



Geant4 Hadronic Physics Group Work Plan for 2025

1st version, 15 January 2025

Hadronic String models (1/3)

- Verification of the string rotation algorithm of **FTF** model using Cronin's experimental data on p-A interactions at 200, 300, and 400 GeV/c
 - The hope is to improve the simulation of hadronic showers
 - Vladimir Uzhinsky
- Tuning of **QGS** parameters for descriptions of meson production in p-p and p-A interactions using NA61/SHINE experimental data, especially for the description of strange meson production
 - Vladimir Uzhinsky
- Study of **FTF** model possibilities for descriptions of nucleus-nucleus interactions at $E_{\text{cms_NN}} > 3$ GeV
 - Especially Au+Au BES/RHIC data, and BM@N/NICA data on Ar+A interactions at 3.2 GeV/nucleon
 - Vladimir Uzhinsky

Hadronic String models (2/3)

- Study of p-p and d-d elastic scattering codes in Geant4, and possibly improvement based on experimental data
 - Aida Galoyan
- Testing and possible improvements of strange particles productions in hadron-nucleus and nucleus-nucleus interactions in the FTF and QGS models coupled with Preco or Binary cascade models using new experimental data at various initial energies
 - Creation of special tests for Geant4 for the strange particles productions
 - Aida Galoyan
- Analysis of probabilities and kinematical spectra of charmed particles production in hadron-hadron and hadron-nucleus interactions in FTF and QGS models, using data of various experiments
 - Creation of corresponding codes for charmed particle production tests
 - Aida Galoyan

Hadronic String models (3/3)

- 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
 - 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 antineutron
 - J-C. David

Precompound / De-excitation models

- Maintenance, user support and improvement
 - Continue the effort of resolving bug reports related to de-excitation
 - N. Chalyi, 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

Hadronic Datasets

- Refinements of the latest hadronic datasets :
G4ENSDFSTATE3.0, PhotonEvaporation6.1, RadioactiveDecay6.1.2
 - Released in G4 11.3, some further tests and refinements are needed
 - On-going effort to solve open bugs in hadronics thanks to these improved datasets
 - Make available the scripts and documentation on how to create these datasets
 - L. Desorgher, V. Ivanchenko, L. Sarmiento, A. Tolosa Delgado, Dennis Wright
- Update of G4PARTICLEXS based on room-temperature cross sections of ParticleHP
 - (See next slide)
 - Vladimir Ivanchenko

ParticleHP model

- Validation, maintenance and user support
 - P. Arce, D. Cano, E. Dumonteil, S. Losilla, E. Mendoza, L. Thulliez, D. Wright, M. Zmeskal
- Implement the use of pre-Doppler broaden cross section database at a given temperature; implement the algorithm that allows to do that at the beginning of a Geant4 simulation (to be as versatile as possible)
 - E. Dumonteil, L. Thulliez, M. Zmeskal
- Implement the AMS (Adaptive Multilevel Splitting) variance reduction technique
 - E. Dumonteil, L. Thulliez
- Extend ParticleHP model to higher energies
 - D. Cano, E. Mendoza
- Refinements of the integrator of the NuDEX model into Geant4
 - D. Cano, E. Mendoza
- Continue the alternative software implementation of the ParticleHP package
 - Vladimir 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 gamma/lepton/neutrino – nuclear physics
 - V. Grichine, V. Ivanchenko
- Maintenance of the interface to FLUKA.CERN hadron-nucleus inelastic interactions
 - Gabrielle Hugo
- Use of Pythia8 as an external generator in Geant4
 - Application for LDMX experiment
 - E. Elen, L. Sarmiento
- Continue the development of the charge exchange model
 - V. Ivanchenko, M. Kirsanov
- Update of the QMD model in the energy region of the heavy ion therapy
 - Yoshihide Sato

Other Hadronic models (2/2)

- Finalising the emulation of the computation via a Deep Learning (DL) model of the QMD and LIQMD hamiltonian derivative.
Exploring the possibility of emulating BLOB or a portion of it with DL
 - L. Arsini, C. Mancini
- Update of the QMD model in the energy region of the heavy ion therapy
 - Yoshihide Sato
- Continue the development of the muonic atoms code
 - Kevin Lynch
- Refactoring of Legendre polynomials implementations
 - Alvaro Tolosa Delgado

Hadronic Validation and Testing (1/2)

- Extending the coverage of hadronic tests in *geant-val*
 - Calorimeter test-beams, [Lorenzo Pezzotti](#)
 - Low-energy neutron tests, [D. Konstantinov](#), [L. Thulliez](#)
- 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
- Support of hadron-therapy applications
 - Serena Fattori