GEANT4
2019 planned developments
kernel modules

Gabriele Cosmo, CERN EP-SFT

for the Geant4 Collaboration

Outline

- Overview of planned developments for 2019
  - Kernel modules
  - Physics (see talks by V.Ivantchenko & A.Ribon)

➢ *All planned features for 2019:*

- **http://cern.ch/geant4/support/planned_features**

Releases

- 2019 release of Geant4
  - Patches for previous releases as needed
- Consolidated releases of VecGeom
  - Further optimization and new shapes
  - Specialized navigators enhancements
  - Documentation

Infrastructure

- Migration of web site to Drupal-8
  - Upgrade from existing Drupal-7 site
- Migration of HyperNews fora to Discourse
- Testing infrastructure in Jenkins
  - Adoption of Docker containers for testing
  - Versioning of builds through pipelines
- Enhancements to Geant4 GitLab workflow
  - Addition of code formatting hooks; integration with Coverity analysis; …
  - Adaptation to new features in future versions of GitLab; study of GitLab CI use
- Build and publication of Docker/Singularity images for releases
- Migration of static preprocessor –D flags to #define/undef directives
- Modularization of Geant4 Libraries
  - Global/granular/optional
- Optimization of Data Libraries
  - Simplify data library configuration/location using layered lookup via self-location, single environment variable, UI commands/C++ API
  - Provide C++ API for accessing/parsing data libraries
  - Optimize file access patterns and formats to minimize number of small files opened

Geometry & Transportation

- VecGeom
  - Implementation of missing shapes/constructs: ellipsoid, elliptical cone, etc..
  - Enhancements to specialized navigators, neighbor volume detection
  - Addition of replicas/divisions – *proposed summer project*
  - Use of Embree library for tessellated shapes – *proposed summer project*
  - GDML writer & ROOT I/O persistency – *proposed summer project*
  - Generation of polyhedral meshes for shapes – *proposed summer project*
  - Overlaps checking – *proposed summer project*
- Implementation of a prototype navigator based on VecGeom
- Separate safety computation and state from navigator
  - Implement strategy for a light-weight base navigator class not holding navigation state
- Profiling and optimization of multiple navigation
  - Revise design and implementation of multiple navigation and coupled-transportation
- Revision of transportation processes
  - Specialized transportation processes for neutral and charged particles

Field Propagation

- Enable default use of interpolation in intersection calculation in field propagation
- Revise protocol between transportation and tracking to better cope with particles looping in field
- Review accuracy of boundary crossing in field
  - Recent ALICE and CMS requirement

Materials & Biasing

- Implementation of an extension for multiple particle type biasing
- Enrich event biasing options
  - leading particle biasing, DXTRAN-like biasing, implicit capture
- Extend generic biasing scheme for at rest case
- Prototype implementation of generic biasing techniques:
  - biasing of charged particles (with cross-section changing over the step)
  - occurrence biasing (continuous density change inside a same volume)
  - material/isotope biasing; Woodcock tracking
- Adoption of the new elastic differential cross-section class in hadron elastic
- Implementation of new elastic differential cross-section class to be used in DXTRAN biasing option
- Investigation on potential difficulties in propagating tiny weights for large cross-section change (neutrino interactions)
- Revision of the GFlash fast-simulation model

Persistency & Analysis

- Enabling of import/export of assemblies envelopes in GDML
- Improvements to n-tuple merging in row-wise mode
- Addition of analysis "executive" to provide possibility to choose output type at run-time
- Additional flexibility in resetting/deleting histograms
- Review support for writing same histogram/profile on file several times
- Handling of more files by analysis manager

Particles & Track

- Improvements and update of G4IonTable and G4ParticleTable to cope with muonic atom and hyperons
- Review of production thresholds

Run & Detector Response

- Multi-threading:
  - Workspace and memory cleanup in MT
  - Finalize new design of threads though tasking mechanism (allow threads to join/leave workers pool)
  - Porting of material scanner to MT
  - Implement hooks for allowing sub-event level parallelism
- Implementation of phase-space file interface to GPS
- Revision of production thresholds

User and Category Interfaces

- Improvements to ZeroMQ interface / Jupyter frontend (backend for UI-command distribution using ZeroMQ message-queue service)
- Integration of G4Py module to CMake build

Visualisation

- OpenGL drivers:
  - New driver OGLFile to produce image files in batch jobs
  - Improvements to toolbar in OpenGL Qt
  - Adaptions to newer OpenGL versions, exploit new functionalities and replace deprecated calls
- Other drivers:
  - New Apple/Metal driver for MacOS and native Qt driver
  - New driver for export to format readable by Paraview
  - Updates to gMocrenFile and gMocren to support visualization attributes and other information
  - New driver G4DAE exporter for export in Collada format
  - Updates to OpenInventor Extended Viewer
  - Development of visualization solutions for iOS and Android devices
  - Rewrite of Wt driver
  - Change from flat format to hierarchical format in VRML
- Support for visualisation of Boolean shapes
- New tool to support high resolution transparent visualization with ability to rotate and zoom
- Visualisation of geometry overlaps
- Support of user-drawn primitives in multi-threaded mode
- Integrated visualization of field lines

Novice & Extended Examples

- New example "dnadamage" for Geant4-DNA
  - Simulation of a DNA chromatin segment with molecular definition
- New cross-sections for gas materials in the "icsd” DNA example
- New example illustrating generic biasing
  - "DXTRAN" MCNP-like option and implicit capture
- Extended biasing examples
  - Fix overlap among B02, B03 and GB03 examples
- Updating selected examples with usage of G4Accumulable
- Porting of Geant4e and related example to multi-threading
- Extension to the DICOM reader to support RT Dose format
- Complete migration to MixMax in EM examples
- Review of examples macros and tests
- Complete application of coding guidelines & code review

Advanced Examples

- Development of alternative approaches for LET calculation in hadron-therapy
- New example for nanomedicine
  - Gold nanoparticles in X-ray radiotherapy
- Migration of air_shower example to multi-threading
- Assessment of physics of advanced examples and analysis of software quality metrics
- Code review and coding guidelines

Thanks!