Abstract Submitted
for the APR12 Meeting of
The American Physical Society

An Energy- and Charge-conserving, Implicit, Electrostatic Particle-in-Cell Algorithm in curvilinear geometry[1] G. CHEN, L. CHACÓN, Oak Ridge National Laboratory, D.C. BARNES, Coronado Consulting — A recent proof-of-principle study proposes an energy- and charge-conserving, fully implicit particle-in-cell algorithm in one dimension [1], which is able to use timesteps comparable to the dynamical timescale of interest. Here, we generalize the method to employ non-uniform meshes via a curvilinear map. The key enabling technology is a hybrid particle pusher [2], with particle positions updated in logical space and particle velocities updated in physical space. The self-adaptive, charge-conserving particle mover of Ref. [1] is extended to the non-uniform mesh case. The fully implicit implementation, using a Jacobian-free Newton-Krylov iterative solver, remains exactly charge- and energy-conserving. The extension of the formulation to multiple dimensions will be discussed. We present numerical experiments of 1D electrostatic, long-timescale ion-acoustic wave and ion-acoustic shock wave simulations, demonstrating that charge and energy are conserved to round-off for arbitrary mesh non-uniformity, and that the total momentum remains well conserved.

[1] Chen, Chacón, Barnes, *J. Comput. Phys.* **230** (2011).
[2] Camporeale and Delzanno, *Bull. Am. Phys. Soc.* **56**(6) (2011); Wang, et al., *J. Plasma Physics*, **61** (1999).

[1]Work supported by ORNL LDRD Program.

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Date submitted: 03 Jan 2012 Electronic form version 1.4