

Hadronic Improvements for Release 9.5

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Outline

- Fritiof (FTF) model
- Precompound/de-excitation
- New neutron models
- Improved muon-nuclear
- Radioactive decay
- Energy/momentum checking
- Cross section re-design
- G4Exception migration
- Physics lists

Fritiof Parton/String (FTF) Model

- Anti-ion-nuclear interactions now included
 - antideuteron, antitriton, anti ^3He , antialpha down to zero incident energy
- Antibaryon-nuclear interactions now included
 - strange and non-strange antibaryons down to zero KE
- New antiproton stopping model
 - uses above feature of FTF

Precompound/De-excitation

- Photo-evaporation
 - in place of existing evaporation data file, user can now substitute his own (as argument in physics list)

Neutron Models

- ENDL/GIDI

- new ENDL high precision neutron models developed to use new data format developed by LLNL
- ENDL99 and ENDF-VII.0 have been converted to new data format and are distributed from LLNL website

- HP Neutron Models and G4NDL

- G4NDL 3.16 fully migrated to ENDF-VII.0
 - 389 isotopes + 3 natural abundances and 9 excited isomer states
 - Thermal scattering files migrated to ENDF/B-VII format
- now possible to clearly identify which db is being used for which reaction
- CIEMAT translation of 8 data libraries including ENDF-6, ENDF-7, JENDL, JEFF, BROND, CENDL, ...
- existing NeutronHP model extended to read these, as well as original HP libraries
- will be distributed from IAEA web site

Improved Muon-nuclear Model

- **G4VDMuonNuclearModel**
 - uses Kokoulin virtual photon spectrum
 - converts photon to π^+ or π^- then uses Bertini cascade to interact pion (instead of LHEP)
- Precursor to replacement of electronuclear and photonuclear models

Radioactive Decay

- Forbidden beta decay added
 - 1st, 2nd, 3rd unique and 1st non-unique
 - new data files, in RadioactiveDecay3.4, to be released with corresponding forbidden decay flags
- Improved photo-evaporation database for gamma emission following internal conversion
 - also bug in calculation of internal conversion coefficients fixed
 - better reproduction of gamma line intensity
- Now can handle $Z > 100$
 - users can develop their own heavy nuclei and set flag to allow their use

Energy/Momentum Checking

- Almost all in-flight hadronic processes now have automatic energy and momentum checking
 - most models conserve to within 1 MeV
 - environment variables available to change allowed level of non-conservation
 - not yet applied to stopping models, CHIPS
- E/p checking now part of routine testing

Cross Section Re-design

- Needed in order to:
 - treat materials which include isomers in composition
 - allow thermal scattering in NeutronHP to automatically handle G4NistMaterials
 - avoid multiple copies of cross section data/calculations
- New methods and refactoring
 - no change in physics performance expected or observed
 - possible slight slowdown due to more complex design

G4Exception Migration

- All hadronic processes, models and cross sections now use new G4Exception
 - error code convention: HAD_XXXX_NNNN, where
 - XXXX = process, model, or cross section abbreviation
 - NNNN = error number within method (not a severity code any longer)
- Expect more uniform error reporting as a result

Physics Lists

- Status change for several physics lists
 - Formerly supported:
 - QGSP_BERT → experimental
 - QGSP_BERT_EMV – replaced by physics list factory
 - CHIPS → experimental
 - Formerly experimental:
 - FTFP_BERT_EMX – replaced by physics list factory
 - FTF_BIC – use FTF for kaons
 - QGSP_BERT_EMX – replaced by physics list factory
 - QGSP_BERT_NOLEP → unsupported
 - QGSP_BERT_TRV → unsupported
 - Shielding → supported

Physics Lists

- Status change for several physics lists
 - Replaced:
 - QGSP – functionality replaced by other physics lists, currently no usable
 - Status undecided:
 - LBE -> experimental or unsupported
 - QBBC -> experiemtnal?