Preliminary Results and Future Goals for a Simultaneous Characterization of a Nested-channel Hall Thruster in Experiment and Simulation

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Within the electric propulsion community there is strong interest in scaling state-of-the-art, flight-qualified technology to higher power levels. For Hall Effect Thrusters (HETs), a method for achieving this scaling is that of nesting multiple discharge channels within a single device. These so-called Nested-channel Hall Thrusters (NHTs) not only provide higher power levels while maintaining a compact device form factor, but are capable of much larger throttling ranges than typical single-channel HETs.

The Plasmadynamics and Electric Propulsion Laboratory (PEPL) at the University of Michigan, in collaboration with the Air Force Office of Scientific Research and NASA, has designed and built two NHTs. The first, the X2, is a 2-channel, 6-kW discharge power thruster intended as a proof-of-concept device. It has been well-characterized throughout its operational envelope. The more recent NHT, the X3, is a 3-channel thruster designed to be capable of up to 200 kW of discharge power. It has been operated up to 61 kW discharge power to date.

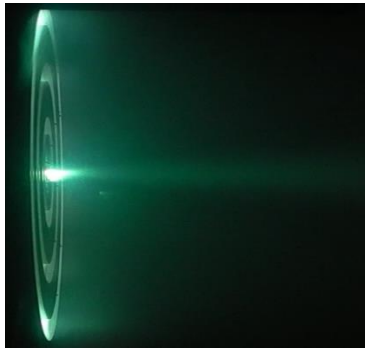

Figure 1: X3 triple channel operation.

A number of interesting phenomena have occurred while operating multiple channels. An apparent thrust gain was measured for the X2, and propellant savings were recorded during the preliminary operation of the X3. To aid in understanding these trends, the Nonequilibrium Gas and Plasma Dynamics Laboratory (NGPDL) is preparing simulations of the NHT thrusters. The hybrid-PIC code HPHall is used. The X2 model will be tested first, to validate the code for NHTs. Next, operation of the X3 thruster will be investigated, at the same time that the plasma plume is being characterized in the vacuum chamber. This unprecedented simultaneous characterization of the thruster in both experiments and simulations will produce a thorough understanding of interactions between channels. The current discoveries will then be used for the design of future NHTs.

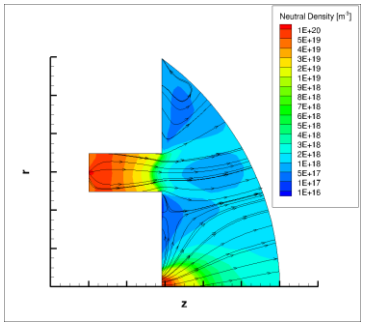

Figure 2: X2 inner channel number density contours.

In this talk, a summary of the work to date with simulations of the X2 and laboratory tests of the X3 will be provided, along with details of the collaboration between PEPL and NGPDL and expected future work.