Abstract Submitted
for the DPP10 Meeting of
The American Physical Society

Adaptive Multiscale Electromagnetic Particle Simulations Y.A. OMELCHENKO, H. KARIMABADI, SciberQuest/UCSD, M. BROWN, Swarthmore College, U.V. CATALYUREK, E. SAULE, OSU — Hybrid (massless fluid electrons, kinetic ions) and full electromagnetic PIC simulations have recently emerged as powerful computational tools for predicting energetic particle transport in large-scale plasma configurations. Multiple time and length scales associated with plasma and magnetic field inhomogeneities put severe restrictions on the timestep and mesh resolution in these applications. We present two approaches intended to relieve these issues. An asynchronous hybrid code, HYPERS discards traditional time stepping in favor of Discrete-Event Simulation (DES). DES adaptively selects time increments for individual particles and local electromagnetic fields by limiting their per-update changes. HYPERS has been designed to simulate 3D compact fusion devices (such as the SSX experiment at Swarthmore) and interactions of streaming plasmas with obstacles. To validate this new code, we compare results from 2D HYPERS simulations with those obtained with a traditional (time-stepped) hybrid code. We also discuss a novel subgridding (EMPOWER) algorithm for full EM-PIC simulations and demonstrate its efficiency on test problems. Both codes are being geared towards peta/exa-scale computer architectures. We report our undergoing efforts on developing efficient dynamic load-balancing strategies for parallel production runs.

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Date submitted: 13 Jul 2010 Electronic form version 1.4