LARG H8 combined run: Analysis status

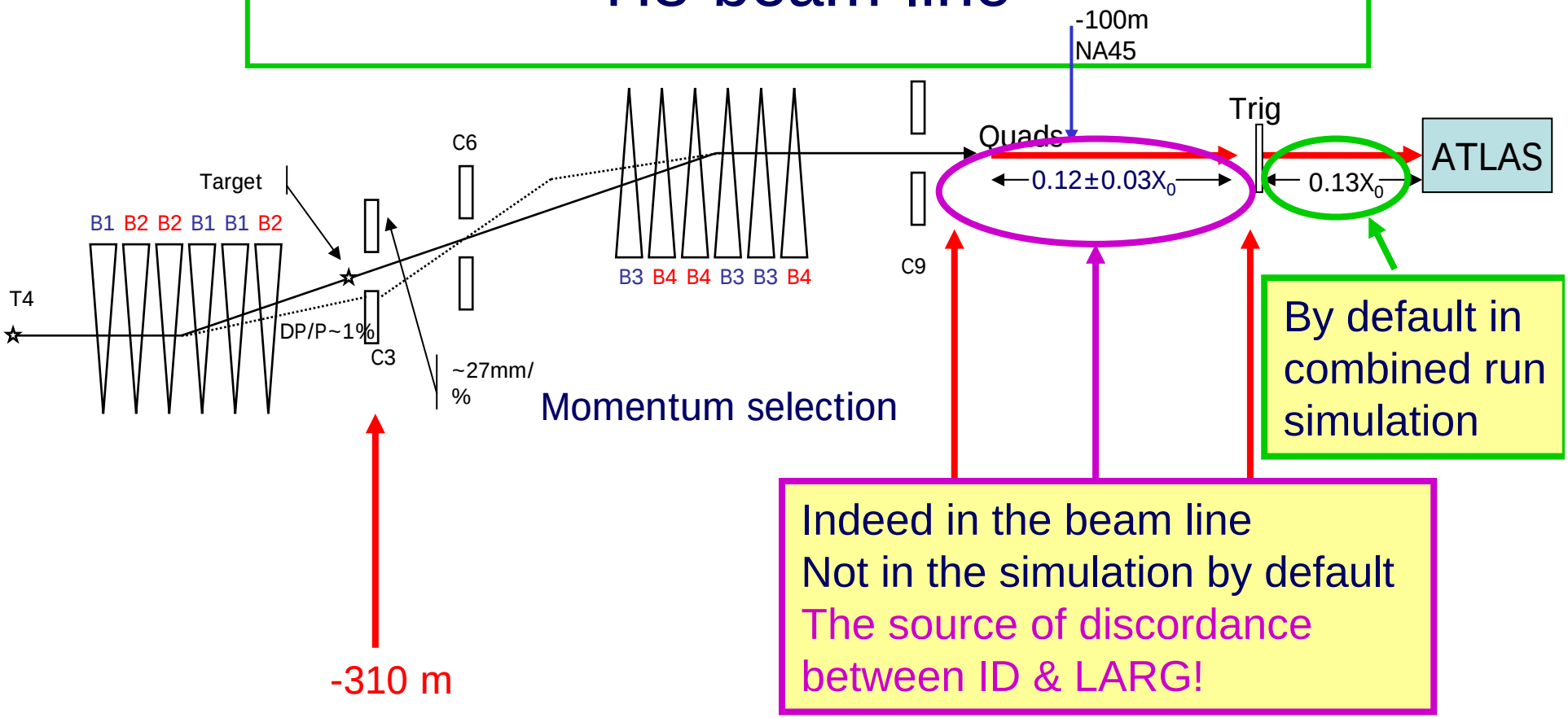
- General
- Data/MC comparison
- ID & beam simulation
- Converted Photon Studies
- Notes or papers to be written

On behalf of LARG-H8 analysis team

Work stream since ATLAS-week in February

- Work has been focused on:
  - MC description of the data
    - one of the aim of the CTB: have understood MC to have a reasonable description at $t_{ATLAS}=0$
  - Energy reconstruction
  - Work with ID & Tiles teams (T. Koffas & F. Sarri's presentations)
    - in particular to understand material description
- Work has started on:
  - Very Low Energy
  - photon conversions

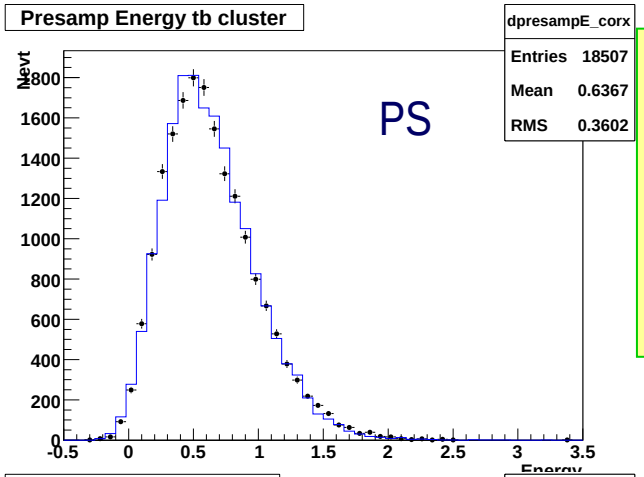
H8 beam line



By default in combined run simulation

Indeed in the beam line
Not in the simulation by default
The source of discordance between ID & LARG!

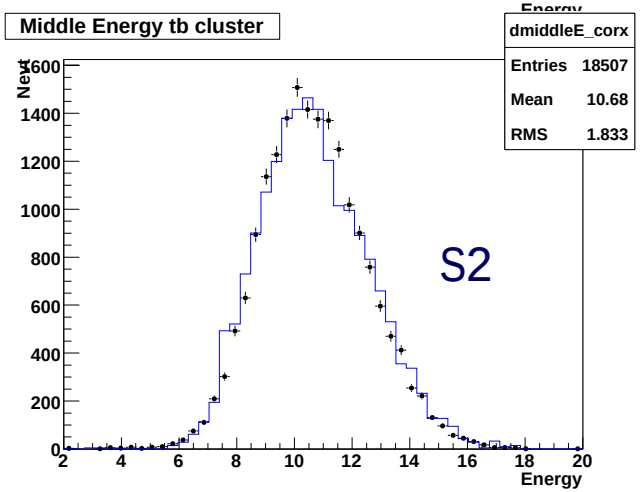
Trigger acceptance depends on energy loss and angular distribution of electrons.
Acceptance functions are being studied

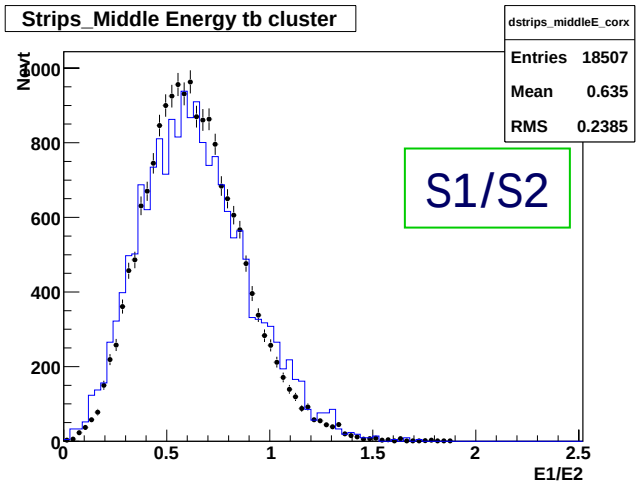


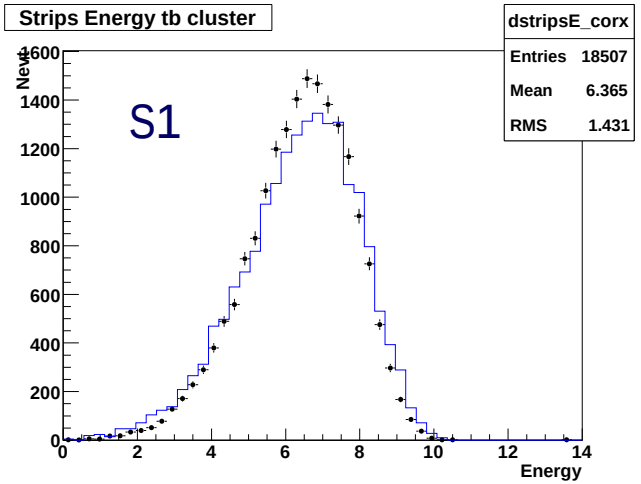
Data vs MC
Adding 0.15X_0 for upstream material in the beam

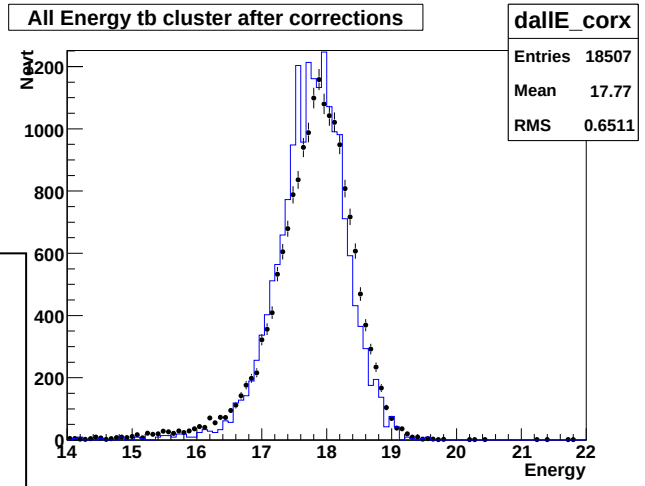
Period 8
20GeV run 2397

RATIOS
Data/MC









PS+S1+S2+S3

E=20GeV Run= 2397

E	1.003
PS	1.007 (0.006)
S1	1.002 (0.002)
S2	0.999 (0.002)
S3	1.021 (0.007)
S1/S2	**0.995 (0.003)**

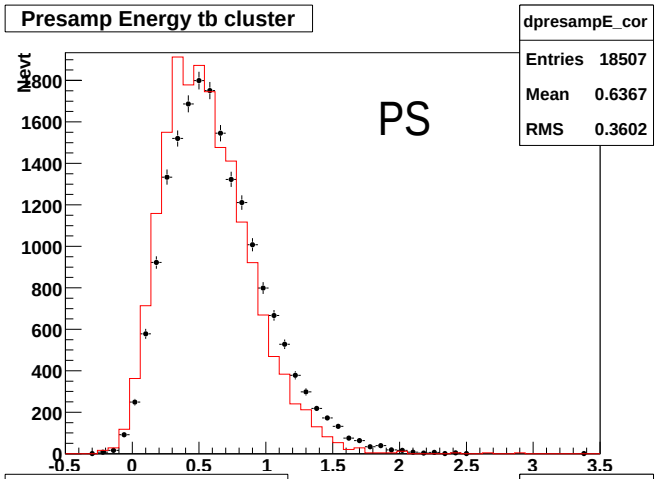
Data vs MC
NO far material

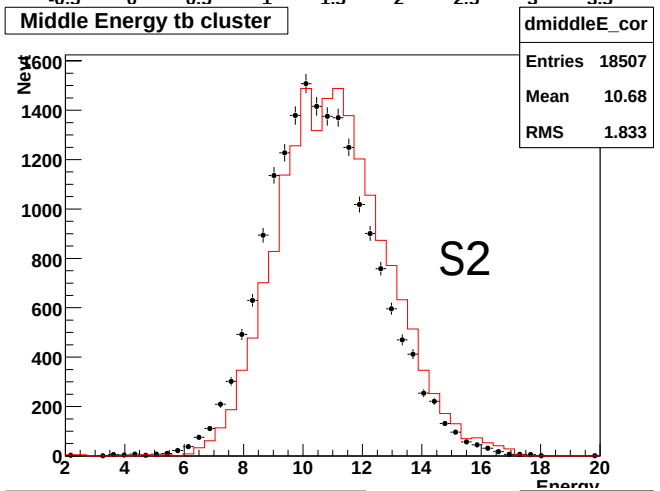
Period 8
20GeV run 2397

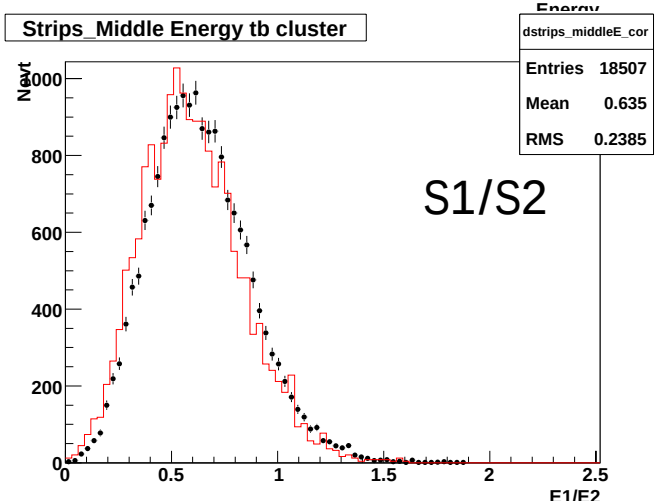
RATIOS
Data/MC

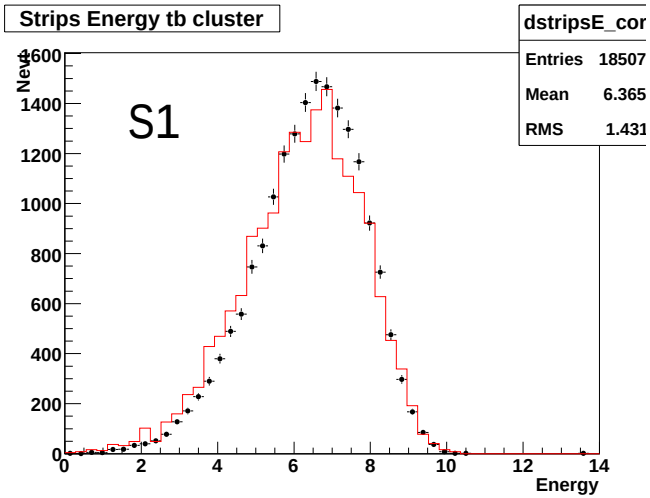
E=20GeV Run=2397

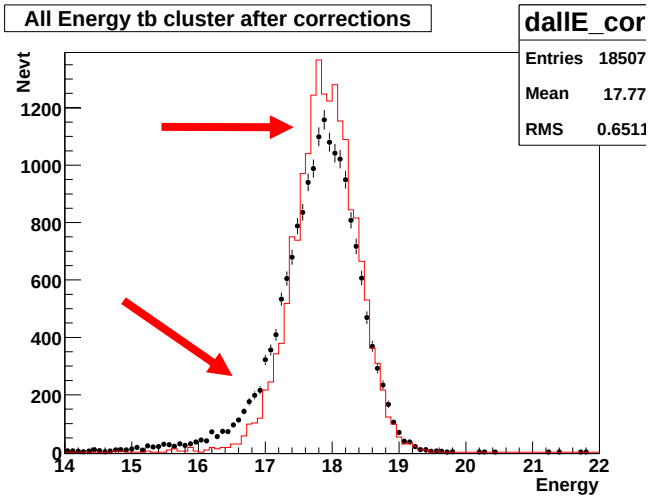
E	0.996
PS	1.122 (0.007)
S1	1.025 (0.003)
S2	0.968 (0.002)
S3	1.000 (0.007)
S1/S2	**1.058 (0.004)**









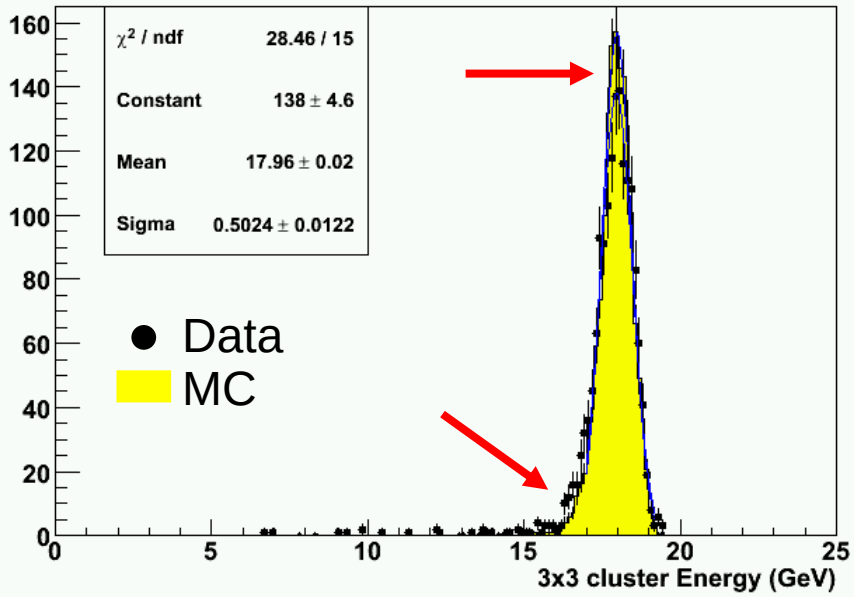


PS+S1+S2+S3

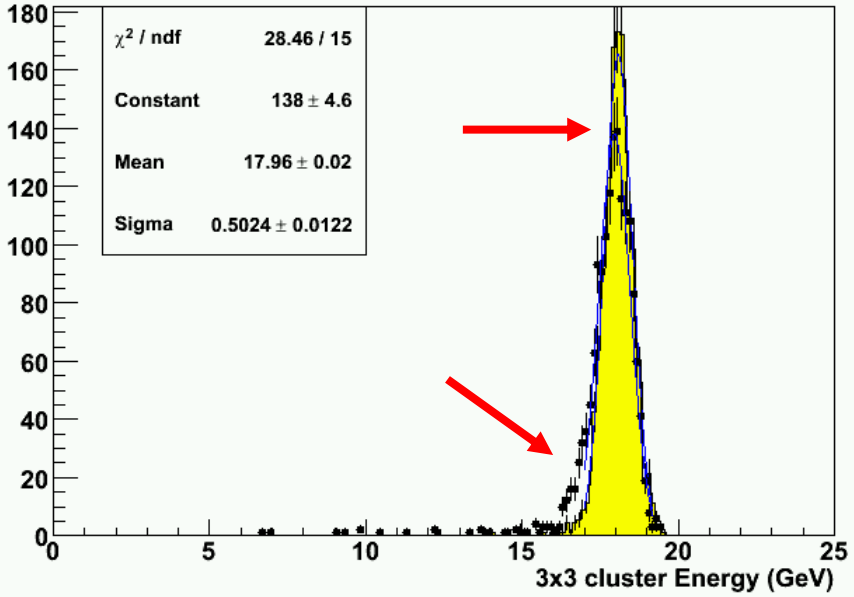
Significant difference in Etot shape
MC needs **12%** increase in PS response
MC needs **6%** increase in S1/S2

Testing the far upstream material hypothesis

15% X_0 extra material at -20m
(inadequate for tail description and incompatible with ID measurements)



No extra material



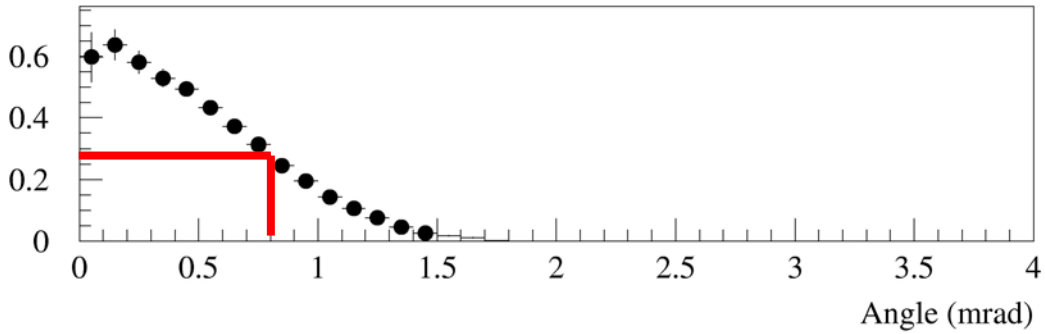
Maybe tail is due to (1) lost photons converting before the focusing magnets, and (2) photons converting after focusing with the electron lost.

Significant difference in shape

MC needs **8-10%** increase in PS response

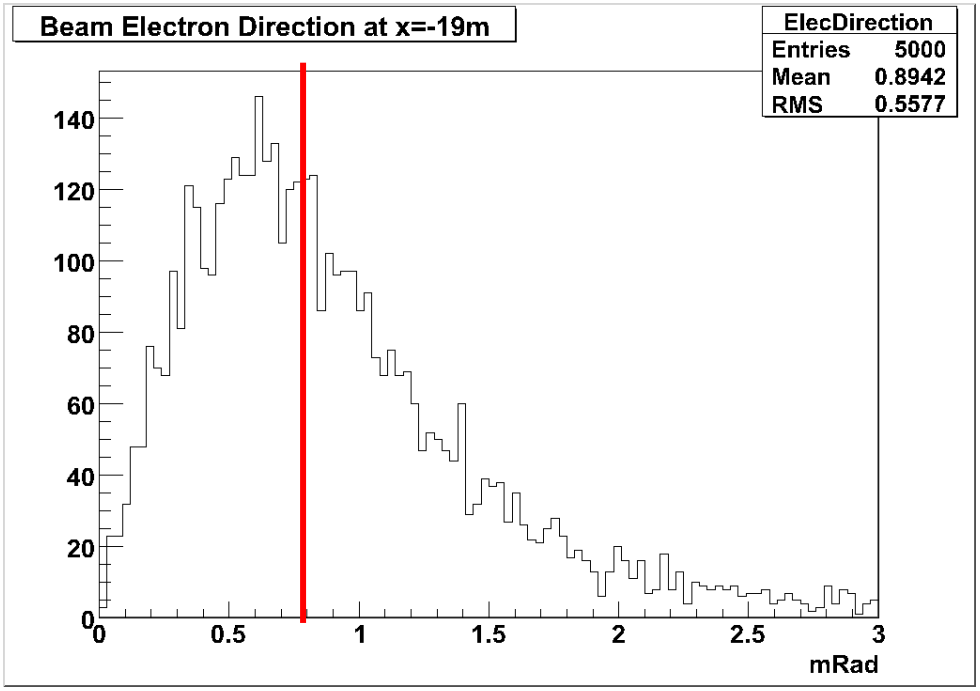
MC needs **5-6%** increase in S1/S2

Energy and Angular Acceptance Study (Monte Carlo)



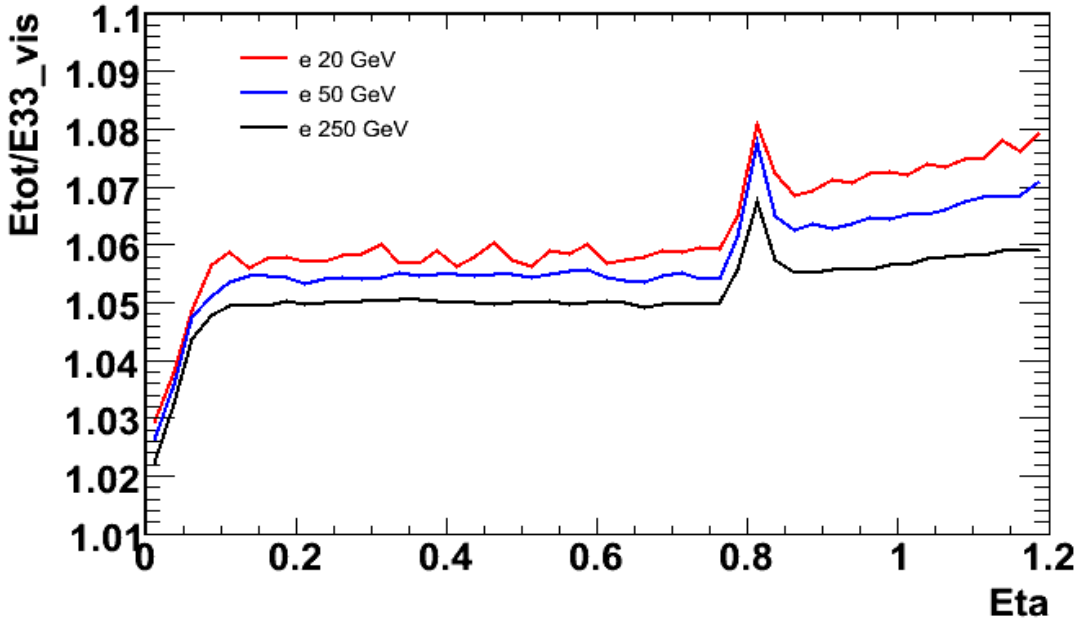
Detailed beam simulation at -25 m from LARG

Angular distribution for electrons after the block of Al representating the forgotten $0.12X_0$ (at -20m from LARG)



Energy Reconstruction Using Calibration Hits Technique

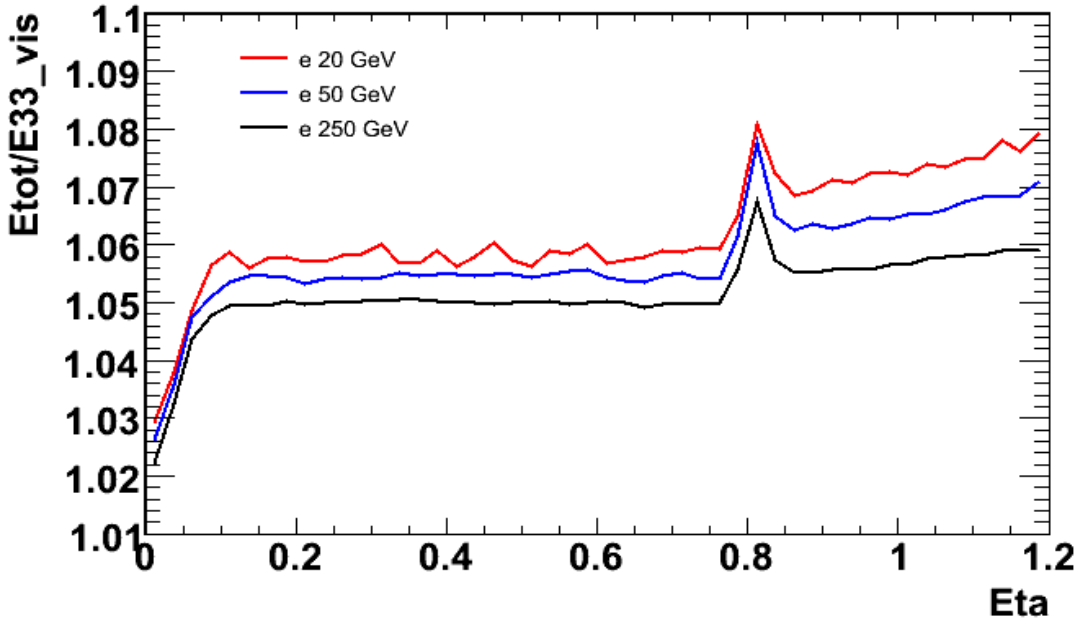
$$E = offset + W_0 E_{ps} + W_{01}\sqrt{E_{ps} E_{st}} + S E_{acc} + W_3 E_{back}$$



Sampling fraction*charge collection*out of Cluster

Energy Reconstruction Using Calibration Hits Technique

$$E = offset + W_0 E_{ps} + W_{01}\sqrt{E_{ps} E_{st}} + S E_{acc} + W_3 E_{back}$$

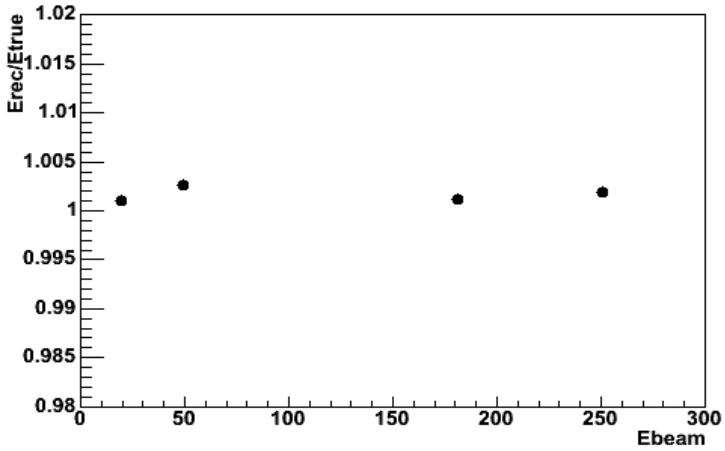


Sampling fraction*charge collection*out of Cluster

Energy Reconstruction: Results for 180 GeV electrons at η=0.4

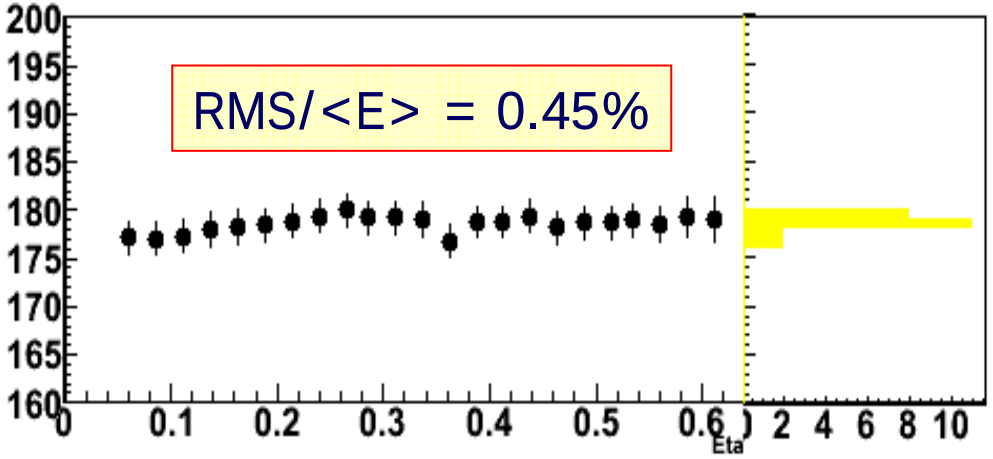
All corrections applied on MC

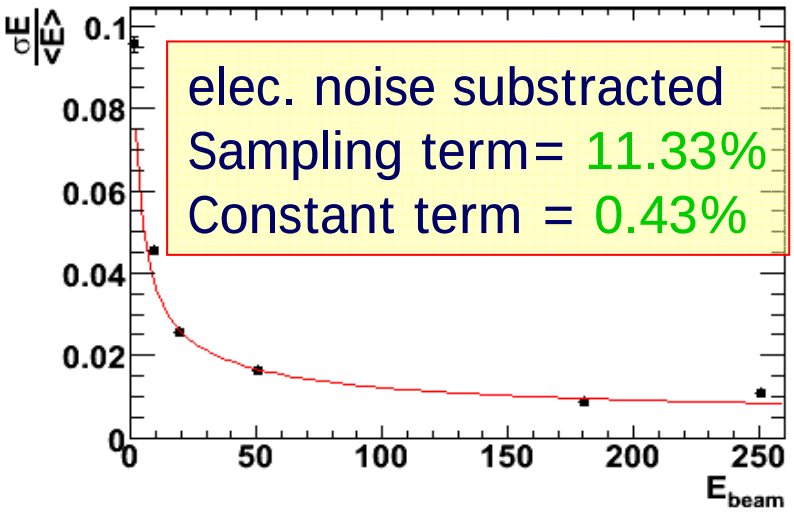
Validation of the method on MC



~0.1%

Results on data





Conclusion on MC description & Energy Reconstruction

- With the latest corrections in the accordion description, there is no need to add matter close to the calorimeter (important change since earlier presentations) to achieve a good description of the data with MC
- LARG needs the "forgotten far material" to describe the data
- Collaborative work between CTB-ID & CTB-LARG teams is ongoing and hoping to converge soon on the understanding of the discrepancy (angular acceptance?)
- Energy reconstruction, using calibration hits, has been improved recently by understanding the effects of Middle-Back cross-talk

Systematics on data/MC

- Presampler:
  - ADC2MeV : 5% (half G4.7-G4.8 difference)
  - Current/Energy map: 1-2%
  - ±5mm Lar upstream: 5%
  - Crack at phi=0 (to be studied)

  } ~ 7%

- E(strip)/E(middle)
  - Lead thickness: 1-2%
  - Strip/middle separation 1%
  - ±5mm Lar upstream: 5%
  - Energy/Current simulation 1%
  - Strip Xtalk correction 1-2%
  - 5% X0 between PS and strips 1-2%
  - Using correct Rinj values 1%
  - Cross-talk middle-strip (to be checked)

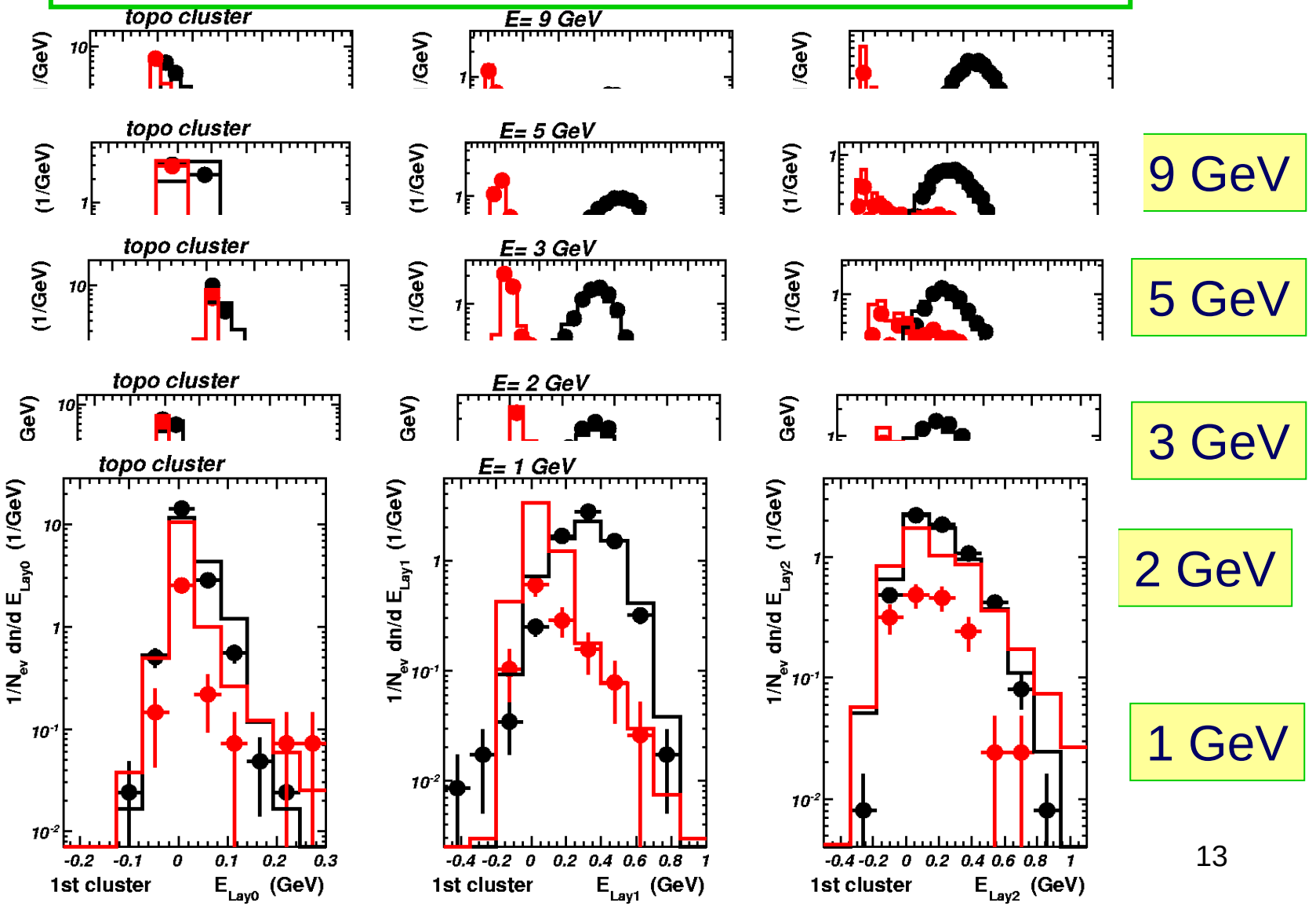
  } ~ 6%

- **Far upstream matter is ~1-2 sigmas of this** *but:*
- Complicated correlations and energy dependence…
  - Should not effect much non-Gaussian energy tails

Very Low Energy: data/MC comparison

- Electrons
- Pions

MC (11.0.41)



9 GeV

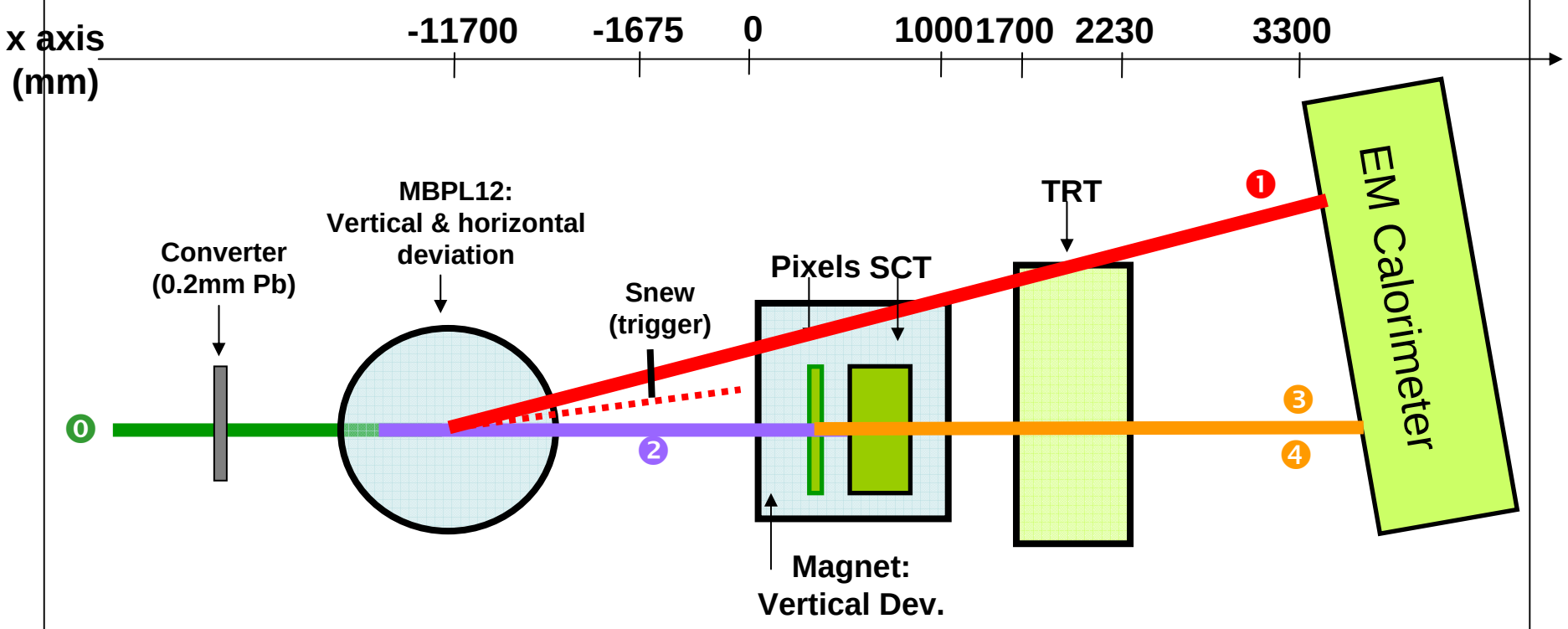
5 GeV

3 GeV

2 GeV

1 GeV

Photon beam studies



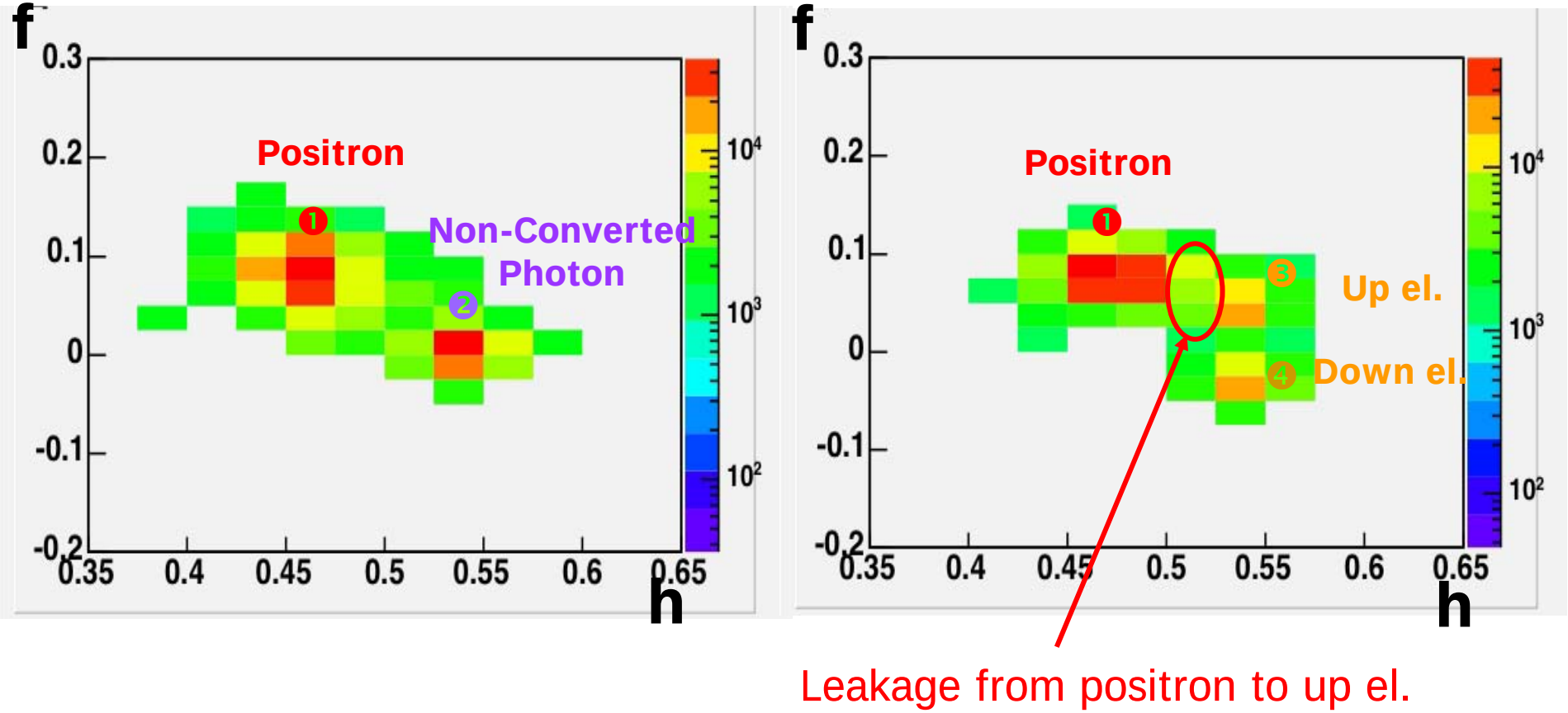
0 Initial Positron 180GeV

1 Positron after Bremstrahlung

2 Non-converted photon

3 4 (e- e+) pair

Events Topology

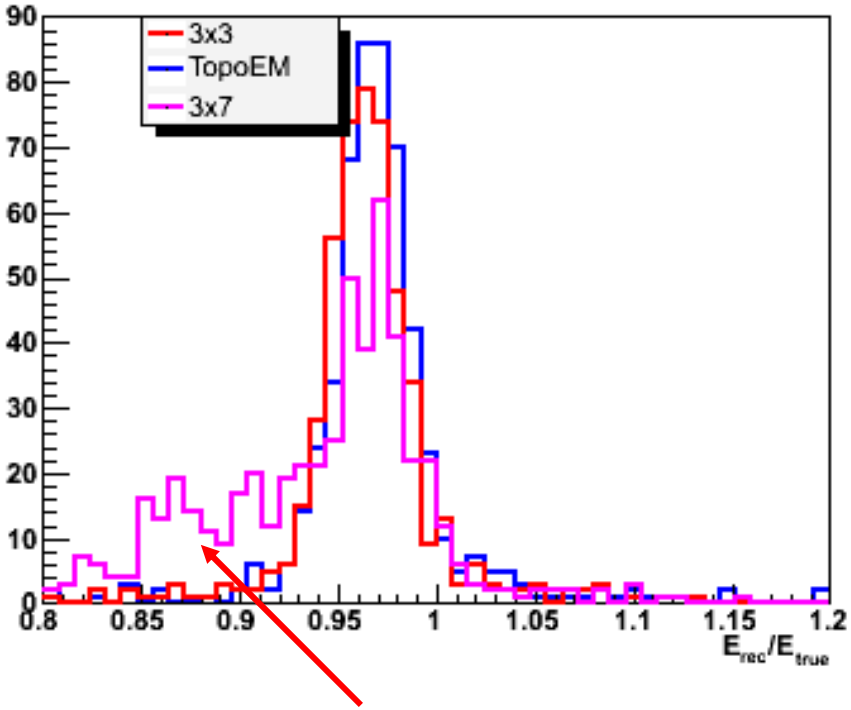


- Photon Energy Scale
- Photon Conversion Reconstruction (EM & EM+ID)

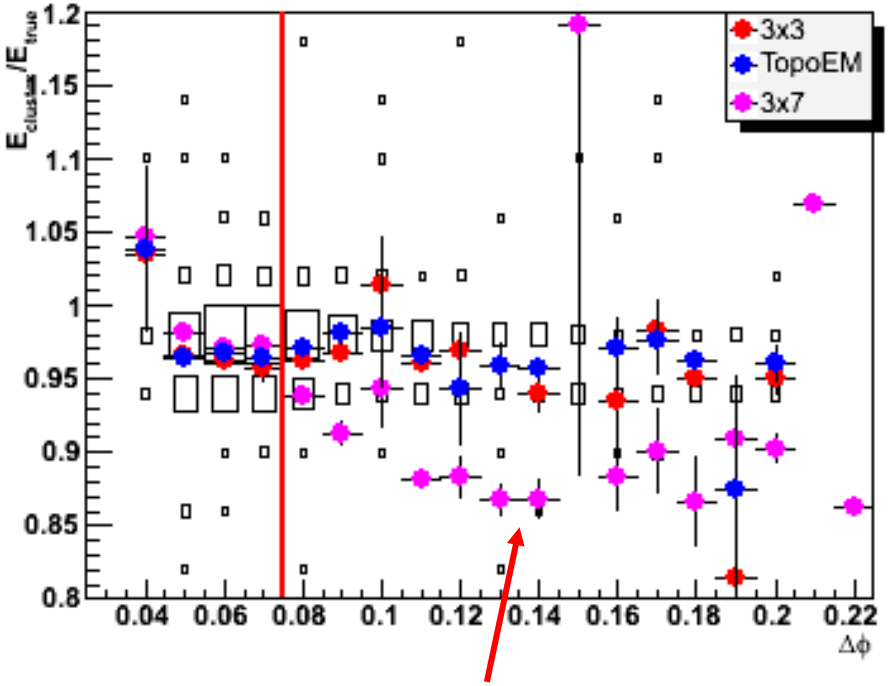
Events with two clusters: converted photons (MC)

(clusters are not calibrated at this point)

Ratio of reconstructed energy over true energy:

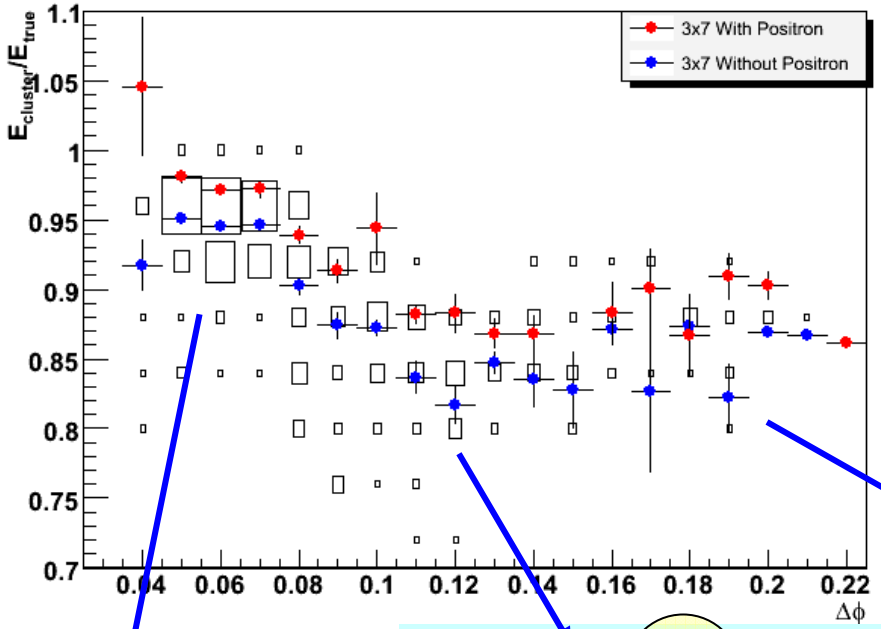


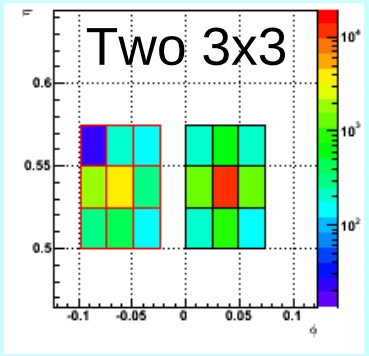
As a function of $\Delta\phi_{topo}$:

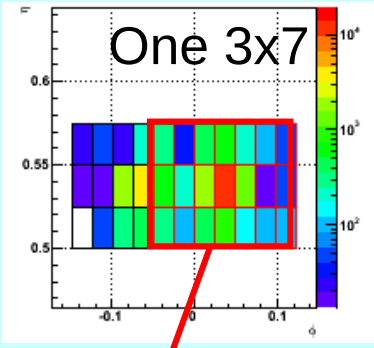


Standard 3x7 clustering behaves « badly»

Standard 3x7 Clustering







Miss 30% of E

→ Would need a "centered" 3x7

$\Delta\phi$=0.05

$\Delta\phi$=0.1

$\Delta\phi$>0.12

E_2

E_1

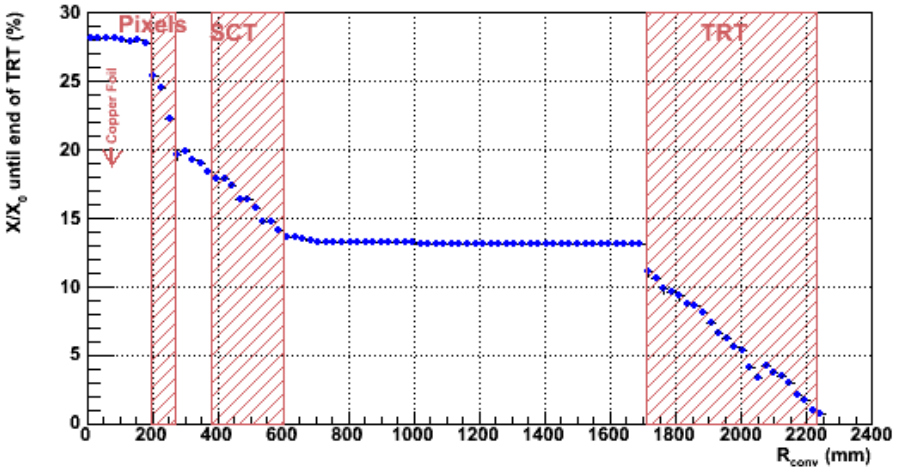
Loose more and more energy

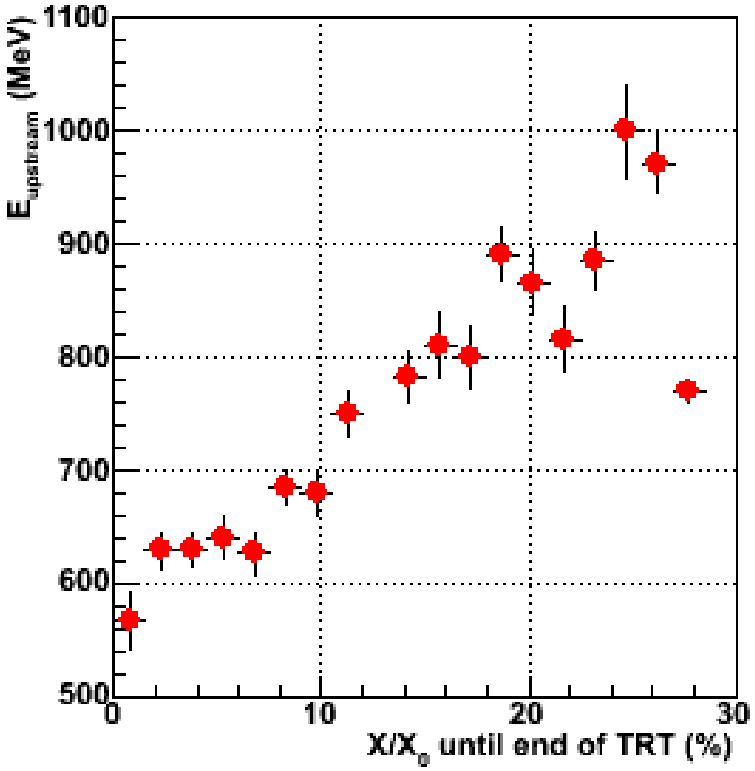
Do not loose more energy because E_2 goes down

→ Difficult to calibrate !!

Converted Photon Calibration

- **Goal:** elaborate dedicated calibration (derived from calibration hits) for conversions and compare it with default calibration (in particular, look how much parameters vary with conv. radius)
- E(PS+upstream) = a + b E_{PS}





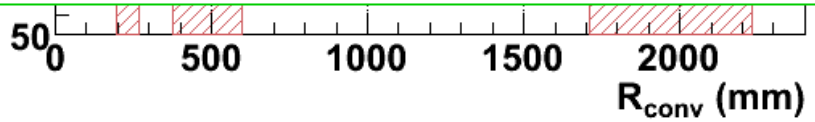
Energy measured in PS not linear with X/X_0

Probable explanation (to be more quantified):

- energy in PS sensitive to beginning of shower
- lateral shape of shower at small shower depth is non-linear
- thus variation of PS energy with X/X0 (i.e. shower depth) is non linear

Also, the distance and presence or not of magnetic field at the moment of conversion probably play a role a well (to be quantified)

→There is thus a real effect on visible PS energy that will make the calibration parameters dependant on conversion radius !



Conclusions

- All the calibration developments done for LARG-CTB are now used in commissioning
  - Very large efforts in the last two years
  - Directly profiting to ATLAS
- Electron energy reconstruction now well understood
  - Calibration Hits Methods implemented
  - Very Low Energy reconstruction down to 1 GeV
- Close to a full understanding of the effect of material in the beam line
  - collaboration with ID
- More refined work now starting
  - Photon reconstruction
  - Photon conversion

CTB-LARG-H8 analysis team

- M. Delmastro, W. Lampl, S. Paganis, P. Johanson, M. Aharrouche, G. Unal, M. Aleksa, M. Ridel, P. Schwemling, E. Buzato, R. Lafaye, T. Carli, S. Laplace, Karl Johan, K. Loureiro, N. Kershen, M. Boonekamp

- Working with ID people: T. Koffas, T. Vu Anh, D. Froidevaux, M. Kataoka