



Geant4 Hadronic Physics Group Work Plan for 2023

2nd version, 15 February 2023

Hadronic String models (1/2)

- Review of experimental and theoretical studies of hypernuclei and anti-hypernuclei, and improvements of their nuclear interactions in Geant4
 - First version, very simplified, released in G4 11.1
 - Vladimir Uzhinsky
- Validation of charm production for **FTF** and **QGS**
 - 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
 - d-d, d-A, t-A, He4-He4, He4-A, C12-A, *etc.*
 - A. Galoyan, V. Uzhinsky

Hadronic String models (2/2)

- Investigate the **FTF** problem of too optimistic energy resolution for pion showers in ATLAS calorimeters
 - ~20% disagreement since G4 10.5, seen in both ATLAS HEC and TileCal
 - L. Pezzotti, A. Ribon, V. Uzhinsky
- 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

- 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
- **Extension for antiproton**
 - J-C. David, D. Zharenov
- Short range correlations in INCL and improvements for ABLA
 - J.L. Rodriguez Sanchez

Precompound / De-excitation models

- Maintenance and user support
 - Continue the effort of resolving bug reports related to de-excitation
- Evaluate FermiBreakUp model, alternative GEM model, and Multi-Fragmentation model
- Improve the simplified treatment of de-excitation for hypernuclei
 - V. Ivanchenko, J.M. Quesada

Radioactive Decay model

- Maintenance, user support and improvement
 - Dennis Wright
- Maintenance of the database
 - Laurent Desorgher

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 Doppler Broadening Rejection Correction (DBRC), probability table for Unresolved Resonance Region, development of new variance reduction techniques (e.g. AMS - Adaptive Multilevel Splitting)
 - E. Dumonteil, L. Thulliez, M. Zmeskal
- Improvement and speed-up of the code
 - V. Ivanchenko, Dennis Wright, P. Arce
- Creating a physics list with explicit thermal scattering, e.g. *QGSP_BIC_HPT*
 - Miguel Antonio Cortes Giraldo

LEND model

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

NCrystal model

- Geant4-NCrystal integration
 - X.Cai, T. Kittelmann

Other Hadronic models (1/2)

- Development and validation of neutrino / lepton – nuclear physics
 - In particular, neutrino oscillation
 - Vladimir Grichine
- Review of the neutrino classes, and biasing of neutrino physics
 - V. Grichine, V. Ivanchenko
- C++ interface to (Fortran) Fluka-Cern and applications
 - New hadronic extended examples
 - Gabrielle Hugo
- 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
 - Kevin Lynch

Other Hadronic models (2/2)

- Add charge exchange option to hadronics
 - Potentially important for hadronic showers : can convert charged pions into neutral ones
 - Existing class *G4ChargeExchange*, *G4ChargeExchangeProcess*, and *G4ChargeExchangePhysics* are currently not used in any reference physics lists
 - Vladimir Ivanchenko
- Emulating hadronic models with generative graph neural networks
 - *E.g.* precise but very slow models like BLOB
 - L. Arsini, C. Mancini
- Low-energy hadronic interactions of protons with ^{11}B
 - Pablo Cirrone

Hadronic Validation and Testing (1/2)

- Continue integrating calorimeter test-beams for hadronic validation in *geant-val*
 - *E.g.* Dual Readout calorimeter, CMS HGCal, CALICE HCAL, and others
 - Lorenzo Pezzotti
- Use fixed target data and calorimeter data for hadronic validation
 - Sunanda Banerjee
- 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)

- Tests and user support via public Geant4 examples
 - Michel Maire
- Validation of electro-production using electron beam at JLab's energies
 - Maurizio Ungaro
- Validation of neutron physics with the TARC test
 - Alex Howard
- New test case for thermal neutron transport
 - Sergio Losilla
- Validation of rare isotopes interaction with matter
 - Paul Guede