Electron trigger efficiency with $Z \rightarrow e^+e^-$

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DESY

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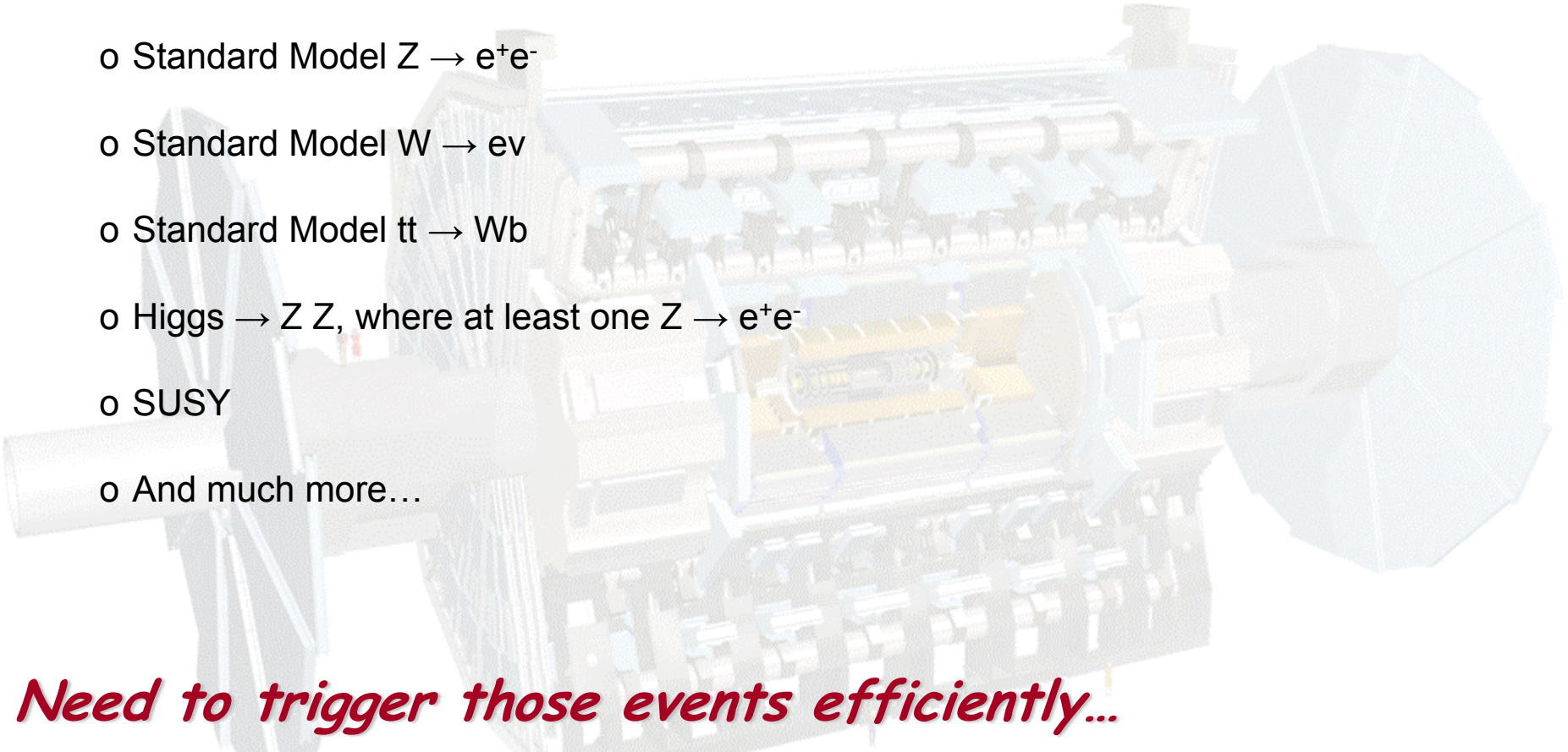
Outline:

- Motivation and Introduction
- Selection
- Results
- Outlook

Motivation

Low energy electrons are interesting for many purposes:

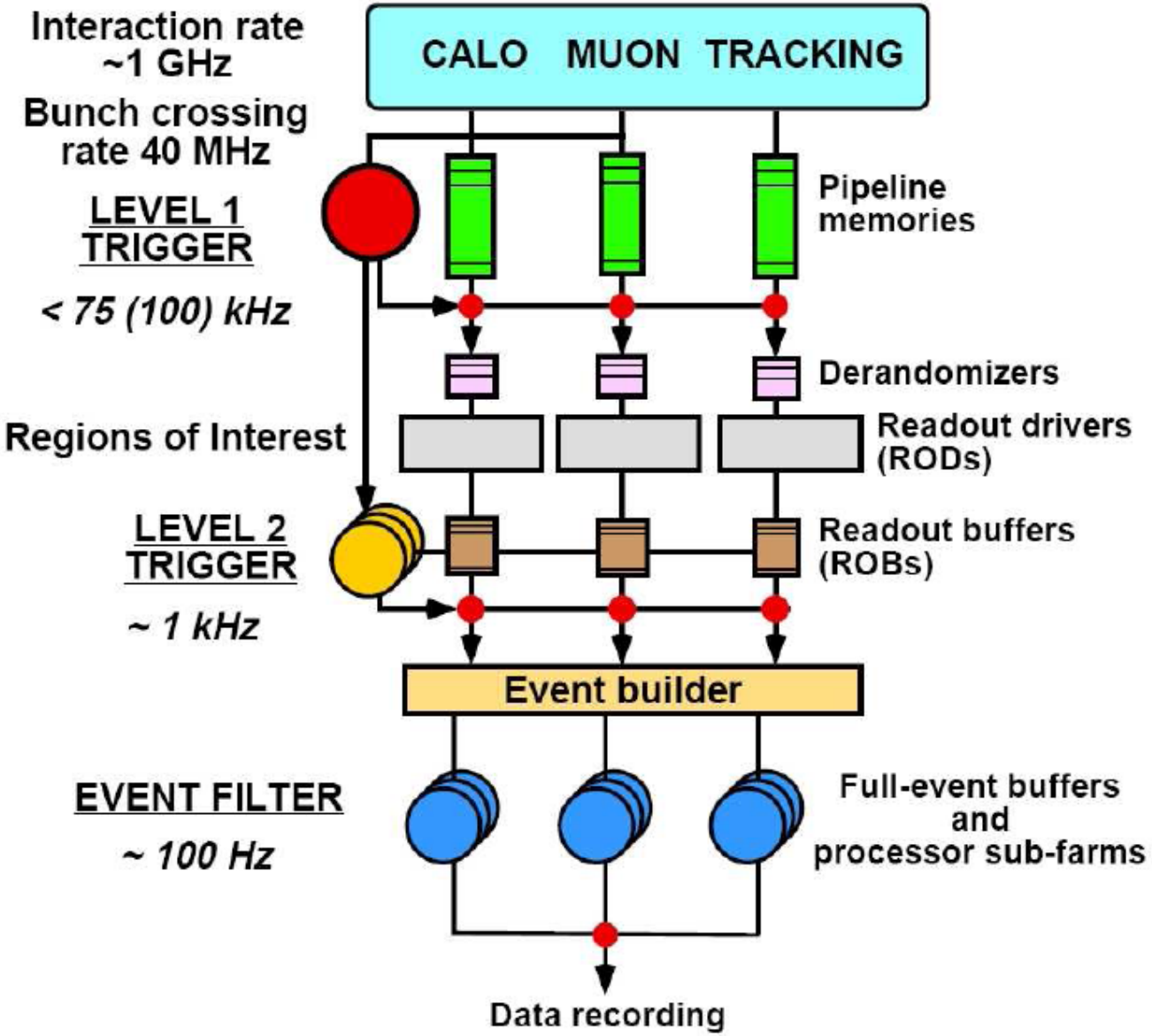
- Standard Model $Z \rightarrow e^+e^-$
- Standard Model $W \rightarrow ev$
- Standard Model $tt \rightarrow Wb$
- Higgs $\rightarrow Z\,Z$, where at least one $Z \rightarrow e^+e^-$
- SUSY
- And much more…



Need to trigger those events efficiently…

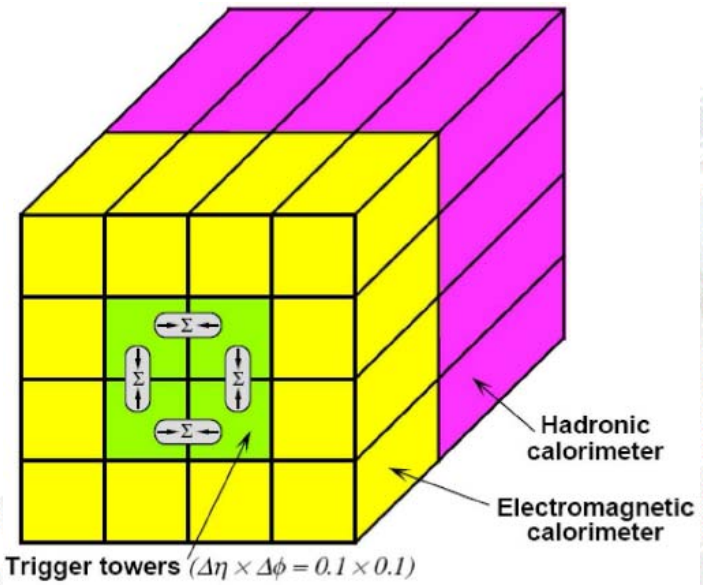
AND DETERMINE THIS EFFICIENCY FROM DATA!!!

The ATLAS Trigger



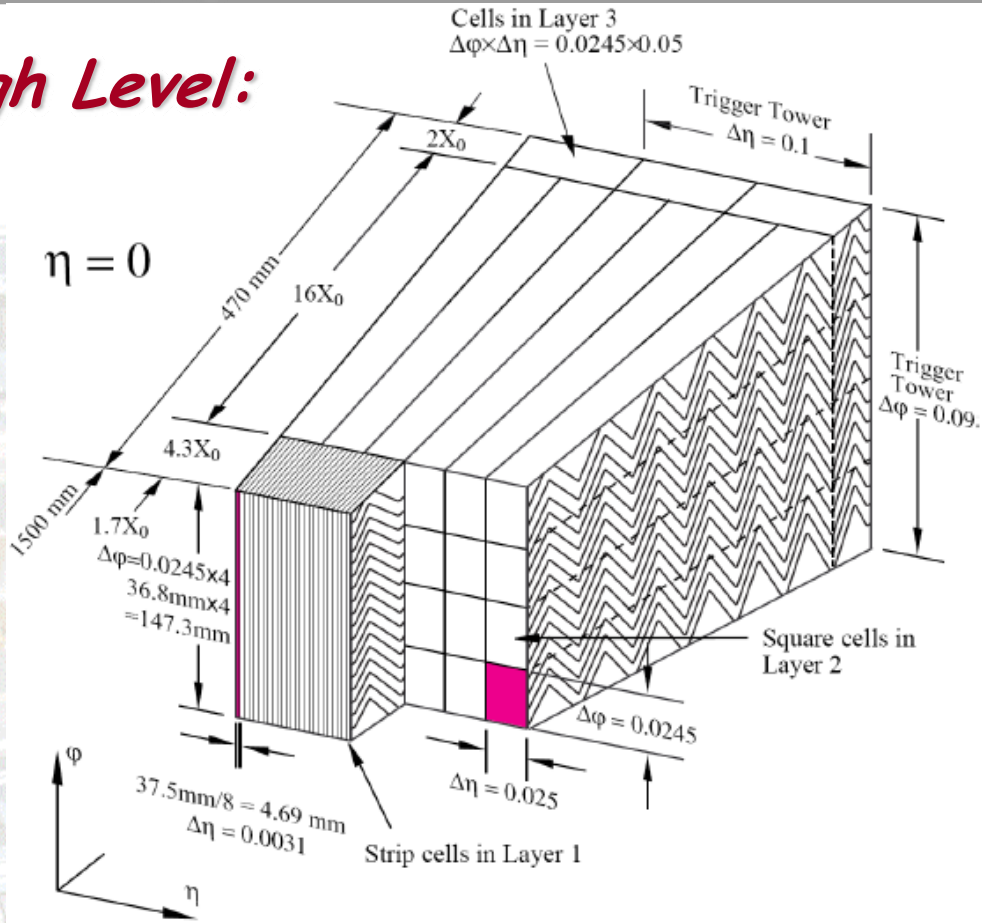
The Electromagnetic Trigger

Level 1:



- Coarse scan for local E maxima.
- EM ring isolation.
- Hadronic ring+core isolation.

High Level:



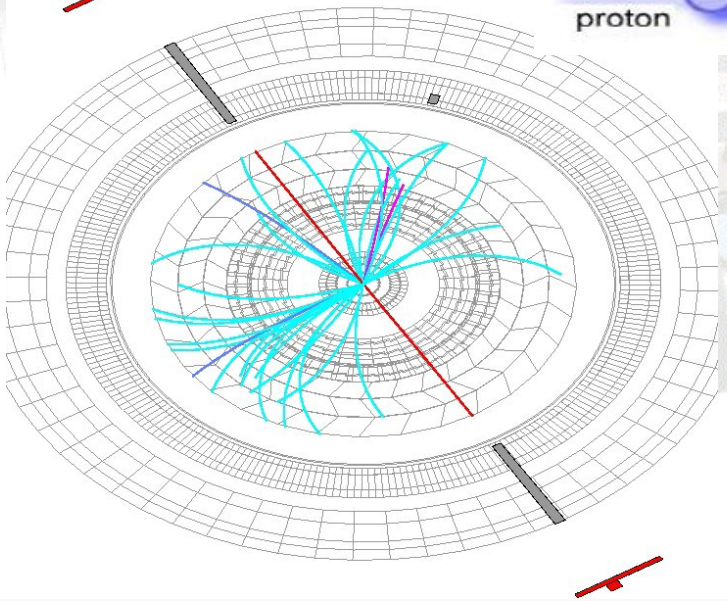
- Full granularity determination of energy.
- Hadronic isolation.
- Shower shapes in first and second sampling.
- Cluster-track matching.

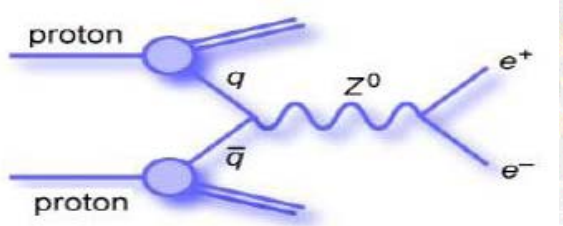
Introduction to the Tag&Probe method

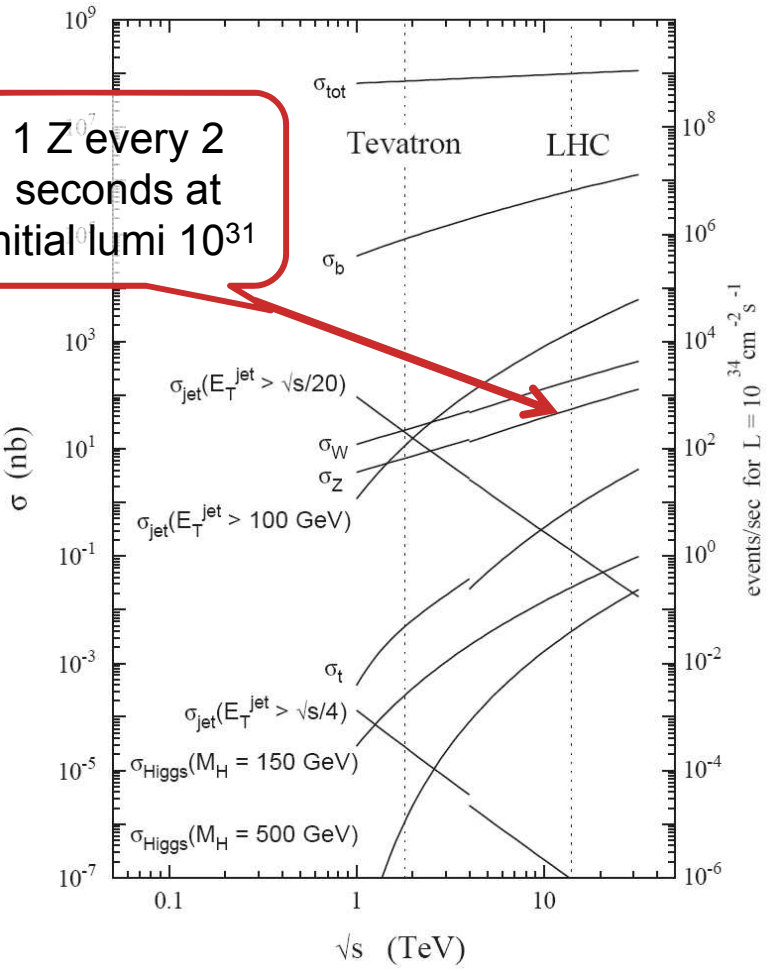
To use real data, you need:

- A clean sample of events where you know you have an electron.
- A large sample of these events.
- Obvious choice: $Z \rightarrow e^+e^-$

Tag&Probe:







- Reconstruct offline $Z \rightarrow e^+e^-$ good events.
- Require that one electron passed all three trigger levels.
- Check if the other electron passes the three triggers…

Offline event selection

Selection:

- Use official cut-based offline electron identification for both electrons: IsEM TIGHT

  Individual jet –rejection factor ~10^5!

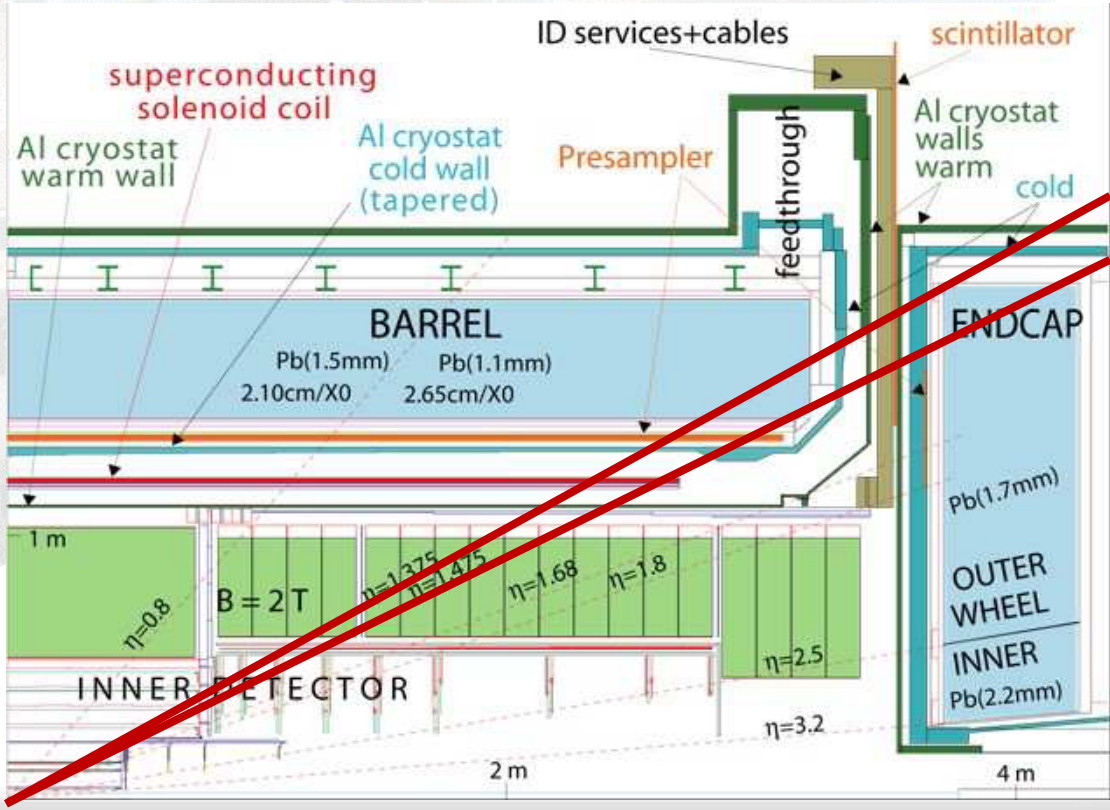
- Remove crack region in the EM calorimeter: offline |eta| < 1.37 || 1.52 < |eta| < 2.4.

- Electron p_T > 15 GeV.

- Z reconstruction e^+e^- invariant mass:

  70 GeV < M_{ee} < 110 GeV

- Tag electron passes all three trigger levels.



Goal and problems

Produce efficiency plot with this method for the performance chapter of the detector paper!

- Requirement to use release 13!!!
  - Very new release with a lot of changes in software/data format.
- The tool to produce these plots in release 12 were not fully available, and are still not (EventView): Write own tools from scratch…

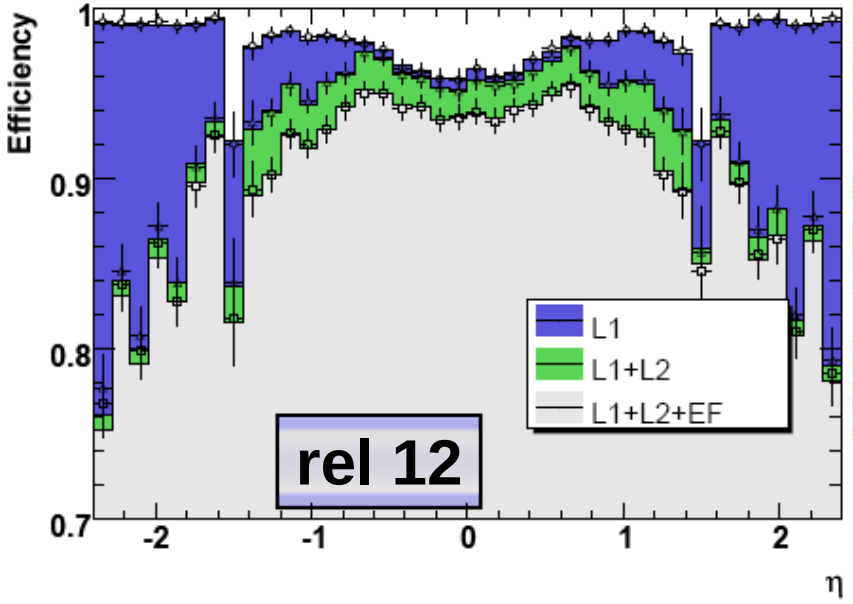
Check the standard isolated single electron trigger e25i:

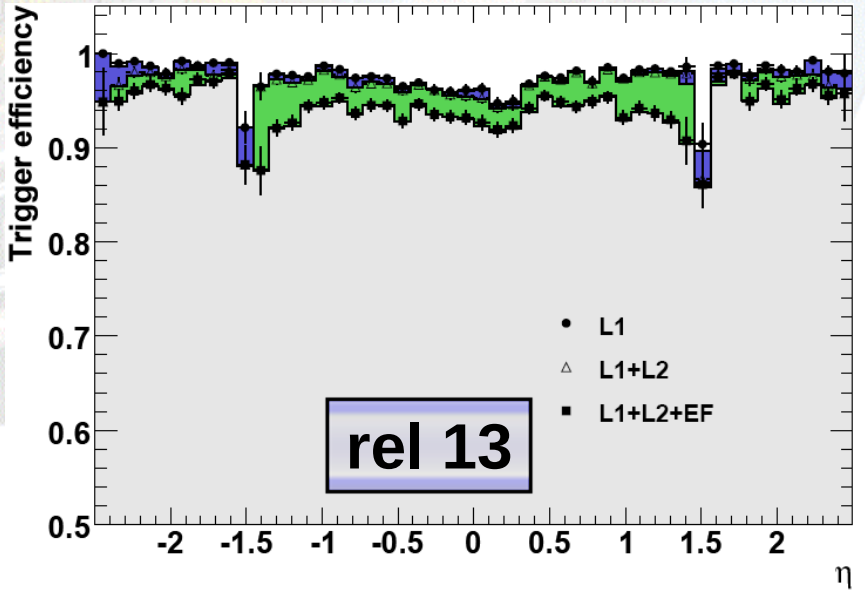
- Intended for running at nominal luminosity of 10^{33}.
- Isolation requirements against hadronic activity and surrounding EM activity.
- Compare Tag&Probe with Monte Carlo Truth efficiencies.

First Check: *Compare with release 12*

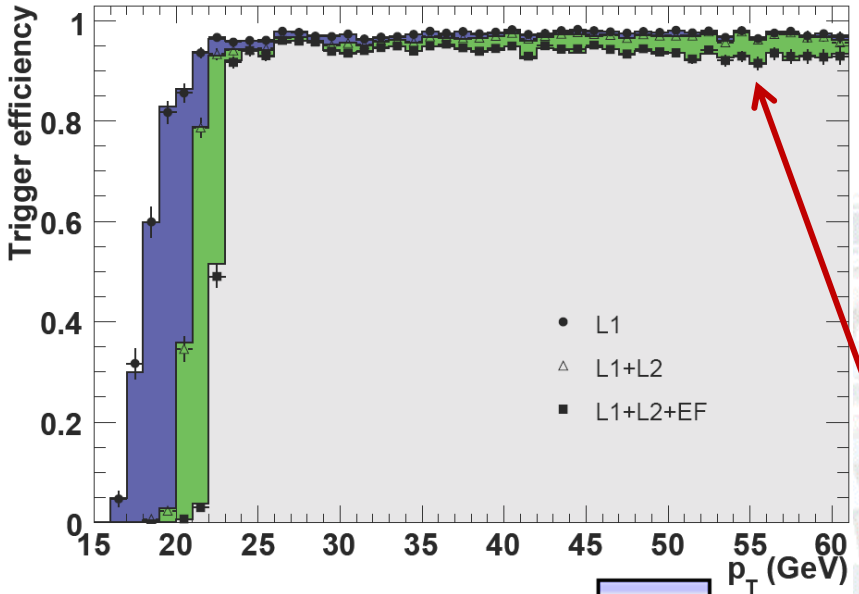
There was a bug in the encap tracking at Level 2:

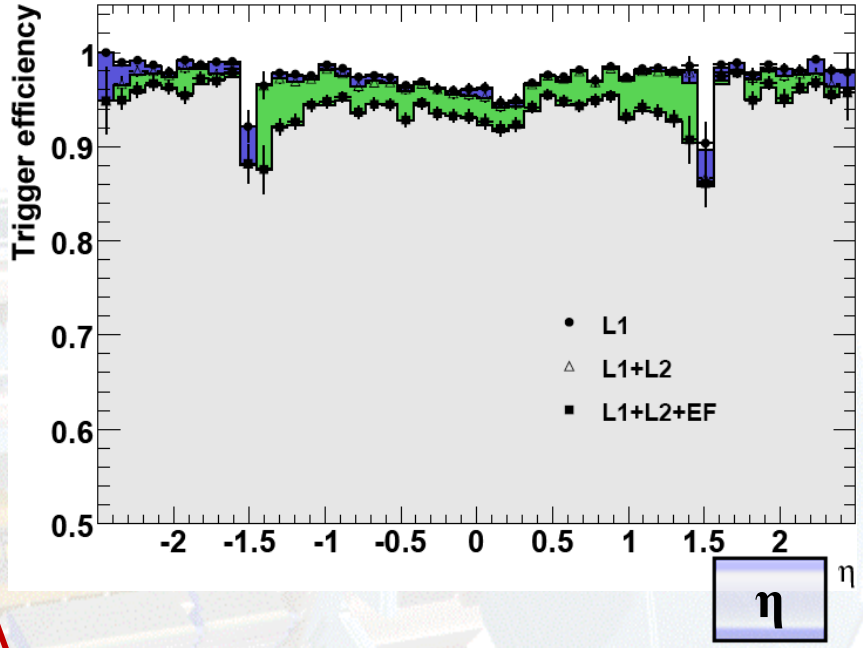
- Known as the “space point bug”.
- This bug was fixed in release 13.
- No efficiency problem any more in the endcaps in release 13!!!





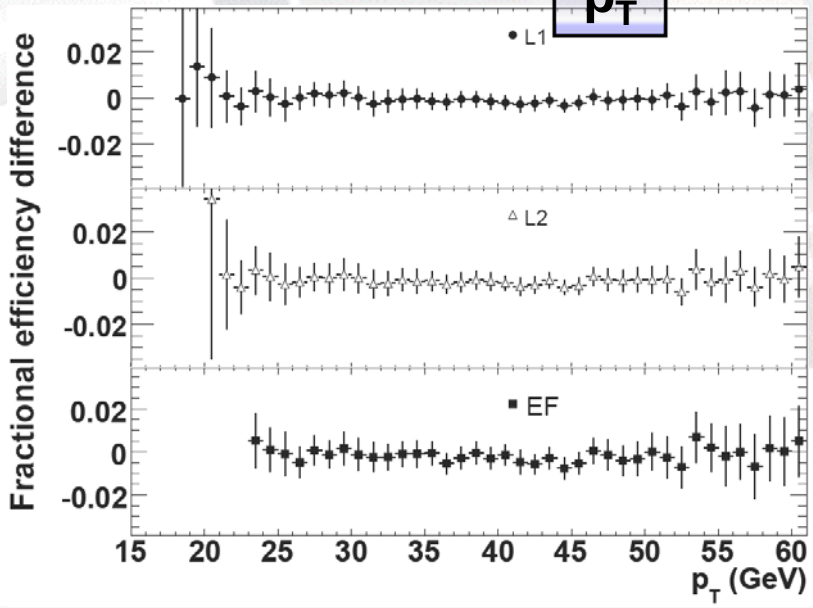
Resulting efficiency plots: Detector Paper!





p_T

η



Spotted problem:

- Event Filter efficiency drops of at high p_T!

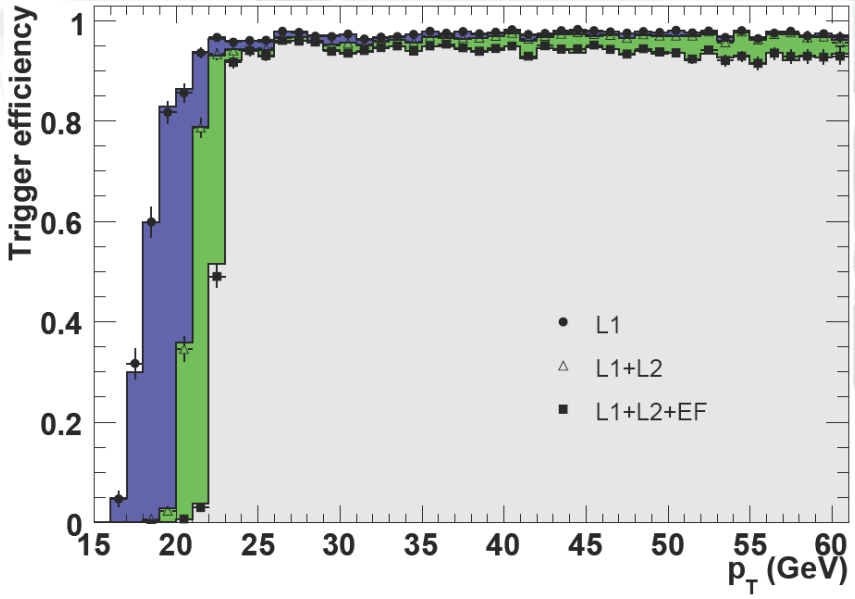
$$\frac{\text{Efficiency(Tag\&Probe)} - \text{Efficiency(Truth)}}{\text{Efficiency(Truth)}}$$

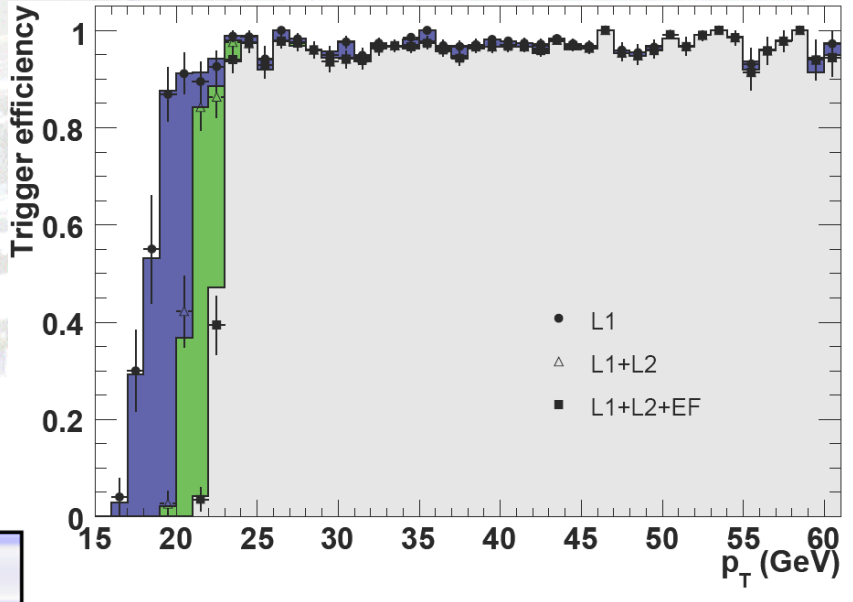
Resulting efficiency plots

Check the Event Filter cuts:

- The cut on the ratio of the transverse energy as measured by the calorimeter to the transverse momentum as measured by the tracking produces this effect!
- Bremsstrahlung…

Remove E_T/p_T cut:





p_T

There are now more trigger items

For the 10^{31} luminosity running:

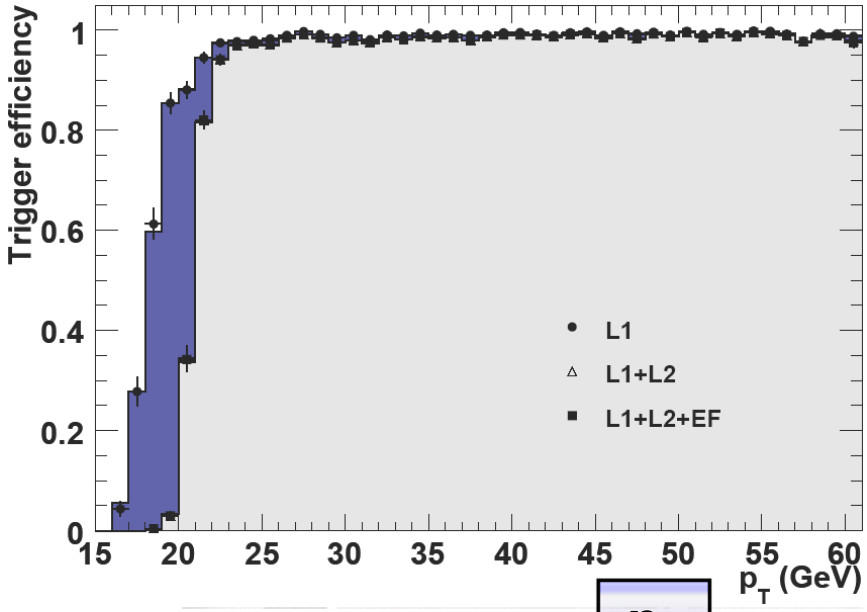
- e20: Rather low threshold without a Level 1 isolation requirement.

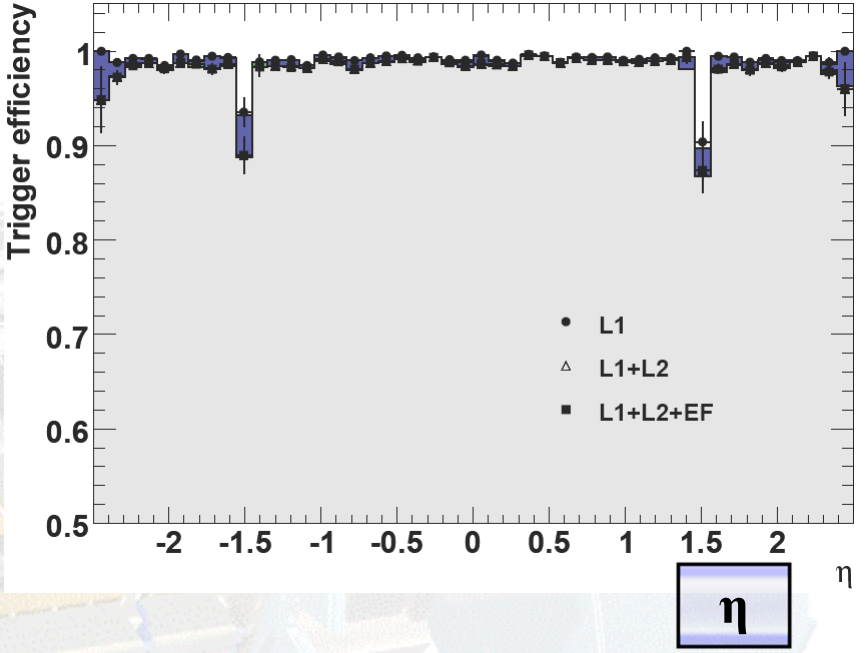
For the 10^{33} luminosity running:

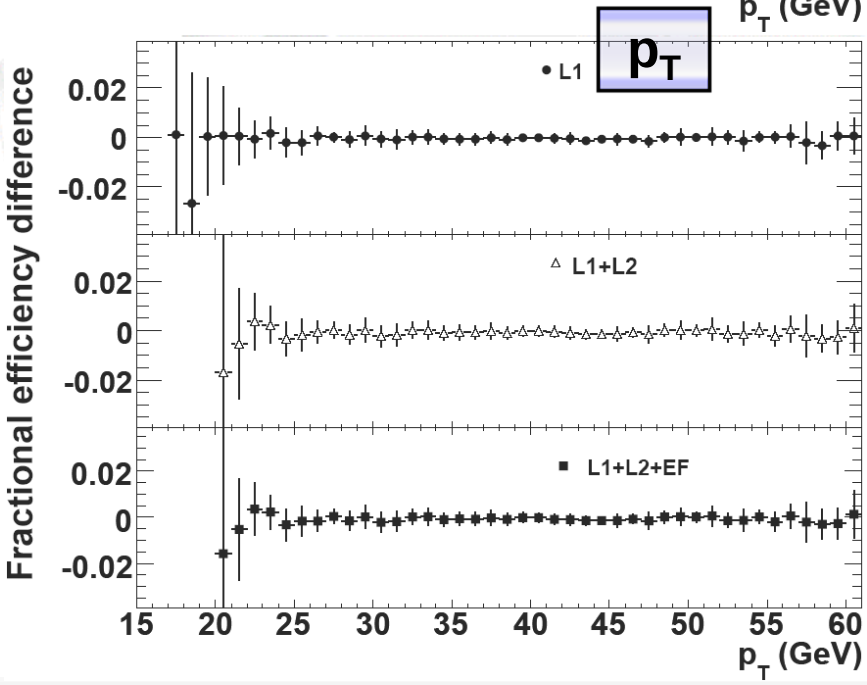
- e22i: A newly optimized isolated single electron trigger intended to replace e25i.

We took a first look at those as well…

e20 trigger item

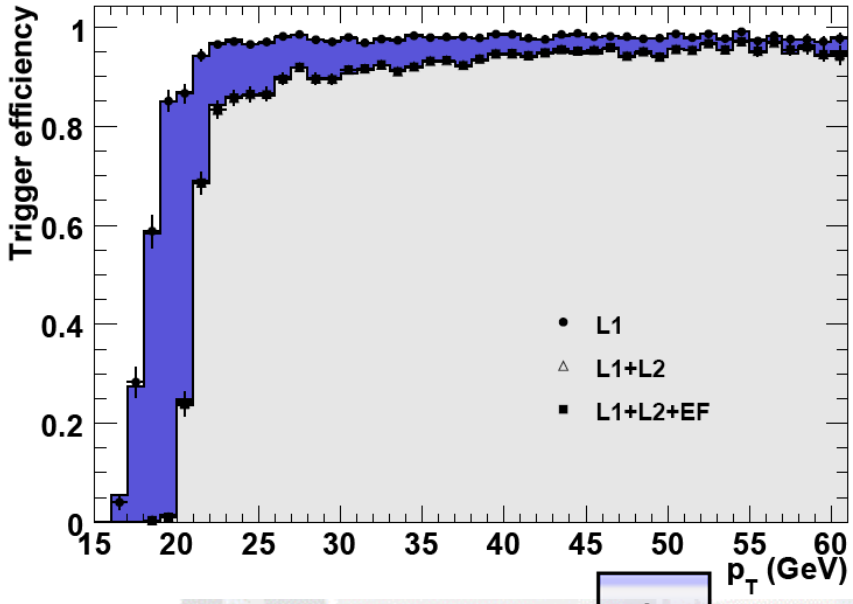


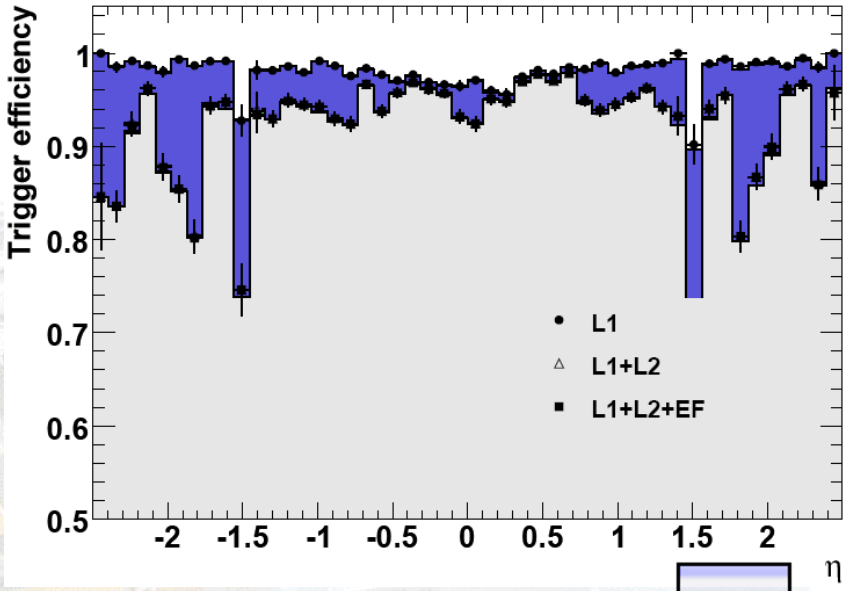




- Very high plateau efficiency!
- No problems spotted…
- Excellent agreement between Tag&Probe and Monte Carlo Truth methodes!

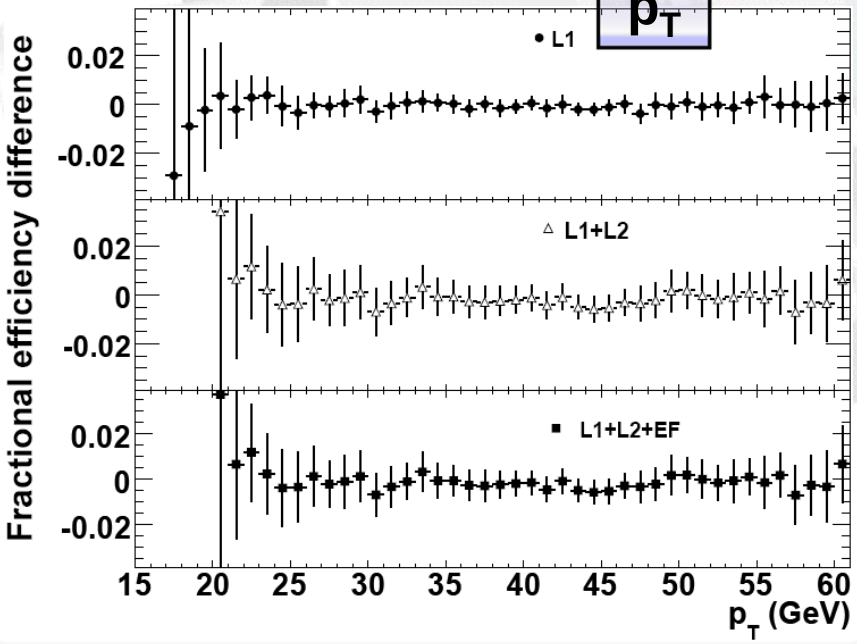
e22i trigger item, tight offline





p_T

η



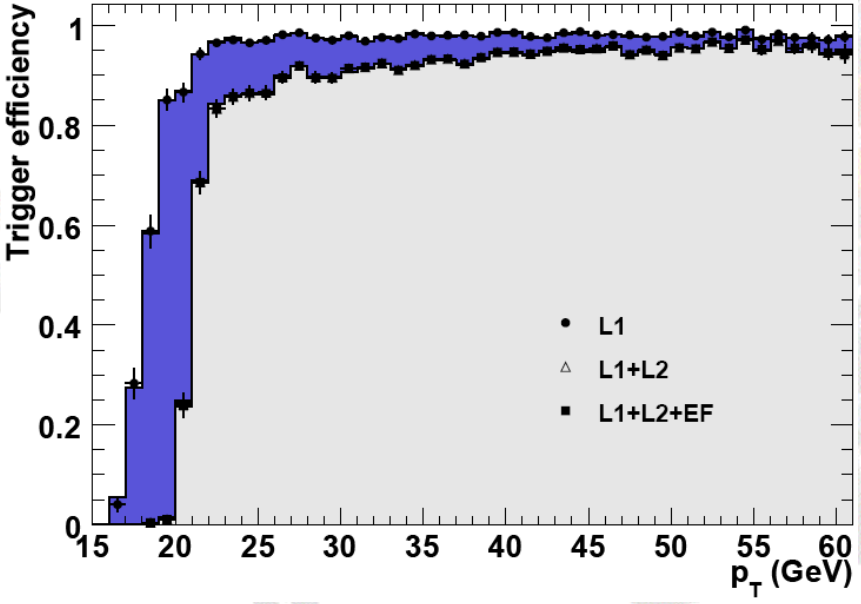
- Very slow rise of level 2 efficiency with p_T!!!
- This is a problem!

e22i modified trigger item, tight offline

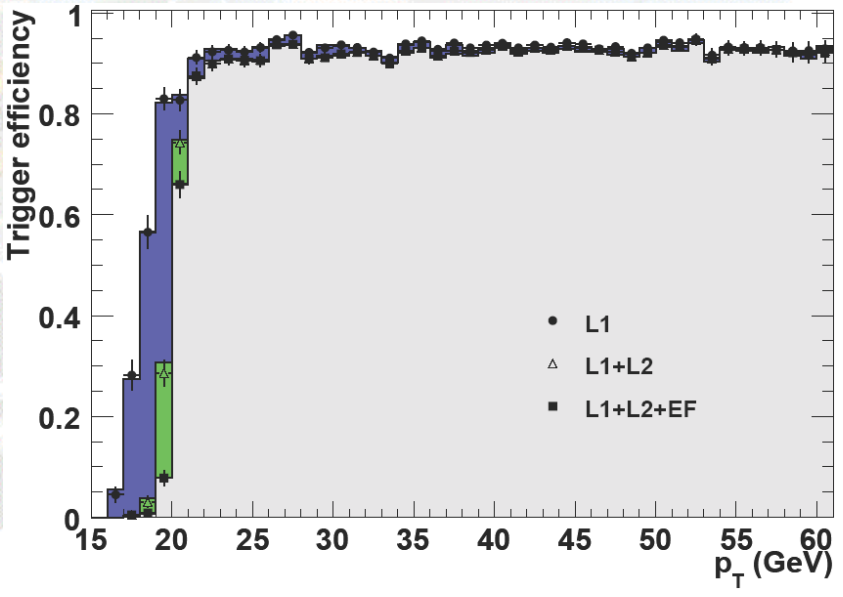
Check the Level 2 cuts:

- One energy ratio cut from the first sampling is responsible! But this cut is very powerful…

Loosen this cut:



p_T



- Also, reduce Level 2 p_T threshold by 1 GeV w.r.t. Event Filter threshold!

Level 2 E_T > 19 GeV (instead of 20.1 GeV); ERatio > 0.73 (instead of 0.87 for |eta| < 1.8 and 0.97)

Conclusions

Detector paper plots were done just in time (tour de force)!!!

Found some problems with the selection: Need to optimize with release 13 Monte Carlo. Previos optimizations of the isolated electron triggers are most likely not optimal…

Next target: Produce rates and efficiencies for the high threshold electron trigger for the CSC note (this weekend)!

Eta plots for different trigger items