

GEANT4 11.0.p01 & 2022 planned developments

kernel modules

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Outline

- Fixes introduced in release 11.0.p01
 - Kernel modules
 - Physics (see talks by V.Ivantchenko & A.Ribon)
- Overview of planned developments for 2022
 - Kernel modules
 - Physics (see talks by V.Ivantchenko & A.Ribon)
 - R&D (see talks by M.Novak & W.Pokorski)
- *Detailed patch release notes:*
 - <http://cern.ch/geant4-data/ReleaseNotes/Patch.11.0-1.txt>
- *List of planned features for 2022:*
 - http://cern.ch/geant4/support/planned_features

11.0.p01 – Bugzilla tickets addressed

[#2204](#) – Wrong sampling of scattering angle of light ion off Hydrogen

[#2397](#) – Missing verbosity check in run/G4MTRunManager.cc

[#2420](#) – G4GenericMessenger: buggy SetRange on DeclareMethod commands (numeric types)

[#2423](#) – Typos in density effect parameter table for 8 materials

[#2456](#) – Wrong MaxBetaChange value in the Cerenkov process in Geant4 11.0

[#2457](#) – Provide const-reference signature for G4MultiUnion::AddNode

[#2463](#) – Building G4.11 on Windows with VS2019 above v16.1

[#2466](#) – Degraded accuracy of the energy loss fluctuation (G4UniversalFluctuation model) in Geant4-11.0

[#2470](#) – G4Scintillation::SetScintillationYieldFactor() declared but not implemented

11.0.p01 – Geometry & Persistency

- Solids/Boolean:
 - G4MultiUnion, added alternative signature for AddNode() taking a pointer to solid. Added 'const' qualification to transformation passed as argument
 - Addressing problem report [#2457](#)
- Persistency/ASCII:
 - Corrected wrong automatic conversion degree-radian for G4Polycone phi angle parameter
 - Based on [GitHub PR#36](#) report

11.0.p01 – Global, Analysis, Intercoms

- Global:
 - G4String: providing overload `operator[] (int)` to workaround compilation error on most recent MSVC compiler
 - Addressing problem report [#2463](#)
- Analysis:
 - Fix in notifying about closing file in `G4GenericAnalysisManager`
- Intercoms:
 - Check and set proper argument types for each individual argument when `G4GenericMessenger::DeclareMethod()` is used
 - Addressing problem report [#2420](#)

11.0.p01 – Tasking, Run

- Tasking:
 - Fixed number of seeds to be generated for the case when seeds from master are seeded only once per task
 - Added verbosity control to some printouts to standard output
 - Addressing problem report [#2397](#)
- Run:
 - Fixed missing 'AnnihToTauTau' entry from default physics list ordering, potentially causing a fatal exception
 - Added verbosity control to some printouts to standard output
 - Addressing problem report [#2397](#)

11.0.p01 – Configuration

- Configuration, Externals:
 - Added missing G4ptl and G4tasking libraries to link list in `geant4-config` script
 - Addressing [GitHub PR#37](#) report

2022 Planned Developments

Kernel

✓ In progress...

✓ Achieved already

Releases

- 2022 consolidation release of Geant4
 - Patches for previous releases as needed
- VecGeom library evolution
 - Further optimizations
 - Including new developments for adaptation on GPUs

Infrastructure

- Enhancements to Geant4 GitLab workflow ✓
 - Review use and integration of automatic performance monitoring tools
 - Additional Geant4Bot capabilities
- Modularization of Geant4 Libraries (global/granular/optional) ✓
 - Identify libraries/modules for merging, splitting, drop/add to a build
 - Profile modularization scheme to ensure performance is not affected
- Enhancements to build system ✓
 - Review mandatory and optional compiler flags needed to build and link to Geant4
- Optimization of Data Libraries
 - Simplify data library configuration/location
 - Review interfaces for data libraries, evaluate API and format changes
- Review need for dedicated sequential only build mode
 - Support sequential applications fully through Tasking Framework
- Move Geant4 web site to Jekyll with Git managed content ✓
- Migrate Geant4 Python module G4Py from Boost to pybind11
- Integration of automated performance monitoring ✓

Geometry & Transportation

- VecGeom
 - Prototype study on surface bounded volumes ✓
 - Support for single precision in data structures and navigation API ✓
 - Improved CUDA support and portability of SIMD-aware solids
 - Handling of construction and run-time errors
 - Implementation of missing shapes/entities in GDML reader
 - Code simplification, removal of unused API/backends
 - Adoption of Gitlab CI & extended platforms support
- Validation/consolidation of interface with navigator based on VecGeom ✓
 - Improve robustness of current interface/adaptor to VecGeom navigator, testing & code integration
- Separate safety computation and its state from navigator
 - Loose coupling of navigator in computation of safety distances from geometrical boundaries
- Prototype navigation indexing class
 - An integer index identifying touchables & associated transportation process
- Alternative BVH navigator and optimization structure ✓
 - Navigation based on Bounded Volume Hierarchy (BVH) technique, either natively in Geant4 or through VecGeom

Magnetic Field & Biasing

- Magnetic Field
 - 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)
 - Symplectic low/high order field integrators (GSoC HSF project)
- Generic Biasing
 - Biasing of charged particle interaction occurrence
 - Prototyping of DXTRAN-like functionality
 - Extend generic biasing scheme for at rest case
- Reverse Monte-Carlo
 - Migration to multi-threading and improvements
 - Use of Reverse MC in parallel geometries

Fast Simulation & Analysis

- Fast Simulation
 - Modernisation of EM shower parameterisation ✓
 - Machine Learning studies on the current model, meta learning for real detector geometries
 - Revision of Fast simulation framework
 - Revision of GFlash models ✓
 - Investigation on relevance of using a specialised tracking for triggering fast simulation
- Analysis
 - Support for multiple output types for n-tuples
 - Addition of flexibility in resetting/deleting histograms
 - Review support for writing same histogram/profile in a file several times (object versions)
 - Organisation of third-party code (HDF5, expat, zlib) in externals/g4tools

Tracking, Run, Detector Response, Scoring & UI

- Tracking:
 - Redesign and implementation of G4ForceConditions
- Multi-threading & Tasking:
 - Reorganization of Run, Tasking and Event categories ✓
 - Sub-event level parallelism prototype
 - Study on parallelisation of initialisation stage
- Scoring
 - Refinement of scorer functionalities and their drawing methods
 - Support of IAEA phase space files for GPS
- UI
 - Change binding tool from boost-c++ to pybind11 ✓
 - Code updates to C++11/14/17 style

Visualisation

- OpenGL/Qt drivers:
 - Migration to Qt6
 - Improvements to toolbar in OpenGL Qt
 - Improvements on sceneTree
 - Fix issue with parametrized volumes
 - Adapt to newer OpenGL versions, exploit new functionalities and replace deprecated calls such as glBegin/glEnd
- 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
 - Interaction OI viewer / UI Qt
- Other drivers:
 - Vtk driver: fully develop large renderings for medical applications
 - 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

- Development of a new example on polarisation
- New example for sub-event parallelism
- New hadronic example for monitoring particle fluence
- Update of selected EM/hadronic examples with usage of G4Accumulable
- New example illustrating generic biasing for "DXTRAN" MCNP-like option and implicit capture
- New gflash parameterisation example for sampling calorimeter
- Porting of Geant4e and related example to multi-threading
- Medical & DNA
 - New radio-biology extended example
 - Validation and development with protons and He4 ions in molecularDNA example
 - New example for the RBE/LET calculation
 - Microdosimetry spectra in a cylindrical domain at the specific water depth imitating silicon detector
 - New medical example for ultra-high dose rate
 - Inclusion of new cross-sections for gas materials in the "icsd" Geant4-DNA example
 - Add the possibility to use the SBS method in the DNA "scavenger" example
 - Implement DNA damage in plasmids with IRT
 - Extension to the DICOM reader to support RT Dose format
- 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
- Further developments of in-silico experimental microdosimetry in the Radioprotection example
- Development of a mammography example
- Development of a SPring-8 synchrotron x-ray polarimetry example for testing low energy polarised gamma-ray physics
- New example showing how to import in Geant4 simulations IAEA Phase Space Files
- Code review, migration to C++17 and coding guidelines ✓
- Measurements of software metrics and statistical analysis over the examples

Thanks!