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Advanced Implicit and Hybrid Techniques for the Simulation of High Density Volumetric and Electrode Plasmas

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Recent advances in implicit and hybrid techniques have demonstrated that finite-difference-time-domain particle-in-cell (PIC) simulation codes can effectively model volumetric and electrode plasmas at high density. Energy-conserving implicit kinetic algorithms greatly relax the spatial Debye length and temporal plasma frequency constraints allowing for larger simulations volumes and times. A new implicit technique based on the Magnetic Implicit algorithm for strongly magnetized plasma permits more accurate orbit calculations even with for cyclotron frequency-time step product much greater than unity. PIC fluid techniques facilitate hybrid simulation and further accelerate the computational speed. These new capabilities allow for more accurate simulation of pulse-power accelerators, high power diodes, laser-plasma interactions, as well as magnetic and inertial confinement machines. In this paper, we explore PIC methodologies for kinetic and multi-fluid simulation. Hybrid techniques for blending the various PIC descriptions into a single integrated simulation will be discussed. Finally, we will present stressing practical examples using these techniques in the LSP simulation code.

Author: Dr WELCH, Dale (Voss Scientific)

Co-authors: Dr ROSE, David (Voss Scientific); Dr THOMA, Carsten (Voss Scientific); Dr OFFERMANN, Dustin (Voss Scientific); MOSTROM, Chris (Voss Scientific); CLARK, Robert (Voss Scientific); Dr GENONI, Thomas (Voss Scientific)

Presenter: Dr WELCH, Dale (Voss Scientific)

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