Geant4 10.7 Release Status

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Summary and Plan

- Not our usual parallel/summary session(s) this year
- Rolling together:
  - Status of new features for 10.7 (thank you to Working Group Coordinators!)
  - Release schedule for 10.7 (see following presentation by Gabriele!)
- In the following summaries, items are marked up:
  - “ ” means “*not in 10.7*”
  - “ ” means “*in progress and expected for 10.7*”
  - “ ” means “*completed for 10.7*”
- Can only summarize, focusing on postponed items, please use the Vidyo chat and Google Live Notes to add additional comments/questions (or just shout out!)

Run, Event and Detector Responses

- Introduction of tasking mechanism
  - See presentation on Thursday
  - And join us to the parallel session Monday
- New scoring functionalities
  - See presentation on Thursday

Tracking

- Status of topics in development plan for 10.7 release
- Use “  ”, “  ”, and “  ” to mark “not in 10.7” “in progress/expected for 10.7” “completed for 10.7”

Particle and Track

- performance tests and improvements
- improvements of code readability and documentation

Geometry

- Code review and optimisation - 
- Interface with navigator based on VecGeom -
- Review accuracy of boundary crossing in field -
- Equation of motion and steppers templated on type of field -
- Revision of the transportation processes; specialised transportation processes for neutral and charged particles -
- Separate safety computation and state from navigator -  *postponed*
- Enable VecGeom shapes as default -  *postponed to major release*

Generic Processes and Materials

- Generic biasing:
  - Implicit capture“ ”
  - DXTRANS“ ”
  - Occurrence biasing of charged particles “ ”
- Fast simulation:
  - Continuation of GFlash models revision : on-going, will continue in 2021
  - Modernisation of EM shower parametrisation : on-going, will continue in 2021

Electromagnetic Physics (1/4)

- Infrastructure:
  - Speed-up of the Urban multiple-scattering model keeping physics performance
  - Reduce CPU at initialisation in MT mode
  - Review for speedup of classes related to transport
  - Implementation of an alternative, specialised transport for e+- and gamma for HEP applications
  - Consolidation of the "general gamma process" approach and extend it for electrons and positrons
  - Study effect of high-energy muon scattering due to high-energy radiative processes
- Adjoint models:
  - General code review of adjoint processes
- Atomic de-excitation:
  - Further development of ANSTO PIXE data library and evaluation of Auger emission yields
  - Implementation of a data base for ionisation cross-sections of K-, L-, and M- shells by heavy ion collisions

Electromagnetic Physics (2/4)

- DNA physics & chemistry
  - Implementation of IRT chemistry transport 
  - Increase of upper limit for DNA proton physics from 100 to 300 MeV
  - Increase upper limit for DNA e- physics Option4 from 10 keV up to 1 MeV
  - Implementation of CPA100 models for DNA related materials  (in progress, > 2021)
- Gamma models:
  - Introduction of quantum entanglement for the gamma transport
  - Review and update of all Livermore gamma models
  - Introduction of linear gamma polarization options into all gamma models
  - Complete the recalculation of atomic electron momentum PDFs and Compton profiles for all elements
  - Introduction of EPICS 2017 cross-sections to all gamma models as an alternative option  (in progress, > 2021)

Electromagnetic Physics (3/4)

- Ionisation processes:
  - Evaluation on usage of ICRU90 stopping power data as default 
  - Evaluation of ion ionisation models for moderate and high energies
  - Review of model for sampling fluctuations of e+- as alternative model
  - Development of ionisation model for gold based on dielectric theory
  - Evaluation of new ion energy fluctuation model 
  - Implementation of Taborda approximation to electron stopping below 30 keV 
- Medical physics applications and radiology:
  - simulation studies on RBE, LET, G-values, and DNA damage 
- Multiple and single scattering:
  - Further tuning and optimisation of Goudsmit-Saunderson model for HEP applications - *(1)*
  - New single scattering model for e+- based on ELSEPA (numerical Dirac-Fock PWA) 
  - Improvements to back-scattering algorithm for the Urban model 
  - Evaluation of Wenzel-VI model performance with 2nd order corrections enabled 

Electromagnetic Physics (4/4)

- Optical photon processes and X-ray physics: extension of modelling of scintillation and WLS 
- Positron annihilation
  - Addition of more accurate two-gamma annihilation using atomic electron momentum PDFs 
  - Evaluation of model for three gamma annihilation
  - Addition of tau pair production by positrons 
  - Extension of energy limit for positron annihilation to hadrons 
- Validation & Testing:
  - Addition of CMS HGCAL test-beam into testing suite 
  - Extend geant-val suite with full set of tests from the EM testing suite 
  - Evaluation of medical physics benchmarks 
  - Introduction of detailed test of stepping for EM calorimeters triggered by ATLAS
  - Support and validation of transition radiation model for ATLAS and ALICE
  - Testing of Synchrotron radiation in complex magnets 

Hadronic Physics

- Charm and bottom hadron - nucleus interactions available in physics lists
- Replacement of hadronic environmental variables with UI commands
- Possibility for users to scale or specify alternative elastic and inelastic cross sections on top of physics lists (for systematic studies)
- Proper deletion of all hadronic models and data at the end of a job
- Further developments and validation of neutrino / lepton - nuclear physics
- Verification and extension of G4PARTICLEXS dataset
- Other, further refinements and extensions in : elastic, Bertini, De-excitation, ParticleHP, Radioactive Decay, anti-baryon treatment in Fritof : likely

Persistency and Analysis

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

User and Category Interfaces

- Status of topics in development plan for 10.7 release
- Use “  ”, “  ”, and “  ” to mark “not in 10.7” “in progress/expected for 10.7” “completed for 10.7”

Visualization

- OpenGL drivers:
  - Study code signing / notarizing issues for using OpenGL from Geant4-based applications on MacOS 10.15 Catalina
  - Improvements to toolbar in OpenGL Qt -
  - Adapt to newer OpenGL versions, exploit new functionalities and replace deprecated calls such as glBegin/glEnd -
    i. Investigate a way to switch from OpenGL to other thing
  - OGLFile to produce image files in batch jobs where no graphics card is present -
- Other drivers:
  - Wt driver: Remove code
  - Implication of the Qt license changes (https://www.qt.io/blog/qt-offering-changes-2020)

Physics Lists and Validation Tools

- Recommendation / Documentation of physics lists for specific use cases
- Documentation of physics lists examples
- complete automated physics list documentation and integrate in web documentation
- Introduction of b/c particles with EM, hadronic, and decay processes
- Allow to vary cross sections and models for systematic studies
- Further develop geant-val
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Testing and Quality Assurance

- Q/A monitoring with Valgrind and Coverity
- Grid testing with simplified calorimeters and other test applications
- Reproducibility tests
- Regular profiling/benchmarking of Geant4 development and public releases, maintenance and evolution of the profiling infrastructure in response to the changing computing environment
- Development of automation scripts and new tests
- Use timemory for monthly/nightly profiling/benchmarking
- Testing Geant4 (Low energy physics using Brachytherapy code) on evolving architecture using KISTI-5 (Nurion, Intel KNL+Skylake) supercomputer

Software Management

- Drop Support for 32bit Windows
- Integrate and test new Tasking Framework
- Integrate Geant4Py build/install
- Modularization of Geant4 libraries
  - Infrastructure complete, review of library organization in 2021
- Build and Publication of Docker Images
- Review mandatory/optional compiler flags for Geant4
- Support Geometry WG on enabling VecGeom as default (*postponed to 2021*)
- Provide pkg-config scripts for use by non-CMake users (*postponed to 2021*)
- Evaluate use of C++17 as minimum for Geant4 (*postponed to 2021*)

Documentation Management

- CI publication of development documents for internal checking
- Explore cross-referencing between guides (postponed)
- Updated release of documentation (mid-year)
- Release of epub and mobi versions of the documents
- Tutorial on how to make and post a video. Adding all our videos on geant4 website - on Laurent - ?
- Automatic documentation generation of Physics Lists
- web presence: host the generated Doxygen on the website - on Ben - ?
- vis documentation on the web? - on John - ?
- All other updates (i.e. documentation of developments should be included in time for 10.7

Novice and Extended Examples

- New examples:
  - biasing "DXTRAN" , biasing “implicit capture” , medical/dna/chem6
- Existing examples improvements:
  - Medical category: Extend the DICOM reader with the RT Dose format.
  - Biasing category: Resolve the overlap in biasing B02/B03 and GB03 examples
  - which implement the same use case
  - Electromagnetic & Hadronic categories: updating selected examples with usage
  - of G4Accumulable
  - errorpropagation category: Porting Geant4e to MT.
  - Medical/dna category: try to include new cross-sections for gas materials in the already existing icsd example

Novice and Extended Examples

- Existing examples improvements (cont.)
  - EM category (and maybe others): Switch to new default random number generator MixMax - 
- Code review/Coding Guidelines
  - Continue with the macros and tests review progress this year, to be continued) 
  - Update Wiki page with obsolete features/coding guidelines 
  - Finish the examples not yet completed (dicomReader) -

Advanced Examples

- Maintenance and bug fixes (1,2)
- Code review (e.g. implementation of the extended examples coding guidelines) in selected examples (1,2)
- Release of GORAD (Geant4 Open-source Radiation Analysis and Design) (2)
- Release of a new example modelling dust cloud (2)
- Developments of alternative approaches for LET calculation in hadrontherapy (1, 2) [*]
- Release of a new CMS example (2)[*]
- Improvement of GammaRayTel example to deal with polarised processes (2)[*]
- Release of a new example for nanomedicine (gold nanoparticles in X-ray radiotherapy) (2)[*] (postponed to 2021)

Summary

- Many items already integrated
- Items not making it to 10.7 are mostly best addressed in the 2021 major release
- **Still many items in progress!**
- **See Gabriele's presentation up next on final deadlines for your Working Groups and code Categories!**