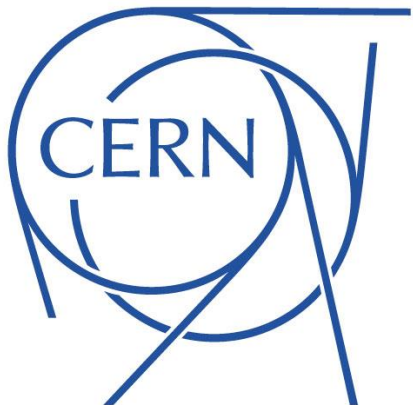


Geometry & Persistency

Recent & ongoing developments

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for the Geant4 Geometry & Persistency Working Groups



Contents

- Development and fixes in the last year
 - Introduced in release 10.6 and patches
- Features expected in Geant4 10.7
 - Currently under development and scheduled for inclusion in the next release

Geometry

Solids

- Revised `G4PVPlacement::CheckOverlaps()` for speed up; improved diagnostics 10.6
- For all solids, use `G4QuickRand()` in `GetPointOnSurface()` 10.6
 - Also reduced max number of tries to generate a point to 100k in Boolean shapes
- Completed revision of `G4Tet`, for speed-up and issues detected in unit tests 10.6.p01
 - Implemented `SetVertices()`, direct modifier for vertices
- Re-established parameterisation mechanism for `G4Tet` and `G4UTet` 10.6.p01
 - Was removed by mistake. Addressing problem report [#2209](#)
- Completed revision of `G4Ellipsoid` 10.6.p01
 - Fixed issues with previous implementation; also addressing problem report [#2206](#)
 - 30%-70% speed-up in all main methods
- Fixed calculation of normal in `G4Trap` for points on edge in `SurfaceNormal()` 10.7.beta
 - Improved also code for `Inside()`
- Fixed mismatch in signature of constructors for the `G4UExtrudedSolid` wrapper 10.6.p02

Navigation & Volumes

- Added hooks for capability to navigate in 'external' geometry: 10.6
 - New base class G4VExternalNavigation for external 'sub'-navigator
 - New type of 'External' physical volume, to flag volumes for external sub-navigator
 - Revisions to G4Navigator to dispatch logical volumes with daughters which are of 'external' physical-volume type
 - An 'external' sub-navigator can be registered with G4Navigator
 - 'placement' and 'external' physical volumes cannot be currently mixed inside same logical volume
- Avoid potential cases of looping infinitely in G4RegularNavigation 10.6.p01
 - Introduced pushing with increasing step size
 - Addressing problem report [#2196](#)
- Fixed registration of G4PVPParameterised daughter in mother volume 10.6
 - Enabling its true volume type (kParameterised) to be recognised and registered in mother logical volume
- G4PhantomParameterisation: reverted precision checks as in version 10.2.p02 10.6
 - Addressing problem report [#2192](#)

Field transportation

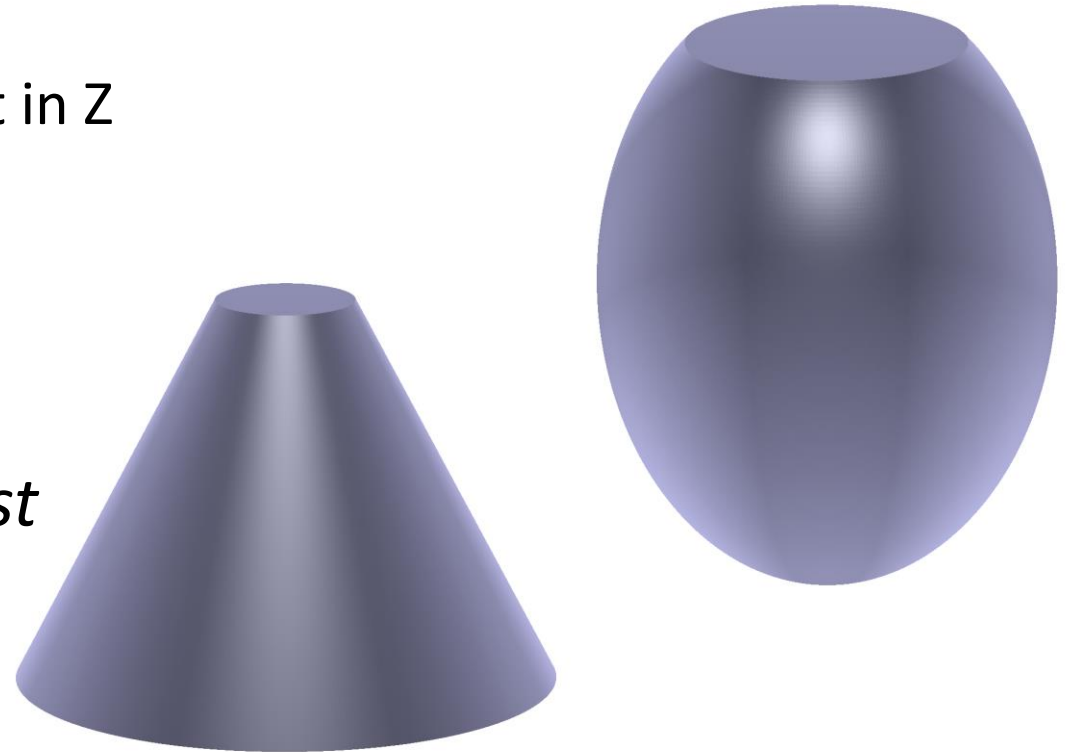
- Added G4SextupoleMagField 10.6
 - A standard sextupole magnet implementation
- Added methods to G4PropagatorInField 10.6
 - Modifier/accessor for a parameter that controls after how many integration sub-steps (in one physics step) the increase of the chord distance is triggered
- New class G4DriverReporter to print progress of drivers 10.7.beta
- Enabled "check-mode" for G4PropagatorInField and G4VIntersectionLocator 10.7.beta
 - Enabling use of a whiteboard for logging/debugging in G4MultiLevelLocator, if "check-mode" in navigation is being activated through UI command

() More details on developments in magnetic field in John's talk after this*

VecGeom: Last added shapes

- Ellipsoid
 - A general triaxial ellipsoid with optional cut in Z
- Elliptical Cone
 - A cone with elliptical cross-section

➤ *GDML schema now complete for all most common shapes*

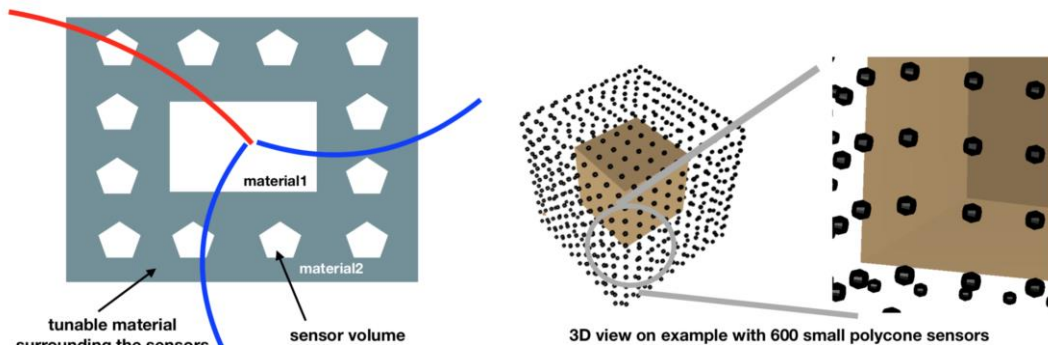


Current VecGeom version

- Version v1.1.7 of VecGeom containing all latest new features and fixes
 - New shapes: ellipsoid and elliptical-cone
 - Fixes for corner-case problems in tube and Booleans
 - Extended all shapes functionality with ability to generate polyhedral meshes
 - For use with visualization and geometry debugging sessions
 - Modernised CMake build infrastructure
 - Reference version for latest Geant4 10.7-beta release
- Doxygen documentation can be generated and now covering most key classes in VecGeom
 - Available from VecGeom GitLab site
- VecGeom primitives can be transparently built through Geant4
 - Original APIs preserved

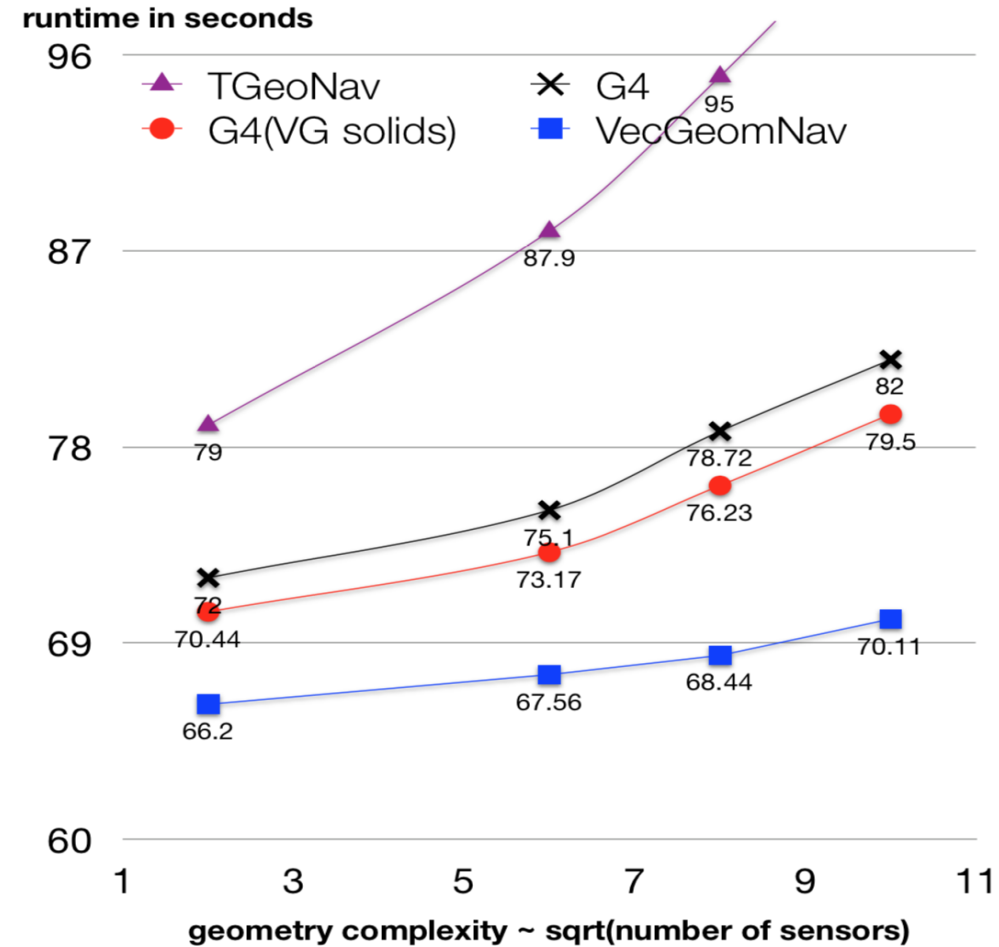
Prototype VecGeom navigation in Geant4

- VecGeom implements structures which benefit from SIMD (vectorized search/traversal of structure)
 - Increasing size of vector registers on future hardware will automatically make algorithm faster
- Other advantages like strong solid specialization would be made available, especially important for simple solids
- Implemented prototype interfacing navigation:
 - Simultaneous existence of Geant4 and VecGeom geometry with necessary synchronization/translation of states/objects
 - Reusing existing logic to handle the navigation state needed by the Geant4 engine for non-voxelised geometries
 - Obtaining promising results on specific configurable test-case benchmark (layered geometry with configurable number of “sensors” shapes)



24 September 2020

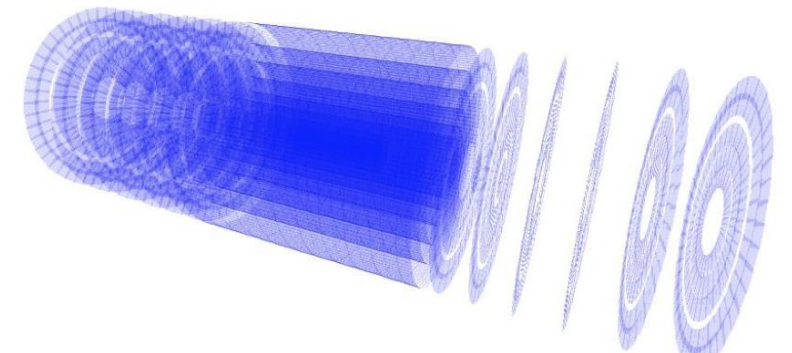
25th Geant4 Collaboration meeting



See “S.Wenzel et al., A VecGeom Navigator plugin for Geant4
CHEP 2019 Proceedings in preparation”

VecGeom: ongoing developments on navigation

- Finalisation of VecGeom navigation interface in Geant4
 - Aim to have it as an optional choice (Beta version) in coming Geant4 release
- GPU-based simplified simulation prototype
 - Ray-tracing using VecGeom CUDA backend on GPUs
 - Identified possible optimizations
 - Use of a global navigation index table with caching of transformations
 - Adoption of single precision in navigation
 - Task part of Geant4 Task-Force for R&Ds
 - http://cern.ch/geant4/collaboration/task_force_rd
 - See talk by A.Gheata in last week R&D parallel
 - <https://indico.cern.ch/event/942142/timetable/#20200>



Persistency

GDML

- G4GDMLRead: fix to avoid double-definition of system units 10.6
- Fixed reading and writing of const properties of materials 10.7.beta
 - Matrices of size 1x1 are now used both for writing out and reading in of const material. This fixes the inconsistency (using constants by the GDML writer) found in the code
 - Const material properties with the same name (in different materials) are now written out with the properties table address appended

Analysis - *from 2020 workplan*

- Attempt to integrate g4tools/plotting in the G4/vis and UI system
- Addition of flexibility in resetting/deleting histograms
- Review support for writing the same histogram/profile in a file several times
- Handling of more files by analysis manager
- Separation of the n-tuple management from the histogram and profiles management

Summary

- Keeping improving and evolving the Geant4 geometry modeler
 - Faster detection of overlaps
 - Introduced ability to hook custom navigation
 - Allowed to interface FLAIR/Moira tool for import of FLUKA geometries
 - Extended field propagator with more tuning hooks and diagnostics tools
- First prototype of VecGeom navigator use in Geant4
 - Promising results from first benchmark
 - Tests going on more complex geometries (ALICE)
- Probing use of VecGeom on GPU devices
 - Ray-tracer demonstrator using VecGeom CUDA backend