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The EMPOWER Code: Electro-Magnetic Particle Operation With Enhanced Resolution H. KARIMABADI, Y.A. OMELCHENKO, H.X. VU, SciberQuest, Inc/UCSD — Large-scale full PIC simulations play a crucial role in the modeling of laser-plasma interactions, accelerators, HPM devices and magnetic reconnection. These simulations ubiquitously employ uniform meshes, which severely limits their CPU speed and in many cases makes high-resolution runs prohibitive even on massively parallel computers. On the other hand, inadequate spatial resolution of realistic features (localized plasma volumes, device boundaries, etc.) is known to result in unacceptable errors. Structured adaptive mesh refinement (SAMR) has successfully been applied to fluid dynamics and MHD simulations. However, extending SAMR to practical electromagnetic particle-in-cell (PIC) models has proven to be nontrivial due to a number of additional numerical challenges, with spurious wave reflection and macro-particle self-force at the coarse-fine mesh interfaces being the most severe. These approximation errors typically result in a significant loss of simulation accuracy, energy/momentum non-conservation and long-time instabilities. We review our progress in resolving these issues in our new EM-PIC code, EMPOWER. We demonstrate the efficiency and accuracy of the new techniques on realistic examples related to simulations of high-power EM pulses and energetic particle beams.

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