Electron Calibration and Performance (11.0.41)

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Outline

- LAr weight extraction status
  - TB02 + Combined Test Beam, ATLAS sim, Calibration Hits, In Situ(?)
- A look at the material maps DC3-02 (eta/phi)
- Single Electron Performance (Linearity/Uniformity/Resolution)
- New LAr layer weights from official samples
  - Electron performance with new weights
  - Discussion
- Electrons from H(130)->4e
  - Egamma, ISEM bits, trk isolation efficiencies vs (eta, pt)
  - Higgs masses
- Future

LAr weight extraction status (incomplete)

- Continuing studies with Test-Beam data
  - TB02 Linearity Studies (Graziani,Carli et al, LAr NIM in progress)
    - Used weights extracted from MC truth including E-dependence (0.1% linearity for E>9GeV)
  - CTB04 Studies (W.Lampl Thesis + LAr CTB group)
    - M. Aharrouche calculated CTB weights
    - W. Lampl, M.Aleksa, I. Wingerter, SP used calibration Hits and applied to data (very prelim <0.5% linearity)
    - K. Loureiro (Thesis) studied electron vs photon weights.
- ATLAS studies
  - organized by the LAr Calibration and egamma Groups (Unal+Zerwas)
  - SP and Scott Snyder(BNL) extracted constants for Rome+DC2
  - L.Carminati et al (Milano) are trying to extract weights including E-dependence, long. Leakage and fluctuations (improves resolution)
  - L.Flores(Wisconsin) extracts constant incl. topo-cluster and photons.
  - Weights for soft electrons by F.Derue (Orsay)

Today (both e/photon)

- The simplest method: we extract weights by a chi^2 fit on single electrons about the MPV (most prob. value) of the reconstructed Energy distribution:

$$\chi^2 = \sum_i^N \frac{\left(E_{rec}^i - E_{true}^i\right)^2}{\sigma^2_{E_{true}^i}}$$

$$E_{rec} = \lambda\left(off + w_0 E_0 + E_1 + E_2 + w_3 E_3\right)$$

$$\lambda, off, w_0, w_3 \text{ only functions of } \eta$$

- In Situ: we must be able to check the quality of the weights with data (Z bosons, E/p, etc). Not an easy task.

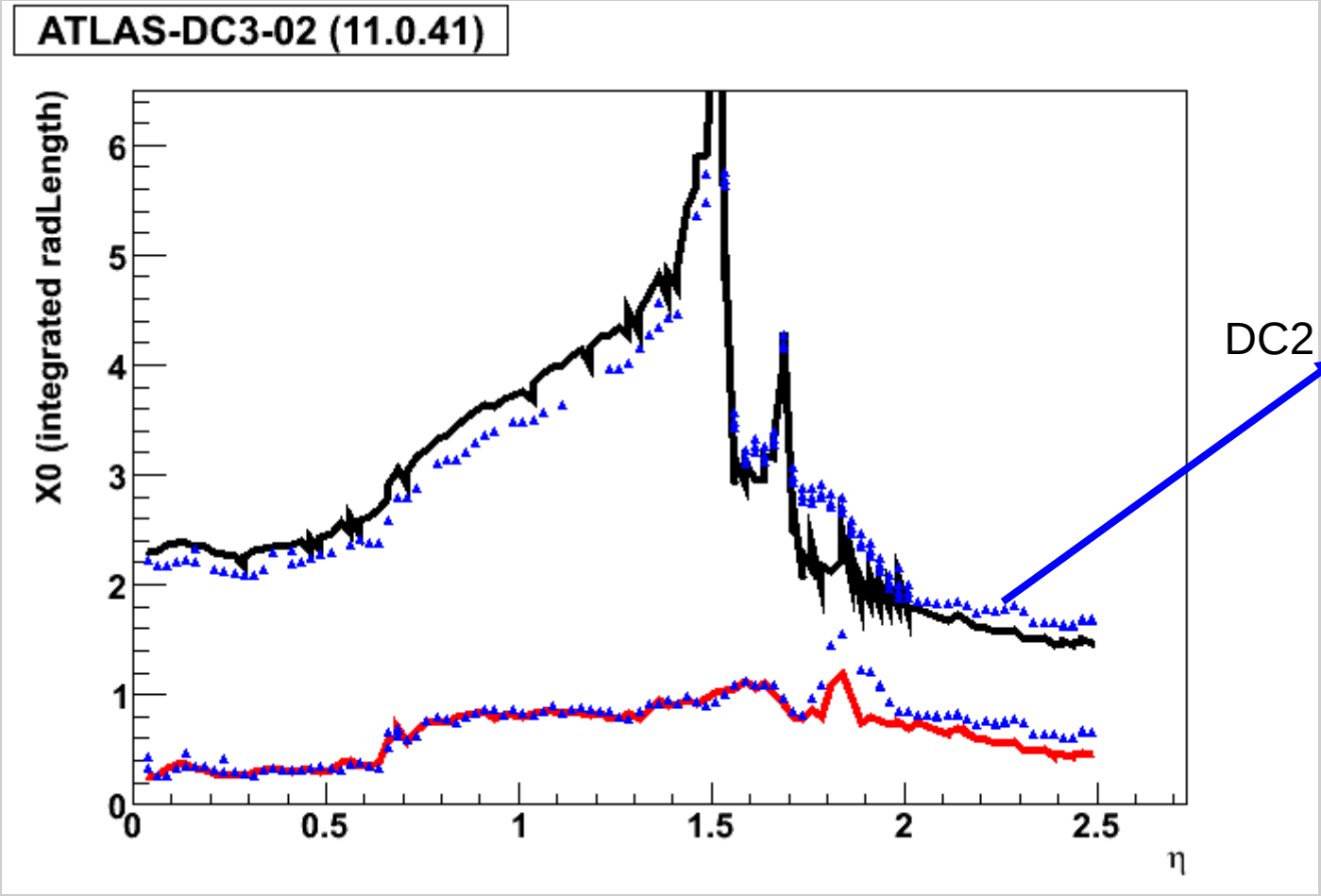
The danger: hidden systematics

- The present simple weights **are not** the "true" weights one would extract from the G4 Simulation itself (i.e. MC hits). They absorb a number of additional factors each contributing a systematic error (Test Beam experience and first data offer priors to these errors).
- Examples:
  - Charge collection effects (E-field in the electrodes) change the weight of the strips wrt middle.
  - Cross-talk in the strips increases the strip response.
  - Non-uniformity of response and many more.
- Notice: detector layout inaccuracies and G4 simulation accuracy do not belong in the category above: they are pure MC hits systematics and could be evaluated with test-beam analysis. Thus they are well decoupled.

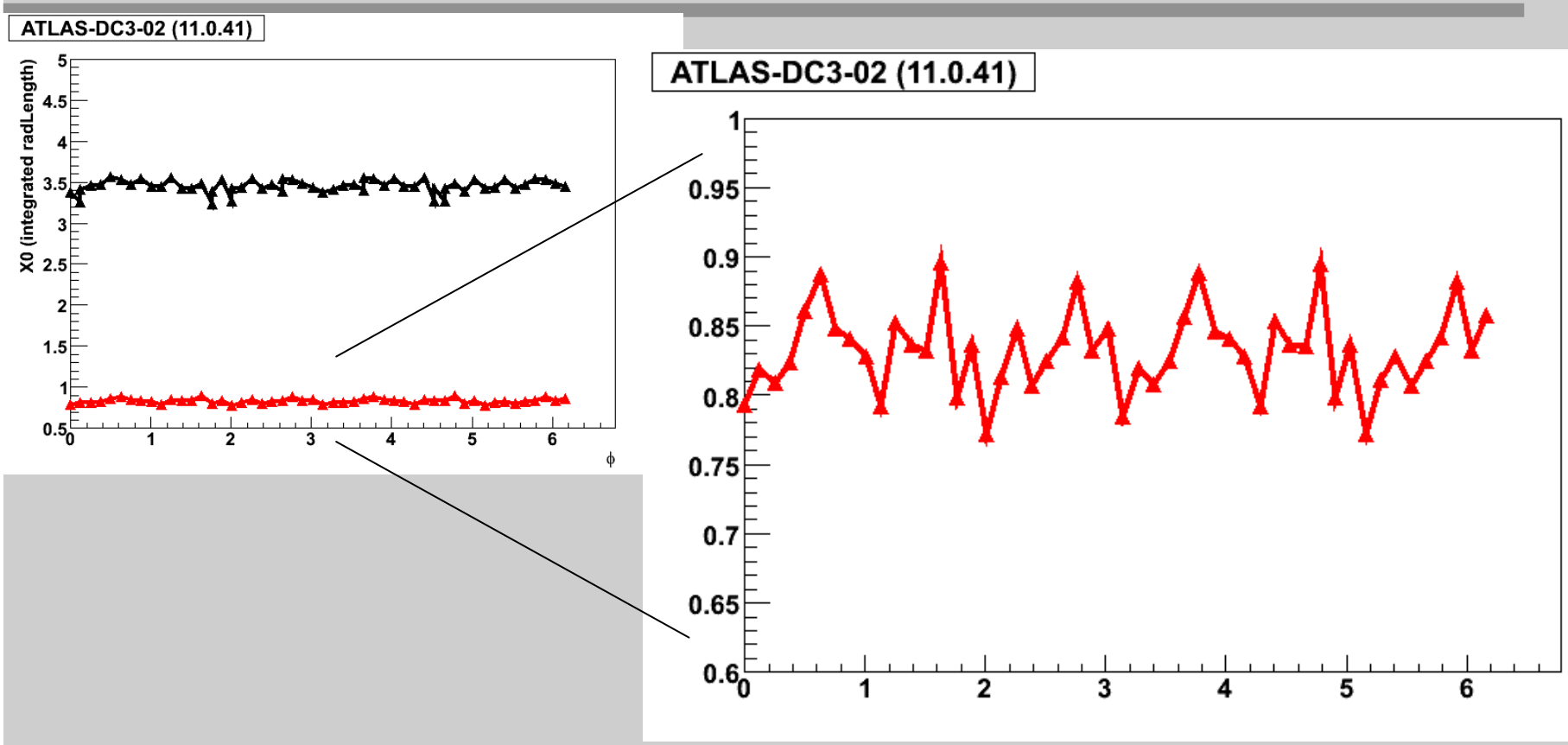
11.0.41 Samples

- Single Electrons
  - csc11.007072.singlepart_e_E25
  - csc11.007060.singlepart_e_E50
  - csc11.007073.singlepart_e_E75
  - csc11.007061.singlepart_e_E100
  - csc11.007074.singlepart_e_E200
  - mc11.004003.Electrons._e100
  - mc11.004022.Electron_Pt_25
- Higgs
  - csc11.005300.PythiaH130zz4l (19k)

ATLAS-DC3-02 Material (X0) vs eta

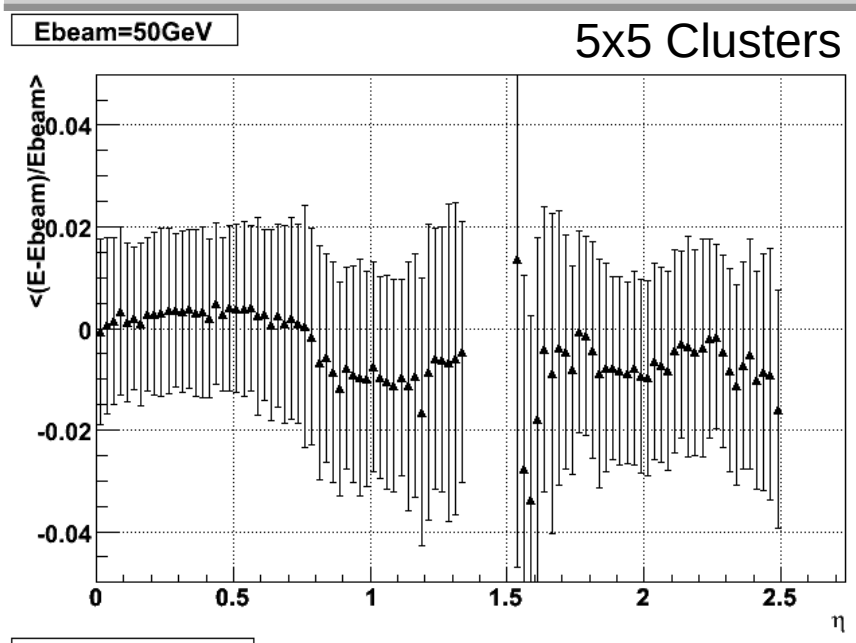


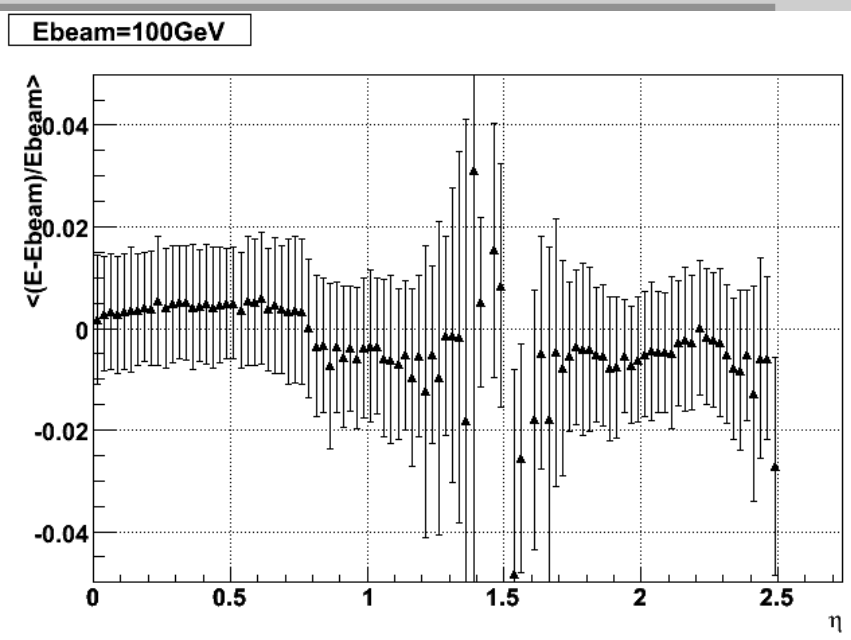
Material (X0) vs ϕ at η=0.8625

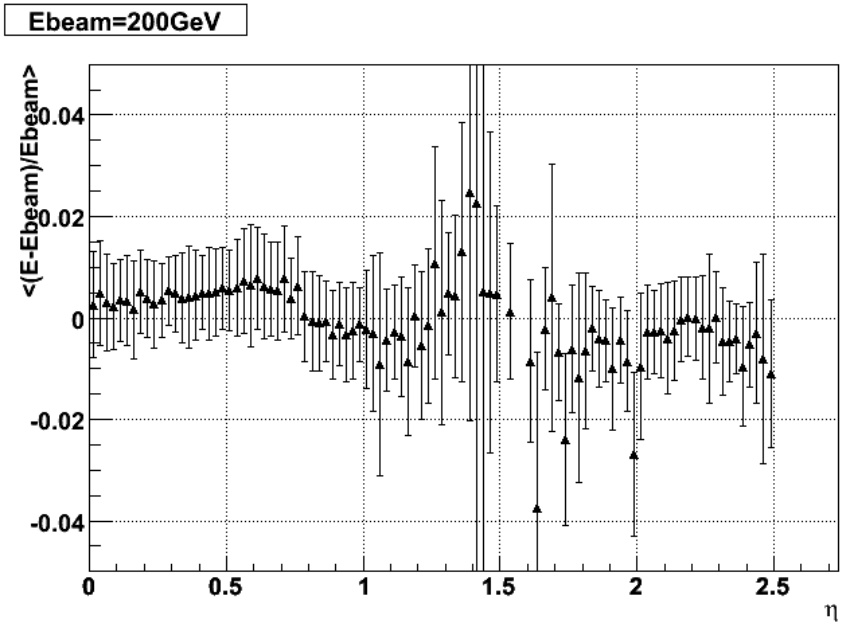


10% of X0 modulation (ID only) in phi

Electron Uniformity/Linearity (11.0.41)

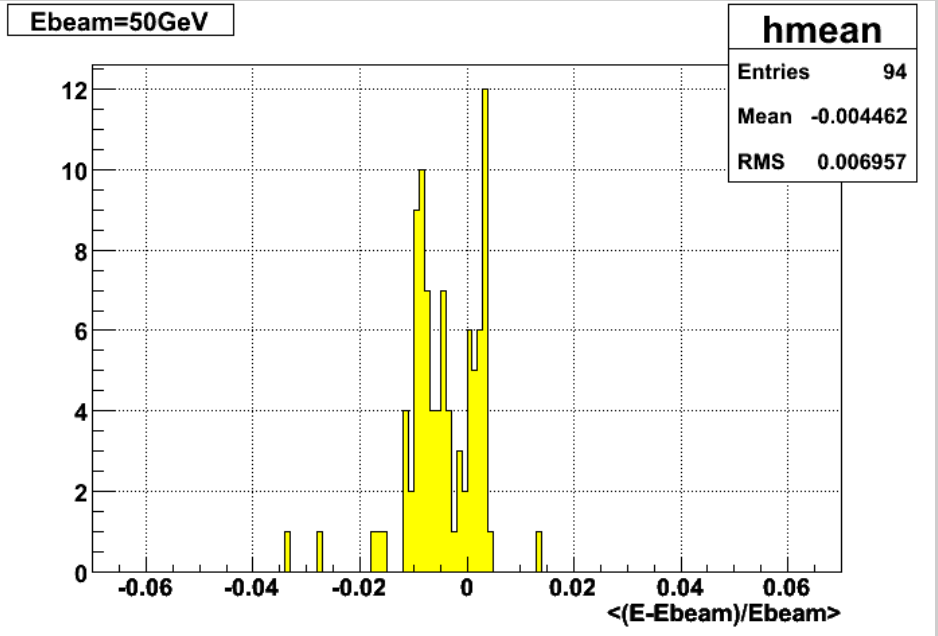


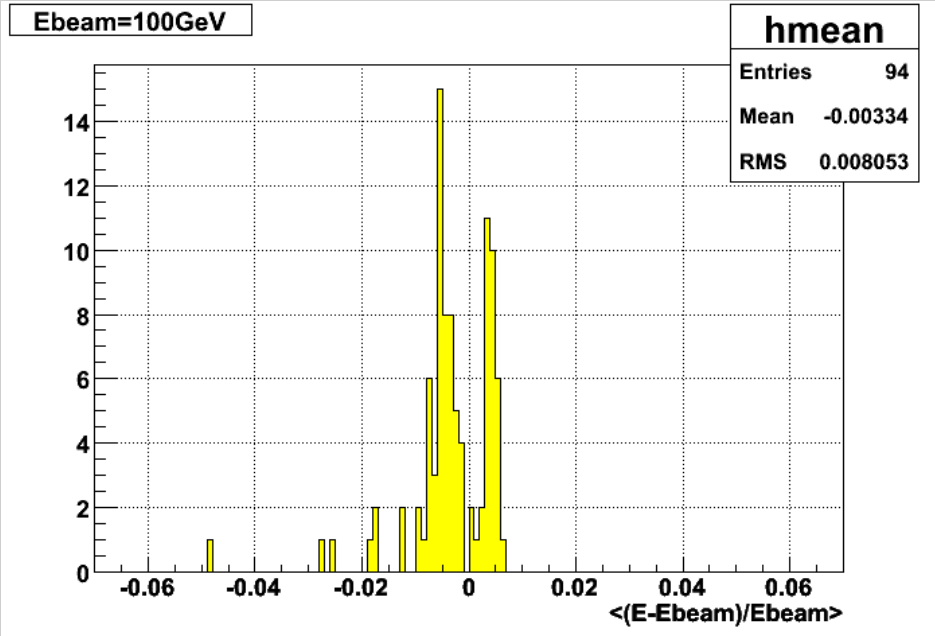




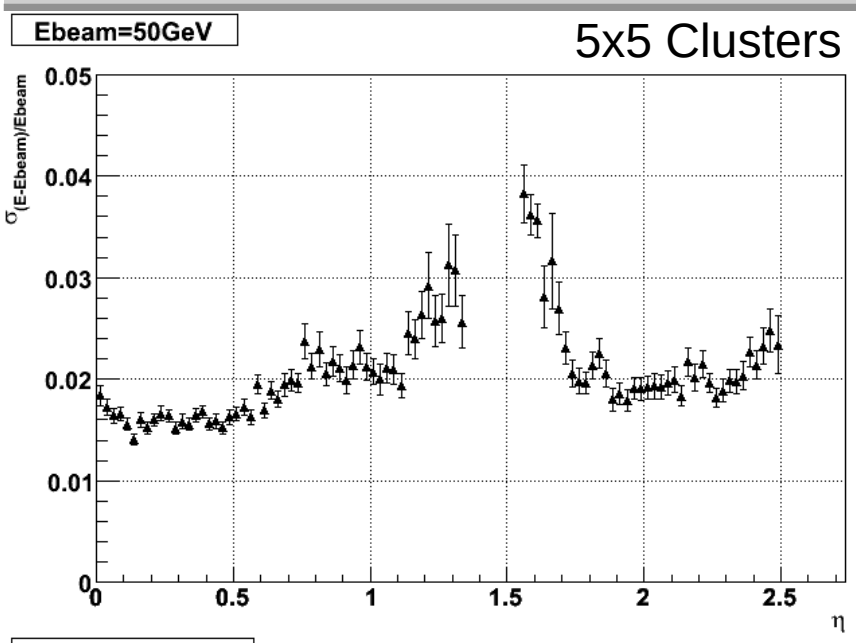
Changes in the layout require recalculation of the layer weights.

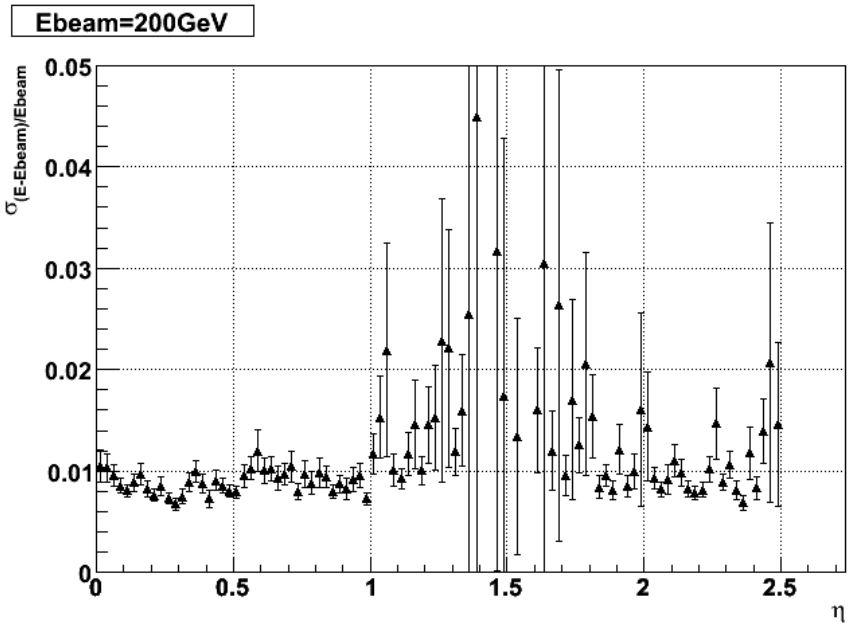
Summary of Uniformity RMS (away from crack)

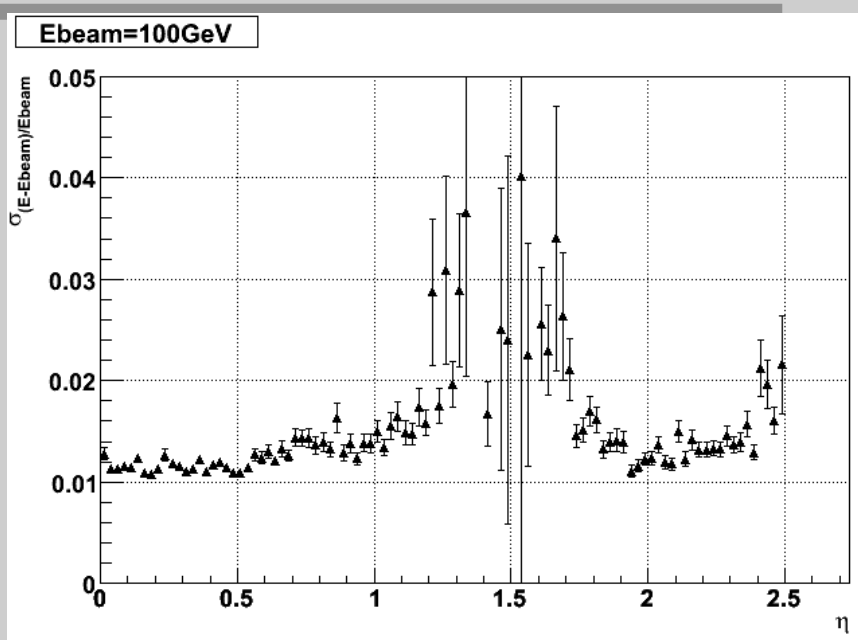




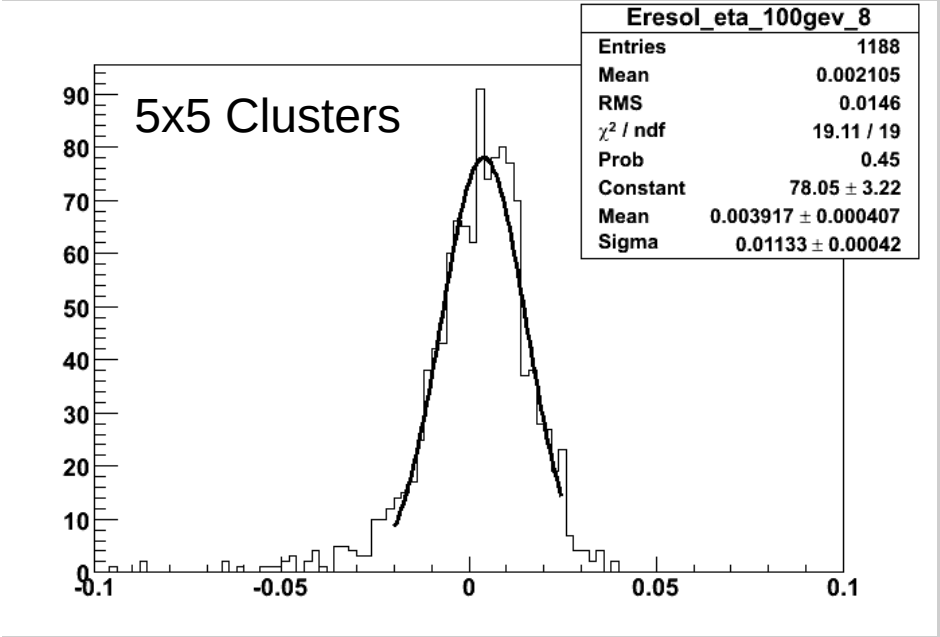
Electron Resolution vs Energy vs η

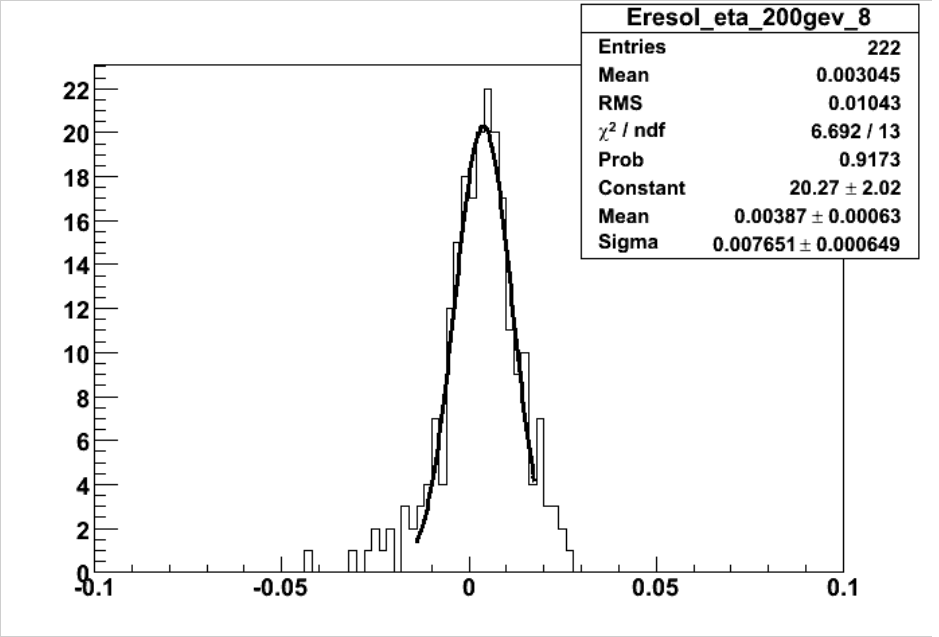




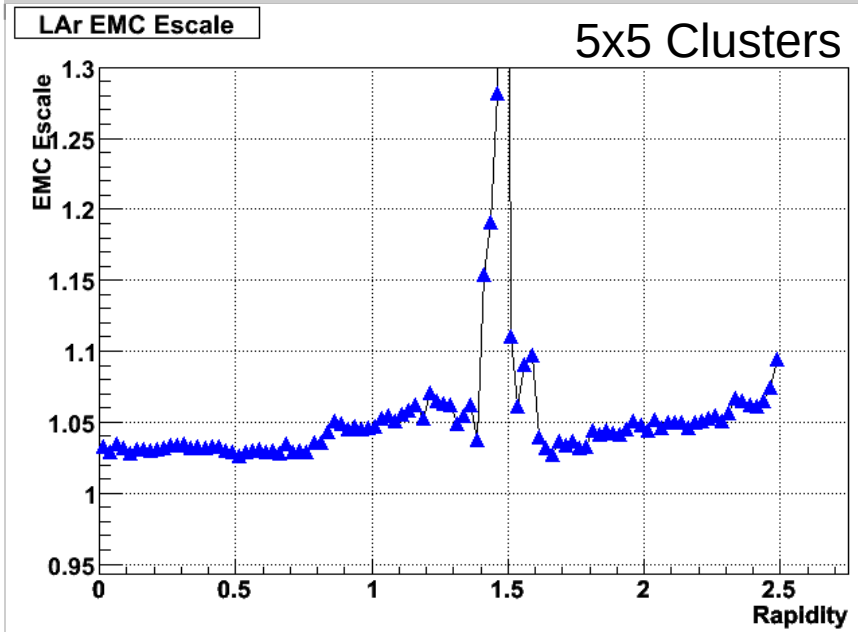


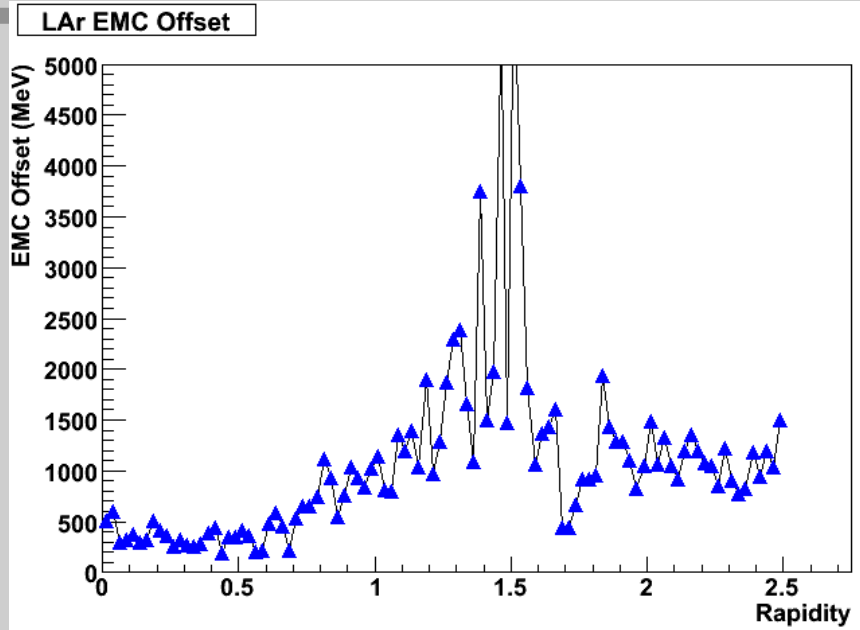
Resolution examples at η=0.2

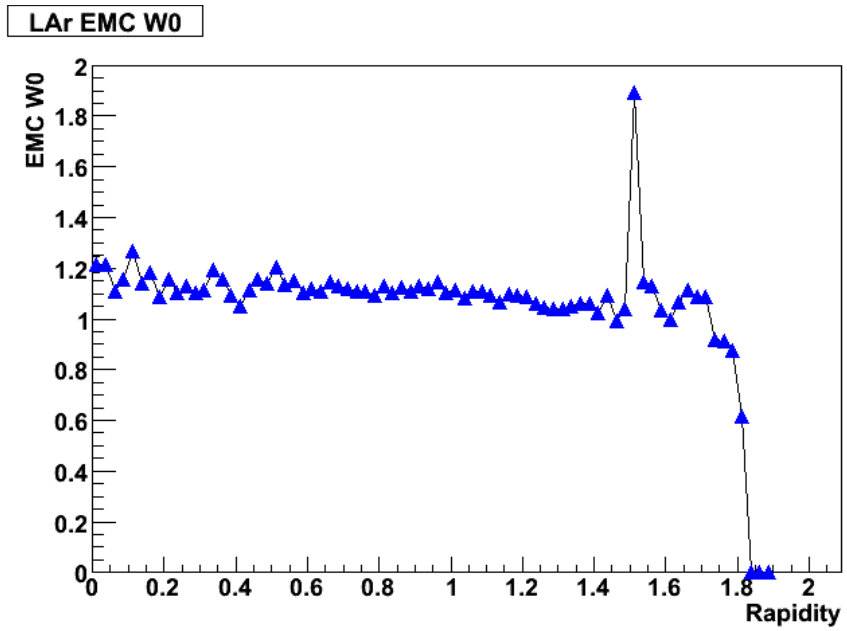


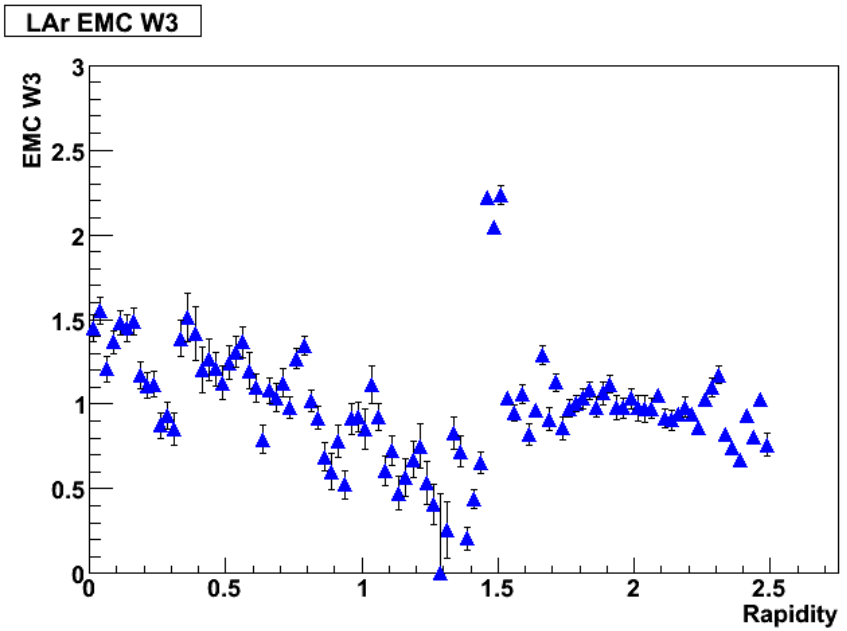


New layer weights (using new 11.0.41 samples)

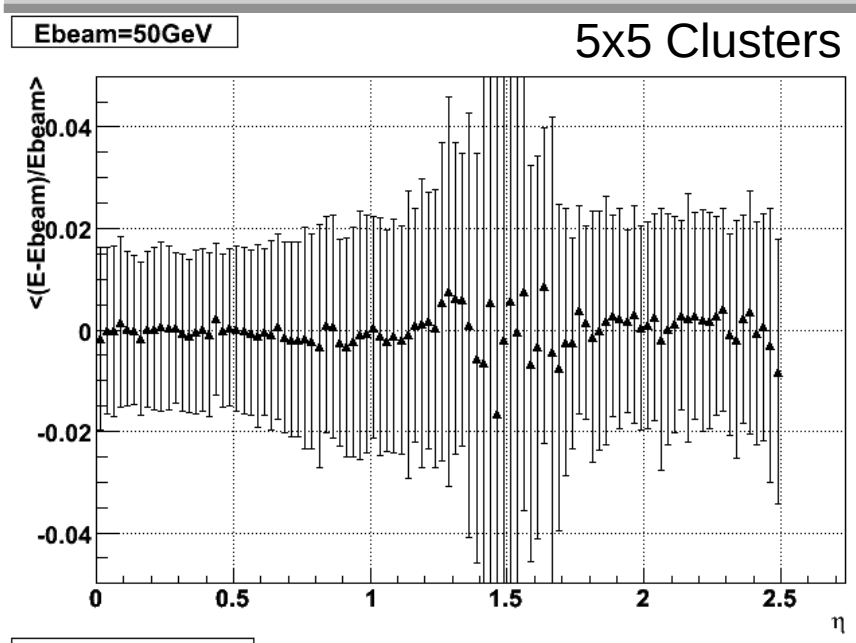


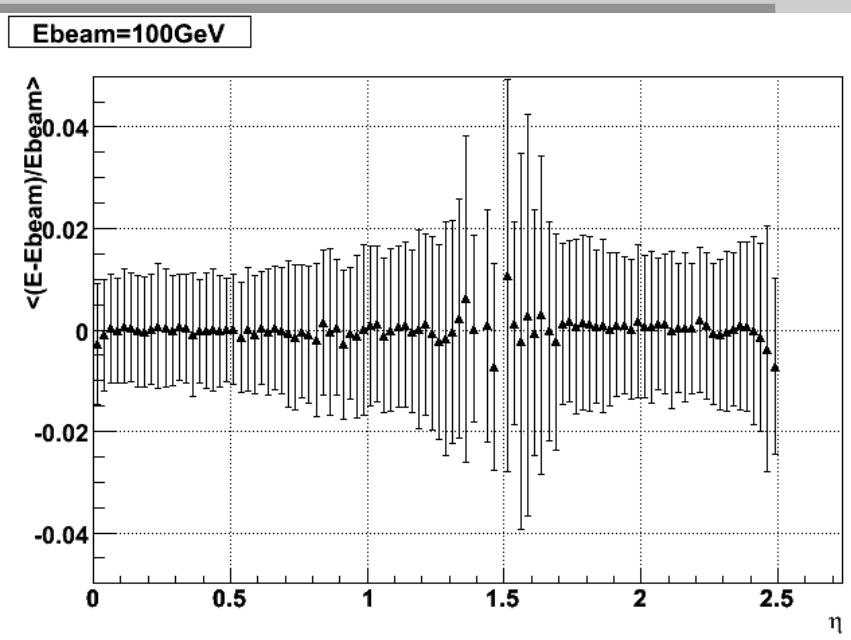


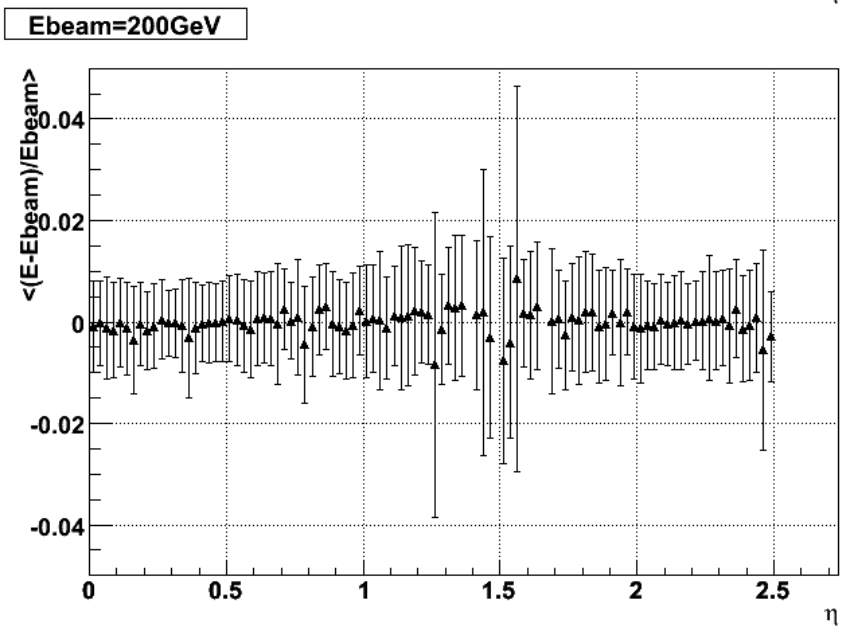




Electron Linearity/Uniformity (new weights)

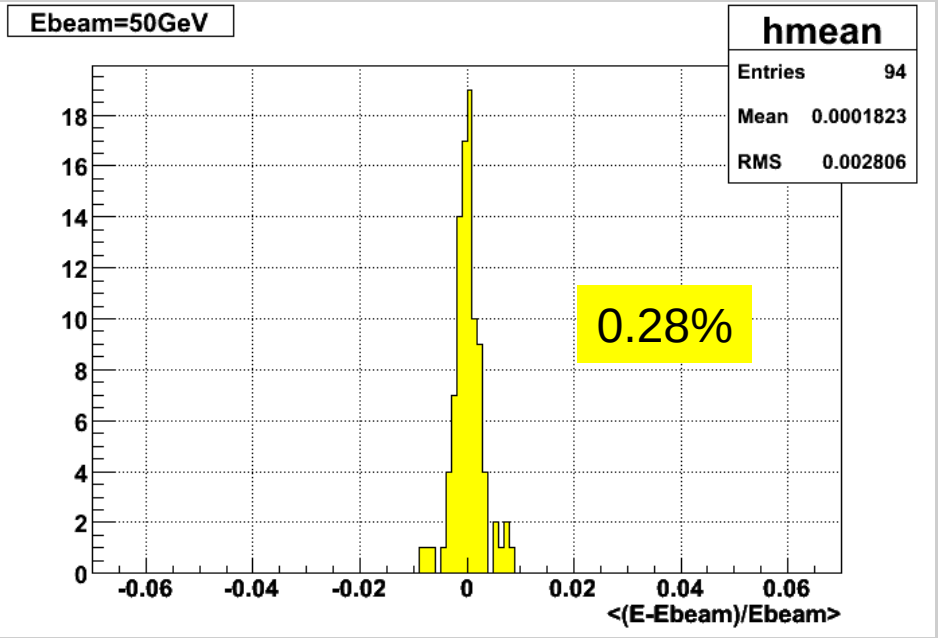


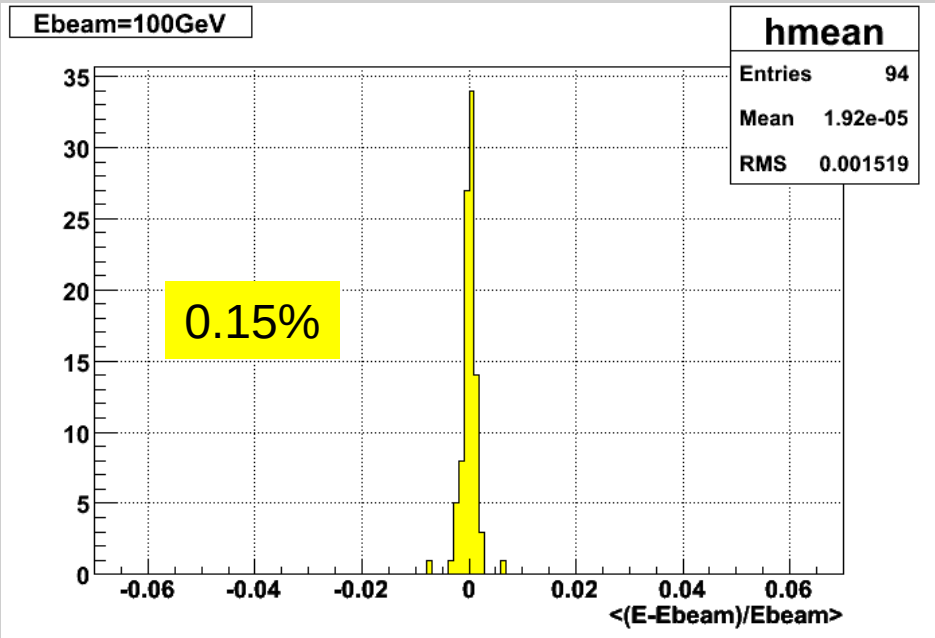




Comment: full statistics of various samples is not available yet except for the 100GeV point.

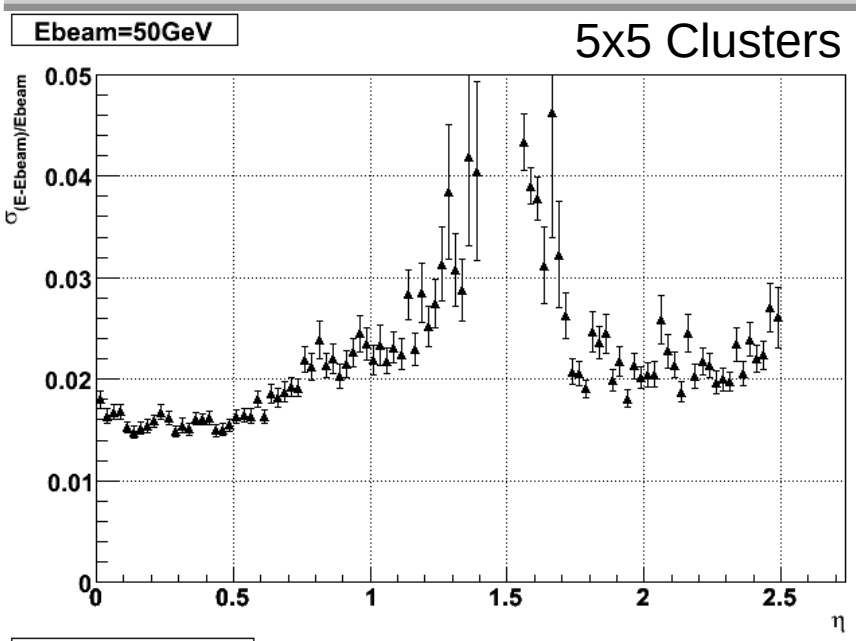
Summary of Uniformity RMS (away from crack)

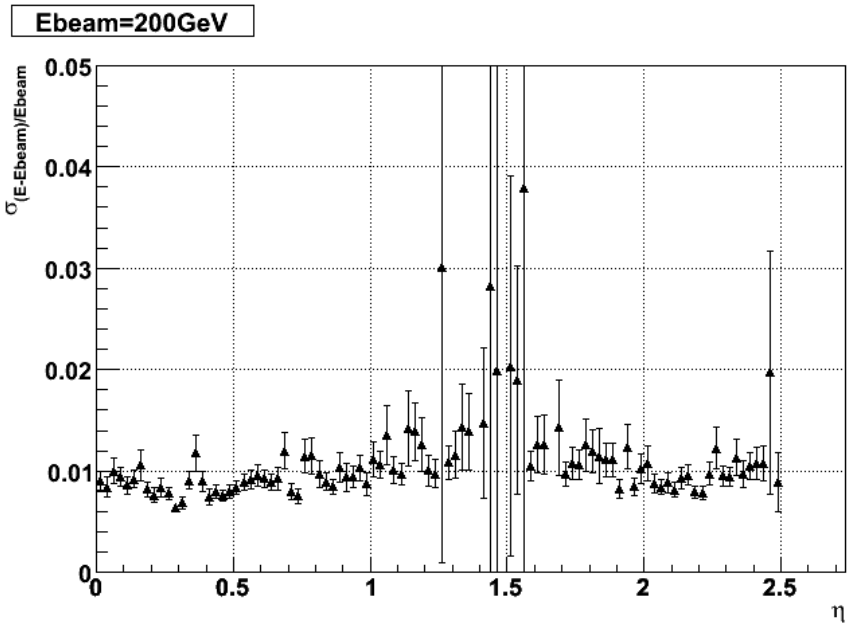


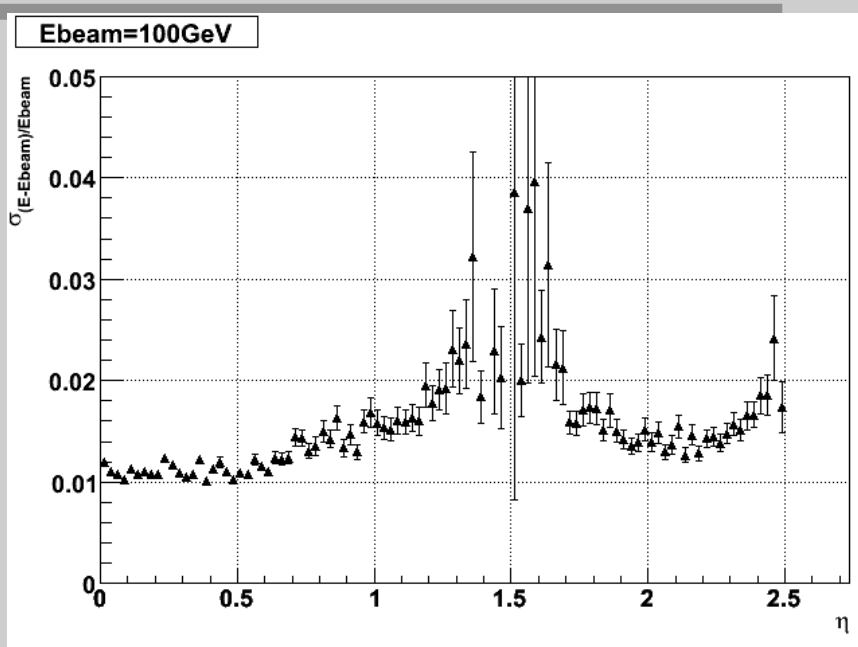


New weights are already satisfactory even with the low statistics (2k events per bin).
Checked with 25,50,75,100,200GeV beams.

Electron Resolution (new weights)





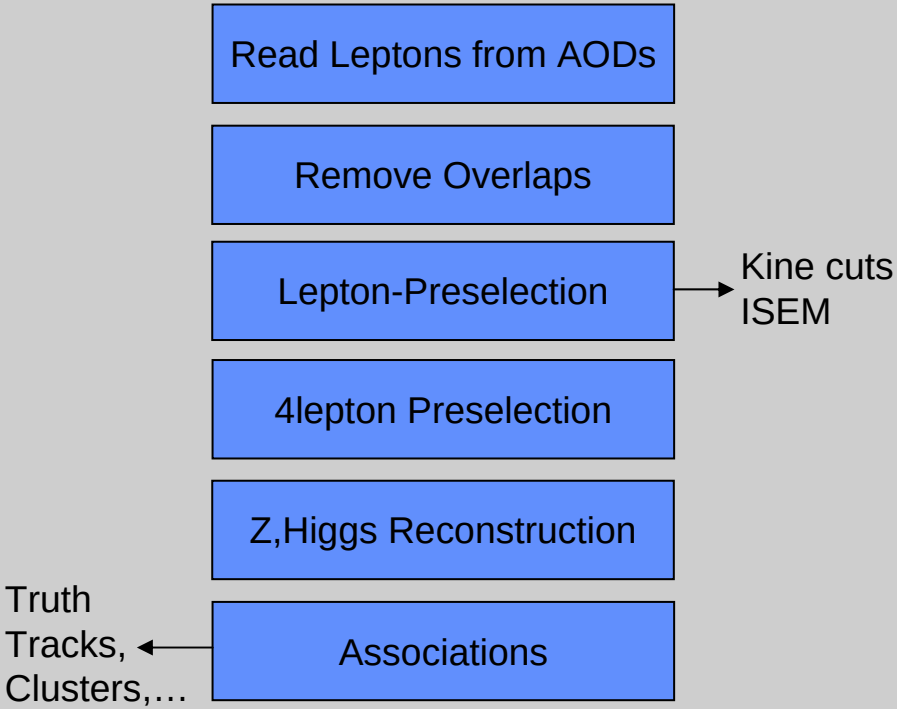


Very small improvement bin-by-bin

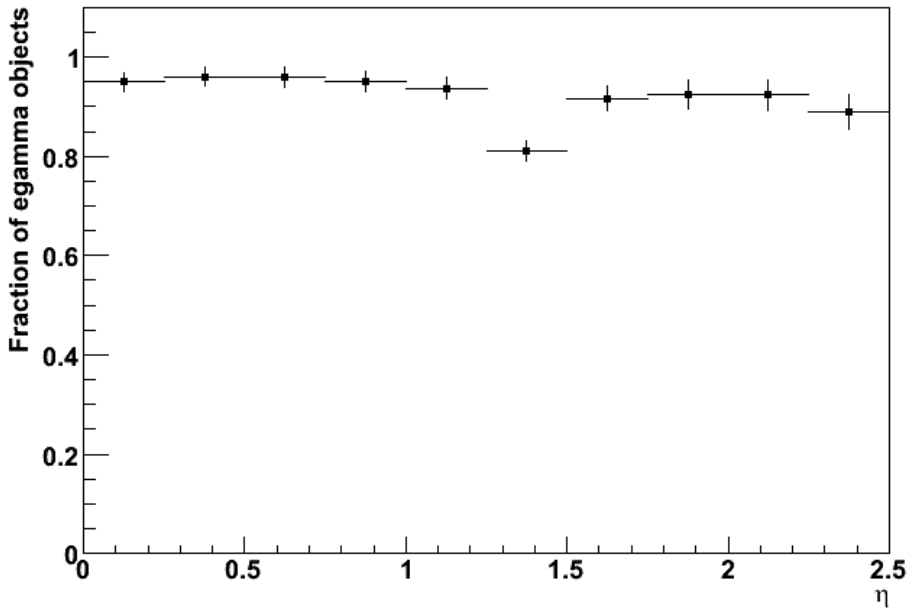
Higgs to 4-electrons (11.0.41)

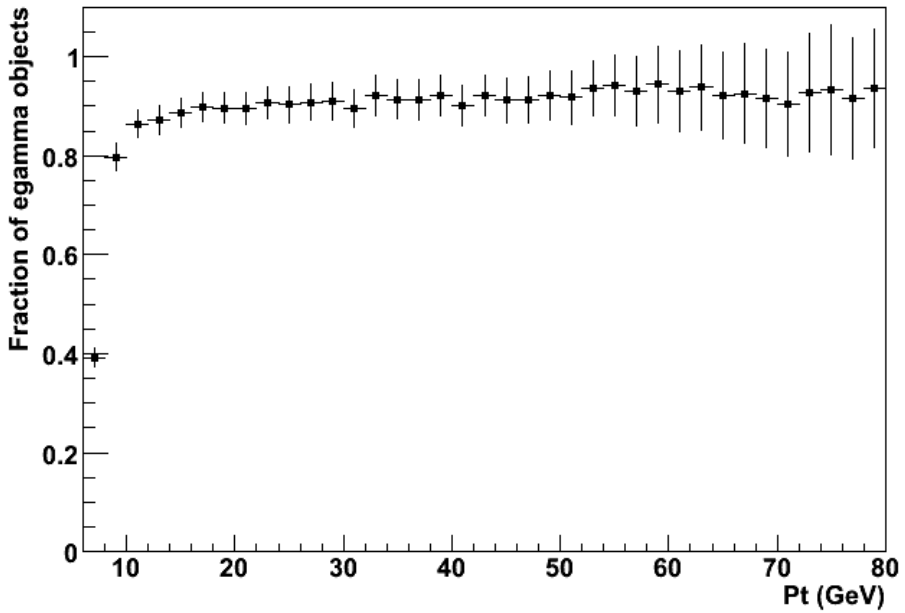
- We ported the analysis to the latest EventView:
  - Most analysis steps are done with Athena tools (EV)
  - AANtuple is produced for final processing (see Higgs talk)
  - Checked in CVS:

http://atlas-sw.cern.ch/cgi-bin/viewcvs-atlas.cgi/offline/PhysicsAnalysis/HiggsPhys/HiggsToFourLeptons/src/



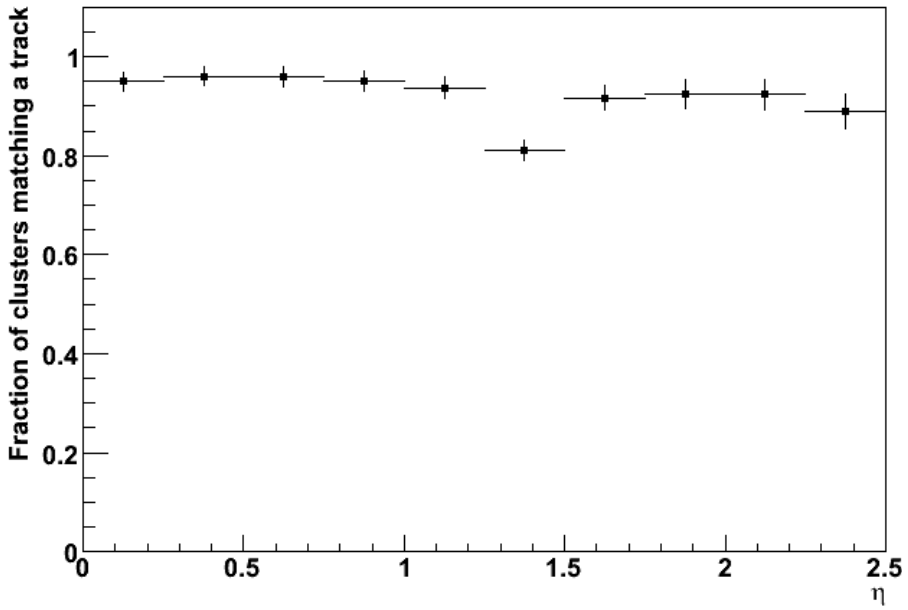
Efficiency: plain egamma objects

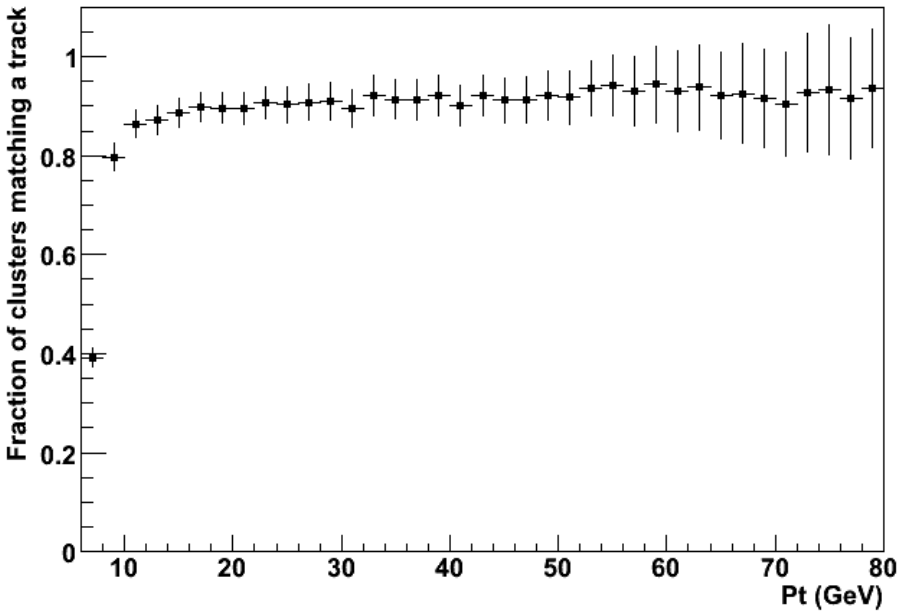




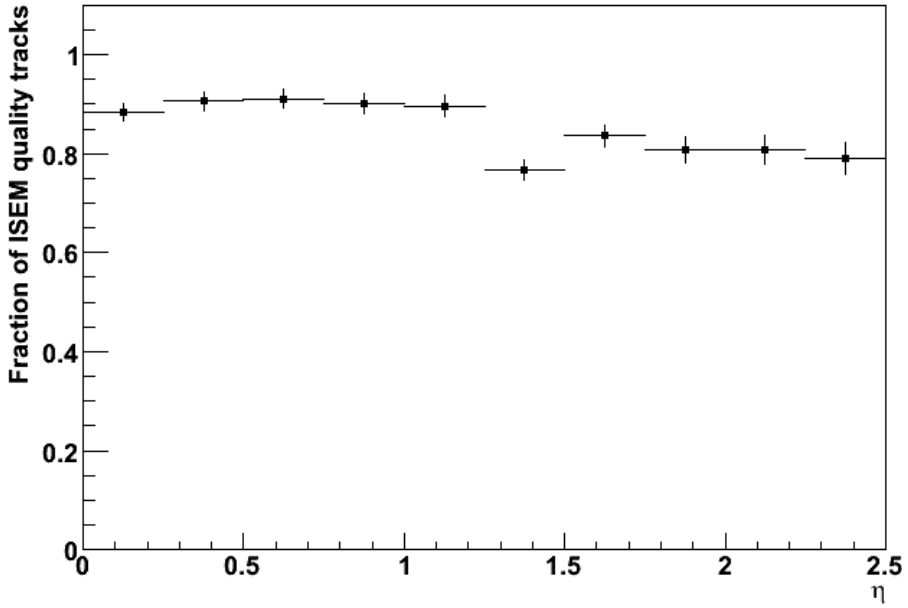
Reminder: The truth matching uses a dR<0.1 cone

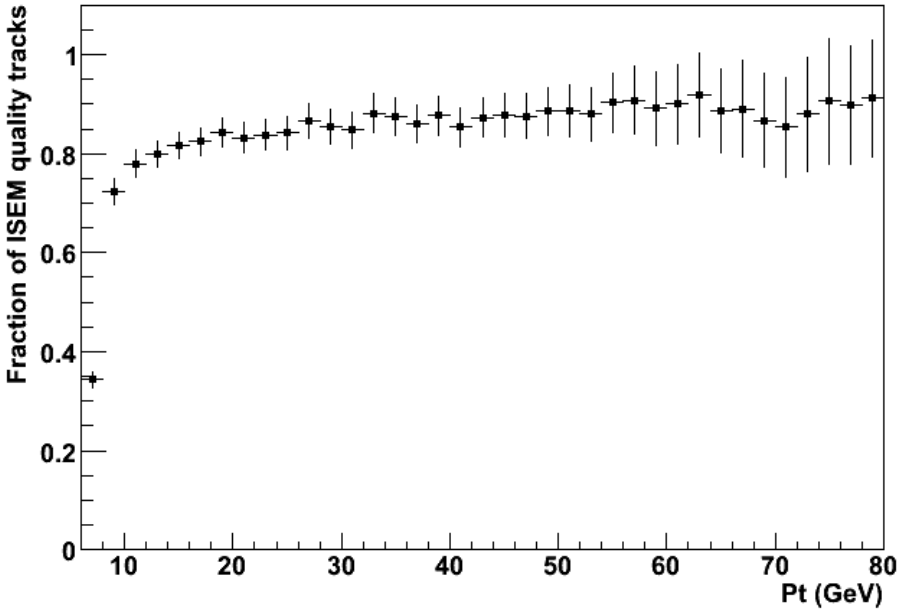
Efficiency: cluster-track matches





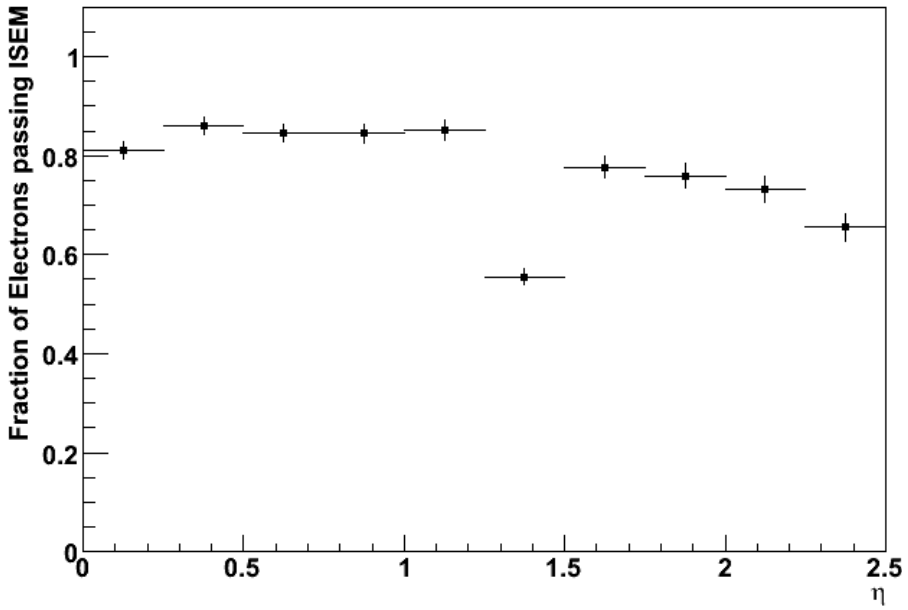
Efficiency: quality cuts (isem bit)

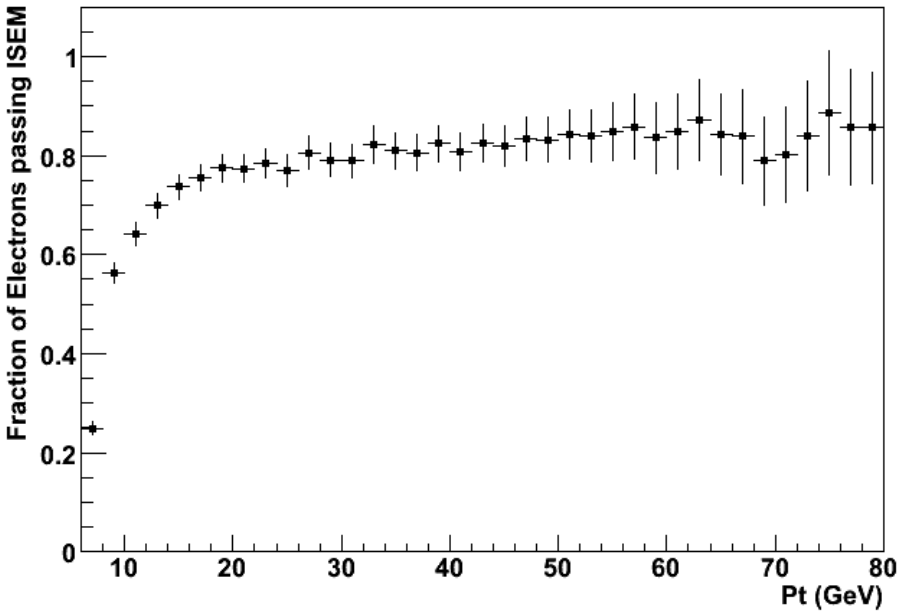




Reminder: ISEM = TrackQual (noTRT) + caloISEM
where:
TrackQual= [E/p + TrkMatch] + [Bhits>1+ Phits>1 + (S+P)>6 + d0<0.2]

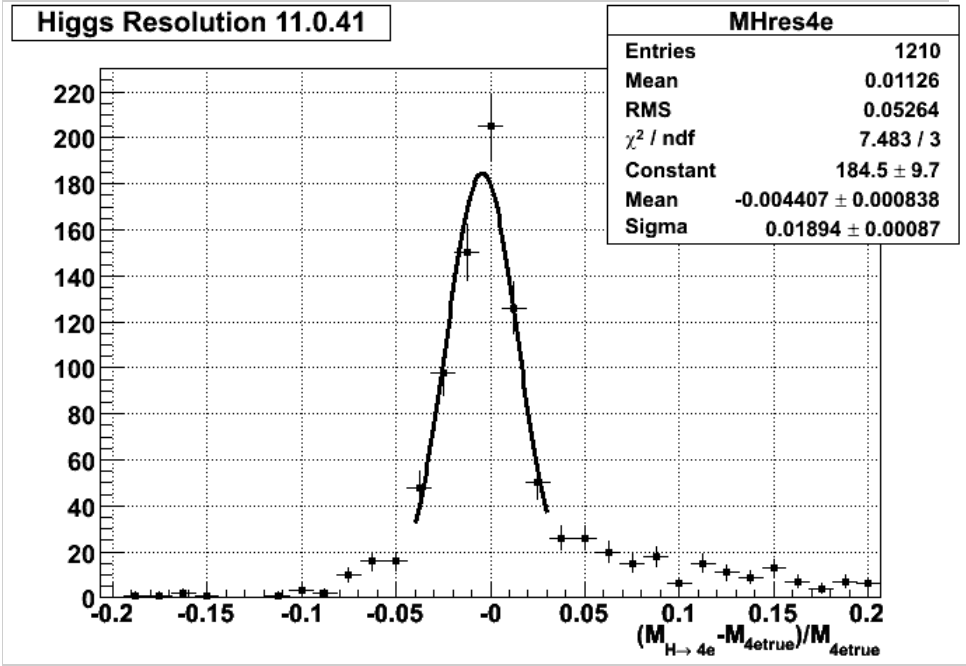
Efficiency: ISEM cut (no TRT)

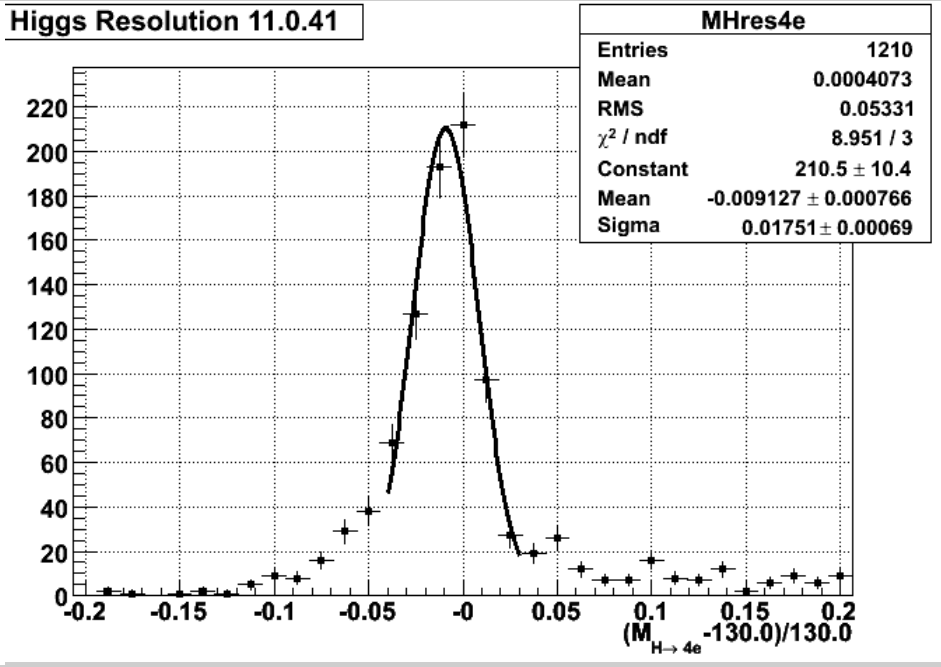




However:
H->4e Trigger efficiency: 1e25 or 2e15 using ISEM: 99.6% (see tomorrow)

Higgs masses





Using true matched electrons (they could have radiated)

Assume nominal Higgs mass

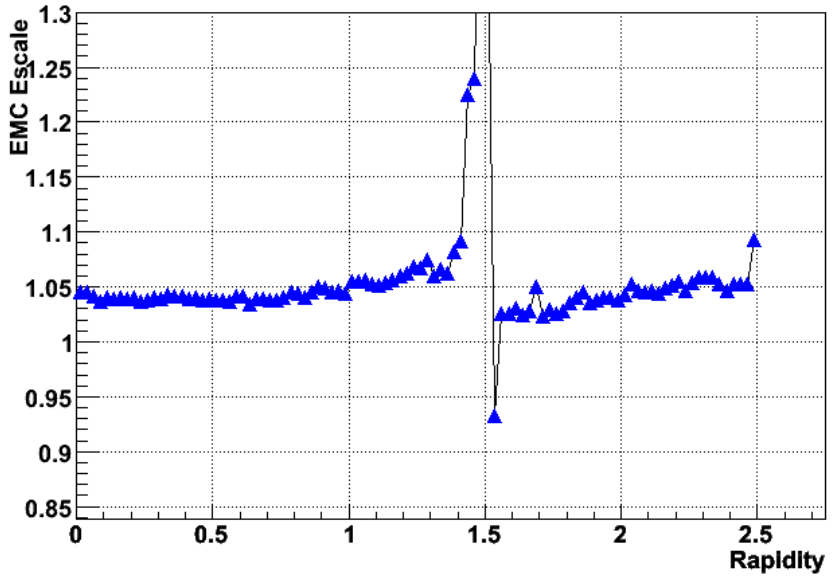
Reminder: new weights will improve mean and resolution

Future

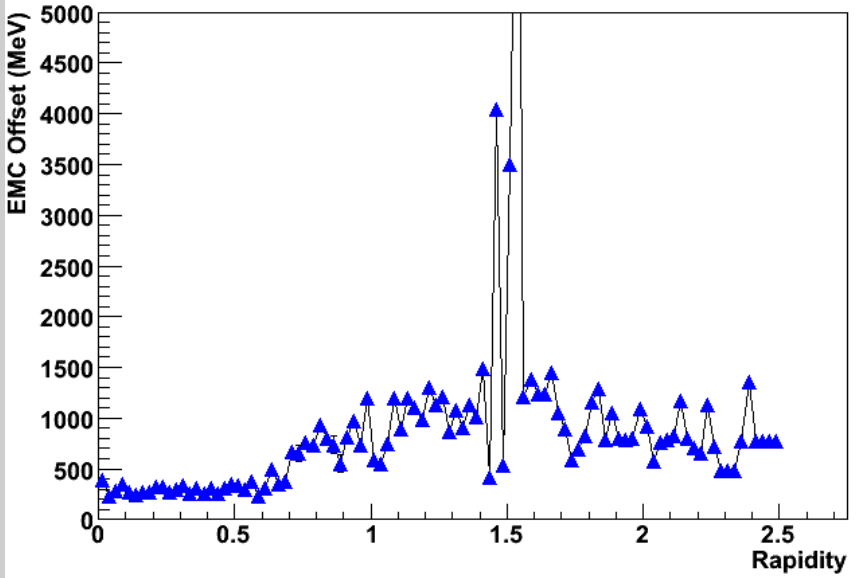
- Experience for Test-Beams shows that we will need a more powerful method for layer weight extraction:
  - Must be able to include energy dependence
  - Must be able to include systematic effects
  - Go from fitting the MPV (most probable value) to a likelihood using the expected electron PDFs.
    - PDFs vary with eta/phi in a material dependent fashion.
    - Move from using bins to using the detector description (X0s).
  - Generalize the method to check calibration in-situ (with Zs etc)
- Recently Amir Farbin (CERN) proposed a method in which all of the above can be implemented.
  - He demonstrated how the energy dependence of the parameters succesfully applied in TB02, can be ported to ATLAS.

Default Layer Weights (Rome)

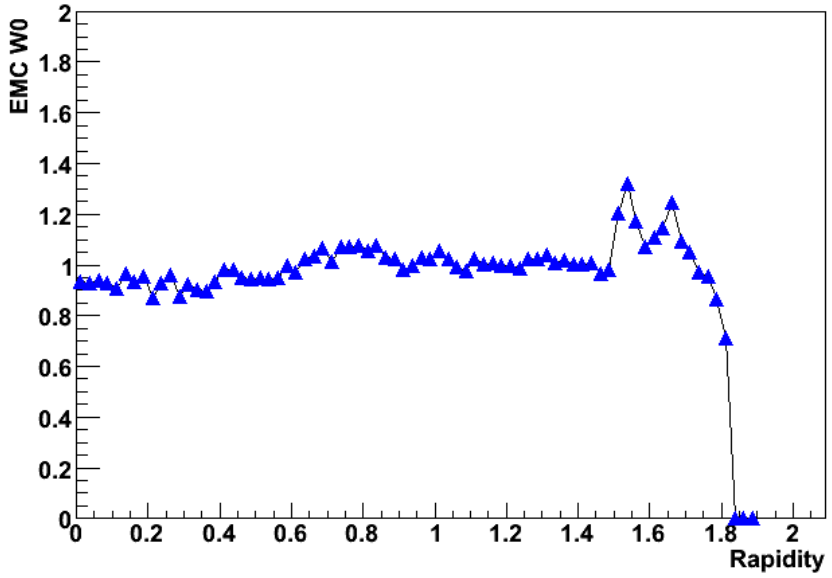
LAr EMC Escale



LAr EMC Offset



LAr EMC W0



LAr EMC W3