Development And Testing Of The Inertial Electrostatic Confinement Diffusion Thruster

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The Inertial Electrostatic Confinement (IEC) diffusion thruster is an experiment in active development that takes advantage of physical phenomenon that occurs during operation of an IEC device. The IEC device has been proposed as a fusion reactor design that relies on traditional electrostatic ion acceleration and is typically arranged in a spherical geometry. The design incorporates two radially-symmetric spherical electrodes. Often the inner electrode utilizes a grid of wire shaped in a sphere with a radius 15 to 50 percent of the radius of the outer electrode. The inner electrode traditionally has 90 percent or more transparency to allow particles (ions) to pass to the center of the spheres and collide/recombine in the dense plasma core at r=0. When operating the IEC, an unsteady plasma leak is typically observed passing out one of the gaps in the lattice grid of the inner electrode. The IED diffusion thruster is based upon the idea that this plasma leak can be used for propulsive purposes.

The IEC diffusion thruster utilizes the radial symmetry found in the IEC device. A cylindrical configuration is employed here as it will produce a dense core of plasma the length of the cylindrical grid while promoting the plasma leak to exhaust through an electromagnetic nozzle at one end of the apparatus. A proof-of-concept IEC diffusion thruster is operational and under testing using argon as propellant (Figure 1).

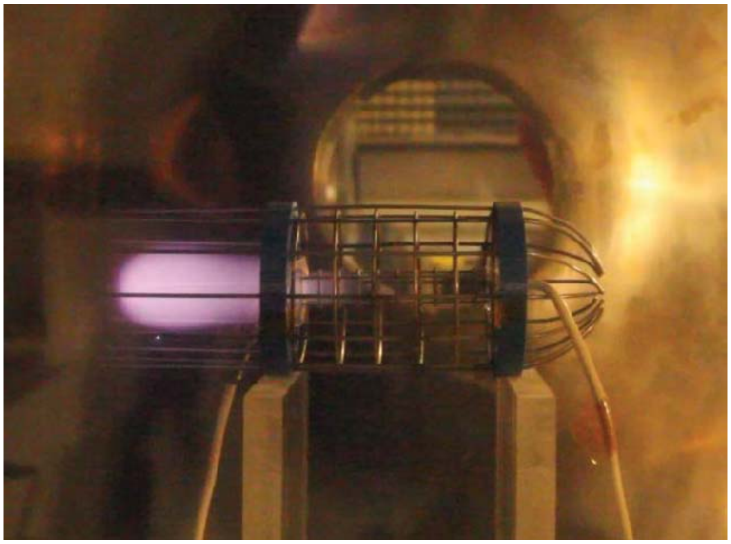

Figure 1 – Proof-of-concept IEC diffusion thruster, nominal operation

Motivated by the qualitative success of the proof-of-concept unit, a new prototype apparatus is being developed. A glass globe has been designed to partially enclose the thruster to promote efficient propellant utilization and thrust production (Figure 2). The forward and top surfaces of the globe are outfitted with multiple feedthroughs for instrumentation and plasma diagnostics. The bottom surface will support thruster mounting and electrical connections. The rear flange can be

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consist of either a partial hemisphere to funnel flow like a nozzle or a flat plate with an orifice. This flexibility allows for the application of a magnetic nozzle on the expanding plasma.

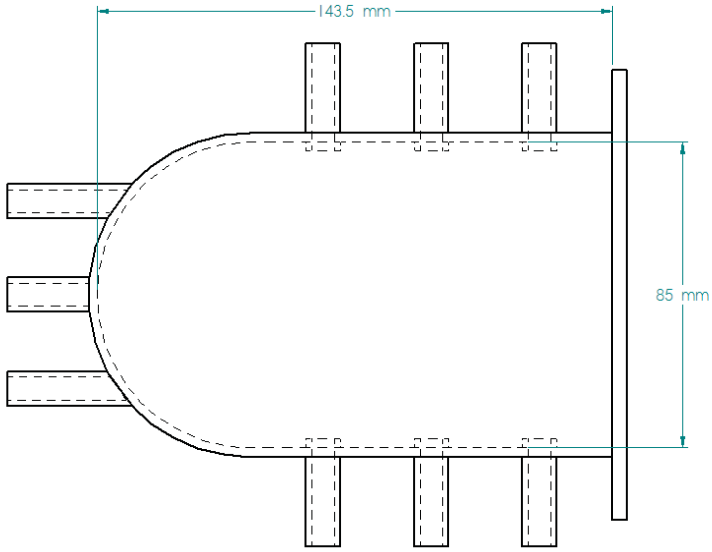

Figure 2 – Thruster Globe Design

The proof-of-concept thruster outer grid was very poorly manufactured. To accomplish more precise manufacturing, the inner and outer grids will be rapid prototyped from titanium. The grids are visible in the rendering shown in Figure 3.

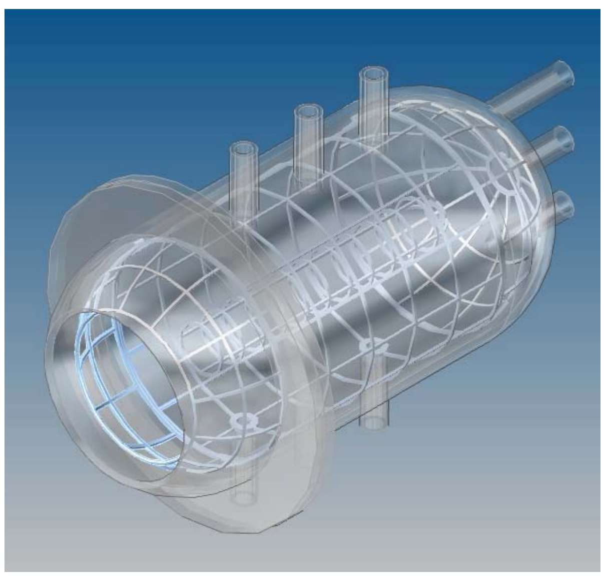

Figure 3 – IEC diffusion thruster with partial hemisphere rear closure

Upon assembly of the new IEC diffusion thruster, we will experimentally measure baseline thrust values and calculate efficiencies. Performance will be quantified as the grid size and intra-grid spacing, and input power levels are varied. The effect of a magnetic nozzle as compared with plasma exhaust through an orifice are quantified in this work.