Trigger Efficiency measurements from Data

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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.

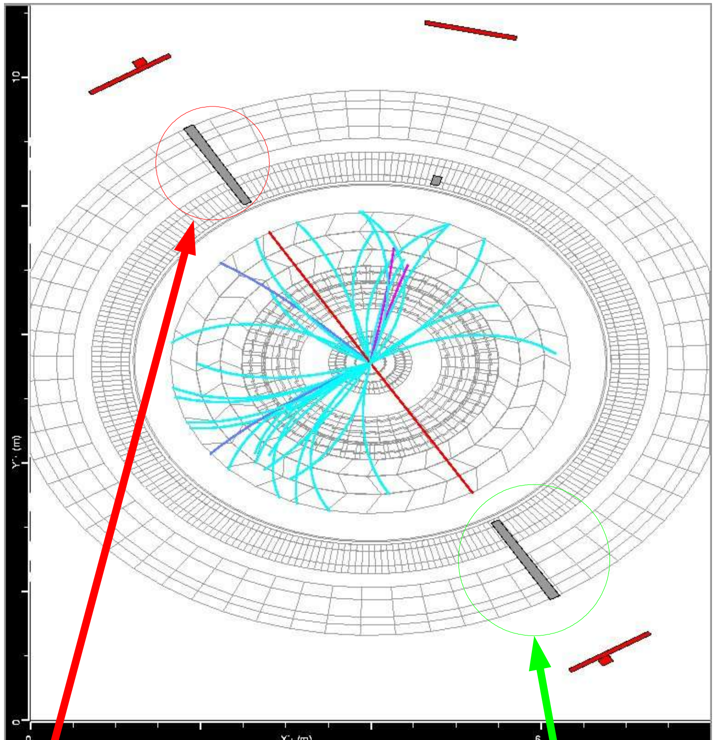
•A good way to do this is to take an benchmark sample that is well understood, (eg Z -> ee) and measure trigger efficiencies in this.

•Aim; To calculate efficiency in the Z->ee sample using data-driven (tag and probe) method, and compare results to those obtain from MC simulation of exotics samples. (eg G(500GeV)->ee).

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 - For high Pt comparisons

The Tag and Probe Method on Z -> ee



Events are selected by requiring a Z mass peak and a good triggered electron (Tag)

Remaining electron (Probe) is used to measure trigger efficiency

- Find an event that gives us a good Z mass peak at Offline level.
  - Event should contain two electrons.
  - 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.
  - Efficiency is given by;

- Efficiency = $P_T^{Reco}(N1) / P_T^{Reco}(N2)$

N1 = Number of Probes passing trigger

N2 = Total number of Probes

Normalisations

- Both MC and Tag and Probe methods must be consistently normalised.
- Electrons are normalised to offline using the official e/gam 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

- Please note that "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.

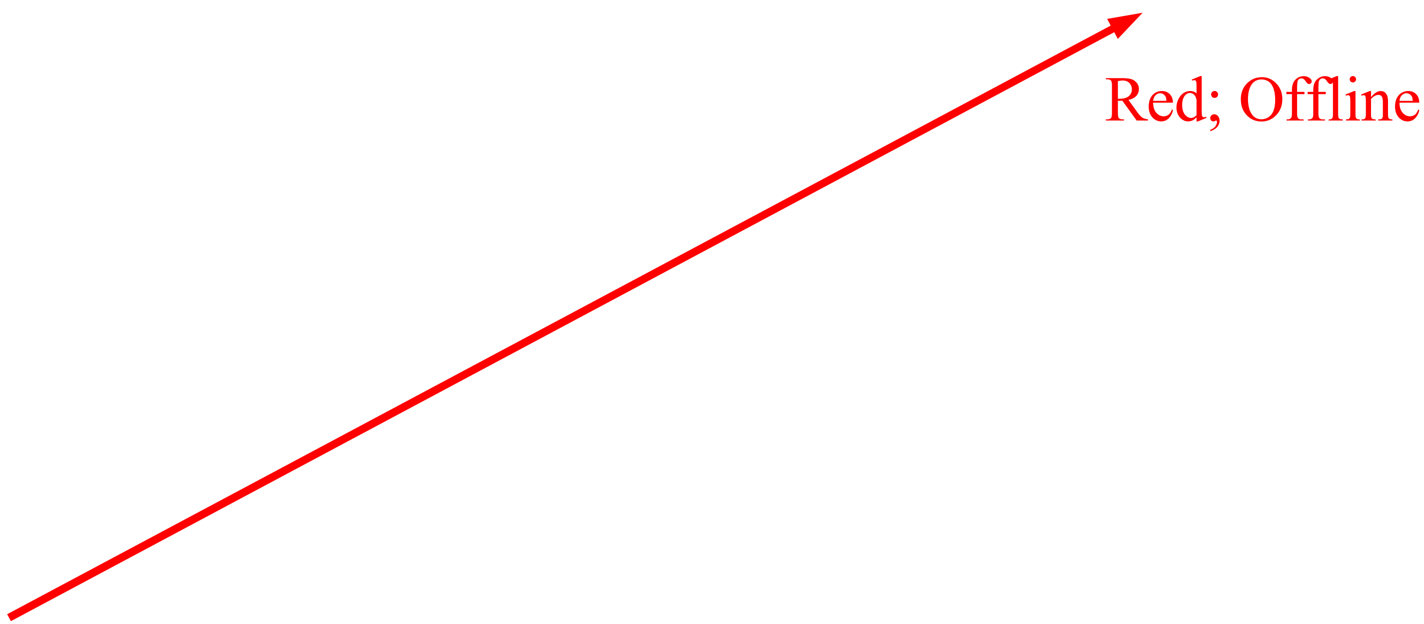
Associating offline objects to trigger objects

•In order to be able 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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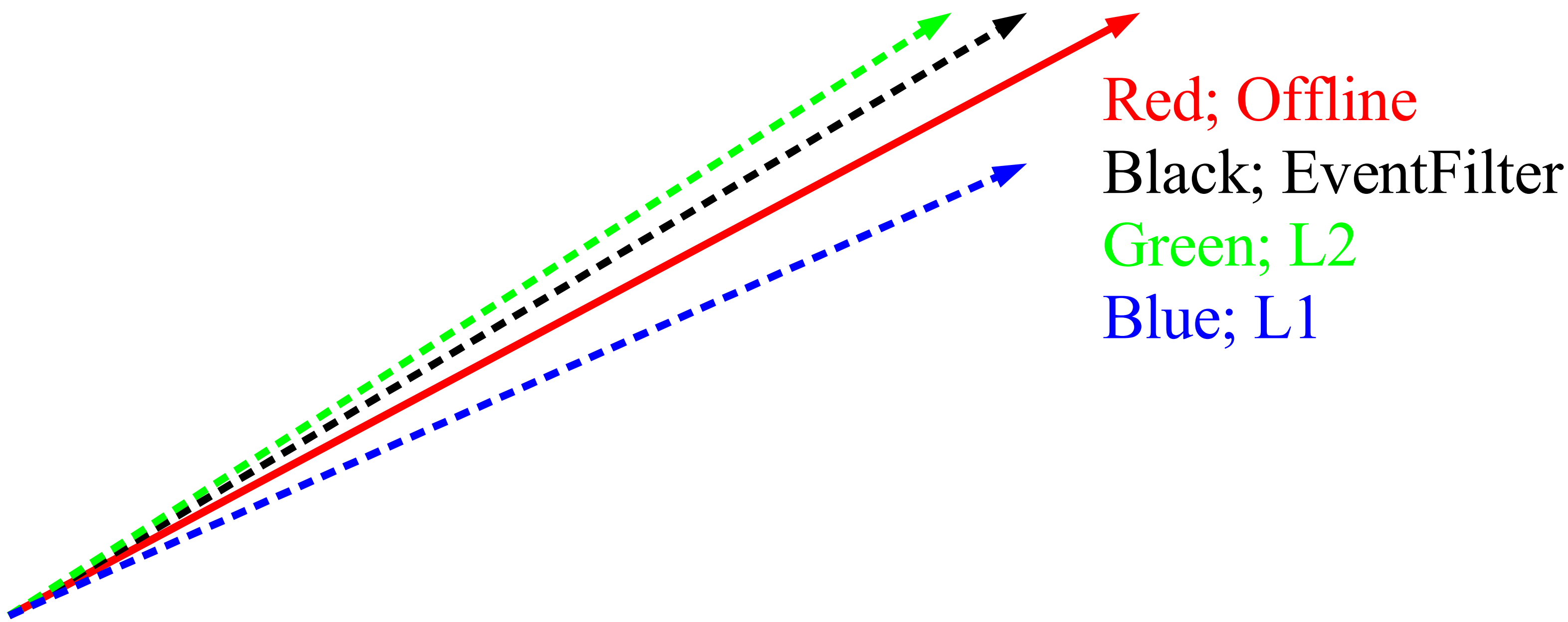

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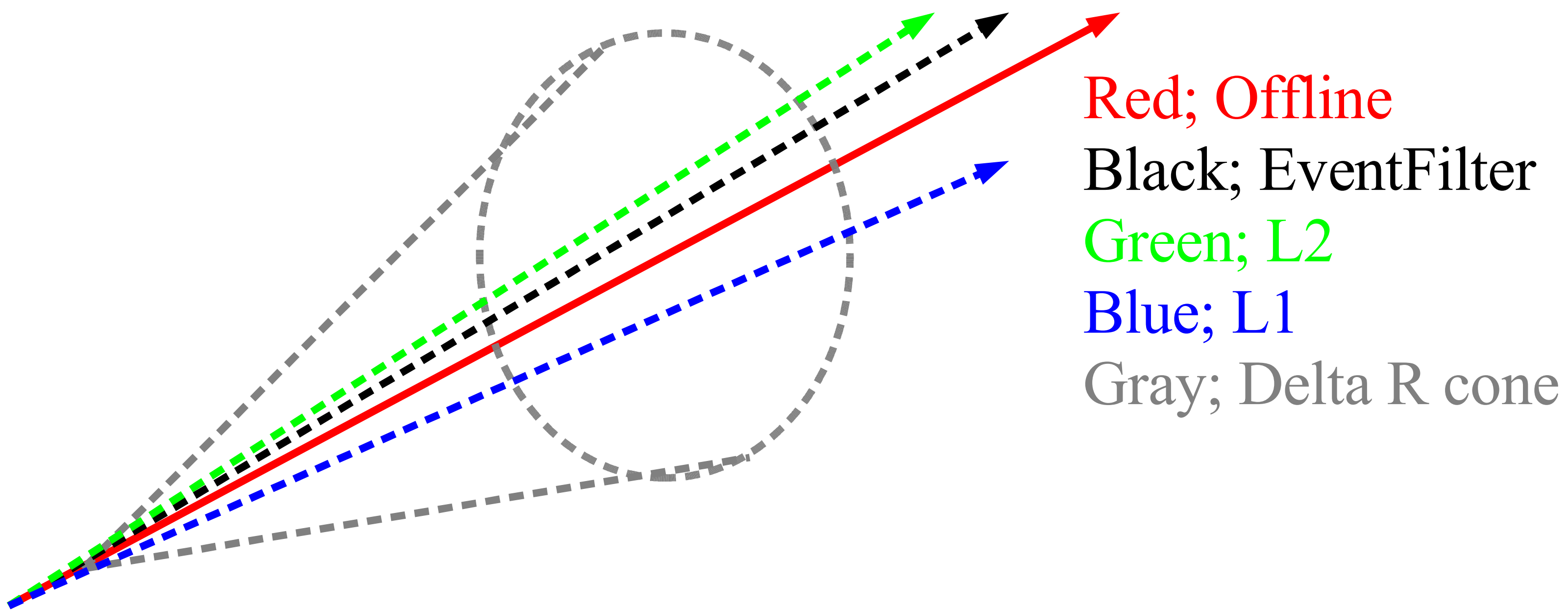
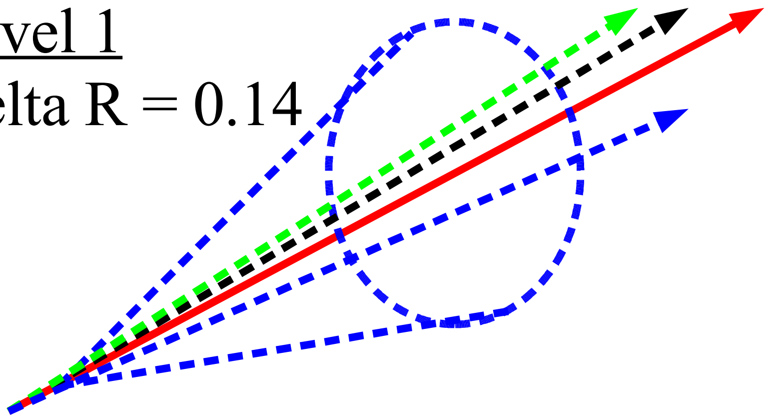


Associating OL objects to trigger objects

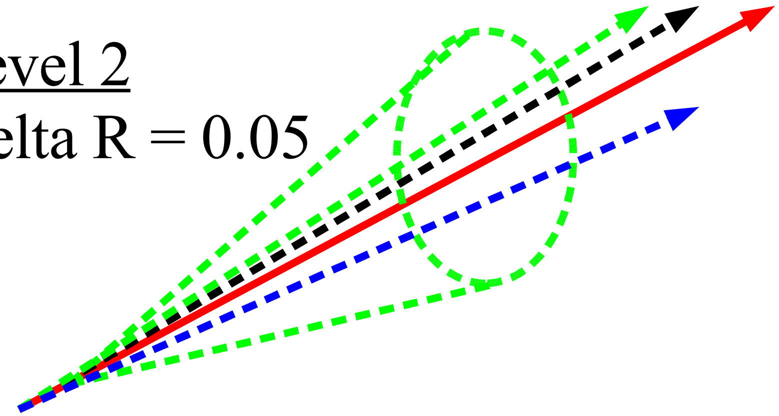
Level 1

Delta R = 0.14



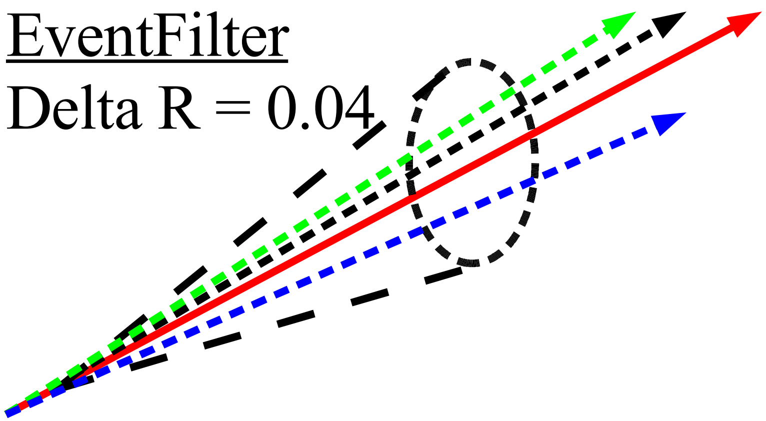
Level 2

Delta R = 0.05

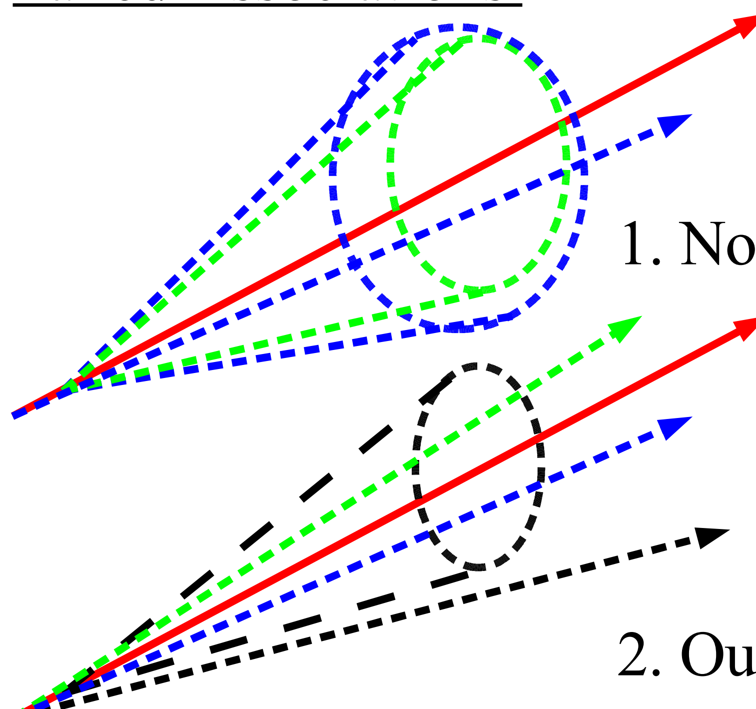


EventFilter

Delta R = 0.04



Failed Associations



1. No Trigger Object

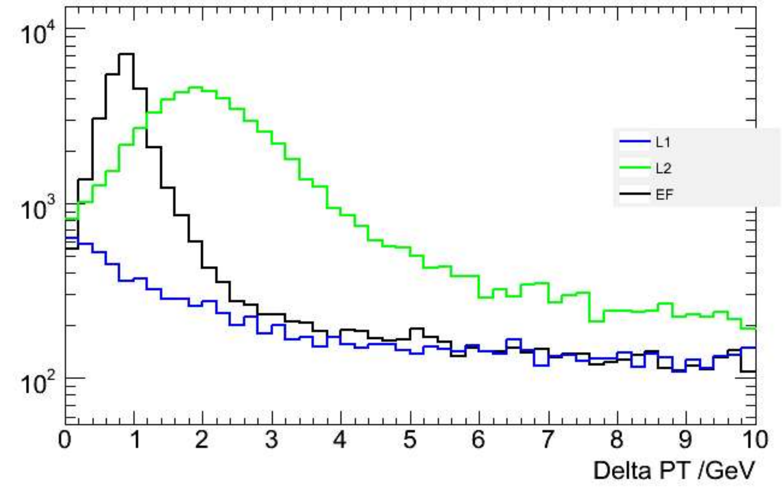
2. Outside delta R

Associating OL objects to trigger objects

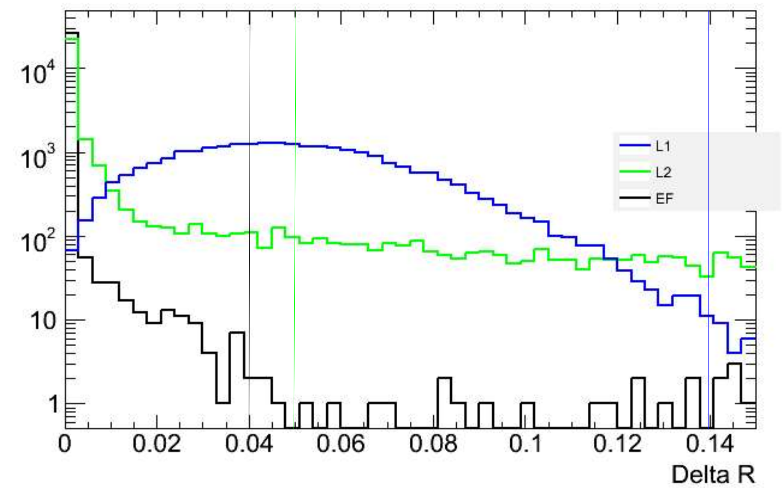
- L1 delta R = 0.14
- L2 delta R = 0.05
- EF delta R = 0.04

not optimised

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



Cut	$Z \to e^+e^-$ 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%



- Why aren't all EF level electrons found at levels 1 and 2, as they should be seeded from L1 and L2?
- Possibly due delta R cone size? L2 electron/photon collection divergence? L2 spacepoint bug?
- Work ongoing.

Efficiency Definitions

•<u>Tag and Probe method;</u>

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

•Efficiency = $P_T^{Reco}(N1) / P_T^{Reco}(N2)$

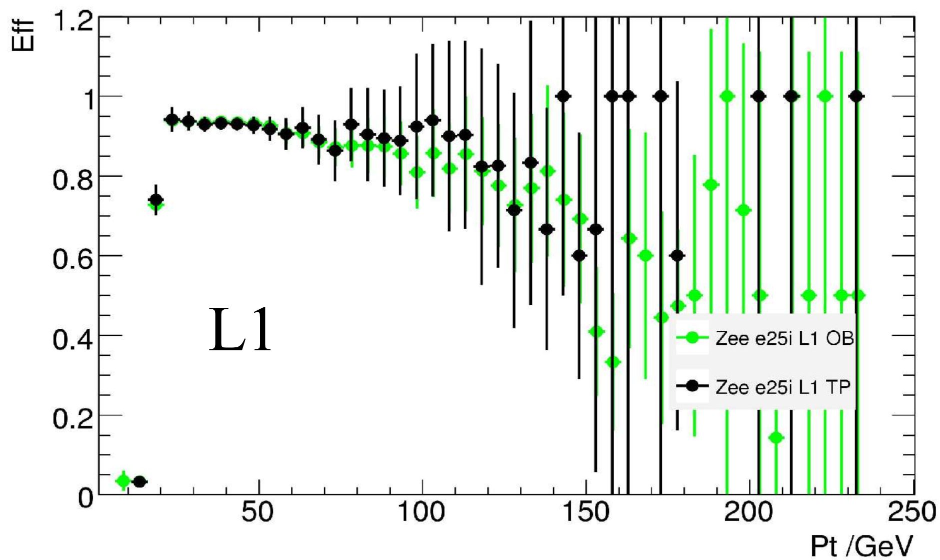
N1 = 2*TagPass = Number of normalised, associated Probes passing trigger.
N2 = 2*TagPass + TagFail = Total number of normalised, associated Probes.

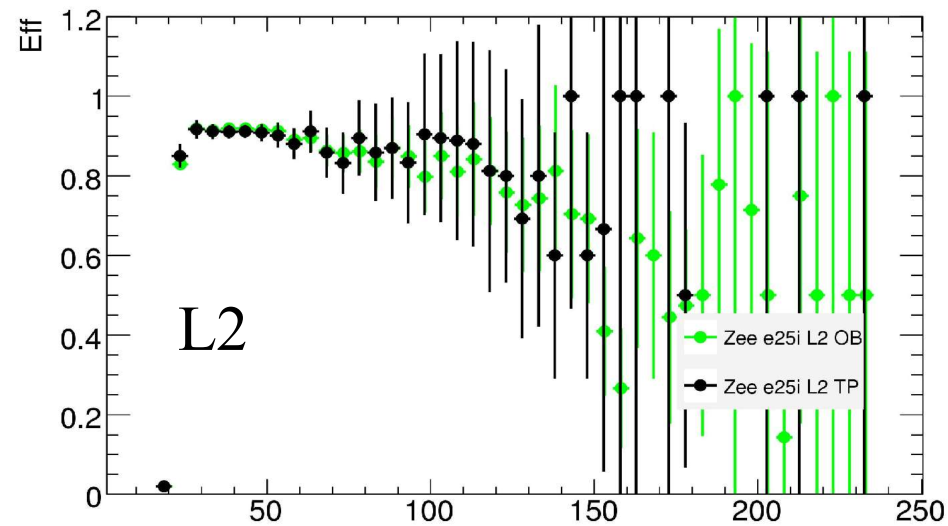
•MCTruth based object method

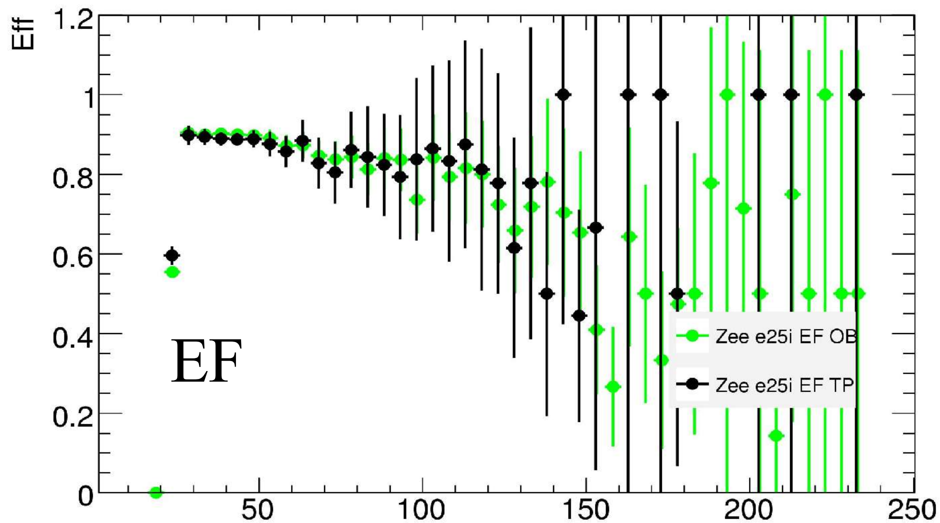
•Efficiency = $P_T^{Reco}(N3) / P_T^{Reco}(N4)$

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

Tag and Probe to Object Method comparisons (e25i)





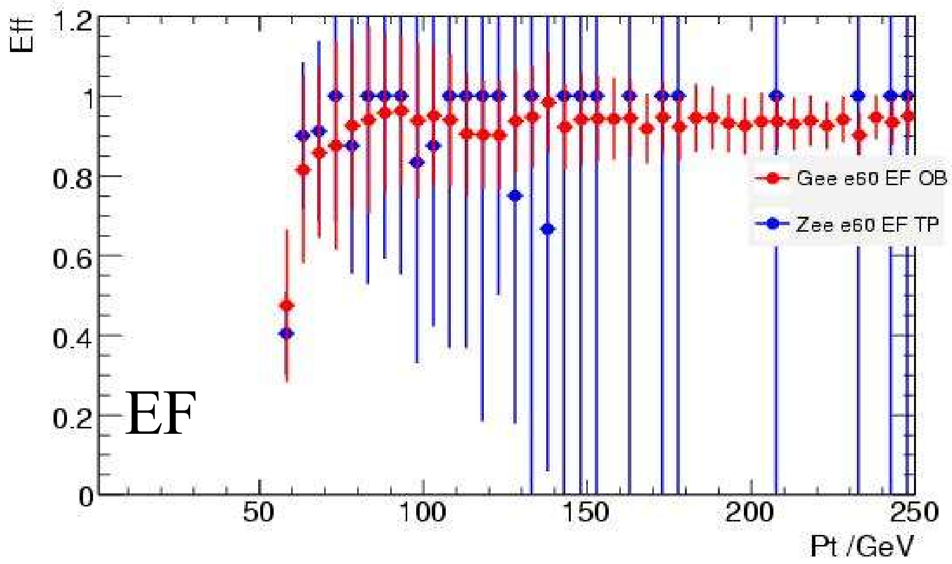


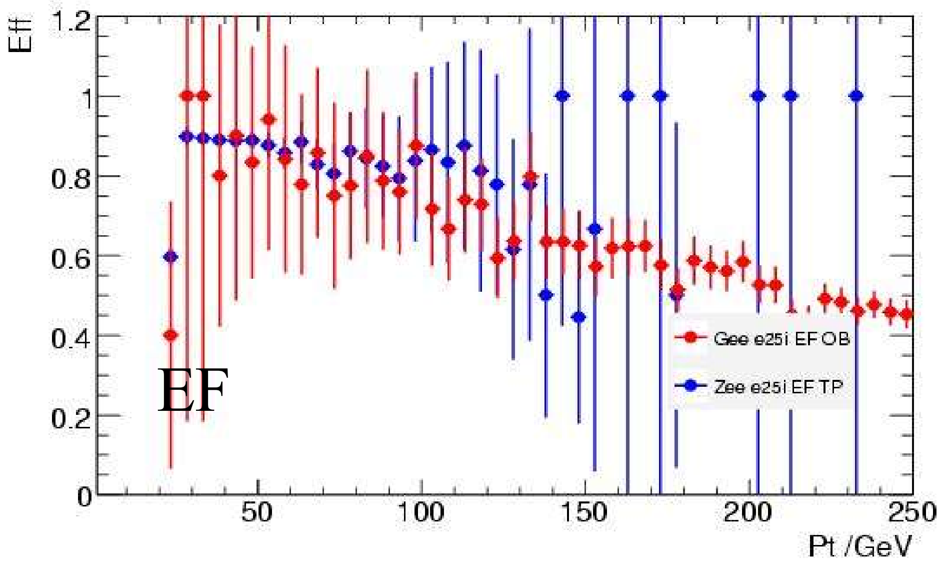
Offline Pt /GeV

- Black – Tag and Probe
- Green – Object (MCTruth)

- Good agreement at all trigger levels.
- Decrease at high Pt due to L1 isolation.
- Limited by low statistics at high Pt.
- 100k events used /470k events available.

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

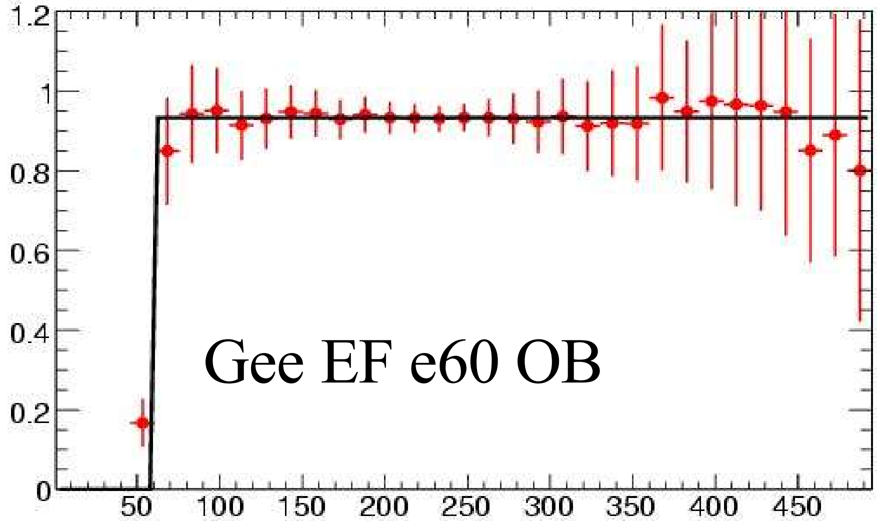


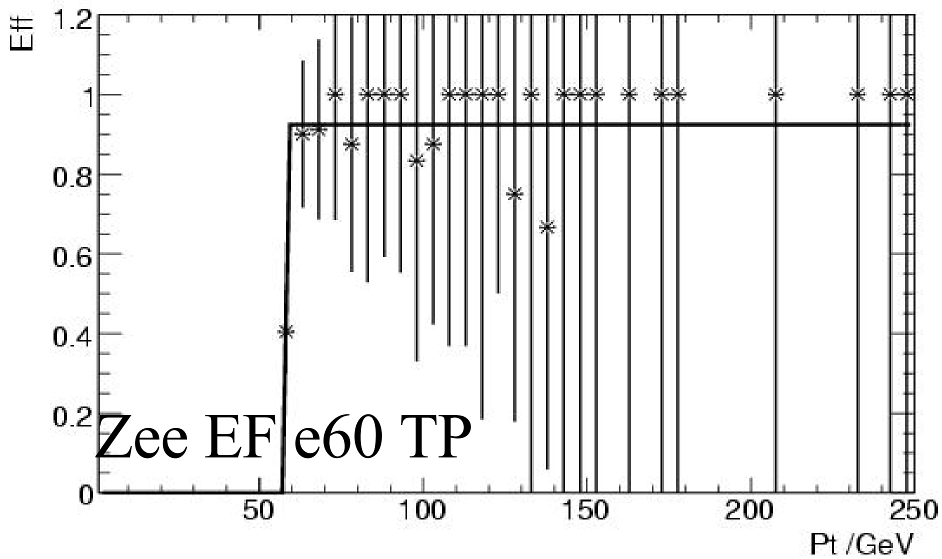


- G->ee e60 (Object) -> Z->ee e60 (Tag and Probe) EF
- Gee Object looks to be underestimating Zee TP.
- Needs full statistics.

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

Parameterizations





- Turn on curves fitted with function;

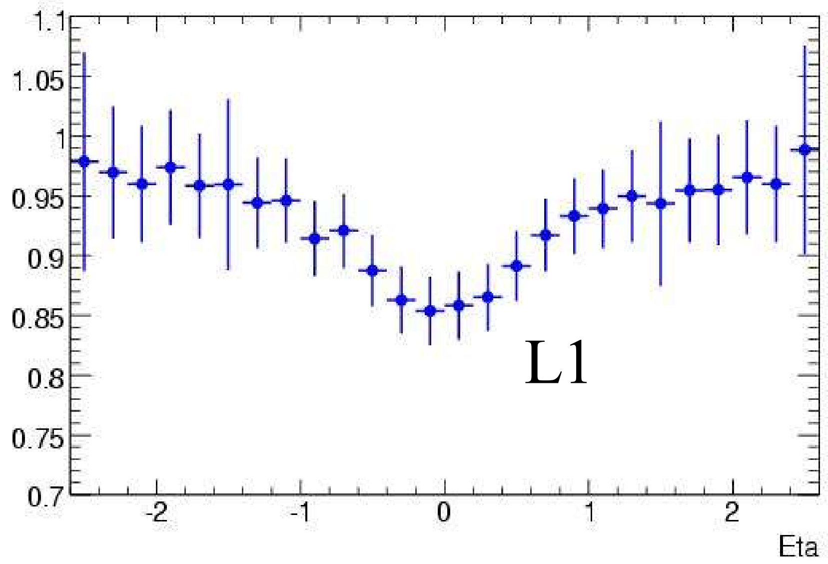
$$f(p_T) = 0.5 \cdot A_2 \cdot (1.0 + erf(\frac{p_T - A_0}{\sqrt{2} \cdot A_1}))$$

- A0 =The Pt value where efficiency reaches half its maximum.
- A1 =The slope of the turn on curve
- A2 =The maximum efficiency in the plateau region
- erf = the error function

G->ee e60 EF A2 = 0.93 +/- 0.01
Z->ee e60 EF A2 = 0.92 +/- 0.09

- This fitting function may lead to underestimation of the plateau region.
- Straight line fit above threshold may be better.

Aside; Notable Trigger Features

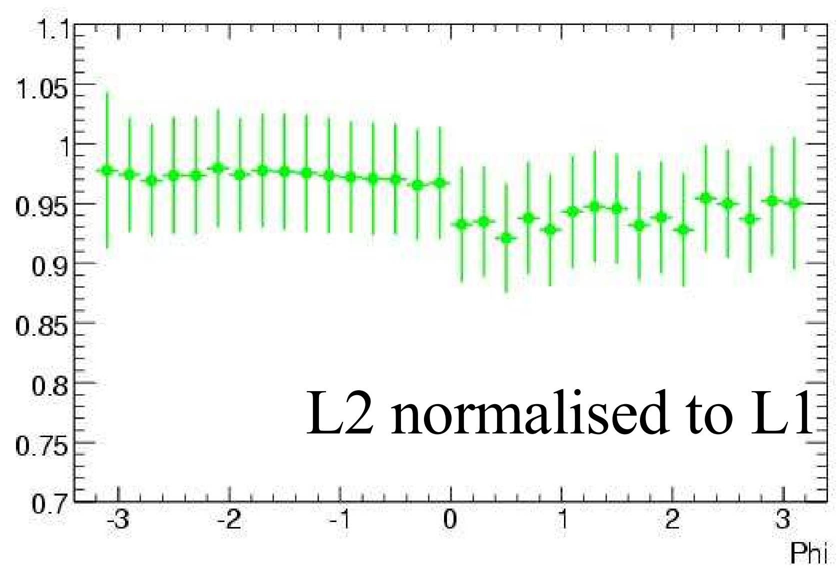


•Seen in both tag and probe and object methods.
•L1 inefficiency in the barrel. Previously seen by M.Flowerdew et al; http://indico.cern.ch/getFile.py/access?conti
•Hadronic Isolation problem.

•Seen in both tag and probe and object methods.

•L2 Phi asymmetry.

•Needs further investigation.



Conclusions and outlook

- Good agreement seen between Tag and Probe and Object methods.

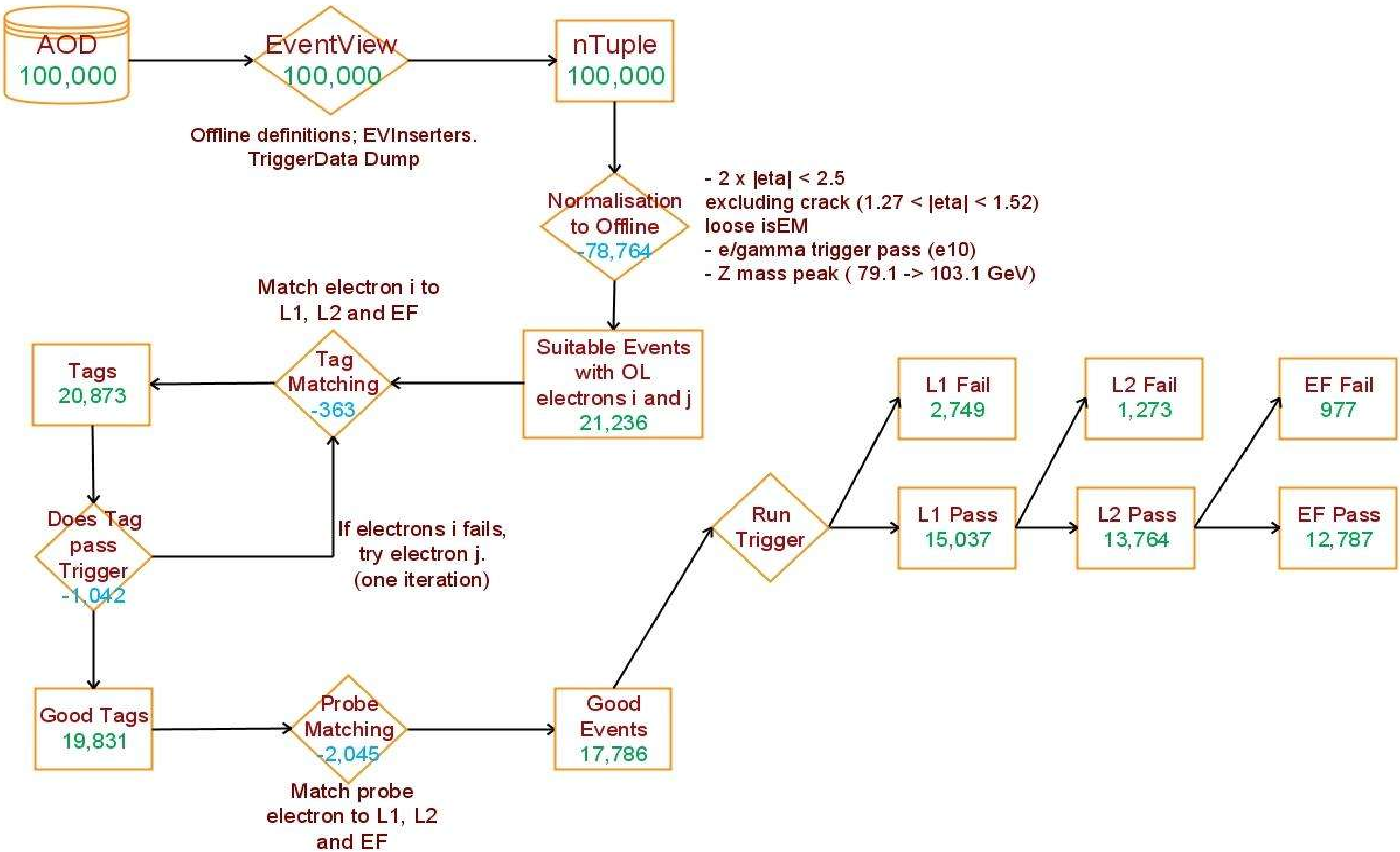
- Parameterizations based on current data for Z->ee Tag and Probe methods (for non isolated triggers) agree with results predicted in G(500GeV) ->ee methods.

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

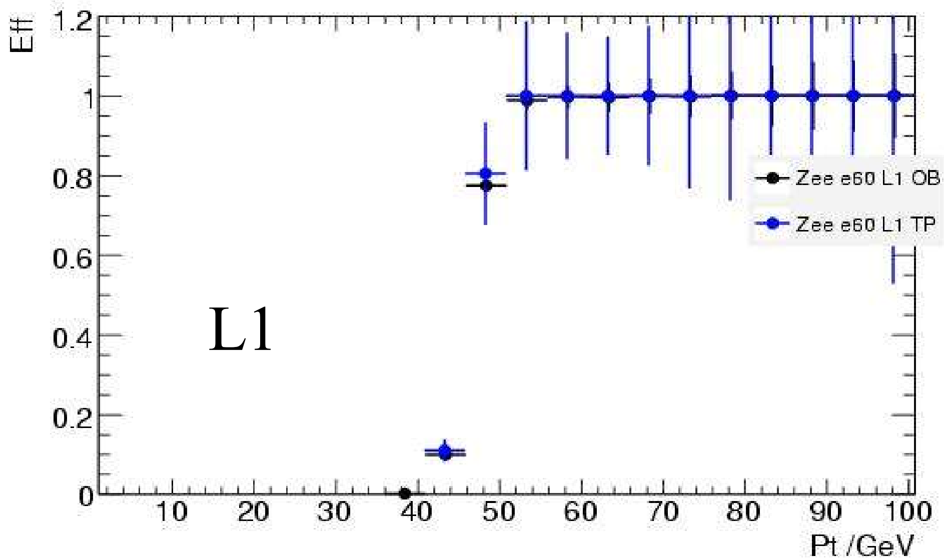
- Further work;
    - Repeat with full Z-> ee statistics.
    - Understand association inefficiencies.
    - Investigate better parameterisations. (Straight line fit above threshold)
    - Investigate angular dependencies.
    - Backgrounds.

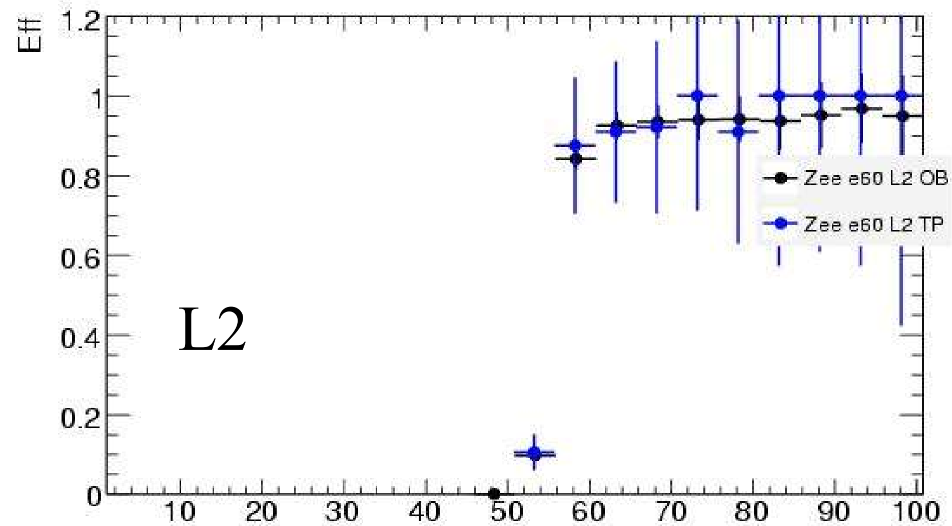
Backup Slides

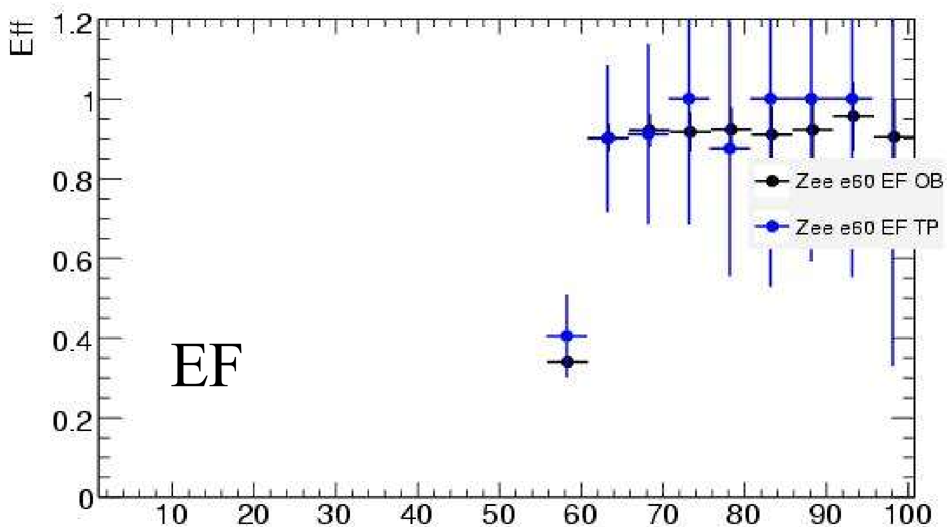
Tag and Probe e25i flow diagram



Tag and Probe to Object Method comparisons (e60)







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