Geant4 Hadronic Physics Group Work Plan for 2024

2nd version, 21 February 2024

Hadronic String models (1/2)

- Verification of pion-nuclear interactions in **FTF** and **QGS** models; revision of fragmentations in both models and of probabilities of FTF processes
  - Vladimir Uzhinsky
- Validation of charm production for **FTF** and **QGS** models
  - In proton-proton, proton-nucleus, nucleus-nucleus interactions
  - A. Galoyan, V. Uzhinsky
- Improvement and validation of antiproton, antineutron and light anti-nuclei annihilations in **FTF**
  - A. Galoyan, V. Uzhinsky
- Validation of **FTF** nucleus-nucleus interactions, including the new diffraction dissociation description, in the range $3 < E_{cms} < 20$ GeV
  - d-d, d-A, t-A, He4-He4, He4-A, C12-A, *etc.*
  - A. Galoyan, V. Uzhinsky

Hadronic String models (2/2)

- Review of Birks' treatment in hadronic calorimeters to take into account the interplay between string (FTF) and intra-nuclear cascade (BERT) models
  - To tackle a recent issue (lower energy response at low energies) reported by ATLAS TileCal test-beam
  - L. Pezzotti, A. Ribon
- Continue the model parameter studies of **FTF**
  - And other models (Preco, Bertini, *etc.*) as well
  - Julia Yarba and other FNAL collaborators (K. Genser, R. Hatcher, S.Y. Jun, H. Wenzel)
- Maintenance and improvement of the hadronic framework; code improvements of **FTF** and **QGS** models
  - Alberto Ribon

Intra-nuclear Cascade models

- Bertini-like (**BERT**) model
  - Improvement of the Feynman-x distribution
    - Dennis Wright
  - Maintenance and user-support
    - M. Kelsey, Dennis Wright
- Binary (**BIC**) model
  - Code review and maintenance
    - Gunter Folger
- Liege (**INCLXX**) model
  - Maintenance and user-support
    - J-C. David, D. Mancusi, J.L. Rodriguez Sanchez, D. Zharenov
  - Extension of ABLA nuclear de-excitation for super-heavy nuclei up to Z=118
    - J.L. Rodriguez Sanchez

Precompound / De-excitation models

- Maintenance and user support
  - Continue the effort of resolving bug reports related to de-excitation
  - Continue the reorganization of de-excitation module: improve design, make de-excitation handler be flexible to consider internal conversions
  - V. Ivanchenko, J.M. Quesada

Radioactive Decay model

- Maintenance, user support and improvement
  - A. Howard, V. Ivanchenko, A. Ribon, Dennis Wright
- Maintenance of the database
  - L. Desorgher, V. Ivanchenko, L. Sarmiento, A. Tolosa Delgado, Dennis Wright

New Hadronic Datasets

- G4ENSDFSTATEDATA, G4LEVELGAMMADATA, G4RADIOACTIVEDATA
  - They are not fully consistent, in particular for nuclear levels with incomplete information
  - There are also some unphysical nuclear levels
  - Several open bugs in hadronics are due to these shortcomings

- Create new versions of the above hadronic datasets
  - That are consistent between them, and with fewer (ideally none) unphysical nuclear levels
  - L. Desorgher, V. Ivanchenko, A. Ribon, L. Sarmiento, A. Tolosa Delgado, Dennis Wright

ParticleHP model

- Validation, maintenance and user support
  - P. Arce, D. Cano, E. Dumonteil, S. Losilla, E. Mendoza, L. Thulliez, D. Wright, M. Zmeskal
- 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
- Support for thermal scattering data;
  implementation of the description of the Unresolved Resonance Region (URR) with probability tables;
  building a data library of Doppler-broaden cross-sections at room temperature;
  development of new variance reduction techniques (Adaptive Multilevel Splitting)
  - E. Dumonteil, L. Thulliez, M. Zmeskal
- Continue revision of the code implementation;
  use *G4PhotoEvaporation* for nuclear de-excitation via gamma emissions
  - V. Ivanchenko

LEND model

- LEND and GIDI update
  - B. Beck, C. Mattoon, Douglas Wright

NCrystal model

- Updating NCrystal-Geant4 hooks
  - X.Cai, T. Kittelmann

Other Hadronic models (1/2)

- Development and validation of neutrino / lepton – nuclear physics
  - In particular, neutrino oscillation in matter
  - Vladimir Grichine
- Use of Pythia8 as an external generator in Geant4
  - Application for LDMX experiment
  - E. Elen, L. Sarmiento
- Continue developing muonic atoms code
  - In particular, muon catalyzed fusion, and improvements in atomic capture physics
  - Kevin Lynch and collaborators
- Emulating hadronic models with generative graph neural networks
  - *E.g.* precise but very slow models like BLOB
  - L. Arsini, C. Mancini

Other Hadronic models (2/2)

- Continue the development of Light-Ion QMD (LIQMD)
  - Quantum Molecular Dynamics (QMD) model for light ions, in particular for medical applications
  - Tuning of the parameters
  - Yoshihide Sato

Hadronic Validation and Testing (1/2)

- Continue integrating calorimeter test-beams for hadronic validation in *geant-val*
  - *E.g.* Dual Readout calorimeter, CMS HGCal and others
  - Lorenzo Pezzotti
- Hadronic validation of selected releases using thin-target data and maintenance of selected tests
  - 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)

- Validation of Geant4 with n_TOF
  - In particular, investigation of the apparent bug observed in the calculation of the neutron flux (non-physical peak at ~42 MeV when thermal scattering of neutrons is activated)
  - M. Cortes-Giraldo, J.A. Pavon Rodriguez
- Tests and user support via public Geant4 examples
  - Michel Maire
- Validation of electro-production using electron beam at JLab's energies
  - Maurizio Ungaro