Time Domain Simulation of edge plasma at RF time-scales

John R. Cary¹, David Smithe, Chet Nieter, Johan Carlsson
Tech-X Corporation

Greg Werner
University of Colorado

RF sheath formation and parametric processes are thought to contribute to parasitic power loss near RF antenna structures. We are developing predictive capability in this area, based upon accurate 3-D geometry representation, and time-domain methods appropriate for modeling of the non-linear processes. A significant computational challenge is the treatment of RF coupling through the edge-plasma, where behavior varies rapidly from near vacuum conditions within the coupler to dense plasma past the edge, with the likelihood of plasma-cutoffs and lower-hybrid and cyclotron resonances within this narrow region. We report on achievement of an implicit plasma dielectric model which is numerically stable for all known cold-plasma dispersion characteristics, including cutoffs, resonances, and mode-conversions. The implicit algorithm also permits operation at time steps much greater than the electron plasma frequency, a necessity for RF time-scale simulation of regions containing denser near-edge plasma. This algorithm is expected to form the foundation of our field algorithms, and will be coupled with particle diagnostics and physics models within the VORPAL FDTD Particle-in-Cell (PIC) simulation software. The VORPAL software also contains state-of-the-art curved-boundary representation capability, for accurate 3-D geometry modeling. We present 1-D and 3-D benchmarking of this algorithm, and report on progress in integration with the VORPAL software.

¹Also University of Colorado

Supported by the SciDAC Center for Wave-Plasma Interactions.