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GPU simulation with Opticks: The future of optical simulations for LZ

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The LZ collaboration aims to directly detect dark matter by using a liquid xenon Time Projection Chamber (TPC). In order to probe the dark matter signal, observed signals are compared with simulations that model the detector response. The most computationally expensive aspect of these simulations is the propagation of photons in the detector's sensitive volume. For this reason, we propose to offload photon propagation modelling to the Graphics Processing Unit (GPU), by integrating Opticks into the LZ simulations workflow. Opticks is a system which maps Geant4 geometry and photon generation steps to NVIDIA's OptiX GPU raytracing framework. This paradigm shift could simultaneously achieve a massive speedup and an increase in accuracy for LZ simulations. By using the technique of containerization through Shifter, we will produce a portable system to harness the NERSC supercomputing facilities, including the forthcoming Perlmutter supercomputer, and enable the GPU processing to handle different detector configurations. Prior experience with using Opticks to simulate JUNO indicates the potential for speedup factors over 1000× for LZ, and by extension other experiments requiring photon propagation simulations.

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