APPLICATION OF THE ADAPTIVE MESH REFINEMENT TECHNIQUE TO PARTICLE-IN-CELL SIMULATIONS OF BEAMS AND PLASMAS

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Abstract

The development of advanced accelerators often involves the modeling of systems that involve a wide range of scales in space and/or time, which can render such modeling extremely challenging. The Adaptive Mesh Refinement technique can be used to significantly reduce the requirements for computer memory and the number of operations. Its application to the fully self-consistent modeling of beams and plasmas is especially challenging, due to properties of the Vlasov-Maxwell system of equations. Most recently, we have begun to explore the application of AMR to the modeling of laser plasma wakefield accelerators (LWFA). For the simulation of a 10 GeV LWFA stage, the wake wavelength is O[100μm] while the electron bunch and laser wavelength are typically submicron in size. As a result, the resolution required for different parts of the problem may vary by more than two orders of magnitude in each direction, corresponding to up to 6 orders of magnitude of possible (theoretical) savings by use of mesh refinement. We present a summary of the main issues and their mitigations, as well as examples of application in the context of LWFA and similar beam-plasma interaction setup.

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