Geant4 Hadronic Physics Group Work Plan for 2022

2nd version, 16 February 2022

Hadronic String models (1/2)

- Validation of charm production for **FTF** and **QGS**
  - In proton-proton, proton-nucleus, antiproton-proton and antiproton-nucleus interactions
  - A. Galoyan, V. Uzhinsky

  and improvement of the decays of charmed hadrons using data of PDG
  - Aida Galoyan
- Improvement of antiproton and light anti-ion annihilations in **FTF**
  - From at rest to hundreds GeV
  - A. Galoyan, V. Uzhinsky
- Validation of **FTF** nucleus-nucleus interactions
  - Vladimir Uzhinsky
- Correct introduction of the formation time in **FTF** and **QGS**
  - Vladimir Uzhinsky

Hadronic String models (2/2)

- First extension of **FTF** for light hypernuclei and anti-hypernuclei projectiles
  - Aimed for a simple but reasonable approch, not expected to be accurate
  - A. Ribon, V. Uzhinsky
- Continue the model parameter studies of **FTF**
  - Julia Yarba and other FNAL collaborators
- Technical investigation of using alternative sets of tuning parameters in **FTF**
  - For different projectile kinetic energies and/or projectile particle types
  - Alberto Ribon
- Investigate the ~20% reduction in energy fluctuations – observed in ATLAS HEC – happening between Geant4 10.4 and 10.5 with **FTF**
  - Alberto Ribon
- Code and hadronic shower improvements of **FTF** and **QGS** models
  - Alberto Ribon

Intra-nuclear Cascade models

- Bertini-like (**BERT**) model
  - Maintenance and user-support
    - M. Kelsey, Dennis Wright
- Binary (**BIC**) model
  - Bug fixes and modernization of the code via new C++ features
    - Gunter Folger
- Liege (**INCLXX**) model
  - Maintenance and user-support
    - J-C. David, D. Mancusi, J.L. Rodriguez Sanchez
  - **Extension for antiproton**
    - J-C. David, D. Zharenov
  - **ABLA** : production of pionic nuclei, and their evaporation to pions
    - Jose' Luis Rodriguez Sanchez

Precompound / De-excitation models

- Maintenance and user support
  - Probabilities of transitions may be improved and a number of bug reports resolved
  - V. Ivanchenko, J.M. Quesada
- Implementation of a simple de-excitation treatment for light hypernuclei and anti-hypernuclei
  - Vladimir Ivanchenko

Radioactive Decay model

- Maintenance and user support
  - Dennis Wright
- Maintenance of the database
  - Laurent Desorgher
- Improvement of the spectrum of beta decays
  - Dennis Wright

ParticleHP model (1/2)

- Validation, maintenance and user support
  - P. Arce, D. Cano, E. Dumonteil, E. Mendoza, S. Losilla, L. Thulliez, D. Wright
- Improvement of the gamma-deexcitation in ParticleHP
  - Replace files in *$G4NDL/Inelastic/Gammas/* with corrected & consistent ones
  - Start using *G4PhotonEvaporation* in ParticleHP
  - Dennis Wright, Artem Zontikov
- New G4NDL4.7 data library
  - New, extended thermal neutron data
  - New, corrected files in *$G4NDL/Inelastic/Gammas/*
  - D. Cano, E. Dumonteil, E. Mendoza, L. Thulliez, D. Wright, A. Zontikov
- Implement an option that forces ParticleHP to respect event-by-event conservations (energy-momentum, baryonic number, *etc.*)
  - Emilio Mendoza

ParticleHP model (2/2)

- Extend ParticleHP model to higher energies
  - D. Cano, E. Mendoza
- Insert in Geant4 the NuDEX code (to generate EM de-excitation cascades)
  - D. Cano, E. Mendoza
- Create a tool to change the charged particle cross sections with user's ones
  - Pedro Arce
- Support for thermal scattering data + development of new variance reduction techniques (*e.g.* AMS and adaptive multilevel splitting)
  - E. Dumonteil, L. Thulliez

LEND model

- LEND, GIDI update
- Upgrade of MCGIDI
  - B. Beck, J. Verbeke, Douglas Wright

NCrystal model

- Update Geant4-NCrystal hooks for recent releases + MT support
- Thermal neutron scattering in liquids
- X. Cai, T. Kittelmann

Hadron Elastic

- Improvement in the elastic scattering of anti-baryons and light anti-nuclei on target nuclei
  - Vladimir Uzhinsky
- Simple elastic scattering treatment for hypernuclei and anti-hypernuclei on target nuclei
  - V. Grichine, V. Ivanchenko

Other Hadronic models

- Development and validation of neutrino / lepton – nuclear physics
  - Vladimir Grichine
- Muonic atoms, molecules, and catalyzed fusion physics
  - Kevin Lynch (with a hired full-time postdoc)
- Adoption of external decayers and maintenance of the related example
  - *examples / extended / eventgenerator / pythia / py8decayer*
  - Julia Yarba
- Use of Pythia8 as an external generator in Geant4
  - Luis Sarmiento (Pico)

Hadronic Cross Sections

- Study low-energy corrections for light anti-ion nuclear cross sections
  - Aimed to better describe ALICE's recent measurements at low energies
  - Vladimir Uzhinsky
- Extension of nuclear cross sections for light hypernuclei and anti-hypernuclei projectiles
  - V. Grichine, V. Ivanchenko
- Provide full integral option for frequently used charged hadrons
  - $\pi^{\pm}$, $K^{\pm}$, p , $\bar{p}$
  - Take into account the variation of the hadronic cross sections of charged hadrons along a step, due to the energy losses by ionization
    - Already included and important in EM physics, might have some effect also in hadronic physics...
  - Vladimir Ivanchenko

Hadronic Validation and Testing (1/2)

- Integrating calorimeter test-beams for hadronic validation in *geant-val*
  - *E.g.* ATLAS HEC, Dual Readout calorimeter, and others
  - Lorenzo Pezzotti
- Use fixed-target data and calorimeter data for hadronic validation
  - Sunanda Banerjee
- Hadronic validation of selected releases using fixed-target data
  - Julia Yarba
- Support, monitoring and documentation of physics lists with the focus on Intensity Frontier (IF) experiments
  - K. Genser, J. Yarba
- Studying the sensitivity of the MC predictions to the variations of various parameters and development of needed infrastructure
  - K. Genser, R. Hatcher, S.Y. Jun, H. Wenzel, J. Yarba

Hadronic Validation and Testing (2/2)

- Tests and user support via public Geant4 examples
  - Michel Maire
- Validation of neutron physics with the TARC test
  - Alex Howard
- New test case for thermal neutron transport
  - Sergio Losilla
- New example for monitoring particle fluence
  - To avoid unexpected large changes in the evolution of Geant4, as reported by ATLAS...
  - Alberto Ribon