

Progress and Developments in Open
Source Electric Propulsion

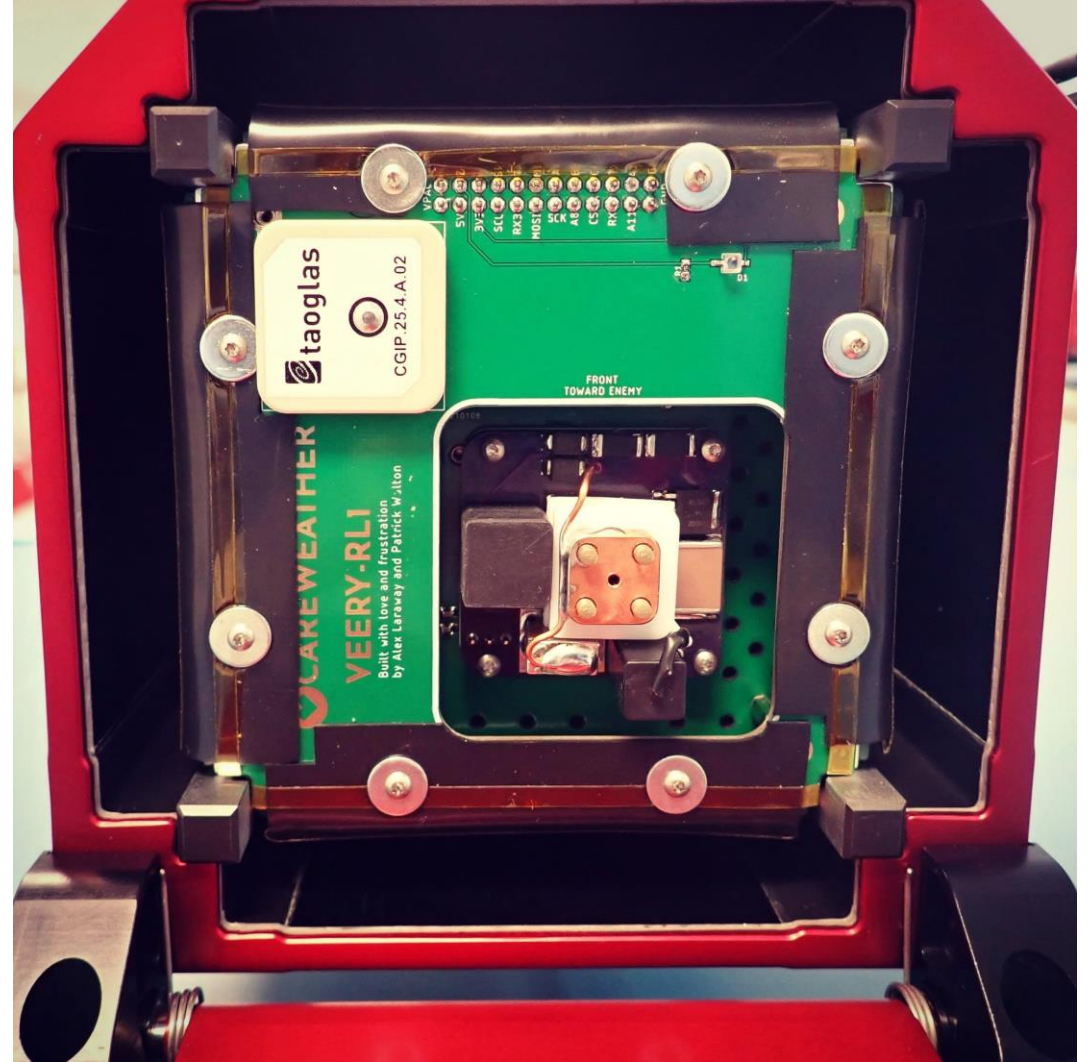
Michael Bretti



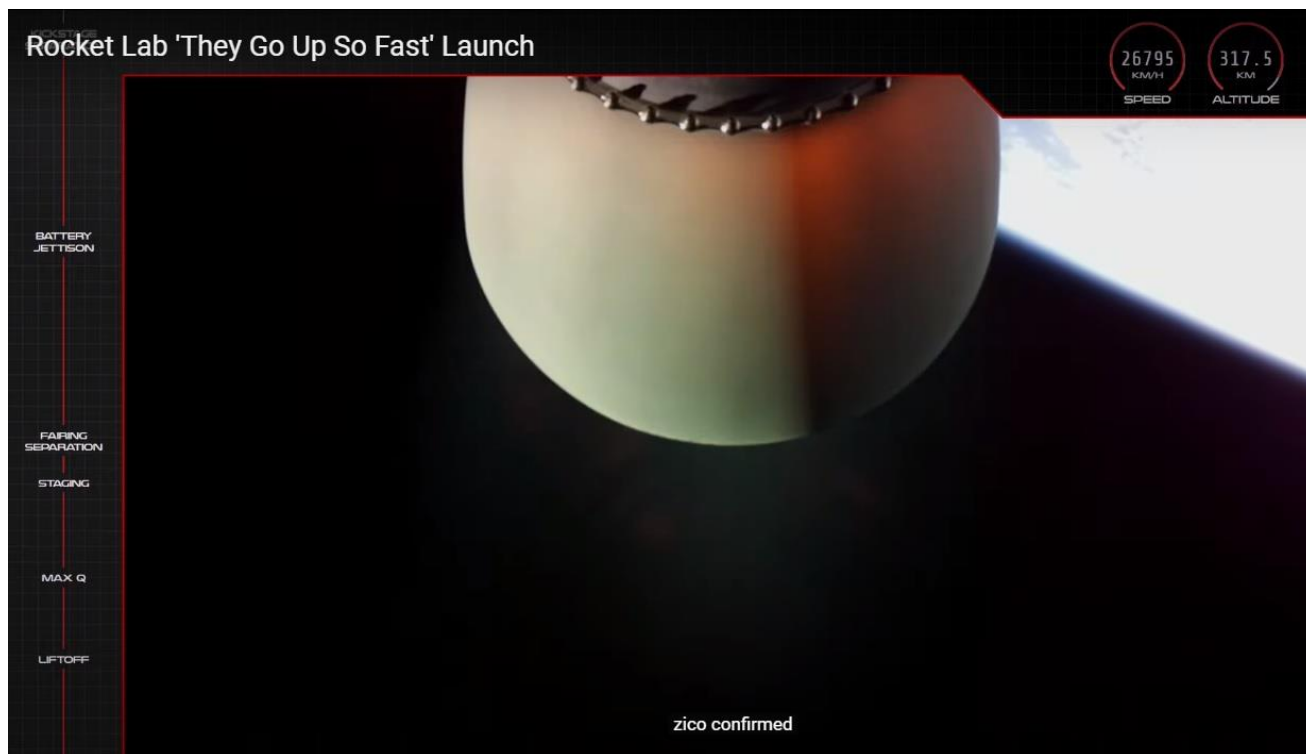
Background

- Only independent maker-based at-home R&D company for advanced plasma/ion thrusters
- Ultra-low cost, easy to manufacture, open-source thrusters for Cubesats and PocketQubes
- Provide resources for hobbyist, educational, enthusiast, nanosat, and picosat communities

Care Weather Technologies Hatchling Veery Collaboration



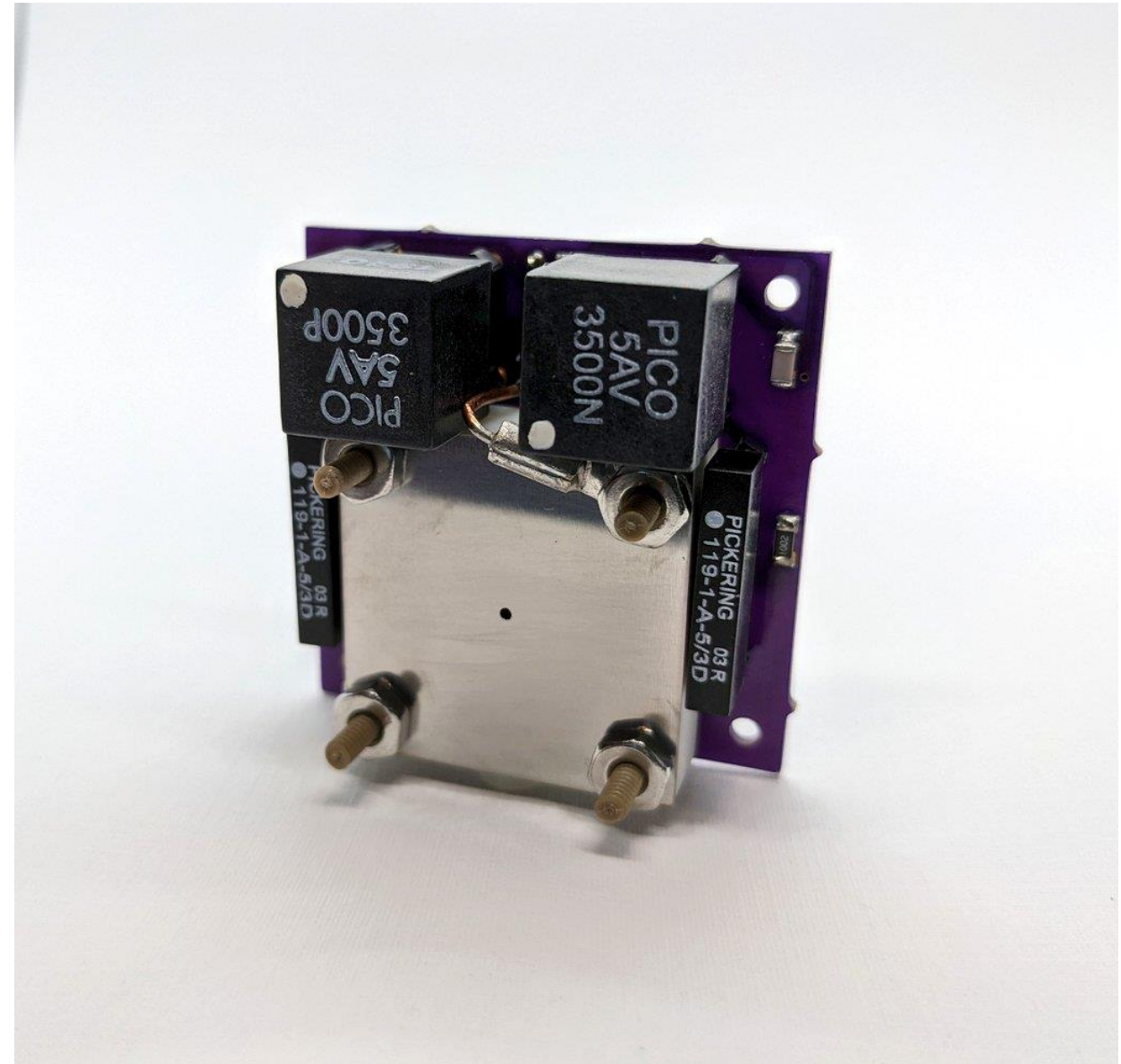
AIS Thrusters Are Orbital Aboard the Hatchling Veery!

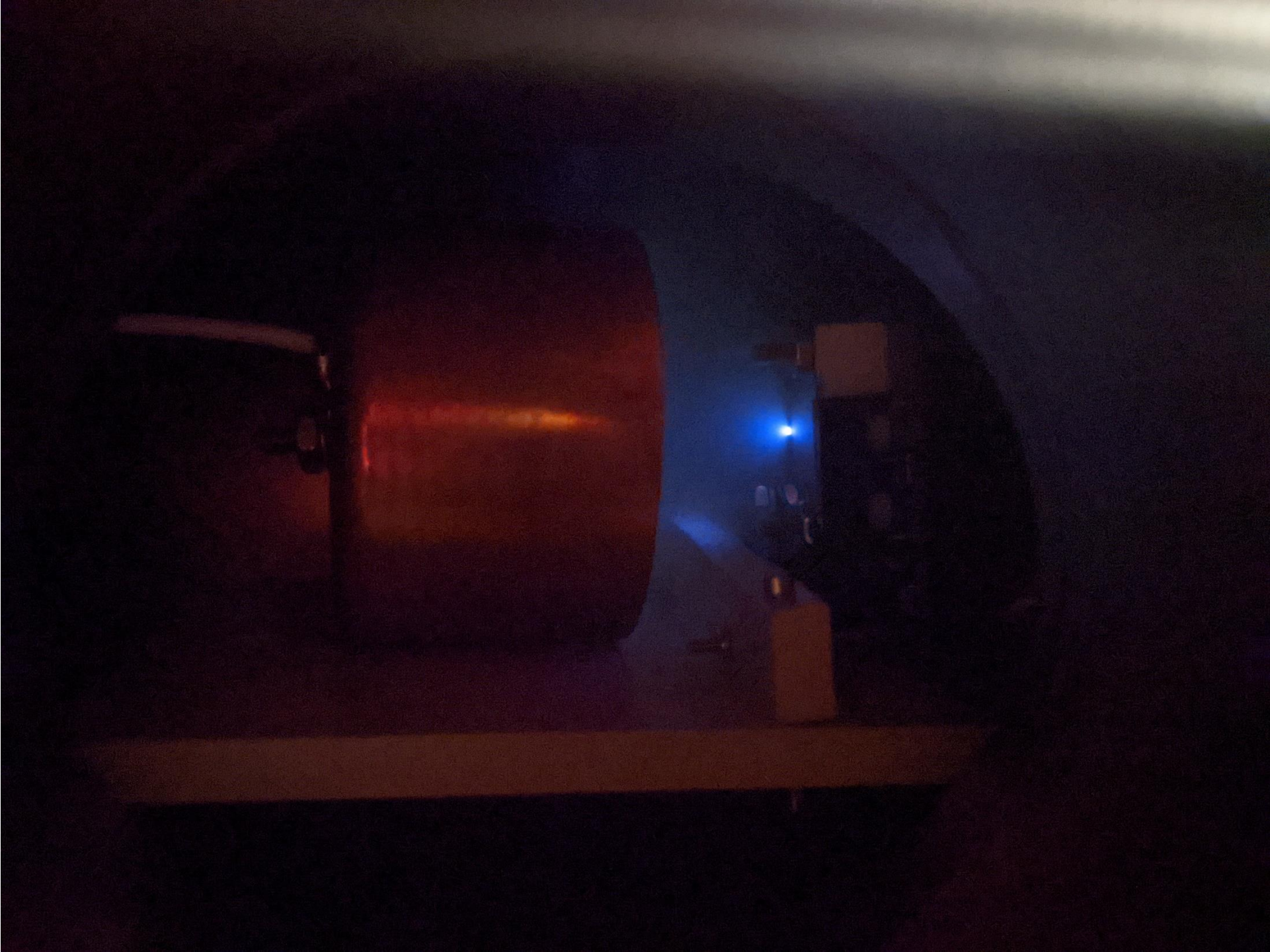


AIS-ILIS1 Ionic Liquid ion Source Electrospray Thruster

Specs (As of Ignition Test #8)

- **Fuel:** EMI-BF4
- **Size:** 42x42x16mm
- **Mass:** 40g
- **Fuel Mass:** 1g
- **Thrust:** 5.86 μ N
- **ISP:** 4200s
- **Power:** 0.8W





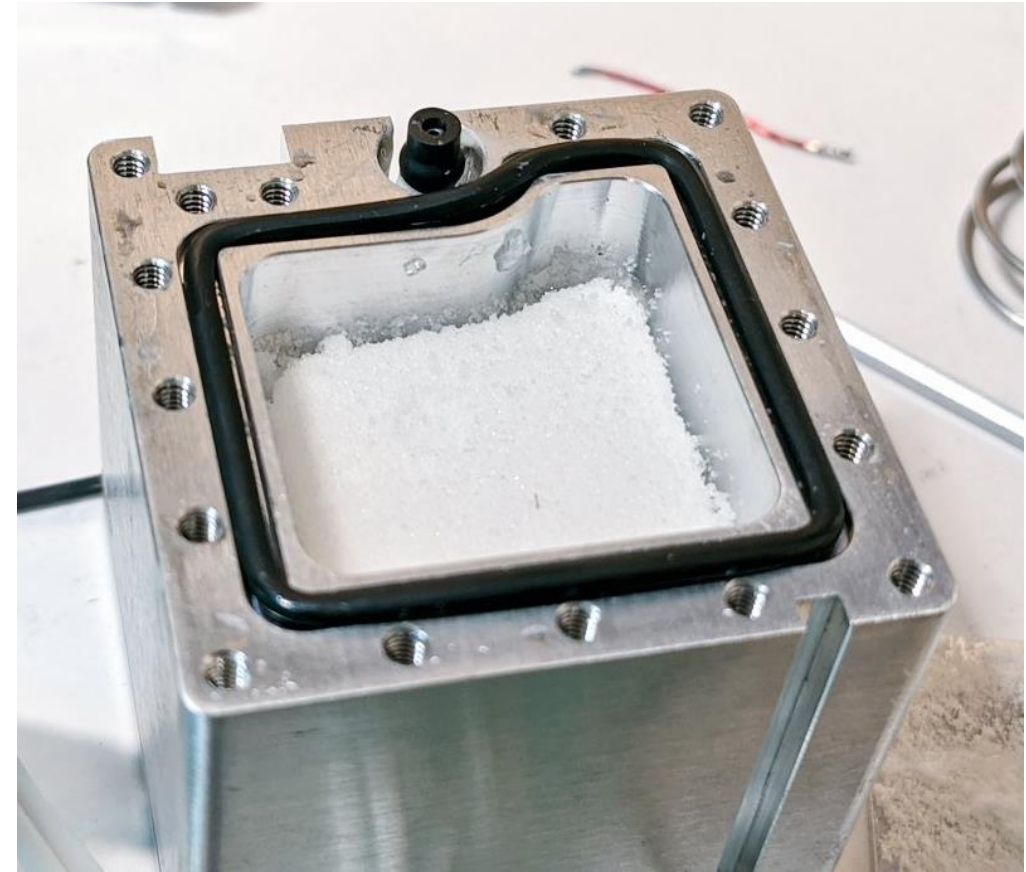
Pioneering Advanced Molecular Fuels for Ultra-Low Power Micro Hall Thrusters - Adamantane

Why Adamantane? Advantages:

- High molecular weight – 136.23
- High molecular ionization cross-section
- Very low sublimation temp in vacuum (<15C)
- Very safe, non-toxic, non-corrosive
- Solid, unpressurized fuel storage

Key Challenges:

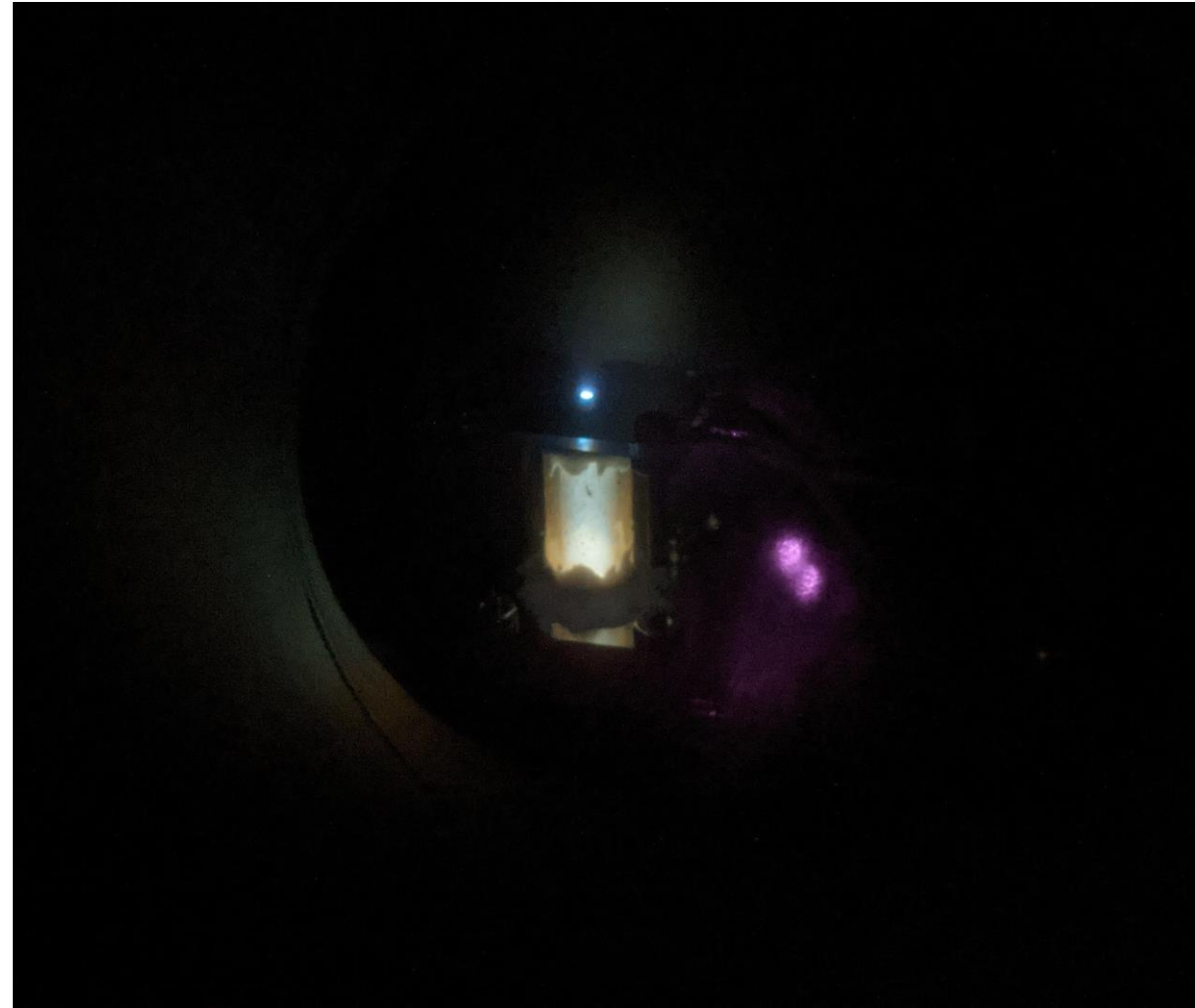
- Highly complex plasma/ion species
- Hydrocarbon plasma – runs “dirty”
- Amorphous carbon deposits
- Large beam losses and ionization inefficiencies



Preliminary Testing with Advanced Molecular Propellants

Low Power Sublimation and Ionization Validation of Adamantane

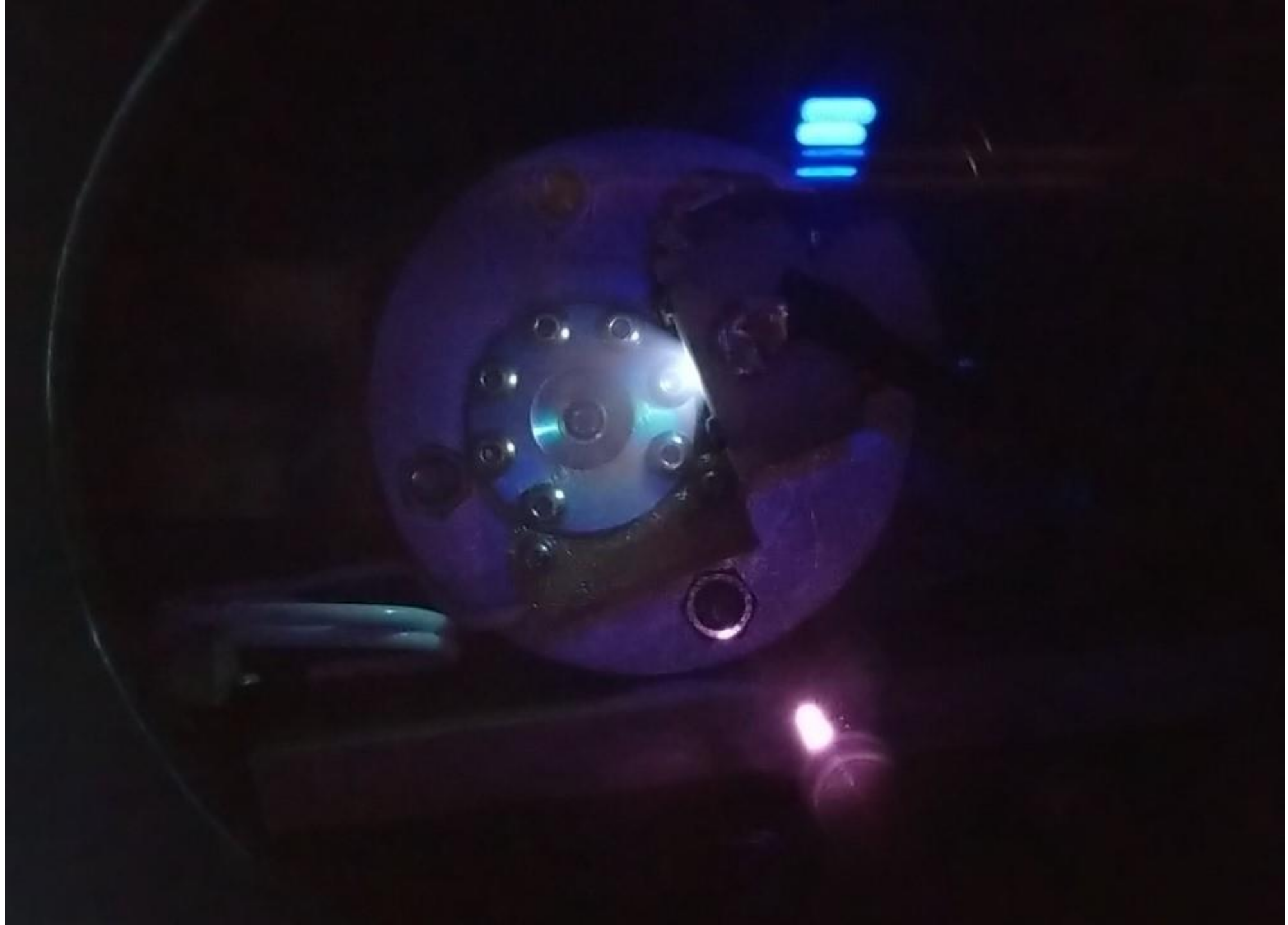
- Low sublimation power: <3W
- Low sublimation temp: <15C
- Low ionization power: <1W-2W
- Multiple topologies demonstrated:
 - Basic glow discharge
 - Ion beam extraction
 - Neutralizer plume extraction
 - Negative charge extraction



AIS-GDN1 Micro Glow-Discharge Hollow Cathode Neutralizer

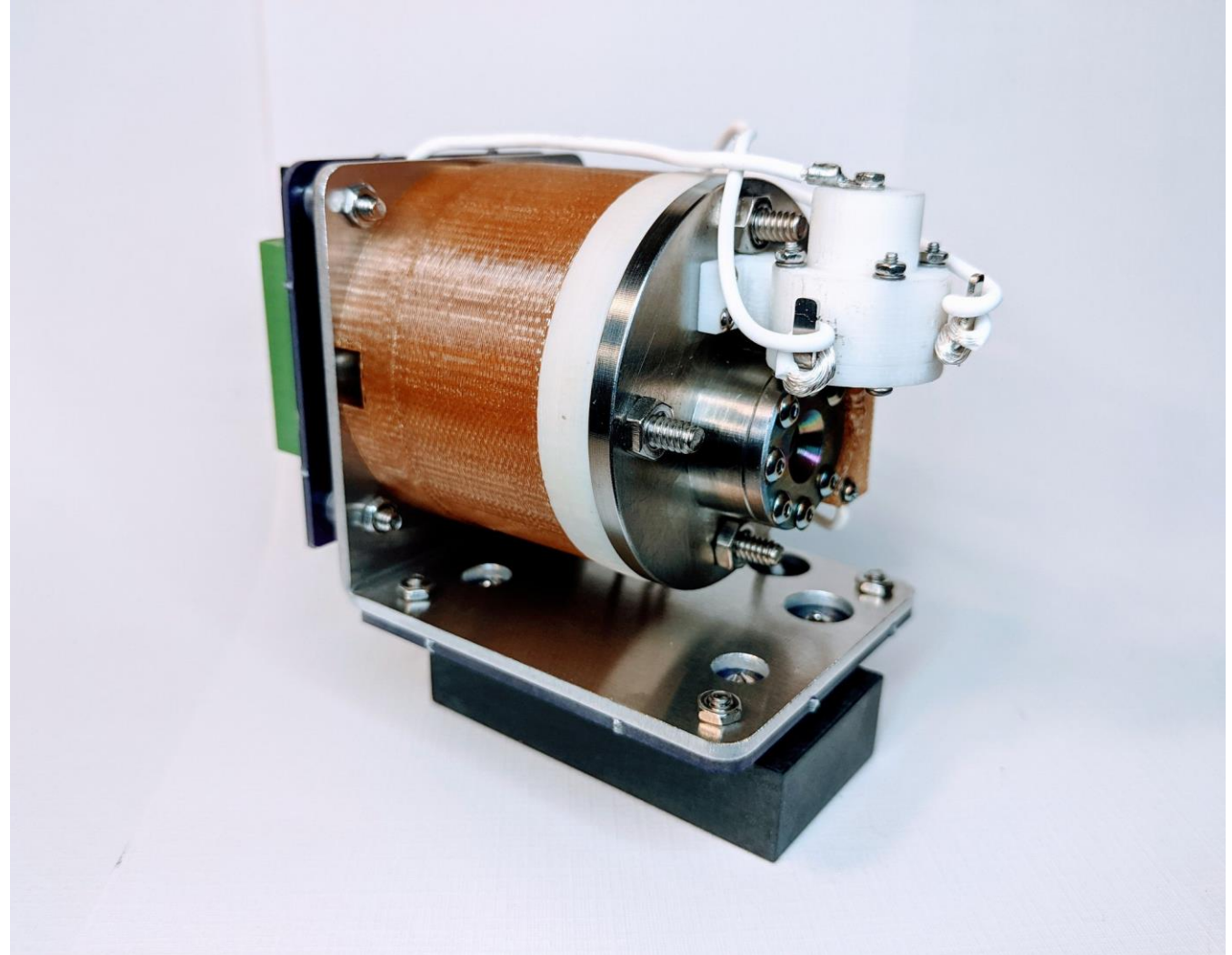
- **Power:** 2W
- **Voltage:** -3kV
- **Size:** 20x20x24mm
- **Mass:** 12g
- **Fuel:** Adamantane (or any gas, noble/reactive)
- **Materials:** Somos PerFORM, Stainless Steel
- **Mechanism:** cold hollow plasma cathode glow discharge





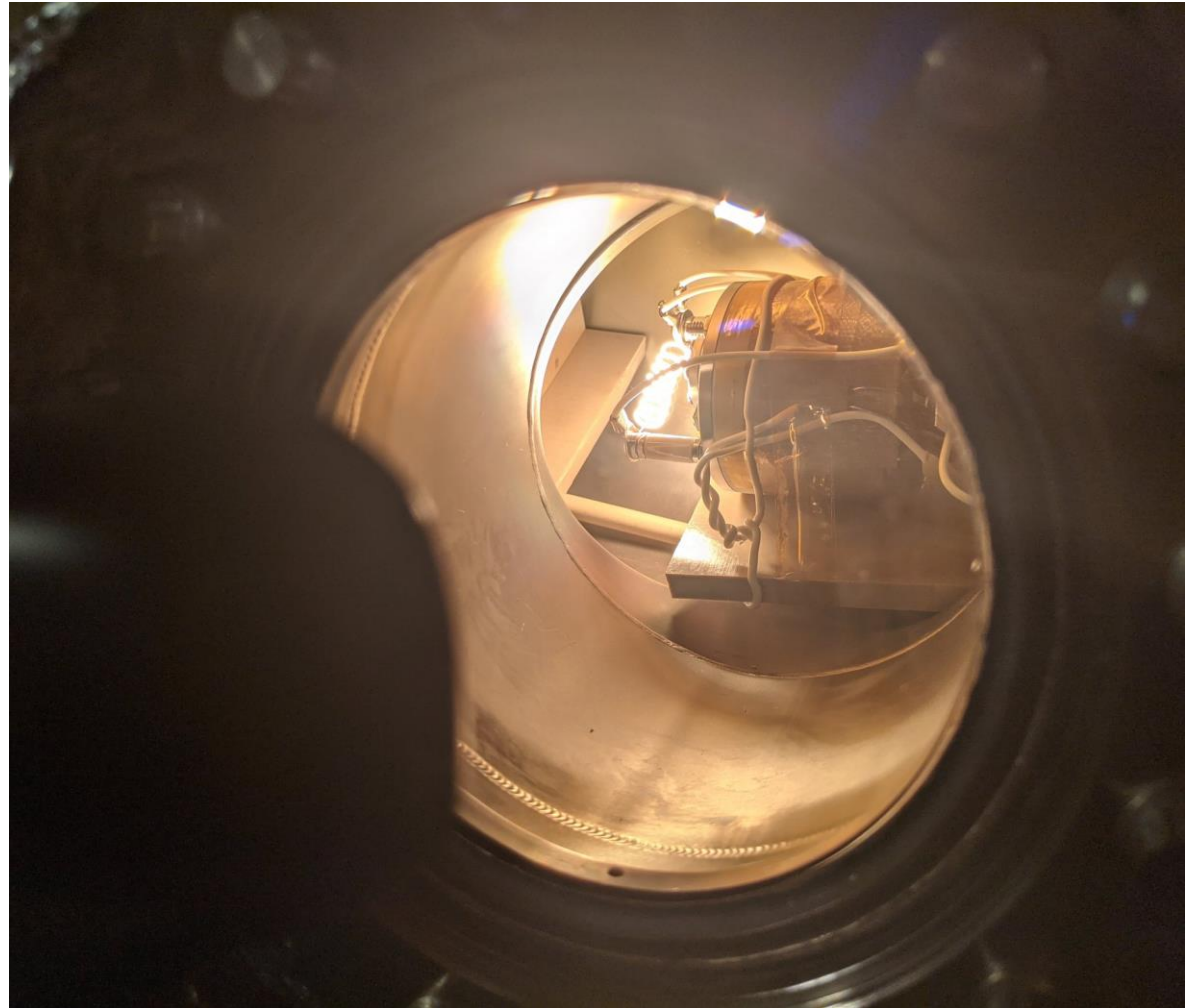
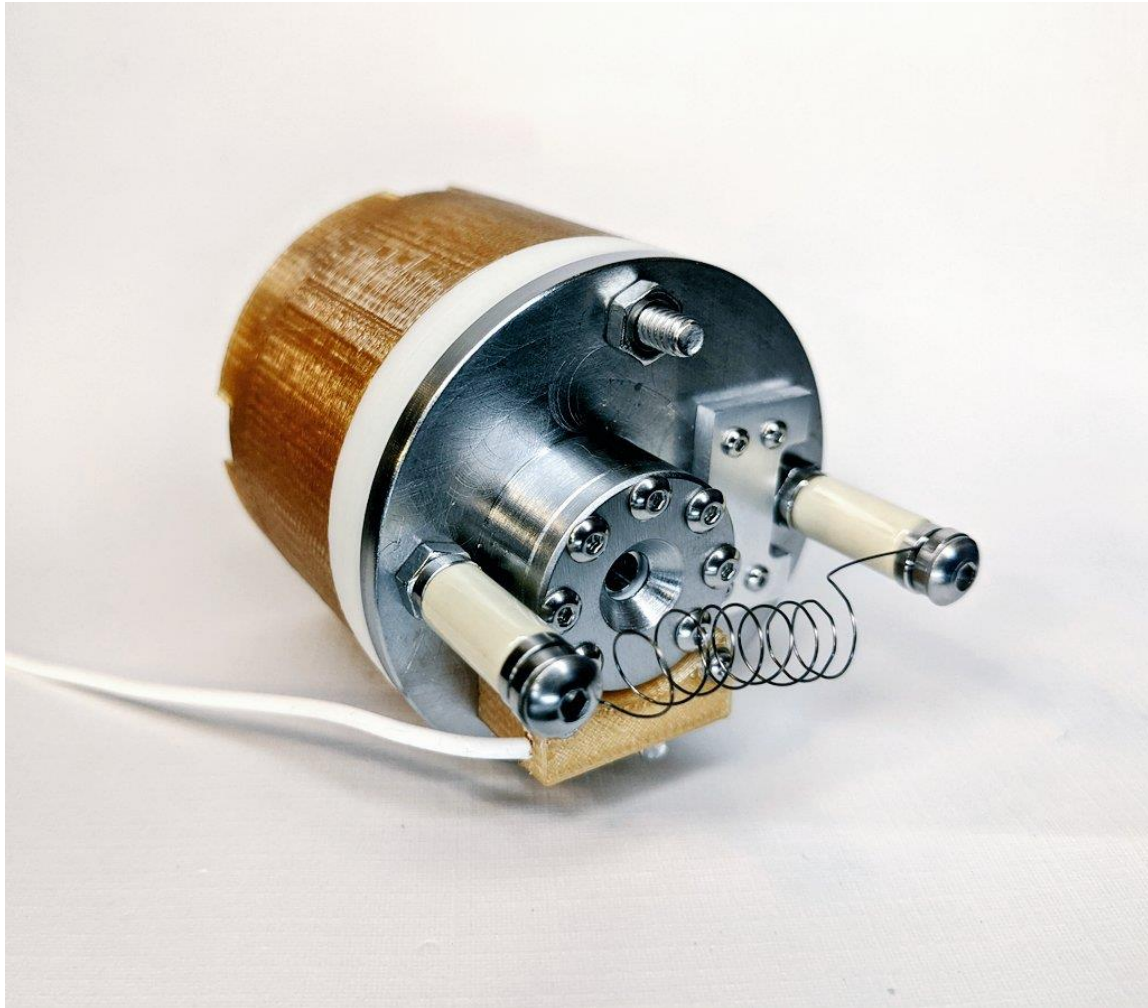
AIS-EHT1 Micro End-Hall Thruster

- **Size:** 51x72x87mm (0.32U)
- **Mass:** 182g
- **Fuel:** Adamantane
- **Fuel Capacity:** 3g
- **Power:** 25W (total system)
- **Expected Thrust:** 30-100uN



AIS-EHT1 Micro End-Hall Thruster

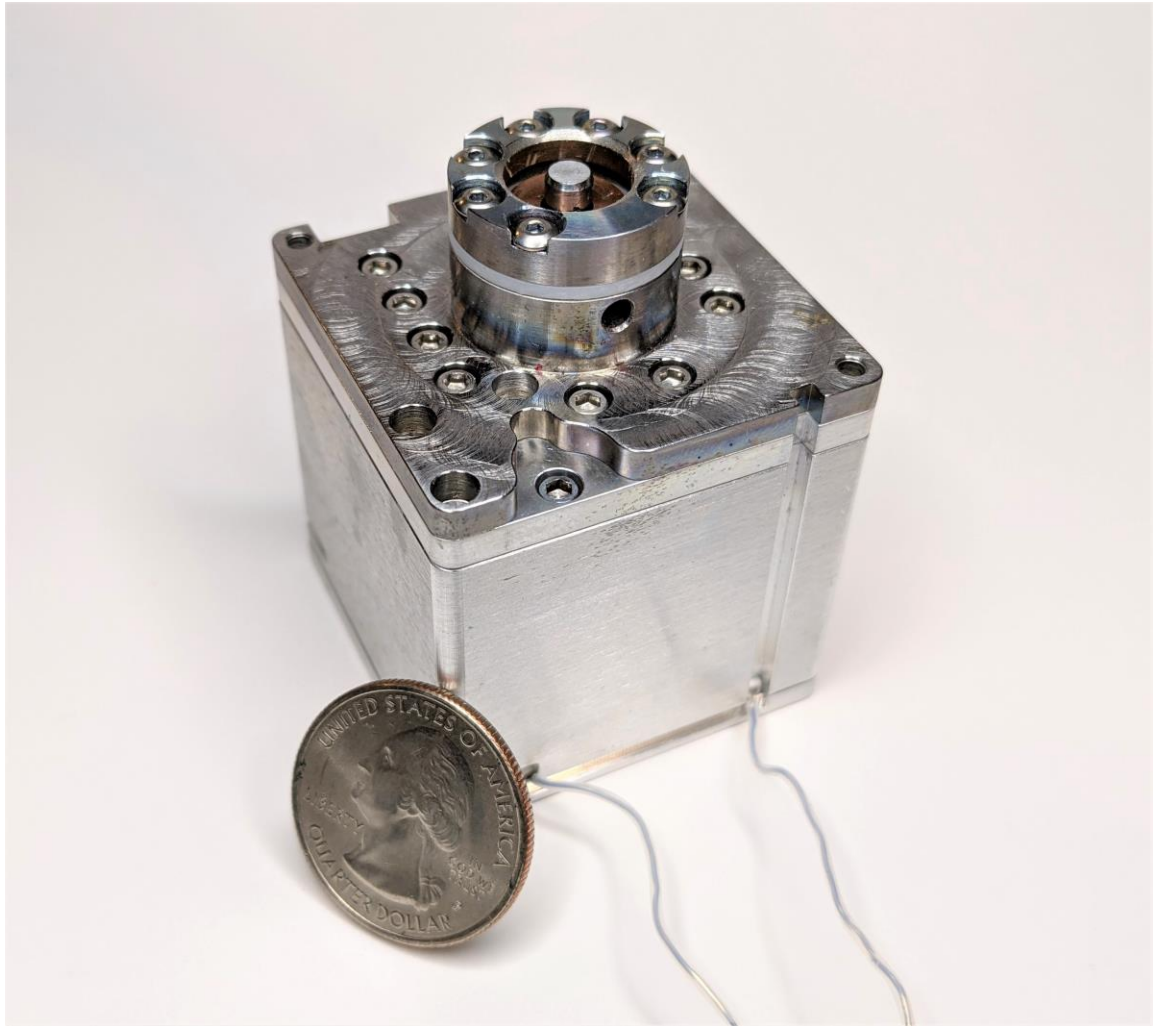
Preliminary Testing with Tungsten Filament Neutralizer



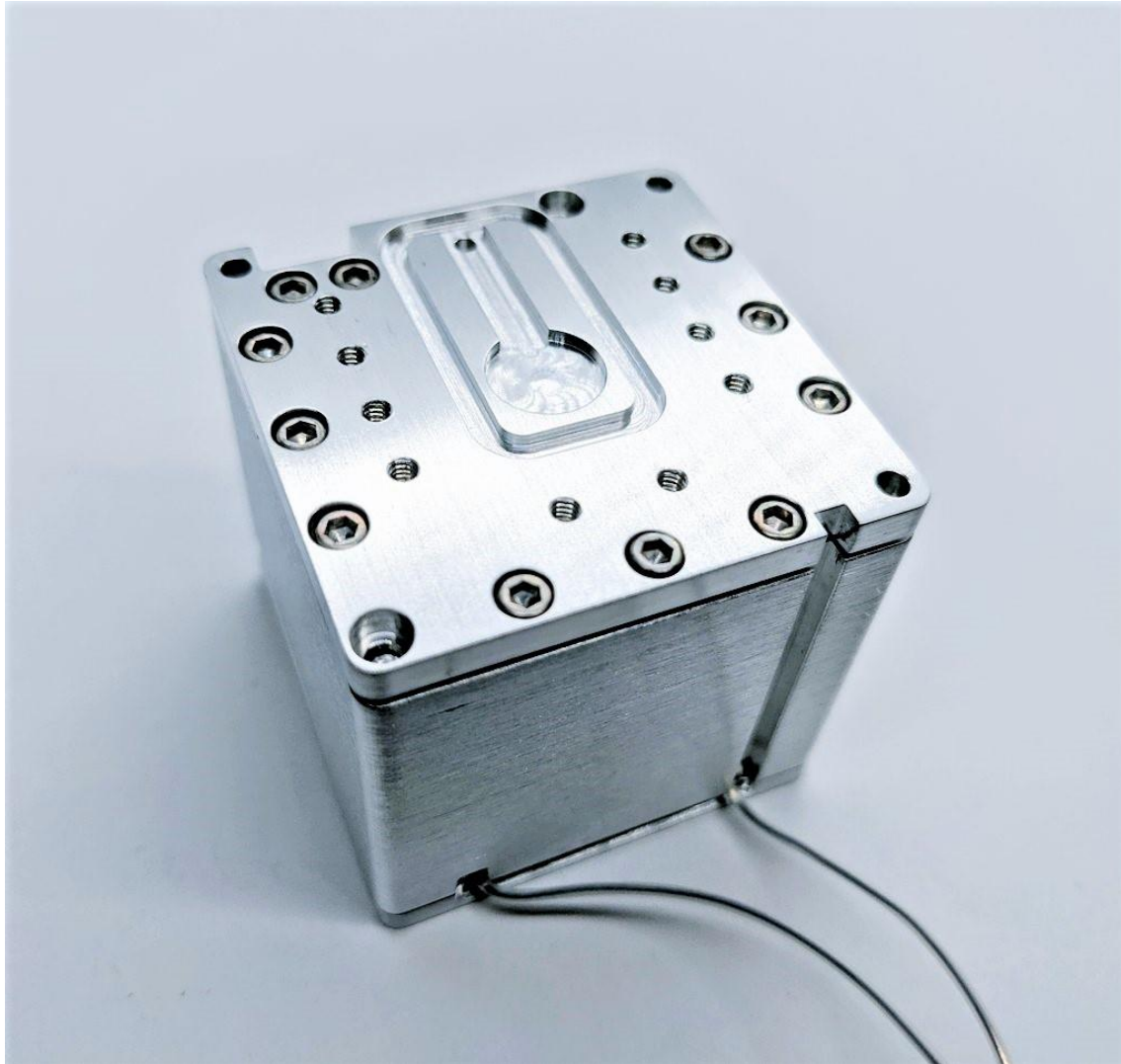


AIS-AHT1-PQ Pico Anode Layer Hall Thruster

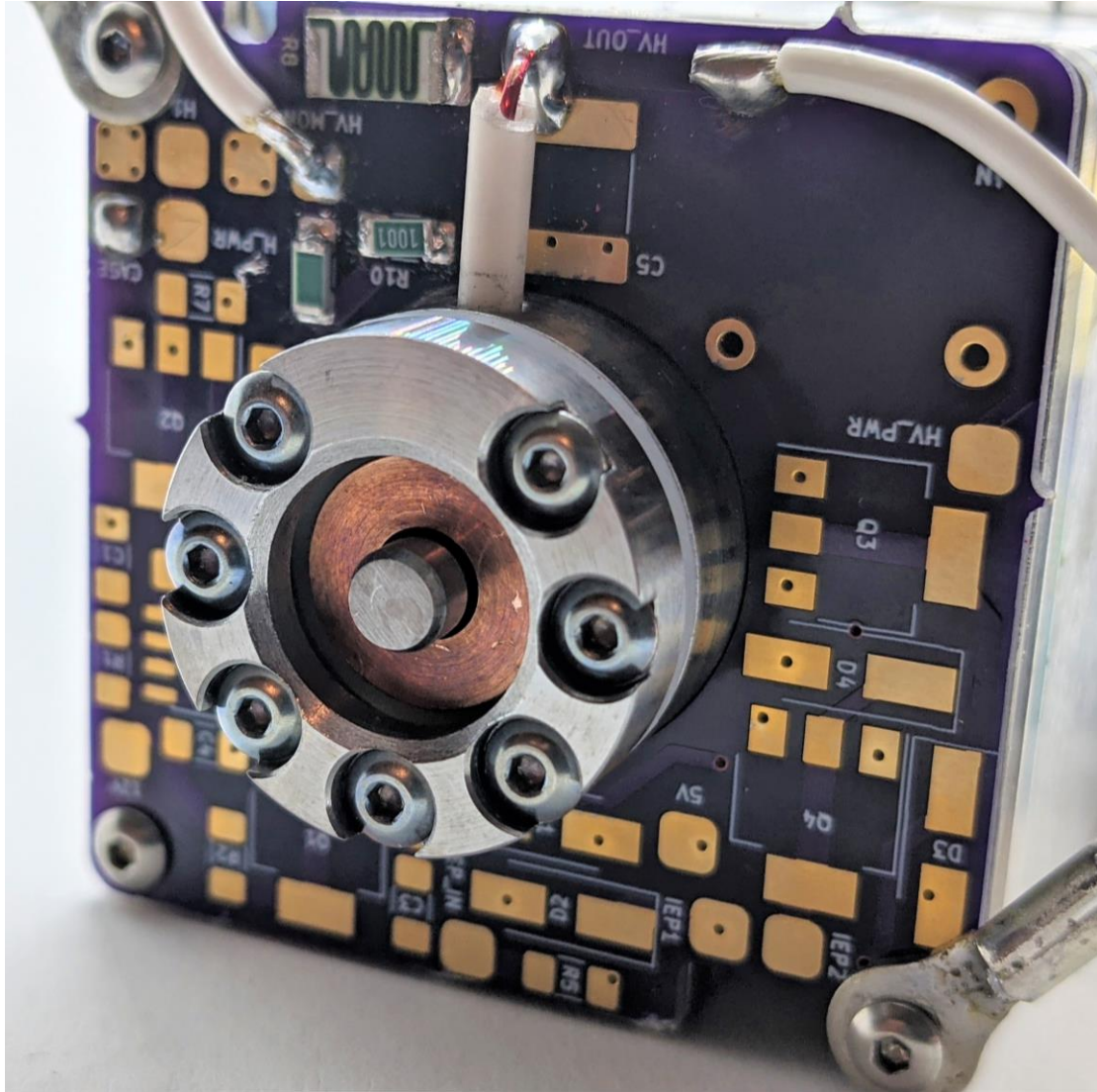
- **Size:** 42x42x56mm (0.125U, 1P)
- **Mass:** 182g
- **Fuel:** Adamantane
- **Fuel Capacity:** 18g
- **Power:** 10W (total system)
- **Expected Thrust:** 20-50uN



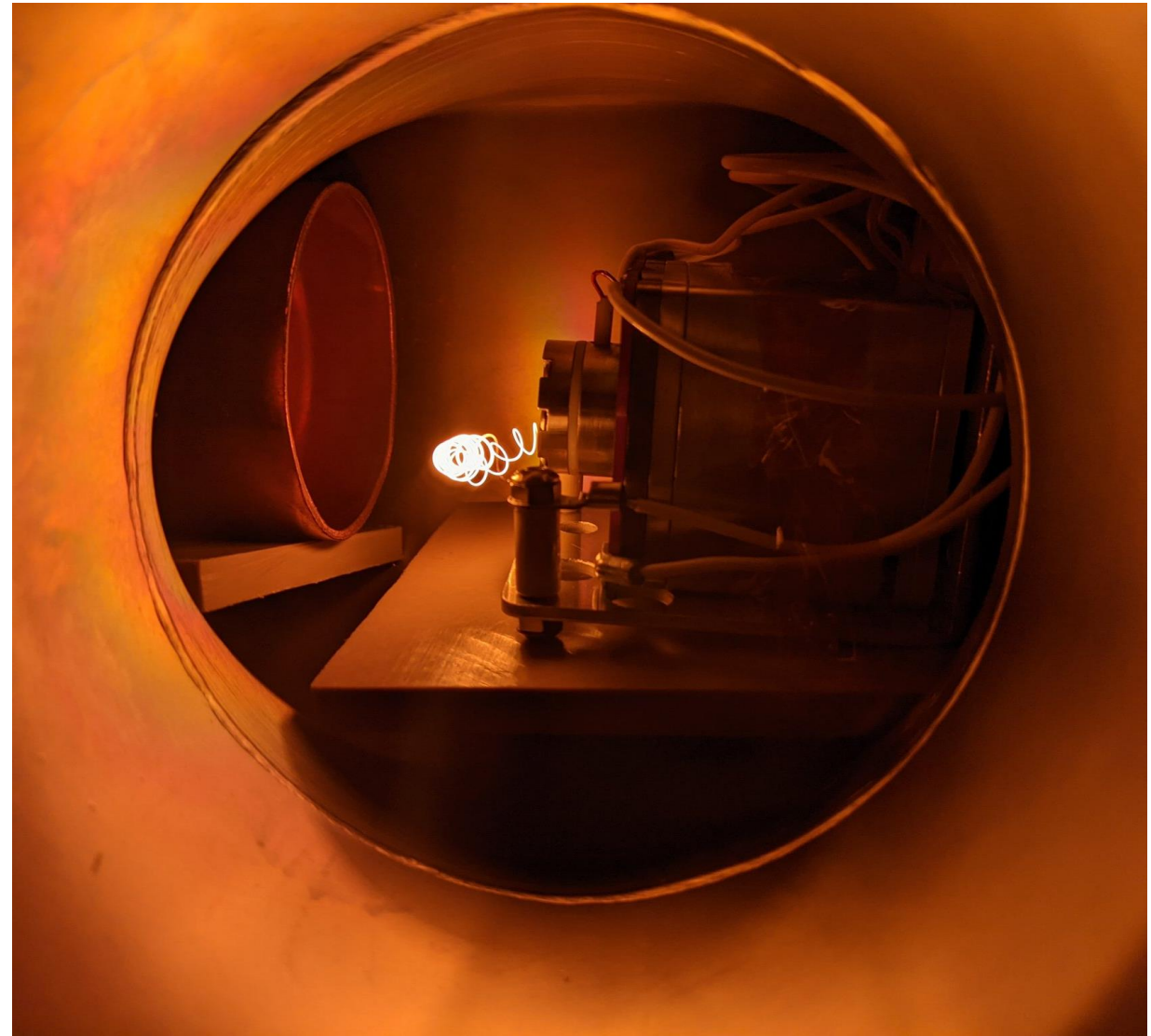
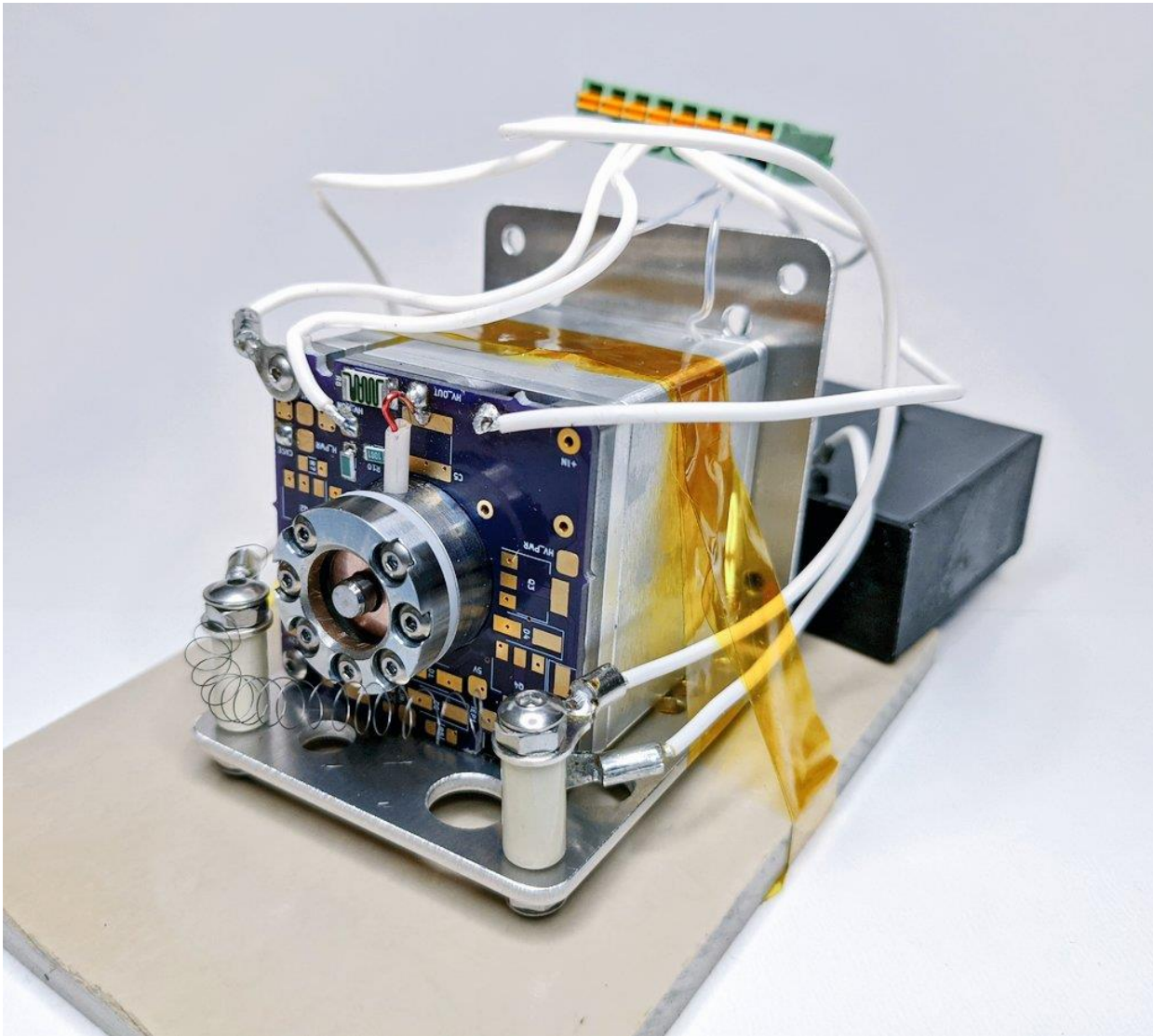
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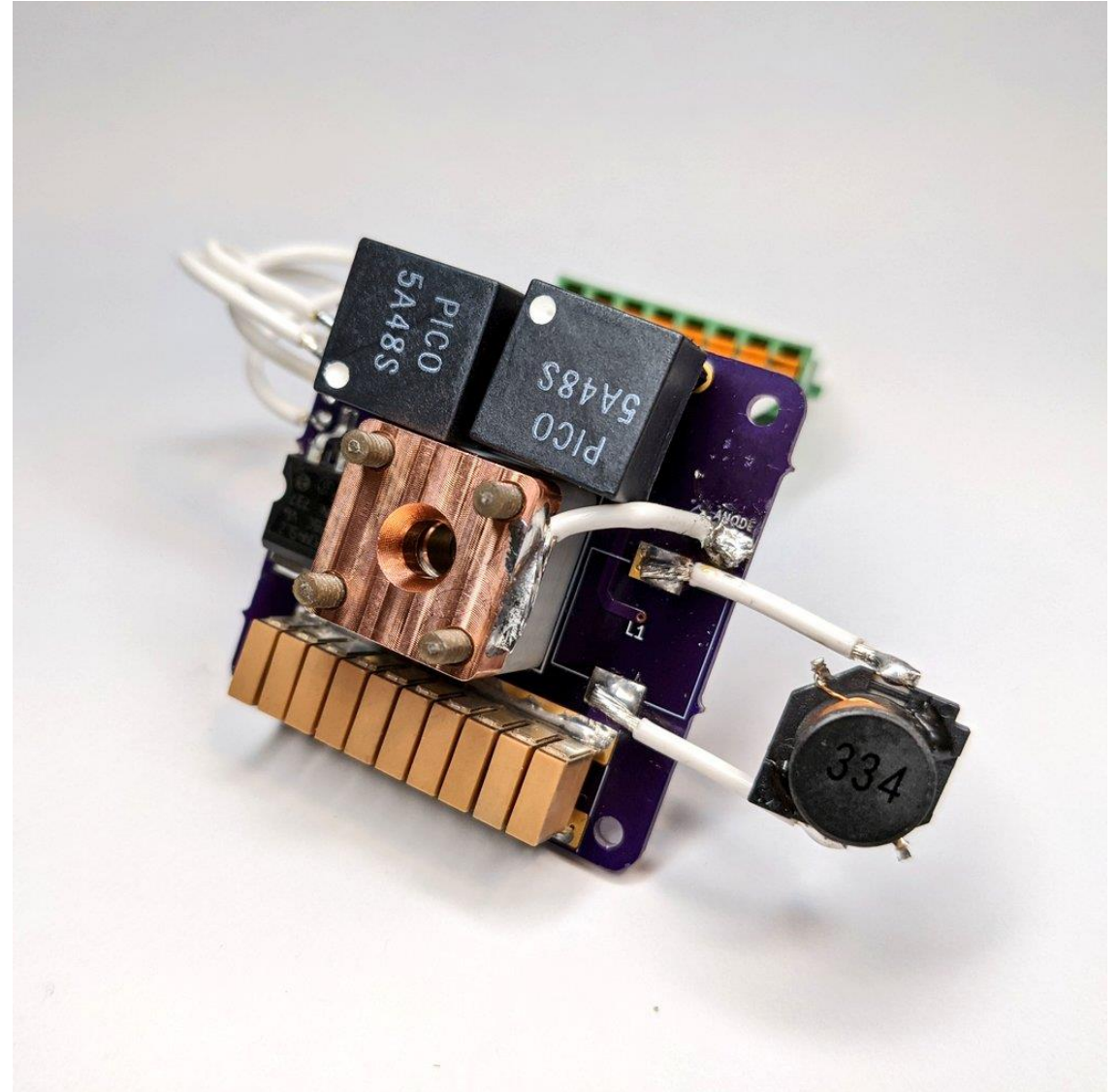


AIS-AHT1-PQ Pico Anode Layer Hall Thruster Testing with Tungsten Filament Neutralizer

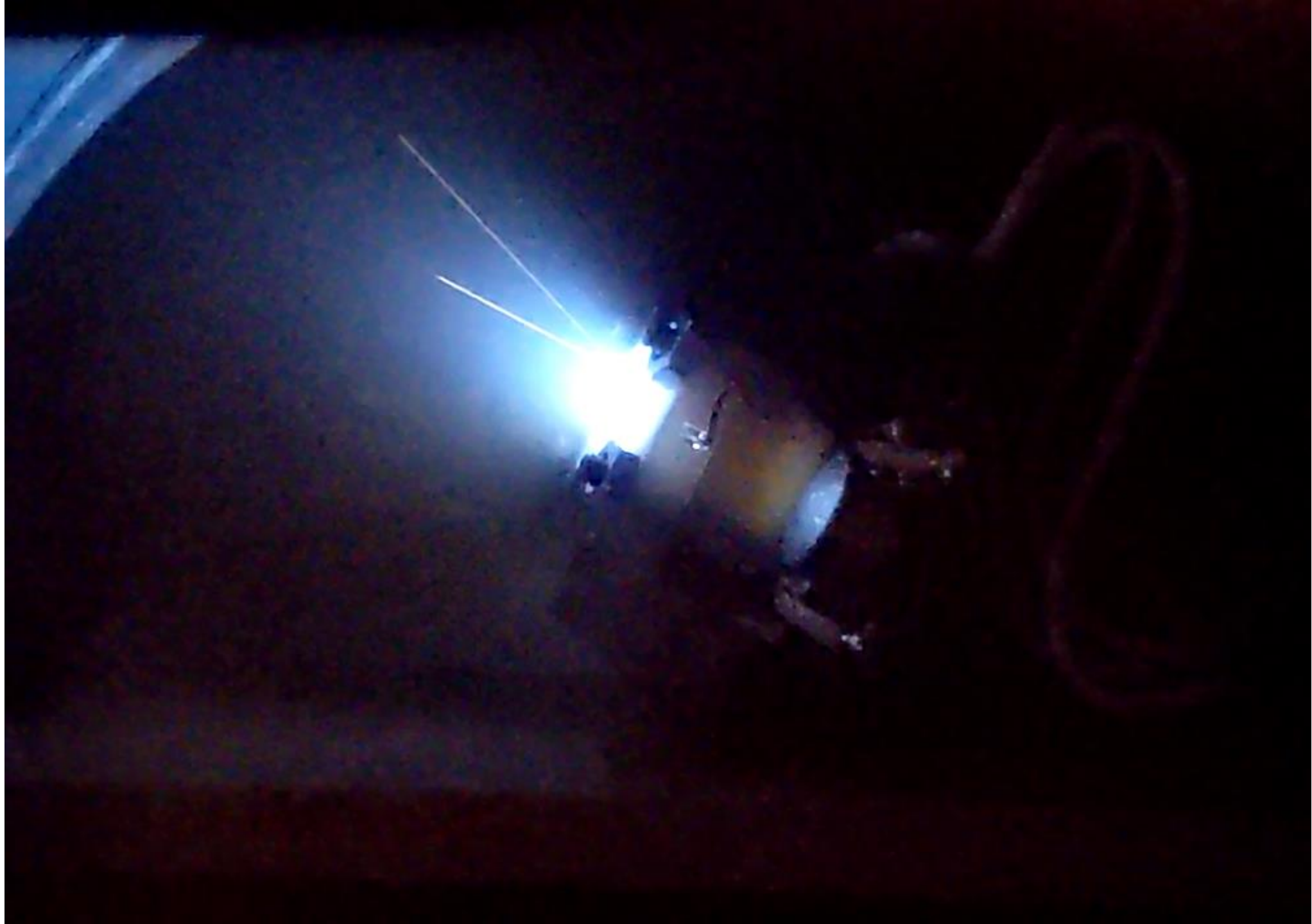


AIS-VAT1-PQ Micro Vacuum Arc Thruster

- **Size:** 42x42x20mm
- **Mass:** <50g
- **Fuel:** any solid metal
(titanium/aluminum current development)
- **Power:** 2.5W
- **Expected Thrust:** 1-10uN







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