Tag and Probe with electrons in BSM channels

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Introduction

•In real data we cannot perform trigger efficiency studies based on MCTruth!

•We need reliable trigger efficiency measurements from data.

•A good way to do this is to take a benchmark sample that is well understood, (eg Z -> ee) and measure trigger efficiencies in this.

•Today; Calculate efficiency in the Z->ee sample using data-driven (tag and probe) method.

•**Extrapolate** these results to compare to those obtained from MC simulation of exotics samples. (eg G(500GeV)->ee).

•Future; Exploit machinery on SUSY samples

Samples used (12.0.6 AODs processed with EventView)

•Z -> ee; 5144.PythiaZee tid_005998 - For Tag and Probe

•G(500GeV) -> ee; 5620.Gee_500_pythia tid_006262

•G(1 TeV) -> ee; 6642

The MC Truth (Object) method

•To obtain object based efficiencies the trigger decision objects are ignored and instead their hypotheses iteratively rerun on the trigger objects we are interested in.

- •Hypotheses defined in; https://twiki.cern.ch/twiki/bin/view/Atlas/TrigHLTelectronHypo and https://twiki.cern.ch/twiki/bin/view/Atlas/TrigHLTphotonHypo

•Efficiency as a function of Pt is defined as

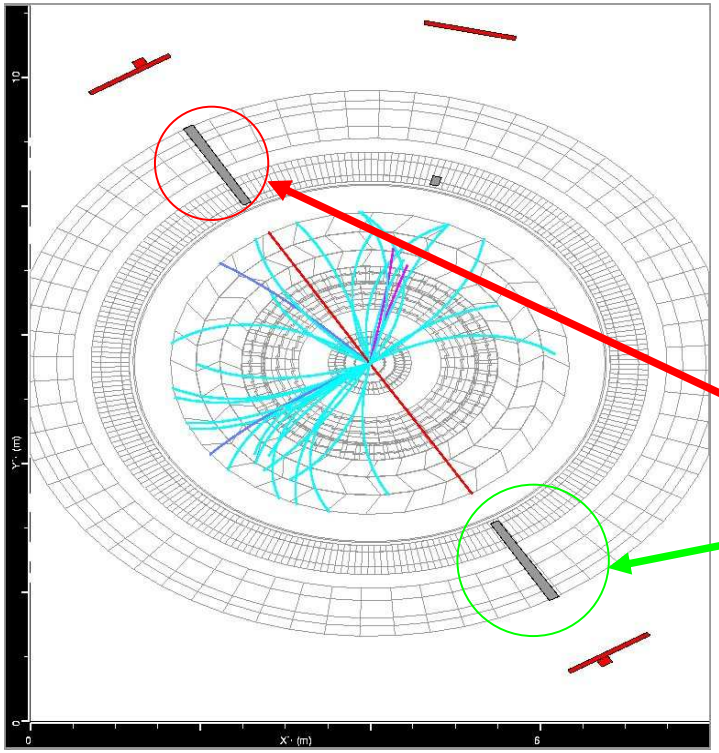
- •Efficiency = N3(Pt) / N4(Pt)

•Where;

- N3 = Number of normalised, associated objects passing trigger
- N4 = Total number of normalised, associated objects.

•See previous presentation for more details; EG11-CSC 09/08/07 http://indico.cern.ch/conferenceDisplay.py?confId=19495

The Tag and Probe Method on Z -> ee



•Find two electron objects that construct a Z mass peak at Offline level.

•Require at least one of these electrons to be a good triggered electron (Tag)

•The Tag electron must pass all trigger cuts
•Use the other electron as a Probe

•The electron trigger efficiency is then measured by the efficiency of the Probe to pass trigger cuts.

Normalisations

•Both MC and Tag and Probe methods must be consistently normalised.
•Electrons are normalised to offline using the official e/gamma normalisation, to remove any detector acceptance and reconstruction inefficiencies so we can study the effects of the trigger alone;

- •|eta| < 2.5
- •no crack; 1.37 < |eta| < 1.52
- •loose isEM

•N.B “offline” is a variable concept. Depends on object definitions and overlap removal used.

•Events are also required to have passed the loosest electron trigger (e10), to make sure the sample only contains events with a potential e/gamma trigger match.

•Recall; Tag and probe requires two electrons and the Z mass peak (79.1 -> 103.1 GeV) (not optimised), ie. We have to normalise these on the basis of the entire event.

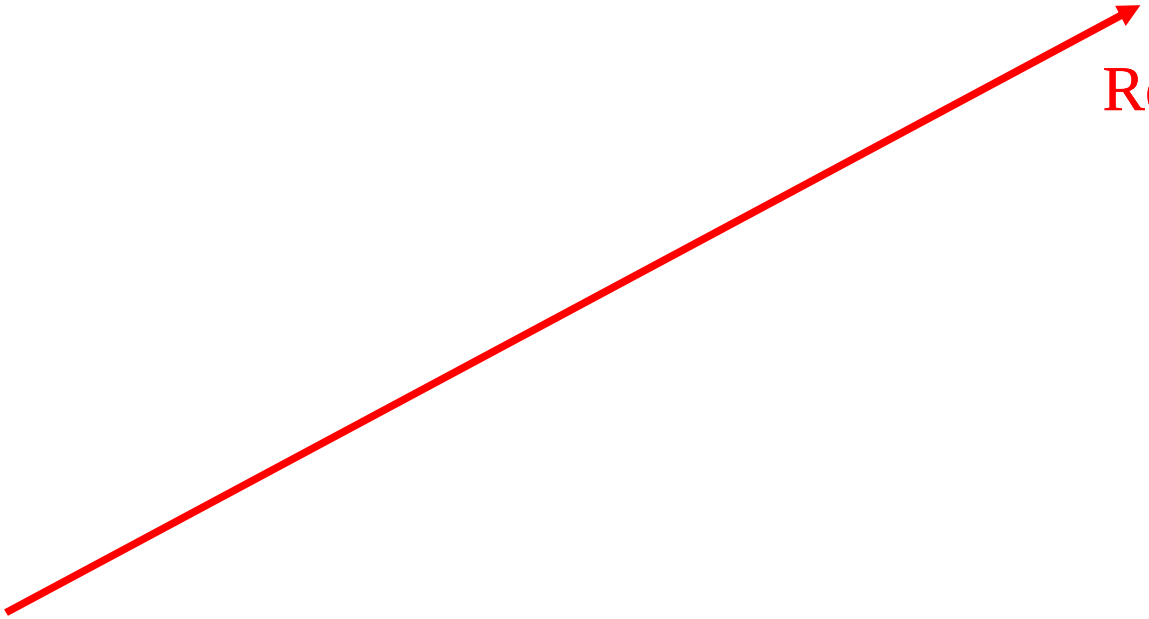
•MC methods treat each electron object individually and so are normalised on an object by object basis.

Associating offline objects to trigger objects

•In order to calculate the trigger efficiency of events, we must associate offline objects to the e/gamma objects seen by the trigger levels.

•This is done using a delta R cone around our offline electron.
  •Where delta R is given by;

$$\Delta R = \sqrt{\Delta\eta^2 + \Delta\phi^2}$$



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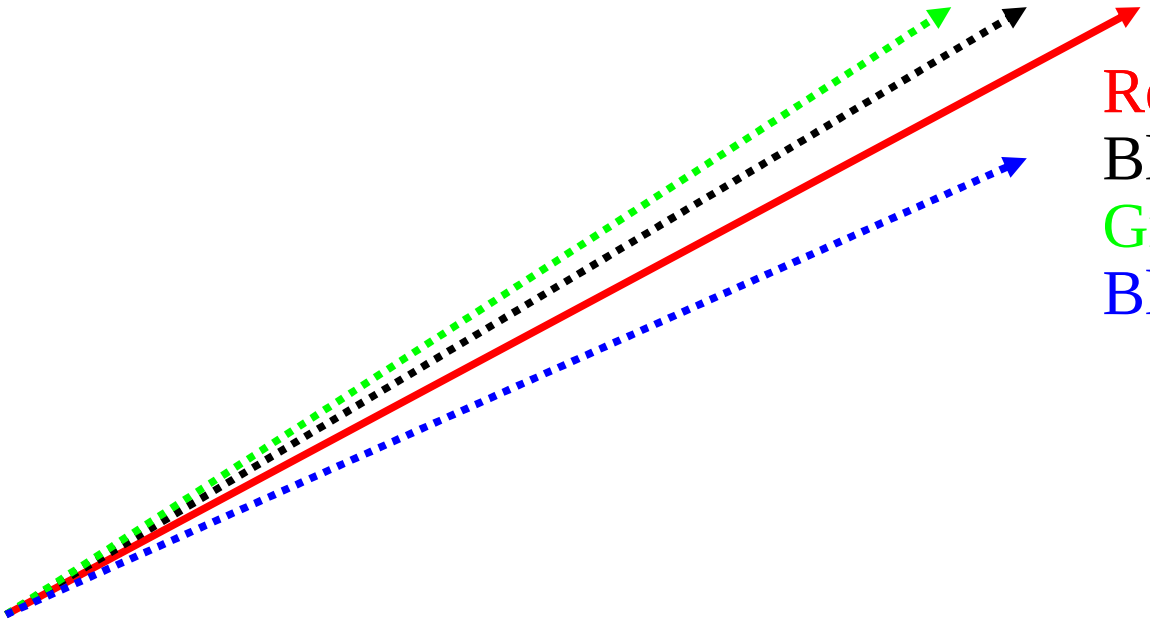

Red; Offline
Black; EventFilter
Green; L2
Blue; L1

Associating OL objects to trigger objects

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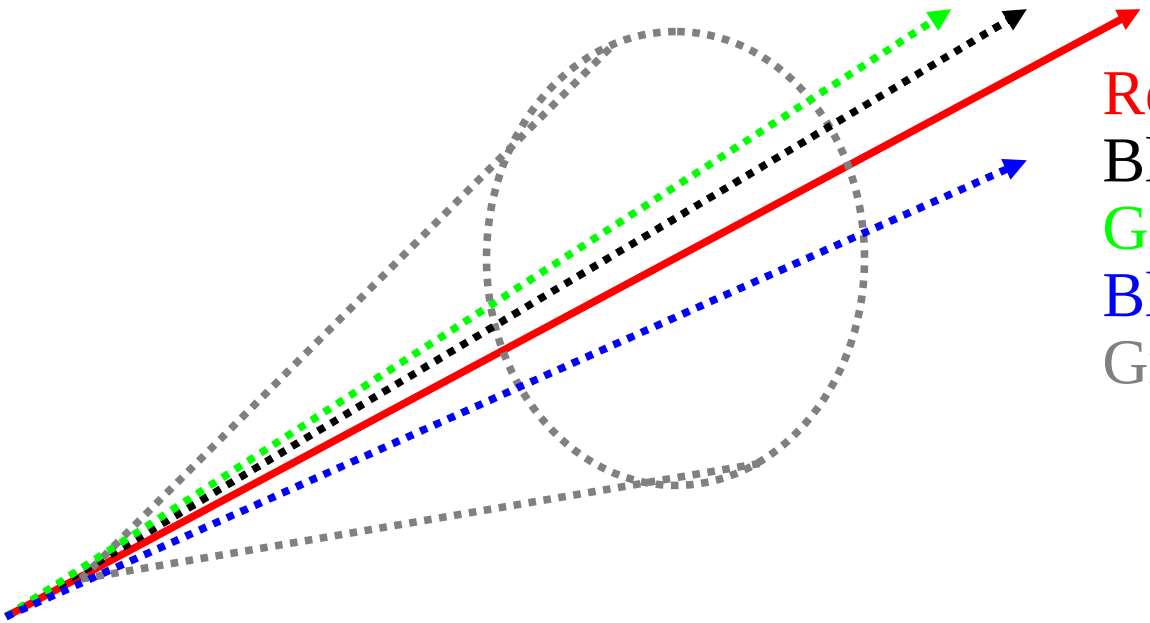
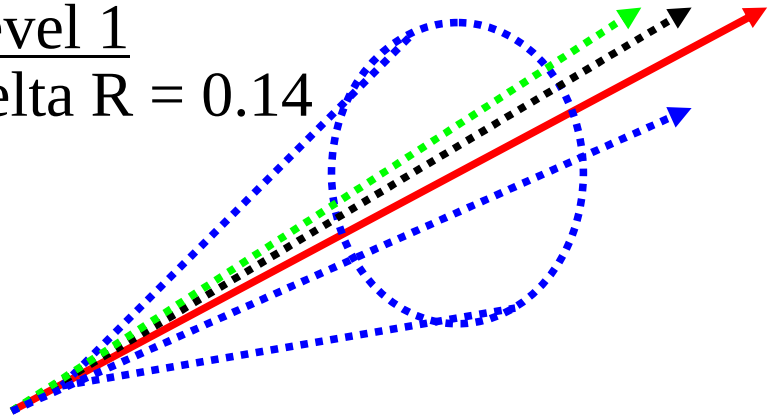


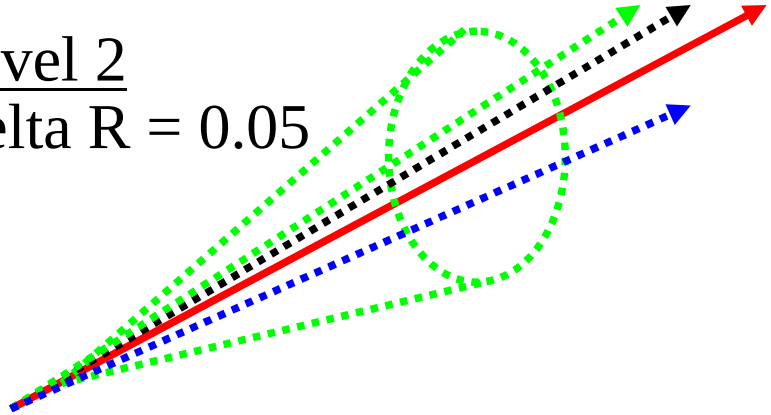
Red; Offline
Black; EventFilter
Green; L2
Blue; L1
Gray; Delta R cone

Associating OL objects to trigger objects

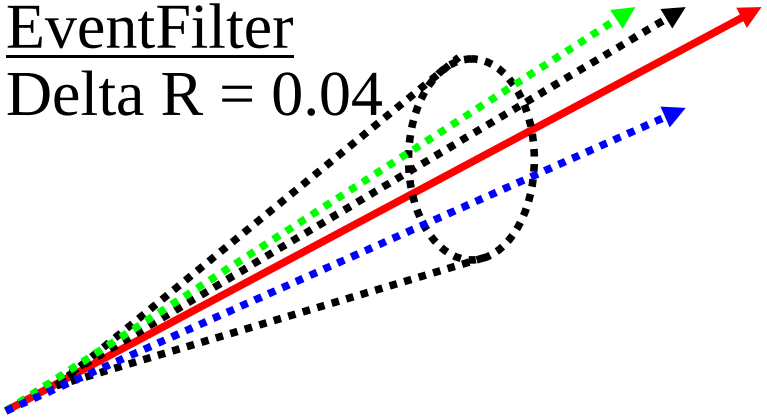
Level 1
Delta R = 0.14



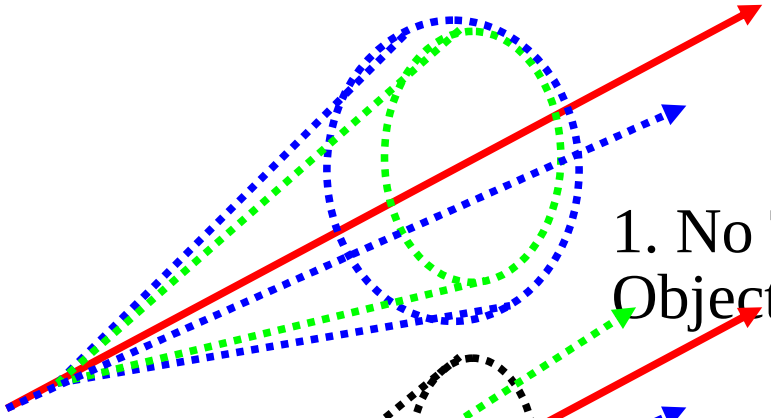
Level 2
Delta R = 0.05



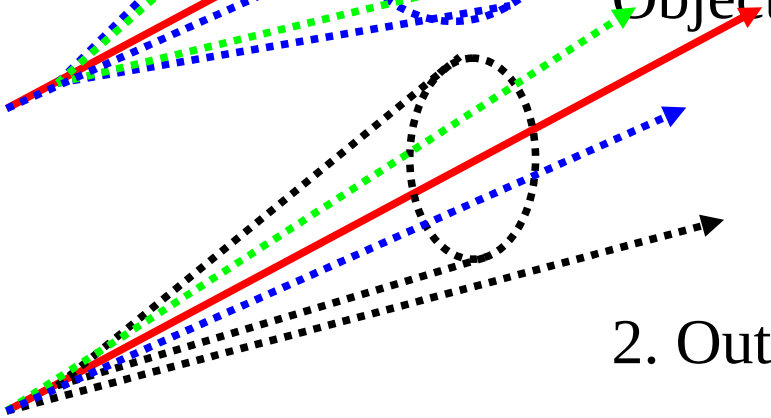
EventFilter
Delta R = 0.04



Failed Associations



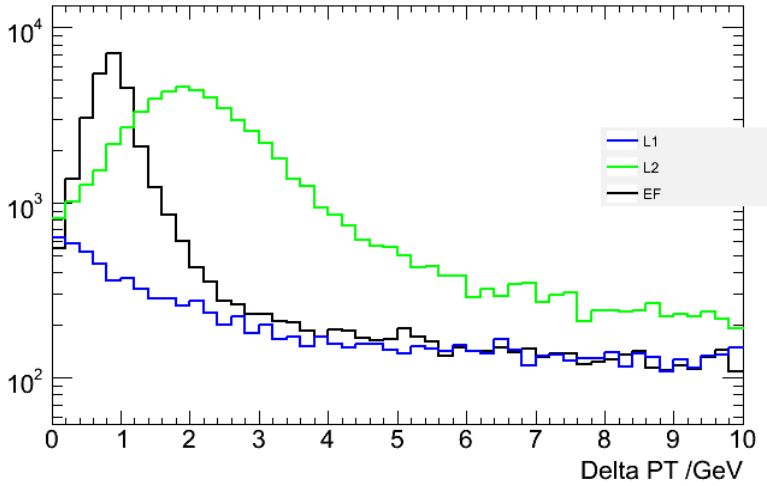
1. No Trigger Object



2. Outside delta R

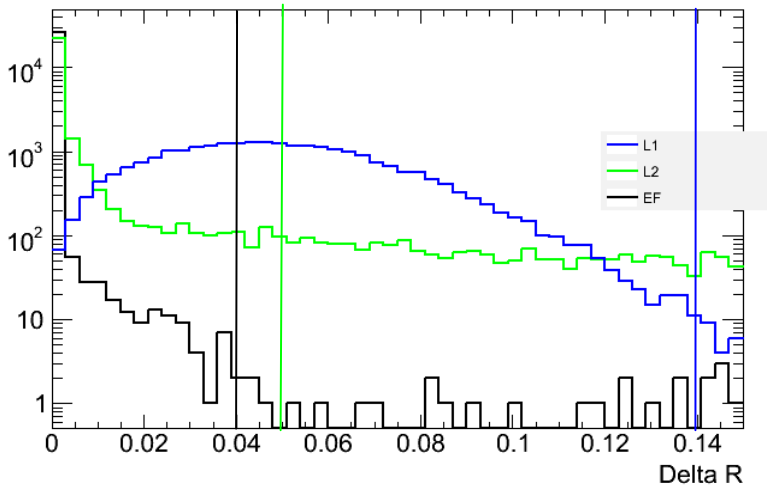
Associating OL objects to trigger objects

- L1 delta R = 0.14
- L2 delta R = 0.05
- EF delta R = 0.04 not optimised



Association cut flow

Cut	$Z \rightarrow e^+e^-$ Tags	
Events / Objects	21,236	
Matching to L1	21,204	99.8%
Matching to L2	20,902	98.4%
Matching to EF	21,225	99.9%
Matching to all	20,873	98.3%



Efficiency Definition Recap

•Tag and Probe method;

•If the probe passes the trigger events are labelled TagPass.
•If the probe fails the trigger events are labelled Tag Fail.

•Efficiency = N1(Pt) / N2(Pt)

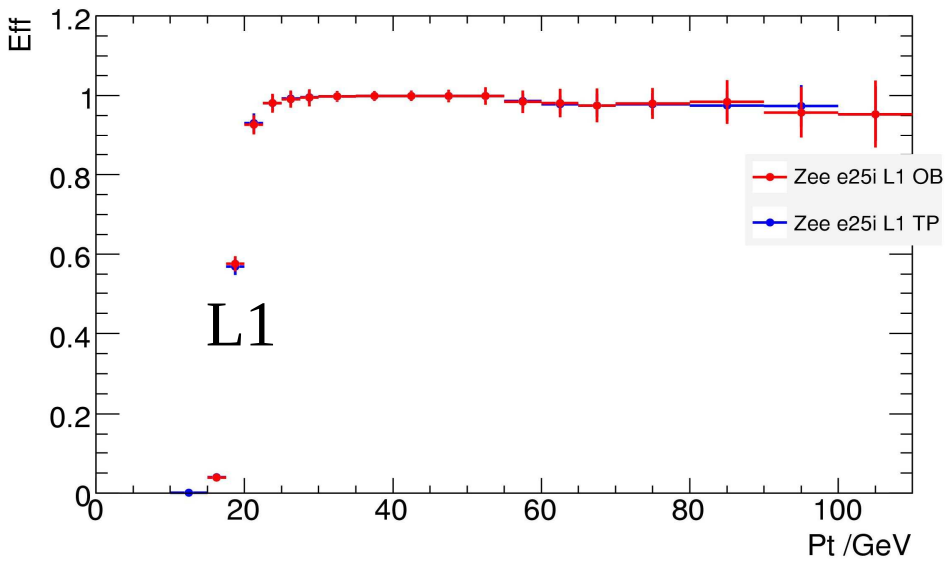
N1 = 2*TagPass = Number of normalised, associated Probes passing trigger.
N2 = 2*TagPass + TagFail = Total number of normalised, associated Probes.

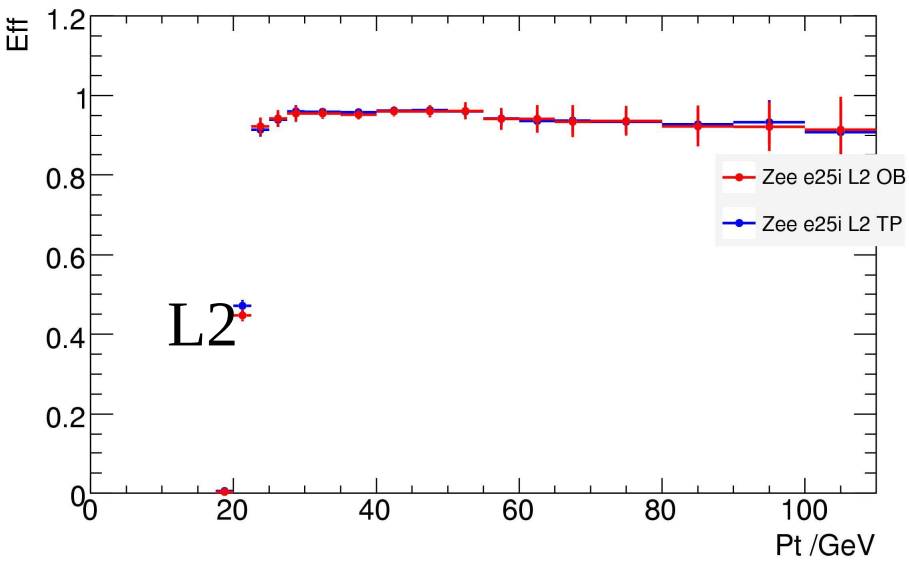
•MCTruth based object method;

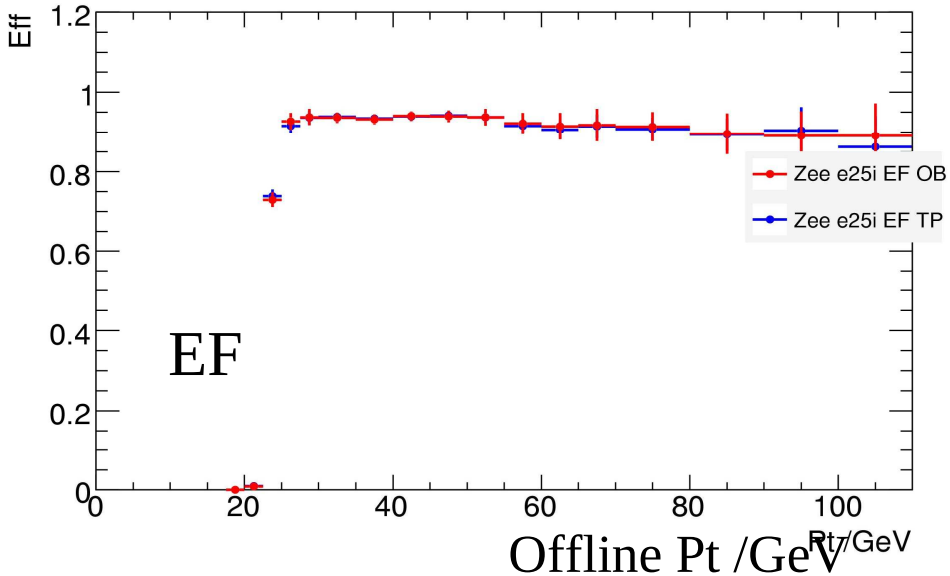
•Efficiency = N3(Pt) / N4(Pt)

N3 = Number of normalised, associated objects passing trigger
N4 = Total number of normalised, associated objects.

Zee Tag and Probe to Object Method comparisons (e25i)



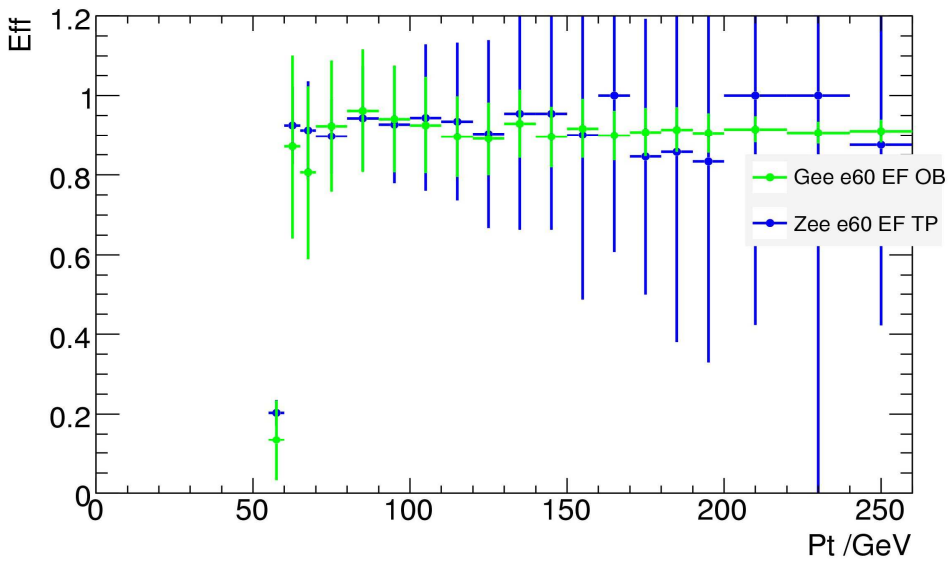


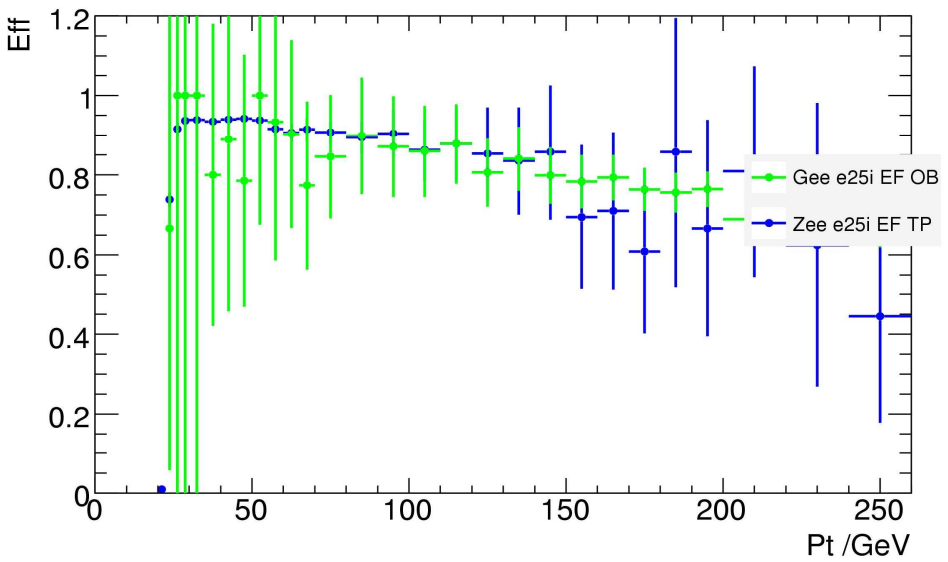


- Blue – Tag and Probe
- Red – Object (MCTruth)

- Good agreement at all trigger levels.
- Decrease at high Pt due to L1 isolation.
- Limited by low statistics at high Pt.
- Error calculation may have to be revised.

Z -> ee Tag and Probe comparisons to G -> ee Object



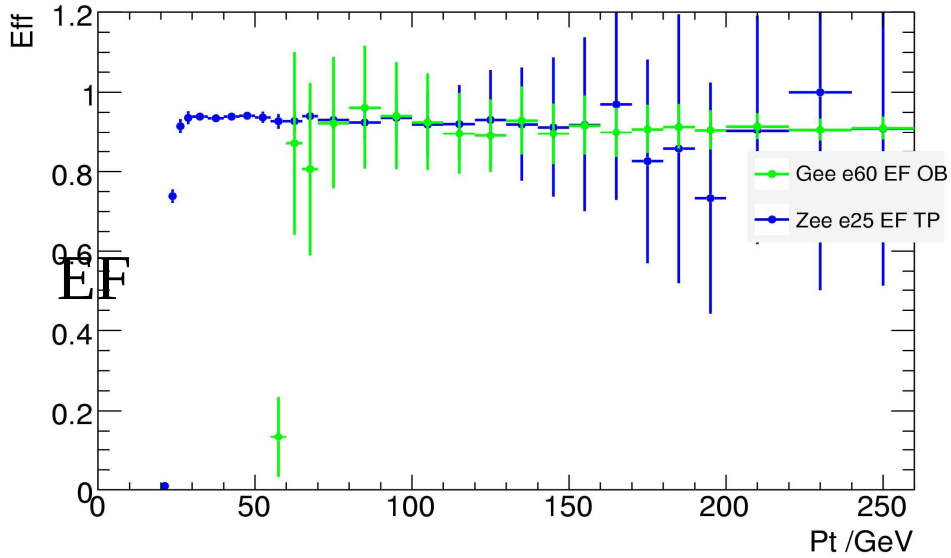


- G->ee e60 (Object) -> Z->ee e60 (Tag and Probe) EF
- Good agreement, but low statistics

- G->ee e25i (Object) -> Z->ee e25i (Tag and Probe) EF
- Both show well known downwards trend with increasing Pt due to L1 isolation.
- Different statistics in different Pt regions.

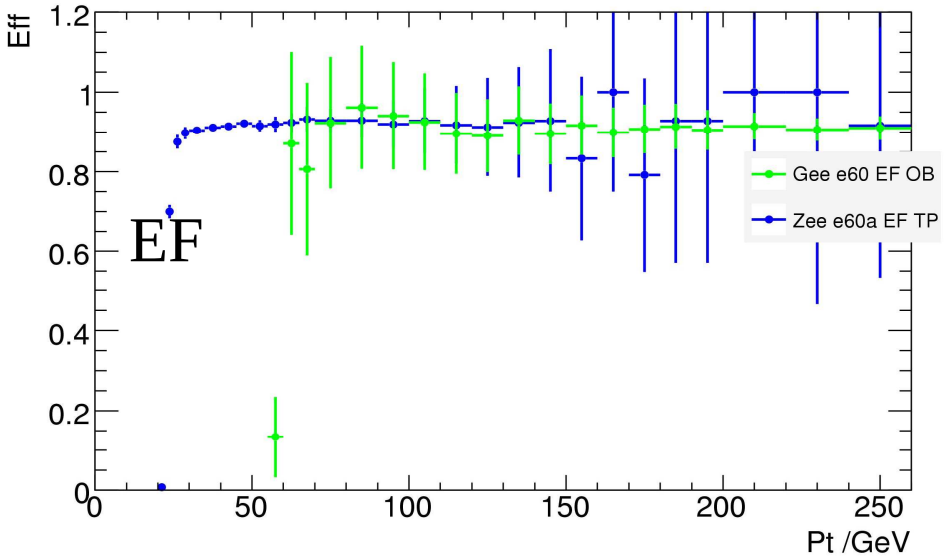
Z -> ee Tag and Probe new triggers comparisons to G -> ee Object

•Existing triggers not ideal for extrapolation to high Pt.
•Try and define a new trigger that makes use of Z->ee statistics (without isolation).
•Use to extrapolate correct efficiency plateau seen in high Pt MC method.



•G->ee e60 (Object) -> Z->ee e25 (Tag and Probe) EF

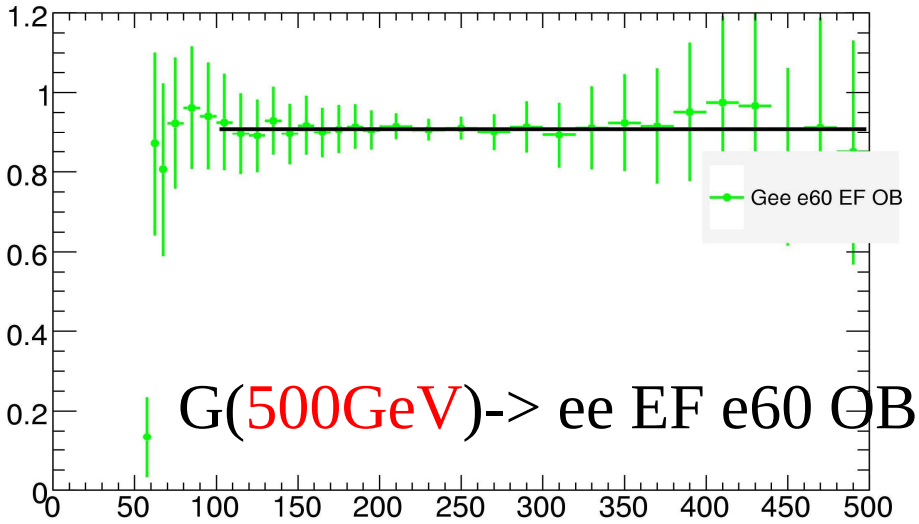
•e25 = e25i without L1 isolation.
•Aim; to remove downward trend due to isolation.

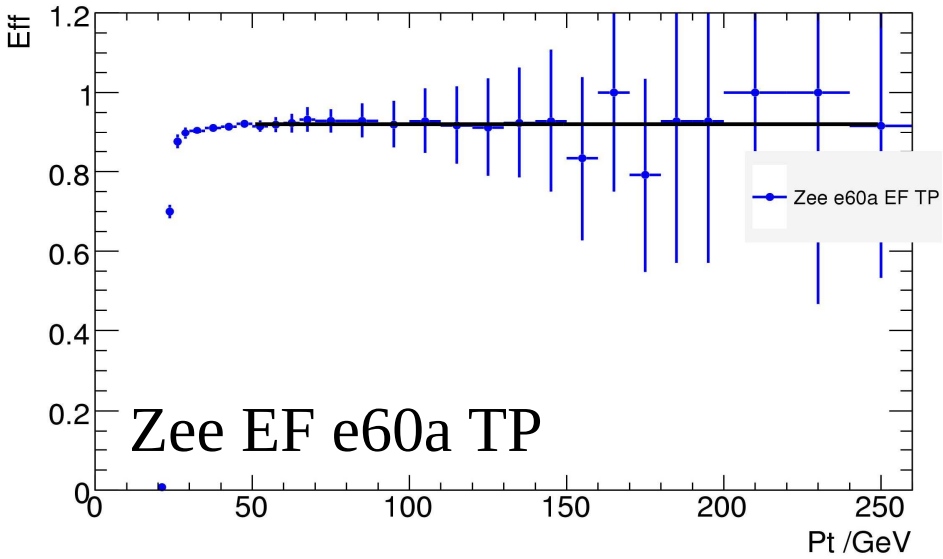


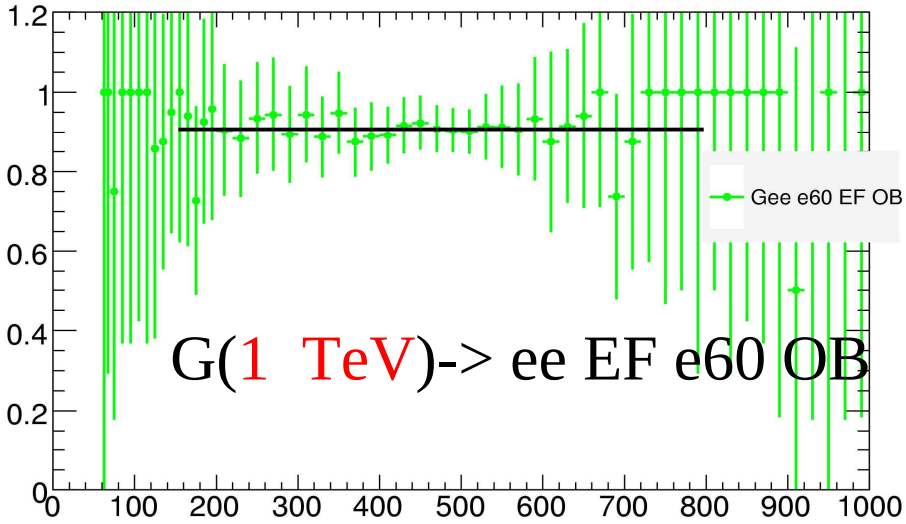
•G->ee e60 (Object) -> Z->ee e60a (Tag and Probe) EF

•e60a = e60 with lowered threshold cut but same shower shape variables.
= e25 with different shower shapes

Comparisons of Parameterizations







G(500GeV)->ee (EF) Eff = 0.91 +/- 0.01
G(1TeV)->ee (EF) Eff = 0.91 +/- 0.02
Z->ee e60a (EF) Eff = 0.92 +/- 0.01
Z->ee e25 (EF) Eff = 0.93 +/- 0.01

•Tag and probe with new triggers give good estimates of G->ee trigger efficiencies.

Conclusions and outlook

•Very good agreement seen between Tag and Probe and Object methods.

•Parameterizations based on Z->ee TP method shows good agreement with G(500GeV, 1TeV) ->ee OB methods.

•TP is a valid method for extrapolation trigger efficiencies to high Pt.
- •Could be used on early data to understand our detector.

•Further work;
- •Reimplement in v13
- •Extend to other samples, eg SUSY
- •Estimate errors as a function of luminosity

Backup Slides

Tag and Probe e25i flow diagram