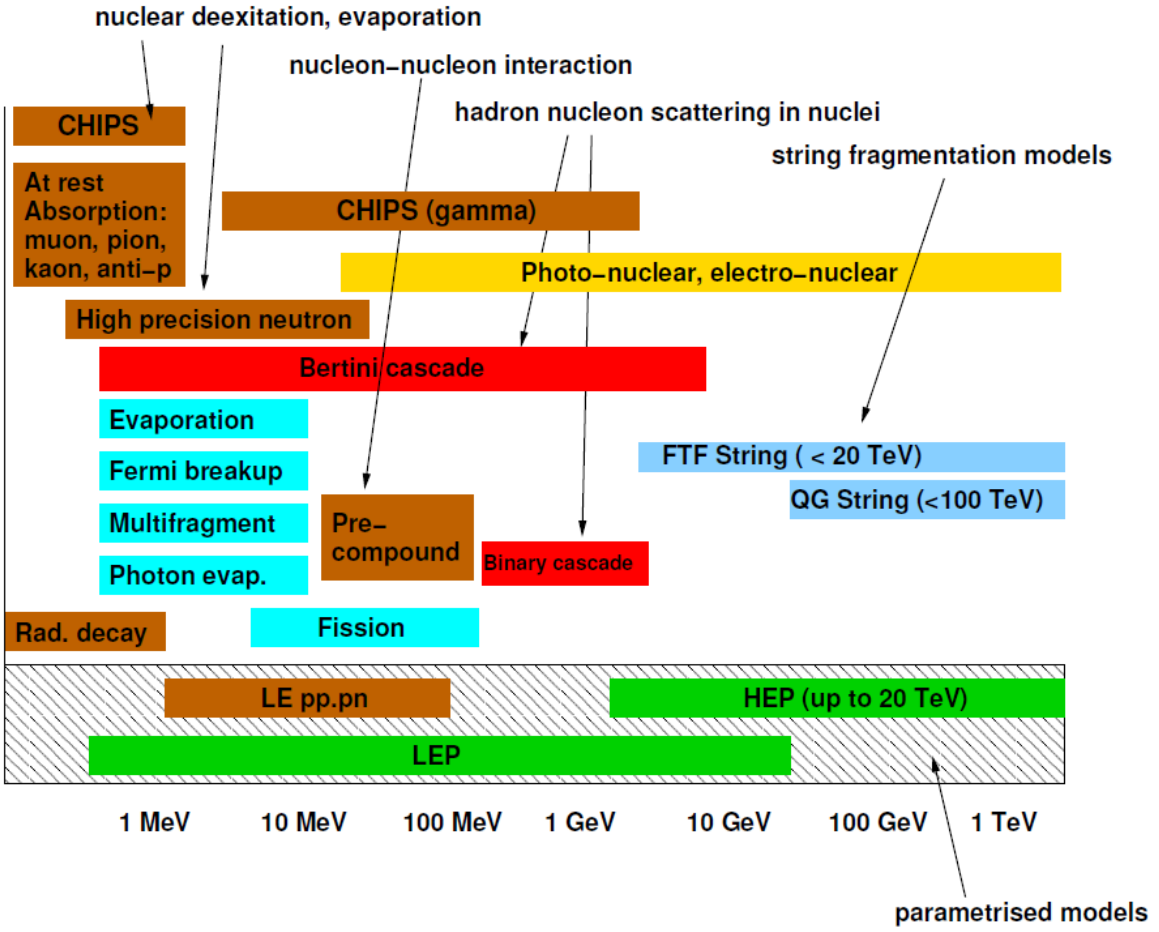
TB data vs MC comparison in barrel

- Big effort invested into validation of Geant4 versions and various physics lists with the TB data:
  - Geant4.9.1 vs. CTB2004 LAr+Tile, mixed beam pions+protons according to the measured share
  - Geant4.9.[2|3] vs. Tile standalone, mainly testing new physics lists

Physics lists

- Several variants of physics list investigated:
  - QGSP (old default)
  - QGSP+BERT (new default)
  - FTFP (+BERT)
  - QGSP/FTFP + BIC
- Comparisons performed in terms of
  - response and resolution/RMS
  - longitudinal and lateral hadronic shower profiles



Summary of the Combined Test-beam Data to Monte Carlo Comparisons of the ATLAS Barrel Calorimeter

- Atlas Barrel Detector (Pixel, SCT, TRT, Lar, Tile) pions from 2-180 GeV (protons mixed in according to fraction measured by TRT)

- Models considered: QGSP (old default), QGSP_BERT (new default)
  FTFP FTFP_BERT (alternative)

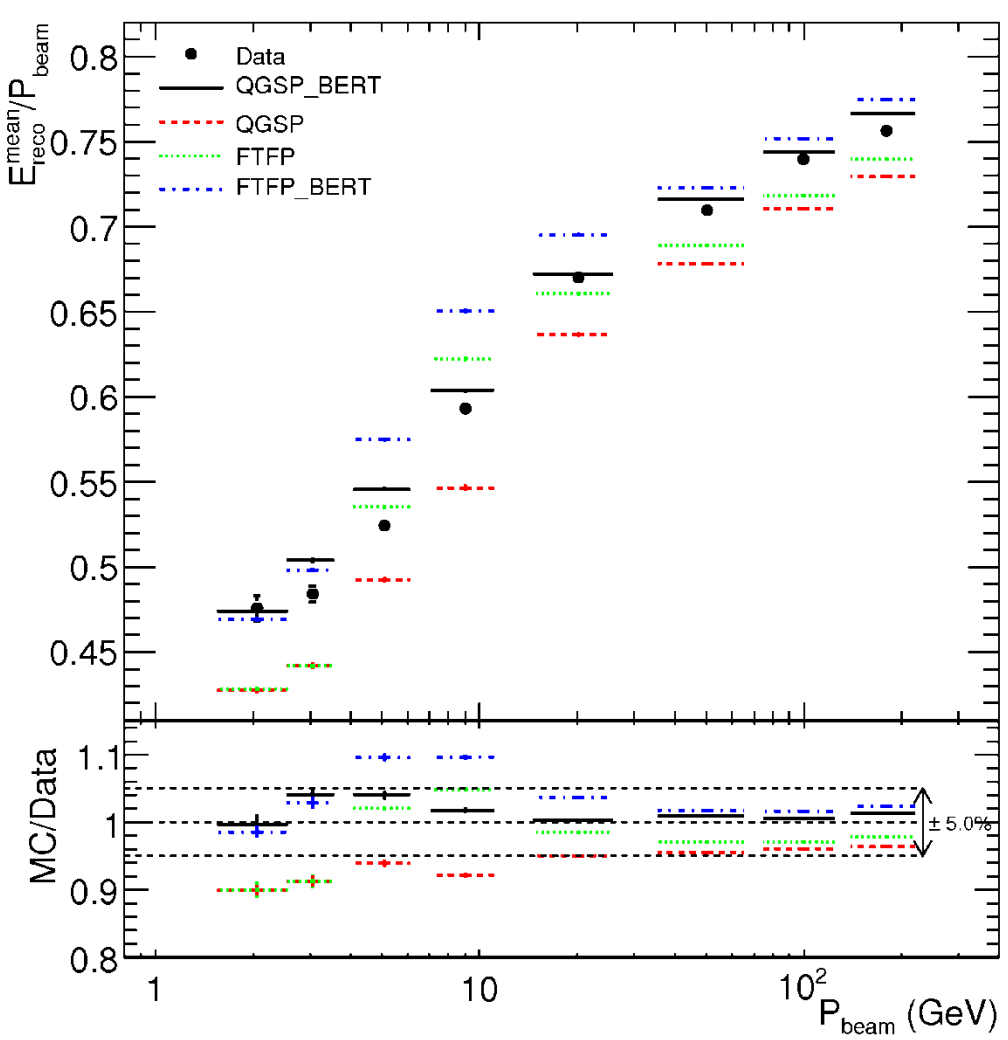
- Linearity and Resolution

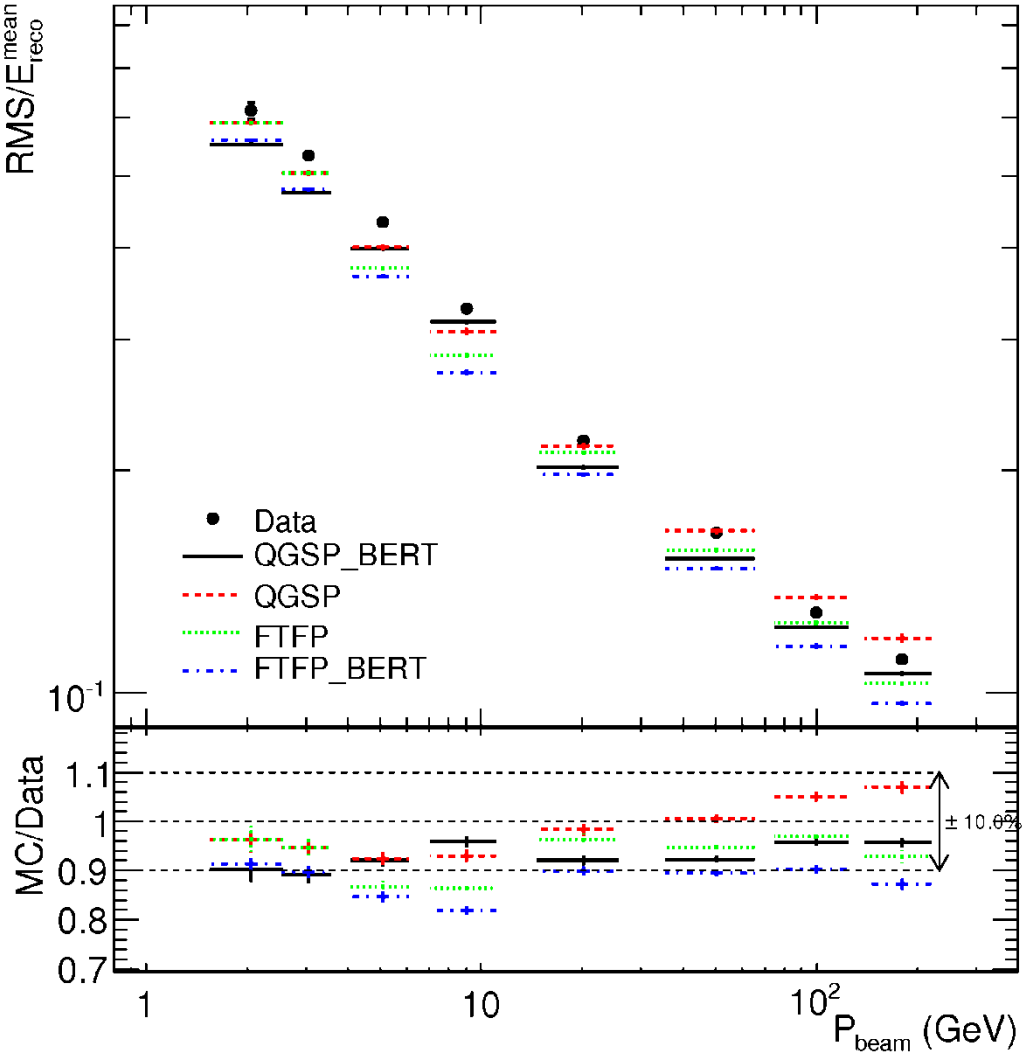
- Longitudinal shower development

- Radial shower development

All results from: ATL-COM-CAL-2009-004

Pion Response and Linearity



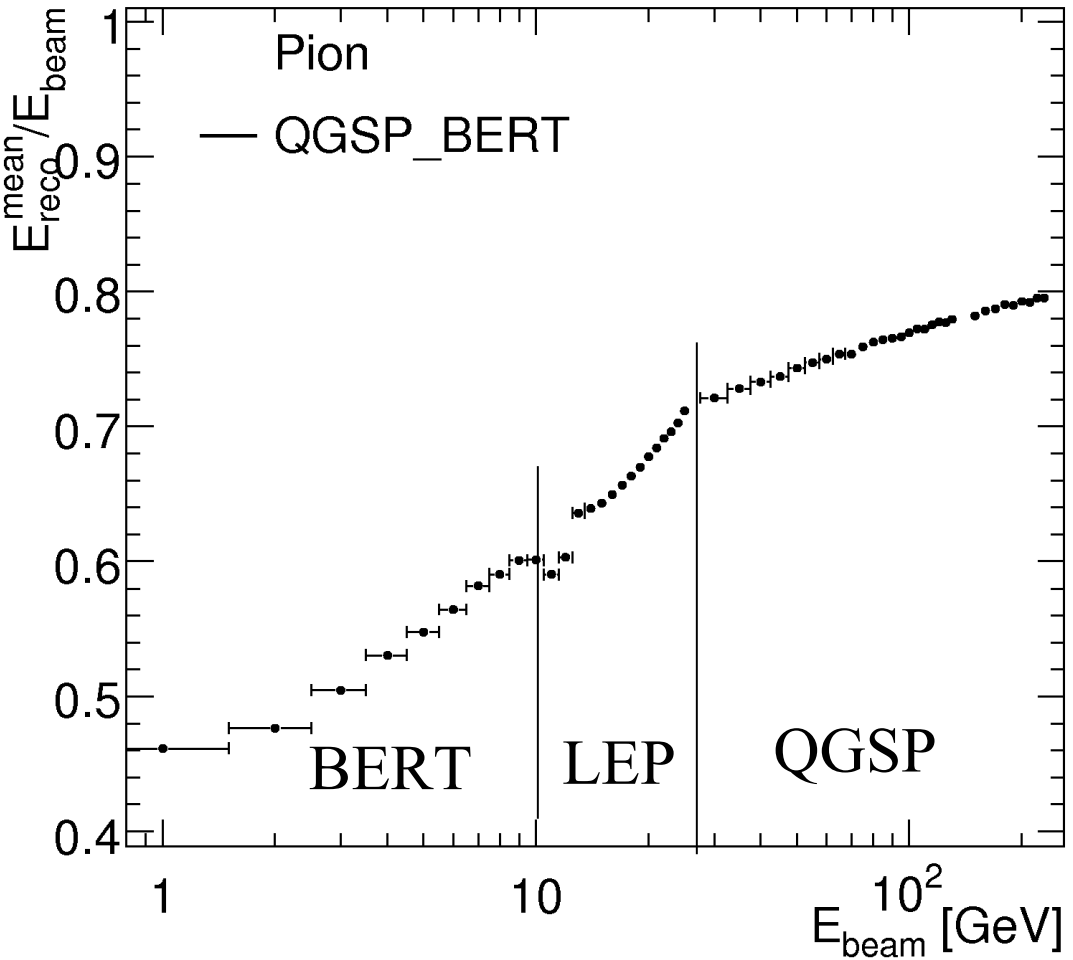


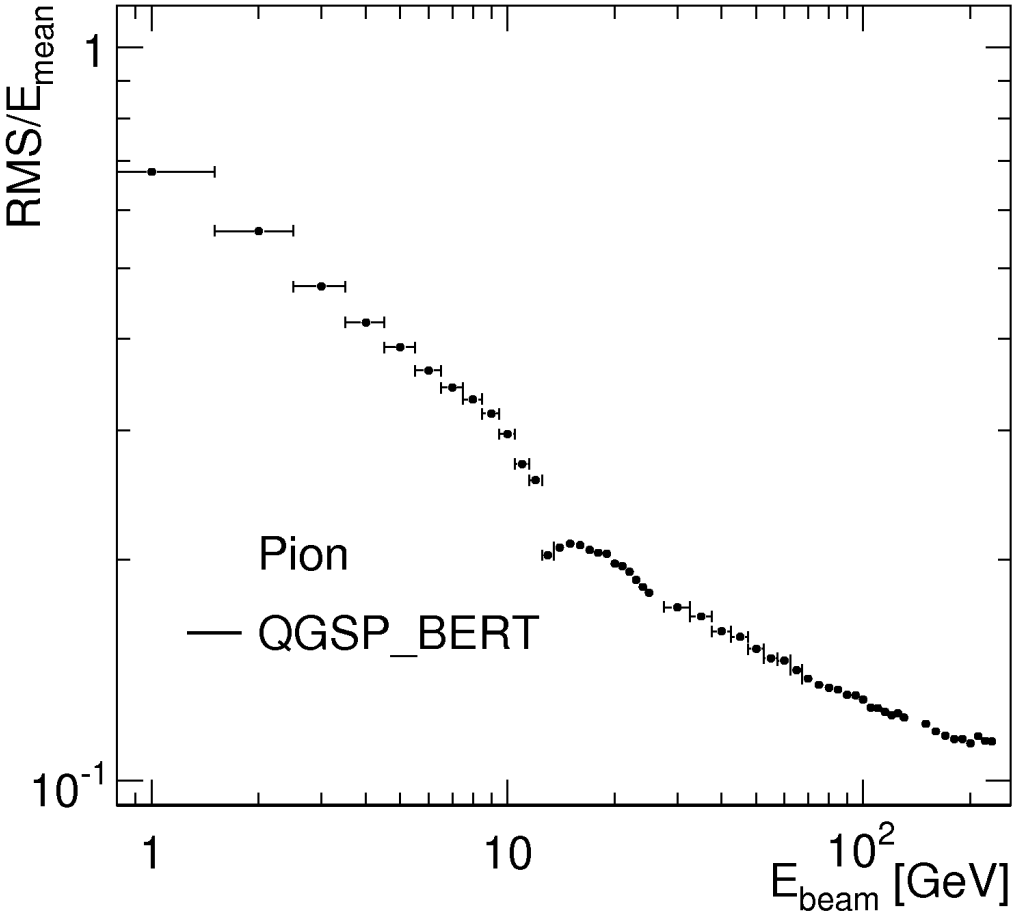
QGSP_BERT: response within 3% E<10 GeV, 1% E>10 GeV
resolution too low (-10% E<10 GeV, -5% E>10 GeV)

FTFP_BERT: response higher

Quite good performance ! … but …

Pion Response and Linearity

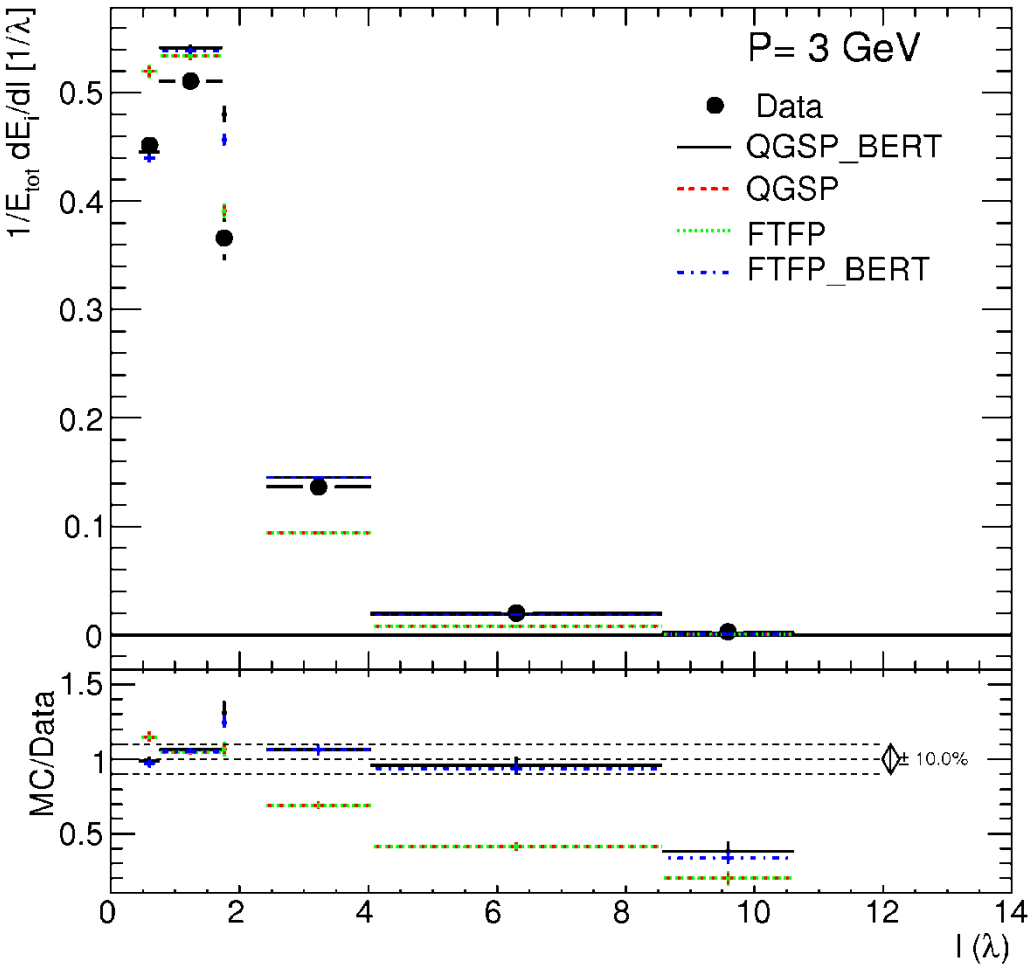


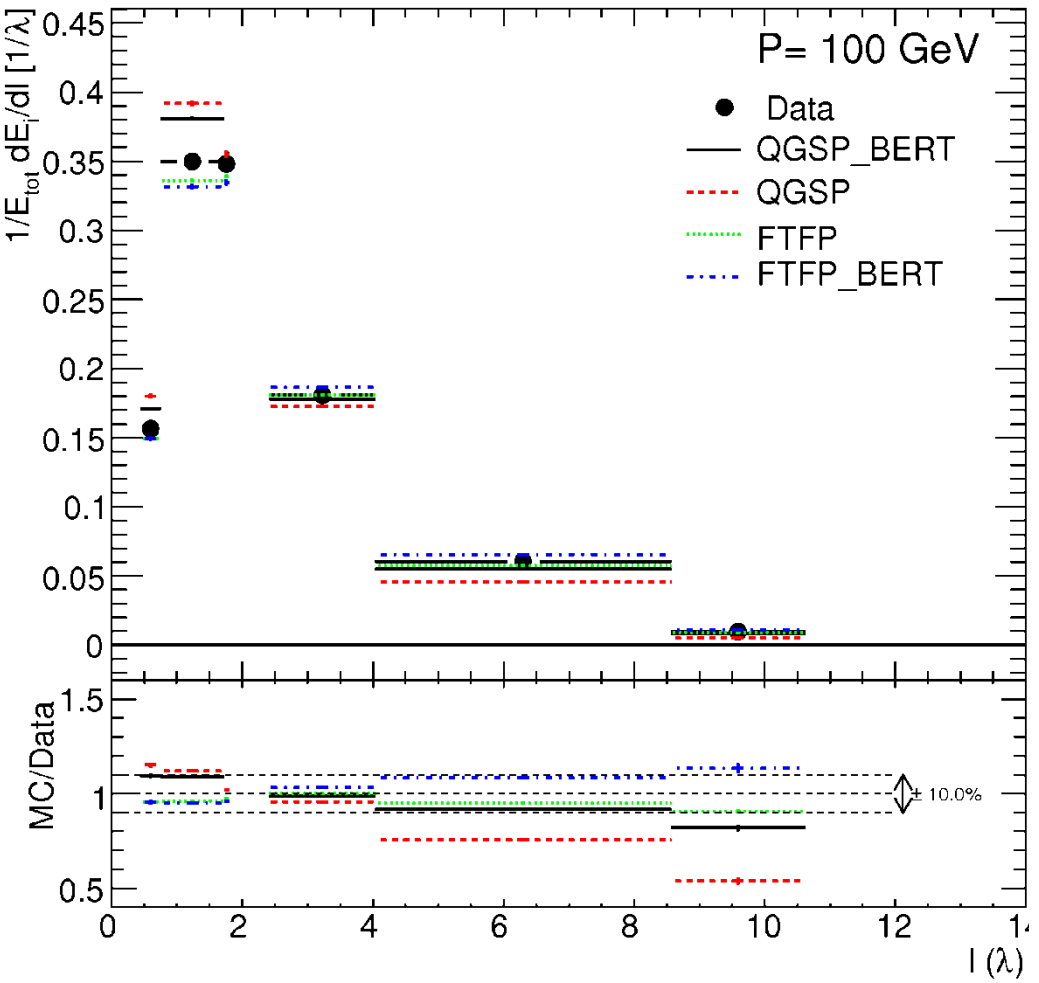


Discontinuities at boundaries where models get mixed
→ Systematic uncertainties for Atlas analysis
G4 developers looking into possible solutions

Similar problems
seen in shower shapes

Longitudinal Shower Development

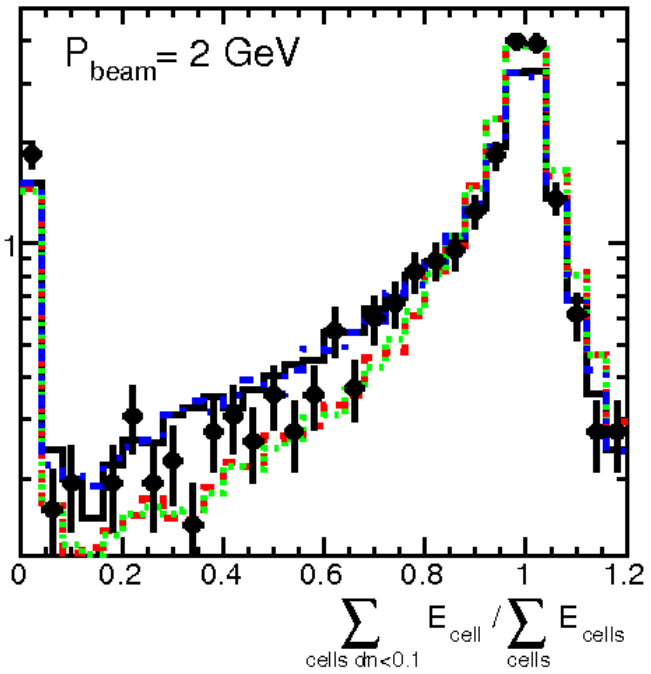


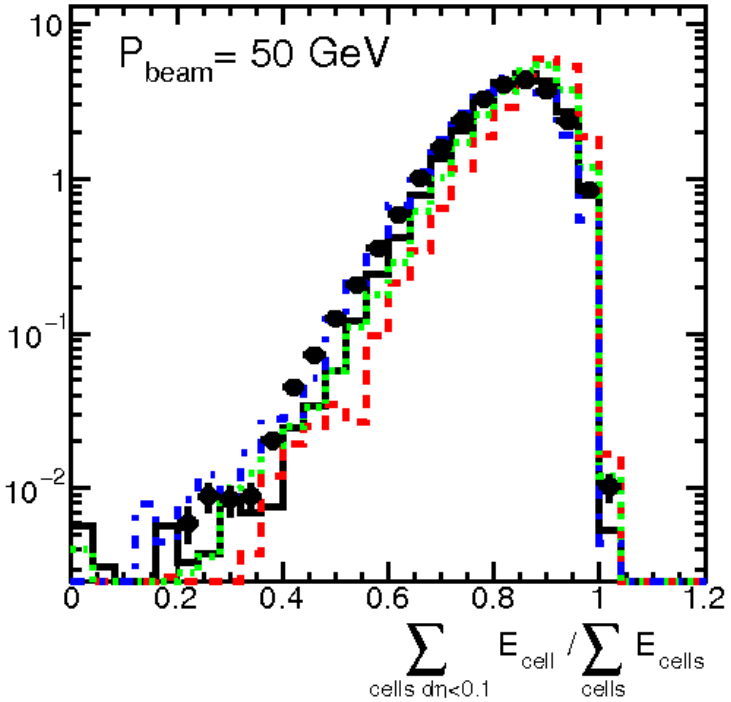


Adding Bertini makes shower longer, but not long enough in case of QGSP

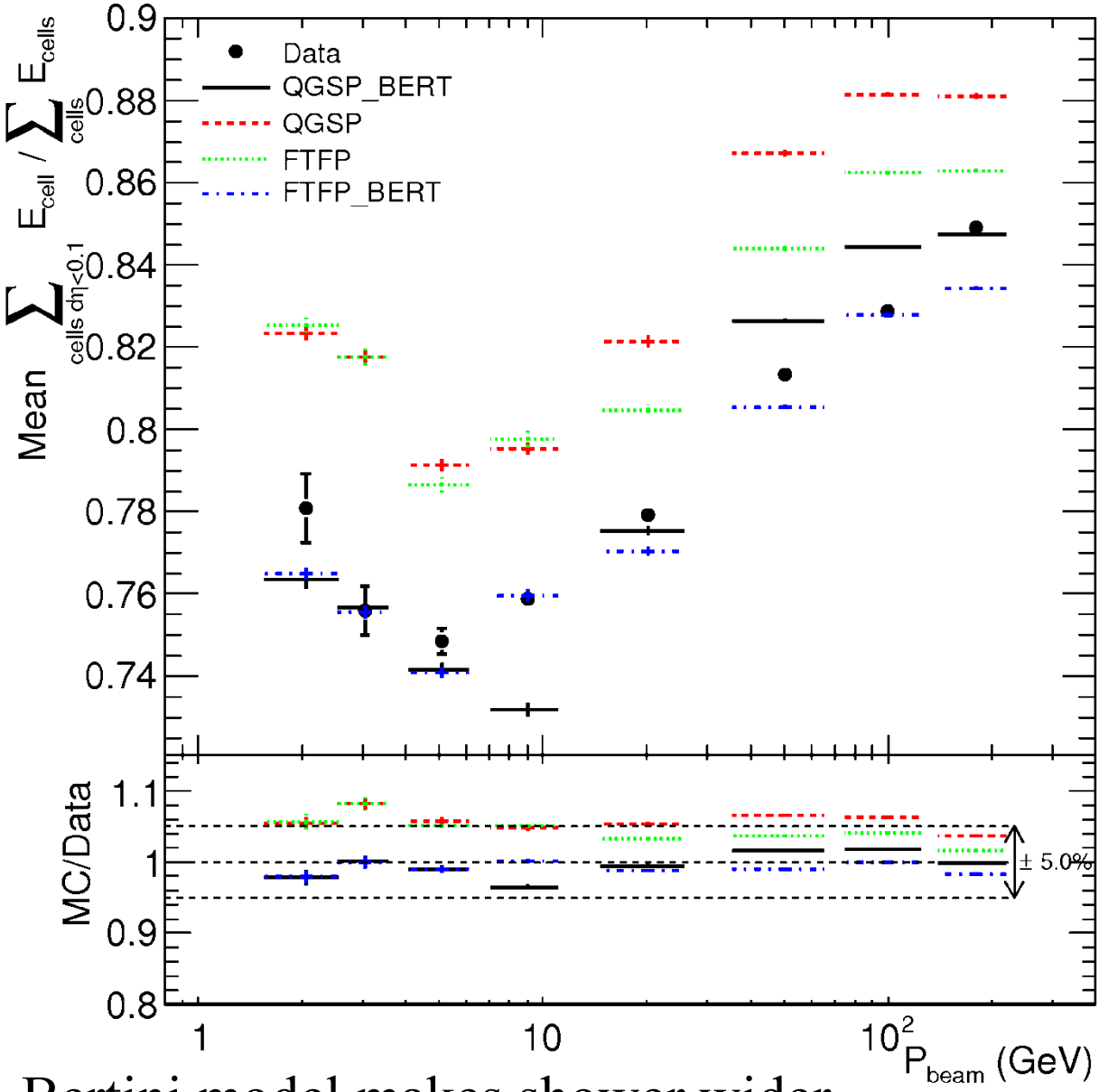
…and a bit too long for FTFP

Transverse Shower Development





Study energy in cone of 0.1/Total energy



Bertini model makes shower wider in better agreement with data

Summary of CTB2004 barrel part

physics list	response	resolution	longitudinal	radial
QGSP	low	ok	too short	too narrow
QGSP_BERT	ok	low	short	narrow
QGSP_BERT_HP	ok	low	short	narrow
QGSP_BERT_NQE	ok	low	too short	narrow
QGSP_BERT_TRV	ok	low	short	narrow
QGSP_BIC	low	low	too short	too narrow
QGS_BIC	low	low	too short	too narrow
FTFP	ok	low	too short	too narrow
FTFP_BERT	high	low	long	narrow
FTFP_BIC	high	low	long	narrow

Summary on TB vs. MC comparison

Data	Physics list	response	resolution	longitudinal	lateral
CTB - Barrel	QGSP	low	OK	too short	too narrow
	QGSP-BERT	OK	low	short	narrow
	FTFP	OK	low	too short	too narrow
	FTFP-BERT	high	low	long	narrow
HEC	QGSP-BERT	~ OK	low	somewhat short	
	FTFP	OK	OK	too short	
	FTFP-BERT	too high	too low	OK	
CTB–EMEC/HEC	QGSP			too short	too narrow
	QGSP-BERT	somewhat high	low	somewhat short	somewhat narrow
CTB-FCAL	QGSP-BERT	almost OK, but FCAL0,1	low	somewhat short	somewhat narrow
FCAL	QGSP-BERT	somewhat high but FCAL0,1	low	somewhat short	somewhat wide FCAL1/2 !!!!

QGSP_BERT seems to be the best compromise, but for sure not perfect !!

New GEANT4 Physics Lists (Tilecal standalone, 90 deg)

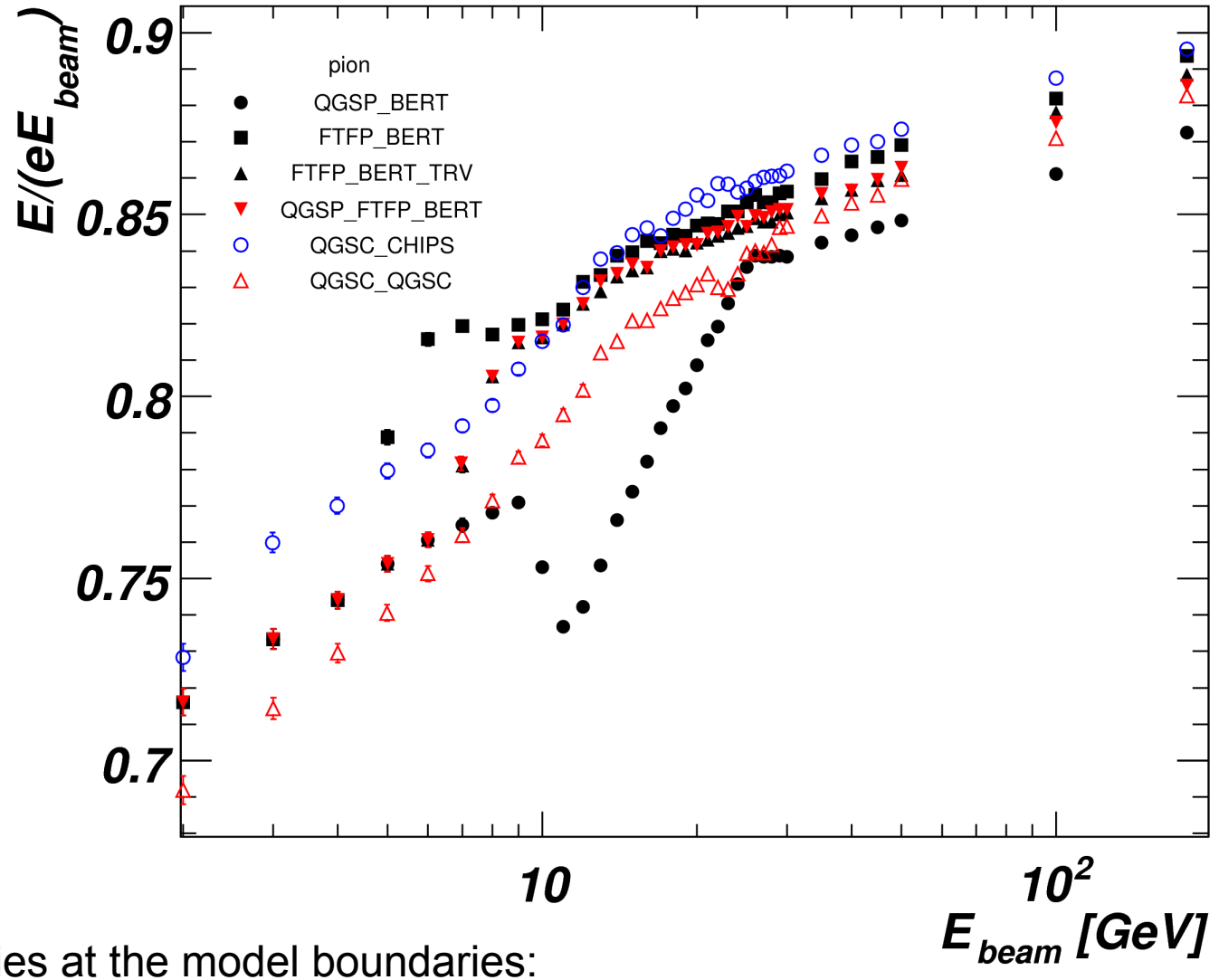
Tancredi Carli

(CERN)

Margar Simonyan

(LAPP)

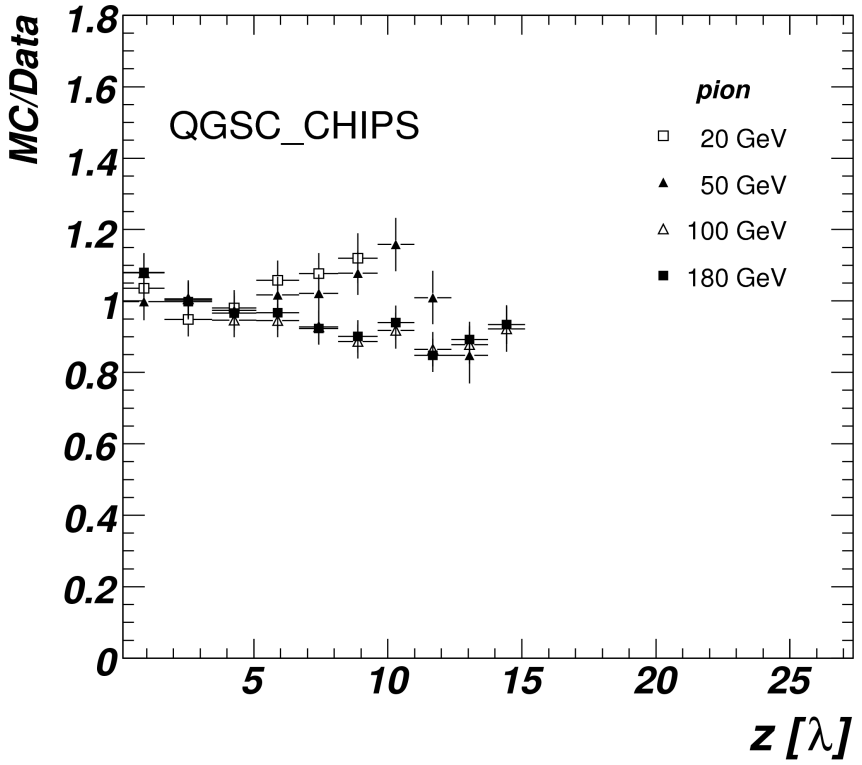
Fine Energy Scan

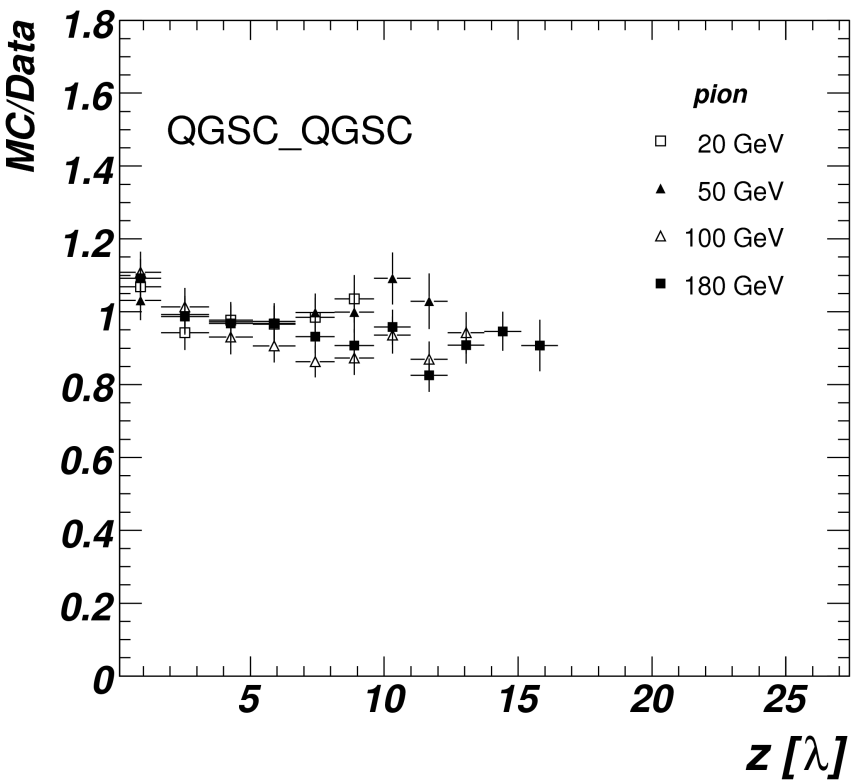


Discontinuities at the model boundaries:

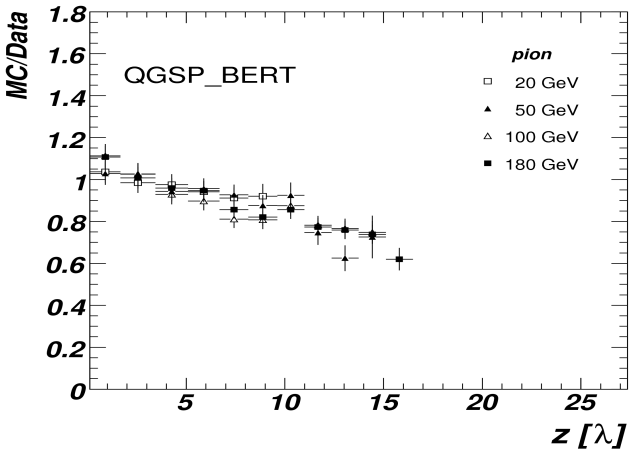
- Some improvement in QGSP_FTFP_BERT (LEP replaced with FTFP)
- QGSC_CHIPS and QGSC_QGSC predict smoother response

Longitudinal shower profiles

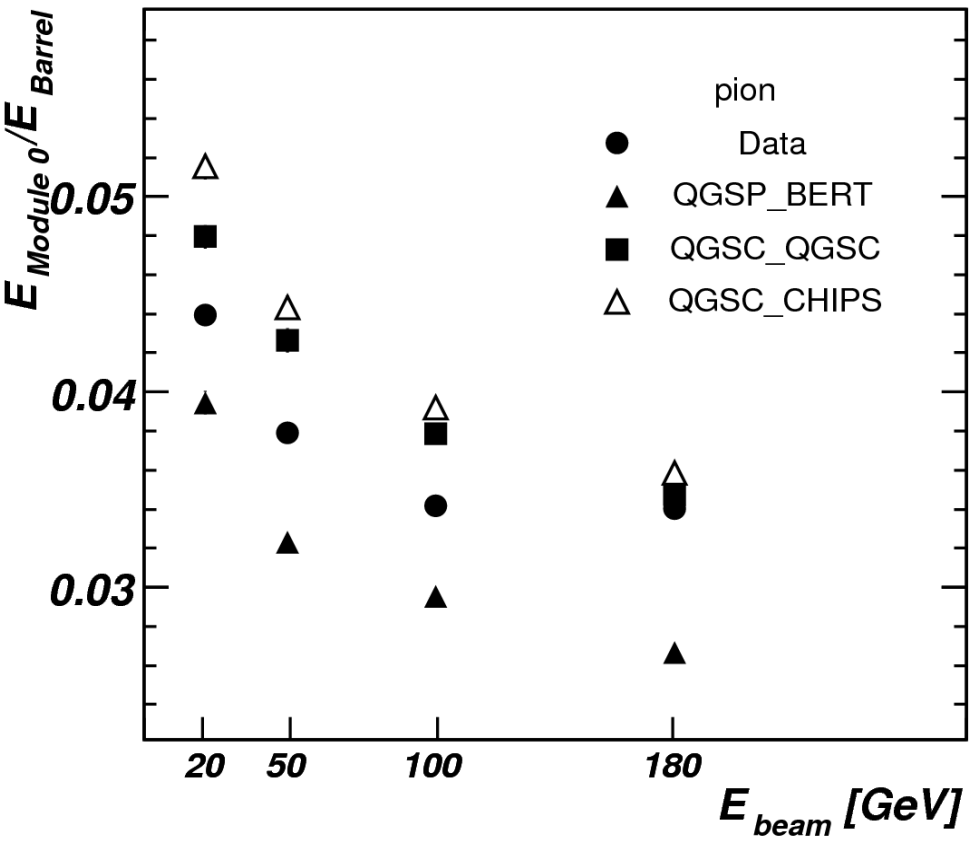




- Well described with QGSC_QGSC and QGSC_CHIPS
- QGSP_FTFP_BERT same as QGSP_BERT (no improvement)

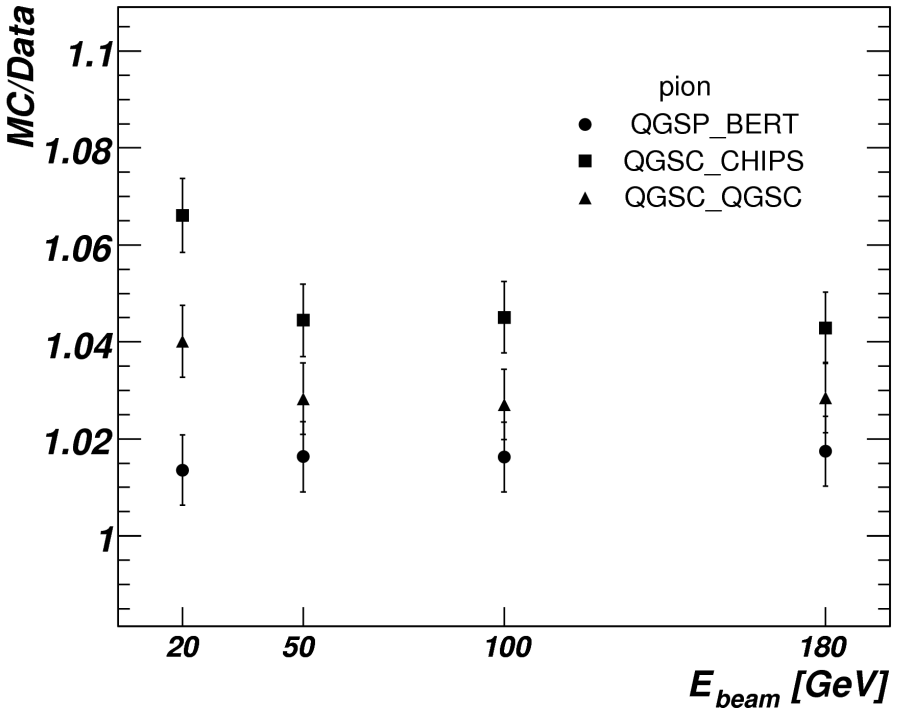


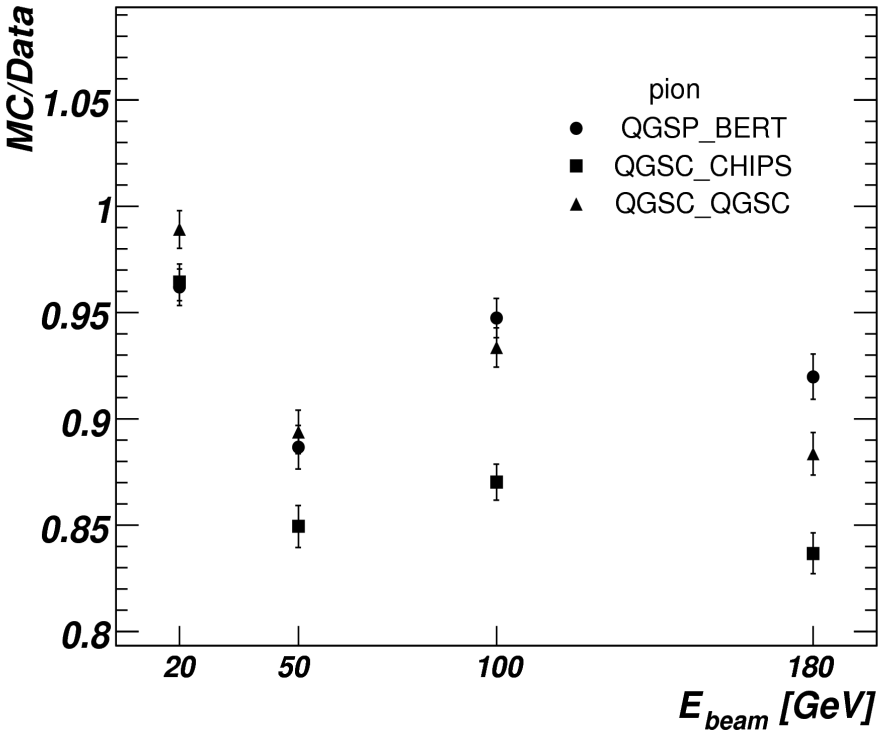
Lateral shower spread



- QGSC_QGSC and QGSC_CHIPS predict wider showers than QGSP_BERT
- QGSP_FTFP_BERT same as QGSP_BERT

Response and Resolution





Response is too high with QGSC_CHIPS and QGSC_QGSC

Conclusions on new physics lists

- Replacing LEP with FTFP in QGSP_BERT makes the transitions a bit smoother; response and shower profiles not affected
- New physics lists (QGSC_CHIPS and QGSC_QGSC):
  - result in reasonable smooth transitions between model boundaries
  - pion induced shower longitudinal development is well described, but showers are wider in MC than in data.
  - the calorimeter response is too high with QGSC_CHIPS and QGSC_QGSC physics list.

Geant4 is improving, but still a lot of work to be done.