

# GEANT4 10.7.p01 & 2021 planned developments *kernel modules*

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# Outline

- Fixes introduced in release 10.7.p01
  - Kernel modules
  - Physics (see talks by V.Ivantchenko & A.Ribon)
- Overview of planned developments for 2021
  - 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/Patch4.10.7-1.txt>
- *List of planned features for 2021:*
  - [http://cern.ch/geant4/support/planned\\_features](http://cern.ch/geant4/support/planned_features)

# Bugzilla tickets addressed

## 10.7.p01:

[#1856](#) – G4NeutronHPThermalScattering doesn't move neutron in the z-direction

[#2183](#) – Some physics constructors set incorrect physics types

[#2290](#) – G4NeutronHPThermalScattering: strange angular behaviour

[#2292](#) – subCutoff production

[#2296](#) – Type for hadron physics

[#2298](#) – G4Profiler.icc: PTL/Globals.hh: No such file or directory

[#2302](#) – Warnings for low energy neutrons in azimuthally replicated volumes

[#2303](#) – Building Geant4 with Qt fails with CMake 3.8 due to missing AUTOMOC paths

[#2305](#) – All GDML read properties of skinsurface and bordersurface elements yields only the G4MaterialPropertyVector of the first occurrence of each property name

[#2306](#) – Bug in get\_bin\_content of h2

# More Bugzilla tickets addressed

## 10.7.p01:

- [#2308](#) – Incorrect interpolation in function G4EmCorrections::Value2
- [#2309](#) – ProcessSubType wiped out with emstandard\_opt1
- [#2311](#) – Interface changes to G4LogicalBorderSurface
- [#2312](#) – Wrong calculation of maximum energy transfer to secondary e- in G4BetheBlochModel
- [#2317](#) – Units from GDML file ignored for arb8 (G4GenericTrap)
- [#2318](#) – G4Trap printout minor problem

# 10.7.p01 - Geometry

## *Geometrical primitives & navigation/volumes*

- Fixed printout in StreamInfo() in G4Trap and G4Para
  - Addressing problem report [#2318](#)
- Added protection against use of invalid normal in G4ScaledSolid::DistanceToOut(p,v)
- Reduced cases of bad speculation in G4PolyhedraSide::Inside() and G4PolyPhiFace::InsideEdges(), based on profiling analysis
- Added creation order index in G4LogicalBorderSurface
  - Addressing problem report [#2311](#)
- Reduced step correction in G4ReplicaNavigation::ComputeStep()
  - Addressing problem report [#2302](#)
- Added protection for thread contention in function G4GeometryWorkspace::DestroyWorkspace()
- Minor optimisation in G4Transportation::AlongStepDolt() to limit not relevant verbosity

# 10.7.p01 – Analysis, Persistency, UI

- Analysis:
  - Fixed problem with merging n-tuples with columns of vector type
- Persistency/GDML:
  - Fix for proper treatment of material properties reading for skin-surface and border-surface elements
    - Problem report [#2305](#)
  - Fixed parsing of regions in `G4GDMLParser::ImportRegions()`
  - Fixed reading of units for `GenericTrap` in `G4GDMLReadSolids`
    - Problem report [#2317](#)
- Interfaces/UI:
  - Fixed command-line-echo highlighting

# 10.7.p01 – Tasking, Visualization

- Tasking:
  - Corrected way to count the number of events processed in a worker thread in G4WorkerTaskRunManager
    - Also fixing a rare crash due excessive access to the seed vector
  - Reduced number of events per task in G4TaskRunManager to evenly distribute events to all available threads
- Visualization/OpenInventor:
  - Consolidation of the OpenInventor Qt viewer

# 10.7.p01 – More ...

- Configuration:
  - Fixed installation path for PTL module headers
    - Problem report [#2298](#)
  - Fixed configure/build with external PTL package v1.0.0
  - Make fail configuration if Qt is enabled with CMake < 3.9
    - Problem report [#2303](#)
  - Fixed potential installation error with Homebrew/MacPorts X11/GL
  - Updated to data-set G4PARTICLEXS-3.1.1
- Data Sets: G4PARTICLEXS-3.1.1
  - Fixed data for He3 and He4 for few light targets

# 2021 Planned Developments

## *Kernel*

✓ In progress...

✓ Achieved already

# Releases

- 2021 release of Geant4
  - Patches for previous releases as needed
- Consolidated releases of VecGeom
  - Further optimizations
  - Enhancements for porting on GPU devices (navigation system and geometry primitives)

# Infrastructure

- Enhancements to Geant4 GitLab workflow ✓
  - Adaptation to new features in future versions of GitLab
  - Additional Geant4Bot capabilities
- Continue study on adoption of GitLab CI ✓
- Modularization of Geant4 Libraries (global/granular/optional) ✓
- Enhancements to build system
  - Allow build/install of VecGeom and other core dependencies
  - Switch to C++17 as minimum requirement ✓
  - Retirement of GNUMake build system
- Optimization of Data Libraries
  - Review access patterns and interfaces for data libraries, evaluate API and format changes
- Review need for dedicated sequential only build mode, supporting sequential applications fully through Tasking Framework
- Prototype of Geant4 web site based on Jekyll and Git managed content ✓
- Migrate Geant4 Python module G4Py from Boost to pybind11
- Integration of automated performance monitoring ✓

# Geometry & Transportation

- VecGeom
  - Optimised global navigation functionality on GPU ✓
  - Improved CUDA support and portability of SIMD-aware solids
  - Support for single precision in data structures and navigation API ✓
- VecGeom solids default and interface with navigator based on VecGeom ✓
- Separate safety computation and its state from navigator
  - Loose coupling of navigator in the computation of the safety distances from geometrical boundaries
- Prototype navigation indexing class
- Review adoption of workspaces for task-based parallelism
- Revision of transportation processes ✓
  - Specialized transportation processes for neutral and charged particles
- Addition of QSS integration methods (Quantized State Simulation)
- Review accuracy of boundary crossing in field (ALICE/CMS requirement)

# Materials & Biasing

- Generic Biasing
  - Enrich event biasing options: DXTRAN-like biasing, implicit capture, occurrence biasing of charged particles with cross-section changing over the step, AMS (Adaptive Multilevel Splitting)
  - Extend generic biasing scheme for at rest case
  - Implementation of a statistical test suite to verify correctness of biased against analogue simulation
- Materials
  - Removal of obsolete interfaces and improvements ✓
- Reverse Monte-Carlo
  - Migration to multi-threading and improvements
  - Proton simulation validation
  - Heavy ions simulation

# Fast Simulation & Analysis

- Fast Simulation
  - Modernisation of EM shower parametrisation, including automated tuning procedures ✓
  - Implementation of an example of ML inference using external libraries for calorimetry fast simulation ✓
- Analysis
  - Integration of g4tools/plotting in the G4/vis and UI system
  - Investigation for a complete move from the output specific managers to G4GenericAnalysisManager
  - Support for multiple files and multiple output types for n-tuples
  - Addition of flexibility in resetting/deleting histograms
  - Review support for writing the same histogram/profile in a file several times (object versions)

# Tracking, Run & Detector Response

- Tracking:
  - Redesign and implementation of G4ForceConditions
- Multi-threading & Tasking:
  - Finalize task-based parallelism and deploy production release ✓
  - Prototype of sub-event level parallelism and determine usability
- Enhancements to command-based scorer and creation a new example to demonstrate its new features
- Reconsider and revisit production thresholds ✓
- Implementation of a phase-space file interface to GPS

# User and Category Interfaces

- Python module:
  - Migration to Python3 as default Python interface (drop of Python2)
  - Change binding tool from boost-c++ to pybind11
- Parallel UI command dispatcher using ZeroMQ as an alternative MPI (experimental)

# Visualisation

- OpenGL/Qt drivers:
  - Improvements to toolbar in OpenGL Qt ✓
  - Study code signing/notarising issues for using OpenGL from Geant4-based applications on MacOS
  - Investigate a way to switch from OpenGL to other technology
  - OGLFile to produce image files in batch jobs where no graphics card is present
  - Adapt to newer OpenGL versions, exploit new functionalities and replace deprecated calls such as glBegin/glEnd
  - Refinements and extensions to the OpenInventor Qt Viewer
  - Improvements and further developments to native Qt3D driver
- Other drivers:
  - Remove code of obsolete/deprecated Wt and Xaw drivers
  - New tools\_sg (TSG) driver based on g4tools ✓
  - Development of visualisation solutions for iOS and Android Devices
- Integrate g4tools/plotting in Geant4 UI system ✓
- Updates to gMocrenFile and gMocren
  - Support visualization attributes and other information

# Novice & Extended Examples

- Removal of visTutor in Basic/B4 example ✓
- New visualisation example illustrating how to create a movie
- New example illustrating generic biasing for "DXTRAN" MCNP-like option and implicit capture
- New extended example to demonstrate more scoring functionalities
- New hadronic example for demonstrating decays of heavy particles
- New radio-biology extended example
- Integration of the Opticks package in a new extended example ✓
- Extended biasing examples: fix overlap among B02, B03 and GB03 examples
- Update of selected EM/hadronic examples with usage of G4Accumulable
- Porting of Geant4e and related example to multi-threading
- Extension to the DICOM reader to support RT Dose format
- Inclusion of new cross-sections for gas materials in the "icsd" Geant4-DNA example
- Migration of examples using local SteppingVerbose class to usage of new class, G4SteppingVerboseWithUnits ✓
- Review of examples macros and tests (coverage of commands and use-cases) ✓
- Complete application of coding guidelines ✓

# Advanced Examples

- Code review and coding guidelines ✓
- Improvement of the webpage and documentation
- Measurements of software metrics and statistical analysis over the examples
- Development of alternative approaches for LET calculation in hadrontherapy
- Removal of no longer maintained examples
- Migration to sub-event parallelism where possible
- Exploit C++17 features where advantageous
- New example for nanomedicine (gold nanoparticles in X-ray radiotherapy)
- New example showing how to import simulations IAEA Phase Space Files

# Thanks!