

GEANT4 11.1.p01 & 2023 planned developments

kernel modules

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



Outline

- Fixes introduced in patch releases 11.1.1 and 11.0.4
 - Kernel modules
- Review of planned developments for 2023
 - Kernel modules
 - Physics (see Alberto & Vladimir talks after this)
- *Detailed patch release notes:*
 - <https://cern.ch/geant4-data/ReleaseNotes/Patch.11.1-1.txt>
 - <https://cern.ch/geant4-data/ReleaseNotes/Patch.11.0-4.txt>
- *List of planned features for 2023:*
 - <https://cern.ch/geant4/planned-features-2023>

Bugzilla tickets addressed

- [#2498](#) – Inelastic neutron cross-section wrongly calculated
- [#2514](#) – dEdX tables contain NaN
- [#2515](#) – G4NumIntTwoBodyAngDst bug in std::fill call in ctor – wrong dimension used
- [#2516](#) – Bug in G4TwoBodyAngularDist.cc: wrong final state for pi+ n charge
- [#2518](#) – Null pointer dereference in G4AnalysisManager::GetNofNtuples()
- [#2520](#) – EMZ lists crash when base materials themselves have base materials
- [#2521](#) – There is a rare problem in G4GammaGeneralProcess – no sub-process
- [#2523](#) – Crash happens when the new process of muon pair production by muons is enabled
- [#2525](#) – geant4-config –libs missing recently builtin SG vis
- [#2530](#) – Unusual behaviour for the “AddEmRegion” macro command

11.0.p04

11.0.p04

11.0.p04

11.0.p04

11.0.p04

11.1.p01

11.1.p01

11.1.p01

11.1.p01

11.0.p04

Patches - Geometry

11.1.p01

- Solids/Boolean:
 - Fixed hang-out in G4MultiUnion, caused by overflow of 'size-1' when 'size' value is zero
- Solids/Specific:
 - G4QuadrangularFacet: fixed references to triangles in the warning message issued when checking for collinear vertices
- Management:
 - G4LogicalVolume: use `std::shared_ptr` for handling visualization attributes. Ignore calls to `SetVisAttributes()` from worker threads
- Magnetic field:
 - Reduced printout for setting any valid value for `epsilon_min/_max` in `G4FieldManager`

Patches - Global, Run, Transportation

11.1.p01

- Global:
 - G4DataVector: simplified and corrected inline methods implementation
- Run:
 - G4PhysicsListHelper: added forgotten process of muon pair production by muons and added general process
 - Addressing problem report [#2523](#)
 - Reduced printout in destruction of run-manager (master and workers), to be coherent with verbose level greater than 1
- Transportation
 - Fixed inadvertent creation of G4TransportationParameters in G4Transportation constructor, determining a change of default looper parameters, responsible for observed warnings at run-time
 - Fixed compilation warning about unused variable with G4VERBOSE unset

Patches – Materials, Particles

- Materials:

- G4Material: allow recursive search for based material

11.1.p01

- Addressing problem report [#2520](#)

- G4Material: added an extra check on number of atoms in method `AddElementByNumberOfAtoms(..)`

11.0.p04

- Addressing problem report [#2514](#)

- Particles:

- G4XicZero, G4AntiXicZero, G4OmegacZero, G4AntiOmegacZero:

11.0.p04

- Updated mean lifetime values according to PDG-2022

- G4Triton, G4AntiTriton: corrected the lifetime value for triton and anti_triton. The half-life (12.32 years) was incorrectly used instead of the mean lifetime (17.774 years) for triton, whereas the anti_triton was incorrectly treated as stable

11.0.p04

- G4AntiNeutron: set the "PDG stable" flag to "false", as for G4Neutron. This has no practical consequences, i.e. anti_neutron decays regardless of this flag

11.0.p04

11.1.p01

Patches – Analysis, Visualisation, Configuration

- Analysis:

11.0.p04

- Added a protection against nullptr in `G4VAnalysisManager::GetNofNtuples()`
 - Addressing problem report [#2518](#)
- Do not remove non-empty HDF5 output files

- Visualisation:

11.0.p01

- Fixed transform in `G4TextModel`; the rotation part of the transform was being ignored. This impacted the implementation of `/vis/scene/add/localAxes`

- Configuration:

11.0.p01

- Fixed configuration/use of TGS visualisation driver in `geant4-config`
 - Addressing problem report [#2525](#)
- Use `PROJECT_` or `Geant4_` scoped `_SOURCE/BINARY_DIR` variables in place of `CMAKE_` scope version to ease use of Geant4 as a CMake subproject
 - Based on [GitHub PR#52](#)
- Removed no longer required `G4VecGeomShim` module
 - `VecGeom` supports/supplies full imported targets since 1.1.18

2023 Planned Developments

Kernel

✓ In progress...

✓ Achieved already in development releases

Infrastructure & Software management

- Enhancements to Geant4 GitLab workflow ✓
 - Review location and documentation for unit and integration tests
 - Review use and integration of performance monitoring tools
 - Additional Geant4Bot capabilities
- Modularization of Geant4 Libraries ✓
 - Identify libraries/modules for merging, splitting, drop/add to a build
 - Profile modularization scheme to ensure performance is not affected
- Updates to testing and build system ✓
 - Extend testing (platforms/compilers) of VecGeom-based builds
 - Review mandatory and optional compiler flags needed to build and link to Geant4
 - Review optimization levels and options for Release builds
 - Provide pkg-config scripts for use by non-CMake build tools
- Formalise support for packages in downstream package managers
 - Spack, Conda, Homebrew, Debian, Gentoo
- Source code static analysis: maintenance & support of Coverity tool ✓

Geometry & Navigation

- VecGeom
 - Complete surface bounded volumes prototype ✓
 - missing solids, integration in AdePT
 - Code simplification, removal of unused API/backends/specialisations ✓
 - Improve portability of SIMD-aware solids
 - Handling of construction and run-time errors
 - Extended platforms support and testing ✓
- Separate safety computation and its state from navigator ✓
 - Loose coupling of navigator in the computation of the safety distances from geometrical boundaries
- Investigate simplification of touchables implementation
 - Code optimisation: removal of unused specialisations and inheritance

Field Propagation

- Addition of QSS integration methods (Quantized State Simulation) ✓
 - Alternative integration method which creates adapted polynomials and evaluates the limit of their validity
- Review accuracy of boundary crossing in field
 - ALICE and CMS requirement

Persistency & Analysis

- Addition of support for parallel geometries in ASCII ✓
- Investigate more flexibility in resetting/deleting analysis objects

Fast Simulation & Biasing

- Fast Simulation
 - Development of ML fast shower models for data generated with Par04 example ✓
 - MetaHEP testing on LHC experiments; implementation for FCC applied to LHC experiments
 - Build a general validation pipeline based on quantitative metrics for evaluating generated showers
 - Implementation and validation of GFlash code with general fast sim tools
 - Revision of GFlash models ✓
- Generic Biasing
 - Biasing of charged particle interaction occurrence
 - Prototyping of DXTRAN-like functionality
 - Extend generic biasing scheme for at rest case
 - Review of generic biasing with parallel world
 - Maintenance of importance biasing and extension to multiple particle type biasing
- Reverse Monte-Carlo
 - Migration to multi-threading and improvements
 - Use of Reverse MC in parallel geometries

Particles, Tracking, Tasking, Scoring & UI

- Particles & Tracking:
 - Update of particle properties to latest PDG data ✓
 - Redesign and implementation of G4ForceConditions
- Multi-threading & Tasking:
 - First prototype of task-based sub-event level parallelism ✓
 - Feasibility study on parallelisation of initialisation stage
- Scoring
 - Review of scoring in parallel worlds
- UI
 - Code updates to C++11/14/17 style ✓

Visualisation

- OpenGL/Qt drivers:
 - Migration to Qt6 ✓
 - Improvements to toolbar in OpenGL Qt
 - Improvements on sceneTree & Rubberband picking
 - Adapt to newer OpenGL versions, exploit new functionalities and replace deprecated calls such as glBegin/glEnd
- Vtk driver
 - Update and consolidation of driver functionalities ✓
 - Fully develop large renderings for medical applications
- Open Inventor:
 - Refinements and extensions to the Open Inventor Qt Viewer ✓
 - Work on reference path to move through the geometry
 - Improved use/install of Coin library
- Other drivers:
 - Improvements and further developments to native Qt3D driver ✓
 - Improvements and further developments to tools_sg (TSG) driver based on g4tools ✓
 - Provide 2min videos for each viewer
 - Development of visualisation solutions for iOS and Android devices

Novice & Extended Examples

- New example of generic biasing for "DXTRAN" MCNP-like option and occurrence interaction of charged particles
- New example of task-based sub-event parallelism ✓
- New hadronic extended examples for C++ interface to (Fortran) Fluka-Cern
- Porting of Geant4e and related example to multi-threading
- Porting of example on polarisation to multi-threading
- New gflash parameterisation example for sampling calorimeter
- Extension to Par04 example to run fast simulation on GPUs
- Medical & DNA
 - New micro-dosimetry example for spectra calculation in a cylindrical domain at specific water depth imitating silicon detector
 - New medical example for ultra-high dose rate
 - New examples to study depth dose profile and for SEU simulation
 - Extension to the DICOM reader to support RT Dose format
 - Inclusion of new cross-sections for gas materials in the "icsd" Geant4-DNA example
 - Add the possibility to use IRT/SBS methods in the DNA "scavenger" example
 - Implement DNA damage in plasmids with IRT
 - Validation and development with protons and He4 ions in molecularDNA example
- Review of examples macros and tests (coverage of commands and use-cases) ✓
- Complete application of coding guidelines ✓

Advanced Examples

- Development of a specific example for proton tomography ✓
- Development of a SPring-8 synchrotron x-ray polarimetry example for testing low energy polarised gamma-ray physics
- Further developments of in-silico experimental micro-dosimetry in the Radio-protection example
- Development of a mammography example
- Development of a new example dedicated to the ATHENA mission ✓
- Implementation of pre-clinical, mice PET images to evaluate a dose distribution for new drugs
- New example showing how to import in Geant4 simulations IAEA Phase Space Files
- Improvement of Hadron-therapy example in the simulation of proton, carbon ion and helium ion beam irradiation
- Code review, migration to C++17 and coding guidelines ✓

Thanks!