Outlook for 2004 Test Beam Studies

Outline

- What we learnt from earlier Test Beams
- Geometry for 2004 Test Beam Setup
- Simulation with TBHCal02
- Simulation with HCALTest
- Calibration with muons

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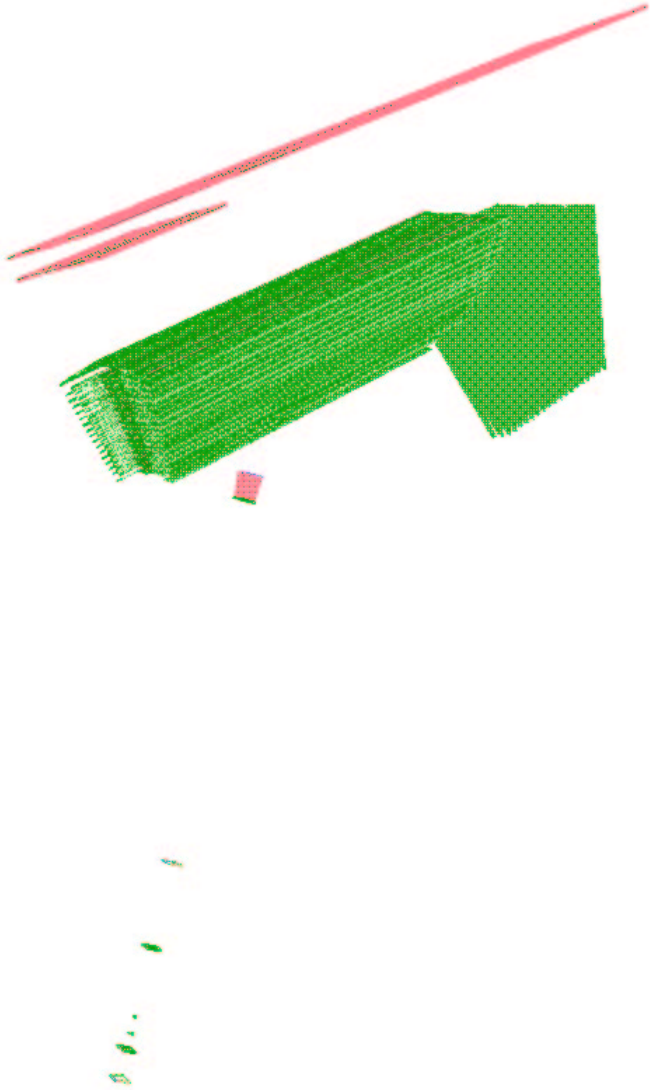
What we learnt so far

- Nonlinearity in the energy response is well described (within $\approx 3\%$) by different Geant4 models.
- There may be some systematic disagreement in energy response at lower beam energies
- Energy resolution of HCal alone setup is explained well by microscopic models at high energies
- For combined setup there is good agreement between data and Monte Carlo in energy resolution for beam energies in the range 20-150 GeV
- Mean of the longitudinal shower profile distributions in data agrees better with microscopic models at high energy
- Width in the shower profile spectrum is much larger in the data at low energies and there is a good agreement between data and parametrised models at higher energies
- Parametrised and microscopic models give different predictions for longitudinal shower profile

Geometry for 2004 Test Beam Setup



Test Beam geometry is defined with:

- 2 wedges of HCal Barrel
- 2 slices of HCal Endcap
- mockup of cables going within the crack between barrel and endcap
- 6-trays of HO detectors for 3 rings
- mockup of CMS magnet
- tail catcher iron
- 7×7 crystal matrix
- mockup of material between ECal and HCal
- beam line trigger counters

Use DDD with xml files
Simulate with Geant 4.6.0.P2

Simulation with TBHcal02

TBHcal02 is equipped with tools to produce Root Trees for different detector configuration and beam condition:

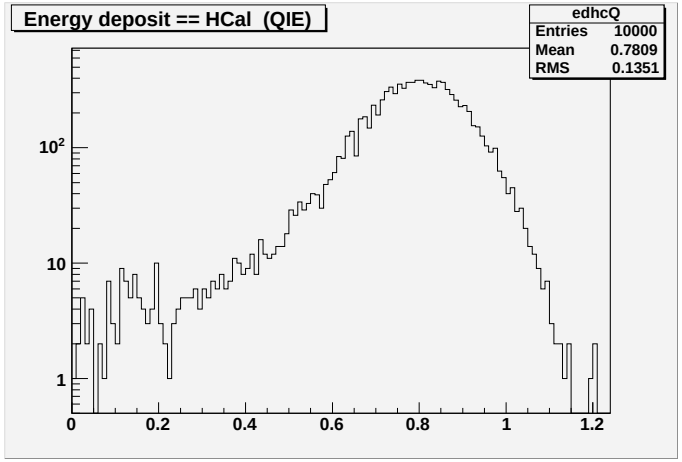
- Setups of different years
- Setups with or without ECal in front
- Beams centred to given tower of HCal
- Posibility to provide the transverse beam profile
- Effect of pulse shaping done ala ORCA (Salavat's code) – integrating a number of time buckets and adding noise
- Use the grouping of layers and towers as in real beam.

  HB1 ($\phi = 1 - 4$) have default grouping (Group 17 19) keeping the lateral towers in tact and only two longitudinal sampling (one for HB and one for HO).

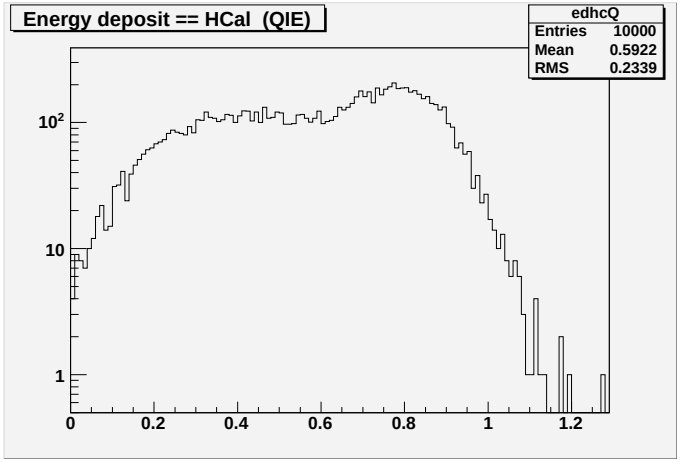
  HB2 ($\phi = 5 - 8$) provide readout of all individual layers of HB (Group 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17) summing all η layers in these layers but lateral profile in ϕ still available
- Possibility of adding noise (Gaussian) to the ECal towers

Energy deposit in HCal for 100 GeV π^- beam:

Without ECal

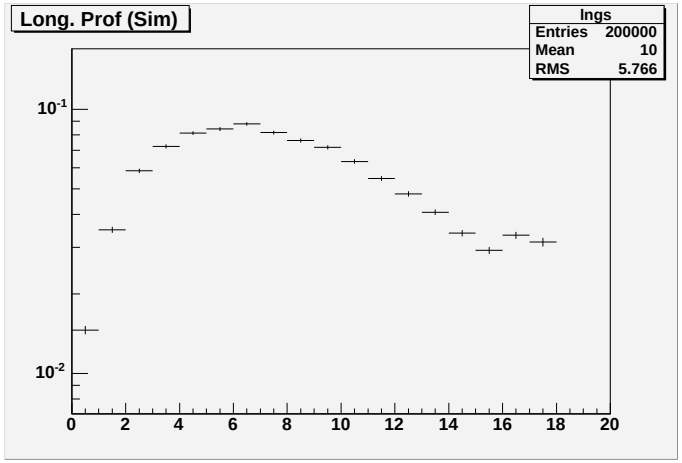


With ECal

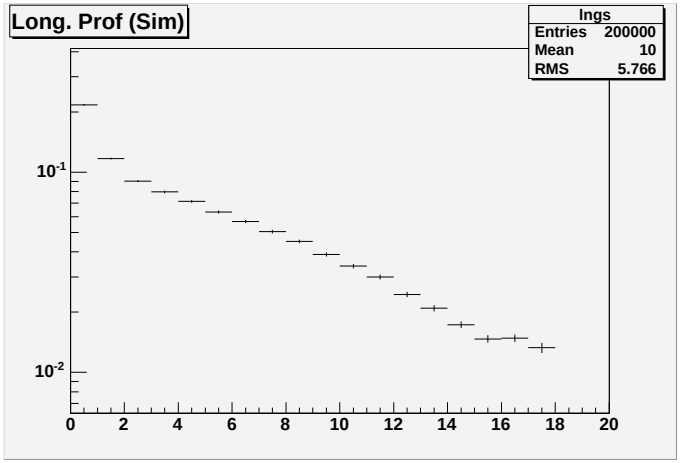


Longitudinal Shower Profile for 100 GeV π

Without ECal

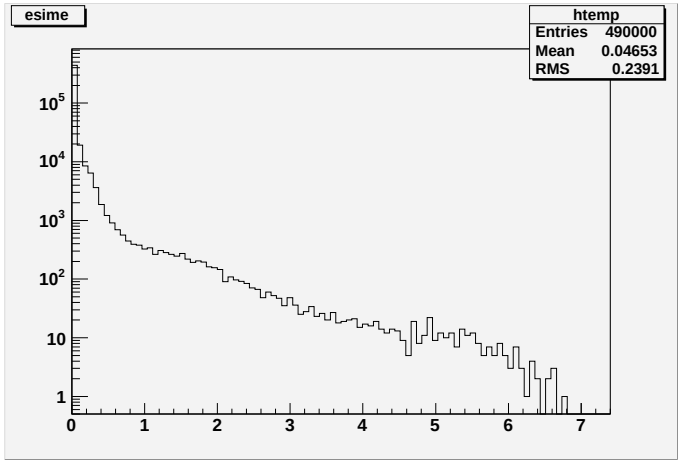


With ECal

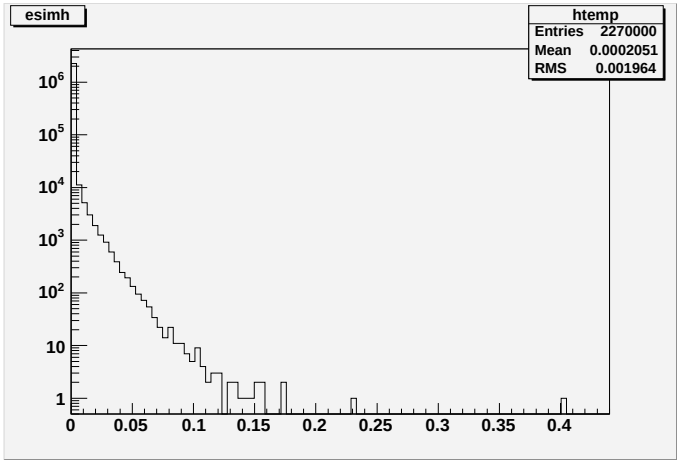


Low energy run with 9 GeV π (simhit level)

Energy in ECal

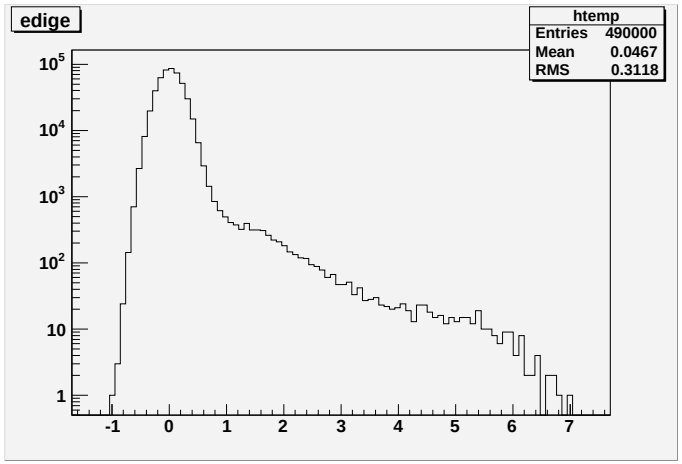


Energy in HCal

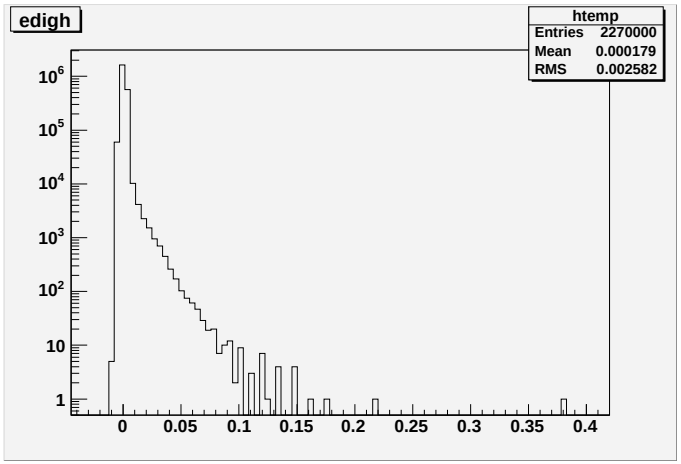


Low energy run with 9 GeV π (with QIE effect)

Energy in ECal



Energy in HCal



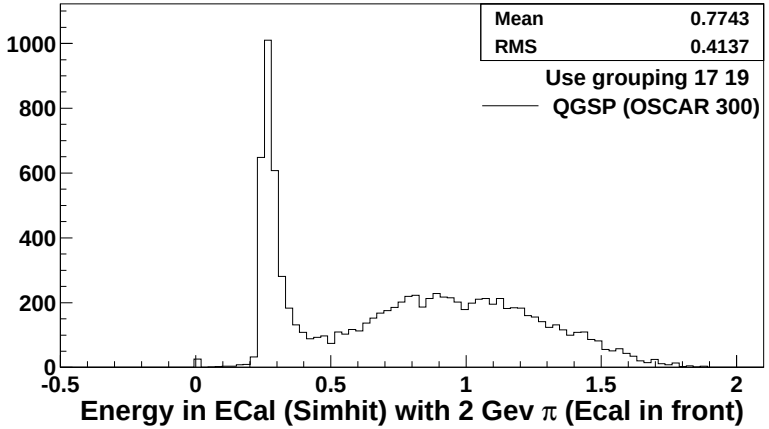
Simulation with HCALTest

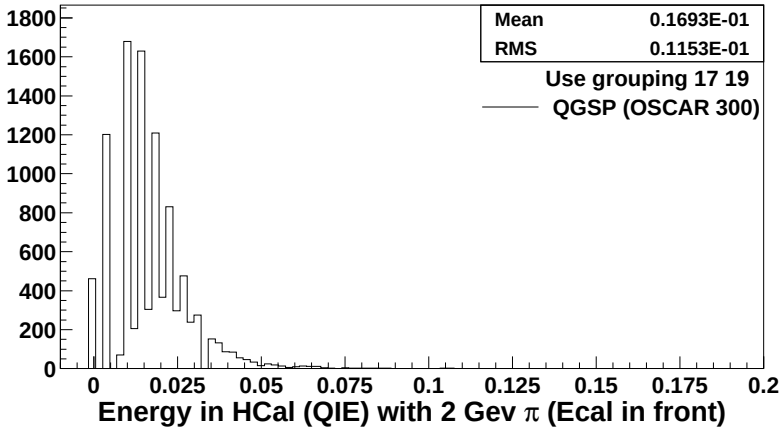
Before 2004 test beam run, the example HCALTest is modified to do some preliminary analysis of a possible Very Low Energy Beam run:

- For HCal simulate QIE (summing up 2 time slices). For ECal no simulation of readout electronics is done.
- Two possible grouping of layers studied:
  - Default grouping (17 19) like HB1
  - Readout all layers individually but no η segmentation (1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19) like HB2
- Shoot at the centre of $\eta = 4$ tower
- Look at 3×3 towers - similar for ECal

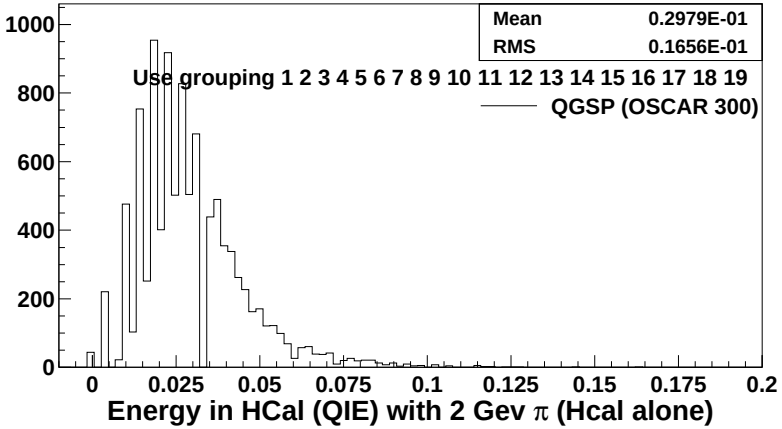
2 GeV π Beam

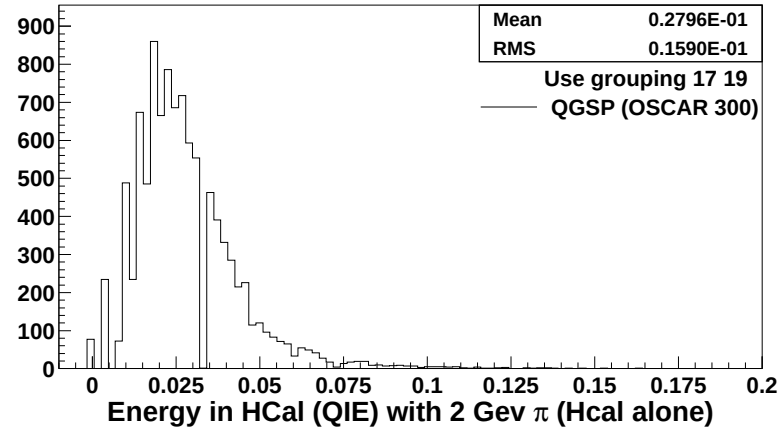
With ECal in front





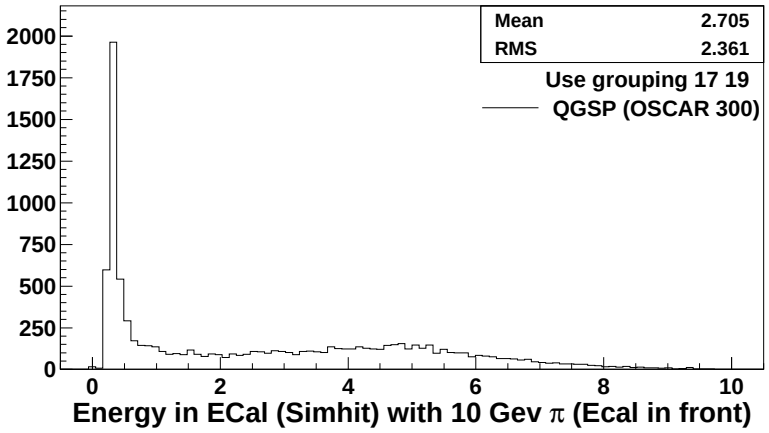
HCal Stand-alone

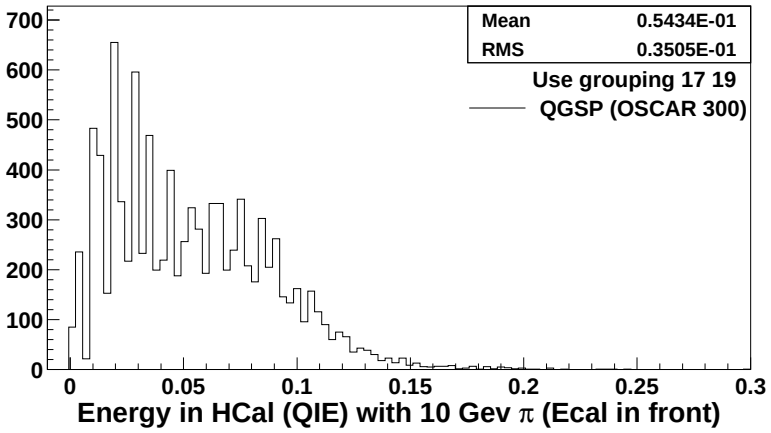




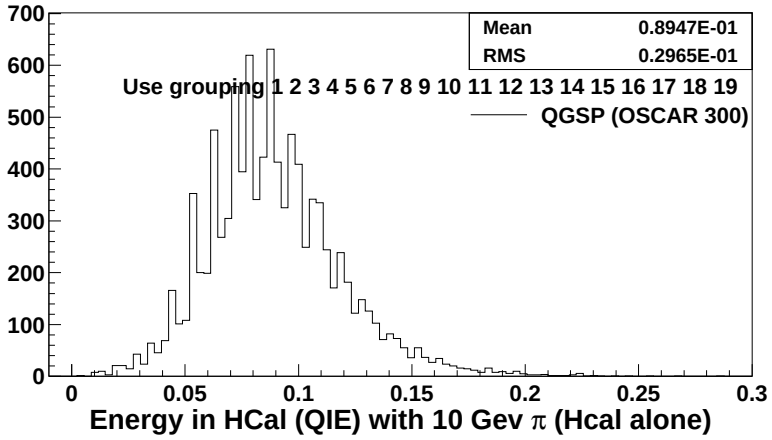
10 GeV π Beam

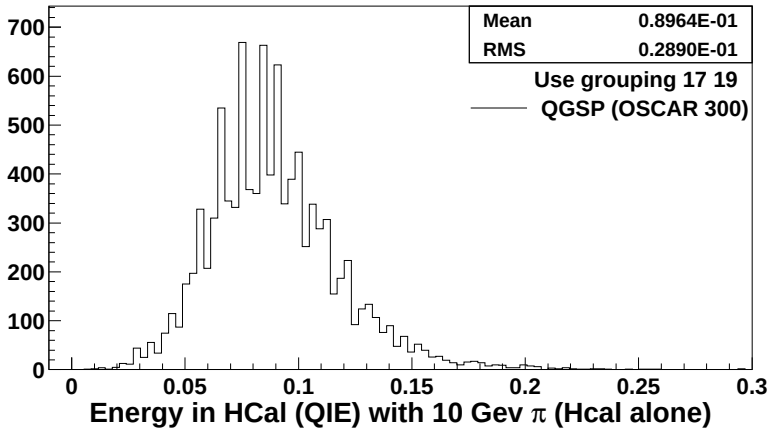
With ECal in front



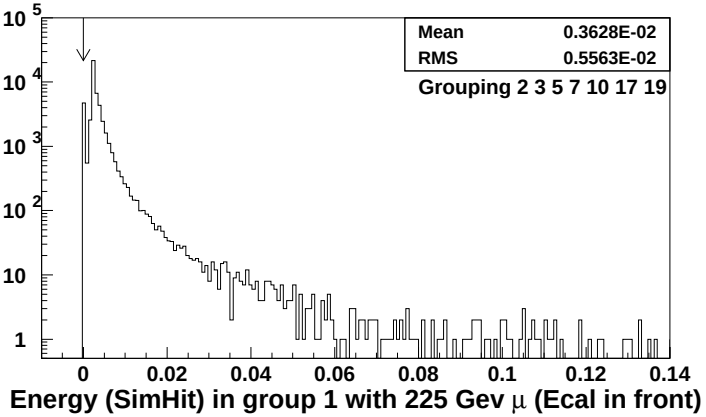


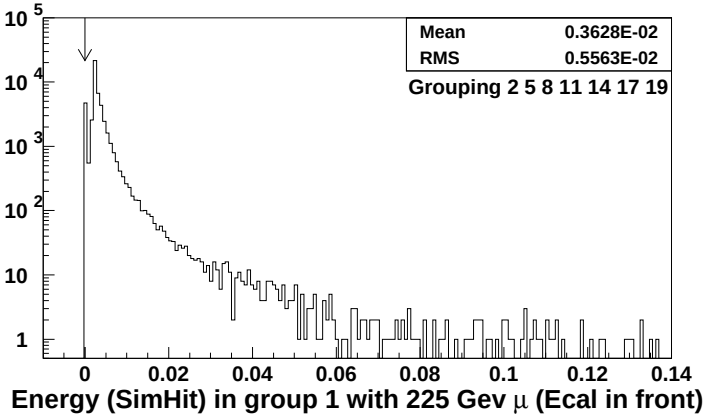
HCal Stand-alone

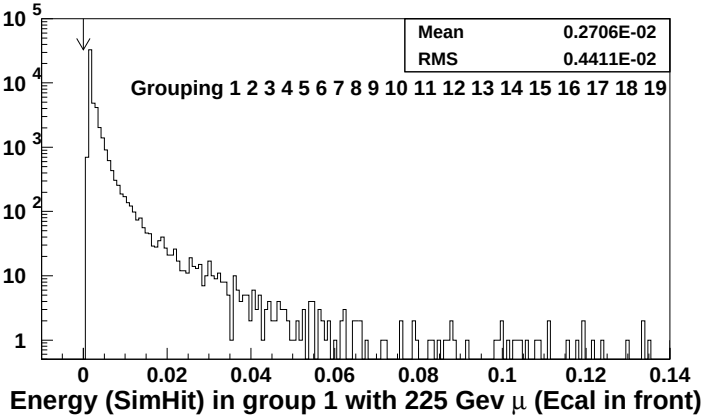


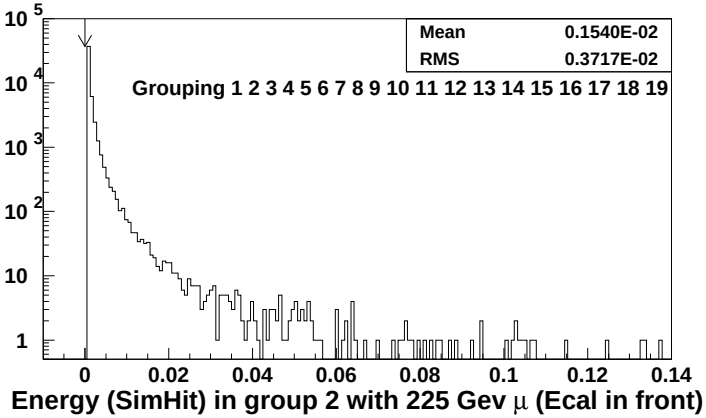


Calibration with Muons

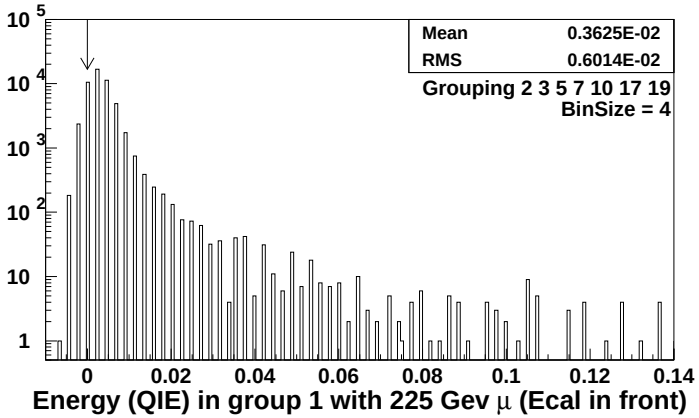


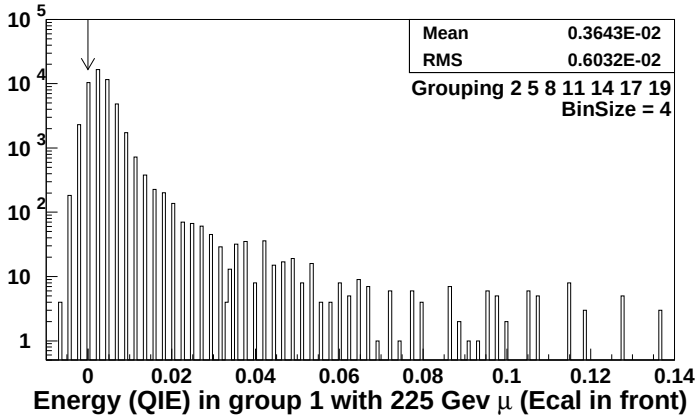


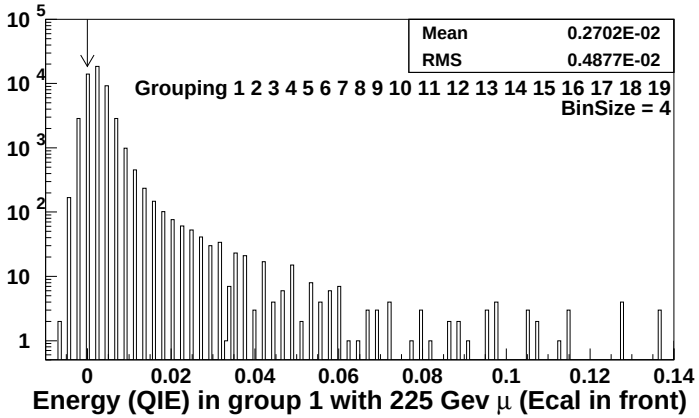


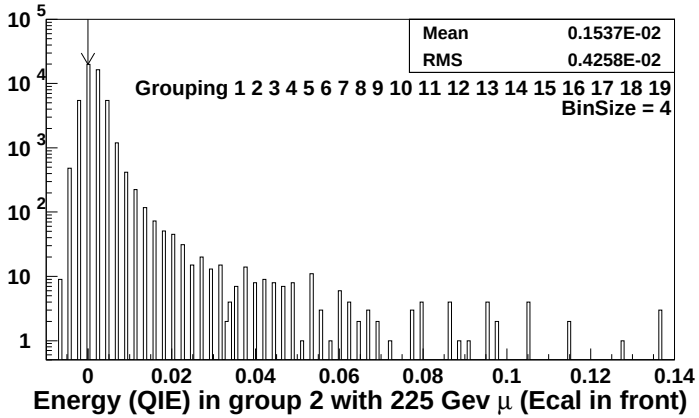


- Simulate with 225 GeV μ in a setup with ECal+HCal
- Separation of the peak from 0 deteriorates as the grouping of layers become finer

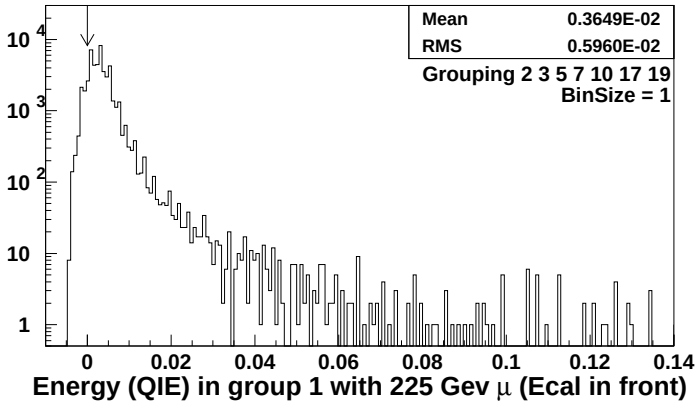


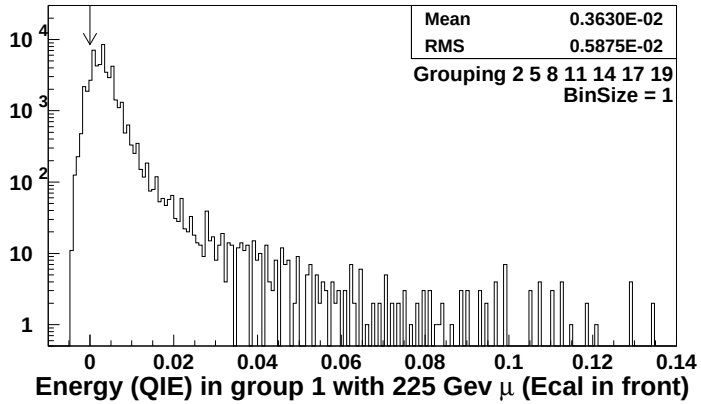


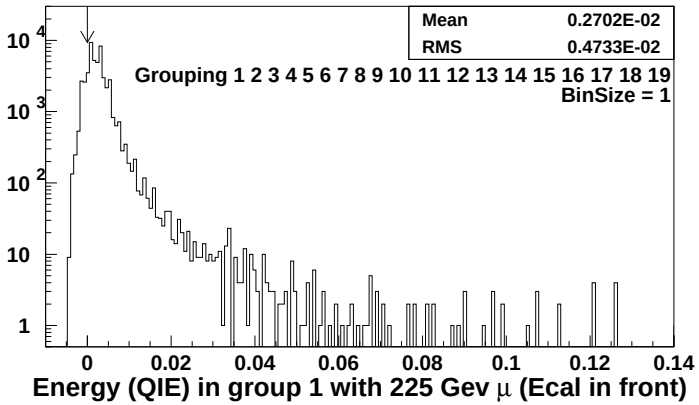


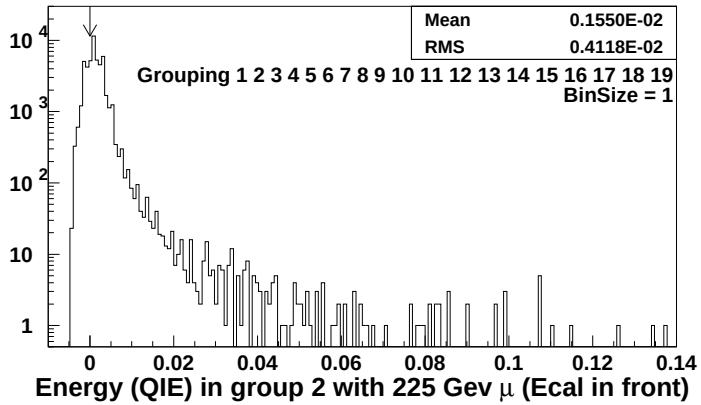


- Simulation of noise and quantisation effect makes the muon signal much worse.
- It gets worse if the number of grouping becomes finer









- Changing the preamplifier gain (parametrised as ADC smallest bin size in PE) by a factor of 4 does not improve signal/noise significantly