

GEANT4 11.1.p02 & 2023 planned developments

kernel modules

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Outline

- Fixes introduced in patch release 11.1.2
 - Kernel modules
- Review of planned developments for 2023
 - Kernel modules
 - Physics (see talk after this)
- *Detailed patch release notes:*
 - <http://cern.ch/geant4-data/ReleaseNotes/Patch.11.1-2.txt>
- *List of planned features for 2023:*
 - <http://cern.ch/geant4/planned-features-2023>

Bugzilla tickets addressed in 11.1.2

[#2530](#) – Unusual behaviour for the "AddEmRegion" macro command

[#2531](#) – An unexpected difference in muon energy loss between Geant4 v10.7.p0n and v11+ ?

[#2541](#) – Cannot Create Analysis Histograms by specifying edges vector

[#2543](#) – Muon/Pion generation difference between Geant4 v11.0.4 and 11.1.1

11.1.2 Patch - Geometry & Persistency

- Magnetic Field:
 - Fixed compilation warnings on clang-15 for mismatched bounds declarations in input parameters for steppers
- Management:
 - In G4Region, now issue a fatal exception if attempting to add a root logical volume which is already set as root for another region
- Solids/CSG:
 - In G4UTrap wrapper, fixed constructor for Right Angular Wedge
- Solids/specific:
 - Fixed uninitialised value in G4VCSGfaceted::SurfaceNormal()
 - Fixed potential uninitialised values in G4VTwistSurface, G4PolyconeSide and G4SolidExtentList
- Persistency/GDML:
 - Fixed cases of failure in exporting tessellated solids

11.1.2 Patch – Analysis, Digits/Hits, Event

- Analysis:
 - Fixed creating histograms with user defined bins
 - Addressing problem report [#2541](#)
- Digits/Hits:
 - Fixed probe scorer with alternative material setting, which was not properly working in tasking mode
- Event:
 - Added missing SetParticleWeight() method to G4ParticleGun
 - Fixed incorrect information of maximum number of tracks in G4TrackStack

11.1.2 Patch – Particles, Run, Parameterisation

- **Particles:**
 - Updated mean lifetime values of G4XicZero and G4AntiXicZero according to values in PDG-2022
 - Corrected values for G4[Anti]OmegacZero
- **Run:**
 - Removed mistyped method declaration GetMasterTheadId() in G4MTRunManager
- **Parameterisation:**
 - Added missing virtual destructor to G4VFastSimSensitiveDetector

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
- Development of an advanced example showing the use of MicroElec ✓
- 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 ✓
- Development of two examples describing ESA telescopes ✓
- Code review, migration to C++17 and coding guidelines ✓

Thanks!