Egamma Performance

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Outline

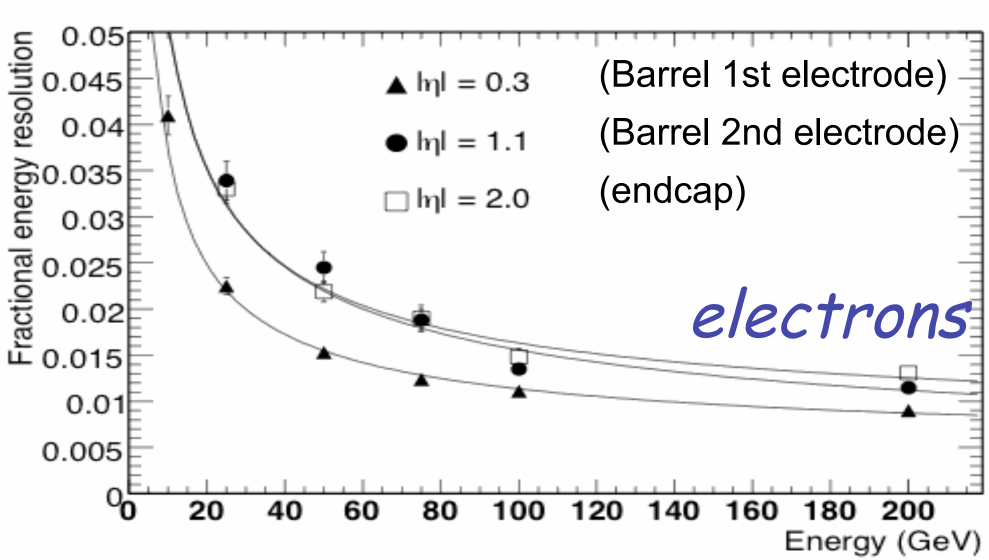
- Calibration and performance of the electromagnetic calorimeter
- Reconstruction and ID efficiencies
  - Electrons
  - Photons
- J/Psi and Upsilon
- Example Expected Performance:
  - Higgs$\rightarrow$eeee
  - Higgs$\rightarrow\gamma\gamma$

- Not covered:
  - Egamma Triggers
  - Conversions (see previous talk)
  - Bremstrahlung (see previous talk)

- Will try to highlight UK Contributions
  - (when I list names it doesn't necessarily mean they were the only person to work on a particular analysis !)

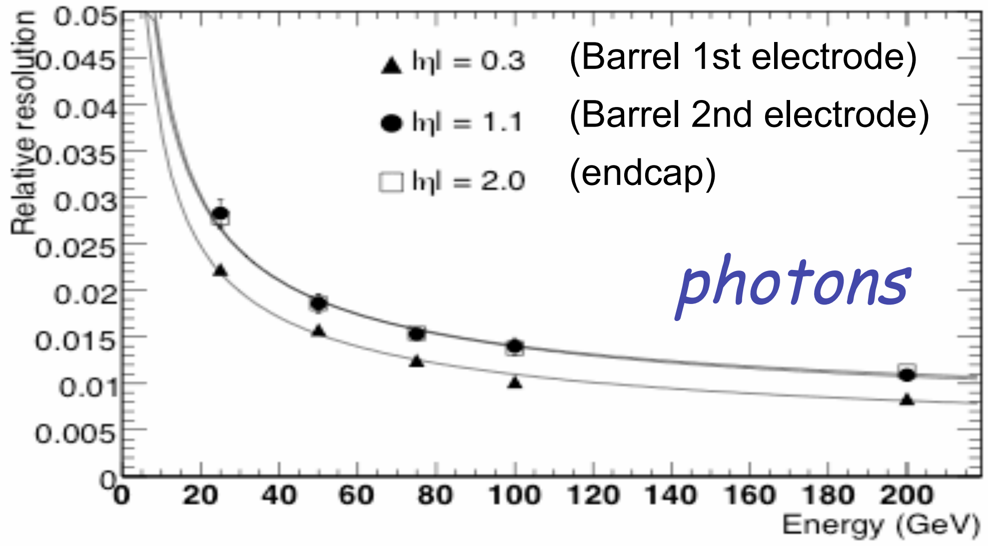
EM Calibration

- Corrections needed for energy deposited in:
  - Inner-detector, cryostat, cables
  - Escapes back of calorimeter
- Cells from the four layers are combined to form clusters.



$$E = s(\eta)[c(\eta) + w_0(\eta)\cdot E_{PS} + E_{strips} + E_{middle} + w_3(\eta)\cdot E_{back}]$$

- Weights are applied to correct for the energy losses providing optimum linearity and resolution.
- Plots for single particle MC
- Resolution drop due to increased material in front of calorimeter

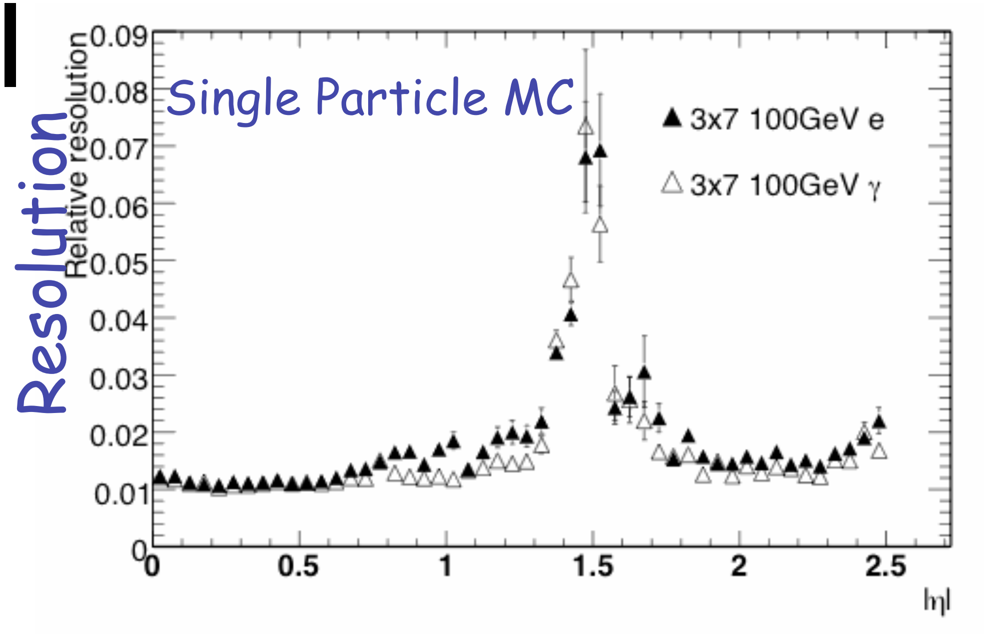


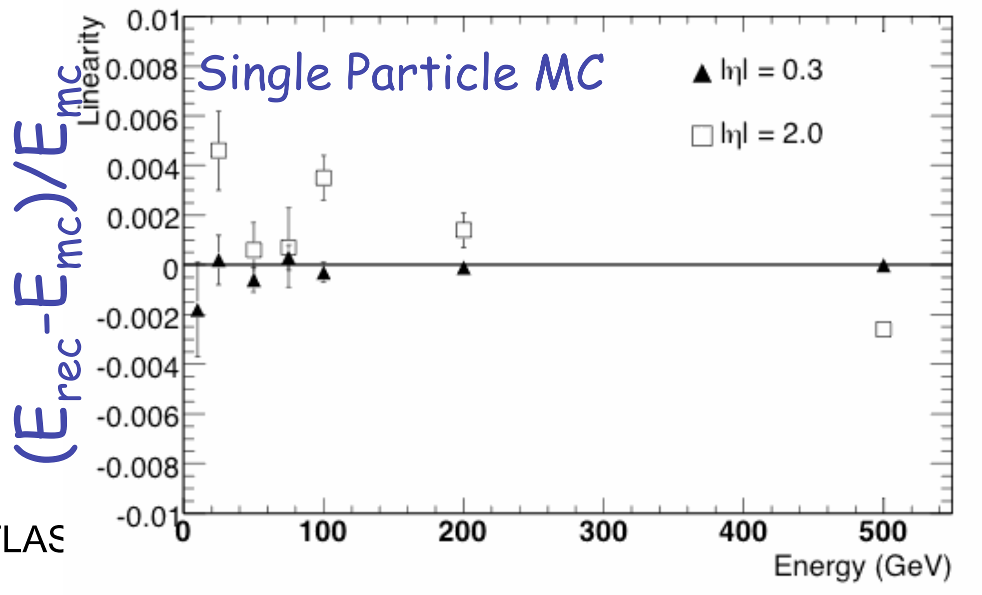
EM Calibration II

- Resolution for electrons and photons as a function of eta

- Linearity for electrons
  - Deterioration in endcap due to absense of presampler, limited statistics

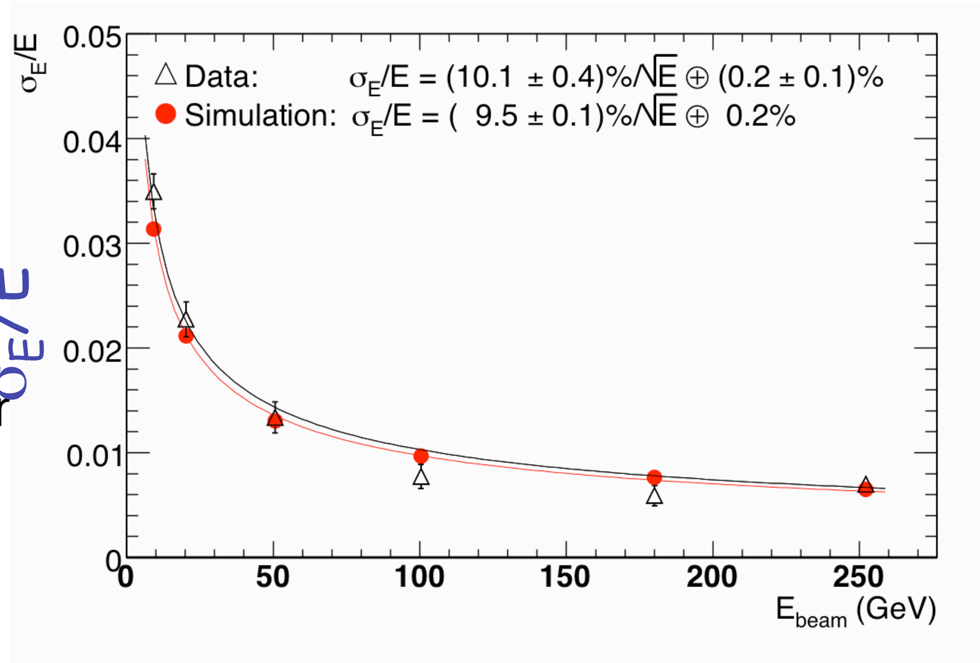
- Proof of pudding is with actual data …..
- Combined Test Beam data ….



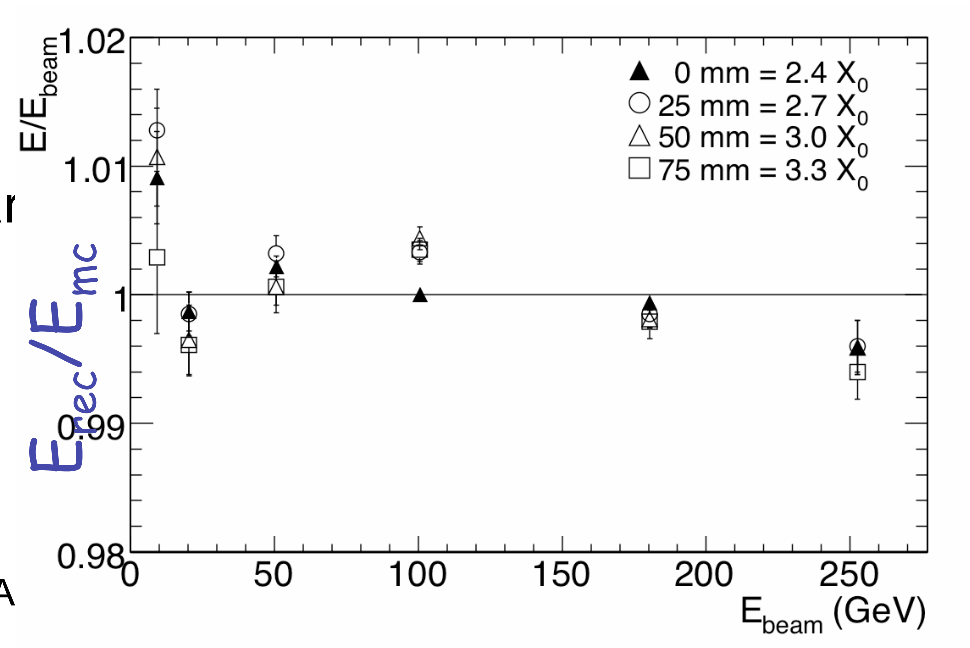


Contributions to the Detector Paper: CTB results

Efstathios Paganis



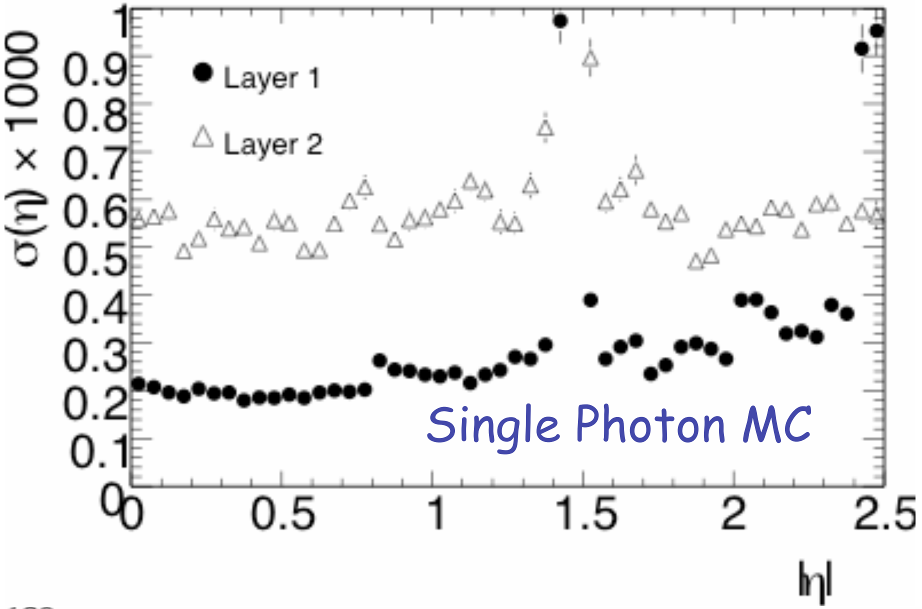
- Fractional energy resolution, for a barrel Lar electromagnetic module ir the CTB.
  - Electronic noise has been subtracted from the data.
  - The results shown are for upstream material of 2.4 X_0,which is that expected in ATLAS at η=0.4.

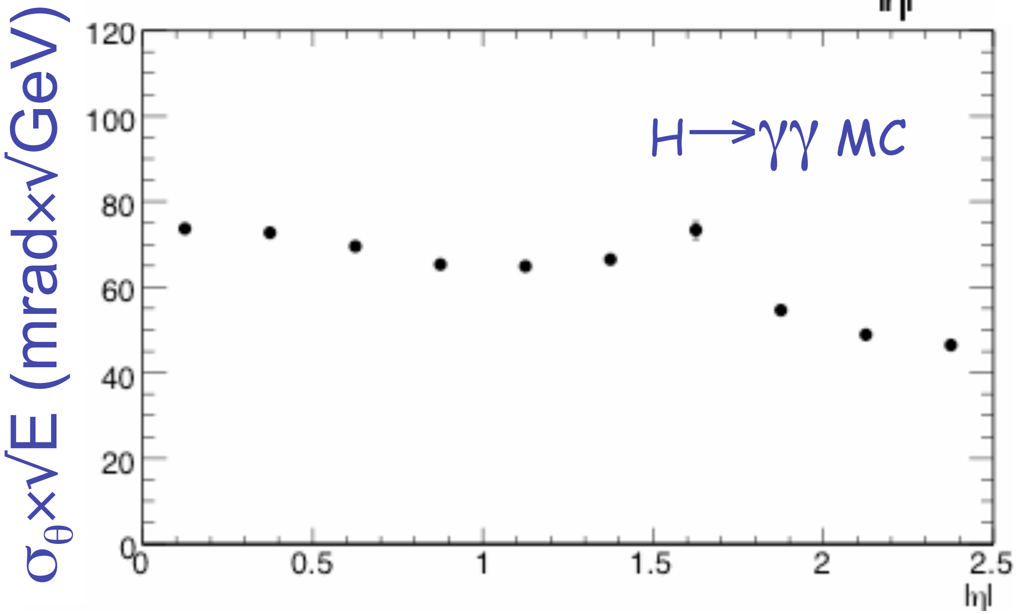


- Linearity of response, for a barrel Lar electromagnetic module
  - at |η| =0.687
  - different amounts of material placed upstream of the active calorimeter.

Position Resolution

- As well as knowing the energy, we also need to know the position of our egamma objects.
- Expected η-position resolution for photon showers with an energy of 100 GeV
- Expected precision on the θ angle of photons from $H \rightarrow \gamma\gamma$,





Offline reco: Guillaume Kirsch, IsEM: Maria Fiascaris

Electron reconstruction and identification efficiency at ATLAS

- Data driven method
- Early data (50 pb^{-1}) aim
- Evaluate efficiencies independently from MC
- Need a clean signature based on electrons
  - Misaligned samples (v12)
  - $Z \rightarrow ee$
  - Filtered jet sample (pt >17 GeV)

Using custom NTuples produced by Ellie Dobson (Oxford) and Mike Flowerdew (Liverpool)

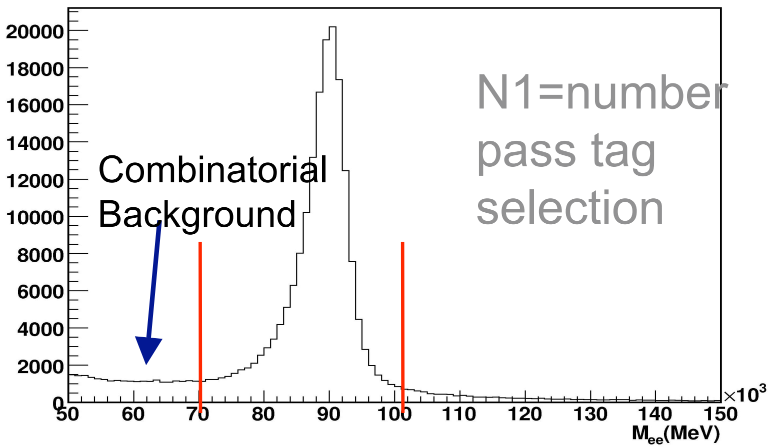
Offline reco: Guillaume Kirsch, IsEM: Maria Fiascaris

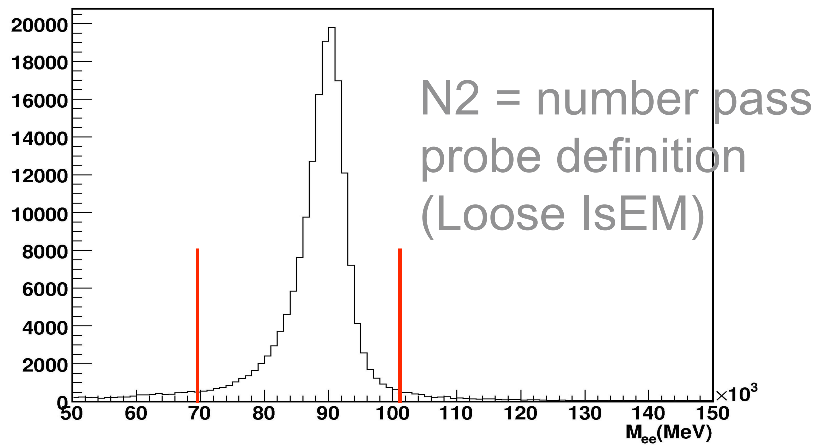
One common method: Tag and Probe

- Tag Selection (N_1):
  - First Electron
    - Triggers Event
    - Tight Offline cuts + Pt + eta
  - Second Electron
    - candidate in opposite hemisphere
    - + Pt + eta
  - 70GeV < M_{ee} < 100GeV

- Probe definition (N_2):
  - Reconstruction Efficiency : LarCaloClus object reconstructed as Electron
  - Identification Efficiency: Loose/Medium/Tight isEM?

$$\varepsilon = \frac{N_2}{N_1}$$





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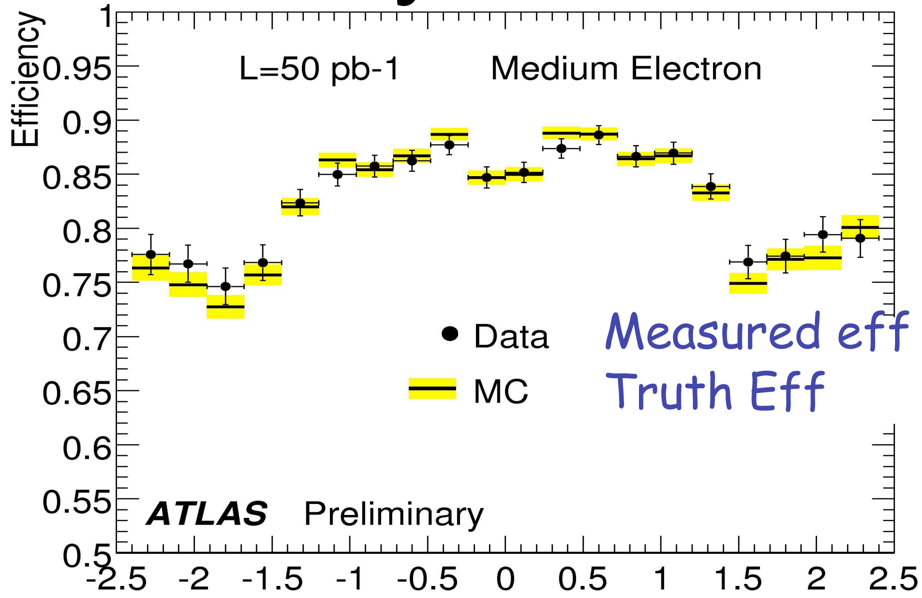
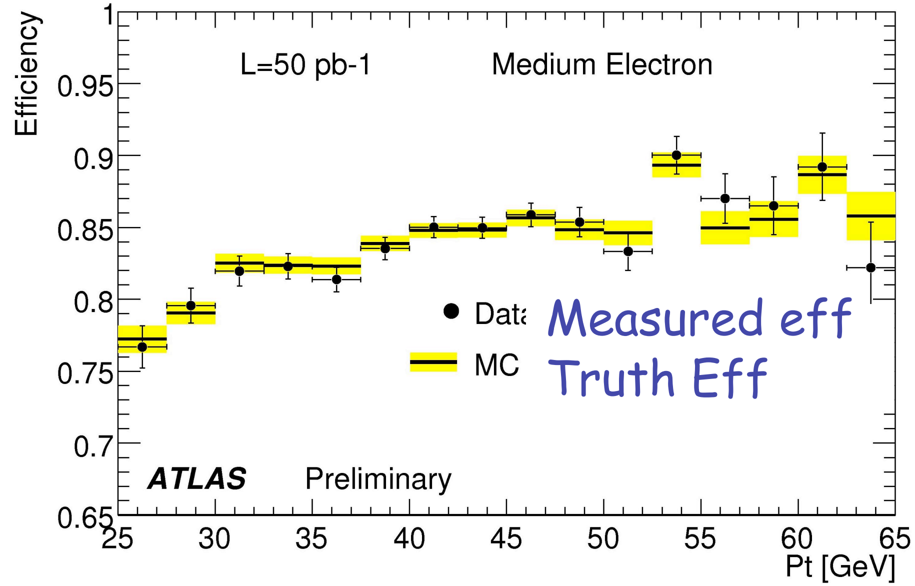
Differential Efficiency I

- electron reconstruction efficiency and ID efficiencies (relative to electron container) calculated separately….and then multiplied together to give overall efficiency.
- Differential Efficiencies in Eta and Pt
- Luminosity: 50 pb^{-1}
- These Plots:
    - Medium IsEM
    - Id Efficiency relative to electron container

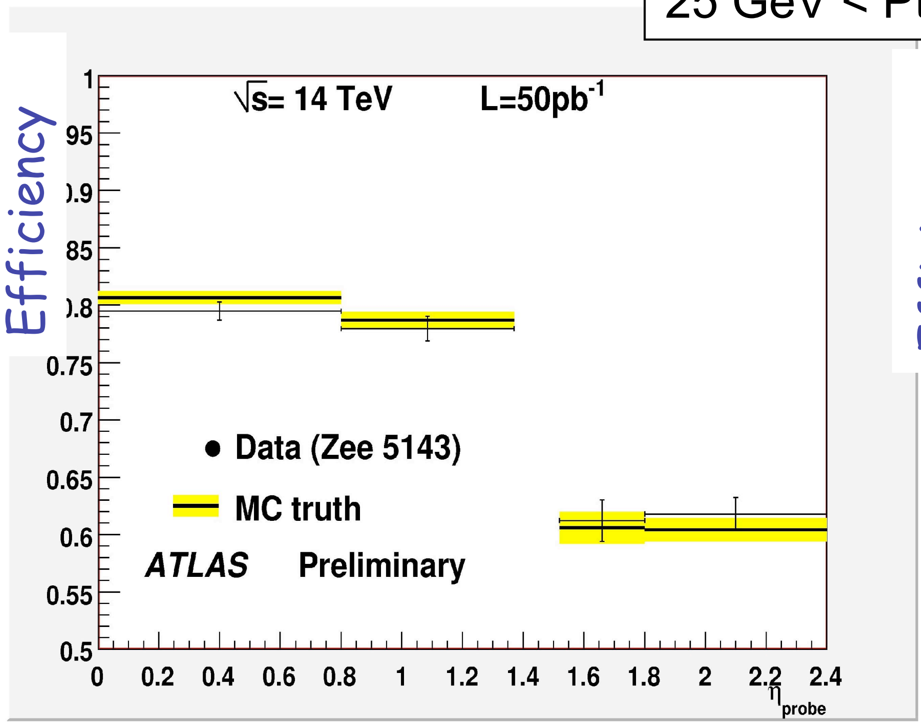




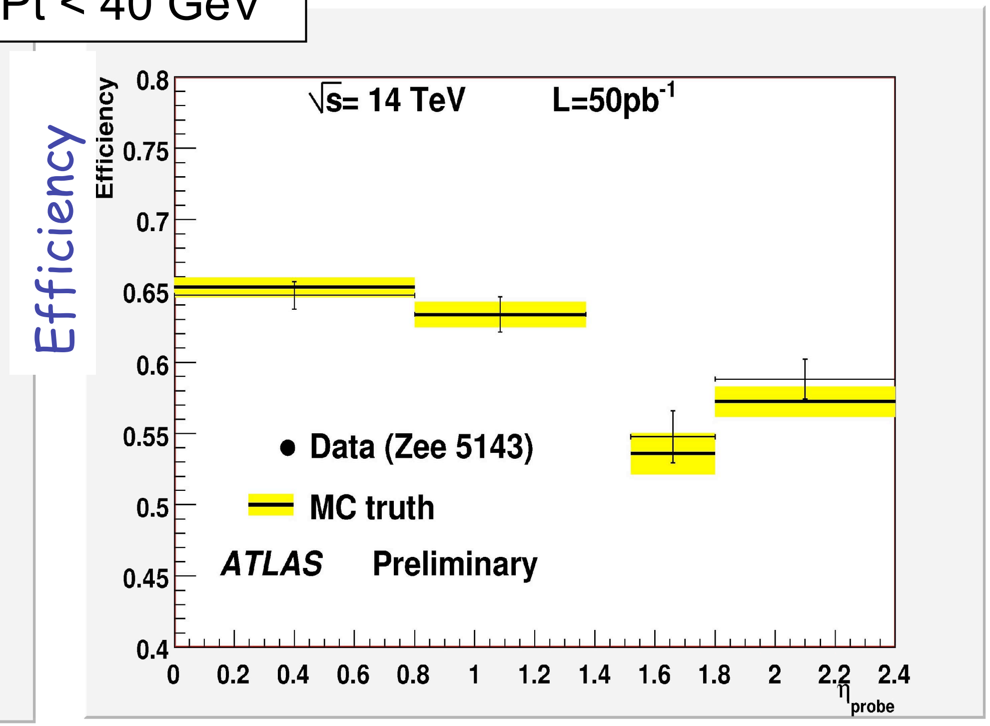
Differential Efficiency (II)

- Overall Efficiency in bins of Eta for 25GeV < Pt < 40 GeV
- Reconstruction Eff. * IsEM Eff

25 GeV < Pt < 40 GeV



Medium IsEM



Tight IsEM

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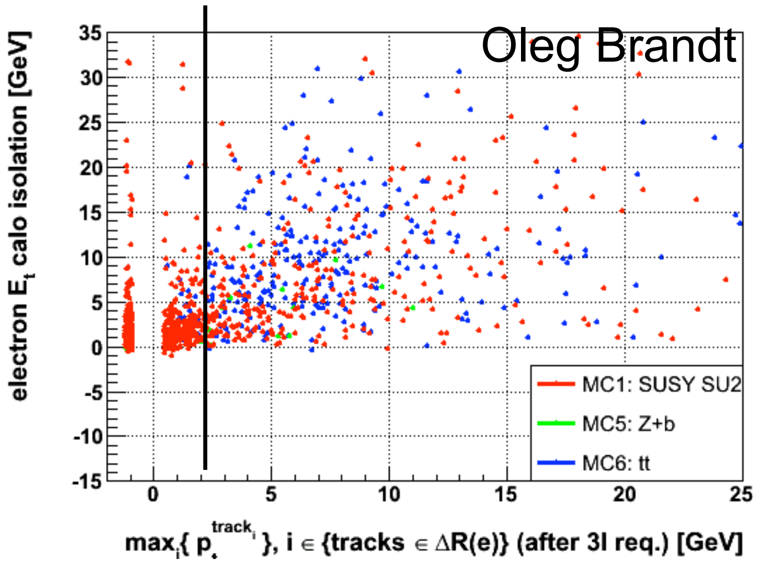


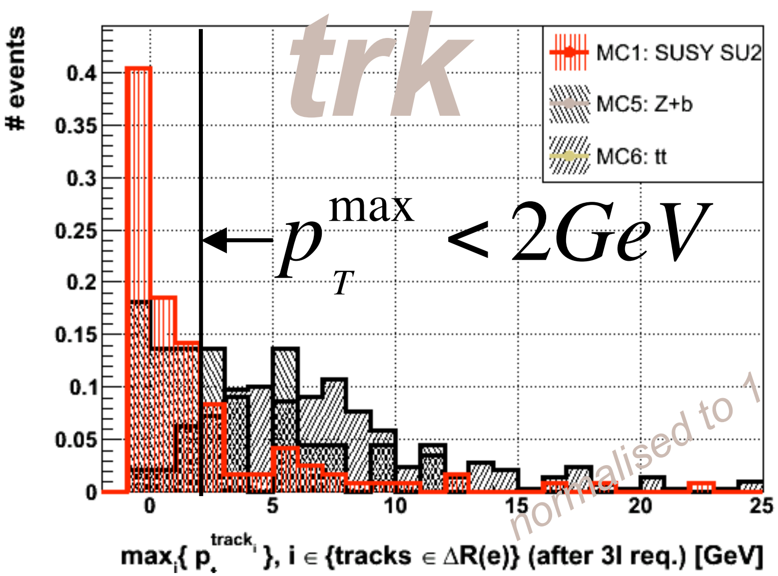
Isolation Studies
(motivation SUSY)

- Calorimeter Isolation
  - „etcone20“ ATLAS calorimeter isolation

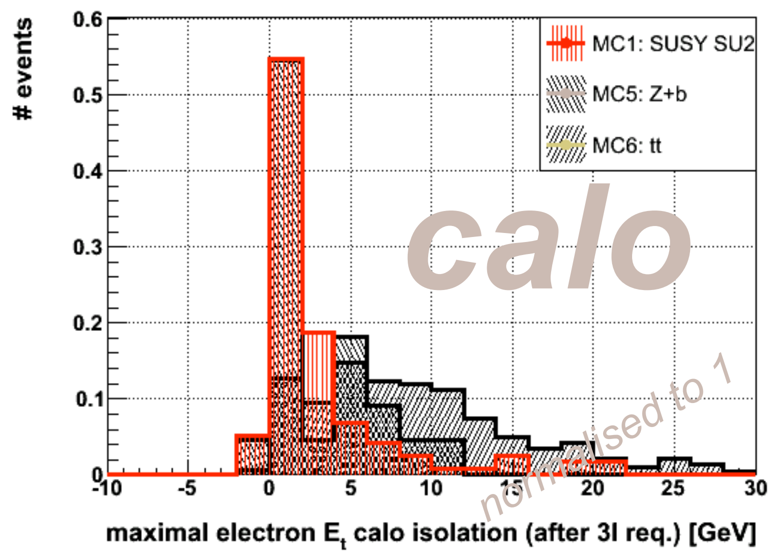
- Track Isolation:

$$I_{0.2}^{\rm trk} \equiv p_T^{\max}(\ell) \equiv \max{}_{i,j}\{p_T^{{\rm track}_i}|{\rm track}_i \in \Delta R(\ell_j)\}$$

- where $\ell = \mu\,, e \qquad \Delta R = 0.2$



rd, ATLAS-UK mee



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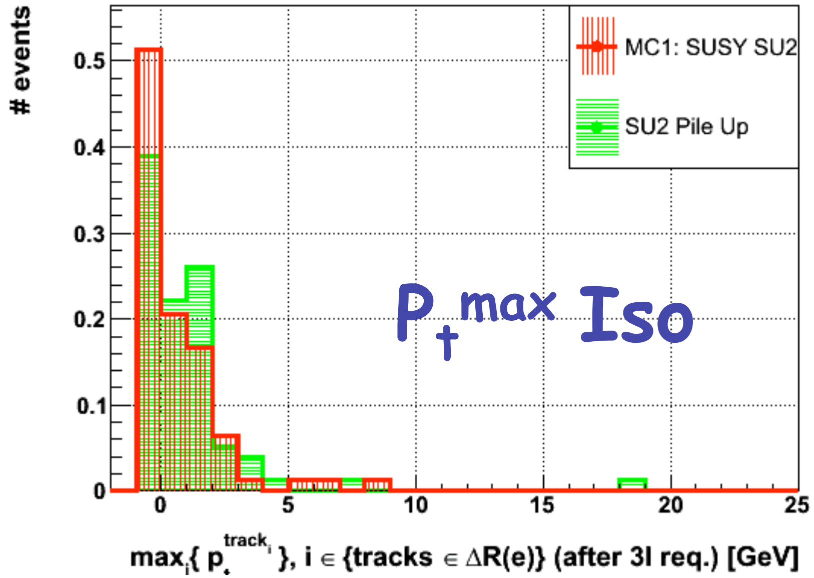
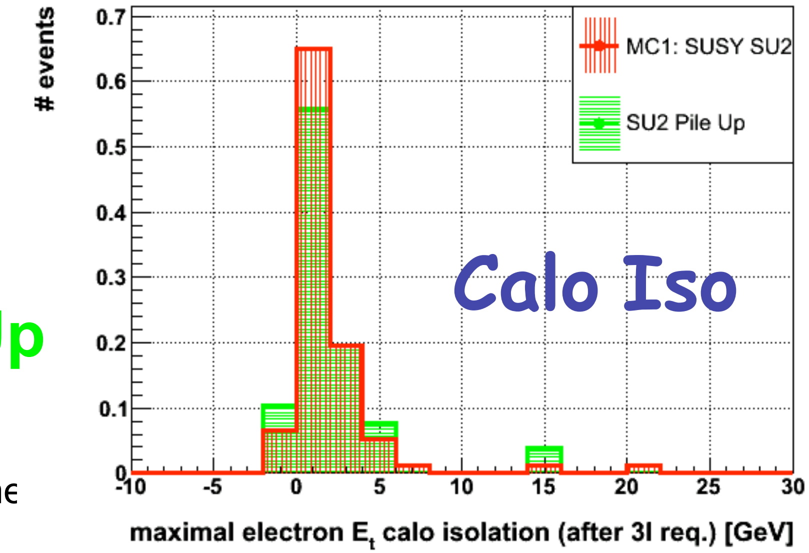
Isolation in Pile-Up Conditions

- Pile Up affects:
  - Track Isolation
  - Calorimeter Isolation
- **Under Investigation**



SU2: No Pile Up

SU2: With Pile Up



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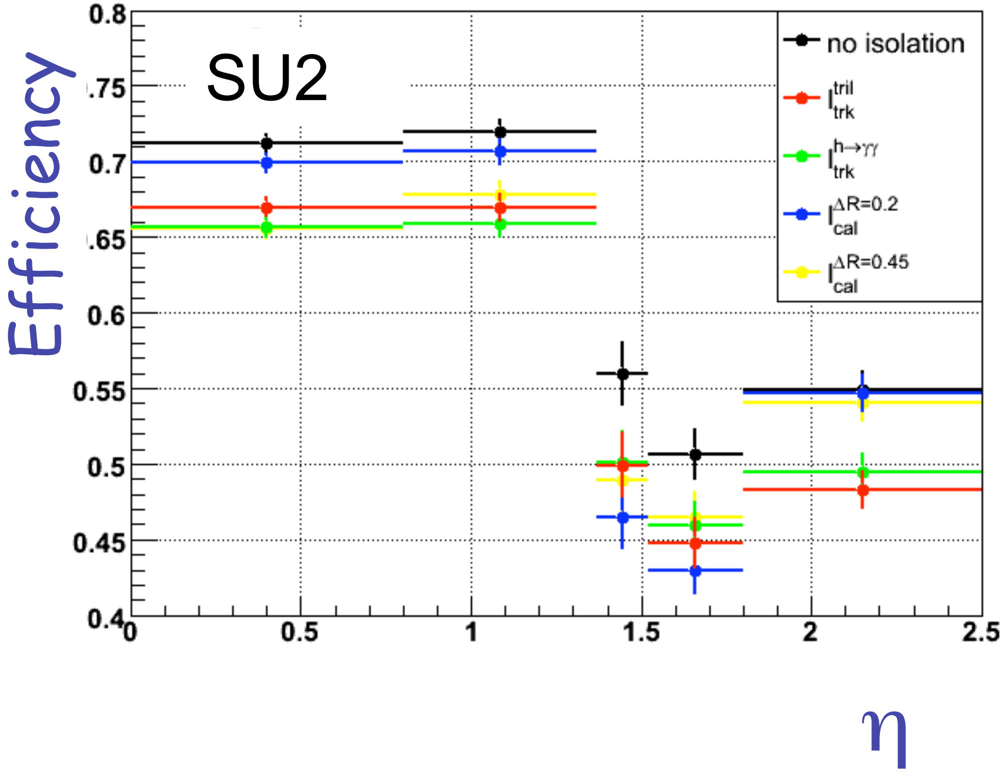
Isolation Efficiencies



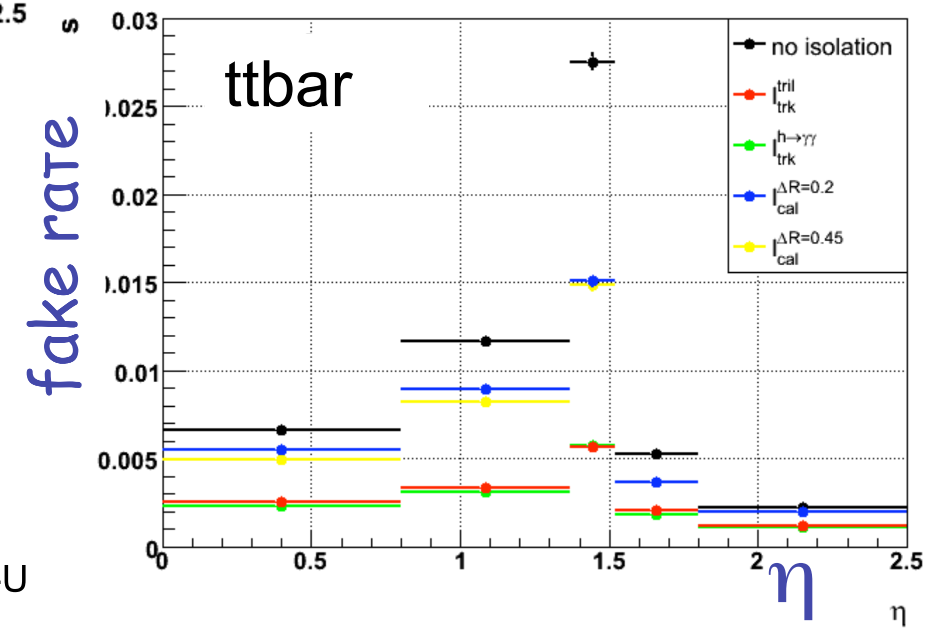
„Pt_max“ trk. isolation.

„Pt_sum“ trk. isolation.

Calo isolation (dR=0.2)

Calo isolation (dR=0.45)

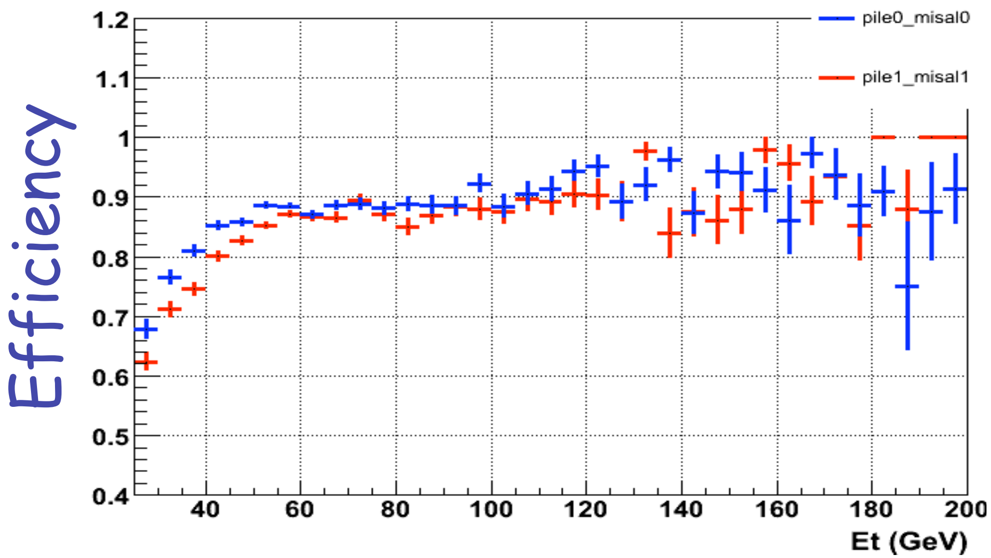
- performance of the track isolation w/r/t fake rates does not degrade around the crack region, as is the case for calo isolation.



Photon ID: IsEM

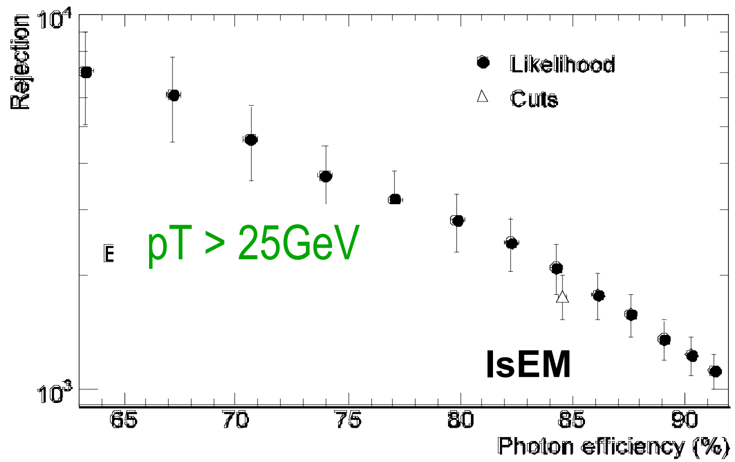
- Shower shape variables:
  - Hadronic leakage
  - Transverse size in 2nd sampling
  - Transverse size in 1st sampling + search for second maximum (π0 rejection)
- Cuts in bins of eta and Et
- Average efficiency after iso cut (10^{33} pileup)
  - 82.0% (misaligned geometry)
  - 84.8% (nominal geometry)

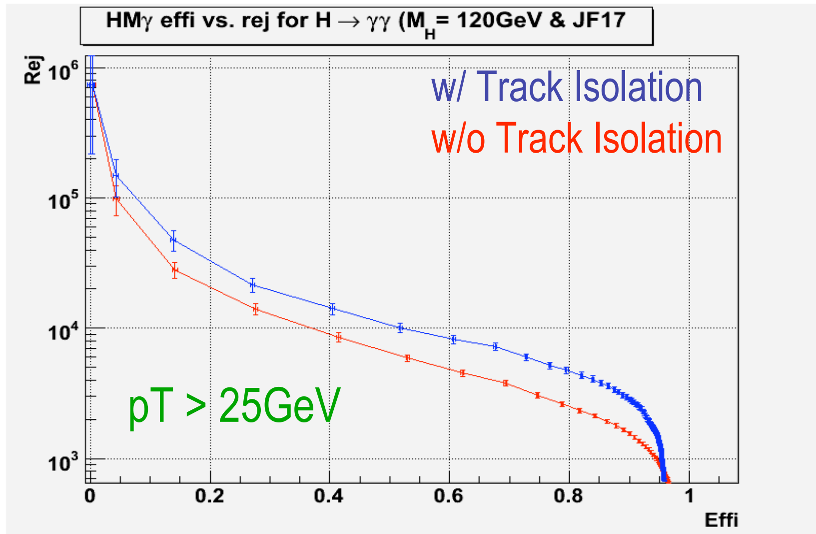
Efficiency before isolation cut

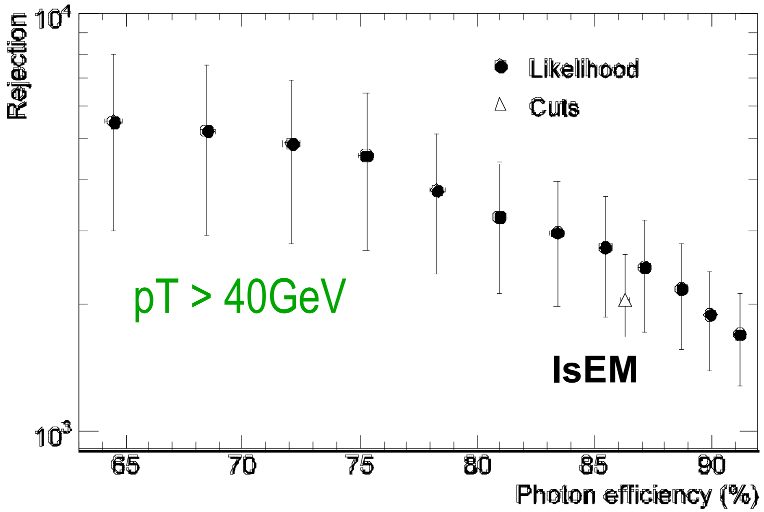


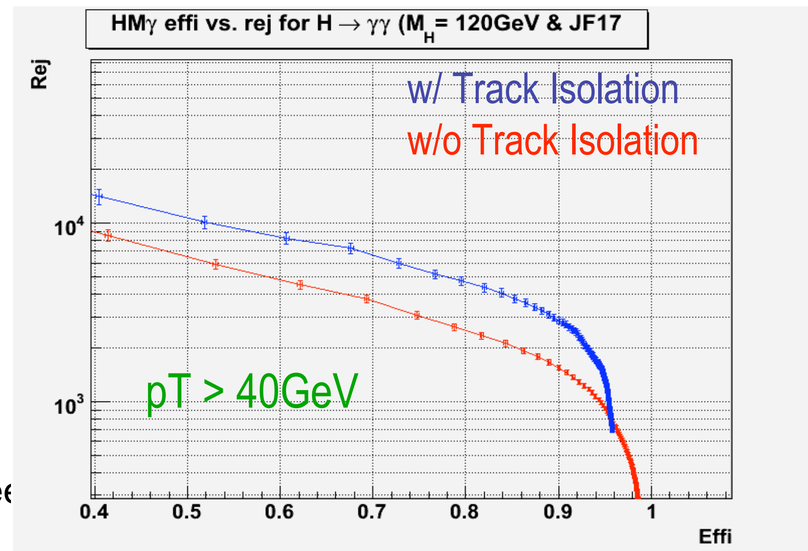
(Yaquan Fang, wisconsin)
(Hyeonjin Kim, University of Texas at Arlington)

Log Likelihood and H Matrix: efficiency from H→γγ sample

- 

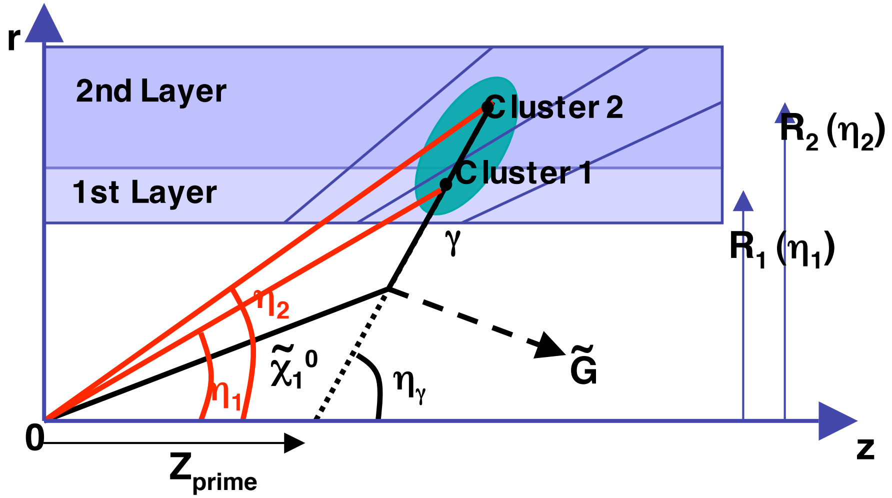
- 

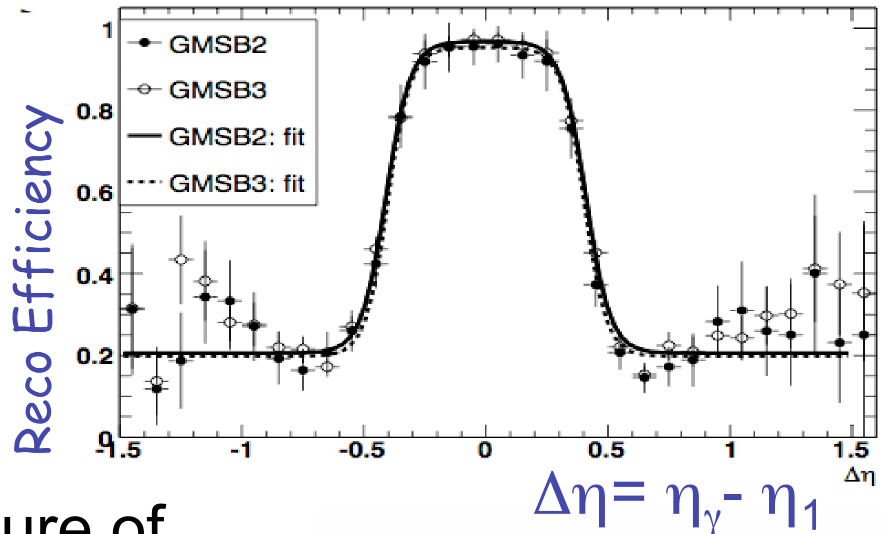


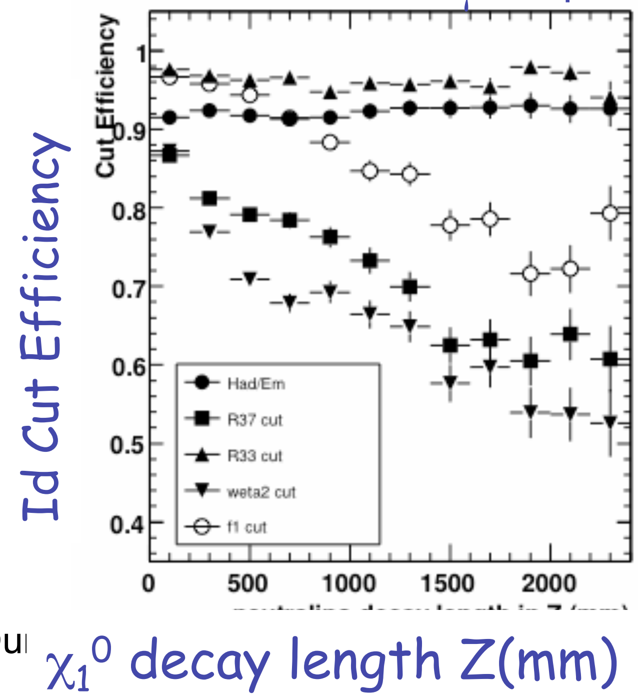


HH

Non-Pointing Photons







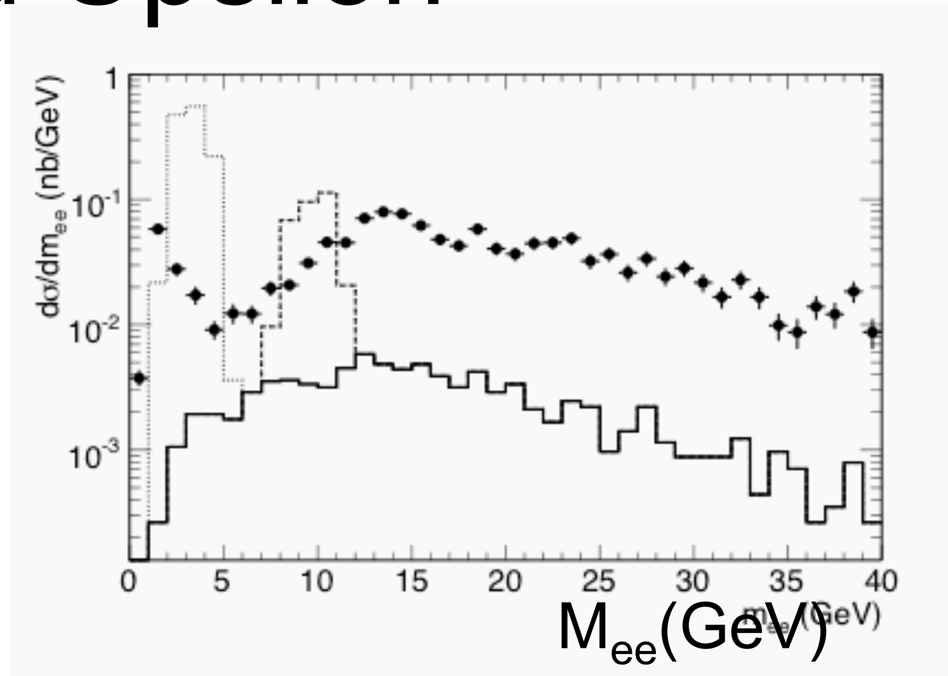
- GMSB SUSY can have a signature of a long lived neutralino decaying to a photon plus gravitino
  - Hence photon does not “point-back” to primary vertex
- Affects Reconstruction and Id Efficiencies
- (plots v12, GMSB MC)

(Vato Kartvelishvili, Evelina Bouhova)

J/Psi and Upsilon

- Low energy resonances will be an important tool to study early data.
  - trigger performance
  - offline electron reconstruction

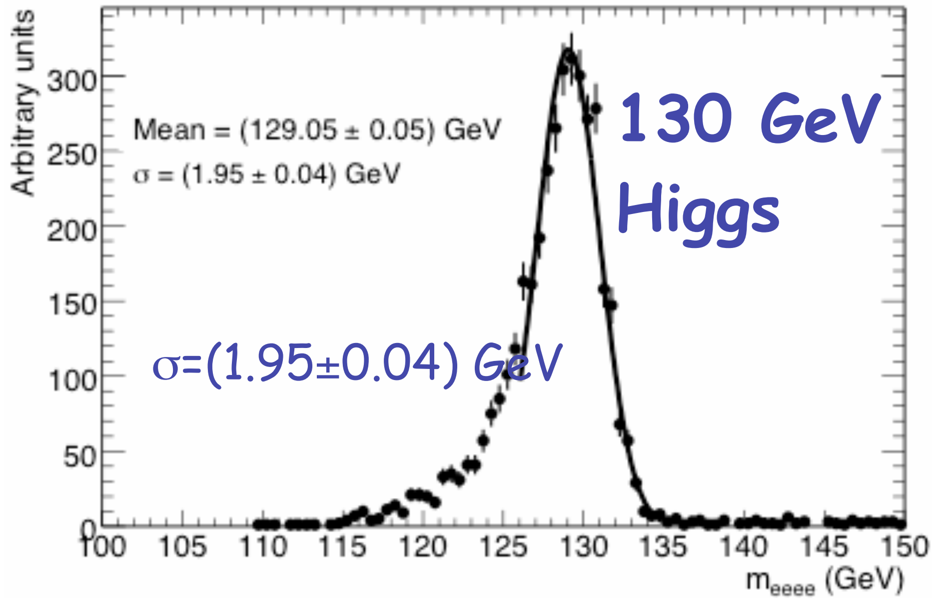
- With 100 pb^{-1} Tight elec cuts
  - Approx 100,000 J/ψ
  - Approx 30,000 Υ

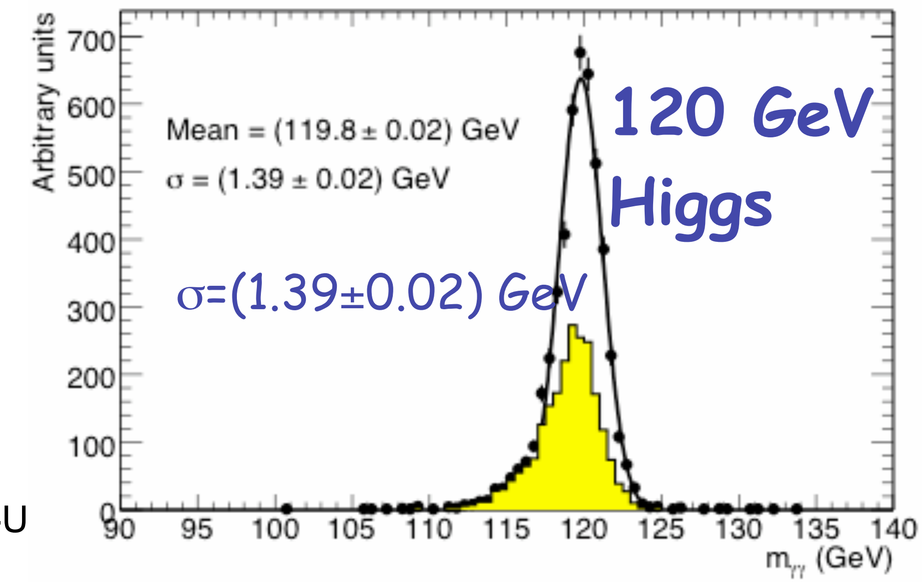


- Signal and background samples available in early data
  - Drell-yan (full histogram)
  - Expected BG after offline selection (full circles)

H→γγ, H→eeee

- The performance of the reconstruction (inc. calibration).
  - Loose cuts for electron
  - Tight cuts for photons
- Photon directions are derived from calorimeter direction and primary vertex info
- (shaded area corresponds to events where at least one photon converted before 80cm)





Summary and Conclusions

- UK people actively involved in a broad spectrum of EGAMMA activities. Important contributions to Detector Paper and CSC notes

- Systematic uncertainties to be quoted in Physics CSC notes for $0.1fb^{-1}$:
- Efficiencies:
  - overall 1%
- Energy scale:
  - Additional comment: 0.1% is at the Z peak, global spectrum: 0.5%
  - Upsilon could give an additional constraint at ~ 0.5%
- Resolution:
  - 20% (relative)
- Rejection:
  - Fake electron rates (when at the level of 10^-3 or below):
  - known to 50% for 100 pb^{-1} overall and integrated over limited range of pT,