Abstract Submitted
for the DPP08 Meeting of
The American Physical Society

Laser wakefield simulation using a speed-of-light frame envelope model BENJAMIN COWAN, DAVID BRUHWILER, PETER MESSMER, KEVIN PAUL, Tech-X Corporation, CAMERON GEDDES, ERIC ESAREY, Lawrence Berkeley National Laboratory, ESTELLE CORMIER-MICHEL, University of Nevada, Reno — Simulation of laser wakefield accelerator (LWFA) experiments is computationally highly intensive due to the disparate length scales involved. Current experiments extend hundreds of laser wavelengths transversely and many thousands in the propagation direction, making explicit PIC simulations enormously expensive and requiring massively parallel execution in 3D. We can substantially improve the performance of laser wakefield simulations by modeling the envelope modulation of the laser field rather than the field itself. This allows for much coarser grids, since we need only resolve the plasma wavelength and not the laser wavelength, and therefore larger timesteps. Thus an envelope model can result in savings of several orders of magnitude in computational resources. By propagating the laser envelope in a Galilean frame moving at the speed of light, dispersive errors can be avoided and simulations over long distances become possible. Here we describe the model and its implementation, and show simulations of laser wakefield phenomena such as channel propagation, self-focusing, wakefield generation, and downramp injection using the model.

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Date submitted: 18 Jul 2008 Electronic form version 1.4