Discharge Chamber Measurements of an Annular-Geometry Ion Engine

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The Next Generation Electric Propulsion Thruster (NGEPT) has many potential advantages over state of the art ion engines [1-2]. The annular discharge chamber geometry allows for operation at relatively high discharge currents, which translates to higher achievable beam currents (i.e. thrust) relative to state of the art devices. The annular ion optics are fabricated from pyrolytic graphite, which substantially increases the throughput capability of the engine. The NGEPT is designed to address the need for a high thrust-density device that can efficiently operate over a wide specific impulse range (2000-5000 s). While there are many potential benefits to the annular geometry, the non-centerline location of the discharge cathode may create non-uniformities in the discharge that lead to non-uniform or even accelerated component wear and reduced electron back-streaming margin. This effort details tests to verify discharge stability, document discharge chamber plasma azimuthal and radial uniformity, and estimate discharge losses.

Tests were conducted at The Aerospace Corporation in a 2.4-m diameter × 9.8-m long cryopumped vacuum chamber with the thruster oriented along the chamber centerline. The spatial uniformity of the discharge was characterized with 14 discharge button probes mounted at various locations on the perforated grid that enclosed the discharge chamber in place of ion optics. Each planar probe was comprised of a 6.4-mm-diameter molybdenum disc that operated in the ion saturation regime. Three Langmuir probes were placed 120 degrees apart to measure the electron density and temperature. The azimuthal location of the electrostatic probes is shown in Fig. 1. The probe data, time-resolved photographs, and the overall development status of the NGEPT will be detailed.

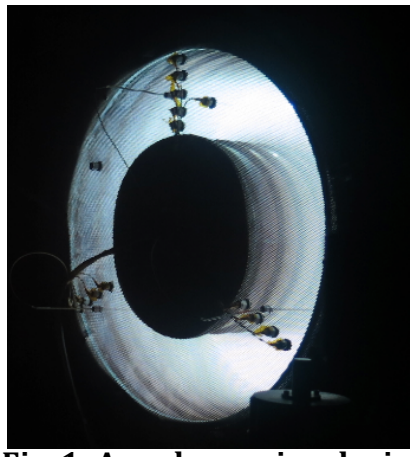

Fig. 1: Annular engine during simulated beam extraction.

References:

1. Patterson et al., Annular Geometry Ion Engine: Concept, Development Stautus, and Preliminary Perfomance, AIAA-2012-3798.
2. Patterson et al., Development Status of High-Thrust Density Electrostatic Engines, AIAA-2014-3422.