Hadronic Showers in Geant4 **11.3.ref01**

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Main Changes in Hadronics *vs.* G4 11.3.ref00 (1/2)

- *hadronic/model/**de-excitation***
  - ***G4ExcitationHandler, G4GammaTransition, G4PhotonEvaporation*** **: removed production of unphysical states. Addressing problem report #2584**
  - *G4NucLevel, G4PhotonEvaporation* : minor, technical fixes
  - *G4DeexPrecoParameters* : added extra enumerator to choose variants of the pre-compound model
- *hadronic/model/pre_equilibrium*
  - *G4PreCompoundInterface, G4PreCompoundTransitionsInt, G4PreCompoundEmissionInt* : new classes (introduced by Vladimir Ivanchenko) for an alternative pre-compound model with respect to the default one (which remains unchanged)
  - *G4PreCompoundModel, G4PreCompoundTransition, G4PreCompoundEmission* : introduced the option to use alternative pre-compound models

Main Changes in Hadronics *vs.* G4 11.3.ref00 (2/2)

- *hadronic/util*
  - *G4Fragment* : added protection against precision loss in the computation of Lorentz boost vector (for a fragment nearly at rest)
- *hadronic/model/particle_hp*
  - *G4ParticleHPThermalScatteringData* : several technical improvements, in particular for initialisation, multi-threading and in throwing exceptions
- *hadronic/model/radioactive_decay*
  - *G4RadioactiveDecay* : fix to enable biasing in radioactive decay. Addressing problem report #2592
- *hadronic/model/lend*
  - *G4LENDCombinedModel* : fix in photo-fission
  - Collected all inelastic models (neutron- and gamma-induced) into a new inelastic physics list constructor, *G4HadronicPhysicsLEND*, and then update accordingly the physics list constructors *G4EmExtraPhysics* and *G4HadronPhysicsShielding*, as well as the physics list *Shielding*

Crashes & Warnings

- No crashes
- No infinite loops
- No new warnings

Reproducibility

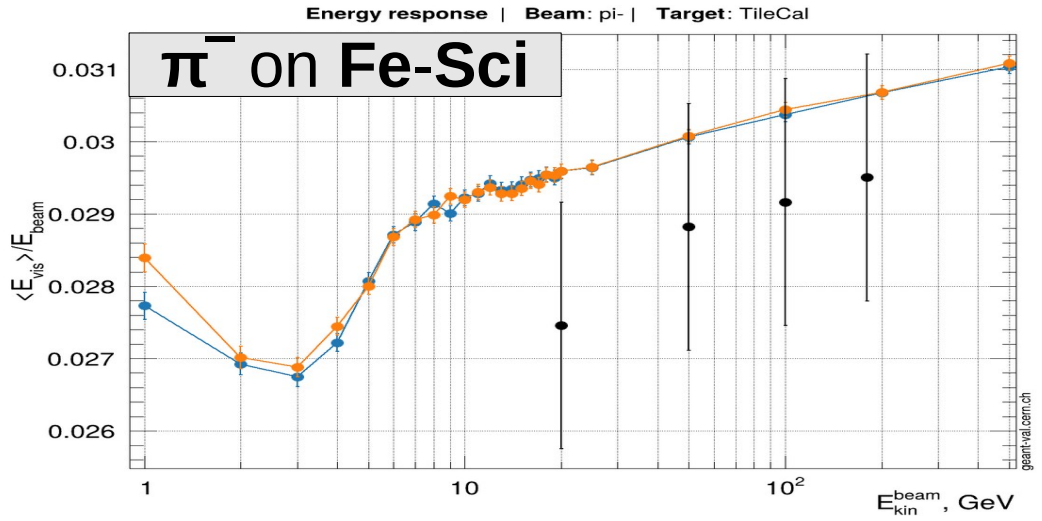
- OK in all cases

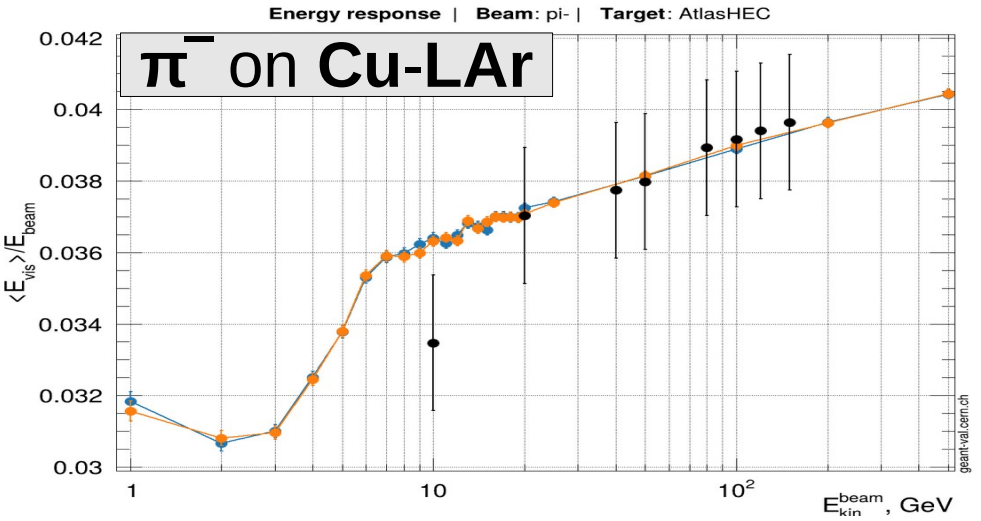
Pion- showers: FTFP_BERT

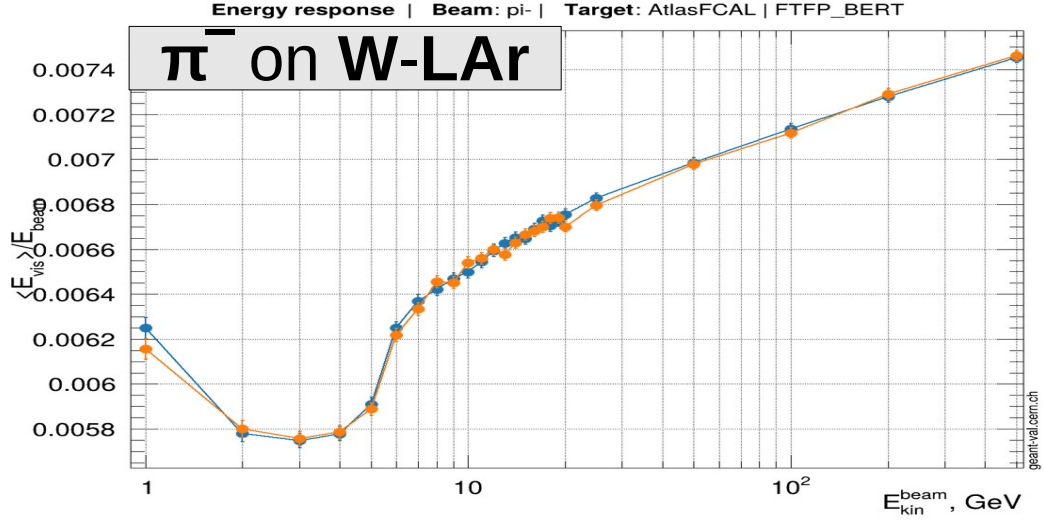
G4 11.3.ref00
G4 11.3.ref01

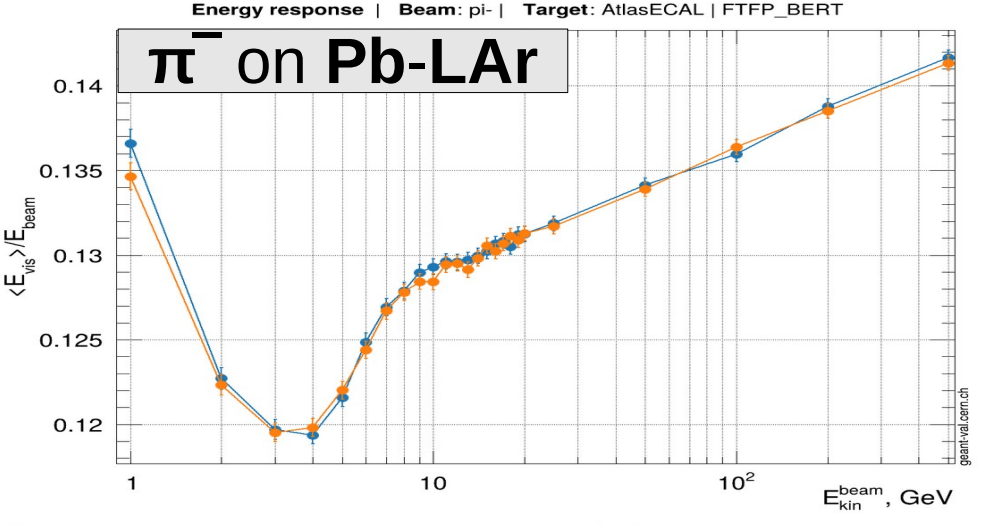
Note : conventional Birks treatment
(easier and no experimental h/e to fit !)

FTFP_BERT : Energy Response

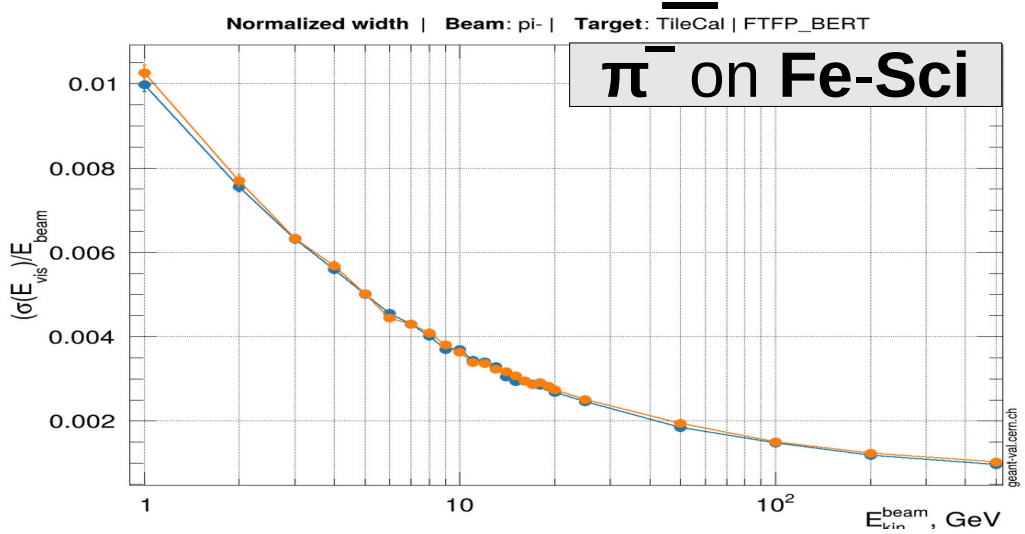


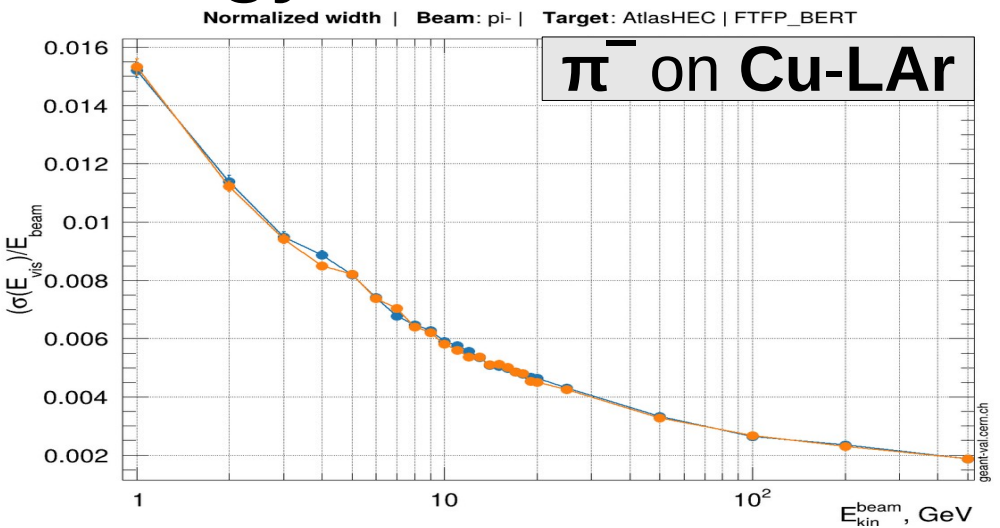


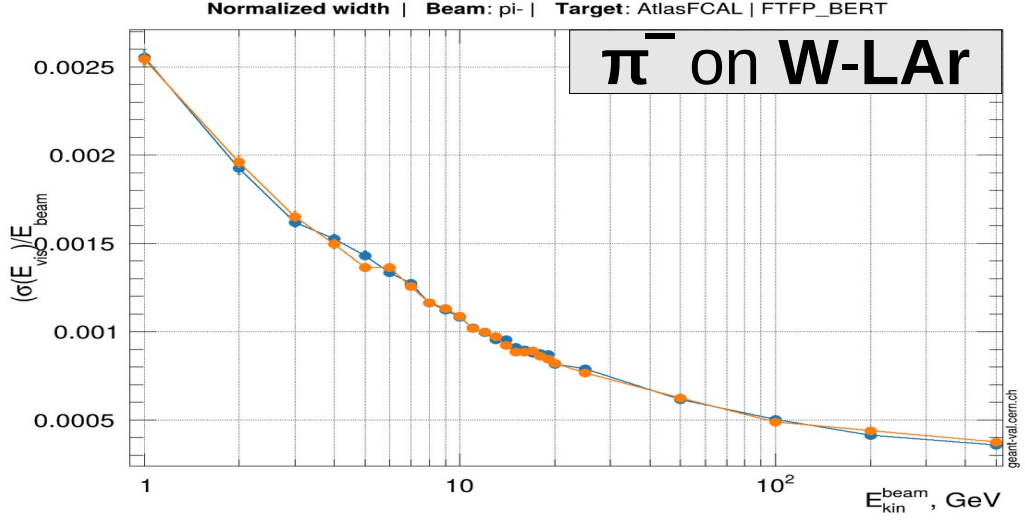


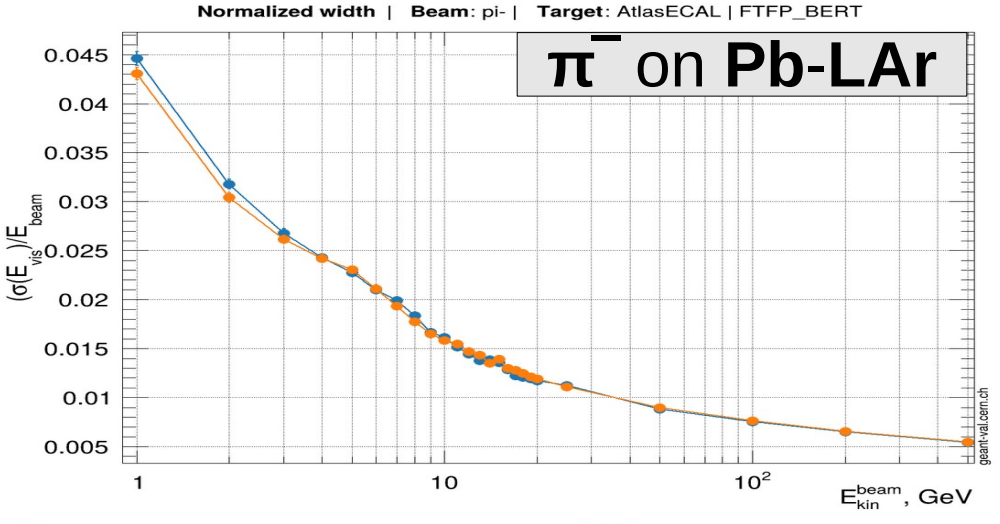


FTFP_BERT : Energy Width

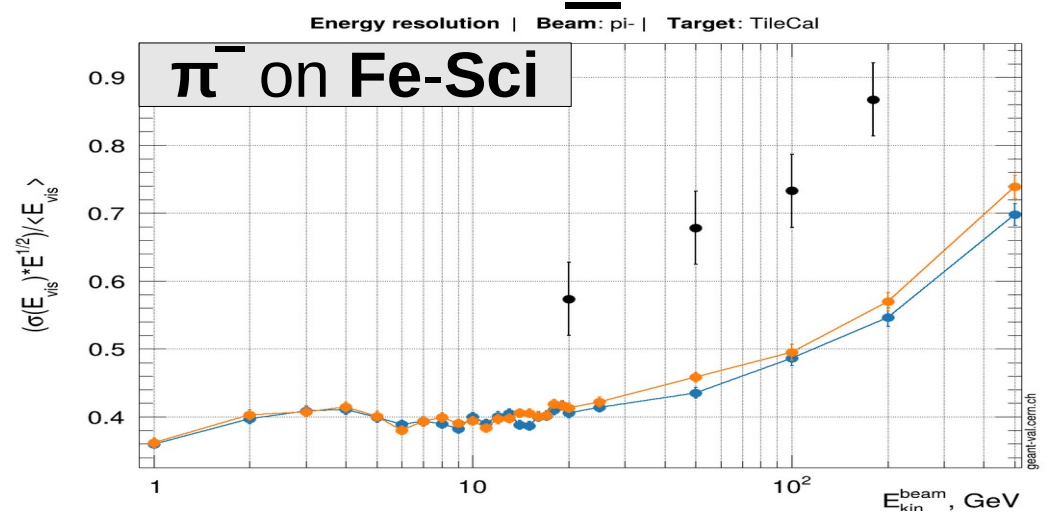


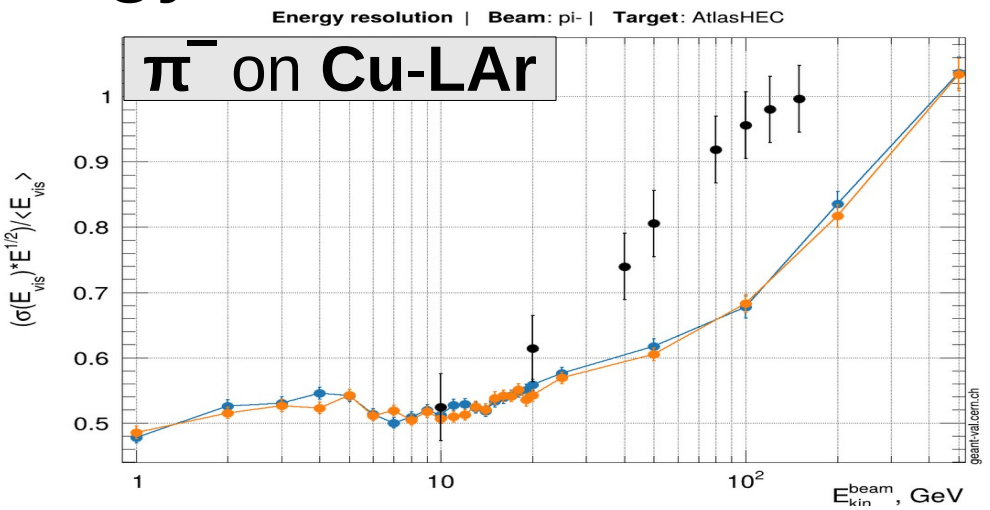


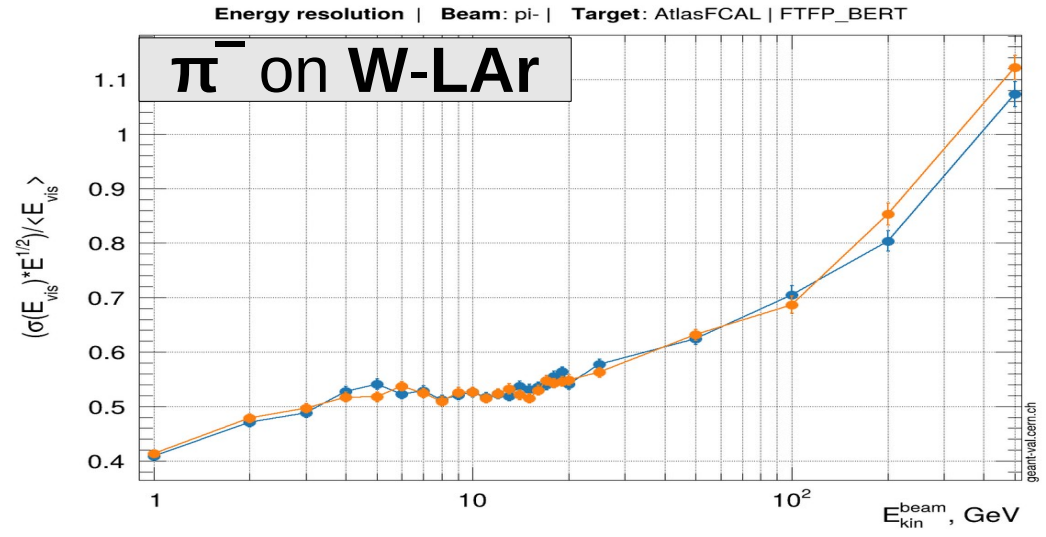


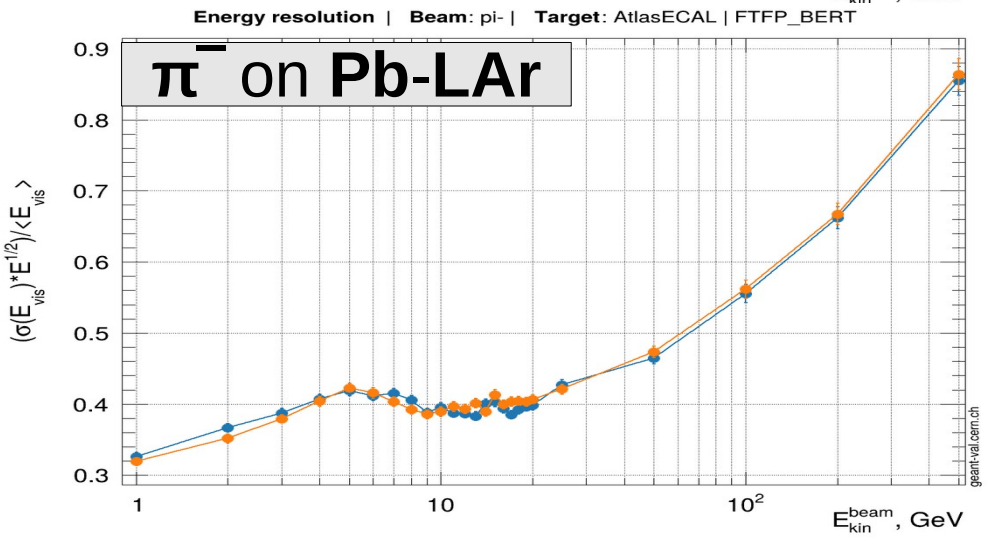


FTFP_BERT : Energy Resolution

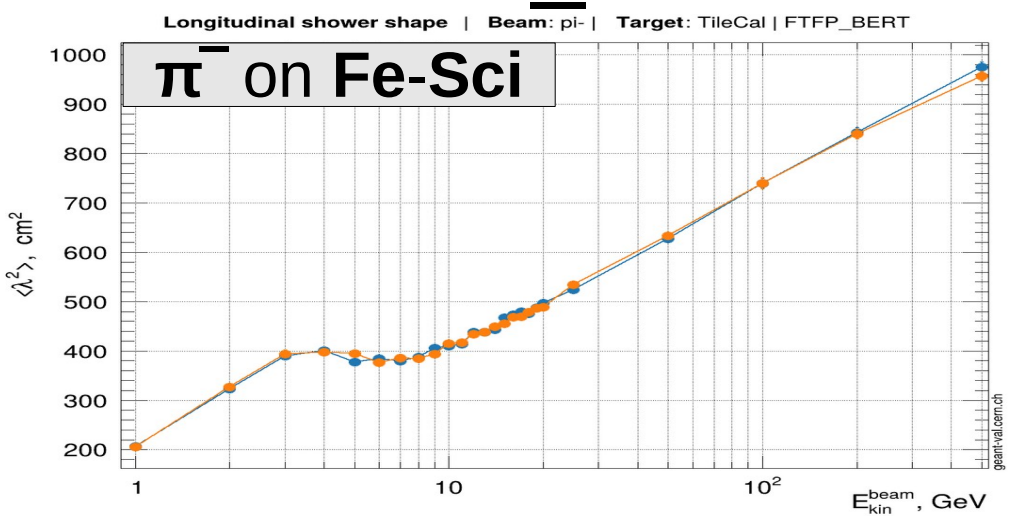


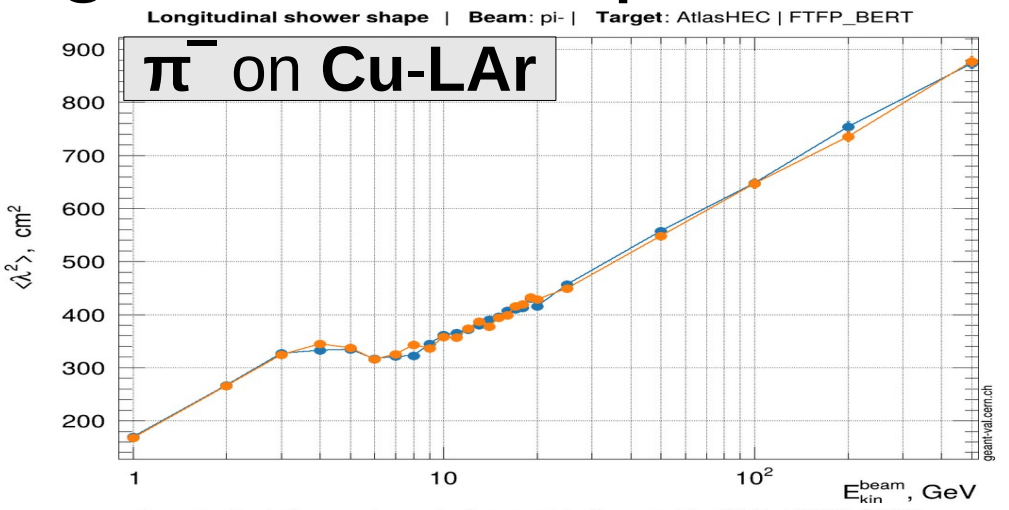


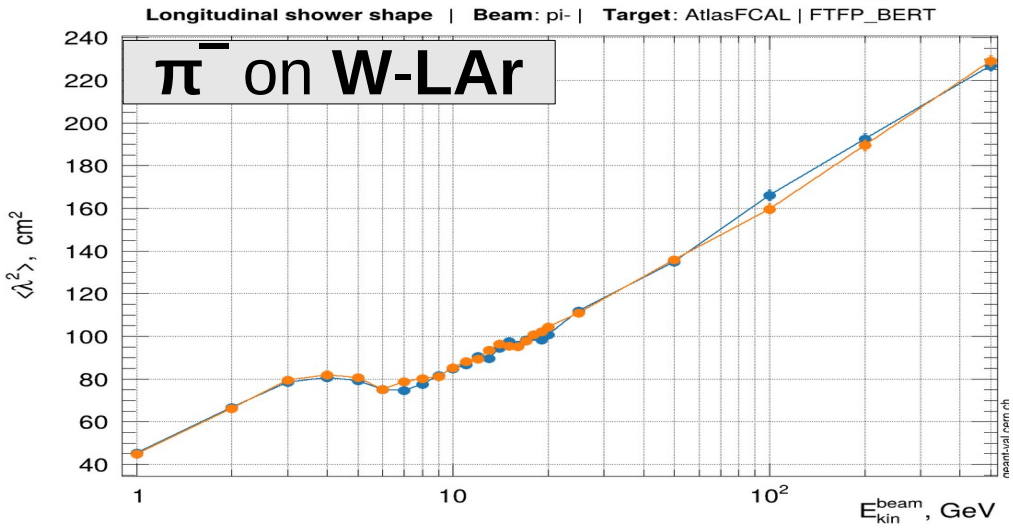


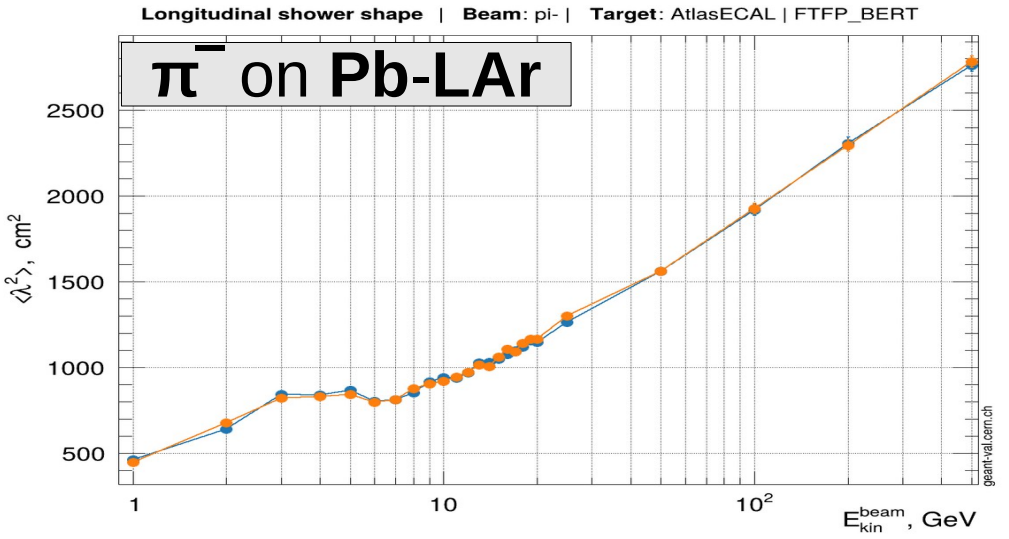


FTFP_BERT : Longitudinal Shape

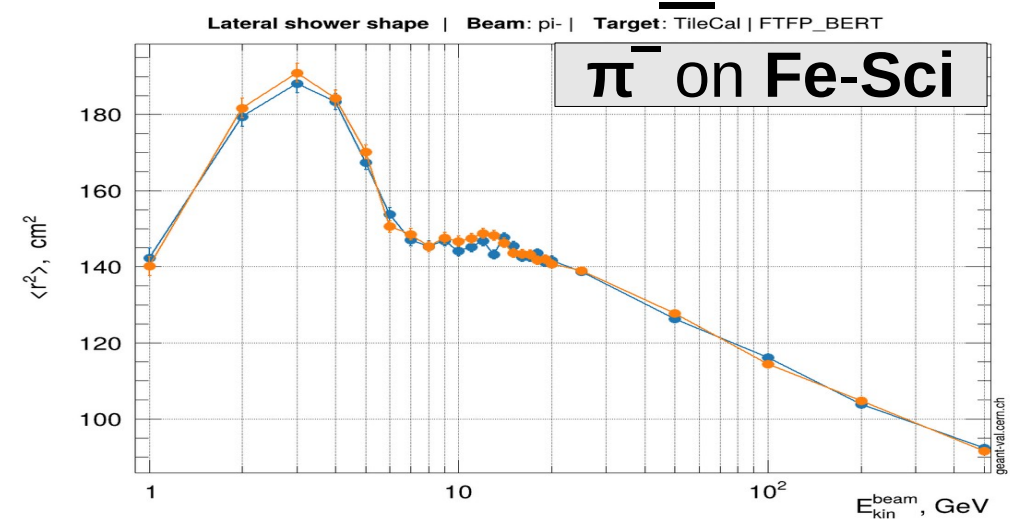


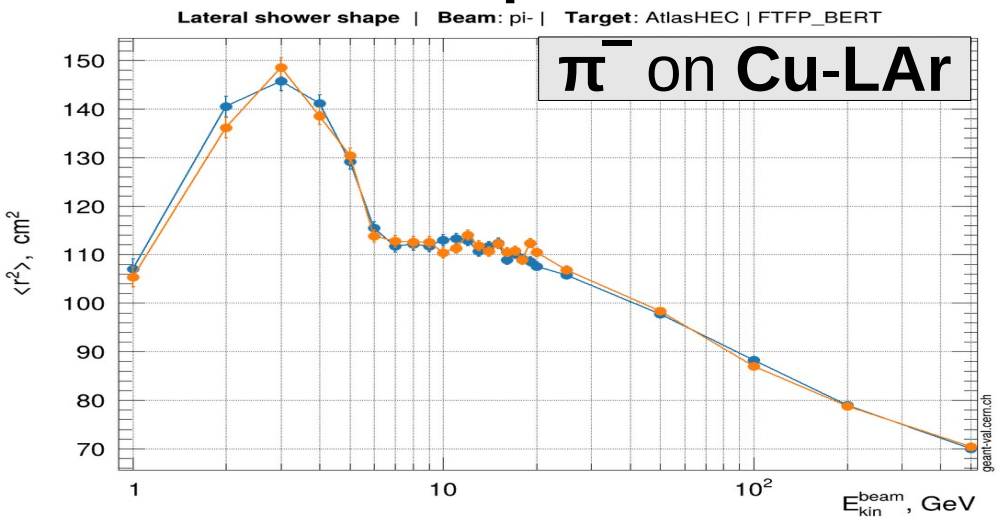


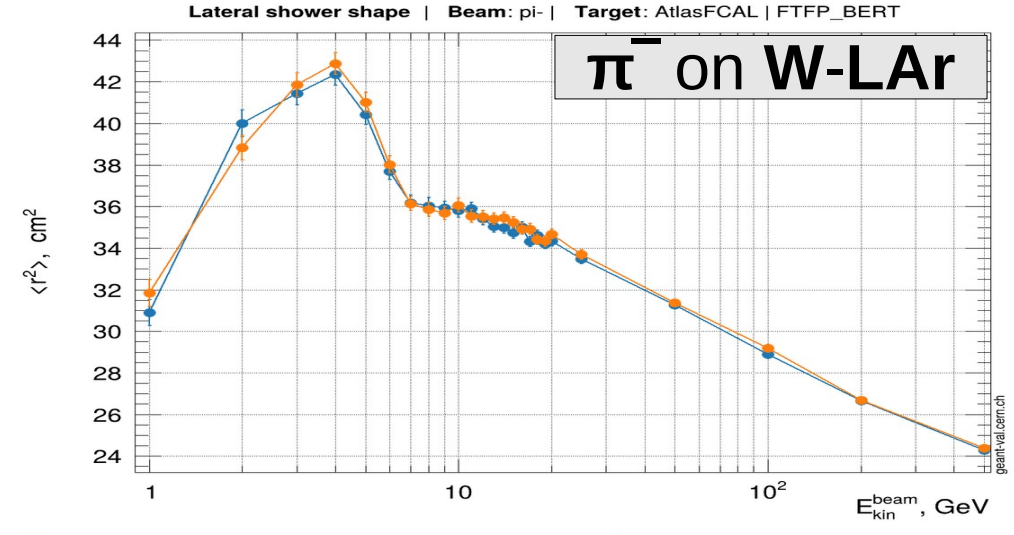


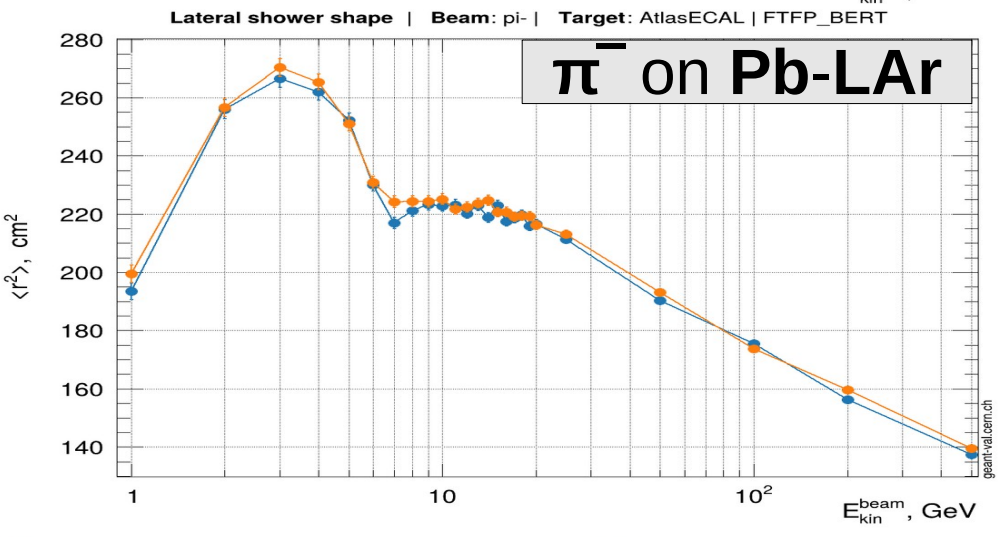


FTFP_BERT : Lateral Shape







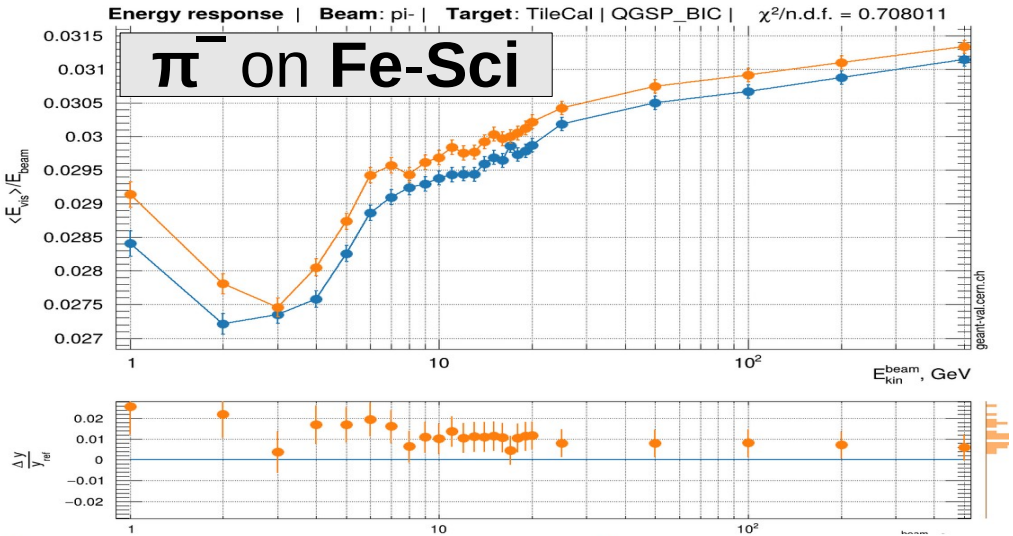


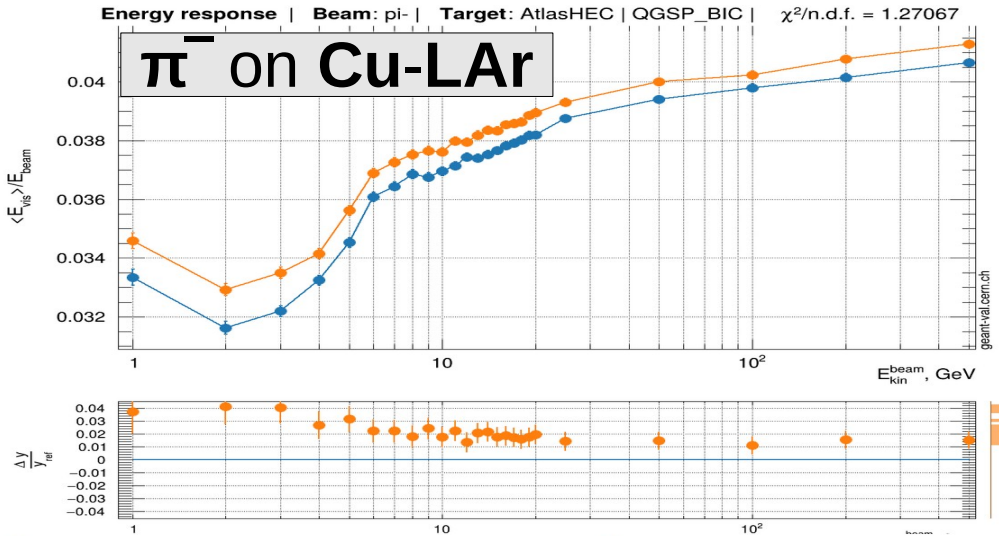
Pion- showers: QGSP_BIC

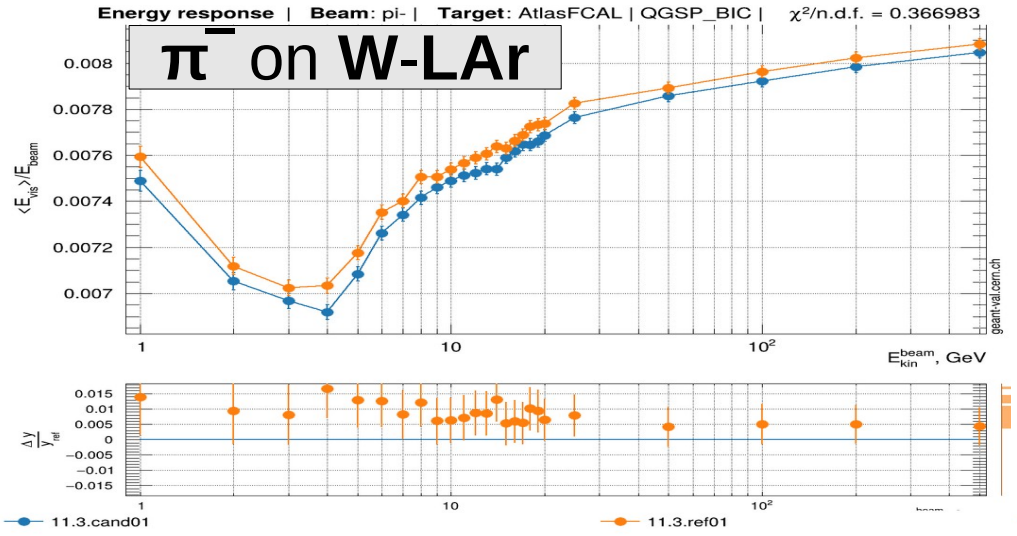
G4 11.3.ref00
G4 11.3.ref01

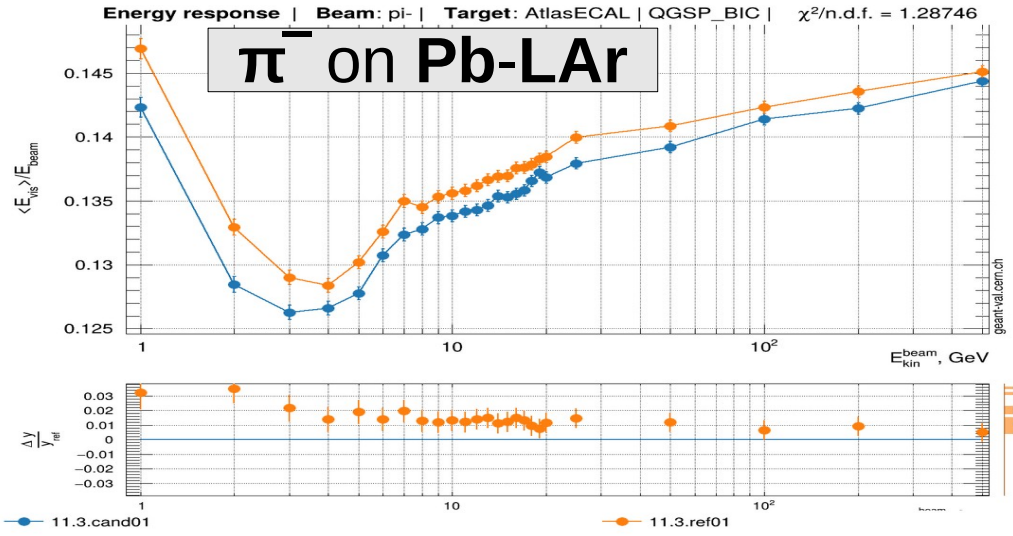
Note : conventional Birks treatment
(easier and no experimental h/e to fit !)

Energy Response

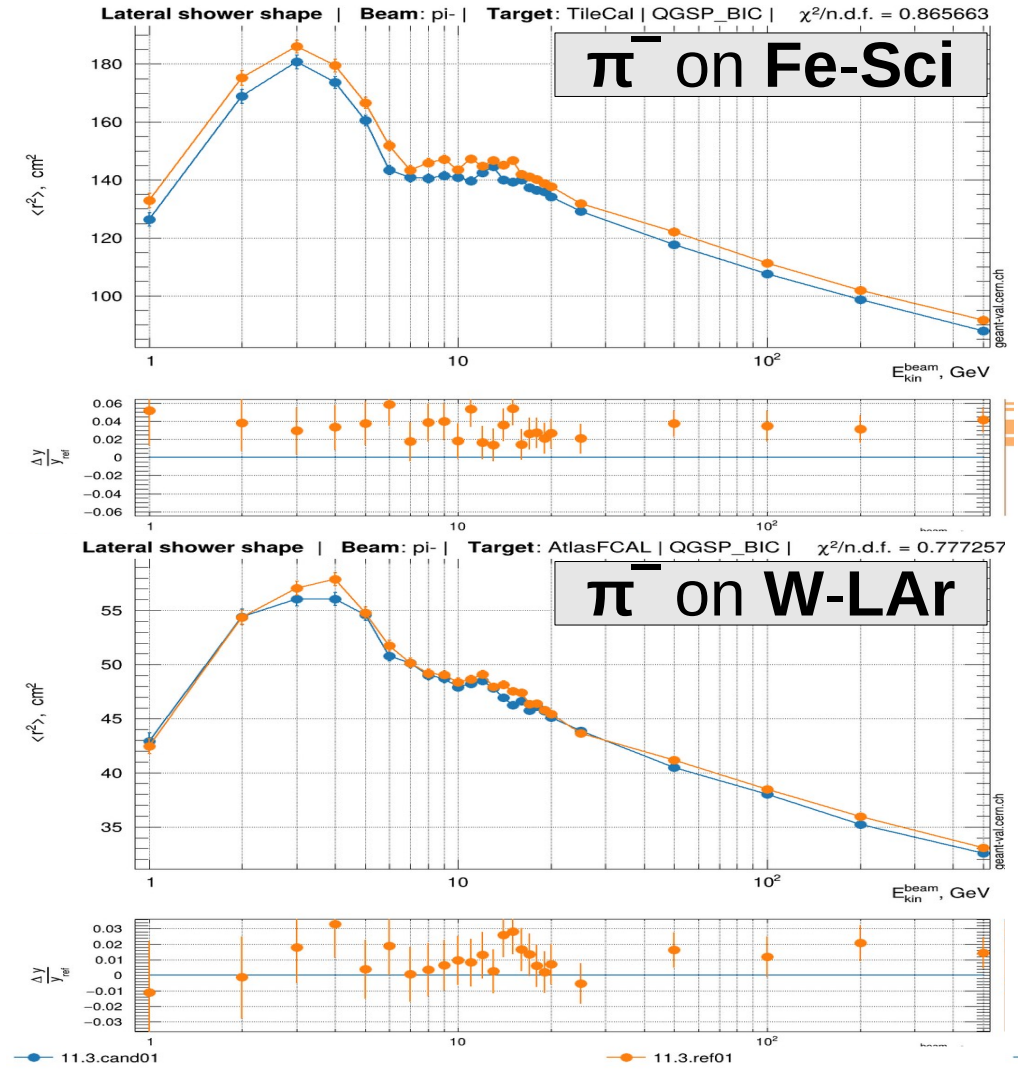


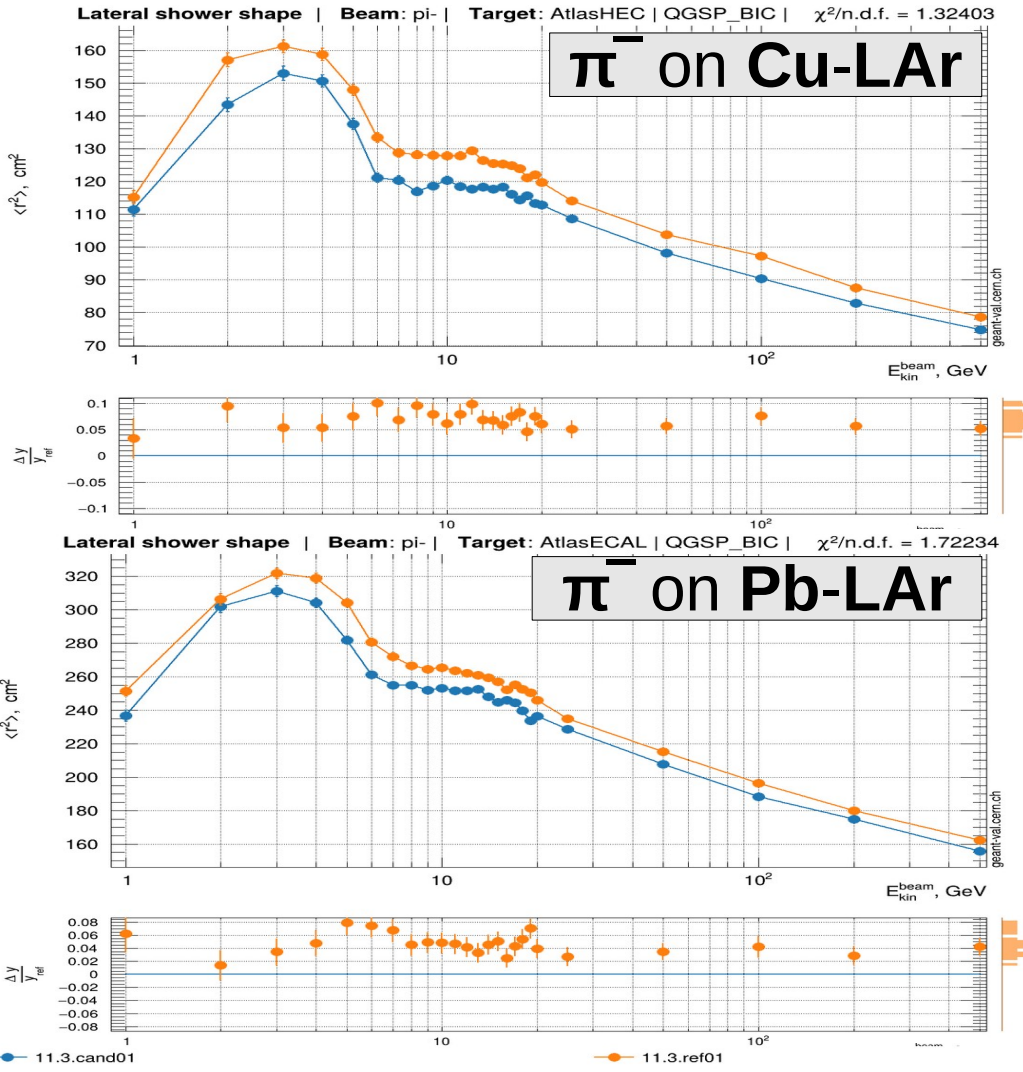






Lateral Shape



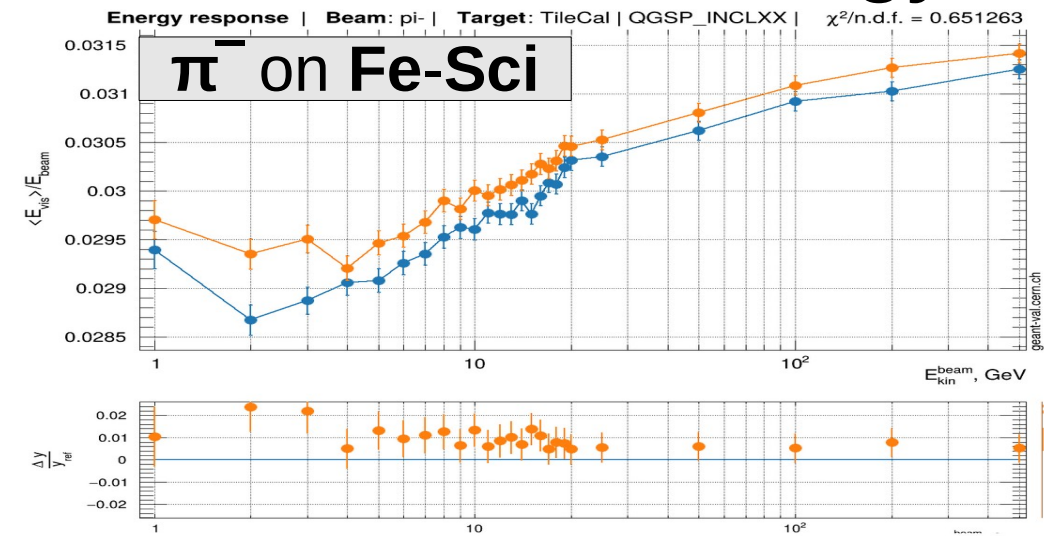


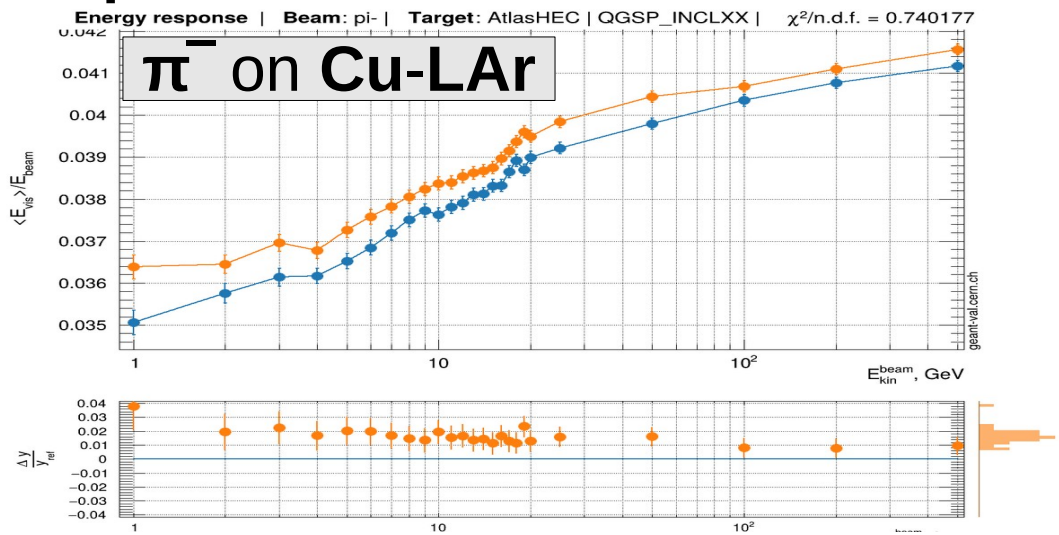
Pion- showers: QGSP_INCLXX

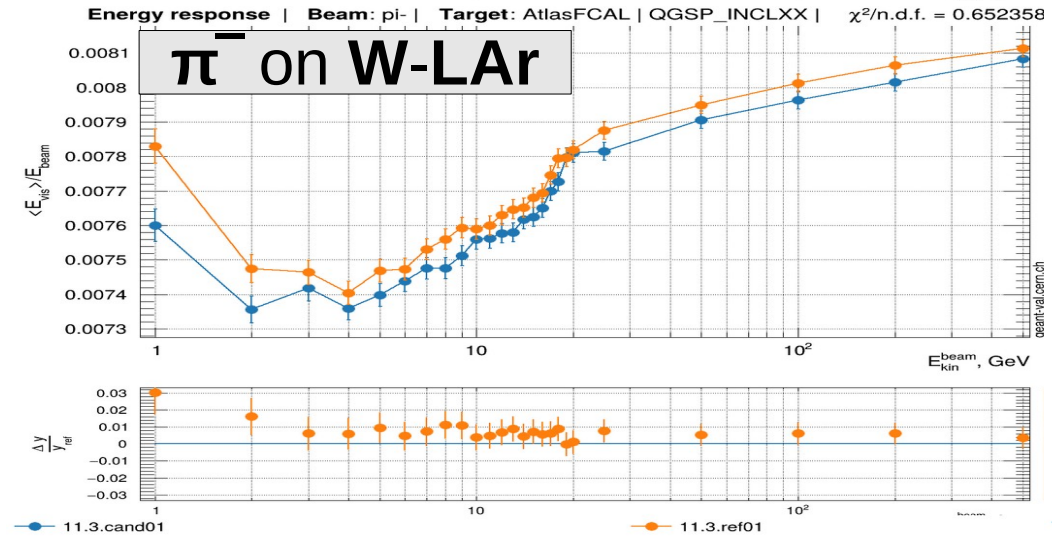
G4 11.3.ref00
G4 11.3.ref01

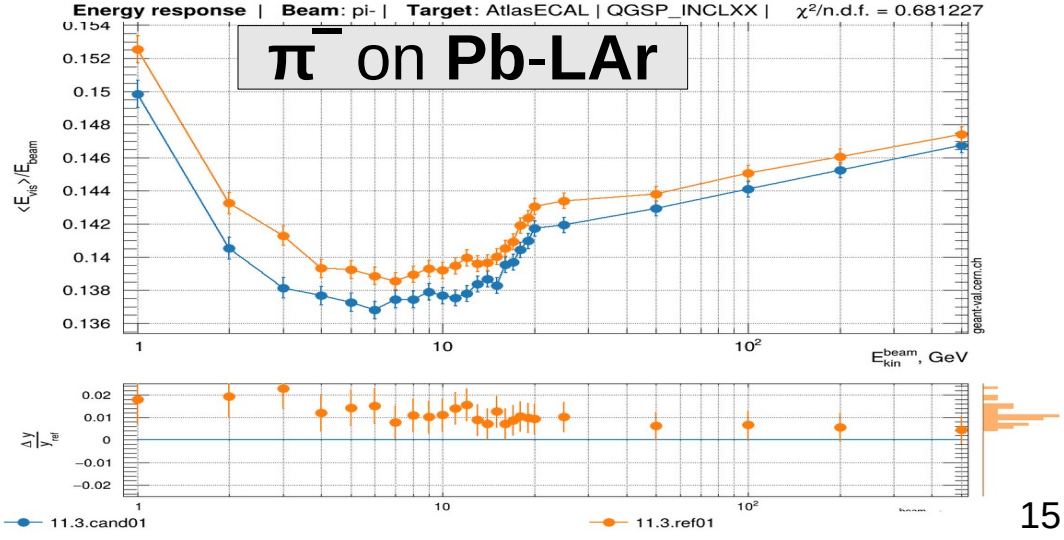
Note : conventional Birks treatment
(easier and no experimental h/e to fit !)

Energy Response

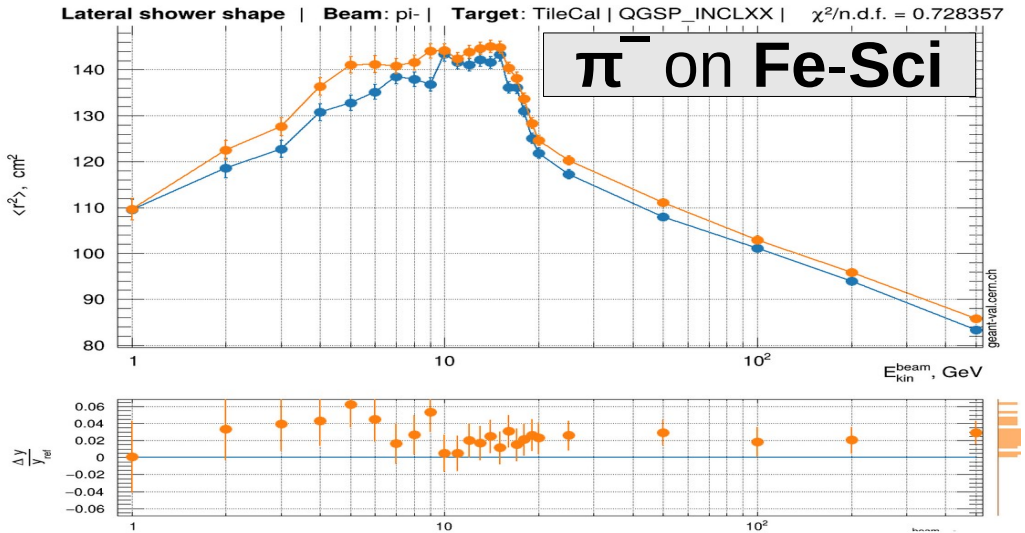


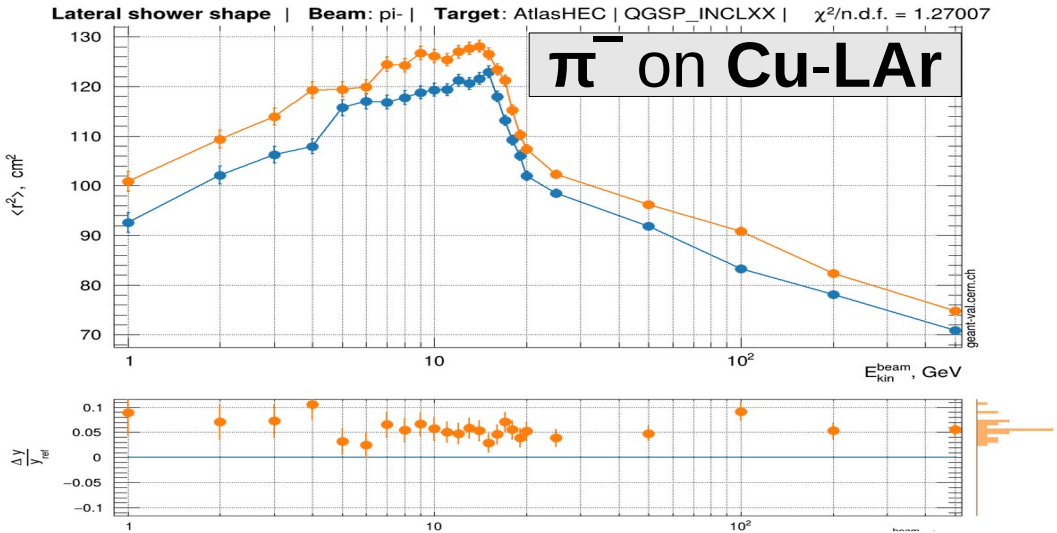


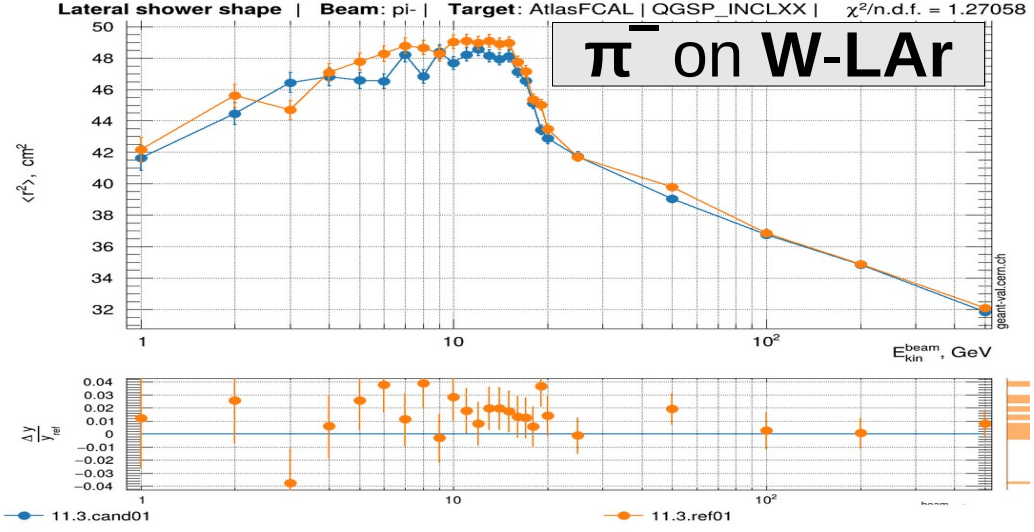


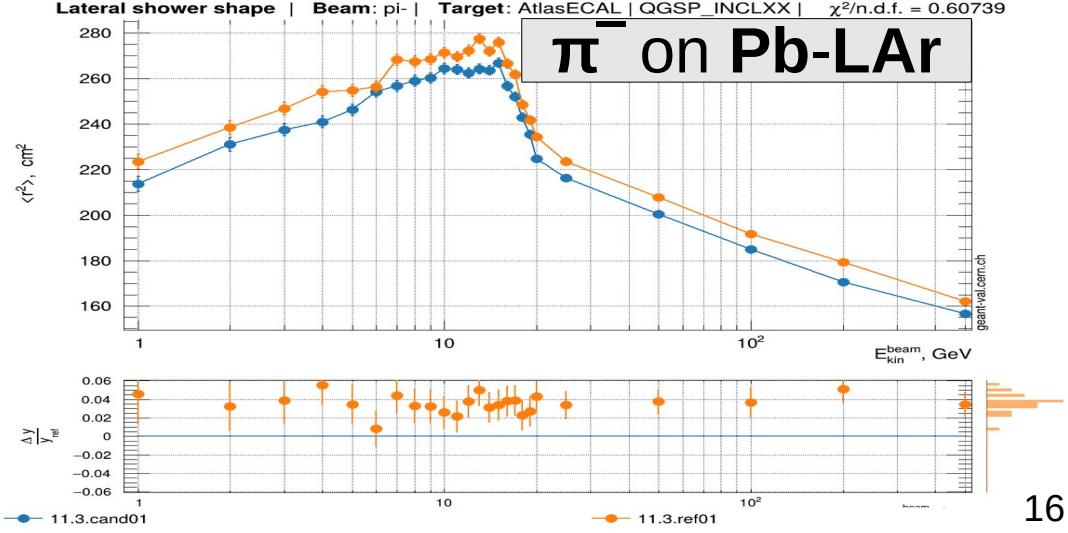


Lateral Shape









Conclusions

- **G4 11.3.ref01**
  - No crashes, no infinite loops, no new warnings
  - Reproducibility is fine in all cases
  - Hadron showers:
    - For nearly all reference physics lists, the hadronic showers of Ref01 are similar to those of Ref00
    - There are only 2 exceptions: **QGSP_BIC** and **QGSP_INCLXX**, for which
      * the **energy response increases by few %**
      * the **lateral shower shapes get wider by few %**

      in Ref01 with respect to Ref00
      - It is very likely due to the changes in **nuclear de-excitation**
        (because only these two reference physics list utilise the Geant4 nuclear de-excitation, whereas the others use the internal Bertini's nuclear de-excitation, which is stable)