GEANT4 10.5.p01 & 2019 planned developments
kernel modules

Gabriele Cosmo, CERN EP-SFT

for the Geant4 Collaboration

Outline

- Fixes introduced in release 10.5.p01
  - Kernel modules
  - Physics (see talks by V.Ivantchenko & A.Ribon)

- Overview of planned developments for 2019
  - Kernel modules
  - Physics (see talks by V.Ivantchenko & A.Ribon)

➢ *Detailed patch release notes:*
  - **http://cern.ch/geant4-data/ReleaseNotes/Patch4.10.5-1.txt**

➢ *List of planned features for 2019:*
  - **http://cern.ch/geant4/support/planned_features**

Bugzilla problem reports addressed - 1

10.5.p01:

#1824 – G4ParticleHPPhotonDist::GetPhotons() needs statistical rejection if repFlag is 0

#2085 – Optical messenger commands not working

#2089 – Differential cross-section of photo-electrons in G4LivermorePolarizedPhotoElectricModel

#2105 – EM logs wider than 80 characters

#2106 – Potential problems with assigning EM physics options to G4Regions

#2111 – G4Polycone fails to find intersection between line and cone

#2123 – Excited nucleus sometimes fails to decay

#2124 – Wrong value of fAlphaMax

#2125 – Uniform biasing error

#2126 – G4mplIonisationWithDeltaModel produces too many delta electrons

#2133 – Pressure/temperature not changing in ConstructNewIdealGasMaterial

#2134 – Wrong density calculation in ConstructNewIdealGasMaterial

#2138 – G4FTFPModel has a memory leak

#2140 – Release of static G4AssemblyStore results in segmentation fault

Bugzilla problem reports addressed - 2

10.5.p01:

[#2142](#) – Physical volume with more than 2 BorderSurface not written correctly in GDML

[#2143](#) – Different OpticalSurface with same MaterialPropertiesTable not written correctly in GDML

[#2145](#) – G4LogicalVolume null FieldManager propagation

[#2147](#) – FPE exception trapping doesn't work on MacOS

[#2150](#) – Set cut in range for protons to zero for HP physics

[#2152](#) – The energy of GenericIon increases infinitely

[#2156](#) – GDML export seg-faults in MT mode

10.5.p01 - Geometry

Geometrical primitives & navigation

- Corrected transformation to local system in G4QuadrupoleMagField
- Speedup in G4SolidStore, G4Region, G4Tet and G4TessellatedSolid for initialisation of complex flat geometries
- Revised algorithms and improved robustness in G4EllipticalTube
- Accurate calculation of radical in G4IntersectingCone
  - Problem report #2111
- Correction in G4AssemblyVolume destructor to avoid double-deletion of internal physical volumes. Problem report #2140
- Fix in G4LogicalVolume::AddDaughter() to avoid propagating pointer to field manager if null
  - Problem report #2145

10.5.p01 – Materials, Particles & Run

- Materials:
  - Fixed atomic number values in simple material printout and fixed build of gas materials in G4NistMaterialBuilder
    - Addressing problem reports #2133 and #2134

- Particles:
  - Allowing absolute zero proper decay time in G4PrimaryParticle

- Run:
  - Fix in G4MultiRunAction to cope with more than one user run action classes
  - Defining unit categories for UI commands that take units in G4UserPhysicsListMessenger

10.5.p01 – Persistency/GDML

- Fix in G4GDMLReadStructure::PhysvolRead() to allow correct import of recursive assembly structures
  - Addressing problem report #2141
- Added protection to G4GDMLParser for dumping geometry only through the master thread. Added extra protection also in reading
  - Addressing problem report #2156
- Fixed export of optical surface properties
  - Addressing problem reports #2142 and #2143

10.5.p01 - More …

- UI commands:
  - Fixed misbehavior in G4UIcommand::RangeCheck() , when string parameter comes prior to numeric-type parameters in commands
  - Added G4UIparameter::SetDefaultUnit() method to simplify definition of a unit parameter

- Visualization:
  - Fix to pick up default number of line-segments per circle from G4Polyhedron in G4ViewParameters

- Configuration:
  - Enable optional activation of FPE detection on MacOS with clang
    - Addressing problem report [#2147](#)

2019 Planned Developments
Kernel

Releases

- ## 2019 release of Geant4

  – Patches for previous releases as needed

- ## Consolidated releases of VecGeom

  – Further optimization and new shapes

  – Specialized navigators enhancements

  – Documentation

Infrastructure

- Migration of web site to Drupal-8
  - Upgrade from existing Drupal-7 site
- Migration of HyperNews fora to Discourse ✔
- Testing infrastructure in Jenkins ✔
  - Adoption of Docker containers for testing
  - Versioning of builds through pipelines
- Enhancements to Geant4 GitLab workflow ✔
  - Addition of code formatting hooks; integration with Coverity analysis; …
  - Adaptation to new features in future versions of GitLab; study of GitLab CI use
- Build and publication of Docker/Singularity images for releases
- Migration of static preprocessor –D flags to #define/undef directives ✔
- Modularization of Geant4 Libraries ✔
  - Global/granular/optional
- Optimization of Data Libraries
  - Simplify data library configuration/location using layered lookup via self-location, single environment variable, UI commands/C++ API
  - Provide C++ API for accessing/parsing data libraries
  - Optimize file access patterns and formats to minimize number of small files opened

Geometry & Transportation

- VecGeom
  - Implementation of missing shapes/constructs: ellipsoid, elliptical cone, etc.. ✔
  - Enhancements to specialized navigators, neighbor volume detection
  - Addition of replicas/divisions – *proposed summer project*
  - Use of Embree library for tessellated shapes – *proposed summer project*
  - GDML writer & ROOT I/O persistency – *proposed summer project* ✔
  - Generation of polyhedral meshes for shapes – *proposed summer project* ✔
  - Overlaps checking – *proposed summer project* ✔
- Implementation of a prototype navigator based on VecGeom ✔
- Separate safety computation and state from navigator
  - Implement strategy for a light-weight base navigator class not holding navigation state
- Profiling and optimization of multiple navigation
  - Revise design and implementation of multiple navigation and coupled-transportation
- Revision of transportation processes ✔
  - Specialized transportation processes for neutral and charged particles

Field Propagation

- Enable default use of interpolation in ✔ intersection calculation in field propagation

- Revise protocol between transportation and tracking to better cope with particles looping in field ✔

- Review accuracy of boundary crossing in field ✔
  - ➢ Recent ALICE and CMS requirement

Materials & Biasing

- Implementation of an extension for multiple particle type biasing
- Enrich event biasing options
  - leading particle biasing, DXTRAN-like biasing, implicit capture ✔
- Extend generic biasing scheme for at rest case ✔
- Prototype implementation of generic biasing techniques:
  - biasing of charged particles (with cross-section changing over the step) ✔
  - occurrence biasing (continuous density change inside a same volume)
  - material/isotope biasing; Woodcock tracking
- Adoption of the new elastic differential cross-section class in hadron elastic
- Implementation of new elastic differential cross-section class to be used in DXTRAN biasing option ✔
- Investigation on potential difficulties in propagating tiny weights for large cross-section change (neutrino interactions)
- Revision of the GFlash fast-simulation model ✔

Persistency & Analysis

- Enabling of import/export of assemblies envelopes in GDML ✔
- Improvements to n-tuple merging in row-wise mode ✔
- Addition of analysis "executive" to provide possibility to choose output type at run-time ✔
- Additional flexibility in resetting/deleting histograms
- Review support for writing same histogram/profile on file several times
- Handling of more files by analysis manager

Particles & Track

- Improvements and update of G4IonTable and G4ParticleTable to cope with muonic atom and hyperons ✔
- Review of production thresholds ✔

Run & Detector Response

- Multi-threading:
  - Workspace and memory cleanup in MT
  - Finalize new design of threads though tasking mechanism (allow threads to join/leave workers pool) ✔
  - Porting of material scanner to MT
  - Implement hooks for allowing sub-event level parallelism
- Implementation of phase-space file interface to GPS
- Revision of production thresholds ✔

User and Category Interfaces

- Improvements to ZeroMQ interface / Jupyter frontend (backend for UI-command distribution using ZeroMQ message-queue service)

- Integration of G4Py module to CMake build ✔

Visualisation

- OpenGL drivers:
  - New driver OGLFile to produce image files in batch jobs
  - Improvements to toolbar in OpenGL Qt
  - Adaptions to newer OpenGL versions, exploit new functionalities and replace deprecated calls ✔
- Other drivers:
  - New Apple/Metal driver for MacOS and native Qt driver ✔
  - New driver for export to format readable by Paraview
  - Updates to gMocrenFile and gMocren to support visualization attributes and other information
  - New driver G4DAE exporter for export in Collada format
  - Updates to OpenInventor Extended Viewer
  - Development of visualization solutions for iOS and Android devices
  - Rewrite of Wt driver
  - Change from flat format to hierarchical format in VRML
- Support for visualisation of Boolean shapes ✔
- New tool to support high resolution transparent visualization with ability to rotate and zoom
- Visualisation of geometry overlaps ✔
- Support of user-drawn primitives in multi-threaded mode
- Integrated visualization of field lines ✔

Novice & Extended Examples

- New example "dnadamage" for Geant4-DNA ✔
  - Simulation of a DNA chromatin segment with molecular definition
- New cross-sections for gas materials in the "icsd" DNA example
- New example illustrating generic biasing
  - "DXTRAN" MCNP-like option and implicit capture
- Extended biasing examples ✔
  - Fix overlap among B02, B03 and GB03 examples
- Updating selected examples with usage of G4Accumulable ✔
- Porting of Geant4e and related example to multi-threading
- Extension to the DICOM reader to support RT Dose format
- Complete migration to MixMax in EM examples ✔
- Review of examples macros and tests ✔
- Complete application of coding guidelines & code review ✔

Advanced Examples

- Development of alternative approaches for LET ✔ calculation in hadron-therapy

- New example for nanomedicine

  – Gold nanoparticles in X-ray radiotherapy

- Migration of air_shower example to multi-threading

- Assessment of physics of advanced examples and analysis of software quality metrics ✔

- Code review and coding guidelines ✔

Thanks!