Shower shape results from Atlas and CMS

G.Folger

10-10-2006

Geant4 workshop Lisbon

Contents

- Atlas Calibration Workshop, September 2006
- LCG Validation meetings

Atlas Calibration workshop

- 3 day workshop, >120 participants
  - From trigger calibrations to W-jet calibration
- Happy with EM physics
  - Multiple scattering of 8.0 gives correct resolution, etc.
    - HEC slightly worse, but still consistent
- Fairly unhappy with hadronics
  - No improvement seen since >3 years

Atlas Calibration workshop

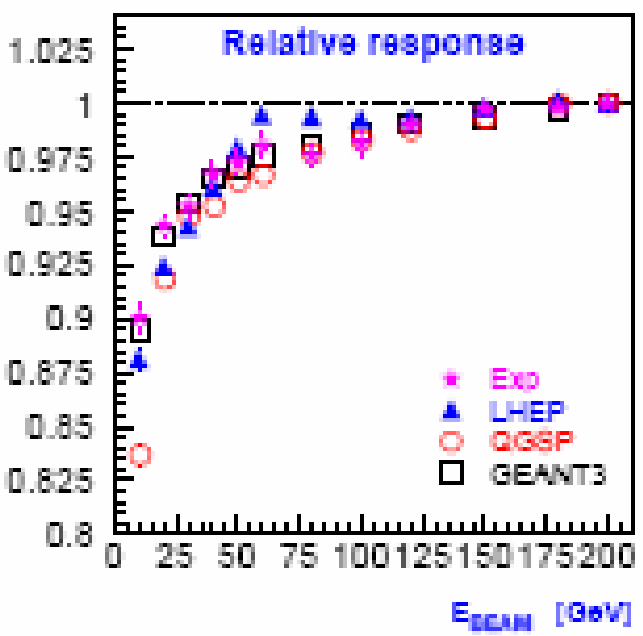
- MC validation was very small fraction of talks
  - Concern on analysis of combined testbeam data

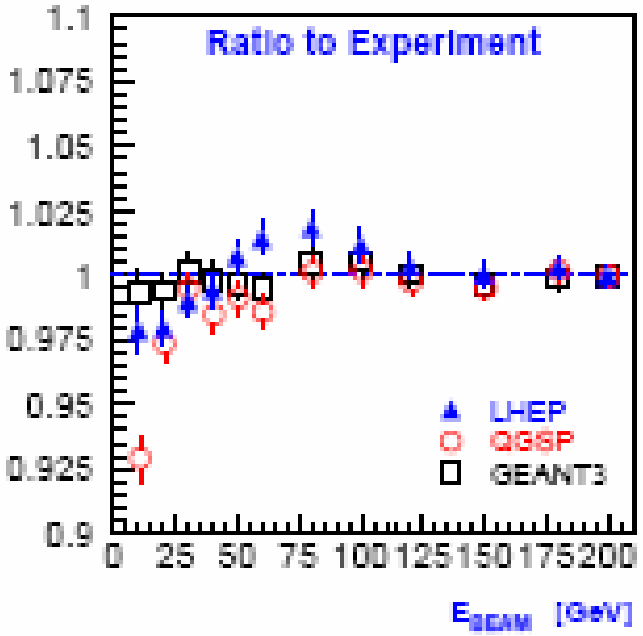
- A.Kiryunin: Status of Monte Carlo Validation for the HEC
- Margar Simonyan: Pion and proton shower profiles measured with ATLAS Tile Calorimeter
- P.Speckmeyer: MC-validation overview

Talks available at meting website: http://atlas-ccw.ifae.es/

GEANT4 physics validation with the HEC testbeam data / Energy scans with pions

Relative response for GEANT4 version 8.0





GEANT3 predictions – closest to the experimental values

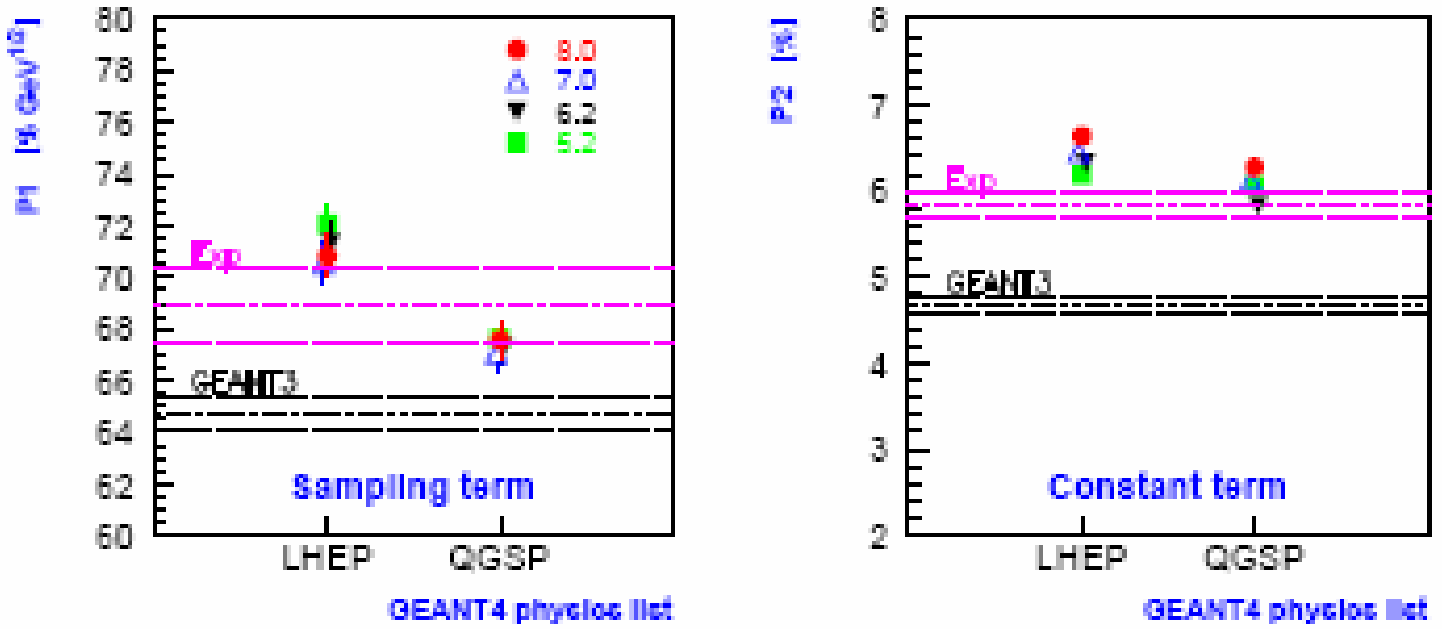
Within errors LHEP and QGSP – consistent as well

Slide by A.Kiryunin

GEANT4 physics validation with the HEC testbeam data / Energy scans with pions

Energy resolution for different GEANT4 versions

$$\sigma/E_0 = P1/\sqrt{E_{BEAM}} \oplus P2$$



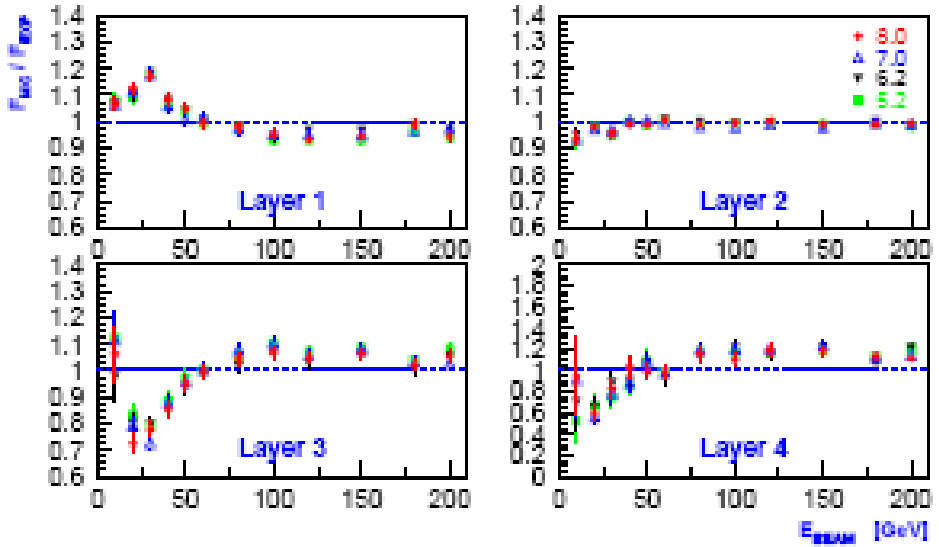
GEANT3 predicts a too good energy resolution

GEANT4 describes the resolution quite well (where QGSP is somewhat better)

No significant changes between GEANT4 versions

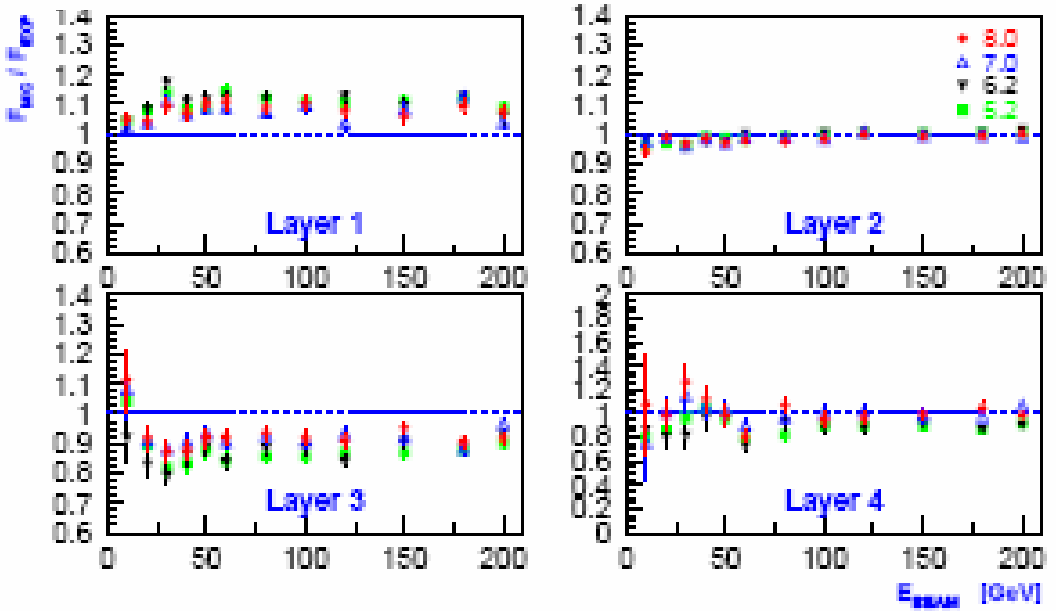
Slide by A.Kiryunin

Fraction of energy in layers for different GEANT4 versions: LHEP



LHEP: No difference between GEANT4 versions

's for different GEANT4 versions: QGSP

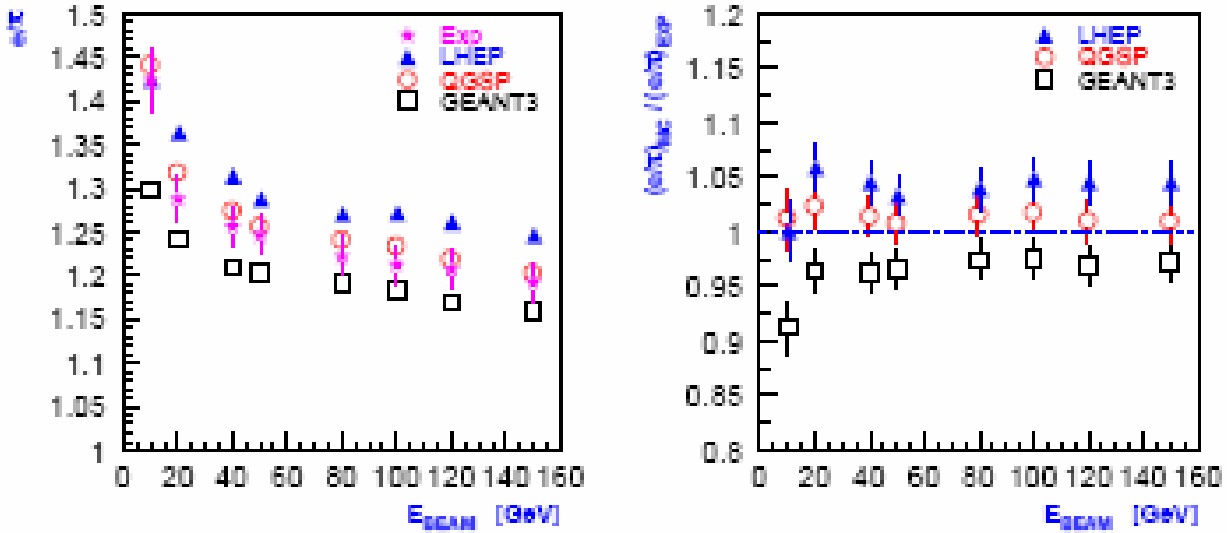


QGSP: Certain improvement between GEANT4 versions 6.2 and 7.0

Slides by A.Kiryunir

GEANT4 physics validation with the HEC testbeam data / Energy scans with pions

Ratio e/π for GEANT4 version 8.0



QGSP describes experimental values of e/π very well

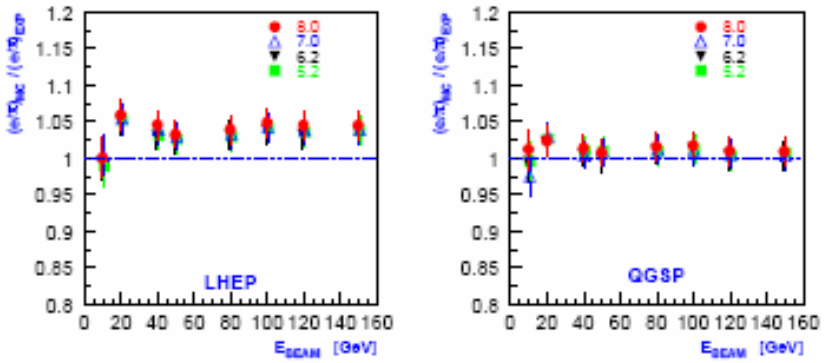
LHEP predicts larger values of e/π

GEANT3 – systematically lower

Costa Brava ACC Workshop September 5, 2006

GEANT4 physics validation with the HEC testbeam data / Energy scans with pions

Ratio e/π for different GEANT4 versions



No difference for e/π-ratio between GEANT4 versions

Slides by A.Kiryunin

From Summar slide
A.Kiryunin

Charged pions (energy scans)

- No significant changes are observed for the version 8.0p01 w.r.t. the previous GEANT4 versions

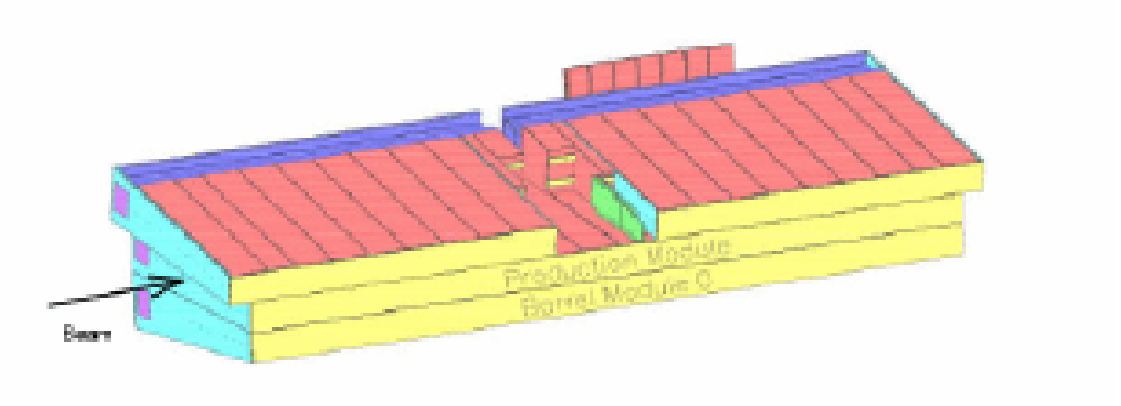
- Main conclusions:
  - QGSP describes well energy resolution, response and ratio e/π
  - LHEP is worse in the description of these parameters (but is at the level of GEANT3)
  - Both GEANT4 physics lists (QGSP and LHEP) meet problems to describe shapes of hadronic showers

Peter Schacht:

Hadronic Calibration: priorities, actions ,next steps ...

- Goal: hadronic calibration is supposed to give the best estimate of true energy deposition in any given η-φ region of the ATLAS calorimeter; missing link to jet calibration is only out of cone correction, underlying event etc., i.e. corrections at physics level only;
- Lacking manpower for TB analysis: crucial to assess systematic errors: apply MC weights to single particle clusters;
- GEANT 4 simulation: can our problems be addressed in a more direct way? How to improve? FLUKA comparison ?

Test beam setup

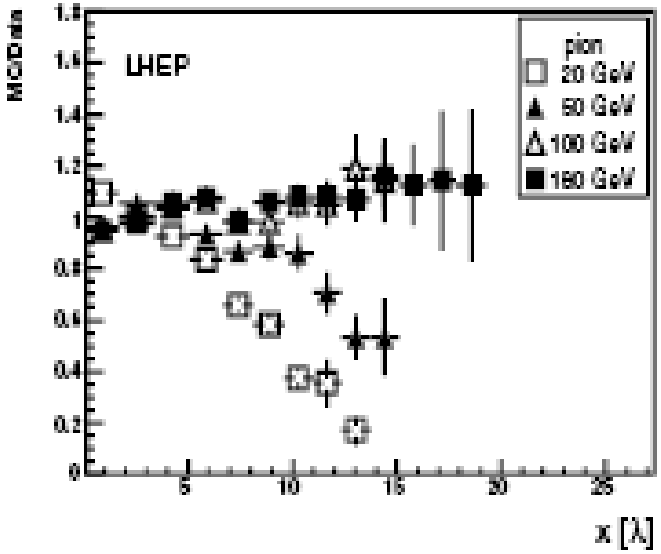


- Beam hits the modules of the detector from the side, perpendicular to the tiles (90 degree run).
- More than 25 nuclear interaction length deep calorimeter.
- Beam hits the center of Barrel module placed in the middle.
- The Extended Barrel modules have different cell geometry and there is a gap between two of them. For these reasons they are not used in this analysis. The response of bottom module is multiplied by factor 2.

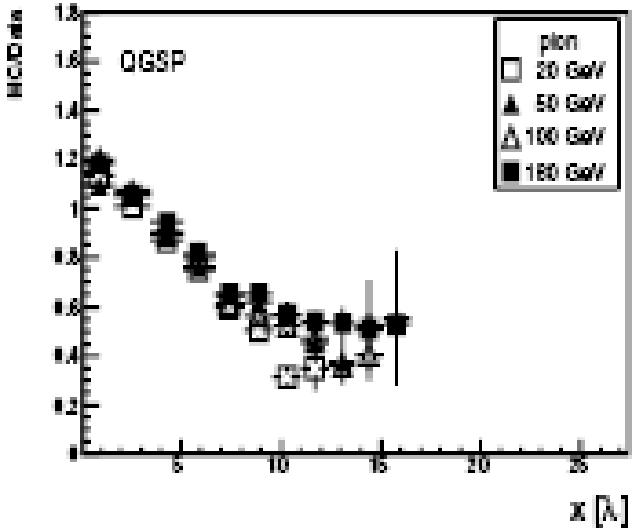
MC and Data comparison

Pion induced showers

Good description at high energies.



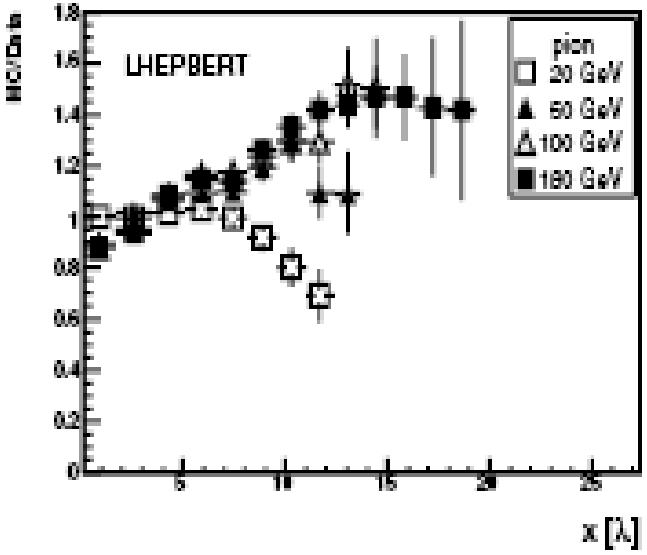
Showers are too short.

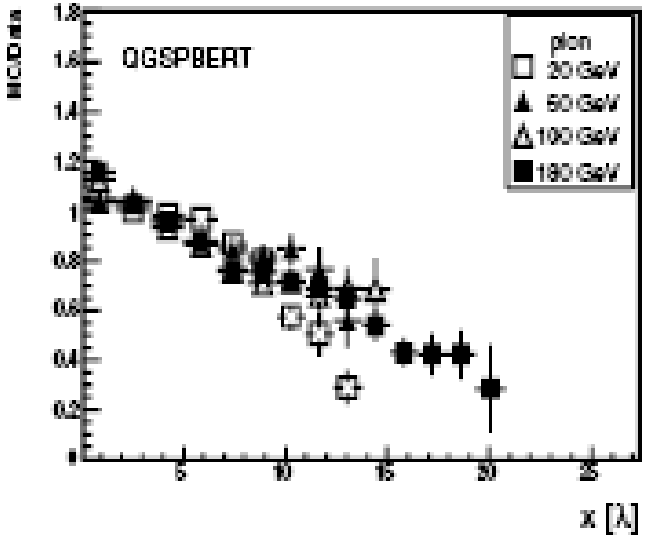


MC and Data comparison

Pion induced showers

Bertini model makes showers longer.



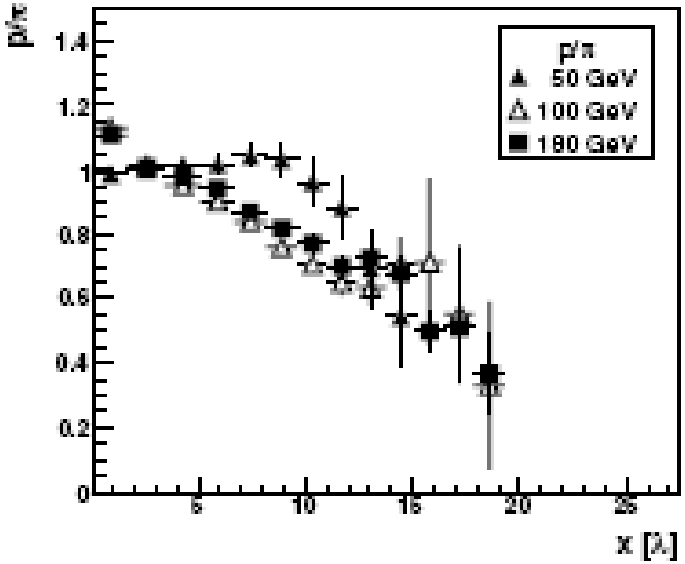


Pion and proton shower profile comparison

1. Proton-nucleus interaction cross-section is larger than pion-nucleus one by about 20%. Protons start showering earlier than pions.
2. Electromagnetic fraction of hadronic shower is larger in case of pions and it is mainly concentrated in the beginning of shower.

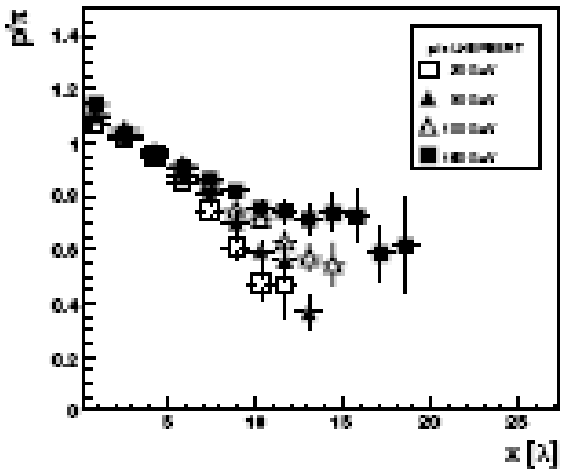
The first effect is dominant at high energies.

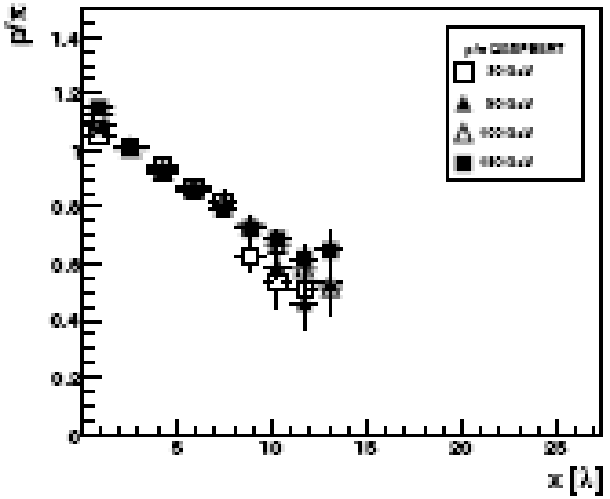
At 50 GeV the effects are compensating each other.



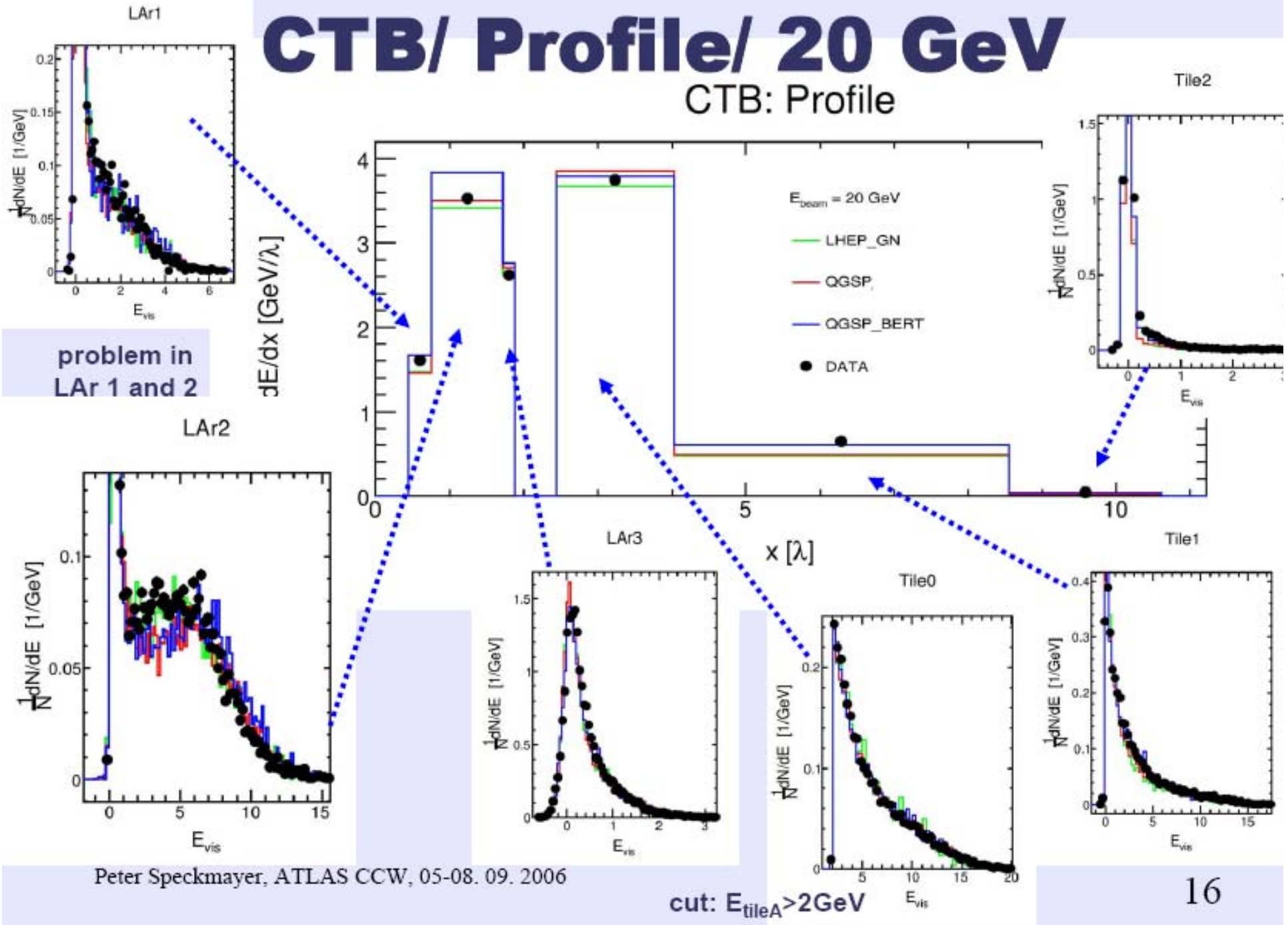
Pion and proton shower profile comparison

- Geant4 is able to predict general behavior of the ratio, but not compensation at 50 GeV.

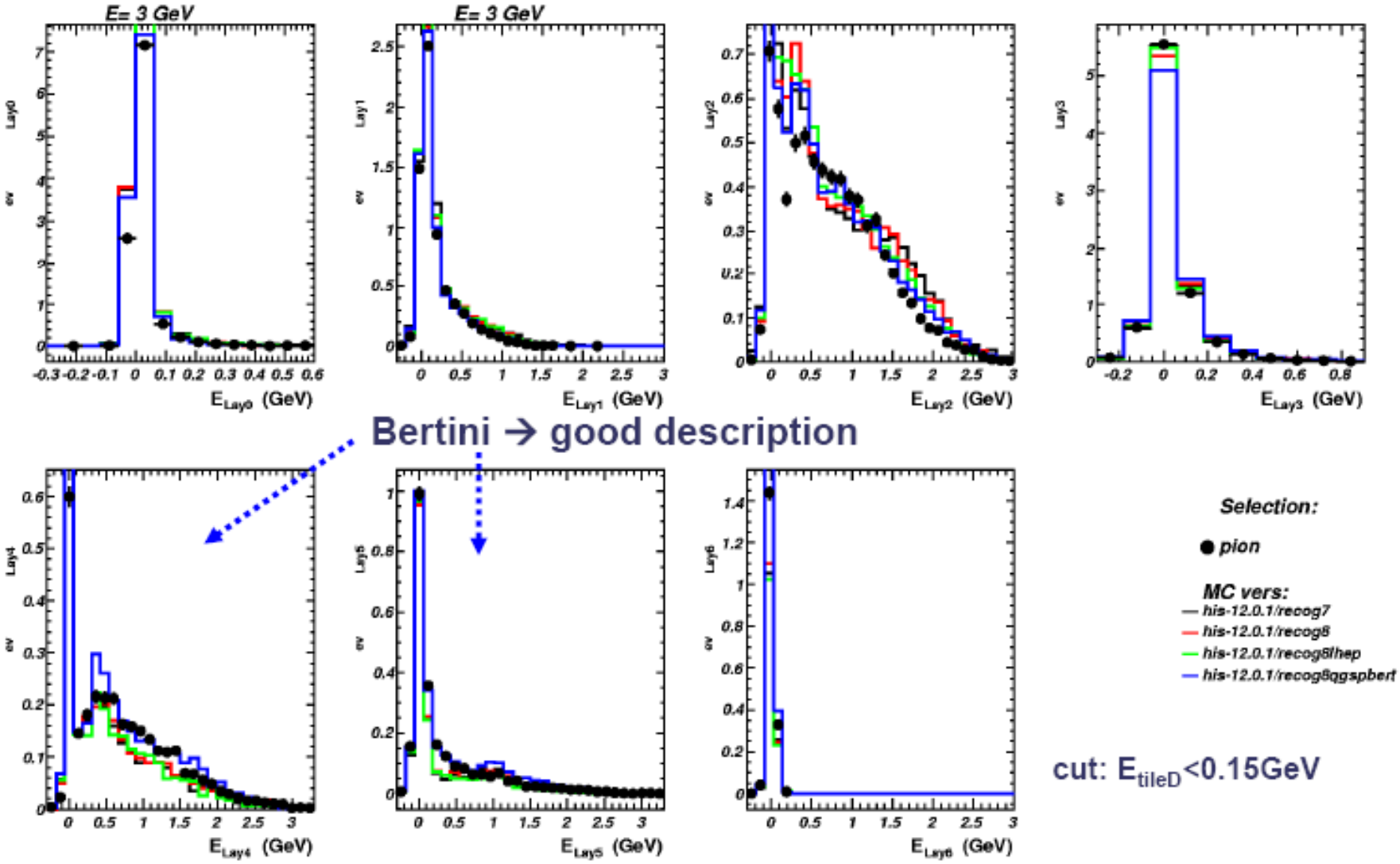




CTB/ Profile/ 20 GeV

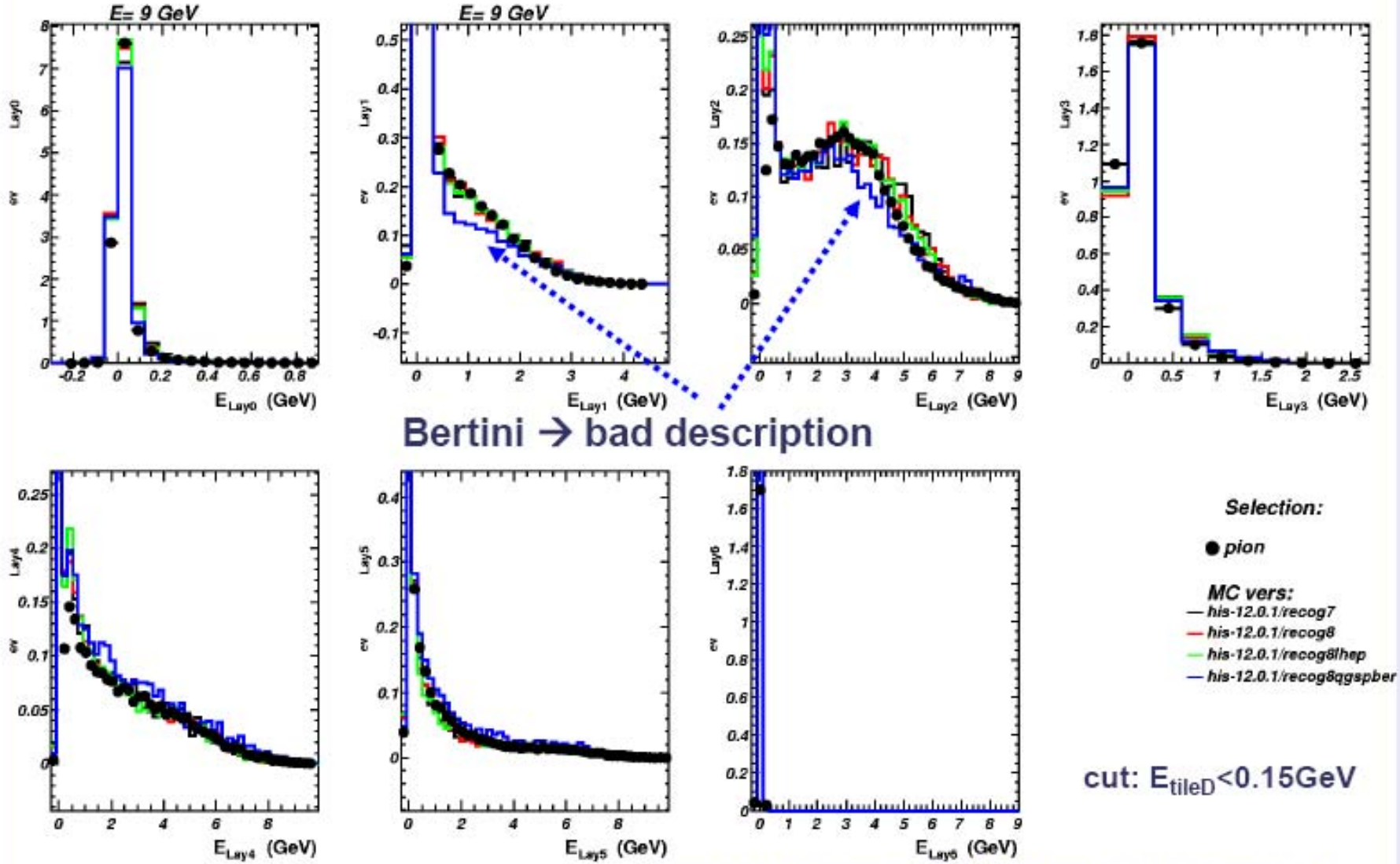


CTB/ VLE/ 3GeV, π



plots by Tancredi Carli

CTB/ VLE/ 9GeV, π



Bertini → bad description

cut: E_{tileD}<0.15GeV

upper Range for Bertini to be tuned?

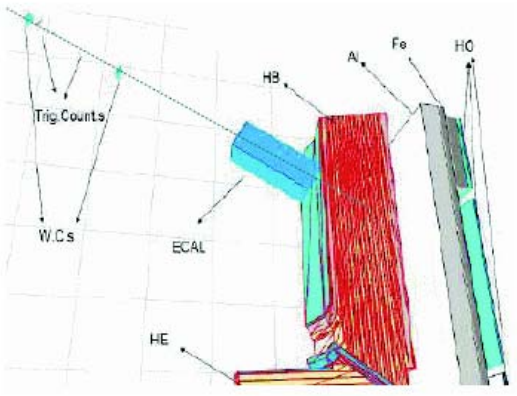
plots by Tancredi Carli

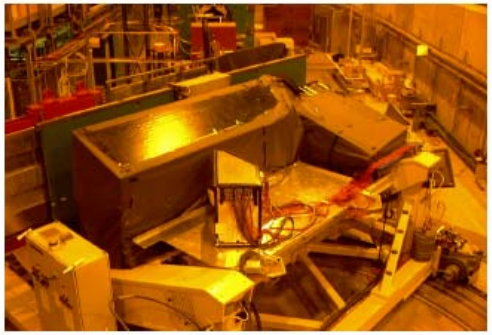
CMS

Validation meeting April 2006

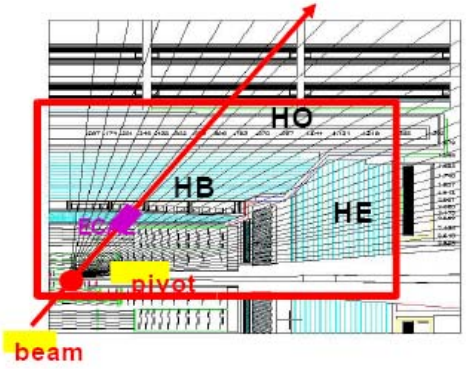
GEANT4 validation with HCAL TB2004 data

J. Damgov (INRNE/FNAL),
S. Piperov (INRNE/FNAL),
S. Kunori (U. of Maryland) et al.

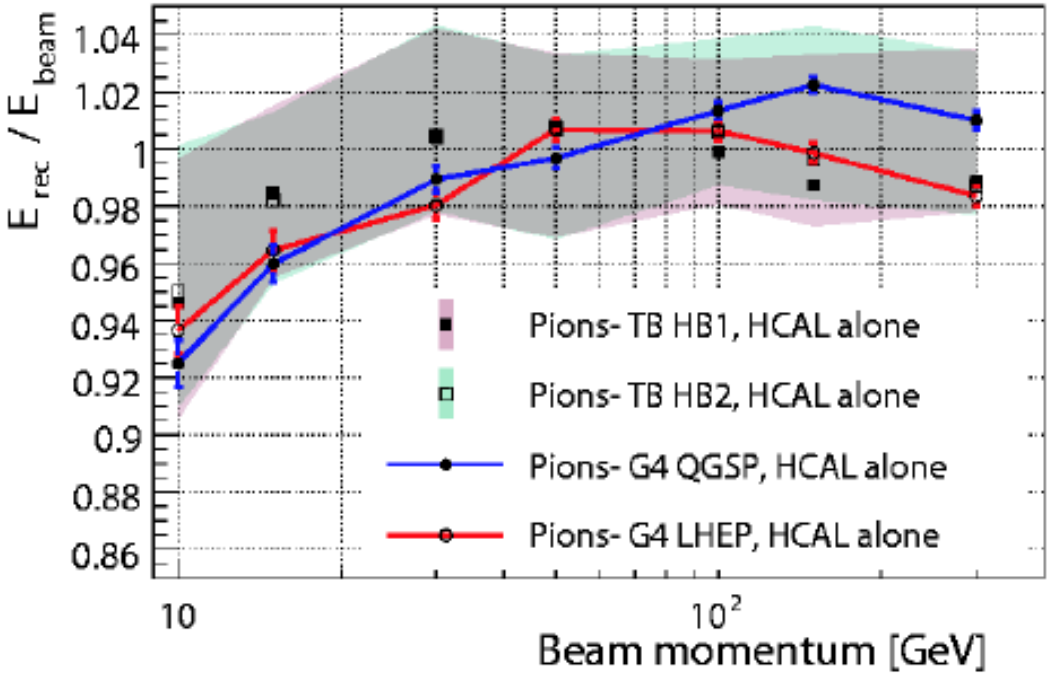


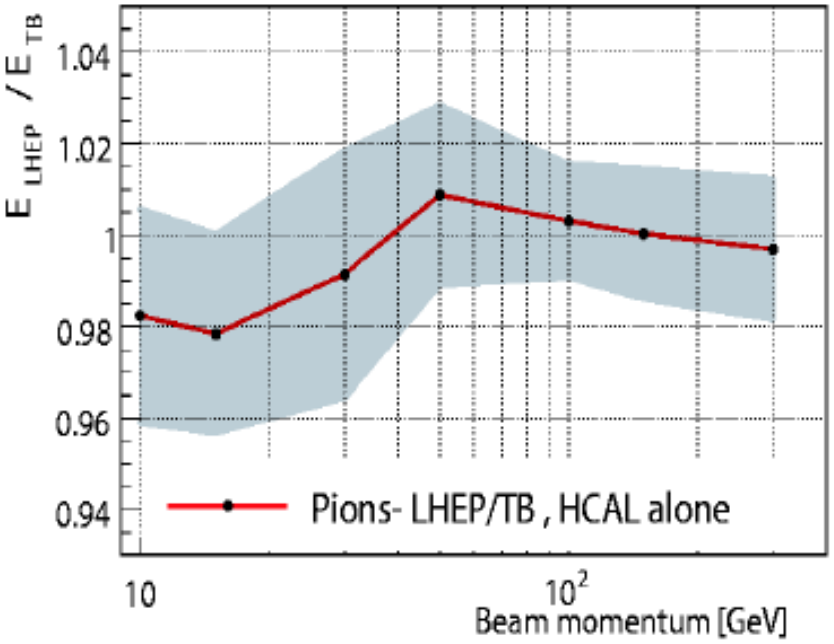


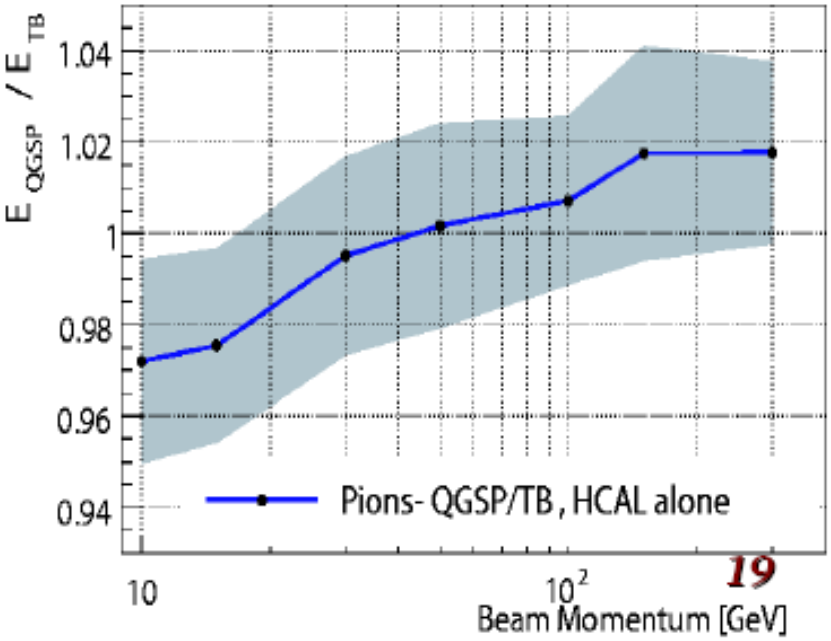
April 2006



Response to pions of HCAL alone

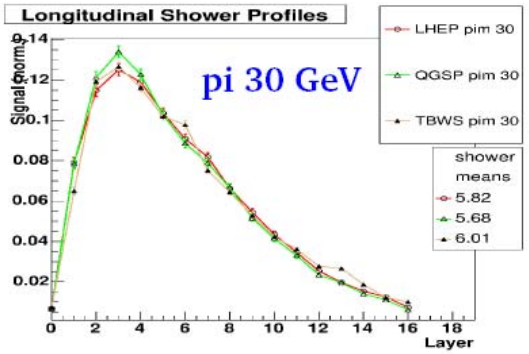


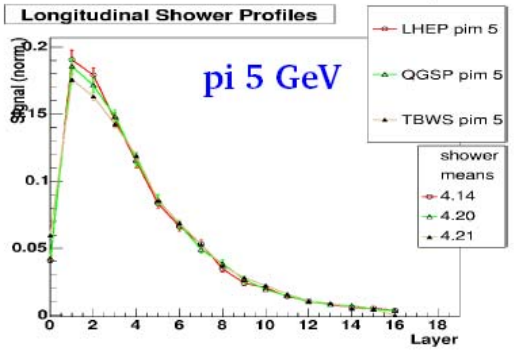




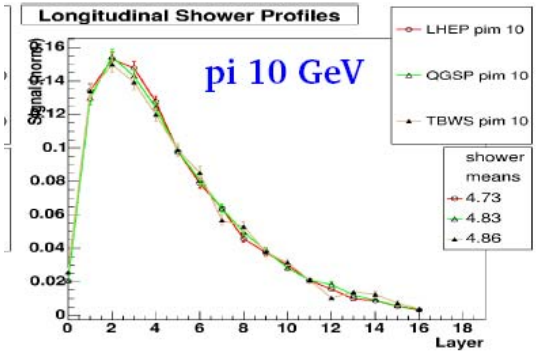
QGSP shows high response at high energies due to smaller leakage on the back of HCAL – shorter sower profile

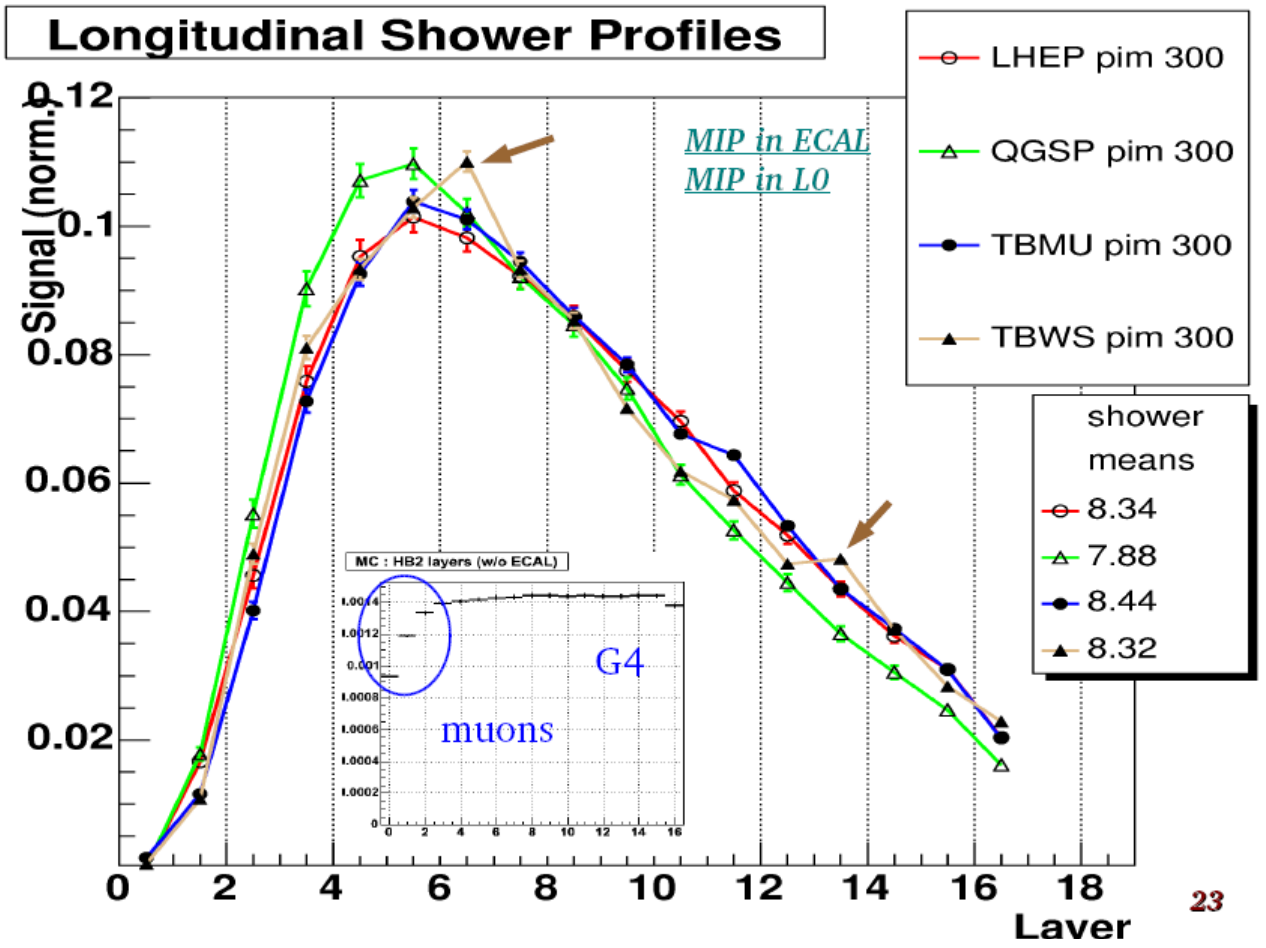
Longitudinal shov





wer profiles (cont.)





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LHEP and QGSP show good agreement with test beam data at low and intermediate energies

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Summary

- Atlas ad CMS ~agree on shower shape
  - QGSP is too short at high Energies
    - LHEP is better
  - Low energies
    - CMS: good agreement for LHEP and QGSP
    - Atlas: both LHEP and QGSP too short
- Response:
  - Atlas: QGSP better
  - CMS: QGSP too high for high energies
- E/pi QGSP better (Atlas)