

Geant4 Hadronic Physics: Work Plan for 2019

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String models (1/2)

- Extension of the string models (FTF and QGS) to **charmed & bottom hadrons**
 - Collect experimental data on charm hadron production in hadron-nucleus interactions for future validation
- Study of **fast** particle production in hadronic interactions
 - Analysis of small-angle particle production in proton and pion nuclear interactions in FTF and QGS
- Study of **slow** particle production in hadronic interactions
 - Revision of the statistical multi-fragmentation model and analysis of nuclear multi-fragmentation data
- Re-thinking of the string fragmentation treatment for **low-mass strings**; development, fine-tuning and validation of **antiproton – nucleus** interactions
 - From rest to hundred GeV

String models (2/2)

- Investigation of physics effects of using Fortran **EPOS** with Geant4 for hadron interactions at very high energy
 - G4 interface to Fortran EPOS introduced in G4 10.5
 - Expected differences for projectiles of energies above few TeV (interesting mostly for FCC-hh)
- Hadronic shower effects of **FTF** and **QGS**
- Code improvements of **FTF** and **QGS**
- Validation of FTF model for **nucleus – nucleus** interactions
- Introduce fusion of quark-gluon strings for FTF and QGS

Intra-nuclear Cascade models

- **Bertini (BERT) model**
 - Improve multi-body phase generation and its validation against HARP data
 - Maintenance and user-support
- **Binary (BIC) model**
 - Development of a **coalescence model**
 - Code review and maintenance
- **INCL++ model**
 - Upgrades and maintenance

Precompound / De-Excitation models

- Include the gamma de-excitation chain into **FermiBreakUp**
- Release of the new **GEM** model

Radioactive Decay model

- Maintenance and update of RadioactiveDecay and PhotonEvaporation **databases**
- Add possibility for the user to add his own **beta spectrum**
- Build **validation test** for radioactive decay
 - *geant-val* or similar
- Include **β -delayed** particle emission
- Connect LLNL **spontaneous fission** model to RDM
- Extend the model to superheavy elements

ParticleHP model

- Validation & Maintenance of ParticleHP
- Validation of the simulation of (α , n) reactions
- Implementation of the SCINFUL-QMD physics
 - Detailed simulation of neutron detectors up to a few hundred MeV
- Improve gamma cascades

LEND model

LEND = Low Energy Neutron Data
GIDI = General Interaction Data Interface

- Complete, test, and release new version of LEND/GIDI :
LLNL low energy nuclear data interface and data
- Maintenance and support of physics lists using LEND
with LLNL fission model

NCrystal model

Model for ~meV neutron
scattering in crystals

- Publish paper describing the model
- Improve integration of the model in Geant4

Elastic models

- Improvement and validation of the **diffuse elastic** model
- Introduce a new model for the elastic scattering of pions
 - With delta-resonance

Other models

- Maintenance and validation of **QMD**
- Maintenance and hypernuclei production in **ABLA++**
- Interfacing **BLOB** to Geant4
 - Low-energy, entry-channel model
- Development and validation of neutrino-nucleus, electron-nucleus and gamma-nucleus final-state models
- Muonic atoms

Cross Sections

- Extension of Glauber-Gribov nuclear cross sections for **heavy projectiles**
 - Hyperons, charmed and bottom hadrons
- **Improve hadronic cross sections**
 - More accurate treatment for elastic
 - Use of TOTEM data for pp

Hadronic Framework

- Investigate possible **simplifications** of the hadronic framework

Validation & Testing

- Addition of experiments **test-beam** simulations to the hadronic physics validation (*geant_val*)
- Validation of cascade models using the **n_TOF** evaluated neutron flux, obtained at EAR1 and EAR2
- Validation and maintenance of **TARC** (*test15*)
- Hadronic validation with **BNL** and **MIPS** data, and with the new high-granularity **CMS** test-beam
- Development and validation of the infrastructure for studying sensitivity of the MC predictions to the **variations of the model parameters**
 - Focus on Precompound, Bertini cascade, and FTF
 - Refining of the model parameters validity ranges if applicable