A low-dispersion, exactly energy-charge-conserving semi-implicit relativistic particle-in-cell algorithm GUANGYE CHEN, CHACON LUIS, ROBERT BIRD, DAVID STARK, LIN YIN, BRIAN ALBRIGHT, LANL — Leap-frog based explicit algorithms, either “energy-conserving” or “momentum-conserving”, do not conserve energy discretely. Time-centered fully implicit algorithms can conserve discrete energy exactly, but introduce large dispersion errors in the light-wave modes, regardless of timestep sizes. This can lead to intolerable simulation errors where highly accurate light propagation is needed (e.g. laser-plasma interactions, LPI). In this study, we selectively combine the leap-frog and Crank-Nicolson methods to produce a low-dispersion, exactly energy-and-charge-conserving PIC algorithm. Specifically, we employ the leap-frog method for Maxwell equations, and the Crank-Nicolson method for particle equations. Such an algorithm admits exact global energy conservation, exact local charge conservation, and preserves the dispersion properties of the leap-frog method for the light wave. The algorithm has been implemented in a code named iVPIC, based on the VPIC code developed at LANL. We will present numerical results that demonstrate the properties of the scheme with sample test problems (e.g. Weibel instability run for $10^7$ timesteps, and LPI applications).

1Lapenta and Stefano. Phys Plasmas(2011)
2https://github.com/losalamos/vpic

Guangye Chen
Los Alamos National Laboratory

Date submitted: 14 Jul 2017

Electronic form version 1.4