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Customized finite difference Maxwell solver for elimination of numerical Cherenkov instability in EM-PIC code PEICHENG YU, FEI LI, THAMINE DALICHAOUCH, UCLA, FREDERICO FIUZA, SLAC, VIKTOR DECYK, ASHER DAVIDSON, ADAM TABLEMAN, WEIMING AN, FRANK TSUNG, UCLA, RICARDO FONSECA, IST, WEI LU, Tsinghua Univ., JORGE VIEIRA, LUIS SILVA, IST, WARREN MORI, UCLA — we present a finite-difference-time-domain (FDTD) Maxwell solver for the particle-in-cell (PIC) algorithm, which is customized to effectively eliminate the numerical Cerenkov instability (NCI) which arises when a plasma (neutral or non-neutral) relativistically drifts on a grid when using the PIC algorithm. We control the EM dispersion curve in the direction of the plasma drift of a FDTD Maxwell solver by using a customized higher order finite difference operator for the spatial derivative along the direction of the drift ($\hat{1}$ direction). We show that this eliminates the main NCI modes with moderate $|k_1|$, while keeps additional main NCI modes well outside the range of physical interest with higher $|k_1|$. These main NCI modes can be easily filtered out along with first spatial aliasing NCI modes which are also at the edge of the fundamental Brillouin zone. The customized solver has the possible advantage of improved parallel scalability because it can be easily partitioned along $\hat{1}$ which typically has many more cells than other directions for the problems of interest.

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