Progress in HIIPER Space Propulsion Device Simulations

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Introduction: A simulation of an advanced space thruster comprised of a coupled Helicon and IEC device is needed to accelerate design. Current work focuses on the simulation of the IEC device with a modified Einzel Lens to collimate and extract plasma for thrust.

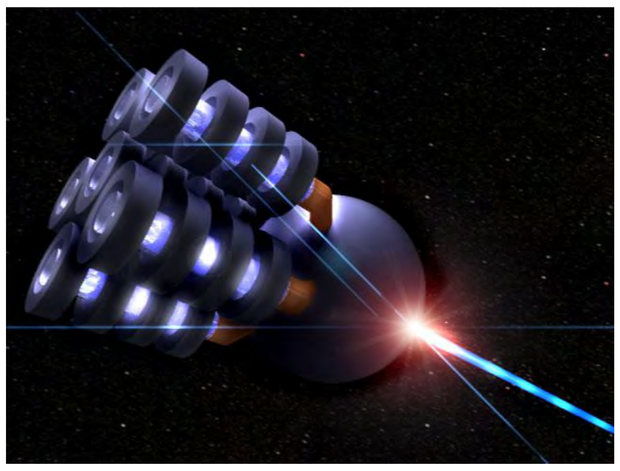

Figure 1. HIIPER in Flight

Computational Methods: The approach is to develop simple models and add complexity as familiarity is achieved with COMSOL's solutions with known results. Once achieved, the IEC and Einzel Lens will be combined in a single simulation. The primary area of interest is the DC Discharge Plasma Module.

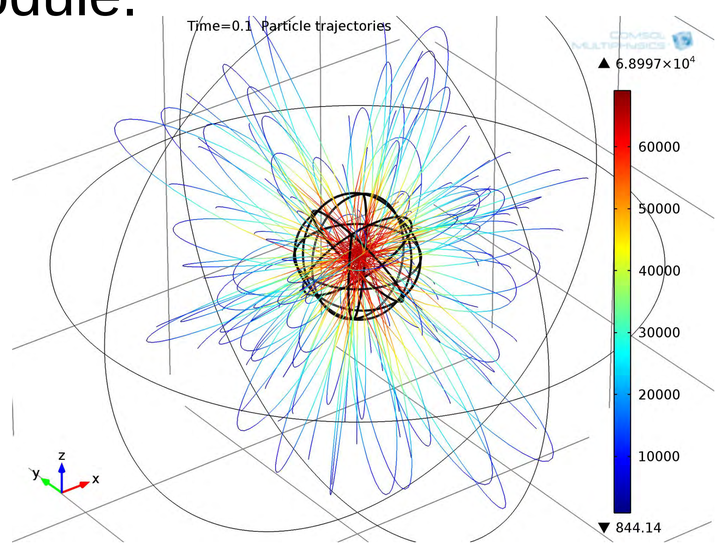

Figure 2. Particle Tracing in IEC

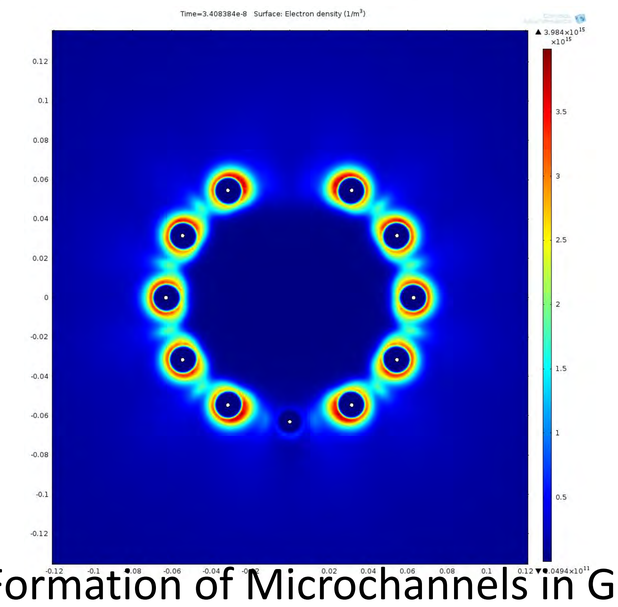

Figure 3. Formation of Microchannels in Grid Plasma

Results: COMSOL shows promise in simulating IEC type plasma devices. The next step is to achieve reliable convergence in simulations by working with the solvers and properly characterizing the problem.

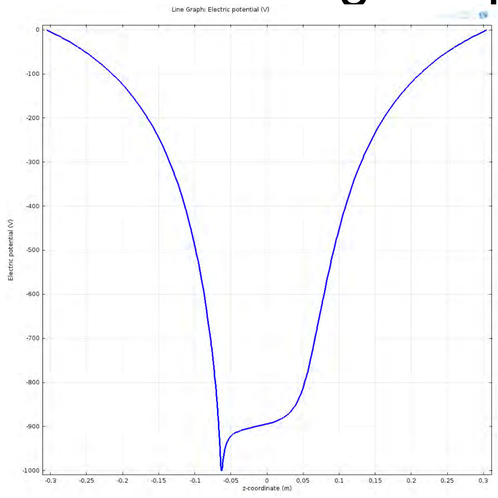

Figure 4. Electric Potential Profile of Asymmetric IEC Grid

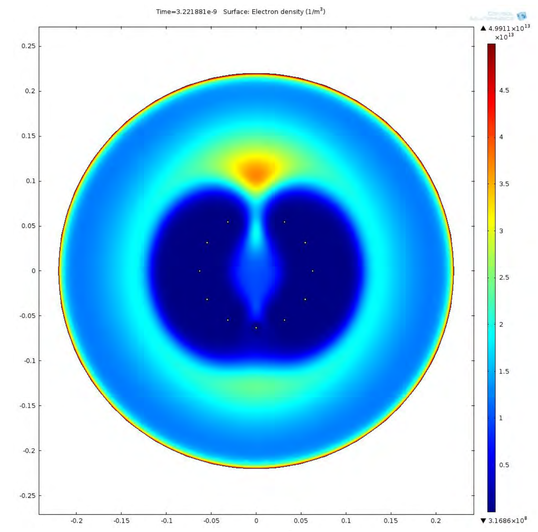

Figure 5. Jet Mode Ion Density

Variable	Value	Units
Peak Density	5E13	m^(-3)
Pressure	10	mTorr
Ion Peak Velocity	6E4	m/s
Ion Energy	2	keV

Table 1. Test Characteristics

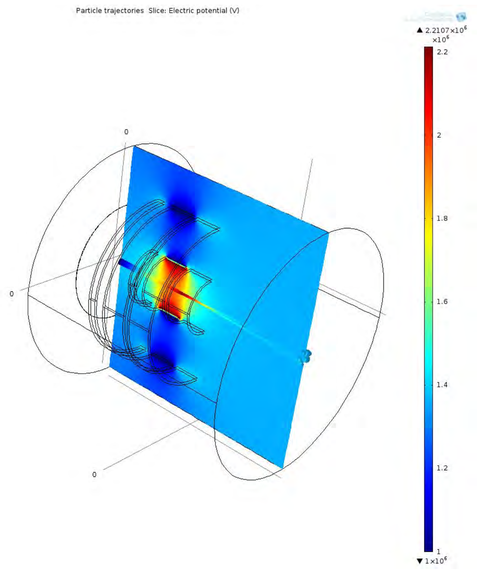

Figure 6. Einzel Lens Particle Trajectories

Conclusions: Simulations are returning results consistent with expected results Once all simulation objectives are accomplished, rapid design iteration can be done through COMSOL.

References:

1. Miley, George H., et al.Discharge Characteristics of the Spherical Inertial Electrostatic Confinement (IEC) Device, IEE Transactions of Plasma Science, 25, No. 4, 733-739 (1997)
2. Nebel, R.A., et al., Theoretical and Experimental Studies of Kinetic Equilibrium and Stability of the Virtual Cathode in an Electron Injected Inertial Electrostatic Confinement Device, Physics of Plasmas, 12(1), 1-8 (2005)

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