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Progress Toward a Parallel MAGIC

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MAGIC[a] is an electromagnetic particle-in-cell code. MAGIC uses the finite-difference time-domain method to support simulations of both two- and three-dimensional geometries with a wide variety of diagnostics and models for outer boundaries, material properties and emission processes. The greater availability of parallel computing platforms has generated interest in a parallel version of MAGIC to enable larger simulations. We are proceeding with an incremental approach to parallelization of MAGIC. An incremental approach will gradually improve the efficiency of the parallel implementation while maintaining the full capability of the MAGIC code. We discuss the recent progress made in implementing loop-level parallelism in MAGIC using OpenMP[b]. OpenMP has been chosen because it permits initial loop-level parallelism while also providing for task-level parallelism in the future. We also outline future plans for improved parallel execution using domain decomposition of the simulation grid and particles.

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Analysis of Self-Force Error In Relativistic PIC Simulations

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Analysis of self-force error in relativistic PIC simulations [1]

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A mathematically and physically rigorous error analysis of Maxwell's equations coupled with Newton-Lorentz equation of motion for relativistic PIC simulations will be given. The goal of this work is an improved PIC algorithm for simulating relativistic plasmas; for example, accelerators and high power microwave tubes. The analysis shows the error of the method in term of Δt and Δx, with computational verification. First, a brief review is presented of the error in the Maxwell and Newton-Lorentz equations analyzed separately. Next, the coupled equations will be analyzed for a single particle. The coupling is accomplished through the use of weighting functions to weight the particle contribution to the source terms of the Maxwell equations, ρ and J, to the grid. The converse operation, weighting the fields back to the particle location, is also considered. Finally, the Klimontovich equation, together with Maxwell's equations, which constitutes an exact description of a plasma, is analyzed. The difference between this and the PIC algorithm defines the error. Refinements and extensions to reduce the error of the classical PIC method are described. The accuracy and stability of these new algorithms, as well as their impact on performance, are examined.