Hadronic Showers in Geant4 **11.2.ref07**

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Main Changes in Hadronics *vs.* G4 11.2.ref06 (1/2)

- Plenty of technical changes everywhere
  - Many of them from Coverity; others related to either initialisation and/or multi-threading
  - Added "_HPT" support to the extensible physics list factory
  - Let's see below the ones that could affect the physics results
- *hadronic/cross_sections/*
  - *G4GammaNuclearXS* : Use CHIPS parameterisation for Zr and W at all energies, for Cr and Y above 25 MeV and for Sn and Gd above 16 MeV
    - The default transition energy 130-150 MeV remains for all other targets
    - Addressing problem report #2609
- *hadronic/models/particle_hp/*
  - A few fixes related to the Unresolved Resonance Region (URR) via Particle Table (PT) treatment
- *hadronic/models/pre_equilibrium/*
  - *G4PreCompoundFragment* : completed implementation of usage of XS cross-sections
  - *G4VPreCompoundFragment*, *G4PreCompoundFragment* : added a new option to use the new cross-section class *G4XSectionXS*

Main Changes in Hadronics *vs.* G4 11.2.ref06 (2/2)

- *hadronic/models/de_excitation/*
  - For pre-compound model, use XS option 1 instead of 3;
    changed interval of applicability Eex/A = (0.1 - 3) MeV instead of (0.1 - 30) MeV
    - Outside this interval, de-excitation module is used
  - New class *G4XSectionXS* , to compute inverse cross-section using G4PARTICLEXS cross-sections for neutrons and light ions
  - *G4EvaporationProbability*, *G4VEmissionProbability* : added use of *G4XSectionXS* as an alternative option
  - *G4CompetitiveFission* : added normalisation factor if *G4XSectionXS* is used
  - *G4EvaporationChannel*, *G4EvaporationProbability* : improved implementation of methods *ComputeInverseXSection(...)* and *ComputeProbability(...)*
  - *G4CoulombBarrier* : changed *theRho* parameter from 0.6 to **0.4**
  - *G4EvaporationProbability*, *G4EvaporationChannel*, *G4VEmissionProbability* :
    do not apply Coulomb barrier for computation of minimum energy of emitted fragments if OPTxs=1

Crashes & Warnings

- No crashes
- No infinite loops
- No new warnings

Reproducibility

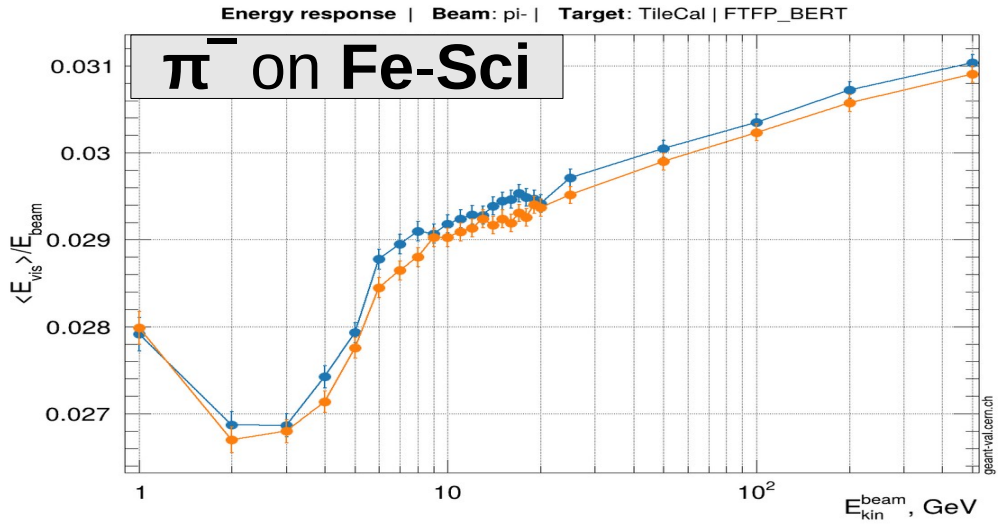
- OK in all cases

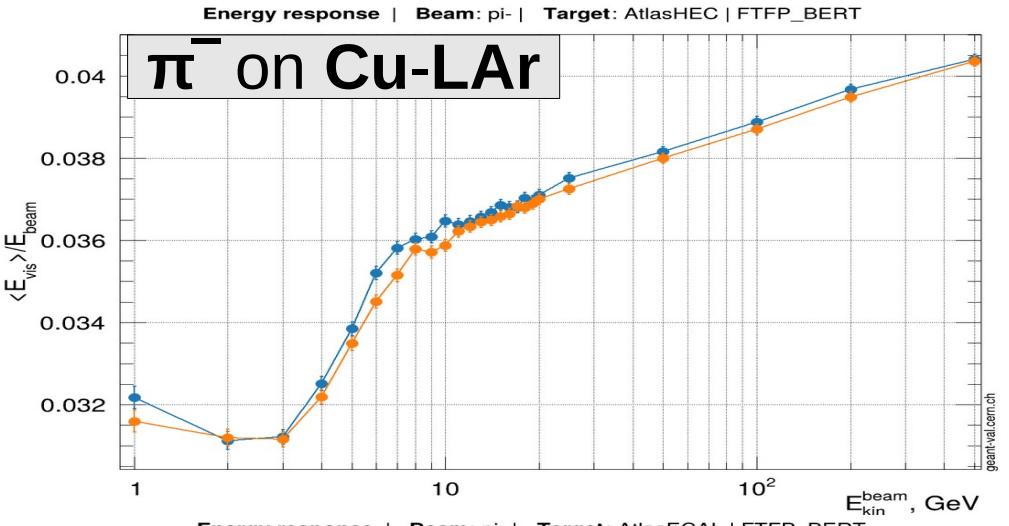
Pion- showers: FTFP_BERT

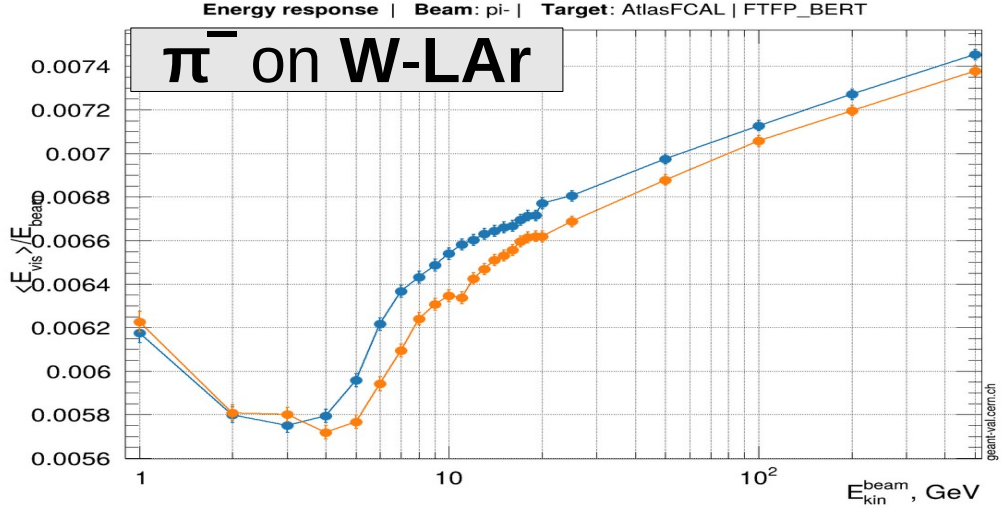
G4 11.2.ref06
G4 11.2.ref07

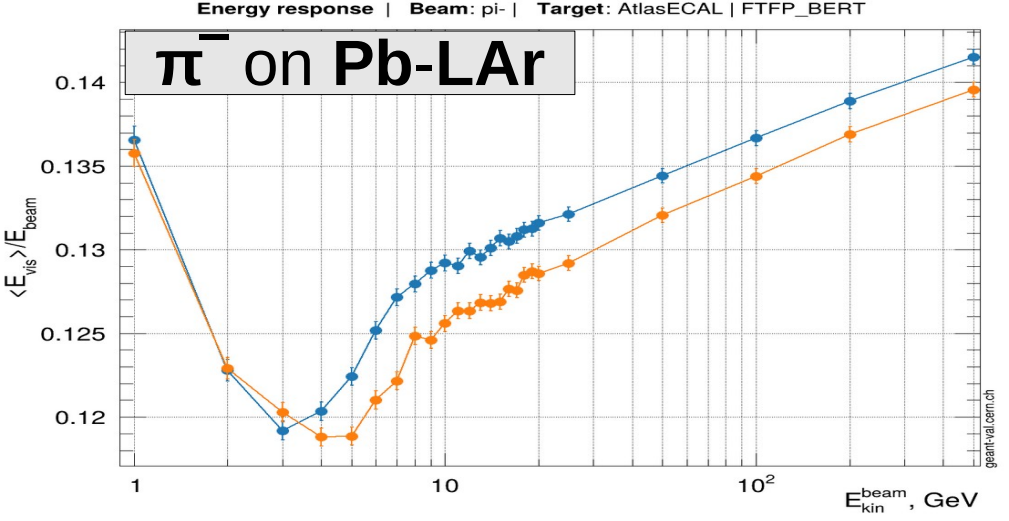
Note : conventional Birks treatment
(easier and no experimental h/e to fit !)

FTFP_BERT : Energy Response



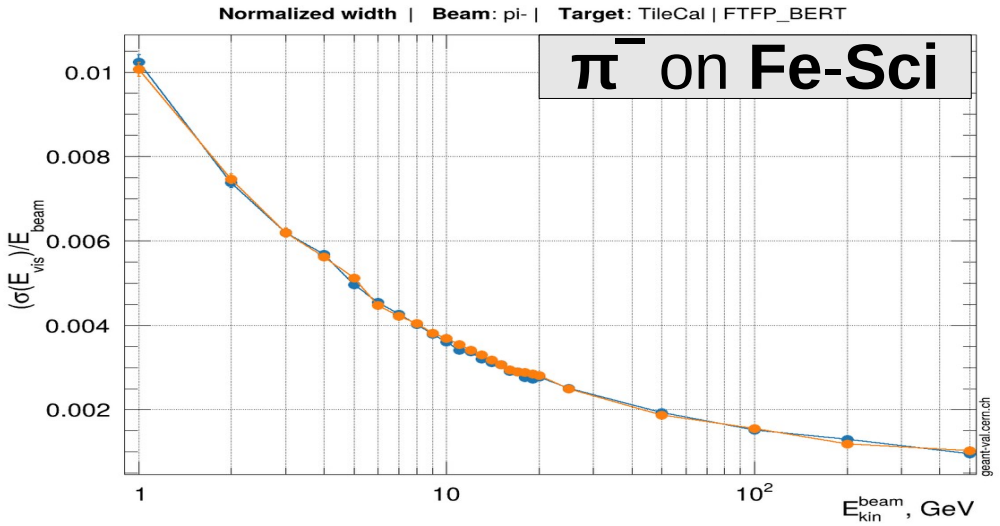


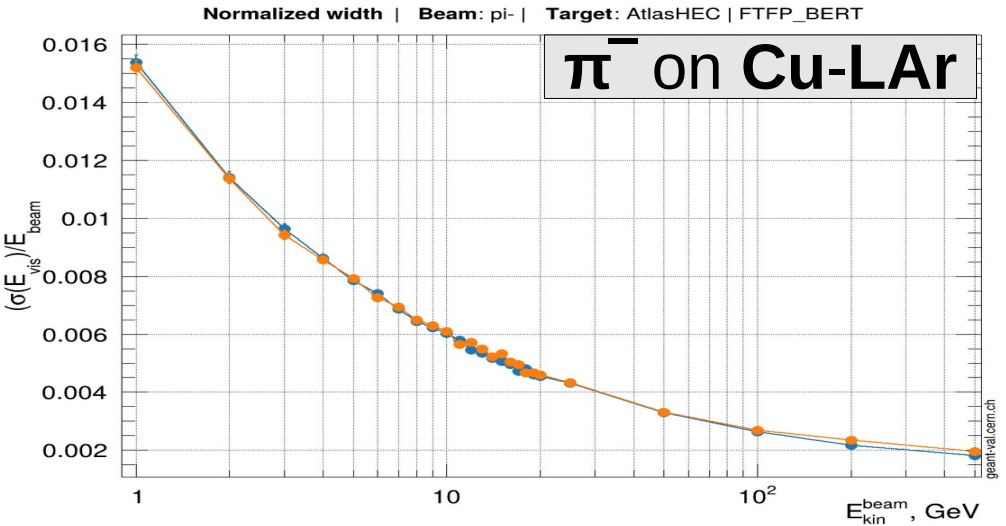


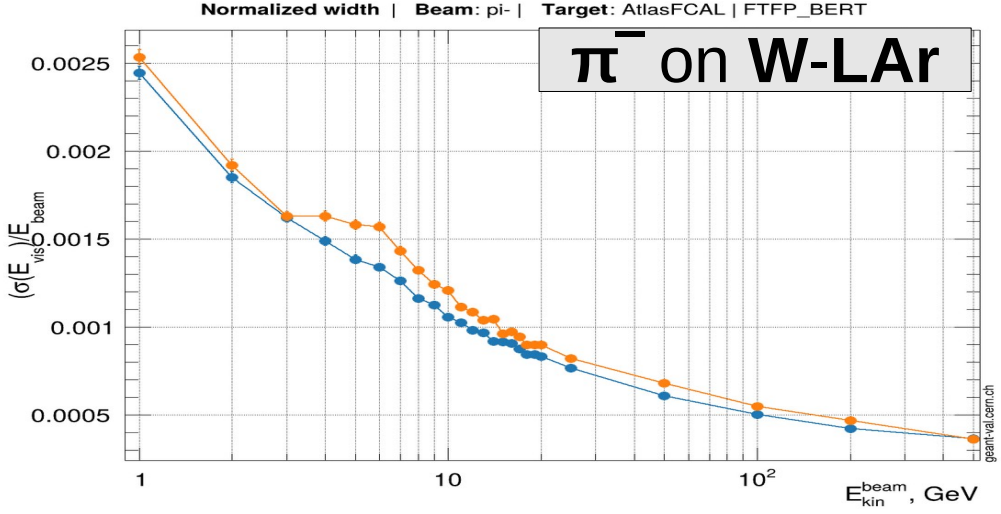


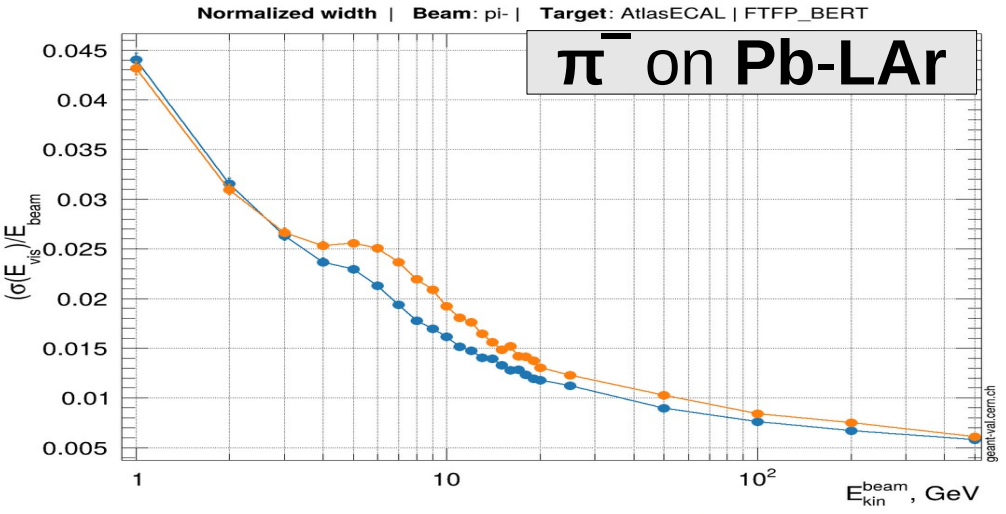
11.3.beta_cand00 11.2.ref07 11.3.beta_cand00 11.2.ref07

FTFP_BERT : Energy Width

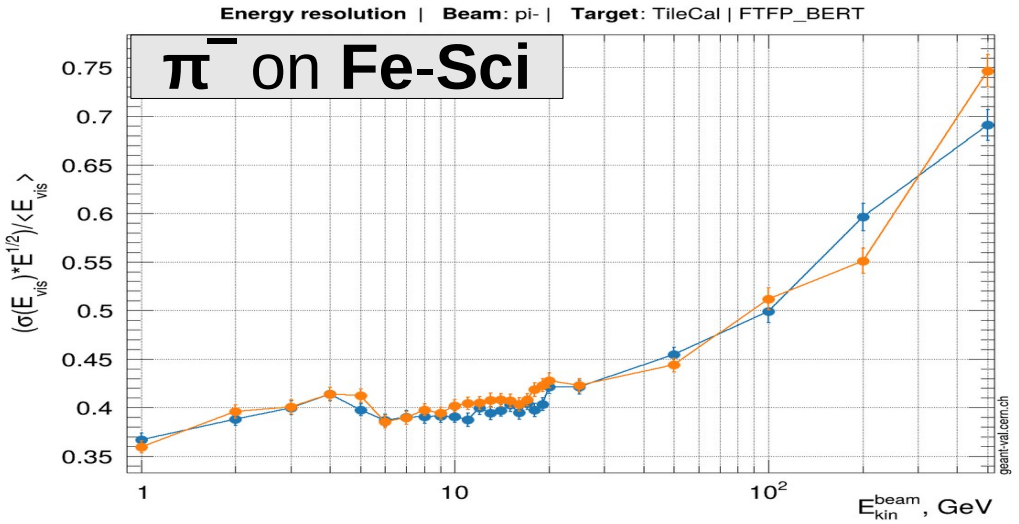


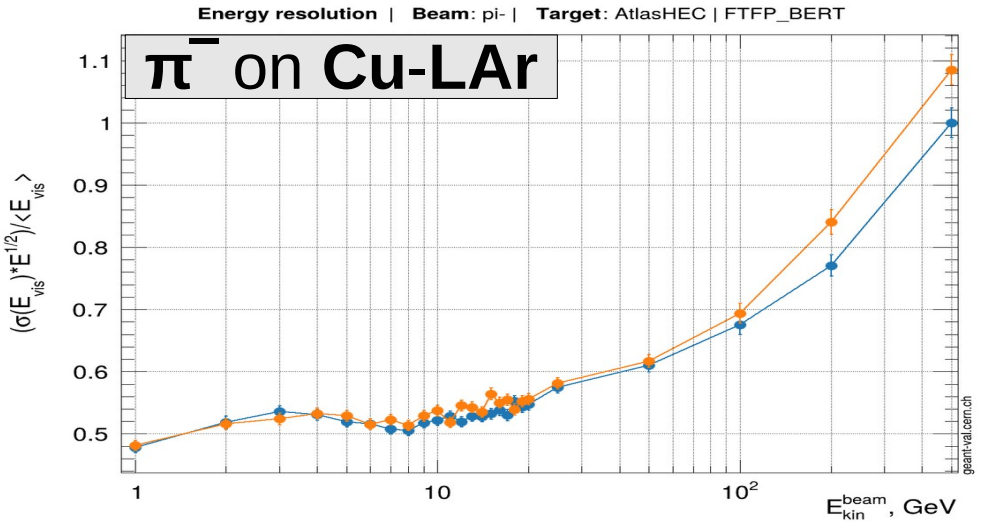


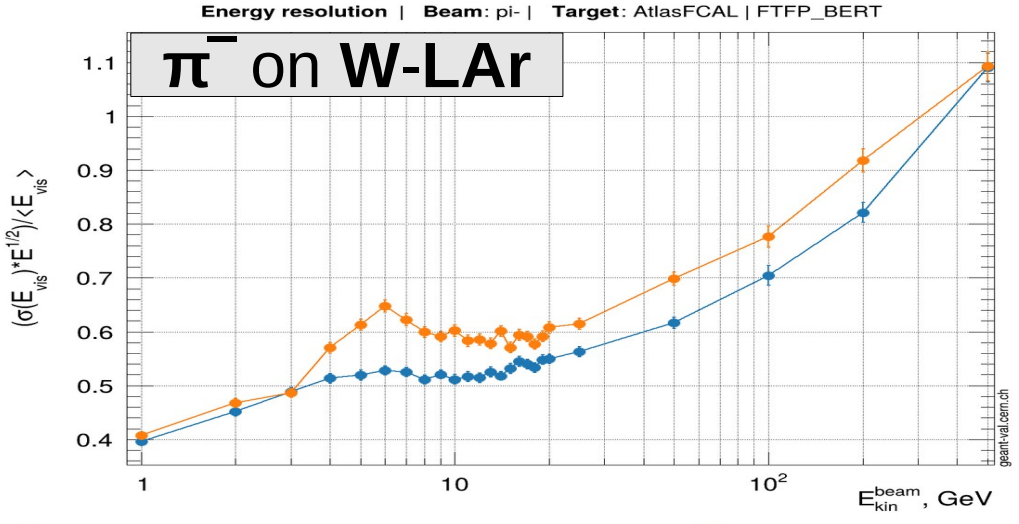


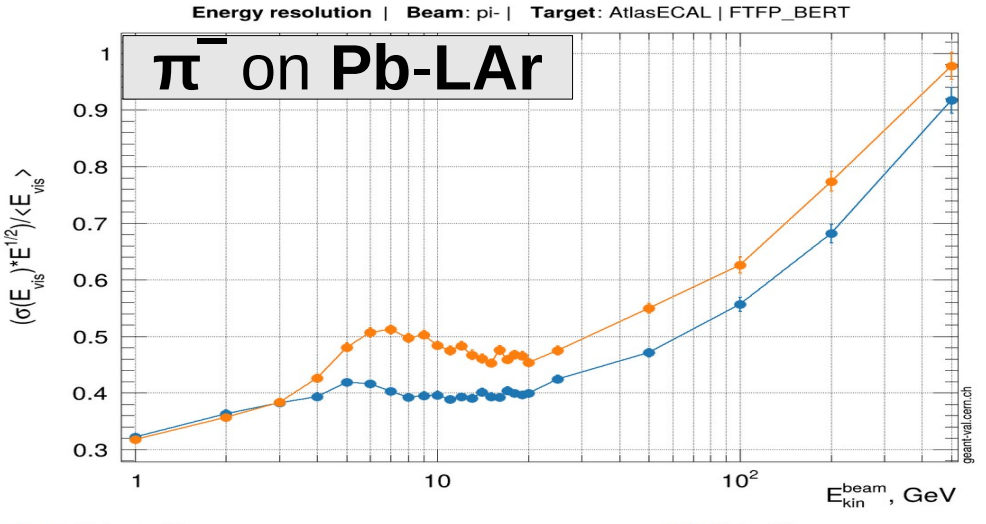


FTFP_BERT : Energy Resolution

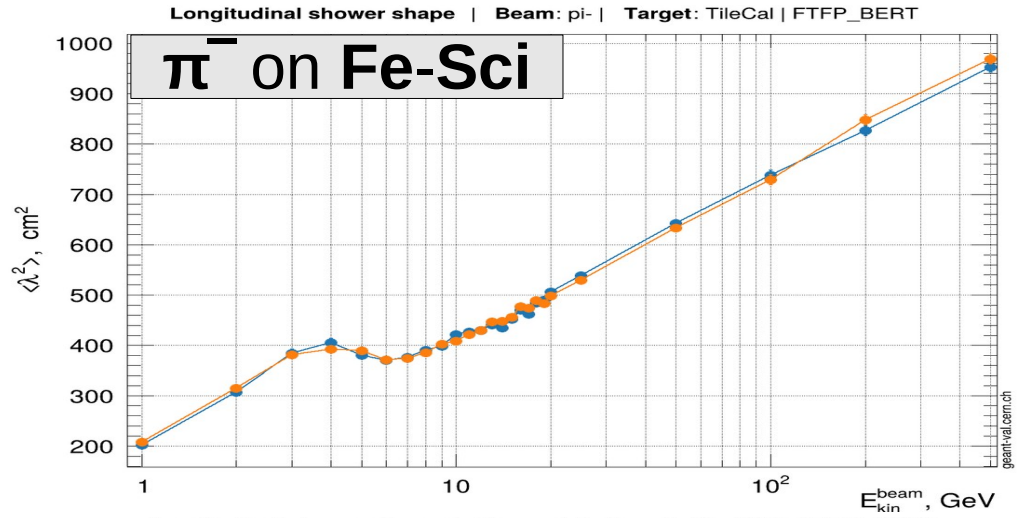


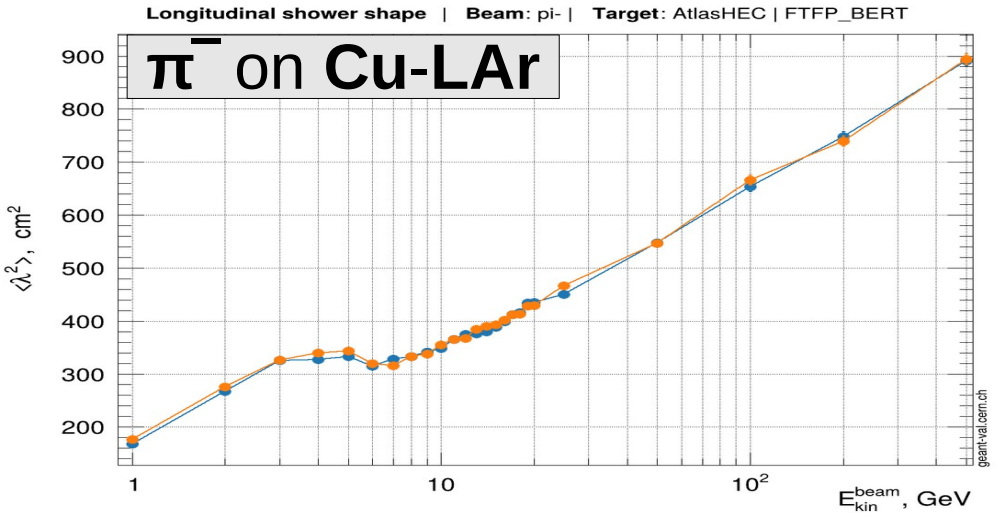


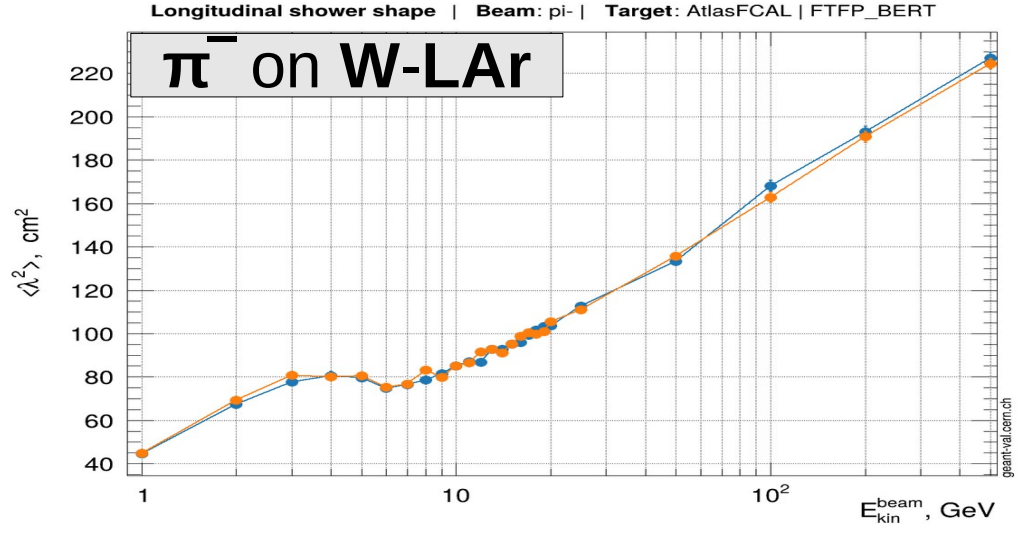


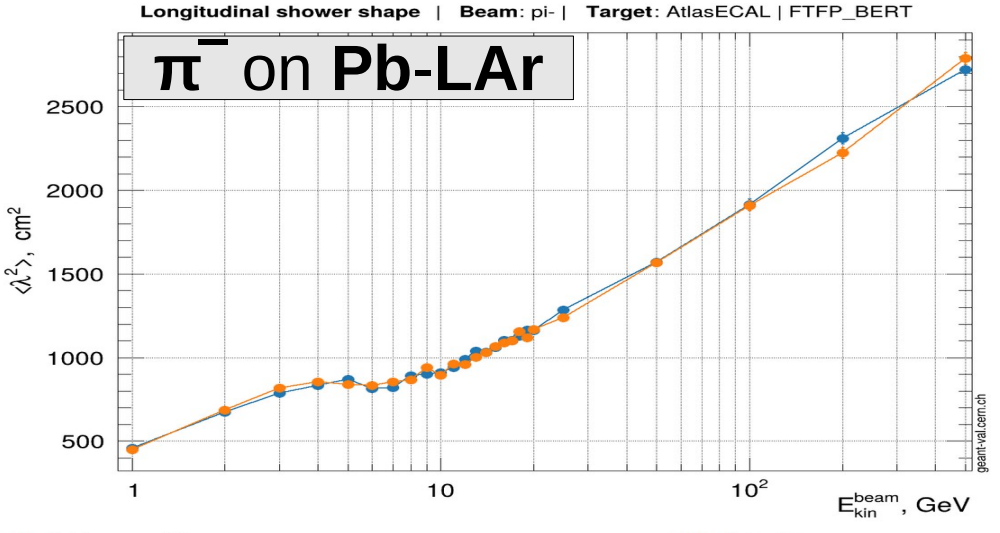


FTFP_BERT : Longitudinal Shape

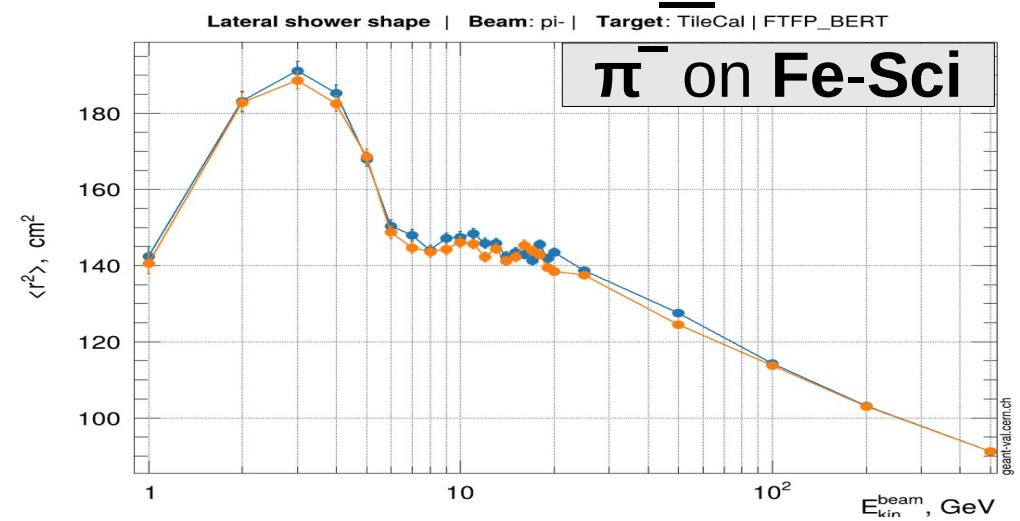


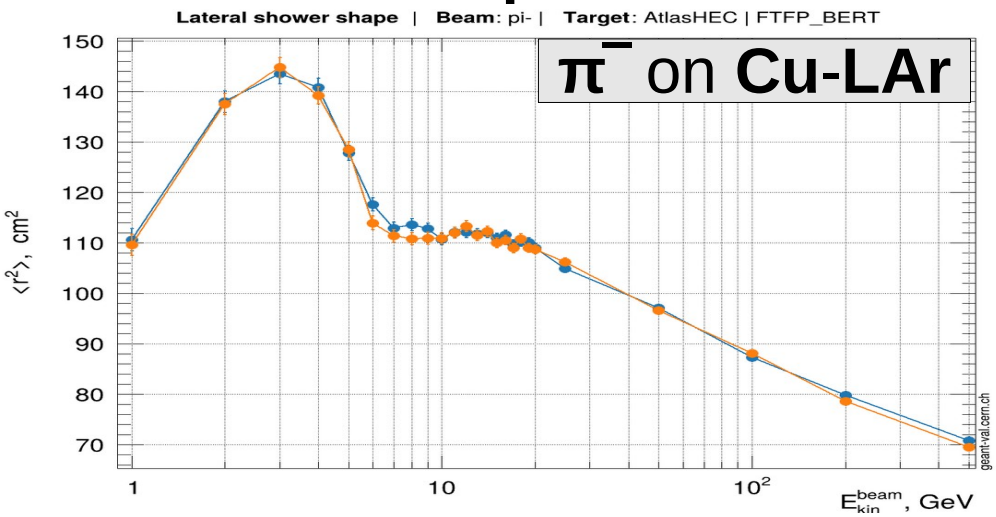


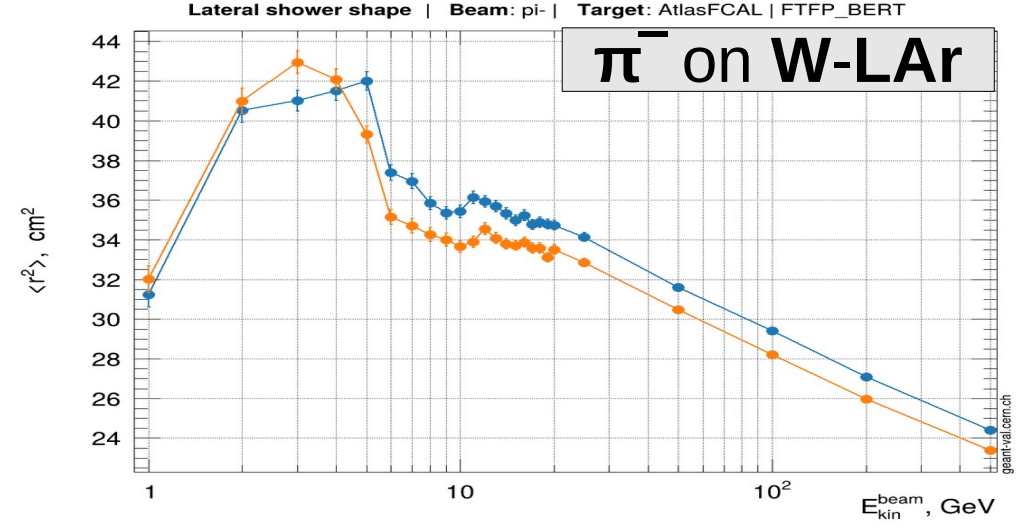


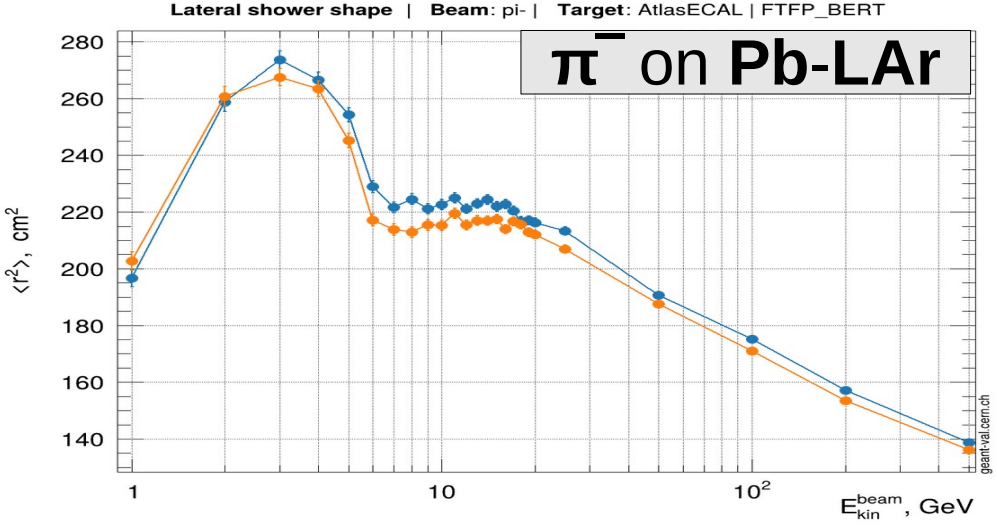


FTFP_BERT : Lateral Shape







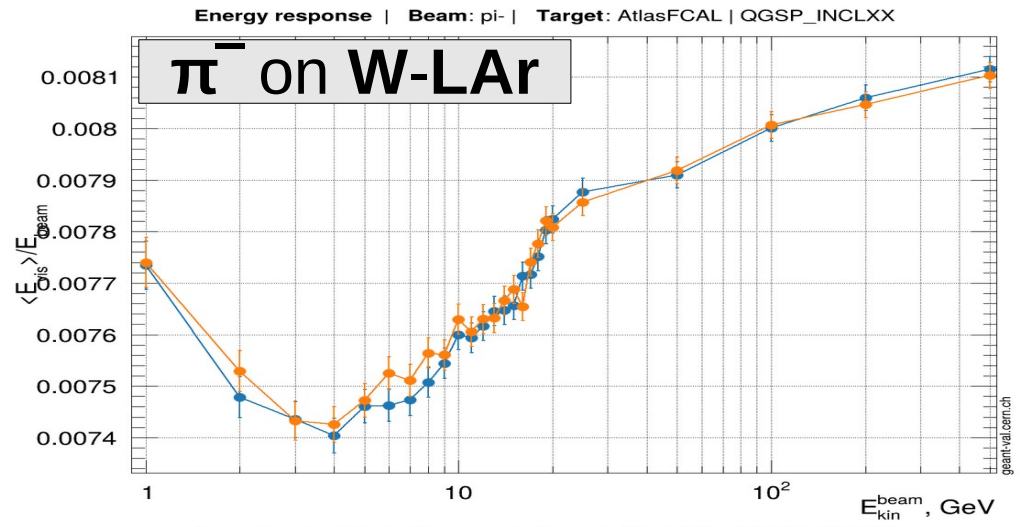


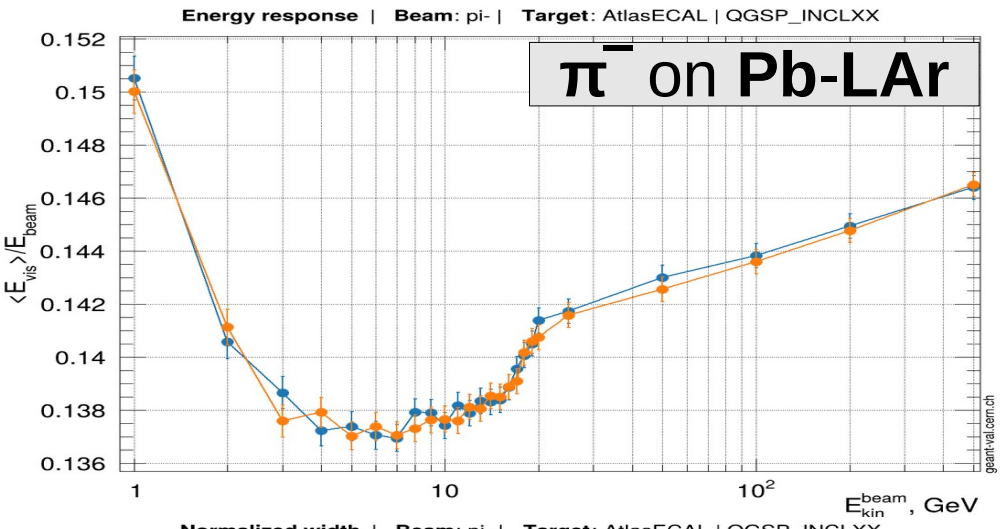
Pion- showers: QGSP_INCLXX

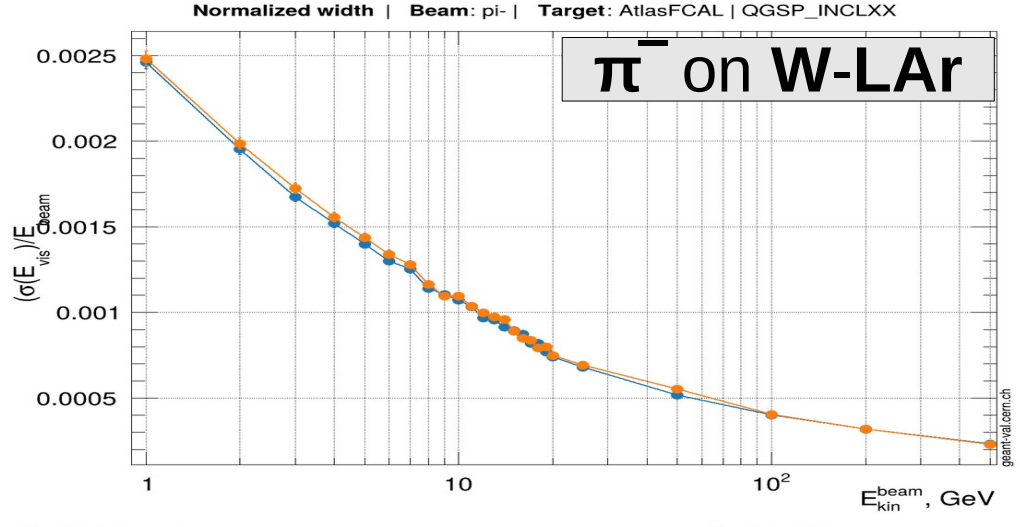
G4 11.2.ref06
G4 11.2.ref07

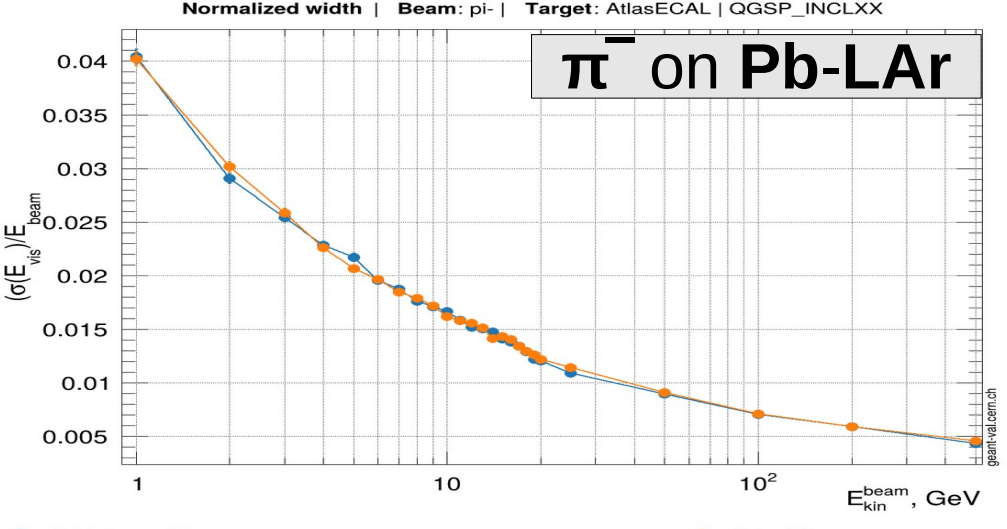
Note : conventional Birks treatment
(easier and no experimental h/e to fit !)

Energy Response & Energy Width

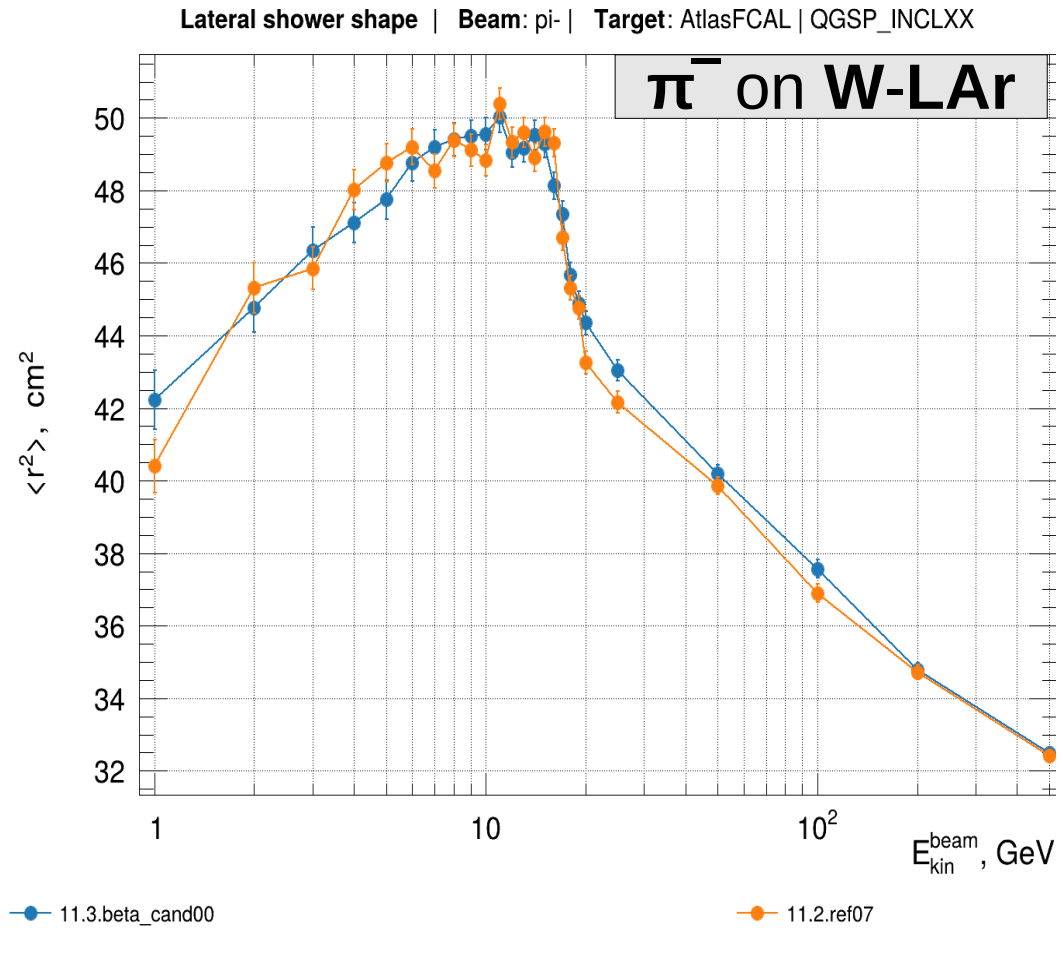


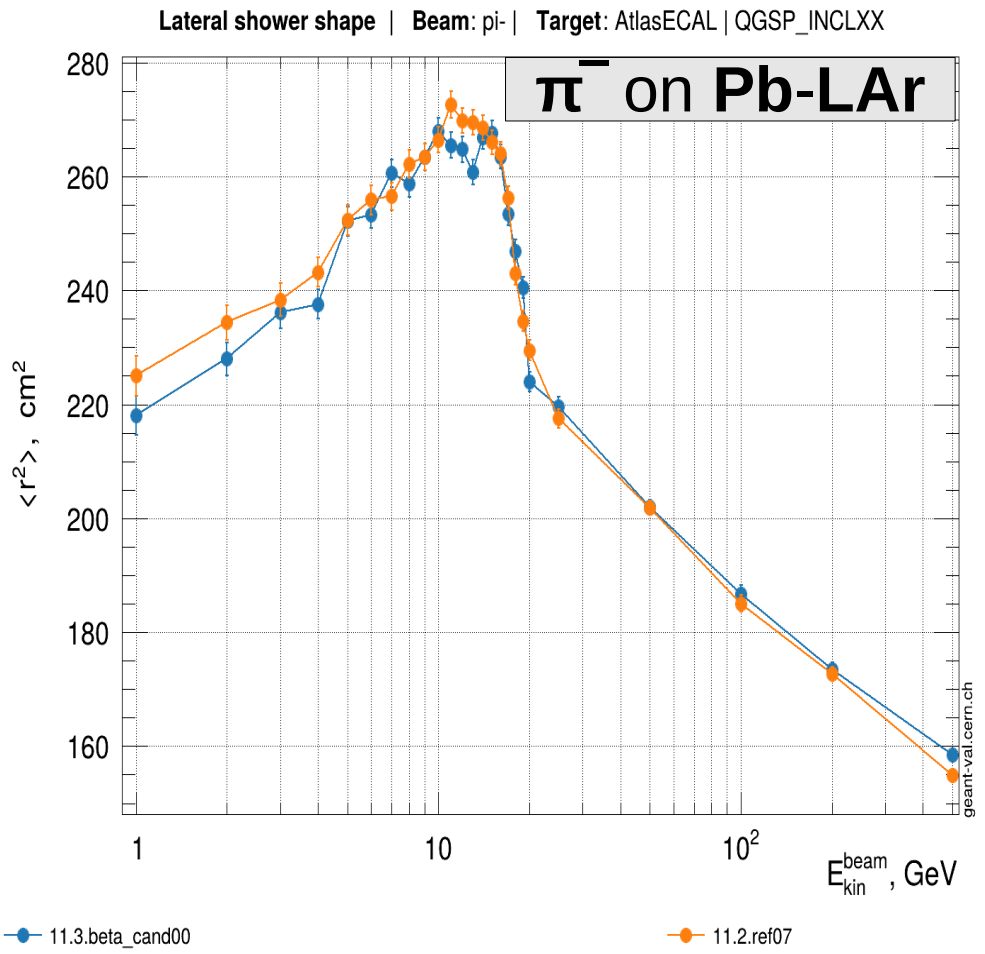






Lateral Shape





Conclusions

- **G4 11.2.ref07**
  - No crashes, no infinite loops, no new warnings
  - Reproducibility fine in all cases
  - Hadron showers
    - For all physics lists – except QGSP_INCLXX – significant and unexpected differences in pion showers, especially in heavy absorbers (W and Pb), with respect to G4 11.2.ref06 :
      - Lower energy response and wider visible energy fluctuations
      - Narrower showers

      Who is the culprit?
      - Likely not nuclear de-excitation (because it would affect INCLXX as well);
      - perhaps pre-equilibrium (not used in INCLXX, but neither in BERT, so not clear...)

      Needs to be investigated!