

GEANT4 11.2.p01, 11.1.p03 & 2024 planned developments

kernel modules

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Outline

- Fixes introduced in patch releases 11.2.1 and 11.1.3
 - Kernel modules
- Review of planned developments for 2024
 - Kernel modules
 - Physics (see talks after this)
- *Detailed patch release notes:*
 - <https://cern.ch/geant4-data/ReleaseNotes/Patch.11.2-1.txt>
 - <https://cern.ch/geant4-data/ReleaseNotes/Patch.11.1-3.txt>
- *List of planned features for 2024:*
 - <https://cern.ch/geant4/planned-features-2024>

Bugzilla tickets addressed

- [#2543](#) – Muon/Pion generation difference between Geant4 v11.0.4 and 11.1.1
- [#2555](#) – Generate minus num of photons @ G4Cerenkov
- [#2556](#) – Changes to FindEXPAT in CMake 3.27 break Geant4PackageCache.cmake file
- [#2564](#) – EXC_BAD_ACCESS (code=EXC_I386_GPFLT) errors from PTL::ThreadPool on Intel Macs with Clang 15
- [#2572](#) – Possible Issue with Calculating Effective Charge of a Material
- [#2582](#) – Compiling on Windows system generate an error C2039: '_finite': is not a member of 'std'
- [#2584](#) – Creation of excited states
- [#2586](#) – Setting a neutron absorber with a $Z > 92$ and using EmStandardPhysics_option3 produces a segfault
- [#2588](#) – Incorrect electron energy in G4RadioactiveDecay
- [#2589](#) – geant4-config outputs incorrect include paths for macOS Framework builds of Qt
- [#2590](#) – ParticleHP with transuranic materials
- [#2594](#) – Neutrino-nucleus interactions not activated for tau neutrinos

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11.1.p03

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Patches - Geometry & Persistency

- Solids/CSG:

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- In VecGeom wrapper G4UTrap, use `GetThetaCosPhi()` and `GetThetaSinPhi()` in method `GetVertices()`; this overcomes a problem with trapezoid reported in CMSSW after migration to VecGeom 1.2.6. Also fixed typo in method `SetAllParameters()`, setter used in parameterisation of shape dimensions

Patches – Global, Intercoms, Run, Tracking

- Global:
 - G4PhysicsModelCatalog: added ID for the Light-Ion QMD model
- Intercoms:
 - Added missing converter LtoS() in G4UImessenger
- Run:
 - Correctly report number of threads from G4TaskRunManager
- Tracking:
 - G4TrackingMessenger: fixed Coverity report for memory leak at exit

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Patches – Configuration, Externals

- Configuration:

- Export non-cache variables to Geant4PackageCache to support CMake \geq 3.27
 - Addressing problem report [#2556](#)
- Added -F flag on macOS with a framework build of Qt
 - Addressing problem report [#2589](#)
- Fixed detection of SoQt/Xt packages, by manually checking versions of found packages
 - Geant4 only requires a minimum version

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- Externals:

- CLHEP: Added missing shootArray() implementation in RandPoissonQ
- G4tools: Updated to version 6.1.1; fixed compilation warnings on Intel/icx compiler and clang-15
- PTL: Disabled optimization of ThreadPool::execute_thread() on Apple/Intel builds
 - Addressing problem report [#2564](#)

11.1.p03

2024 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
- 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
 - Provide pkg-config scripts for use by non-CMake build tools
- Source code static analysis ✓
 - maintenance & support of Coverity tool

Geometry & Navigation

- VecGeom
 - Complete surface bounded volumes prototype ✓
 - missing solids, integration in AdePT, optimisation structure
 - Extension of BVH navigator to surfaces handling
 - Code simplification, removal of CUDA specific code
 - Improve portability of SIMD-aware solids
- Reduce geometry initialization time using multi-threading
 - Reduce time spent for voxelisation of complex geometry setups by adopting multi-threading/tasking technique
- Investigate use of multi-threading to speed up overlap checking and volume calculation
 - Study possibility to speed-up generation of random points on surface using multi-threading
- Investigate alternative implementation of navigation history
 - Review implementation of navigation history for possible memory and speed optimisation

Field Propagation

- Optimisation of QSS field driver (Quantized State Simulation) ✓
 - Review existing implementation of QSS for improving robustness and speed (QSS3)
- New UI commands for controlling field parameters ✓
 - Provide UI commands for simple applications (with one field manager / configuration only) to control parameters for propagation of charged particles in field and the accuracy of intersection of their curved trajectories with volumes
- Complete implementation of high-order “symplectic” integrator for accelerator applications
 - Review, complete and test existing Beta implementation of “symplectic” integrator
- Review accuracy of boundary crossing in field
 - ALICE and CMS requirement

Persistency & Analysis

- Addition of support for parallel geometries in ASCII ✓
- Accumulables: add support for most frequent std collections (array, vector)
- Regular maintenance & extensions ✓

Fast Simulation & Biasing

- Fast Simulation
 - Implementation and validation of GFlash code with general fast sim tools
 - Continuing revision of GFlash models
 - Inclusion of detailed vs fast simulation comparison/validation tests into geant-val
 - Extensions to Par04 example ✓
- Generic Biasing
 - Biasing of charged particle interaction occurrence
 - Prototyping of DXTRAN-like functionality
 - Extend generic biasing scheme for at rest case
 - Improvements to parallel world scoring
 - Improvements to importance biasing and extension to multiple particle type biasing
 - Inclusion of analogue vs biased simulation comparison/validation tests into geant-val
- Reverse Monte-Carlo
 - Migration to multi-threading and improvements
 - Use of Reverse MC in parallel geometries: investigation of discrepancies for thick shield cases

Particles, Run, Tracking, Tasking & Scoring

- Particles & Tracking:
 - Update of particle properties to latest PDG data ✓
 - Redesign and implementation of G4ForceConditions
- Multi-threading & Tasking:
 - First phase implementation of task-based sub-event parallelism ✓
 - Feasibility study on parallelisation of initialisation stage ✓
- Run:
 - Enhancements to material scanner utility ✓
 - Interface to HepMC3
- Scoring
 - Review of scoring in parallel worlds

Visualisation

- OpenGL/Qt drivers:
 - Complete full support for Qt6 ✓
 - Rubberband picking
 - Adapt to newer OpenGL versions, exploit new functionalities and replace deprecated calls such as glBegin/glEnd
- Vtk driver
 - Jupyter notebook interface to VTK (via KitWare Trame)
 - Shared AR viewer target export
 - USD(Z) export
 - Solid cylinder for trajectory (option) to enable usage of exported data in a wide range of 3D applications
 - Physically based rendering (PBR) for VTK
- 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 ✓
 - Ability to change color map according to preset maps
 - 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 gflash parameterisation example for sampling calorimeter
- New example of task-based sub-event parallelism ✓
- New examples for probe scorer
- Biasing examples: fix overlap among B02, B03 and GB03 examples
- Modernization of the extended parameterisation examples
- Medical & DNA
 - Updates and improvements to G4DNA icsd, dnadamage and clustering examples
 - Validation and development with protons and He4 ions in molecularDNA example
- Clang-tidy checks on selected extended examples categories
- Continue application of coding guidelines ✓

Advanced Examples

- Improvement to MicroElec example to show the use of novel electron low energy cross-sections for solid state materials beyond silicon
- Further developments of in-silico experimental micro-dosimetry in the Radioprotection example
- Development of a mammography example
- Implementation of pre-clinical, mice PET images to evaluate a dose distribution for new drugs
- Upgrade of the medical_linac example
- Design of realistic phantoms of C. elegans in the stim_pixe_tomography example
- Development of a new geometry reproducing some dosimeters used in FLASH radiotherapy in the eFLASH_radiotherapy example
- Development of new detectors, SiC and TEPC microdosimeters, in the exp_microdosimetry example
- Improvement of Hadron-therapy example in the simulation of proton, carbon ion and helium ion beam irradiation for the calculation of track and dose averaged LET ✓
- New example showing how to import in Geant4 simulations IAEA Phase Space Files
- Code review, migration to C++17 and coding guidelines ✓

Thanks!