

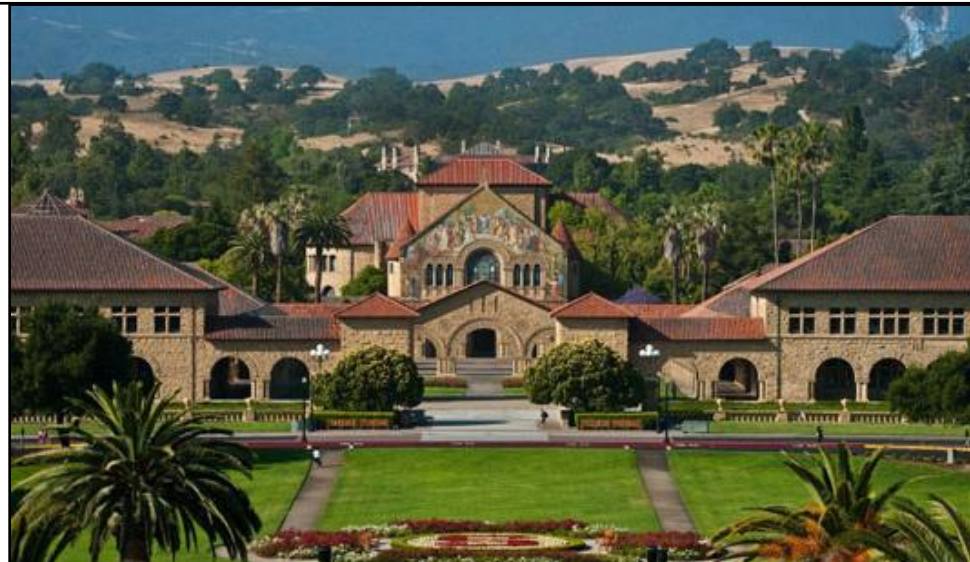
A Compact Helicon Thruster for Small Satellites

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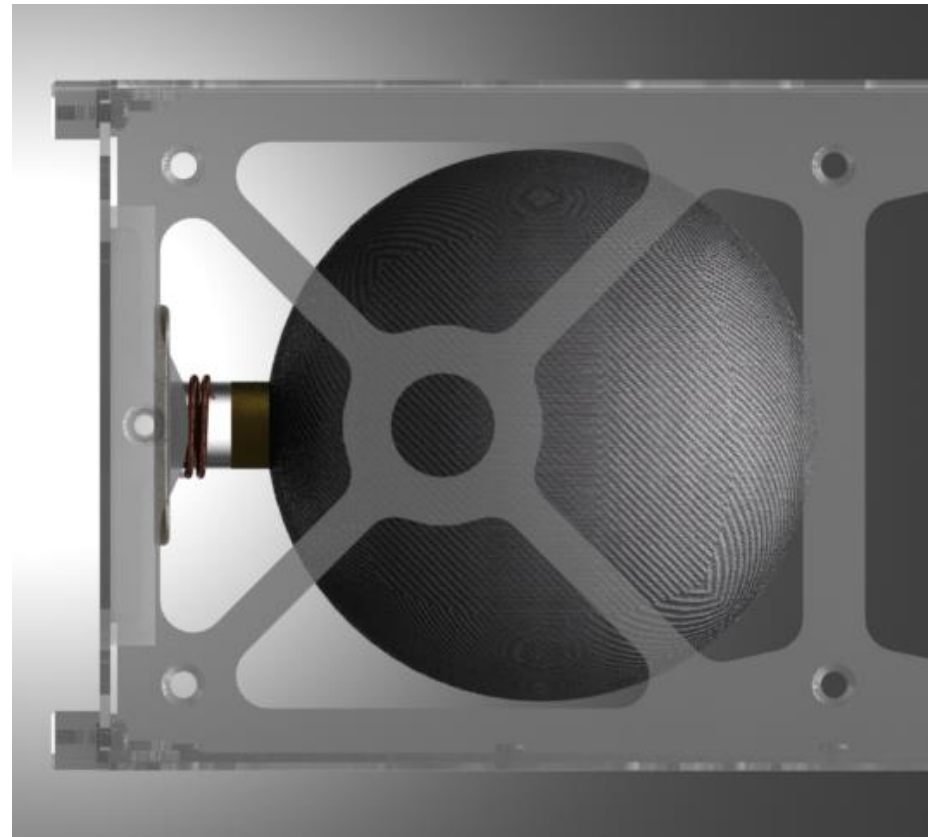
David Biggs, Luke Raymond, Wei Liang, Nicolas Gascon, Juan Rivas-Davila, Mark Cappelli

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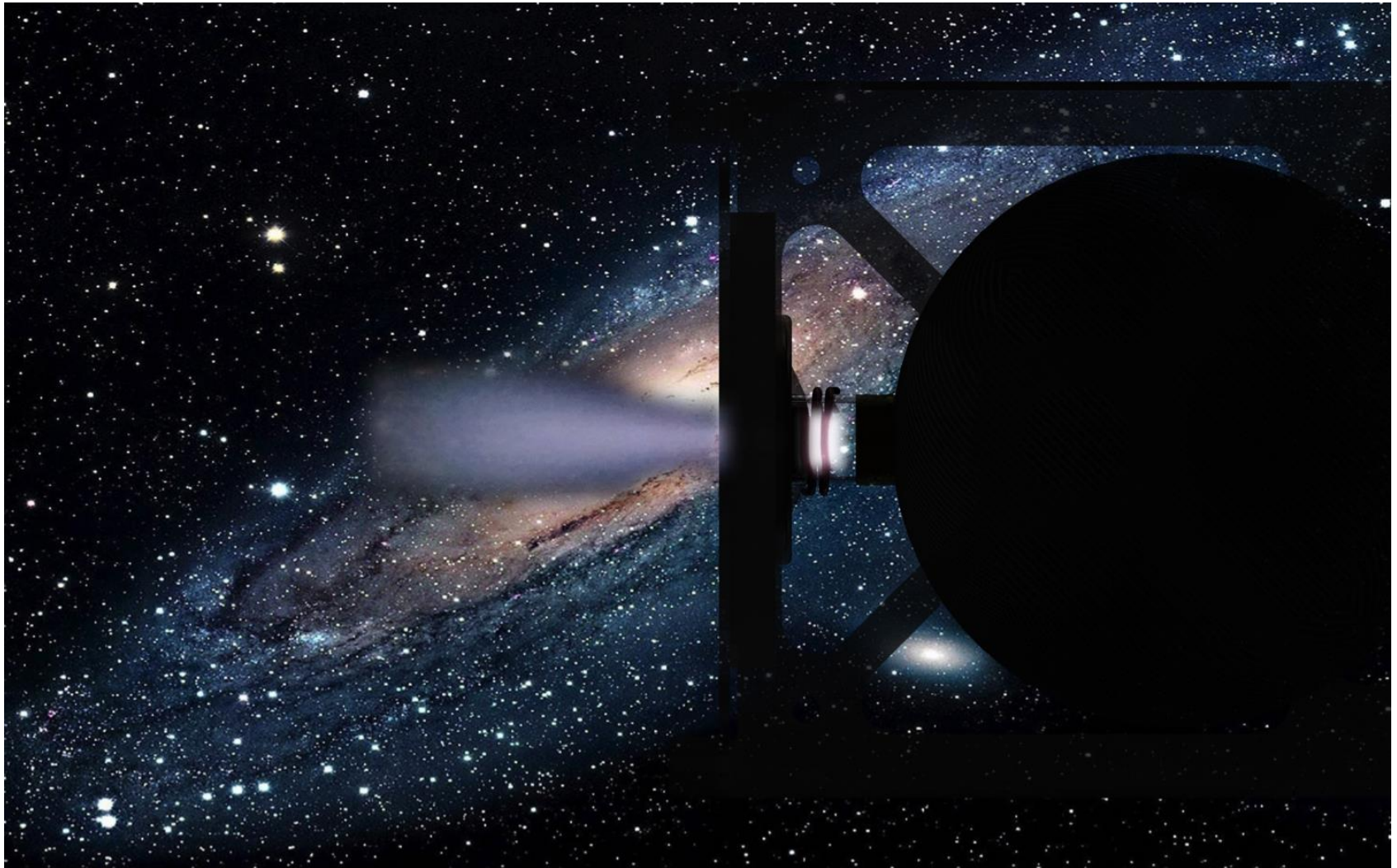
Goals:

- **Low-cost** and **reliable** small satellite electric propulsion system
- RF Inverter, propellant tank, and magnetic nozzle in 1U (10x10x10 cm)



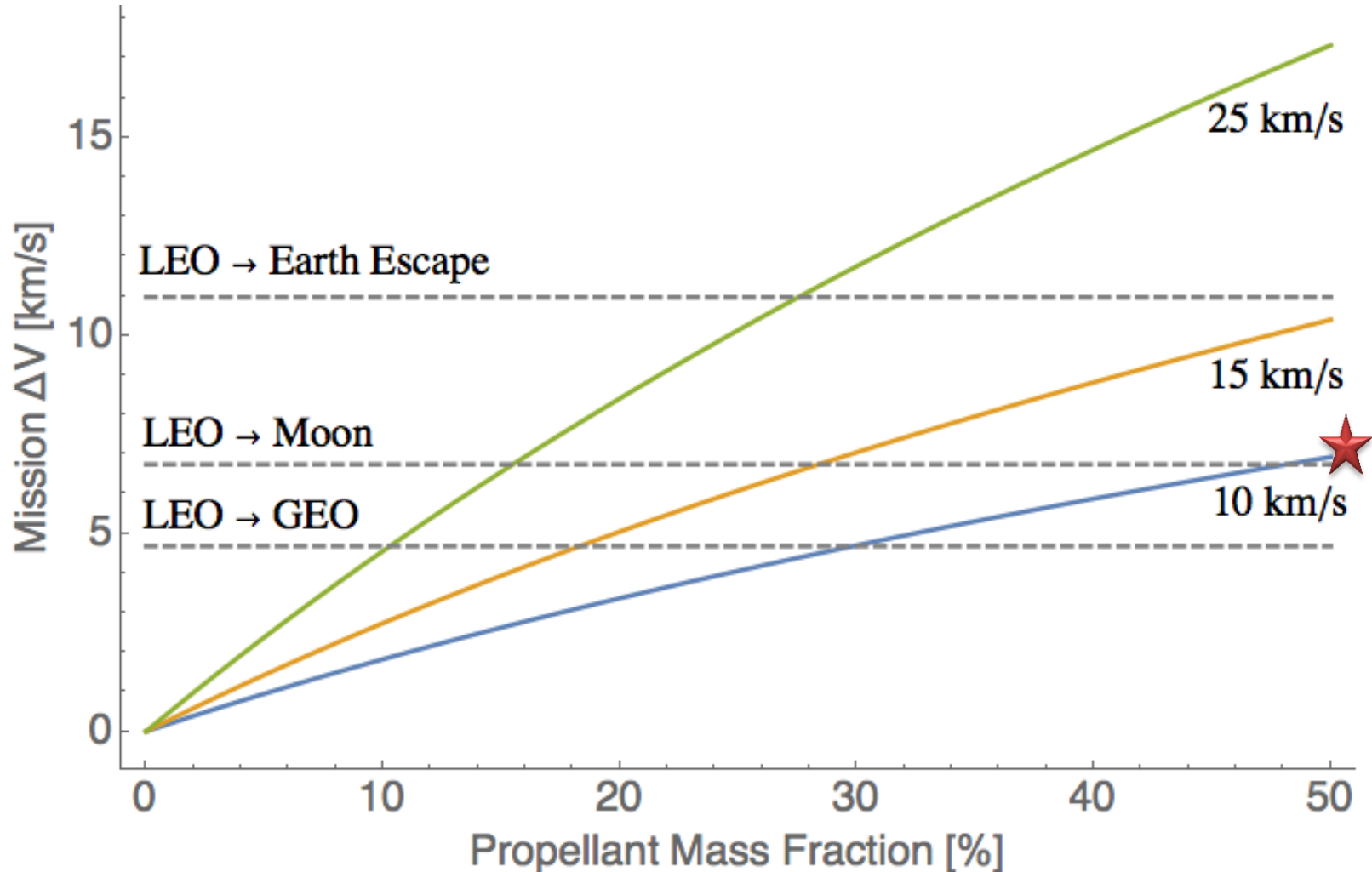
CubeSat frame model by ©Pumpkin, Inc

Realistic Mission Photo



CubeSat frame model by ©Pumpkin, Inc

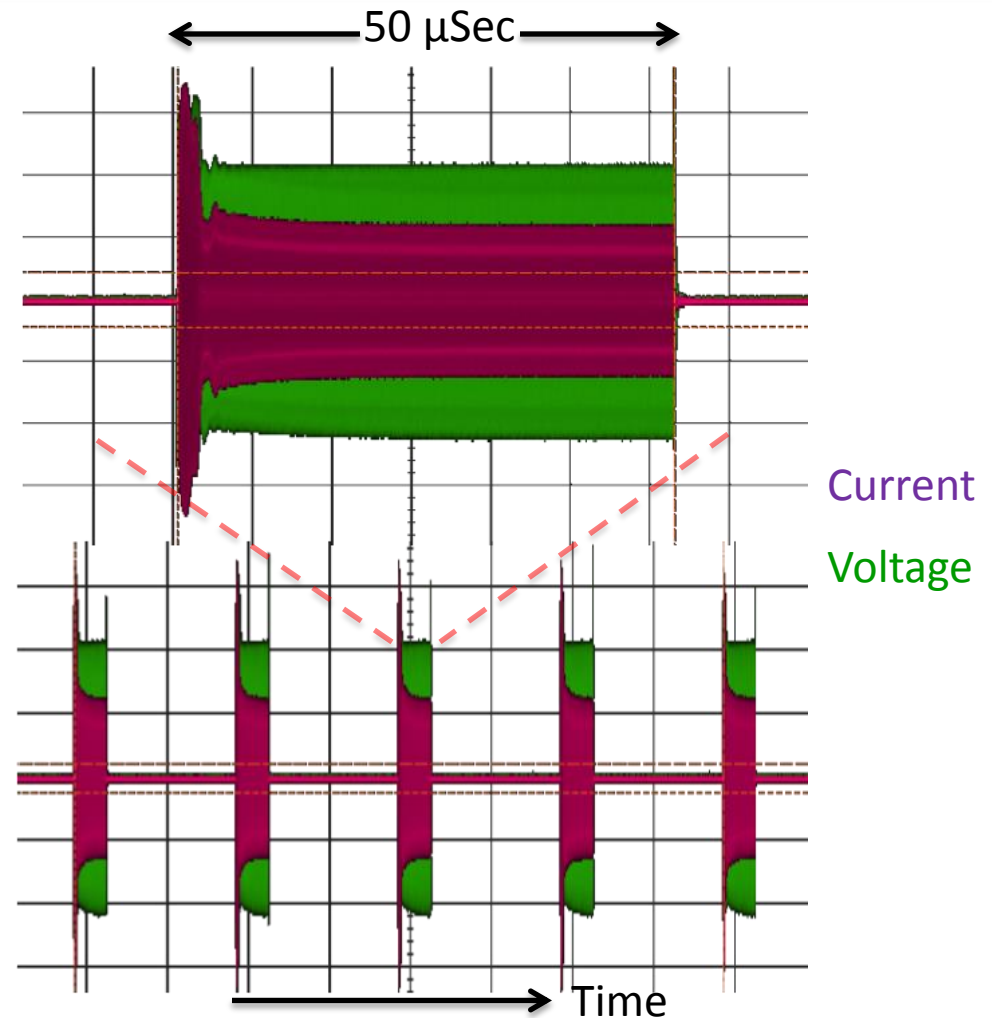
Mission ΔV vs. Propellant Mass Fraction



RF Inverter Design

Pulsed RF inverter

- Frequency: 28 MHz
- Pulse Rate: 5 kHz
- Peak Power: 25 W
- Avg Power: 5 W



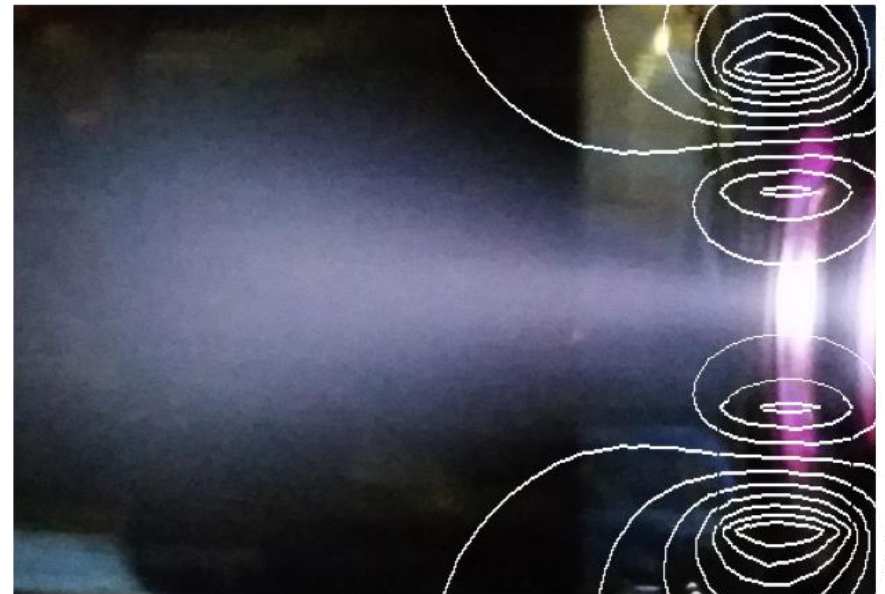
What is a helicon plasma?

- High density, low pressure inductively coupled plasma discharge
- Typical radiofrequency range of 10-100 MHz
- Helicon waves are circularly polarized plasma waves with an applied substantially axial magnetic field

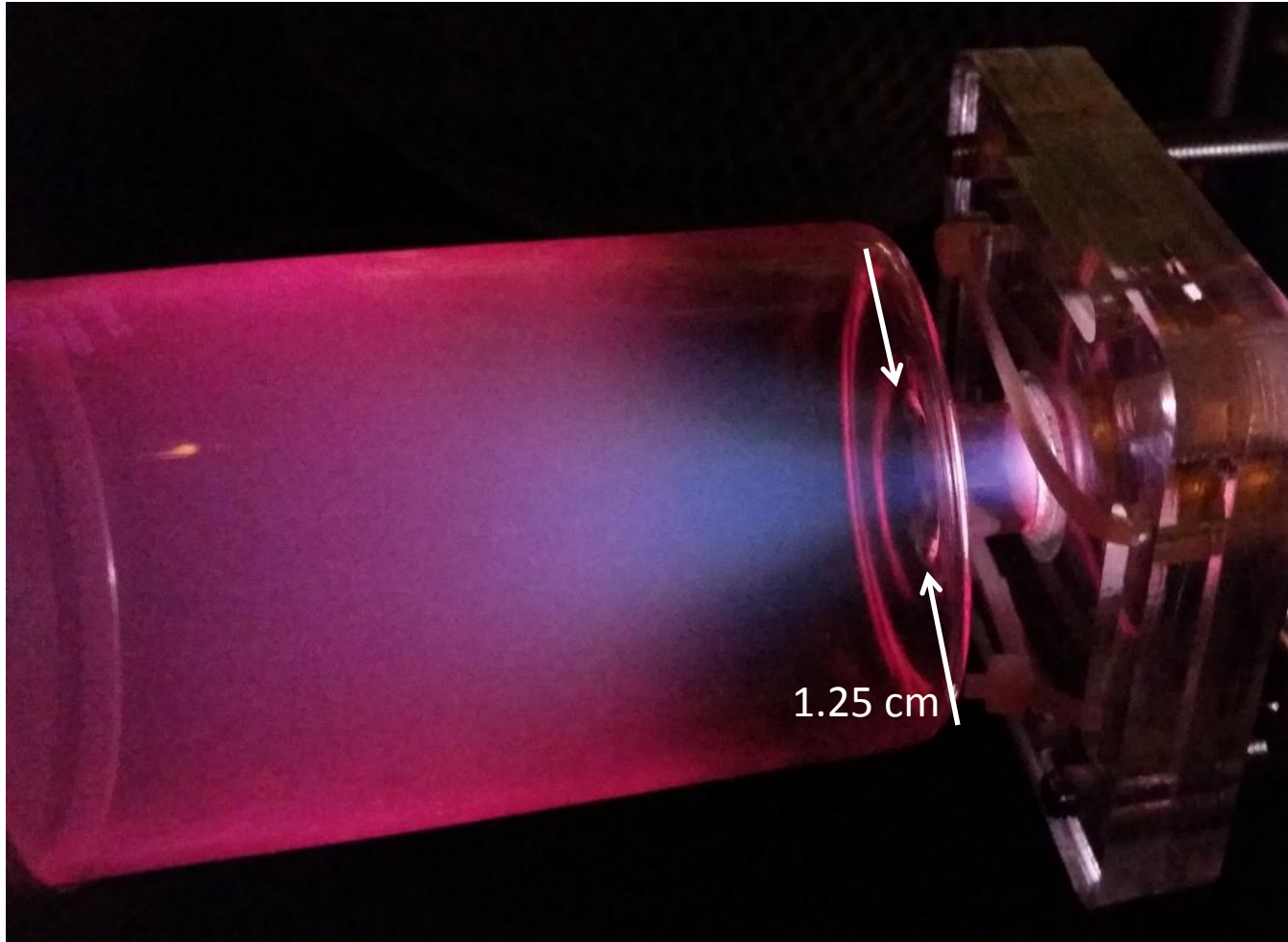
Plasma Discharge Modes



- Electrons convert transverse thermal energy to axial kinetic energy
- High axial electron energy develops an ambipolar field with slower ions
- Accelerates ions to generate **thrust**



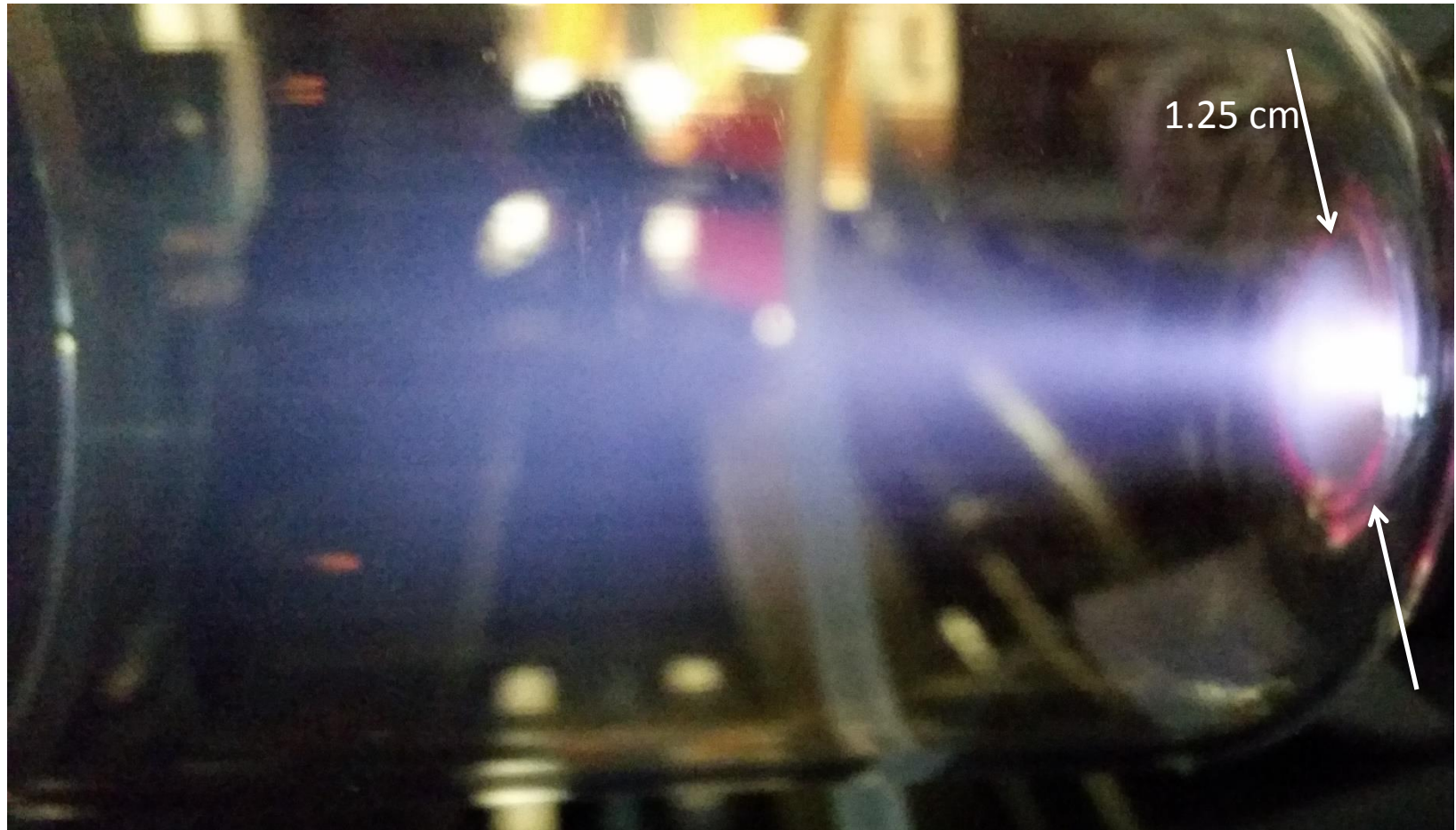
Initial Testing with Argon Gas



Experimental Probe Setup



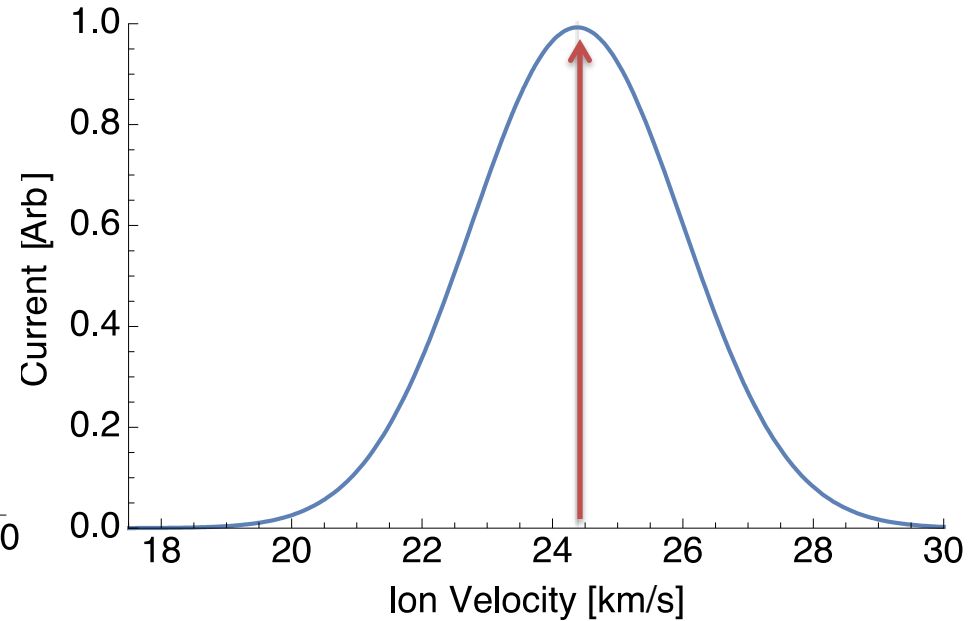
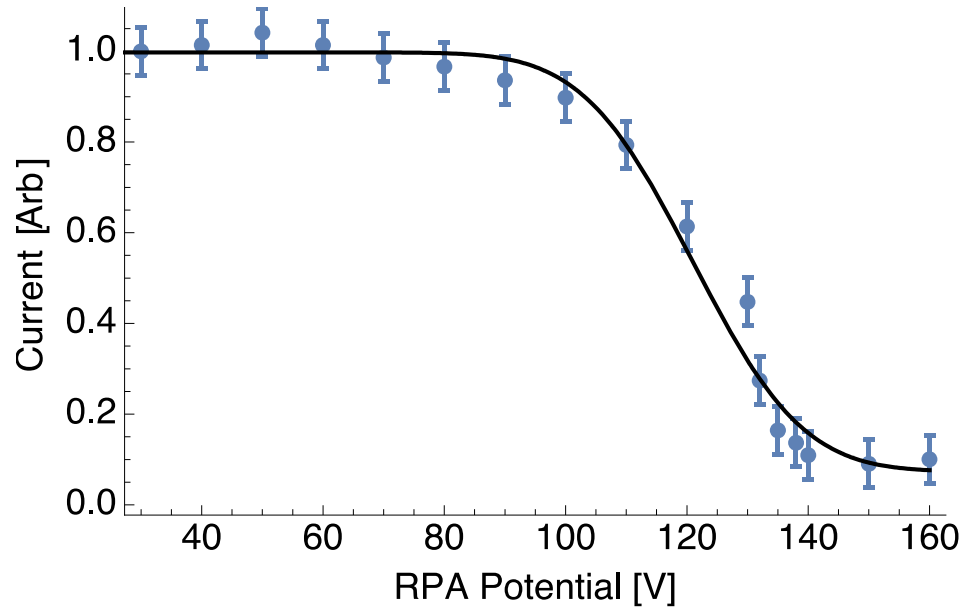
Testing at 138 MHz



Testing at 138 MHz



Ion Velocity

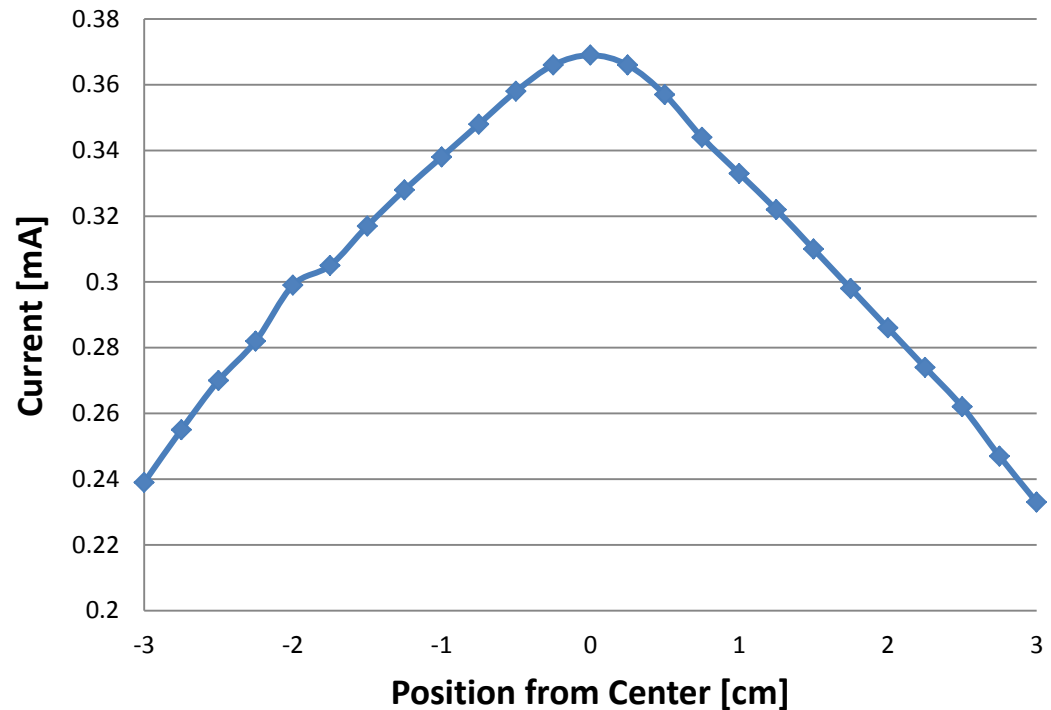


- Retarding Potential Analyzer (RPA) data at 138 MHz indicates an ion velocity of **24.5 km/s**

Total Ion Current

- Integrating the current vs. position provides a total ion current of **1 mA**

Faraday Probe Data at 138MHz



Preliminary Probe Data

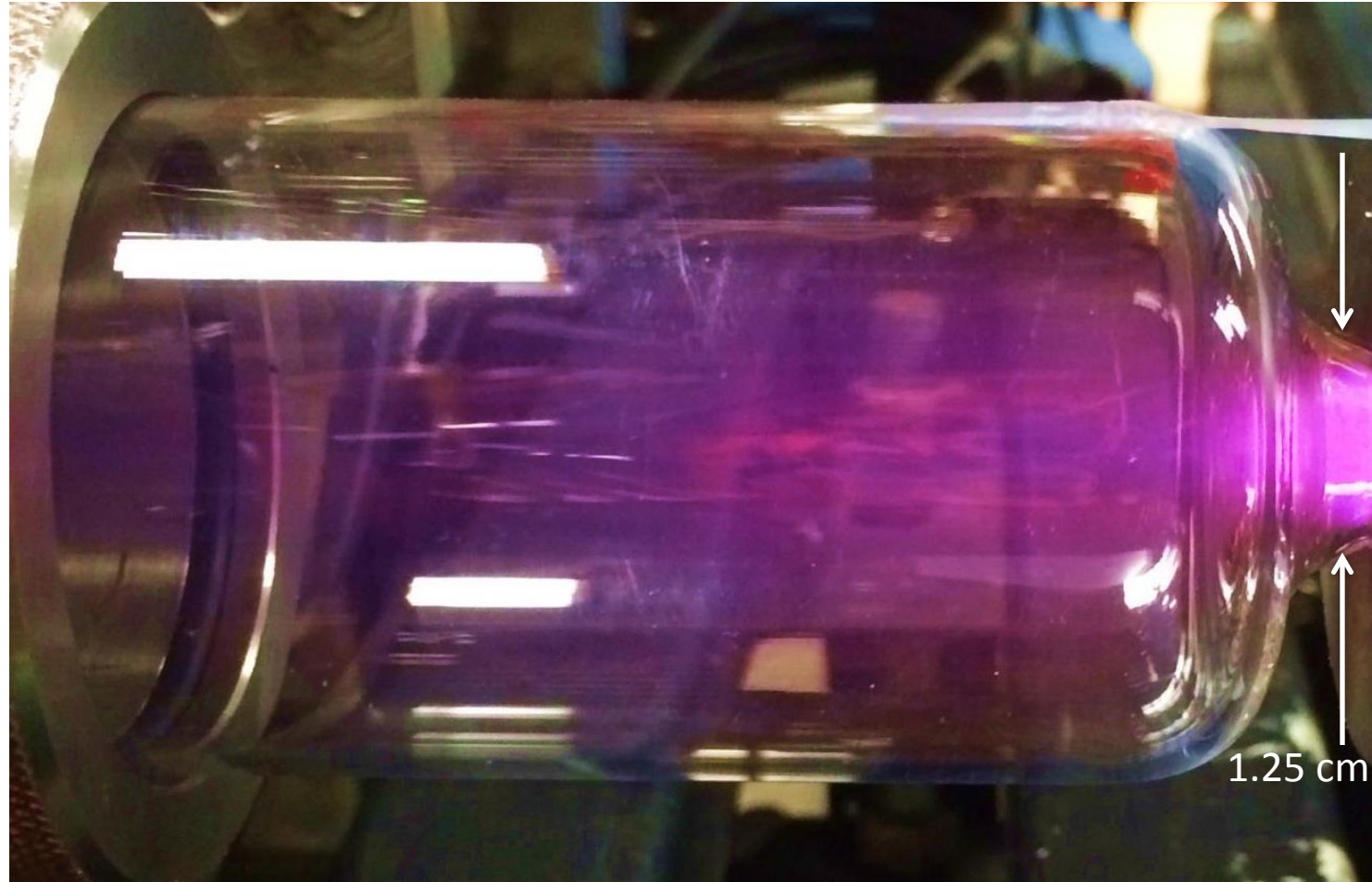
Helicon Thruster Testing with Argon Gas

Frequency [MHz]	40	138
Approx. Plasma Power [W]	<1	<1
Ion Velocity [km/s]	16.5	24.5

Using <1 W at 138 MHz we achieve:

- Total Ion Current ~ 1 mA
- **Thrust Efficiency $\sim 10\%$**
- **Thrust $\sim 10 \mu N$**

Water Thruster



Questions?

