Status of the Geant4 Physics Validation with the ATLAS HEC Testbeam

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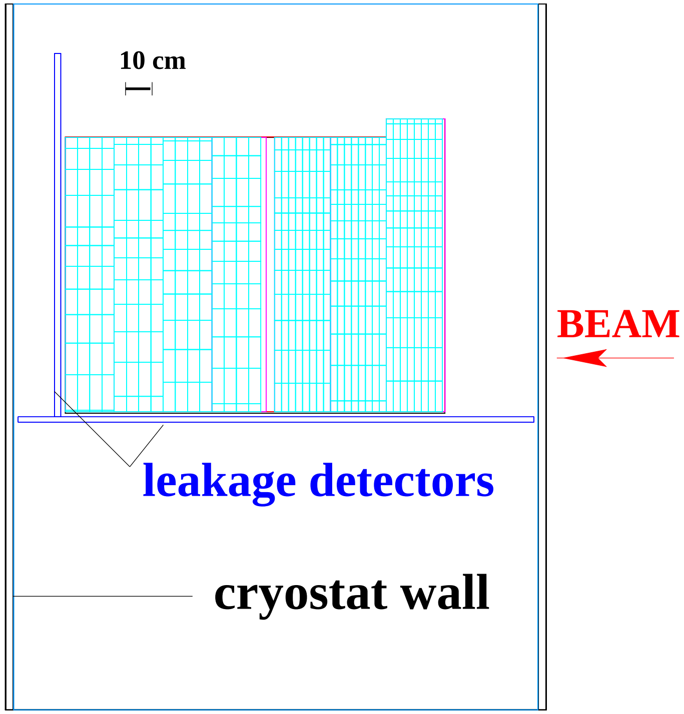
- HEC stand-alone beam tests: experimental data and simulations
- Electron results
- Pion results
- Conclusions and plans

HEC Stand-Alone Testbeam

- Experimental results:
  - B. Dowler *et al.*, NIM A482 (2002) 94.
  - Additional analysis of 2001 data

- Geometrical description of testbeam elements (very close in Geant4 and Geant3 codes)
  - beam line elements (MWPCs, scintillator counters)
  - cryostat (with LAr excluder)
  - calorimeter modules
    - sensitive LAr
    - sensitive copper plates
  - "virtual" leakage detectors

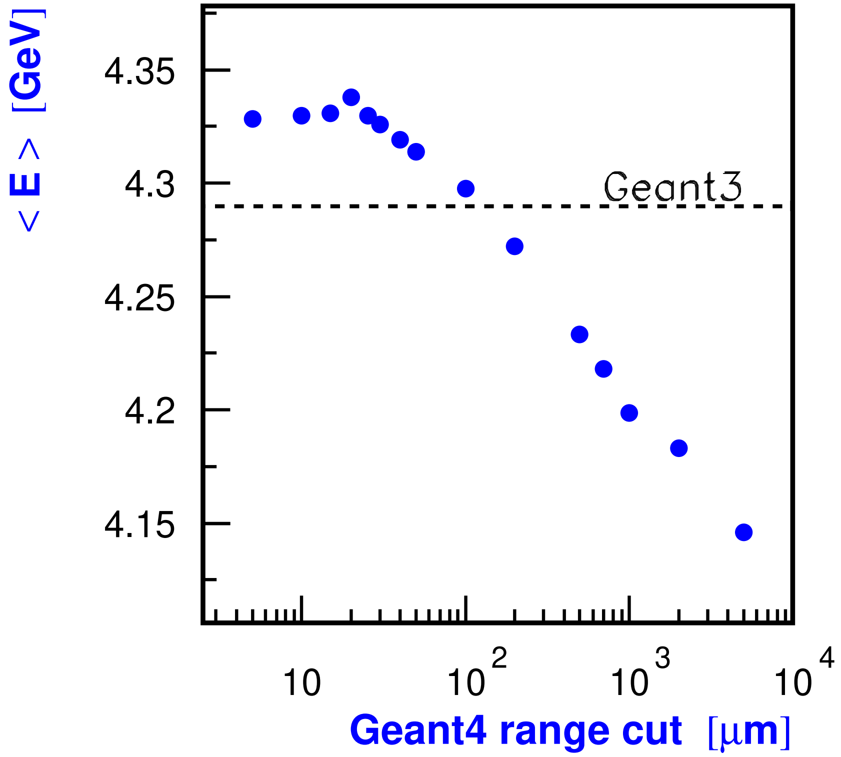


- Geant4
  - Version 5.0p01
  - Hadronic physics lists for calorimetry
    http://cmsdoc.cern.ch/~hpw/GHAD/HomePage/
    * LHEP
    * QGSP
    * QGSC
    * FTFP
  - Different range cuts

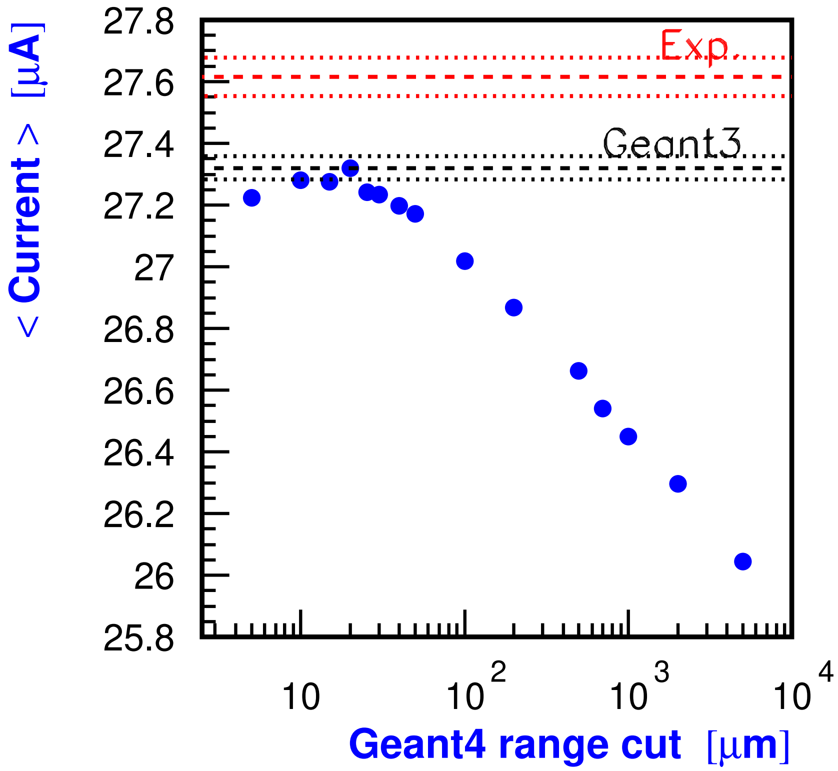
- Geant3
  - Version 3.21
  - G-CALOR (hadronic shower code)
  - 100 keV transport cuts and 1 MeV process cuts

Electron Results

- 100 GeV electrons: scan over range cut

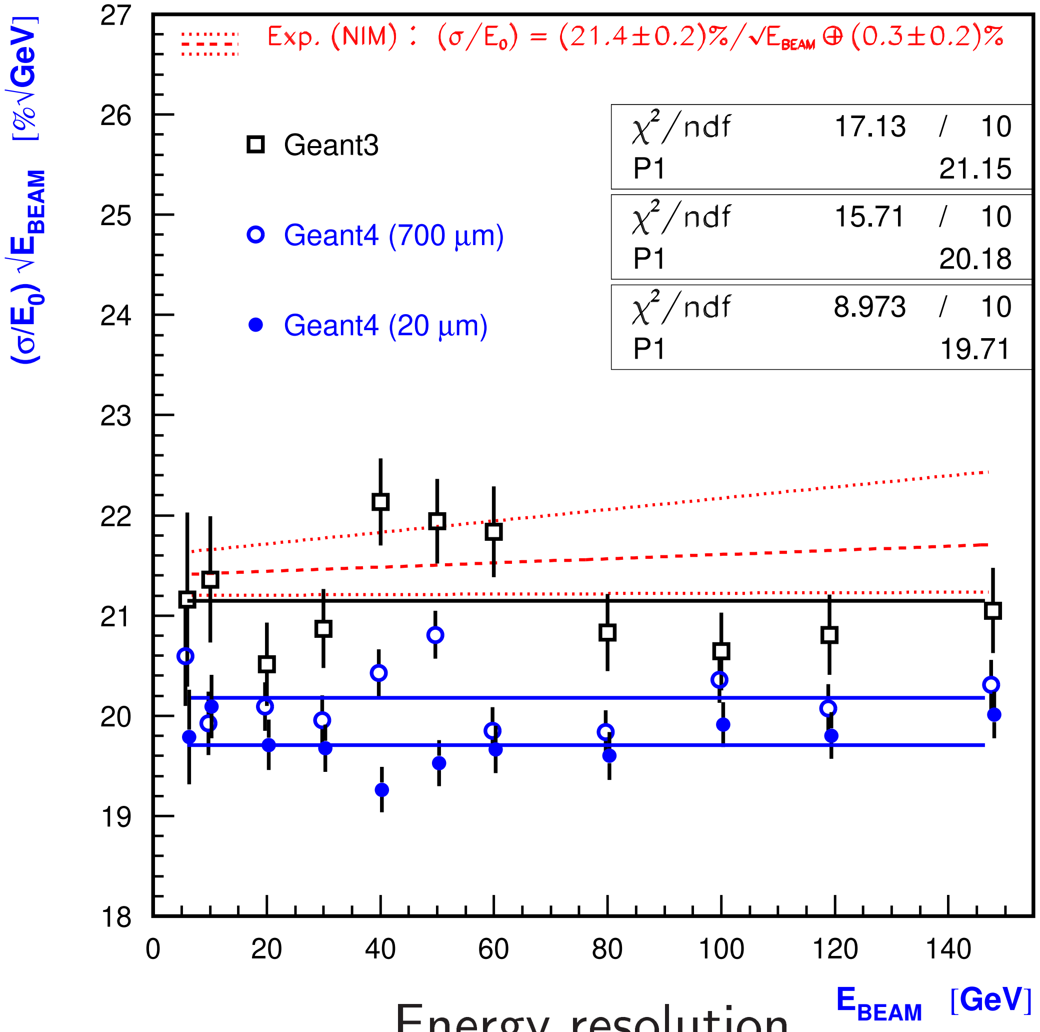


Signal in the first two layers



Signal in the most loaded channel
(visible energy $\times$ 7.135 μA/GeV)

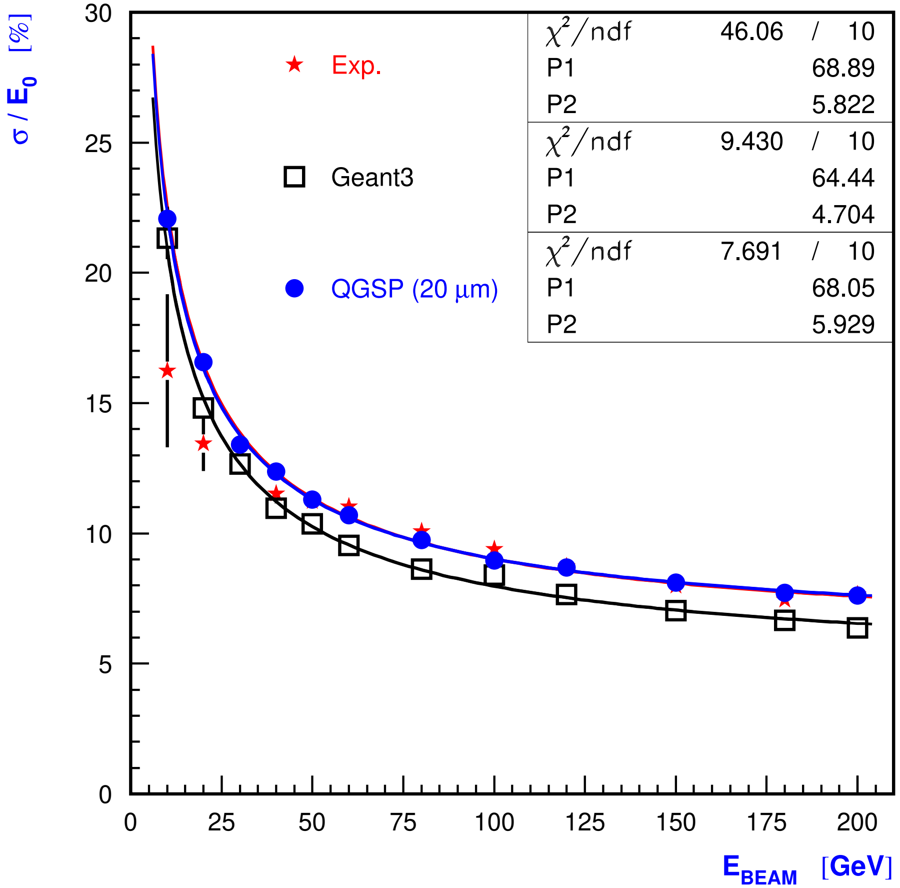
- Energy scan with electrons:
  - 6-147.8 GeV
  - 6 cell tower
- Geant4: 20 and 700 μm range cut



Energy resolution

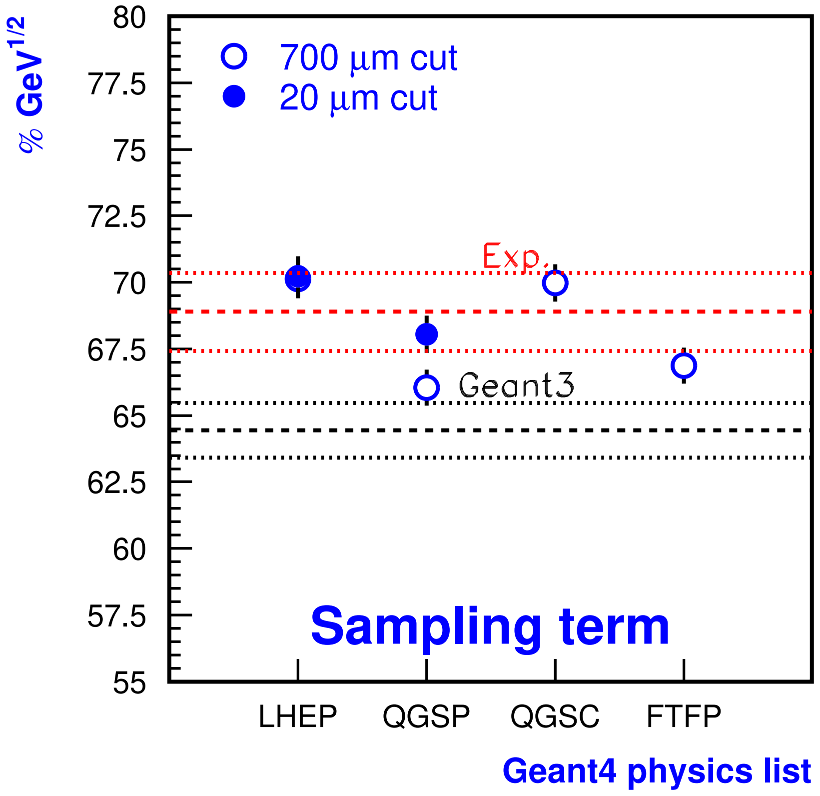
Pion Results

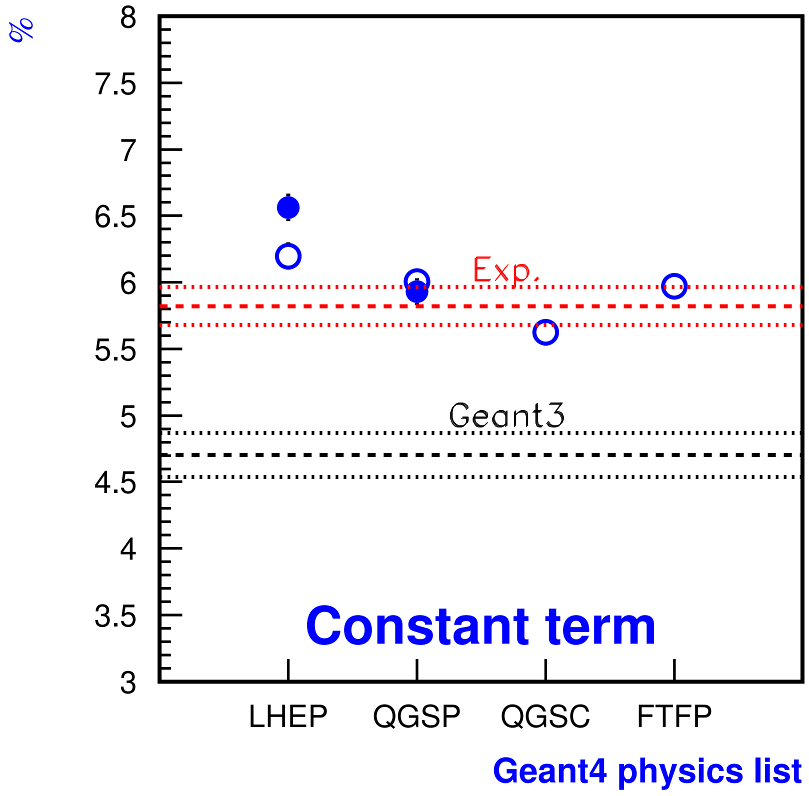
- Energy scan with negative pions:
  - 10-200 GeV
  - fixed cluster
- Geant4:
  - 20 μm range cut (LHEP and QGSP)
  - 700 μm range cut (all lists)



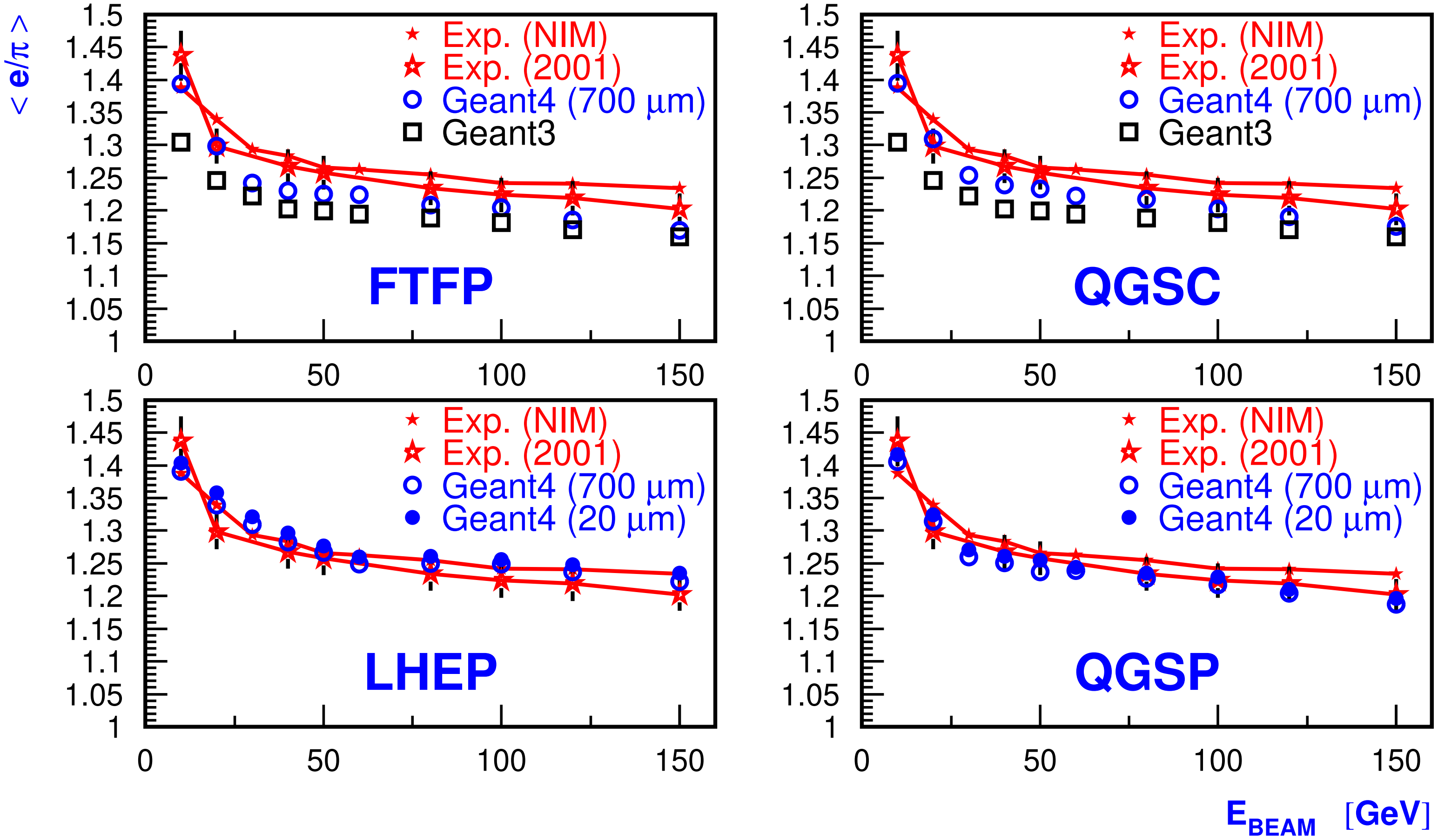
Energy resolution

Terms of pion energy resolution



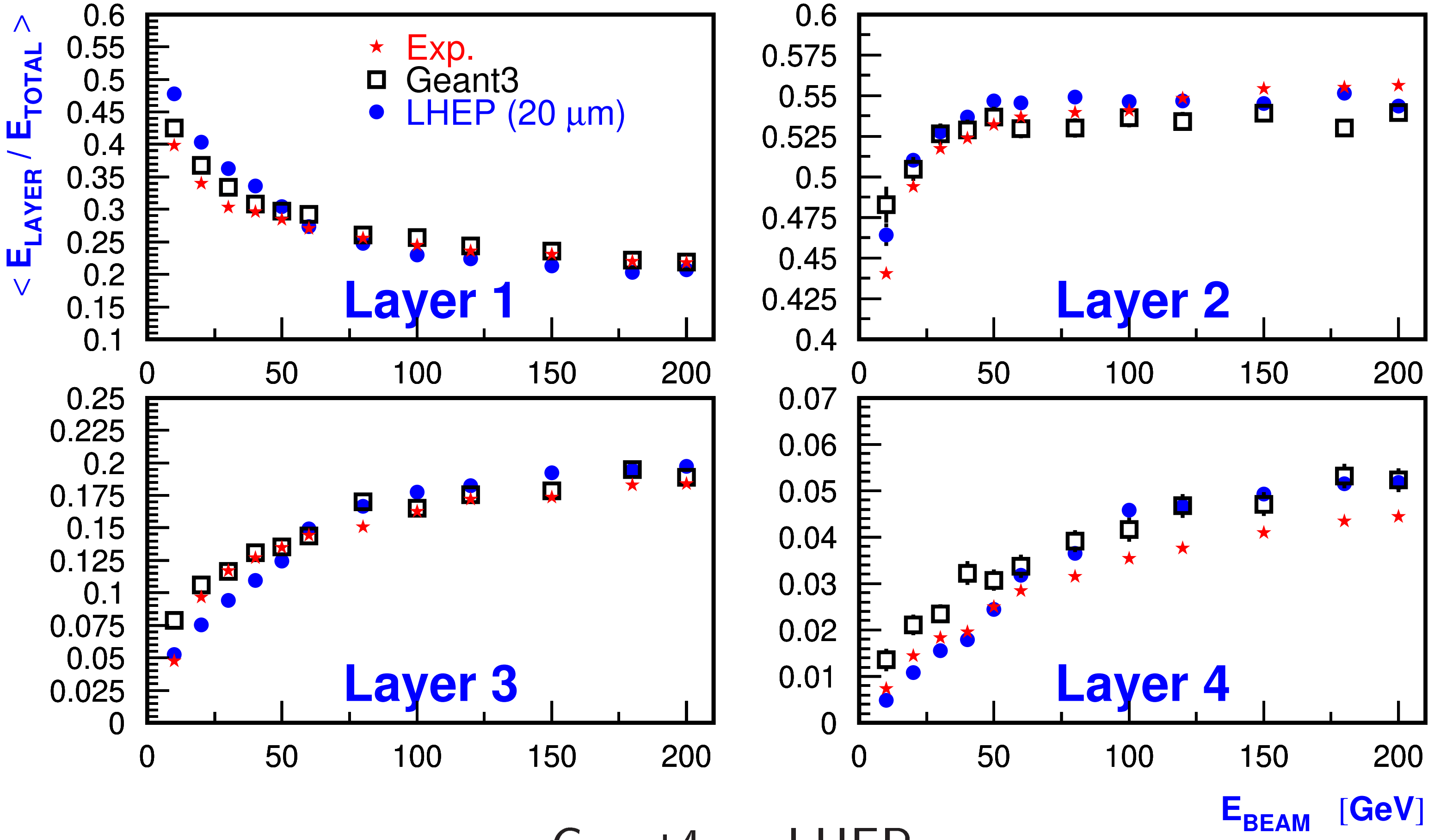


Ratio e/π



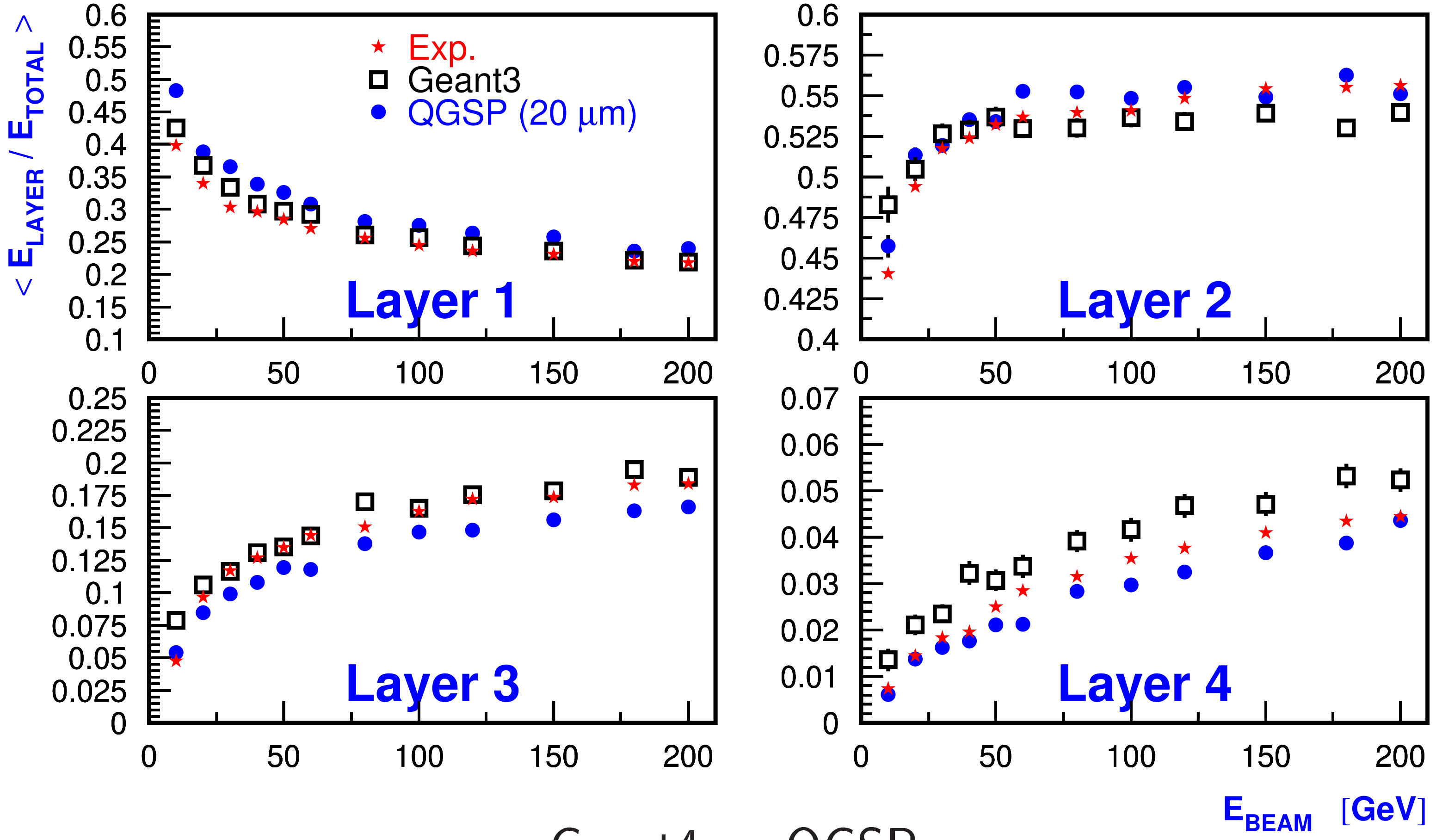
< e/π >
Exp. (NIM)
Exp. (2001)
Geant4 (700 μm)
Geant3
FTFP
QGSC
Geant4 (20 μm)
LHEP
QGSP
E_BEAM [GeV]

Fraction of energy in HEC layers



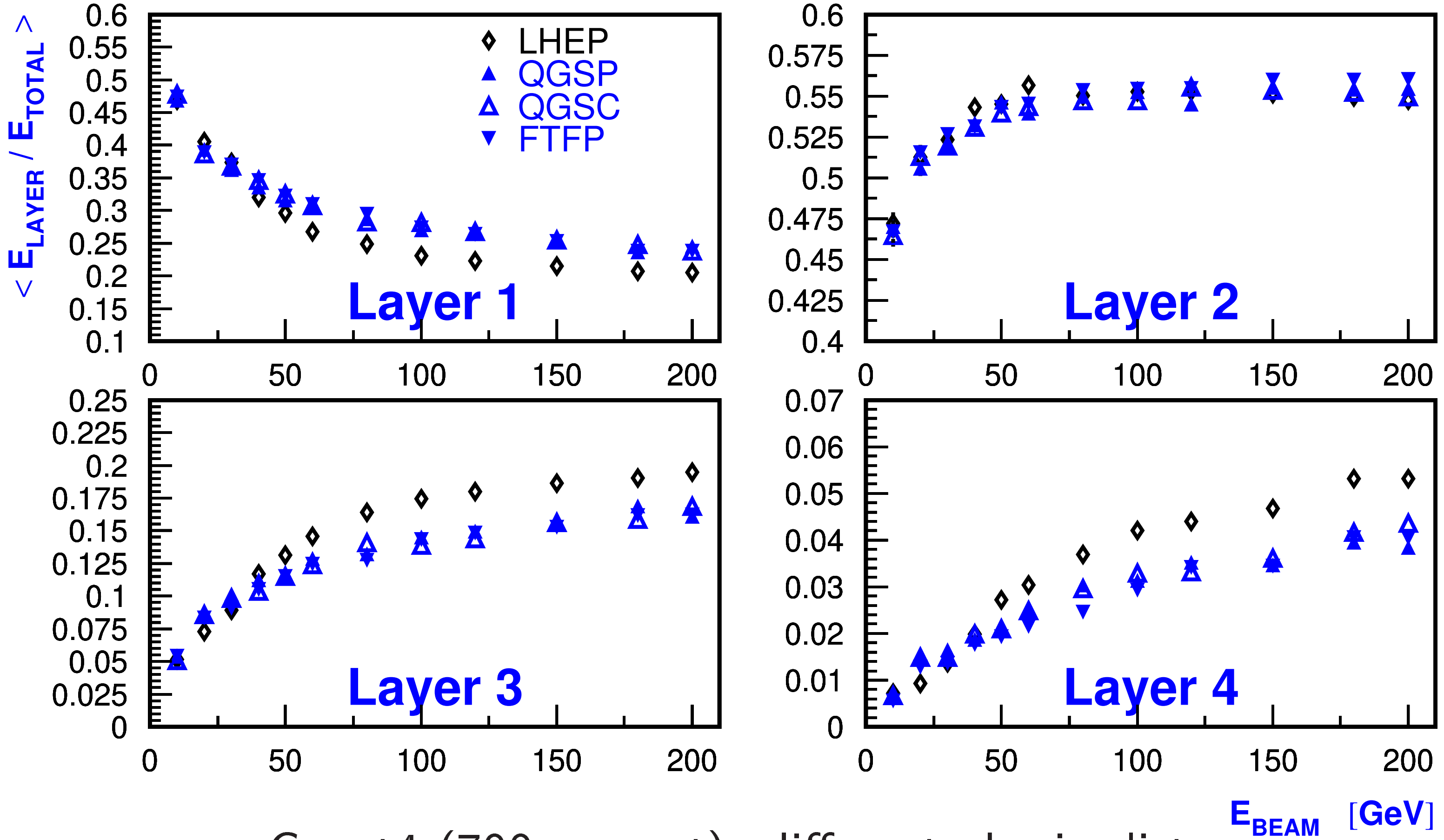
Geant4 — LHEP

Fraction of energy in HEC layers



Geant4 — QGSP

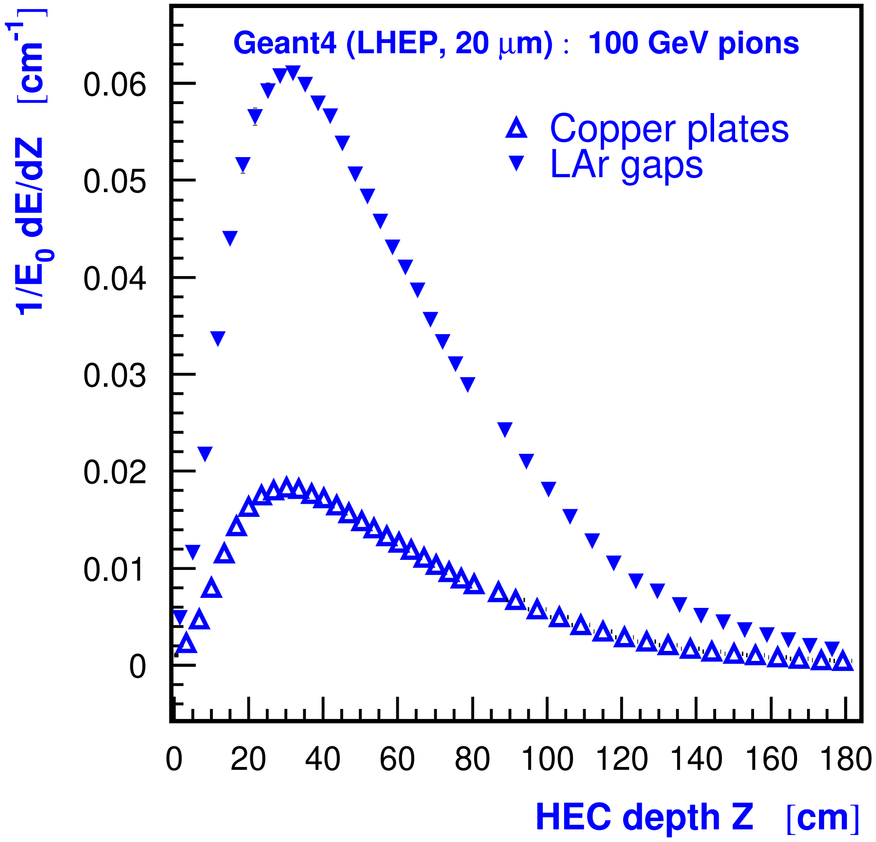
Fraction of energy in HEC layers



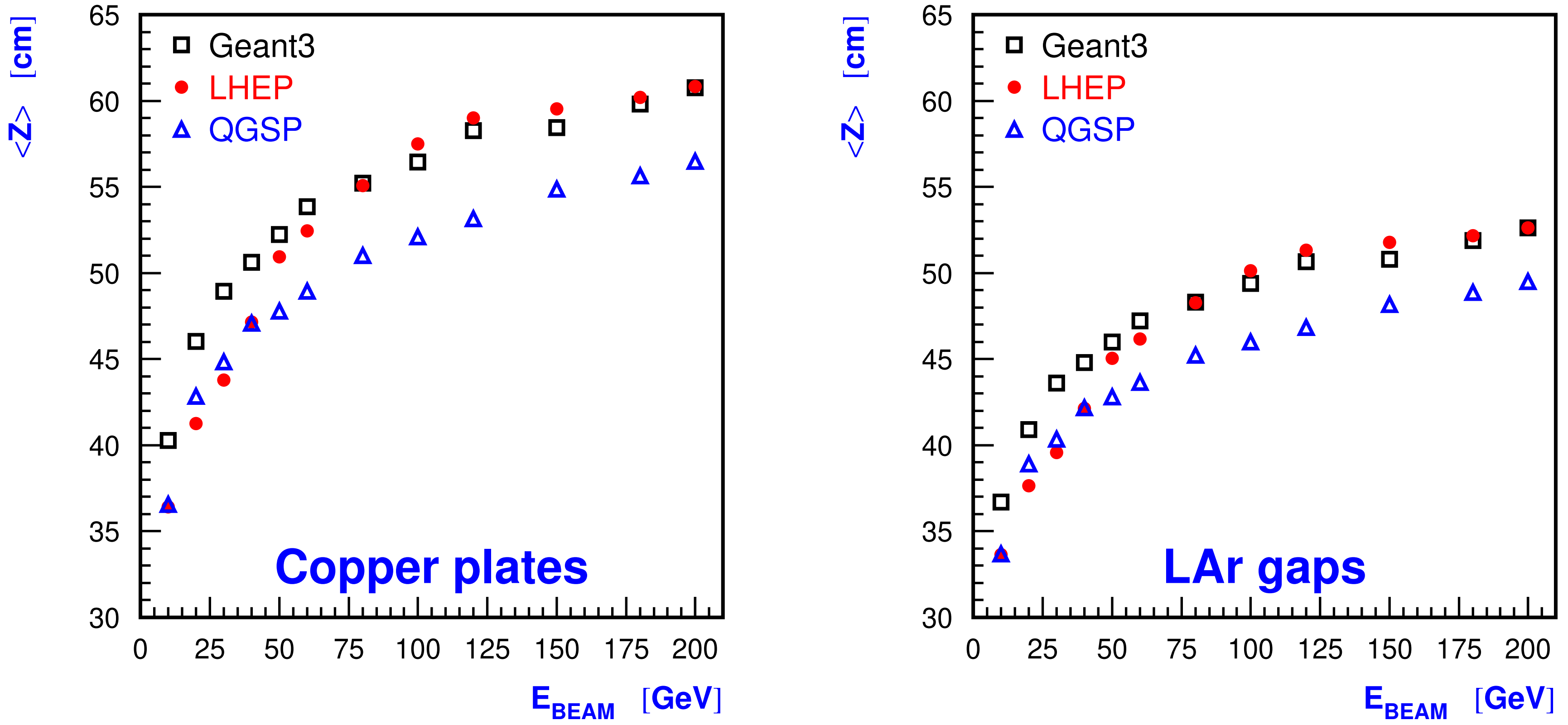
Geant4 (700 μm cut): different physics lists

Longitudinal profiles

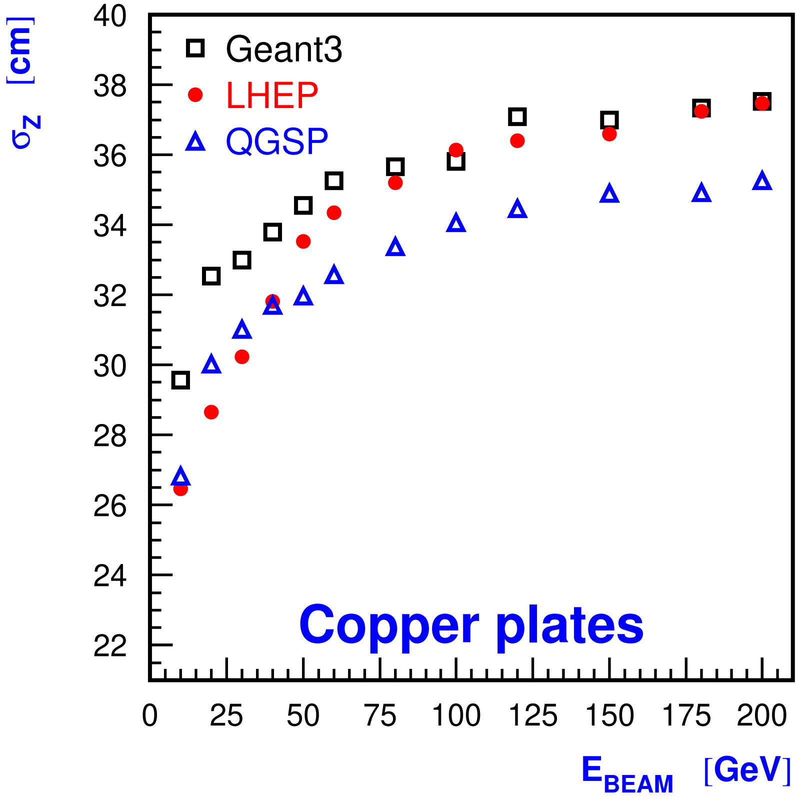
- Special simulations from the front face of the calorimeter ("no beam")
- Geant4: LHEP and QGSP (20 μm range cut)
- HEC longitudinal structure:
  - 42 copper plates (25 and 50 mm thick)
  - 40 gaps of LAr (8.5 mm thick)

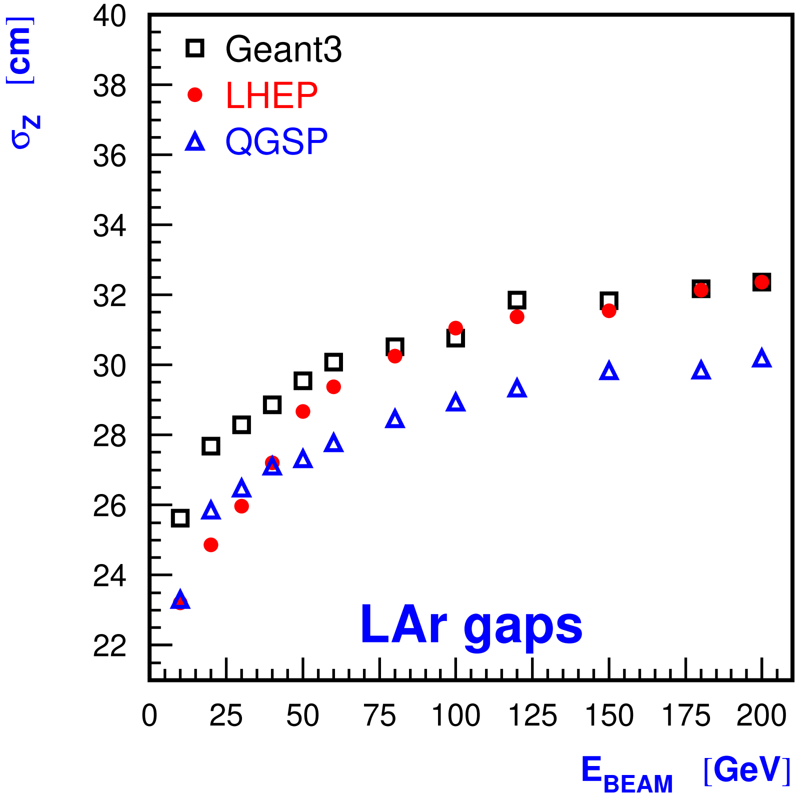


Average longitudinal position of a shower

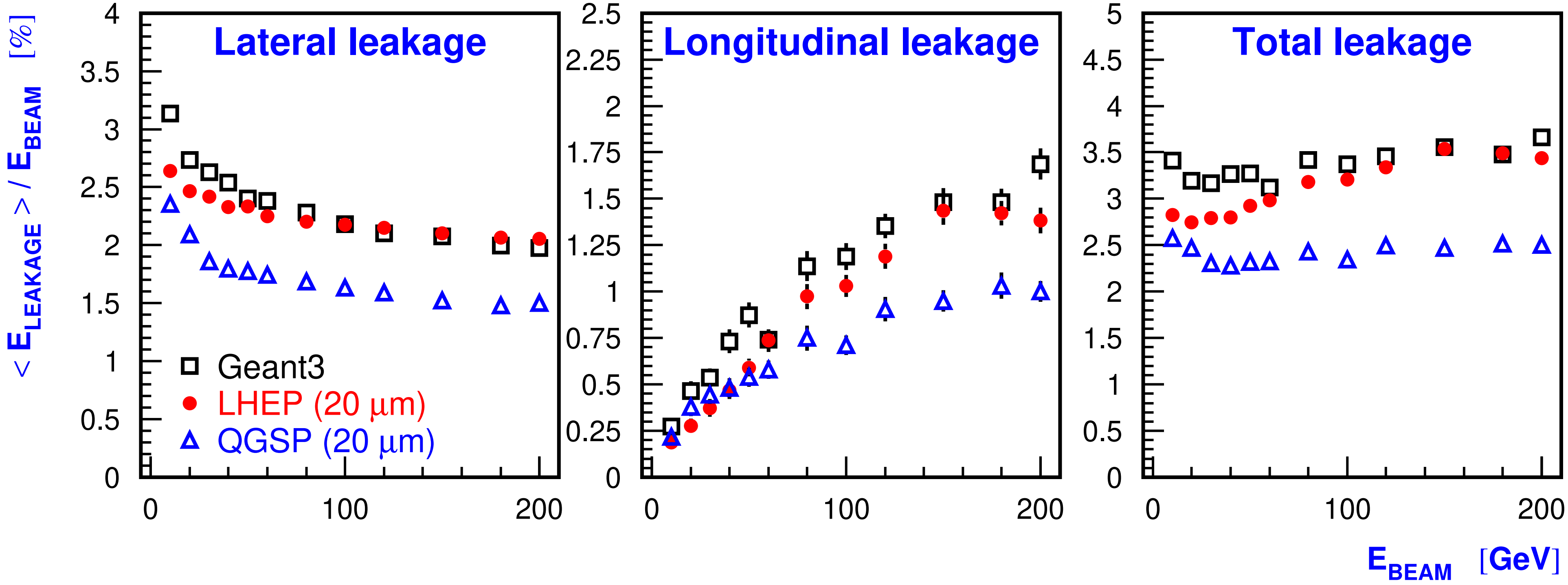


Longitudinal spread of a shower





Energy leakage



Conclusions and Plans

- Conclusions
  - New round of Geant4 based simulations with version 5.0p01 was carried out for the HEC testbeam
  - Electron results are very similar to the previous ones (obtained with version 4.1)
  - Further improvement (w.r.t. Geant4 version 4.1) is observed for charged pion simulations
  - QGSP and LHEP physics lists describe rather well:
    - the energy resolution for pions
    - the e/π-ratio
  - There are still some problems in the description of longitudinal development of hadronic showers

- Plans
  - Fulfill some simulations with version 5.2
  - Prepare a note on Geant4 physics validation with the HEC testbeam
  - Continue work on simulations for combined beam tests of EMEC and HEC