Hadronic Showers in Geant4 10.6.**ref09**

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Main Changes in Hadronics *vs.* 10.6.ref08

- Changes only in the FTF string model
  - Bug-fix in quasi-elastic to avoid double counting of elastic on Hydrogen
    - Thanks to NA61/SHINE ! Expected no impact on hadronic showers
  - Extended FTF configuration interface for quark exchange
    - With and without excitation, for baryon and pion projectiles
    - No changes in the random sequence !
  - Improved description of Pt-Xf correlations in 158 GeV/c pp NA49 data
    - **String formation** : implemented new splitting of excited hadrons into quark-antiquark or quark-diquark (in the method G4DiffractiveExcitation::CreateStrings)
    - **String fragmentation** (G4LundStringFragmentation) : introduced a new parameter, a kind of "temperature" for sampling the Pt of produced hadrons; this parameter has been tuned for different fragmentation processes. The string direction (one of string's properties, whose value can be either +1 for projectile-like strings or -1 for target-like strings) is now treated correctly and used to invert the results of the string fragmentation (in the string rest frame) when the string direction is -1.

Crashes & Warnings

- No crashes
- No infinite loops
- Neither new warnings nor more frequent known (rare) ones

Reproducibility

- OK all “traditional” tests
- Added a new set of reproducibility tests for the new Tasking mechanism (see next page for more information)
  - All OK
  - Not possible before Ref09 before of crashes in SimplifiedCalo

New: Testing Tasking Reproducibility

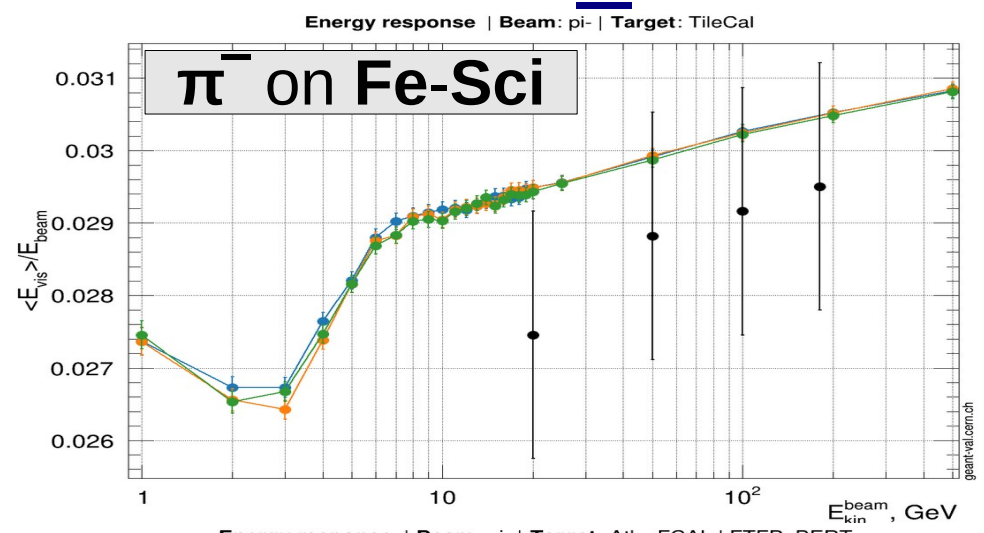
- Testing “weak” and “strong” reproducibility using SimplifiedCalo
  - “Weak” : running twice with the same starting random generator status
  - “Strong” : running a long run, saving the random generator status at the beginning of each event, and checking against short 1-event runs
- Short 1-event run in “Serial” mode; long runs in 4 modes:
  - export **G4FORCE_RUN_MANAGER**=**Serial** | **MT** | **Tasking** | **TBB**
- Notes:
  - “Serial” mode produces the same random sequence as the old sequential
  - “MT” mode produces the same random sequence as the old multi-threaded (with 2 threads by default)
  - “Tasking” is the default (i.e. when unset G4FORCE_RUN_MANAGER)
  - It is enough to have 1 build of Geant4 with -DGEANT4_USE_TBB=ON

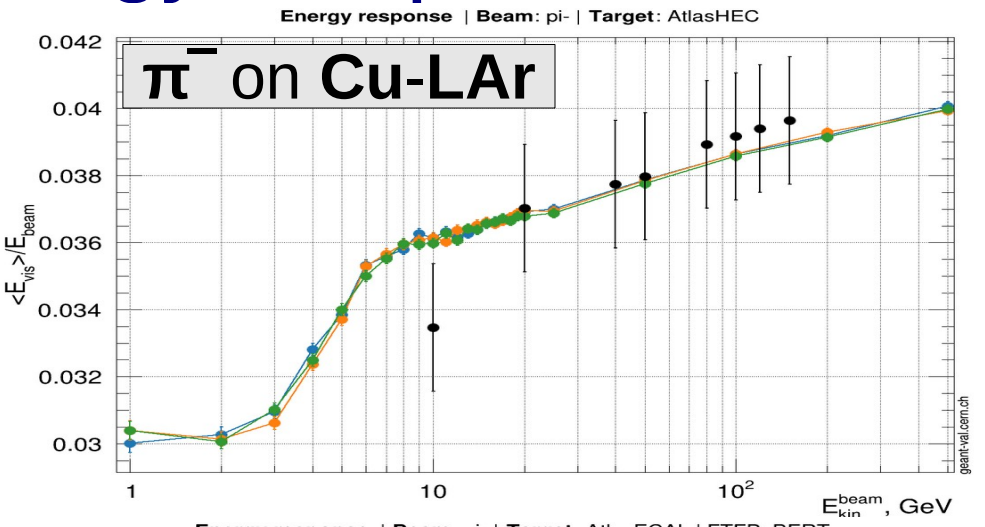
Pion− showers: FTFP_BERT

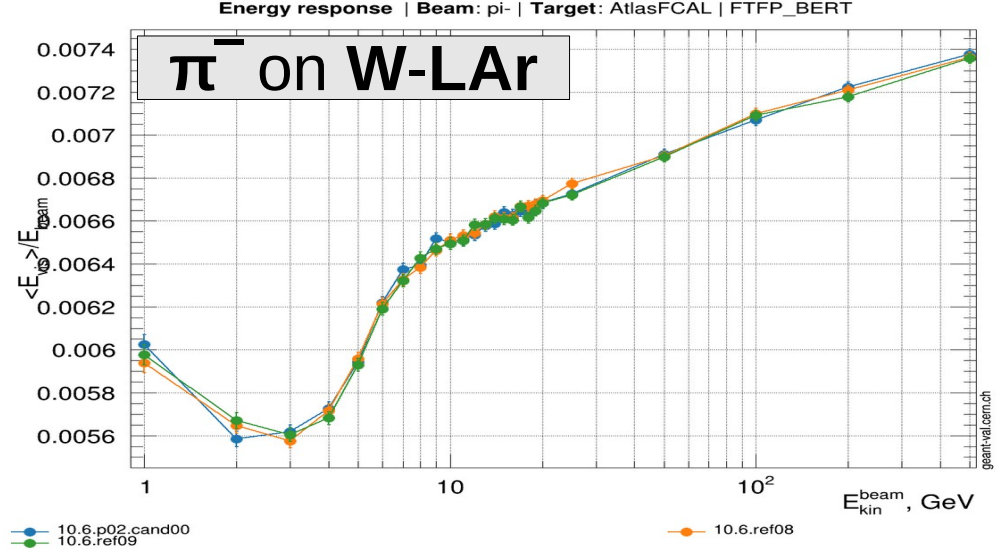
G4 10.6.ref09
G4 10.6.ref08
G4 10.6.p02

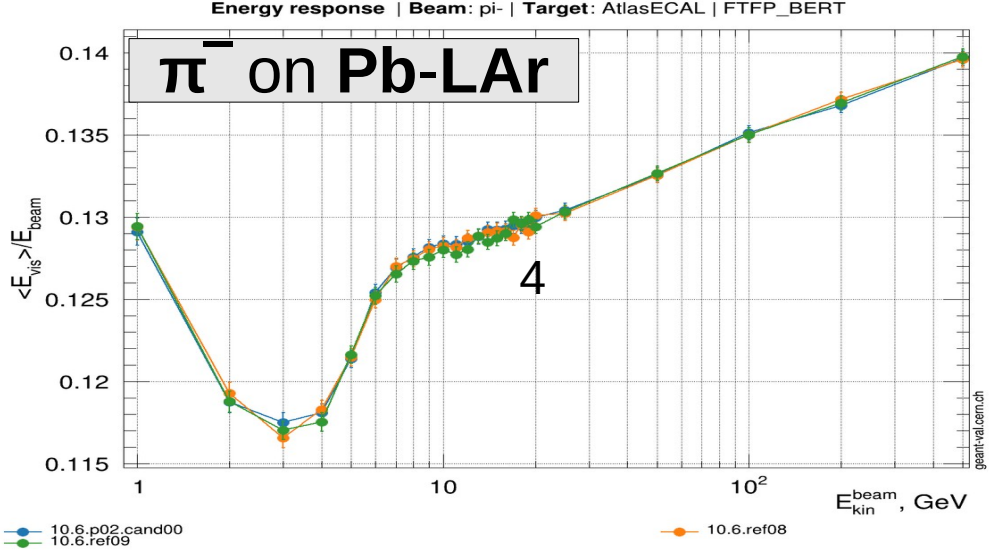
Note : conventional Birks treatment
(easier and no experimental h/e to fit !)

FTFP_BERT : Energy Response

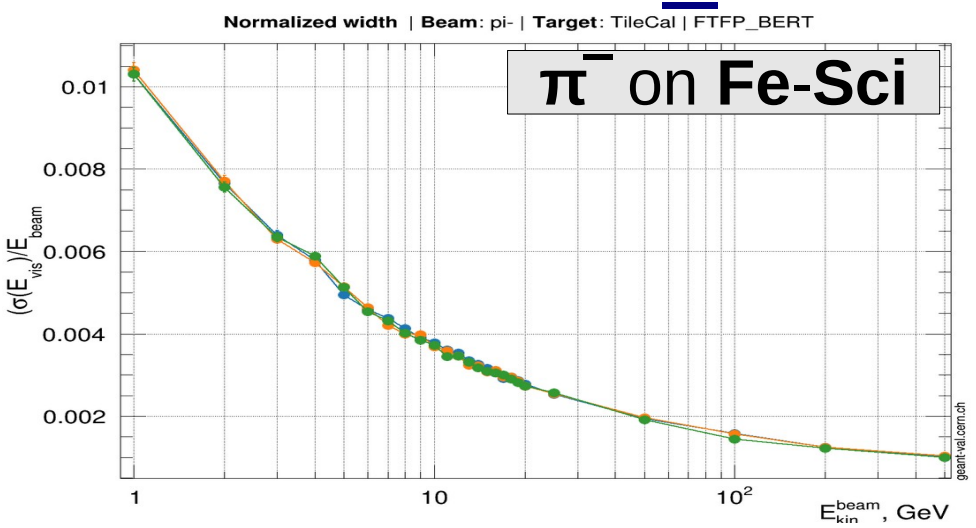


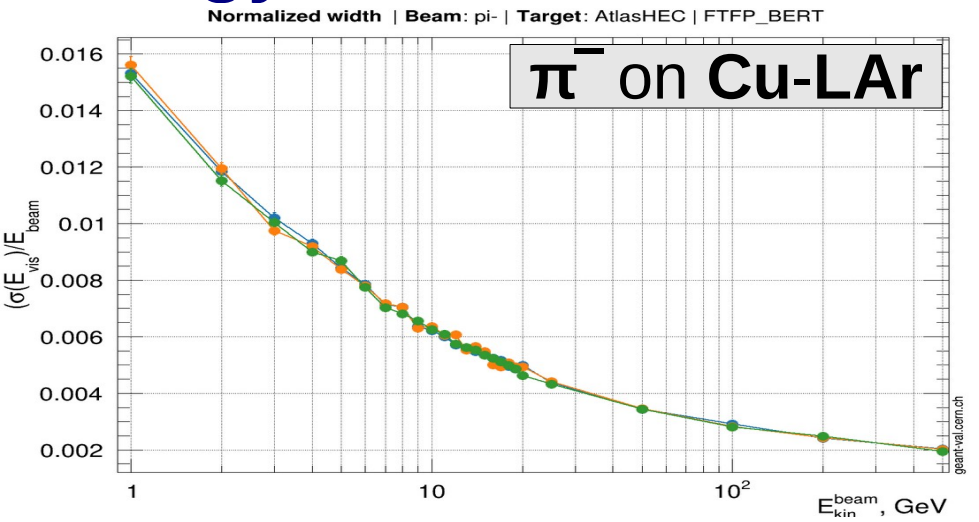


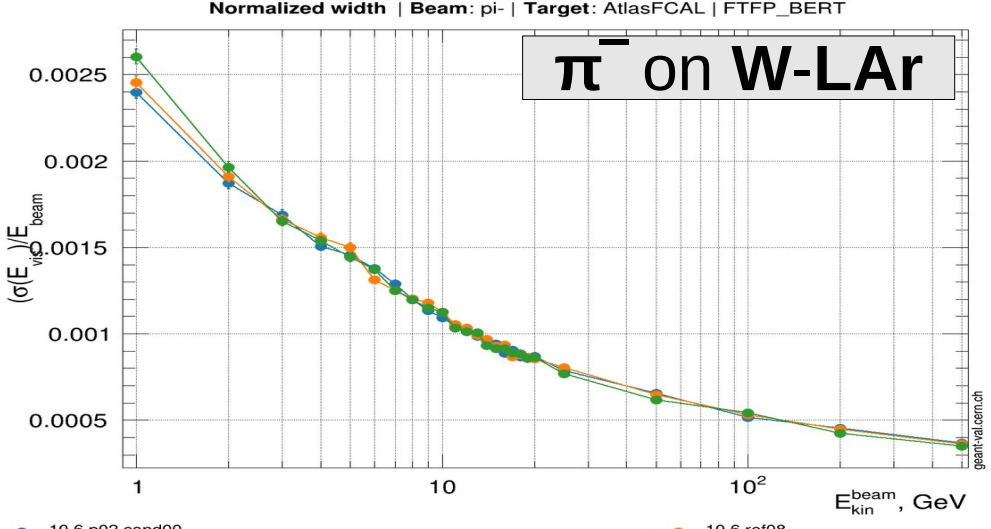


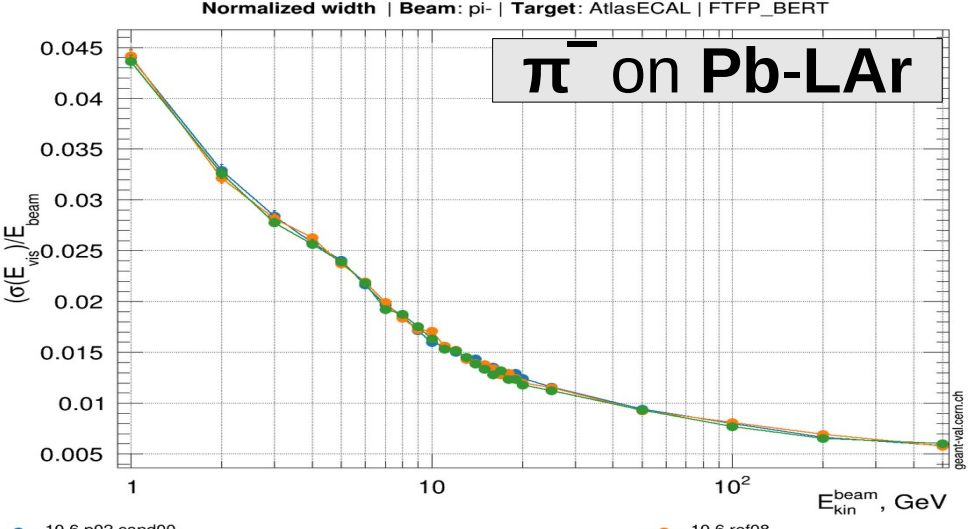


FTFP_BERT : Energy Width

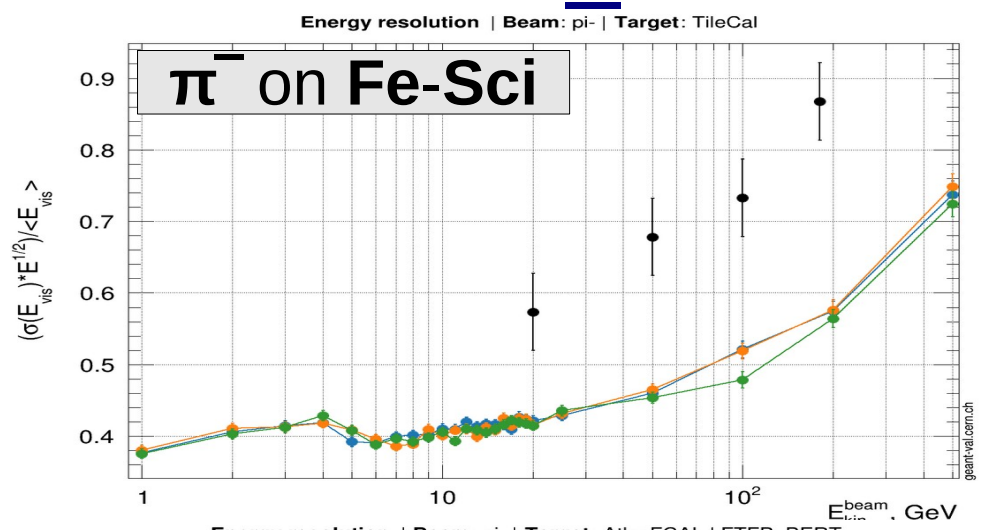


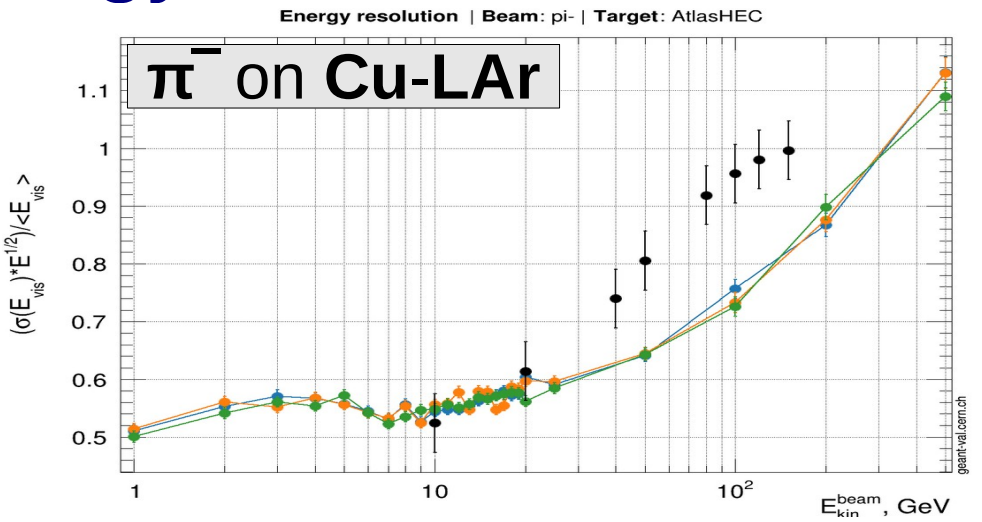


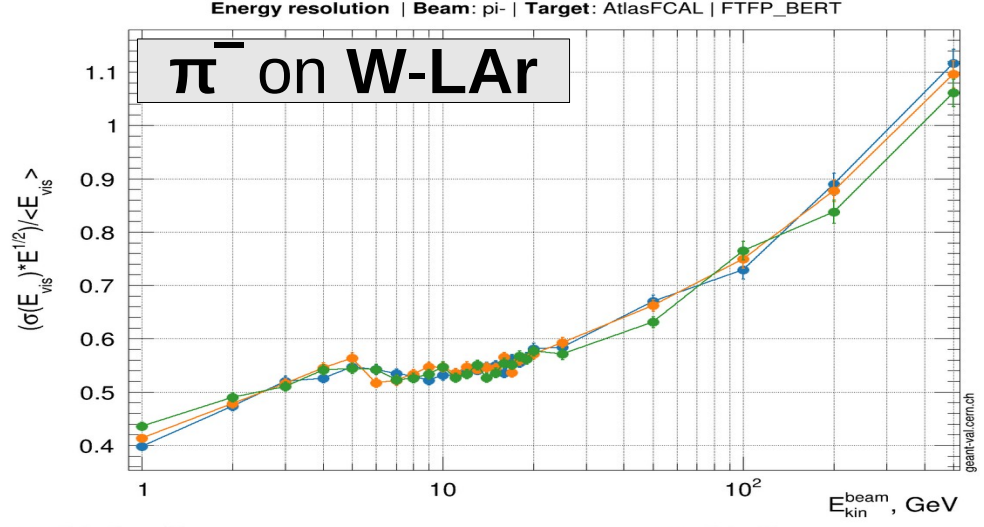


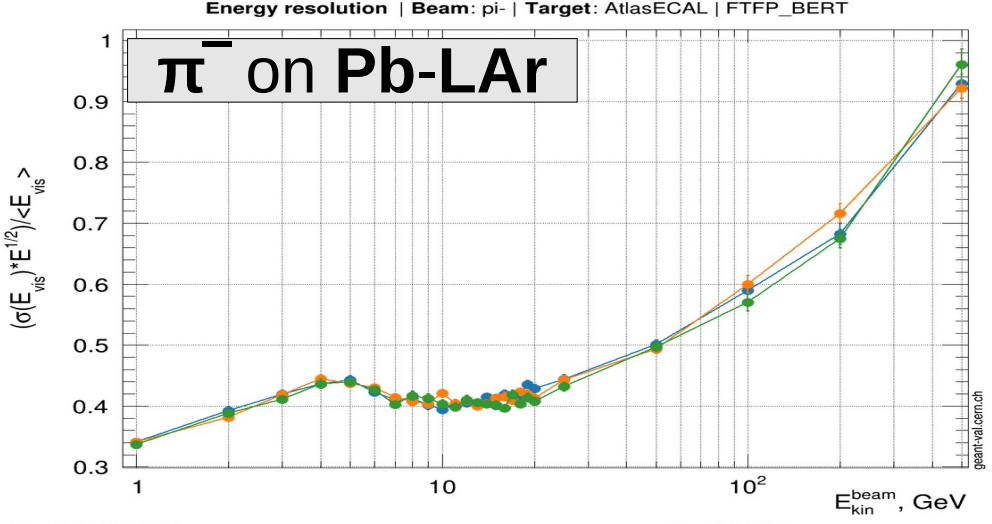


FTFP_BERT : Energy Resolution

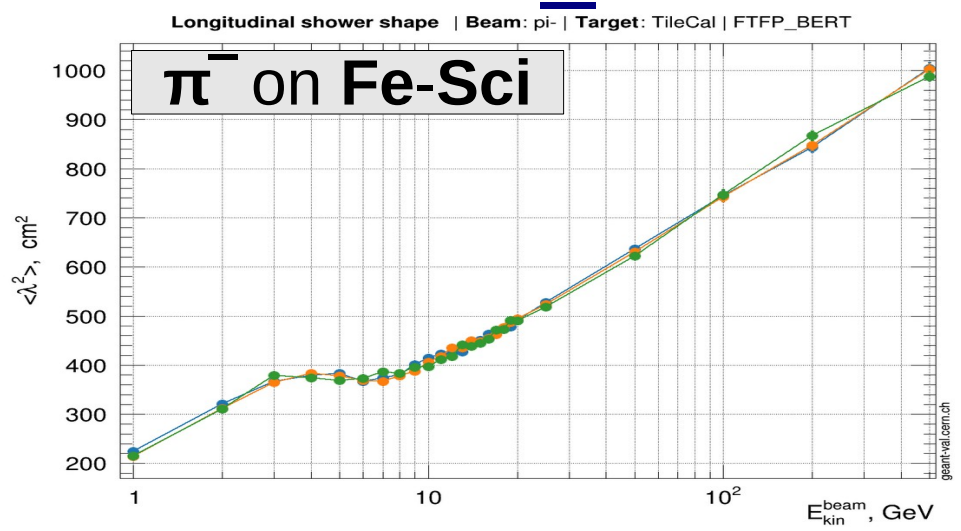


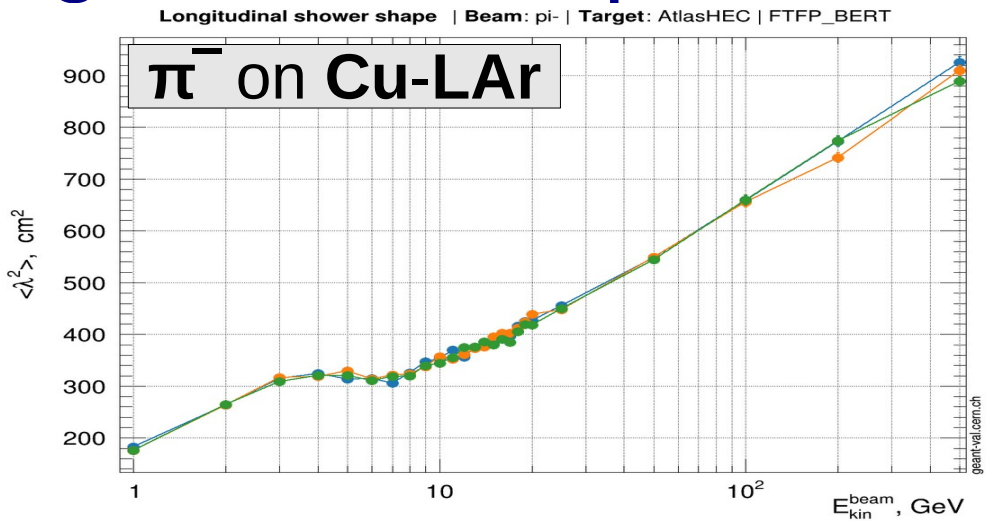


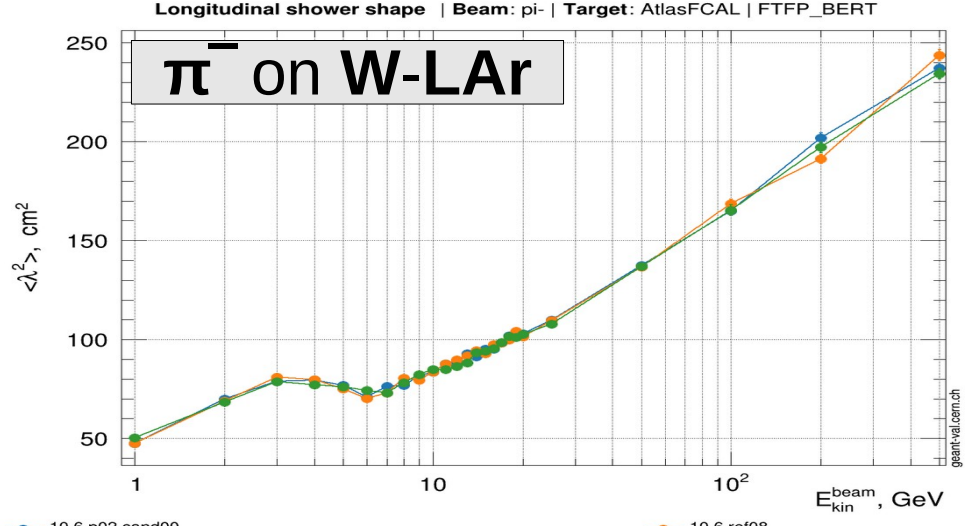


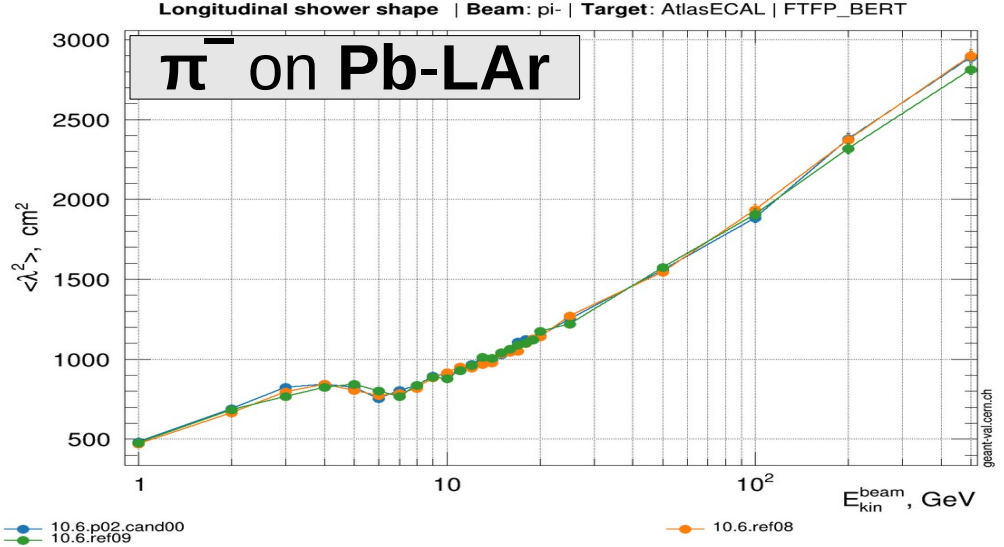


FTFP_BERT : Longitudinal Shape









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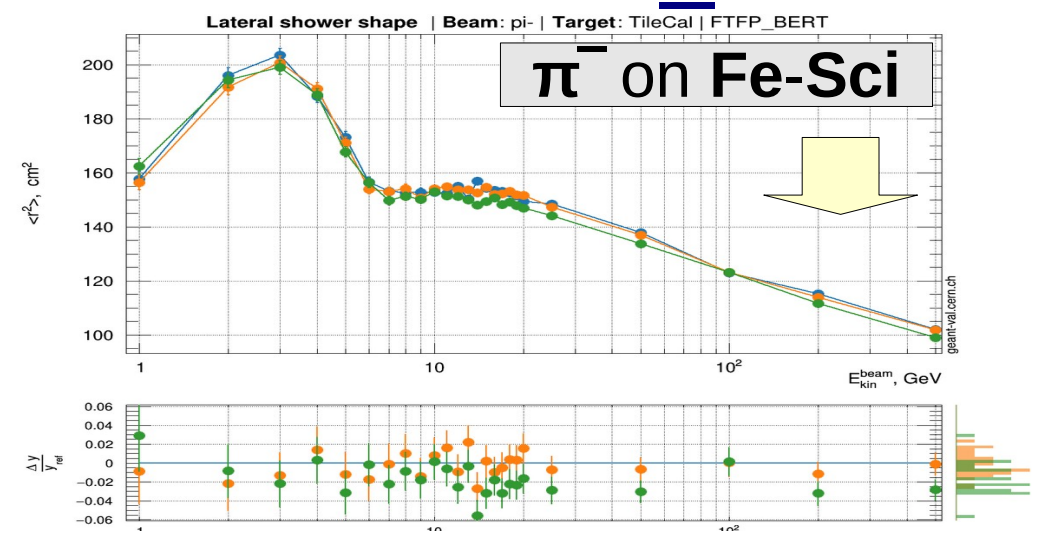
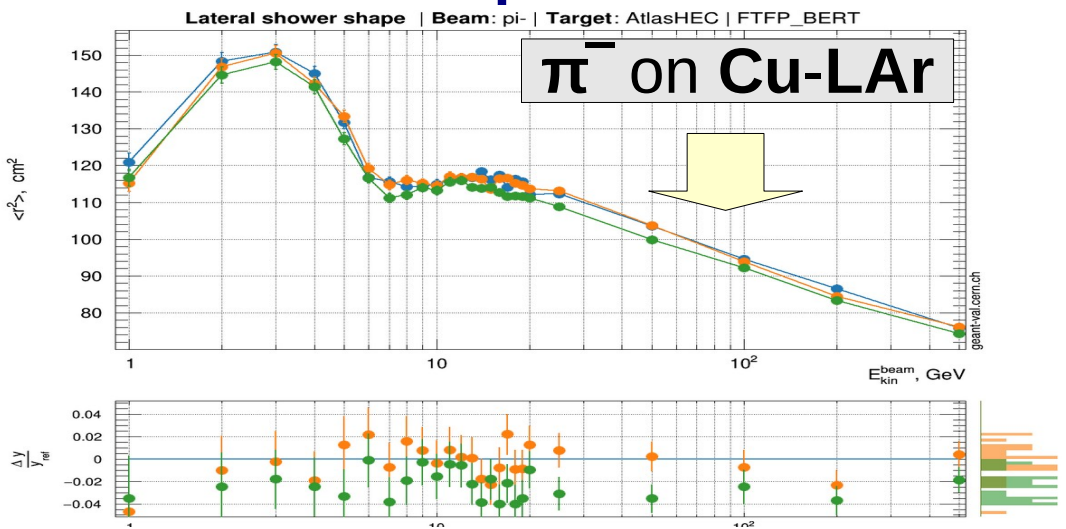
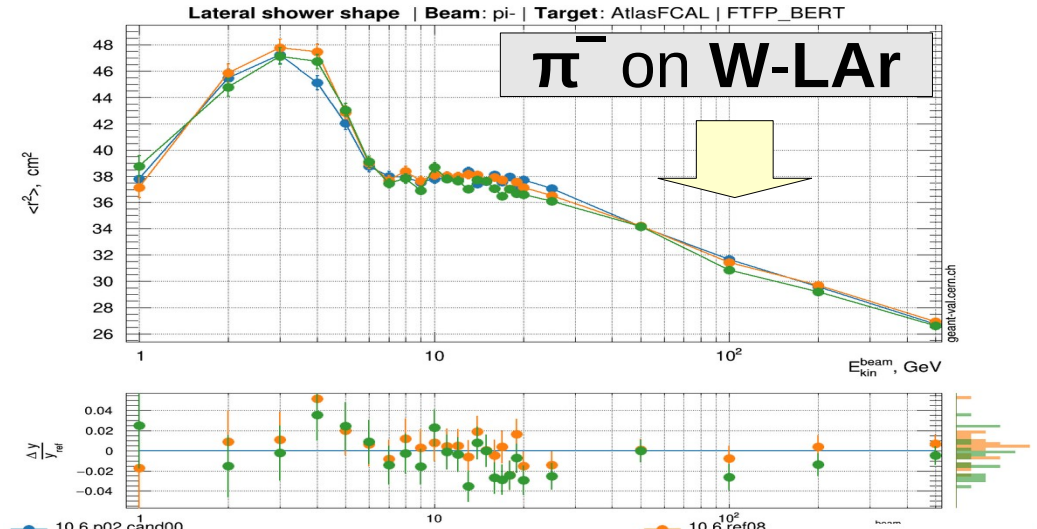
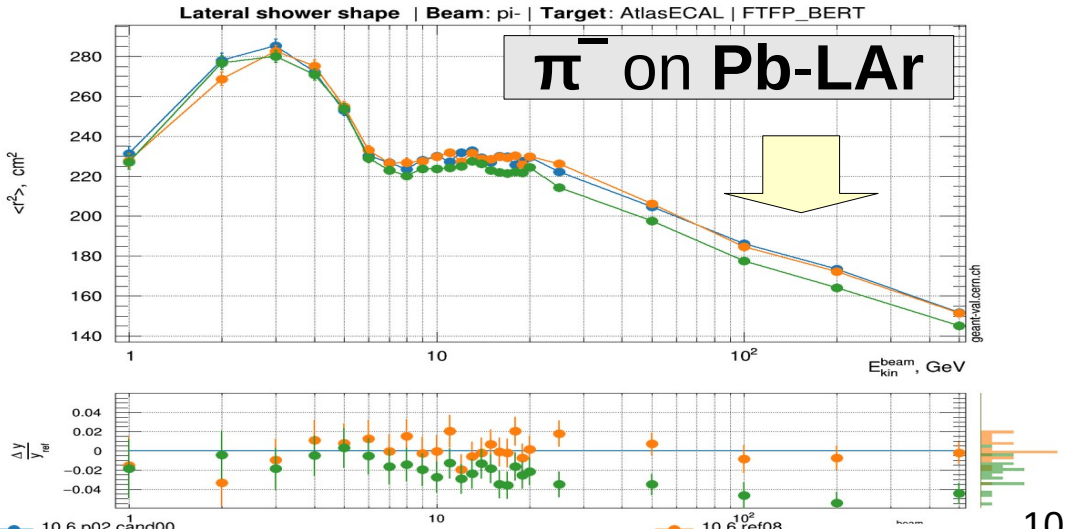






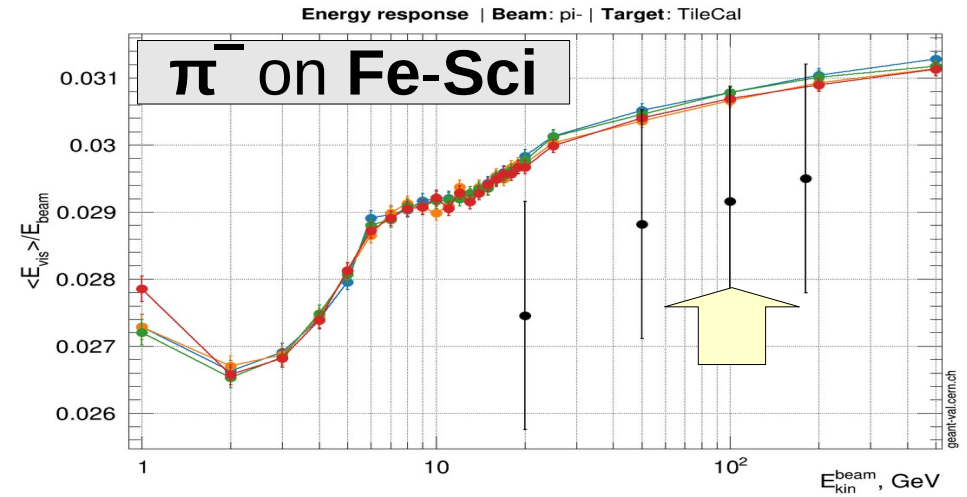


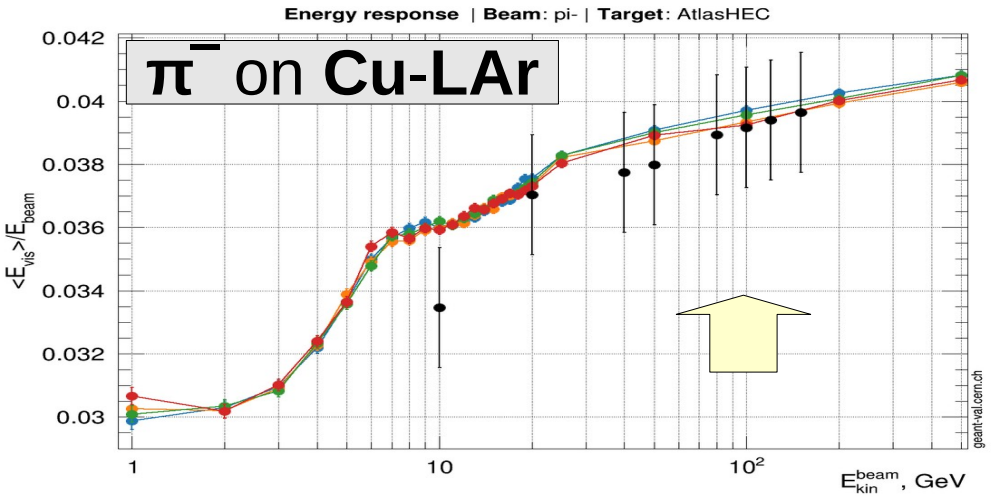
Pion− showers: QGSP_BERT

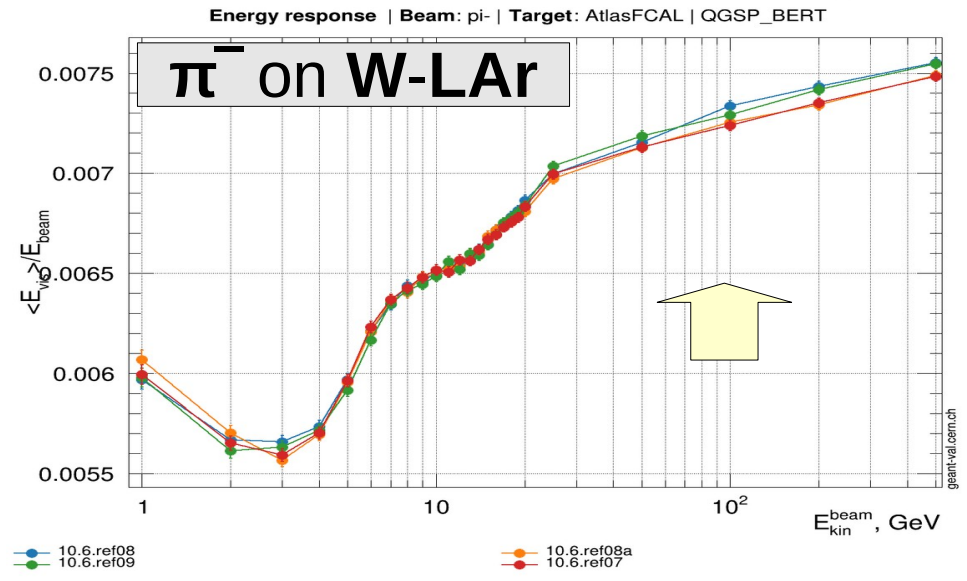
G4 10.6.ref09
G4 10.6.ref08
G4 10.6.ref08a (rolled back QGS hadronization)
G4 10.6.ref07

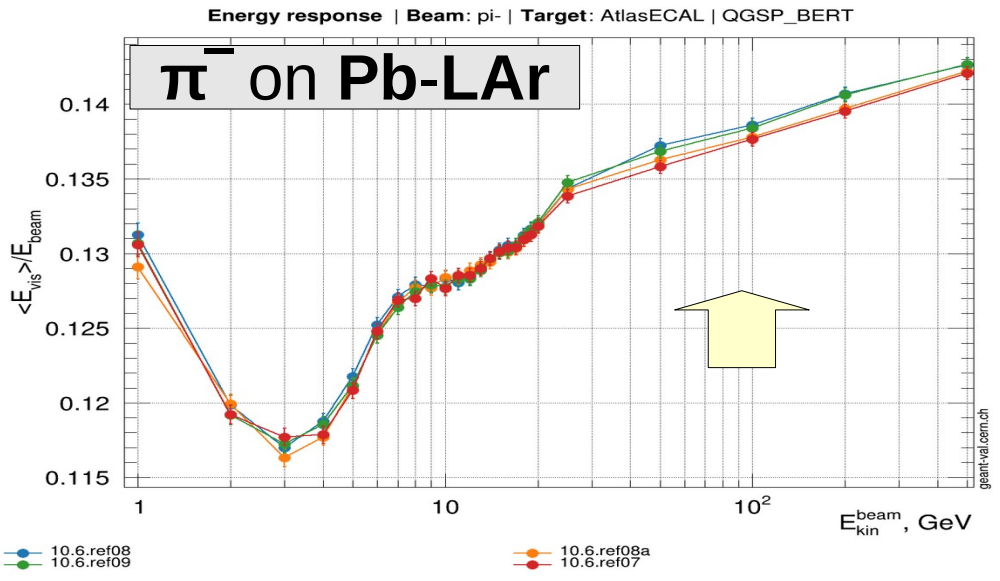
Note : conventional Birks treatment
(easier and no experimental h/e to fit !)

QGSP_BERT : Energy Response

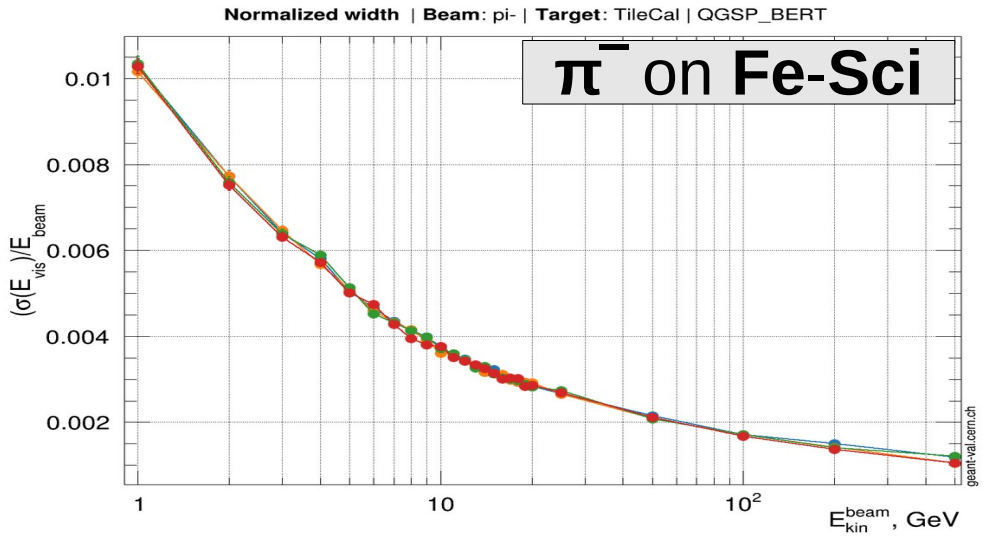


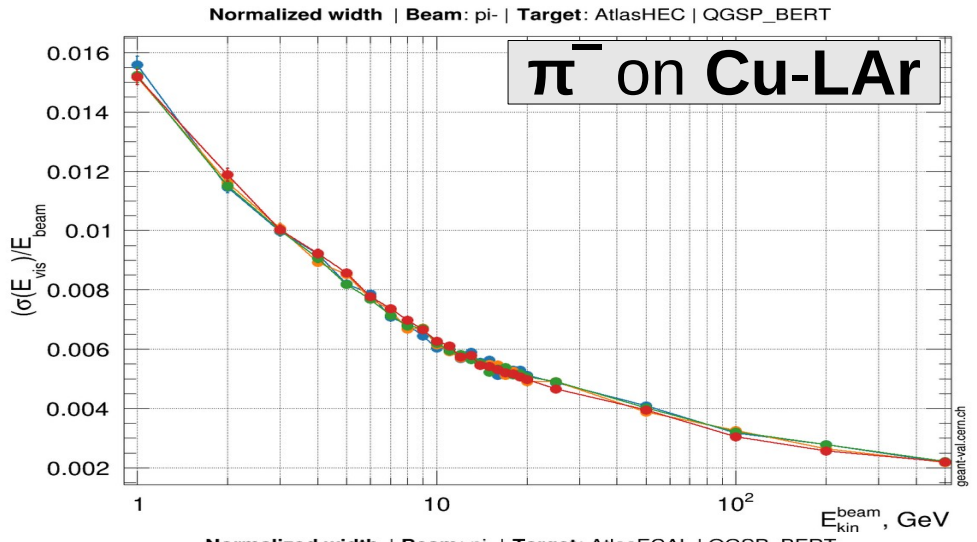


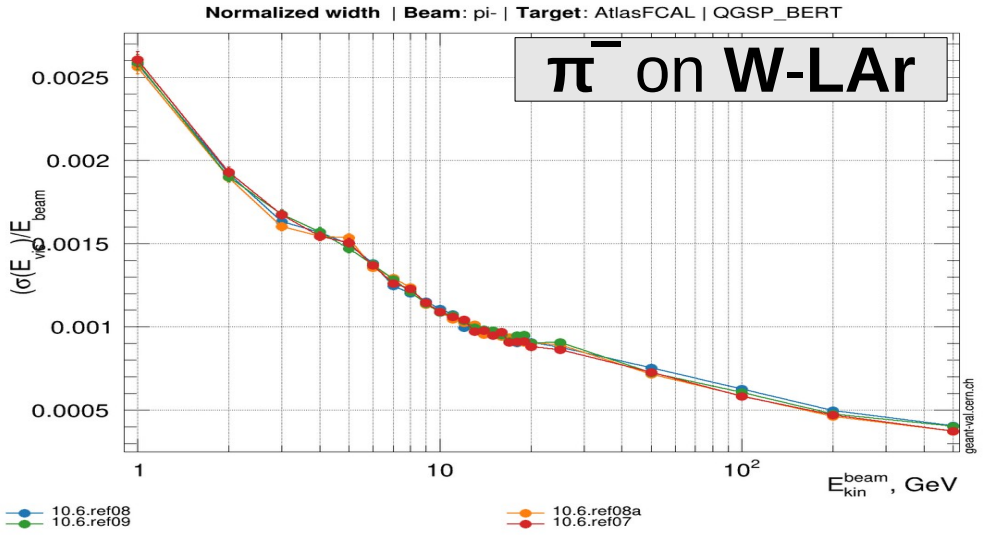


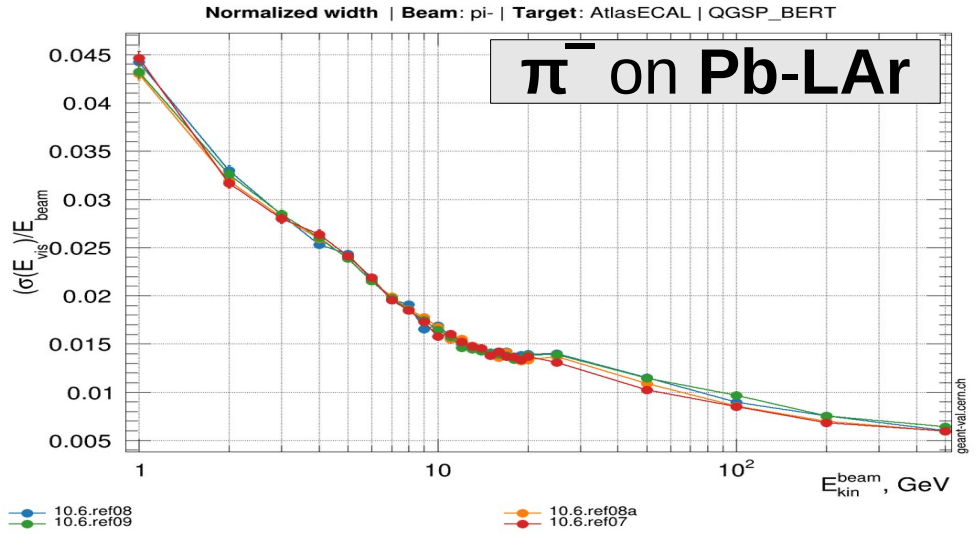


QGSP_BERT : Energy Width









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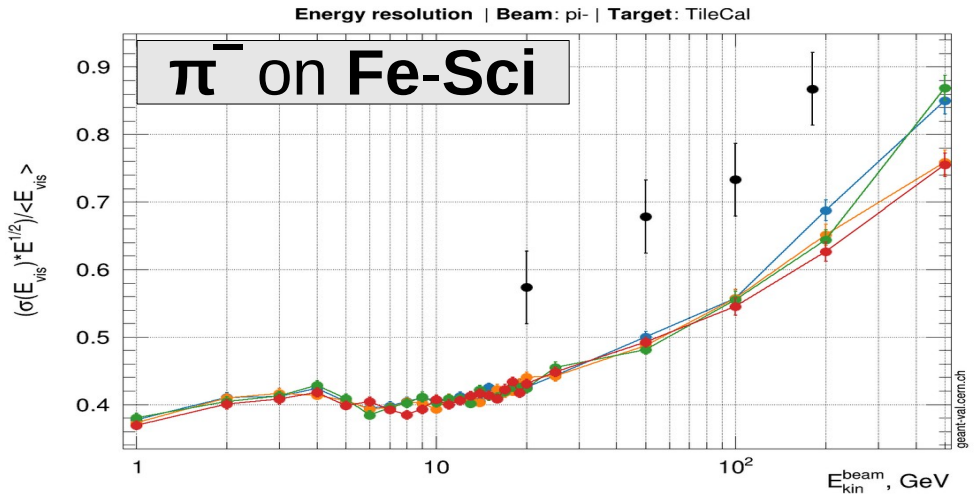
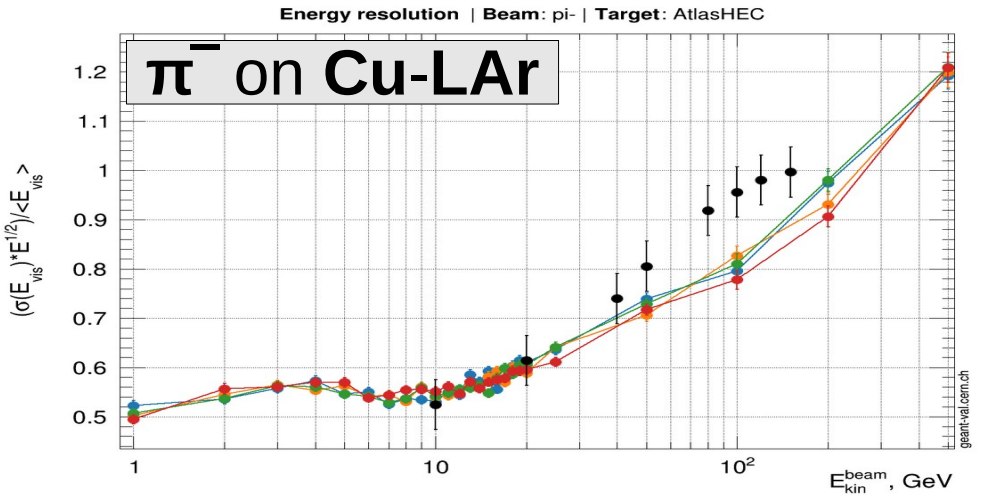
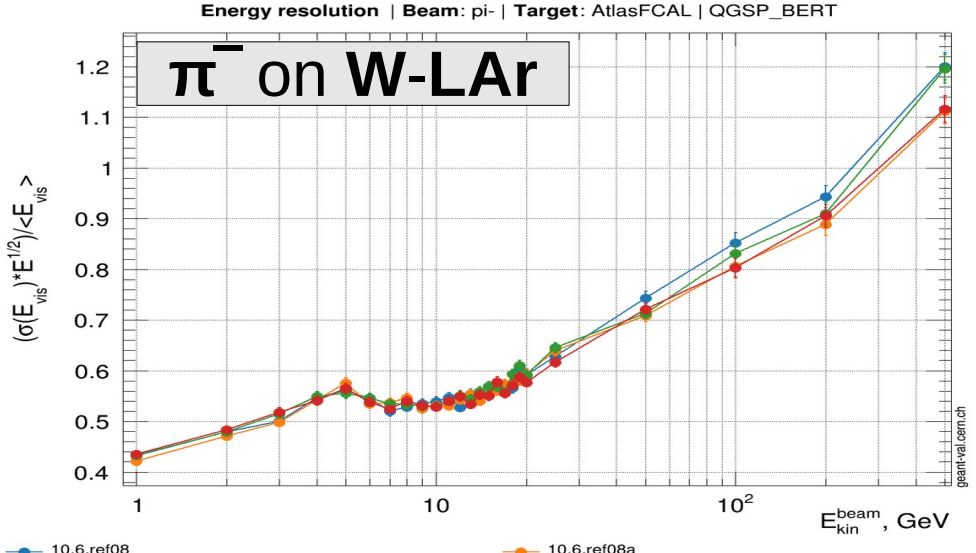
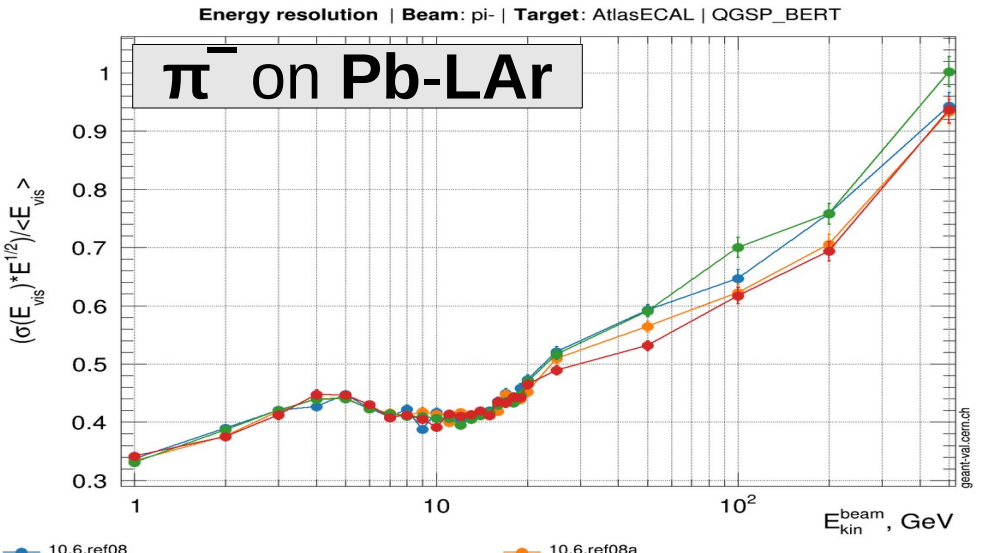
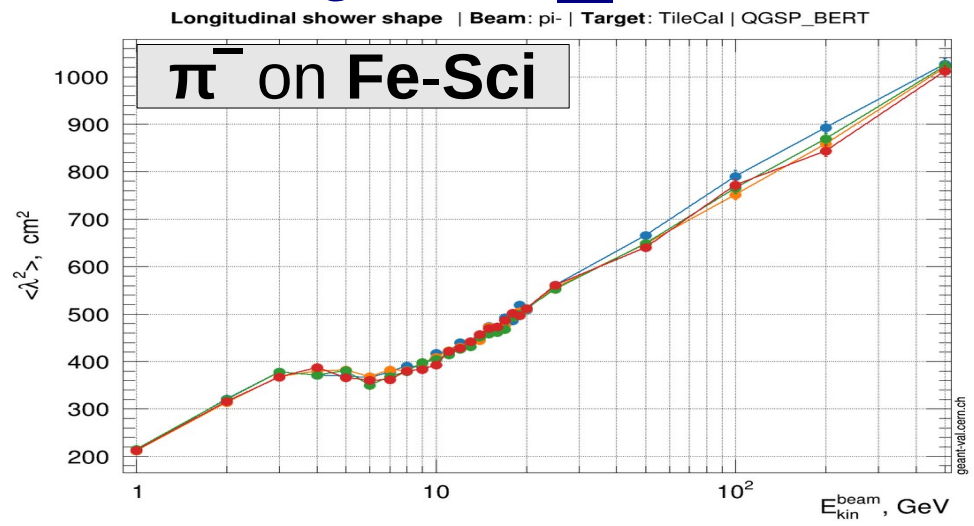


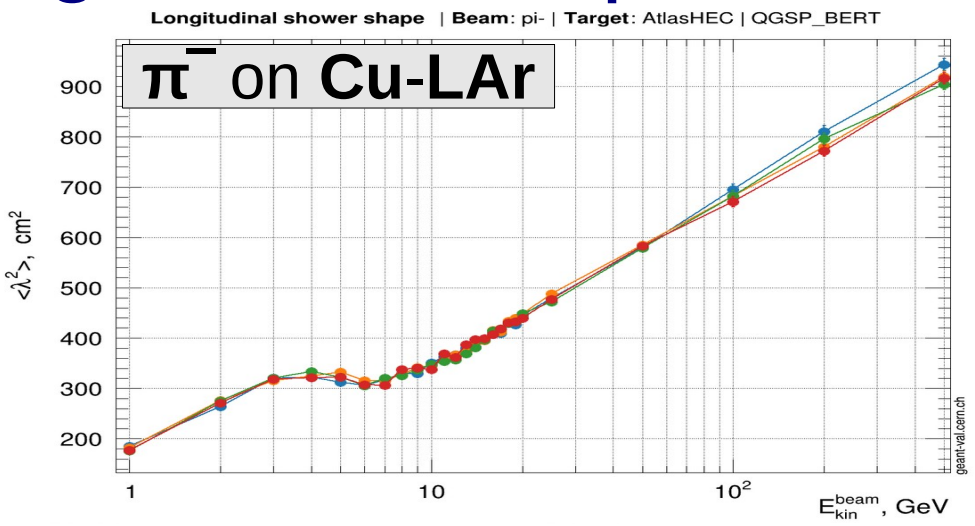


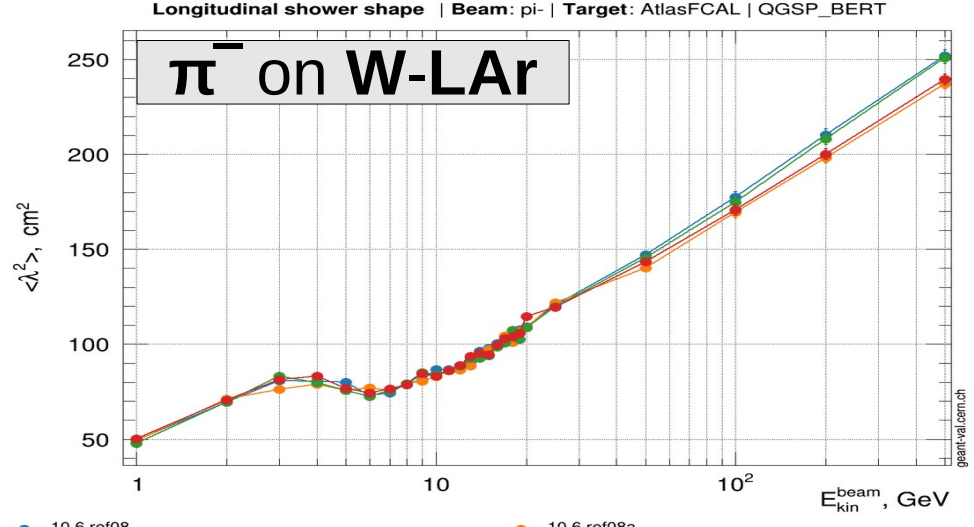


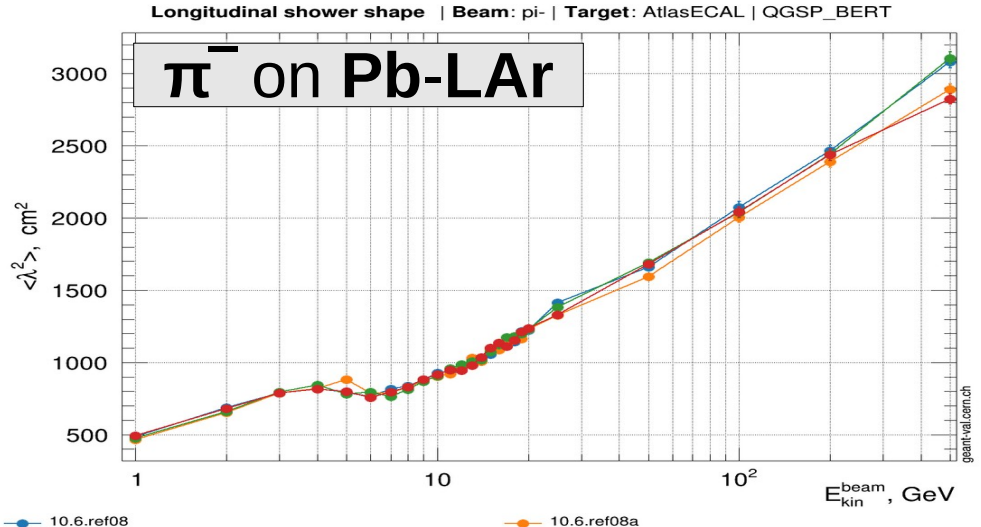


QGSP_BERT : Longitudinal Shape









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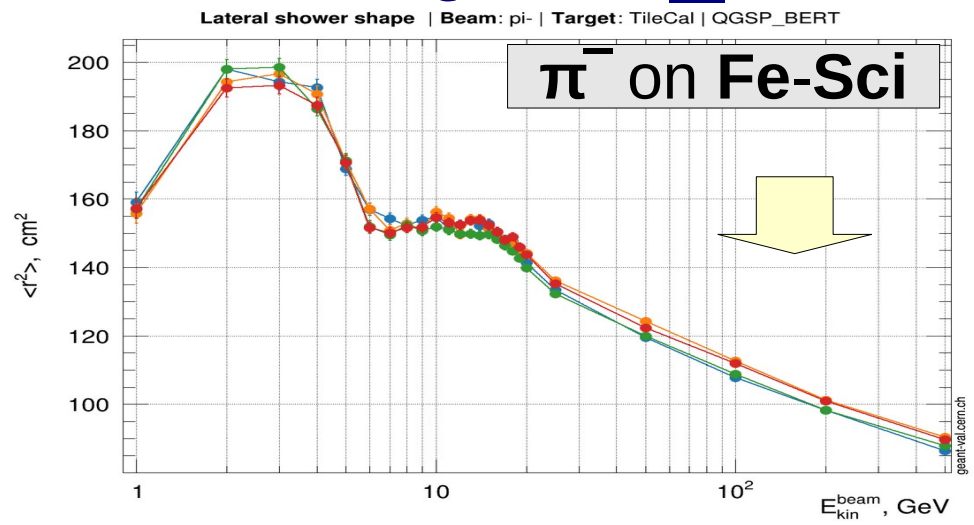

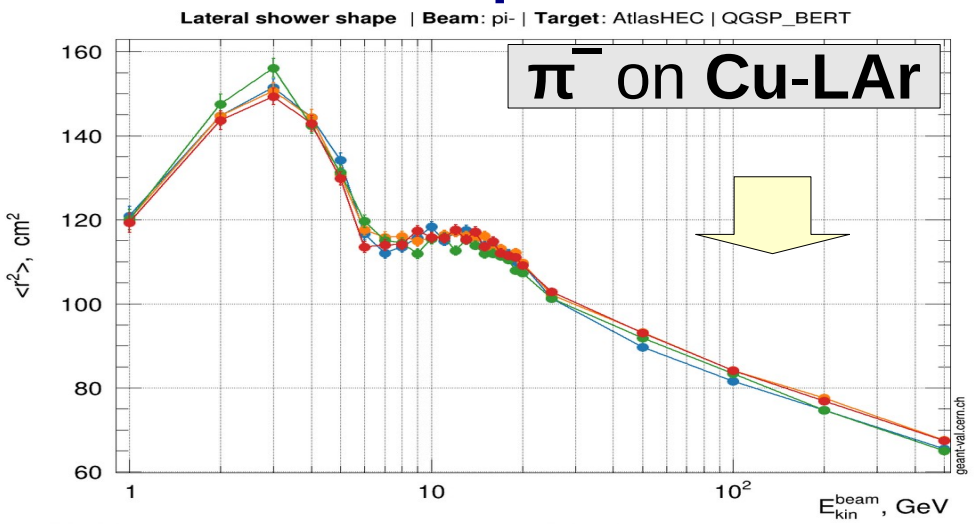

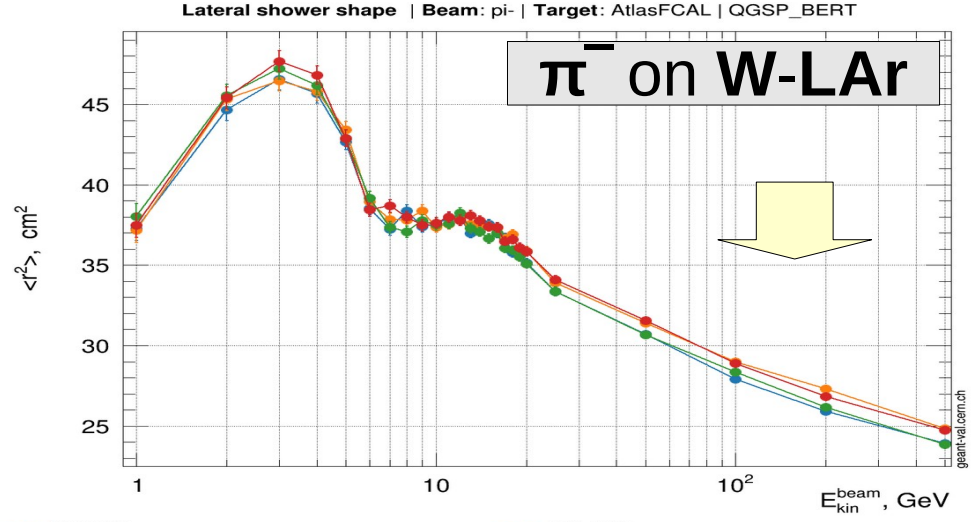

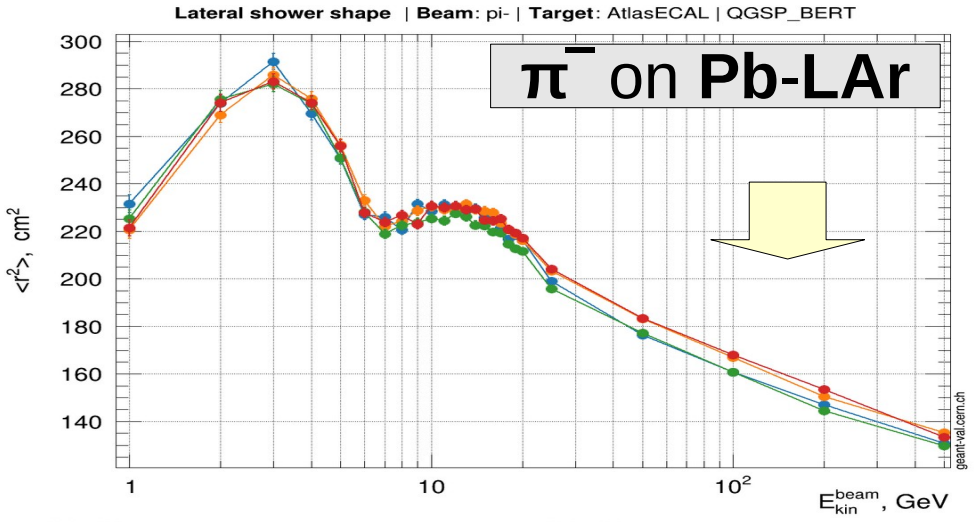

Pion– showers: FTFQGSP_BERT

G4 10.6.ref09
G4 10.6.ref08
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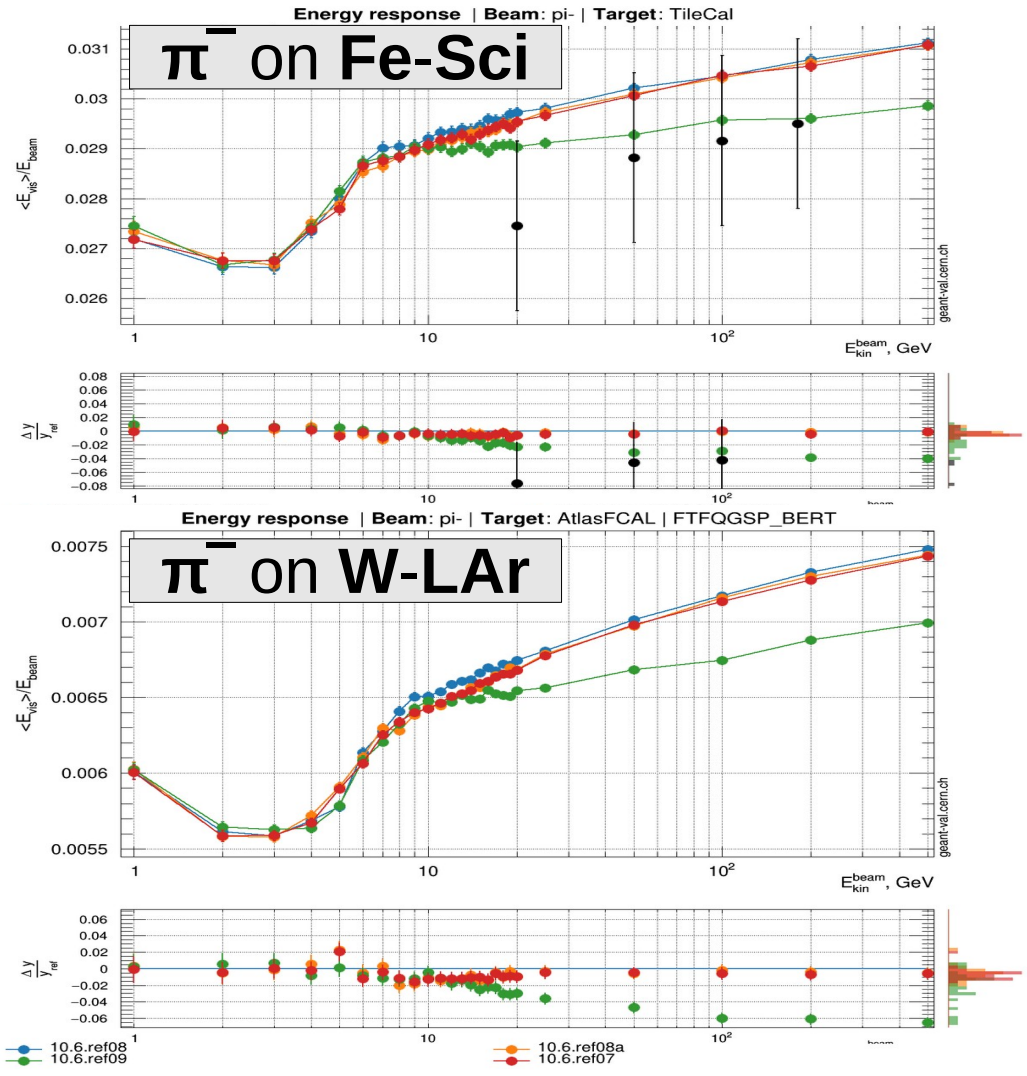
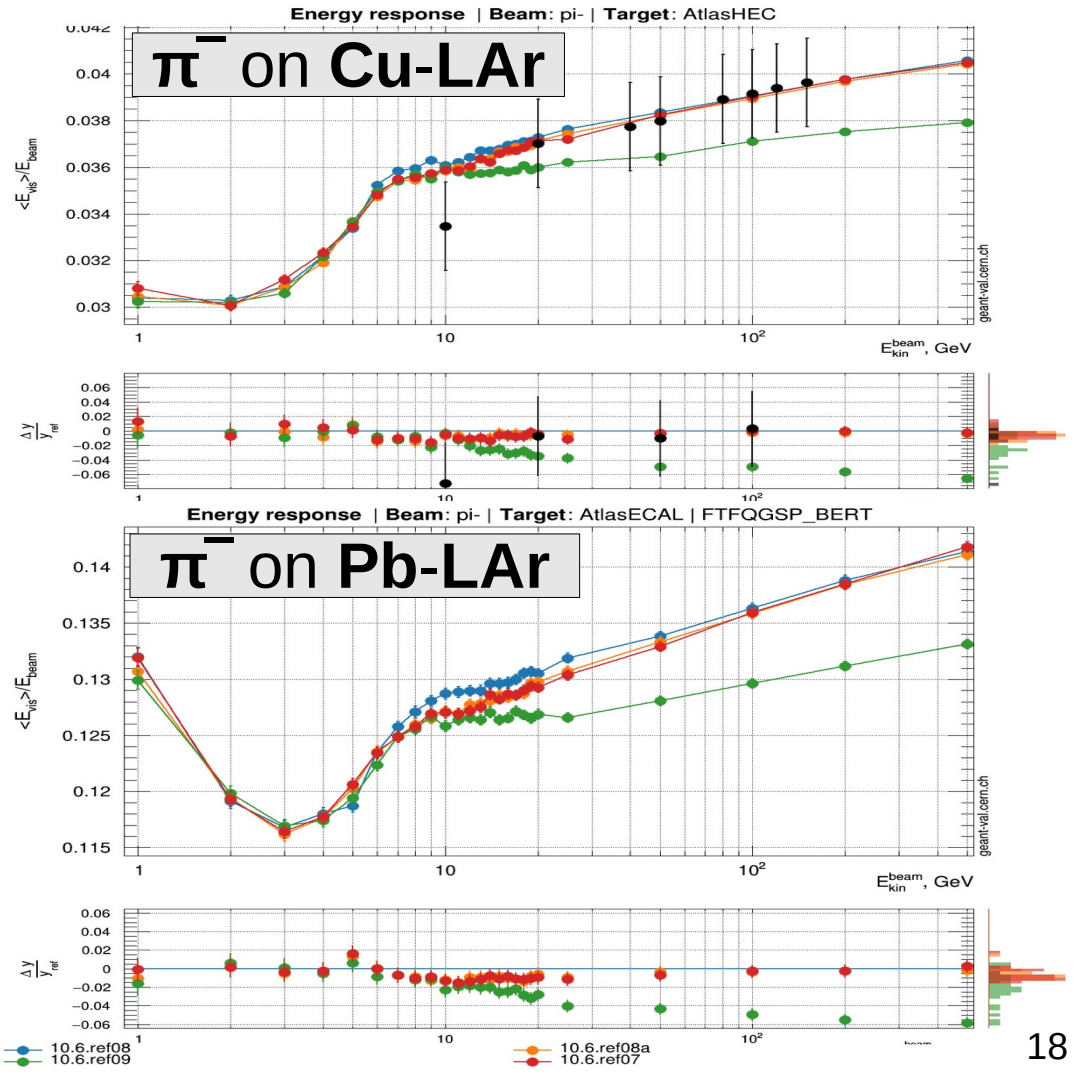
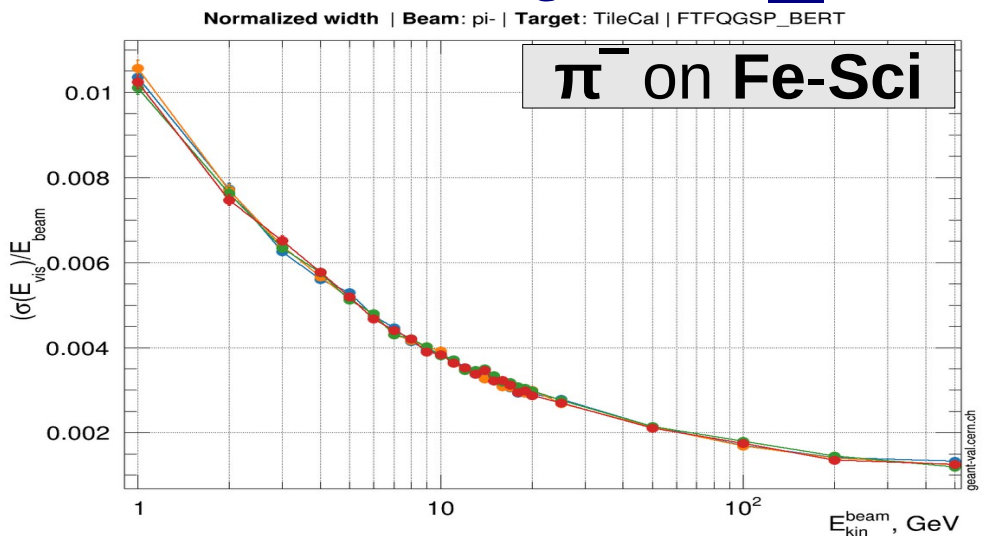
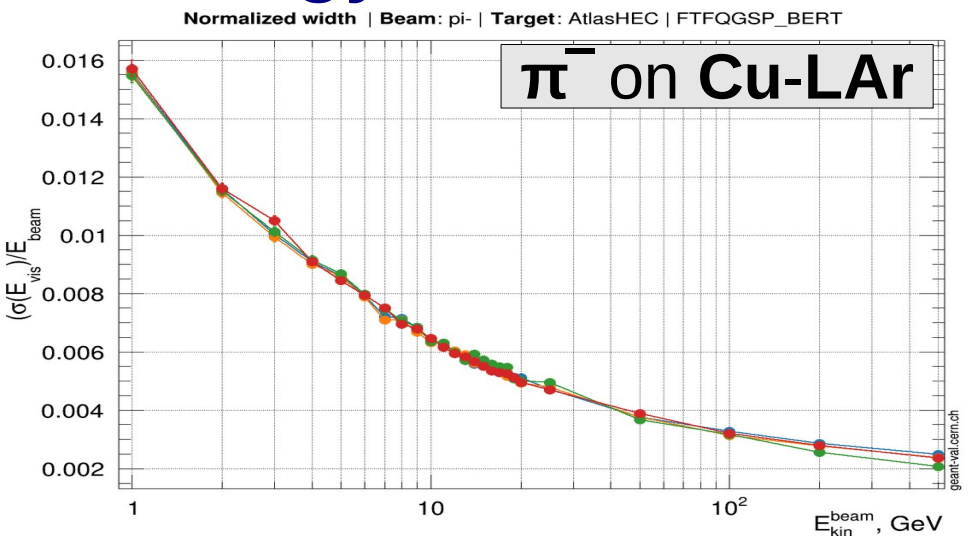
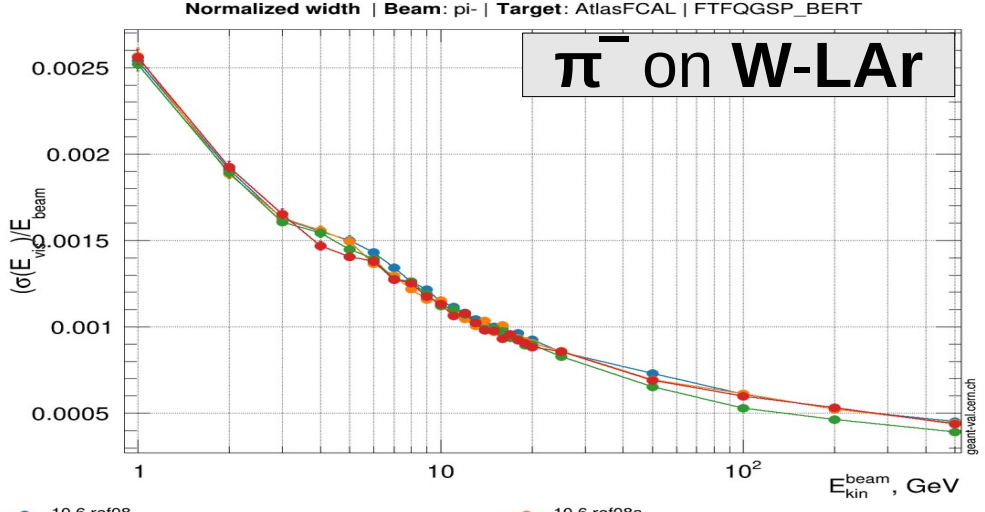


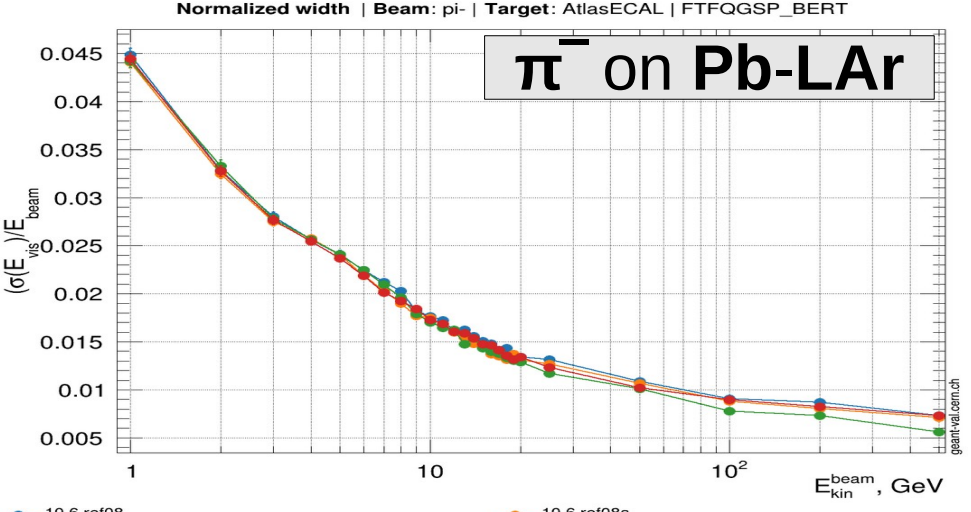


FTFQGSP_BERT : Energy Width

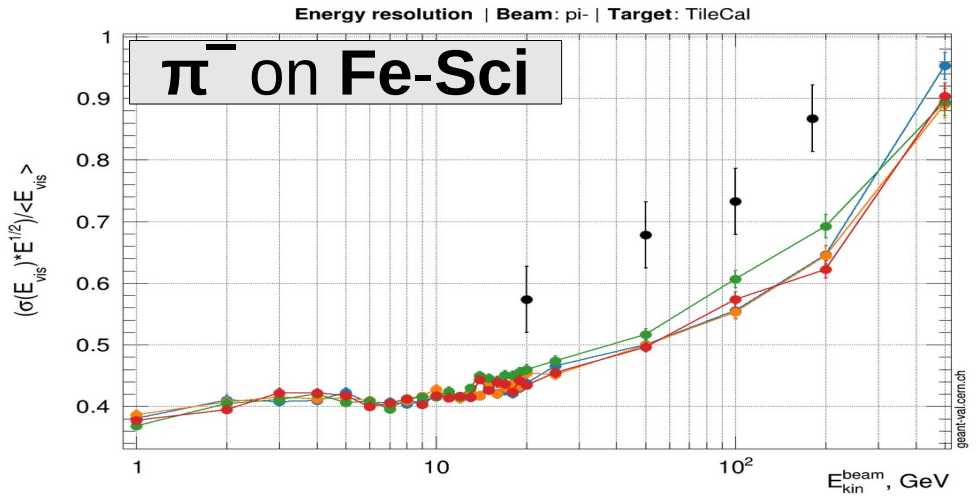


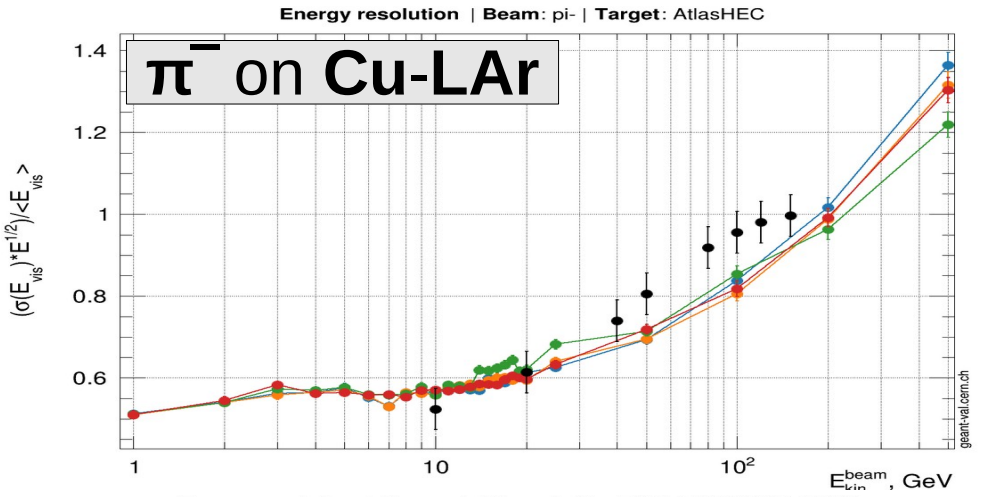


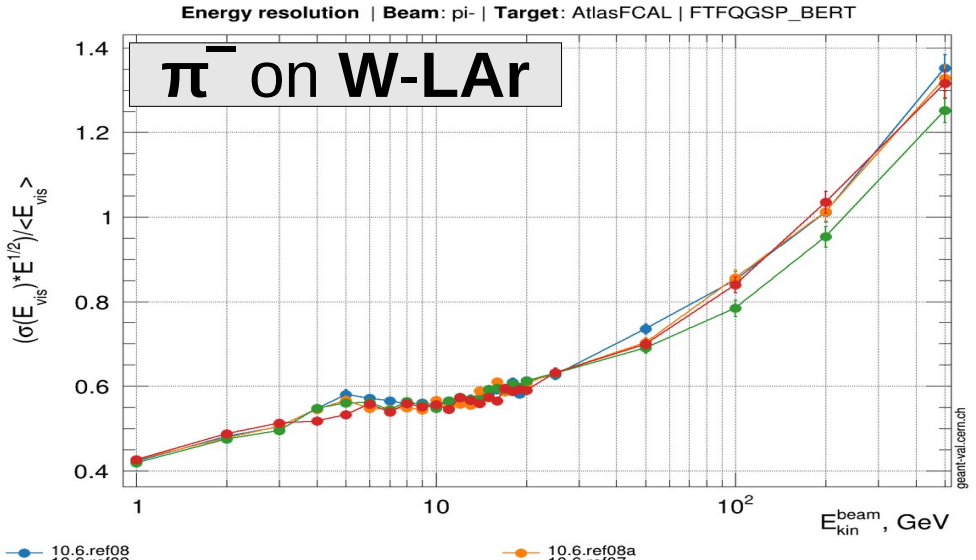


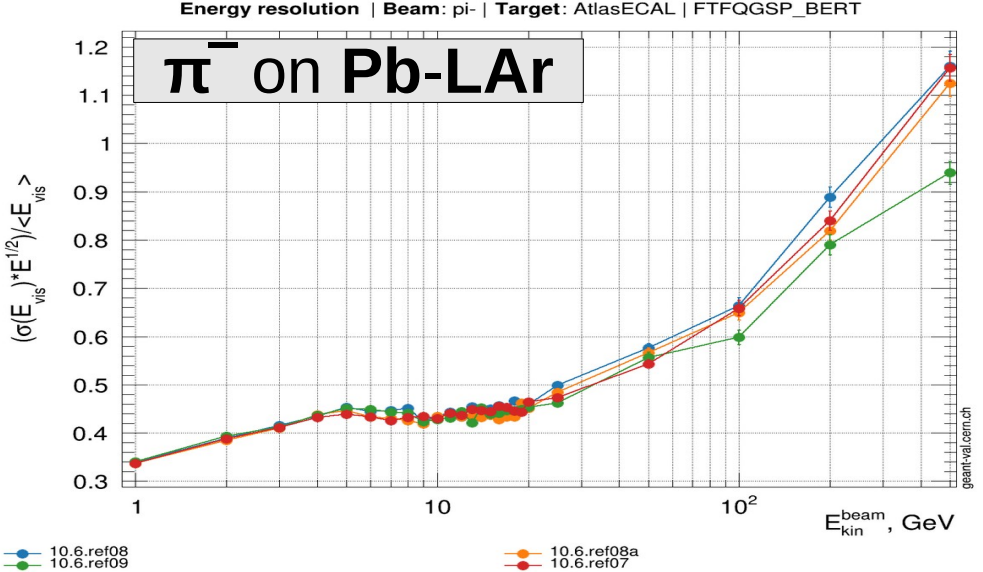


FTFQGSP_BERT : Energy Resolution

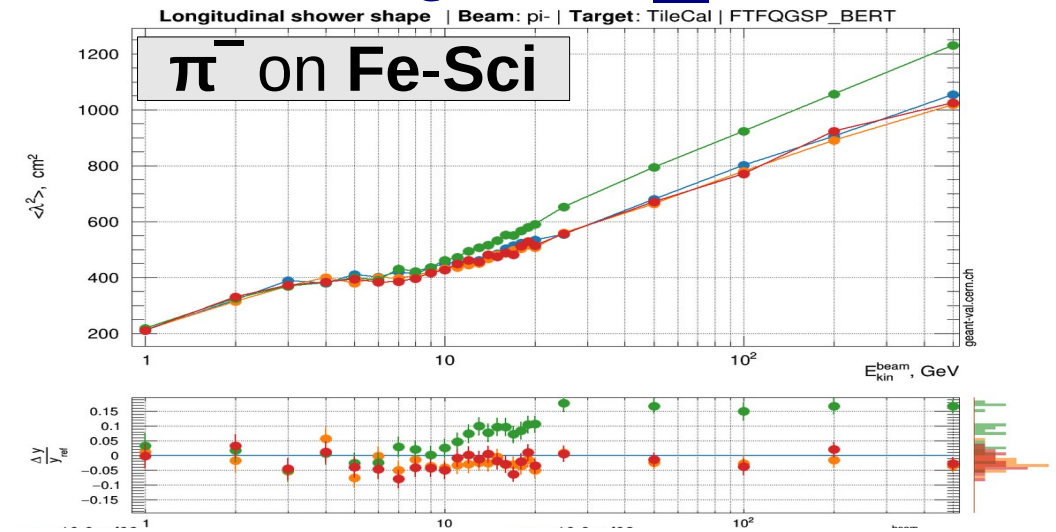


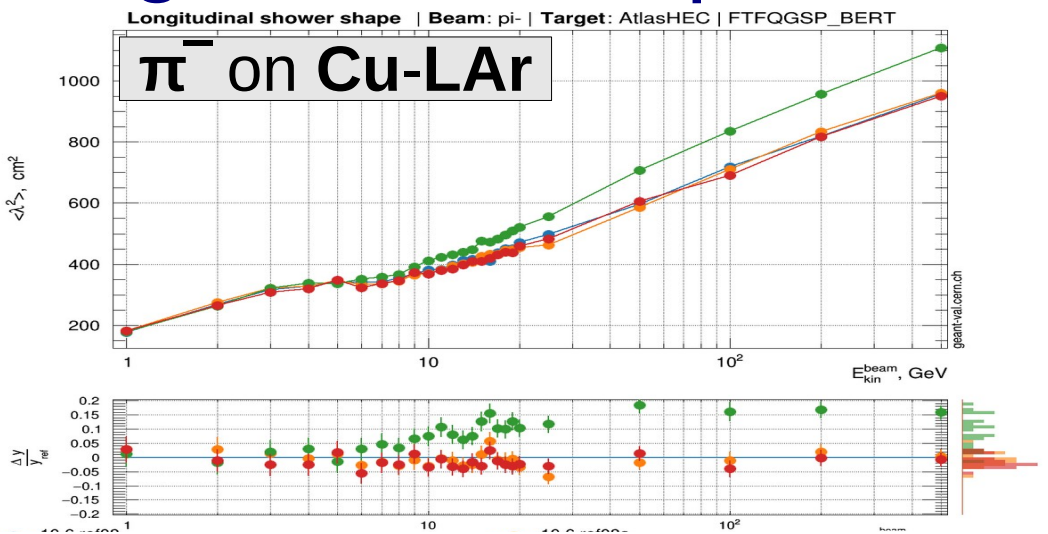


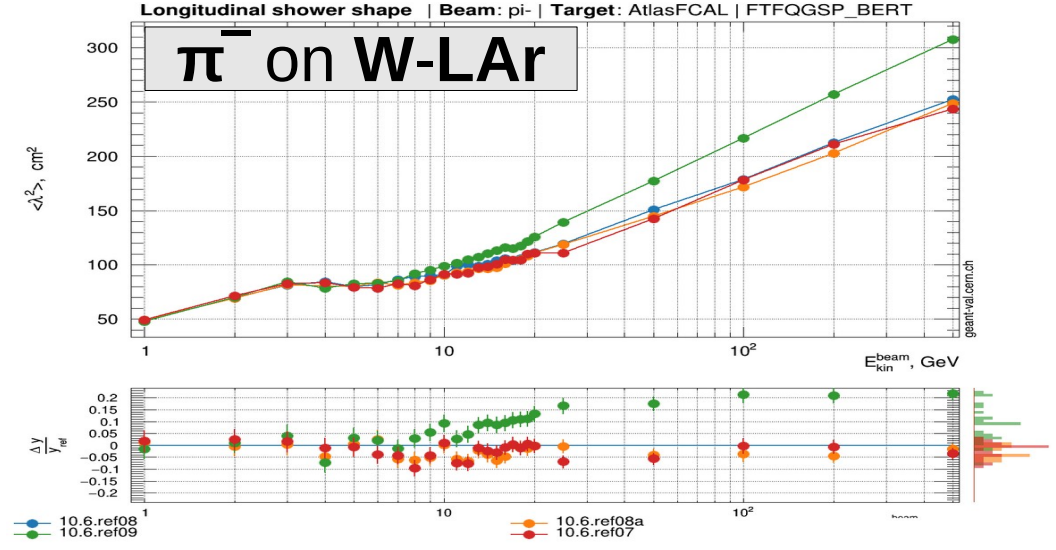


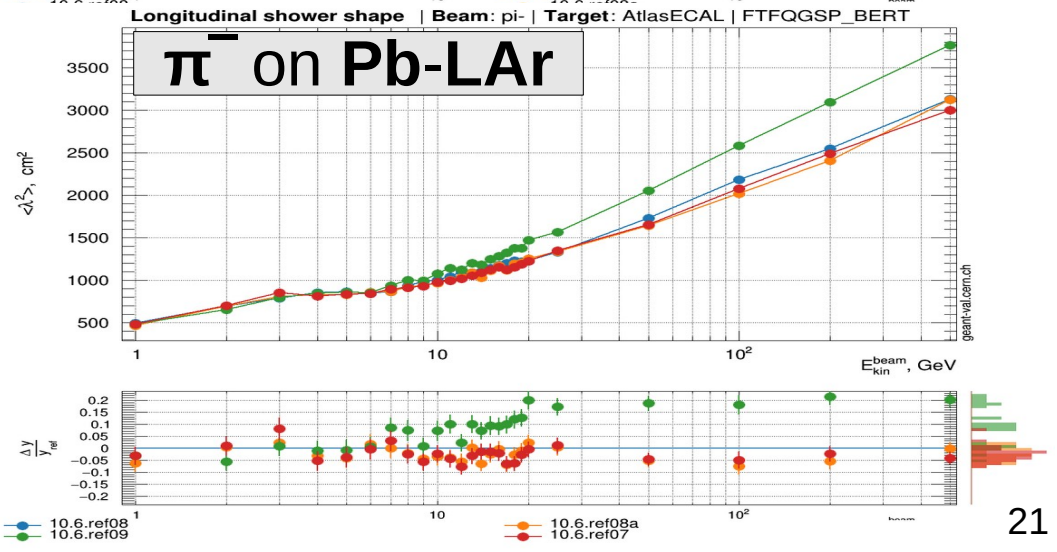


FTFQGSP_BERT : Longitudinal Shape

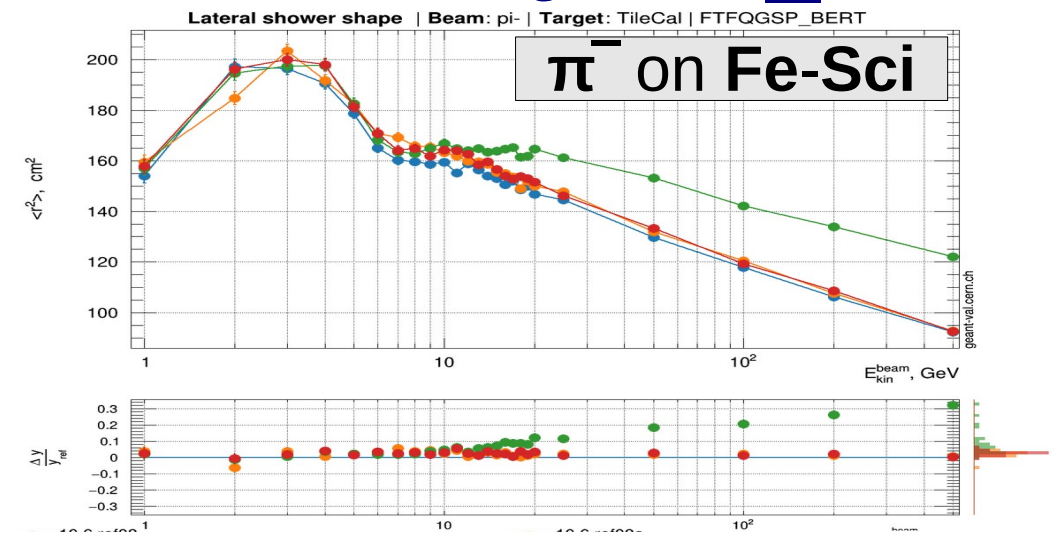


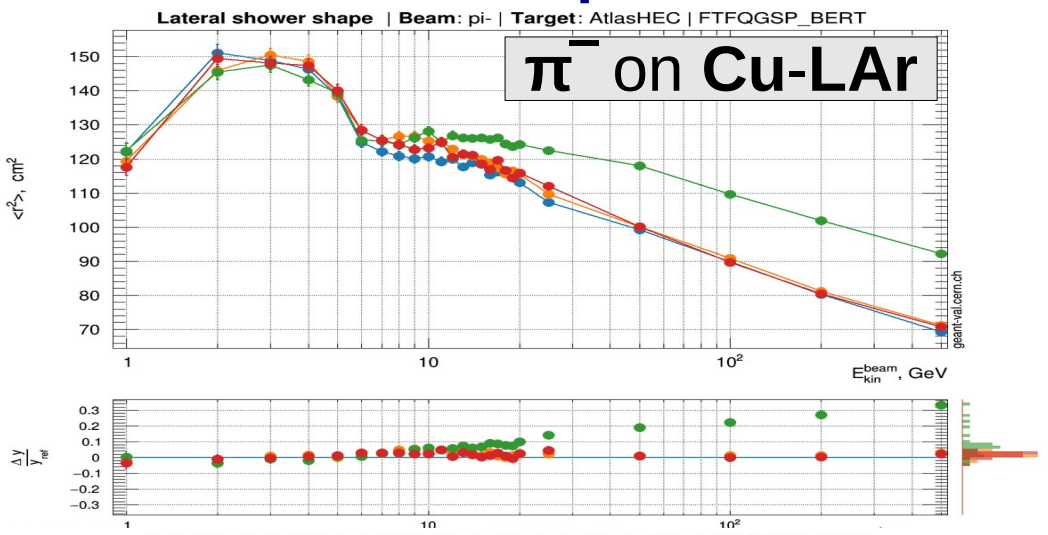


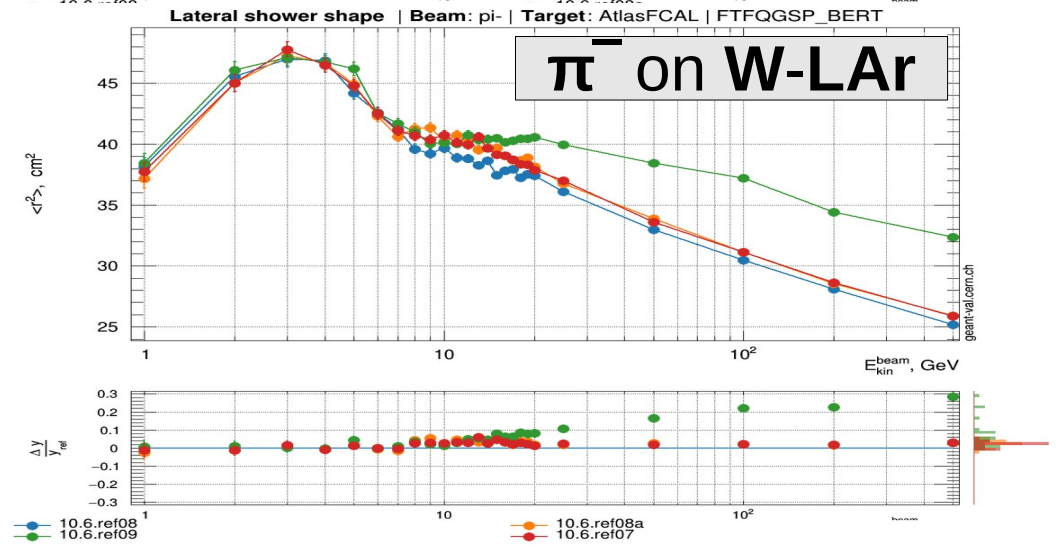


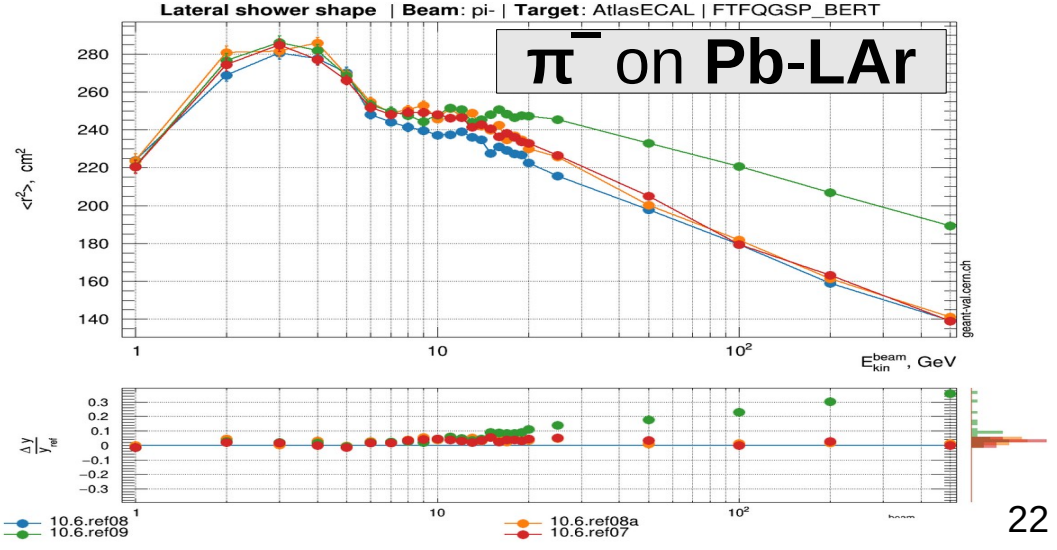


FTFQGSP_BERT : Lateral Shape









Conclusions

- **G4 10.6.ref09**
  - No crashes, no infinite loops, no new warnings
  - Reproducibility is OK, also with the new Tasking
  - Hadron showers
    - Few % narrower showers for FTF-based physics lists
    - Stable showers for QGS-based physics lists
      - Confirmed that the changes seen in Ref08 vs. Ref07 were due to the bug-fix in the fragmentation phase of the QGS string model
    - Surprising big changes in FTFQGSP_BERT showers!
      - Few % lower energy response; more or less stable energy resolution; 10-20% longer showers and 10-30% wider showers
      - Appears in Ref09, where only FTF has changed. Under investigation...