

# Common Software Updates

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LHCC Referees, 2021-11-16



# HL-LHC Review

- Much effort went into the LHCC review of the common software areas
- Generally positive feedback from the CSAs about the review process and the questions from the panel
- We look forward to the outcomes

# Generators

- Mostly worked on the inputs for the LHCC review
- Work on MadGraph on GPU is progressing nicely
- Lots of papers addressing challenges in the generators that affect HL-LHC (e.g., negative weights) are coming out

	MC@NLO	MC@NLO- $\Delta$
[2002.12716]	111	$\Delta$ -441
$pp \rightarrow e^+e^-$	6.9% (1.3)	2.0% (1.1)
$pp \rightarrow e^+\nu_e$	7.2% (1.4)	2.3% (1.1)
$pp \rightarrow H$	10.4% (1.6)	0.5% (1.0)
$pp \rightarrow Hb\bar{b}$	40.3% (27)	31.3% (7.2)
$pp \rightarrow W^+j$	21.7% (3.1)	7.4% (1.4)
$pp \rightarrow W^+t\bar{t}$	16.2% (2.2)	11.5% (1.7)
$pp \rightarrow t\bar{t}$	23.0% (3.4)	7.7% (1.4)

[Frederix, et al.](#)

Implementation ( $e^+e^- \rightarrow \mu^+\mu^-$ )	MEs / second Double
1-core MadEvent Fortran scalar	1.50E6 (x1.15)
1-core Standalone C++ scalar	1.31E6 <b>(x1.00)</b>
1-core Standalone C++ 128-bit SSE4.2 (x2 doubles, x4 floats)	2.52E6 (x1.9)
1-core Standalone C++ 256-bit AVX2 (x4 doubles, x8 floats)	4.58E6 (x3.5)
1-core Standalone C++ "256-bit" AVX512 (x4 doubles, x8 floats)	4.91E6 (x3.7)
1-core Standalone C++ 512-bit AVX512 (x8 doubles, x16 floats)	3.74E6 (x2.9)
Standalone CUDA Nvidia V100S-PCI-E-32GB (2560 FP64 cores*)	7.25E8 <b>(x550)</b>

[A Valassi et al.](#)

# Simulation



- In preparation for final Geant4 11.0 release expected December 10th
- New bug-fix release [10.7.p03](#)
- New release VecGeom v1.1.18
  - Improvements and fixes to multiple shapes to support single precision mode
  - Enhancements to interface of VecGeom Navigation with Geant4
  - Fixes to BVH navigation for GPU support
  - Improved CUDA support in configuration
- [Advanced CERN Geant4](#) training course on October 4-8th
  - Full attendance, ~70 participants
- HSF Simulation WG looked at [New ML Techniques for Simulation](#)
  - Topic continues to be very active in the community - HSF is an effective meeting point
  - Upcoming meetings on FPGAs, DD4hep and future colliders



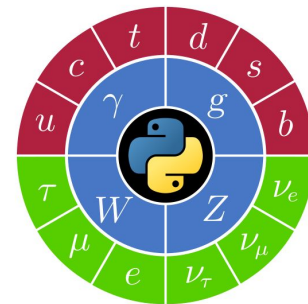
# ROOT: Foundation and Analysis

- LHCC review input
  - For key foundation evolution, RNTuple being central
  - For the analysis toolkit layer
- A very effective documentation week
  - The whole team reserved a common week for improving the [ROOT manual](#) for novice physicists, to replace the old Users' Guide
  - To be continued right before Christmas, however, the manual has improved significantly, see [the blog](#)
- Much work to be presented at ACAT, for instance RDataFrame, distributed RDataFrame, RNTuple, RooFit, lossy compression, with significant (terrific, actually!) progress in all areas
  - See our [ACAT presentations / posters!](#)

# HSF Analysis WG and Analysis Grand Challenge

- WG
  - Document summarising the use of [metadata in HEP physics](#) analysis is almost finalised
  - Ongoing work with IRIS-HEP to expand HEP [analysis benchmarks](#), discussed in a recent [WG meeting](#)
  - Presentations from LHCb recently on [fits performed at b-factories](#)
- Analysis Grand Challenge (AGC, organized by IRIS-HEP and others, e.g. PyHEP, USATLAS, USCMS)
  - Multi-year effort, started with [pilot workshop](#) held 3-4 Nov, dedicated to **showcasing tools and workflows** related to the so-called “Analysis Grand Challenge” (AGC) to demonstrate technologies envisioned for use at the HL-LHC
  - AGC focuses on **running a physics analysis at scale**, including the handling of systematic uncertainties, binned statistical analysis, reinterpretation and end-to-end optimization
  - AGC makes use of **new and advanced analysis tools developed by the wider Python ecosystem community e.g., SciKit-HEP**, and relies on the development of the required cyberinfrastructure to be executed at scale. (102 registrations, up to 82 participants at a time)

# PyHEP



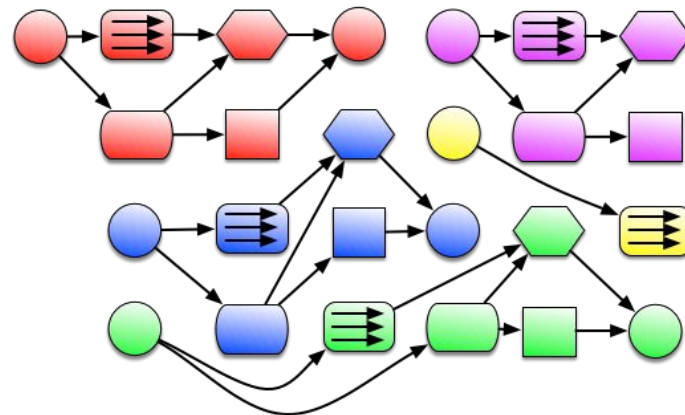
- WG prepared the "Data Science Tools for Analysis" document for the Computing review
- Monthly topical meetings continued in Autumn with a first tutorial on Quantum Computing
  - [Qibo quantum simulator](#)
- Agenda for 2022 to be discussed

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# HSF Frameworks WG

- Two meetings on multi-threading in [ATLAS](#) and [CMS](#)
- Discussion of how [pile-up digitisation and overlay](#) is handled in ATLAS





# Tools, Infrastructure and Packaging



- CernVM-FS 2.9 feature release is tagged and being pushed out to large-scale testing; highlights:
  - Significant speed-up for container conversion and distributed publishing
  - New platforms: Debian 11, SLES 15, AArch64 EL 8
  - Tech preview: support for publishing in k8s clusters
- Releases: LCG
  - LCG\_101 released in September 2021 (ROOT 6.24/04, Python 3.9.6, gcc8, 10, 11, clang 12)
    - Also for aarch64/ARM, cuda
    - Spack based stack still work in progress
  - Increasing number of packages build for ARM architecture
  - New compilers were made available: gcc 11.2, clang 13
- Packaging WG organised a meeting with Spack lead developer, Todd Gamblin
  - Excellent discussion on Spack plans and HEP needs

# HSF Training WG



THE  
CARPENTRIES

- HEP Training paper has been [published on CSBS](#)
- C++ course is involving more people in developing the material
  - Now a [monthly meeting](#) of everyone involved
  - More than 200 students trained so far (over 3 editions)
- [Matplotlib training](#) in active development
- Next [Software Carpentry](#) event 13-15 December

# Training Grand Challenge, HSF Training with IRIS-HEP

- Recent workshop to define goals for the following:
  - Sufficient **scalability** in the training activities such that all students and postdocs can receive training in both the introductory material and the more advanced material. In the steady state we expect a required scale approximately equal to the number of incoming students each year.
  - **Sustainability** by developing community processes by which both the instructors involved in training activities, and the training materials themselves, are continually renewed and meet the other two goals.
  - **Training Scope** - a curriculum (introductory, intermediate, advanced) that broadly meets the needs of the community and evolves over time as needed.
  - **Diversity and Inclusion** - The participation in the training should be representative of our community and (as we engage earlier in the pipeline) should work to represent the society at large
- A concrete training plan for 2022 will follow

# Other Meetings, Events and Activities



- Mini-workshop on the use of [Julia in HEP](#)
  - Report is being written
- [Software and Computing Roundtable](#), organised with JLab and BNL
  - Excellent recent meetings on Streaming Readout and on ML and simulation
- [Compute Accelerator Forum](#)
  - FPGAs, Nvidia GPU developments and Kokkos abstraction layer
- [EP R&D Days](#)
  - First workshop for the EP E&D projects, including Software Work Package and discussion with EIC
- [Software Institute for Data Intensive Science](#)
  - EU COST funding application submitted in October
- Proposal to build stronger US/European/HSF research software collaborations with India submitted to the US NSF
- Healthy number of HSF talks at important HEP meetings
  - [ILCX](#)
  - [SWIFT-HEP](#)
  - Snowmass: [Software and Computing for Small HEP Experiments](#)