

LHCC Review for HL-LHC Computing

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HL-LHC Computing

- HL-LHC will bring significant challenges in software and computing
 - High pile-up (~ 200) makes each event more complex, impacting directly on reconstruction times and pile-up digitisation
 - Higher trigger rates ($\sim 10\text{kHz}$) means that the number of events to record, store and analyse rises dramatically from earlier LHC runs
 - *Precision physics will require theory inputs that reduce errors to the same/lower level than from simulation and experiment (and fit in the budget)*
- LHCC want to ensure that preparations to face this challenge are well mapped out and credible
 - This will be an ongoing process over the next few years
 - May 2020 - initial review looked at plans from ATLAS and CMS, from a common software perspective (prepared by HSF, including generators) and DOMA
 - **November 2021** - next review phase, with a particular focus on common software projects
 - See charge attached to the agenda
 - Then by CDRs, TDRs in the coming years

November 2021 Review Objectives

- *focus on the **requirements, plans and readiness** of activities that are common to the experiments*
- *main goal of this review is to ensure the experiments, WLCG, and the relevant software projects, have **common and realistic expectations** of requirements and timescales*
- *help the experiments plan their strategies and assist the projects in **focusing on priorities** and **identifying any pinch-points***
- Areas which are reviewed are expected to provide a concise document (20-30 pages total)
 - There will be one document that covers the *Event Generator* area
 - In addition to *Introduction; Simulation; Foundational Tools; Analysis; DOMA*
 - To be delivered by **1 October**

Specific Topics to Cover

- A description of the project and present plans and timelines to deliver *the agreed functionality and performance*
- Describe how the project is managed, including how it will set priorities, monitor progress, and communicate with stakeholders.
- Present the current status of the development teams and note any gaps in skills or effort.
- Describe any major risks, potential functionality gaps, and dependencies on other projects

N.B We also have the recent paper, *Challenges in Monte Carlo event generator software for High-Luminosity LHC* [[2004.13687](#)], which will be a great help

What did the review ask us to cover?

The common activities are expected to include:

- Event Generators
- Geant 4
- Data Organization, Management and Access (DOMA) software components:
 - Rucio
 - File Transfer Service (FTS)
 - Storage interfaces and caching layers
 - Network technologies including monitoring and software defined networks.
- ROOT:
 - IO/persistency
 - Framework for Data Analysis
- Data Science Tools in use for analysis (such as data frames and python bindings).

No specifics given!

- This gives us (experiments, generator teams) considerable latitude to decide which topics are the most useful to include

What to choose?

- Generators as a field is a wide and varied set of codes
 - With many interdependencies
 - We can't usefully review all of that, nor are we asked to
- Guidelines for the selection of topics
 - Commonality guided
 - Review projects used by multiple experiments, not experiment specific codes (that comes later)
 - Resource guided
 - Which generators are expected to consume the most cycles for the LHC experiments in the HL-LHC era
 - Higher order calculations
 - Can we foresee optimising the code in this case?
 - Trade generality for speed? Port to new architectures? Reduce -ve weights?
 - Functionality guided
 - Where do we use critical functionality from a project, with no or few alternatives
 - Here we would focus on the sustainability of the project
 - Some technical matters, such as thread safety may be relevant

First Ideas of Projects to Cover

- As discussed with the experiments, we had some thoughts on what to cover
 - The main matrix element generators for ATLAS and CMS
 - Sherpa
 - MadGraph5_aMC@NLO
 - POWHEG
 - Hadronizers and Decayers
 - Pythia - Tauola?
 - EvtGen
 - Heavy Ion
 - EPOS
 - HIJING
 - Data Format
 - HepMC

All TBD!

Timeline...

- Deliver a document to the LHCC reviewers by 1 October
 - We do believe that this will be most usefully done in a rather open way
 - Input, comments and feedback from the experiments will be key
 - Which would mean that at the very minimum *we would need **September** as a polishing and refinement time*
- In order to have time for reflection and feedback we probably need an early draft of inputs by end of **June**
- This means that we actually have not very much time!
- Document structure...
 - Some general introduction (drawing on what we already have written [[2004.13687](#)] ✓)
 - Then project specific information

Summary

- Plans for HL-LHC software and computing are being reviewed by the LHCC
 - Focus on common software projects this time around
- Generators are going to be a key part of the HL-LHC programme
 - Driven by the need for precision
 - In turn driving the resource consumption
- The review is quite some work to prepare, but not without opportunities
 - Chance to reflect on the longer term goals of projects in the event generation domain
 - Chance to strengthen the links between the needs of the LHC experiments and the generator teams
 - Chance to identify areas of weakness with sufficient time to address them
- We cannot promise any particular outcome from the review, but there is an opportunity to have an *independent assessment of project needs*
 - The LHCC report to the funding agencies, who could be receptive to calls for additional support