Geant4 Plan of Work 2020

Infrastructure, Geometry & Transportation

Summary 2019

- *Major achievements*
- *Presented also at last January Technical Forum*

Releases

- Geant4 10.6
  - http://cern.ch/geant4-data/ReleaseNotes/ReleaseNotes4.10.6.html
  - Patch releases: 10.5.p01
- New releases of VecGeom, v1.1.1 to v1.1.5
- Geant4 Monthly development releases

Highlights Infrastructure 2019

Updates to infrastructure

- Migrated Geant4 Users Forum to Discourse @ CERN
  - From Hypernews @ SLAC
- Migrated to full use of CMake Imported Targets and Properties
  - Allowing for easer modularization and a fully relocatable Geant4 installation
- Considerably reduced use of environment variables at installation/use
  - Promoted pre-processor flags to fixed #define statements in generated headers at configuration/build time
- Geant4 Testing infrastructure
  - Better integration with LCG builds/views and Docker images
  - Added support for new systems/compilers configurations
- Improvements to GitLab workflow for patches and release management
  - Added code formatting hooks
  - First study of adoption of GitLab CI
- Started migration of Web site to Drupal-8

Nightly integration testing & validation tools

- Simulation validation portal (geant-val.cern.ch)
  - Further development/improvement to the portal
  - Integrated 20+ EM/calorimeter tests and tests of interest for medical physics
  - Integrated first test from the GATE (Geant4 Application for Tomographic Emission) collaboration
  - Ongoing integration of test-beam benchmarks

Highlights Geometry & Transport 2019

Geometrical Primitives & Persistency

- Updated VecGeom library, VecGeom v1.1.5
  - Selection for enabling use made at configuration
    - https://gitlab.cern.ch/VecGeom/VecGeom/tree/v01.01.05
  - Introduced generation of polyhedral meshes for all shapes
  - First implementation of dedicated GDML reader for persistency
  - Added new missing shapes (ellipsoid, elliptical-tube, elliptical-cone)
    - All shapes (excepts for twisted) now available for replacement
  - Extended Doxygen documentation
- Revised algorithms in Geant4 for overlaps checking
  - Speedup and improved diagnostics
- Enabled import/export of assembly envelopes in GDML

Navigation & Field

- Added hooks for enabling partial or complete replacement of navigation algorithms
  - Allowing interfacing with Flair/Moira for use of Fluka geometries with Geant4
  - First prototype implementation of a navigator based on VecGeom
- Reviewed treatment of looping particles in field propagation
  - Enhanced diagnostics and settings, fully under user control
- Enabled default use of interpolation for intersection calculation in field propagation
  - New interpolation-capable integration scheme chosen for shorter steps
  - Helix-based scheme chosen for steps larger than 2*pi times the curvature radius at the initial location
- C++11 revision of geometry code

Workplan 2020

- *Program of work still under preparation*
- *Full version to be presented at next Technical Forum*
- *User support not taken into account*

(*) Carry over from 2019

Releases

- 2020 release of Geant4 - *(all)*
  - Overall planned features for inclusion to be published in March
  - Discussion at the next Geant4 Technical Forum
- Consolidated releases of VecGeom - *(GA, GC, AG, GL, RS, ET, SW)*
  - Further optimizations
  - Enhancements to navigators (CPU/GPU)
  - Documentation

Infrastructure

- Evaluation/possible adoption of GitLab CI - *(GF, BM)*
- Enhancements to Geant4 GitLab workflow - *(GA, GC, GF, PM, BM)*
  - Integration with Geant4Py build
  - Adaptation to new features in future versions of GitLab
- Modularization of Geant4 Libraries (*) - *(GC, BM)*
  - Global/granular/optional
- Enhancements to build system - *(GA, GC, GF, JM, BM)*
  - Allow build/install of VecGeom and other core dependencies
  - Switch to C++17 as minimum requirement
- Optimization of Data Libraries (*) - *(GC, BM)*
  - Simplify data library configuration/location
  - Provide C++ API for accessing/parsing data libraries
  - Optimize file access patterns and formats to minimize number of small files opened
- Migration of web site to Drupal-8 - *(GF, SFT fellow)*
  - As also part of workplan for SFT sites
- Extend use of workspaces and task-based parallelism in Geant4 (*) - *(GC, JM)*

Testing & Validation

- Continuous integration of new physics (EM & hadronic) tests - (DK, GrL, IR, GF)
  - Including test-beam benchmarks
- Simulation validation portal (geant-val.cern.ch) (*) - (DK, GrL, IR)
  - Complete migration from Angular.js to latest Angular
  - Improvements towards more friendly representation/display of results
  - Further development/improvement of user interfaces
  - Inclusion of more tests for MC generators
  - Overall review of the system in view to release geant-val2
- Integration of new Geant4 tests with corresponding experimental data

Geometry & Transportation

- VecGeom - (*GA, JA, GC, AG, MG, GL, RS, ET, SW*)
  - Enhancements to navigators, neighbor volume detection
  - Use of Embree library for tessellated shapes – *proposed summer project*
  - Gilbert-Johnson-Keerthi Algorithm for Convex Shapes – *proposed summer project*
- Interface with navigator based on VecGeom in Geant4 - (*JA, GC, SW*)
- Separate safety computation and state from navigator (*) - (*JA, GC*)
  - Implement strategy for a light-weight base navigator class not holding navigation state
- Revision of transportation processes; specialized transportation processes for neutral and charged particles (*) - (*MA, GC, JA*)
- Review accuracy of boundary crossing in field (*) – *(JA, DS)*
  - ➢ ALICE and CMS requirement
- Equation of motion and steppers templated on type of field – *(JA, DS)*

Tutorials / Schools / Workshop in 2020

- Technical Training @ CERN on Geant4
  - Beginners Course, 21-23 January
  - Advanced Course, 24-26 March
- ESIPAP School in Archamps
  - Geant4 Tutorial, 10-11 February
- Geant4 Collaboration Workshop
  - IRISA Laboratory, Rennes (France), 21-25 September
- LPCC Detector Simulation Workshop
  - @CERN, in fall (dates to be fixed soon)

People involved (*)

- *Guilherme Amadio (GA), CERN*
- *John Apostolakis (JA), CERN*
- *Makoto Asai (MA), SLAC*
- *Gabriele Cosmo (GC), CERN*
- *Gunter Folger (GF), CERN*
- *Andrei Gheata (AG), CERN*
- *Mihaela Gheata (MG), CERN/ALICE*
- *Dmitri Konstantinov (DK), IHEP/CERN*
- *Grigory Latyshev (GrL), IHEP/CERN*
- *Guilherme Lima (GL), FNAL*
- *Jonathan Madsen (JM), LBNL Berkeley*
- *Pere Mato (PM), CERN*
- *Ben Morgan (BM), Warwick University/ATLAS*
- *Witold Pokorski (WP), CERN*
- *Ivan Razumov (IR), IHEP/CERN*
- *Raman Sehgal (RS), BARC*
- *Dimitry Sorokin (DS), MIPT*
- *Evgueni Tcherniaev (ET), CERN*
- *Sandro Christian Wenzel (SW), CERN/ALICE*

(*) - List includes people outside SFT
- Most dedicating only few % effort (sum <4 FTEs)