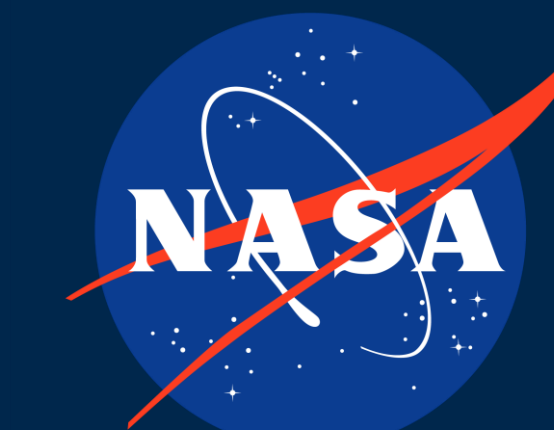


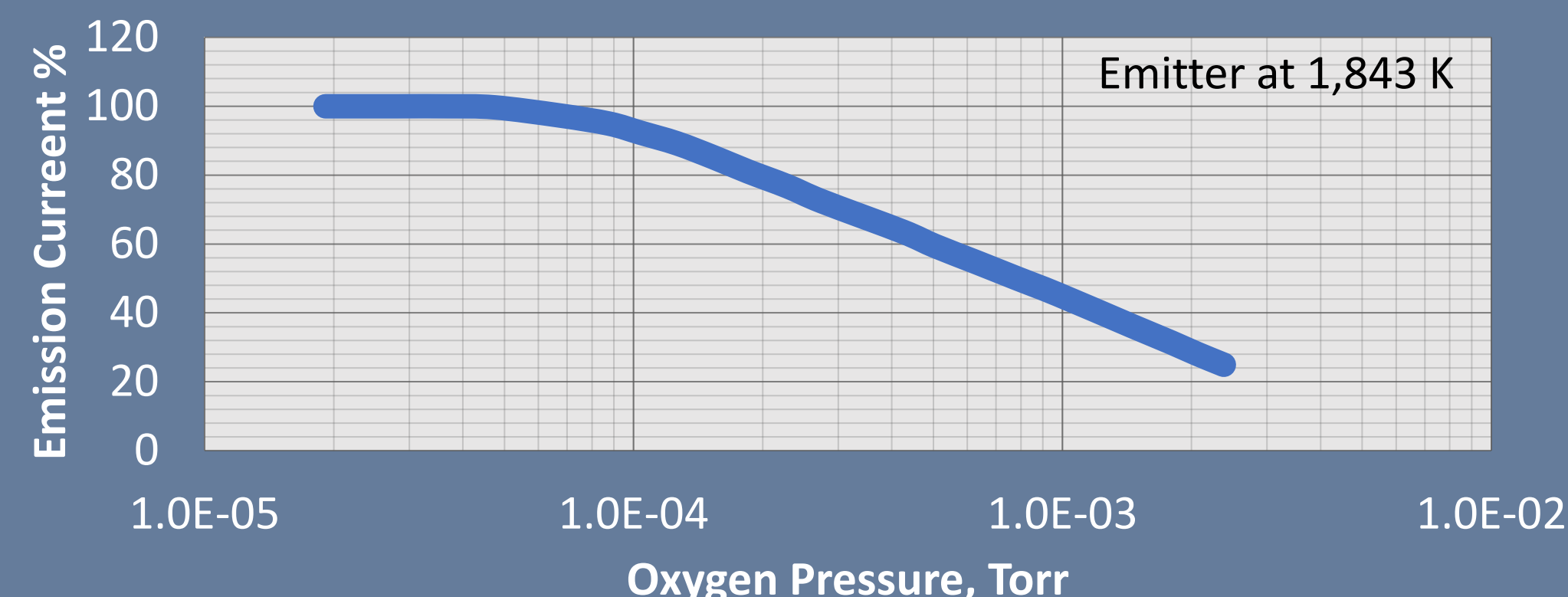
Investigation of a Low-Pressure Cathode Design for High-Current Operation on Chemically Reactive Gasses

Tate Gill (a), Dan Goebel (b) and Benjamin Jorns (a)



Motivation

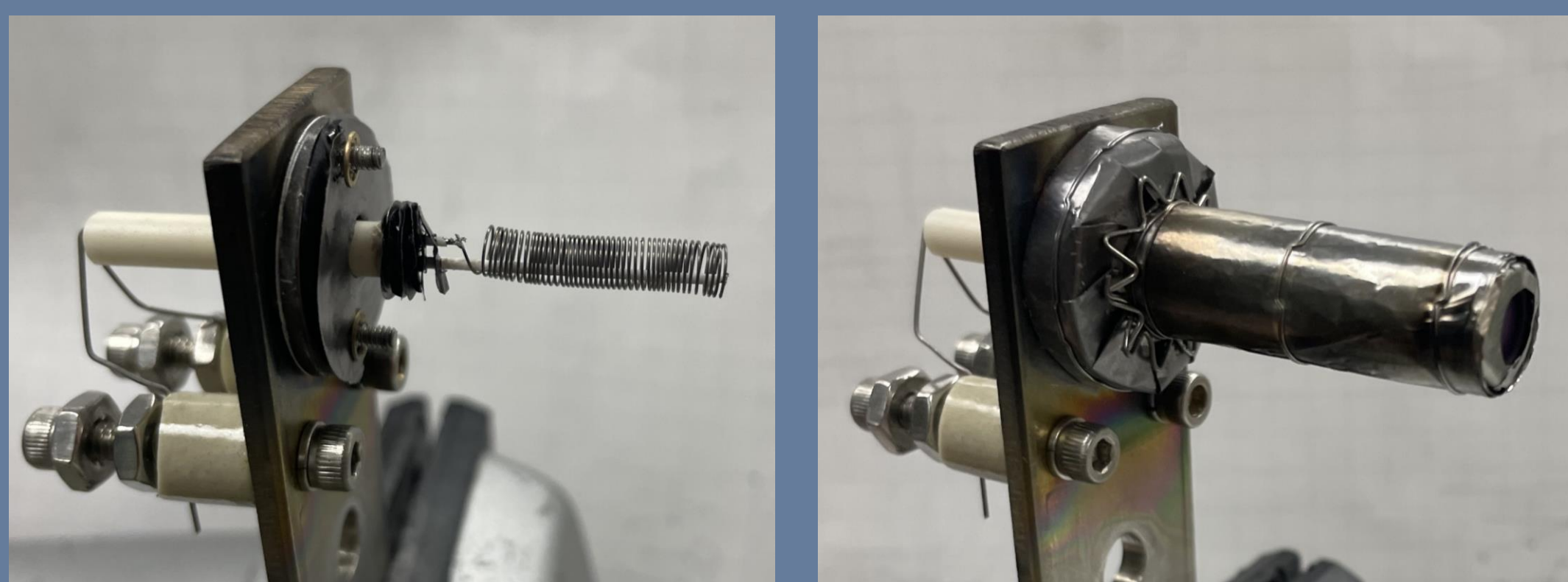
- Alternative molecular propellants (N_2 , O_2 , H_2O , CO_2 , ...) are highly enabling for air-breathing/ISRU EP missions.
- Thermionic LaB_6 cathodes can easily source the electron currents required (10's – 100's of amps).
- Hollow cathodes will poison on these gases.
- **BUT** LaB_6 exhibits resilience to poisoning if kept below $\sim 1 \times 10^{-4}$ Torr ambient pressure.



Reproduced from: H. E. Gallagher J. of Applied Physics 40, 44 (1969)

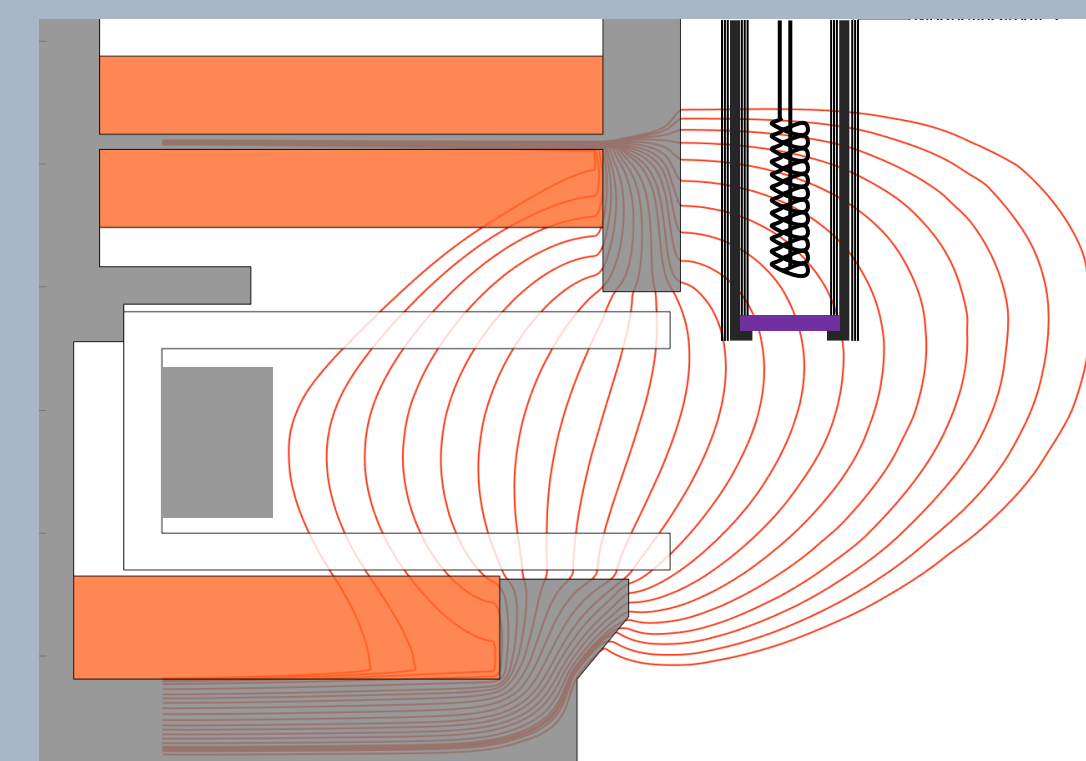
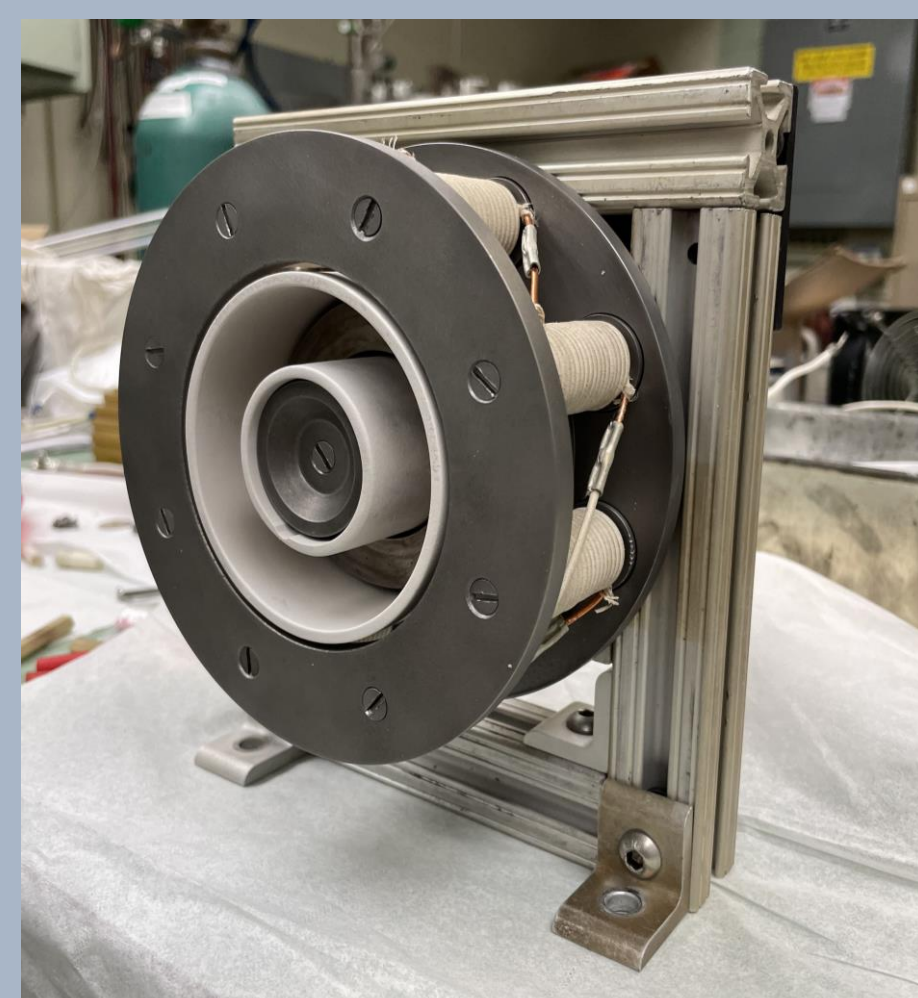
IS IT POSSIBLE TO OPERATE A LaB_6 CATHODE WITH THE AMBIENT PLASMA FROM A THRUSTER?

Cathode Design



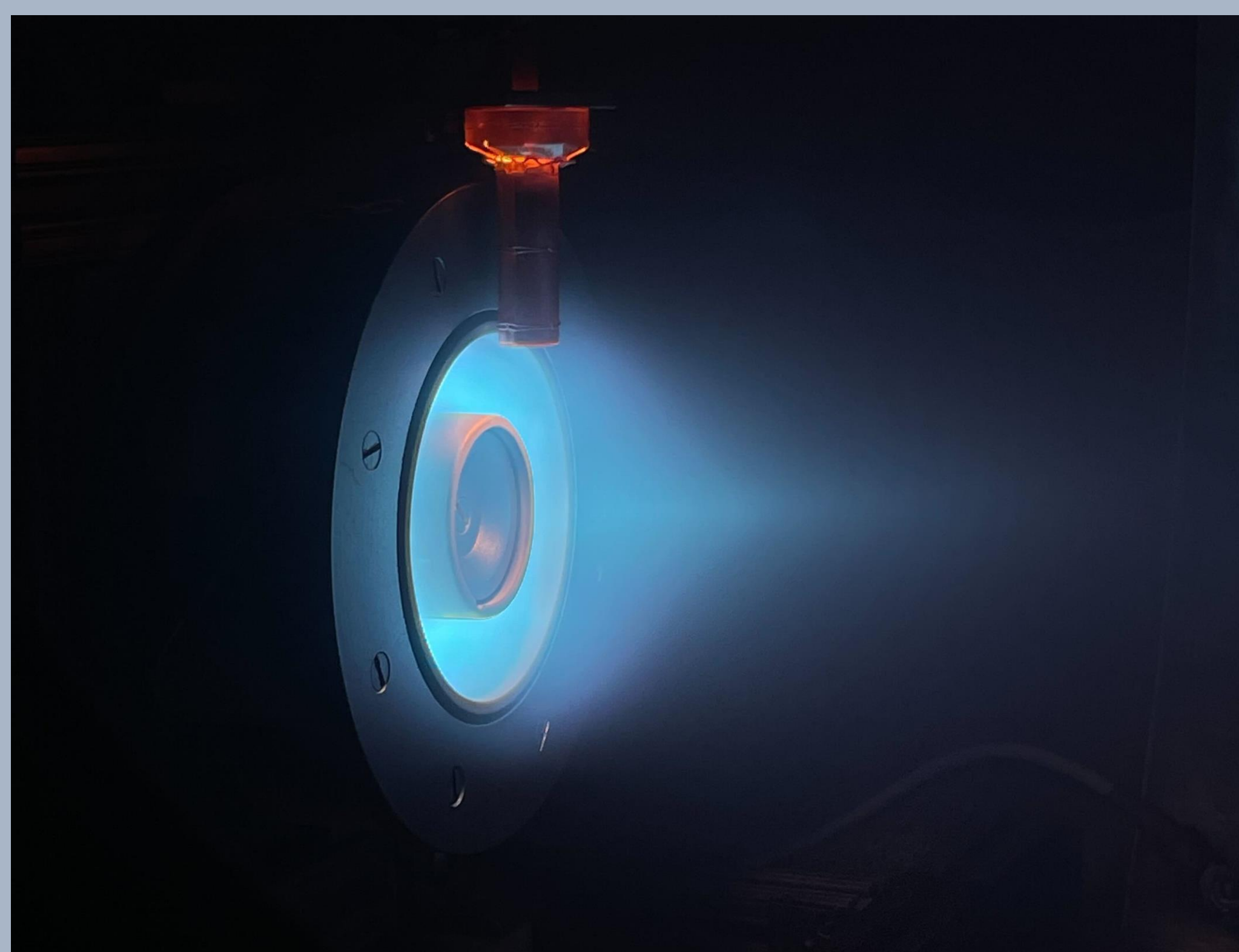
- \varnothing 1/4" LaB_6 Insert
- Graphite cathode tube with BN thermal break
- Heated from behind by 125 W tungsten filament held by alumina rod
- Tantalum and tungsten multilayer heat shielding on inner and outer diameter

Experiment



2D magnetic field simulation with approx. cathode location

- Cathode prototype run with PEPL-70 Hall thruster (based on SPT-70/SPT-100 designs) at JPL
- **Xenon** used as propellant as proof of concept
- Performed parameter sweeps over heater power anode voltage, and anode flow rate
- Monitored discharge characteristics and anode current



PEPL-70 At 300 V 2.6 A running with propellantless cathode

Conclusion

CATHODE SUCCESSFULLY SOURCED 2.6 A MINIMUM SPECIFIC POWER OF 37 W/A

- Emitter temperature above thermionic limitation at 95 W heater power and space charge is "filled" by beam ions
- Increasing overall current to thruster (voltage/flow) does not require additional heater power \downarrow W/A
- Qualitative coupling to beam remains a challenge

Results

