed in the course of the work for both efforts. Support for undergraduate and graduate researchers were provided either directly to the program or indirectly through awards from the Seed, Equipment and Infrastructure Investment program and funds were provided for general research infrastructure support utilized by program members.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<p>The Solar System Science and Exoplanets program is growing at NAU and modifications and upgrades to the research infrastructure have been necessary to accommodate the needs of program researchers. The costs of these modifications, as well as the timeline for their completion, have been subject to fluctuation based on market forces facing the state and have resulted in slight delays to program growth.</p>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>The students supported by TRIF in these programs have acquired significant experience in the development of spacecraft instrument technology and hardware, as well as other aspects of planetary science. These students will take their skills into the workforce both inside and outside of Arizona. Furthermore, TRIF investment has also allowed us to build a significant technical infrastructure here at NAU, which will facilitate further research and student training into the future. Research in the Solar System Science and Exoplanets program at NAU represents an area of growth for the university and is rapidly becoming a strength of NAU's research enterprise. NASA's DART mission was arguably the highest profile effort pursued by this agency in the last several years, and one of the primary leaders of this effort is an NAU researcher. Similarly, program researchers have made great strides in Mars exploration research and astrophysics, and led in these areas in a manner that has enabled unique and empowering student research opportunities. Students trained in this program are in excellent position to meet the industrial needs of the state in aerospace and planetary science.</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$50,719	\$0		\$50,719
Basic Research	\$774,928	\$416,060		\$1,190,988
Applied Research	\$0	\$0		\$0
Development	\$0	\$0		\$0
Total	\$825,647	\$416,060		\$1,241,707
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	4	6		10
Graduate Students	33	33		66
Undergraduate Students	5	26		31
Sponsored Project Funding	\$3,231,586	\$3,094,950		\$6,326,536
Publications in Academic Peer-Reviewed Journals	43	63		106
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Northern Arizona University			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	Adapting to a Changing Environment			
<b>Problem Statement</b>				
<p>The Challenge: Predict the impact of a changing environment on soils, the atmosphere, ecosystems, and natural populations. Changes in our environment and climate have resulted in alteration of many aspects of the world today, including the strength and duration of weather events and changes in the average temperature and precipitation relative to historical patterns. As the environment changes, life on Earth changes with it. A deep understanding of how the flora and fauna on Earth are impacted by these changes (including wildlife ecosystems, forests, and even soils) will be required for society to effectively adapt as our environment changes around us.</p>				
<b>Program Description</b>				
<p>Under the Adapting to a Changing Environment program, NAU makes investments in two Research Centers: The Center for Ecosystem Science and Society (EcoSS) and the Center for Advancing Western Landscapes (CAWL). Researchers in EcoSS investigate the interactions of biological communities—from single cells to the entire globe—with the environment, with a particular eye for how they both respond to and influence environmental change. EcoSS provides opportunities for the training of future scientists and actively engages the public in the discoveries made by the center. CAWL has advanced cross-disciplinary environmental research and training at NAU with a focus on the Colorado Plateau. The center has taken the initiative to provide science-based leadership to address conservation and environmental challenges in the West. Additional complementary research in the Adapting to a Changing Environment program occurs through faculty-led initiatives from the School of Earth &amp; Sustainability, Department of Biological Sciences, School of Forestry, School of Informatics, Computing, &amp; Cyber Systems and the Sustainable Communities program.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>With recognized leaders in environmental science and ecology, and with synergy from skills in remote sensing and computational modeling, NAU is uniquely positioned to train the next generation of scientists to tackle problems in these areas. NAU has multidimensional strength in this program, including faculty who incorporate field-based, molecular genetic and bioinformatic approaches to understanding how changing climate impacts life on earth. The integration of sensor technology with informatics allows researchers to conduct longitudinal studies to assess ecosystem and forest health. Together with research in forestry and ecology, this work informs sustainable development goals and management practices. Program researchers mentor students across degree programs that take full advantage of NAU's unique place-based strength of being situated in the natural laboratory of the Colorado Plateau.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>Changing land management practices and climate variation are fundamentally altering Earth's landscapes, but scientists don't have a complete picture of their impact on global ecosystems. Program researchers use unique instruments, facilities, and field-based experiences to study the interactions of biological communities to determine how they respond to and influence environmental change. This information helps forge new solutions to environmental challenges and aids public deliberation and land-management efforts across Arizona and beyond. NAU's Adapting to a Changing Environment program provides outstanding experiential education opportunities and research engagement for undergraduate and graduate students, preparing them for careers with natural resource management agencies, federal and university research laboratories, and environmental consulting firms, among other in-demand career pathways.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$593,844	\$350,000	\$350,000	\$1,293,844
Basic Research	\$359,788	\$573,967	\$459,800	\$1,393,555
Applied Research	\$0	\$0	\$0	\$0
Development	\$0	\$0	\$0	\$0
Total	\$953,632	\$923,967	\$809,800	\$2,687,399
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$270,000	\$540,000
Postdocs Supported	8	9	10	0
Graduate Students	44	47	47	141
Undergraduate Students	35	38	40	113
Sponsored Project Funding	\$4,237,633	\$4,164,990	\$4,073,196	\$12,475,819
Publications in Academic Peer-Reviewed Journals	80	88	96	264
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Northern Arizona University			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	Adapting to a Changing Environment			
<b>Progress Summary</b>				
<p>Over the previous year, researchers in the Adapting to a Changing Environment program have continued to make important discoveries on the impact of prolonged drought on microbial communities in soil and predictions of the fate of carbon in a warming Arctic permafrost. Program investigators also expanded research addressing environmental sustainability and adaptive capacity in the Southwest, both critical elements of a prosperous future for Arizona. Program researchers are working with the Department of Energy to study changing microbial interactions as the soil warms and studying how the Alaskan forests adapt to a changing climate. Researchers in this initiative, particularly in the Center for Adaptive Western Landscapes (CAWL) and the Center for Ecosystem Science and Society (ECOSS) have demonstrated high productivity in external funding, with over twenty newly funded grants and many scientific publications. Education of the next generation of field scientists was another strength of the program, with training for over sixty total undergraduate and graduate students.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>Funding provided to the Understanding a Changing Environment program enabled researchers to study the interactions of biological communities to determine how they respond to and influence environmental change as well as to train future scientists and disseminate information about their discoveries to the public. TRIF monies supported applied biological research, collaborative planning and field-based educational experiences to forge new solutions to landscape-scale environmental challenges. Research foci have included ecosystem processes, biodiversity, and restoration; the link between genetic diversity patterns and ecosystem services; fire recovery in ecological and social communities; sustainable grazing and agriculture; and sustainable management of traditionally important plant species. In two new awards to the university, these continued efforts resulted in over \$3M in funding from the Department of Energy and over \$9M from the National Science Foundation. TRIF funds were used to provide operational support for ECOSS and CAWL. Funds were also used to aid improvements and fire recovery efforts for the Southwest Experimental Garden Array, which is overseen by program researchers. Support for undergraduate and graduate researchers were provided either directly to the program or indirectly through awards from the Seed, Equipment and Infrastructure Investment program and funds were provided for general research infrastructure support utilized by program members. Instrument and infrastructural upgrades for researchers in this program were also enabled by TRIF funding. Support for undergraduate and graduate researchers were provided either directly to the program or indirectly through awards from the Seed, Equipment and Infrastructure Investment program.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<p>Production from the program has been hampered over the course of the previous year due to loss of some skilled faculty to other universities and private businesses. Recruitment of new faculty into the program was a dedicated effort of the prior year.</p>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>The research conducted in the Understanding a Changing Environment program seeks to identify solutions to key sustainability needs impacting multiple sectors in Arizona, from agriculture and ranching to recreation and public lands to tribal managers. Program researchers also transfer the knowledge gained by these efforts to key stakeholders throughout the state by gathering and updating stakeholder advisory teams, contributing to public information venues such as newspaper articles, podcasts, media interviews and educational videos, and co-developing research with indigenous elders in a tribal forum setting.</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$199,897	\$279,011		\$478,908
Basic Research	\$644,142	\$83,672		\$727,814
Applied Research	\$0	\$0		\$0
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$844,039</b>	<b>\$362,683</b>		<b>\$1,206,722</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$2,817		\$2,817
Postdocs Supported	11	8		19
Graduate Students	62	41		103
Undergraduate Students	27	18		45
Sponsored Project Funding	\$6,705,932	\$14,973,654		\$21,679,586
Publications in Academic Peer-Reviewed Journals	117	106		223
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Northern Arizona University			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	Forest Health and Land Management			
<b>Problem Statement</b>				
<p>The Challenge: Development of a sustainable management strategy to improve forest health and lessen the risk of catastrophic wildfire. Forests in the western U.S. provide invaluable resources and services to the nation. In addition to the financial benefit they provide, healthy forests also contribute to people's quality of life. Forests provide clean air and water, contribute to biodiversity, recreational opportunities, and scenic landscapes. Unmanaged forests, on the other hand, are at risk of catastrophic wildfires and post-fire flooding that damage landscapes and livelihoods. An interdisciplinary and coordinated approach to develop and promote the best science to inform management is required to accomplish forest restoration and watershed protection is needed inside and outside of Arizona.</p>				
<b>Program Description</b>				
<p>Under the Forest Health and Land Management initiative, NAU invests in researchers in the Ecological Restoration Institute (ERI), along with faculty in the School of Forestry, School of Earth &amp; Sustainability, and School of Informatics, Computing &amp; Cyber Systems. ERI seeks solutions to the costly environmental problems of degraded forest health and unnatural wildfire. Losses of city and county revenue from decreased tourism, short-term job losses, damage to water supplies, and the devastation experienced by those who live through catastrophic wildfire are just some of the economic impacts that ERI's work seeks to alleviate. Additionally, investments in the program support the development and use of remote sensing technology to monitor forest health, wildfire recovery, and the effect of environmental change on wildlife populations. Past TRIF investments in these units have enabled NAU to provide training in restoration science, including fieldwork experiences, to hundreds of graduate and undergraduate students.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>Centered in the largest ponderosa pine forest in North America, and with the only School of Forestry in the state, NAU is uniquely positioned to pursue this challenge. NAU's ERI plays a primary role in forest restoration initiatives across the west and is the lead member of the multi-university Southwest Ecological Restoration Institute (SWERI). Ongoing research and restoration work performed in NAU's highly regarded School of Forestry supports active management and conservation of our natural resources in concurrence with the revival of the forest products industry in Arizona. In the 1950's, the Arizona State Land Department dedicated 4000 acres of forest in Northern Arizona as an "outdoor laboratory" for NAU. Building on this history, the 50,000 acre Centennial Forest was established in 2000, offering a premier location for research and workforce training for students in Forestry undergraduate and graduate programs.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>Arizona has over 18 million acres of forested land within its boundaries. Unmaintained and unhealthy forests are at significant risk of catastrophic wildfire which disrupts the lives and livelihood of communities who live in proximity to these natural resources. The development of thinning and land restoration practices minimizes the risk of wildfires, and in turn lessens the economic impact of these natural disasters. In addition to the introduction of responsible land management and resource conservation practices that protect residents throughout the American west, program researchers are developing industry partnerships to revive the forest products industry in Arizona, thus improving the economic outlook for rural communities within the forests of the state. The long-term partnerships NAU has developed with federal government entities such as the USGS, National Park Service, U.S. Forest Service and the Bureau of Land Management will continue to generate environmental, economic, and social wellbeing improvements for stakeholders across the rural portions of Arizona. Finally, the research underway in this critical area has been, and will continue to be, essential for experiential training in restoration science, including fieldwork experiences, to many graduate and undergraduate students.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$1,205,000	\$625,000	\$500,000	\$2,330,000
Basic Research	\$359,788	\$385,467	\$459,800	\$1,205,055
Applied Research	\$0	\$0	\$0	\$0
Development	\$0	\$0	\$0	\$0
Total	\$1,564,788	\$1,010,467	\$959,800	\$3,535,055
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$100,000	\$0	\$0	\$100,000
Postdocs Supported	2	2	2	0
Graduate Students	8	10	10	30
Undergraduate Students	15	18	22	55
Sponsored Project Funding	\$3,626,718	\$3,817,599	\$3,962,319	\$11,406,636
Publications in Academic Peer-Reviewed Journals	40	44	48	132
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Northern Arizona University			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	Forest Health and Land Management			
<b>Progress Summary</b>				
<p>Researchers in the Forest Health and Land Management program are recognized regionally, nationally and internationally for leadership in developing science-based solutions to solve forest health and wildfire crises across the globe. Program researchers examined burn severity data from over 700 fires in the state over the last thirty years to assess important trends in the size and intensity of wildfires that threaten populations. Numerous efforts were documented which provided scientific analyses of wildfires managed for resource benefit and the impacts of these actions on future resilience of the forests. They also provided a fact sheet and policy brief for decision makers addressing common misinformation around the topic of wildfires and forest management. Program researchers have leveraged TRIF funds to initiate a nationwide wildfire treatment map. This effort is the first of its kind in the nation and is supported by over \$16M of federal infrastructure funding. Researchers have continued to broaden opportunities that sponsor undergraduate and graduate students to participate in field-based research and experiential training.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>Over the course of the previous year, TRIF funds were used to support faculty startup accounts and operational support for the Ecological Restoration Institute, the School of Forestry and the School of Earth and Sustainability. Support for undergraduate and graduate researchers were provided either directly to the program or indirectly through awards from the Seed, Equipment and Infrastructure Investment program and funds were provided for research infrastructure support utilized by program members.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<p>Recruitment of talented students into the work pursued remains an active effort for program researchers, but we are optimistic effective recruitment strategies are in place.</p>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>Work by researchers in the Forest Health and Land Management program reduces the risk of wildfire and post-wildfire flood damage through practical forest management and restoration. In Arizona, forest health is directly tied to water security, the sustainability of rural and forest-based economies, and the health and safety of the residents of the state. Research in the following year will continue to develop practices that keep Arizona's forests healthy and keeps the populations that live within them safe. This program is a core component of NAU's research enterprise and a recognized area of historical strength for the university, and TRIF funding has enabled program researchers to continue its important work for the benefit of residents in the state of Arizona.</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$745,532	\$977,569		\$1,723,101
Basic Research	\$538,700	\$198,677		\$737,377
Applied Research	\$0	\$0		\$0
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$1,284,232</b>	<b>\$1,176,246</b>		<b>\$2,460,478</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$198,677		\$198,677
Postdocs Supported	2	7		9
Graduate Students	25	39		64
Undergraduate Students	20	63		83
Sponsored Project Funding	\$3,398,402	\$10,706,802		\$14,105,204
Publications in Academic Peer-Reviewed Journals	67	75		142
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Northern Arizona University			
TRIF Investment Area	Workforce Development			
Program Name	Continuing Support for Existing Access and Workforce Development Programs			
<b>Problem Statement</b>				
<p>NAU offers a legacy of strong programs that align with the workforce demand across the State of Arizona. The programs serve transfer students, including adult learners, through statewide and online delivery modes. Additionally, the support for the development of real-time labor demand and workforce analysis is aligned with the programming offered. The continuation of these program investments is critical to continue the delivery and support of flexible high-quality programming that meets the needs of the Arizona workforce.</p>				
<b>Program Description</b>				
<p>The existing academic programs supported through A/WD TRIF funding cross many disciplines. They are intentionally designed in flexible manners, including but not limited to 90/30-degree completion programs, certificates, and graduate degrees. For the 90/30-degree completion programs, NAU faculty collaborate with our community college partners to design and design programs in Arizona that include well-articulated progression plans for students to follow from entry point through graduation. The following academic discipline areas deliver more than sixty certificate, undergraduate and graduate programs online and at statewide sites through the TRIF A/WD initiative. These programs will continue to be supported with this important funding: Communication Sciences &amp; Disorders Programs, Educational Leadership Programs, Educational Psychology Programs, Educational Specialties Programs, Teaching &amp; Learning Programs, Health Sciences Programs, Nursing Programs</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>NAU has a significant advantage for serving Arizona transfer students and adult learners through the delivery of workforce-driven programs at our statewide sites. These locations provide place-bound students the much-needed access to high-quality educational pathways, while empower them to maintain their life commitments, particularly jobs, family, and community responsibilities.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>High-growth labor trends are commonly described as above-average student and labor market demand growth and volume. According to Hanover Research, Arizona student degree completion trends and employment projections indicate there are 11 high-growth fields projected at the bachelor's level. Additionally, there are 14 high-growth fields projected at the master's level. All projected high-growth fields are captured within the existing academic programs supported through A/WD TRIF funding. The continued delivery of these programs is essential for the sustainability and growth of programs that align with current and projected workforce trends.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$2,758,788	\$2,539,588	\$2,539,588	\$7,837,964
Basic Research	\$0	\$0	\$0	\$0
Applied Research	\$0	\$0	\$0	\$0
Development	\$0	\$0	\$0	\$0
Total	\$2,758,788	\$2,539,588	\$2,539,588	\$7,837,964
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	0
Graduate Students	1235	1321	1321	4010
Undergraduate Students	2749	2941	3235	8925
Sponsored Project Funding	\$0	\$0	\$0	\$0
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0



# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Northern Arizona University			
TRIF Investment Area	Workforce Development			
Program Name	Continuing Support for Existing Access and Workforce Development Programs			
<b>Progress Summary</b>				
<p>Accomplishments This project supports online and in-person statewide programs offered through the College of Education and the College of Health and Human Services, serving students where they live and learn. They are designed to meet the needs of adult learners, especially those with some college and no degree or who are looking to advance in their careers by earning masters or terminal degrees. NAU experienced a small overall enrollment decrease (-3.8%; N=82) in these programs from the previous year. To increase access, statewide offerings were expanded, including masters programs in School Psychology, School Counseling, and Clinical Mental Health Counseling. Similarly, the Principal Certification program has greater outreach with a newly created Accelerated Masters Program in EDL-PK12 Certification offered within school districts, aimed at preparing local leaders for school administration positions throughout the state. Investment Detail This Project funded 28 full-time and 196 part-time faculty across 57 education and health science programs. Operational funding was used for vendor supported program market research and analysis, as well as for licenses for Lightcast, an online platform for market research and career outlook. Future Outlook NAU will continue to 1) enhance academic programming that addresses evolving workforce needs throughout the State; 2) implement action items from various task forces related to regional workforce development, high impact marketing, and improved student and career service experiences; 3) explore opportunities for targeted recruitment in regions with high job demand and lower educational attainment levels, as well as other under-served communities.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>There are currently eight new College of Education and College of Health and Human Services online programs launching in fall 2023 in direct response to needs of Arizona businesses. NAU invested in expanding statewide and online operations. Enrollment Management, Student Affairs, University Advising, Workforce Development and the Regional Hubs all have staff working in-person around the state to recruit and retain students and engage with the business community. The recently launched Arizona Attainment Alliance (A++) advances NAU's strong relationship with Arizona community colleges to boost Arizona's post secondary attainment rate.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<p>NAU's competitors are private and public institutions, in and outside of Arizona, all of whom, at some level, are recruiting students who seek high return on educational investments. The cost of marketing is expensive and must therefore be done with small investments yielding the greatest impact. Although we have taken action to address attrition, recruitment of high-quality prospective students has not been as successful as hoped. Recruiting staff and faculty has also been challenging, likely a result of the changes brought by the pandemic in addition to the cost of living in Arizona.</p>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>NAU is committed to ensuring post-graduation success. In FY23, NAU awarded 652 degrees and 67 certificates in education and health science disciplines, resulting in over 700 candidates for jobs in hospitals, clinics, and schools. A majority (58%) of these graduates completed master's or terminal degrees, preparing them for leadership and other high-wage careers.</p>				
<b>Additional Notes</b>				
<p>There are three reasons for the expense beyond budget on the project. We had significant carryover funds from FY22. These funds provided additional faculty lines in FY23 that supported required liberal studies courses for online undergraduates; supported the pay rate increase for NAU faculty and staff in January 2023 funded by this project; and, we also expended \$1.0M dollars in part-time faculty pay in the College of Education for statewide and online instruction.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$2,798,571	\$4,776,040		\$7,574,611
Basic Research	\$0	\$0		\$0
Applied Research	\$0	\$0		\$0
Development	\$0	\$0		\$0
Total	\$2,798,571	\$4,776,040		\$7,574,611
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	1362	1287		2649
Undergraduate Students	776	769		1545
Sponsored Project Funding	\$0	\$0		\$0
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Northern Arizona University			
TRIF Investment Area	Workforce Development			
Program Name	Instructional and Graphic Design Support for High-quality Programming			
<b>Problem Statement</b>				
<p>Providing well-developed faculty professional development programs increases overall organizational satisfaction. Professional instructional design drives engaging learning experiences within faculty coursework. A focus on instructional design is necessary to develop and deliver high-quality, accessible programs for all learners. Course enrichments for adult learners will provide classroom design that create effective learning experiences. Busy working professionals will be more engaged and retained through professional design practices. Ongoing TRIF funding will support innovative development of new and existing programs, including alternative credentials, learning modules, stackable programming, as well as prior learning assessments and portfolios.</p>				
<b>Program Description</b>				
<p>The following instructional and graphic design strategies will be supported through the TRIF A/WD initiative. • Coordination of a university-wide instructional and graphic design team to develop transformative and equitable educational opportunities for all learners, including the growing diverse population of adult learners and working professionals • Intentional universal design practices for the creation of instructional materials and utilization of educational technology that enables student success • Ensuring that workforce training, lifelong learning, and professional development programs are developed with competency-based focus design that articulate to learning outcomes</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>Designing classroom instruction that utilizes emerging educational technologies to engage and satisfy adult learners will lead to high-quality learning experiences. The ongoing support of the coordinated team of instructional and graphic designers aligns with NAU's vision to create access to high-quality programming by delivering the highest course quality through the professional development of NAU faculty.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>NAU serves a diverse population of students through the statewide and online programs. The instructional and graphic designers provide expert learning design, educational graphics and creative design, educational technology services, and training support for all NAU faculty, including online and statewide faculty members. Instructional design principles will support the faculty to deliver engaging content that will lead to effective connections between students, faculty, as well as more involvement from students in their learning.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$1,123,554	\$1,123,553	\$1,123,553	\$3,370,660
Basic Research	\$0	\$0	\$0	\$0
Applied Research	\$0	\$0	\$0	\$0
Development	\$0	\$0	\$0	\$0
Total	\$1,123,554	\$1,123,553	\$1,123,553	\$3,370,660
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	0
Graduate Students	50	100	100	350
Undergraduate Students	100	200	300	600
Sponsored Project Funding	\$0	\$0	\$0	\$0
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Northern Arizona University			
TRIF Investment Area	Workforce Development			
Program Name	Instructional and Graphic Design Support for High-quality Programming			
<b>Progress Summary</b>				
<p><b>Accomplishments</b> The Instructional Design and Support Team (IDST), formerly e-Learning Center, continues to support faculty in the design and development of high-quality courses. The annual output of course development or redesign projects decreased from 49 to 21 over the last year, largely due to the team's shift in focus. In collaboration with the Teaching and Learning Center, efforts centered on development and hosting of new faculty training resources, workshops, tutorials, and webinars in support of a NAU's new learning management system, Canvas, which launched in summer 2023. Investment Details This project supports 13.5 FTE and includes funding for staff professional development. There were staffing changes through retirements and other departures that resulted in salary-savings. Remaining vacancies will be filled in FY24. Future Outlook The Instructional Design and Support Team (IDST) will continue in their efforts to support faculty adaption of our new learning management system, Canvas, as well as leading strategic online program and course developments or redesigns for new workforce aligned programming. The team will be restructured with a sole focus toward online programming. We are working in partnership with our colleagues at ASU's EdPlus to adopt proven best practices in building scalable programming, supporting faculty across a variety of disciplines and reaffirming our alignment to the university charter.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
IDST had a busy year. In addition to supporting the university-wide learning management system transition, 21 new online courses were developed in FY23, and 22 new and redesigned courses are in progress or in final review. All of them strategically advanced as part of the high-demand, workforce alignment. For example the Fire and Forest Management Professional undergraduate certificate historically offered in-person in Flagstaff, has been developed as an online program starting fall 2023. This certificate is specifically designed for firefighting professionals who need a 401c government certification. Students from across the country can now earn this certificate from wherever they are located.				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
IDST experienced turnover due to retirements and resignations this year. Recruitment of qualified candidates has been very challenging. Additionally, alignment of our statewide and online academic portfolio with state and regional needs requires new academic programs. Though we aim for efficiency, we want to be certain new programs are warranted by systematic market analyses. If justified, programs are vet ed through faculty curriculum processes then systems must be set up. Additional stages involve marketing and recruitment before courses are designed and offered. The full cycle, from concept to implementation, takes more time than the three-year AWD award cycle.				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
NAU's Statewide and Online programs contributed to the Arizona economy by awarding college diplomas to 719 Arizona residents in FY23, all of whom benefited from the instructional design team's expertise in learning design and educational technology.				
<b>Additional Notes</b>				
Funding for the Information Technology Help Desk, which supports student inquiries for LMS access, faculty inquiries for course development and LMS access ended in FY23 and the performance measures for students are no longer being captured. However, 992 faculty were served through one-on-one course development, LMS migration, symposium and other trainings developed and hosted by this project.				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$797,747	\$778,564		\$1,576,311
Basic Research	\$0	\$0		\$0
Applied Research	\$0	\$0		\$0
Development	\$0	\$0		\$0
Total	\$797,747	\$778,564		\$1,576,311
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	148	0		148
Undergraduate Students	609	0		609
Sponsored Project Funding	\$0	\$0		\$0
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Northern Arizona University			
TRIF Investment Area	Workforce Development			
Program Name	New and Expanded Programming			
<b>Problem Statement</b>				
<p>The Covid-19 pandemic has disrupted the labor market in unprecedented manners across the State of Arizona, including the closings of nonessential businesses, significant demands in healthcare, and sudden shifts to remote work. These disruptions have resulted in displacements of much of the workforce, including but not limited to, service workers, education providers, sales, and social service fields. A significant number of affected workers represent socioeconomically vulnerable diverse populations. Workers are urgently seeking flexible and stackable pathways of education that provide new career and advancement opportunities through upskilling and furthering their educations.</p>				
<b>Program Description</b>				
<p>We have organized an action team to provide an inclusive and collaborative review of our current portfolio of academic programs, delivery models, and student services for each of the statewide sites. This action team is further charged to identify the unique labor demand needs of the individual communities surrounding each statewide site and provide recommendations for new and expanded programming in collaboration with the community college partners. Programming recommendations will include workforce development strategies and student services to best serve our current and future students across the State of Arizona. NAU's implementation of related actions will be data-driven and well-informed through the collective voices and work of the action team. The commitment of A/WD funding is critical for the success of this effort. Examples of potential programming: Grow Your Own Program – Teacher Education: The Grow Your Own program will prepare future teachers to make a difference in their communities. CS4ALL Teaching Certificate – Teacher Education: NAU's strong expertise in computer science pedagogy and teacher training make it a natural partner in the state's Computer Science vision.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>We are well-positioned to reach urban and rural communities through our established statewide sites. The delivery of new and expanded programs will represent high workforce demand and will also provide much needed access to local communities. Proposed expansion of programs will offer a wider range of credentials and new ways of operating in collaboration with community colleges, including opportunities to partner across staff and faculty, building stackable program pathways, and employing universal design practices across programs in 90/30 programs.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>As reported in the 2020 College Completion Report, most of the state public universities' graduates stay in Arizona, find jobs, and contribute to the state's workforce. Providing access to degree attainment in high demand fields for place-bound adult learners will continue to support who would otherwise face undue challenges in pursuing a baccalaureate or graduate degree. Additionally, we will provide upskilling of the workforce communities surrounding our individual statewide sites that will provide pathways for securing a job near their homes and result in the retention of our working residents of Arizona.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$219,112	\$555,624	\$672,348	\$1,447,084
Basic Research	\$0	\$0	\$0	\$0
Applied Research	\$0	\$0	\$0	\$0
Development	\$0	\$0	\$0	\$0
Total	\$219,112	\$555,624	\$672,348	\$1,447,084
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	0
Graduate Students	20	60	60	200
Undergraduate Students	30	60	120	210
Sponsored Project Funding	\$0	\$0	\$0	\$0
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Northern Arizona University			
TRIF Investment Area	Workforce Development			
Program Name	New and Expanded Programming			
<b>Progress Summary</b>				
<p>Accomplishments As a result of NAU task force recommendations for new programs, five colleges and NAU-Yuma will launch a total of 22 new workforce aligned online academic programs in fall 2023, nine of which are also offered at in-person across the state. This project funds faculty positions in new online academic programs in Organizational Leadership and Computer Science and Forestry, who work closely with the Instructional Design and Support Team to build new courses for these programs. Investment Details This project supports five full-time faculty teaching in online programs and stipends for faculty to develop the courses needed for the new programs. Other new online and statewide programs received funding support outside of AWD. Future Outlook The competency-based version of the Master of Organizational Leadership will launch in August 2023, we added instructional support for online undergraduate programs and new general studies courses, and support is being developed for new programs set to launch in fall 24. We anticipate equal or greater interest from colleges to bring online and in-person, high-demand programming across the state based on market analyses, labor trends, and regional needs.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>US jobs requiring a bachelor's degree is expected to increase by 10% in the next decade, according the Bureau of Labor Statics, and although Arizona's unemployment rate has fallen in the last year to 3.5%, the year-over-year employment rate change was just 2.1%. As the nation moves through its current economic cycle, NAU is positioned to bring equitable post-secondary value to our students through career-aligned academic programming, career services, and hands-on work experiences through internships and other fieldwork experiences. Our new online and statewide offerings for fall 2023 show a commitment by our academic leaders to align their efforts to the needs of Arizona.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<p>Competition for recruiting highly qualified faculty and staff has been an unanticipated outcome of the COVID-19 pandemic. Additionally, new and expanded programming in alignment with state and regional needs entails various processes. Though we aim for efficiency, we want to be certain new programs are warranted by systematic market analyses. If justified, programs are vet ed through faculty curriculum processes then systems must be set up. The last stages involve marketing and recruitment before courses are offered. The full cycle, from concept to implementation, takes more time than the three-year AWD award cycle.</p>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>NAU continues to have robust enrollments in programs aligned to Arizona workforce needs that are offered online or at locations around the state. As we work to strengthen existing relationships with employers and partner with new, emerging industries, we are confident we can continue to provide critical degree at ainment access, at an affordable price, to citizens seeking career entry, advancement or change.</p>				
<b>Additional Notes</b>				
<p>Enrollments in new programming will begin fall 2023 (FY24)</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$0	\$367,144		\$367,144
Basic Research	\$0	\$0		\$0
Applied Research	\$0	\$0		\$0
Development	\$0	\$0		\$0
Total	\$0	\$367,144		\$367,144
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	0	0		0
Undergraduate Students	0	0		0
Sponsored Project Funding	\$0	\$0		\$0
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Northern Arizona University			
TRIF Investment Area	Workforce Development			
Program Name	Seed Equipment and Infrastructure Investment			
<b>Problem Statement</b>				
<p>The Challenge: Provide resources to departments/centers, faculty and students to ensure the University remains responsive to current needs of the state. The ability of an institution to succeed in research, student training and workforce development requires support in a variety of ways. Students benefit from the mentorship of expert researchers through paid fellowships or project grants. Early/Mid-career faculty require support to host students and seed funding to help acquire key data to help find external funding. Departments can develop through strategic planning funds to support faculty working in areas that benefit the university's mission. Investment into research infrastructure ensures the university pursues cutting edge-work and effectively trains students to meet the evolving needs of employers.</p>				
<b>Program Description</b>				
<p>The Seed, Equipment and Infrastructure Investments (SEII) program provides a competitive mechanism for NAU researchers, students and/or interdisciplinary teams to request internal support for equipment, infrastructure, seed funding, or strategic planning for new programs to train students in emerging areas of workforce need. Requests will be solicited from eligible investigators doing research in a TRIF-supported initiative, and will be evaluated by internal and external referees on their scientific excellence, impact on student training and workforce development, and alignment with broader strategic goals of the university. We anticipate that researchers participating in programs recognized as Areas of Distinctive Excellence for NAU will be very competitive for support through the SEII program, as will researchers who, in collaboration with others, aim to explore how their own research can integrate with and benefit from these recognized areas of expertise. Improving student outcomes and expanding access to research traineeships or research workforce development are a major focus of the request.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>NAU prides itself as an institution that is dedicated to student access and success, and empowers our students to succeed both in the classroom and the research laboratory. Through this novel program, the university will be able to foster new research opportunities in a manner that is inclusive of the diverse research strengths of research on campus, as well as to help ensure the robustness of our research enterprise and its ability to remain responsive to the evolving workforce needs in our community. Providing exceptional student training and experiential learning opportunities has always been a core mission of NAU and this program will allow us to significantly expand the number of students we serve, and broaden the demographic of students who participate in research.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>The Seed, Equipment and Infrastructure Investments program serves to help the research enterprise at NAU operate optimally, which in turn continues to aid the state's economic growth through providing rigorously trained individuals to support workforce needs in high-demand areas throughout Arizona in all TRIF supported initiatives.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$2,800,000	\$3,500,000	\$4,025,000	\$10,325,000
Basic Research	\$519,167	\$474,167	\$487,500	\$1,480,834
Applied Research	\$354,166	\$514,166	\$527,500	\$1,395,832
Development	\$276,667	\$436,667	\$450,000	\$1,163,334
Total	\$3,950,000	\$4,925,000	\$5,490,000	\$14,365,000
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$525,000	\$650,000
Postdocs Supported	0	2	3	0
Graduate Students	8	10	10	30
Undergraduate Students	50	60	70	180
Sponsored Project Funding	\$0	\$0	\$0	\$0
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Northern Arizona University			
TRIF Investment Area	Workforce Development			
Program Name	Seed Equipment and Infrastructure Investment			
<b>Progress Summary</b>				
<p>The Seed, Equipment and Infrastructure Investment program enables NAU to be responsive to areas of need as they emerge, and has enabled investment into and implementation of the University's Elevating Excellence strategic roadmap. The program is centrally administered and distributes funding on a competitive basis to individuals or teams across the university via a number of internally reviewed intramural programs. Included in this program are offerings that provide seed funding to develop workforce training experiences both on the mountain campus as well as in new markets of Arizona, aids development of new externally sponsored programs, enables the acquisition and support of specialized instrumentation or laboratory renovations, and provides funding for undergraduate and graduate student research experiences across the research enterprise. The most significant component of the program is its support for the Elevating Excellence Impact Funding program, which aims to support projects, campus-wide, that are positioned to immediately advance the strategic priorities of the university.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>The majority of the funds in this program have been dedicated to launching and implementing NAU's Elevating Excellence award program. This transformational program enables the university's goal of creating experiences and environments where students can learn and succeed, supported by faculty and staff. The Elevating Excellence program issued calls for proposals focused on advancing institutional efforts to increase undergraduate and graduate student success. Program funds were distributed via review of applications from several competitive intramural processes. One of the largest investments from this program aimed to expand the number of opportunities for undergraduate research and experiential learning by a dramatic expansion of programming in NAU's Office of Undergraduate Research and Creative Activities (OURCA) to support mentored research and workforce development experiences for undergraduate students across campus. Investment into research infrastructure and instrumentation of strategic importance to campus research efforts across TRIF initiatives was also made through this program, as was the direct support of graduate student researchers and their projects. TRIF funds were also used to support small pilot projects that allow researchers to acquire key data to accelerate their efforts to secure extramural funding.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<p>The Seed, Equipment and Infrastructure Investment program is a new offering from NAU and is intended to be flexible in order to meet the evolving needs of the research enterprise. These needs arise over the course of the year and expenditures from the program to address the needs are not always facile to predict. We expect that expenditures for this program will bet er align with our estimated budgets as this program continues to evolve and mature.</p>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>Outfitting the research enterprise at NAU with the tools it needs to provide meaningful research training experiences for students is one of the main goals of the program, and investments into this program in the previous year has allowed the university to dramatically expand these opportunities across campus. NAU has always been commit ed to providing an effectively trained research workforce to address the business needs of the state, and is growing our efforts as the industrial needs of the state continue to expand.</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$413,053	\$4,199,125		\$4,612,178
Basic Research	\$97,447	\$495,416		\$592,863
Applied Research	\$29,844	\$30,091		\$29,844
Development	\$29,844	\$0		\$29,844
Total	\$570,188	\$4,724,632		\$5,294,820
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$371,289		\$371,289
Postdocs Supported	0	0		0
Graduate Students	52	38		90
Undergraduate Students	88	221		309
Sponsored Project Funding	\$0	\$0		\$0
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Northern Arizona University			
TRIF Investment Area	Workforce Development			
Program Name	Student Service and Support			
<b>Problem Statement</b>				
<p>As US society has increasingly created a narrative of questioning the value of higher education, students and their families have had greater interest in assurances that the university experience and achieving a college degree will lead to social mobility through expanded employment opportunities. This specific population will benefit from a prescriptive degree completion plan that increases access through barrier-free support. Now more than ever, it is critical that all students, including adult learners, receive holistic services and support throughout the student lifecycle, particularly in the areas of purposeful academic and career alignment, participation in internship and externships, transferable career skill development, and strong job seeking skills.</p>				
<b>Program Description</b>				
<p>Example of proposed programming: • University Advising Access Connected Care Team: The creation of the University Advising Access Connected Care Team (ACCT) will build new institutional services devoted to increasing access and student success, with a particular emphasis on non-traditional transfer students and academic programs supporting workforce development. We will directly address the distinct needs of non-traditional and adult learners through a case-management approach, which guides students through institutional policies and processes, serves students outside traditional business hours, and integrates an infrastructure that utilizes data and technology for data-driven decision-making and efficient operations.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>ACCT will substantially improve our ability to open access pathways and build capacity in workforce development programs. The North Valley site provides an ideal location convenient for place-bound students within Phoenix, Statewide Sites, and surrounding communities. We will provide on-site services at the North Valley site with a focus on degree attainment in a timely and cost-effective manner. The student support will collaborate across university and community college partners to attract and serve students with barrier-free educational pathways, including the development of a comprehensive structure for accessing prior learning for credit.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>In July 2021, Arizona ranked 39th amongst US states in unemployment rates at 6.6% (national average is 5.4%, U.S. Bureau of Labor Statistics) and 33rd in college attainment rates (30% compared to the national average of 33%). College degrees can result in greater access to higher paying jobs and provide protection against unemployment during economic downturns. But college degrees alone do not provide access to higher paying job opportunities; students also need experiences that build transferable job skills and access to social networks that provide access to such jobs. By investing in to embed career development in academic programs, as well as provide direct support to students to build a strong professional portfolio of transferrable career skills enhanced with internship experiences, NAU will advance its commitment to equitable postsecondary value.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$1,277,146	\$1,219,979	\$1,082,361	\$3,579,486
Basic Research	\$0	\$0	\$0	\$0
Applied Research	\$0	\$0	\$0	\$0
Development	\$0	\$0	\$0	\$0
Total	\$1,277,146	\$1,219,979	\$1,082,361	\$3,579,486
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	0
Graduate Students	481	713	713	2171
Undergraduate Students	1070	1587	2174	4831
Sponsored Project Funding	\$0	\$0	\$0	\$0
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0



# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Northern Arizona University			
TRIF Investment Area	Workforce Development			
Program Name	Student Service and Support			
<b>Progress Summary</b>				
<p>Accomplishments Implementation of cross-divisional task force-identified priorities to enhance online and statewide student support services are underway. These priorities include the development of wrap-around support services for students, including advising, retention, financial aid, tutoring, mental health and other services. The Transfer Admissions Team have streamlined the process for transfer student admission decisions to 1-2 days. Investment Details The University Advising Access Connected Care Team was instrumental in helping students during the Fall 22 and Spring 23 terms. They supported students who experienced a myriad of challenges while trying to complete their coursework. The staff focused on coaching, mentoring, and holistic support to connect students to essential university resources, support those who required additional guidance due to their circumstances, and responded to faculty and staff alerts about students who may need additional support. Statewide/Regional Hubs and Office of Workforce Development units are responsible for the development and cultivation of partnerships for the university. These partnerships across government partners, public agencies, and other strategic partners will accelerate enrollment, employment, hands-on skill development, and overall student success and experience. University Admissions and Personalized Learning have staff funded by this project who will support improved admission processing and project management for new Personalized Learning programming launching in fall 2023. Future Outlook The majority of student support services for students learning online or at statewide locations has been offered online. The Statewide Services and Academic Programming Taskforce Report, dated January 15, 2022, recommended creating four distinct in-person regional hubs (Northern, Central, Southeast, and Southwest) with each comprised of specialized teams to support scalability of recruitment and student services. The Southwest and Central hubs are fully implemented while we continue to develop and hire personnel needed for the other teams.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>We have built holistic services with teams focused on the unique needs of adult learners, engaged with businesses to champion the development of workforce aligned and place-specific programming, and invested across the university to develop in-person student support programs similar to the Yuma Educational Success (YES) program at the NAU-Yuma Branch Campus. We have identified and built upon best practices for supporting non-traditional learners and have been able to pilot projects that so far seem promising, efficient, and scalable. We have several curricular projects aimed at streamlining and updating the academic portfolio while ensuring workforce market demand alignment and design of high quality courses built on internal instructional design and educational technology resources.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<p>Delays in personnel recruitment for vacant positions has caused unexpected delays in project implementation. Additionally, the full process cycle, from new program concept to implementation, takes more time than the three-year AWD award cycle.</p>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>NAU aims to create a sense of belonging for all of our students. To do so, we have built robust student support services for Flagstaff-based students. Being comparably successful for students who live away from Flagstaff is challenging. With over 7,000 students enrolled in online and statewide programs in Fall 2022, 68% of them Arizona residents, much of our engagement is done via electronic communications. Our efforts to bring in-person service hubs throughout the state will provide all of our students with an opportunity to experience the care, support and engagement that will impact retention and completion.</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$81,590	\$1,168,994		\$1,250,584
Basic Research	\$0	\$0		\$0
Applied Research	\$0	\$0		\$0
Development	\$0	\$0		\$0
Total	\$81,590	\$1,168,994		\$1,250,584
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	0	518		518
Undergraduate Students	315	4935		5250
Sponsored Project Funding	\$0	\$0		\$0
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	Northern Arizona University			
TRIF Investment Area	Workforce Development			
Program Name	Workforce Training, Lifelong Learning, and Professional Development			
<b>Problem Statement</b>				
<p>Arizona is facing a worker shortage across several sectors, including the service industry, high-skilled technical talent, and manufacturing environments. Arizona sectors with high job losses due to the pandemic include education, sales, and social services, with the current job market privileging bachelor's and master's degree recipients. Arizona's Hispanic or LatinX populations are reported at 31.7%, a significantly higher percentage than the rest of the country. Hispanic, first-generation, non-traditional, and low-income students often seek formal education and/or workforce training to enhance their opportunities. The demand for workforce training, lifelong learning, professional development will remain strong as community members seek alternative educational pathways toward sustainable employment.</p>				
<b>Program Description</b>				
<p>Mesa Workforce Development Center: The NAU School of Hotel and Restaurant Management (SHRM) is working with Intermetics Partners and Kind Hospitality to develop a facility that will serve as an education and training hub located at Skybridge Arizona in Mesa, AZ. The leaders of SkyBridge estimate 10,000-12,000 new jobs will be created within the next decade on site, based on the mixed use of the 3.5 million square feet slated for development, and that is just within Phoenix-Mesa Gateway Airport. The Center will prepare students and workers for jobs by providing the necessary skills and credentials through apprenticeships and employer required occupational training in addition to their regular academic instruction. Other proposed workforce training, lifelong learning, and professional development programs include a Microelectronics Workforce Training Program, Industry 4.0 Workforce Training Lab, Financial Planning Certificate, Risk Management and Insurance Certificate, Hospitality Innovative Technology (HIT) Certificate, Organizational Leadership Series, Customer Service Institute, and K-12 Center.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>The Mesa Workforce Development Center Skybridge partner, Swift, is already a corporate partner for the W.A. Franke College of Business (FCB) Risk Management and Insurance (RMI) program. The corporation has made a significant donation to the RMI program. The state of Arizona has been home to many semiconductor and electronics manufacturing companies since 1950's. Recently, TSMC and Intel both announced their investment to build additional semiconductor fabs in Chandler, AZ. The Microelectronics Workforce Training Program will provide the industry with a talented and intelligent university-educated workforce that will innovate, build new products, and adapt to new technologies. Short, non-credit programming that allows workforce training, lifelong learning, and professional development opportunities will enable adult learners and working professionals to quickly upskill or change careers completely. These non-traditional educational and training pathways are essential to building a strong and adaptable workforce in Arizona.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>The Mesa Workforce Development Center, with state-of-the-art facilities, will be able to provide affordable and accessible education and training where people work and live. Swift, a Phoenix, Arizona-based American truckload motor shipping carrier with over 23,000 trucks, is the largest common carrier in the United States. Mesa, Arizona was recently ranked by Bloomberg CityLab as one of the top 10 cities with the fastest-growing job markets and fastest-growing populations. NAU will help develop the talent that hospitality employers need to accommodate present and future demand for their products and services. This workforce development center will increase HRM's visibility in the greater Phoenix area, assisting with student recruitment and the building and maintaining of a stronger enrollment pipeline. According to the Greater Phoenix Economic Council's (GPEC) 2020 Report on Operational Structure Global Business Trends, "Nerve Centers" are the latest evolution of corporate shared services that place heightened importance on process innovation, utilization of Industry 4.0 technologies, and integration of operations and information across the organization. NAU's Industry 4.0 Workforce Training Lab (I4TL) will play a critical role in Greater Phoenix Nerve Centers by providing cutting edge corporate workforce trainings. FCB will also have greater engagement with working professionals and industry and community stakeholders. It will also strengthen the FCB brand and FCB outreach efforts in the greater Phoenix area. The workforce training programs will provide working professionals with a flexible learning schedule, which is important because many of them work non-traditional work shifts in operations that are 24/7. Additionally, digital skills and knowledge gained in Hospitality Innovative Technology programs are a fundamental part of the success of businesses in a state that relies heavily on tourism. As Arizona continues to add new companies and more people to our state, opportunities for employees to move into management positions will be greater. The need for quality supervisory training will be critical, especially for technical industries that expect strong growth, like advanced manufacturing, information technology and healthcare. Additionally, offering non-credit, affordable programming that provides hands on training in this area could help businesses of all types develop employees with stronger customer service skills. Better trained employees will hopefully lead to growth in an organization's customer base and sales. The Arizona Teachers Academy has provided strong financial incentives to attract new teachers into the profession. However, teacher retention is a big issue for Arizona schools with many leaving within the first few years of entering the profession. Expanding our professional development offerings provided by the NAU College of Education and the K12 Center will support new and continuing teachers, which is critical to building tomorrow's workforce.</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$800,600	\$740,456	\$761,350	\$2,302,406
Basic Research	\$0	\$0	\$0	\$0
Applied Research	\$0	\$0	\$0	\$0
Development	\$0	\$0	\$0	\$0
<b>Total</b>	<b>\$800,600</b>	<b>\$740,456</b>	<b>\$761,350</b>	<b>\$2,302,406</b>

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	Northern Arizona University			
TRIF Investment Area	Workforce Development			
Program Name	Workforce Training, Lifelong Learning, and Professional Development			
<b>Progress Summary</b>				
<p>Accomplishments The Office of Workforce Development at NAU includes Educational Partnerships and Continuing Education. It establishes and enhances business partnerships across the state, with the goals of providing workforce training, lifelong learning, and professional development opportunities. In addition, Continuing Education develops alternative and continuing education classes for Arizona communities and completes real-time workforce and market demand analyses for Academic Affairs. In close collaboration with college faculty and leadership, 38 new academic program proposals were supported by this team and 17 not-for-credit, continuing education programs were offered, both in-person and online, serving a total of 326 participants. The unit also worked with the W.A. Franke College of Business and provided the ongoing organizational groundwork for the establishment of a new campus location offering six business programs in the east valley, with anticipated final approvals by the beginning of 2024. Additional workforce development and lifelong learning programs are being developed with that college and the College of Engineering, Informatics, and Applied Sciences with planned launches throughout FY24. Programs include microelectronics workforce training, industry workforce training Lab, financial planning, risk management and insurance, hospitality innovative technology, organizational leadership, customer service, and professional development expansion for the K12 Center. NAU continues to expand partnerships with businesses and other organizations across the State to support employee degree completion, providing specific skills through certificates, and to inform future workforce needs. NAU had 117 such business partners in FY23. Investment Details Funds supported the hiring of faculty and staff to support the new programming and initiatives, travel for coordination meetings with workforce development boards and businesses in throughout the state, hosting the first Arizona Clean Hydrogen Workshop. Future Outlook With our college partners engaged in their workforce education and training programs, we look forward to launching these new educational pathways throughout the next reporting period.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>Engagement with Arizona industries, especially those experiencing labor shortages, allowed us to identify gaps in professional development programming and opportunities for ad hoc workforce training programs. In one instance, Continuing Education partnered with a Phoenix-based manufacturing company that recently experienced high-turn over in supervisory/leadership positions due to a significant number of retirements, particularly during the pandemic. NAU developed and provided industrial leadership training for their emerging leaders who do not have baccalaureate degrees. A few graduates of the training program have already signaled their intention to pursue leadership degrees with NAU and they will be able to start their programs with academic credit achieved through Prior Learning Assessment. Innovative and actionable agreements like this program allow NAU to make immediate socioeconomic impact across the State.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<p>Collaborating across a large geographic area and ensuring we can meet multiple community workforce needs in multiple ways will require additional staffing. We have experienced challenges recruiting candidates for vacancies in this arena.</p>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>Ensuring Arizonans possess the skills and education necessary to be competitive in the Arizona job market is central to this project. To do so, we collaborate with workforce development offices, engage with chambers and other business associations, engage employers, join consortia for emerging industries, monitor national, regional, and state labor trends and identify labor gaps.</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$123,907	\$592,471		\$716,378
Basic Research	\$0	\$0		\$0
Applied Research	\$0	\$0		\$0
Development	\$0	\$0		\$0
Total	\$123,907	\$592,471		\$716,378
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	0	0		0
Undergraduate Students	163	326		489
Sponsored Project Funding	\$0	\$0		\$0
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0



# TECHNOLOGY AND RESEARCH INITIATIVE FUND

UNIVERSITY OF ARIZONA

FISCAL YEAR 2023





## EXECUTIVE SUMMARY

UArizona achieved \$824 million in research expenditures last year, and TRIF continues to drive advancement of initiatives that align with areas of state and national need, and where we have faculty expertise and specialized facilities, infrastructure, and enabling technologies.

We leverage TRIF investment to attract new funding to the state; provide unique student training programs to prepare a diversified, modern workforce; jump-start innovation that creates economic and societal impact; support a robust entrepreneurial ecosystem; and move inventions stemming from university research into the marketplace.

### INITIATIVES

Improving Health; National Security Systems; Space Exploration and Optical Sciences; Water, Environment and Energy Solutions; and Workforce Development.

### HIGHLIGHTS

- We leveraged TRIF investment to attract \$266 million in new sponsored projects funding. For example, TRIF investments in the Micro Nano Fabrication Center helped secure a transformational investment from the Arizona Commerce Authority that will allow us to build not only a state-of-the-art physical facility to support semiconductor manufacturing, but digital and virtual reality platforms that will allow us to deploy workforce training across the state.
- TRIF-supported research programs engaged 2,740 undergraduates, 741 graduate students, and 138 post-doctoral appointees. For example, the TIMESTEP Summer Internship allowed undergraduates in the physical sciences and mathematics to connect with small to mid-sized businesses/industry based in Southern Arizona, creating paths to employment and connecting businesses with university resources. Additionally, as the leading cyber program for undergraduates in the U.S, we taught 1,500+ students this year and produced 268 additional graduates, delivering a large cadre of talent to improve cyber resilience in Arizona and beyond.
- 28 patents were issued, and 3 new startup companies were launched based on technology from TRIF-supported research. For example, researchers developed a drug that has been licensed to the Tucson-based start-up, Proneurogen, and has begun first-in-human trials for the treatment of vascular dementia, the most common form of Alzheimer's disease. With an emphasis on moving inventions into the marketplace, UArizona ranks No. 30 among universities worldwide for U.S. patents issued.







UArizona invested 64% of its FY 2023 TRIF funds toward research on improving health and finding national security solutions. The university also invested significant TRIF funds towards research on water, environment, and energy. The research dollars were used mainly (77%) to support research infrastructure and applied research.

These investments generated \$265.8 million in outside related sponsored project funding, resulted in 4 startups, and supported 4,047 graduate and undergraduate students.

Exhibit UA.1: FY 2023 UArizona Base Allocation Expenditure Summary

**\$31,946,002**  
Proposal 2023

2023 Proposal vs Actual

● Proposal 2023 ● Actual 2023

**\$26,432,595**  
Actual 2023

University of Arizona



Proposal 2023 and Actual 2023 by Investment Area

● Actual 2023 ● Proposal 2023

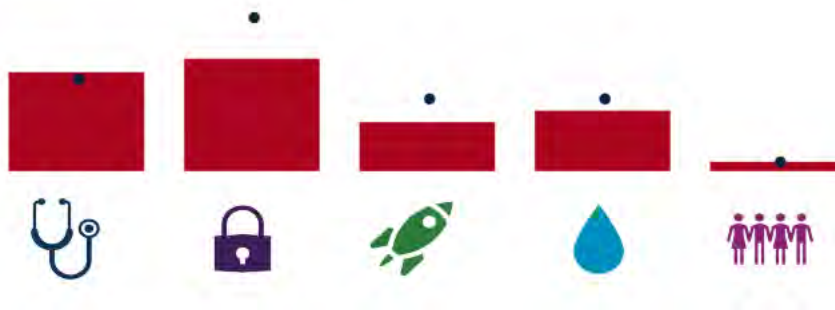


Table UA.1: FY 2023 TRIF Expenditures by Investment Area

InvestmentArea	Proposal 2023	Actual 2023	Budget Delta
Improving Health	\$7,357,469	\$7,926,148	(\$568,679)
National Security Systems	\$12,294,265	\$9,007,250	\$3,287,015
Space Exploration and Optical Solutions	\$5,785,535	\$3,921,776	\$1,863,759
Water, Environment and Energy Solutions	\$5,785,540	\$4,837,307	\$948,233
Workforce Development	\$723,193	\$740,114	(\$16,921)
<b>Total</b>	<b>\$31,946,002</b>	<b>\$26,432,595</b>	<b>\$5,513,407</b>



Exhibit UA.1: FY 2023 TRIF Revenue and Expenditures by Investment Area and Initiative (\$ Millions)

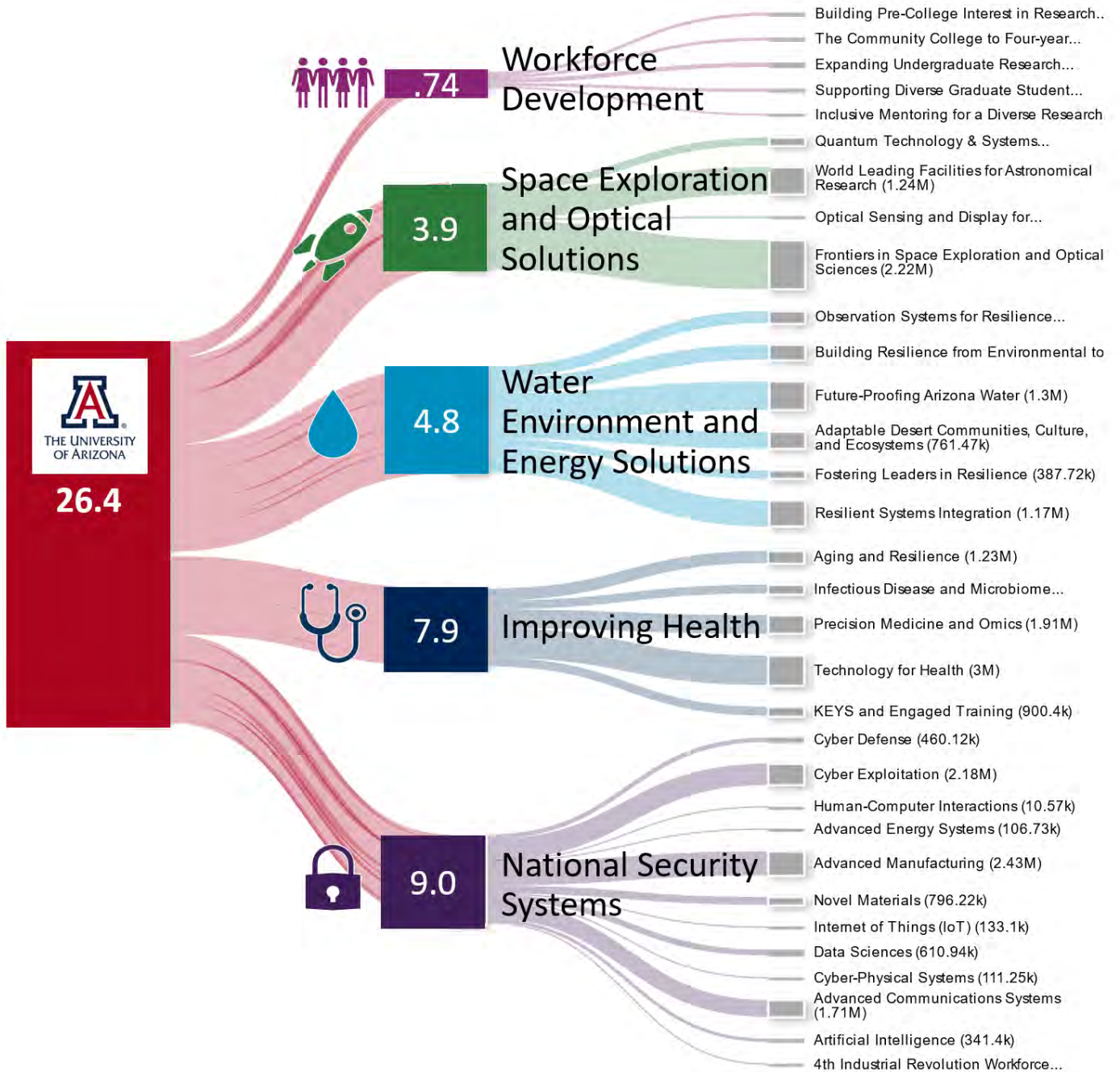


Table UA.2: FY 2023 Performance Measures

Measures	2023 Projections	2023 Actuals
Faculty Startup Package Expenses	6,655,704	9,636,915
Postdocs Supported	176	138
Graduate Students	500	741
Undergraduate Students	464	3,306
Sponsored Project Funding	\$159,400,003	\$265,787,443
Publications in Academic Peer-Reviewed Journals	699	455
Startups	15	4

Exhibit UA.2: FY 2023 TRIF Expenditure by Research Category (in millions)

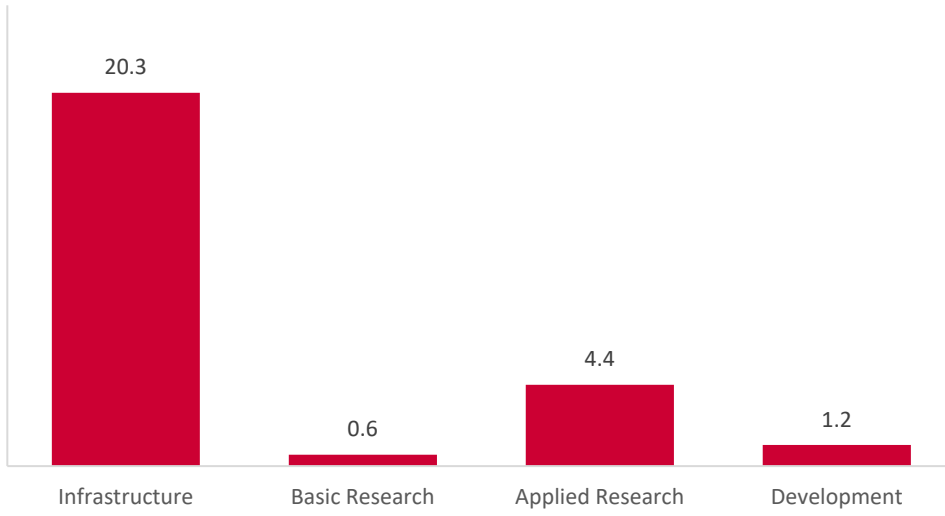
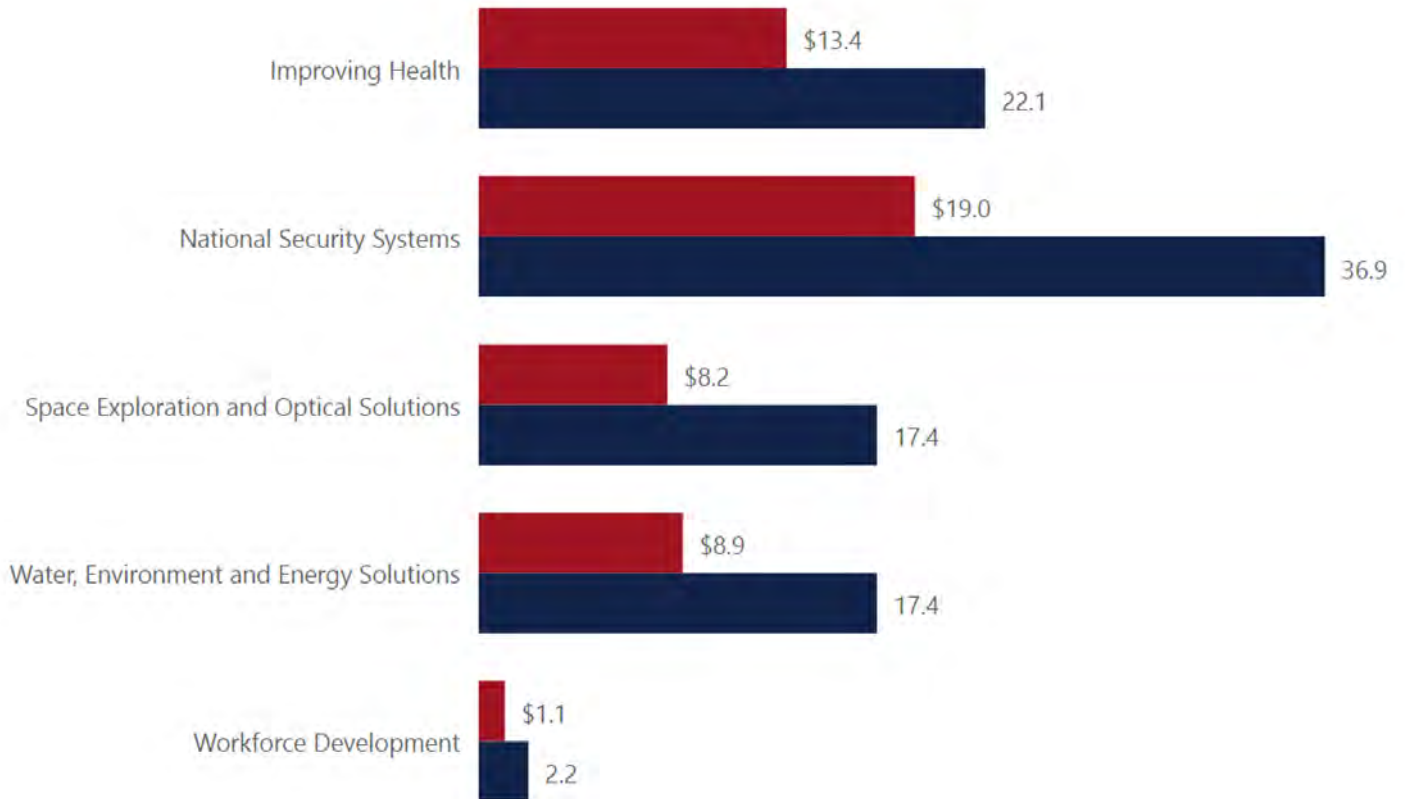


Exhibit UA.3: FY 2023 – FY 2023 Cumulative Expenditures vs 3 Year Proposals

● 2 Year Actual ● 3Yr Proposal



# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	Improving Health			
Program Name	Aging and Resilience			
<b>Problem Statement</b>				
<p>With more and more individuals living longer, an aging Arizona population will bring unique challenges and opportunities in health care. Critical research and development still needs to be done to understand the processes of normal and healthy aging; determine the causes of age-related diseases; develop and test drugs, devices, and behavioral interventions to minimize handicap and disease; and maximize functionality and independence for a higher quality of life.</p>				
<b>Program Description</b>				
<p>We expect to gain a better understanding of common initiating mechanisms across four age-associated neurodegenerative diseases (Alzheimer's, Parkinson's, multiple sclerosis, and ALS). We also will continue trials into potential therapeutics and interventions to reverse cognitive decline. Technology developments will be leveraged into advances in home health, mobile health (mHealth), and telemedicine applications that bring safety, security, and medical care to all corners of the state and beyond. Working with the resources of the University of Arizona's NCI-designated Comprehensive Cancer Center, we will embark on programs to prevent cancer through precision lifestyle modifications and early detection, and cure cancer with greater understanding of its biological underpinnings and new treatments, such as immunotherapy.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>We are uniquely poised to conduct both basic and clinical research into the biology of aging and age-related brain diseases such as Alzheimer's, Parkinson's, and other neurological conditions. We have expertise in many areas related to aging and age-related disease, particularly in psychosocial, cognitive, immune, inflammation, neurodegenerative, metabolic, and geriatric care. Our studies range from brain imaging to looking at molecular and genomic changes during aging to dietary and exercise interventions. Together with our health and community partners, we have the expertise and support to translate basic studies into effective treatments and life-enhancing strategies for humankind, which ultimately will reduce health care costs and increase the chance for a long, healthy, productive, disease-free life.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$569,289	\$569,289	\$569,289	\$1,707,867
Basic Research	\$220,048	\$220,048	\$220,048	\$660,144
Applied Research	\$385,084	\$385,084	\$385,084	\$1,155,252
Development	\$55,012	\$55,012	\$55,012	\$165,036
<b>Total</b>	<b>\$1,229,433</b>	<b>\$1,229,433</b>	<b>\$1,229,433</b>	<b>\$3,688,299</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$275,060	\$3	\$495,108	\$1,155,252
Postdocs Supported	25	25	25	75
Graduate Students	65	65	65	195
Undergraduate Students	70	70	70	210
Sponsored Project Funding	\$20,000,000	\$20,000,000	\$20,000,000	\$60,000,000
Publications in Academic Peer-Reviewed Journals	92	92	92	276
Startups	0	1	0	1

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona			
TRIF Investment Area	Improving Health			
Program Name	Aging and Resilience			
<b>Progress Summary</b>				
<p>UArizona continues to make significant basic and translational discoveries to better understand the health implications of aging and age-related brain diseases such as Alzheimer's, Parkinson's, and other neurological conditions. We are learning more about how humans can achieve a lifetime of good health by studying the biological mechanisms of healthy versus diseased aging. There are many ongoing projects that range from studying the results of dietary, behavior, and lifestyle modifications as a form of prevention to continuing trials of potential therapeutics and interventions to reverse cognitive decline. With the award of an equipment grant from the National Institutes of Health, UArizona will be among the first institutions in the country to house what is currently the most powerful FDA-approved 3T MRI instrument in the world. This technology will produce the most clear and comprehensive images of the brain to-date, dramatically enhancing current research projects and enabling new discoveries. Another important example of sustained investment leading to outstanding return is the Precision Aging Network, which is in its second of a five-year National Institutes of Health grant. Created and led by UArizona, the ultimate goal of the network is developing more effective brain-aging treatments and interventions targeted to the individual.</p>				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
<p>In one important discovery, UArizona researchers have developed a glycopeptide drug based on the hormone Angiotensin (1-7) that has been licensed to the Tucson-based start-up, Proneurogen, which has begun first-in-human trials for the treatment of vascular dementia, the most common form of Alzheimer's disease. This would be one of the first disease-modifying treatments that will slow or even reverse the effects of vascular dementia. Another devastating neurodegenerative disease, Parkinson's, most often affects those upwards of 60 years old. While it's commonly known for its movement-related symptoms, it also affects people's voices. These vocal changes appear much earlier in the disease's development – sometimes decades before movement-related symptoms. Using zebra finches as a model, researchers have identified a specific gene commonly associated with Parkinson's that may be behind vocal-related issues. Next steps will be to apply these findings to human data which could provide more answers that lead to better Parkinson's diagnoses and treatments – ones that come long before movement-related symptoms tell a patient to visit a neurologist.</p>				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
<p>While resilient aging remains a grand challenge that will require continued investment and cutting-edge research and innovation, no serious roadblocks were encountered in fiscal year 2023. The year was marked by outstanding progress in understanding the fundamentals of healthy and abnormal aging, creating partnerships across the university, state, and country, and developing and translating discoveries that will continue to make a difference to Arizonans and those around the world.</p>				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
<p>This TRIF project provides benefits to the state by supporting multidisciplinary collaborations throughout the UArizona enterprise as well as strong external partnerships, research continues to lead to successful discoveries and patents, technological advances, and spinout companies focused on healthy aging and resilience. As the population in Arizona continues to age, discoveries from our researchers will directly impact quality and longevity of life. Through collaborations within the BIO5 Institute, the Arizona Center for Drug Discovery, and other UArizona institutes and departments, opportunities to commercialize life enhancing medications and therapies will grow.</p>				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$658,551	\$797,634		\$1,456,185
Basic Research	\$2,471	\$19,108		\$21,579
Applied Research	\$117,916	\$205,353		\$323,269
Development	\$136,918	\$205,072		\$341,990
Total	\$915,856	\$1,227,167		\$2,143,023
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$197,155	\$422,362		\$619,517
Postdocs Supported	6	4		10
Graduate Students	35	33		68
Undergraduate Students	54	63		117
Sponsored Project Funding	\$29,020,922	\$38,324,919		\$67,345,841
Publications in Academic Peer-Reviewed Journals	54	16		70
Startups	1	0		1

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	Improving Health			
Program Name	Infectious Disease and Microbiome Sciences			
<b>Problem Statement</b>				
<p>Infectious disease is the major cause of death in low-income countries, and emerging infectious diseases threaten countries worldwide, as the COVID-19 pandemic has shown. Researchers learn more every day about the role the human microbiome (both bacteria and viruses) plays in health and behavior. An example includes respiratory diseases that are considered to result from a combination of genes, environment, and lifestyle. The role of microbes in health and disease through interconnected human-animal-plant-earth reservoirs presents a complexity which is of vast importance and not yet completely understood.</p>				
<b>Program Description</b>				
<p>We will leverage the considerable infrastructure we have developed for testing and serology of COVID-19 into a broader infrastructure for understanding, preventing, and treating infectious disease and possible future pandemics, as well as understanding the long-term effects of these diseases. We will also develop models of vector-borne infections such as Zika. Understanding the variables affecting mosquito spread in Arizona may inform strategies to stop the transmission of Zika and keep Arizona free of this disease. Finally, we will look inside the human body to understand the healthy microbiome in niches throughout the body, as well as dysbiosis and its effect on diseases such as gastrointestinal cancers and infertility.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>UArizona's interdisciplinary researchers are pushing the boundaries of knowledge. Our outstanding investigators across immunobiology, public health, medicine, animal and comparative biomedical sciences, and others work together with complemented expertise to solve complex problems. TRIF-supported facilities such as the genetically engineered mouse models and biosafety level 3 and omics capabilities support cutting-edge research to enable new discoveries related to the role of microbes in human health and disease.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>•Development of more accurate, rapid, and inexpensive tests for COVID-19 and future infectious diseases</li> <li>•Better understanding of demographic and health history effects on immunoprotection gained with vaccination against COVID-19 and other diseases</li> <li>•New clinical trials to show effect of potential therapies for respiratory illnesses</li> <li>•Better understanding of the healthy biome in various human organs, and development of therapies for dysbiosis</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$569,289	\$569,289	\$569,289	\$1,707,867
Basic Research	\$220,048	\$220,048	\$220,048	\$660,144
Applied Research	\$385,084	\$385,084	\$385,084	\$1,155,252
Development	\$55,012	\$55,012	\$55,012	\$165,036
<b>Total</b>	<b>\$1,229,433</b>	<b>\$1,229,433</b>	<b>\$1,229,433</b>	<b>\$3,688,299</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$275,060	\$3	\$495,108	\$1,155,252
Postdocs Supported	25	25	25	75
Graduate Students	65	65	65	195
Undergraduate Students	70	70	70	210
Sponsored Project Funding	\$20,000,000	\$20,000,000	\$20,000,000	\$60,000,000
Publications in Academic Peer-Reviewed Journals	92	92	92	276
Startups	0	1	0	1

Arizona Board of Regents  
Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona			
TRIF Investment Area	Improving Health			
Program Name	Infectious Disease and Microbiome Sciences			
<b>Progress Summary</b>				
Thanks to specialized TRIF-supported UArizona facilities, seed funding and equipment, BIO5 Institute researchers made great progress in understanding the long-term effects of COVID-19, and are continuing work targeted at actionable strategies to fight other infectious diseases such as Valley fever. Collaboration allowed us to develop insight into enhanced prevention, diagnostic, and treatment options, and resulted in large projects being funded by the NIH, CDC, and other sponsoring agencies. Advances were made in understanding the role that microbes play in human well-being, such as gut, brain, and immune system health.				
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>				
UArizona researchers participated in a national effort to understand why some people develop long-term symptoms following COVID and how to better treat and prevent long COVID. Our scientists are leading one of 15 adult national cohorts that contributed to the study and have discovered an initial roadmap to diagnosing long COVID which will be validated in ongoing studies. We received further funding to study long COVID in Arizonans enrolled in the CoVHORT initiative. Data collected shows more than 30% of people infected experience long COVID, so research into better diagnostics and treatments for suffering Arizonans will continue. UArizona researchers studied gastrointestinal (GI) long COVID in patients. With \$3.7 million in funds from the NIH, results indicate COVID patients suffering GI symptoms during acute disease were four times more likely to develop GI long COVID, with 30.6% of those patients having post-infectious irritable bowel syndrome symptoms. We will expand this work to better understand immune responses that may trigger inflammation. These findings may lead to treatments for GI long COVID and other intestinal infections.				
<b>What, if anything, hasn't worked as well as was hoped?</b>				
This year marked an official end to the COVID pandemic; however, lingering health challenges and mysteries remain. The important recruitment of volunteers for human research and trials remained difficult, especially subjects who are at high risk for infection. This difficulty has been easing and is expected to be resolved in the next fiscal year.				
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>				
Scientists continued an initial study looking at how elevated levels of an enzyme, sPLA2-IIA, could be used as a biomarker when understanding severity of COVID. The analysis in the submitted manuscript suggested increased levels of certain biomarkers aligned with COVID patients dying from multiple organ failure versus those who survived infection. The interdisciplinary team filed two provisional patents and formed a new-startup company, Resonance Pharma Inc. to further research in understanding devastating diseases like COVID-19. Our scientists also looked at diseases affecting humans from possible food and water contamination. The Arizona Department of Health Services estimates that foodborne illness affects one in six across the U.S. With a Center for Produce Safety funded project, UArizona is using next generation sequencing technologies to develop rapid detection tools for foodborne pathogens. This ongoing research is aiding in critical detection tools for food safety for the Arizona produce industry. Researchers focused on new therapies to treat Cytomegalovirus (CMV), often an invisible virus that infects more than half of U.S. adults by the time they are 40. While many will not realize they have CMV, infected individuals who are immunocompromised are subject to multiple organ failure or even death. It also is the leading cause of viral birth defects such as hearing loss, blindness, developmental disabilities, and microcephaly (small head). UArizona researchers studying this virus are developing mass spectrometry approaches and lipid libraries to aid in developing other antiviral therapies that will help people in Arizona and beyond.				
<b>Additional Notes</b>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$353,607	\$508,045		\$861,652
Basic Research	\$0	\$108,833		\$108,833
Applied Research	\$285,179	\$273,449		\$490,532
Development	\$0	\$0		\$0
Total	\$638,786	\$890,327		\$1,529,113
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$54,023		\$54,023
Postdocs Supported	13	15		28
Graduate Students	61	58		119
Undergraduate Students	48	76		124
Sponsored Project Funding	\$78,657,229	\$45,673,250		\$124,330,479
Publications in Academic Peer-Reviewed Journals	80	114		194
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	Improving Health			
Program Name	KEYS and Engaged Training			
<b>Problem Statement</b>				
<p>As one of the core tenets of our mission, we are committed to training and inspiring our next generation of scientists. Many students interested in the biosciences are never able to practice and contribute to hands-on research in actual laboratories. Through BIO5's KEYS Research Internship Program, we provide real-world application of classroom learning to spark intellectual and creative curiosity and connect Arizona's excelling students with UArizona while still in high school. These real-world laboratory experiences with BIO5 build a pipeline of talent into our state universities, prepare students for success in college and career, and help strengthen our state's future knowledge-based workforce.</p>				
<b>Program Description</b>				
<p>BIO5 engages and trains our future generations of scientists through innovative internship programs and an interactive learning environment that promotes experiential learning and STEM proficiency in Arizona. Undergraduates, graduates, postdocs, and even high school interns experience practical application of what they learn in the classroom by working side by side with world-class researchers in BIO5 labs. Forty percent of those working in BIO5 are students. We will continue to engage the pipeline of trainees from the high school through postdoc levels through programs like KEYS and active learning research opportunities for UArizona students. We will also demonstrate how student success and experiential research are integrally linked. Our KEYS Research Internship Program binds talented high school students to UArizona early, which often provides the foundation to keep them in Arizona for, and after, college.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>The seven-week KEYS Research Internship Program offers a unique opportunity to talented high school students who have a strong interest in science, health, or the environment. The internship provides students with laboratory experience and the ability to work with world-class scientists on real research projects. Since 2007, 526 students have completed the KEYS internship. Of those, 71 percent have chosen to stay in Arizona for college, with the majority of those at ending UArizona. KEYS alumni are automatically accepted into UArizona's Honors College, and most pursue STEM-related degrees and careers. BIO5 also engages students at post-secondary levels through initiatives including the Student-Industry Networking Event, Post-Doctoral Fellowship program, and the BIO5 Ambassadors program.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>We expect the benefits to Arizona to include: •Increased student participation in KEYS statewide through both a computational, remote version and an in-person laboratory-based version, boosting the interest in STEM careers among Arizona high school students •Increased number of companies and external entities who participate in activities such as the student-industry networking event leading to connections and internships •Increased number of well-trained personnel from bachelors to doctoral levels available to work with and/or be hired by our Arizona biosciences industry</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$681,234	\$681,234	\$681,234	\$2,043,702
Basic Research	\$74,255	\$74,255	\$74,255	\$222,765
Applied Research	\$74,255	\$74,255	\$74,255	\$222,765
Development	\$0	\$0	\$0	\$0
<b>Total</b>	<b>\$829,744</b>	<b>\$829,744</b>	<b>\$829,744</b>	<b>\$2,489,232</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	75
Graduate Students	0	0	0	0
Undergraduate Students	50	50	50	150
Sponsored Project Funding	\$0	\$0	\$0	\$0
Publications in Academic Peer-Reviewed Journals	12	12	12	36
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	Improving Health
Program Name	KEYS and Engaged Training
<b>Progress Summary</b>	
<p>In FY23, over 1,000 undergraduates, graduate students, postdocs, and even high school interns had opportunities to engage in STEM activities and apply classroom learning by working side by side with world-class researchers in BIO5 Institute labs. Developing the workforce of tomorrow's STEM leaders and sharing the impact of BIO5 research and discovery is embedded within BIO5's mission. Training programs like the KEYS Research Internship, BIO5 Ambassadors, and the Postdoctoral Fellowship encourage active learning, and engagement opportunities including the annual Discover BIO5 event, Women in STEM series, researcher seminars, various community event sponsorships, and BIO5's Science Talks podcast allow the public to learn the value a research university brings to the people of our community and state. - The 2023 KEYS cohort encompassed 49 in-person and 7 virtual interns from 37 Arizona high schools chosen from a total of 367 applications from across the state. - Adding this cohort, the number of KEYS alumni now totals 687 students from 101 Arizona high schools. - This year marks the highest number of high schools represented since the inception of the KEYS Research Internship program. - 93 UArizona faculty or doctoral students mentored KEYS interns in 48 labs. - 2022 KEYS alumnae Carol Chen was one of 20 Arizona students selected for the Flinn Foundation's scholarship. There are now 18 KEYS alumni Flinn Scholars. - 11 KEYS alumni presented their research posters at the 2022 AZBio Awards Student Discovery Zone. One alum placed 1st and another placed 3rd for the high school level.</p>	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
<p>While the world moved towards a post-pandemic reality, BIO5 remained innovative in its commitment to training and inspiring the next generation of STEM experts by offering the KEYS Research Internship and our other training programs in a hybrid format. Whether learning hands-on bioscience skills in our labs or computational skills that complement bench research as part of virtual training, KEYS students are now better prepared for success in college and beyond.</p>	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
<p>BIO5 has been able to continue to provide inspiring hands-on training to high school, undergraduate, and graduate students. However, creating effective programming that results in a prepared next generation biosciences talent pool is a complex and expensive undertaking. An order of magnitude scale-up of the KEYS Research Internship is necessary to meet Arizona's future talent needs. As BIO5 looks to increase impact and broaden the talent pool, the cost of intensive training becomes challenging. Intensive mentoring, an ever more advanced curriculum, and science literacy and skills training requires more resources than can be supported by TRIF. The BIO5 Institute has established an endowment with private and industry donors and is working to expand support.</p>	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
<p>Because of the continued success of the KEYS program and other BIO5 training initiatives, an increased number of well-trained personnel from bachelors to doctoral levels are available to work with and/or be hired by our Arizona biosciences industry. Providing an online, virtual learning environment for students outside of Pima County has boosted representation from other counties. Students receive experience that excites them about attending our in-state public universities and about future STEM careers. Engagement with state and national biotech and industry partners increases student networking opportunities. These relationships allow for long-term commitments to STEM workforce development in Arizona. Additionally, opportunities were provided to internal and external audiences to learn about the impact of BIO5 research through tours, events, meetings, interactive programming, and collaborative partnerships.</p>	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$800,315	\$896,867		\$1,697,182
Basic Research	\$0	\$3,535		\$3,535
Applied Research	\$0	\$0		\$205,353
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$800,315</b>	<b>\$900,402</b>		<b>\$1,700,717</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	1	2		3
Undergraduate Students	58	85		143
Sponsored Project Funding	\$3,717,460	\$3,223,481		\$6,940,941
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0



# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	Improving Health			
Program Name	Precision Medicine and Omics			
<b>Problem Statement</b>				
Omics refers to collective technologies that explore the role of different molecules and how they interact with various bodily systems. Proteins, lipids/fats, and their metabolic products are all important and accessible indicators of human health. The study of omics is critical to developing personalized, targeted therapies to boost efficacy, improve health, lessen adverse exposures, and reduce health care costs. To analyze the vast amounts of omics data and turn it into actionable precision medicine, the science of bioinformatics needs not only to be used, but be further developed, using the combination of computer science, statistics, mathematics, and engineering.				
<b>Program Description</b>				
We expect to make major strides in four general areas. First, we will create a comprehensive approach in the nascent field of pharmacogenomics. Rather than a one-size-fits-all approach to therapy or dosage based on gross factors such as body surface area, drug prescriptions—and in particular polypharmacy—we need to take into account an individual’s genomic factors. Second, with gene interactions, we are beginning to understand not just the impact of single genes on health but also the interplay of many, or even hundreds, of genes on complex conditions such as diabetes and heart disease. Extracting this information using conventional naive biostatistical models may require numbers of participants exceeding the world’s population. We will develop new models to enable extraction of complex data. Third, we will develop models of the transcriptome, which is the initial product of gene expression. We will determine the difference between “nature and nurture,” or the effect of the environment (internal and external) on gene expression. Finally, to address the unsustainable cost of drug development, we will advance an adaptable clinical trials model to improve outcomes and reduce costs.				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
UArizona has a strong infrastructure in both expertise and instrumentation to develop omics and precision medicine. Investments in sequencing and mass spectroscopy facilities have occurred with past TRIF investments, with a particular emphasis on metabolomics and precision nutrition. The National Science Foundation-sponsored CyVerse and the UArizona Center for Biomedical Informatics and Biostatistics bring strengths in extracting actionable knowledge from large data sets. In addition, UArizona’s partnership with Banner Health, including the All of Us program, means that enormous amounts of health data are available for researchers to analyze and drive subsequent experiments and therapy development.				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
The benefit to Arizona will include: •UArizona is successful in obtaining a Clinical and Translational Science Award with partners across Arizona to move promising science to translation, •An increase in Banner Health and other clinical partner collaborative grants and contracts, bringing research dollars to Arizona and increasing research and clinical staff jobs, •More clinical trials in Arizona because of the expertise in adaptive clinical trial design, which will provide cutting-edge treatment options for Arizonans and more rapid development of cures.				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$569,289	\$569,289	\$569,289	\$1,707,867
Basic Research	\$220,048	\$220,048	\$220,048	\$660,144
Applied Research	\$385,084	\$385,084	\$385,084	\$1,155,252
Development	\$55,012	\$55,012	\$55,012	\$165,036
Total	\$1,229,433	\$1,229,433	\$1,229,433	\$3,688,299
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$275,060	\$0	\$495,108	\$1,155,252
Postdocs Supported	25	25	25	75
Graduate Students	65	65	65	195
Undergraduate Students	70	70	70	210
Sponsored Project Funding	\$20,000,000	\$20,000,000	\$20,000,000	\$60,000,000
Publications in Academic Peer-Reviewed Journals	92	92	92	276
Startups	1	0	1	2

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	Improving Health
Program Name	Precision Medicine and Omics
<b>Progress Summary</b>	
<p>UArizona infrastructure to develop omics and precision medicine has been considerably strengthened thanks to TRIF support, ultimately resulting in the improved health of Arizonans affected by environmental and genetic impacts. Next-gen laboratory tools and specialized facilities help to create new insights into the molecular makeup of individuals, allowing for significant progress in advancing personalized therapies and extracting meaning from complex data using biomedical informatics.</p>	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
<p>Researchers received a \$3.4 million-dollar STTR Phase II grant and a Flinn Foundation grant to develop SP-A peptidomimetic compound as a potential life-saving treatment for asthma and COPD through the UArizona startup, RaeSedo, Inc. Now in its second year, RaeSedo Inc. moves to the next phase having met all milestones from its Phase 1 SBIR grant, including the development of small peptides derived from a protein in the lungs that have key anti-inflammatory properties. Researchers plan to use the new award to evaluate the compound next in animal models. We are addressing the opioid crisis in Arizona and beyond by better understanding how pain signals cascade through the nervous system and how the human body responds to opioids. A focal point is building a research program around heat shock protein 90, or Hsp90, a protein important in regulating opioid signal transduction and how opioids affect the signals in the human body. Scientists are now developing isoform selective Hsp90 inhibitors for opioid therapy, which they expect to enhance opioid pain relief while reducing side effects like addiction. These drugs should reach human testing in the next five years. This work has directly led to 4 publications and nearly \$3.2 million in NIH funding.</p>	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
<p>BIO5 Institute faculty, together with Tech Launch Arizona, have had an extremely productive year, with two new startup companies, and 18 licenses and options of patented technology to companies throughout Arizona and the world. Biotech startup companies have flourished in the region, utilizing UArizona core facilities on a fee-for-service basis, and leasing bench space to develop their innovations. An ongoing challenge is retaining these companies in Arizona. As their capital and space demands increase, we must assure these biotech startups grow in place rather than move to more established biotech hubs.</p>	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
<p>In 2021, a UArizona Health Sciences study estimated the Arizona economic burden of Valley fever totals \$736 million. Valley fever is a disease caused by fungus grown in the soil and dirt. Because southern Arizona has the most cases in the state, access to patient samples is more conveniently accessed here. UArizona researchers have developed the first effective licensed fungal vaccine in the U.S. Because TRIF has supported specialized lab space such as dedicated biosafety level 3 facilities, the Valley fever vaccine is becoming reality. This is also a model for tackling other dangerous fungal pathogens. Another UArizona lab is exploring a novel immunomodulatory pathway to facilitate cardiac repair, or ways to modulate the immune system to repair the heart due to ischemic congestive heart failure (CHF), which currently has no treatment to address the underlying cause. We have created a cardiac patch composed of human iPSC-derived cells seeded onto a bioresorbable mesh embedded with human neonatal fibroblasts. In animal models with CHF, this patch increased blood flow and improved heart function by regenerating heart cells. Startup UArizona biotechnology company, Avery Therapeutics, is licensing these technologies and driving the heart patch technology towards commercialization.</p>	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$503,138	\$1,361,483		\$1,864,621
Basic Research	\$0	\$78,133		\$78,133
Applied Research	\$291,221	\$274,784		\$496,574
Development	\$306,092	\$192,477		\$498,569
<b>Total</b>	<b>\$1,100,451</b>	<b>\$1,906,877</b>		<b>\$3,007,328</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$86,084	\$499,428		\$585,512
Postdocs Supported	28	16		44
Graduate Students	106	69		175
Undergraduate Students	125	133		258
Sponsored Project Funding	\$48,929,390	\$50,819,044		\$99,748,434
Publications in Academic Peer-Reviewed Journals	95	50		145
Startups	1	2		3

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	Improving Health			
Program Name	Technology for Health			
<b>Problem Statement</b>				
<p>Advances in technology always have been quickly adopted to aid human health and well-being. For example, the rise of computer technology in the 1950's enabled computational tomography (CT) scans that allowed clear visualization of the human brain for the first time. More recently, strong, flexible, and inert materials have made long-term implantable vascular shunts possible. Improving Health depends upon continual adoption of technology and innovation to solve problems identified by scientists and physicians.</p>				
<b>Program Description</b>				
<p>The Fourth Industrial Revolution envisions a convergence of biological, physical, and data sciences. This collaborative approach has long been a hallmark of BIO5. Specifically, we will do the following: Point-of-care imaging: We will create new, noninvasive imaging tools for earlier diagnosis and treatment of disease -enabling point-of-care imaging that can even be done by an individual with a smartphone; Closed-Loop Sensors Lab: Sensors/detectors/cameras and closed-loop "sensors/data -&gt; analysis -&gt; intervention -&gt; measure impact" experiments will measure the effect of environmental perturbations on workplace performance, analyze reaction to social interactions, negotiation, team building exercises, etc., and develop/monitor the effects of "electroceuticals" or wearable therapeutics; Wearable technology: Develop new materials and electronic technologies further enabling bat ery-less, wireless, conformable wearables; Shared resources: Modern biology requires ever more complex instrumentation, to expedite large-scale, team science grants. These grants in turn will boost federal research funding, serve as a resource for local industry, and create new services and companies in Arizona.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>With co-located engineering, optical sciences, and medical disciplines, UArizona is poised to make technology advances and rapidly apply them to human health. The culture of interdisciplinary research and strong translational sciences, together with a supportive intellectual property environment with Tech Launch Arizona and the Eller College of Management's McGuire Entrepreneurship Program, mean that innovations are rapidly turned into products to improve the health and wellness of Arizonans and beyond.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>•Increased industry engagement with faculty and students through facilities and services, including analytical chemistry, imaging, bioinformatics, and sensors, leading to synergies in research and development, and accelerating Arizona bioindustry</li> <li>•An increase in technology transfer activities related to sensors and imaging technology with more patents and licenses</li> <li>•Additional external funding in wearable technology, home health, and telemedicine related to expertise in cutting-edge technology and resources such as the Sensors Lab</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$1,568,901	\$1,568,901	\$1,568,901	\$4,706,703
Basic Research	\$381,158	\$381,158	\$381,158	\$1,143,474
Applied Research	\$762,315	\$762,315	\$762,315	\$2,286,945
Development	\$127,052	\$127,052	\$127,052	\$381,156
Total	\$2,839,426	\$2,839,426	\$2,839,426	\$8,518,278
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$635,263	\$0	\$635,263	\$1,905,789
Postdocs Supported	25	25	25	75
Graduate Students	65	65	65	195
Undergraduate Students	70	70	70	210
Sponsored Project Funding	\$20,000,000	\$20,000,000	\$20,000,000	\$60,000,000
Publications in Academic Peer-Reviewed Journals	92	92	92	276
Startups	1	0	1	2

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	Improving Health
Program Name	Technology for Health
<b>Progress Summary</b>	
<p>UArizona has made significant strides in advancing the technology and innovation necessary to solve complex health challenges and make a difference in the lives of Arizonans and those around the world. TRIF supports the BIO5 Institute's interdisciplinary approach in bringing together researchers from across the university to maximize the type of innovative thinking that leads to the next important technological discoveries. TRIF support has enabled equipment purchases such as advanced microscopes, sequencers, and other specialized equipment that accelerates research advances and is available to partner academic institutions and industry colleagues across Arizona. As researchers develop new devices, diagnostics, and instruments, these innovations turn into products that improve human health. Continued partnership with Tech Launch Arizona has provided means for more and more researchers to think about their discoveries as commercializable technologies.</p>	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
<p>UArizona researchers have developed better and noninvasive wearables that can help capture health-related data, advanced imaging tools for earlier diagnosis of disease, and new technologies to enhance healthy living and aging. UArizona is among the first institutions to receive the new 3 Tesla MRI instrument model, which is the most powerful FDA-approved MRI instrument in the world and will enhance current projects and enable new discoveries relating to brain science. UArizona researchers continue to develop wearable technology and sensors, for example studying paper thin sensors on bone to better characterize bone fracture recovery and using wireless and battery-free sensors to monitor a person's motor function during normal physical activity for frailty detection. Through TRIF funding, the BIO5 Biomedical Device Prototyping Service is bringing together researchers to develop a tongue-based sensor system that could control a robotic arm, enabling individuals with high level paralysis to interact with their environment in complex ways and greatly enhance their independence, health, and sense of well-being.</p>	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
<p>Global supply chain problems and workforce shortages continue to plague the tech industry, leading to significant delays in acquisition of supplies and equipment. In some cases, the COVID-19 related retirement of skilled technicians has led to the loss of industry capabilities. BIO5 faculty have been creative in technology workarounds, and have worked with companies to restore expertise, for example in endoscopic lens design.</p>	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
<p>The robust research and innovation ecosystem at UArizona paired with the supportive intellectual property environment fostered by Tech Launch Arizona provides regular opportunity to turn discoveries into products and technologies that directly improve health. In addition, TRIF support of our cutting-edge equipment and facilities has enticed world-renowned scientists to relocate to UArizona. Spinoff company, Ceria Therapeutics, recently moved to UArizona along with its founding scientist. In addition to hiring staff and scientists and mentoring UArizona students in their lab, they have moved significant grant money here with the company. Working with Tech Launch Arizona, the company has disclosed intellectual property regarding the development of diagnostic and therapeutics for in utero growth restriction. The company is also working with several other UArizona researchers and physicians, and benefits from the outstanding infrastructure of UArizona core facilities with promising work in additional areas such as identifying specific cell types and gene expression during inflammatory diseases like irritable bowel syndrome and Valley fever, as well as the pathogenesis of diabetic wound healing impairment.</p>	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$1,850,634	\$2,417,371		\$4,268,005
Basic Research	\$0	\$80,679		\$80,679
Applied Research	\$185,882	\$437,212		\$391,235
Development	\$0	\$66,113		\$66,113
<b>Total</b>	<b>\$2,036,516</b>	<b>\$3,001,375</b>		<b>\$5,037,891</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$242,603	\$262,098		\$504,701
Postdocs Supported	12	15		27
Graduate Students	121	56		177
Undergraduate Students	95	124		219
Sponsored Project Funding	\$15,004,103	\$23,164,095		\$38,168,198
Publications in Academic Peer-Reviewed Journals	56	47		103
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	National Security Systems			
Program Name	Advanced Manufacturing			
<b>Problem Statement</b>				
Advanced manufacturing (AM) includes concepts in rapid prototyping and parts-on-demand, additive manufacturing (e.g., 3D printing), sustainable and environmentally sound processes, and advanced robotics and other forms of automation. Enabling technologies can include materials, equipment, processes, software, and computation. AM has the potential to shorten product development timelines, improve worker safety, increase production, reduce waste, and preserve the natural environment. Significant challenges remain for widespread implementation of many AM technologies and include materials research, robotics, in-process quality control, and product inspection.				
<b>Program Description</b>				
Presently there are several elements of AM that are coalescing around areas such as aerospace research. These elements include advanced materials and additive manufacturing. TRIF funding will help accelerate and expand these efforts, fostering maturation toward larger extramural funding mechanisms. Opportunities exist for novel application of AM to new domains, and TRIF resources will be devoted to supporting projects that will target these opportunities with unique ideas. Over the next five years, we expect continued aggregation of related areas of research (e.g. AR/VR, advanced materials, robotics) around AM, facilitated by TRIF support.				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
UArizona has many research programs and experienced investigators active in new materials development, additive manufacturing equipment and processes, artificial intelligence for process improvement, environmental engineering, and advanced robotics. In one particular area of AM, additive manufacturing, faculty across several units have collaborated to form the Additive Manufacturing Initiative. This group seeks to leverage faculty expertise and resources to further research and training in the application of 3D printing to challenges in manufacturing in extreme conditions, next-generation manufacturing, and adaptive process control. The team also has initiatives in workforce development, including using virtual and augmented reality technology to teach advanced manufacturing practices.				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• Maturation of at least one program area into a research center focused on AM</li> <li>• Increased coordination of related research and technologies around AM</li> <li>• Development of new application areas for AM and the number of potential sponsors of extramurally funded research</li> <li>• Cultivation of a larger number of partnerships with a growing AM industry base, particularly those in Arizona</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$552,980	\$552,980	\$552,980	\$1,658,940
Basic Research	\$178,238	\$178,238	\$178,238	\$534,714
Applied Research	\$262,115	\$262,115	\$262,115	\$786,345
Development	\$178,238	\$178,238	\$178,238	\$534,714
Total	\$1,171,571	\$1,171,571	\$1,171,571	\$3,514,713
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$209,692	\$1	\$209,692	\$629,076
Postdocs Supported	1	1	1	75
Graduate Students	3	3	3	9
Undergraduate Students	2	2	2	6
Sponsored Project Funding	\$2,083,333	\$2,083,333	\$2,083,333	\$6,249,999
Publications in Academic Peer-Reviewed Journals	17	17	17	51
Startups	0	1	2	3

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	National Security Systems
Program Name	Advanced Manufacturing
<b>Progress Summary</b>	
<p>Researchers continued their work in advanced manufacturing related to aerospace and defense industries, additive manufacturing, and smart buildings, bolstered by a significant investment from the Department of Defense. Several pieces of new equipment will be installed over the next year in UArizona's new Applied Research Building. There was a notable increase in research related to the semiconductor industry, as well as energy and green materials and structures. The use of artificial intelligence (AI) and machine learning (ML) for manufacturing is increasing as researchers use these tools for both advanced manufacturing and quality control applications. - Three initial investment projects in the UArizona Micro and Nano Fabrication Center (MNFC) funded with TRIF dollars were directed at safety systems, as well as new equipment to support both research and workforce development. These projects were instrumental in helping to secure a major investment from the Arizona Commerce Authority (ACA) in the MNFC. - A major appropriation of \$10M was awarded by the U.S. Army for advanced manufacturing capabilities that will be acquired by the Department of Materials Science and Engineering and housed in the new Applied Research Building. These resources will support research and workforce development. - Advanced robotic systems are being developed that can retrofit building envelopes to increase energy efficiency.</p>	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
<p>Several projects are using advanced tools like additive manufacturing, including novel materials for use in 3D printing and advanced robotics. Increasingly, these approaches are leveraging AI and ML technologies to improve outcomes. Optical techniques for material inspection down to the nano scale are being developed with TRIF support. Investments have been made in equipment and other capabilities, including in the semiconductor manufacturing space, to support both research and workforce development.</p>	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
<p>Aside from specific technical challenges associated with some of the projects, a major theme was supply chain issues and competition for skilled labor, primarily graduate students and postdocs.</p>	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
<p>TRIF investments have allowed researchers to conduct experiments in support of proof-of-concept studies that have led to significant follow-on funding. - A \$10M investment by the U.S. Army will support additional advanced manufacturing research and workforce development. - A significant investment was secured from the ACA to bring the MNFC to state-of-the-art, including virtual reality training for undergraduate students. - New curricula and partnerships with regional colleges (Pima Community and Central Arizona Colleges) will expand workforce development impact. - A number of industrial partnership are under development, particularly in the semiconductor industry where a state-wide task force led by ACA has aggregated a large number of Arizona chip manufacturers, supplies and other original equipment manufacturers. - UArizona faculty with expertise in advanced manufacturing and semiconductor materials are actively participating on large grant funding efforts like the recent Department of Defense Microelectronics Commons, a \$180M funding opportunity.</p>	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$1,588,081	\$2,118,747		\$3,706,828
Basic Research	\$306,546	\$9,660		\$316,206
Applied Research	\$144,812	\$302,281		\$350,165
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$2,039,439</b>	<b>\$2,430,688</b>		<b>\$4,470,127</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$122,427	\$1,543,602		\$1,666,029
Postdocs Supported	1	9		10
Graduate Students	14	31		45
Undergraduate Students	20	28		48
Sponsored Project Funding	\$5,228,930	\$6,565,724		\$11,794,654
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	1		1

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	National Security Systems			
Program Name	Data Sciences			
<b>Problem Statement</b>				
<p>Many areas of the Fourth Industrial Revolution (4IR) produce and/or can benefit from large pools of data. However, data in and of itself is not useful unless properly interpreted. Analytics provides for the systematic computational analysis of data using techniques such as text-to-data (e.g., natural language processing), machine learning, data visualization, and image informatics. Current challenges such as analysis of unstructured data, computation time, predictive accuracy, and complex event processing provide opportunities for additional academic research.</p>				
<b>Program Description</b>				
<p>Data sciences is at the core of many research activities at UArizona, and establishment of the Data Science Institute (DSI) has been instrumental in creating an array of capabilities available to many investigators and teams. Over the next five years, this initiative will use TRIF funds to expand the application of data science techniques, in particular the use of DSI, among a broader base of users. We will take concepts, practices, and capabilities from tools like CyVerse and support their expansion beyond life science research so that they can be utilized more broadly. We will support projects that apply data science to more application domains and demonstrate utility in a wider array of problems solving endeavors. TRIF support will also be directed toward the application of data sciences at different size scales. This initiative will support projects that seek to implement the use of data science techniques, especially those that enable data analysis and interpretation in new and novel ways.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>Through DSI, numerous faculty across the university have access to core capabilities in many facets of data processing and analysis, visualization, and interpretation. DSI fills the gap between research software and domain science by working with research teams at the cutting edge of data-driven discovery. Currently, DSI offers support in four applied focus areas, including natural language processing, machine learning, large-scale data visualization, and image informatics. Individual investigators working in various 4IR fields can leverage the DSI for their own investigations that require data analytics, as well as collaborate on research that aims to answer important questions and broaden the application of data analytics itself.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• Increased awareness and utilization of data sciences as a research tool, particularly DSI and CyVerse, across all 4IR- related initiatives</li> <li>• Growth of CyVerse beyond life sciences</li> <li>• Implementation of data science techniques at a range of dataset size scales</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$301,351	\$301,351	\$301,351	\$904,053
Basic Research	\$178,238	\$178,238	\$178,238	\$534,714
Applied Research	\$429,868	\$429,868	\$429,868	\$1,289,604
Development	\$262,114	\$262,114	\$262,114	\$786,342
<b>Total</b>	<b>\$1,171,571</b>	<b>\$1,171,571</b>	<b>\$1,171,571</b>	<b>\$3,514,713</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$209,692	\$1	\$209,692	\$629,076
Postdocs Supported	2	2	2	75
Graduate Students	5	5	5	15
Undergraduate Students	3	3	3	9
Sponsored Project Funding	\$2,083,333	\$2,083,333	\$2,083,333	\$6,249,999
Publications in Academic Peer-Reviewed Journals	17	17	17	51
Startups	0	1	2	3

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	National Security Systems
Program Name	Data Sciences
<b>Progress Summary</b>	
<p>Data Sciences was one of the fastest growing areas of the IT4IR investment portfolio. The application of AI and ML, as well as new methods for data processing, analytics and visualization continue to show that big data are increasingly powerful tools in technology development. The ability to inexpensively store and process massive amounts of data has enabled data sciences approaches to surpass conventional methods such as theoretical modeling. The application space for these techniques continues to expand, and in the FY2023 portfolio there were projects ranging from detecting misinformation online to analyzing academic research trends over time to risk assessment and early wildfire detection. - TRIF funding created preliminary data that facilitated a new partnership with the National Interagency Fire Center Southwest Coordination Center. - ML techniques were developed to assess research trends from an NSF database of more than 350,000 awards. - Data analytics were used to predict “super blooms” of pollen to warn of the potential for an especially severe allergy season. - A TRIF funded project was instrumental in securing additional funding for traffic light safety assessments in the City of Phoenix. - A single cell data analysis project supported by TRIF has led to a \$16M grant from the National Institutes of Health.</p>	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
<p>Approaches that leverage big data are seeing increasing use at UArizona, spurred by the application of AI and ML and the decreasing expense of data storage and computational time. Researchers are not only developing solutions for challenges proffered by state and federal research funding agencies, but for our own internal use as well. Like many organizations around the country and world, our faculty and students are developing a growing appreciation the advantages these tools offer. Unstructured data sets, previously ignored or under-appreciated data, and new areas of inquiry are being explored and assessed by both faculty and students. Training in these areas is being embraced by many students and the field is growing in its workforce development activities. We are quickly learning more about our own systems and archived information and applying it to problem solving and acquiring competitive advantages.</p>	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
<p>A continual challenge is that accuracy of most of the tools and outcomes of data analysis relies on the amount of data, which in some cases is massive and can be a limitation, especially when it is not easily available or its use is restricted. Debate about a framework for standards and government oversight of technologies such as AI will continue to present challenges to research in this field. Another challenge will be data storage and archiving requirements, especially those from federally sponsored research.</p>	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
<p>The stature of data science is growing rapidly driven by public exposure and opinion on popular (and controversial) AI platforms such as ChatGPT. TRIF funding is allowing us to expand our own experience with these technologies and increase experiential learning opportunities for students, both in the classroom and laboratories. This field is taking on a life of its own and TRIF funding is allowing UArizona to seed a variety of projects that are making use of data science technologies, thereby allowing the university to stay at the forefront of both research and workforce development. Many industries actively locating to Arizona are seeing the same trends, and experiencing first-hand the value of data sciences in many parts of their businesses. Translation of our research and access to a well trained workforce will continue to allow Arizona companies to leverage these tools.</p>	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$419,260	\$610,942		\$1,030,202
Basic Research	\$871,429	\$0		\$871,429
Applied Research	\$0	\$0		\$205,353
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$1,290,689</b>	<b>\$610,942</b>		<b>\$1,901,631</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$195,914	\$294,153		\$490,067
Postdocs Supported	6	5		11
Graduate Students	23	15		38
Undergraduate Students	49	23		72
Sponsored Project Funding	\$19,349,775	\$2,147,532		\$21,497,307
Publications in Academic Peer-Reviewed Journals	17	12		29
Startups	0	0		0



# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	National Security Systems			
Program Name	4th Industrial Revolution Workforce Development			
<b>Problem Statement</b>				
<p>The Fourth Industrial Revolution is characterized by a period of an unprecedented rapid change. Concepts are advancing so quickly to implementation, led mostly by large companies, that the existing workforce struggles to keep pace. Moreover, academic programs that would train the pool of new workers are falling behind the demand for skills in new employees. Particularly in STEM fields, the imperative for a focus on fundamentals and connection of theory to practice leaves little room for additional training in areas required for the 4IR. Development of new programs that can address the training of both existing workers and current students is necessary to feed the needs of the 4IR workforce.</p>				
<b>Program Description</b>				
<p>TRIF funding will support the expansion of STEM education programs at UArizona, especially in those that target growth in enrollment from groups underrepresented in fields of study related to 4IR. We will seek out and fund initiatives that bring faculty and staff together to address an urgent need for the 4IR workforce of the future. Several funding agencies, particularly those in the Department of Defense, are launching new programs related to STEM education and workforce development to fill a current pipeline that has been diminishing over time in the US. We will employ TRIF funding strategically to strengthen programs so that they are competitive on a national level.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>UArizona already has institutional strengths in STEM fundamentals education, as well as ongoing emphasis in connecting theory to practice with curricula, such as our four-year Craig M. Berge Engineering Design Program. Faculty with expertise in pedagogical, social, and behavioral research can complement ongoing program development to help implement new teaching modalities (e.g., online learning), and we can expand industry partnerships not only to serve workers interested in continuing education, but also to provide internship and co-op opportunities to traditional students. Current programs such as the Catapult Engineering Program seek to support and mentor underrepresented groups to help students persist in their degrees and graduate.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• Development of innovative STEM-based workforce development programs, particularly those that address known pipeline shortages for government and industry</li> <li>• Success in competing for at least one major STEM training grant</li> <li>• Growth in partnerships with stakeholders such as government labs and industry to better align workforce development programs with their needs and expand experiential learning for students</li> <li>• Launch of at least one workforce development program that partners with K-12 and community colleges, across a spectrum of institutions but especially in areas with disadvantaged and/or underserved populations</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$359,635	\$359,635	\$359,635	\$1,078,905
Basic Research	\$145,619	\$145,619	\$145,619	\$436,857
Applied Research	\$116,495	\$116,495	\$116,495	\$349,485
Development	\$29,124	\$29,124	\$29,124	\$87,372
Total	\$650,873	\$650,873	\$650,873	\$1,952,619
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$116,495	\$1	\$116,945	\$349,935
Postdocs Supported	0	0	0	75
Graduate Students	1	1	1	3
Undergraduate Students	3	4	5	12
Sponsored Project Funding	\$2,083,333	\$2,083,334	\$2,083,335	\$6,250,002
Publications in Academic Peer-Reviewed Journals	10	11	12	33
Startups	0	1	1	2

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	National Security Systems
Program Name	4th Industrial Revolution Workforce Development
<b>Progress Summary</b>	
<p>Several TRIF-funded workforce development projects were completed in FY2023, including one related to semiconductor manufacturing and two related to faculty training in technology transfer. We continue to build a “community of scholars” around 4IR and encourage technology development, translational research, and technology transfer activities among both researchers and students. One project is a derivative of a faculty workshop focused on translational research and involves experts in the social and behavioral sciences. It aims to understand the understanding, attitudes, behaviors, and motivations of researchers toward policies related to university policies and practices, as well as incentive systems. Another project is focused on creating a new venture mentoring system to foster commercialization of 4IR technologies. It is based on an MIT program and can support both faculty and students. - A new research project seeks to understand the motivations and responses innovators have toward institutional policies and incentives with the goal of informing university leadership on future policy actions. - Expanding the availability of commercialization mentors with 4IR expertise will help foster technology transfer and support a community of scholars. - TRIF investments in the Micro Nano Fabrication Center have helped to secure an additional, transformational investment from the Arizona Commerce Authority (ACA) that will support semiconductor workforce training.</p>	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
<p>Faculty will benefit from additional support for translational research that can catalyze research directed toward solving the problems that affect Arizonans. The university is leveraging research by social and behavioral scientists to inform policies that will support the development of new 4IR technologies. UArizona has invested in important infrastructure related to its semiconductor research and workforce training endeavors, which has allowed us to attract even larger investments which will in turn attract more industry partnerships, student interest, and research-active faculty.</p>	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
<p>These programs are progressing well but are directed at fundamental change in policies, practices, and deeply entrenched faculty behavior and attitudes. It will take time to understand the best path forward, and change will be slow.</p>	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
<p>We are leverage both TRIF as well as follow-on ACA funding to build not only a state-of-the-art physical facility to support semiconductor manufacturing, but digital and virtual reality platforms that will allow us to deploy workforce training across the state. We will work with partners at the community college level to provide training for jobs that don't require a four-year college degree, as well as those that do. We are creating access for Arizonans to high paying jobs as the semiconductor industry grows within the state. Additionally, we are working to improve our translational research and technology transfer programs so that more of the work we do is translated outside the university for the benefit of Arizona.</p>	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$693,462	\$0		\$693,462
Basic Research	\$36,321	\$0		\$36,321
Applied Research	\$0	\$0		\$205,353
Development	\$200,085	\$116,705		\$316,790
<b>Total</b>	<b>\$929,868</b>	<b>\$116,705</b>		<b>\$1,046,573</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	3		3
Graduate Students	10	6		16
Undergraduate Students	5	8		13
Sponsored Project Funding	\$47,463	\$242,520		\$289,983
Publications in Academic Peer-Reviewed Journals	8	0		8
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	National Security Systems			
Program Name	Advanced Communications Systems			
<b>Problem Statement</b>				
<p>The requirement for assured, secure, and ad hoc communications with independent, remote, and other systems operating under at ack requires creative, innovative, and breakthrough approaches to consistently establish connections and deliver that data in a timely way. Quantum communications, optical communications, new approaches to encryption, and other approaches to sound and radio-frequency devices are desperately needed by the military and may add value to the methods of the Fourth Industrial Revolution.</p>				
<b>Program Description</b>				
<p>We anticipate the development of fundamental science and prototype systems that, with additional federal or industrial engagement, can lead to effective commercial and military solutions. We would expect to see even greater collaboration among the colleges and such sites as Ft. Huachuca, providing students with multidisciplinary research experiences ready to compete for top jobs in these industries and fields.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>The UArizona Colleges of Science, Optical Sciences, and Engineering are perfect sources of these types of solutions. From the \$26M NSF-funded Center for Quantum Networks, an engineering research center, to our efforts in the Frontiers of Sound, acoustic waves research for next-generation information processing, we have the skill and the scientific and technical collaborations in place to answer these challenges.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• Increased industrial-sponsored research in advanced communications systems</li> <li>• Increased federal, defense, and intelligence agency sponsored projects</li> <li>• Increased recruiting of top faculty and students</li> <li>• Increased licensing and tech transfer impacts</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$799,188	\$799,188	\$799,188	\$2,397,564
Basic Research	\$323,598	\$323,598	\$323,598	\$970,794
Applied Research	\$258,879	\$258,879	\$258,879	\$776,637
Development	\$64,720	\$64,720	\$64,720	\$194,160
<b>Total</b>	<b>\$1,446,385</b>	<b>\$1,446,385</b>	<b>\$1,446,385</b>	<b>\$4,339,155</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$258,879	\$1	\$258,879	\$776,637
Postdocs Supported	2	2	2	75
Graduate Students	3	3	3	9
Undergraduate Students	3	3	3	9
Sponsored Project Funding	\$1,666,667	\$1,666,667	\$1,666,667	\$5,000,001
Publications in Academic Peer-Reviewed Journals	22	22	22	66
Startups	0	1	2	3

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	National Security Systems
Program Name	Advanced Communications Systems
<b>Progress Summary</b>	
<p>Much of the advanced Communications work was shared with Space Exploration efforts. The support went into ensuring continued support for new faculty hires and startup activities, and new efforts involving cube/small satellites, sensor development, quantum communications research, and a novel integrated 1m telescope. In a concentrated effort, space signals, their capture, analysis, interpretation, and translation of results into recommendations and insights for governmental applications in space domain awareness.</p>	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
<p>New sensors have been built, students have been educated in the methods necessary to become effective researchers in this area, machine learning has been advanced to analyze that sensor data, and modeling systems for those signals have been demonstrated.</p>	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
<p>Timing of project starts, supply chains, and the continuity of funding across fiscal years are always a challenge to projects where instruments, sensors, and computing infrastructure have to be integrated and deployed. TRIF funding made a huge difference in the success of this team and their research impact.</p>	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
<p>In addition to expanding the cadre of productive researchers in this area, giving experiential learning opportunities to students interested in space and space systems, and creating a highly capable SSA telescope, the work of the Space 4 center has solidified its leadership position with the United States Space Force, and is attracting to Arizona opportunities for new investments in research, technology, and innovation to serve the space domain awareness mission.</p>	
<b>Additional Notes</b>	

Investment Detail				
	2022	2023	2024	Total
Infrastructure	\$798,438	\$1,594,543		\$2,392,981
Basic Research	\$480,864	\$119,178		\$600,042
Applied Research	\$0	\$0		\$205,353
Development	\$0	\$149		\$149
<b>Total</b>	<b>\$1,279,302</b>	<b>\$1,713,870</b>		<b>\$2,993,172</b>
Performance Measures				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$798,438	\$433,611		\$1,232,049
Postdocs Supported	3	4		7
Graduate Students	25	29		54
Undergraduate Students	17	16		33
Sponsored Project Funding	\$2,037,482	\$2,891,130		\$4,928,612
Publications in Academic Peer-Reviewed Journals	0	22		22
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	National Security Systems			
Program Name	Advanced Energy Systems			
<b>Problem Statement</b>				
Energy systems are required everywhere from deep sea to space, and from miniature applications to electrical grid storage devices. Meeting these demands requires a broad range of energy systems with discrete size, weight, power density, capacity, and cost targets. New approaches to providing these solutions are slow to emerge in the commercial market and must rely on fundamental and applied research that can rapidly scale and transition to commercial production.				
<b>Program Description</b>				
We anticipate making advances in fundamental science, prototype systems, and teaching and learning that ensure Arizona serves the needs of commerce and the military, and that the state is an attractive destination for these industries.				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
These solutions require the combined creativity of electrical, mechanical, and systems engineers, materials scientists, and application space expertise. The close-knit activities between the UArizona Colleges of Engineering and Science faculty are ideal for attacking these problems.				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• Increased industrial-sponsored research in energy systems</li> <li>• Increased federal, defense, and intelligence agency sponsored projects</li> <li>• Increased recruiting of top faculty and students</li> <li>• Increased licensing and tech transfer impacts</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$409,616	\$409,616	\$409,616	\$1,228,848
Basic Research	\$132,028	\$132,028	\$132,028	\$396,084
Applied Research	\$194,159	\$194,159	\$194,159	\$582,477
Development	\$132,028	\$132,028	\$132,028	\$396,084
<b>Total</b>	<b>\$867,831</b>	<b>\$867,831</b>	<b>\$867,831</b>	<b>\$2,603,493</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$155,327	\$1	\$155,327	\$465,981
Postdocs Supported	1	1	1	75
Graduate Students	3	3	3	9
Undergraduate Students	2	2	2	6
Sponsored Project Funding	\$1,666,667	\$1,666,667	\$1,666,667	\$5,000,001
Publications in Academic Peer-Reviewed Journals	13	13	13	39
Startups	0	1	2	3

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	National Security Systems
Program Name	Advanced Energy Systems
<b>Progress Summary</b>	
Robotic approaches to addressing the climate crisis through building retrofit are being developed with strong industry engagement that is leading to industry funded follow-up research.	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
Robotic methods have been developed that reduce the need for humans to be put in dangerous positions retrofitting the exteriors of buildings for improved energy efficiency. These efforts not only increase safety, but speed the application of energy saving technologies to building envelopes. Intellectual property has been disclosed to Tech Launch Arizona on these methods, and a provisional patent is being filed. Courses in computational techniques are being fortified with the insights from this project.	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
A longer performance period would have allowed this project to generate more progress on the intended robotic solutions, especially given the global supply chain crisis which slowed receipt of some of the robotic equipment.	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
Not only can this project demonstrate a pathway to reduce the energy consumption for the U.S. (in itself a National Security interest), but it generates numerous dual-use insights in robotic guidance, navigation and amp control, as well as sensors and electronics design. Students leave the courses and lab experiences with greater skills in advanced 3D printing, manufacturing, and electronics integration.	
<b>Additional Notes</b>	

Investment Detail				
	2022	2023	2024	Total
Infrastructure	\$376,331	\$106,729		\$483,060
Basic Research	\$0	\$0		\$0
Applied Research	\$0	\$0		\$205,353
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$376,331</b>	<b>\$106,729</b>		<b>\$483,060</b>
Performance Measures				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$276,795		\$276,795
Postdocs Supported	0	0		0
Graduate Students	0	0		0
Undergraduate Students	0	0		0
Sponsored Project Funding	\$0	\$0		\$0
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	National Security Systems			
Program Name	Artificial Intelligence			
<b>Problem Statement</b>				
<p>The field of artificial intelligence (AI) can encompass research in machine learning, computer visioning, and natural language processing. Application of such research can create computational approaches to human-like reasoning that can augment decision making. A laudable goal of AI is to replace human decision making, particularly where the task is extremely complex and/or large amounts of data are involved. The quality of any AI system is dependent on the data used to develop and support it. Major challenges are data quality, bias, structure, labeling, and methods to curate large datasets.</p>				
<b>Program Description</b>				
<p>An important objective for TRIF support in the AI initiative is to bring existing research and application capabilities together in new ways to create synergies and increase opportunities for both funding and impact. We expect there are step-function gains that can be realized by connecting investigators and seeding new projects that will expand the development and application of AI. At present, there is fervent excitement around AI that is making it challenging to understand what represents true opportunity for UArizona. TRIF funding will be employed to bring together AI investigators from across campus to sort through potential strategies for expansion of AI research and technologies and determine the best path. We expect at least one outcome to be a cogent roadmap that will help UArizona establish itself as a leader in AI in one or more research and/or application domains.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>UArizona currently deploys AI approaches across several research domains, including AI research itself. Recent and current programs include applications of AI in cybersecurity, space exploration, health care, education, sustainability, transportation, and border security. UArizona investigators are developing new approaches to AI itself, such as machine learning algorithms that adapt over time. Current efforts span multiple departments and colleges and provide the potential to pull teams of AI specialists together to address even larger challenges.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• Development of an AI roadmap that details a strategy for UArizona to follow toward a position of national prominence</li> <li>• Determination of AI-related areas where UArizona can be competitive and establish world-class programs</li> <li>• Demonstration of UArizona leadership in one or more research or application domains related to AI (e.g., major grant award, center of excellence)</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$647,342	\$647,342	\$647,342	\$1,942,026
Basic Research	\$262,115	\$262,115	\$262,115	\$786,345
Applied Research	\$209,692	\$209,692	\$209,692	\$629,076
Development	\$52,422	\$52,422	\$52,422	\$157,266
<b>Total</b>	<b>\$1,171,571</b>	<b>\$1,171,571</b>	<b>\$1,171,571</b>	<b>\$3,514,713</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$209,692	\$1	\$209,692	\$629,076
Postdocs Supported	0	0	0	75
Graduate Students	1	1	1	3
Undergraduate Students	3	3	3	9
Sponsored Project Funding	\$2,083,333	\$2,083,333	\$2,083,333	\$6,249,999
Publications in Academic Peer-Reviewed Journals	17	17	17	51
Startups	0	1	2	3

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	National Security Systems
Program Name	Artificial Intelligence
<b>Progress Summary</b>	
<p>The AI portfolio consists of two projects, one fundamental that addresses control systems for technologies like robotics, and another that facilitates the assessment of ultrasound images. The first project has focused on sequential decision-making in autonomous robotic systems, an especially difficult challenge for systems that are intended to operate without human observation and the benefit of immediate human intervention. The second project is using ML techniques to process ultrasound images and diagnose carpal tunnel syndrome. Both are yielding important preliminary data for new funding applications. - TRIF funding is supporting fundamental AI algorithm development for complex systems like autonomous robots. - TRIF funding is supporting a unique collaboration between orthopedic surgeons and data scientists.</p>	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
<p>AI is proliferating across the UArizona campus in a multitude of ways, but mostly as a tool to support other research rather than fundamental research on AI itself. TRIF supported projects are catalyzing new collaborations as researchers in other fields discover the value of leveraging AI in their application domains.</p>	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
<p>AI development in general can suffer from inaccuracies most often relating to the data sets on which they are trained. Access to curated data sets of sufficient quality and quantity will continue to be a challenge.</p>	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
<p>AI/ML will continue to advance rapidly in its sophistication, accuracy, and applications. Arizona's population is already seeing the impact in many leading-edge applications to everyday life. These will continue to expand with an effort at making mundane or routine, data intensive tasks more highly automated. At present, UArizona's involvement in AI is around its application rather than fundamental research on AI itself. This will continue to yield benefits to Arizonans as AI technologies quickly become more accurate. Adoption into commercial spaces will be fostered by more translational research and commercialization activities supported by the university. These endeavors will be accelerated by expansion of the Data Science Institute and programs in the College of Engineering such as the new Computer Science and Engineering bachelor's degree program.</p>	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$0	\$176,218		\$176,218
Basic Research	\$61,860	\$0		\$61,860
Applied Research	\$0	\$165,187		\$205,353
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$61,860</b>	<b>\$341,405</b>		<b>\$403,265</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	1		1
Graduate Students	5	11		16
Undergraduate Students	2	2		4
Sponsored Project Funding	\$0	\$0		\$0
Publications in Academic Peer-Reviewed Journals	17	0		17
Startups	0	0		0



# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	National Security Systems			
Program Name	Cyber Defense			
<b>Problem Statement</b>				
<p>Our hyper-digital world, where anything that can be referred to as a “device” is probably connected or connectable to the internet, creates a vast attack surface for bad behavior, whether from script-kiddies, criminals, or nation states. This is true for commercial, government, consumer systems, and a wide swath of America’s defense systems. Preventing attacks that deny or degrade the confidentiality, integrity, or availability of the data or systems is critical to a well-functioning military, economy, and society.</p>				
<b>Program Description</b>				
<p>TRIF investments in cyber defense activities are intended to develop countermeasures and solutions to phishing, ransomware, advanced persistent threat, and more subtle attack mechanisms.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>The university is home to talented and innovative electrical and computer engineers and scientists and draws globally competitive students to Arizona. They are backed by top physicists and mathematicians, and they have access to some of the most advanced modeling and research platforms in the world. Our College of Applied Science and Technology (CAST) in Sierra Vista offers degree and certificate programs to train personnel in machine learning, artificial intelligence, and cybersecurity. We have achieved the highest level of recognition from defense agencies for our ability to contribute to solutions in this area.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• Open-source solutions</li> <li>• Increased industrial-sponsored research in cyber defense</li> <li>• Increased federal, defense, and intelligence agency sponsored projects</li> <li>• Increased recruiting of top faculty and students</li> <li>• Increased licensing and tech transfer impacts</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$463,313	\$579,141	\$579,141	\$1,621,595
Basic Research	\$176,037	\$220,047	\$220,047	\$616,131
Applied Research	\$258,879	\$323,598	\$323,598	\$906,075
Development	\$258,879	\$323,598	\$323,598	\$906,075
<b>Total</b>	<b>\$1,157,108</b>	<b>\$1,446,384</b>	<b>\$1,446,384</b>	<b>\$4,049,876</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$207,103	\$1	\$258,879	\$724,861
Postdocs Supported	1	1	1	75
Graduate Students	3	3	3	9
Undergraduate Students	2	2	2	6
Sponsored Project Funding	\$1,666,667	\$1,666,667	\$1,666,667	\$5,000,001
Publications in Academic Peer-Reviewed Journals	17	22	22	61
Startups	0	1	2	3

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	National Security Systems
Program Name	Cyber Defense
<b>Progress Summary</b>	
While previously supported by the Advanced Energy Systems initiative, the work conducted in Year 1 to establish a digital twin for the University provides a platform for eventually defending university networks, for training more students in cyber defense, and for developing novel tools to delay, deny, and defeat hackers and cyber-criminals. New tools for detecting cyber-attacks on manufacturing equipment have also been developed.	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
UArizona is seeing a growing collaboration between our National Security Agency Center of Academic Excellence and our University's Information Security Office, where tools can increasingly be shared not only for teaching cyber defense, but for analyzing and for defending university networks.	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
Limited funding horizons detract from large-scale impacts in cyber defense programs. We hope to better integrate cyber defense programs with other National Security Strategy programs to position the university to address larger, more complex, and more targeted solutions for governmental and industry resilience, and better economic impact.	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
Together with its work in cyber exploitation, the programs in cybersecurity are teaching, training, and delivering a large cadre of talent to improve cyber resilience in Arizona and beyond. One benefit of the cyber-attack detection tools is that critical product quality defects can now be traced to conditions that caused them, including cyber attacks.	
<b>Additional Notes</b>	

Investment Detail				
	2022	2023	2024	Total
Infrastructure	\$324,401	\$448,258		\$772,659
Basic Research	\$829,415	\$11,858		\$841,273
Applied Research	\$0	\$0		\$205,353
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$1,153,816</b>	<b>\$460,116</b>		<b>\$1,613,932</b>
Performance Measures				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$324,401	\$448,258		\$772,659
Postdocs Supported	0	0		0
Graduate Students	6	8		14
Undergraduate Students	6	5		11
Sponsored Project Funding	\$169,777	\$1,082,773		\$1,252,550
Publications in Academic Peer-Reviewed Journals	0	4		4
Startups	1	0		1

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	National Security Systems			
Program Name	Cyber Exploitation			
<b>Problem Statement</b>				
Understanding how our digital systems can be adversely impacted by bad actors starts with the initiative on cyber defense, outlined above. The cyber exploitation initiative focuses on the second and third order effects when a breach occurs: How we delay, deny, and defeat attempts to cause our digital systems to mislead us, perform in unintended and dangerous ways, or slow down or confuse the integrated or cyber-physical systems with which they are associated.				
<b>Program Description</b>				
TRIF investments in cyber exploitation technologies will deliver techniques, software, and improved instruction in methods to ensure the safe and continuous operation of systems that have been challenged or threatened.				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
We are fortunate to have faculty and staff with real-world experience dealing with these threats for the Department of Defense and in industrial settings. Again, in this area, we have achieved the highest level of recognition from defense agencies for the quality of our faculty, infrastructure, and instruction.				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• Open-source solutions</li> <li>• Increased industrial-sponsored research in cyber exploitation</li> <li>• Increased federal, defense, and intelligence agency sponsored projects</li> <li>• Increased recruiting of top faculty and students</li> <li>• Increased Licensing and tech transfer impacts</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$297,630	\$223,223	\$223,223	\$744,076
Basic Research	\$176,037	\$132,028	\$132,028	\$440,093
Applied Research	\$424,561	\$318,421	\$318,421	\$1,061,403
Development	\$258,879	\$194,159	\$194,159	\$647,197
<b>Total</b>	<b>\$1,157,107</b>	<b>\$867,831</b>	<b>\$867,831</b>	<b>\$2,892,769</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$207,103	\$1	\$155,327	\$517,757
Postdocs Supported	1	1	1	75
Graduate Students	4	4	4	12
Undergraduate Students	3	3	3	9
Sponsored Project Funding	\$1,666,667	\$1,666,667	\$1,666,667	\$5,000,001
Publications in Academic Peer-Reviewed Journals	17	13	13	43
Startups	0	1	2	3

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	National Security Systems
Program Name	Cyber Exploitation
<b>Progress Summary</b>	
The cyber operations program is now impacting over 1,196 students, and an additional 334 undergraduates with certificates. There are now 268 graduates of the cyber operations majors, and 164 students have achieved their proficiency certificates during the program. Over 9, 500 student credit hours were conducted in FY23.	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
TRIF has supported expanding student involvement and impact, growing the cadres of faculty and staff to deliver the programs with a goal of getting to 2,000 students by 2025, improving the infrastructure of the virtual learning environment, and expanding the marketability of the programs to build awareness of this valuable Arizona program.	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
Highly focused investments sometimes prevent integration with other collaborative and symbiotic program opportunities due to the specificity of key performance indicators. This poses challenges to creating a comprehensive ecosystem that is agile and evolves to meet threats and opportunities as they arise. Having longer funding periods, with room for innovation and program collaboration could yield higher value for program impact.	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
As the leading cyber program for undergraduates in the U.S, we have taught 1,500+ students this year, producing 268 additional graduates and 164 skilled persons contributing toward improved cyber capabilities for Arizona and beyond.	
<b>Additional Notes</b>	

Investment Detail				
	2022	2023	2024	Total
Infrastructure	\$1,064,625	\$2,139,650		\$3,204,275
Basic Research	\$9,441	\$36,008		\$45,449
Applied Research	\$0	\$0		\$205,353
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$1,074,066</b>	<b>\$2,175,658</b>		<b>\$3,249,724</b>
Performance Measures				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$1,064,625	\$2,139,650		\$3,204,275
Postdocs Supported	0	0		0
Graduate Students	0	0		0
Undergraduate Students	6	1200		1206
Sponsored Project Funding	\$921,080	\$1,392,997		\$2,314,077
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	National Security Systems			
Program Name	Cyber-Physical Systems			
<b>Problem Statement</b>				
<p>Industry has traditionally relied on highly linear data and communications for decision making. Cyber-physical systems (CPS) enables real-time access to data and intelligence from a myriad of sources and locations simultaneously, with the potential to fundamentally change the way businesses operate. Challenges in CPS include many fundamental questions regarding system integration, safety, accuracy, data processing, and reliability.</p>				
<b>Program Description</b>				
<p>At present there are several active programs that focus on CPS problems and technologies. TRIF funding would support further growth and expansion. Over the next five years, we expect that the number of competitive grants submissions from these programs will grow and the number of research sponsors will increase beyond past experience, which recently has been limited mostly to NSF. In particular, current opportunities exist with the Department of Defense, NASA, and industry that we can and should pursue. TRIF funding will also make investments to increase UArizona's activities in this domain by bringing current groups together for larger projects, as well as introducing new investigators to the field through seed grants. One area that may be particularly fruitful is CPS application to health care. With the growth of telemedicine, which is largely focused on video-enabled patient interactions (especially during the SARS-CoV-2 pandemic), innovators are turning to the next frontier. This will undoubtedly involve CPS-enabled platforms such as remote surgery.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>UArizona has a history of involvement in CPS research since at least 2014. We held a workshop for faculty interested in CPS funded by the NSF and most recently were awarded another NSF grant in "Computationally Aware Cyber-Physical Systems." UArizona has many units and individual investigators across the university conducting research and student training in the broad field of CPS. The Compositional Systems Labs, housed within Systems and Industrial Engineering and aligned with the UArizona Transportation Research Institute, works in the fields of transportation and autonomous vehicles. The College of Science (Applied Math), Electrical and Computer Engineering, and the Center for Applied Genetics and Genomic Medicine also are engaged in CPS activities.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• Growth of existing CPS activities and an increase in the number of submitted proposals, particularly beyond NSF</li> <li>• Increased participation of faculty in CPS-related research, especially from related areas (e.g., mechanical engineers that work on the physical systems side)</li> <li>• Expanded application space for CPS-related technologies in all relevant areas, but importantly in health care</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$301,351	\$301,351	\$301,351	\$904,053
Basic Research	\$262,114	\$262,114	\$262,114	\$786,342
Applied Research	\$429,868	\$429,868	\$429,868	\$1,289,604
Development	\$178,238	\$178,238	\$178,238	\$534,714
Total	\$1,171,571	\$1,171,571	\$1,171,571	\$3,514,713
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$209,692	\$1	\$209,692	\$629,076
Postdocs Supported	2	2	2	75
Graduate Students	5	5	5	15
Undergraduate Students	3	3	3	9
Sponsored Project Funding	\$2,083,333	\$2,083,333	\$2,083,333	\$6,249,999
Publications in Academic Peer-Reviewed Journals	17	17	17	51
Startups	0	1	2	3

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	National Security Systems
Program Name	Cyber-Physical Systems
<b>Progress Summary</b>	
<p>The work on two projects funded by TRIF in the Cyber-Physical Systems domain continue to address the challenge of humans interacting with computer-controlled systems such as autonomous robots and drones, as well as using these systems for activities with physically demanding or repetitive tasks that are difficult or even impossible for humans. We continue to use TRIF funding to support infrastructure, pilot project activity, and experiential learning opportunities for students. - TRIF funds were recently used to purchase a new test bed system comprised of motion capture cameras, hardware, and software that can record and analyze the motion of complex robotic systems, including drones and ground-based robots - TRIF is supporting new initiatives that use drones and advanced robotics in agricultural applications, such as aerial health/behavior monitoring of production animals that are far ranging (e.g. cat le).</p>	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
<p>The CPS portfolio at UArizona is small but growing, especially in the area of autonomous systems for a variety of applications. Drones and robotics are generally suited for applications that are difficult for humans, but as these technologies improve they can be used for an increasing array of tasks, especially when combined with other technologies such as sensors, data processing, and AI. Initial TRIF investments in CPS are allowing the university to attract additional research-active faculty so that we can add to our critical mass of expertise and activity in this field, thereby growing research activity and capacity for workforce development.</p>	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
<p>CPS is a multidisciplinary field that is best served by contributions from researchers in a number of related fields. Attracting a critical mass of talent will take some time and require more investment, especially in the field of healthcare. Supply chain issues have presented roadblocks in the past year, and have prevented progress on existing projects.</p>	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
<p>Expansion of drone and advanced robotics application domains, such as in the agricultural sector, is allowing UArizona to quickly grow its research programs and compete for additional funding. Recent applications have been submitted to the Department of Defense, NASA and the NSF. Investment in a new motion capture system increases our capacity for cutting edge research and attracts new faculty members.</p>	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$75,191	\$111,245		\$186,436
Basic Research	\$78,562	\$0		\$78,562
Applied Research	\$0	\$0		\$205,353
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$153,753</b>	<b>\$111,245</b>		<b>\$264,998</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$75,191	\$62,418		\$137,609
Postdocs Supported	1	0		1
Graduate Students	2	8		10
Undergraduate Students	6	3		9
Sponsored Project Funding	\$8,000	\$43,929		\$51,929
Publications in Academic Peer-Reviewed Journals	17	0		17
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	National Security Systems			
Program Name	Human-Computer Interactions			
<b>Problem Statement</b>				
Computer systems used to be designed to respond to human input efficiently and consistently. With wearables, digital assistants, ubiquitous data, and artificial intelligence-infused and connected objects, we now require approachable, accessible, efficient interactions for compute-capable platforms to interact with humans. In many critical applications and systems, we also have moved from a time of a human operator in the control loop, to a human supervisor on the control loop. Safety, ergonomics, multi-sensory interactions, and intuitive interfaces are critical.				
<b>Program Description</b>				
Research in the area of human-computer interaction should reduce errors in the use of our defense systems, reduce the training burden as users transition to new systems, and reduce human stress in the use of these systems.				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
UArizona has strong electrical and computer engineering faculty as well as depth in artificial intelligence and mathematics. We have strong language centers; psychology, physiology, and social sciences faculty; and design themes around strengthening the built environment. These multidisciplinary talents will help us shape the interface between the real world and digital terrain, building efficiency and removing impediments to national security system interfaces and practices.				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• Increased industrial-sponsored research in human-computer interactions</li> <li>• Increased federal, defense, and intelligence agency sponsored projects</li> <li>• Increased recruiting of top faculty and students</li> <li>• Increased licensing and tech transfer impacts</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$148,815	\$148,815	\$148,815	\$446,445
Basic Research	\$129,439	\$129,439	\$129,439	\$388,317
Applied Research	\$212,280	\$212,280	\$212,280	\$636,840
Development	\$88,019	\$88,019	\$88,019	\$264,057
<b>Total</b>	<b>\$578,553</b>	<b>\$578,553</b>	<b>\$578,553</b>	<b>\$1,735,659</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$103,551	\$1	\$103,551	\$310,653
Postdocs Supported	0	0	0	75
Graduate Students	3	3	3	9
Undergraduate Students	3	3	3	9
Sponsored Project Funding	\$1,666,667	\$1,666,667	\$1,666,667	\$5,000,001
Publications in Academic Peer-Reviewed Journals	9	9	9	27
Startups	0	1	2	3

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	National Security Systems
Program Name	Human-Computer Interactions
<b>Progress Summary</b>	
UArizona researchers have created underwater “tents” that serve as platforms to interact with and to control the robotic and sensor systems increasingly used to explore the largest portion of the Earth’s surface – its oceans and waters. These “blue” networks, and our ability to interact with aquatic systems are critical to understanding and obtaining economic or national security value from the oceans and beyond.	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
Aquanauts have successfully deployed to the Biosphere 2 “Ocean” to test the tents, tool-kits, and other systems necessary for deployment at scale. The sensors, robots, and data systems have been integrated to produce data analysis and experiences in the UArizona virtual reality system, the “holodeck.”	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
The genetic sampling conducted in the Biosphere 2 “Ocean” was a success, but additional support would help refine our methods, and better attribute genetic samples for comparative studies in the real world. These projects take place at the intersection of not only science and engineering, but of national security and the economy. More sustained support will drive more integrated innovation.	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
Undergraduate students are directly engaged in the process through experiential learning “Vertically Integrated Projects (VIPs)”, and their work is being incorporated into the curriculum of at least three undergraduate courses, and also in research and visitor experiences at Biosphere 2.	
<b>Additional Notes</b>	

Investment Detail				
	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$172,604	\$9,433		\$182,037
Applied Research	\$0	\$0		\$205,353
Development	\$0	\$1,138		\$1,138
<b>Total</b>	<b>\$172,604</b>	<b>\$10,571</b>		<b>\$183,175</b>
Performance Measures				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	1	4		5
Graduate Students	3	6		9
Undergraduate Students	8	4		12
Sponsored Project Funding	\$0	\$115,125		\$115,125
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0



# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	National Security Systems			
Program Name	Internet of Things (IoT)			
<b>Problem Statement</b>				
<p>The Internet of Things (IoT) is represented by devices with a multitude of capabilities, including self-identification, localization, diagnostic status, data acquisition, processing, and device-to-device and device-to-network communication. Devices function under the umbrella of the internet, which serves as a means of data transfer and communication. Application areas can be broadly categorized in terms of consumer, organizational, industrial, infrastructure, and military sectors. Technologies that support the IoT include wireless, low-power consumption electronics, energy storage, miniaturization, cloud computing, and data analytics. Barriers such as compatibility and lack of a clear value-proposition have hampered adoption. Security and privacy concerns with respect to data usage also have tempered enthusiasm.</p>				
<b>Program Description</b>				
<p>We anticipate this initiative will focus resources around current areas of demonstrable leadership in IoT technologies (e.g., transportation, agriculture, mining), as well as emerging areas (e.g., health monitoring), to deepen expertise and solidify critical mass. Over the next five years, one or more of these programs will be capable of maturation to national research center status, with commensurate federal funding support (e.g., ERC, MURI, NIH P01 or P50). TRIF funding also would support smaller programs in a “seed and feed” approach. The nature of IoT research involves a wide application space, and new discoveries can potentially be directed toward a myriad of applications and/or combined with related technologies to address ever-larger challenges. TRIF seed grants in the IoT initiative will be used to ensure that a pipeline of discoveries emerges over the five-year timeframe, and that this culture persists in the future.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>As a large land-grant university, UArizona is positioned to address complex system problems in a variety of application domains. Current research in wireless communications, low-energy consumption sensors, agricultural automation, data analytics, machine learning, wearables, advanced manufacturing, robotics, and transportation provide broad capabilities and expertise that can be directed toward important research questions that currently limit the effective application of IoT technologies. The university's ability to form strong academic-industry partnerships can help focus research and accelerate translation through proof-of-concept, technology transfer, and commercialization.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• Development of a community around IoT technologies that includes multiple investigators, a convergence research approach, education and training programs directed toward workforce development, and increased technology transfer activity</li> <li>• Increased synergy between currently diffuse areas of IoT research and improved competitiveness for large, center-type funding awards</li> <li>• Development of a robust pipeline of seed projects that address emerging challenges and new application spaces</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$469,103	\$469,103	\$469,103	\$1,407,309
Basic Research	\$178,238	\$178,238	\$178,238	\$534,714
Applied Research	\$262,115	\$262,115	\$262,115	\$786,345
Development	\$262,115	\$262,115	\$262,115	\$786,345
Total	\$1,171,571	\$1,171,571	\$1,171,571	\$3,514,713
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$209,692	\$1	\$209,692	\$629,076
Postdocs Supported	2	2	2	75
Graduate Students	5	5	5	15
Undergraduate Students	3	3	3	9
Sponsored Project Funding	\$2,083,333	\$2,083,333	\$2,083,333	\$6,249,999
Publications in Academic Peer-Reviewed Journals	17	17	17	51
Startups	0	1	2	3

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	National Security Systems
Program Name	Internet of Things (IoT)
<b>Progress Summary</b>	
<p>TRIF-funded projects in the Internet of Things (IoT) portfolio continue to be directed toward sensor systems and devices designed to improve quality of life. Examples include a sensor system for visually impaired people to help them navigate complex environment, healthcare monitors that can recognize a fall and another that detects a wound in a diabetic person's foot, as well as an implantable sensor to monitor bone repair. - Additional funding was secured from the Congressionally Directed Medical Research Program (CDMRP) for continued development of in situ bone healing sensor technology. The funding will support a translational study in a large animal model. - A new autonomous vehicle testbed is being purchased using TRIF funds, which will allow researchers across several departments conduct further sensor hardware and software development to support innovations in autonomous vehicle and self-driving technologies.</p>	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
<p>A new state-of-the-art autonomous vehicle testbed will allow researchers from several departments across the university test new sensors, wireless communication, data acquisition and processing technologies, and AI technologies. This work will have application in areas including commercial and industrial systems, infrastructure, and military. A bone healing sensor application has advanced toward a large animal study and secured significant investment from the Department of Defense. This work will advance the technology further toward definition of the regulatory pathway and eventually human clinical trials. Several patents have been filed, including three this year, and a new startup company has been formed to commercialize the technology.</p>	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
<p>One significant challenge for the healthcare technologies-related projects are the timelines for translation and commercialization. Especially for implantable sensors, the regulatory pathway is long and requires significant financial resources to make a startup company successful.</p>	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
<p>The state will benefit through UArizona's advanced transportation and healthcare research in the IoT domain. Autonomous vehicle platforms will support ongoing research that can be translated to Arizona's growing footprint in autonomous vehicles and self-driving systems for electric vehicles. Workforce development and experiential learning using these systems will further support this growing Arizona industry. Commercialization of healthcare products such as bone healing sensors will help Arizona citizens that suffer fractures, and startup companies based on these technologies provide jobs in the sector.</p>	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$3,234	\$133,105		\$136,339
Basic Research	\$137,844	\$0		\$137,844
Applied Research	\$339,237	\$0		\$544,590
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$480,315</b>	<b>\$133,105</b>		<b>\$613,420</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$125,860		\$125,860
Postdocs Supported	3	0		3
Graduate Students	7	0		7
Undergraduate Students	19	0		19
Sponsored Project Funding	\$401,797	\$1,003,255		\$1,405,052
Publications in Academic Peer-Reviewed Journals	17	0		17
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	National Security Systems			
Program Name	Novel Materials			
<b>Problem Statement</b>				
Military systems operate in extreme environments that pose challenges to structural and packaging materials. Their energy systems require lightweight and high-electrical discharge capabilities. The structures require materials systems with unique fastening and joining methods. Increasingly, those materials must accommodate additional functionality and embedded systems than previous systems.				
<b>Program Description</b>				
We expect substantial progress in fundamental materials development, testing, and evaluation of coupon (small materials samples) and larger scale-up materials models, technical artifacts, and prototypes.				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
Through growing collaborations with Arizona's resident military and intelligence components, our scientists are increasingly familiar with the operational and design issues that these systems must accommodate.				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• Increased industrial-sponsored research in novel materials</li> <li>• Increased federal, defense, and intelligence agency sponsored projects</li> <li>• Increased recruiting of top faculty and students</li> <li>• Increased licensing and tech transfer impacts</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$319,675	\$319,675	\$319,675	\$959,025
Basic Research	\$129,439	\$129,439	\$129,439	\$388,317
Applied Research	\$103,551	\$103,551	\$103,551	\$310,653
Development	\$25,888	\$25,888	\$25,888	\$77,664
<b>Total</b>	<b>\$578,553</b>	<b>\$578,553</b>	<b>\$578,553</b>	<b>\$1,735,659</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$258,879	\$1	\$258,879	\$776,637
Postdocs Supported	0	0	0	75
Graduate Students	3	3	3	9
Undergraduate Students	3	3	3	9
Sponsored Project Funding	\$1,666,667	\$1,666,667	\$1,666,667	\$5,000,001
Publications in Academic Peer-Reviewed Journals	9	9	9	27
Startups	0	1	2	3

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	National Security Systems
Program Name	Novel Materials
<b>Progress Summary</b>	
UArizona researchers are exploring and identifying new ferromagnetic materials that work at a nanoscale. Work has begun in one-dimensional ferromagnetic materials systems. For the first time, these researchers have discovered ferromagnets with transition temperatures that remain below room temperature.	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
They are also exploring new chemical motifs that will produce ferromagnets with higher transition temperatures.	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
While this work has succeeded in discovery of new materials and translation of those insights through seven publications including those in top tier journals (which positions UArizona well for additional federal research support), the level of funding has not yet allowed for integration with other research to drive these innovations toward market adoption.	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
Ferromagnetic materials are often used for non-volatile information storage on hard drives, in tapes, and other digital media. They are also used for information processing where either light or electricity are used to drive a change in the magnetic order of the material. These innovations are directly in keeping with Arizona's initiatives to attract, build, and innovate in the computer chip and IT industries, and position the state to better compete for federal economic development dollars.	
<b>Additional Notes</b>	

Investment Detail				
	2022	2023	2024	Total
Infrastructure	\$976,178	\$634,649		\$1,610,827
Basic Research	\$18,795	\$92,467		\$111,262
Applied Research	\$0	\$0		\$205,353
Development	\$0	\$69,100		\$69,100
<b>Total</b>	<b>\$994,973</b>	<b>\$796,216</b>		<b>\$1,791,189</b>
Performance Measures				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$859,695	\$306,355		\$1,166,050
Postdocs Supported	1	5		6
Graduate Students	7	21		28
Undergraduate Students	10	16		26
Sponsored Project Funding	\$6,015,937	\$2,398,019		\$8,413,956
Publications in Academic Peer-Reviewed Journals	0	10		10
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	Space Exploration and Optical Solutions			
Program Name	Frontiers in Space Exploration and Optical Sciences			
<b>Problem Statement</b>				
To achieve any of our objectives in Space Exploration and Optical Sciences, we need to be able to recruit the talent and establish the new programs necessary to respond to the latest developments in—and actively create the future of—those fields. This means hiring the scientists and engineers who are developing those fields and providing them with the resources necessary to succeed. These resources can include students, technical support, and equipment. This investment in the future is crucial to sustaining our current successes and building the new success stories.				
<b>Program Description</b>				
UArizona has world leaders in many fields and subfields within the Space Exploration and Optical Sciences focus area. However, to remain a leader as an institution, we need to continue to add future leaders in burgeoning fields and replace the expertise we inevitably lose as the current leaders age and retire. In particular, UArizona has a history of developing sensors and instruments that leverage emerging technologies to make revolutionary measurements, but we need to continue to hire the scientists who are able to make this happen.				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
UArizona is home to internationally recognized faculty, staff, and students in Steward Observatory, the Lunar and Planetary Laboratory, and the College of Optical Sciences. This reputation makes the university a destination of choice for the very best talent in space exploration and optical sciences. Securing resources to recruit that talent, however, remains a major challenge.				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
The primary measure of success is adding faculty who: • generate new streams of funding • attract high-quality new students • build programs that integrate with the existing strengths of the University's Space Exploration and Optical Sciences areas				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$639,350	\$639,350	\$639,350	\$1,918,050
Basic Research	\$258,879	\$258,879	\$258,879	\$776,637
Applied Research	\$207,103	\$207,103	\$207,103	\$621,309
Development	\$51,776	\$51,776	\$51,776	\$155,328
Total	\$1,157,108	\$1,157,108	\$1,157,108	\$3,471,324
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$415,000	\$0	\$415,000	\$1,245,000
Postdocs Supported	1	1	1	75
Graduate Students	2	2	2	6
Undergraduate Students	0	0	0	0
Sponsored Project Funding	\$500,000	\$500,000	\$500,000	\$1,500,000
Publications in Academic Peer-Reviewed Journals	15	15	15	45
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	Space Exploration and Optical Solutions
Program Name	Frontiers in Space Exploration and Optical Sciences
<b>Progress Summary</b>	
As a global leader in space and optical sciences, University of Arizona is widely recognized for cutting-edge science that pushes boundaries in both the theoretical and the functional spheres. TRIF has funded a variety of projects for individual researchers pursuing new approaches to studying everything from the origin of life to the largest stellar explosion (gamma-ray burst) ever detected. This funding has been used to bring in new faculty who are either currently developing new technologies or those who are doing the work that will lead to the use (or necessity) of the kind of new technologies that can best be developed at UArizona.	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
The problem statement has been addressed in a wide range of ways and across multiple axes. The support spans theoretical/computational based work, practical support for instruments, support for facilities, and observational projects. This project has been used to recruit high quality talent and retain them.	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
As with other projects, staff retention is always a concern. We continue to take an active role in supporting staff and trying to attract new researchers.	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
- TRIF support helped us to establish of a state of the art photogrammetry lab to determine the topography of planetary surfaces from stereo images. - TRIF funds are being used to modernize UArizona's Unoccupied Aircraft Systems (UAS) infrastructure to create new opportunities for planetary analog research and field-based testing of new technology. UASs have revolutionized field-based geology and represent the next frontier for planetary exploration. - With TRIF support, we solved a longstanding problem in abiotic sulfur cycling, representing a major advance in our understanding of the origin of life. We anticipate considerable follow-up work, with concomitant grant support. - TRIF support catalyzed the selection of the Kuiper Materials Imaging and Characterization Facility (KMICF) (\$2.9M) as one of 10 other facilities for the inaugural class in the NASA Planetary Science Enabling Facilities program. - TRIF supported the development of an open source GPU-accelerated general relativistic ray-tracing code. - TRIF funded researchers were key contributors to the study of the brightest gamma-ray burst ever discovered, one of which relied heavily on world-class telescopes operated by UArizona with TRIF support. - Work initiated by TRIF has become a core part of the existing MagAO-X exoplanet imaging instrument on the 6.5m Magellan Telescope, and is at the core of the exoplanet imaging instrument for the Giant Magellan Telescope, which may provide the first images of habitable exoplanets.	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$2,544,695	\$2,221,866		\$4,766,561
Basic Research	\$0	\$0		\$0
Applied Research	\$0	\$0		\$205,353
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$2,544,695</b>	<b>\$2,221,866</b>		<b>\$4,766,561</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$1,886,985	\$1,667,771		\$3,554,756
Postdocs Supported	12	9		21
Graduate Students	68	37		105
Undergraduate Students	75	38		113
Sponsored Project Funding	\$10,771,885	\$22,257,995		\$33,029,880
Publications in Academic Peer-Reviewed Journals	148	42		190
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	Space Exploration and Optical Solutions			
Program Name	Optical Sensing and Display for Human-Centered Intelligent and Autonomous Systems			
<b>Problem Statement</b>				
<p>Since the dawn of computing, the interface between computers and humans has become progressively more personal, from computer room to desktop to mobile phone. The next revolution, wherein people will live and work in ubiquitous digital spaces, is just starting, and it will spawn entirely new economies and improvements in quality of life. Optical sensing is a critical enabling technology in this revolution, and we already are witnessing the increasing proliferation of sophisticated 3D optical sensing and imaging in consumer mobile platforms, autonomous vehicles, entertainment, smart spaces for enterprise business, remote medicine, and remote sensing for scientific discovery, defense, environment, and agriculture. Rapid progress in these applications is enabled by breakthrough advances in underlying optical and laser technologies using chip-scale structured illumination, LIDAR, stereoscopic and novel focal plane array concepts for 3D imaging, and human-computer interface technologies such as gesture-recognition systems and augmented and virtual reality (AR/VR) displays. Integrating these technologies with emerging computing and communication platforms, especially neural and quantum processing, will be key in the new digital age. The future economic potential of optically enabled intelligent systems is enormous, and the moment is now for Arizona to lead through regional economic development that leverages faculty strength with investments supporting more integrative, applications-driven programs.</p>				
<b>Program Description</b>				
<p>This initiative will advance UArizona's scientific/engineering leadership in a very high-impact area. We will establish applications-driven collaborative research teams to accelerate the development of underlying optical technologies, ranging from breakthrough chip-scale 3D imagers with integrated neural processors, to smart displays and interfaces that enable ubiquitous information access, to new free-form optics that enable 100x reductions in size, weight, power, and cost (SWaP-C). In addition to the discovery engendered by cutting-edge applications research, this applications-driven approach lays the groundwork for increased private-sector partnerships, commercial transitions, and economic development.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>UArizona is exceptionally well positioned to take on this challenge. The College of Optical Sciences has eight faculty members strongly engaged in this area of optical sensing and display, including a new Endowed Chair and three additional new hires, spanning the core technologies and application domains mentioned above. These faculty are pursuing innovations that offer exciting promise in providing game-changing technical capabilities and cost reduction. They are also leaders in their field and have exceptionally strong industry engagement, with more than \$10M in private-sector research support and IP revenue over the past four years. By linking with engineering, medicine, and data science, this effort will leverage synergies from university-wide investments.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>This TRIF initiative will produce compelling ROI, including: • Growth in optical sensor research grants/contracts, including a major center proposal • Workforce development, producing BS, MS, PhD, and postdoc/research scientist talent with application team experience to support regional economic development • Intellectual property generation with an excellent record of licensing potential • New start-up companies and strengthened relationships with local tech companies</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$781,593	\$441,593	\$441,593	\$1,664,779
Basic Research	\$0	\$0	\$0	\$0
Applied Research	\$375,514	\$575,514	\$575,514	\$1,526,542
Development	\$0	\$140,000	\$140,000	\$280,000
<b>Total</b>	<b>\$1,157,107</b>	<b>\$1,157,107</b>	<b>\$1,157,107</b>	<b>\$3,471,321</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$500,000	\$0	\$200,000	\$900,000
Postdocs Supported	6	10	14	75
Graduate Students	8	15	15	43
Undergraduate Students	0	0	0	0
Sponsored Project Funding	\$800,000	\$2,000,000	\$3,500,000	\$6,300,000
Publications in Academic Peer-Reviewed Journals	8	12	20	40
Startups	0	0	1	1

# Arizona Board of Regents

University	University of Arizona
TRIF Investment Area	Space Exploration and Optical Solutions
Program Name	Optical Sensing and Display for Human-Centered Intelligent and Autonomous Systems
<b>Progress Summary</b>	
<p>The Optics for Autonomous Services and Interactive Systems (OASIS) effort led by the Wyant College of Optical Sciences enjoyed substantial expansions of scope and funding this year. In addition to continued college support from the IT sector in augmented and virtual reality technologies in excess of \$1M/year, OASIS applications underway now also include chip-scale no-moving-parts LIDAR and high-resolution dynamic sports telemetry for advance athlete performance analysis. Recently, the U.S. Department of Defense has also launched major OASIS projects to TRIF recipients totaling \$5.36M in advanced fused multi-camera infrared imaging systems for pilot situational awareness and chip-scale bat lefield networking. - Developed major OASIS program traction with US Department of Defense and an expanding customer set in IT, sports, and entertainment. - Designed thematic collaborative OASIS laboratory layout occupying 2nd floor of new Grand Challenges Research Building. - Hired two new OASIS tenure track faculty members. - Expanded dialog and support from OASIS manufacturing technology partners, including VIAVI, Applied Materials and Coherent, all three AZ state universities, and community colleges, both in technology and workforce development.</p>	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
<p>OASIS partners span from IT-based companies including Meta, Apple, Microsoft, Amazon, and Magic Leap, to technology developers for automation, autonomous driving and manufacturing, to underlying component and materials manufacturers including VIAVI, Applied Materials and Coherent, to application developers in defense, education, healthcare, environment, sports, and entertainment. The program began to expand its reach across all sectors, in part in the context of proposal for an NSF TIP Engine Type I development grant. While that development grant proposal was not funded, the effort has helped to gain support for regional investment in underlying OASIS manufacturing technologies and cooperation in workforce development across AZ universities, community colleges, and private sector partners. Work with defense partners has illustrated compelling examples of warfighter benefits of OASIS technologies, with a prime example being ultra-wide-field multispectral imaging for persistent automated threat sensing while simultaneously allowing pilots detailed viewing of desired scenes with no moving parts. Additional work in Short Wave Infrared (SWIR) drone surveillance includes a highly active flight program at Santa Rita Experimental Station. A program in chip-scale free-space optical links for data and position, navigation and timing has also launched this year. These programs have attracted substantial and rapidly growing funding from the US Department of Defense.</p>	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
<p>While our initial bid for an NSF TIP Engine Type I development grant was not funded, we are continuing to focus and engage in a growing portfolio of high-value research and workforce development partnerships. In our proposal we did not adequately illustrate the genuine traction we have with some of the largest OASIS technology providers, manufacturers, and users, and will continue to enrich those relationships while also bolstering regional partners, including both established multi \$B companies and entrepreneurial start-ups. Continued focus and commitment, and several recent large successes with strong potential for more, will provide the basis for future larger-scale funding successes.</p>	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
<p>- 17 patents were filed by TRIF-supported OASIS faculty and extramural research volume has expanded to approx. \$3.4M/yr, enabling strong and growing contributions to workforce development with 17 PhD and 9 MS students. - The Wyant College of Optical Sciences added two additional faculty members in OASIS theme areas.</p>	
<b>Additional Notes</b>	

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

Investment Detail	2022	2023	2024	Total
Infrastructure	\$0	\$83,429		\$83,429
Basic Research	\$0	\$0		\$0
Applied Research	\$0	\$24,677		\$205,353
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$0</b>	<b>\$108,106</b>		<b>\$108,106</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	0	1		1
Undergraduate Students	0	0		0
Sponsored Project Funding	\$2,989,822	\$487,228		\$3,477,050
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	1		1



# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	Space Exploration and Optical Solutions			
Program Name	Quantum Technology & Systems Engineering			
<b>Problem Statement</b>				
<p>UArizona has successfully launched a vital program in quantum information science and engineering (QISE), including its recent leadership role in the NSF Center for Quantum Networks. Quantum technologies also are positioned to benefit a host of additional applications and markets that harness advanced sensor systems in physical sciences, life sciences, and defense. To lead the emerging quantum economy, UArizona must galvanize a high-impact, integrative, university-wide QISE effort.</p>				
<b>Program Description</b>				
<p>This TRIF initiative will focus resources on developing explicit systems-scale solutions and demonstrators with unambiguous quantum performance advantage, ideally in sensor spaces that will strongly complement other UArizona investment areas, such as those in space sciences, National Security Systems, and Improving Health. To support CQN and other emerging systems QISE applications, and to bring experience in deployable quantum systems, the College of Optical Sciences has committed an Endowed Chair faculty position to lead in quantum systems engineering. It will also support committed Research, Innovation and Impact matching funds for CQN and additional infrastructure required for the QISE effort, such as advanced e-beam lithography tools.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>With its prior substantial faculty investments in QISE, combined with its high-visibility national leadership with CQN, UArizona is exceptionally well positioned. Potential quantum systems applications include sensors systems for defense and scientific discovery and communications solutions beyond the scope and budget of CQN. This TRIF initiative will harness resources in the Colleges of Optical Sciences, Engineering, Science, and Medicine, and CQN has additionally broken new ground by funding societal impacts research in the Colleges of Law and Social and Behavioral Sciences.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>This TRIF initiative will produce more than a 10x ROI, including: • Growth in quantum research proposals, grants, and contracts • Intellectual property generation with an excellent record of licensing potential • Regional workforce development, producing increased BS, MS, PhD, postdoc, and research scientist talent with experience in applications-driven teams • QISE start-up companies and strengthened relationships with local tech companies</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$1,021,593	\$871,593	\$871,593	\$2,764,779
Basic Research	\$0	\$0	\$0	\$0
Applied Research	\$135,514	\$135,514	\$135,514	\$406,542
Development	\$0	\$150,000	\$150,000	\$300,000
<b>Total</b>	<b>\$1,157,107</b>	<b>\$1,157,107</b>	<b>\$1,157,107</b>	<b>\$3,471,321</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$800,000	\$0	\$600,000	\$2,000,000
Postdocs Supported	3	8	12	75
Graduate Students	8	14	14	42
Undergraduate Students	0	0	0	0
Sponsored Project Funding	\$600,000	\$2,400,000	\$3,500,000	\$6,500,000
Publications in Academic Peer-Reviewed Journals	4	8	12	24
Startups	0	0	1	1

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	Space Exploration and Optical Solutions
Program Name	Quantum Technology & Systems Engineering
<b>Progress Summary</b>	
<p>UArizona leadership in Quantum Information Science and Engineering (QISE) is growing rapidly, based in part around the flagship Center for Quantum Networks (CQN) NSF Engineering Research Center (ERC). TRIF-supported faculty have attracted additional funding from agencies including NSF, ONR, ARO, AFOSR, DARPA, NASA and private sector partners, now totaling &gt;\$9M/year for current TRIF-supported faculty. In addition to the information security and the potential to network quantum computers for unprecedented computation resources, this technology shows promise for enhanced sensing with applications being explored for defense, medicine, and even long-baseline astronomical imaging. - The portfolio of QISE engagements and customers continues to grow in number, in funding, and in application domain. - An entire floor of the new Grand Challenges Research Building has been designed to house the Center for Quantum Networks (CQN) NSF ERC in a highly collaborative space for QISE faculty from several participating colleges. - The QISE team has initiated the Arizona Quantum Initiative (AQI) to strengthen state-wide collaboration in technology, workforce development, and visibility among academic, government, and private sector partners. - Four new QISE tenure track faculty members have been hired.</p>	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
<p>The QISE effort has had tremendous success and growth in FY23 with contract volume from current TRIF supported faculty along in excess of \$9M/year. Our interdisciplinary research program spans many subtopics such as quantum repeaters for long-range quantum communications, quantum networking, generating highly entangled states of light for enhancing sensor networks, 2D quantum materials for use as highly-sensitive photon detectors and single-photon sources, spin-based qubits built using solid-state defects in diamond and other host materials, quantum opto-mechanical and quantum-photonics systems, mathematics and algorithms underlying quantum-powered security, fault-tolerant quantum error correction codes and efficient decoder realizations for both quantum communications and quantum computing, ensemble cold atom spin qubit systems for exploring new paradigms of quantum control and simulations, Bose Einstein condensates, and more. We have launched the Arizona Quantum Initiative (AQI) focused on building Arizona as a world leader in QISE with a mission is to deliver quality education, cutting-edge research, and effective partnerships, attracting diverse talent and investment to quantum technology development in the state.</p>	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
<p>Hiring and retention continues to be a challenge. In conjunction with Arizona's challenges in maintaining competitive faculty pay on a national landscape, our QISE effort lost two valuable faculty members. The initial launch of AQI has also presented challenges just due to the very intense pace of activity and demands on participant's time. However, it is recognized that building a state-wide enterprise will take time and commitment.</p>	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
<p>- 11 patents were filed in QISE technologies and faculty extramural research volume of just current TRIF QISE faculty has expanded to &gt;\$9M/year, with the broader QISE effort at UA at &gt;\$12M/year enabling strong and growing contributions to workforce development with 21 PhD students and 3MS students. - The SPIE Endowed Chair in Optical Sciences arrived to bolster our QISE bringing a unique partnership with Sandia National Laboratories. This a major investment in quantum system engineering, including a multi-\$M new laboratory in the Grand Challenges Research Building. - Ongoing searches for several new QISE faculty positions generated promising candidates, with three new QISE faculty accepted joining in 23/24.</p>	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$577,420	\$354,119		\$931,539
Basic Research	\$0	\$0		\$0
Applied Research	\$0	\$0		\$205,353
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$577,420</b>	<b>\$354,119</b>		<b>\$931,539</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$577,420	\$354,119		\$931,539
Postdocs Supported	3	0		3
Graduate Students	10	3		13
Undergraduate Students	0	0		0
Sponsored Project Funding	\$13,645,465	\$11,307,856		\$24,953,321
Publications in Academic Peer-Reviewed Journals	36	0		36
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	Space Exploration and Optical Solutions			
Program Name	University of Arizona Space Institute			
<b>Problem Statement</b>				
<p>UArizona has an unparalleled history of involvement and leadership of major space science facilities and missions, both space-based and ground-based. Competition within academia, industry, and the federal government, however, has developed strong infrastructures for proposal development and project management, while UArizona has simply maintained its previously successful approach. The competitive landscape has changed, and UArizona must develop common infrastructure among space exploration and optical sciences to more effectively compete for research support in the future.</p>				
<b>Program Description</b>				
<p>The University of Arizona Space Institute (UASI) will provide a structure to aid in the development, proposal, and operation of large spacecraft missions and space- and ground-based instruments. By increasing both the number of operational projects and the support to develop them, UASI will help supply and retain the necessary workforce, providing the engineering and scientific expertise to develop, advance, propose, and operate the next generation of large projects funded by NASA, NSF, NOAA, and other government agencies. Successful proposal of such major missions and projects takes years of work, which is usually beyond the means of individual investigators or departments to support. The integrated UASI enables such long-term, higher-profile investments.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>UArizona was the first university to manage a planetary lander mission (Phoenix Mars Lander) and to lead a New Frontiers mission (OSIRIS-REx). Our scientists and engineers have developed, supplied, and operated a significant number of instruments to NASA planetary flagship missions (Pioneer 10, Voyager, Cassini, and numerous Mars missions) and NASA astrophysics flagship missions (NICMOS for the Hubble Space Telescope, MIPS for the Spitzer Space Telescope, and NIRCams for the James Webb Space Telescope), as well as ground-based telescopes that have significantly expanded our understanding of the universe (Multiple Mirror Telescope, the two 6.5m Magellan Telescopes, Large Binocular Telescope, the 24.5 Giant Magellan Telescope under construction, Spacewatch, and the Catalina Sky Survey).</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>This TRIF initiative will produce more than a 20x ROI, including: • Growth in the number of multi-million dollar spacecraft mission and instrument contracts • Increased number of positions in a highly skilled workforce capable of designing, building, and operating spacecraft hardware and missions • Increased number of students involved in spacecraft missions and projects • Increased opportunities for Arizona companies to participate in spacecraft missions and projects</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$432,247	\$432,247	\$432,247	\$1,296,741
Basic Research	\$103,551	\$103,551	\$103,551	\$310,653
Applied Research	\$258,879	\$258,879	\$258,879	\$776,637
Development	\$362,430	\$362,430	\$362,430	\$1,087,290
Total	\$1,157,107	\$1,157,107	\$1,157,107	\$3,471,321
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	75
Graduate Students	0	0	0	0
Undergraduate Students	0	0	0	0
Sponsored Project Funding	\$2,000,000	\$4,000,000	\$6,000,000	\$12,000,000
Publications in Academic Peer-Reviewed Journals	0	5	15	20
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	Space Exploration and Optical Solutions
Program Name	University of Arizona Space Institute
<b>Progress Summary</b>	
The University of Arizona Space Institute (UASI) provides the structural framework for the development, proposals, and operation of large spacecraft missions and space and ground-based instruments. UASI is operating, or has contributed to the development of, several world-class facilities that support such projects. TRIF support for UASI's mission is increasingly crucial, as the Strategic Implementation Funding that was a primary source of support to stand up UASI expired at the end of FY23.	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
TRIF support of UASI has provided seed grants for preparation of research proposals for spacecraft missions, spacecraft instruments, and large projects involving ground-based telescopes. TRIF investment will also help provide solutions to three upcoming challenges: 1) Improving communication among researchers interested in space projects (a new website under development will host several important types of information); 2- Establishing a sustainable funding model (discussions on methods are ongoing); and, 3- developing mechanisms of support for the university's talented technical staff in the times between major funding.	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
No, TRIF investment continues to produce results that uplift our university and state.	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
- An economic impact study supported by UASI determined that space science and exploration at UArizona employs 900 individuals, brings in more than \$100M in external funding per year, and generates an economic and community impact of approximately \$560M per year (roughly that of hosting a Super Bowl annually). - Over the past 30 months, UASI has supported 36 different projects (8 new projects in FY23) across four different colleges within UArizona. One spacecraft instrumentation development proposal was funded this year, along with one spacecraft proposal each of the previous two years. Another 8 proposals are in review, and 10 more are in preparation. - The OSIRIS-Rex mission will become the OSIRIS-APEX this year. After dropping off the sample return canister on Earth in September of 2023, the spacecraft will rendezvous in 2029 with the hazardous near-Earth asteroid Apophis. The proposal for the \$365M extended mission was funded by UASI. Of the total amount funded, \$73.2M will come to the University of Arizona. - Construction of detectors for GUSTO, a \$40M long-duration balloon mission led by UArizona, is complete, and the mission is expected to fly to Antarctica in late 2023 to study the life-cycle of stars by detecting the abundance of oxygen, carbon, and nitrogen. - Progress continued on ASPERA, a \$20M mission to launch a small satellite and one of four Pioneer-class missions selected in FY21 after being one of the first proposals supported by UASI. - Operated by UASI, the Applied Research Building (ARB) officially opened, although most facilities are not fully occupied yet. The ARB contains state-of-the-art laboratories that will be used by UArizona researchers and will be available for use by Arizona aerospace and other high-technology companies. These facilities include the largest thermal vacuum chamber at a university, a mission operations center capable of supporting multiple missions at once, a vibration testing facility (including a large shaker table), a high bay and payload assembly area, and an anechoic chamber. - The Space Analog for the Moon and Mars (SAM), a hi-fidelity, sealed and pressurized habitat and research center, has been constructed at the UArizona Biosphere 2. SAM offers visiting researchers experience in 1) life-support systems; 2) closing air, food, and water cycles; 3) use of pressurized space suits and tool use; 4) a study of the microbiome of built environments; and 5) computer models and controls. SAM is the only operating pressurized habitat analog for living on the Moon or Mars in the world today.	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$0	\$0		\$0
Applied Research	\$0	\$0		\$205,353
Development	\$0	\$0		\$0
Total	\$0	\$0		\$0
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	0	0		0
Undergraduate Students	0	0		0
Sponsored Project Funding	\$5,588,724	\$957,657		\$6,546,381
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	Space Exploration and Optical Solutions			
Program Name	World Leading Facilities for Astronomical Research			
<b>Problem Statement</b>				
Over 280 UArizona researchers (and additional students and faculty at ASU and NAU) depend on our world-renowned astronomical research facilities to produce transformative scholarship and return to Arizona, through external funding, 10x the currently provided state funding. We need \$2.4M per year of additional funding to maintain our current level of observatory operations and protect and grow our external funding.				
<b>Program Description</b>				
UAArizona will continue to use our facilities to make further ground-breaking discoveries. We anticipate progress in the characterization of planets around other stars, including the search for signs of life in the atmospheres of these planets. The Event Horizon Telescope will perform further tests of Einstein's theory of gravity by studying the nearest massive black holes. Our well-equipped telescopes will identify the sources of gravity wave-producing events and provide new insights into the formation and evolution of stars and galaxies. We will use our facilities to train the next generation of astronomers and industry innovators.				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
UAArizona has been a leader in space sciences for over a century. Our five mountaintop observatories in the desert Southwest, under clear, dark skies, have brought the world's most talented students, engineers, and faculty to Arizona. These exceptional people have produced the innovations leading to our leadership in both space- and ground-based research facilities, not only in Arizona, but around the world. With our federal (e.g., NASA, Department of Energy (DOE), NSF) and foreign partners, we have developed the observatories and space missions that enable our past transformative discoveries, from proving the existence of dark matter to the first image of a massive black hole.				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• Greater than a 700 percent ROI, through external funding, on the funds provided to support and upgrade our facilities.</li> <li>• Completion of the next five observing campaigns of the Event Horizon Telescope (which uses our radio telescopes on Mount Graham and Kit Peak) to complete our studies of the massive black holes in the nearest galaxies.</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$794,677	\$794,677	\$794,677	\$2,384,031
Basic Research	\$155,327	\$155,327	\$155,327	\$465,981
Applied Research	\$103,551	\$103,551	\$103,551	\$310,653
Development	\$103,551	\$103,551	\$103,551	\$310,653
Total	\$1,157,106	\$1,157,106	\$1,157,106	\$3,471,318
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	20	20	20	75
Graduate Students	40	40	40	120
Undergraduate Students	0	0	0	0
Sponsored Project Funding	\$14,000,000	\$14,000,000	\$14,000,000	\$42,000,000
Publications in Academic Peer-Reviewed Journals	20	20	20	60
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	Space Exploration and Optical Solutions
Program Name	World Leading Facilities for Astronomical Research
<b>Progress Summary</b>	
The University of Arizona continues to be a world leader in astronomical research. Our facilities, including the Large Binocular Telescope (LBT) at Steward Observatory, the Arizona Array, and Magellan Observatory continue to provide groundbreaking discoveries and act as a draw for top talent to come to the university. TRIF funding for each of these has resulted in good ROI across a range of metrics, including outside investment, research papers, and support of students and postdocs.	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
We've achieved a greater than 10x ROI for the funds invested in astronomical research facilities this year. The continued success of the Event Horizon Telescope has continued with an image of Quasar NRAO 530, after successful images of the SMBHs at the center of M87 and the Milky Way galaxy. We continue to be a world leader in astronomical facilities and research.	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
Competition for talent has been an issue for staff retention and recruiting. We are taking steps to offer entry points at multiple career levels to expand our recruiting pool, and are making changes in workplace practice that we hope will enhance morale and retention.	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
By maximizing TRIF investment, we are able to impact Arizona through new money brought into our economy through these large grants and collaboration, new jobs made available through the funding of long-term projects, and increased use of our world-class facilities and equipment by those in Arizona and beyond. 1) Generated \$10M annual investment in the LBT from Instituto Nazionale di Astrofisica, Beteiligungsgesellschaft, Ohio State, University of Minnesota, University of Notre Dame, and University of Virginia for support of research operations, which includes salaries for 45 full-time UArizona employees. 2) Access to the Magellan Observatory has allowed a new instrument built by the University of Arizona to be commissioned this year (April 2023 for MagAO-X). MagAO-X confirmed the discovery of new star, HIP 67596 C. This star was first identified by UArizona PhD student, Logan Pearce, using the previous MagAO system on Magellan Clay. 3) Generated \$500K of outside investment into the Arizona Array, which demonstrated moon bounce techniques at 10.45 GHz, as well as installing and updating multiple feeds, feed mounts, and processing equipment.	
Additional Notes	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$1,183,163	\$1,237,685		\$2,420,848
Basic Research	\$0	\$0		\$0
Applied Research	\$0	\$0		\$205,353
Development	\$0	\$0		\$0
Total	\$1,183,163	\$1,237,685		\$2,420,848
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	14	5		19
Graduate Students	15	10		25
Undergraduate Students	0	5		5
Sponsored Project Funding	\$21,107,894	\$5,016,671		\$26,124,565
Publications in Academic Peer-Reviewed Journals	43	82		125
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	Adaptable Desert Communities, Culture, and Ecosystems			
<b>Problem Statement</b>				
<p>For humans to continue to live in arid lands, we must understand how we can be resilient to impacts associated with climate change and other stresses affecting the linked human and natural systems of the desert. Southern Arizona and northwest Mexico are in the crosshairs of global climate change. Many changes that will eventually affect the rest of the world are starting here in the arid Sonoran Desert; our experiences can inform communities across the globe. Integrated research, education, and outreach grounded in community needs is necessary to guide actions, policies, and decisions that preserve and enhance these linked cultural and ecological systems.</p>				
<b>Program Description</b>				
<p>With our history and living-laboratory location in the Sonoran Desert, we will draw upon our geographic heritage, experience, skills, expertise, and relationships with Southern Arizona communities to provide resilience solutions for arid lands in other parts of the world. Additionally, we will establish a program of science, culture, and art; form transdisciplinary university/stakeholder working groups to accelerate innovative solutions to the challenges of future life in the desert; and launch undergraduate, graduate, and community experiential courses that train the next generation of researchers in resilience thinking and science.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>In April 2020, the UArizona established the Arizona Institutes for Resilience (AIR) to aggregate its unique resources and programs under one administrative unit, which will strengthen this initiative. More than a century of research at the Desert Laboratory at Tumamoc Hill has revealed how life has adapted to an arid and unpredictable environment. Building on data from long-term plots, knowledge of ecosystem responses to prior climate changes, and an understanding of the persistence of humans in this region, we can transform how we address future ecological challenges. The potential and opportunities of the Desert Lab are significant and range from place-based research to field courses and programs for students and the community in culture, arts, and sciences. In addition to Tumamoc Hill, activities at Biosphere 2 likewise blend ecosystem science with arts and culture at a world-renowned, unique, controlled-environment research facility.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• Production of science-based information products that use our unique research laboratories of Tumamoc Hill and Biosphere 2 to understand how life has adapted, and may adapt in the future, to the changing climate</li> <li>• Increased education of communities about the impacts of climate change and how to build resiliency to change through science, culture, and the arts by taking advantage of the public interest in Tumamoc Hill and Biosphere 2</li> <li>• Recognition as a world leader in developing and implementing resilience solutions for arid lands elsewhere</li> <li>• Establishment of new university-community partnerships working together to develop new approaches to resiliency</li> <li>• Increased number of students learning about resilience science through hands-on experiences and experimental courses</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$575,939	\$403,353	\$403,353	\$1,382,645
Basic Research	\$43,146	\$129,439	\$129,439	\$302,024
Applied Research	\$302,025	\$302,025	\$302,025	\$906,075
Development	\$43,146	\$129,439	\$129,439	\$302,024
Total	\$964,256	\$964,256	\$964,256	\$2,892,768
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$431,464	\$0	\$215,732	\$862,928
Postdocs Supported	4	4	4	75
Graduate Students	20	20	20	60
Undergraduate Students	15	15	15	45
Sponsored Project Funding	\$5,666,667	\$5,666,667	\$5,666,667	\$17,000,001
Publications in Academic Peer-Reviewed Journals	14	14	14	42
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	Water, Environment and Energy Solutions
Program Name	Adaptable Desert Communities, Culture, and Ecosystems
<b>Progress Summary</b>	
Researchers in this TRIF project secured external funding to continue and advance research, filed patents for novel methodologies, published numerous peer-reviewed articles, engaged the public and community organizations to increase community knowledge and resilience, and engaged undergraduate and graduate students in internships and research.	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
<ul style="list-style-type: none"> <li>- Generated datasets and preliminary reconstructions that enhance our understanding of the current megadrought in Arizona and the broader Southwest as well as historical interactions between stream flows and drought conditions that are relevant to land-use and water-resource managers.</li> <li>- Provided internship opportunities for students to learn community water conservation methods, flood reduction and stormwater retention methods, and participate in community engagement and outreach in diverse communities.</li> <li>- Worked with artists and community partners to advance resilience research using art research methodologies and promote resilience through community engagement.</li> <li>- Partnered with the San Carlos Apache Tribal Council to produce a documentary about the success of the San Carlos Apache Health Clinic, which will help educate Arizonans about the transformative change this organization is making in health equity in their community and how their approach can serve as a model for others.</li> <li>- Filed a provisional patent for methods to study how microbial communities contribute to soil health.</li> <li>- Provided tours, presentations, and discussions about scientific research and career to hundreds of students.</li> <li>- Provided tours, presentations, and discussions about paleontology to connect Arizonans to the deep time heritage of the state, including Arizona's world-recognized fossil localities.</li> <li>- Demonstrated the health benefits that urban parks can provide to communities and developed planning and design strategies based on research results.</li> </ul>	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
<ul style="list-style-type: none"> <li>- The complexity of the relationship between tribal and University IRB processes has slowed down some teams. While navigating these challenges, regular meetings continue to provide for knowledge-sharing and community building.</li> <li>- The amount of time needed to build relationships with tribal and community partners was underestimated by some teams, who are now working with designated point people and/or a consultant in the community who can facilitate meetings and discussions between researchers and community members and leadership.</li> </ul>	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
The research in this project advances Arizona's resilience on environmental, social, and cultural levels. The strong community engagement aspects of this project engaged communities statewide so that they are better informed and more involved in contributing to resilience. Engaging communities, including K-12 students, ensures that future generations of Arizonans will understand our state's climate challenges as well as ways to address those challenges while enhancing a sense of communal well-being.	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$482,430	\$237,536		\$719,966
Basic Research	\$11,009	\$19,324		\$30,333
Applied Research	\$81,732	\$503,797		\$287,085
Development	\$63,928	\$816		\$64,744
<b>Total</b>	<b>\$639,099</b>	<b>\$761,473</b>		<b>\$1,400,572</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$428,167	\$40,505		\$468,672
Postdocs Supported	5	12		17
Graduate Students	11	125		136
Undergraduate Students	17	88		105
Sponsored Project Funding	\$1,306,029	\$7,012,389		\$8,318,418
Publications in Academic Peer-Reviewed Journals	1	12		13
Startups	0	0		0



# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	Building Resilience from Environmental to Human Health			
<b>Problem Statement</b>				
<p>Arizona's changing climate, population, demographics, and land use patterns, as well as sudden shocks to the system from pandemics, heat waves, wildfires, and other natural phenomena, bring a continuous stream of health challenges to our communities. People are moving closer to the urban/wild interface, and changing climate brings new or more intense natural hazards and new vectors for disease transmission into our region. Communities need reliable information about the nature and extent of threats, the economic costs of threats and possible counter actions, where the greatest vulnerabilities lie, and scenarios for building resiliency to their effects. Resource use and extraction industries are critical to the Arizona economy but have an impact to our environment that needs to be addressed.</p>				
<b>Program Description</b>				
<p>New research will advance our understanding of the impacts of heat, drought, and other climate impacts as well as of sources of contaminants to water, air, and food systems in order to help develop early warning systems that preempt environment-human crises. Researchers will collaborate with communities to develop mitigation strategies, produce scenario evaluation tools, and build community education programs. New approaches to mining and reclamation will enable these industries to prosper while preserving our environment.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>UArizona researchers study major public health issues such as those due to vector-, air-, and water-borne diseases; heat waves; and water and food contamination as they relate to a changing climate. In addition, UArizona is helping to develop a worldwide early warning system for monitoring other emerging zoonotic mutations with human crossover potential. A newly formed collaborative for global adaptive pandemic solutions led by UArizona places us at the forefront of research dedicated to identifying and filling knowledge gaps to better prepare for pandemic impacts by dedicating attention to prophylactics and treatments that are ready for deployment when needed.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• Establishment of new partnerships with Arizona communities, governments, and tribes to help them prepare for heat, drought, and disease-related impacts associated with climate change and to build resilience to future threats</li> <li>• Development of new threat-warning and evaluation tools for resource managers, utilities, and industry</li> <li>• Creation of solutions aimed at combating pandemics and addressing their social and economic impacts</li> <li>• Support for the sustainability of the Arizona mining industry through new partnerships and approaches</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$575,940	\$403,354	\$403,354	\$1,382,648
Basic Research	\$43,146	\$129,439	\$129,439	\$302,024
Applied Research	\$302,025	\$302,025	\$302,025	\$906,075
Development	\$43,146	\$129,439	\$129,439	\$302,024
Total	\$964,257	\$964,257	\$964,257	\$2,892,771
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$431,465	\$1	\$215,732	\$862,929
Postdocs Supported	4	4	4	75
Graduate Students	20	20	20	60
Undergraduate Students	15	15	15	45
Sponsored Project Funding	\$5,666,667	\$5,666,667	\$5,666,667	\$17,000,001
Publications in Academic Peer-Reviewed Journals	14	14	14	42
Startups	0	1	0	1

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	Water, Environment and Energy Solutions
Program Name	Building Resilience from Environmental to Human Health
<b>Progress Summary</b>	
TRIF support has allowed researchers funded in this project to advance and communicate their research through external funding, industry collaborations and partnerships, partnerships with Arizona counties and medical providers, development of analytical methods and predictive models of benefit to the state of Arizona with potential applications across the United States, engagement of undergraduate and graduate students in research, peer-reviewed publications, and technology patents.	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
- Organization of a research and technology transfer forum at ended by individuals from the mining industry and state and federal agencies and regulators. - Investigation into production of solar energy on metal-contaminated lands combined with plants that both improve soil quality and can be harvested to recover the metals. - Collaborations with industry partners to address revegetation challenges in the mining industry and evaluate vegetation as potential carbon sinks at mine legacy sites. - Use of state-of-the-art monitoring equipment to assess bacteria and viruses in water systems throughout Arizona. - Provision of innovative landscape designs that mitigate sewage spills and flooding events and advance stormwater management. - Evaluation of the beneficial impact of routine weather forecasts to reduce human mortality from extreme heat. - Expansion of a portfolio of public-health community engagement materials to include a climate and infectious disease module. - The filling of multiple patents to advance non-invasive health monitoring technologies.	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
- Researchers experienced challenges with contractor agreements, which have since been streamlined and resolved. - Projects that depend on community-based research were sometimes delayed due to the amount of time it takes to establish and develop new partnerships. Additionally, researchers sometimes discovered that community needs and concerns were more complex than was originally understood. Additional community engagement in these circumstances gave researchers the feedback they needed to pivot to achieve research goals while also respecting and fulfilling community needs. - Field research and community engagement became more difficult to coordinate during the height of the pandemic, but this is now easing. Research projects often need to be adjusted in response to shifting partner needs, and social, economic, and political contexts. - Researchers who are also clinicians experienced challenges completing both TRIF-funded research and clinical responsibilities. These individuals reduced their clinic time and compensation to make more time for and progress on their TRIF-funded research.	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
This TRIF project provides benefits to the state by advancing understanding and forecasting of, and adaptation to Arizona's most challenging climatic conditions, including extreme heat events and their health impacts, floods, and infectious diseases. This project also includes research into effective environmental remediation of and resource recovery at mining sites that are critical to Arizona's economy.	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$123,391	\$229,513		\$352,904
Basic Research	\$280,941	\$0		\$280,941
Applied Research	\$318,539	\$242,942		\$523,892
Development	\$95,328	\$200,778		\$296,106
<b>Total</b>	<b>\$818,199</b>	<b>\$673,233</b>		<b>\$1,491,432</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$115,452	\$214,938		\$330,390
Postdocs Supported	5	1		6
Graduate Students	44	39		83
Undergraduate Students	39	7		46
Sponsored Project Funding	\$21,221,868	\$11,243,743		\$32,465,611
Publications in Academic Peer-Reviewed Journals	32	11		43
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	Fostering Leaders in Resilience			
<b>Problem Statement</b>				
Arizona is home to a diverse population with varying strengths, interests, and vulnerabilities. Preparing for a resilient future requires our next generation of leaders and decision makers to reflect that diversity and be able to communicate across sectors and disciplines. STEM training is necessary, particularly for the initiatives described in this planning document, but with fluency that goes beyond just STEM. New cross-disciplinary fields are emerging that mix science with technology or policy, for example, and we need to draw students into them. Students, in turn, seek opportunities to make a difference in their communities even before they graduate.				
<b>Program Description</b>				
To prepare the next generation for the future workplace and guide students on a career path related to resilience, we will increase diversity in existing scholarship and internship programs; design and implement experiential learning curricula; expand internship programs to include more opportunities, especially with underserved populations and for less advantaged students; offer more leadership training and mentoring for junior faculty via TRIF-funded programs; grow programs to reach K-12 students in STEM and attract them to the university; and create and offer new environment-focused courses that allow high school students to gain UArizona credit.				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
The university has established programs in science communications training for graduate students and faculty, experiential learning, and cross-disciplinary collaboration, with strong ties and programs supporting Hispanic and Indigenous communities. This program will be expanded and adapted to undergraduate students. New internship programs will place students in paid positions in the community where they can test potential careers while providing valuable service to local organizations. UArizona also supports several programs that train teachers to bring STEM into K-12 classrooms and is developing a series of environment-focused dual enrollment classes that will allow high school students to gain UArizona credit and familiarity with the many paths an environmental degree can follow.				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• Provide increased opportunities for resilience-focused experiential learning through courses and internships</li> <li>• Increase the number of students engaging in resilience-related training</li> <li>• Increase the number of students from underserved populations engaged in environmental and resilience-focused programs</li> <li>• Increase involvement by junior faculty in applied resilience-focused research that engages with communities, strengthening ties between the university and Arizona communities</li> <li>• Increase the scientific and technical knowledge of Arizona communities through greater engagement with university students and faculty</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$575,939	\$403,353	\$403,353	\$1,382,645
Basic Research	\$43,146	\$129,439	\$129,439	\$302,024
Applied Research	\$302,025	\$302,025	\$302,025	\$906,075
Development	\$43,146	\$129,439	\$129,439	\$302,024
Total	\$964,256	\$964,256	\$964,256	\$2,892,768
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$431,464	\$0	\$215,732	\$862,928
Postdocs Supported	5	5	5	75
Graduate Students	30	30	30	90
Undergraduate Students	25	25	25	75
Sponsored Project Funding	\$5,666,667	\$5,666,667	\$5,666,667	\$17,000,001
Publications in Academic Peer-Reviewed Journals	5	5	5	15
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	Water, Environment and Energy Solutions
Program Name	Fostering Leaders in Resilience
<b>Progress Summary</b>	
Funding for this TRIF project enabled experiential learning opportunities for undergraduate and graduate students from diverse backgrounds and fields of study to advance their knowledge, develop their and professional skillsets, and provide opportunities for them to make positive impacts in their local community.	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
<p>- Financial support for 12 Carson Scholars to conduct graduate-level research in environment, sustainability, resilience, and related fields. The Carson Scholars presented their research during the annual March 2023 Earth Week event. - Awarded 12 Diana Liverman Scholars in improving communication and outreach capabilities for community partners via site maps, 3D models, a podcast virtual tour, and social media content. The Scholars presented their research in a spring student showcase event. - Supported 12 Indigenous students representing 10 different tribes in the inaugural year of the Indigenous Correspondents Program, in which students received specialized training in science communication and journalism. This program delivered monthly training workshops and provided diverse experiential learning opportunities for students. - Empowered 43 students from historically excluded and marginalized communities with self-efficacy and self-advocacy skills they need to succeed as artists, creators, and scholars via the InVisibility SALON. - Mentored 11 graduate students from diverse fields of study in the use of open science practices for computationally focused research, computational infrastructure, and data science tools in the Roots for Resilience program.</p>	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
<p>- Fewer new initiatives were developed in this area than originally planned due to unanticipated additional sources of TRIF funding devoted to student opportunities, such as the TRIF Opportunities Initiative Fund, combined with an abundance of high-quality funding opportunities in other priority areas. - Teams have taken time to make sure that there is proper faculty mentoring for graduate and undergraduate students, find and match peer mentors, and update program curriculum based on student feedback.</p>	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
<p>Providing experiential learning opportunities ensures that students graduate with the knowledge, confidence, and skill sets necessary to enter the workforce or graduate education as effective communicators, researchers, and leaders comfortable with and skilled in both research and community engagement. These opportunities help retain students because they improve the University experience and help students build strong connections with peers in their cohorts as well as the researchers and community organizations with whom they work.</p>	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$0	\$8,740		\$8,740
Basic Research	\$0	\$0		\$0
Applied Research	\$135,024	\$222,185		\$340,377
Development	\$133,019	\$156,798		\$289,817
<b>Total</b>	<b>\$268,043</b>	<b>\$387,723</b>		<b>\$655,766</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	3	3		6
Graduate Students	55	32		87
Undergraduate Students	15	94		109
Sponsored Project Funding	\$2,973,345	\$830,100		\$3,803,445
Publications in Academic Peer-Reviewed Journals	15	0		15
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	Future-Proofing Arizona Water			
<b>Problem Statement</b>				
<p>From farmers and ranchers to tourists, developers, miners, and legislators, Arizonans are concerned about the state's water supply. We seek reliable supplies of clean water for our municipalities, industries, and ecosystems. We seek new technologies to treat contaminated water and new means to use it more efficiently and distribute it equitably. The science and technology of clean and reliable water is extremely important, as is having people understand the options and trade-offs associated with alternative paths forward and encouraging the exploration of creative new ways to manage water in the state.</p>				
<b>Program Description</b>				
<p>Water resources are arguably among the most—if not the most—pressing environmental issue facing Arizona. To ensure a reliable and safe water supply for all Arizonans, we will form new types of partnerships between scientists, engineers, and policymakers; produce concept papers that connect science to policy and bring science to bear on addressing and resolving water management challenges; commercialize new water treatment technologies; promote a greater diversity of voices influencing water resources management; and engage in innovative partnerships with the private sector.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>Ranked No. 1 in the nation in water resources, the UArizona has more than 280 faculty and researchers in 48 departments and programs that specialize in topics related to water. Expertise ranges from the physical and social sciences, economics, and public policy to civil engineering, biology, and environmental chemistry, addressing drought and climate, environmental systems, management and policy, society and culture, and technology and industry. UArizona works with numerous stakeholder communities at federal, tribal, regional, state, and local scales to develop water management plans and policies, and runs the Arizona Laboratory for Emerging Contaminants. Additionally, the Water and Energy Sustainable Technology (WEST) Center develops new methods to detect, quantify, and treat contaminants in water.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• Establishment of new partnerships with water managers and policymakers in Arizona and the Southwest, ranging from small communities to large municipalities and state/regional scale</li> <li>• New water policies and management decisions informed with science</li> <li>• Creation of new water quality and water management tools and technologies co-developed with users</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$575,940	\$403,354	\$403,354	\$1,382,648
Basic Research	\$43,146	\$129,439	\$129,439	\$302,024
Applied Research	\$302,025	\$302,025	\$302,025	\$906,075
Development	\$43,146	\$129,439	\$129,439	\$302,024
Total	\$964,257	\$964,257	\$964,257	\$2,892,771
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$431,465	\$0	\$215,732	\$862,929
Postdocs Supported	4	4	4	75
Graduate Students	20	20	20	60
Undergraduate Students	15	15	15	45
Sponsored Project Funding	\$5,666,667	\$5,666,667	\$5,666,667	\$17,000,001
Publications in Academic Peer-Reviewed Journals	14	14	14	42
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	Water, Environment and Energy Solutions
Program Name	Future-Proofing Arizona Water
<b>Progress Summary</b>	
TRIF support has allowed researchers funded in this TRIF project to advance and communicate their research through external funding, educational engagement materials that are relevant to both professionals and the public, collaboration with University, tribal, county, utility, non-profit, and industry partners, engagement of undergraduate and graduate students in research, and white papers and peer-reviewed journal publications. Interest in this funding area has increased as Arizona's water supplies are increasingly negatively impacted by regional drought, as reflected by the additional expenditures made in this project.	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
- Developed novel chemicals that can bind to and remove 25 different PFAS ("forever chemicals") from water and new methods for the analysis of "hidden" PFAS. - Worked with undergraduate and graduate students in a vertically integrated research project to develop visual explanations of scientific concepts for use by broadcast meteorologists. - Engaged students and faculty in collaborative watershed management and completed a watershed management development plan. - Expanded internship opportunities for students to learn about water management and create more resilient communities through University-community partnerships. - Partnered with community-driven projects on the Navajo Nation related to water resource assessment and off-grid water treatments. - Produced Water Factsheets for additional Arizona counties.	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
- The funding allocation for this project, while an increase over our original budget, reflects the growing interest in, quality of, and importance of this research area. - Project spending was occasionally affected by staff hiring delays due to pandemic impacts. This resulted in some research teams needing additional time to expend funds and continue their research. - Some teams reported logistical and operational challenges, such as delays scheduling meetings or receiving feedback and review on research plans and drafts, when managing complex collaborations between faculty, students, and community or industry partners. - Researchers uncovered unanticipated behaviors of PFAS, which can accumulate at the surface of thin water films that may accelerate the movement of PFAS in water systems. This is being addressed by new research that applies detergent research to better understand this behavior. - Researchers communicated the need for improved analytical capabilities at the University for the quantification of PFAS, which are difficult to analyze. The University is working to address these needs through grants to fund new equipment.	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
As Arizona faces a hotter, drier future, this TRIF project significantly benefits the state by developing new technologies for managing, analyzing, and improving the current and future quality of Arizona's water. Multiple teams are working on methods and technologies for removing PFAS from Arizona water sources, and research focused on Arizona's watersheds contributes to effective management of the state's water resources while increasing community engagement in this process and enhancing community resilience.	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$389,943	\$389,015		\$778,958
Basic Research	\$0	\$0		\$0
Applied Research	\$413,832	\$908,278		\$619,185
Development	\$0	\$4,975		\$4,975
<b>Total</b>	<b>\$803,775</b>	<b>\$1,302,268</b>		<b>\$2,106,043</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$389,943	\$165,390		\$555,333
Postdocs Supported	4	11		15
Graduate Students	21	35		56
Undergraduate Students	43	33		76
Sponsored Project Funding	\$6,133,282	\$4,483,466		\$10,616,748
Publications in Academic Peer-Reviewed Journals	27	12		39
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	Observation Systems for Resilience Monitoring and Modeling			
<b>Problem Statement</b>				
<p>We can bet er prepare for change if we are able to monitor it in real time. Data related to weather, water resources, soil and vegetation conditions, air quality, greenhouse gases, wind and solar energy, and other conditions allow us to predict what we might expect in the future and plan accordingly. Monitoring parameters on the ground, while critically important, is time and labor intensive, and each monitoring point has only a limited radius of relevance. Monitoring from above ground using instruments on airplanes, balloons, and satellites permits greater spatial coverage and sampling frequency. Combined, these methods produce higher-resolution results and improved predictions.</p>				
<b>Program Description</b>				
<p>Leveraging our existing strengths and programs, we will launch a regional-scale climate forecasting center and produce energy forecasting products codeveloped with utilities. We will contribute to science, policy, economic, and technology solutions to help monitor and manage greenhouse gas emissions and develop more refined local and regional-scale climate, weather, and other models. We also will grow partnerships with communities to codevelop data and information products that allow them to make decisions based on greater understanding of probable conditions.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>UArizona has long-established expertise in space exploration and remote sensing, the study of Earth processes, and climate-related modeling, which, when combined, yield the potential for powerful new observation-based products and physical and economic forecasts. While efforts are distributed in colleges and institutes across the university, the globally recognized Arizona Remote Sensing Center aggregates experts and programs specifically dedicated to supporting decisions informed by its products and services. New programs are designed for identifying ways for communities to identify large methane emit ers and other major carbon producers, anticipate growing conditions, help the military prepare for changing conditions and mitigate hazards, and evaluate the economic costs of environmental impacts.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• New partnerships with Arizona and other industries and communities</li> <li>• Development of new water and energy management and forecasting tools for Arizona resource managers, industry, and utilities</li> <li>• Establishment of new regional-scale climate forecasting center</li> <li>• Development of new means to monitor and help manage greenhouse gas emissions</li> <li>• Creation of new energy forecasting products codeveloped with utilities</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$575,940	\$403,354	\$403,354	\$1,382,648
Basic Research	\$43,146	\$129,439	\$129,439	\$302,024
Applied Research	\$302,025	\$302,025	\$302,025	\$906,075
Development	\$43,146	\$129,439	\$129,439	\$302,024
Total	\$964,257	\$964,257	\$964,257	\$2,892,771
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$431,465	\$1	\$215,732	\$862,929
Postdocs Supported	4	4	4	75
Graduate Students	20	20	20	60
Undergraduate Students	15	15	15	45
Sponsored Project Funding	\$5,666,667	\$5,666,667	\$5,666,667	\$17,000,001
Publications in Academic Peer-Reviewed Journals	14	14	14	42
Startups	0	0	1	1

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	Water, Environment and Energy Solutions
Program Name	Observation Systems for Resilience Monitoring and Modeling
<b>Progress Summary</b>	
TRIF support has been critical in allowing researchers to advance and share data, leverage to secure external funding, collaborate with industry and academic partners, develop cutting-edge forecasting services and new technologies to mitigate post-fire flood events, create a variety of enhanced, novel monitoring and modeling methods, and engage undergraduate and graduate students in research.	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
<ul style="list-style-type: none"> <li>- Formal launch of the Center for Applied Hydroclimate Sciences (CAHS) to provide more accurate hydroclimate prediction and projections to help leverage better decision making and science translation.</li> <li>- Negotiation of climate assessment contracts with utility industry partners in Arizona and elsewhere.</li> <li>- Provision of power forecasts for 3.5 GW of renewable energy generation for Arizona utility companies.</li> <li>- A new forecasting contract with the Salt River Project to deliver industry-leading weather and power forecasts for solar and wind resources.</li> <li>- Development of methods that expand the capability of airborne remote sensing technologies to include dryland vegetation types.</li> <li>- Investigation into the influence of North Pacific climate on precipitation and snowpack in the Southwest, uncovering linkages and trends that will improve capacity for predicting drought in western North America.</li> <li>- Documentation of a historic mega earthquake in the Pacific Northwest that will increase the maximum allowable earthquake size used in engineering design and improve understanding of fault behavior that can serve as a short-term warning system for a region with more than 4 million residents.</li> </ul>	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
<ul style="list-style-type: none"> <li>- Researchers reported some continued delays due to the pandemic but indicated that they were able to migrate most of their operations to online/remote formats at the peak of pandemic concerns to continue making progress on research.</li> <li>- Researchers reported unanticipated delays and challenges in negotiating contracts with industry partners, due to a variety of factors including changing priorities and leadership on behalf of partner organizations.</li> <li>- Some of the researchers in this project were severely impacted by the October 5, 2022, tragedy at the University of Arizona, resulting in delays to the project as individuals took on more responsibilities or rebalanced responsibilities in response to the event. This also resulted in funds being underspent by impacted teams during this fiscal year.</li> </ul>	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
This TRIF project provides benefits to the state through technologies and methods that enhance the ability to observe, monitor, model, and predict weather conditions, rainfall and other hydroclimate conditions, power usage and renewable power generation, mitigate post-fire flooding events, and understand the connection between climate conditions in Arizona and the Pacific region all enhance Arizona's ability to meet energy demands, anticipate environmental changes, and adapt to changing conditions. Together these endeavors make the state of Arizona more resilient to changing climate conditions.	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$329,666	\$373,645		\$703,311
Basic Research	\$0	\$0		\$0
Applied Research	\$58,047	\$71,019		\$263,400
Development	\$11,355	\$94,032		\$105,387
<b>Total</b>	<b>\$399,068</b>	<b>\$538,696</b>		<b>\$937,764</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$189,317	\$94,305		\$283,622
Postdocs Supported	4	4		8
Graduate Students	10	12		22
Undergraduate Students	63	19		82
Sponsored Project Funding	\$12,085,759	\$6,337,940		\$18,423,699
Publications in Academic Peer-Reviewed Journals	68	13		81
Startups	0	0		0



Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	Water, Environment and Energy Solutions			
Program Name	Resilient Systems Integration			
<b>Problem Statement</b>				
<p>Transformational changes in our production of secure and sustainable energy, food, and water sources, and in the efficient use of energy, are among the most significant global challenges of the 21st century. As energy demands, food scarcity, and climate variability increase, the means to create and maintain reliable and resilient energy delivery systems, food production systems, and water supplies sufficient to sustain and enhance our society, our economy, and our ecosystems are of paramount importance, especially in regions like Arizona and the Southwest. An integrated and aggressive approach that incorporates economic considerations is required to solve these problems, especially as these regions are home to many communities that are particularly vulnerable to such changes.</p>				
<b>Program Description</b>				
<p>We will develop new materials, technologies, and operations targeted to energy-efficient water reuse and purification for all sectors as well as smarter data and decision-making platforms with robust links to policy and decision-making processes for water and energy production and use. We also will integrate new science and technology with policy development, decision making, support, and education; produce new designs of the future for a more resilient and efficient urban and rural environment; and create regional test beds and new public-private partnerships.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>UArizona researchers are at the forefront of the food-energy-water nexus, exploring ways to address our scientific, technological, economic, and societal challenges. UArizona partnerships with Indigenous communities, particularly the Navajo Nation, are developing technical solutions to build reliable, affordable access to energy, water, and food while training the next generation of food-energy-water systems professionals to tackle these challenges. The university has been a pioneer in the development of agrivoltaics, with the flagship project at Biosphere 2 named a 2018 World Changing Idea, subsequent experiments initiated at local area schools, and discussions expanded to large-scale Arizona growers. UArizona researchers work closely with government officials in Yuma to enhance agriculture in the region, where food, energy, and water are of great socioeconomic importance, but would be scarce if not for thoughtful, informed resource management. Further, UArizona's new RESTRUCT program harnesses expertise from across the university to address the complex design, engineering, social, economic, and environmental challenge of envisioning, defining, and advancing the future built infrastructure. Various organizations such as the British Standards Institution, the Marriot Corporation, and the Campbell Gray Hotel group, as well as universities across the US, acknowledge our expertise and leadership.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• New partnerships with Arizona industry and government</li> <li>• Creation of better data and decision-making platforms for resource managers, utilities, and others users</li> <li>• Creation of knowledge for policy- and decision-makers arising from university-community partnerships</li> <li>• Development of new materials, technologies, and operations targeted to energy-efficient water reuse and purification</li> <li>• Integration of new science and technology with policy development, decision making, and education</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$575,940	\$403,354	\$403,354	\$1,382,648
Basic Research	\$43,146	\$129,439	\$129,439	\$302,024
Applied Research	\$302,025	\$302,025	\$302,025	\$906,075
Development	\$43,146	\$129,439	\$129,439	\$302,024
Total	\$964,257	\$964,257	\$964,257	\$2,892,771
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$431,465	\$1	\$215,732	\$862,929
Postdocs Supported	4	4	4	75
Graduate Students	20	20	20	60
Undergraduate Students	15	15	15	45
Sponsored Project Funding	\$5,666,667	\$5,666,667	\$5,666,667	\$17,000,001
Publications in Academic Peer-Reviewed Journals	14	14	14	42
Startups	0	0	1	1

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	Water, Environment and Energy Solutions
Program Name	Resilient Systems Integration
<b>Progress Summary</b>	
<p>Researchers in this TRIF supported project secured significant external funding and are working on additional proposals, submitted patents for innovations pertaining to solar cell technology and management of food waste, produced numerous publications, launched an ecological restoration portal for the state of Arizona (ecorestore.arizona.edu), engaged undergraduate and graduate students in research, and are advancing novel research into the potential of tropical species to help mitigate climate change in Arizona.</p>	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
<p>- Discovered that agrivoltaics (combining agriculture and photovoltaics) can promote an equal amount of food production with 50% of the irrigation usually required. - Signed an MOU with an international solar company to begin operations in Arizona, which will allow and provide financial support for future research on their photovoltaics site. - Submitted a pending patent for a solar tower to dry food waste on a large scale. - Submitted a patent for the development of an electrochemical probe with applications in all-perovskite solar cells and partnered with the National Renewable Energy Laboratory to evaluate performance of perovskite in solar cell and other applications. - Produced a restoration ecology activity book and an ecological restoration portal (ecorestore.arizona.edu) for the state of Arizona. - Published on economical and environmentally sustainable recycling of lithium-ion battery waste materials. - Produced preliminary results suggesting tropical trees and coffee are resilient to temperatures higher than previously known and engaged with Biosphere 2 visitors to explain why tropical forest species will help mitigate future climate change in Arizona.</p>	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
<p>- Increased interest in this funding area has led to increased allocations of funding, as reflected in the budget for this project. While this represents a change from our original budget, it reflects growing need for research into sustainable agricultural and energy production, which overall will greatly benefit the state of Arizona. - Some teams underestimated the length of time that pandemic-related delays would impact supply chains for research equipment, as well as challenges related to finding and hiring research personnel at all levels. - The team working on lead-tin perovskite materials found that the techniques for producing these materials was more complicated than anticipated based on existing literature. The team is addressing this by working to automate appropriate parts of the process and developing technologies that can monitor the stability of the perovskite materials.</p>	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
<p>TRIF enabled researchers to advance Arizona's capacity for sustainable agricultural production with reduced water usage, efficient, renewable energy generation, sustainable recycling of lithium-ion waste, and provide community engagement materials for Arizonans interested in direct participation in ecological restoration. All these endeavors help ensure that the state of Arizona remains agriculturally, energetically, and economically resilient in a hot, drier future.</p>	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$742,132	\$321,224		\$1,063,356
Basic Research	\$28,031	\$27,520		\$55,551
Applied Research	\$251,572	\$783,078		\$456,925
Development	\$109,151	\$42,092		\$151,243
<b>Total</b>	<b>\$1,130,886</b>	<b>\$1,173,914</b>		<b>\$2,304,800</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$452,239	\$231,274		\$683,513
Postdocs Supported	6	11		17
Graduate Students	35	62		97
Undergraduate Students	106	60		166
Sponsored Project Funding	\$12,650,611	\$13,345,573		\$25,996,184
Publications in Academic Peer-Reviewed Journals	37	8		45
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	Workforce Development			
Program Name	Building Pre-College Interest in Research and Technical Careers			
<b>Problem Statement</b>				
<p>One of the pre-college barriers to early development of Arizona's technically skilled workforce is an overall lack of awareness and interest among K-12 students about the requirements for the desirable Arizona jobs they ultimately will want to pursue. This is particularly true within communities with less access to research and fewer technically skilled role models with whom to engage. Early exposure to research and technology, and the career possibilities that go with those skillsets, through a variety of targeted outreach activities, will help inspire the future workforce.</p>				
<b>Program Description</b>				
<p>By building and supporting broader pre-college awareness of, and interest in, research opportunities and highly skilled careers among Arizona's students, UArizona can help influence the next generation of diverse leaders taking Arizona's industries to new heights of productivity and growth. These future leaders will develop new perspectives on the variety of research and technical careers available to them, how those career paths will positively impact their communities and the state, and the skills needed to join the workforce. As UArizona works to overcome the barriers that historically have limited participation in such careers, we will develop more meaningful partnerships with community stakeholders, engaging them to participate in building these talent pipelines for the betterment of our state.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>UArizona has a long history of supporting pre-college students through a multitude of programs and structures designed for K-12 audiences to advance Arizona's future workforce. Many of our programs provide expertise in skill building and mentoring in key areas that are typically barriers to STEM and technical career preparation readiness. TRIF funds can leverage these existing programs and structures, which have resulted in trusted relationships with Southern Arizona's young learners, their teachers, and their families. While not a comprehensive list, examples of programs that work directly with youth include the Upward Bound program, Early Academic Outreach, Engineering 102, Native Student Outreach and Resiliency (Native SOAR), Mentoring and Education for Science in Tucson (MESCIT), Keep Engaging Youth in Science (KEYS), discussed in the Improving Health section of this plan), Girls Who Code, and Imagine Your STEM Future.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• Increased awareness of and interest in research and technical careers among Arizona pre-college students and their larger community, particularly among populations who have historically had less access to such careers</li> <li>• Increased opportunities for exposure to state-of-the-art scientific and technical infrastructure and research faculty</li> <li>• Knowledge of or participation in research projects that are co-created between researchers and community stakeholders</li> <li>• Increased awareness of important Arizona economic development and research initiatives, and the associated future career opportunities</li> <li>• Development of formal and informal educators that have the skills to support student research and technical career-related experiences</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$84,209	\$84,209	\$84,209	\$252,627
Basic Research	\$0	\$0	\$0	\$0
Applied Research	\$0	\$0	\$0	\$0
Development	\$24,270	\$24,270	\$24,270	\$72,810
Total	\$108,479	\$108,479	\$108,479	\$325,437
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	75
Graduate Students	0	0	0	0
Undergraduate Students	0	0	0	0
Sponsored Project Funding	\$0	\$0	\$0	\$0
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	Workforce Development
Program Name	Building Pre-College Interest in Research and Technical Careers
<b>Progress Summary</b>	
<p>All sectors of Arizona's commerce, industry, and research rely on data that translates to results and thus, need a workforce with the technical skills to analyze and make sense of data sets. Currently, very few Arizona high schools offer courses beyond AP Statistics, which, for many students is not accessible. TRIF funds are being invested in two areas to support the development of science and technology literacy among rural high school teachers and students&amp;#58; 1- Southern Arizona Research, Science, and Engineering Foundation's (SARSEF) Class-wide Authentic Rural Research Experience for Students. 2-Data Sciences Academy Educators in Data Science Fellowship, which supports teachers' efforts to bring data science protocols into any course they teach, thus exposing students to data collection, data analysis, and data-driven interpretation. Both programs will create a broader entryway into data-heavy post-secondary programs and careers.</p>	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
<p>Four high school science teachers from rural schools in southern Arizona were matched with research scientists (graduate students and postdoc fellows) to grow partnerships where each person brings their area of expertise to the relationship to learn from each other. This synergistic collaboration yields the following benefits. 1- Research scientists become more effective in science outreach. 2- Teachers become more confident in their ability to provide authentic research experiences for their classes. 3- Students develop research skills, gain a deeper understanding of scientific exploration, and explore potential career pathways. Teachers commented that "Students liked being able to gather data for a real problem that wasn't just in a textbook.&amp;quot; And, "I was surprised about the amount of buy-in for the least academically advanced students, many of whom now say that they like science and feel much more confident in their academic abilities."</p>	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
<p>Fellows roles need to be better defined in the future to maximize impact.</p>	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
<p>The SARSEF Class-wide Authentic Rural Research Experience for Students program addressed multiple challenges inherent in high school research. High school teachers are responsible for 100-150 students who they teach 3-5 times a week for as little as 50 minutes each period. Most high school teachers lack bandwidth or experience that prepares them for implementing long term student-driven research. Four teachers from Sahuarita High School, Willcox High School, Douglas Center for Academic Success, and Safford High School, and 95 students who had not self-identified as successful science students or engaged in previous research were impacted. This program works to broaden onramps to Arizona's STEM careers and thus creates a more diverse workforce. The Data Sciences Academy Educators in Data Science Fellowship supported 21 teachers from across Arizona (Window Rock to Sierra Vista) to bring data science protocols into their classrooms. Fellows attended a five-day professional development program in the summer and continued their education through monthly trainings. Fellows created standards-based lesson plans which were made available for any educator to download and use in their own classes. As a further result of the Fellowship, two new high school data science courses were created. Finally, the Data Sciences Academy has been involved in two related projects&amp;#58; 1- Working with the Arizona Department of Education to convene statewide discussions with teacher leaders to develop K-12 state standards for teaching data sciences. 2- Implementing virtual state-wide Data Science Circles to support a larger pool of Arizona teachers in their efforts to bring data science protocols into their classrooms.</p>	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$47,750	\$146,289		\$194,039
Basic Research	\$0	\$0		\$0
Applied Research	\$0	\$0		\$205,353
Development	\$0	\$0		\$0
Total	\$47,750	\$146,289		\$194,039
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	7	13		20
Undergraduate Students	58	53		111
Sponsored Project Funding	\$373,185	\$0		\$373,185
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	Workforce Development			
Program Name	Expanding Undergraduate Research Opportunities			
<b>Problem Statement</b>				
Undergraduate research is well known as a high-impact educational practice that leads to increased retention and a stronger workforce. An early undergraduate research experience (URE) in social sciences and humanities leads to significant gains in analytical and critical thinking skills for first- and second-year students, especially for first-generation students. UREs, particularly during the academic year, lead to increased interest and persistence in STEM, especially for underrepresented minorities. However, the traditional one-on-one apprenticeship model prevalent at UArizona limits the number of students with these experiences to a select few.				
<b>Program Description</b>				
TRIF funds will support the expansion of undergraduate research opportunities to provide equitable access to research experiences for students who historically have had less access to research early in their academic careers. The funds will also be used to support student's direct participation in TRIF-funded research projects and the dissemination of best practices in the various models of undergraduate research engagement.				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
UArizona offers numerous long-running undergraduate research programs supported by the institution that address societal needs. As a Hispanic-Serving Institution and an American Indian and Alaska Native-Serving Institution, the university is now more intently focused on the "servingsness" aspect of these designations. The culture within science departments has been shifting to recognize the value of offering research opportunities to a wide majority of students and not to just the top, most academically talented.				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• A more expansive distribution of research opportunities</li> <li>• Increased diversity and representation among UArizona students who have access to research experiences and research-rich curriculum</li> <li>• Increased number of research-rich courses and other research opportunities targeted to first- and second-year students</li> <li>• Increased number of VIPs</li> <li>• Increased number of awarded proposals that incorporate scaled-up research experiences in their education plans</li> <li>• Overall increased retention in STEM of underserved and underrepresented students</li> <li>• Overall increased enrollment in graduate research programs among historically underserved and underrepresented students necessary to realize Arizona's workforce challenges</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$83,394	\$83,394	\$83,394	\$250,182
Basic Research	\$49,862	\$49,862	\$49,862	\$149,586
Applied Research	\$49,862	\$49,862	\$49,862	\$149,586
Development	\$39,890	\$39,890	\$39,890	\$119,670
Total	\$223,008	\$223,008	\$223,008	\$669,024
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	75
Graduate Students	0	0	0	0
Undergraduate Students	0	0	0	0
Sponsored Project Funding	\$0	\$0	\$0	\$0
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	Workforce Development
Program Name	Expanding Undergraduate Research Opportunities
<b>Progress Summary</b>	
<p>UArizona's Undergraduate Research and Inquiry (URI) Collaborative aims to ensure that students representing all Arizona communities get access to undergraduate research experiences (UREs), especially those who have been historically underrepresented in research. TRIF funds supported the expansion of paid, mentored apprenticeship research experiences with faculty, Undergraduate Research Ambassadors (URAs), industry internships, and course-based undergraduate research experiences (CUREs). TRIF supported 520 CUREs in FY23, a 134% increase over last year.</p>	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
<p>We have leveraged TRIF funding to create, improve, and scale inclusive undergraduate research experiences for more students. Examples of infrastructure and resources built include a centralized website and undergraduate research database, a training institute to assist faculty in developing course-based research experiences, seed grants for faculty to support undergraduate researchers on their research projects, and coordinators to support and expand internal and external research opportunities.</p>	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
<p>- In the post-COVID environment, it continues to be challenging to get students to attend training workshops. - With TIMESTEP, lack of transportation options for students who don't own their own vehicles to get the UArizona Tech Park or other off campus employer sites is a barrier to participate in internships. Funding for a Tech Park shuttle would be ideal. - Working with departments to understand the value of CUREs and support faculty in continuing to teach CUREs.</p>	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
<p>- 11 faculty hired an additional 30 directed research positions enabling more students to develop workforce skills including emerging fields like data and statistical analysis and coding. - 6 students hired as Undergraduate Research Ambassadors to increase communication about available UREs. Outreach more than tripled this year, providing 767 direct, high-impact interactions with students and generating over 25,923 points of engagement via online marketing and content creation, email list management, materials development, and social media efforts. - The TIMESTEP Summer Internship Program allowed UArizona undergraduates in the physical sciences and mathematics to connect with small to mid-sized businesses/industry based in Southern Arizona, creating paths to employment and exposing businesses to university resources. Many see graduate school as the only post-baccalaureate option, resulting in a high student attrition rate from these majors. TIMESTEP provides an alternative by preparing them for industry careers leading to greater retention. TRIF supported 24 intern positions; 33% from an underrepresented minority group and 17% female. 14 companies offered internships. TIMESTEP leveraged TRIF funding to raise \$47,500 from returning and new Tucson-based companies participating in the program. - UArizona leveraged TRIF funds with a Department of Education Title III grant to offer the CURE Training Institute for faculty to learn how to incorporate authentic research experiences into courses targeted for first and second year students, making it possible for higher numbers of undergraduates to engage early in authentic research. The traditional apprenticeship research experience vastly limits the number of students who can engage in research if faculty can only provide 1-on-1 mentoring to a handful of students. - Nine faculty and research staff were funded to develop and teach seven additional CURE courses across seven colleges, totaling 22 CURE courses at UArizona. This created new UREs for 466 additional students- largely first gen/low-income/underrepresented minorities. - This fall, all sections of UArizona's intro biology lab will be taught as a CURE, potentially adding research experiences for nearly 1,500 students/year.</p>	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$178,912	\$202,653		\$381,565
Basic Research	\$0	\$0		\$0
Applied Research	\$0	\$0		\$205,353
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$178,912</b>	<b>\$202,653</b>		<b>\$381,565</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	1	1		2
Undergraduate Students	196	1111		1307
Sponsored Project Funding	\$800,743	\$658,453		\$1,459,196
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	Workforce Development			
Program Name	Inclusive Mentoring for a Diverse Research Workforce			
<b>Problem Statement</b>				
<p>Many of us need the support of high-quality mentors to succeed and advance in our professions. This is especially true for those who are pursuing careers in research and high-tech fields. Mentoring often is most impactful when the mentor and mentee share the same gender, cultural background, or life experience. UArizona must be able to ensure that future and early-career researchers receive high quality, culturally inclusive mentoring through a robust training landscape and increase the pool of diverse mentors to serve the needs of our students and our future workforce.</p>				
<b>Program Description</b>				
<p>Through TRIF funding, we will leverage these efforts and provide support to establish a mentoring community focused on innovating, increasing awareness, and disseminating best practices; develop higher-quality mentoring across TRIF-funded research projects and participants; create a centralized infrastructure to support culturally responsive and asset-based mentoring workshops; and implement a system for follow-up support to research mentors, particularly those participating in TRIF-funded research initiatives and projects. Additionally, we anticipate supporting an increased campus-wide understanding of how to overcome insensitivities in the mentor-mentee relationship; a series of events convening research thought leaders from community colleges and UArizona to identify barriers and solutions to mentoring challenges; and increased rewards and recognition for faculty who engage in high-quality mentoring practices and who carry higher-than-normal mentoring loads to provide mentoring to students who are from similar backgrounds.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>A number of early-stage efforts exist on campus around research mentor training, mentoring in STEM and health science, peer mentoring, and inclusive mentoring. The Office of Societal Impact has developed workshops for faculty, staff, and peer mentors on culturally responsive and asset-based, inclusive mentoring. An interactive training series is under development, supported by the Provost's Office of Diversity &amp; Inclusion, in which Black, Indigenous, and People of Color (BIPOC) faculty will mentor other faculty as they undergo training to mentor BIPOC students. The UAHS Office of Diversity &amp; Inclusion offers a series of training and support for mentoring students specifically in the health sciences.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• Development of a comprehensive database of training opportunities and mechanisms to track trainings offered and taken</li> <li>• Among TRIF-funded research projects, an increased number of faculty and staff who have completed research mentor trainings</li> <li>• Among TRIF-funded research projects, an increased number of students with high-quality, inclusive research mentors</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$48,746	\$48,746	\$48,746	\$146,238
Basic Research	\$35,067	\$35,067	\$35,067	\$105,201
Applied Research	\$35,067	\$35,067	\$35,067	\$105,201
Development	\$11,689	\$11,689	\$11,689	\$35,067
Total	\$130,569	\$130,569	\$130,569	\$391,707
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	75
Graduate Students	0	0	0	0
Undergraduate Students	0	0	0	0
Sponsored Project Funding	\$0	\$0	\$0	\$0
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	Workforce Development
Program Name	Inclusive Mentoring for a Diverse Research Workforce
<b>Progress Summary</b>	
<p>Research shows that high quality mentoring is essential to retain and graduate students in STEM fields, particularly students who are the first in their family to attend college, students from low income backgrounds, and students who identify as from a minority ethnic or racial background. STEM higher education environments are complex, competitive, and there is often a 'hidden curriculum' that is invisible to these marginalized students as compared to their more affluent peers who have family members who have experienced college or even work in higher education. TRIF funds have been used to support staff who develop and implement culturally inclusive mentor training and who directly mentor undergraduate and graduate students.</p>	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
<p>Four staff members were supported by TRIF funds under our mentoring initiative. Two staff members worked directly with students in our undergraduate research programs including TIMESTEP (Tucson Initiative for Minoritized Student Engagement in Science) and ASEMS (Arizona's Science, Engineering and Math Scholars) Programs. Both programs serve students from marginalized and minority backgrounds who are majoring in STEM. TIMESTEP is specifically aimed at students who are majoring in Astronomy, Physics, Mathematics, and Computer Sciences. Students are paired with summer industry internships and academic year research placements in UArizona research labs. ASEMS students are paired with faculty across campus who hire undergraduate student researchers. The program coordinators that we support mentor the students through the entire process of securing placements, including resume building, finding opportunities, interview skills, and other aspects of finding and succeeding in research opportunities. TRIF funds also supported a graduate student to contribute to the development and implementation of an inclusive mentor training for faculty who host diverse undergraduate students as researchers. Finally, TRIF funds supported the 'STEM Students of Color' group, hosted by the Graduate College, which is an informal mentoring program where diverse graduate students are provided with a safe space for discussing some of the challenges they face in the STEM graduate environment.</p>	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
<p>Because the mentor trainings are a somewhat intensive time commitment and also require small group work and role playing, it is important to keep each training session small. This in turn affects the numbers of students who are impacted because each faculty person only mentors a handful of undergraduate students. We are in the process of hiring a full time staff person who will offer this training regularly in order to scale the number of faculty trained and in parallel, students impacted.</p>	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
<p>Two sessions of the Inclusive Mentor Training program were hosted during the year, serving approximately 25 faculty across a variety of STEM disciplines who were hosting summer undergraduate researchers. Approximately 100 undergraduate students benefited from the improved mentoring from faculty and program staff across a number of programs.</p>	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$68,299	\$93,372		\$161,671
Basic Research	\$0	\$0		\$0
Applied Research	\$0	\$0		\$205,353
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$68,299</b>	<b>\$93,372</b>		<b>\$161,671</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	2	0		2
Undergraduate Students	0	0		0
Sponsored Project Funding	\$108,696	\$499,730		\$608,426
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0



# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	Workforce Development			
Program Name	Supporting Diverse Graduate Student Researchers			
<b>Problem Statement</b>				
<p>Graduate students are the backbone of the research workforce at UArizona and frequently transition to high-tech industries in their careers. They generally outnumber other staff researchers, and prospective students are actively recruited by research-intensive graduate programs. Upon graduation, they are highly sought by industry. However, diverse graduate students pursuing these programs often face barriers, at both the recruitment and acceptance stages. Even if accepted into a program, they can face a lonely and unwelcoming environment. UArizona seeks a highly representative group of passionate graduate students who have the training to succeed in research-intensive careers after they leave graduate school.</p>				
<b>Program Description</b>				
<p>TRIF funding will prioritize research projects that include graduate student researchers from across Arizona's complex demographics; connect research efforts and lived experiences to address issues of importance to Arizona's communities; are open to recruiting graduate students from within UArizona's existing undergraduate community; require inclusive mentor training for their research teams; and provide professional development opportunities so students can master technical skills and those that promote collaboration, creativity, and critical thinking. These are exactly the skills that Arizona's high-tech industries are seeking.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>With TRIF investment, UArizona can leverage and support a number of existing programs and structures to address the challenges described above. The Graduate College oversees the McNair Program, funded by the U.S. Department of Education, and the Undergraduate Research Opportunities Consortium, both of which serve diverse undergraduates and prepare them for graduate school. A number of graduate training programs and Graduate Interdisciplinary Degree Programs exist on campus in disciplinary areas that TRIF funds, and we will work with these programs to advance efforts towards growing Arizona's research and technical workforce and a vibrant economy.</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<ul style="list-style-type: none"> <li>• TRIF-funded research teams representing the breadth of Arizona society</li> <li>• TRIF-funded research teams are more likely to tackle Arizona's grand challenges that directly impact Arizona's communities and industries</li> <li>• Among TRIF-funded research projects, higher numbers of underrepresented students persist year-to-year in research-intensive fields, developing the skills to succeed in the high-tech workforce</li> <li>• Among TRIF-funded research projects, graduate students report feeling welcome in their research-intensive environment</li> </ul>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$62,254	\$62,254	\$62,254	\$186,762
Basic Research	\$44,775	\$44,775	\$44,775	\$134,325
Applied Research	\$44,775	\$44,775	\$44,775	\$134,325
Development	\$14,925	\$14,925	\$14,925	\$44,775
<b>Total</b>	<b>\$166,729</b>	<b>\$166,729</b>	<b>\$166,729</b>	<b>\$500,187</b>
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	75
Graduate Students	0	0	0	0
Undergraduate Students	0	0	0	0
Sponsored Project Funding	\$0	\$0	\$0	\$0
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	Workforce Development
Program Name	Supporting Diverse Graduate Student Researchers
<b>Progress Summary</b>	
TRIF funds continue to help us support graduate students as the backbone of research at UArizona and key to the development of our future workforce. Specifically, we are giving those traditionally underrepresented in research the financial means, mentoring, and training to succeed in research-intensive careers after they complete their degrees. We also invest money into studying the barriers and opportunities for graduate students to succeed in majors that will most benefit Arizona's workforce needs in research and technical fields into the future.	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
During this TRIF funding cycle, we hired two graduate students studying higher education who conducted a research project on inclusion and equity in STEM graduate programs. We have presented our findings to educators at the American Educational Research Association, and submitted a paper to the Studies in Graduate and Postdoctoral Education journal. We have also created an open source library with research about effective and inclusive practices in mentoring of graduate students. We are in the process of creating a webpage to share the library and findings from our research. TRIF funds also supported the development of a new program offered through the UArizona Graduate College that supports diverse students by connecting them to industry and providing holistic support. More details about that program can be found in the next section. We are capitalizing on the TRIF investment by supporting the Graduate College in seeking additional funding for the project through a National Science Foundation Innovations in Graduate Education proposal.	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
It can be difficult to access institutional data about the graduate student experience. While much data is readily available about undergraduate students, graduate student data tends to live in departments rather than at an institutional level. Therefore, research requires more than just quantitative data analysis but also quite a bit of qualitative research to understand the student experience.	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
Our goal with this research project is to identify some of the factors that cause diverse STEM graduate students to stop or drop out of graduate school prior to earning their degree. Often this is because, while they may have been awarded funding initially, they do not have a guaranteed funding source for the full four years of their PhD program. Due to this, we have leveraged TRIF funds for 'last mile awards' when graduate students are near to graduation but face financial challenges and therefore are at risk of not completing their degrees. Other factors include students, particularly those from marginalized or minority backgrounds, facing a hostile environment where there is a 'sink or swim' ethos. For Arizona to continue to graduate students with the research and technical expertise that is needed at the highest levels of innovation, as an institution we must understand the barriers and put measures in place to address them. As a result of these research findings, we are investing in a new program for graduate students at ending UArizona called the Hispanic Serving Institution Graduate Communities for Academic Fellowship and Efficacy (CAFE). This program will provide holistic support to diverse graduate students in science and engineering by mentoring them through completion of their degrees and assisting them in developing community and self-efficacy. TRIF funds were used as an early lever to solicit additional funding for the program, which is now fully funded by several sources and will launch in Fall 2023. There are 18 graduate students who have applied to participate in the program.	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$88,112	\$148,302		\$236,414
Basic Research	\$0	\$0		\$0
Applied Research	\$0	\$0		\$205,353
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$88,112</b>	<b>\$148,302</b>		<b>\$236,414</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	1		1
Graduate Students	0	8		8
Undergraduate Students	0	9		9
Sponsored Project Funding	\$454,335	\$1,250,671		\$1,705,006
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

University	University of Arizona			
TRIF Investment Area	Workforce Development			
Program Name	The Community College to Four-year University Transition			
<b>Problem Statement</b>				
<p>Many Arizona students begin their postsecondary study at a two-year community college, due to financial resources or because they lack the academic qualifications and competitiveness to begin at one of the state's four-year universities. Students who seek to transfer to UArizona and have an interest in STEM majors often face several barriers. Research opportunities and other experiential learning experiences are scarce at community colleges, so transfer students struggle to compete for such experiences when they arrive at UArizona. Additionally, a difference exists in the academic cultures between community colleges and four-year universities, especially in the research-intensive STEM and pre-health fields.</p>				
<b>Program Description</b>				
<p>TRIF funding will support UArizona programs that assist students through the transfer process into technical and research-intensive majors, provide paid research opportunities to transfer students to work on TRIF-funded research initiatives, and involve foundational research that will help us understand and overcome barriers for community college transfer students into research-rich degree programs and careers.</p>				
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>				
<p>UArizona houses the nationally known Center for the Study of Higher Education, with leading scholars whose research on the following topics can inform initiatives relevant to strengthening workforce development programs with community colleges: • The challenges Latinx, African American, and low socioeconomic status (SES) students face transitioning into four-year college, research-intensive degree programs • College planning strategies and trajectories of diverse community college transfer students • Recruitment and access issues for community college students into research-rich majors and careers</p>				
<b>Is there an Arizona Specific Benefit or Impact?</b>				
<p>• Increased number of students accessing communication tools or events • Increased transfer overall from Arizona community colleges into research-intensive majors at UArizona • Increased number of students selecting STEM or other research-rich majors upon transferring • Increased faculty partnerships between community colleges and UArizona researchers • Increased indicators for participation in undergraduate research before transferring • Increased retention of community college transfer students in STEM to graduation</p>				
<b>Investment Detail</b>				
	2022	2023	2024	Total
Infrastructure	\$52,144	\$52,144	\$52,144	\$156,432
Basic Research	\$8,453	\$8,453	\$8,453	\$25,359
Applied Research	\$12,679	\$12,679	\$12,679	\$38,037
Development	\$21,132	\$21,132	\$21,132	\$63,396
Total	\$94,408	\$94,408	\$94,408	\$283,224
<b>Performance Measures</b>				
	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0	\$0	\$0
Postdocs Supported	0	0	0	75
Graduate Students	0	0	0	0
Undergraduate Students	0	0	0	0
Sponsored Project Funding	\$0	\$0	\$0	\$0
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

University	University of Arizona
TRIF Investment Area	Workforce Development
Program Name	The Community College to Four-year University Transition
<b>Progress Summary</b>	
TRIF funding continues to support community college students in navigating the transfer process to UArizona into technical and research-intensive majors, providing paid research opportunities to community college and transfer students to work on TRIF-funded research initiatives, and involving foundational research so that students will overcome barriers to research-rich degree programs and careers. As part of these efforts, UArizona is taking a comprehensive approach to increase the number of students historically underrepresented in research to attain degrees in STEM fields, an approach that includes a STEM student learning community, early access to undergraduate research, and support for students from low-income households to remain in STEM majors.	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
We are working to build new relationships and strengthen existing relationships with two-year community colleges- most of which are Hispanic Serving Institutions- as well as tribal colleges by creating programs that give potential transfer students a bridged learning and mentoring community as well as research experiences so that they are more prepared and competitive upon transfer to UArizona.	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
It can be difficult to collaborate with community and tribal colleges because they have limited research administration support and also limited personnel who can allocate time to special projects that are outside of their job duties.	
<b>Describe the Arizona benefit or impact of this TRIF project for the last year.</b>	
TRIF funding leveraged a \$5M Department of Education Title III HSI STEM grant aimed at building institutional capacity to remove barriers for Latinx students and students from low-income households in attaining bachelor's degrees in STEM with a strong emphasis on transfer students. Related activities to support transfer students include scaling up UArizona's nationally recognized STEM retention program, Arizona's Science, Engineering, and Math Scholars (ASEMS) program into STEM learning communities targeting 450 incoming students launching in fall 2023. Students will take linked courses together centered around a societal impact topic based on the U.N. Sustainable Goals. Students will receive peer mentoring, academic support, and one-on-one coaching from ASEMS staff. TRIF is supporting the conversion of a Pima Community College introductory biology lab course into a course-based undergraduate research experience (CURE). This CURE course parallels the same biology lab course at UArizona that is being converted into a CURE. Therefore, Pima students will not experience "being left behind" as they will also have engaged in research as well prior to transferring. UArizona hosted a 10-week summer research program for Diné College students who have been participating in the University's USDA-funded Bridge to STEAM partnership program. The summer program was offered to current participants to engage in a full-time research experience. Nine STEM scholars participated in 40 hours per week of research training, specimen identification and collection, genetic analysis, data processing and analysis, research writing and presentations, laboratory skills training and lab management, a research reading circle, and training in professional and social networking. The Bridge to STEAM team was able to leverage TRIF funding as match funds to secure \$50,000 in additional funding from the USDA. This provided the opportunity for eight Diné College students to continue working on the research projects they began during the summer, and through paid, research internships for the 2022-2023 academic year. Of the nine funded during the summer and academic year, 100% were indigenous students, 78% were female, and 100% were from low-income households.	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$16,568	\$149,498		\$166,066
Basic Research	\$0	\$0		\$0
Applied Research	\$0	\$0		\$205,353
Development	\$0	\$0		\$0
<b>Total</b>	<b>\$16,568</b>	<b>\$149,498</b>		<b>\$166,066</b>
Performance Measures	2022	2023	2024	Total
Faculty Startup Package Expenses	\$0	\$0		\$0
Postdocs Supported	0	0		0
Graduate Students	1	10		11
Undergraduate Students	0	3		3
Sponsored Project Funding	\$75,000	\$1,010,178		\$1,085,178
Publications in Academic Peer-Reviewed Journals	0	0		0
Startups	0	0		0

# TECHNOLOGY AND RESEARCH INITIATIVE FUND

ABOR INITIATIVES, GRANTS AND OPERATIONS

FISCAL YEAR 2023



ARIZONA BOARD OF  
**REGENTS**

ASU ♦ NAU ♦ UA



## ARIZONA BOARD OF REGENTS TRIF EXECUTIVE SUMMARY

The Arizona Board of Regents is responsible for the coordination, administration, and verification of the appropriate use of TRIF funds. The board ensures that taxpayer dollars are guided by the objectives established by voters and result in outcomes that benefit Arizona. The board also uses TRIF grants to leverage university expertise to help solve community issues and allocates funds for special projects and initiatives designed to be catalysts to improving and strengthening Arizona.

In June of this year, the board dedicated \$30 million in TRIF funds to address the critical health care workforce shortage and improve Arizona's health care outcomes. The universities will use the funds to create and expand new and existing academic programs to meet Arizona's health care workforce and research needs.

Special projects and initiatives include:

- Providing small awards to the Arizona SciTech Festival, an annual statewide celebration of science, technology, engineering, math, and the arts featuring over 1,000 expos, workshops, conversations, exhibitions, and tours designed to inform Arizonans about how these industries will drive our state forward.
- Supporting the ASU Innovation Open competition for university students developing hard tech ventures. The program provides venture mentorships and funding for student competitors on the cutting-edge of tech.
- Publishing K-20 attainment outcomes through a partnership with the National Student Clearinghouse and the Arizona Department of Education.
- Connecting Arizona researchers with university collaborators across the world through the Elsevier Pure Portal, an online solution to increase the impact and visibility of Arizona research.

Regents' Research and Community Grants pair Arizona's public university researchers with government agencies and community organizations to address longstanding challenges in Arizona.

This past year, the board awarded Regents' Research Grants to universities help reduce Arizona firefighter cancer and cardiovascular risks and prevent wildfires by using sound to detect bark beetle tree infestations that are destroying Arizona forests.

The board awarded Regents' Community Grants to university experts that can solve challenging problems for Arizona's local communities. Lack of attainable housing in rural Arizona is a critical challenge for rural fire departments and communities. One community grant partners NAU researchers with rural firefighting agencies and statewide government associations to develop a series of strategies and implementable programs for firefighters to access attainable housing in Prescott and other rural areas.



Through its oversight, administration, grant awards and direct initiatives, the board is committed to actions that expand research to directly benefit Arizona, increases Arizona’s educational attainment and prepare Arizona’s workforce for the high technology jobs needed in the 21st century economy.



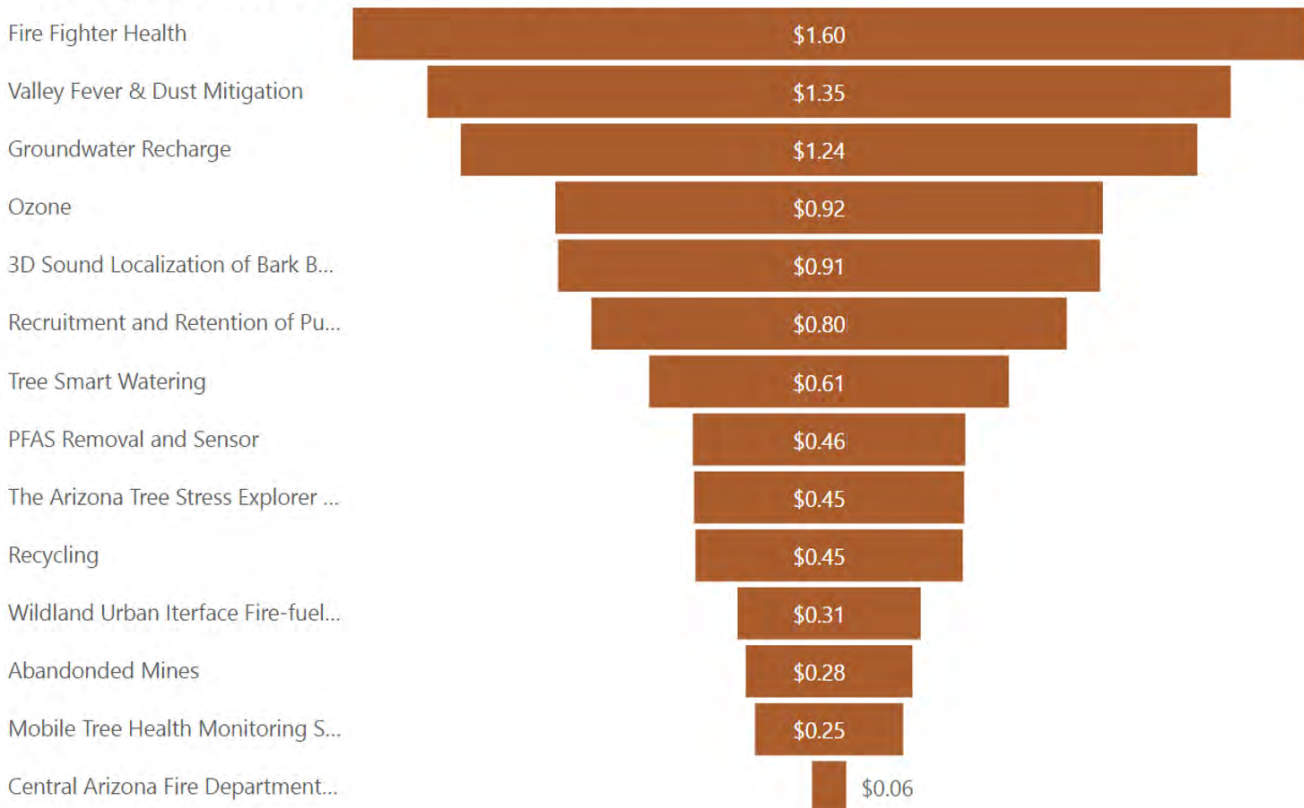


Table 1: FY 2023 Board Approved Initiatives

<b>Arizona Innovation Alliance</b>	\$700,000
<b>Board Attainment and Workforce Initiatives</b>	\$5,000,000
<b>Board Office Operations</b>	\$2,000,000
<b>General Education Assessment</b>	\$300,000
<b>Health Sciences and Workforce Analysis</b>	\$320,329
<b>Opportunity Initiatives</b>	\$30,000,000
<b>Phoenix Bioscience Core</b>	\$5,000,000
<b>Total</b>	<b>\$43,320,329</b>

Exhibit 1: FY 2023 Board Approved Regents and Community Grants (\$ Millions)

2023 Regents Research & Community Grants





# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

Program	Arizona Innovation Alliance		
<b>Problem Statement</b>			
<p>Arizona trails the national average in four-year college going and completion. Less than half of today's Arizona high school graduates pursue a 2- or 4-year degree. Of these students, just over 60% are completing their degrees with disparate educational outcomes for historically underrepresented populations.</p> <p>The state's ability to increase attainment rates is heavily reliant on a cascade of systems-level improvements, enhanced coordination across the breadth of Arizona's education system, and the scale of innovative strategic approaches to student success.</p>			
<b>Program Description</b>			
<p>The Arizona Innovation Alliance is a partnership between Arizona State University, Northern Arizona University, and the University of Arizona with the mission of enhancing the performance of higher education in the state. Modeled on the success of the University Innovation Alliance, the AIA emerged from a shared belief that through enhanced collaboration, we can find new and better ways to improve educational access and attainment among Arizona residents.</p> <p><b>Goals:</b></p> <ul style="list-style-type: none"> <li>• Improve overall student success and graduation rates of AZ residents, with particular attention on traditionally underserved populations</li> <li>• Deploy educational practices and programs that combine high standards of student outcomes with cost-effective teaching and student supports</li> <li>• Optimize resource allocations between student tuition and state appropriations for affordable and accessible education among AZ residents</li> </ul> <p>In service to its mission, AIA serves as a tri-university hub for collective advancement leveraging the following approaches:</p> <ul style="list-style-type: none"> <li>• Develop space to enable shared learning across institutions, deepening collective understanding of promising practices state and nationwide</li> <li>• Test and verify new methods for student success, access, and affordability through the development of institutional and collaborative pilot programs</li> <li>• Scale what's working by leveraging collective resources, identifying external funding sources, and bridging partnerships</li> <li>• Disseminate learning to enhance collective engagement opportunities and replication of promising practices across the AZ education ecosystem</li> </ul> <p>Through in-kind contributions, the Alliance Convener, alongside University Liaisons appointed by each University President, serve as the executive team and provide overall strategic guidance for AIA-affiliated initiatives. The annual investment of TRIF supports management staffing for the Assistant Director and Fellow appointments at each institution for related travel and events as well as modest seed funding for affiliated initiatives.</p> <p>A full report of the AIA's activities is available upon request at the board office.</p>			
<b>The Arizona Specific Benefit or Impact</b>			
<p>The ability to boost attainment rates is critically tied to future workforce needs and the economic vitality of the state. By 2030, nearly 70% of all jobs in Arizona will require postsecondary education and training beyond high school. If current attainment rates remain stagnant, it is estimated that the state will experience an annual shortage of over 26,000 bachelor's degrees.</p> <p>Education Forward wrote in their report "Billions to Gain, "all told, the billions in economic gains that come from expanding postsecondary enrollment and completion—not to mention the thousands of individuals empowered with greater economic opportunity and prosperity—more than justify the investments required of the state to ensure that more students graduate high school and go on to pursue a postsecondary education."</p>			
<b>Investment Detail</b>			
	2022	2023	2024
Budget Provided	700000	700000	
Budget Actual	700000	700000	
<b>Performance Measures</b>			
	2022	2023	2024
Continued Collaboration and Sharing of Best Practices	Yes	Yes	



# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

Program Board Attainment and Workforce Initiatives				
Problem Statement				
<p>Far too few Arizona students pursue education or advanced training after graduating high school (53%). Arizona currently ranks near the bottom of all states in the percent of high school graduates who continue their education the year after completing high school. To demonstrate the postsecondary pipeline in Arizona: For every 100 Arizona 9<sup>th</sup> graders, 78 will graduate high school on time; 43 of those 78 will enroll in postsecondary education the semester after graduating from high school; and 8 of these students will graduate with a 4-year degree within six years.</p> <p>Expanding access to college opportunities and increasing postsecondary attainment will be critical to ensuring low-income, first-generation, and underrepresented students are equipped for social mobility in an economy that increasingly relies on a skilled workforce.</p>				
Program Description				
<p>Board Attainment and Workforce Initiatives established strategies focused on developing or expanding outreach programs to help students alongside their families prepare for college. Initiatives include:</p> <ul style="list-style-type: none"> <li>• Arizona State University to expand its bilingual WeGrad through curriculum expansion, technology, enhancements, and marketing and promotion.</li> <li>• Northern Arizona University's to create an early-outreach middle and high school program – Family Access, Communication, Transition and Support (FACTS) that focuses on expanding support for families throughout their student's journey to college and when they are enrolled at NAU.</li> <li>• University of Arizona to increase parent and family engagement and opportunity, specifically in underserved Arizona communities, through additional in-person engagement with families of prospective students, enhancing College Academy for Parents programming, and creating new programs including Arizona Family Nights.</li> <li>• FAFSA Peer Coach Program to create a team of high school seniors in 24 Arizona high schools who bring awareness and assistance to students and families with the FAFSA. The participating districts include Tucson Unified School District, Peoria Unified School District, Marana Unified School District, and Tempe Union High School District.</li> <li>• Letter campaign for Arizona 8<sup>th</sup> graders and their families that focuses on admission criteria, including courses needed, for Arizona public universities as well as how to pay for college.</li> </ul>				
Is there an Arizona Specific Benefit or Impact?				
<p>The Board Attainment and Workforce Initiatives will have a significant positive impact helping to increase the number of low-income, first generation and underrepresented Arizona students who apply to college, matriculate, and succeed in attainment of high-quality certificates and 2 and 4-year college degrees, and to foster the conditions for sustainable change by focusing on communication, tools and resources to address the needs of Arizona students and families.</p> <p>Engagement and academic success in middle school and high school is critically important to ensure students complete high school and have a viable path to and through postsecondary education. Although most middle school and high school students say they want to pursue postsecondary education or training, a significant portion are not actively engaged in college and career readiness activities in middle school and high school.</p> <p>Additionally, ensuring that students complete the Free Application for Federal Student Aid (FAFSA) is a crucial step for closing postsecondary access and attainment gaps. High School seniors who complete the FAFSA are 90% more likely to enroll in postsecondary education.</p>				
Investment Detail				
Budget Provided	2022	2023	2024	Total
	5000000	5000000		
Performance Measures				
	2022	2023	2024	Total
Number of students and families served	N/A	N/A		
Inter-university research projects				
Inter-university research award amount				

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

Program	Board Attainment and Workforce Initiatives			
How has the problem statement been addressed in the last year by this TRIF project?				
<p>Board Attainment and Workforce Initiatives have expanded access to college opportunities through expanded statewide programming aimed at increasing college knowledge and direct support to Arizona students and families. Programming included expanded in-person and hybrid college access support for students and families around the topics of completing a college application and filling out the FAFSA; digital resource enhancements to middle school and high school students and families; increased bilingual engagement with Arizona students and families; and expanded early college awareness among Arizona middle school students.</p>				
Provide an evaluation of the effectiveness of the project in increasing college-going and completion rates in Arizona				
<p>Arizona State University - WeGrad conducted 43 in-person and nine digital programs this year, delivering nearly 30,000 instructional hours in metro Phoenix and Yuma, graduating 3,371 families and students.</p> <p>Northern Arizona University – FACTS engaged over 62,000 families of prospective and current NAU students through The Lumberjack Family Hub newsletters and announcements, printed resources, and presentations to ensure that families have the knowledge, sense of belonging, and resources to support their students as they explore, attend and graduate from college successfully. Secured a fall 2023 partnership with Coconino High School to pilot Team College Bound, NAU college readiness curriculum for families of high school students.</p> <p>The University of Arizona brought 2,753 eighth and ninth grade students from Southern Arizona to campus for “Arizona Road Trip”. The day-long campus visits gave students from underrecognized communities the opportunity to experience campus, think about college earlier, make connections, and begin planning for their futures. Students participated in programming around choosing academic pathways, finding careers, and how to fund their postsecondary education.</p> <p>The Arizona Board of Regents recruited, trained, and deployed 108 FAFSA Peer Coaches to amplify FAFSA messaging in 24 Arizona High Schools reaching 11,601 Arizona high school seniors with FAFSA information to support completion of the form.</p> <p>The Arizona Board of Regents letter campaign, which included information on the 16 core studies in high school and planning for college, was sent to nearly 70,000 8<sup>th</sup> graders across Arizona.</p>				
Additional Notes				
Investment Detail				
Budget	2022	2023	2024	Total
	2023203	1392494		
Performance Measures				
Number of students and families served	2022	2023	2024	Total
Inter-university research projects	N/A	254,925		
Inter-university research award amount				

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

Program	Board Office Operations		
Problem Statement			
<p>There is a need to ensure the coordination, administration and ensuring the appropriate use of TRIF funds in accordance with Arizona law and Board of Regents direction.</p>			
Program Description			
<p>The board office is responsible for the coordination, administration and ensuring the appropriate use of TRIF funds. In addition, the board office is responsible for the management of several TRIF supported programs that support and promote the goals established by the TRIF statute and board direction.</p> <p>The board office budget support the salaries of staff associated with TRIF's administration, and the running of specific TRIF supported projects as well as specific initiatives supported by TRIF, including:</p> <p>The Arizona SciTech Festival, which is an annual, statewide celebration of Science, Technology, Engineering and Math (STEM), and creates signature events communities statewide to encourage educational attainment and innovation in the STEM fields.</p> <p>Elsevier Experts, which provides the state and its people with direct access to information on the university faculties scientific expertise.</p> <p>The ASU Innovation Open, which underwrites a competition designed to challenge and advance university student innovators who aim to develop hard tech ventures.</p> <p>National Clearing House data acquisition, which monitors whether Arizona high school students enroll in and graduate from postsecondary education institutions both within Arizona and elsewhere.</p> <p>Tableau software subscription, which assist faculty in visualizing, presenting and report scientific research and scholarly work.</p>			
The Arizona Specific Benefit or Impact			
<p>The Board of Regents' promise to Arizona is to increase postsecondary access and attainment for Arizona students; to seek solutions to societal challenges; and to do both while increasing quality, affordability, and efficiency.</p> <p>The board is committed to ensuring access for qualified residents of Arizona to undergraduate and graduate institutions; promoting the discovery, application, and dissemination of new knowledge; extending the benefits of university activities to Arizona's citizens outside the university; and maximizing the benefits derived from the state's investment in education.</p> <p>In accordance with the board's promise, mission and direction the board office administers TRIF funds to support university centered activities and initiatives aligned with the TRIF statutes mandate to improve educational attainment, expand access, create cutting edge research for the benefit of Arizona and prepare Arizona for the new economy and high technology industries.</p>			
Investment Detail			
	2022	2023	2024
Budget Provided	2000000	2000000	
Budget Actual	1213252	1967561	
Performance Measures			
	2022	2023	2024
ABOR Office Projects Completed	Yes	Yes	

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

Program	General Education Assessment		
Problem Statement			
<p>At its November 2020 meeting, the Arizona Board of Regents approved an allocation of TRIF funds for the purpose of developing a common set of General Education Assessments across the ABOR system. These assessments are intended to ensure that, among several important educational goals, Arizona public university graduates possess the competencies and knowledge necessary to be leading participants in Arizona's 21st century economy, particularly in high-tech industries. The assessments will cover written communication, quantitative reasoning, critical thinking, and civic knowledge, and will be developed through a tri-university working group.</p>			
Program Description			
<p>Each university has agreed to collect and assess, using a commonly developed rubric, a randomized and representative sample of 350 incoming and 350 outgoing pieces of undergraduate student writing (or other relevant artifacts), focusing on one assessment area per year. The universities began this process with the assessment of written communication in FY2022, and they have continued with an assessment of quantitative reasoning in FY2023. To conduct this work, the universities each need to recruit, train, and compensate a team of assessors as well as fund assessment staff and supporting software.</p> <p>The universities have committed to providing annual General Education assessment reports from the tri-university working group, with each annual report focusing on the previous year's assessment results. Their report on the written communication assessment was presented in fall 2022, and the quantitative reasoning assessment report will be presented this fall, 2023. Further reports will follow in subsequent years.</p>			
The Arizona Specific Benefit or Impact			
<p>The General Education Assessment process will result in better preparation and education of Arizona public university graduates by ensuring that they gain the competencies and knowledge required to be key contributors to Arizona's economy, especially in high-tech industries. It will achieve this impact by two primary means:</p> <ul style="list-style-type: none"> <li>• Accountability, by measuring student achievement in the four areas identified by the Arizona Board of Regents (written communication, quantitative reasoning, critical thinking, and civic knowledge)</li> <li>• Improvement, by understanding what can be done on individual campuses to support and improve teaching and learning in the four areas.</li> </ul> <p>In particular, the assessment process will establish how well undergraduates at each institution are meeting student learning outcomes for the four areas, how well students are supported in developing effective competencies and skills in the four areas, and the opportunities for supporting and further enhancing those attributes.</p> <p>The tri-university approach and overall assessment process has included the opportunity to share data, research, goals/objectives, and knowledge across campuses to make Arizona's public universities stronger. No other state has collaborated and coordinated comprehensive undergraduate assessment in this way and Arizona is positioned to be a national leader in General Education assessment because of the unique and powerful nature of this project.</p>			
Investment Detail			
	2022	2023	2024
Budget Provided	300000	300000	300000
Budget Actual	100000	300000	
Performance Measures			
	2022	2023	2024
Complete the Assessment& Report Results	Yes	Yes	

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

Program Health Sciences and Workforce Analysis			
Problem Statement			
<p>Arizona is facing a shortage of healthcare professionals in various fields, including nursing, primary care, and mental health. The shortage of healthcare professionals has led to limited access to services, longer wait times, decreased quality of care, and increased healthcare costs.</p> <p>Arizona's public universities produce the majority of health care professionals in Arizona. The Arizona Board of Regents desired to study whether Arizona's public universities could expand their health care professional programs to address the health care shortage over time.</p>			
Program Description			
<p>The university presidents, senior administrators and the board office worked with specialized consultants to review the current structure of health sciences in Arizona, including performing an inventory of current health science assets, programming, organizational governance.</p> <p>The board office in conjunction with Beth Kohler Consulting, the ASU Seidman Research Institute, and others to analyzed Arizona's health professional workforce, looking at how Arizona's worker to population ratio compares to national averages, as well as expected changes to supply and demand over the next 10 years.</p> <p>The analysis found that Arizona's existing worker to population ratio is below the national average for all healthcare professions except for pharmacists and chiropractors. The analysis also provides insight into possible university efforts to expand the number of health care providers within Arizona.</p>			
The Arizona Specific Benefit or Impact			
<p>The analysis made several recommendations to reduce the gap in Arizona health care workforce, including working to identify expansion opportunities that align with Arizona's health care workforce needs, work closely with the health care industry to improve student preparedness and retention, seek legislative funding to support these efforts, and launch specific projects to identify the mental health workforces needs and how to address those needs.</p>			
Investment Detail			
	2022	2023	2024
Budget Provided	0	1600000	
Budget Actual		320329	
Performance Measures			
	2022	2023	2024
Completed the Analysis and Reported/Discuss with Board as Appropriate		Yes	

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

Program Opportunity Initiatives			
<b>Problem Statement</b>			
<p>Arizona is facing a shortage of healthcare professionals in various fields, including nursing, primary care, and mental health. The shortage of healthcare professionals has led to limited access to services, longer wait times, decreased quality of care, and increased healthcare costs. These challenges are especially magnified in rural areas.</p> <p>Additionally, the shortage of healthcare professionals in the state has resulted in a high turnover rate among healthcare providers, leading to decreased continuity of care for patients, and a negative economic impact on the state's healthcare sector.</p>			
<b>Program Description</b>			
<p>The board allocated \$30 million in FY 2023 TRIF Opportunity Initiatives Funds to Arizona's public universities as an investment to address the shortage in healthcare workforce and improve Arizona's healthcare outcomes.</p> <p>The funding is allocated in amounts as directed by the Board Chair:</p> <ul style="list-style-type: none"> <li>To ASU to establish a new medical school and expand or create other health sciences programs that will meet Arizona's needs for healthcare professionals and healthcare access. ASU is expected to submit a strategic plan or roadmap with accompanying business plan detailing the expected use of the TRIF funds in accordance with this narrative to the board by January 1, 2024.</li> <li>To NAU to develop strategies to increase enrollments in healthcare professions and programs including allied health and nursing, as well as developing a model for community and rural health access. NAU is expected to submit a strategic plan or roadmap with accompanying business plan detailing the expected use of the TRIF funds in accordance with this narrative to the board by January 1, 2024.</li> <li>To UArizona to develop strategies for expanding healthcare professionals including medical school students and needed residencies, as well as identifying opportunities for expanding healthcare research. UArizona is expected to submit a strategic plan or roadmap with accompanying business plan detailing the expected use of the TRIF funds in accordance with this narrative to the board by January 1, 2024.</li> </ul> <p>The universities will use the allocated opportunity grant funding in accordance with the TRIF statute, board policy and direction to support and expand existing and new academic programs to meet Arizona's healthcare workforce and research needs and an optimized economic healthcare sector for Arizona.</p>			
<b>The Arizona Specific Benefit or Impact</b>			
<p>An Arizona health care workforce analysis found that Arizona's existing worker to population ratio is below the national average for all healthcare professions except for pharmacists and chiropractors. The development and expansion of additional health care workforce and health science programs will help close Arizona's health care workforce gap.</p>			
<b>Investment Detail</b>			
	2022	2023	2024
Budget Provided	0	30000000	0
Budget Actual		30000000	
<b>Performance Measures</b>			
	2022	2023	2024
Develop and strategy to expand health care workforce professionals and research		Yes	



# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

Program	Phoenix Bioscience Core			
Problem Statement				
Establish an on-location resource center led by an Executive Director at the PBC for on-site entities, stakeholders and outside interested parties.				
Program Description				
<p>The PBC Executive Director position and TRIF resources for operations were initiated in mid-2020. The Executive Director reports to Enterprise Executive Committee.</p> <p>The PBC serves as:</p> <ol style="list-style-type: none"> <li>1. A central resource;</li> <li>2. Liaison with the City of Phoenix;</li> <li>3. Lead, coordinator and/or facilitator for optimizing activities and opportunities for the PBC, universities and interested partners and stakeholders;</li> <li>4. Coordinator for on-site planning, and marketing initiatives;</li> </ol> <p>Coordinator for academic, research, business, economic and community partnership development.</p> <p>Further information is available through the board office.</p>				
What is the Arizona advantage and/or anticipated Funding Opportunities?				
The location, on-site entities, including the universities, and off-site partners create a unique attraction for potential partners interested in connecting with the academic, research and business activities and expertise at the PBC.				
Is there an Arizona Specific Benefit or Impact?				
The unique attributes of the activities and expertise at the PBC provide great potential for continued research, technological and business economic expansion and diversification for the state.				
Investment Detail				
Budget	2022	2023	2024	Total
	700000	1000000	1000000	
Performance Measures				
Part of the 2024 work plan includes development of metrics that will reflect the progress and performance of the PBC office and the affiliated PBC entities.	2022	2023	2024	Total

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

Program	Phoenix Bioscience Core			
How has the problem statement been addressed in the last year by this TRIF project?	The on-site PBC Office continues to serve as a resource center for the PBC.			
Progress Summary	PBC Offers activities related to coordinating and expanding on-site and offsite activities, outreach, and partnership development continue to mature, with development of master planning, strategic initiatives and performance metrics targeted for the coming year.			
This project may have been addressing very difficult scientific or operational challenges. What, if anything, hasn't worked as well as was hoped?	Not applicable to the PBC initiative.			
Describe the Arizona benefit or impact of this TRIF project for the last year.	The profile of the PBC Office continued to gain exposure within and outside the state, and as the foundational networking and partner connections continue to expand, the resulting economic opportunities for the state are anticipated to start being realized in the coming years.			
Additional Notes				
Investment Detail	2022	2023	2024	Total
Budget	700000	1000000	1000000	
Performance Measures	2022	2023	2024	Total
Part of the 2024 work plan includes development of metrics that will reflect the progress and performance of the PBC office and the affiliated PBC entities				

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

<b>Project Name</b>	Valley Fever & Dust Mitigation
<b>Problem Statement</b>	According to the Arizona Department of Environmental Quality (ADEQ), Arizona would benefit from a cost-effective solution and or an options study that suggests how to identify an optimal fallow field plan that minimizes wind-blown PM10 emissions and preserves programmatic incentives available to farmers. We have chosen to focus on an important health aspect of airborne particulates, transmission of Valley fever. This is critical for farmland and other activities such as construction that produce dust and are important to economic advancement in Arizona.
<b>Program Description</b>	Northern Arizona University (NAU), the University of Arizona (UA), and Arizona State University (ASU) are collaborating on an integrated statewide research project to identify, characterize and map hotspots and routes of exposure for the fungus that causes Valley fever, medically known as coccidioidomycosis. By understanding the environmental source of the pathogen, its characteristics, propagation in soil, and mechanisms of transmission through air, we will enable more rapid progress towards containing the pathogen where it originates.
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>	This collaboration will encompass diagnostic, therapeutic and vaccine development in addition to the environmental source studies. This new collaborative will form the basis for attracting long term funding for the effort from state, federal, commercial, and philanthropic sources.
<b>Is there an Arizona Specific Benefit or Impact?</b>	The economic impact of Valley fever to Arizona in 2019 was \$736 million. This is over \$71 million life-time cost for each diagnosed infection. NAU, UA, and ASU propose to collaborate on an integrated statewide research project to identify, characterize and map hotspots and routes of exposure for the fungus that causes Valley fever. By understanding the environmental source of the pathogen, its characteristics, propagation in soil, and mechanisms of transmission through the air, we will enable more rapid progress towards containing the pathogen where it originates.

Arizona Board of Regents  
Technology and Research Innovation Fund (TRIF) Program 2023 Report

Program Name	Valley Fever & Dust Mitigation			
Progress Summary	ASU, NAU, and UA have been working together collecting and analyzing soil, air, and clinical isolates. Over 1000 soil samples were collected during the first year of this project; May 16, 2022 - May 15, 2023, 275 isolates have been received. We project that this project will accrue approximately 750 isolates, 300 more than originally estimated. Discussions have been initiated with developing the logistics for AzDHS and Maricopa County Public Health to participate in populating clinical information linked to the clinical isolates. Developed a novel <i>C. posadasii</i> genomic DNA capture and enrichment system to be used with complex DNAs extracted from soil and air filter samples. We used this DNA capture and enrichment system to generate robust <i>C. posadasii</i> genomic data from a DNA sample extracted from soil obtained in Tucson. Subsequent phylogeographic analysis of the resulting data, together with existing <i>C. posadasii</i> genomes obtained from isolates, revealed that the soil sample was phylogenetically related to other samples obtained from Tucson, demonstrating the power of this approach for high-resolution genotyping and geographic assignment of unknown samples. Conducted initial geospatial model development with Decision Theater team to develop a habitat suitability index for <i>Cocci</i> based on existing soil survey data.			
How has the problem statement been addressed in the last year by this TRIF project?	High volume PM10 air samplers have been collecting samples in suspected hot spot locations. Monitoring of PM10 aerosol at Mesa site in progress on a 1 in 6 day EPA schedule. In the first year, May 16, 2022 - May 15, 2023, 35 samples collected, chemical analysis is in progress (66% completed). Shared samples with NAU. Collaborative data analysis and additional site selection with NAU and UA are ongoing.			
What, if anything, hasn't worked as well as was hoped?	Applying machine learning/deep learning methods to conduct classification analysis to predict the presence of coccidioides in Arizona by considering the soil samples with the presence of coccidioides collected by the soil/air PCR group as labeled data points and further identifying locations with similar soil characteristics. Progress is being made toward the ability to predict and prevent Valley fever presence in soils/air.			
Describe the Arizona benefit or impact of this TRIF project to the state and its citizens over the last year (primary performance metric)	On April 11, 2023 we had an error of procedure in installing a set of soil moisture and temperature sensors on the Washington National Primate Research Center (WaNPRC) site on the Salt River Pima-Maricopa Indian Community Land. Once this error was revealed, the sensors were uninstalled on May 3, 2023. Discussions are ongoing with WaNPRC and the Salt River Pima-Maricopa Indian Community to know how to proceed.			
Additional Notes				
Investment Detail	2022	2023	2024	Total
Infrastructure	\$25,803	\$0		\$25,803
Basic Research	\$555,515	\$1,351,406		\$1,906,921
Applied Research	\$0	\$0		\$0
Development	\$0	\$0		\$0
Total	\$0	\$1,351,406		\$1,351,406
Impact Indicators	2022	2023	2024	Total
Number of meetings/calls with state agency or point-of-contact	4	0		4
Number of marketing, public relations or media pieces published.	0	0		0
Sponsored Project Funding Enabled by the Regents' Grant	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

<b>Project Name</b>	Tree Smart Watering
<b>Problem Statement</b>	
<p>Nationwide, landscape irrigation consumes nearly 30% of all residential water. In Arizona, climate change has generated an enormous amount of interest in planting trees to increase canopy cover to make the urban environment more livable. However, an extended drought coupled with extreme heat in Arizona (e.g., 2022-2023) calls for innovative solutions for tree watering that support increased water demand during establishment. Various conventional tree watering strategies exist (e.g., flood, sprinkler, drip). However, many challenges exist, such as water draining too fast, high evapotranspiration loss, and high cost prohibiting large-scale application. In Arizona, performance data on tree watering is even more sparse. To address these challenges, smart tree watering techniques are critically needed that can effectively maintain soil moisture and promote tree establishment while being cost-effective.</p>	
<b>Program Description</b>	
<p>We use a multi-scale study approach to address the above challenges by integrating field experiments with numerical modeling. At the site-scale, we collect performance data on innovative watering materials and green stormwater infrastructure practices through controlled field experiments (80 saplings) and by gathering in-situ data from a community park in Tucson. We assess tree health, survival rates, and water consumption. At the city-scale, we examine tree watering schemes at four distinct landscape types (oasis, mesic, xeric, and desert). We use sensor technologies to collect data on soil moisture and soil temperature. Additionally, we use these empirical data to calibrate and validate the numerical urban canopy modeling to forecast the performance benefits of water savings and other co-benefits and tradeoffs at city and regional scales. Last, in collaboration with Arizona Department of Forestry and Fire Management, we expect to broadly disseminate the project findings.</p>	
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>	
<p>The UA &amp; ASU team has the institutional advantage to accomplish the project goals and amplify project impacts. The team encompasses expertise in areas such as landscape architecture and planning (Yang), landscape ecology and GIS/remote sensing (Li), soil and plant science and sensor technology (Buzzard), green infrastructure/water harvesting and geospatial technology (McCormick), materials science and chemistry (Loy), land/vegetation/irrigation modeling and sensor technology (Wang), and machine learning and optimization (Xu). Additionally, we plan to seek federal/state funding to expand the project (e.g., US Forest Service), building on our established collaborations with the urban forestry and water departments in Tucson and Phoenix and various other partners.</p>	
<b>Is there an Arizona Specific Benefit or Impact?</b>	
<p>We anticipate significant environmental, economic, and social benefits from this TRIF project. (1) Smart watering technologies may create more favorable soil moisture conditions for newly planted trees, requiring relatively low water consumption and thus promoting water conservation. (2) The project may offer cost-effective solutions to enhance tree canopy cover, mitigating urban heat and providing health and well-being benefits. (3) The project can help develop more sustainable or stricter irrigation guidelines and recommendations for municipalities regarding tree planting and maintenance during early establishment. (4) We developed a user-friendly field survey app to monitor tree health and water use. This app can be made available for Arizona citizens, freely accessible via a weblink and QR code. (5) We established a robust student mentoring/training program, involving students at the doctoral, master's, undergraduate, and high-school levels. (6) We expect to scale up the water-saving benefits to the city scale through modeling approaches.</p>	

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

Program Name	Tree Smart Watering
<b>Progress Summary</b>	
<p>This report highlights the progress made over the past seven months, including project scoping and consultation (January–March) and data collection (March–July). (1) We sought advice from the Arizona Department of Forestry and Fire Management, urban forestry and water departments in Tucson and Phoenix, Tucson Storm to Shade Program, and other partners. Following a series of consultations, we selected four tree species, including native/drought-adaptive and non-native high water-use ones (desert willow, hackberry, ironwood, and oak) and we compare them using four different smart watering techniques (cellulose-based hydrogel, plastic-based hydrogel, organic mulch, and rainwater harvesting basin) against the conventional drip irrigation as the baseline. (2) We have been collecting data from 80 saplings planted at the UA Agriculture Center and from established trees on UA campus. Our preliminary data show positive signs that the smart watering techniques may provide water-saving benefits, although a longer study period is needed to validate this finding. Currently, the cellulose-based hydrogel and organic mulch appear to be more effective in maintaining soil moisture than other technologies and may provide long-term water self-sufficiency.</p>	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
<p>The project goal is to provide mobile, efficient, and scalable urban tree watering solutions in Arizona’s urban environment, with the objectives of (1) providing smart watering technologies that enhance tree survival during establishment and (2) quantifying water savings resulting from new technologies for saplings as well as established trees. Our work partially fulfills Objective #1, and we have completed preparatory work (e.g., model setup, data collection) to achieve Objective #2.</p>	
<b>What, if anything, hasn’t worked as well as was hoped?</b>	
<p>We anticipate significant environmental, economic, and social benefits from this TRIF project. (1) Smart watering technologies may create more favorable soil moisture conditions for newly planted trees, requiring relatively low water consumption and thus promoting water conservation. (2) Trees subjected to reduced irrigation experiments are demonstrating steady and healthy growth, endorsing water-saving approaches. This also offers cost-effective solutions to enhance tree canopy cover, mitigating urban heat and providing health and well-being benefits. (3) This project can help develop more sustainable or stricter irrigation use guidelines and recommendations for municipalities regarding tree planting and maintenance during early establishment. (4) We have developed a user-friendly field survey app to monitor tree health and water use. This app can be freely accessed by Arizona citizens via a weblink and QR code. (5) We established a robust student mentoring/training program, involving over 15 students across doctoral, master’s, undergraduate, and high-school levels.</p>	
<b>Describe the Arizona benefit or impact of this TRIF project to the state and its citizens over the last year (primary performance metric)</b>	
<p>We are addressing three unexpected issues. (1) The year’s prolonged drought, hot er weather, and delayed monsoon season have posed severe challenges for tree establishment (e.g., a 30% mortality rate in oak trees). Additionally, a hailstorm with heavy rains/winds in Tucson (7/28/2023) also caused tree damage. (2) The buried hydrogels in several tree plots surfaced during the monsoon season (three months after being added), resulting in reduced water retention capacity. We are conducting a lab experiment to adjust the specifications of hydrogel use (e.g., quantity, burial depth, inspection method). (3) Several sensor encapsulations were inundated during larger storms, leading to partial data loss. We are exploring alternative methods for sensor installations.</p>	
<b>Additional Notes</b>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$0	\$605,113		\$791,980
Applied Research	\$0	\$0		\$0
Development	\$0	\$0		\$0
Total	\$0	\$605,113		\$605,113
Impact Indicators	2022	2023	2024	Total
Number of meetings/calls with state agency or point-of-contact	0	2		2
Number of marketing, public relations or media pieces published.	0	5		5
Sponsored Project Funding Enabled by the Regents’ Grant	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

<b>Project Name</b>	Recruitment and Retention of Public Safety Personnel
<b>Problem Statement</b>	This project investigates the cause and scope of both statewide and local issues in retention and recruitment for public safety employees. It also identifies potential strategies for improving retention and recruitment and the contexts in which those strategies would be most effective.
<b>Program Description</b>	Research teams from Arizona State University, Northern Arizona University, and the University of Arizona will use qualitative and quantitative data to investigate barriers to effective employee retention and recruitment in public safety agencies across Arizona. The scale of the problem will be defined as well as the impacts of important local context such as rural/urban geographies, the role of inter-agency employee migration, and the demographics of current employees. In addition to characterizing retention and recruitment problems, strategies for increasing retention and recruitment quality and effectiveness will be sourced from comparable policy contexts.
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>	We are leveraging expertise across three Arizona Board of Regents Universities: Arizona State University, Northern Arizona University, and the University of Arizona. We anticipate these cross-disciplinary collaborations will continue in the future beyond the scope of this grant.
<b>Is there an Arizona Specific Benefit or Impact?</b>	See "Describe the Arizona benefit or impact of this TRIF project to the state and its citizens over the last year (primary performance metric)" below.

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

Program Name	Recruitment and Retention of Public Safety Personnel
Progress Summary	
<p>Since grant funds were allocated in Spring 2023, the research teams have</p> <ul style="list-style-type: none"> <li>- analyzed two secondary datasets, the County Supervisors' Association public safety agency survey and the Public Safety Personnel Retirement System, to investigate trends in employee retention and migration between agencies;</li> <li>- fielded a second stage of the County Supervisor's Association public safety agency survey to increase response rate and update that dataset;</li> <li>- fielded two qualitative surveys to gather data from more than 1000 current public safety employees across Arizona;</li> <li>- designed an instrument for a general Arizona population survey on public safety recruitment motivations to be completed in August 2023;</li> <li>- interviewed more than 30 employees in public safety leadership positions across the state, with analysis forthcoming;</li> <li>- conducted a nation-wide policy review of strategies to increase retention and recruitment in public safety positions, with emphasis on comparable governance, geographic, and demographic contexts;</li> <li>- presented a mid-project progress review and touchpoint with the working group.</li> </ul>	
How has the problem statement been addressed in the last year by this TRIF project?	
Funding was granted in Spring 2023. In the time that has since elapsed our research teams have designed and implemented six research project components which are now underway to address the questions posed by the working group.	
What, if anything, hasn't worked as well as was hoped?	
This research is intended to understand if there is a persistent statewide problem with employee and retention and recruitment in public safety careers. This research is currently in progress but will inform the development of strategies and recommendations for recruitment and retention of public safety personnel. These strategies may be tailored to local contexts based on results provided by this research, but their implementation is outside the scope of this grant.	
Describe the Arizona benefit or impact of this TRIF project to the state and its citizens over the last year (primary performance metric)	
Multiple secondary datasets that we anticipated being available for analysis have proved to be incomplete, unreliable, or otherwise limited. Our teams have pivoted their approaches to rely either on datasets from other sources or primary data collection; however, these secondary data gaps may impact longitudinal analysis of employment trends.	
Additional Notes	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$0	\$800,000		\$800,000
Applied Research	\$0	\$0		\$0
Development	\$0	\$0		\$0
Total	\$0	\$800,000		\$800,000
Impact Indicators	2022	2023	2024	Total
Number of meetings/calls with state agency or point-of-contact	0	20		20
Number of marketing, public relations or media pieces published.	0	2		2
Sponsored Project Funding Enabled by the Regents' Grant	0	0		0



# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

<b>Project Name</b>	PFAS Removal and Sensor
<b>Problem Statement</b>	
<p>Conventional water treatment does not remove PFAS to regulatory levels, mostly due to the nature of the molecular interactions of PFAS with water, their low concentrations, and their high solubility. These treatments—including adsorption, ion exchange, and pressure-driven membrane processes—provide no selectivity, demonstrate quick breakthrough and unsustainable regeneration, and require disposal of brines or concentrates with high PFAS concentrations. The challenge becomes greater as new and more complex chemical mixtures are used in Arizona since each PFAS family member responds differently to treatment. For example, short-chain and ultra-short chain PFAS have been adopted for commercial production to circumvent regulations on long-chained PFAS. However, studies have shown that removal efficiency with the most common treatment, adsorption with granulated activated carbon (GAC), is significantly lower than that of longer-chained PFAS.</p>	
<b>Program Description</b>	
<p>Our team understands the interactions between different PFAS molecules and sorbent surfaces that provide the critical information that informs cost-effective detection and remediation. Poly- and perfluoroalkyl substances (PFAS), listed as an emerging contaminant by the Environmental Protection Agency (EPA) since 2014, accumulate in soil, surface water, and groundwater. Due to their persistent and bio-accumulative nature, PFAS are a widespread public health concern and considered “forever” contaminants. The goal of this project is to create a cost-effective technologies to detect and remediate different types of PFAS in water. The approach uses advanced sorbents (“sponges”) that can be modified to remove all types of PFAS from water under a wide range of conditions. These sponges are constructed from low-cost, environmentally-friendly materials (cellulose) and are regenerable. Advanced sensors are employed to provide real-time monitoring of PFAS concentrations during operation, which allows rapid adjustments to optimize the treatment system. We expect that the unique properties of our new sorbents, in combination with real-time monitoring, will provide an innovative, cost-effective method for treating PFAS-contaminated waters.</p>	
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>	
<p>This project is one of the first projects to work holistically on sustainable detection and treatment of PFAS. We have already leveraged the work we are working to apply or multiple federally sponsored projects such as NSF and DOD.</p>	
<b>Is there an Arizona Specific Benefit or Impact?</b>	
<p>There is an urgent need to close the gap between innovative water research and applied engineering to ensure that we meet the water needs of our global growing population. We often produce cutting-edge research but there is a delay between publication of results, information sharing to the public and scaling up innovative technologies. The fundamental scientific knowledge produced by this project will benefit society and AZ specifically as it will deepen knowledge on fundamentals of emerging contaminants in water (and how they can be removed to improve water quality) while disseminating this knowledge to our communities. The successful completion of this project on engineered materials will increase the efficiency and reduce the cost of the traditionally expensive detection and treatment of PFAS, and open a pathway for sustainable treatment of other emerging contaminants in our environment. We envision the use of these new sorbents to be scalable and targeted for POU strategic sites. Successful outcomes from this project will have a significant impact in AZ as we are a state that is characterized by arid and semi-arid conditions and with the constant threat of severe water scarcity thus it is imminent to ensure that we can use all sources of water even the ones that were previously contaminated using novel technologies.</p>	

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

Program Name	PFAS Removal and Sensor
<b>Progress Summary</b>	
<p>This report contains a review of updates of the first year of performance. In summary, we are working on identifying optimal modifications of molecules for sorption/desorption on sponges for each structural category of PFAS, we have started collecting information to perform simultaneous QSPR analysis on sorption/desorption, we have started the fabrication of robust and rapid sensors for synthetic ground water and we have initiated water quality assessment of water sources in Coconino County and the Navajo Nation. We have successfully shown that we can adsorb PFAS on sponge surfaces and we are at the process trying to identify the possible pathways for desorption. Additionally, we have requested permission and we were granted that to collect water samples from various sources on the Cocopah Reservation. We have collected water from the Cocopah Reservation at various sites. Requests to collect additional water samples on the Navajo Reservation (additional to the secondary effluent from Tuba City and Chinle) was requested but no response most notably due to weather challenges over the spring semester.</p>	
<b>How has the problem statement been addressed in the last year by this TRIF project?</b>	
<p>We have successfully shown that we can absorb PFAS effectively on sponge surfaces, while this was our first hypothesis the most important part is the desorption mechanism. On the detection front we have demonstrated that a system with molecular imprinted polymer and electrochemical sensor we can detect PFOS with an experimental limit of detection of 0.1 nM in pure water. We stressed here that such measurement is significantly faster than conventional methods, on the order of minutes.</p>	
<b>What, if anything, hasn't worked as well as was hoped?</b>	
<p>We have so far conducted experiments in all fronts and collected fundamental understanding of PFAS adsorption and desorption. This is critical as current methods of treatments cannot remove all PFAS effectively that means that we need to employ different treatment techniques for different PFAS molecules. At this point we reiterate that there are thousands of PFAS molecules but only five will be regulated by the EPA at extremely low concentrations. This is where the importance of the sensor is elucidated. Currently in Arizona we do not have certified laboratories that can detect PFAS concentrations at the levels that EPA will require thus the need for quick and economical detection is urgent. Our project so far has shown that we can detect at relevant concentrations at least one PFAS that is regulated.</p>	
<b>Describe the Arizona benefit or impact of this TRIF project to the state and its citizens over the last year (primary performance metric)</b>	
<p>The biggest challenge with our research is ensuring there are no interferences with the LC/MS analysis. The team spends a lot of time ensuring all materials used both in the equipment and to collect our samples do not adsorb any of the PFAS. Our study is focusing on environmentally relevant concentrations thus any adsorption on other surfaces could skew our results. We are planning as part of this study to provide a full report on appropriate material use for adsorption experiments at environmentally relevant concentrations and provide updates on current EPA methods used for LCMS analysis of PFAS molecules. Sensor reversibility and drifts; While we successfully demonstrated the ability to generate a calibration curve (signal vs. concentration) of the MIP sensor, we observed a few issues regarding reversibility and drifts in performance of the sensors. Specifically, the swelling and contractions that occurred between consecutive sensing measurements produced noticeable effects on the physical morphology of the MIP films. Our main goal of this program is to address these shortcomings by developing fundamental understanding that relate structure of MIPs to their sensing performance.</p>	
<b>Additional Notes</b>	

Investment Detail				
	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$160,000	\$458,333		\$618,333
Applied Research	\$0	\$0		\$0
Development	\$0	\$0		\$0
Total	\$0	\$458,333		\$458,333
Impact Indicators				
	2022	2023	2024	Total
Number of meetings/calls with state agency or point-of-contact	7	0		7
Number of marketing, public relations or media pieces published.	3	0		3
Sponsored Project Funding Enabled by the Regents' Grant	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

<b>Project Name</b>	Ozone
<b>Problem Statement</b>	
<p>Currently we do not understand how the unique southwest natural environment and potential ozone precursor sources in Arizona--nitrogen oxides (NOx), volatile organic compounds (VOCs), and biogenic volatile organic compounds (BVOCs) impact or assist in the production of ozone in Arizona. Thus, it is not clear which types of controls can be put in place or voluntary actions Arizonans can take to reduce ozone and improve air quality. Beyond the existing photochemical air modeling and analysis, Arizona needs a better predictive method to establish the independent and reasonably controllable variables influencing ozone in Arizona." -ADEQ</p>	
<b>Program Description</b>	
<p>We respond to ADEQ's problem statement by proposing to carry out collaborative research activities (between ASU and UArizona) focused on integrating available measurements of these chemical compounds with a state-of-the-art regional air quality model and satellite products of O3 and its associated compounds (Modeling and Data Analysis -- UArizona). We will carry out four major research tasks: 1) Conduct O3 simulations for the recent decade and evaluate the hourly-to-decadal and kilometer-scale variations of simulated O3 and associated compounds with existing ADEQ datasets and satellite data of O3, NO2, formaldehyde (CH2O), carbon monoxide (CO), and methane (CH4) for regional context. 2) Assess how the Phoenix/Tucson urban airshed shifts between NOX-limited and VOC-limited regimes over the year through a series of model experiments as weather and desert ecosystem influences O3. 3) Quantify the relative contributions of the following: a) transport of pollution from nearby states (e.g., California, northwest Mexico), b) emissions from industrial and transportation sectors, c) plants (e.g., creosotebush), &amp; d) fires 4) Estimate county-wide emissions of NOx, VOCs, and BVOCs via inverse and filtering methods.</p>	
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>	
<p>Our team includes Drs Arellano (modeling), Sorooshian (measurement), Bertton (chemistry), Meredith (VOC fluxes) and Lim (AQ sensor network). We are well-positioned to tackle this problem given our combined synergistic expertise and previous/on-going research and scientific leadership on AQ-related topics. Our approach is mature and has been applied to AQ weather forecasting and O3 assessment in other states like Colorado.</p>	
<b>Is there an Arizona Specific Benefit or Impact?</b>	
<p>We assist ADEQ in advancing their O3 assessment capabilities by using model and data-driven approaches to quantify the relative contributions of key processes influencing O3 levels observed in the region. These capabilities are envisioned to aid in science-informed air quality management and policy activities in Arizona.</p>	

Arizona Board of Regents  
Technology and Research Innovation Fund (TRIF) Program 2023 Report

Program Name	Ozone
Progress Summary	
<p>Our main milestones for Year 1 are to&amp;#58; 1) coordinate with ADEQ and ASU collaborators with regard to the research problem statement; 2) collect measurement data of O3 and its precursors and conduct initial analysis for 2010-2022; and 3) conduct km-scale and statewide WRF-Chem O3 simulation and evaluation for select periods chosen by ADEQ. We assembled our research team beginning Summer 2022 but mostly made progress in hiring graduate students and starting our research during Fall 2022. We encountered a major delay on hiring and on visa application of one of our postdocs, who has yet to arrive in UArizona. During Fall 2022, we also experienced a major setback (tragic shooting incident in our department) that resulted in lower research productivity during the initial stage of our research. Progress in our research has improved late Fall and continued strong in Spring 2023 enabling us to achieve several aspects of the three milestones by the end of Year 1. We are continuing to conduct our Year 2 research activities this Summer 2023 with our postdoc and graduate students working full time for this project.</p>	
How has the problem statement been addressed in the last year by this TRIF project?	
<p>We conducted the following initial assessment of O3 and precursors trends from data and models. 1) We have carried out&amp;#58; a) air mass trajectory analysis to identify contributions of various sources of O3 precursors from neighboring areas of Maricopa, Yuma, and Pima counties; b) O3 time series analysis to identify anthropogenic pollution signatures; c) O3 extreme event analysis to identify exceptional episodic events like fires, heat waves, dust storms, and inter-state pollution transport that could impact O3; and d) analysis of spatial and temporal patterns and their covariations with other pollutants to identify chemical regimes 2) We have also carried out five model simulations for the month of June (2017-2021). These simulations are currently being evaluated against the following USEPA surface site data, satellite column retrievals, ADEQ forecasts, NCAR O3 forecasts and reanalysis. Initial results show reasonable performance enabling us to pursue interpretative modeling activities during Summer 2023.</p>	
What, if anything, hasn't worked as well as was hoped?	
<p>Several manuscripts (at least 5) are currently in preparation reporting our initial assessment of O3 and precursors (see above activities) including a manuscript describing the state of knowledge, needs, and opportunities on the state of O3 in Arizona. We organized 7 Zoom meetings to coordinate our activities with ADEQ. This project has additionally provided leverage to acquire a NASA Pandora instrument to enter their monitoring network for column-based measurements of O3, NO2, and CH2O; the instrument is anticipated to be installed on the rooftop of a University of Arizona campus building in Fall 2023. This instrument will aid in studying O3 to assist the state and will provide additional educational and outreach activities for Arizona citizens. Impact to Arizona has been through&amp;#58; 1) hiring 3 students and 2 postdocs; 2) teaching students on the fundamentals of O3 chemistry; 3) providing awareness to the O3 problem in the state to; a) students (courses being taught by the PIs), b) international/national O3 experts (scientific meetings); c) DHHS (round-table discussion); and d) public (media exposure).</p>	
Describe the Arizona benefit or impact of this TRIF project to the state and its citizens over the last year (primary performance metric)	
<p>While we develop our team Summer 2022, we only completed identifying research tasks for each team member during Fall 2022. Note Naghme Soltani has not started her research yet as her visa application has been delayed until now. Our graduate students started working late Fall. Due to coursework and unforeseen circumstances (especially the tragic shooting on Oct 5 in HAS), our research productivity was limited during the first semester. This gradually improved Spring 2023. Our team has now been doing full time research Summer 2023.</p>	
Additional Notes	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$423,959	\$921,149		\$1,345,108
Applied Research	\$0	\$0		\$0
Development	\$0	\$0		\$0
Total	\$0	\$921,149		\$921,149

Impact Indicators	2022	2023	2024	Total
Number of meetings/calls with state agency or point-of-contact	7	0		7
Number of marketing, public relations or media pieces published.	3	0		3
Sponsored Project Funding Enabled by the Regents' Grant	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

<b>Project Name</b>	Fire Fighter Health
<b>Problem Statement</b>	
<p>Firefighters have increased cancer rates compared to the general population. Cardiovascular disease is also a leading cause of firefighter deaths. A major concern of the Arizona fire service is exposure to per- and polyfluoroalkyl substances (PFAS) which have been linked to cancer, cardiovascular disease and other diseases. We have previously shown that Arizona firefighters have higher serum PFAS levels than the general population. Arizona firefighters are requesting a study to test the effectiveness of blood or plasma donation to lower their PFAS levels, based on a previous study in Australia demonstrating these interventions were effective in lowering PFAS levels over 12 months of time. However, the study did not determine if these interventions also reduced the risks of cancer and cardiovascular disease. Having a cellular biological clock greater than one's chronological age (years since birth), measured through blood DNA methylation, is a risk factor for multiple diseases including cancer, cardiovascular, and neurological diseases, as well as death from all causes combined. We have previously shown that firefighters with increased serum PFAS levels also have biological clocks greater than their chronological age. Arizona firefighters are also interested in reducing their cancer and cardiovascular disease risks even if they do not have elevated PFAS levels and have expressed interest in testing interventions to improve these outcomes.</p>	
<b>Program Description</b>	
<p>We will enroll 1,500 Arizona firefighters from across the state in a three-year study. Perfluorooctane sulfonate (PFOS) is the PFAS chemical generally found at the highest concentration in blood. As carried out in the Australian study, only firefighters with high serum PFAS (<math>\geq 5</math> ng/ml PFOS) will be offered participation in a randomized controlled trial comparing plasma donation, blood donation and no treatment (a control group) over a 12-month period, as the blood or plasma donation interventions are likely to be less effective for individuals with lower serum PFAS levels. Firefighters with lower serum PFAS (PFOS <math>&lt; 5</math> ng/ml) will be randomized to two interventions (Zone 2 exercise and intermittent fasting) selected by the fire service and shown to reduce cancer or cardiovascular risks in previous peer-reviewed studies in the general population, as well as a no-intervention comparison group. Biological clocks will be measured in all firefighters participating in the selected interventions. Study participants will receive their personal serum PFAS and biological clock results.</p>	
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>	
<p>The proposed research will build on our national Fire Fighter Cancer Cohort Study (FFCCS), a unique prospective cohort of firefighters from departments across the US.</p>	
<b>Is there an Arizona Specific Benefit or Impact?</b>	
<p>This research provides Arizona firefighters the opportunity to measure their serum PFAS levels, as this testing is not part of their annual medical evaluation. If their PFAS levels are elevated, there are specific recently published clinical guidelines to guide additional evaluation. If serum PFAS and their adverse health effects can be reduced through blood or plasma donation, then the results of this study will provide the evidence necessary to recommend these treatments to all firefighters and individuals in the general public with elevated serum PFAS levels. The lack of other known treatments for elevated serum PFAS increases the importance of this study proposal. The other interventions (Zone 2 exercise, and intermittent fasting) prioritized by the firefighters and demonstrating cancer and cardiovascular risk reduction benefits in this study will also be broadly disseminated to the fire service, helping to keep them healthy. The results of research with firefighters will also inform treatments to improve advanced biological age in the general population.</p>	

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

Program Name	Fire Fighter Health
Progress Summary	
<p>Our project was funded in January of this year (2023). Since receiving notice of the award, we established a fire service liaison group to guide and name the overall study (Firefighter Collaborative Research Project) and select the two interventions for individuals not meeting the elevated serum PFAS levels required for the blood and plasma donation study. These interventions are Zone 2 exercise and intermittent fasting. We have worked with twenty-one Arizona fire agencies so far across the state to provide information to their firefighters about the study. We worked with blood and plasma donation centers across the state to provide donation locations for blood and plasma. We have completed the human subjects (institutional review board) approval process for the three randomized control trial arms and began screening firefighters into the FCRP study in July. As of 8/9/23 we have screened 225 firefighters for FCRP and sent 151 serum samples for PFAS analysis. These have been analyzed within two weeks of receipt and we are preparing the first serum PFAS report-back to the participating firefighters to be sent in the next few weeks.</p>	
How has the problem statement been addressed in the last year by this TRIF project?	
<p>We have provided opportunities for Arizona firefighters to have their serum PFAS measured and reported back to them and to participate in health and wellness study looking at reduction of serum PFAS, cardiovascular risk and the improvement of overall health and wellness with the goal of reducing their serum PFAS levels. We have already sent serum samples from over 150 firefighters for PFAS analysis and will be expanding screening in the Phoenix area this month (August 2023) with other parts of the state to follow.</p>	
What, if anything, hasn't worked as well as was hoped?	
<p>The blood and plasma donation centers have been highly supportive of our study, as there is an ongoing shortage of blood and plasma products, and these treatments can be life-saving. Firefighters are one of the most dependable groups in terms of donations, and there is great excitement about the opportunity to increase the number of firefighters donating blood and plasma. The firefighters participating in the study also directly benefit from having their serum PFAS measured.</p>	
Describe the Arizona benefit or impact of this TRIF project to the state and its citizens over the last year (primary performance metric)	
<p>We had hoped to start firefighter recruitment in May or June 2023 but needed to wait until July 2023 given the complexity of the project with three interventions and the requirement to complete all the human subjects approval process prior to initiating the study.</p>	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$0	\$1,602,459		\$1,602,459
Applied Research	\$0	\$0		\$0
Development	\$0	\$0		\$0
Total	\$0	\$1,602,459		\$1,602,459
Impact Indicators	2022	2023	2024	Total
Number of meetings/calls with state agency or point-of-contact	0	50		50
Number of marketing, public relations or media pieces published.	0	16		16
Sponsored Project Funding Enabled by the Regents' Grant	0	0		0

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

<b>Project Name</b>	Central Arizona Fire Department Recruitment and Retention Challenges Related to Housing
<b>Problem Statement</b>	The Central Arizona Fire and Medical Authority (CAFMA) serves approximately 106,500 residents in the municipalities of Chino Valley, Prescott Valley, Dewey-Humboldt and unincorporated areas, such as Paulden and Williamson Valley Road. The City of Prescott Fire Department, which covers a population of over 45,000, and the Central Arizona Fire and Medical Authority serve over half the population of Yavapai County. Both agencies face significant challenges in recruitment and retention, and the biggest challenge is the lack of affordable housing options. According to a report by Rounds Consulting Group, housing affordability and availability has shifted from being considered as a social, health and welfare issue into a critical economic development concern. Advances in Arizona's ability to attract high value-added businesses are at risk, primarily due to shortages in workforce supply and a lack of workforce housing. The affordable housing issue being the most important factor that adversely affects firefighter personnel (and other essential workers) recruitment and retention; however, it also affects the region's economic development potential and essential safety operations. CAFMA currently has 23-38 operational position openings, and 10 non-operational openings. In the next 3-5 years, it's predicted there will be 25-50 new positions, plus another 15 for two new fire stations. Many applicants cannot find options to live in the region and either do not apply or leave shortly after receiving extensive specialized training at a cost of approximately \$100,000.
<b>Program Description</b>	This project is to pinpoint the problems of fire personnel recruitment and retention in the Region, explore the options to address those problems, and mechanisms to implement those options. The proposed research will use both quantitative (e.g., administrative, survey data and analysis,) and qualitative data (e.g., literature review, best practices, policy review, focus groups, interviews) to describe the challenges, and to develop a series of strategies and implementable programs for firefighters at affordable housing in the region. Guiding research questions: What are the challenges in recruiting and retaining fire personnel in the Region? How big are those challenges? How big is the housing stock that can be used as fire personnel housing? What is the gap (in terms of both quantity and housing types)? What are the cases in comparable cities and towns that successfully addressed the affordable housing problems for public sector employees? What are their proposed strategies, plans, and programs, and how do they work? What is the potential of recruiting fire personnel locally? What are the options to train a fire personnel pipeline locally? What resources can CAFMA and Prescott Fire Department tap into to address the affordable housing and workforce pipeline issues? What can be added to increase fire personnel's career desirability? How will the proposed options work in terms of implementation?
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>	We will deploy a multi-pronged approach to pinpoint the problem with recruitment and retention for CAFMA and provide options and strategies to address the problem. EPI has expertise in primary and secondary social and economic data collection and analysis, public policy, and planning/programming. Our research has informed different levels of decision-making. As EPI is doing the data analyses in the Technology and Research Initiative Fund (TRIF) Recruitment and Retention of Public Safety Personnel project, we will have statewide benchmark data available, and lessons learned to inform the research of this project.
<b>Is there an Arizona Specific Benefit or Impact?</b>	Lack of affordable housing and lack of local fire profession pipeline are the two primary challenges negatively impact firefighter recruitment and retention in the Region. The difficulty of recruiting and retaining firefighter personnel (and other essential workers) affects the region's essential safety operations which limits its economic development potential. This project includes both research activities that pinpoint and break down the problems, and the planning/programming component that explores the options and strategies. According, the benefits to Arizona has two tiers. The first one being that the research results will elaborate the problems and provide a detailed and clear picture of the affordable housing needs for firefighters in the Prescott Region, and provide a methodology of analyzing housing issues that could be used in other regions of the state. Secondly, the comprehensive programming that addresses both housing access and "train local, hire local", workforce pipeline development, as well as their financing component, based on a collaborative process, will provide options on addressing firefighter affordable housing and workforce development issues could serve as a toolkit for not only for the Prescott Region, but also for other rural areas in the state who face the same challenges.

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

Program Name	Central Arizona Fire Department Recruitment and Retention Challenges Related to Housing
Progress Summary	
How has the problem statement been addressed in the last year by this TRIF project?	
What, if anything, hasn't worked as well as was hoped?	
Describe the Arizona benefit or impact of this TRIF project to the state and its citizens over the last year (primary performance metric)	
Additional Notes	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$0	\$57,560		\$57,560
Applied Research	\$0	\$0		\$0
Development	\$0	\$0		\$0
Total	\$0	\$57,560		\$57,560
Impact Indicators	2022	2023	2024	Total
Number of meetings/calls with state agency or point-of-contact	0	0		0
Number of marketing, public relations or media pieces published.	0	0		0
Sponsored Project Funding Enabled by the Regents' Grant	0	0		0



# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program Proposal

<b>Project Name</b>	3D Sound Localization of Bark Beetles
<b>Problem Statement</b>	The bark beetle, an insect with notable environmental consequences, has become a focal point in ecological research. These beetles are often implicated in damage to forest ecosystems, leading to concerns in areas such as forestry management, biological diversity, and climate regulation.
<b>Program Description</b>	We have applied the technique of Near-Field Acoustic Holography (NAH) to detect the bark beetle. NAH offers a method for examining the anatomy and behaviors of the bark beetle through complex wave analysis and sound field reconstruction. Our research aims to provide precise and detailed insights into the structural characteristics and functional aspects of the bark beetle, utilizing the quantitative capabilities of NAH to detect and study them non-invasively in trees. The essence of NAH lies in its ability to translate sound waves into visual imagery. Our endeavors extend beyond mere observation, targeting actionable insights that can contribute to effective pest management. By employing NAH, our goal is to detect the bark beetle non-invasively within trees, avoiding damage to the living bark and minimizing ecological disturbance. This has the potential to revolutionize how infestations are identified and treated, permitting early detection and precise localization of them.
<b>What is the University's Advantage and/or Anticipated Funding Opportunities?</b>	The success of our research project is underpinned by the advantageous position of our institution in both resources and location. We currently fund two PhD students dedicated to this project, alongside two undergraduates who were actively involved and compensated throughout the summer. We are actively seeking opportunities for additional funding and scholarships for our team, targeting undergraduate awards such as the NASA space grant award and the NAU Hooper Award. Looking forward, we also see promising funding opportunities with industry partners and potential military applications for erroneous noise detection, with possibilities for patents for our prototype device and technology development, opening doors to commercialization through programs such as the NSF Small Business Innovation Research (SBIR). The principal investigator benefits from excellent lab facilities within the institution, encompassing a wide range of resources including microscopes, optical tables, optical equipment, and state-of-the-art computing technology. Moreover, our location in Northern Arizona offers unique access to forested areas heavily impacted by bark beetles, providing an unparalleled opportunity to observe and study these insects in their natural habitat. Through partnerships with specialized forestry experts within the region, we are able to deepen our understanding of the subject.
<b>Is there an Arizona Specific Benefit or Impact?</b>	Located in a region particularly affected by bark beetles, Arizona's forested areas suffer from the environmental implications of these insects, threatening the natural ecosystem and contributing to economic challenges in the forestry industry. By conducting this research within the state, we are not only able to access essential natural habitats for direct study but also to contribute scientific insights and develop solutions that directly address a local environmental issue. Our partnerships with forestry experts and the potential applications of NAH in noise detection further extend our impact to various sectors within Arizona, including industry and defense. Moreover, our commitment to funding and education, such as supporting PhD students and undergraduates, also contributes to the growth of Arizona's academic and scientific community. As we continue to explore funding opportunities and broaden our research applications, we envision this project further fostering innovation, environmental stewardship, and economic growth within Arizona.

# Arizona Board of Regents

## Technology and Research Innovation Fund (TRIF) Program 2023 Report

Program Name	3D Sound Localization of Bark Beetles
Progress Summary	Our research team is making substantial strides in developing a specialized technology tailored to detect bark beetles in trees. Currently, the team is actively engaged in constructing a handheld microphone detector array, focusing on its design and calibration to ensure the targeted detection of bark beetles. Through the execution of proof-of-principle experiments utilizing a commercial microphone array, we are simulating bark beetle sound patterns by generating known sounds behind tree bark and subsequently performing quantitative analysis using Near-Field Acoustic Holography (NAH). The approach capitalizes on the capability of NAH to precisely locate the 3D position of the sound source behind the bark by extracting and analyzing the phase information. This application of holography to locate sound sources in 3D, also known as backpropagation of the field, signifies a novel aspect of our methodology. Our efforts are further augmented by the unique interdisciplinary expertise of the Principal Investigator (PI), who is successfully applying principles from optical holography to acoustic holography. Collectively, these innovations have yielded promising results with known sound sources, laying a solid foundation for continued research and the potential for real-world applications in bark beetle detection and environmental preservation.
How has the problem statement been addressed in the last year by this TRIF project?	Over the last year, the TRIF project has made substantial strides in addressing the problem statement by focusing on the detection and analysis of bark beetles, an environmental concern in forested areas. We've designed and begun development on a handheld microphone detector array tailored to detect bark beetles within trees. The project has successfully conducted proof-of-principle experiments using Near-Field Acoustic Holography (NAH), demonstrating the ability to locate sound sources behind tree bark with precision. Leveraging the Principal Investigator's expertise in optical holography, have been integrated into the project, resulting in significant progress. These achievements mark a crucial step towards non-invasive bark beetle detection and offer potential applications in environmental conservation.
What, if anything, hasn't worked as well as was hoped?	The TRIF project has delivered tangible benefits to the state of Arizona and its citizens over the last year, contributing to the preservation of its rich forested areas by targeting the bark beetle problem. The development of a specialized handheld microphone detector array for bark beetle detection will provide an innovative and non-invasive means to identify infestations, allowing for more timely interventions, as well as helping Arizona Department of Forestry and Fire Management staff to be able to detect them more effectively. By collaborating with local forestry experts and utilizing the unique geographical advantages of Northern Arizona, the project will enhance our understanding of the beetle's impact on local ecosystems. Furthermore, the project has contributed to the educational sector by funding and involving both PhD and undergraduate students from the fields of physics and optical science. The strides made in erroneous noise detection using NAH also open doors to future industrial and military applications, emphasizing the project's broad and positive impact on the state's technological advancement and environmental stewardship.
Describe the Arizona benefit or impact of this TRIF project to the state and its citizens over the last year (primary performance metric)	One challenge that has emerged in the course of our project is the difficulty in recruiting a student skilled in neural network deep learning development. This specialized skill set is critical to the ambitious goal of automatically identifying the sounds specific to bark beetles, distinguishing them from other noises in the forest environment. Efforts to fill this gap are ongoing, and a postdoctoral student may be required to help fill this gap.
Additional Notes	

Investment Detail	2022	2023	2024	Total
Infrastructure	\$0	\$0		\$0
Basic Research	\$0	\$911,918		\$911,918
Applied Research	\$0	\$0		\$0
Development	\$0	\$0		\$0
Total	\$0	\$911,918		\$911,918
Impact Indicators	2022	2023	2024	Total
Number of meetings/calls with state agency or point-of-contact	0	4		4
Number of marketing, public relations or media pieces published.	0	0		0
Sponsored Project Funding Enabled by the Regents' Grant	0	0		0





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