Hadronic Showers in Geant4 11.1.cand02

G. Folger, D. Konstantinov, A. Ribon
CERN EP-SFT
Main Changes in Hadronics vs. G4 11.1.cand00

- hadronic / models / radioactive_decay /
  - G4RadioactiveDecay : added printout of the flag of atomic relaxation (cand-01)
Main Changes in Hadronics vs. G4 11.1.cand01

- **hadronic / models / binary_cascade** /
  - *G4GeneratorPrecompoundInterface*: in the *PropagateNuclNucl* method, in the case of anti-nucleus projectile, convert also lamdas into anti-lamdas after the de-excitation
    - De-excitation always assumes nuclei, not anti-nuclei, so at the end we needs to transform all the nucleons into anti-nucleons in the case of excited anti-nuclei; this was done correctly for protons and neutrons, but not for lamdas in the case of anti-hypernuclei

- **hadronic / models / pre_equilibrium** /
  - *G4PreCompoundModel*: in the case of hypernuclei, do not perform pre-compound emission but only the equilibrium emission

- **hadronic / models / de_excitation** /
  - *G4ExcitationHandler*: added sanity checks and protections in the case of hypernuclei and anti-hypernuclei
    - These changes reduced significantly the number and size of warnings of large energy violations (which are rejected and then the final-state is resampled) seen in nuclear interactions of hypernuclei and, even more, anti-hypernuclei projectiles.
    Note: there are still cases of energy violations (few GeV maximum), and off-shell final-states
Tests of light hypernuclei and anti-hypernuclei inelastic nuclear interactions

- examples / extended / hadronic / **Hadr01**
  - Added UI commands to enable inelastic nuclear interactions of charmed and bottom hadrons, as well as inelastic nuclear interactions of light hypernuclei and anti-hypernuclei projectiles. Added macro files to demonstrate these interactions.
    - In cand-02

- examples / extended / hadronic / **Hadr09**
  - Extended for inelastic nuclear interactions of light hypernuclei and anti-hypernuclei projectiles
    - In cand-02
    - Note that charmed and bottom hadrons were already included in G4 11.0

*Note: these tests are meant for inelastic hadronic interactions. But charmed and bottom hadrons, as well as light hypernuclei and anti-hypernuclei have also elastic nuclear interactions, and electromagnetic interactions (if charged, ionization and multiple scattering)*
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 11.0.cand00
G4 11.1.cand02

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

- **π on Fe-Sci**
- **π on Cu-LAr**
- **π on W-LAr**
- **π on Pb-LAr**
FTFP_BERT : Energy Width

\( \pi^- \) on Fe-Sci

\( \pi^- \) on Cu-LAr

\( \pi^- \) on W-LAr

\( \pi^- \) on Pb-LAr
FTFP_BERT: Energy Resolution

π on Fe-Sci

π on Cu-LAr

π on W-LAr

π on Pb-LAr
FTFP_BERT : Longitudinal Shape

π⁻ on Fe-Sci

π⁻ on Cu-LAr

π⁻ on W-LAr

π⁻ on Pb-LAr
**FTFP_BERT : Lateral Shape**

- **π⁻ on Fe-Sci**
- **π⁻ on Cu-LAr**
- **π⁻ on W-LAr**
- **π⁻ on Pb-LAr**
Conclusions

- **G4 11.1.cand02**
  - No crashes, no infinite loops, no new warnings
  - Reproducibility OK
  - Hadron showers
    - No changes with respect to G4 11.1.cand00