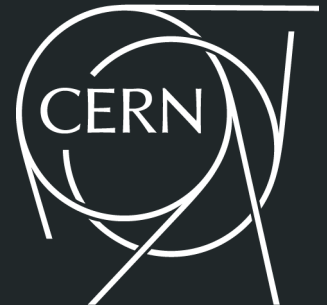


Software Update

Graeme Stewart, for SFT and HSF

2018-09-11



Geant4



- Geant4 10.4 released December 2017
 - Two patch releases in February and May 2018
- Highlights (Geometry and Kernel)
 - Updates to geometry primitives
 - Improved basic shapes providing computing speedup and more compact code
 - New multi-union construct as a native type, implementing efficient multiple-union of several volumes with same material
 - Enhanced integration with the new VecGeom Unified Solids library
 - New [VecGeom version v01.00.00](#)
 - New default magnetic-field stepper, implementing a 5th order embedded Runge-Kutta method, providing higher accuracy
 - Improved memory management in multi-threaded mode
 - MixMax random generator now adopted as the default random engine
 - Updated particle properties to PDG-2017; new functionality for handling muonic atoms

Geant4



- Highlights (Physics)
 - Updated version of the Goudsmit-Saunderson multiple-scattering and Livermore photoelectric models
 - New interfaces for optical properties with faster computation
 - Extended Fritiof string model to include smearing of resonance masses
 - INCL intra-nuclear cascade model now providing treatment of primary kaons and hyperons and production of secondaries
 - Improvements in de-excitation and elastic-scattering with new models for neutrino-electron and neutron-electron scattering
 - New module for gamma-nuclear - final-state model combining Bertini Cascade and LEND
 - New module including channeling and phonon modeling
- Outlook
 - Fast simulation included in EP R&D proposals, machine learning emphasised

GeantV R&D

- GeantV R&D aims at demonstrating benefits of vectorized particle transport
 - Allows exploitation of vector operations on modern CPUs
 - Groups (vectors) of tracks executing together each process/stage
- Status
 - Alpha tag: full EM transport, vectorized geometry/magnetic field, scalar physics, user interfaces, examples of different complexity
- Plan for 2018:
 - Demonstrate the achievable speed-up in realistic application
 - Aiming at complete EM shower simulation in a vector flow
 - Beta tag: EM physics models fully vectorized, more examples, more feedback from community

ROOT



- ROOT 6.14 was released in June 2018
 - Two patch releases since then, in July and August
- Highlights
 - Improved thread safety
 - RDataFrame no longer experimental
 - Modern functional interface to data analysis
 - TMVA supports additional deep learning classes
 - Convolutional networks and recurrent layers
 - Better interoperability between C++ vector types and numpy arrays in PyROOT
 - Moved to faster compression library for speed (currently rolled back until some performance issues are fixed)

CernVM and LCG Releases



- CVMFS 2.5.0 released in May, 2.5.1 patch release in August
 - Enables parallel installation of releases for different platforms
 - Under testing by LHCb and ATLAS, significant speedup for publishing of nightly builds
 - Hardening and pre-production testing of Ceph S3 object store backend
 - Significant speed-up for publication of nightly builds compared to file system backend
- CernVM 4 Production Release, June 2018
 - RHEL 7 based virtual machine image and container image for LHC experiments
 - Used by compute jobs in the cloud (OpenStack, commercial)
 - Used at ATLAS P1 HLT farm for offline processing
 - RHEL 6 based CernVM 3 remains maintained
- LCG_93 (May) and LCG_94 (September) released
 - BE department is a new user

Google Summer of Code

- We had a record 29 students this year, 26 completed (above average)
- Highlights
 - Spark data analysis with PyROOT
 - Parallelised CNNs on GPUs
 - New JavaScript client for CVMFS



Project Areas	Students	Organisations
ROOT	4	CERN, Princeton, UNL, KIT, UO, UJI
TMVA	5	CERN, EPFL, ETH, UFL, UdeA
Geant4/GeantV	2	CERN, MIPT
CVMFS	1	CERN
Rucio (ATLAS)	2	CERN, UOslo
Eigen (ATLAS)	1	RAL
HAhRD (CMS)	1	LLR
DIRAC (LHCb)	1	CERN
SixTrack	1	CERN
CERNBox	1	CERN, AARNet, ownCloud
Ganga	1	CERN, Imperial College
WLCG	1	CERN
DIANA/HEP	1	Princeton
GoHEP	1	LPC
ACTS	1	LAL, CERN
Spark3D	1	LAL
Allpix Squared	1	CERN, UG
Falcon	1	UFL, UdeA
Magboltz	1	UTA
YAMPL	1	ANL, LBNL

Community White Paper and other Presentations

- Michel Jouvin gave a very well received [plenary presentation](#) at CHEP
- Graeme Stewart gave a talk at the ECFA meeting in Barcelona on [Future opportunities and challenges for software in HEP](#)
 - Will be summarised in the ECFA briefing
- CWP is submitted to Computing and Software for Big Science
 - Referee feedback is very positive, only minor changes requested

Institute for Research and Innovation in Software for High Energy Physics

- IRIS-HEP has received [NSF funding](#) of \$25M, PI: Peter Elmer (Princeton), co-PIs: Gordon Watts (Washington), Brian Bockelman (Nebraska)
 - 30FTEs for 5 years
 - 17 collaborating institutes involve ATLAS, CMS and LHCb
 - HL-LHC is the primary science driver
 - Main software R&D work areas:
 - Analysis systems
 - Innovative algorithms for trigger and reco (using machine learning)
 - Data Organisation, Management and Access (DOMA)
- HSF worked very closely with our US colleagues, well aligned with the CWP
 - Will be working with the HSF for wider community engagement

PyHEP

- Python is a ‘first class’ language in HEP
- Traditionally an emphasis on developer productivity over code runtime
 - Popular in analysis and job configuration/steering
- Has become the lingua franca for data science and machine learning
 - Steering high performance backends gives excellent performance for the right problems
- Two day [workshop](#) organised before CHEP, chaired by Eduardo Rodrigues
 - 70 participants
- Talks covered python ecosystem, LHC analysis, non-LHC experiments, C++ and ROOT bindings, distribution and evolution
 - Keynote from JupyterLab
- Excellent post-workshop feedback
 - Setup [PyHEP discussion chat](#), community [inventory of packages, training materials](#)

Packaging Group

- [Packaging group](#) continues to work on common solutions to problem of building and distributing a HEP software stack
 - Use cases and test stack were established
- [CHEP presentation](#) from Ben Morgan made the work of the group more widely known
 - Nix prototype advancing in LHCb
 - Spack adding new features essential for HEP
 - E.g., recent PR for stacking Spack builds on top of each other
- Solutions focusing on *containers* and *CVMFS* as key technology advances

Software Forum

- HSF re-established the Software Forum
 - Communicating about ongoing projects
 - Discussion of needs and tracking of problems
 - Channel of communication to other disciplines
- Two meetings before the summer
 - DD4hep and DD* common geometry packages
 - Used by CLIC/ILC and FCC, being adopted by CMS and LHCb
 - Vectorisation toolkits
 - SoAContainer from LHCb
 - VecCore wrapper from ROOT/G4 teams
 - Meetings mostly planned for the rest of the year

Future Activities in Preparation

- Physics Generator Re-engineering [Workshop](#)
 - 26-27 November
 - Bring theorists, experimentalists and software engineering talent together
 - Tackle the engineering required for HL-LHC on modern hardware
- Setting up three new working groups in key HEP areas
 - Analysis, Reconstruction, Simulation
 - Nominations from experiments and from the community
 - Establishing mandate now, but will be based around goals of the CWP Roadmap
 - Groups should be established in the next month
 - Start activities this year
- Next WLCG/HSF workshop being planned now
 - 18-22 March 2019
 - East Coast USA location (TBD)