PARALLEL FLUID SIMULATIONS OF NONLINEAR BEAM LOADING IN LASER WAKEFIELD ACCELERATORS

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Abstract

Laser wakefield accelerators (LWFA) have accelerated ~100 pC electron bunches to GeV energies over cm scale distances, via self-trapping from the plasma. Self-trapping cannot be tolerated in staged LWFA modules for high-energy physics applications. The ~1% energy spread of self-trapped electron bunches is too large for light source applications. Both difficulties could be resolved via external injection of a low-emittance electron bunch into a quasi-linear LWFA, for which the dimensionless laser amplitude is less than two. However, significant beam charge will result in nonlinear beam loading effects, which will make it challenging to preserve the low emittance. The cold, relativistic fluid model of the parallel VORPAL framework* will be used to simulate the laser-driven electron wake, in the presence of an idealized electron beam. Profiles of the electron beam density, laser pulse envelope and plasma channel will be varied to find a nonlinear beam loading configuration that approximately flattens the electric fields across the beam. Hybrid fluid-PIC simulations will be used to measure the self-consistent emittance growth of the beam.

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