Abstract Submitted
for the DPP10 Meeting of
The American Physical Society

An energy-conserving nonlinearly converged implicit particle-in-cell (PIC) algorithm[1] G. CHEN, L. CHACÓN, Oak Ridge National Laboratory, D.C. BARNES, Coronado Consulting — Conventional explicit PIC methods have to resolve short-time and small-scale plasma dynamics, suffering from very stringent temporal and spatial stability constrains. An implicit approach can in principle remove these restrictions and solve for long-time and large-scale dynamics. However, a large system of algebraic equations needs to be solved. In this work, we use a Jacobian-free Newton-Krylov method to invert an electrostatic Vlasov-Ampère system. Unlike earlier attempts to implicit PIC, our approach self-consistently couples particles and fields, achieving simultaneous convergence on the full system. We show that the implicit formulation enables an exact total energy conservation principle. We have found that the accuracy of the simulation for a large timestep is crucially dependent on enforcing charge conservation and adequately resolving particle orbits. These are accomplished by particle subcycling and orbit averaging, with the energy conservation preserved. We present results of standard test cases such as Langmuir wave, Landau damping, two-stream instability and ion acoustic wave, compared with those from explicit simulations.

[1]Work supported by ORNL's Laboratory Directed Research & Development (LDRD) Program.

G. Chen
ORNL

Date submitted: 26 Jul 2010 Electronic form version 1.4