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Laser Wakefield Simulation Using a Speed-of-Light Frame Envelope Model[1] BENJAMIN COWAN, DAVID BRUHWILER, PETER MESSMER, KEVIN PAUL, Tech-X Corporation, ESTELLE CORMIER-MICHEL, ERIC ESAREY, CAMERON GEDDES, Lawrence Berkeley National Laboratory — 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 FDTD/PIC simulations enormously expensive. We present a model which substantially improves the performance of LWFA 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 this also allows larger timesteps. We show that this envelope model has much lower numerical dispersion error than FDTD, while maintaining second-order convergence. We demonstrate a complete 3D simulation of a meter-scale LWFA stage with over 10^5 speedup over explicit FDTD. In addition, we show studies of kinetic interpolation errors and simulations of particle trapping.

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