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Geant4 performance optimization in the ATLAS experiment

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Software improvements in the ATLAS Geant4-based simulation are critical to keep up with the evolving hardware and increasing luminosity. Geant4 simulation currently accounts for about 50% of CPU consumption in ATLAS and it is expected to remain the leading CPU load during Run 4 (HL-LHC upgrade) with an approximately 25% share in the most optimistic computing model. The ATLAS experiment recently developed two algorithms for optimizing Geant4 performance: Neutron Russian Roulette (NRR) and range cuts for electromagnetic processes. The NRR randomly terminates a fraction of low energy neutrons in the simulation and weights energy deposits of the remaining neutrons to maintain physics performance. Low energy neutrons typically undergo many interactions with the detector material and their path becomes uncorrelated with the point of origin. Therefore, the response of neutrons can be efficiently estimated only with a subset of neutrons. Range cuts for electromagnetic processes exploit a built-in feature of Geant4 and terminate low energy electrons that originate from physics processes including conversions, the photoelectric effect, and Compton scattering. Both algorithms were tuned to maintain physics performance in ATLAS and together they bring about a 20% speedup of the ATLAS Geant4 simulation. Additional ideas for improvements currently under investigation will be also be discussed in the talk. Lastly, this talk presents how the ATLAS experiment utilizes software packages such as Intel's VTune to identify and resolve hot-spots in simulation.

Consider for promotion

No

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