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**Simulation of meter-scale laser wakefield stages using an envelope model**[1] BENJAMIN COWAN, DAVID BRUHWILER, ESTELLE CORMIER-MICHEL, Tech-X Corporation, CAMERON GEDDES, ERIC ESAREY, Lawrence Berkeley National Laboratory — Simulation of laser-plasma accelerator (LPA) stages is computationally intensive due to the disparate length scales involved. The next generation of LPA experiments, such as those at the upcoming BELLA facility, will extend stage length to $\sim$1 m—over one million laser wavelengths. This makes explicit PIC simulations prohibitively expensive. We can substantially improve the performance of LPA simulations by modeling the envelope evolution of the laser field rather than the field itself, allowing for much coarser grids. Here we describe the model and its implementation in the parallel VORPAL framework. We present rigorous benchmarks, showing second-order convergence and accurate group velocity. We also show excellent agreement with scaled explicit simulations for LPA parameters relevant for meter-scale stages, while attaining orders of magnitude speedup. In addition, we describe techniques and trade-offs involved in resolving the laser fields into the depletion regime. We then present use of this method to simulate 10 GeV stages at full scale, for design relevant to future BELLA experiments.

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