

GEANT4 9.4-beta and 9.4 highlights

Gabriele Cosmo, CERN PH-SFT
for the [Geant4 Collaboration](#)

Outline

- Major features introduced in release 9.4-beta
 - Geometry
 - Physics
 - Kernel & Interfaces
 - All details in:
 - <http://geant4.cern.ch/support/Beta4.9.4-1.txt>
- Highlights on 9.4
 - All planned features for 2010:
 - http://geant4.cern.ch/support/planned_features.shtml

Release 9.4-beta (on June 25th)

(details in <http://geant4.cern.ch/support/Beta4.9.4-1.txt>)

9.4-beta: Geometry

- New features and fixes in solids
 - Boolean solids: new recursive algorithm for improving visualization of Boolean combinations of shapes
 - Improvements in **G4Box** solid following code review
 - New **G4GenericTrap** specific shape (with GDML support)
 - Arbitrary trapezoid with up to 8 vertices standing on two parallel planes perpendicular to the Z axis (**Arb8** in Root)
 - Fix in **G4TessellatedSolid** to correct treatment of optical photon transport for internal reflection at surface
 - Addresses problem report [#1103](#)
- Features in volumes
 - Specialized allocator for handling internal vector in **G4NavigatorHistory**, to optimise memory management and reduce fragmentation
 - Measured ~2% average run-time speed-up

9.4-beta: EM physics

- Significant developments for multiple scattering models
 - New **G4GodsmithSoundersonMscModel** and **G4WentzelVIMscModel**
 - Fully based on theory and providing more precise results than **G4UrbanMscModel93**
 - G4UrbanMscModel93 still the default for e+-
- New model, **G4ICRU73QOModel**, for low-energy ionisation of negatively charged hadrons
- A protection is introduced for computation of Barkas corrections for low-energy highly charged particles
 - Following ATLAS request for exotic heavy objects with charge 150^*e^-
- Included scintillation rise time to **G4Scintillation**
- First version of transportation code for magnetic monopole
 - Provided in extended example
- Bug fix in atom selection during sampling of Bremsstrahlung in compound materials
 - May have a minor effect on ECAL simulation

9.4-beta: Low-energy EM physics

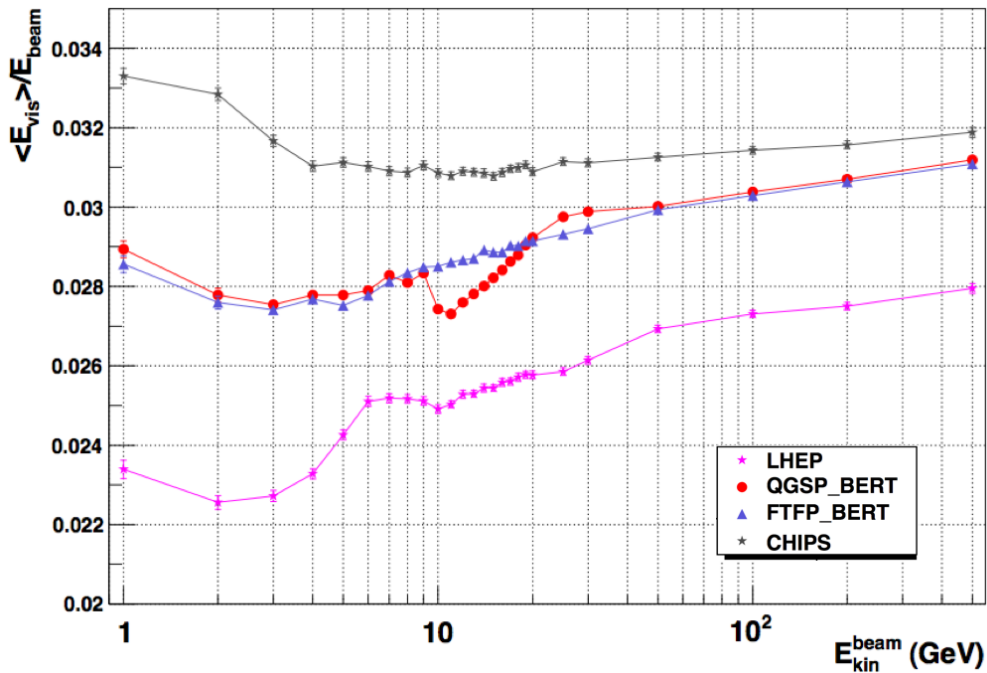
- Upgrades of G4Penelope from version 2001 to version 2008
 - New models for gamma-rays: Compton, Gamma-Conversion, Photo-Electric, Rayleigh
 - New classes (Beta version) to manage multi-element atomic oscillators
- Bug fixes in **G4AtomicDeexcitation** and **G4AugerTransition**
- G4DNA: new prototype excitation model for electrons
- Developments in PIXE classes
 - Fixing existing bugs and improving the goodness of the results especially at higher energies
 - New classes to interface to empirical ionization cross sections
 - Added possibility to choose which model to use for the calculation of shell ionization cross-section
- Requires new G4LEDATA data set, version 6.13

9.4-beta: Hadronic Physics

- Major cleanup of the Bertini cascade
 - Optimisation of memory allocation (up to 5% measured CPU improvement) and code review
- Added protections for numerical problems in pre-compound model
 - Addressing rare problems of FTF based Physics Lists
- Rewritten utility classes for de-excitation/evaporation
 - Migration to use integer Z and A
 - Reduced number of allocations of intermediate objects
 - By default FermiBreakUp model to decay light fragments ($A < 17$)
 - New default evaporation model (combines extra 60 GEM decay channels vs 8)
 - Some fixes for photon evaporation (precise 4-momentum balance in the Binary Cascade and pre-compound model)
- Significant developments for CHIPS models
- New fast precise neutron cross-sections code and data (Beta version)
- Removed obsolete code for **leading_particle** model

9.4-beta: Physics Lists

- Cleanup of old obsolete/blocked lists
- Added new constructor with same signature for all builders & verbosity argument
- New experimental physics list QGSP_BERT_CHIPS (validation ongoing)
 - uses CHIPS model for all “misc” particles (anti-protons, anti-neutrons, hyperons)
 - uses CHIPS cross-section for kaons
 - tested by CMS and BESIII experiment, still room to improve but goes in the correct direction



- Revised FTFP_BERT and QGSP_FTFP_BERT lists
- FTFP_BERT physics list shows agreement with QGSP_BERT (best for LHC)
 - Thanks to improvements in FTF (quark exchange, Reggeon cascade)
 - No discontinuity in response

9.4-beta: Optical Physics & Materials

- Fix for back-painted surfaces to avoid applying twice reflectivity
 - Addressing problem report [#1114](#)
- Updated parameterisation of density
 - For pure materials via atomic number (before was available only by material name – NIST materials only)
 - Minor effect on signals of tracker devices

9.4-beta: Visualization & Interfaces

- New UI command `/vis/open` for OpenGL and OpenInventor viewers
 - `/vis/open OGL`, `/vis/open OI`
 - Applicable for either X11 and Qt graphics
 - Allows the same macro to be used whether one is on Linux or Windows (e.g. calling `OGLSX` on Linux and `OGLSWin32` on Windows)
- Introduced `DispatchToModel` without `'i_mode'`
 - Simplifying commands for drawing trajectories
- Major improvements to Qt drivers
 - Added tab-widgets
 - Allowing to embed viewer within UI command window

Highlights on release 9.4 (December 17th)

(details in http://geant4.cern.ch/support/planned_features.shtml)

More Features planned for 9.4

- Release 9.4-beta made available on June 25th
 - Includes some new features part of the program for release 9.4 of December 2010
- Additional features will be part of the final 9.4 release
 - *At this point in time, it is not guaranteed that all of them will make it !*

Geometry

- Review of navigation verbosity & control at step number
- Implementation of precise **ComputeSafety** () in navigation
- Extension of divisions to allow for gaps in replicated daughters
- More Q/A review to code and addressing open issues

More Features planned for 9.4 - 2

Materials

- Addition of extra data for ion stopping powers
- Review of atomic shell energies
- Introduction of variable density

Particles

- Update properties of particles to PDG 2010
- Review implementation of static tables and treatment of ions for thread-safety

More Features planned for 9.4 - 3

Standard EM

- Extend capability of helper classes
- Addition of option for allowing to setup EM parameters via cut value
- New model of delta-electron production based on ICRU'52 data
- Establish more effective sampling of displacement in Urban multiple-scattering
- Updated gamma-conversion model at low-energies
- Updated Bremsstrahlung model for e+/- for energies $E < 1$ GeV
- Development of Doppler broadening parameterisation

Low Energy EM

- Penelope 2008 e+/- processes
- Pair production in the electron electric field
- Radiative correction for pair production in the nuclear field
- Reimplementation of anti-proton model of ionisation

More Features planned for 9.4 - 4

Hadronic Physics

- Implementation of fast neutron capture model
- Improved break-up method in de-excitation
- Complete interface from Bertini cascade to pre-compound
- Implementation of direct pion absorption in Binary cascade
- Improved trailing effect and elastic pi-nucleon angular distributions effect in Bertini cascade
- Implementation of Reggeon cascade in QGSM, and extension of QGSM down to lower energies
- Extension of FTF model to nucleus-nucleus collisions
- Implementation of an interface for HIJING model
- Development of ion-ion model for elastic scattering
- Development of integral nucleus-nucleus cross-sections

More Features planned for 9.4 - 5

Scoring

- Full revision of scorers to accept user-defined unit
- Cylindrical and spherical meshes for command-based scoring

UI & Environments

- Support for Python 3.0 in G4Py

Visualization

- Support of dynamic loading for visualization drivers
- Improved visualization tools for regular voxel geometries
- Support filtering of geometry according to attributes
- Integrated visualization of field lines

Advanced Examples

- Introduction of DICOM images for Medical-Linac and Hadrontherapy examples
- New examples: *GammaKnife* (simulation of a real 'radio-surgery' apparatus); *IORT* (simulation of a real apparatus for Intra Operative Radio Therapy); *Cexmc* (Charge exchange Monte Carlo)

9.4: more ...

- Configuration
 - New optional configuration & installation system based on CMake
- First prototype thread-safe/multi-core kernel
 - Alternative code tree to be released based on release 9.4 series
- Complete list of planned developments for 2010 at:
 - http://geant4.cern.ch/support/planned_features.shtml

Planned supported platforms for 9.4

- Linux SLC5, gcc-4.1.2, gcc-4.3.X, 32/64 bits
- MacOSX 10.6, gcc-4.2.1, 64 bits
- Windows/XP and CygWin Tools
 - Compiler Visual C++ 10.0 (Visual Studio 2010)
- Also tested: gcc-4.5.X, icc-11.X, VC++-9.0

Thanks!