Geant4 Hadronic Physics Group Work Plan for 2025

2nd version, 18 February 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_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

- 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 the production of strange particles 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 production of strange particles
  - Aida Galoyan

- Analysis of probabilities and kinematical spectra of charmed particles produced in hadron-hadron and hadron-nucleus interactions in FTF and QGS models, using data of various experiments
  - Creation of corresponding tests for the production of charmed particles
  - Aida Galoyan

3

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)

- 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

- ## Maintenance and development of the ABLA++ model

  - Code optimization, cleanup, and documentation improvement
  - Improving the description of fission-barrier heights with existing experimental data
  - Adding more fission modes to improve the description of mass and charge distributions of fission fragments
  - Jose Luis Rodriguez Sanchez

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, L. Thulliez, A. Tolosa Delgado, Dennis Wright

- Testing of the radioactive decay biasing

  - Alex Howard

Hadronic Datasets

- Refinement of the latest hadronic datasets :
  G4ENSDFSTATE**3.0**, PhotonEvaporation**6.1**, RadioactiveDecay**6.1.2**
  - 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, E. Mendoza, L. Sarmiento, L. Thulliez, A. Tolosa Delgado, Dennis Wright

- Update of G4PARTICLEXS based on room-temperature cross sections of ParticleHP
  - (See next slide)
  - Vladimir Ivanchenko

ParticleHP model (1/2)

- Validation, maintenance and user support

  - P. Arce, D. Cano, E. Dumonteil, V. Ivanchenko, 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

- Translation of new nuclear data library releases from the ENDF-6 format to the G4NDL format, and verification

  - D. Cano, E. Mendoza

- Continue the alternative software implementation of the ParticleHP package

  - Vladimir Ivanchenko

ParticleHP model (2/2)

- 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 integration of the NuDEX model into Geant4, and expand its usage (not only in neutron capture reactions)

  - D. Cano, E. Mendoza

LEND model

- LEND and GIDI update
  - B. Beck, 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

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 heavy ion therapy

  - Yoshihide Sato

- Continue the development of the muonic atoms

  - Kevin Lynch

- Refactoring of the implementations of Legendre polynomials

  - 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

- Study of the sensitivity of the MC predictions to the variations of various parameters and development of needed infrastructure

    - K. Genser, R. Hatcher, S.Y. Jun, 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
- Validation of hadronic models
  - Michael Taylor