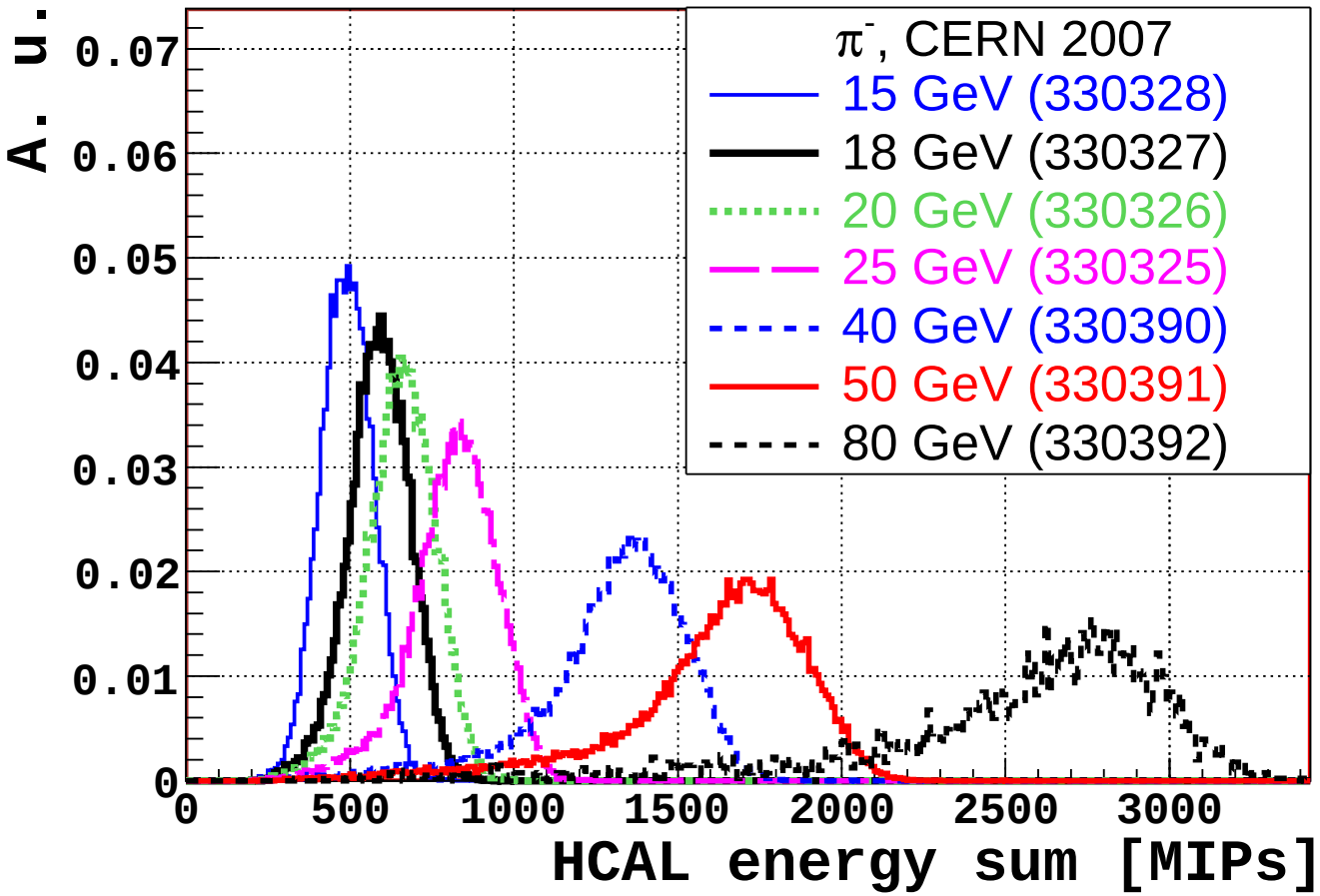
AHCAL Lateral Profiles

Angela Lucaci-Timoce

Overview

Event Selection

- Events with showers starting in HCAL:
  N_{ECAL} *hits* < 50, N_{HCAL} *hits* > 150
- Data sample: π^- runs from CERN 2007, from 15 to 80 GeV



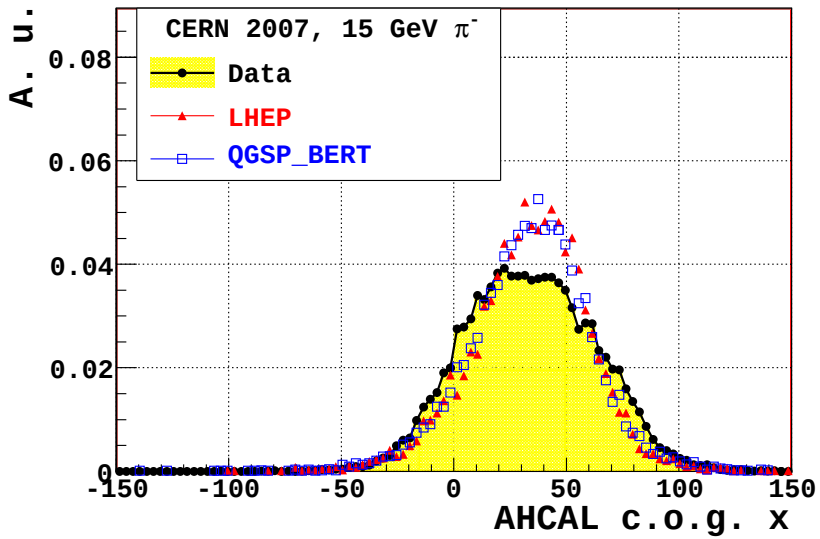
Analysis Strategy

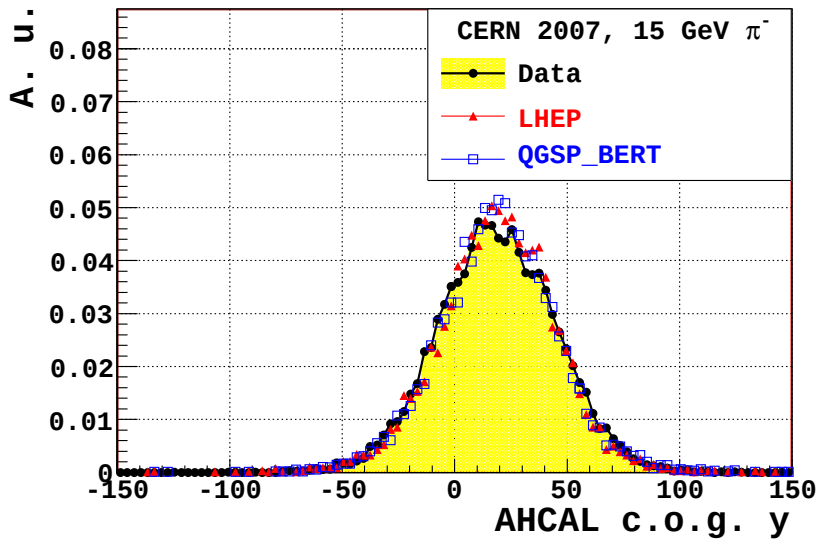
- Identify tracks in the shower based on *TBTrack* package
- Look at the distance of an AHCAL hit to the track:

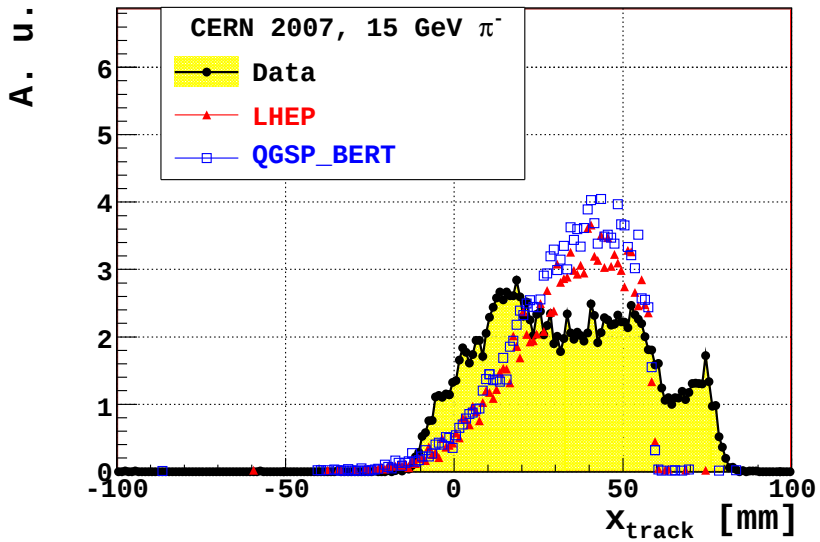
$$\rho = \sqrt{(x_{AHCAL} - x_{track})^2 + y_{AHCAL} - y_{track})^2}$$

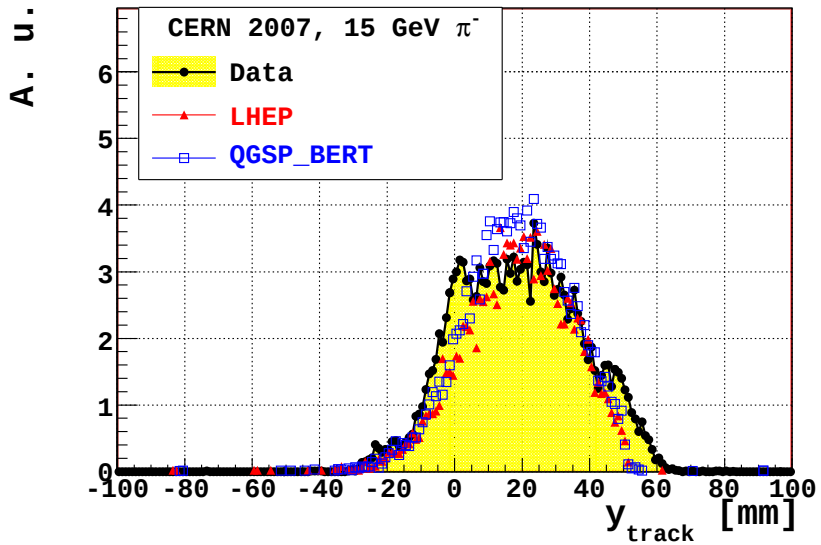
- Build rings of radius 10 mm around the track
- Measure the **transverse energy density**, i.e. total AHCAL energy sum deposited in a given ring of radius ρ, divided by area of that ring
- Important: Monte Carlo samples simulated based on information from data, but MC distribution are Gaussian (which is not true for data, especially at low energies)

Starting Plots: 15 GeV



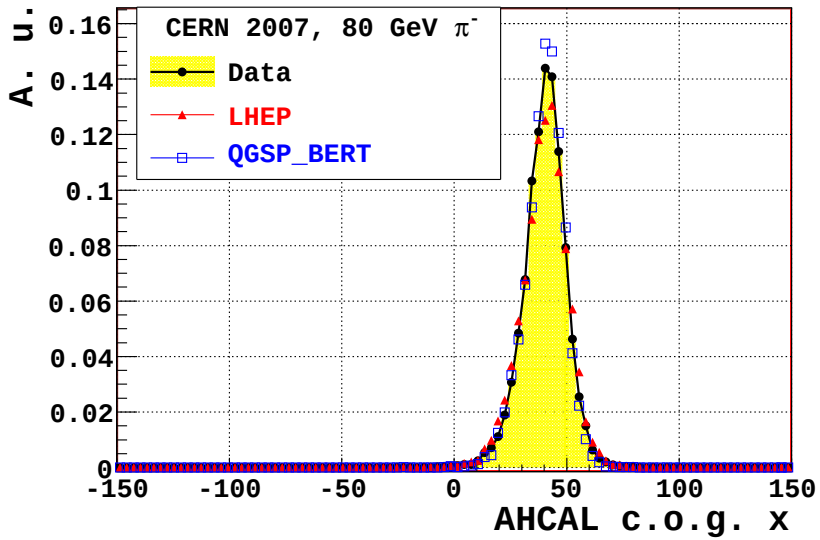


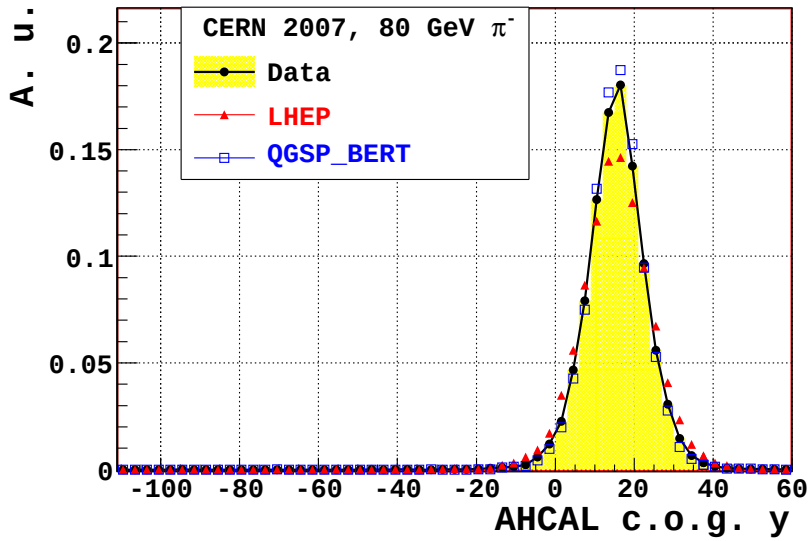


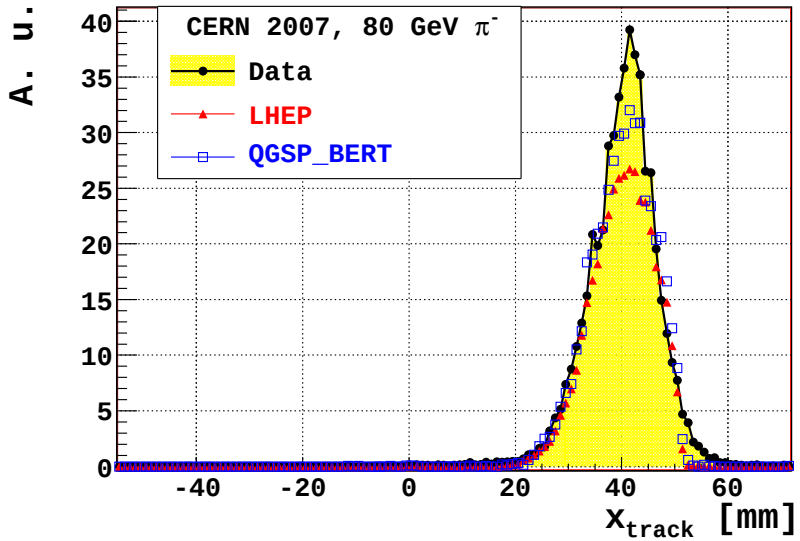


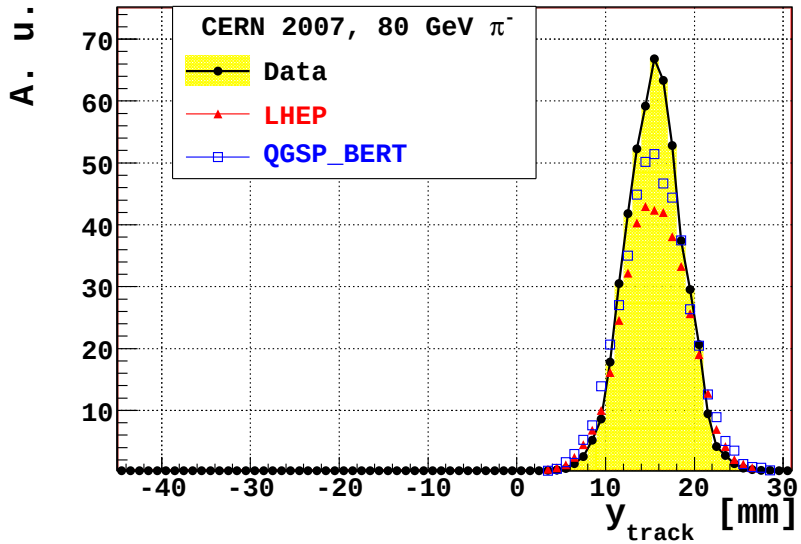
- Peculiar structure of the beam profile not reproduced in Monte Carlo

Starting Plots: 80 GeV





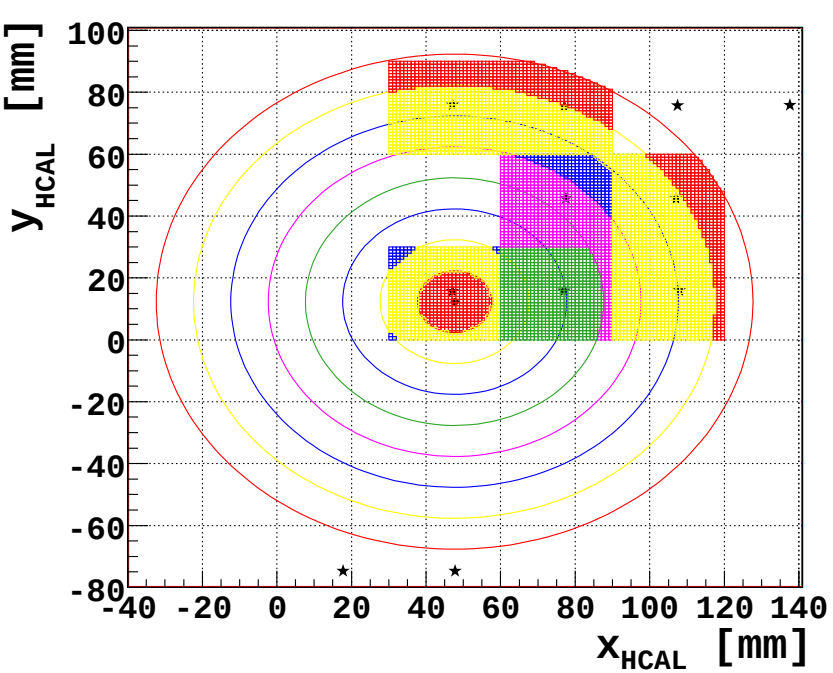


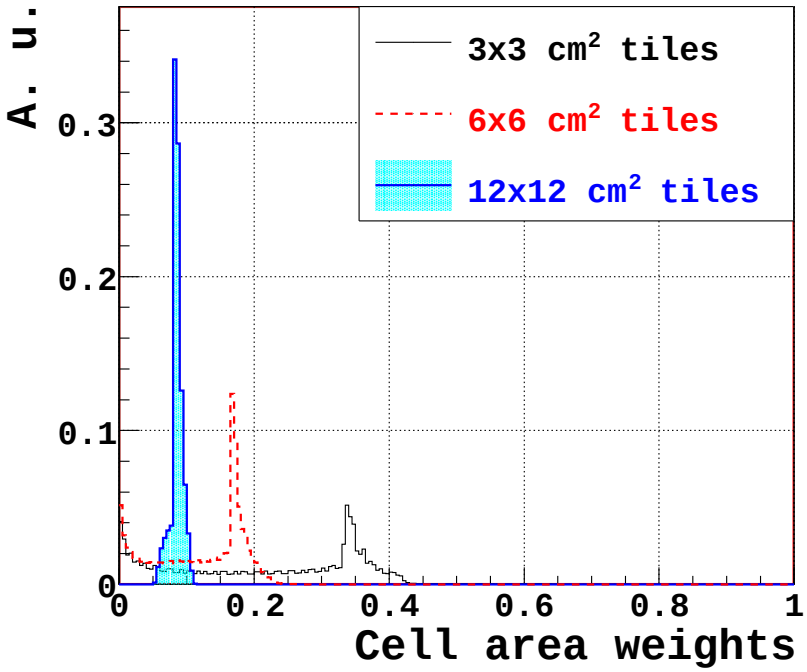


- Better situation at high energies

Geometrical Effects: Cell Area in a Ring

- Be default, energy of an AHCAL hit deposited in the center of a cell
- To cross check the effect on the shape of the transverse profile shape: divide each cell in a 1×1 mm^2 grid
- Weight the energy with the fraction of cell area in a given ring

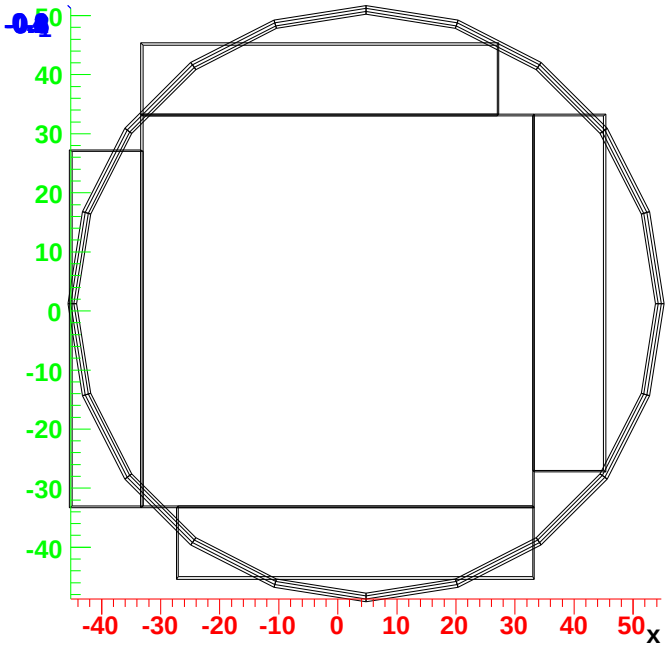


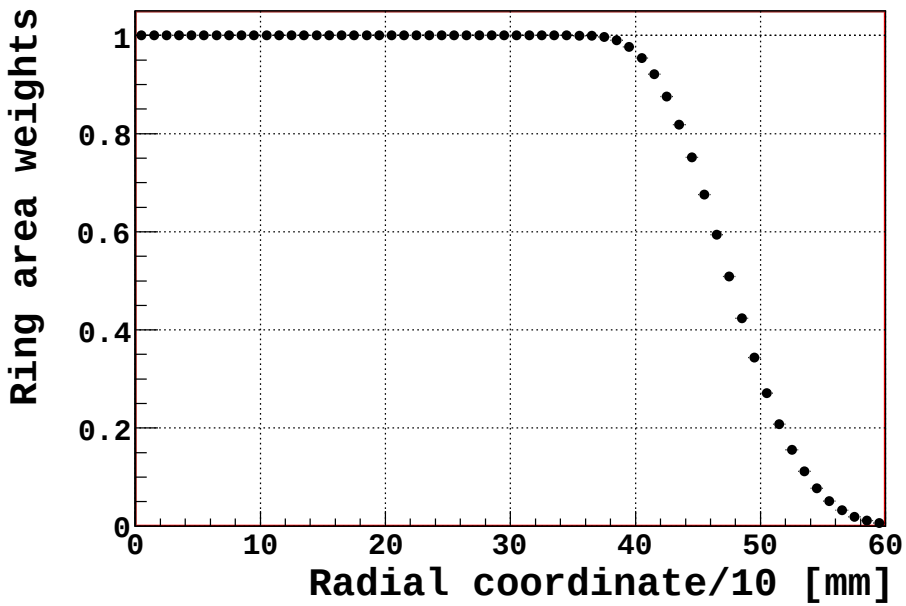


- Cell area weights: the larger the cell size, the smaller its area in a ring

Geometrical Effects: Ring Area in Detector

- Large radius rings not fully included in detector
- Weight area of the ring with fraction of ring area which is contained in AHCAL

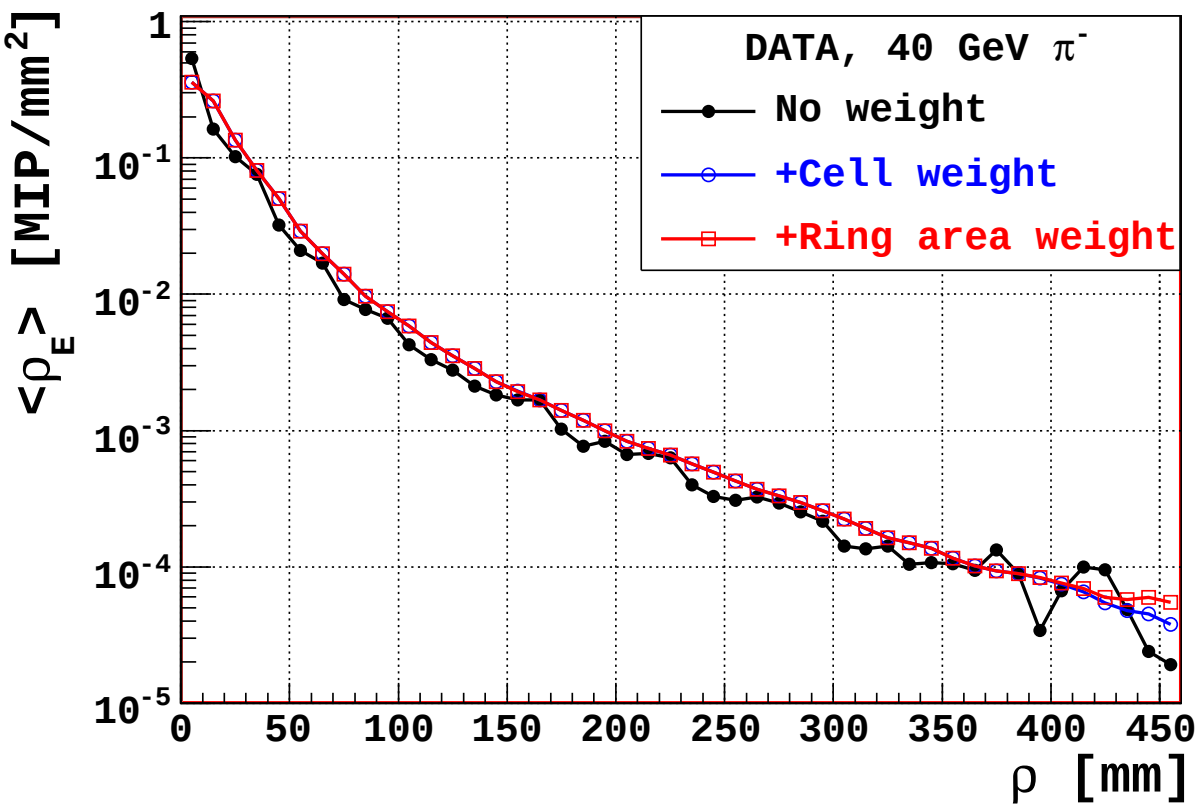




- Ring area weights: important only at detector edges

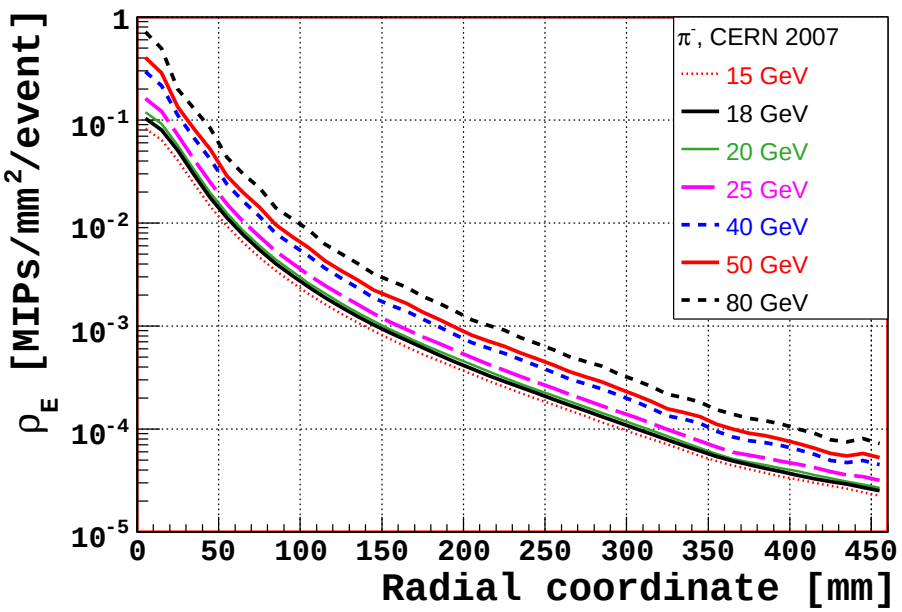
Geometrical Effects: Conclusions

- Transverse profile for a 40 GeV run before and after weighting

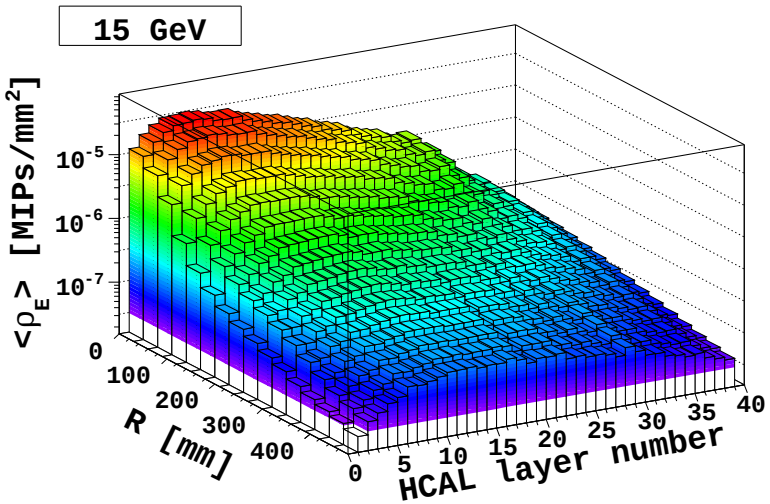


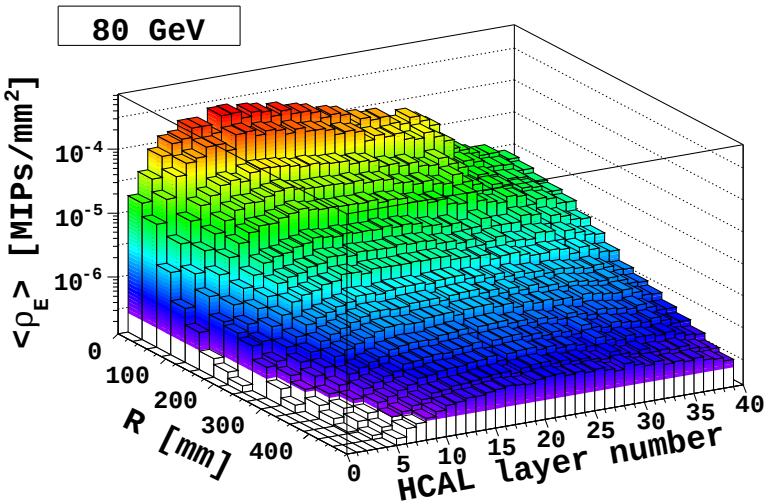
- Weighting due to cell area induces a smoothening of the profile

Results: Transverse Profiles

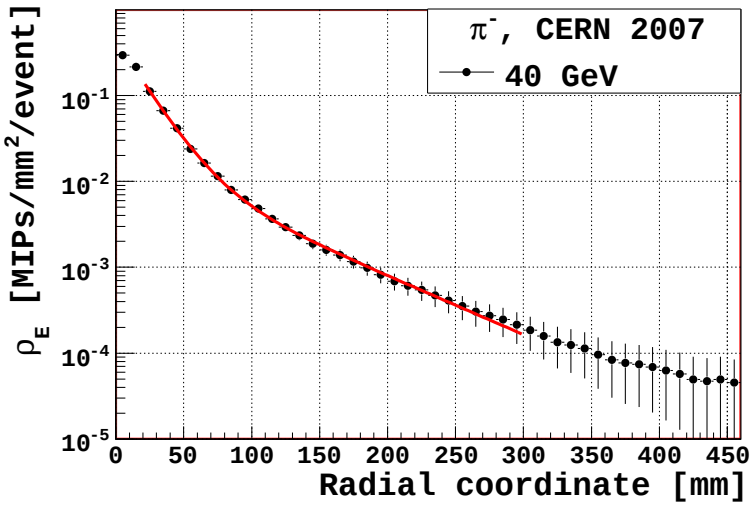


- Shape of transverse profile similar for all analysed energies and independent of energy, as expected

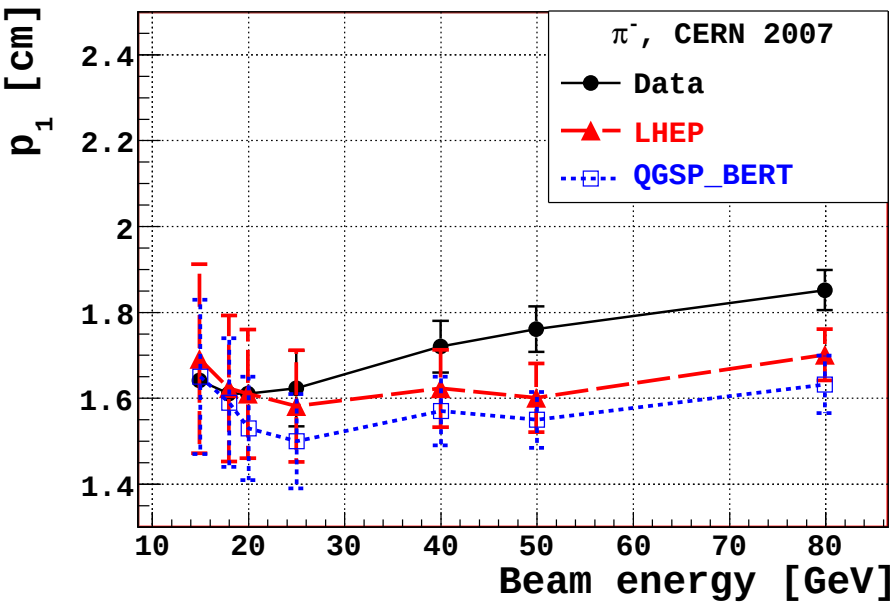


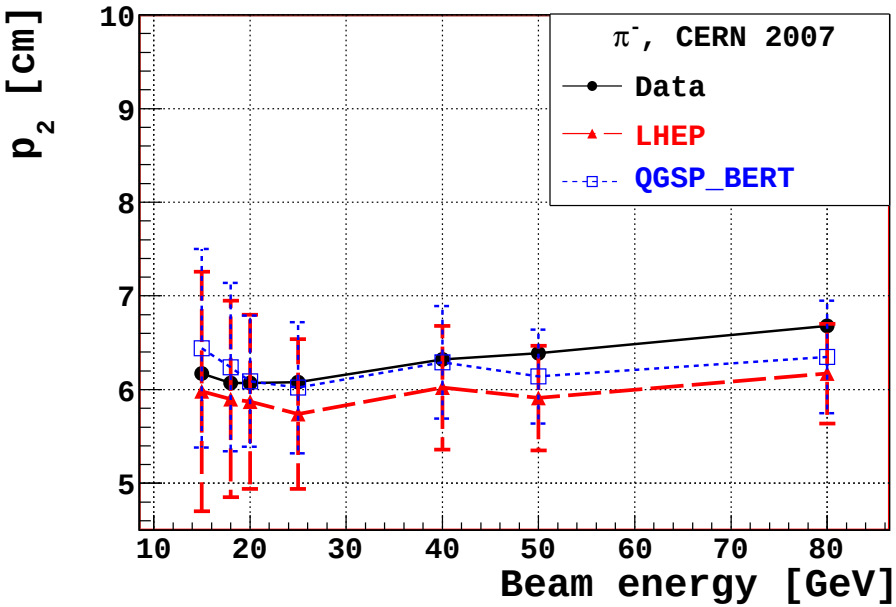


Results: Fit of Transverse Profiles

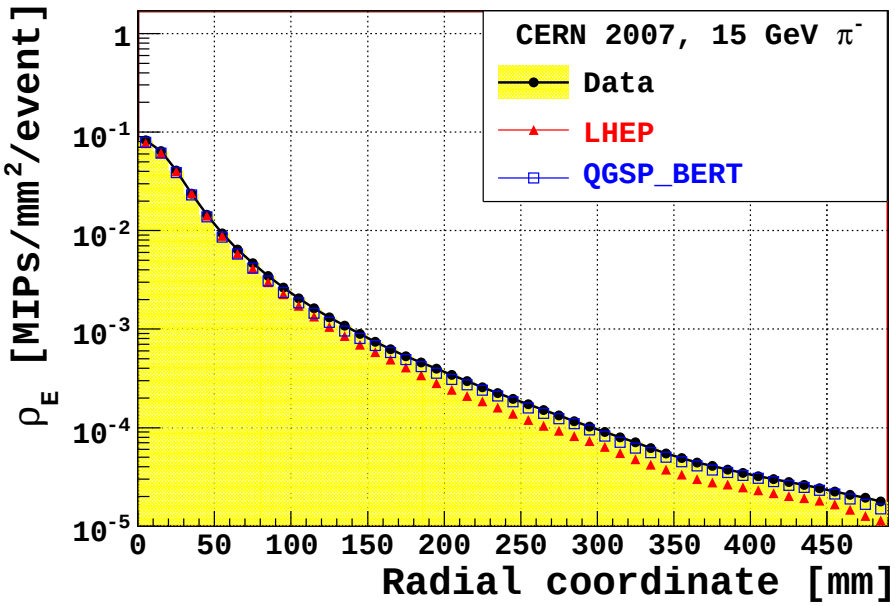


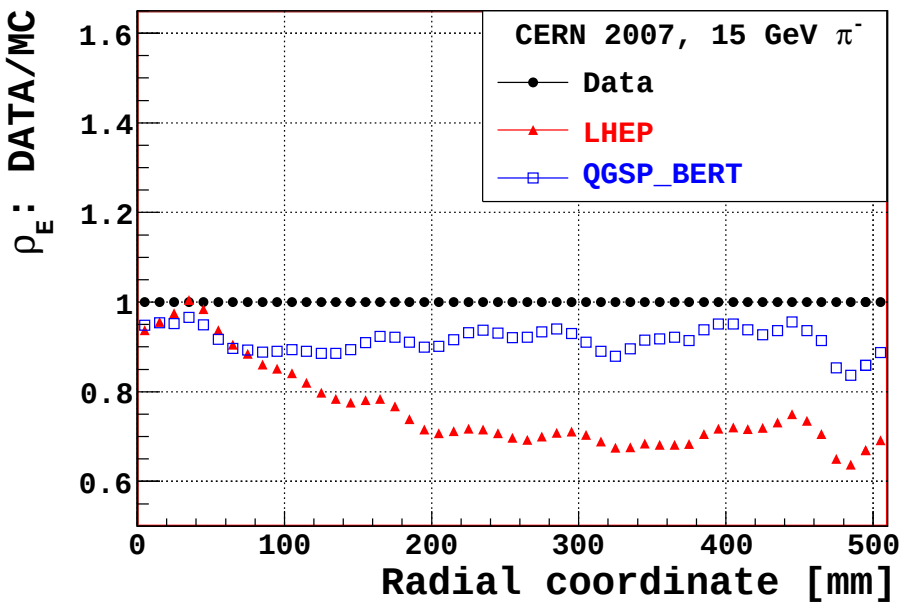
- Fit function:
  $p_o \cdot \exp(-\rho/p_1) + p_2 \cdot \exp(-\rho/p_3)$,
  where p_0, p_2 - normalisation factors, and p_1 (p_3) radius of electromagnetic (hadronic) part of the shower

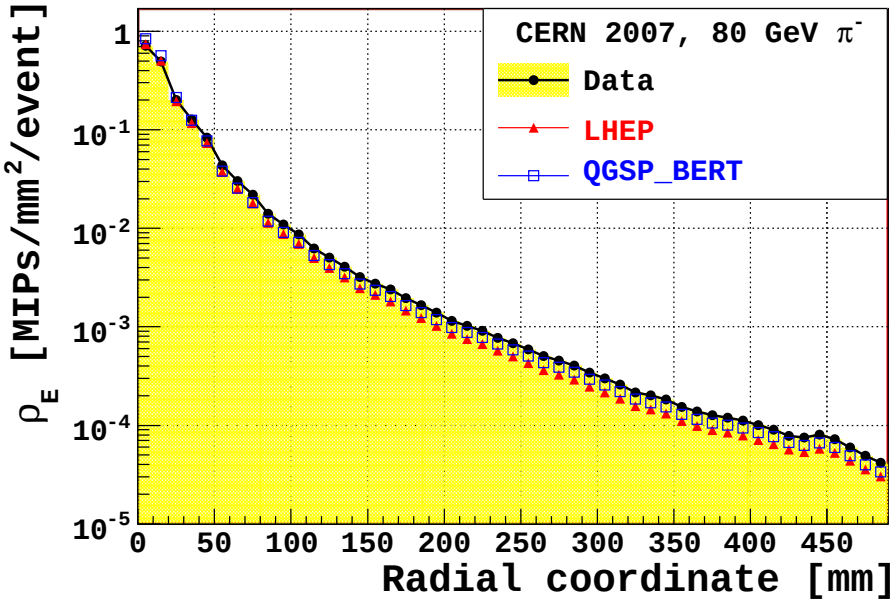


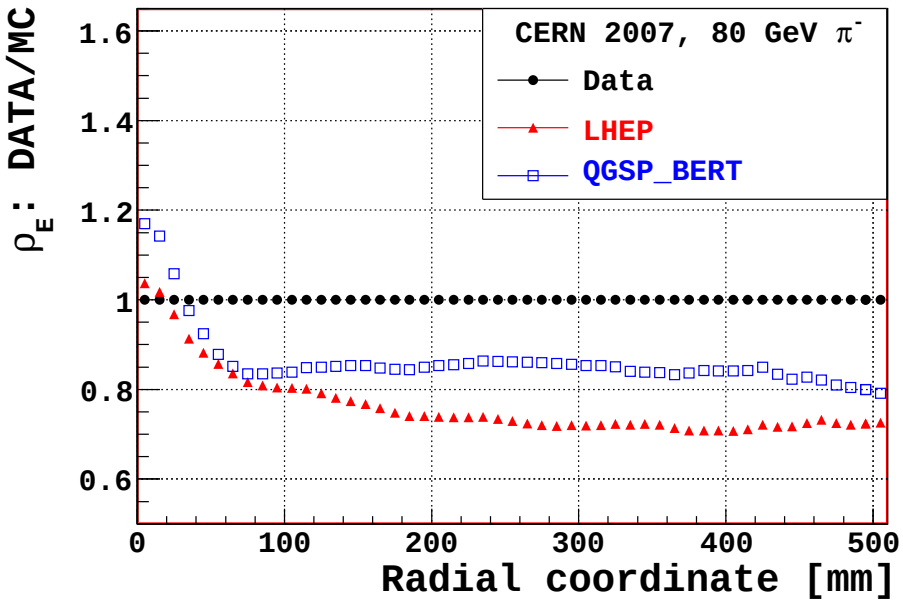


Results: Data - Monte Carlo Comparison

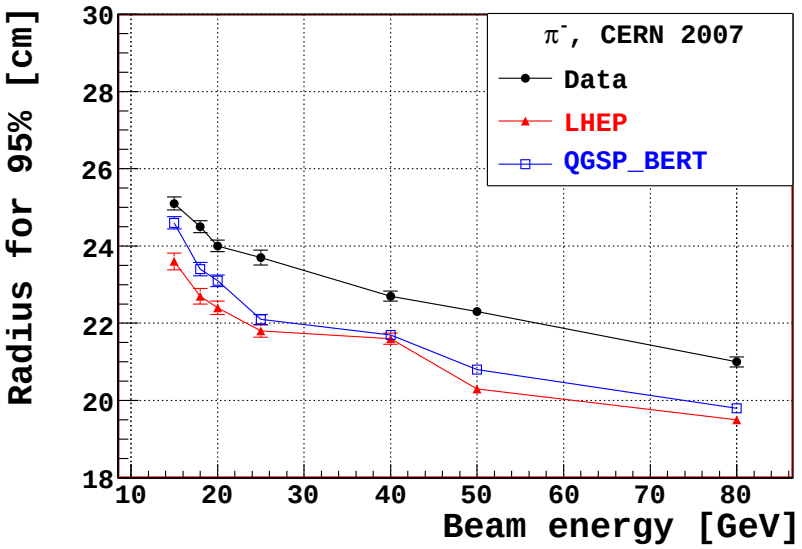




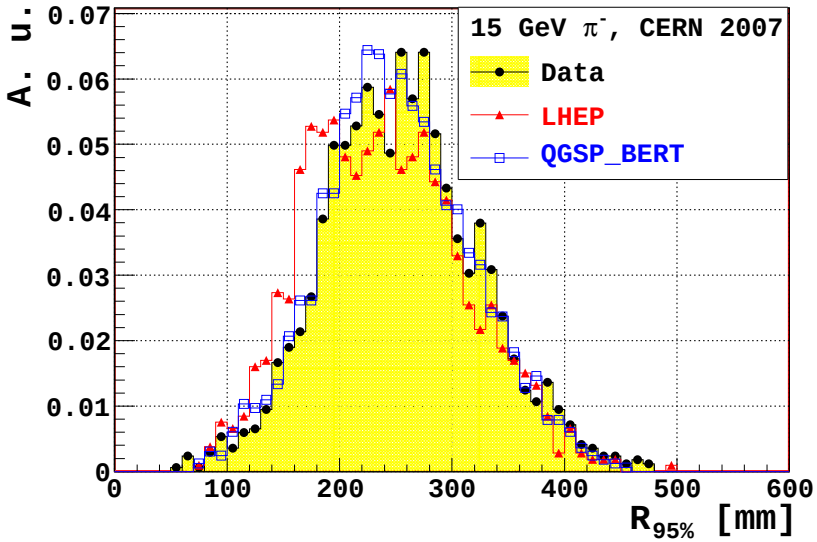


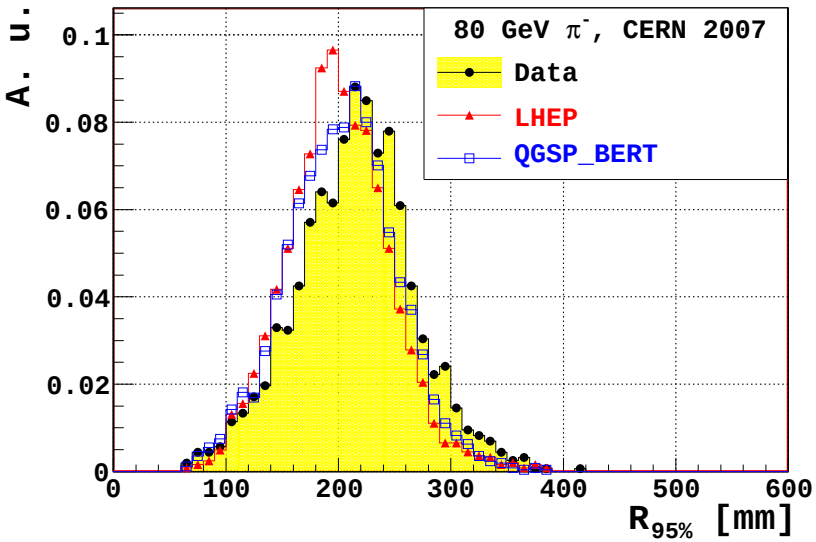


Results: Lateral Containment

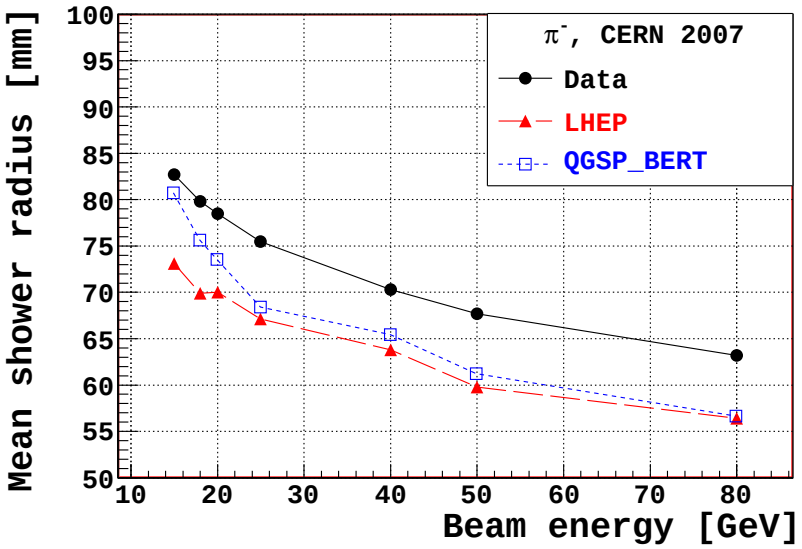


- $R_{95\%}$ - shower radius, at which approx. 95% of total AHCAL energy is transversally deposited





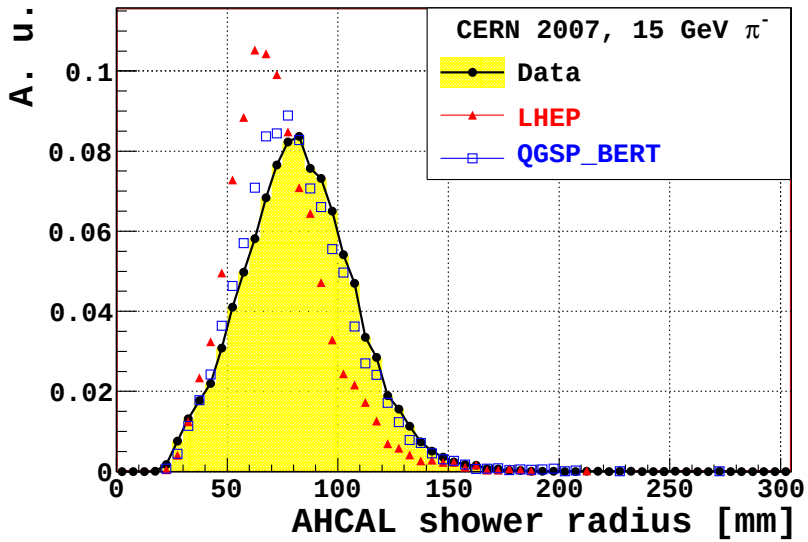
Results: Mean Shower Radius

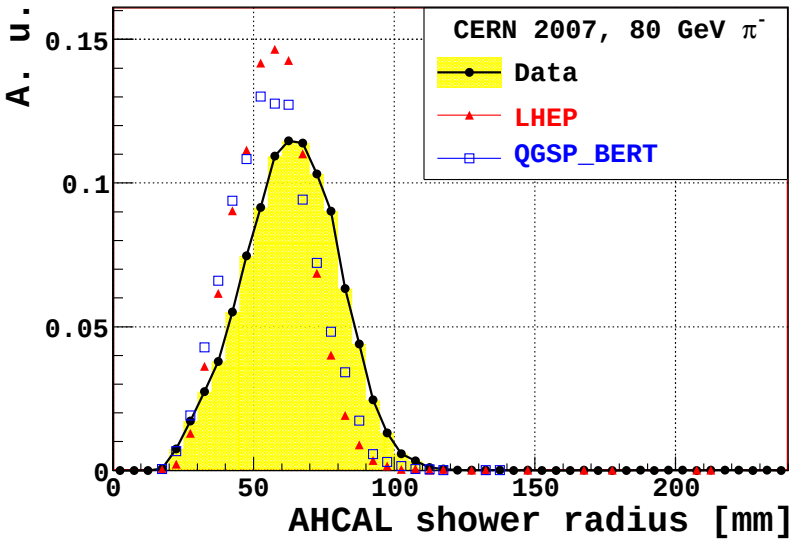


- Energy weighted shower radius:

$$< R >_{event} = \sum_i E_i \cdot \rho_i / \sum_i E_i$$

- Results for the 18 GeV point consistent with results from CAN011c
- Note: plot is zero suppressed (differences not so large)





Conclusions

- Analysis of transverse development of showers induced by negative pions with energies from 15 to 80 GeV
- Geometrical effects due to particular structure of the AHCAL modules studied
- Transverse profiles for all AHCAL and layerwise presented
- Data to Monte Carlo comparison: QGSP_BERT describes data within 20%, but...
- Energy scale difference still inside
- Most likely to change: latest developments in the electromagnetic analysis indicate a 10% shift in Monte Carlo (see talk of Sergey Morozov)