Status of the pions analysis using 2004 Combined Test beam data

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Description of the 2004 Combined Testbeam

Full slice of ATLAS detector (trackers, calorimeters, muon spectrometer)

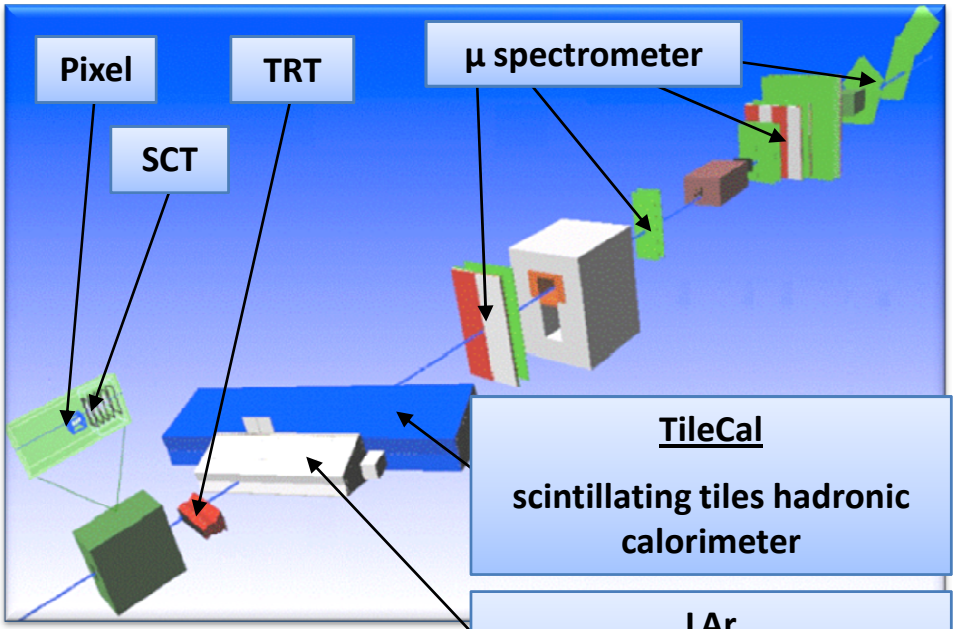
- Final version of the electronics
- Realistic geometry

Physics program

- Study of standalone performances
- Study of combined performance
- Data/MC comparisons

Data sample

- electrons, **pions**, muons
- energy from 1 GeV to 350 GeV
- η (pseudo-rapidity) from 0.2 to 0.65 (central part of the calorimetry)
- η from 0.7 to 1.2 (Gap region in TileCal)



Analysis of the pions in calorimeters

Different types of pion analysis

- TileCal standalone (no interaction in LAr)
- Combined LAr+TileCal studies : high energy, very low energy

Possible strategies for exploitation of the data

- *step 1 : data quality check*
  - Establish a set of pions selection cuts
  - Establish criterions to select “good” sets of data
  - Reconstruct the energy in calorimeters (with limited number of parameters)
  - Study the systematic effect (stability of the response, error on beam energy, biases…)
- *step 2 : data/MC analysis*
  - Systematic comparison between data and MC
  - Performances of reconstruction algorithms (noise reduction, clustering…) on real data
  - …

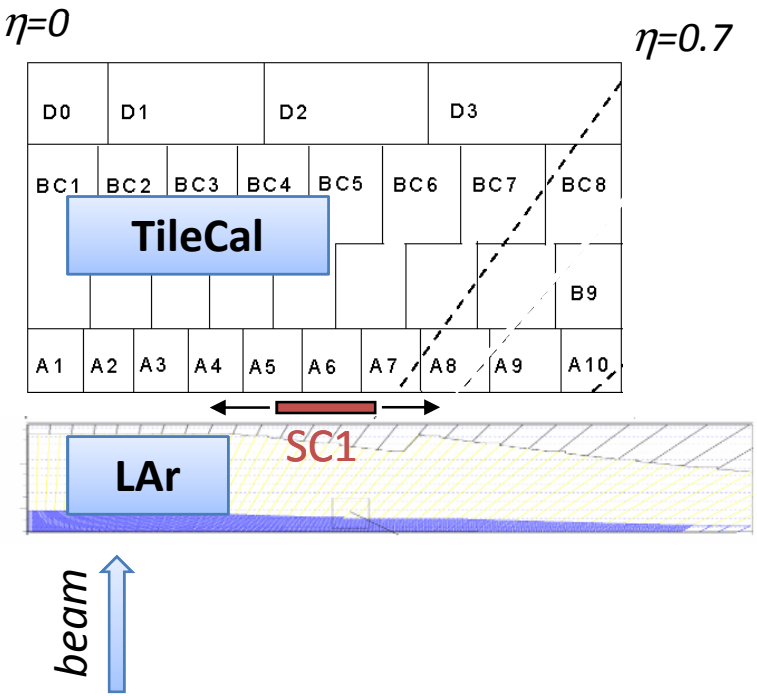
TileCal “standalone” analysis : description

Goal

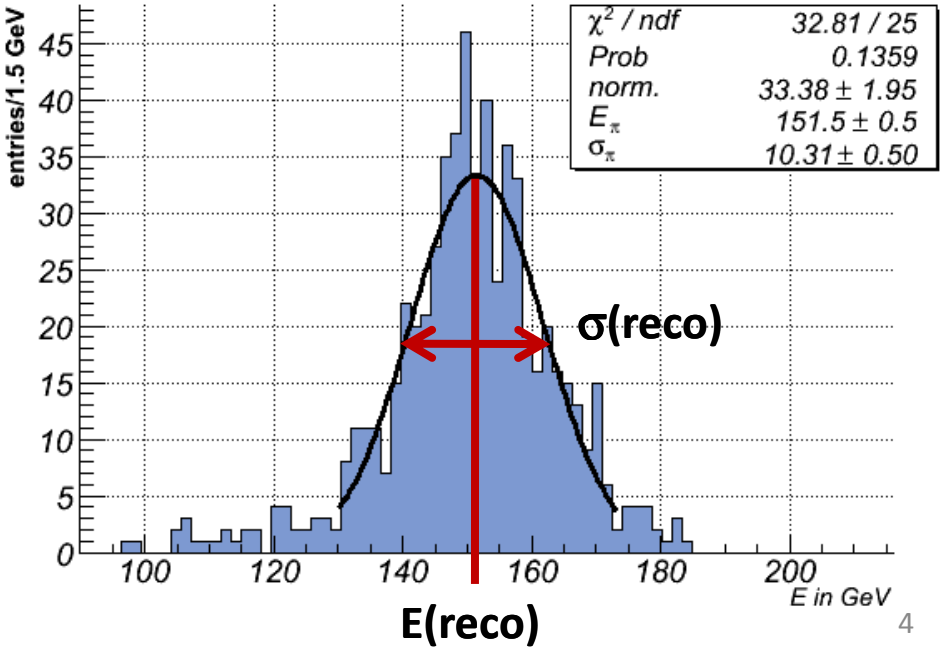
- Comparison with previous TileCal standalone test beams (from 1995 to 2003)

Selection criterions

- low signal in LAr (compatible with a minimum ionizing particle)
- low signal in SC1 scintillator



Example : 180 GeV pions at η=0.35



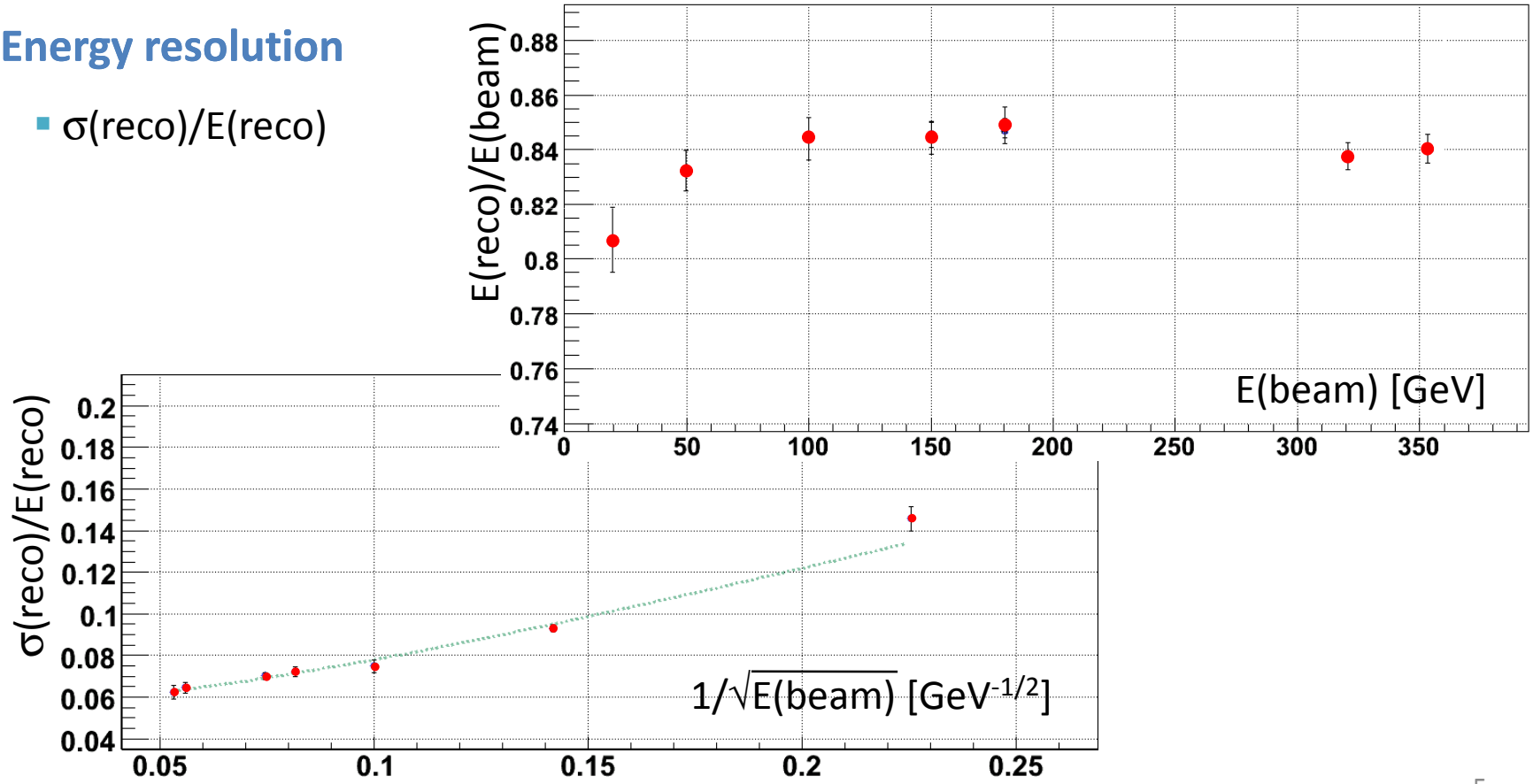
TileCal “standalone” analysis : some results

Linearity

- expressed as E(reco)/E(beam)
- measured at the electromagnetic scale (no corrections)

Energy resolution

- σ(reco)/E(reco)



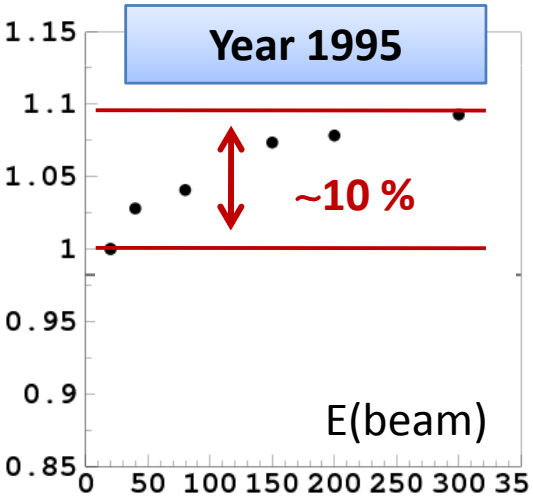
TileCal “standalone” analysis : conclusions

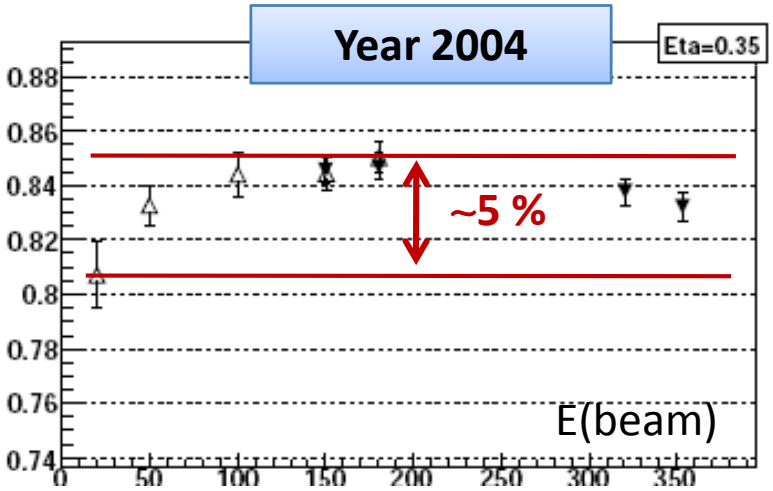
Confidence level on the 2004 data

- uncertainty on E(reco)/E(beam) : 1 % (dominated by statistical error)
- uncertainty on σ(reco)/E(reco) : <5 %

Comparison with previous TB

- still some inconsistencies on the linearity of the pion response



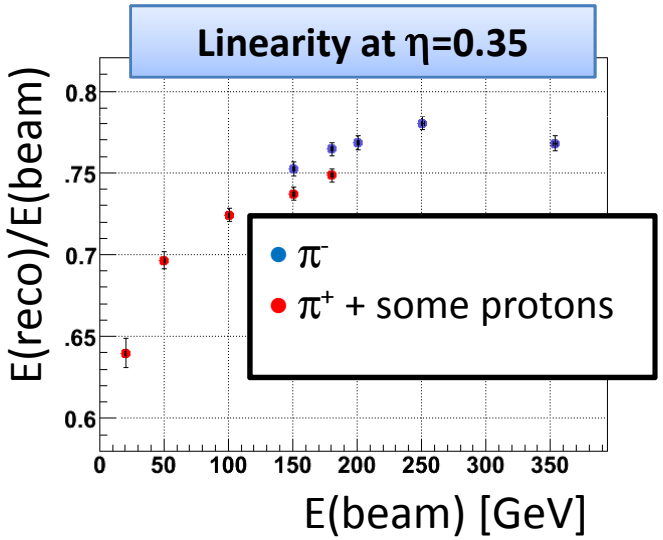


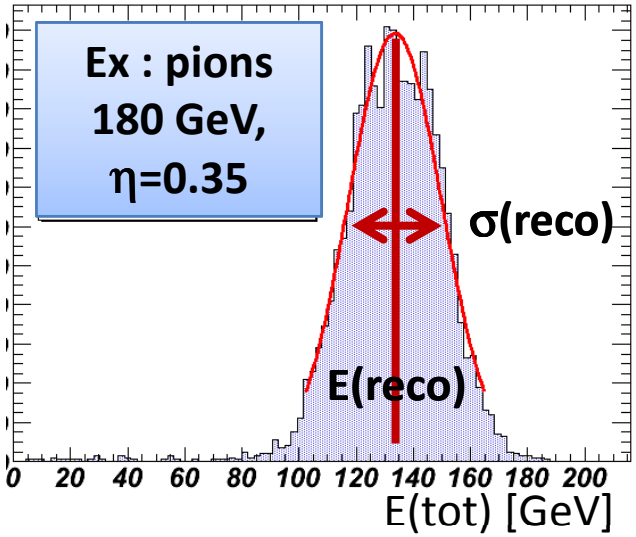
- many possible reasons have been studied (electronics, calibration, bias by the event selection…)
- Work is still going on : pion task force weekly meetings

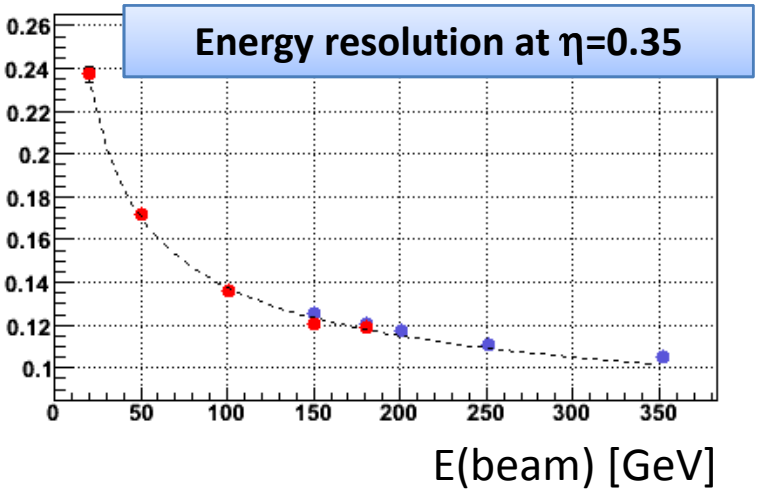
Combined analysis for high energy pions

Pion sample

- from 20 to 350 GeV
- η from 0.2 to 0.65
- E(tot) = E(LAr) + E(TileCal) at electromagnetic scale







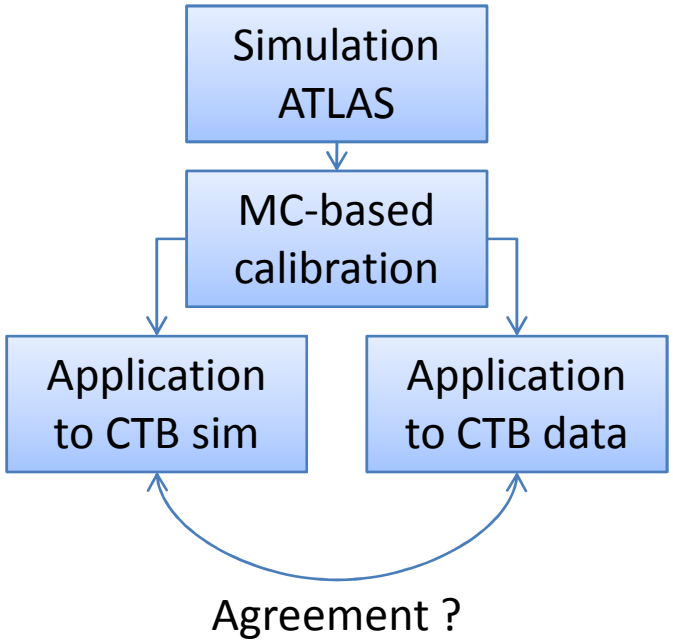
Confidence on the data

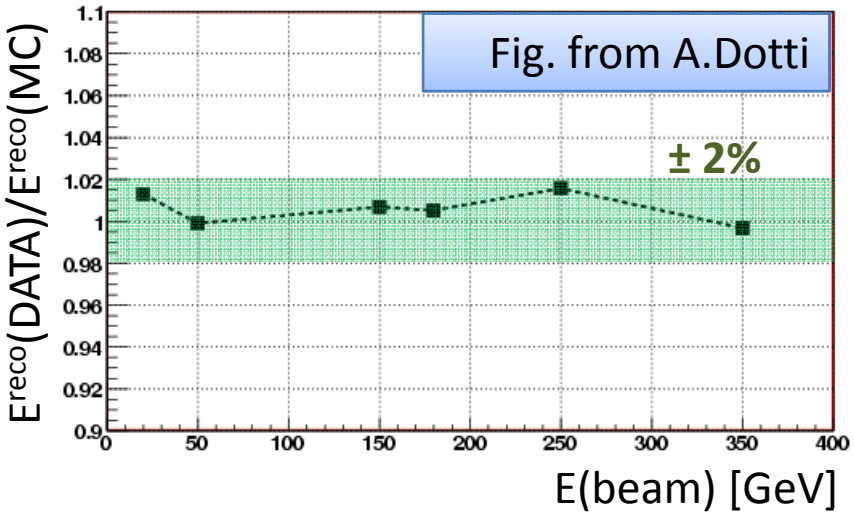
- ~0.5 % precision on E(reco)/E(beam)
- ~2 % precision on σ(reco) (width of the response)

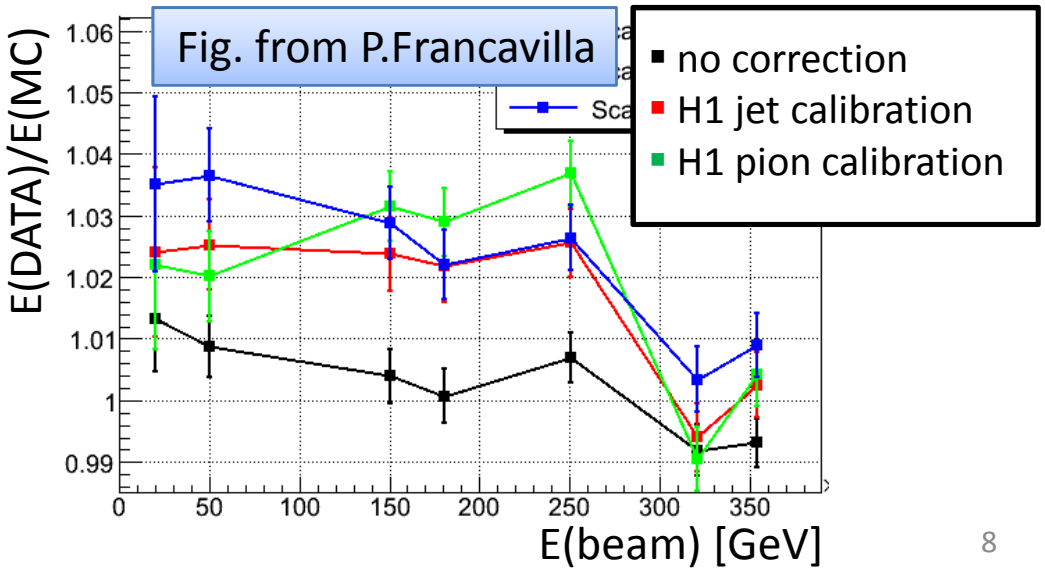
Combined analysis for HE pions : ongoing studies

MC/Data comparison

- direct comparison with simulation reproducing CTB geometry
- MC/Data comparison after application of the same ATLAS style corrections both on CTB simulation and real data







Combined analysis for very low energy pions

Data sample

- pions from 3 GeV to 9 GeV
- central part of the calorimeters : $0.2 < \eta < 0.65$

Pions selection

- large contaminations from electrons and muons
- pions can be isolated using the TRT + beam line detectors + calorimeters info
- estimated remaining contaminations after cuts :

Electrons	High energy muons	Decay muons
< 6 %	< 10 %	< 3.5%

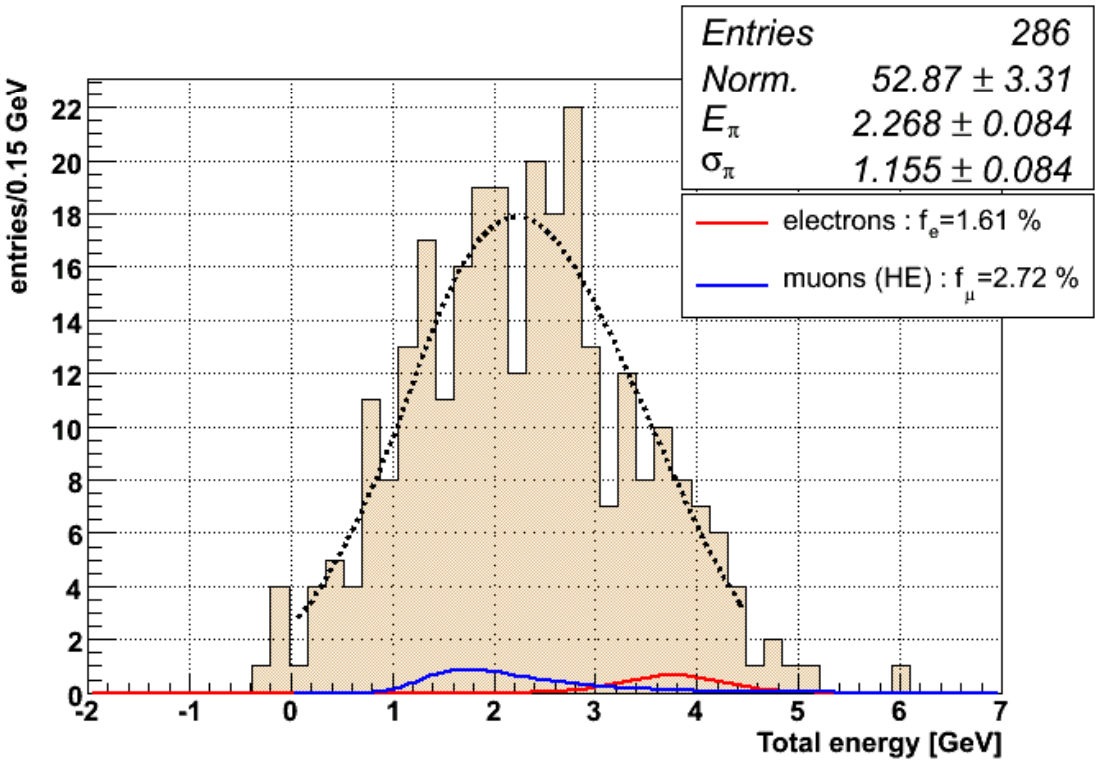
Combined analysis for VLE pions : results

Pions energy reconstruction

- E(tot) = E(LAr) + E(TileCal) at em scale
- fit E(Tot) distribution using :

Electrons contribution Muons contribution

$$f(E) = (1 - f_e - f_\mu) \times Gauss(E_\pi, \sigma_\pi) + f_e \times Gauss(E_e, \sigma_e) + f_\mu \times Shape$$



f_e, f_μ : measured fraction of electrons and muons

E_e, σ_e : mean and sigma for electrons (measured on data)

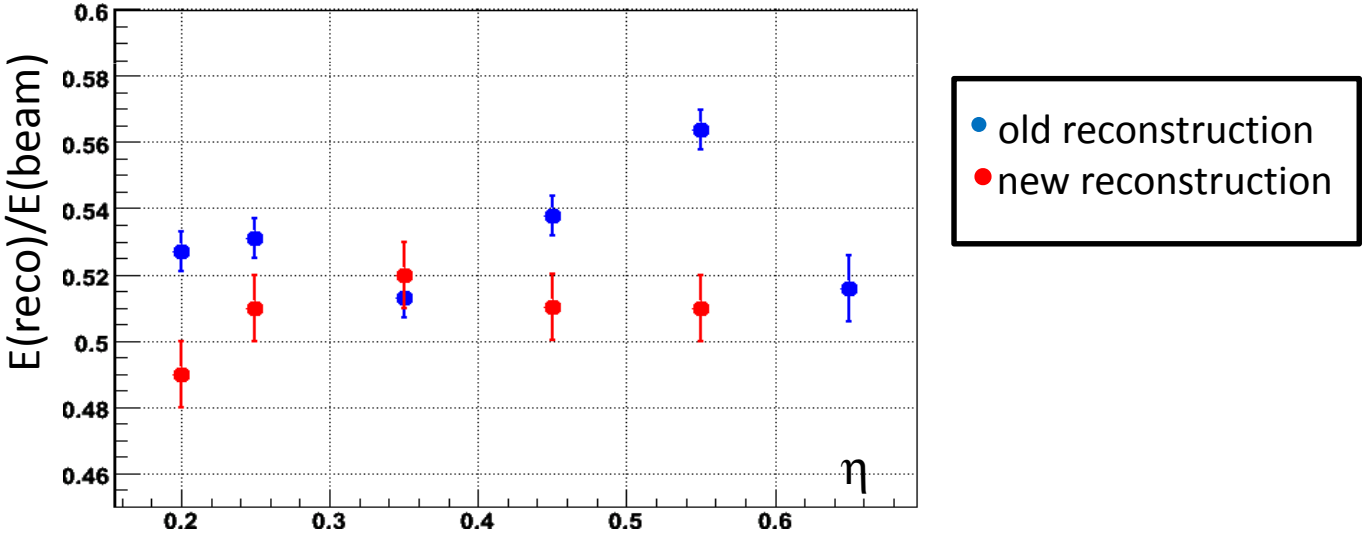
VLE pions : results, ongoing studies

Confidence on the data

- uncertainty on E(reco)/E(beam) : 1 to 4 % (dominated by statistical error)
- uncertainty on σ(reco)/E(reco) : 2-20 % (dominated by statistical error)

Ongoing analysis

- re-analysis with new corrections (for cross-talk in LAr cells, pedestal shift…)



- Systematic comparison between data taken in 2004 with different beam configurations : still some discrepancies

conclusions on data quality

TileCal standalone

- uncertainty on E(reco)/E(beam) : **1 %** (dominated by statistical error)
- uncertainty on σ(reco)/E(reco) : **<5 %** (dominated by statistical error)
- the Pion Task Force is still investigating about the discrepancy in the linearity of the response between 2004 and previous TB

Combined analysis : high energy pions

- **~0.5 %** precision on E(reco)/E(beam) (dominated error on the beam impulsion)
- **~2 %** precision on σ(reco)/E(reco)

Combined analysis : very low energy pions

- uncertainty on E(reco)/E(beam) : **1 to 4 %** (dominated by statistical error)
- uncertainty on σ(reco)/E(reco) : **2-20 %** (dominated by statistical error)
- still ongoing studies on systematic uncertainties

Possible strategies using CTB data

Systematic comparison MC/Data

- simulation with CTB-2004 geometry
- tuning/validation of the MC model using data

Test of the reconstruction/calibration on single pions (data vs MC)

- clustering algorithm
- calibration (to bring the rec energy to the particle energy)

Longer term issue

- reconstruction of single charged pions in ATLAS events and comparison with CTB data