The University Of Sheffield.

Electrons in CTB: status of data/MC comparisons

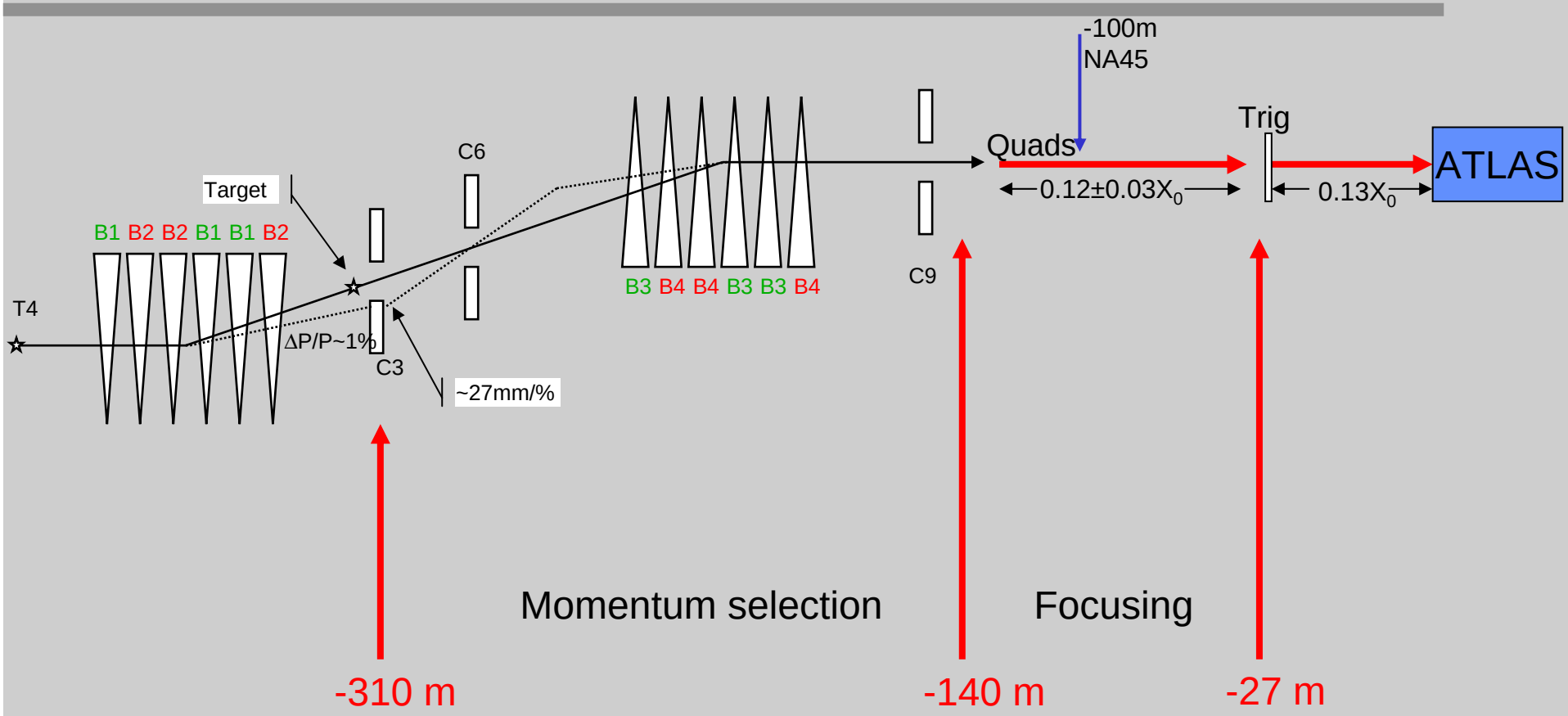
LAr & Inner Detector H8 CTB groups

Physics Week, CERN, 30-May-2006

Introduction

- LAr Material problem: partially solved
  - No additional material needed in the region from trig scintillators to EM Cal.
  - Reasons: improved Detector Description, analysis biases, other:
    - Pb thicknesses at cold, strips/middle boundary on electrode: 4-5% on S1/S2
    - Data vs MC reconstructed phi was biased: 2% effect
    - Other smaller factors.
  - Results from periods 5, 6, 8 including Very Low Energy and ID inputs.
- For publication quality results an accurate simulation of the incoming electron+photon spectrum from the beam-line is needed.
  - Electron momentum distribution must be compatible with the ID
  - e+γ energy distribution must be compatible with what is measured in EM Cal.
    - Beam line has air stretches and beam pipe windows (0.12±0.03X0)
    - Trigger acceptance depends on E-loss and angular distributions
- Atlas-like longitudinal weight extraction:
  - Extracted from MC and applied to data in different periods!
  - Use the same code used for extraction of offline 12.0.0 weights.

H8 beam line



Trigger acceptance depends on energy loss and angular distribution of electrons. Acceptance functions have been produced and will be tested with data in combined runs. Inner Detector an important player here.

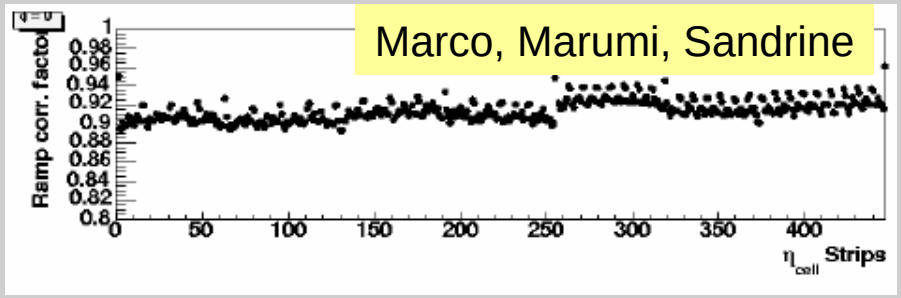
Maarten, Nicolas, Elias

EMBarrel: factors (4) applied to Data and MC

Data factors:

PS Correction = **1235/1149** —G4→ (ADC2MeV G4v4.8) / (ADC2MeV G4v4.7)

Strip Correction = **0.91** —Measured→



MC factors:

EMscale = **0.975** —Matched→ Run 1000952, period 5

PSscale = **0.946** → Losses at phi=0 due to non-modelling of the PS module crack. To be checked from data

Offline version: 11.4.0, Geant: G4v4.07-patch-01
Default MC: with 0.15X0 at -20m to simulate material in the beamline
(not the best thing to do)

Results

- Period 8 combined runs: EM and ID

- Periods 5 , 6
  - 5 energies, 9-180GeV

- Period 8 (Very Low Energy runs)
  - Momentum selection few meters upstream CTB triggers (-27m)

Data vs MC
ONLY far material

Period 8
20GeV run 2397

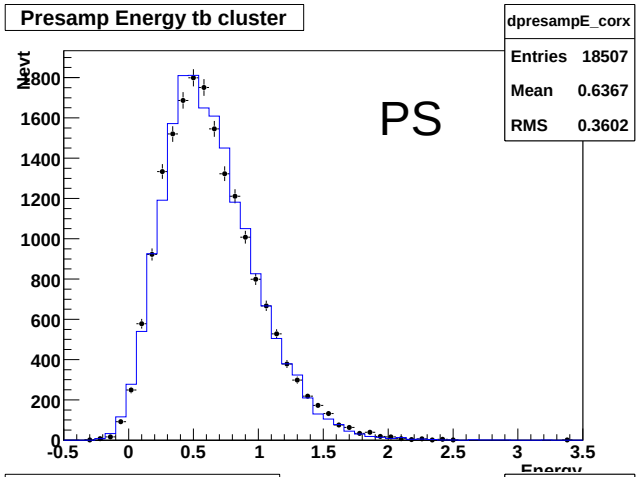
RATIOS
Data/MC

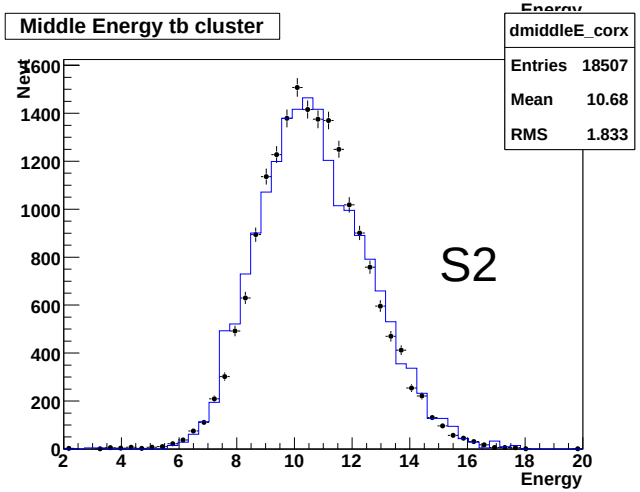
E=20GeV Run= 2397

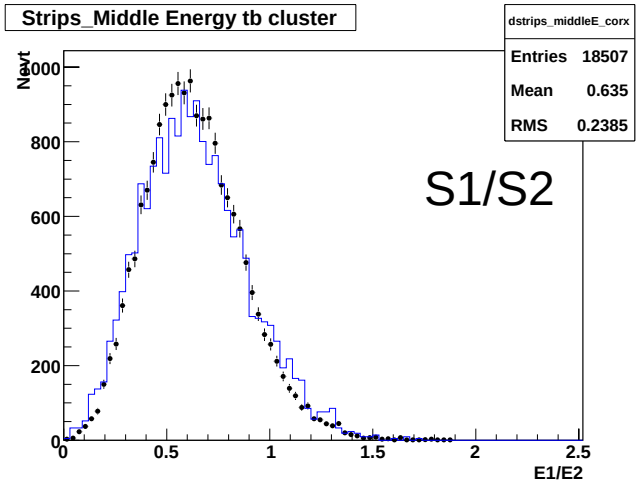
E	1.003
PS	1.007 (0.006)
S1	1.002 (0.002)
S2	0.999 (0.002)
S3	1.021 (0.007)
S1/S2	**0.995 (0.003)**

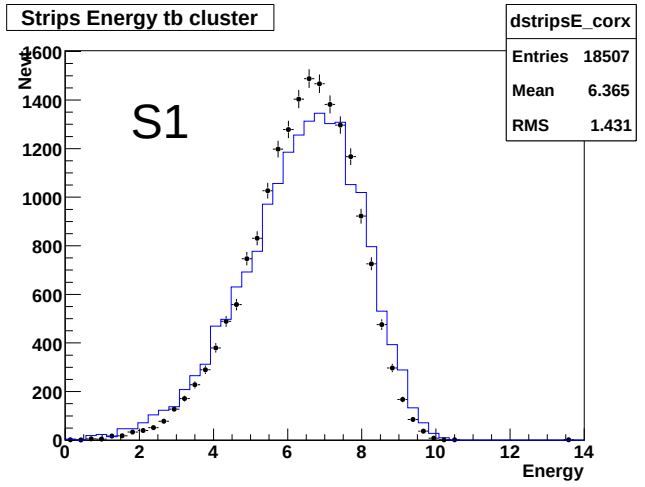
PS+S1+S2+S3

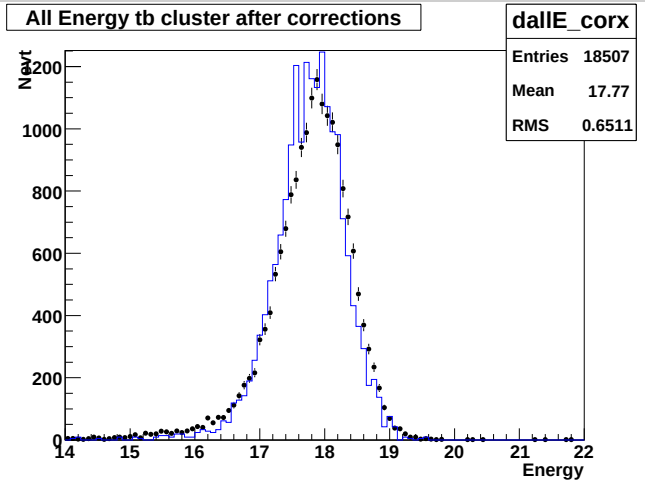
Per Johansson











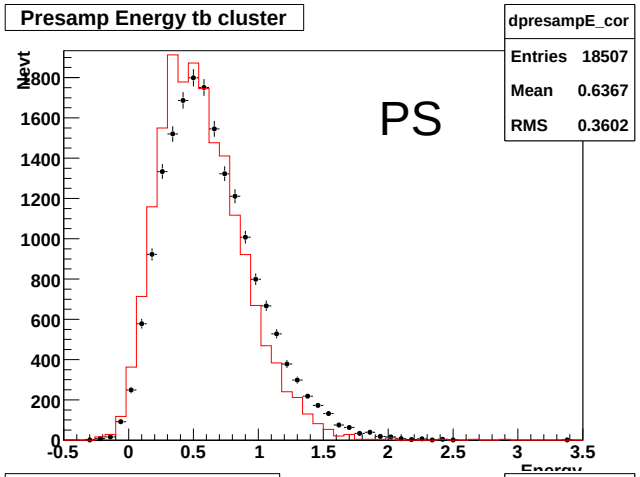
Data vs MC
NO far material

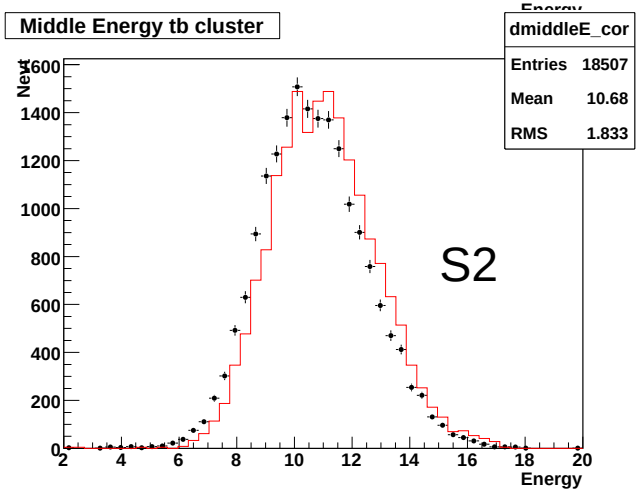
Period 8
20GeV run 2397

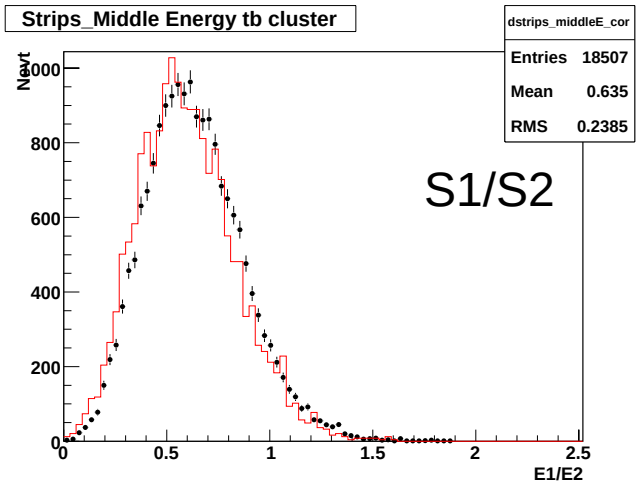
RATIOS
Data/MC

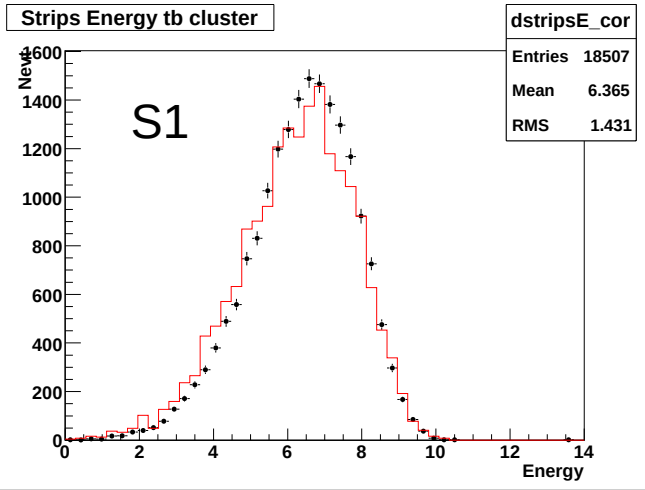
E=20GeV Run=2397

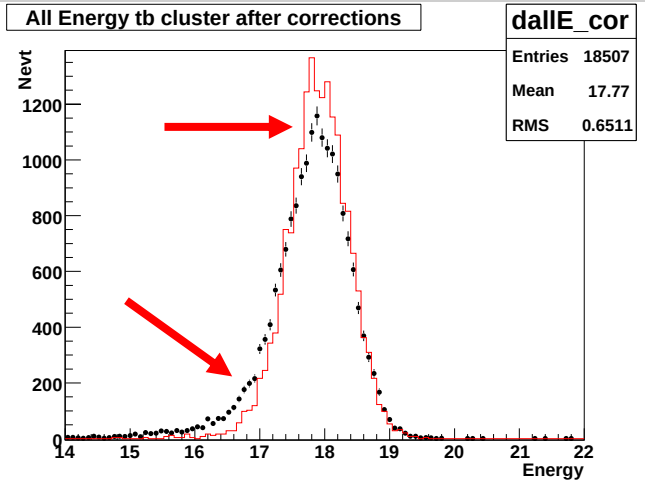
E	0.996
PS	1.122 (0.007)
S1	1.025 (0.003)
S2	0.968 (0.002)
S3	1.000 (0.007)
S1/S2	**1.058 (0.004)**











PS+S1+S2+S3

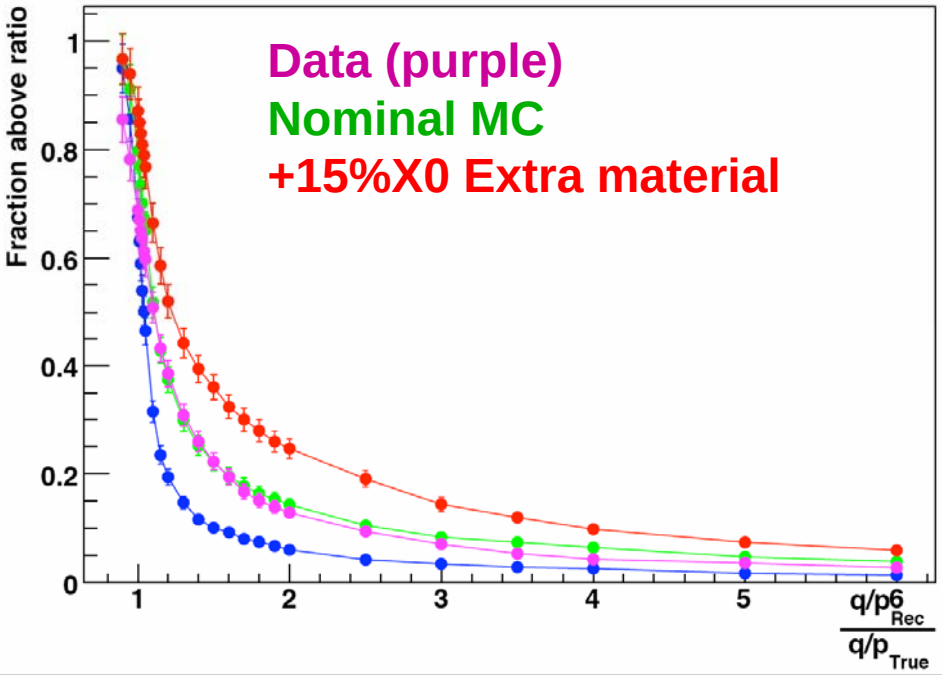
Significant difference in Etot shape
MC needs **12%** increase in PS response
MC needs **6%** increase in S1/S2

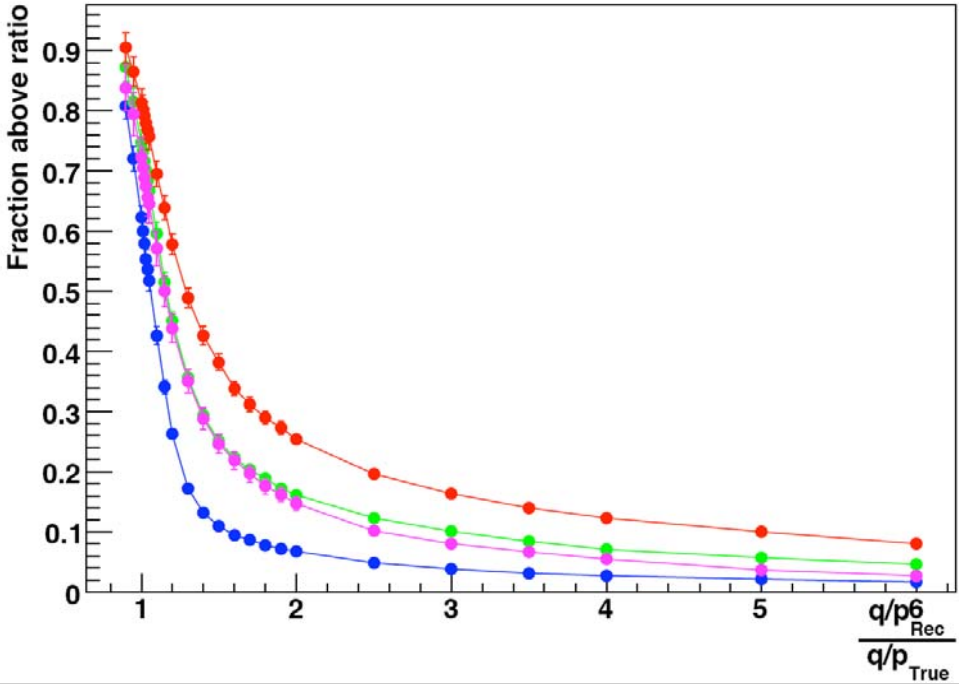
ID (SCT segments) P_{true}/P_{rec} integral distributions

Tom, Daniel et al

9GeV VLE run (insensitive to far upstream material)

20GeV e run (sensitive to far upstream material)





- Plots show the fraction of electrons with P_{true}/P_{rec} > xvalue
- Data suggest the absence of tails in the electron Energy distributions at the entrance of the ATLAS CTB (-27m).
- Systematics for ID are currently at the level of the difference between data and nominal MC.

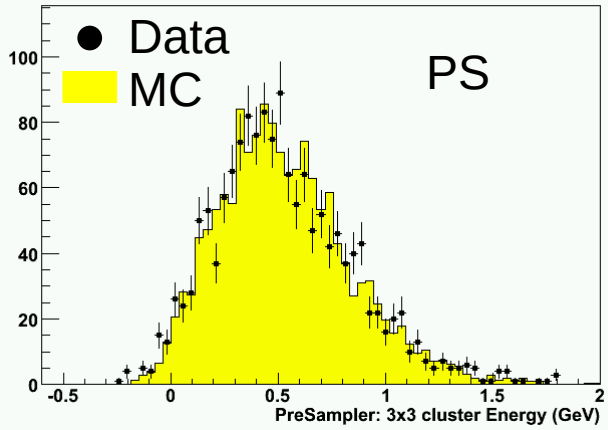
Results

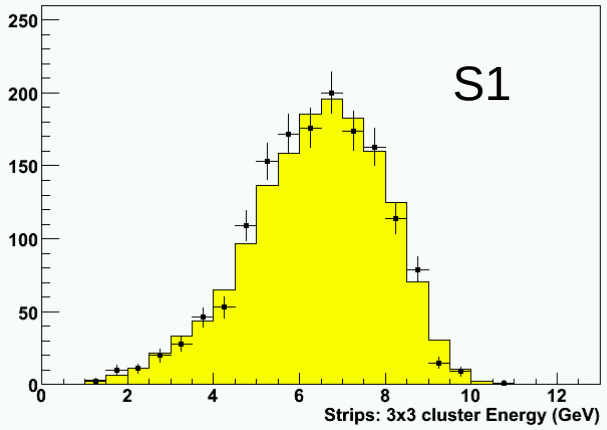
- Period 8 combined runs: EM and ID

- Periods 5 , 6
  - 5 energies, 9-180GeV

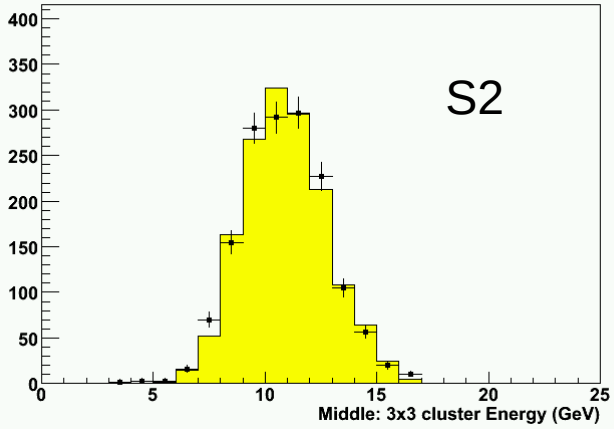
- Period 8 (Very Low Energy runs)
  - Momentum selection few meters upstream CTB triggers (-27m)

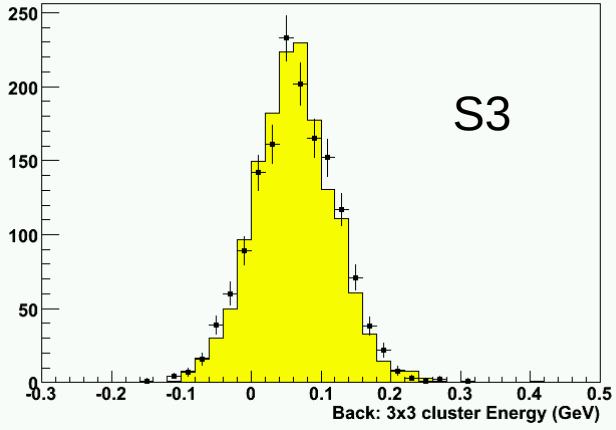
Data vs MC
ONLY far material





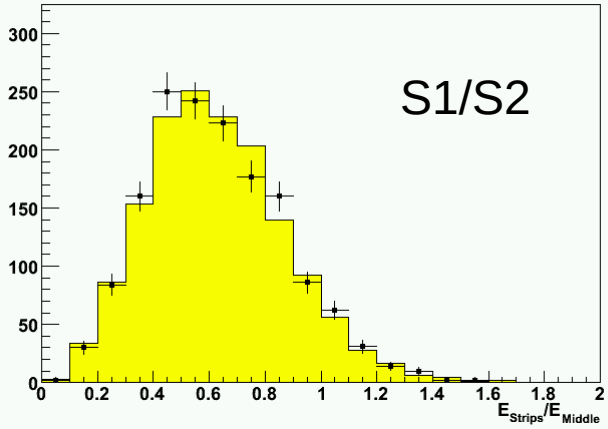
RATIOS
Data/MC

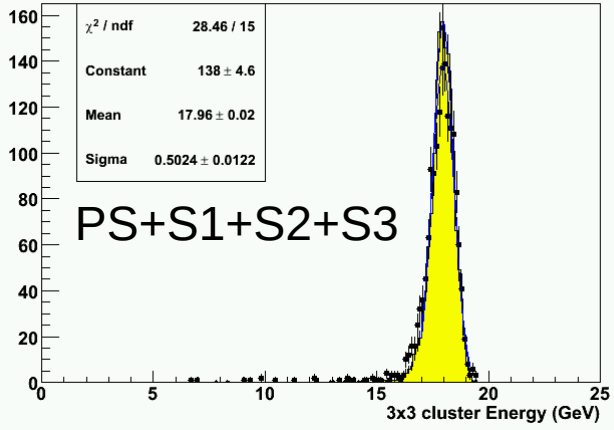




E=20GeV R=1000952

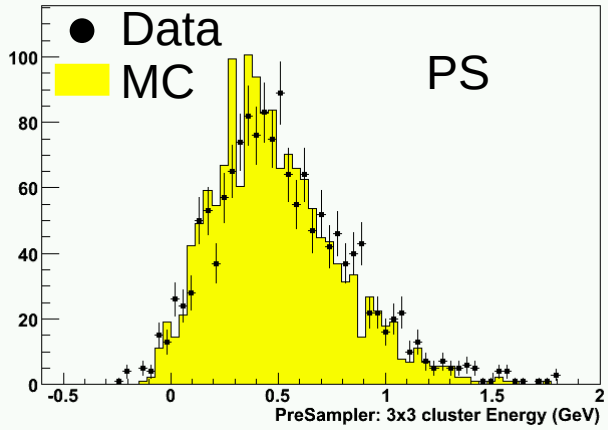
E	1.0	(0.001)
PS	0.993	(0.018)
S1	0.992	(0.007)
S2	0.995	(0.005)
S3	1.014	(0.030)
S1/S2	**0.997**	**(0.012)**

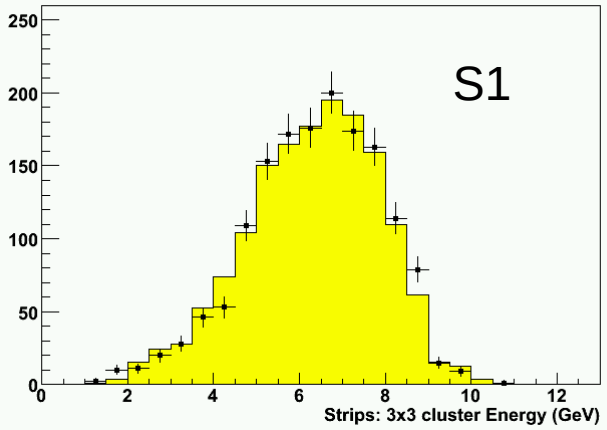




Electrons in CTB

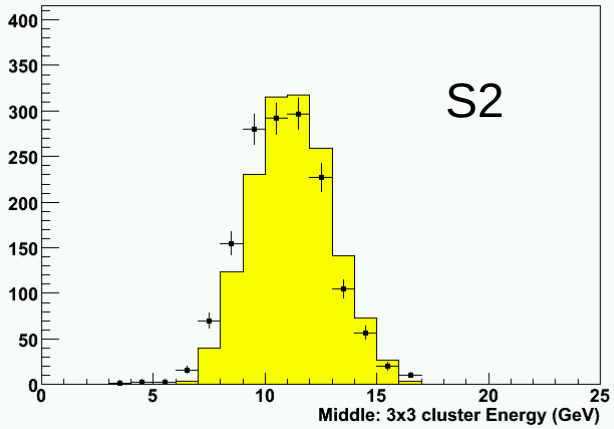
Data vs MC
NO far material

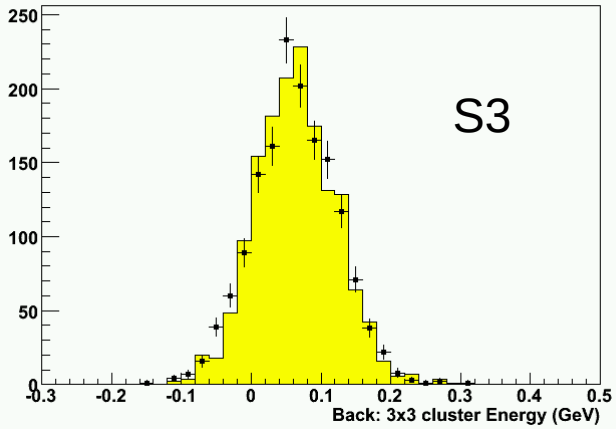


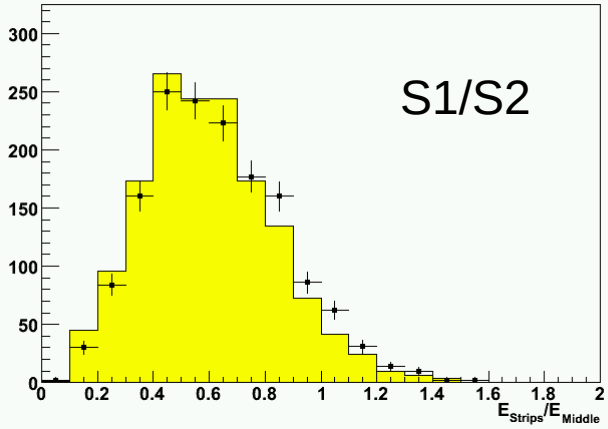


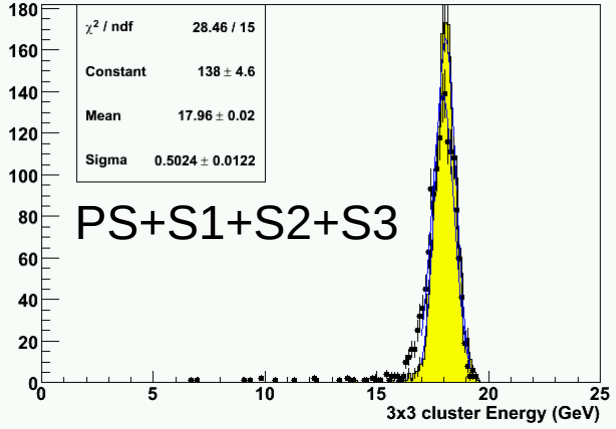
RATIOS
Data/MC

E=20GeV R=1000952	
E	0.995(0.001)
PS	1.08 (0.02)
S1	1.009(0.009)
S2	0.968(0.006)
S3	0.098(0.030)
S1/S2	**1.05 (0.01)**





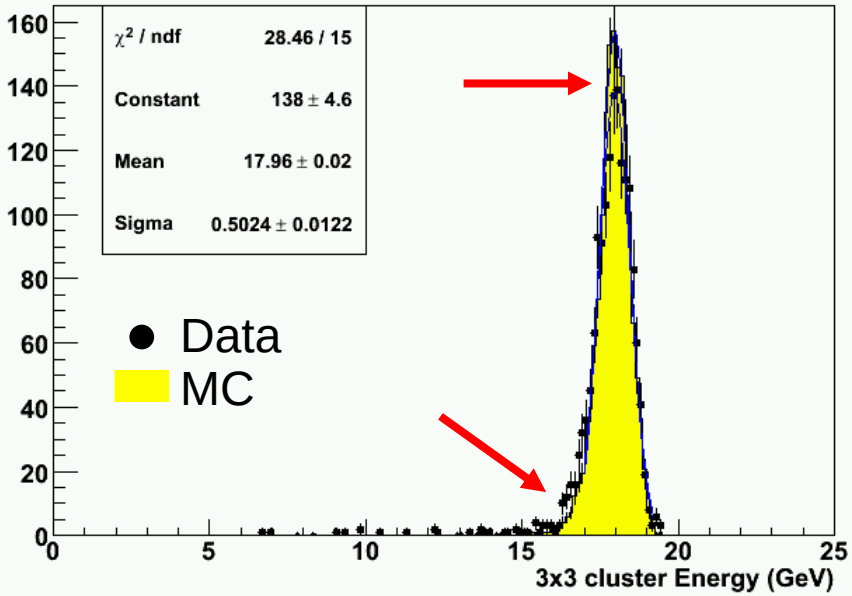




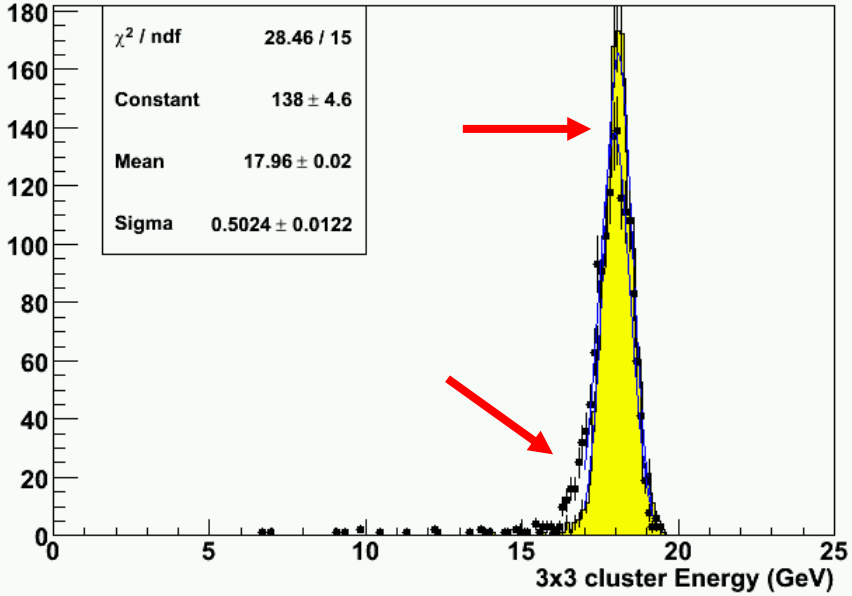
Electrons in CTB

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

More energies (periods 5,6)

Data/MC

	9GeV	20GeV	50GeV	100GeV	180GeV
E	0.993(0.002)	1.0 (0.001)	1.004(0.001)	1.003(0.001)	1.002(0.001)
PS	1.08 (0.03)	0.99 (0.02)	1.00 (0.02)	1.05 (0.02)	1.04 (0.02)
S1	0.98 (0.01)	0.992(0.007)	0.994(0.007)	1.022(0.009)	1.02 (0.01)
S2	0.98 (0.01)	0.995(0.005)	1.002(0.003)	0.993(0.003)	0.995(0.003)
S3	0.9 (0.1)	1.01 (0.03)	1.03 (0.01)	1.00 (0.01)	1.03 (0.02)
S1/S2	**1.01 (0.02)**	**1.00 (0.01)**	**1.00 (0.01)**	**1.03 (0.01)**	**1.03 (0.02)**

Runs: 1004160,1000952,1000947,1000942,1000999

Conclusion: first indication that there is no material missing in the calorimeter region. The “material problem” seems now that it was due to imperfect Detector Description and beam profile biases in the comparisons.

Results

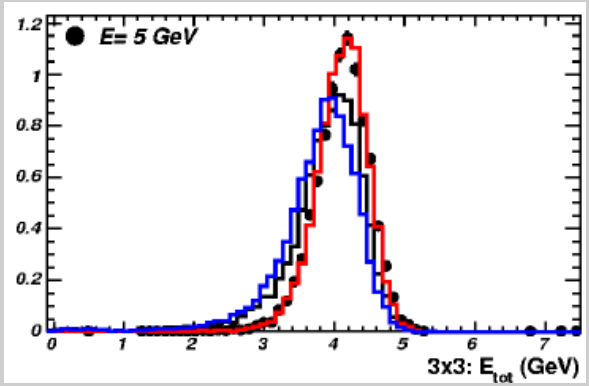
- Period 8 combined runs: EM and ID
- Periods 5 , 6
  - 5 energies, 9-180GeV
- Period 8 (Very Low Energy runs)
  - Momentum selection few meters upstream CTB triggers (-27m)

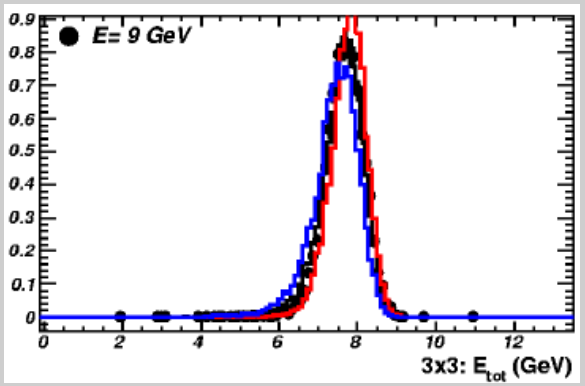
Very Low Energy runs: Data vs MC

Tancredi

Red: No far material

Blue/Black: With far material

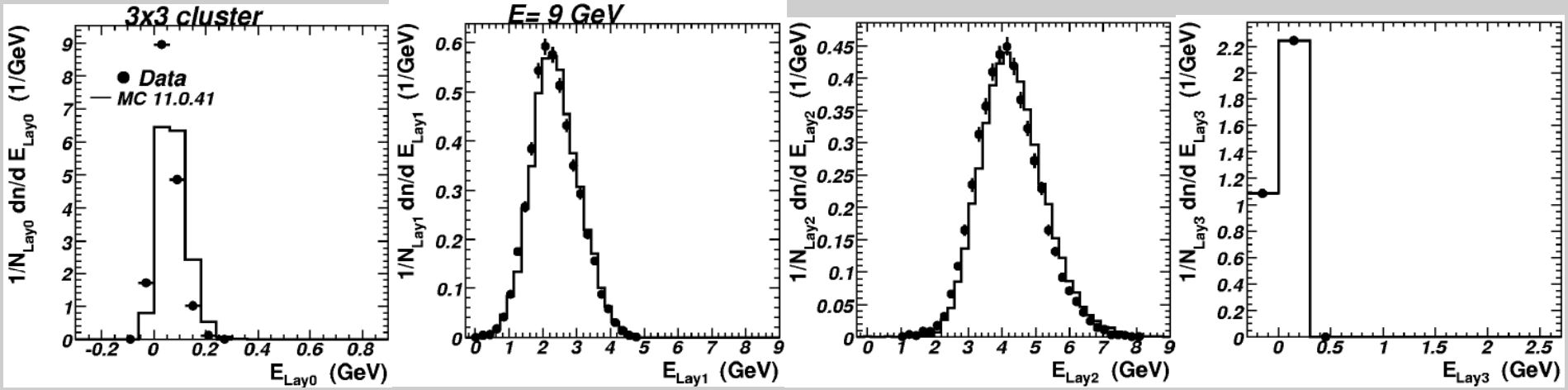




VLE summary:

Good description without any far upstream material:

We don't expect strong effects from the beam-line because the momentum selection occurs just upstream our trigger.



A look at the systematic errors on PS, S1/S2

Guillaume

Error in the MC PS prediction

Uncertainty	Error	Calculation
ADCtoMeV	5%	Using half of the G4.7-G4.8 difference
Error in Current map	1-2%	Guess
±5mm LAr in front of the PS	5%	Simulation
Non-modelling of phi=0 crack betw. modules	tbd	

Error in the MC S1/S2 prediction

Uncertainty	Error	Calculation
Pb Thickness	1-2%	Lead thickness at warm
Strip/Middle separation	1%	Assume 0.5mm uncertainty
±5mm LAr in front of the PS	5%	Simulation
Energy/Current simulation	1%	
Xtalk Correction	1%	
Using correct Rinjection	1%	
0.05X0 between PS/S1	1-2%	Guess

No material gives 12% shift in Eps and 6% shift in S1/S2:
this probably means that the LAr is not so sensitive in the position and amount of material of 0.05X0 or so. However we haven't checked carefully shape dependences and correlations.

Summary from the LAr side

- Periods 5,6: energies 9-180GeV
- Period 8: energy 20GeV

require extra material 0.1-0.15X0 (consistent with the existing material in the far straight section of the beam line)

- VLE runs: Energy up to 9GeV

Do not require any extra material: This is what we expect because the momentum selection is done very close to the CTB trigger.

- No adhoc extra material needs to be added in front of the LAr
- No material is missing from our trigger to the LAr

Checking the ATLAS longitudinal weights

- Weights extracted from MC period 5, (20, 50, 100 GeV)
- Use the same algorithm as for ATLAS 12.0.0
- Weights applied at 9 and 180GeV and period 8, 20GeV (Data and MC).
- 3x3 cluster (Atlas 3x5, 3x7, 5x5)

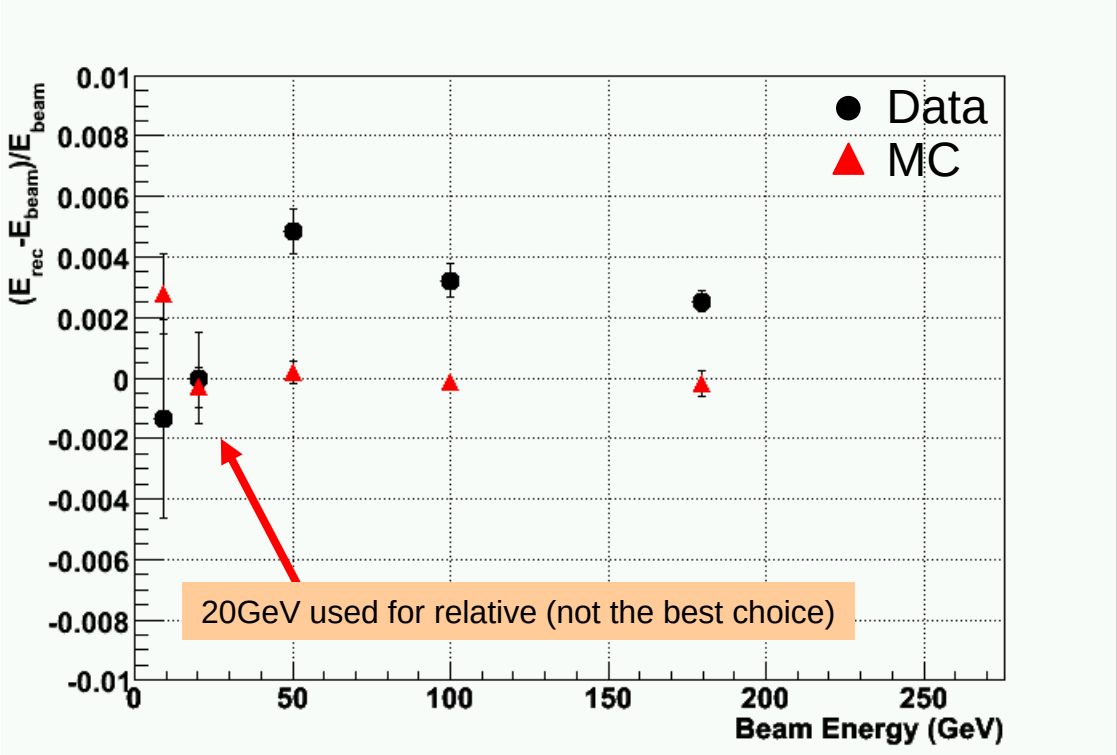
$$E_{rec} = scale \cdot (offset + w_0 E_0 + E_1 + E_2 + w_3 E_3)$$

1.099 277MeV 1.19 1.1

Comment: the above weights are reasonably close to the ATLAS ones (3x5)
To compare one has to unfold the factors applied in the CTB and the 3x3 vs 3x5.

Application of ATLAS Long. Weights on Data

Long.Weights: we used 20,50,100GeV to obtain



Systematic Errors:

Current Reproducibility: included

$$\frac{\Delta p}{p} = \frac{1}{2} \cdot \frac{0.2[A]}{3.14\,p[A]} 100\%$$

Collimator misalignment: tbd

OFC timing dependence: tbd

Sync. Rad. at high energies: tbd

Status: **0.5%** total data spread from 9-180GeV. MC quite linear (as in ATLAS).

However: application in period 8 20GeV runs gives **MCcal/20GeV = 0.986**.
For period 8 data we get (preliminary): **19.76, 49.6, 79.9, 179.6 GeV** (very encouraging).

Summary/Future

- Material problem partially solved:
  - Remaining discrepancies between Calo and ID measurements are currently investigated with better beam-line description.
  - If it was not for the CTB we would have to figure this out in situ
  - Significant experience gained in understanding the systematics
- Beam-line systematics:
  - Presence of Air+Windows together with B-optics. CTB trigger acceptance depends on Eloss and angular electron distributions.
- Towards publications:
  - Best MC input spectrum in simulation is being studied/produced (collaboration between ID and LAr groups)
  - How necessary is to move in G4v4.8 ?
    - better MCS description.
    - More $E_{visible}$ in the LAr => better resolution.
    - Decision is needed before summer.