Hadronic Showers in Geant4 10.7.**p02** (plus something on Ref05)

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CERN EP-SFT

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Main Changes in Hadronics *vs.* 10.7.p01

- De-excitation
  - Changed half-life time threshold for isomer production from **1 microsecond** to **1 nanosecond**
    - The goal is to avoid unphysical missing energy cases as reported by NA61/SHINE Collaboration
- Radioactive Decay
  - Fixed bug in the track weight of secondaries when using Radioactive Decay in analogous mode with “external” biasing (e.g. generic biasing, GPS generator with weights, *etc.*)
    - In the method G4RadioactiveDecayBase::DecayAnalog()
- ParticleHP
  - Fixed condition in G4ParticleHPInelasticCompFS:::CompositeApply()
- Physics lists
  - G4HadronPhysicsShielding : corrected parameters of the **M** variant
    - Transition between FTFP and BERT should be 9.5 – 9.9 GeV for pions, kaons protons and neutrons
    - ShieldingM is used by Mu2e

Crashes & Warnings

- No crashes
- No infinite loops
- No new warnings

Reproducibility

- All OK
  - Both usual tests and the new ones for tasking

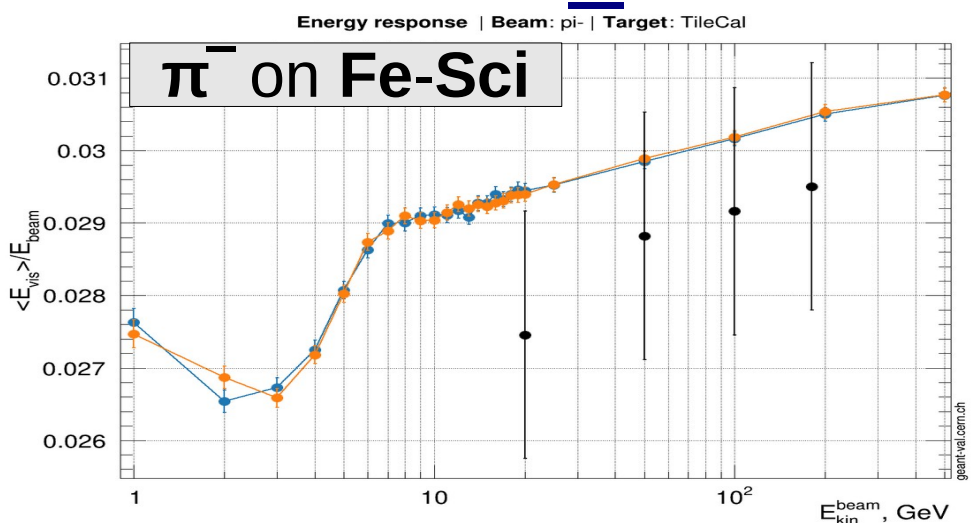
Pion- showers: FTFP_BERT

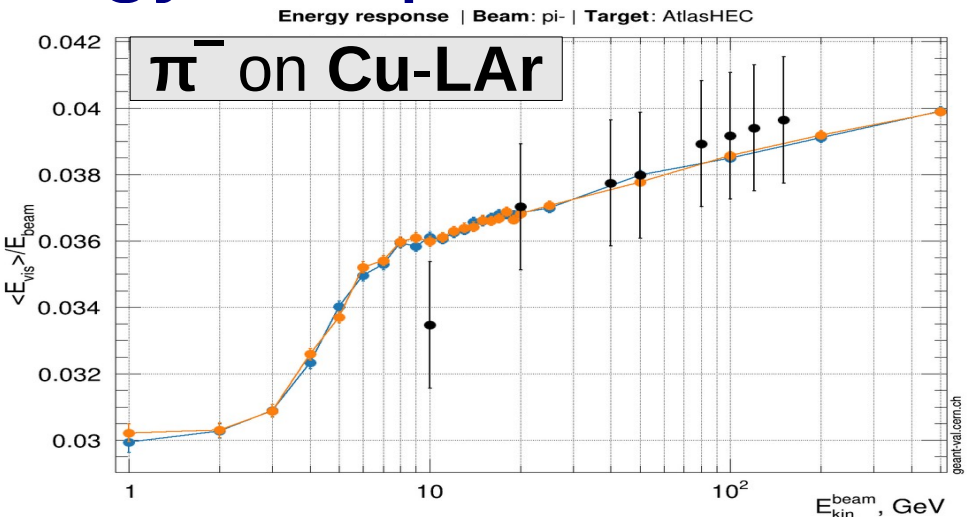
G4 10.7.p02

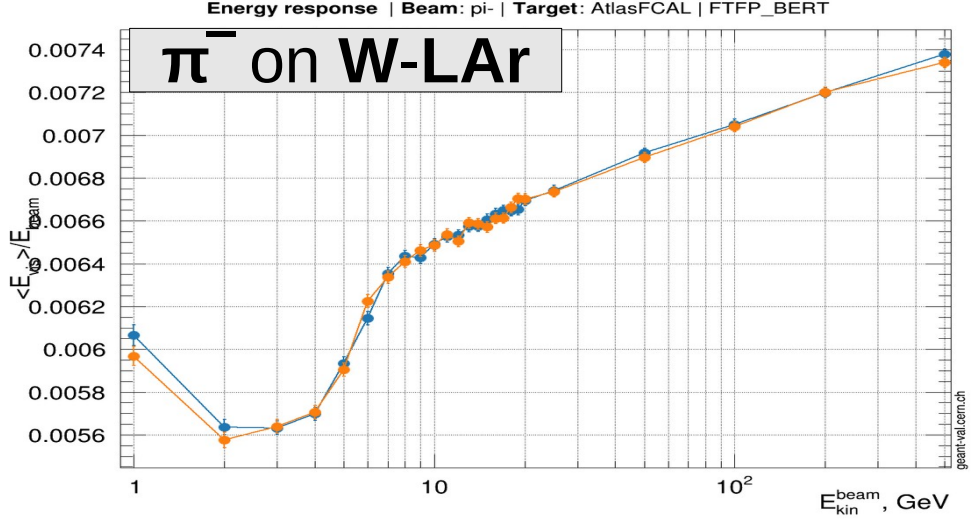
G4 10.7.p01

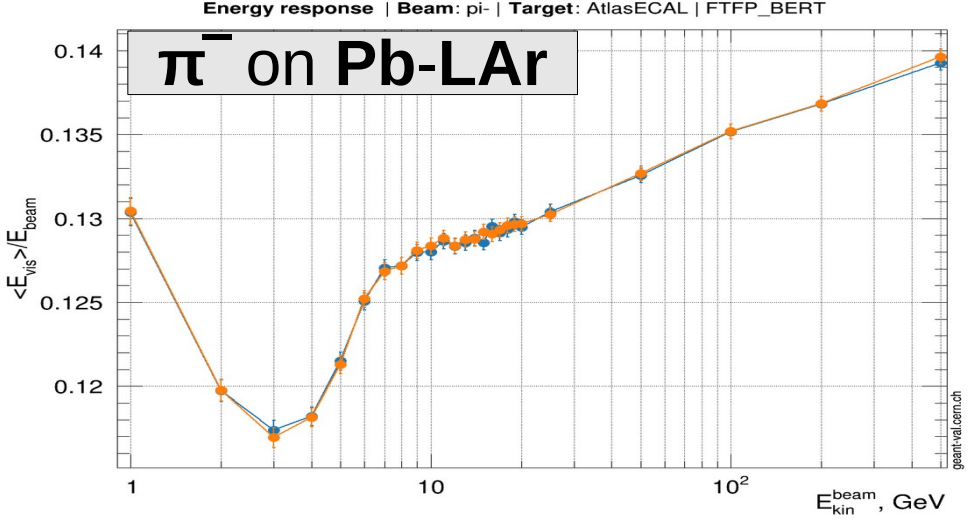
Note : conventional Birks treatment
(easier and no experimental h/e to fit !)

FTFP_BERT : Energy Response

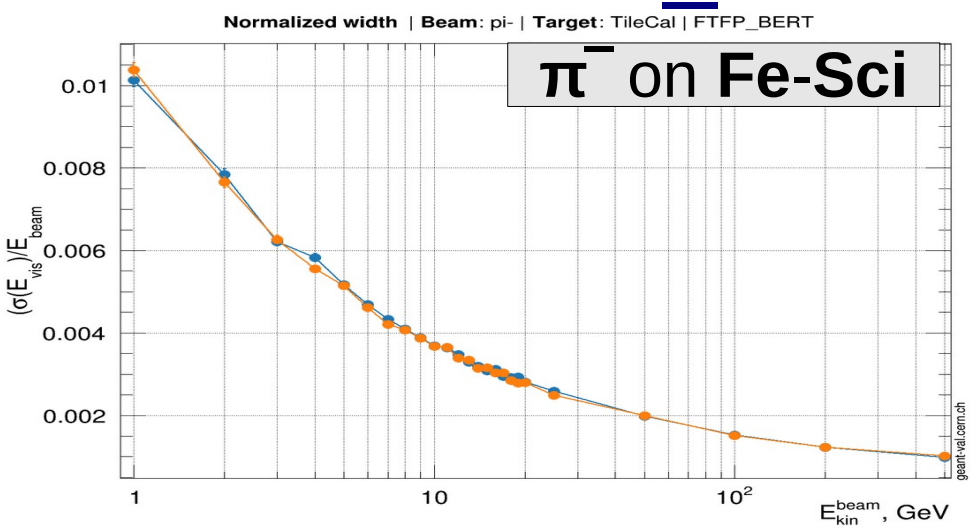


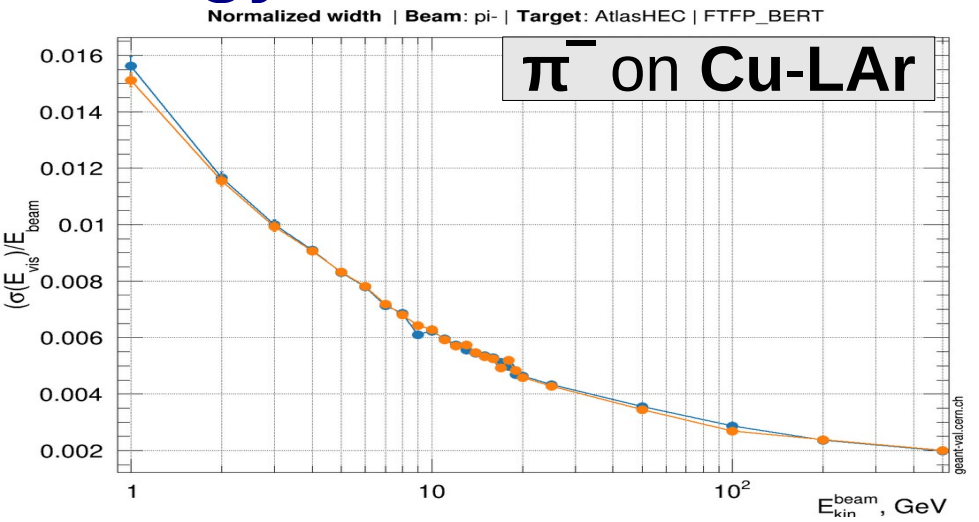


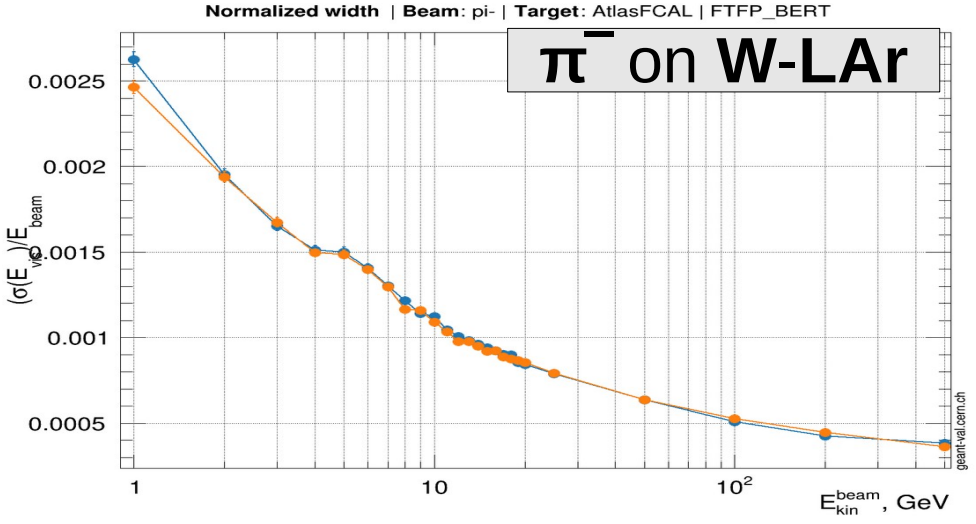


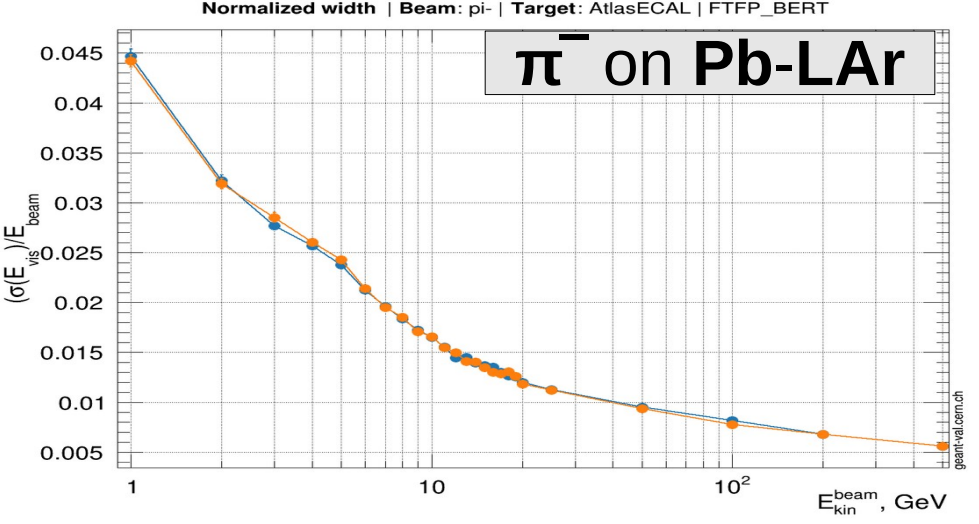


FTFP_BERT : Energy Width

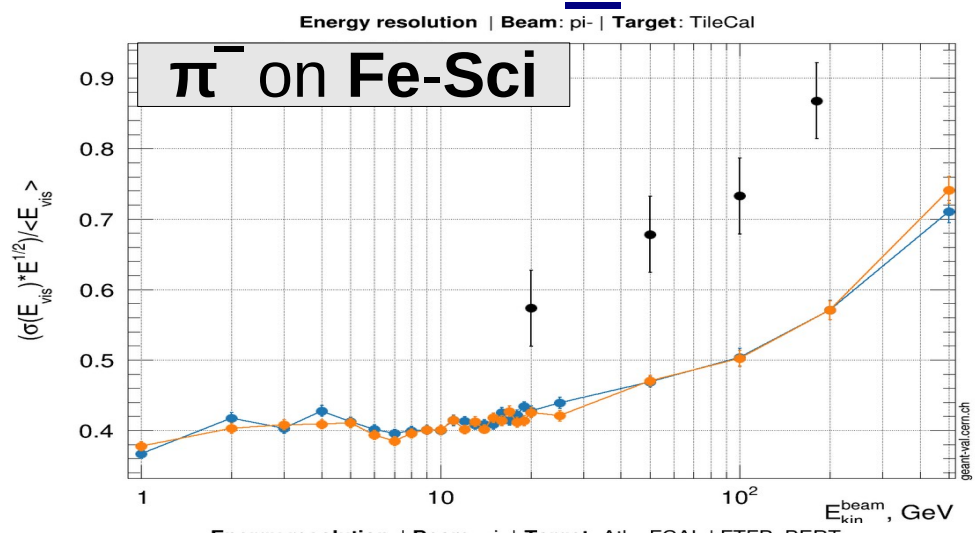


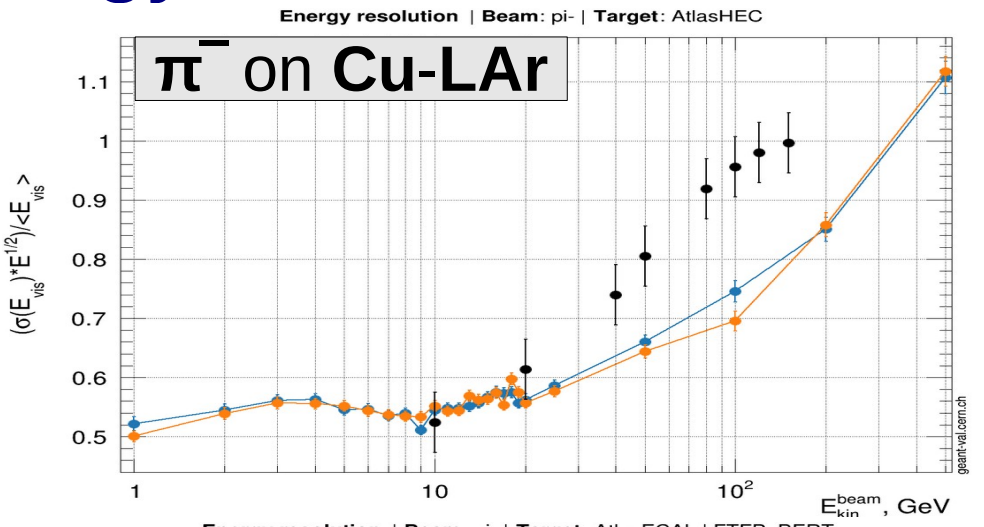


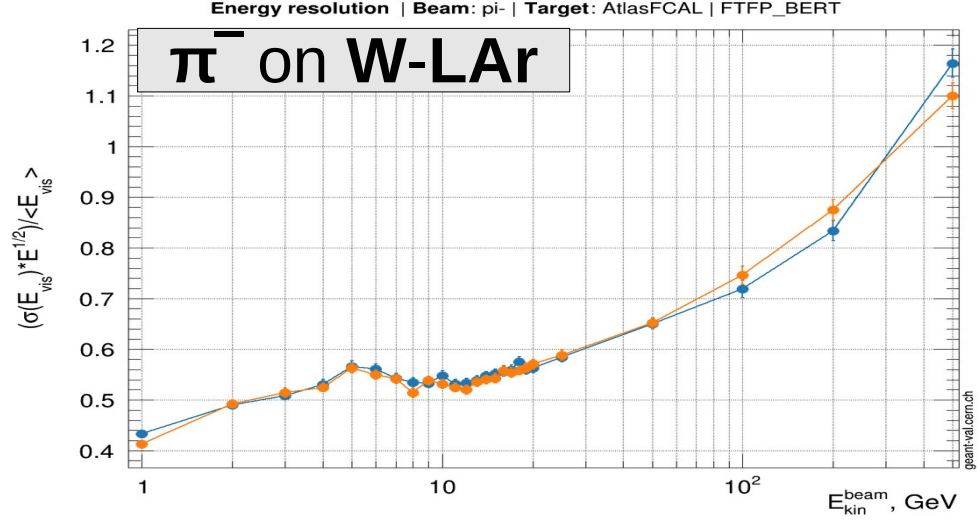


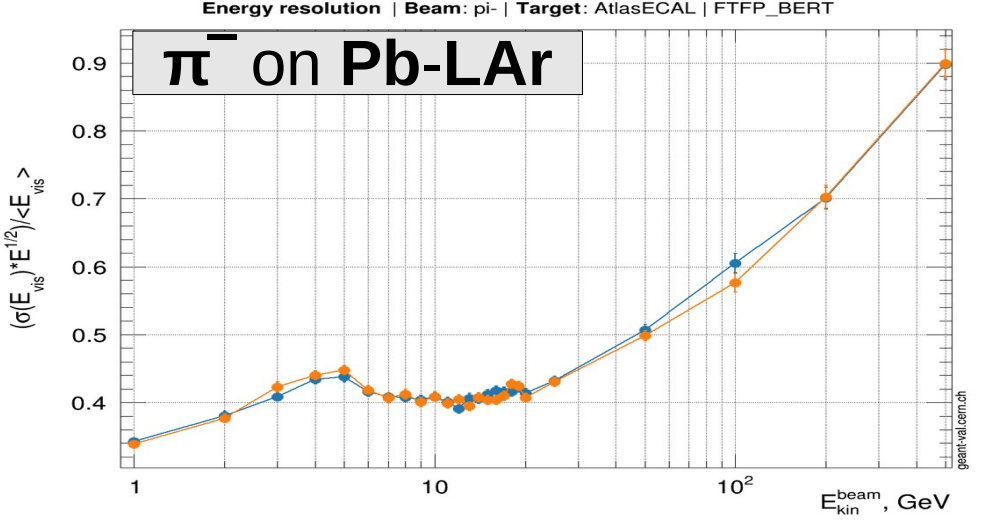


FTFP_BERT : Energy Resolution

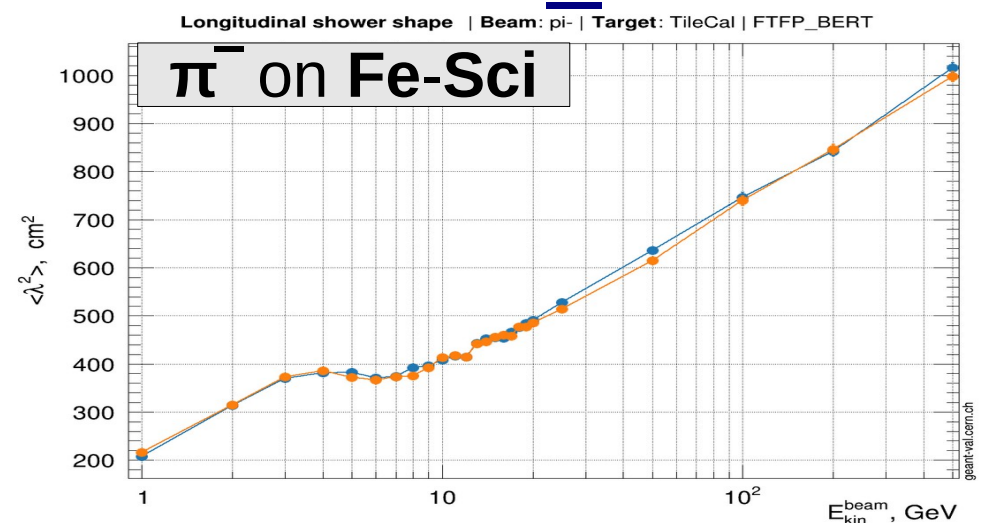


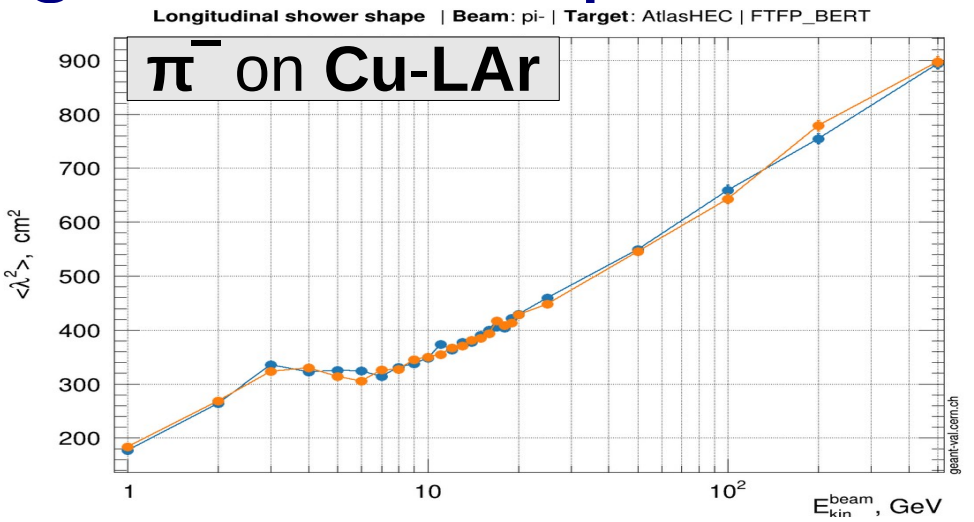


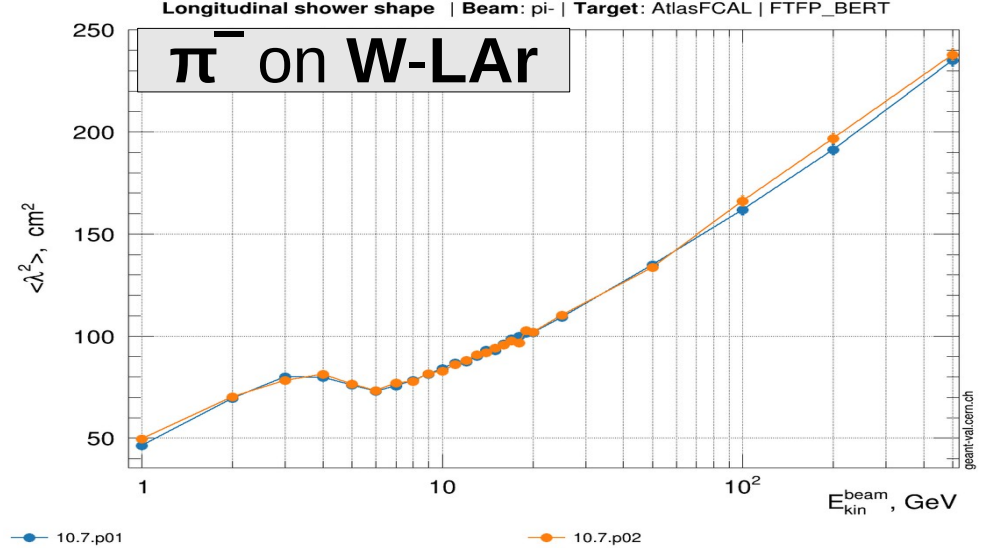


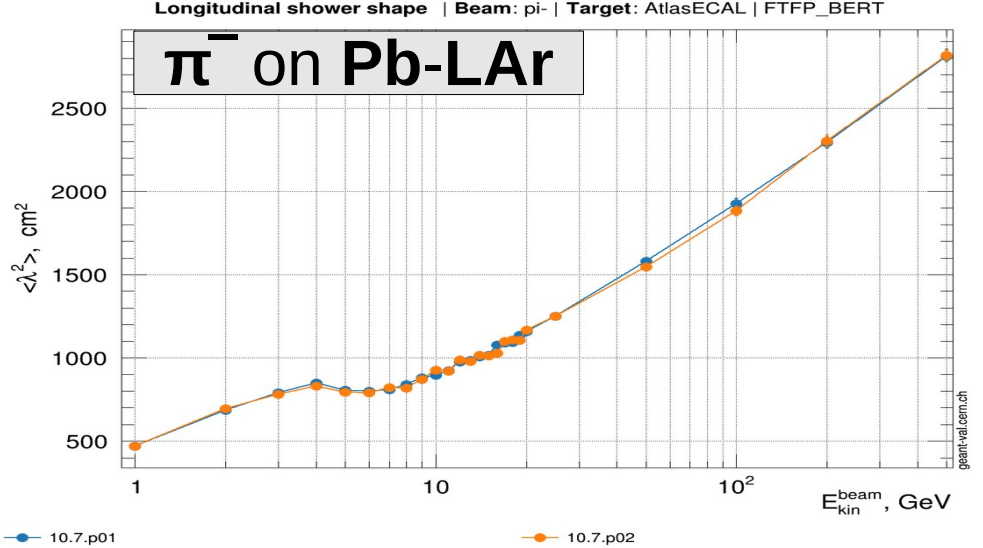


FTFP_BERT : Longitudinal Shape

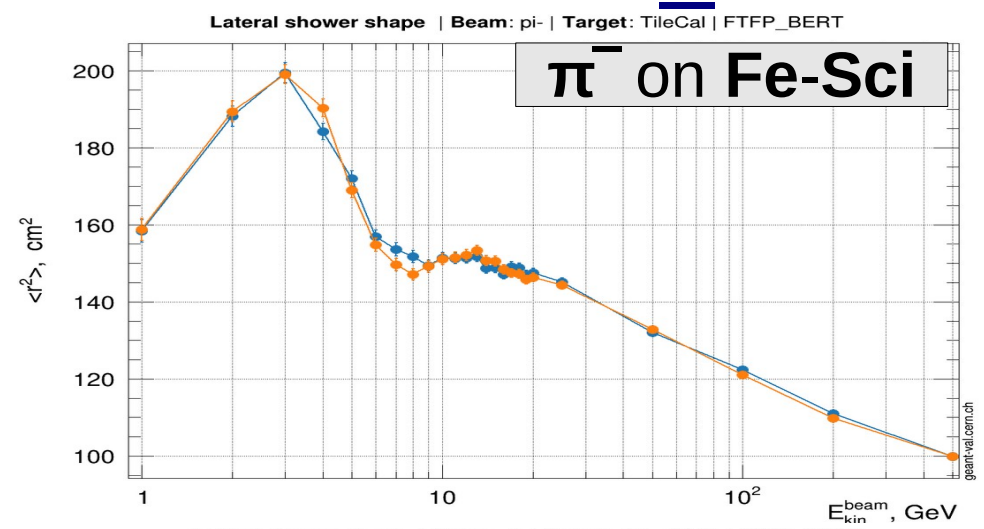


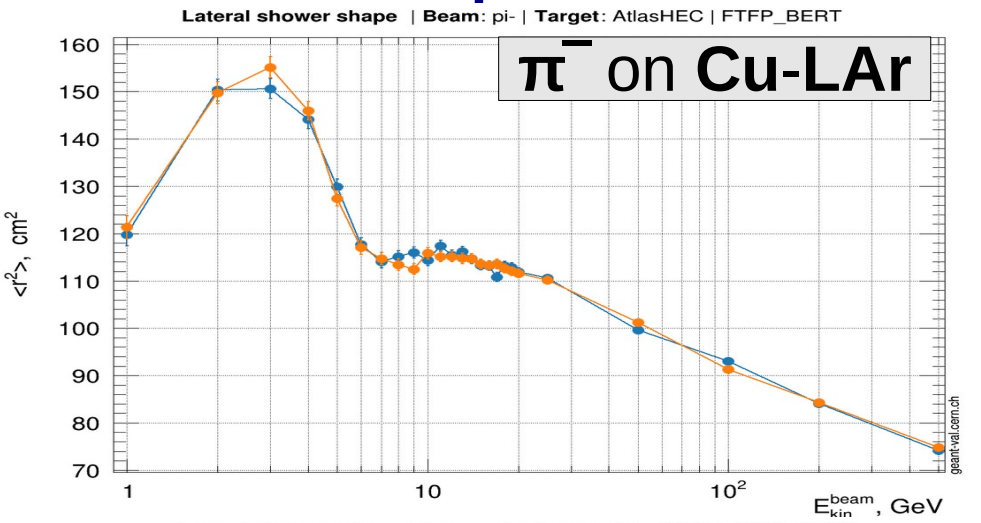


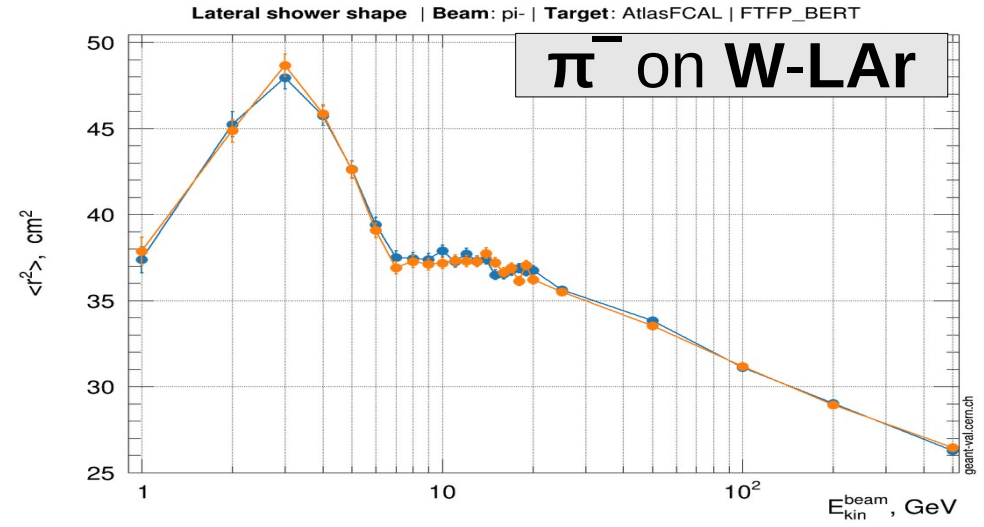


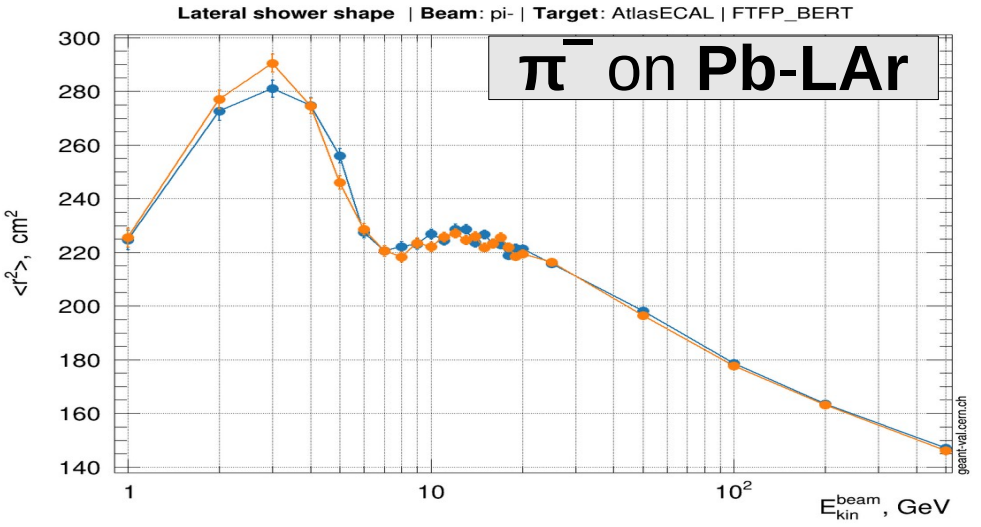


FTFP_BERT : Lateral Shape









Conclusions

- **G4 10.7.p02**
  - No crashes, infinite loops, or new warnings
  - Reproducibility OK
  - Hadron showers
    - Similar to those of G4 10.7.p01

Back-up : Ref05

Reminder

- Hadron showers in G4 10.7.ref05 have
  - ~1% smaller visible energy
  - ~1-2% narrower showers

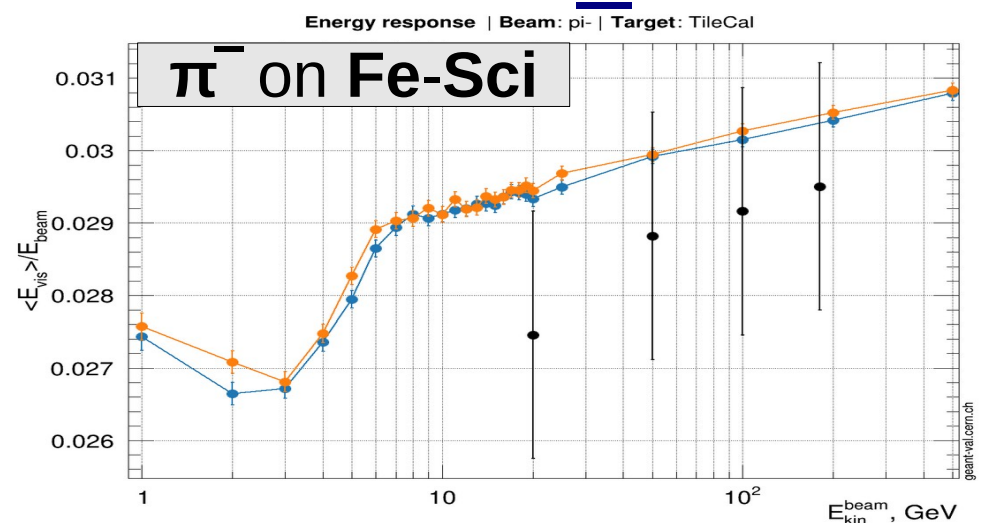
  with respect to those of G4 10.7.ref04
  - Not clear the reason for these changes

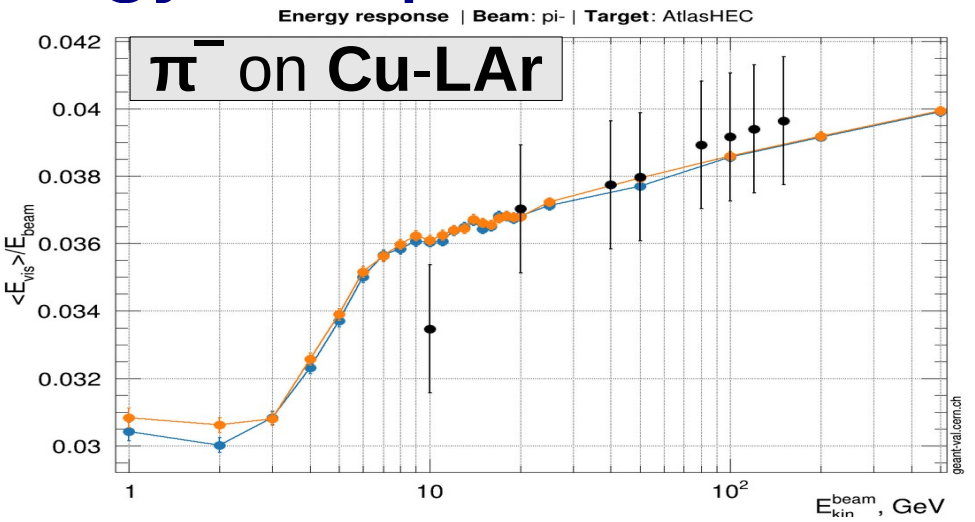
Pion- showers: FTFP_BERT

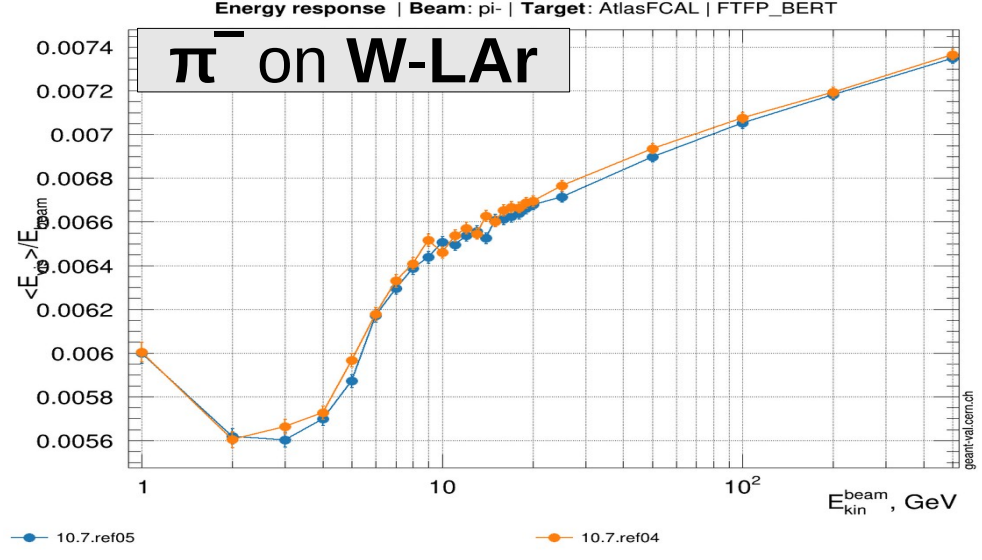
G4 10.7.ref05

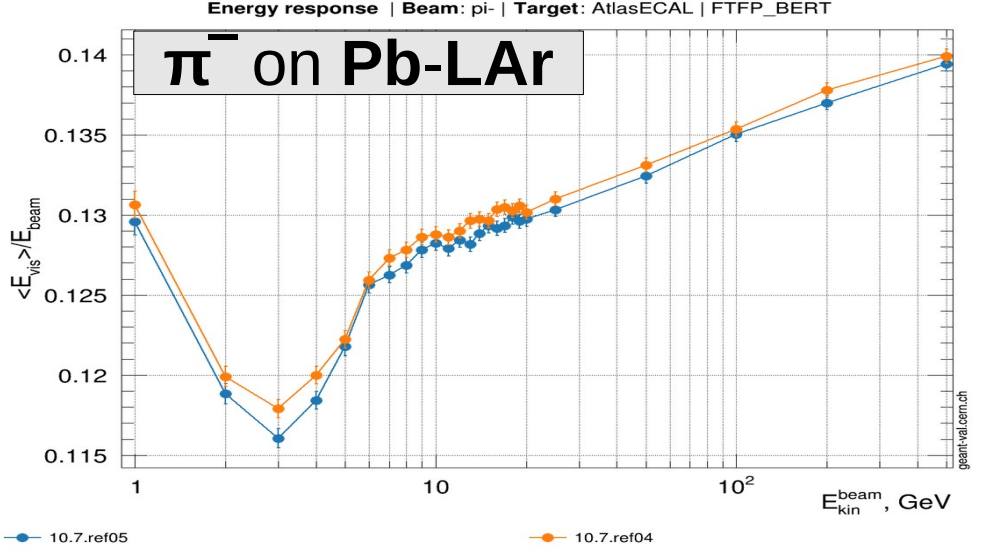
G4 10.7.ref04

FTFP_BERT : Energy Response

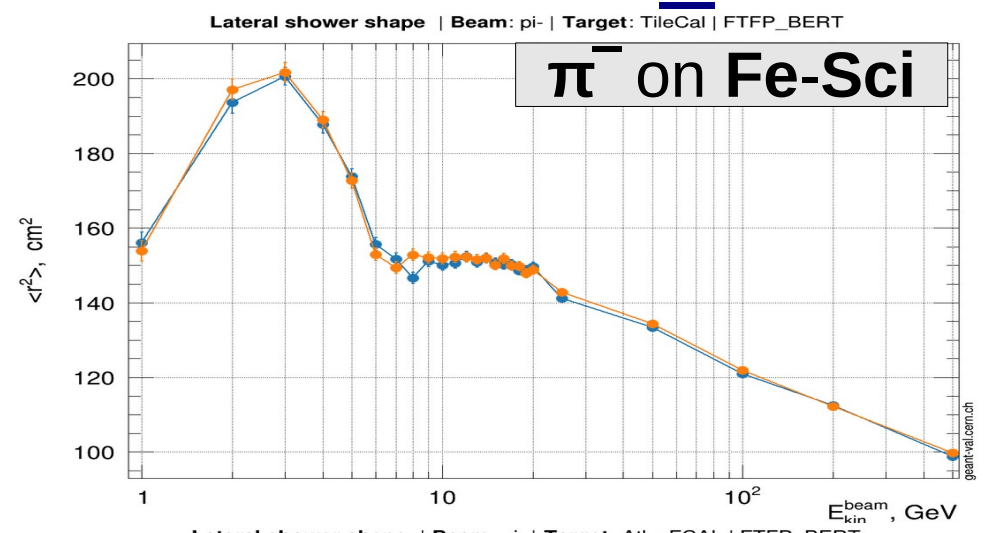


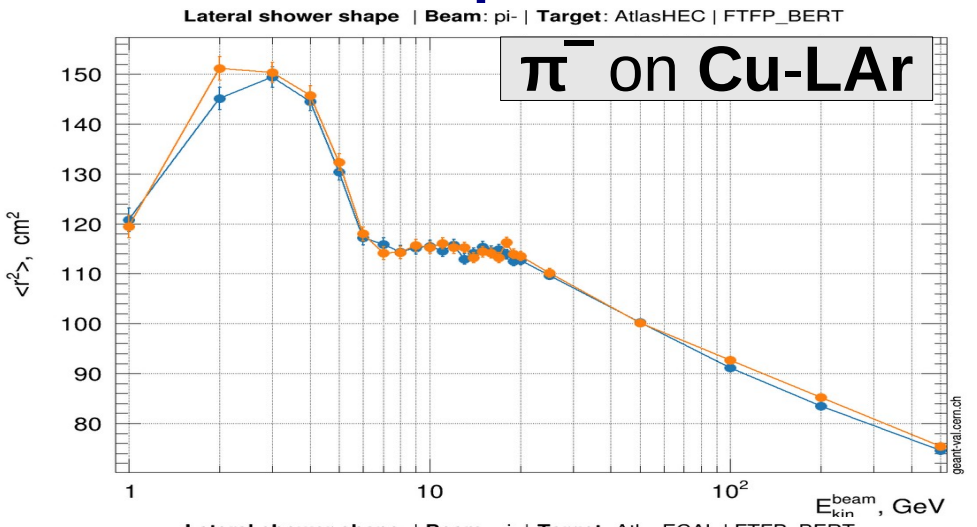


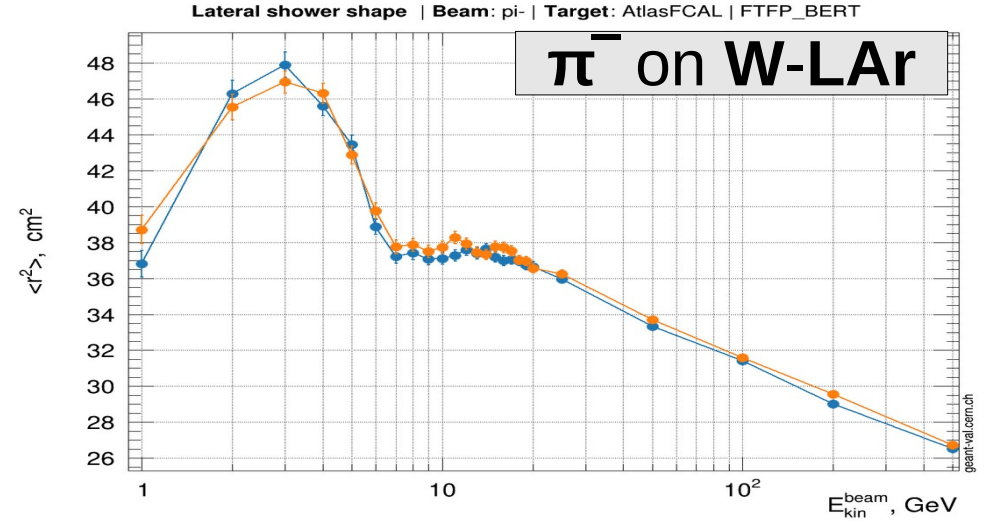


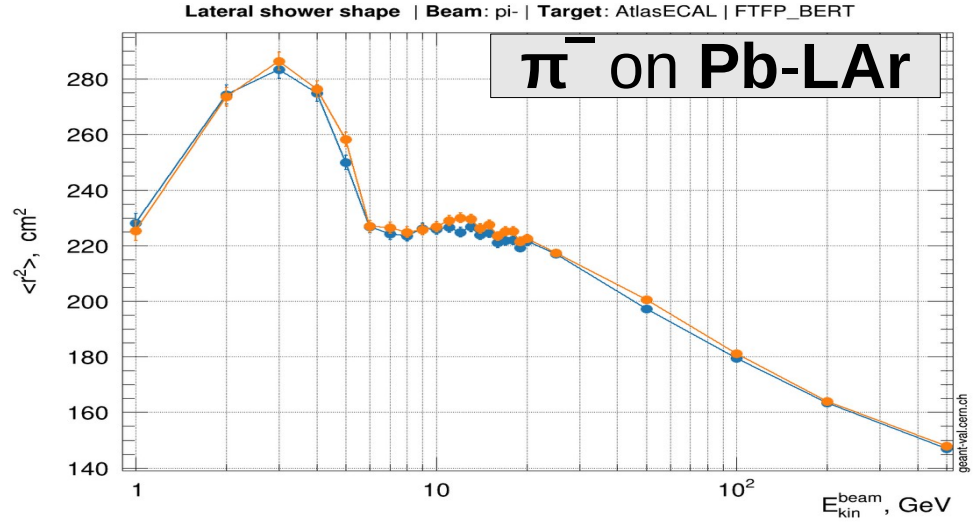


FTFP_BERT : Lateral Shape









Bug introduced in Ref03 and then fixed in Ref05

- A bug was introduced in G4 10.7.ref**03** in the method:
  - **G4ionEffectiveCharge::EffectiveChargeSquareRatio**

  but the changes in hadronic showers with respect to 10.7.ref02 were overlooked and not reported (my fault!)
- The bug was then fixed in G4 10.7.ref**05**
- Because of this bug, there are two equivalent classes of hadronic showers which differ by **~1% in energy response** and **~1-2% in lateral shower shapes**
  - 10.7.{ p01 , p02 , ref00 , ref01 , ref02 , ref05 } OK !
  - 10.7.{ ref03 , ref04 } Buggy !

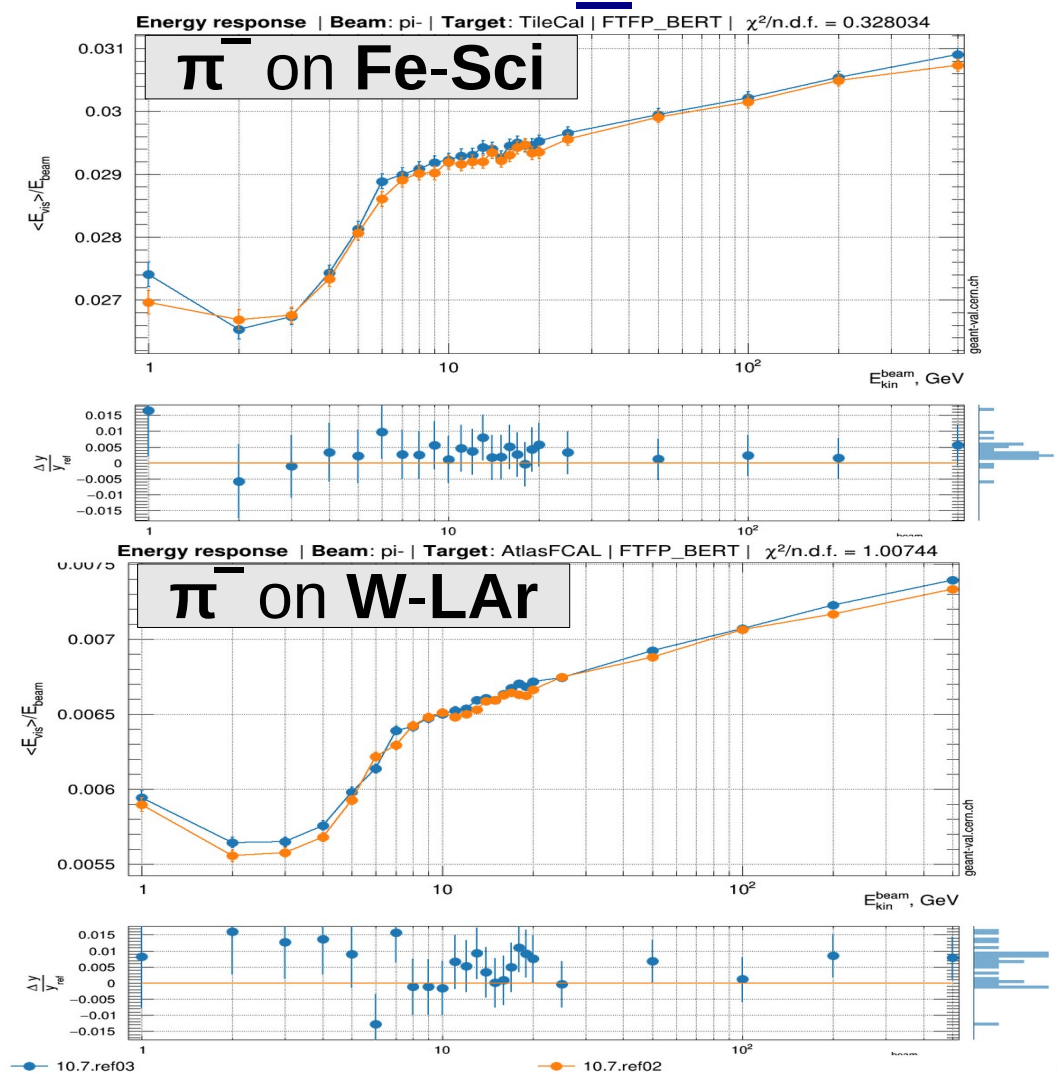
Pion- showers: FTFP_BERT

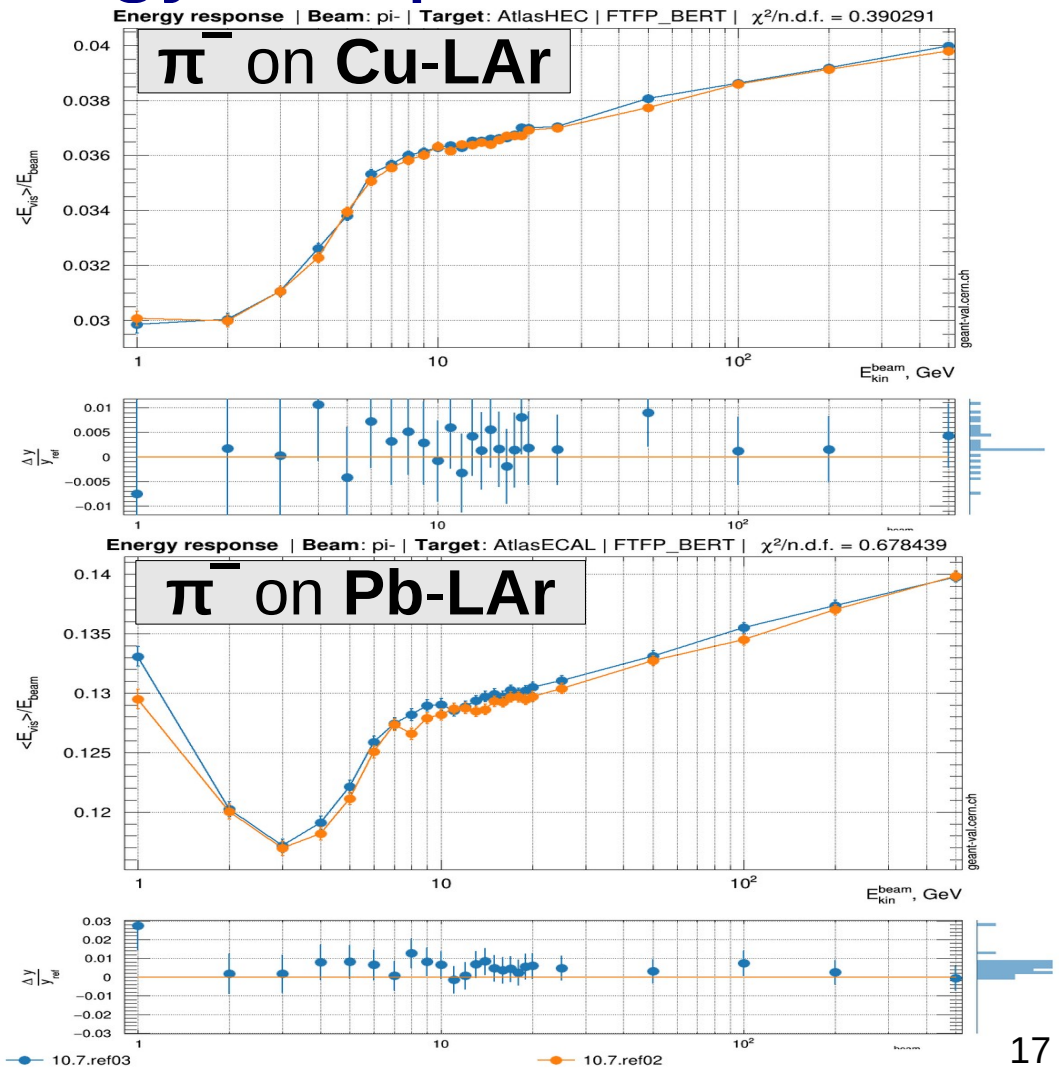
G4 10.7.ref03

G4 10.7.ref02

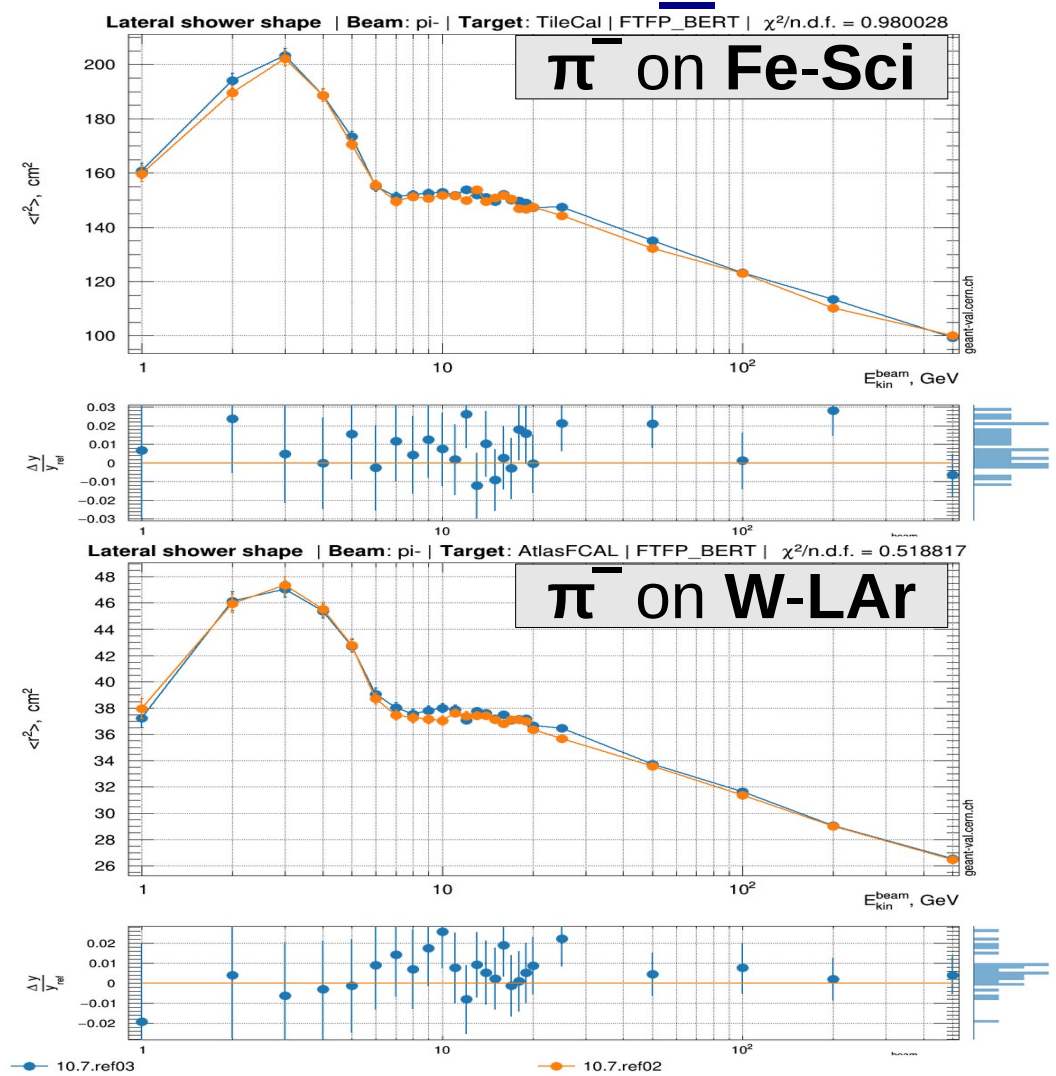
Note : conventional Birks treatment
(easier and no experimental h/e to fit !)

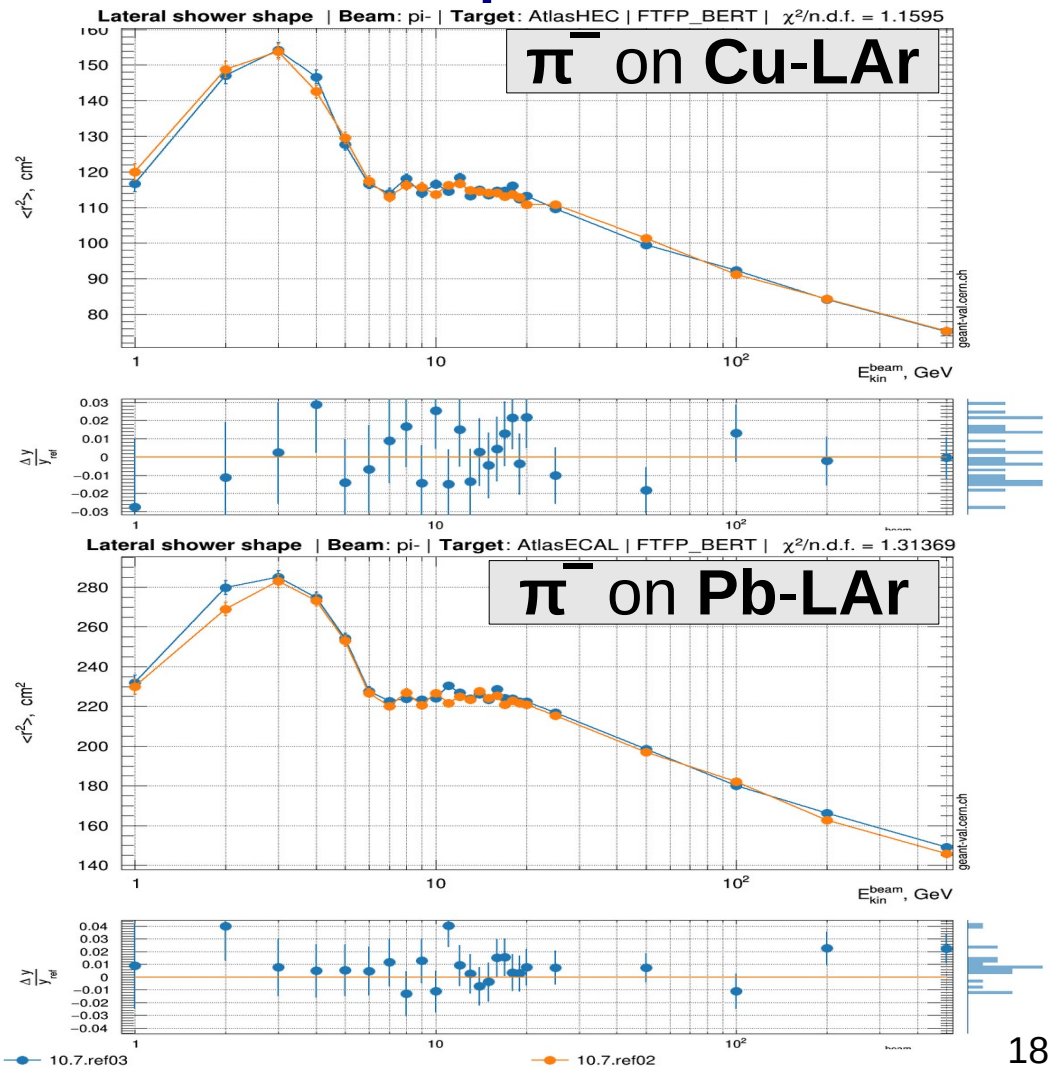
FTFP_BERT : Energy Response





FTFP_BERT : Lateral Shape





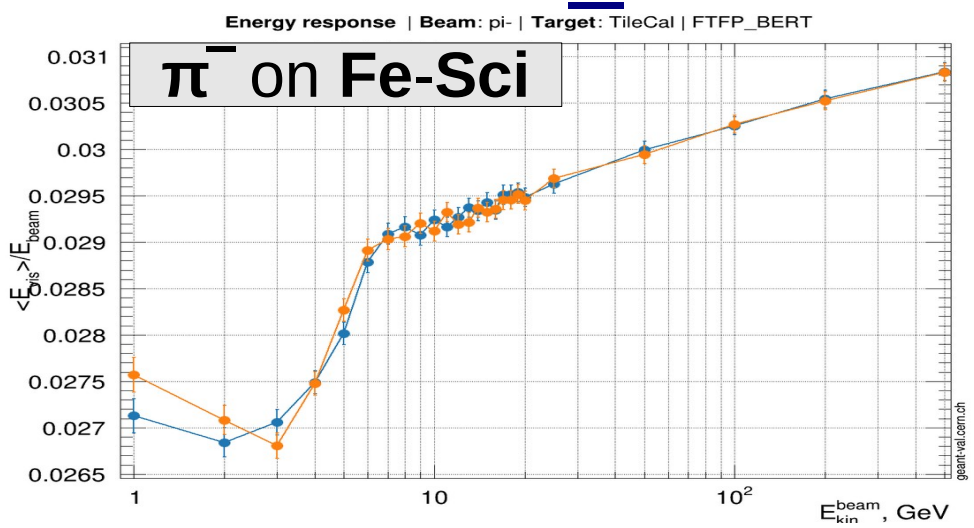
Pion- showers: FTFP_BERT

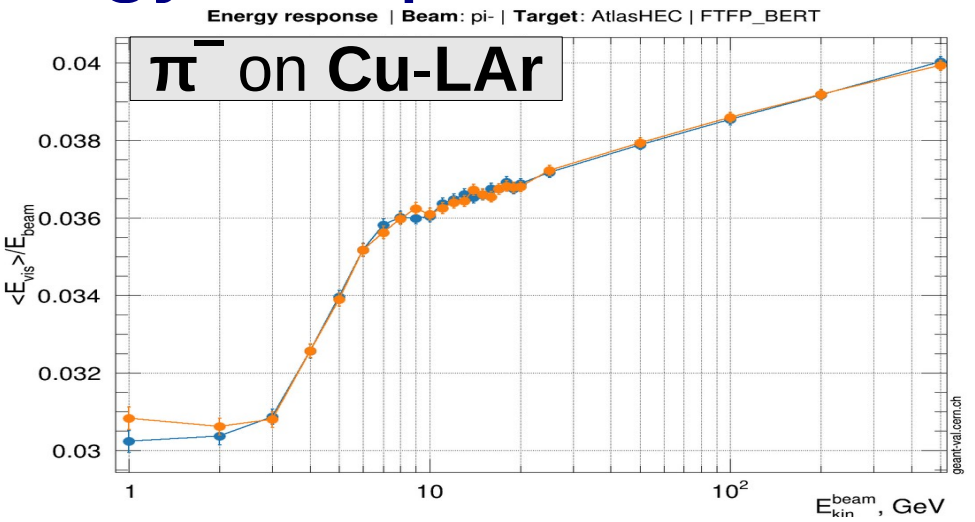
G4 10.7.ref05a as Ref05 but without bug-fix

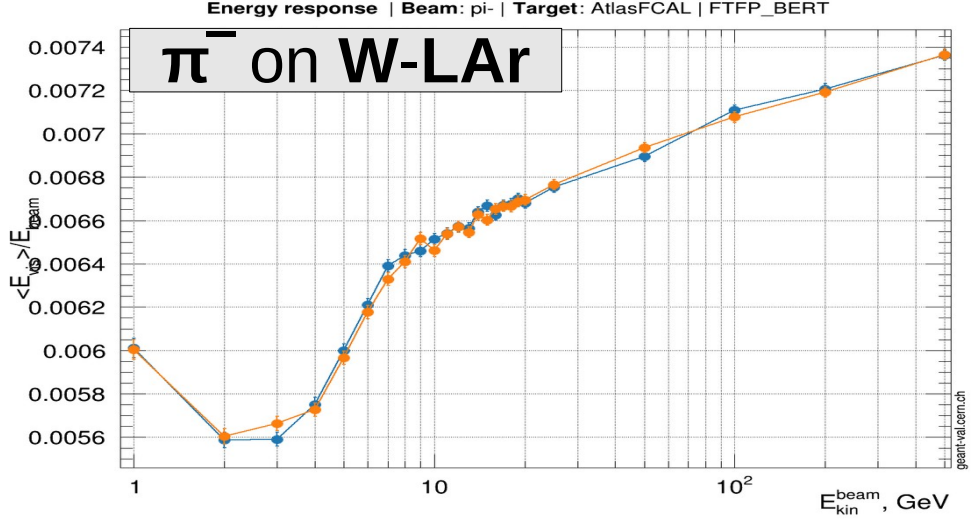
G4 10.7.ref04

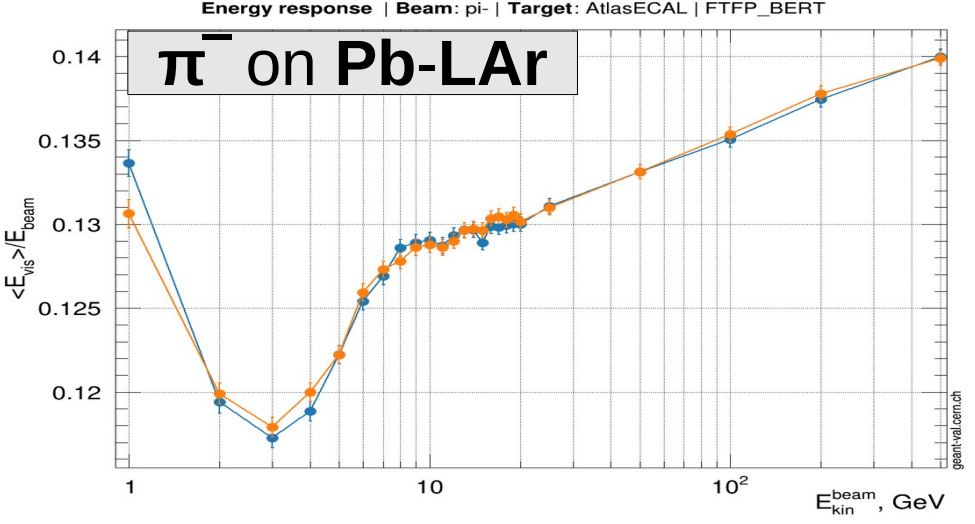
Note : conventional Birks treatment
(easier and no experimental h/e to fit !)

FTFP_BERT : Energy Response

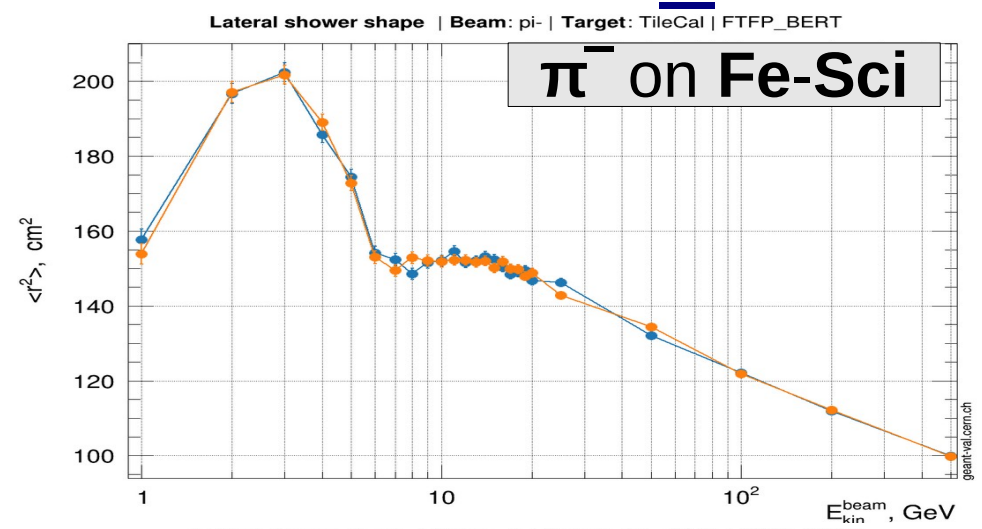


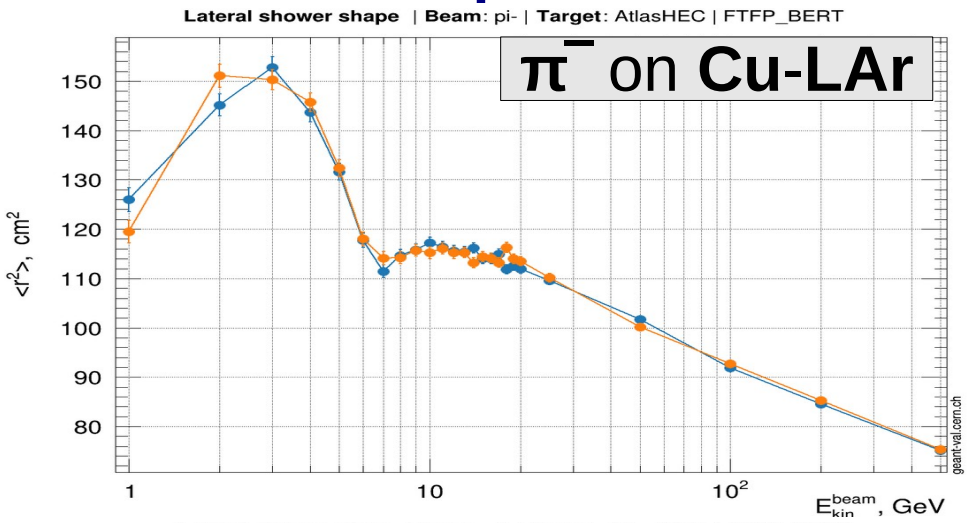


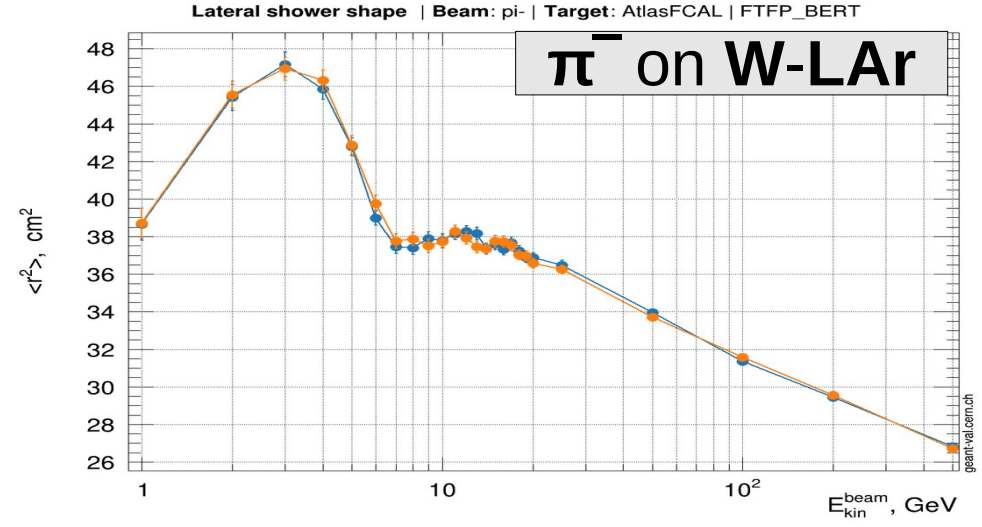


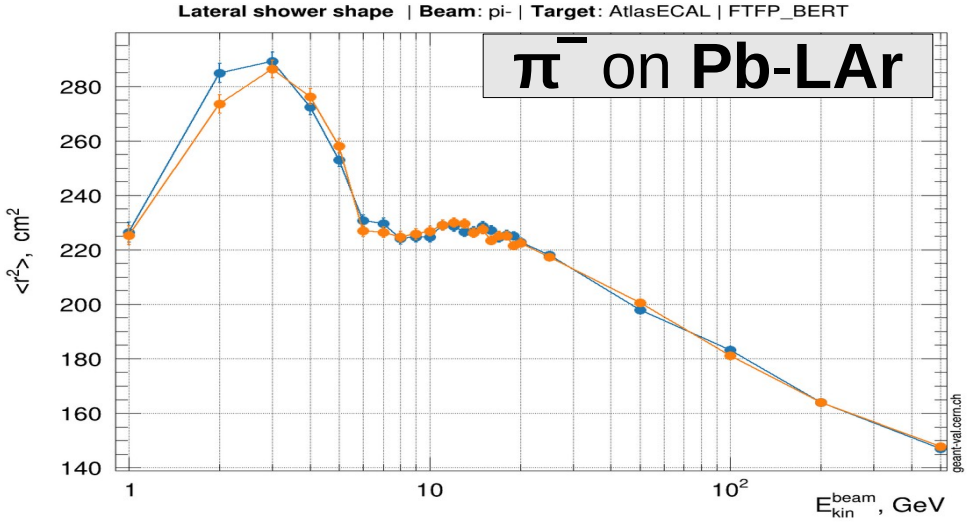


FTFP_BERT : Lateral Shape









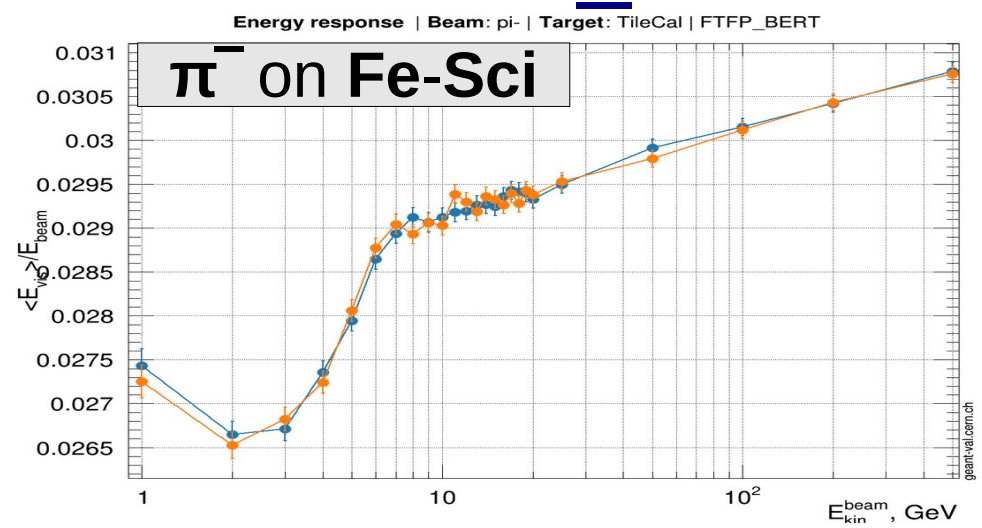
Pion- showers: FTFP_BERT

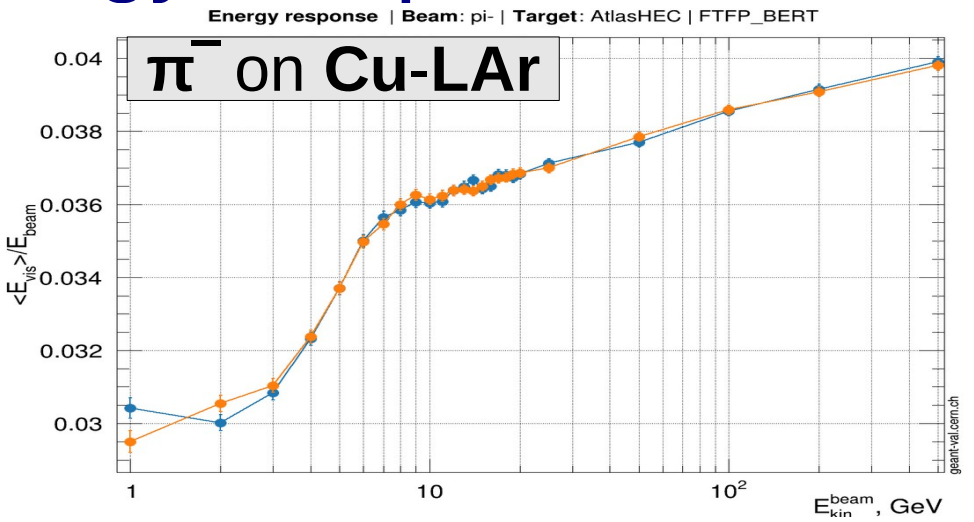
G4 10.7.ref05

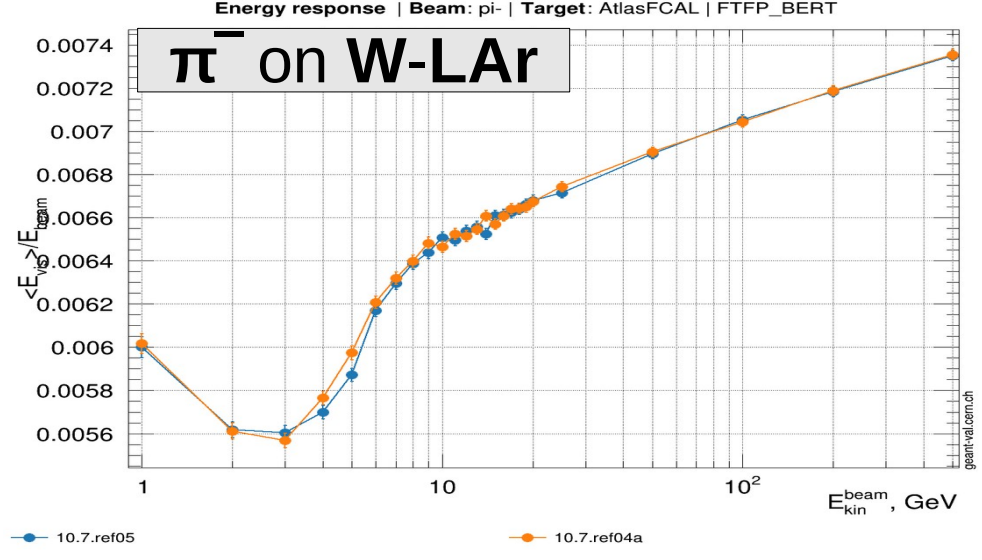
G4 10.7.ref04a as Ref04 but with bug-fix

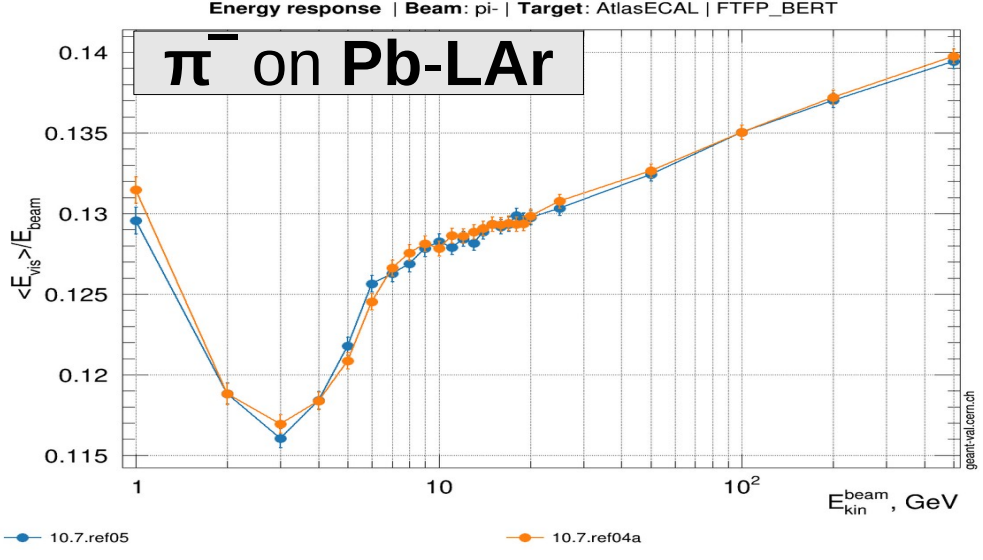
Note : conventional Birks treatment
(easier and no experimental h/e to fit !)

FTFP_BERT : Energy Response









FTFP_BERT : Lateral Shape