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Optimizations for a semi-implicit, energy- and charge-conserving particle-in-cell algorithm with iVPIC[1] G. CHEN, L. CHACON, R. F. BIRD, L. YIN, B. J. ALBRIGHT, D. J. STARK, W. D. NYSTROM, Los Alamos National Laboratory — A semi-implicit, energy- and charge-conserving PIC algorithm has recently been developed for solving the relativistic Vlasov-Maxwell system. [2] The algorithm employs the leap-frog scheme for Maxwell's equations, and a Crank-Nicolson scheme for the particle equations. The implicit field-particle integration ensures exact accounting of energy transfer between the field and particles. A new particle pusher is used to be exactly energy- and charge-conserving. We have designed a simple and effective Picard iteration algorithm that only requires a single orbit computation per outer iteration, thereby minimizing wall-clock time impact vs. the explicit VPIC algorithm. The Picard algorithm requires only a few iterations (3-5) to converge to single precision round-off levels. With further code optimizations we have obtained speedups of a factor of 3 vs. a naive implementation, resulting in a cost per implicit iteration comparable to a single explicit update of the baseline VPIC implementation. As a result, the semi-implicit algorithm is only a few times slower than the explicit baseline. We present numerical results that demonstrate the speedups of the algorithmic and code optimizations with sample test problems.

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[2]Chen et al, arXiv:1903.01565v2, submitted to J. Comput. Phys.

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