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## Celeritas: evaluating performance of HEP detector simulation on GPUs

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Celeritas is a Monte Carlo (MC) detector simulation library that exploits current and future heterogeneous leadership computing facilities (LCFs). It is specifically designed for, but not limited to, High-Luminosity Large Hadron Collider (HL-LHC) simulations. Celeritas implements full electromagnetic (EM) physics, supports complex detector geometries, and runs on CPUs and Nvidia or AMD GPUs. Celeritas provides a simple interface to integrate seamlessly with Geant4 applications such as CMSSW and ATLAS FullSimLight.

Using EM-only benchmark problems, we show that one A100 GPU is equivalent to 32-240 EPYC CPU cores on the Perlmutter supercomputer. In a test beam application using the ATLAS tile calorimeter geometry and full hadronic physics simulated by Geant4, offloading EM particles to Celeritas results in a 3x overall speedup on GPU and 1.2x on CPU.

We will present the current capabilities, focusing on performance results including recent optimization work, power efficiency, and throughput improvement.

### Significance

Heterogeneous architectures are increasingly more common, particularly within the TOP500 systems. LHC experiments such as ATLAS and CMS spend a significant amount of their computing budget on detector simulation traditionally done on CPUs. With the upcoming HL-LHC, the data complexity and quantity will significantly increase, challenging the current simulation software. This work will enable experiments to use GPUs for detector simulations.

### References

<https://indico.jlab.org/event/459/contributions/11818/>

### Experiment context, if any

ATLAS,CMS

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