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Thoughts on Detector/Beam Modeling Letter of Interest

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2nd Snowmass COMPF2-Theoretical Calculations and Simulation

Working Group Meeting

June 10th, 2020

The needs and possible approaches to address them

- Speedup Detector/Beam (Geant4) simulations
 - Rewrite algorithms to adapt to the evolving hardware (e.g. GPUs replacing CPUs) using appropriate software tools
 - Keeping in mind portability, i.e. not having to (re)write vendor-specific code
 - And/or (as mentioned in other subgroups) combine forces and try to influence the hardware evolution (unlikely?)
 - While still adjusting algorithms
 - Investigating ML techniques and parameterizations to replace certain stages of simulation and geometry, making sure appropriate agreement with standard (Geant4) simulations is obtained
 - Still needs to have sufficient Geant4 samples to train the AI and for parameterization templates

The needs and possible approaches to address them (cont'd)

- Assure Physics Model Development & Improvements for all the frontiers (Energy, Intensity, Cosmic) in terms of accuracy and covering all the needed physics areas
 - E.g. electromagnetic, hadronic, optical, solid state, rare, currently not implemented (background) processes
 - Can be done by implementing/improving models in Geant4, interfacing with external packages (if feasible), or (re)writing external packages which can be used stand alone or as Geant extensions or in post processing
 - E.g. VecGeom and WireCell (DUNE)
 - Adequate and continuous staffing levels and availability of appropriate career paths required
 - Focus on need to fund software and computing in all frontiers

The needs and possible approaches to address them (cont'd)

- Assure Software Evolution, Maintenance and User Training & Support
 - Adequate and continuous staffing levels and availability of appropriate career paths required
 - Where will we be in 10-15 years?
 - GPUs, FPGAs and other accelerators omnipresent...likely not going to disappear; keep in mind “simple” data structures
 - Other energy-efficient devices, e.g. scaling throughput processors, TPUs, IPU, (any *PU)
 - Quantum supremacy demonstrated; breakthrough(s) in QIS and quantum computing?

Possible background material/references

- 2017 Papers mentioned on the HSF Site: A Roadmap for HEP Software and Computing R&D for the 2020s
 - <https://hepsoftwarefoundation.org/organization/cwp.html>
- HSF Detector Simulation Working Group
 - <https://hepsoftwarefoundation.org/workinggroups/detsim.html>
- GeantV: Results from the prototype of concurrent vector particle transport simulation in HEP
 - <https://arxiv.org/abs/2005.00949>
- Geant4: Task force for R&Ds
 - https://geant4.web.cern.ch/collaboration/task_force_rd
- Celeritas Project <https://github.com/celeritas-project>
 - <https://indico.cern.ch/event/904385/contributions/3818859/attachments/2019713/3376693/presB-celeritas.pdf>
- 2020 HL-LHC Computing review paper: Common Tools and Community Software for the LHCC
- HEP CCE: cross-cutting initiative to promote excellence in high performance computing (HPC) including data-intensive applications, scientific simulations, and data movement and storage
 - <https://press3.mcs.anl.gov/hepfce/>

Feedback & Participation more than welcome

Please contact us and/or use meeting Google doc live notes