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GPU accelerated simulations of channel formation via laser gas interaction for LWFA

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Lasers of sufficient intensity passing through a neutral gas will ionize the gas creating a plasma channel in its wake. A shock can propagate from this locally heated region through the created plasma and background gas, however the density of the plasma will determine the dynamics of the plasma. For collisional (high density) plasmas this can be modeled with a fluid code, however a kinetic simulation is required for low collisionality. The Vorpal code [1] allows for self-consistent modeling of the laser pulse, plasma formation via field ionization, laser-plasma interaction, and subsequent plasma dynamics via particle-in-cell and EM simulation. It also includes a reaction framework that enables the simulation of collisional dynamics such as elastic collisions, impact ionizations, and charge exchange reactions. Because of the computational expense of kinetic (particle-in-cell) codes, we have made use of modern hardware through GPU acceleration of the field and particle dynamics as well as the reactions. We will show results for these laser-plasma interactions in low density regimes, and we will also present the performance we see in moving to GPU simulations.

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