Three-D complex-geometry semi-implicit finite-difference time-domain simulation of edge plasma at rf time-scales *

David N. Smithe and Ammar H. Hakim
Tech-X Corporation, Boulder USA

Time domain simulation of plasmas in the rf time scale range is difficult because the time-scale is long compared to the electron plasma wave period, and in addition, the various cutoff and resonance behaviors within the plasma insure that any explicit finite-difference scheme would be numerically unstable. We resolve this dilemma with a new algorithm [1] based upon a semi-implicit method (e.g., explicit Maxwell, implicit plasma), such that all linear plasma dispersion behavior are faithfully reproduced at the available temporal and spatial resolution, despite the fact that the simulation time-step may exceed the electron gyro and electron plasma time scales by orders of magnitude. This new algorithm is now available in the Vorpal parallel computing simulation framework, which can provide complex boundary modeling of edge geometry such as antenna, limiters, and other 3-D structures. The result is a unified model joining the power delivery system to the bulk plasma. We report on benchmarking of the new capability for several classical benchmarks, including tunneling through low density edge plasma, cyclotron resonance, and mode-conversion to ICW (ion cyclotron wave). We also report on initial efforts to include 3-D edge geometry, including wave launcher with realistic edge density profiles.

[1] Smithe, Bull. Am. Phys. Soc. **51**, No. 7, CI2-6 (2006).

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