Hadronic Physics Lists

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Geant4 workshop

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Contents

- Recap changes for 9.6

- Changes implemented for 10.0

Recent Updates

- Goal: Eliminate use of CHIPS in main physics lists
  - CHIPS used as
    - Stopping models
    - Gamma and electro-nuclear
      - G4EmExtraPhysics.{hh,cc} do not use Bertini
    - Quasi-elastic in QGS, cross section and model
    - Kaon cross section
    - Hyperons
- Prepare physics list independent of CHIPS
  - FTFP_BERT_TRV an experimental list, used to test development of alternative models and code.
- G4 9.6beta: FTFP_BERT does not use CHIPS
  - Use cross sections by M.Kossov, but ported/re-implemented to use standard interface.

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Achieved for 9.6

Main physics lists free of CHIPS

- Cross sections were extracted

- QGS uses quasi-elastic as 'extracted' from CHIPS

- Stopping uses

  - FTF for anti-baryons

  - Bertini/Precompound for pi-, K-, Sigma-, Xi-, and Omega-

Use best Cross sections
FTFP_BERT, QGSP_BERT

- Use the agreed set of cross-sections

  - Proton, Neutron G4BGGNucleonInelastic

  - Pions: G4PiNuclearCrossSection & Glauber-Gribov

  - Kaons: G4ChipsKaonPlusInelasticXS (from cross_sections/)

- Shen for ion cross sections

  - In G4IonBinaryCascadePhysics and G4IonFTFPBinaryCascadePhysics

  - Tripathi cross sections no longer used

- G4BGGHadronElasticXS proton elastic cross section for G4HadronElasticXS

Factory

- adding the factory machinery, adding the registry

- implementing the generic physics list

- cross section factory

  - Allow reuse of cross sections

Added physics lists

- FTFP_BERT_HP

- 4 new, physics lists, labeled obsolete

  - save previous settings for lists in use by LHC for backwards compatibility

  - QGSP_BERT_95, QGSP_BERT_95XS, QGSP_FTFP_BERT_95, QGSP_FTFP_BERT_95XS

9.6

- Supported are:
FTFP_BERT, FTFP_BERT_HP, G4GenericPhysicsList, QBBC, QGSP_BERT, QGSP_BERT_HP, QGSP_BERT_NOLEP, QGSP_BIC, QGSP_BIC_HP, QGSP_FTFP_BERT, Shielding,

- Experimental are:
FTF_BIC, FTFP_BERT_TRV, QGS_BIC, QGSP_INCLXX,

- Obsolete/unsupported are:
CHIPS, CHIPS_HP, LHEP, LHEP_EMV, QGSC_BERT, QGSC_CHIPS, QGSP, QGSP_BERT_95, QGSP_BERT_95XS, QGSP_BERT_CHIPS, QGSP_FTFP_BERT_95, QGSP_FTFP_BERT_95XS, QGSP_QEL,

- Unknown status:
FTFP_BERT_EMV, FTFP_BERT_EMX, LBE, QGSP_BERT_EMV, QGSP_BERT_EMX, QGSP_BERT_TRV, QGSP_BIC_EMY,

Geant4 10.0

Re-organize directory structure

9.6 and before

- Two directories
  - Lists
    - Physics lists and hadronic constructors
  - Builders
    - All the rest
  - and tests

- 9.6 ref01 & 10.0
  - 12 directories
  - Lists
  - Constructors
    - Split further to physics (9 dirs)
  - Builders
  - Util
  - and tests

Technical Changes since 9.6

- Delete obsolete lists and associated builders and physics constructors

- Many fixes for coverity and warnings

- Changes for MT

  - new G4VUserPhysicsList API,

  - Share physics-list objects between threads

  - Processes/models thread local

Complete migration away from CHIPS and LEP/HEP

- Was started for 9.6, but not complete

- Remove projectile diffraction, based on CHIPS

- LHEP
  - Stopping physics uses FTF and Bertini
  - Neutron capture uses G4NeutronRadCapture and G4NeutronCaptureXS
  - Fission only kept for HP lists

G4 9.6.ref09 / Geant4 10.0

- Supported are:
  - FTFP_BERT(_HP),
  - QGSP_BERT(_HP), QGSP_BIC(_HP), QGSP_FTFP_BERT
  - Shielding
  - QBBC
  - G4GenericPhysicsList

- Experimental are:
  - FTFP_BERT_TRV
  - FTFP_INCLXX(_HP), QGSP_INCLXX(_HP)
  - FTF_BIC, QGS_BIC

- Obsolete/unsupported None

- Unknown status: LBE

Summary

- Number of physics lists largely reduced
  - Removed CHIPS and LHEP
  - No obsolete
- Use 'best' cross sections
- New Factories with registration mechanism (9.6)
  - Lists – end user
  - Cross sections – internal
- Technical changes
  - New directory layout
  - Migration to MT
  - Fixes for coverity
- Active category, with many collaborators contributing
  - 2013: Andrea, Davide, Gabriele, Gunter, Luciano, Makoto, Mathieu, Peter
  - Large number of tags (O(100))

Backup….

Change of model use 9.6 -1

- G4IonBinaryCascadePhysics with G4IonPhysics
- Added nuclear capture at rest of anti-nuclei with Fritiof/Precompound
- Changed default physics for stopping, lepto-nuclear, and ion.
- Only LHEP- and CHIPS-based physics lists keep using exactly
- the same physics as before
- Replace G4MuonMinusCaptureAtRest with G4MuonMinusCapture everywhere:
  - G4BertiniAndFritiofStoppingPhysics, G4QStoppingPhysics, G4LHEPStoppingPhysics, G4StoppingHadronBuilder, LBE.icc
- Replaced (removed) G4QandFTFStoppingPhysics with the new class G4BertiniAndFritiofStoppingPhysics in FTFP_BERT and FTFP_BERT_TRV

Change of model use 9.6 -2

- For nuclear capture at rest in both FTFP_BERT and FTFP_BERT_TRV,

- use Bertini for pi-, K-, and Sigma-; FTF/Preco for anti-proton

- and anti-Sigma+; removed CHIPS for Xi- and Omega-.

- created new builders using Bertini gamma nuclear

  - migrated FTFP_BERT to use the new builders

- In G4QandFTFStoppingPhysics the annihilation at rest of anti_sigma+ are now handled by FTF.

Removed physics lists/builders 9.6

- Replaced (removed) G4QandFTFStoppingPhysics with the new class

- G4BertiniAndFritiofStoppingPhysics in FTFP_BERT and FTFP_BERT_TRV

- Remove INCL builders

- Removed obsolete physics list QGSP_INCL_ABLA

Ions

- Cross section used is G4ComponentGGNuclNuclXsc for all

LBE

- Change of modeling
  - G4UrbanMscModel instead on Urban93
  - replaced LEP/HEP with FTFP+BERT