Title: Current Distribution Along an Antenna in Magnetized Plasma Using the PF-FDTD Model

Jeffrey Ward
Grand Valley State University
wardje@gvsu.edu

Abstract:
Antennas have a long history in Metrology, especially for performing in-situ plasma measurements. However many of the dominate theories in use require a Quasi-Static analysis and prescribed current distributions. These approximations produce data that is an order of magnitude off from experimental data near critical frequencies of interest. This paper will outline a Full-Wave Self-Consistent Numerical model based upon a combination of Maxwell's equations, Ohms law, and the 13 Moment Plasma Fluid equations. A central difference approximation is used to convert the governing differential equations into finite difference equations that can then be programs. Simulation results show that near the parallel resonance (the upper hybrid frequency currently used to deduce electron densities), the current distribution becomes more exponential in nature. But just after the upper hybrid frequency, where plasma acoustic waves begin to propagate, the peak location migrates off of the feed location. This produces a numerical model more in agreement with experimental data. However the simulation of the mid to low frequency plasma oscillations, with their long wavelengths, combined with the use of electrically short antennas, which require small spatial gridding, produce an ill conditioned multi-scale spatial problem. In addition a combination of electrical and compression based waves complicate the absorbing boundary condition, requiring significant memory and run times, hindering the parameterization of the model for experimental data analysis.