Geant4 Hadronic Physics: recent patch G4 10.4.p01 and Work Plan for 2018

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Outline

- Recent patch G4 10.4.p01
- **Program of work for Geant4 Hadronic Physics**
 - Note: items in italics and smaller size at the bottom will be tackled only if man-power is available, else postponed to next year

G4 10.4.p01

Hadronic Physics Changes in G4 10.4.p01

- Only minor, technical fixes
 - Radioactive Decay
 - Added check that the environment variable G4RADIOACTIVEDATA is pointing to a correct directory (addressed problem #1942)
 - Bertini
 - Replaced use of obsolete std::bind2nd with std::bind (relevant for C++17)
 - Fixed self-consistency (missing #include) in various header files

HADRONIC PHYSICS

String models (1/2)

- Fritiof (FTF) model
 - Finalizing FTF model description of NA61/SHINE data on π^-C interactions at 158 and 350 GeV/c
 - Tuning of FTF parameters for K+P and K+A interactions
 - Tuning and validation of FTF model for strange meson and hyperon production in antiproton interactions
 - Validation of FTF for nucleus-nucleus interactions and extension of the validation test-suite for string models (test22) with high-energy nucleus-nucleus data
 - Further improvements and validation of HIJING for p-Pb and Pb-Pb collisions at LHC
 - Study of exp. data on **charm particle production** in proton and antiproton interactions with protons and nuclei. Implementation of charm particle production in FTF model

String models (2/2)

- Quark Gluon String (QGS) model
 - Further tuning and improvement of QGS
 - Documentation of QGS
 - Study potential extensions of QGS :
 - gamma, electron and neutrino interactions
 - inclusion of hard processes
- General
 - Hadronic shower effects of FTF and QGS
 - Code improvements of FTF and QGS
 - Further investigation and possibly solution of the tension between thin-target vs. hadronic showers
 - Interfacing Fortran **EPOS** with Geant4
 - As first step for covering hadronic interactions at energies above few TeV

Intra-nuclear Cascade models

- Bertini (BERT) model
 - Extension of $\pi + / \pi / \pi 0$ nucleon 6,7,8,9-body final states to include strange pair production
 - Maintenance and user-support
 - Code review and eventual re-engineering
- Binary (BIC) model
 - Maintenance and code review
- INCL++ model
 - Completion of strangeness physics in INCL
 - Upgrades & maintenance
 - Hypernuclei production in ABLA++

Precompound / De-Excitation models

- Complete the new GEM (Generalized Evaporation Model) model
- Modification of FBU (Fermi Break Up) model with addition of gamma transition channels
- Improvement of the parameterisation of the probabilities of evaporation
- Tuning parameters and validation with thin-target data of pre-equilibrium and de-excitation models

Radioactive Decay model

- More correct partial K, L1, L2, L3, M1-M5 electron capture probability; implementation of electron capture form N shell
- Develop Z-dependent tables of electron capture coefficients
- Maintenance of the RDM & PhotoEvaporation data-sets
- RDM biasing improvements
- Beta-delayed neutron emission
- Extension to Super Heavy Elements (SHE)

ParticleHP model

- Maintenance of ParticleHP
- Maintenance and update of the IAEA Geant4 neutron data libraries website (including JEFF-3.3 and ENDF/B-VIII)
- Maintenance of the Fission Fragment module

LEND model

(LEND = Low Energy Neutron Data, GIDI = General Interaction Data Interface)

- Development for neutron- and gamma-induced reactions
- New version of LEND/GIDI
- Maintenance and support of physics lists for LEND
- Develop validation tests for G4LENDorBERTModel photo-nuclear m.
 NCrystal model

(Model for ~meV neutron scattering in both poly- and single-crystals)

- Paper to descibe the physics of the model in detail
- Improved integration of NCrystal in Geant4

Elastic models

• Review of hadron elastic models

Other models

- Muonic atom
- Low-energy, entry-channel models: SMF and BLOB
 - Semiclassical one-body approaches to solve Boltzmann-Langevin equation
- Nuclear Coulomb excitation model
- Neutrino interactions:
 - R&D for neutrino-nucleus final state generator
 - Inserting neutrino physics in Geant4 framework

Cross Sections

- New version of G4NEUTRONXS data set
- R&D on hadronic cross sections

Validation & Testing

- Composition, monitoring and validation of physics lists for the Intensity Frontier (IF)
- Maintenance, and periodic execution of Test19, Test23, Test47, Test48, Test75
- Hadronic validation with BNL and MIPs data, and with the new high-granularity CMS test-beam
- Physics highlights release page
- Development of the infrastructure for studying sensitivity of MC predictions to the variations of the model parameters
- Possible integration of interfaces of Geant4 hadronic models to be used by GENIE neutrino interaction code

Other Validation activities

- Transforming test-beam simulations from the experiments (e.g. ATLAS and CALICE) as Geant4 stand-alone applications useful for hadronic physics validation
- Convert TARC into test15 to be run in nightlies
- Validation of cascade models with the n_TOF evaluated neutron flux
- Validation of low-energy models

Hadronic Framework

- Investigate possible simplifications of the hadronic framework
 - Starting with some design ideas recently considered in the context of GeantV physics...