Performance and Initial Investigation of Channel Interactions on Nested Hall Thrusters Sarah E. Cusson, Scott J. Hall, Ethan T. Dale, Alec D. Gallimore *Aerospace Engineering, University of Michigan, Ann Arbor, MI, United States*



Abstract

The University of Michigan, in collaboration with NASA and the Air Force Office of Scientific Research, has developed two nested-channel Hall thrusters: the X2 and the X3^{1,2}. The X2 is a 6-kW two-channel thruster that was designed as a proof of concept for nesting channels concentrically. The successful results of the X2 project lead to the development of the X3, a 200kW three-channel thruster. Presented here are performance results from the X2 and the X3 as well as data investigating anomalous increases in thrust seen on nested Hall thrusters.

Thrusters



A feature of nested Hall thrusters is the ability to the channels in any configuration, leading to seven firing configurations for the X3 and three

Results



Motivation

Scaling Hall thrusters to highpower via nesting channels maximizes the power-to-mass ratio, relies on proven technology and enable missions to Mars and beyond.



With a 5.2 km/s change in velocity from Earth LEO to Mars capture orbit, electric propulsion can deliver a 0.83 mass fraction. figuring configurations for the X2. This allows for greater throttling range over a single channel



thruster. During operation, the channels of each thruster were run off individual power supplies, commerciallyavailable rack mounted power supplies were used to power the

cathode and electromagnets, and commerciallyavailable mass flow controllers were used to deliver high-purity xenon to the thrusters. Each thruster runs off a single-centrally mounted LaB₆

Pressure Control



Diagnostics





cathode.

Test Matrix

Test Matrix for X3

Condition	Power [kW]
Inner	4.1
Middle	9.5
Outer	16.4
Inner + Middle	13.6
Inner + Outer	20.5
Middle + Outer	25.9
Three - Channels	30.0

Cathode Centerline

 Liang, R., "The Combination of Two Concentric Discharge Channels into a Nested Hall-Effect Thruster," Ph.D.
Dissertation, University of Michigan, 2013.
Florenz, R., "The X3 100-kW Class Nested-Channel Hall Thruster: Motivation, Implementation, and Initial Performance," Ph.D. Dissertation, University of Michigan, 2014.
Hall, Scott J., Sarah E. Cusson, and Alec D. Gallimore. "30kW Performance of a 100-kW Class Nested-channel Hall Thruster." (2015).

Diagnostics used to measure nested Hall thrusters include Faradays probes, high speed current probes and inverted pendulum thrust stands.

to collect current density

The X2 installed on an inverted pendulum thrust stand

Condition	Power [kW]
Inner (TP2, TP4)	1.25
Outer (TP3, TP5)	3.24
Dual Channel (TP1)	4.50

Test Matrix for X2

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