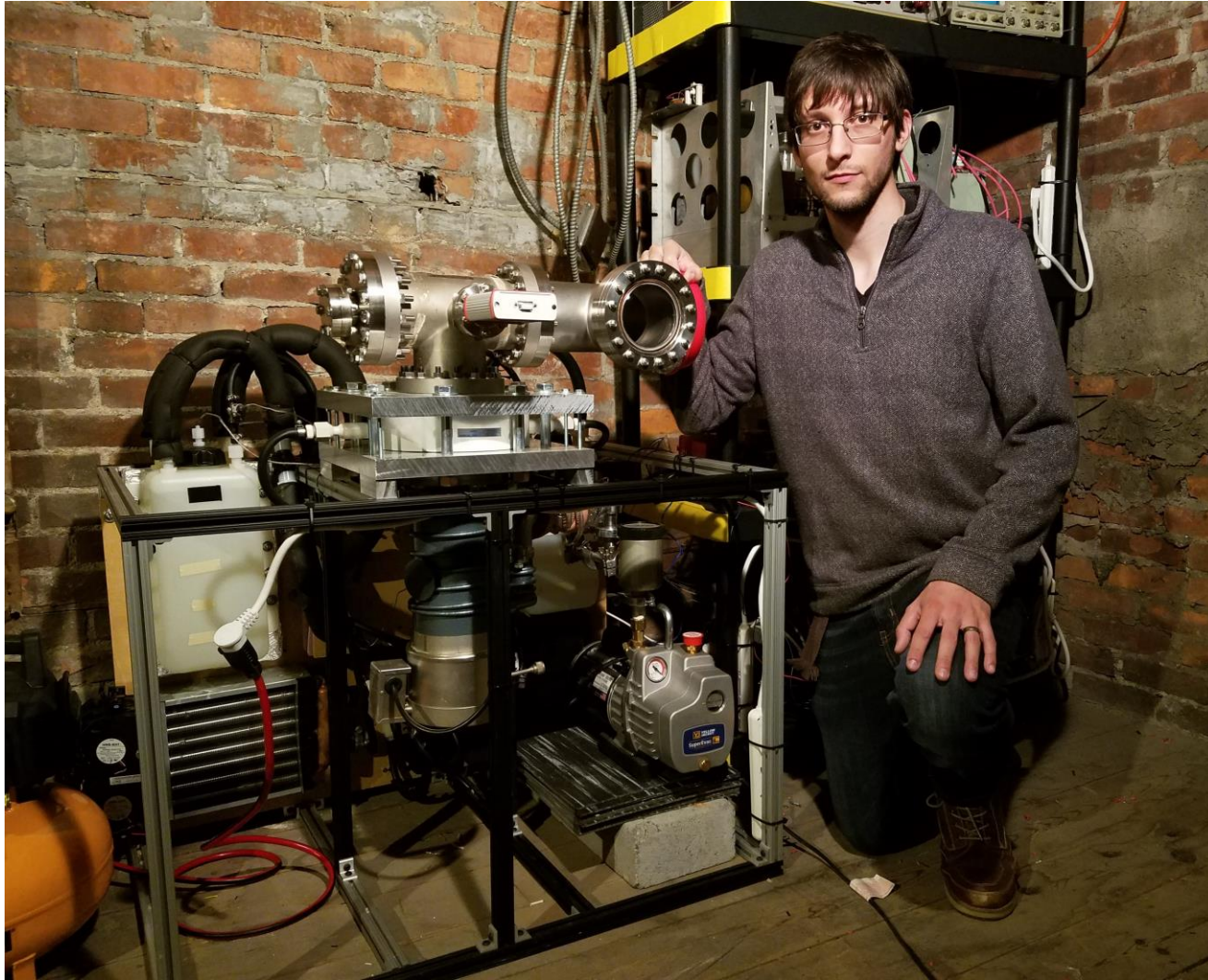


Progress and Developments of Open Source
Electric Propulsion for Nanosats and Picosats at
Applied Ion Systems

Michael Bretti



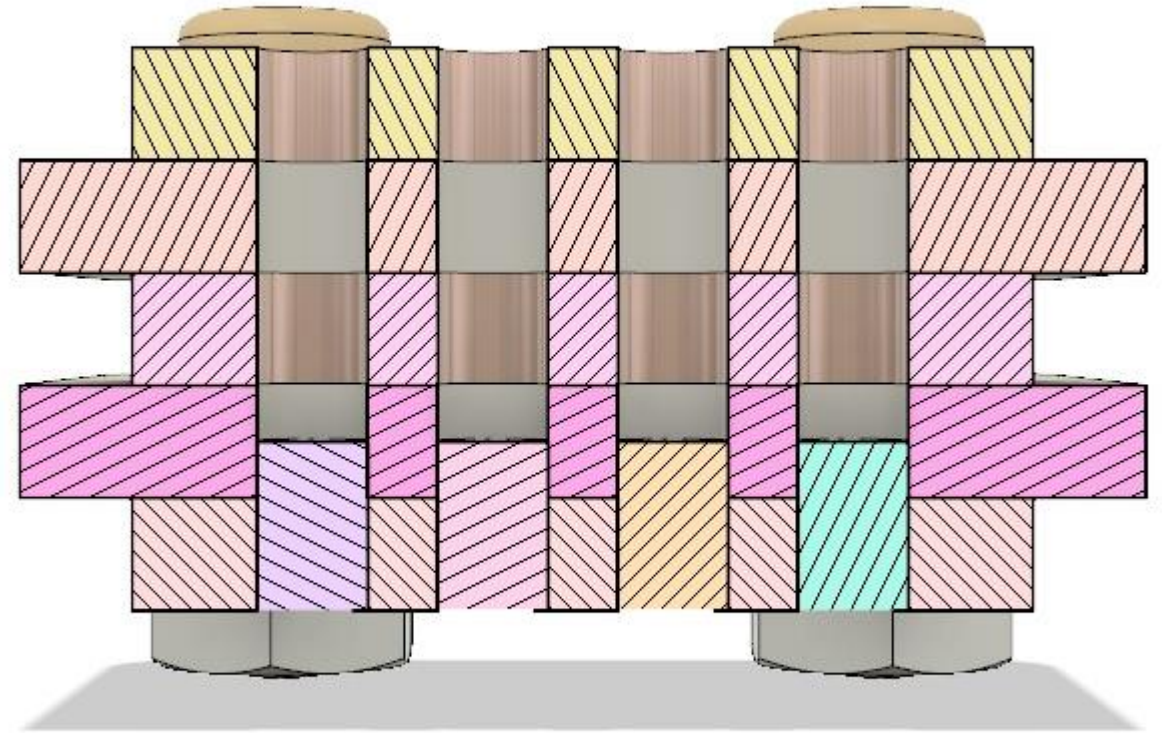
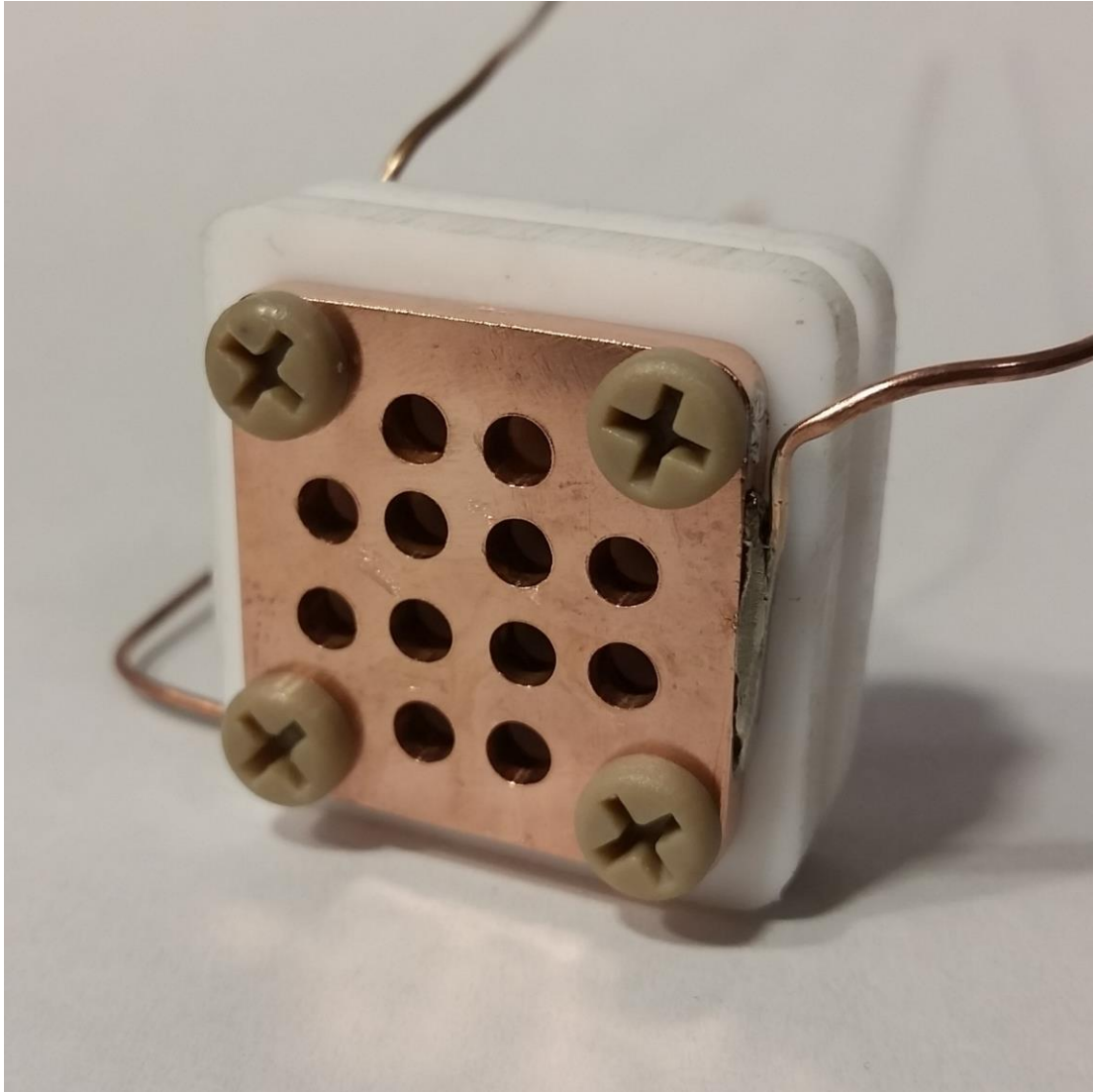


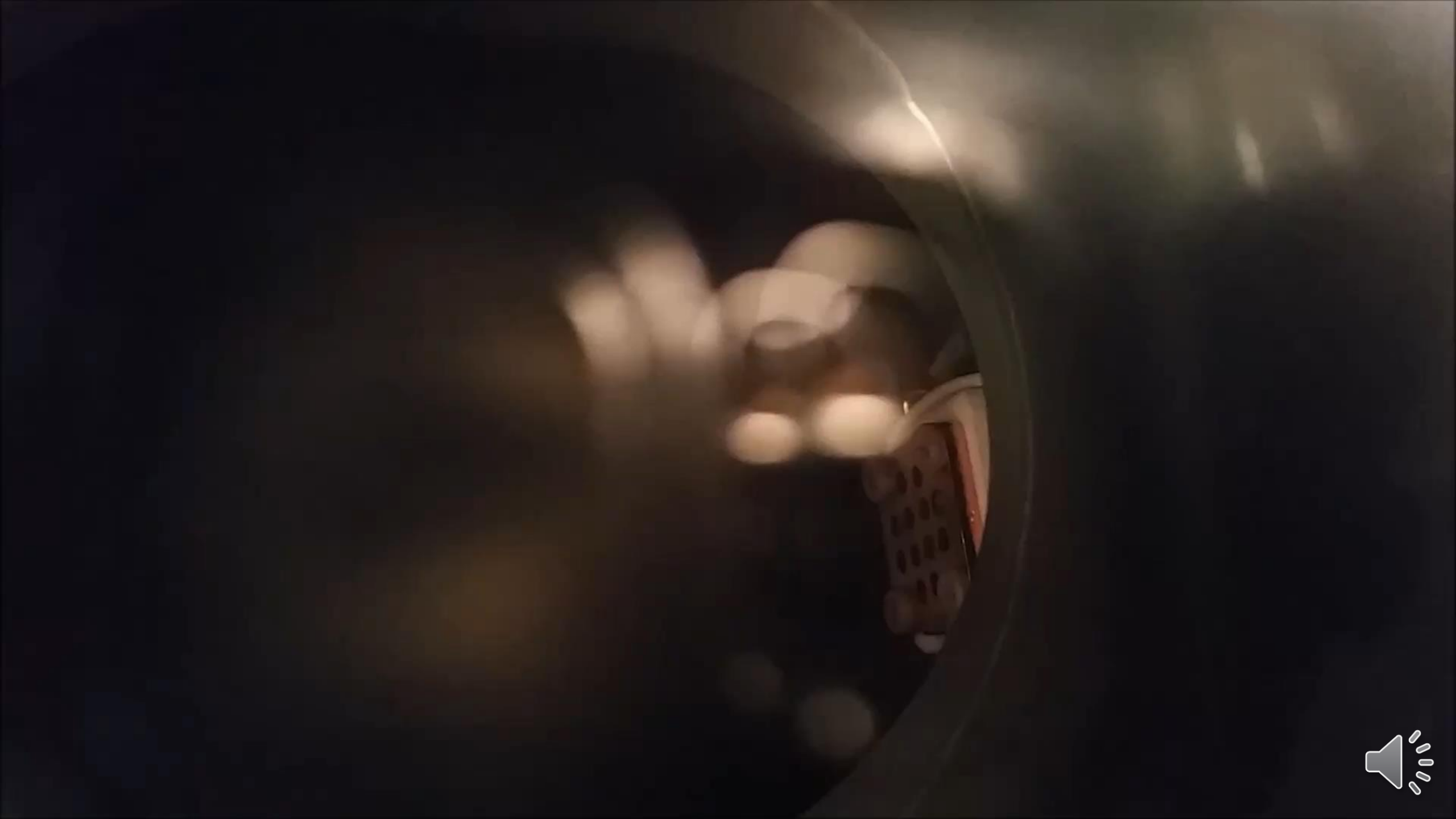
Background

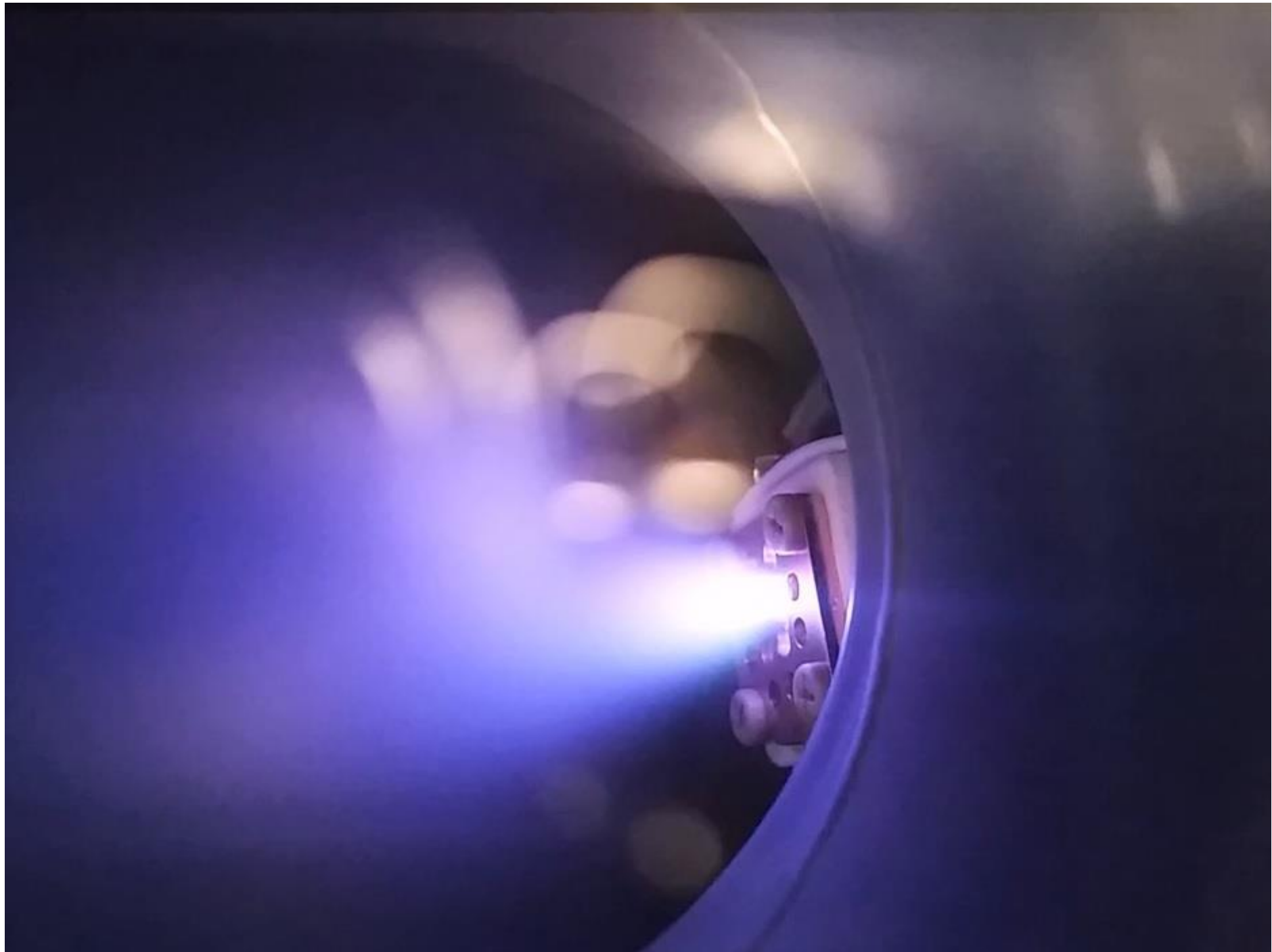
- Founder of Applied Ion Systems
- Only independent maker-based at-home R&D program for advanced plasma/ion thrusters
- Ultra-low cost, easy to manufacture, open-source thrusters
- Provide resources for hobbyist, educational, enthusiast, nanosat, and picosat communities



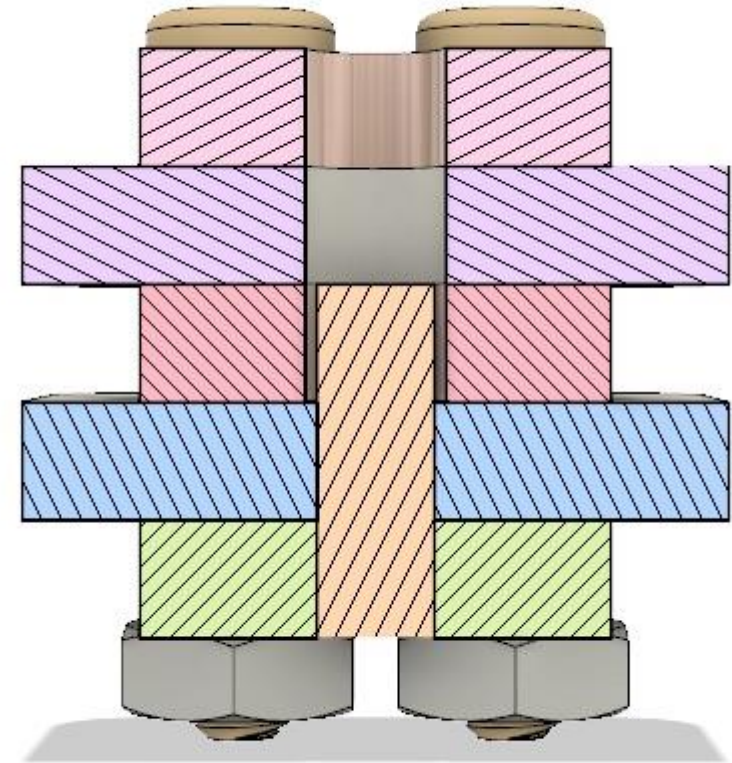
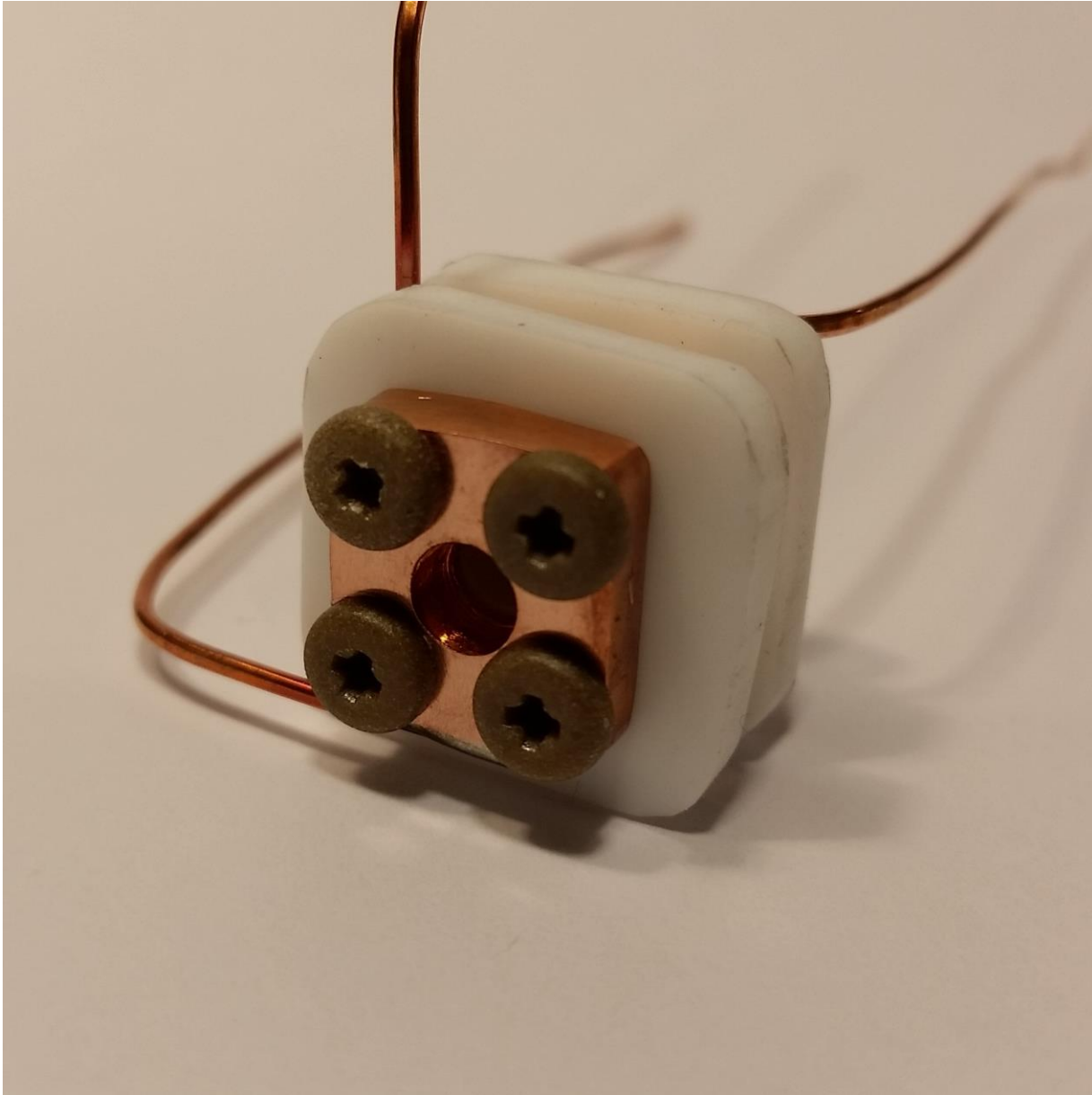
The First Prototypes: The AIS-gPPT1



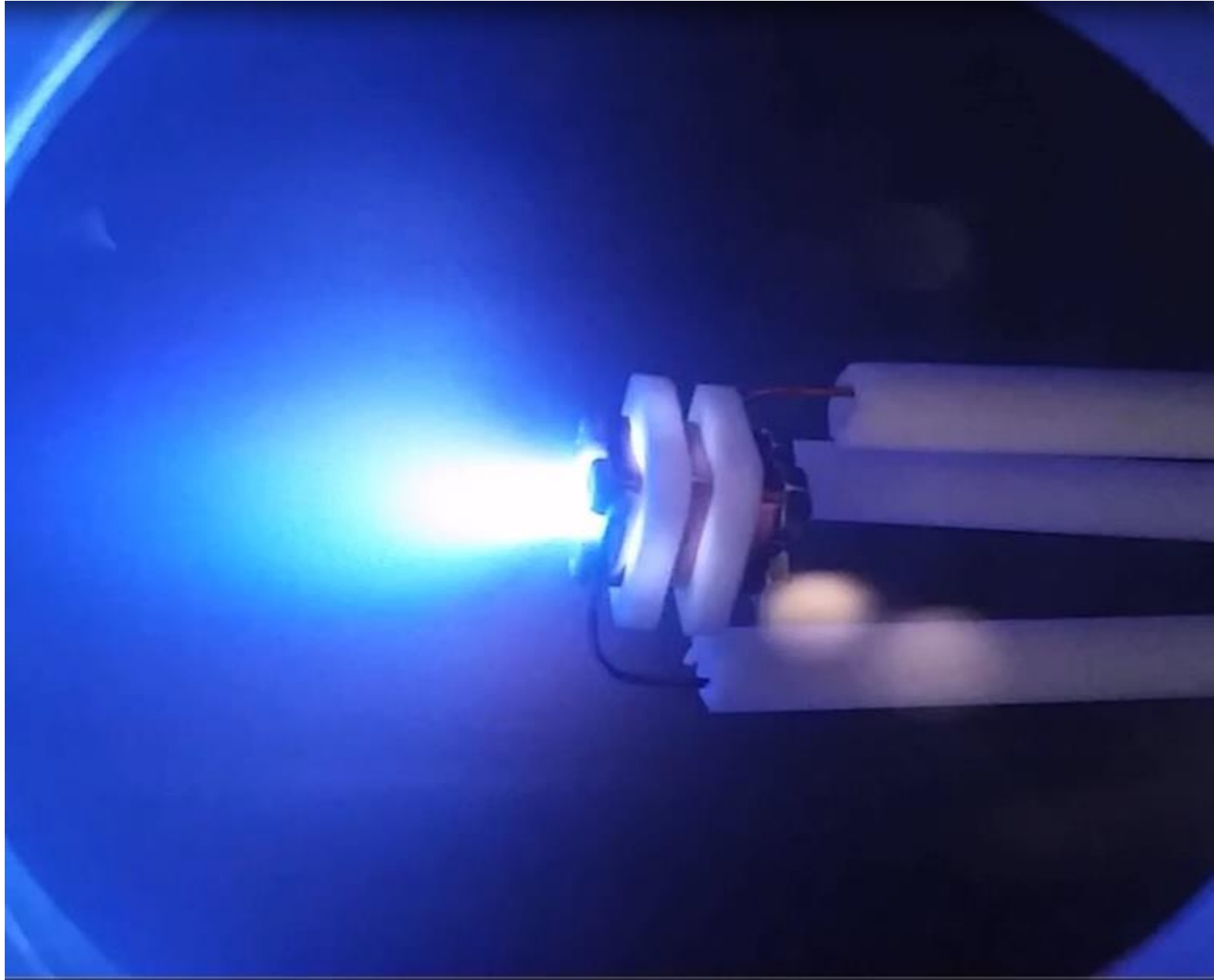




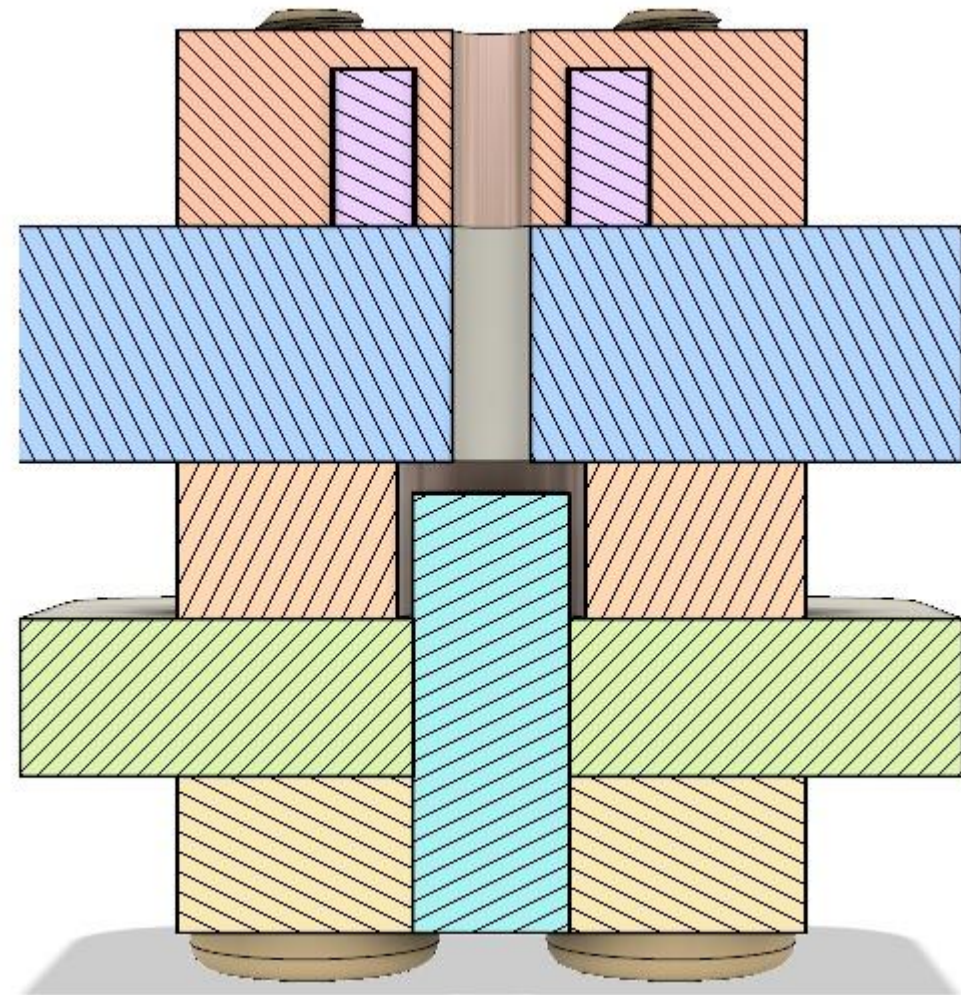
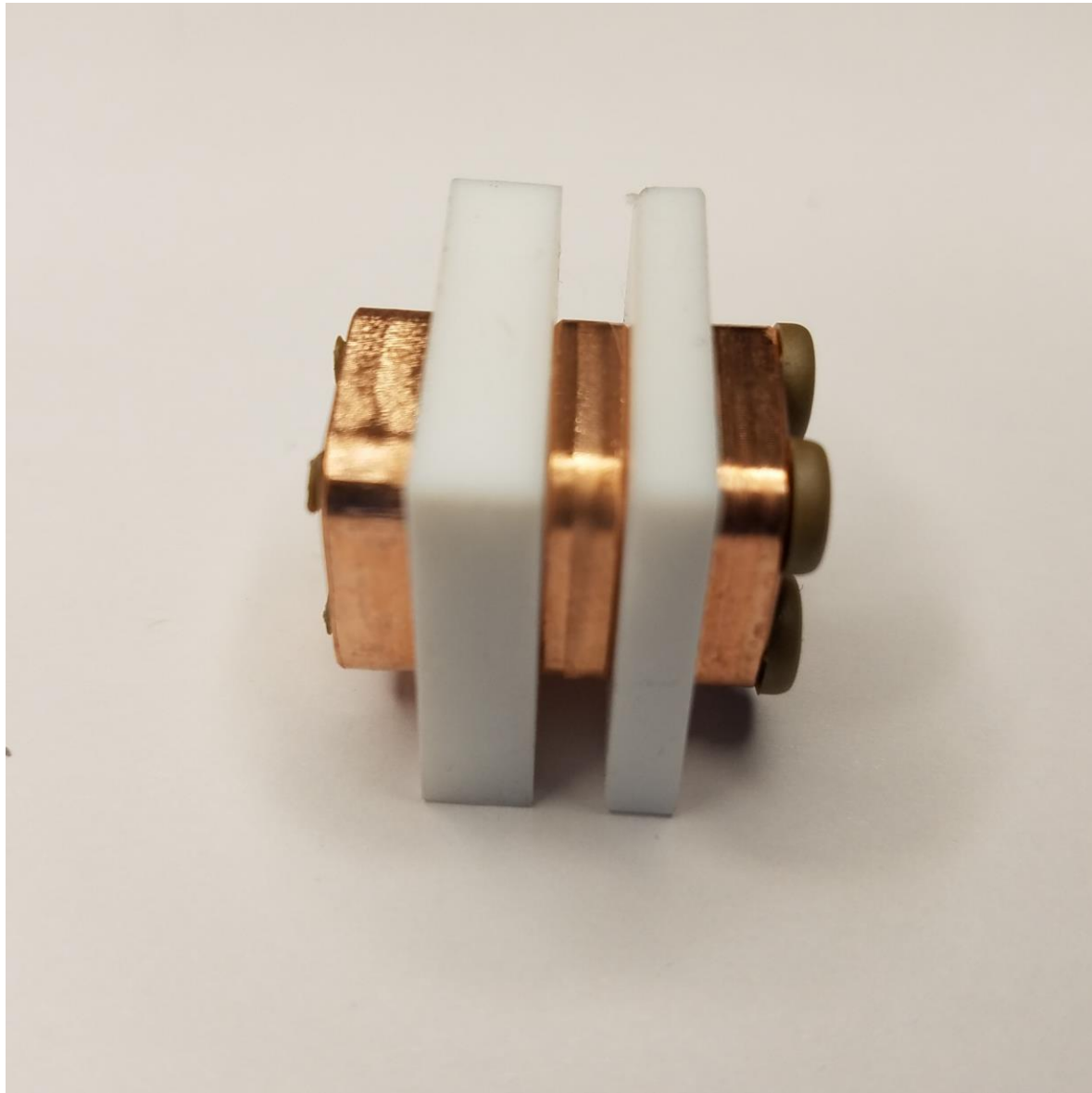
The First Prototypes: The AIS-gPPT2-1C



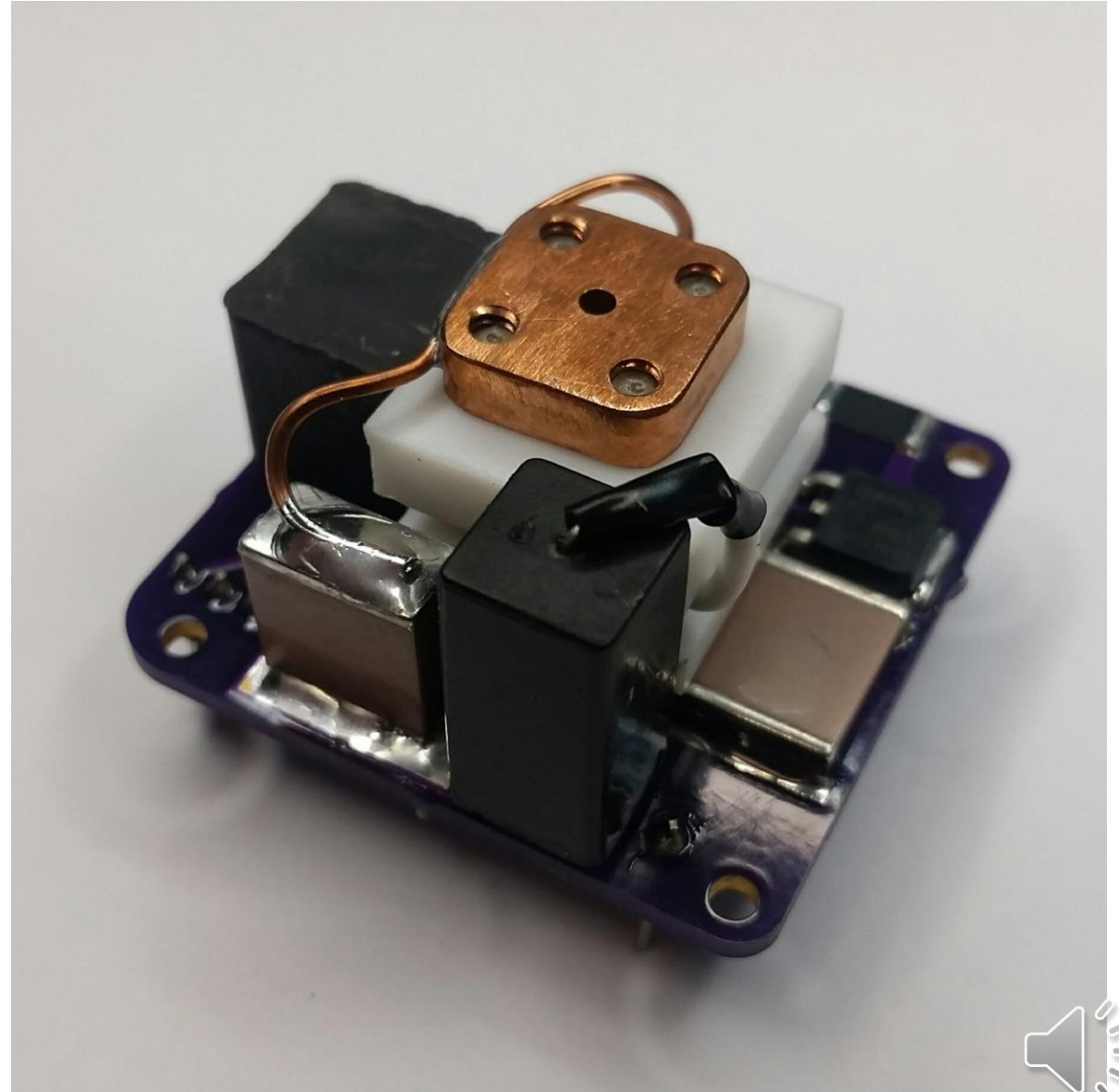
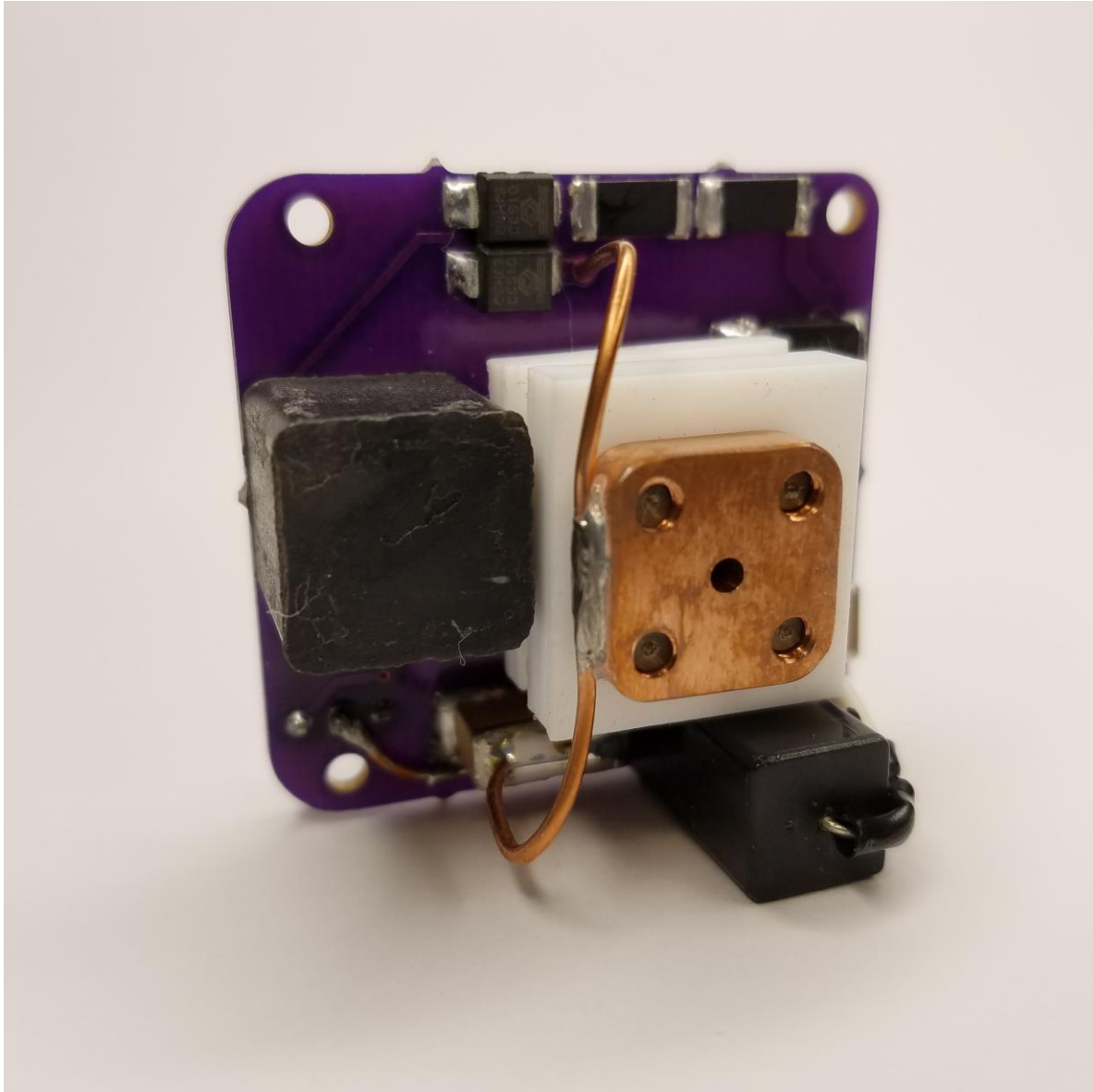




The AIS-gPPT3-1C: Improved Micro PPT for PocketQubes

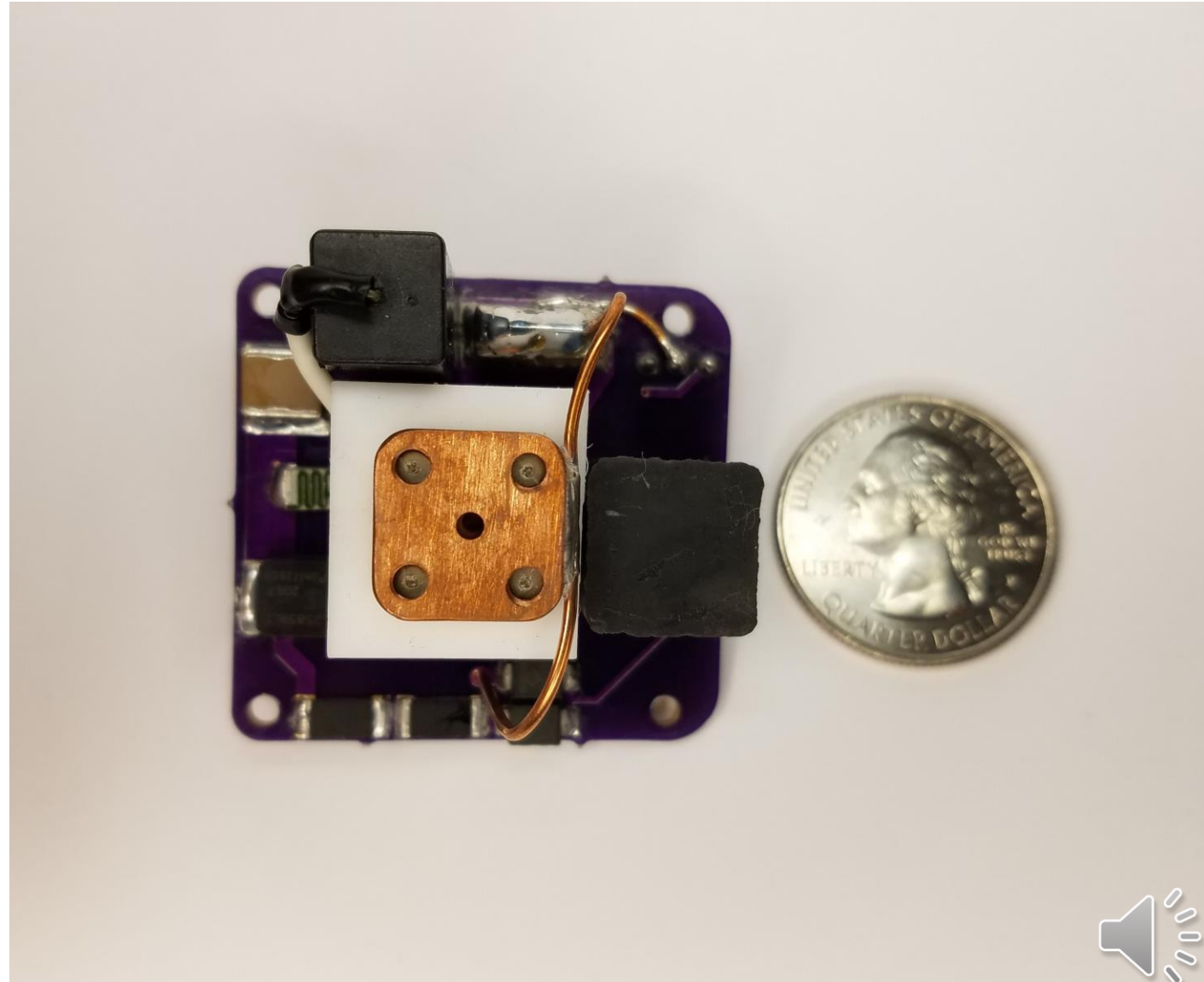


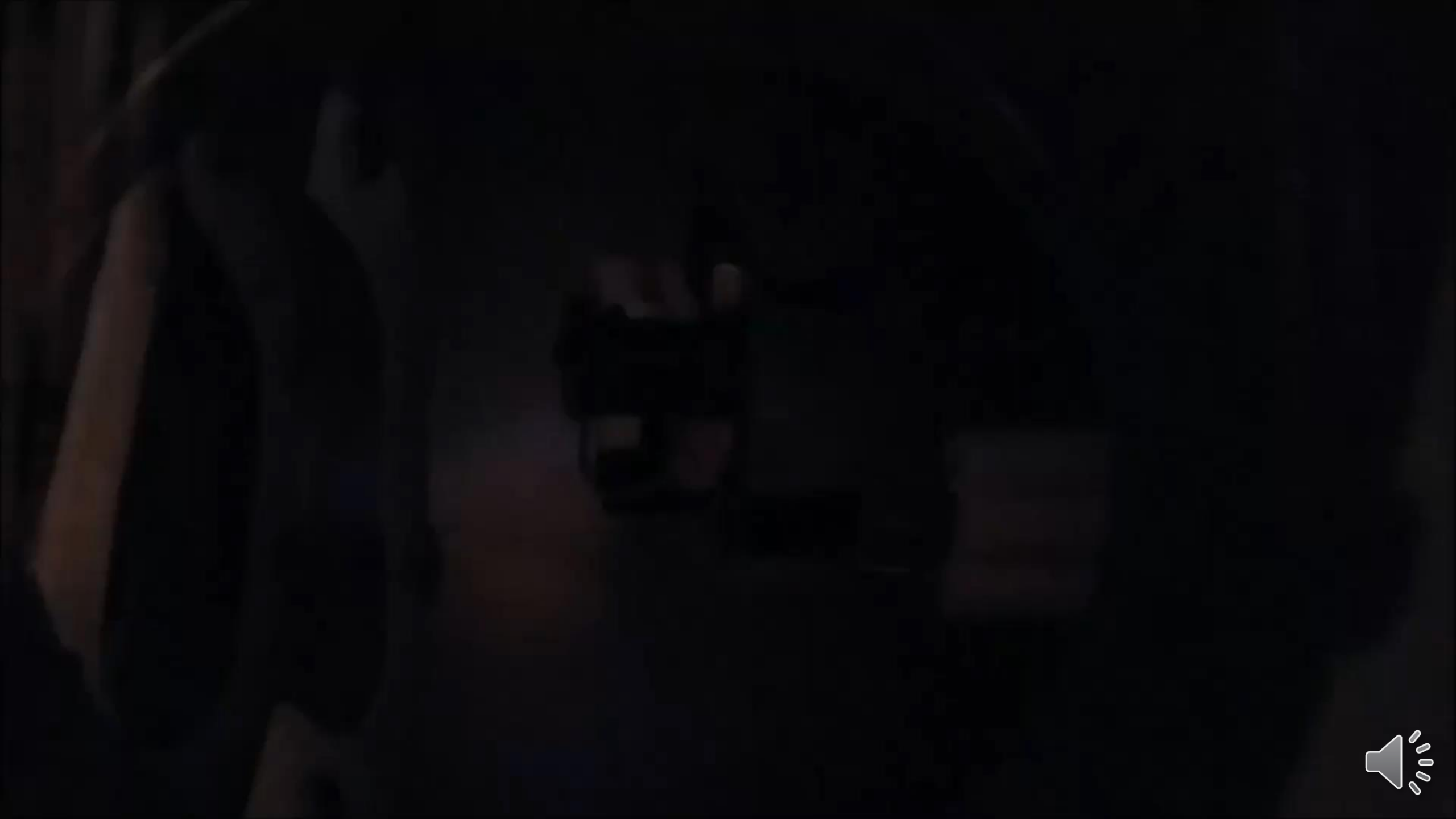
AIS-gPPT3-1C Integrated Propulsion Module

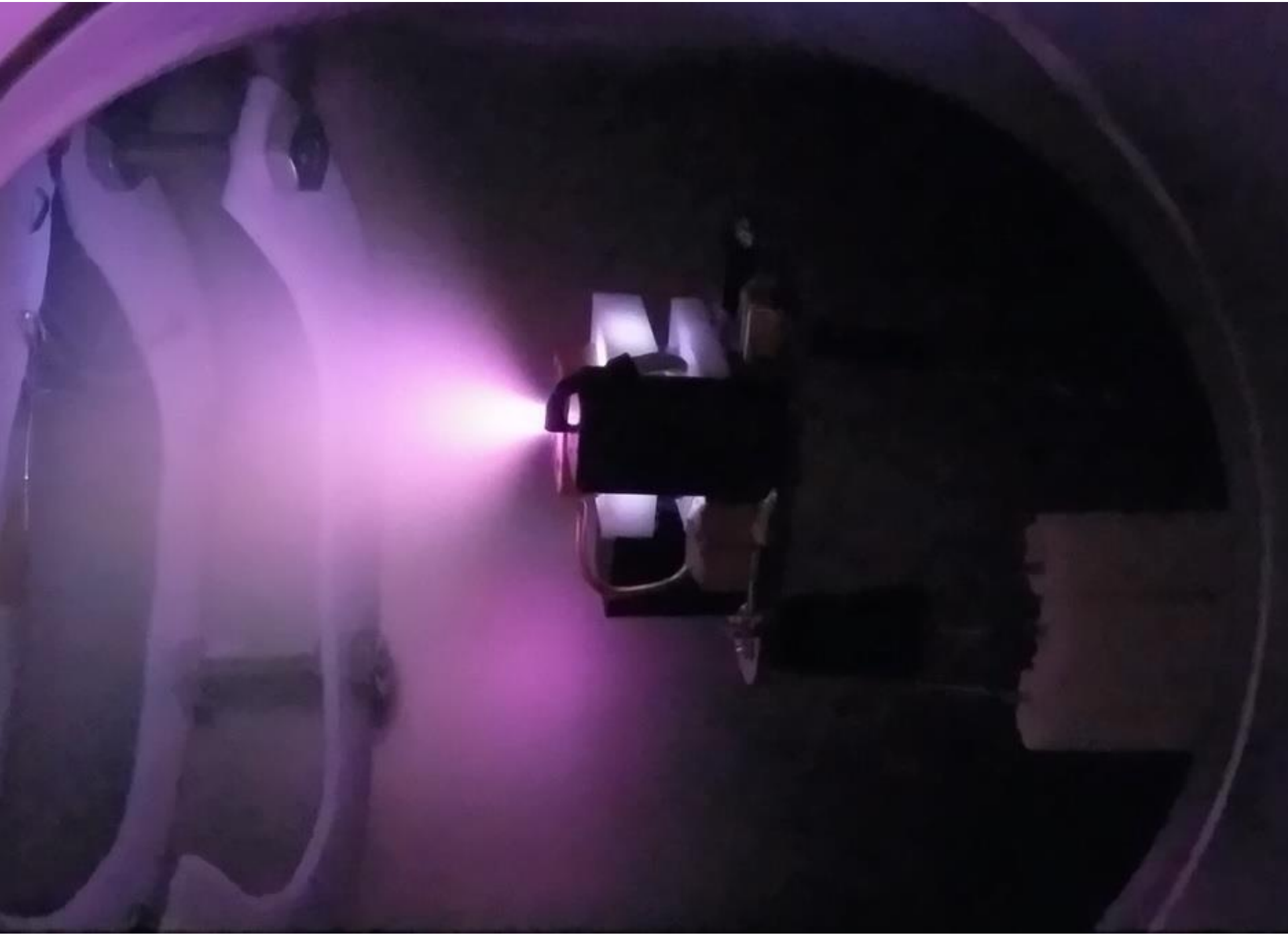


AIS-gPPT3-1C Integrated Propulsion Module Specs

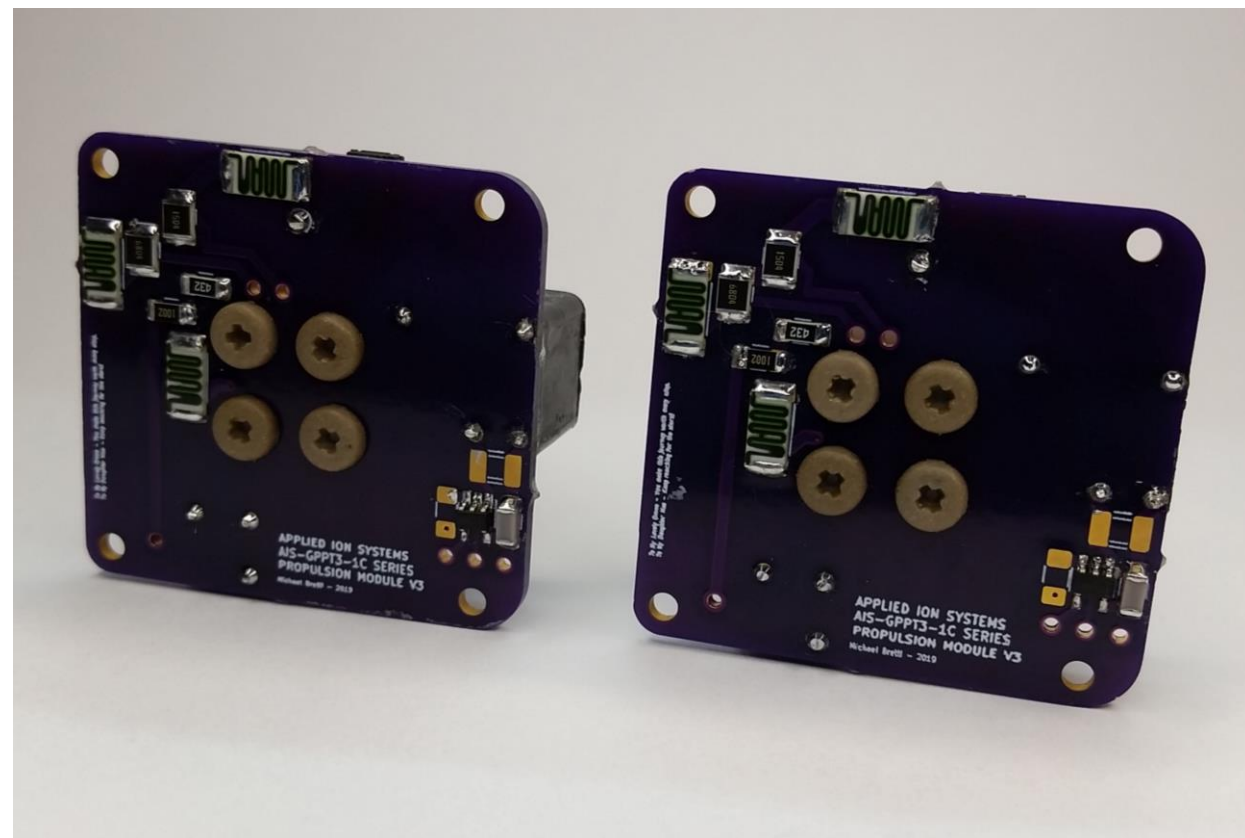
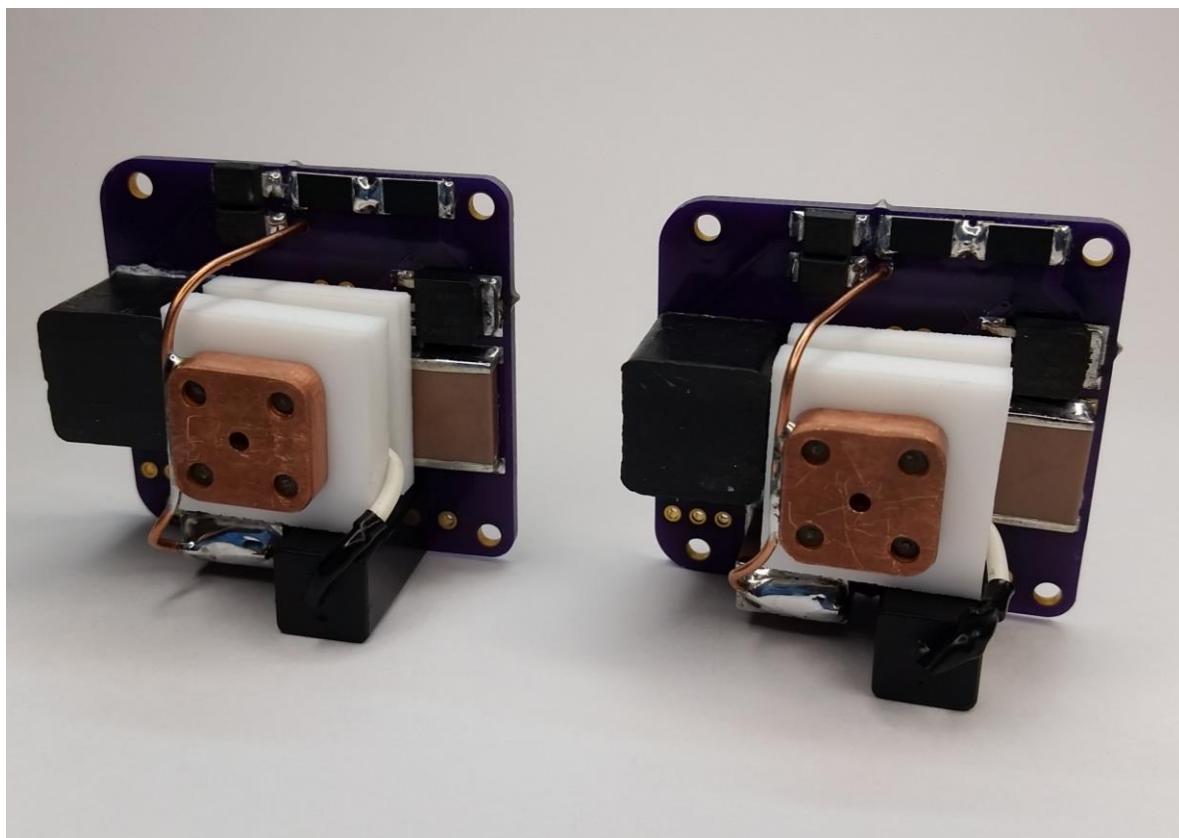
- 40mm x 38mm x 24mm
- Voltage: 3.3-5V
- Power: <math><550\text{mW}</math>
- Impulse Bit: 0.65uNs
- Rep Rate: 0.25-0.30Hz
- Thrust @ 0.30Hz: 0.22uN
- Mass: 34 grams
- Plug/Play: V+, GND, EN, TRIG, VOUT



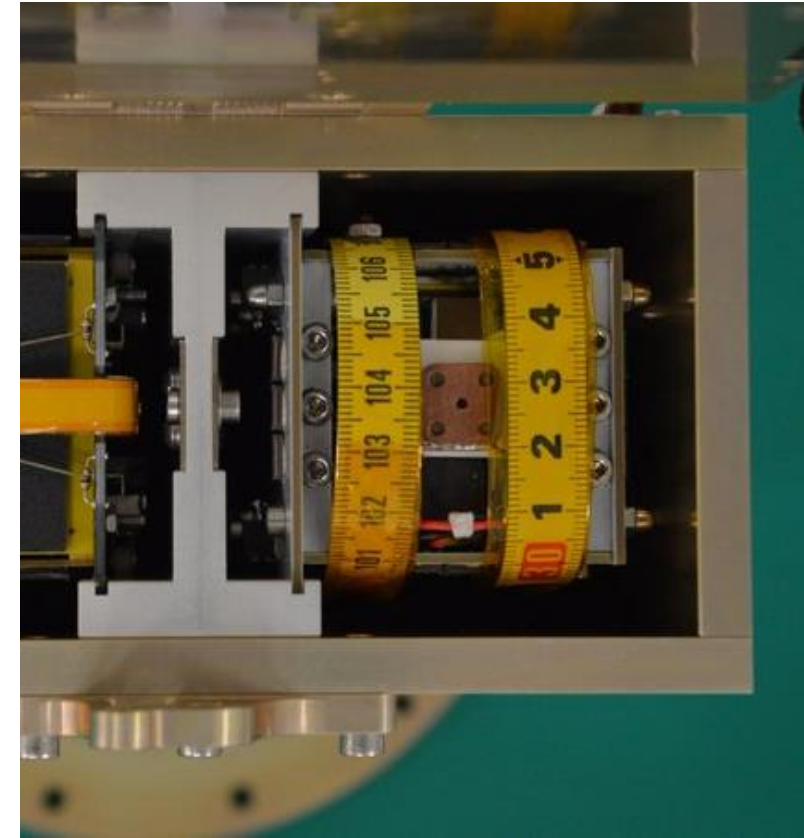
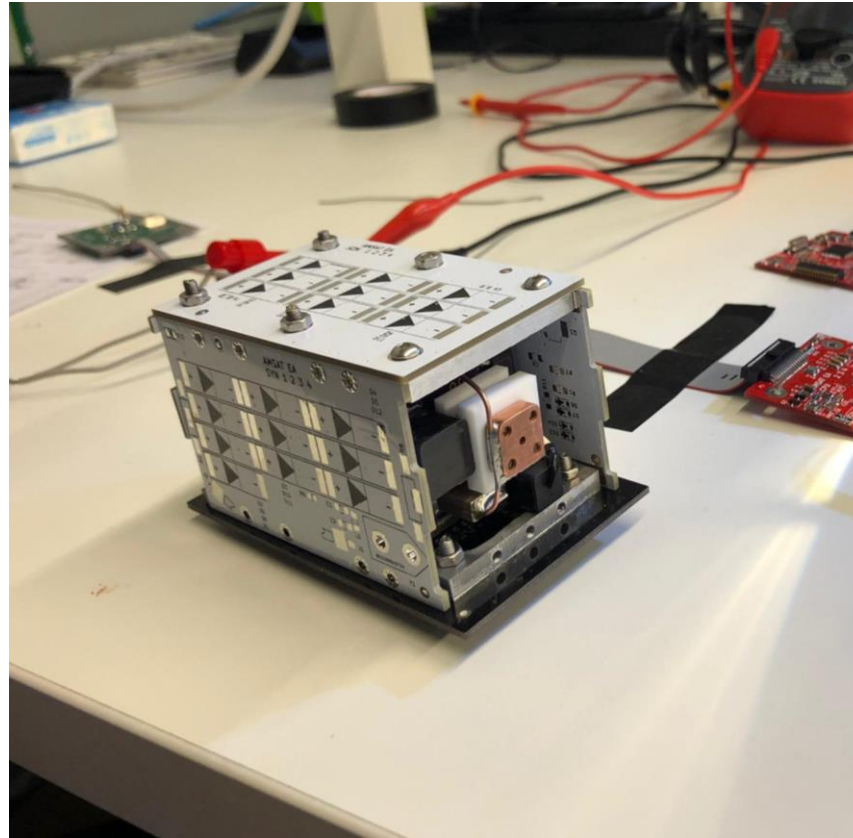
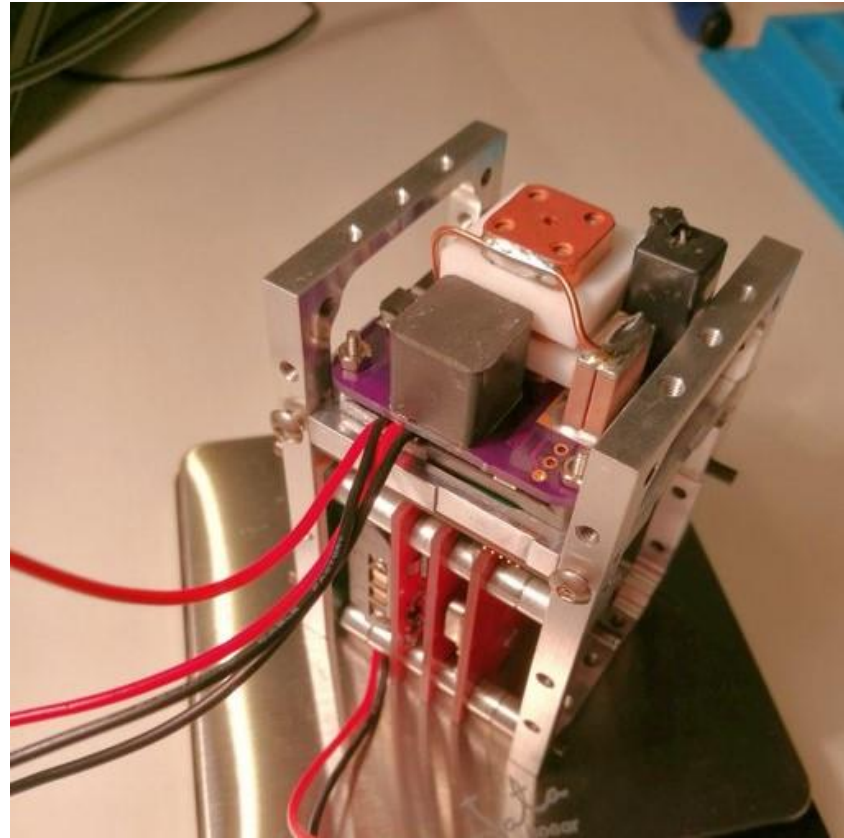




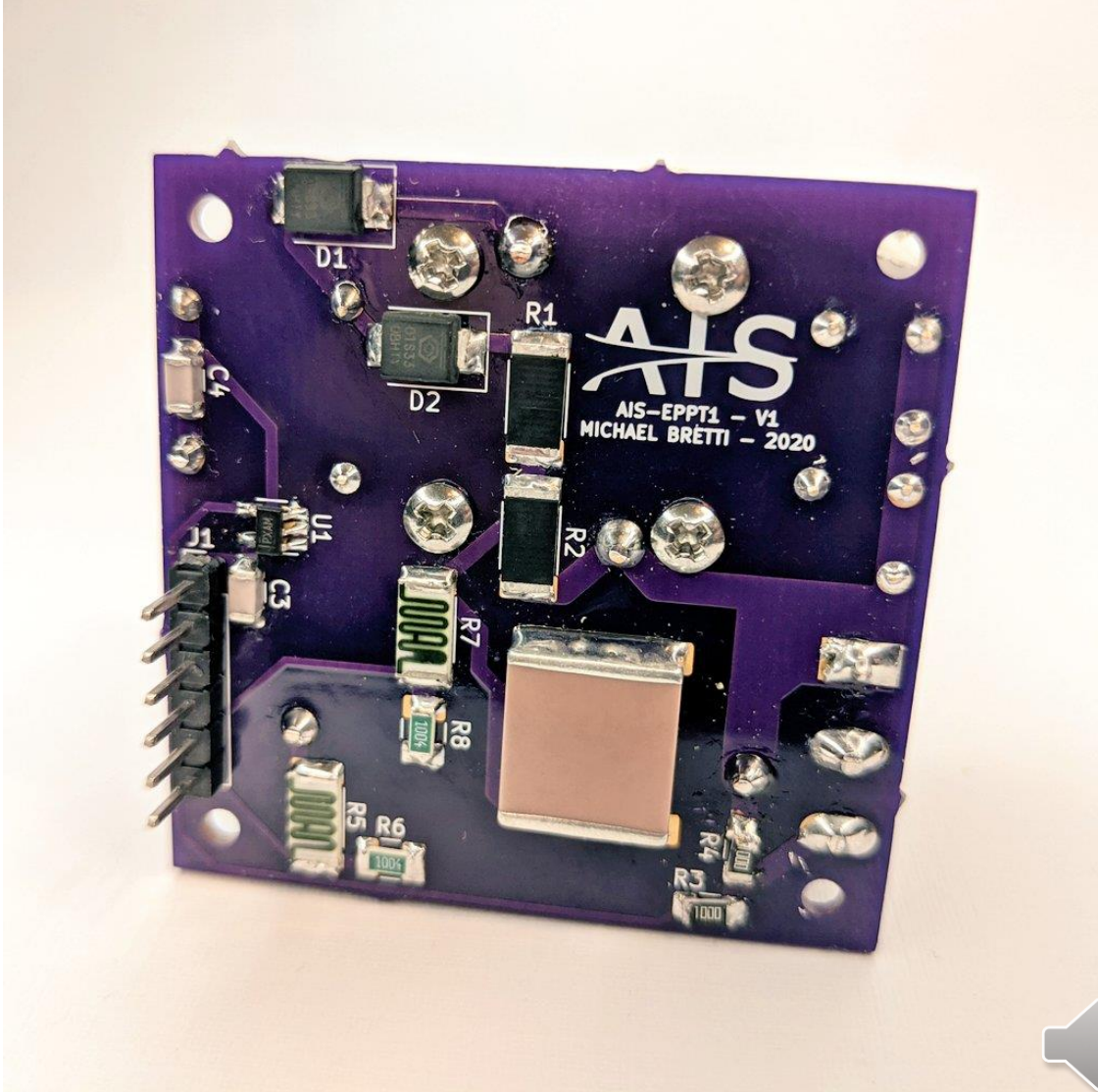
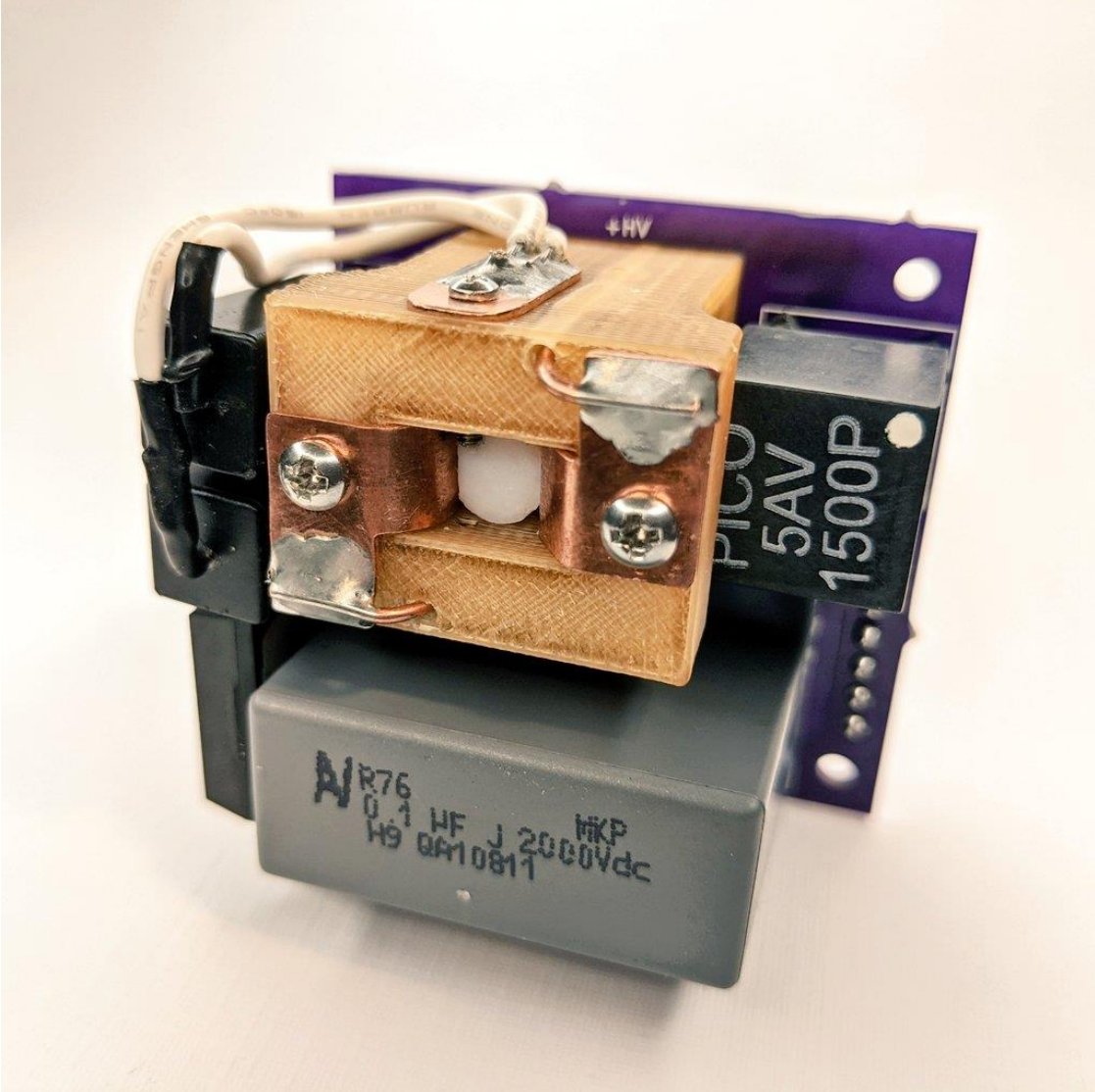
AMSAT-Spain GENESIS Collaboration



AMSAT-Spain GENESIS Integration

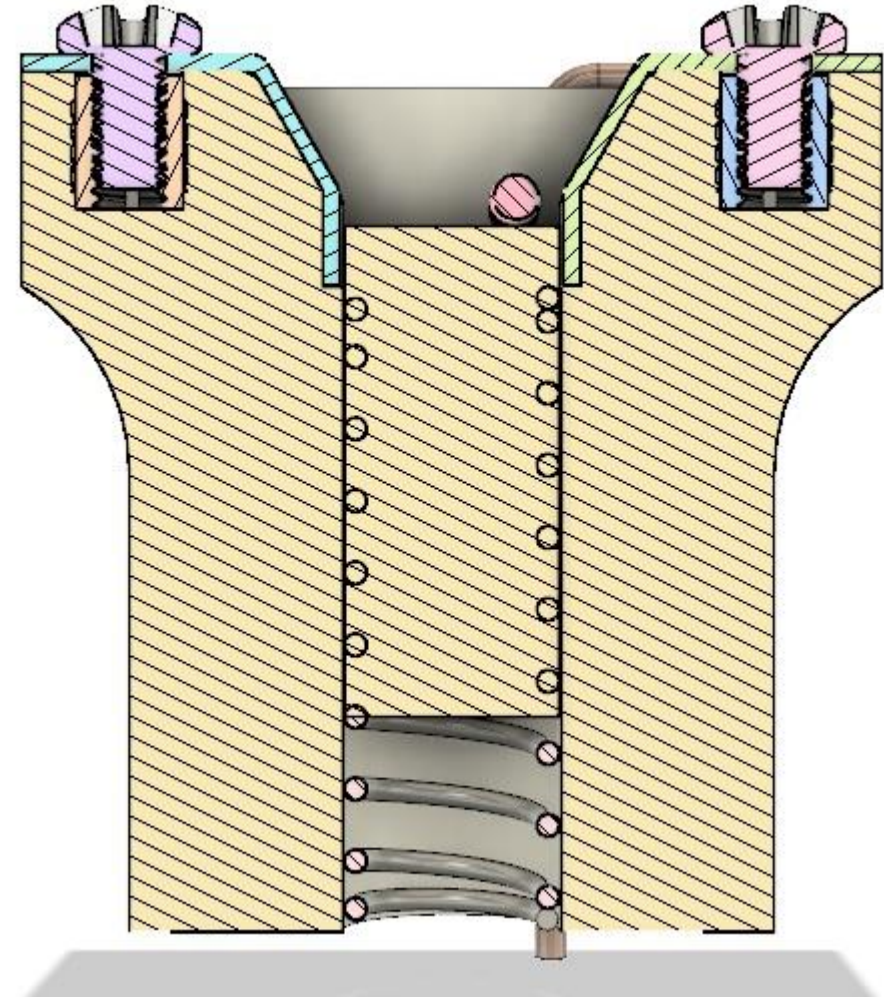


AIS-EPPT1 Micro Pulsed Plasma Thruster

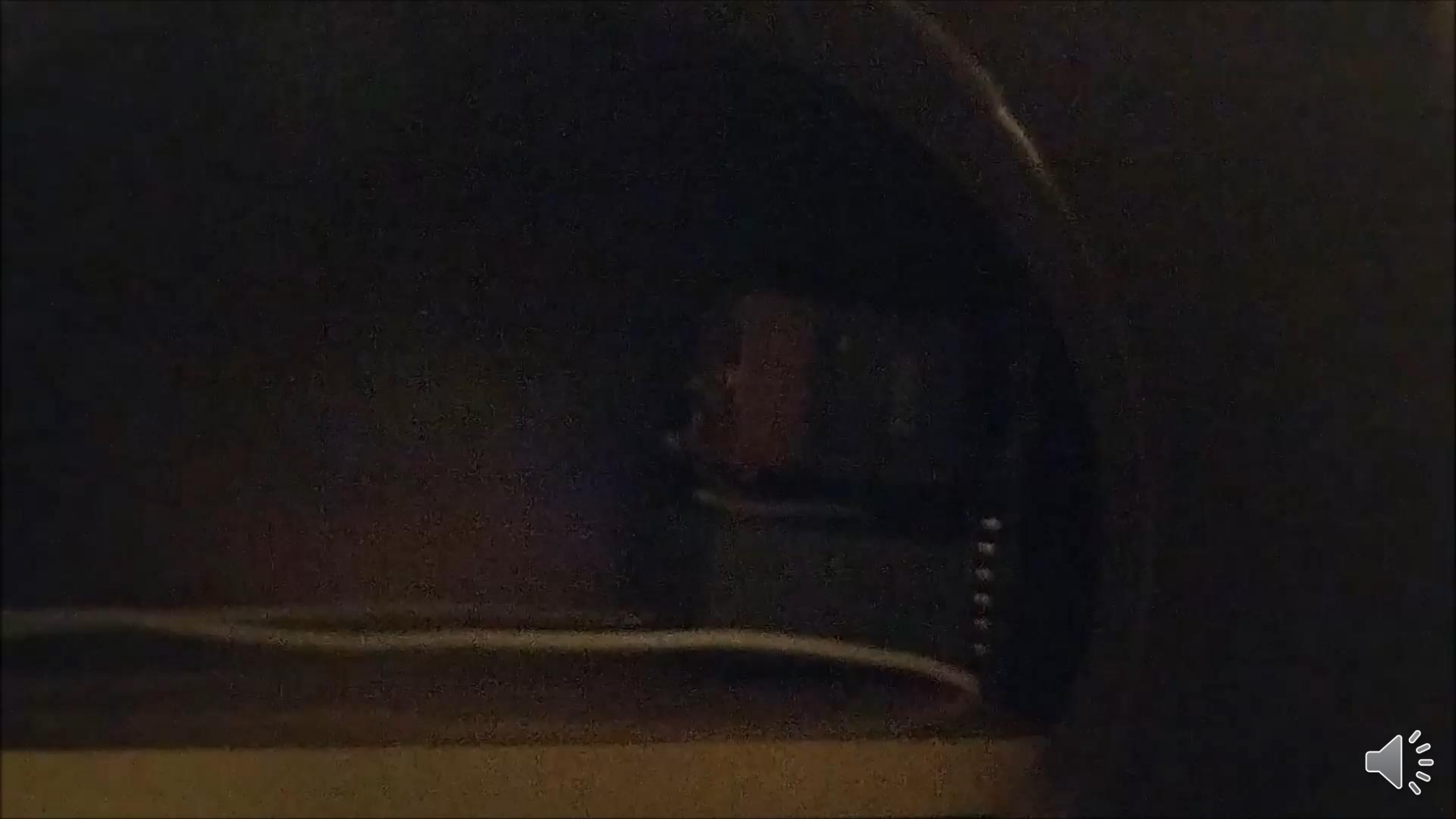


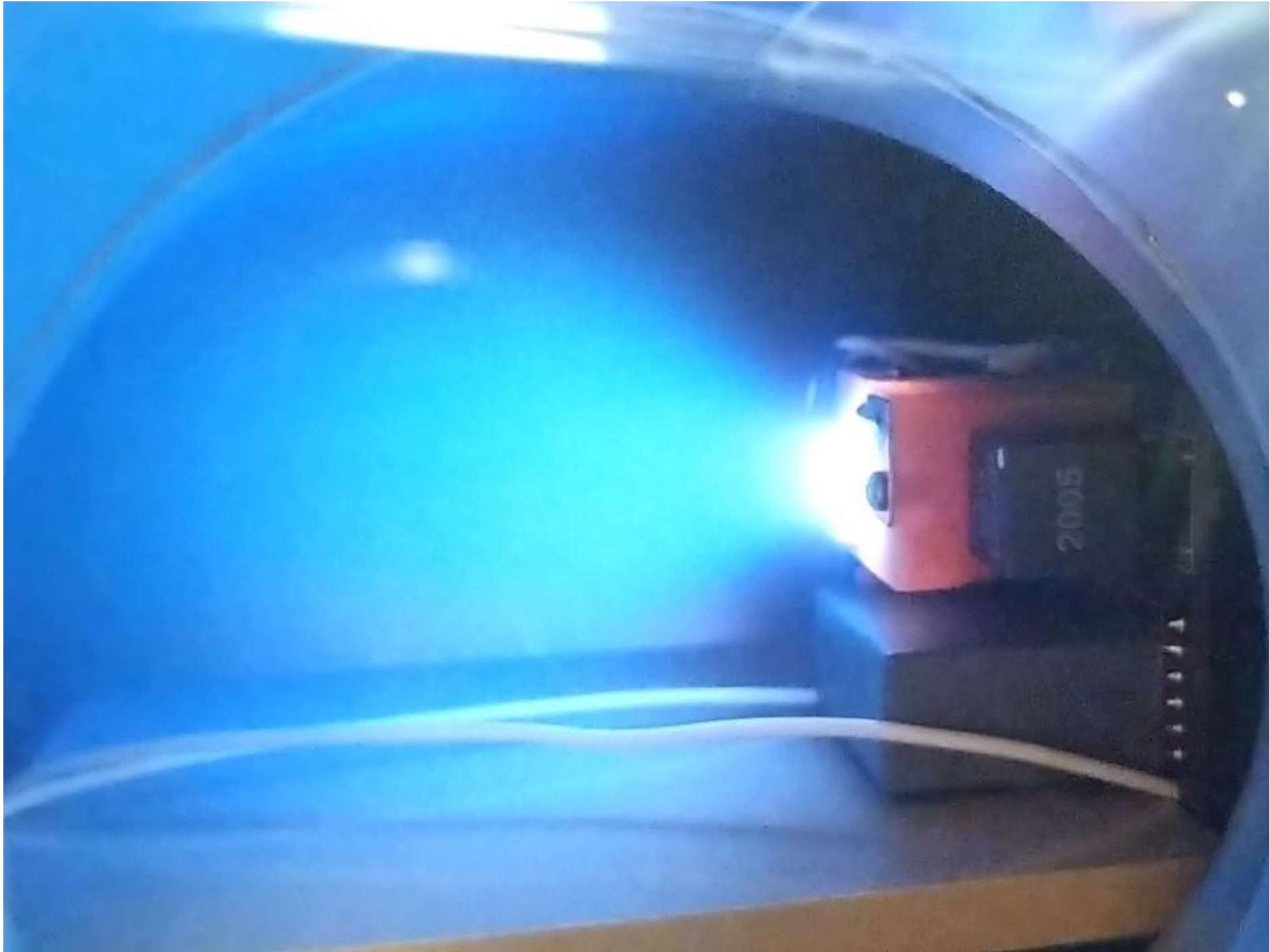
Improved Features of the AIS-EPPT1

- Spring fed fuel
- Diverging rail electrodes
- Higher power/more efficient HV supply
- More robust main bank capacitor
- Dual ignition transformer
- Improved thyristor for triggering
- 3D printed housing
- Built in modularity
 - Expandable housing for fuel capacity
 - Multiple standard film pulse cap compatibility
- Up to 3Hz rep rate
- Lower cost, modular, higher thrust, higher ISP, longer lifetime

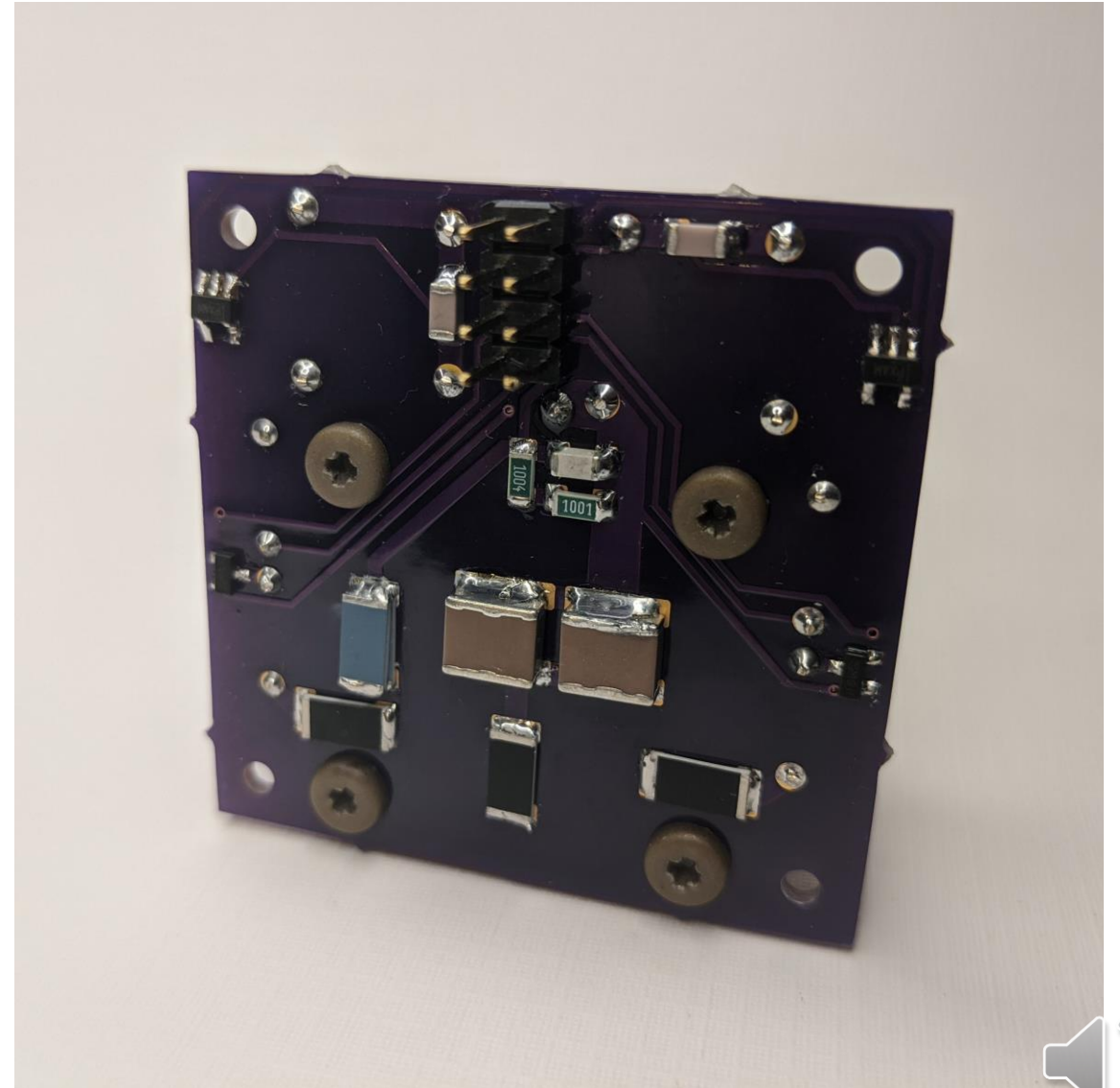
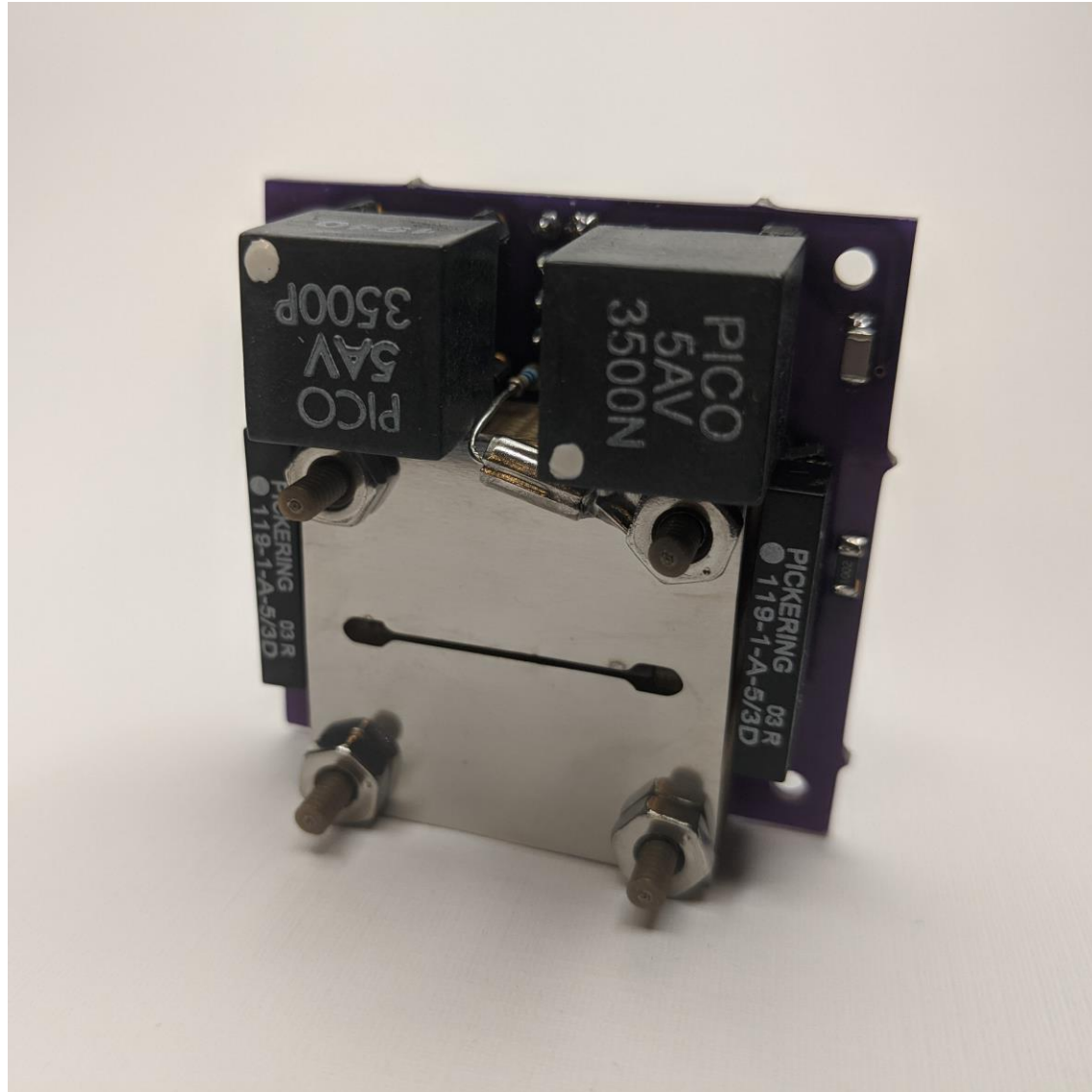






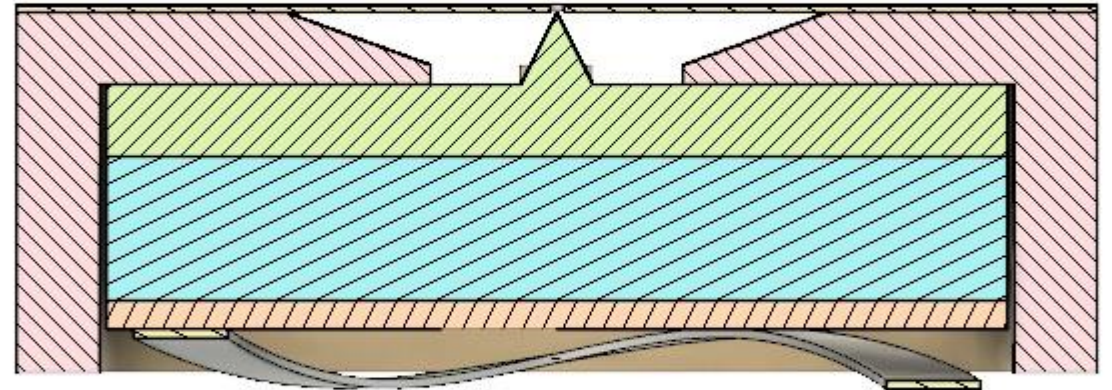


AIS-ILIS1 Ionic Liquid Electrospray Thruster

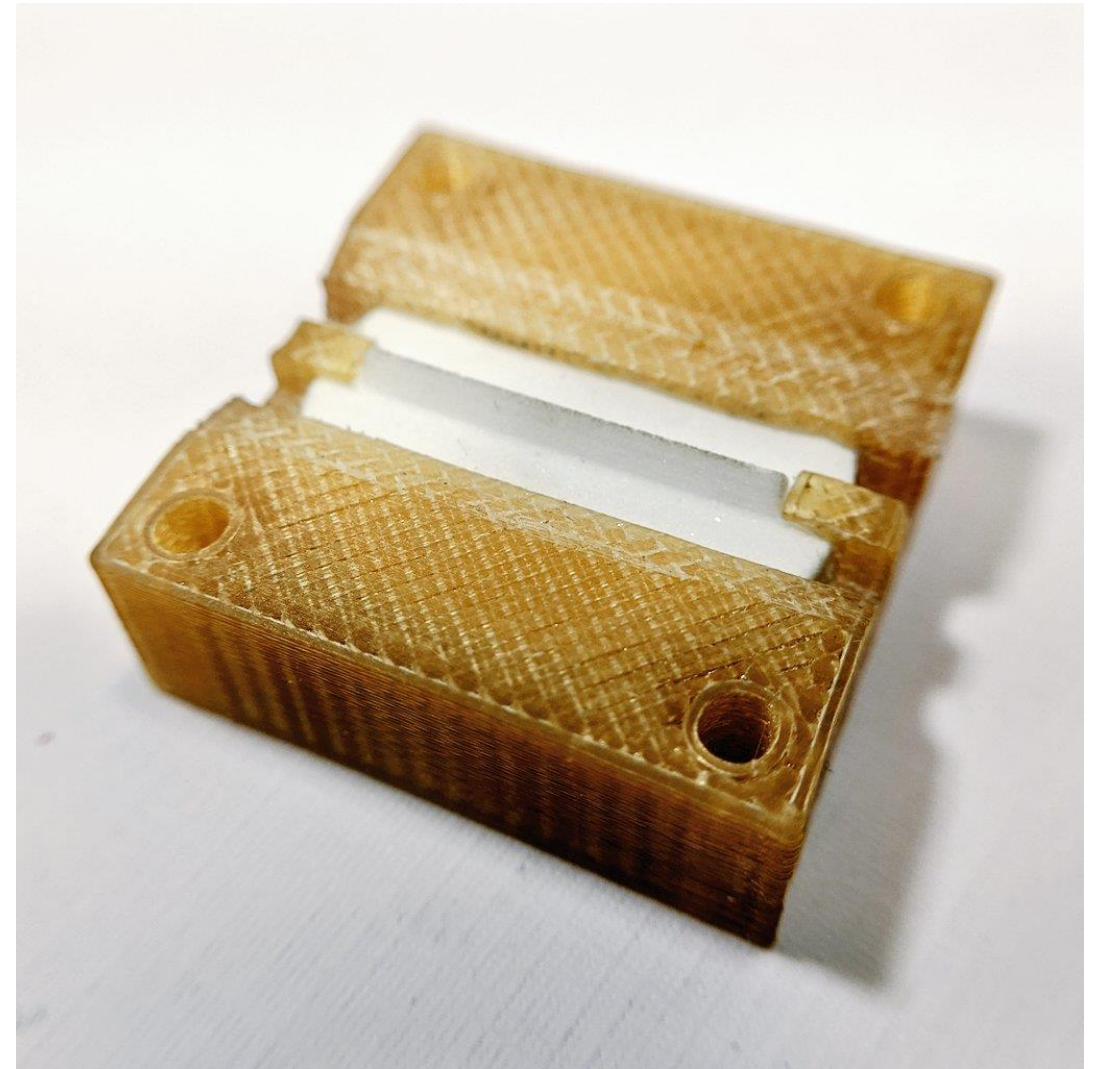


Specifications (Currently Tested V6 Prototype)

- **Size:** 45x45x16mm
- **Dry Mass:** 39g
- **Fuel:** EMI-BF4
- **Fuel Capacity:** 1g
- **Emitter:** CNC Machined Glass Ridge
- **Nominal Thrust:** 0.04uN
- **Peak Thrust:** 0.4uN
- **ISP:** 4144-4320s
- **Vin:** 5V
- **Power:** <0.4W
- **Accl. Voltage:** up to +/-5kV



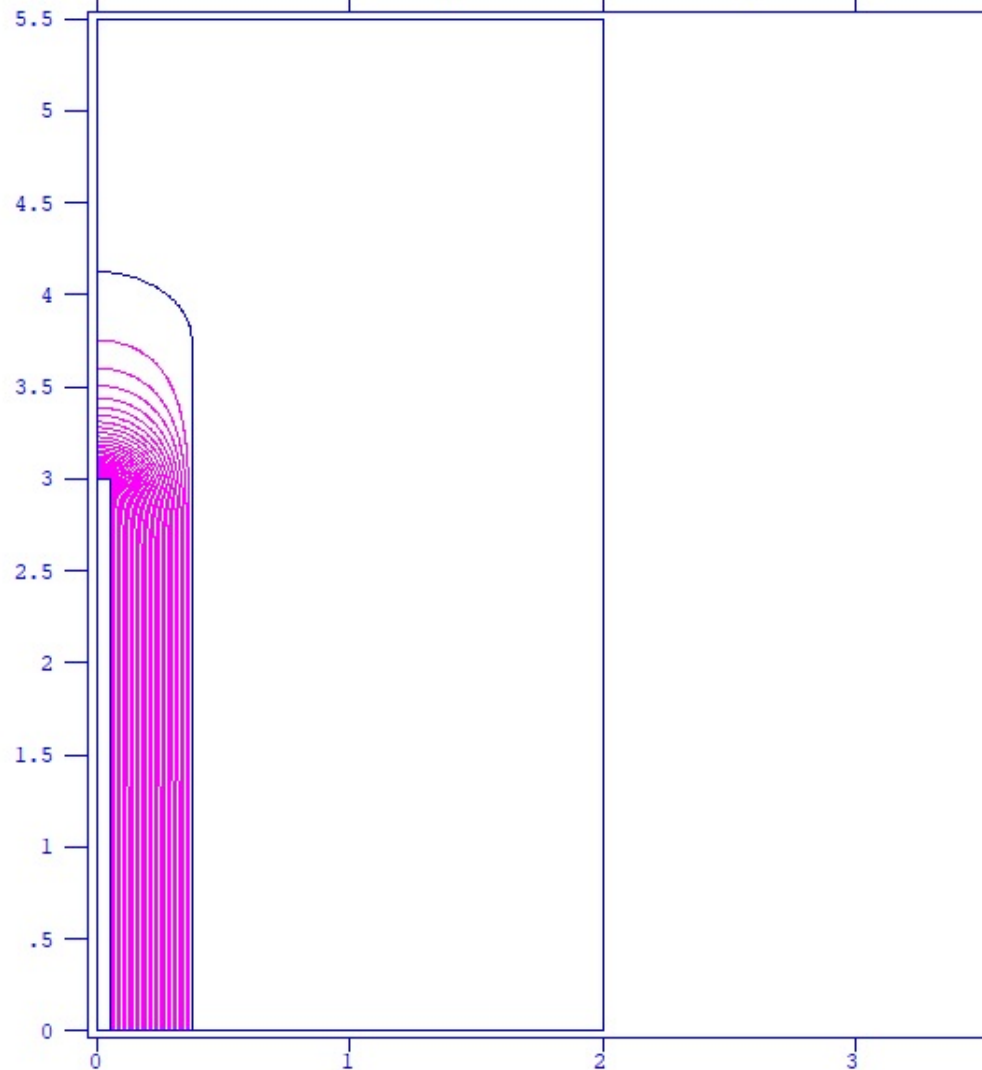
CNC Machined Porous Glass Ridge Emitter



Extractor Geometry Optimization

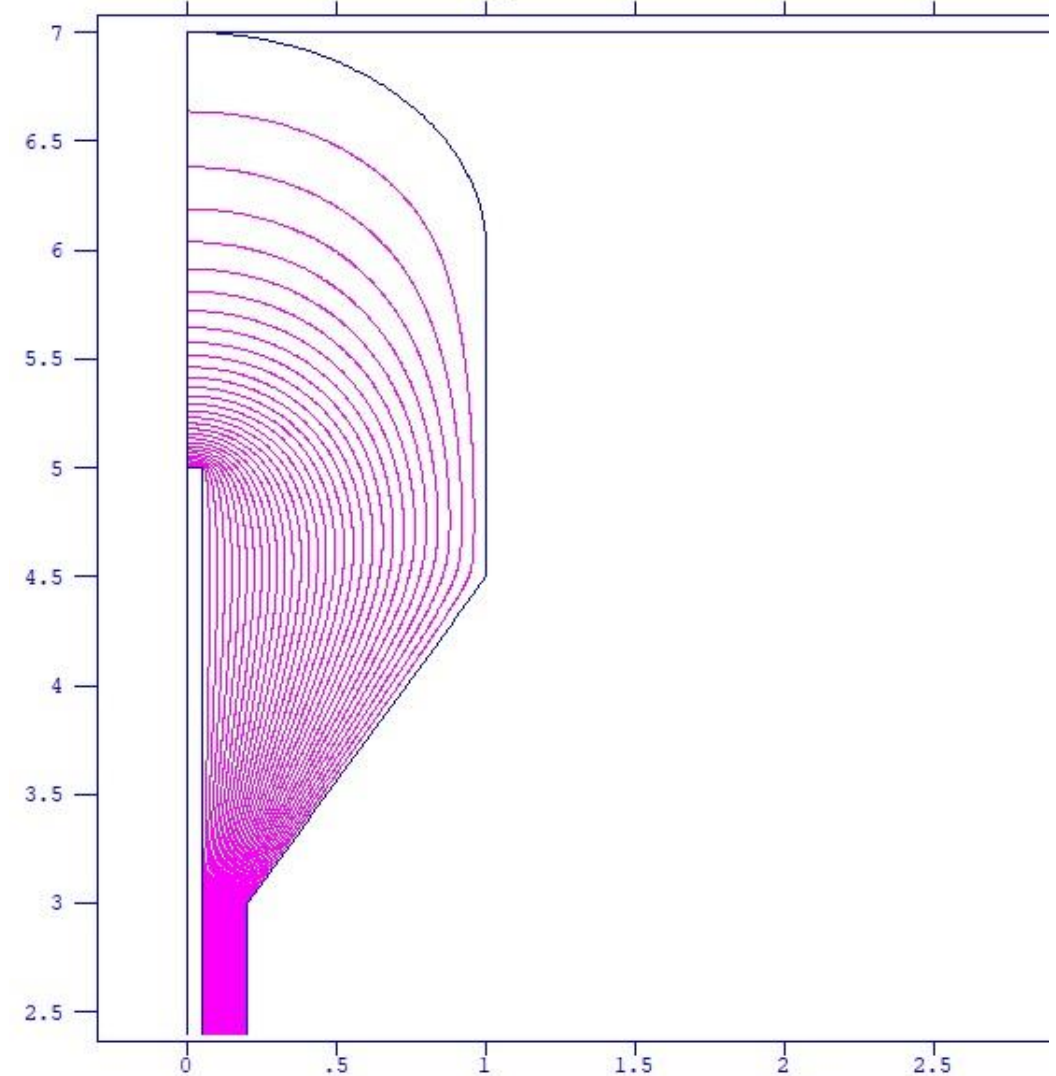
Standard Linear Slit Extractor

AIS-ILIS1 Emitter Field - 2kV, 0.75mm Extractor Aperture Fields

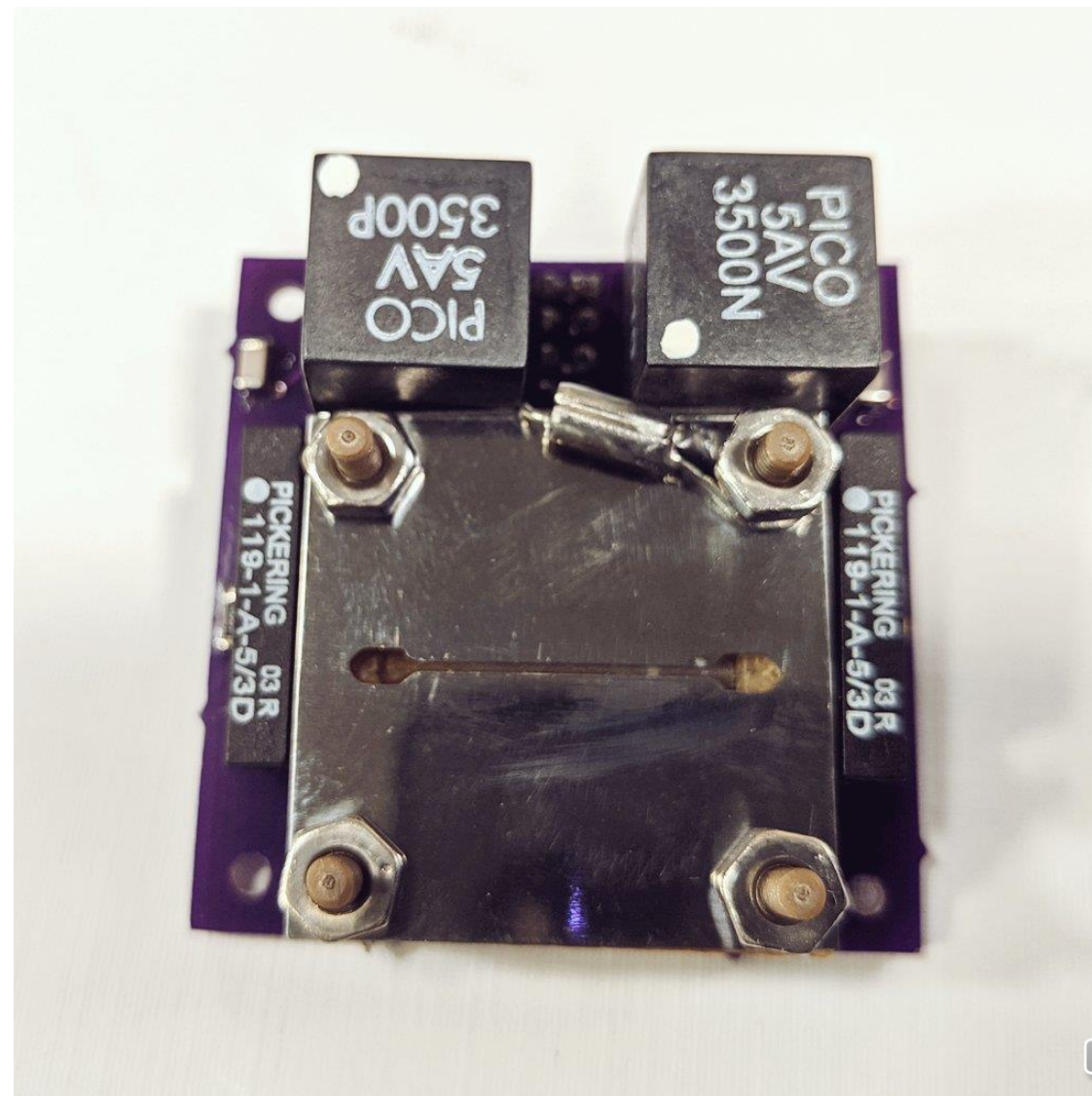
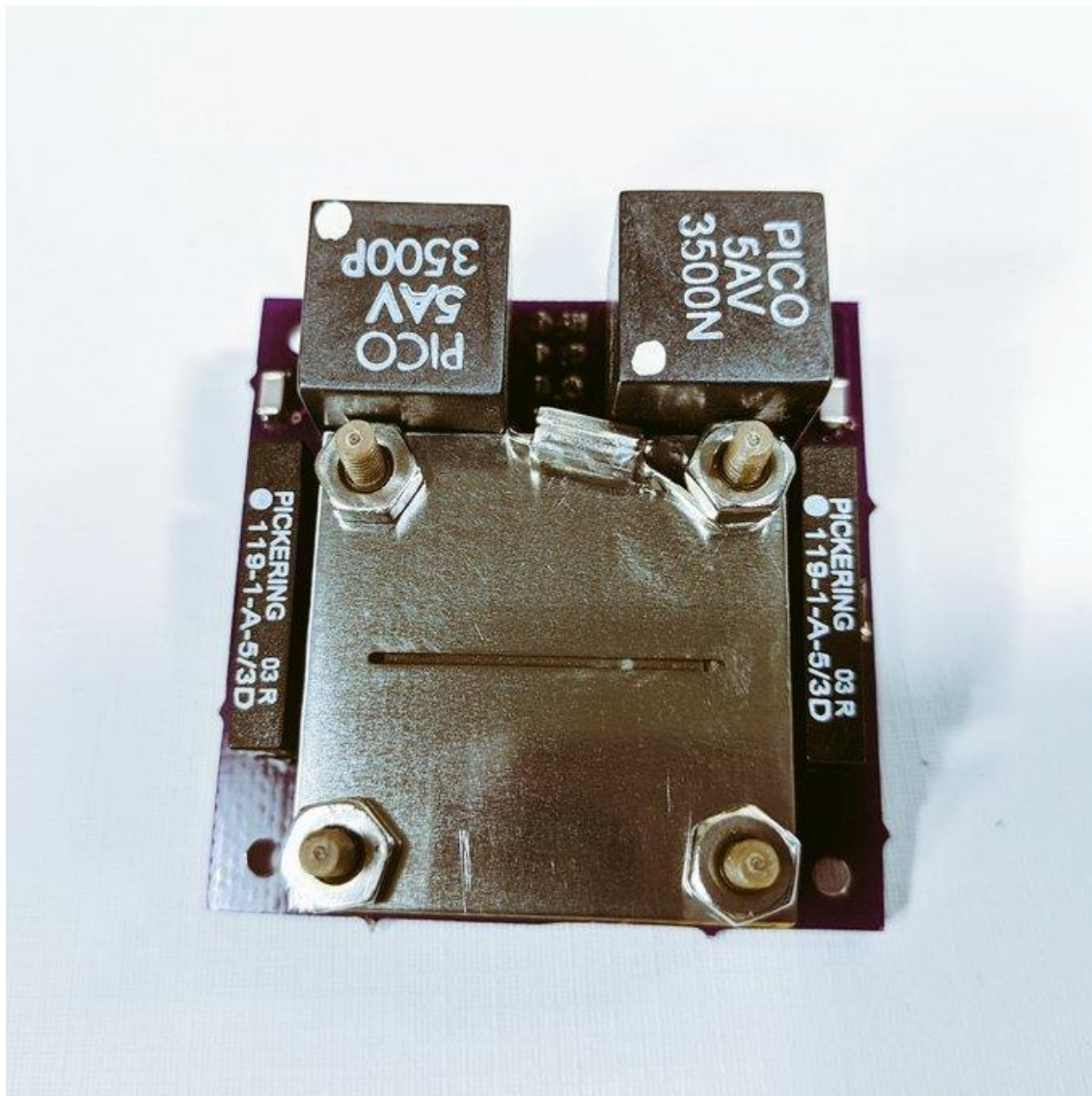


Enhanced Flared Slit Extractor

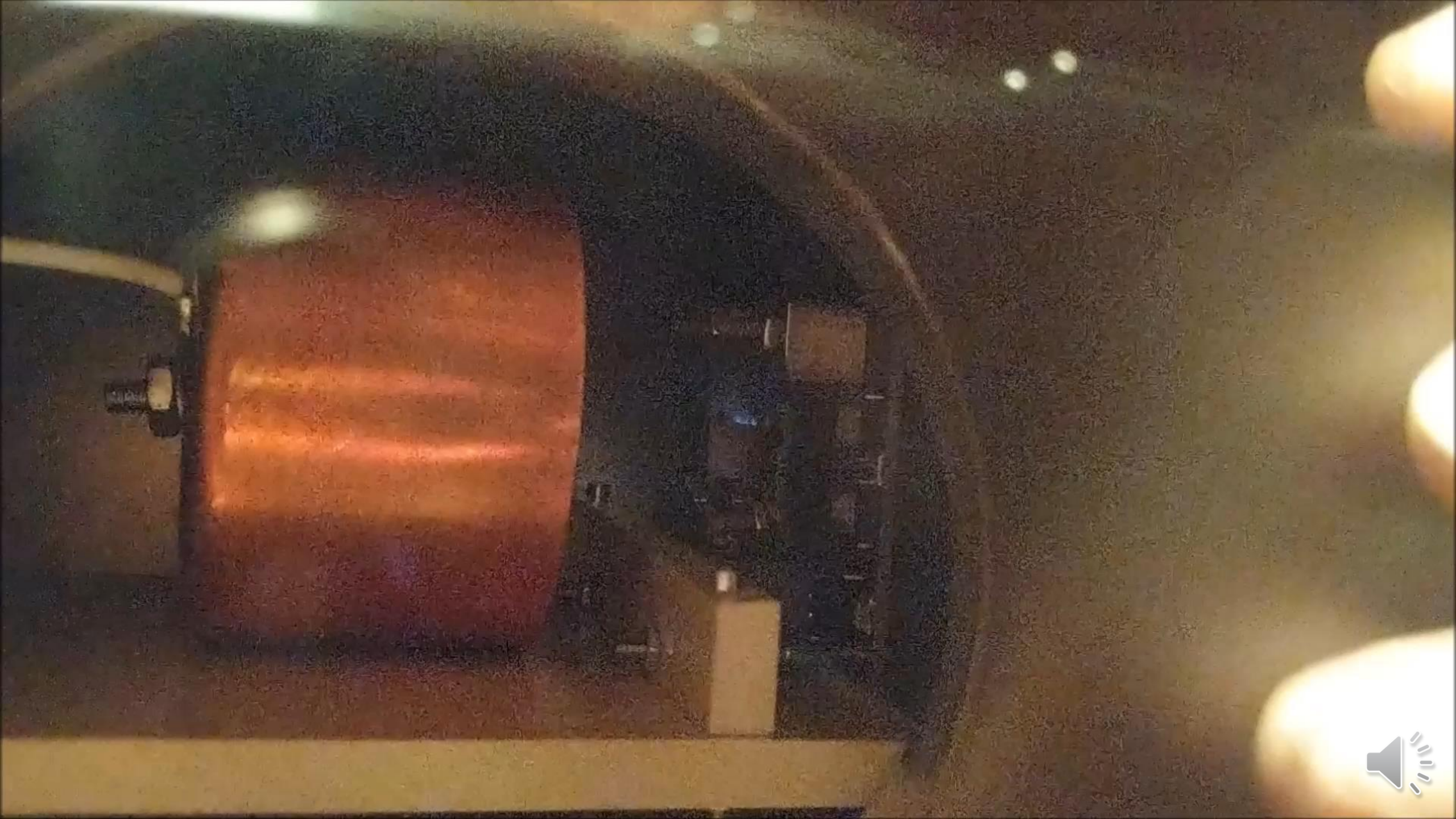
AIS-ILIS1 Enhanced Extractor - Aperture Field - 0.4mm Extractor, 2kV

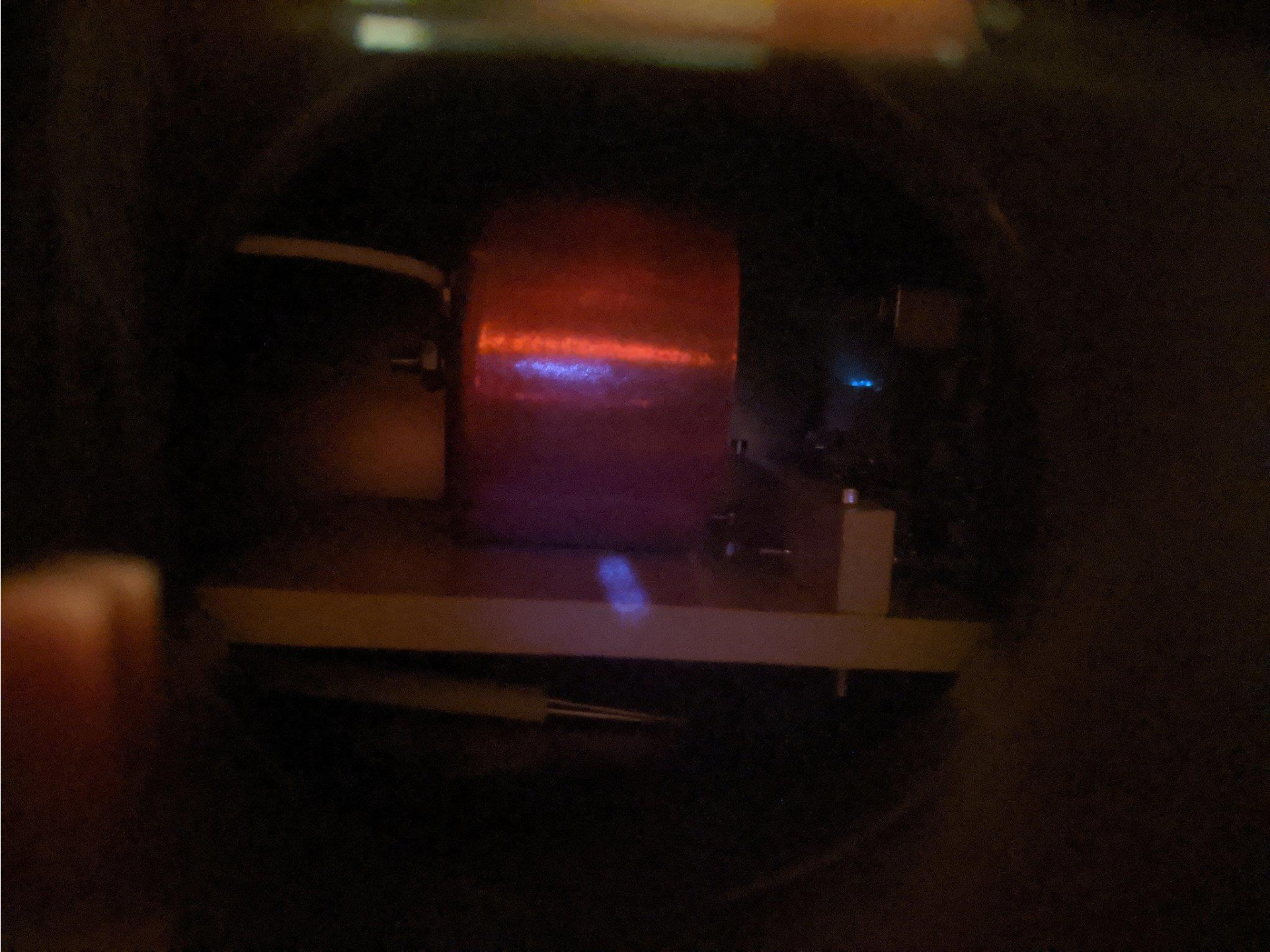


Extractor Geometry Optimization

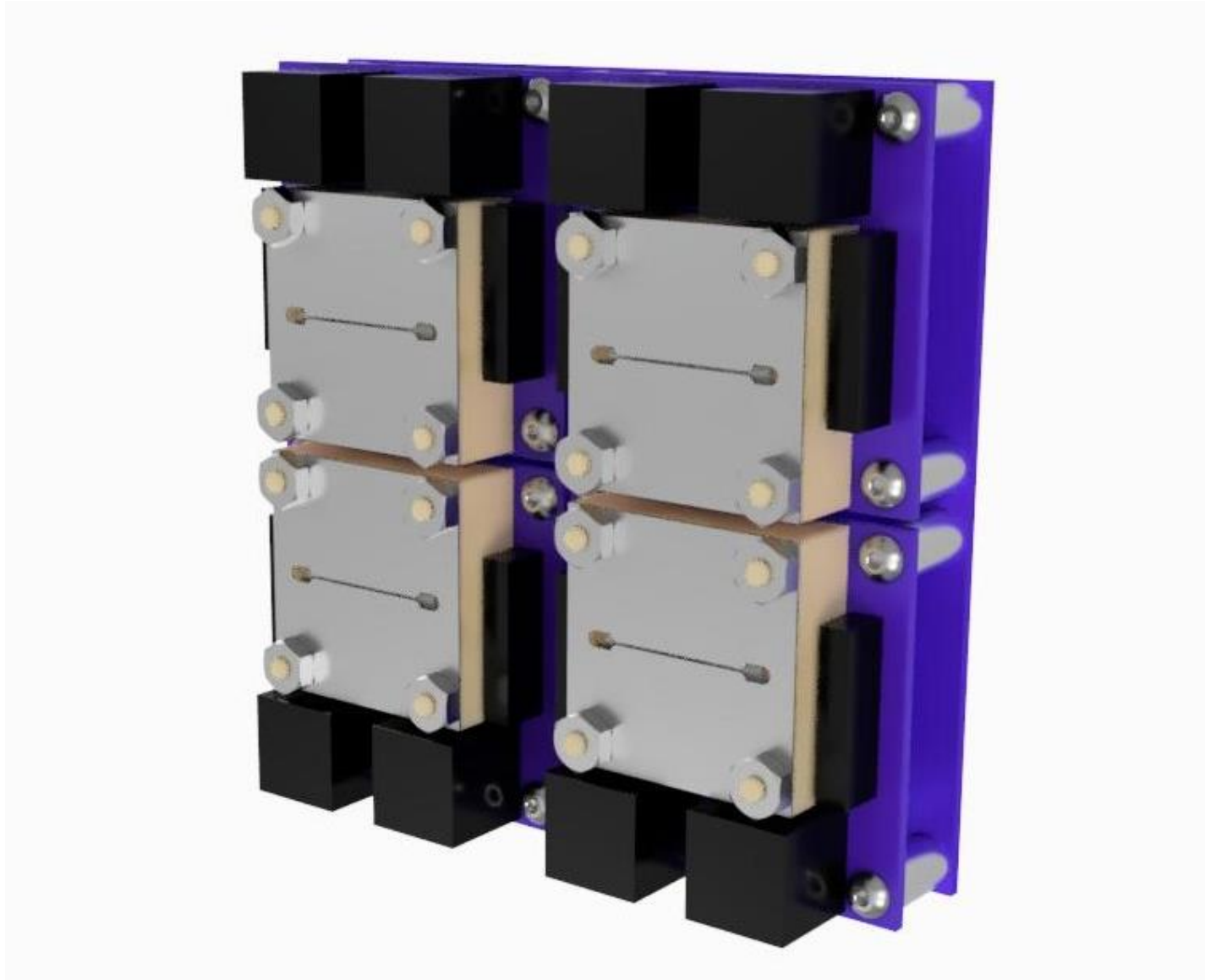








Versatility of Electrospray Scaling – Module Clustering for Larger Satellites



Pushing the Boundaries of PQ Ion Thruster Performance

The AIS-ILIS2

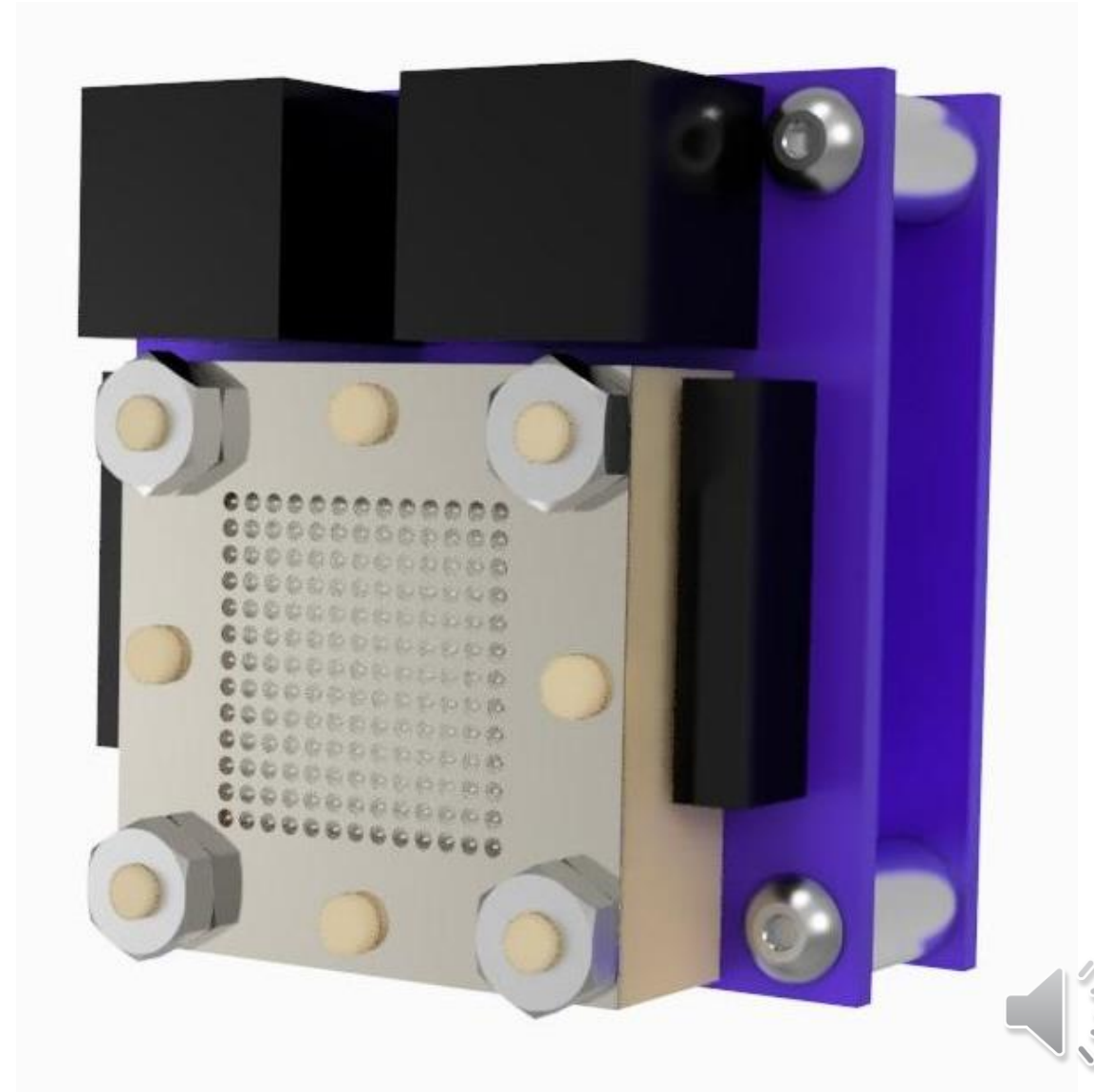
Power: 1.6W

Thrust: $>20\mu\text{N}$

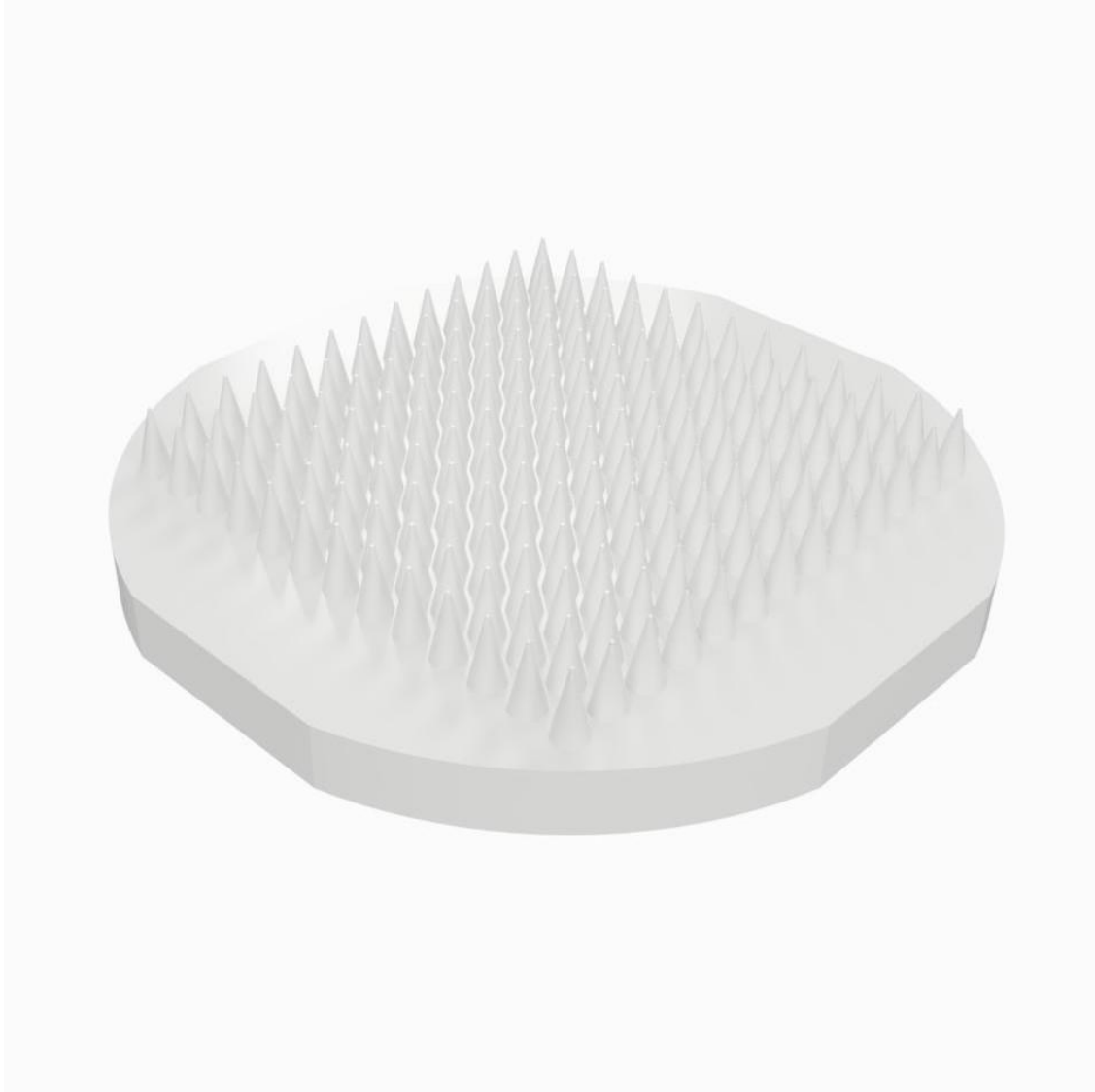
ISP: $>3500\text{s}$

Total Impulse: $>50\text{Ns}$

Volume: 45x45x27mm

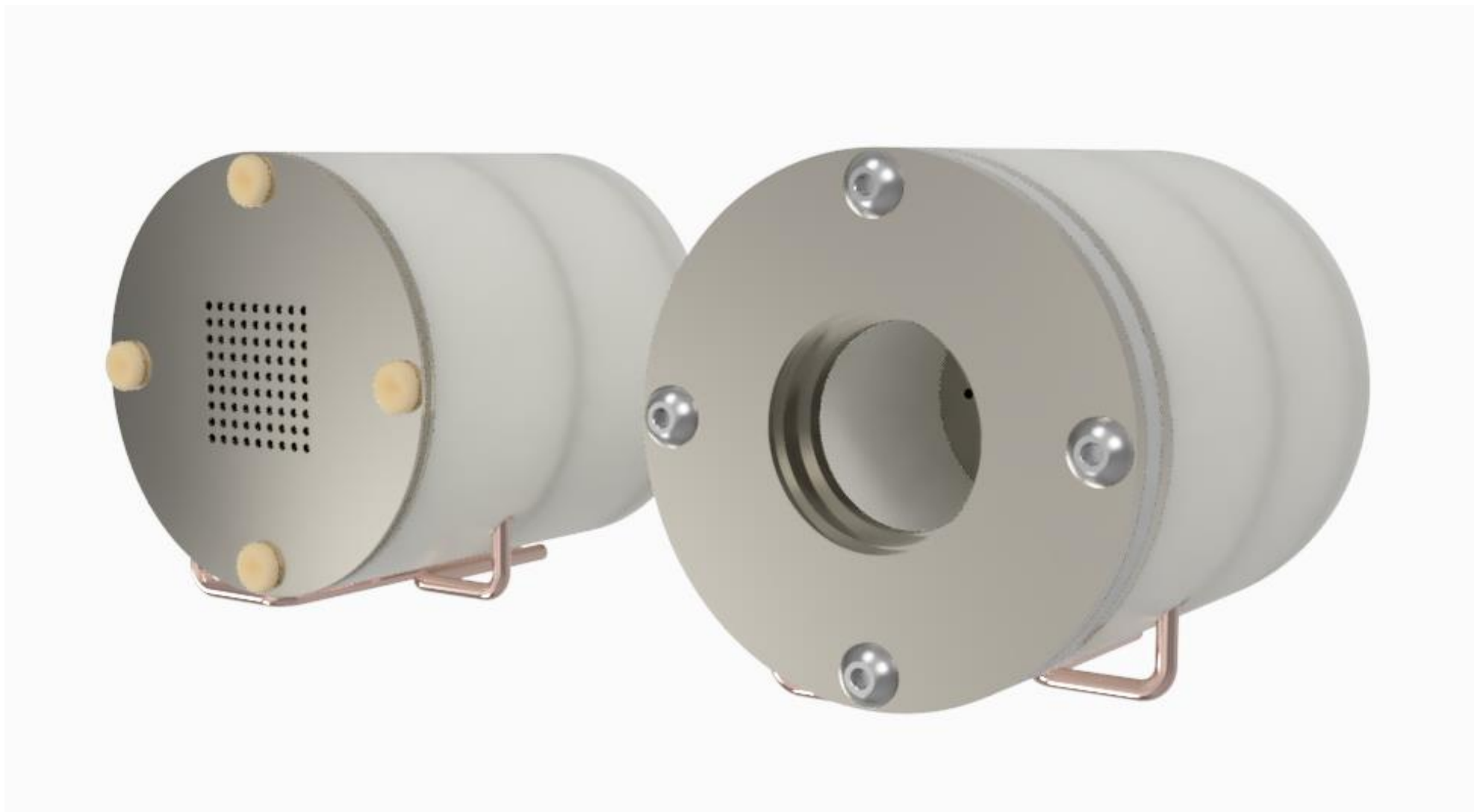


AIS-ILIS2 – Spike Array Emitter



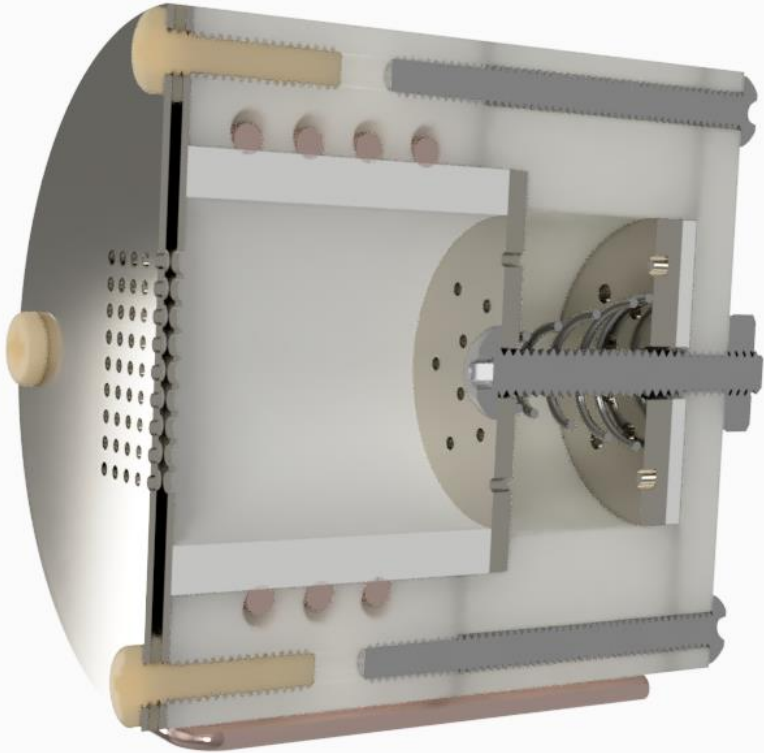
AIS-Io Series

Modular, Low-Cost, Solid Iodine Fueled Thrusters

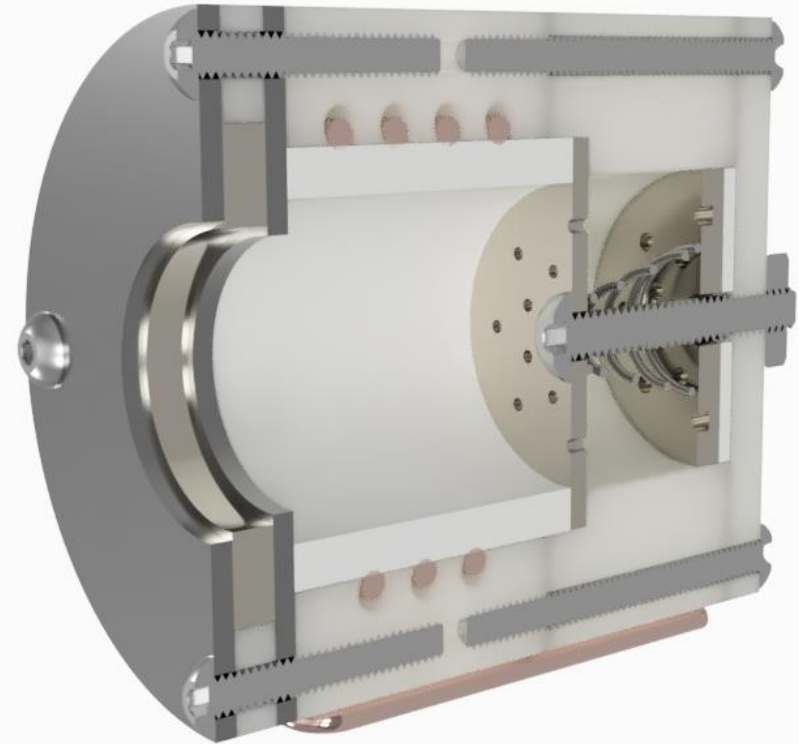


AIS-Io Series: Extreme Modularity

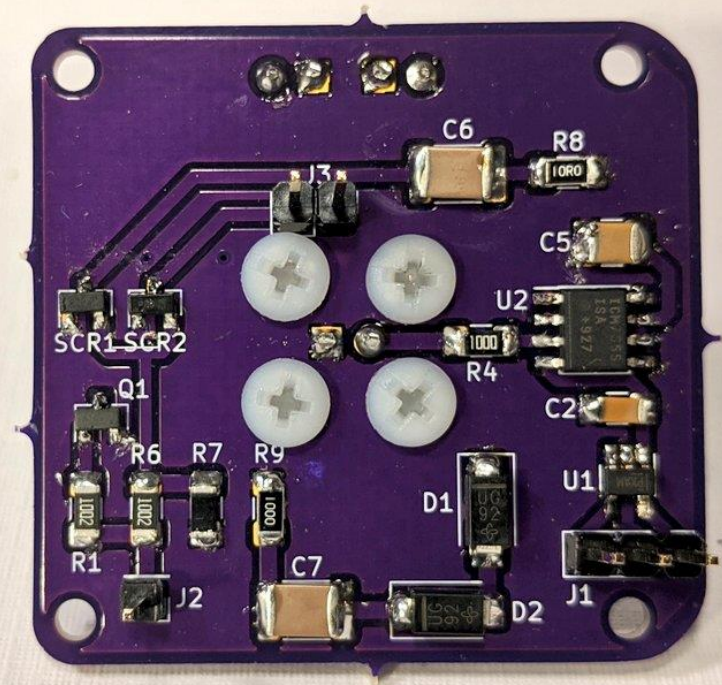
AIS-Io Series RF Gridded Ion Thruster



AIS-Io Series RF Plasma Thruster



Learning Kits – AIS-gPPT3-1C





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AIS



Thank You!

