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Challenges of PIC Simulations at High Laser Intensity[1] SCOTT V. LUEDTKE, ALEXEY V. AREFIEV, TOMA TONCIAN, BJORN MANUEL HEGELICH, The University of Texas at Austin — New lasers with very high intensity pulses ($I > 10^{22}$ W/cm^2) are being commissioned to explore new regimes of laser-matter interactions. These lasers require accurate particle-in-cell (PIC) simulations, which may require new computational approaches to efficiently produce physically accurate results. We examine the constraints on PIC simulations at high field intensity imposed by both the particle pusher and field solver. As proposed by Arefiev, et al. (Physics of Plasmas 22, 013103 (2015)), we implement adaptive sub-cycling in the Boris pusher of the EPOCH code and demonstrate its effectiveness in efficiently reducing errors from the pusher. It is well know that the use of a finite-difference scheme also modifies the electromagnetic wave dispersion relation. We examine the effect of the resulting discrepancy in the phase velocity on electron acceleration, and demonstrate that relatively small errors in the phase velocity lead to substantial changes in the electron energy gain from the laser pulse. We discuss the corresponding conditions for the field solver. These results are relevant to direct laser acceleration and underdense ionization experiments.

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