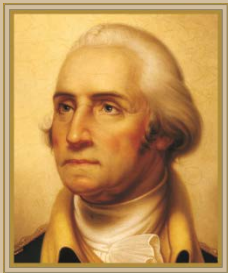


Thruster Subsystem Design for the Ballistic Reinforced Communication Satellite (BRICSat-P)



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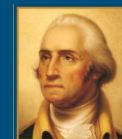
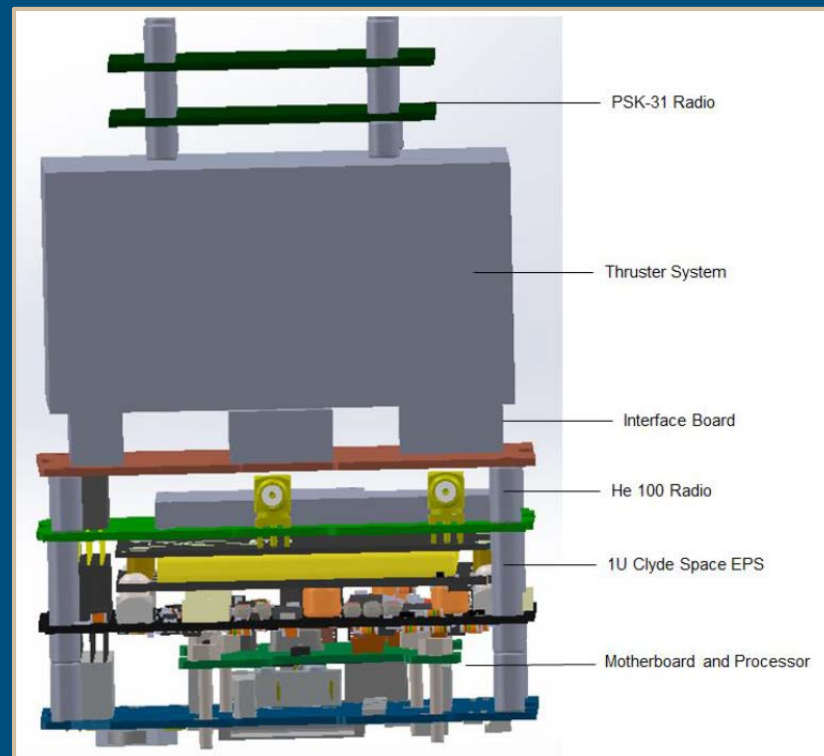
Presented By:
Joseph Lukas

Team Members:
George Teel
Samudra Haque
Alexey Shashurin
Professor Michael Keidar



USNA Mission

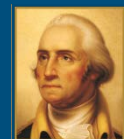
- BRICSat-P 2015 launch
- 500 km: Attitude control, orbit change, & deorbit
- Subsystem fits in 6 cm x 10 cm x 10 cm area





Success Criteria

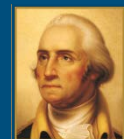
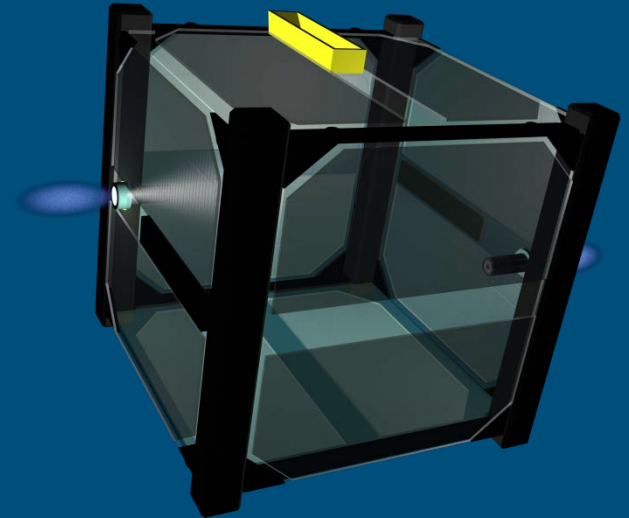
- Initial and repeatable firing
- BRICSat rotation of 6 rpm
- Stable spin and de-spin





Propulsion Requirements

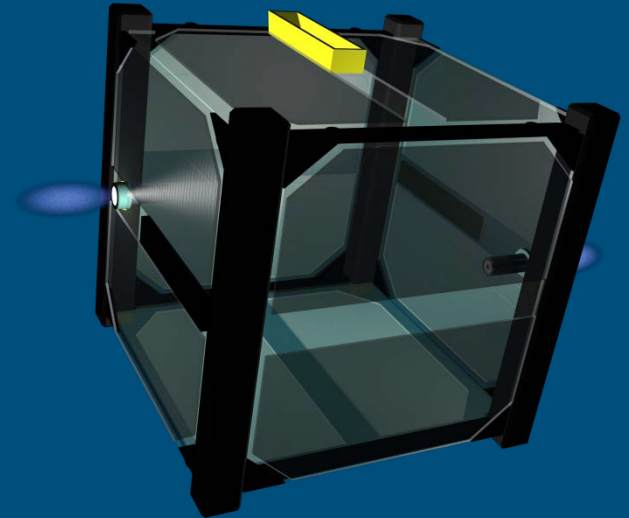
- **Electric propulsion that is...**
 - Low-cost
 - Reliable and simple
 - No pressurized tanks
 - Power efficient
 - Scalable and modular
 - Safe for the satellite



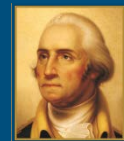


Propulsion Requirements

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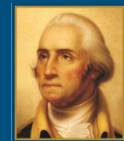
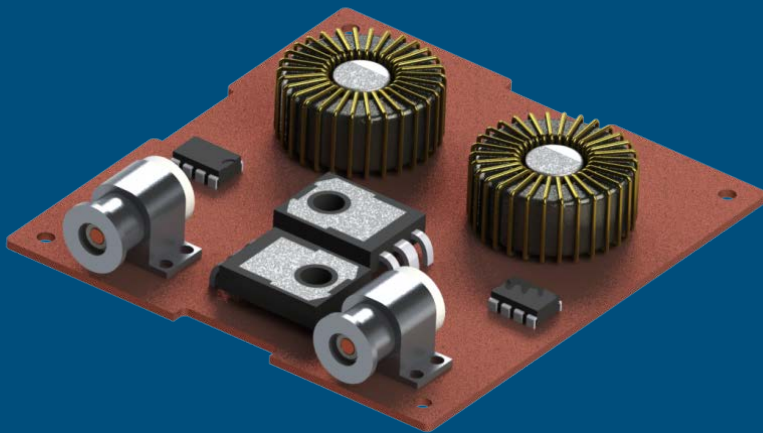
Solid Propellant





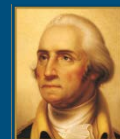
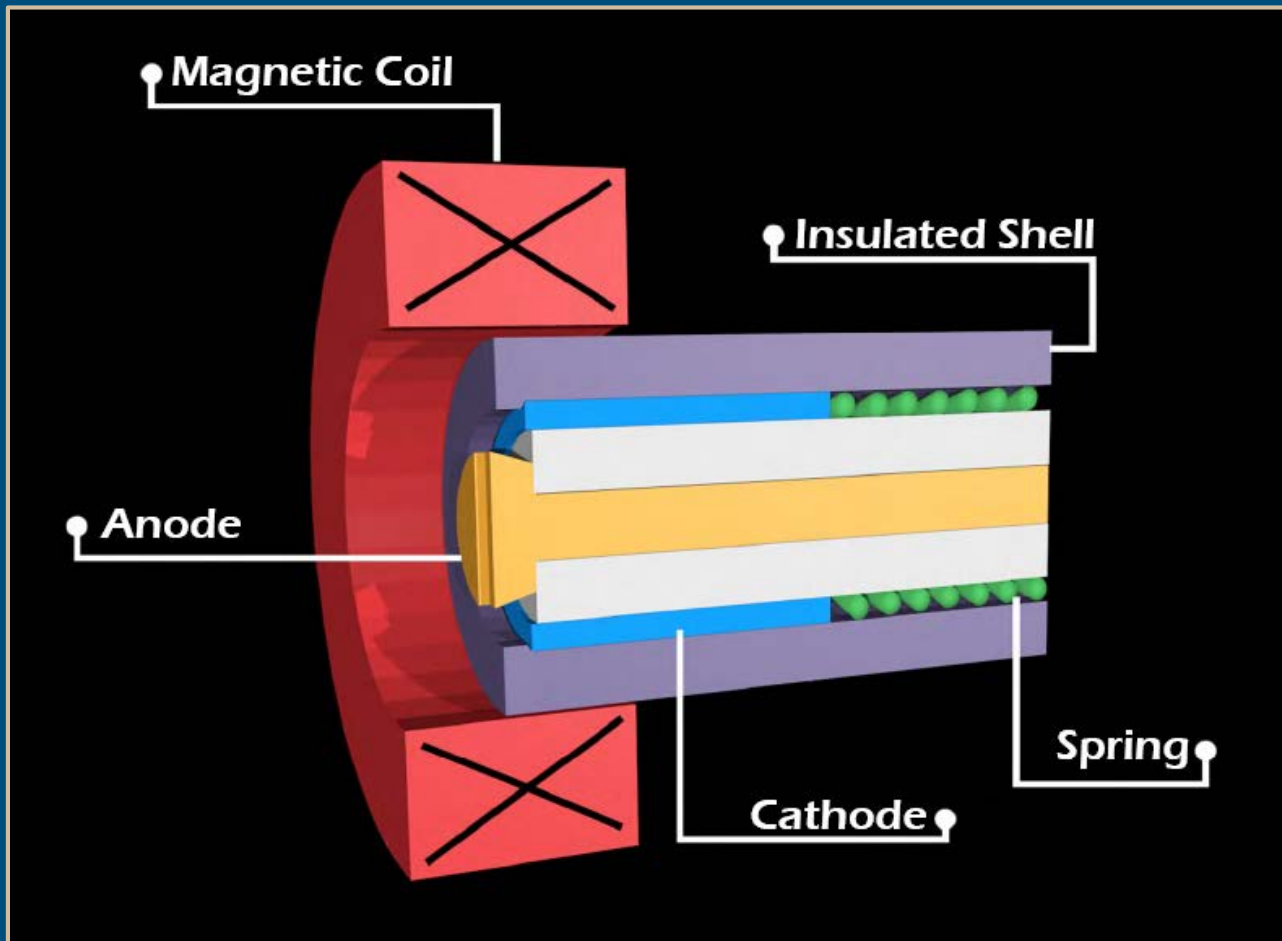
Micro-Cathode Arc Thruster (μ CAT)

- Generation III



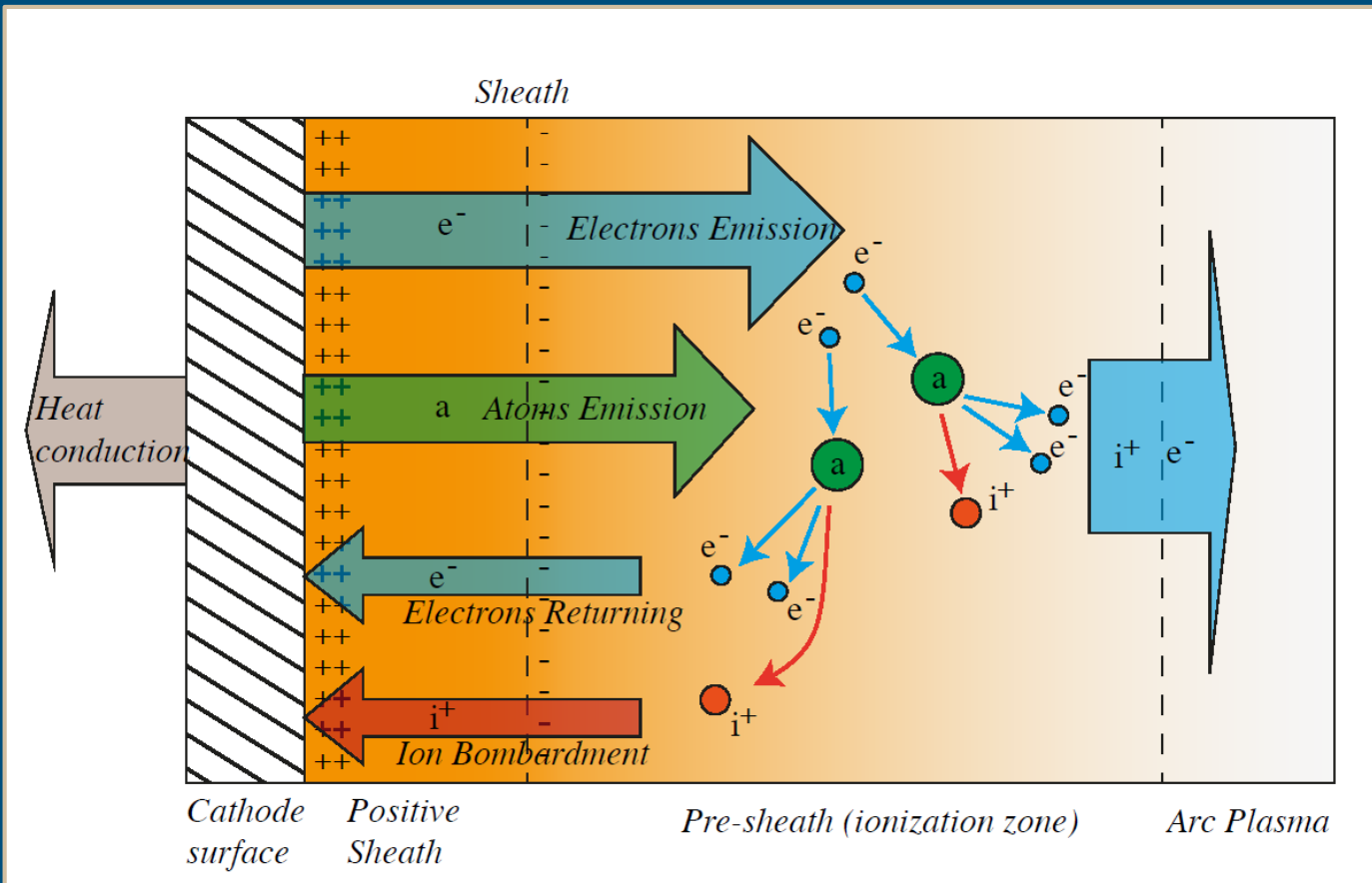


Thruster Head Components



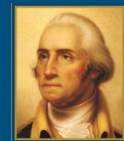


How It Works





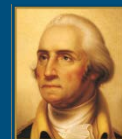
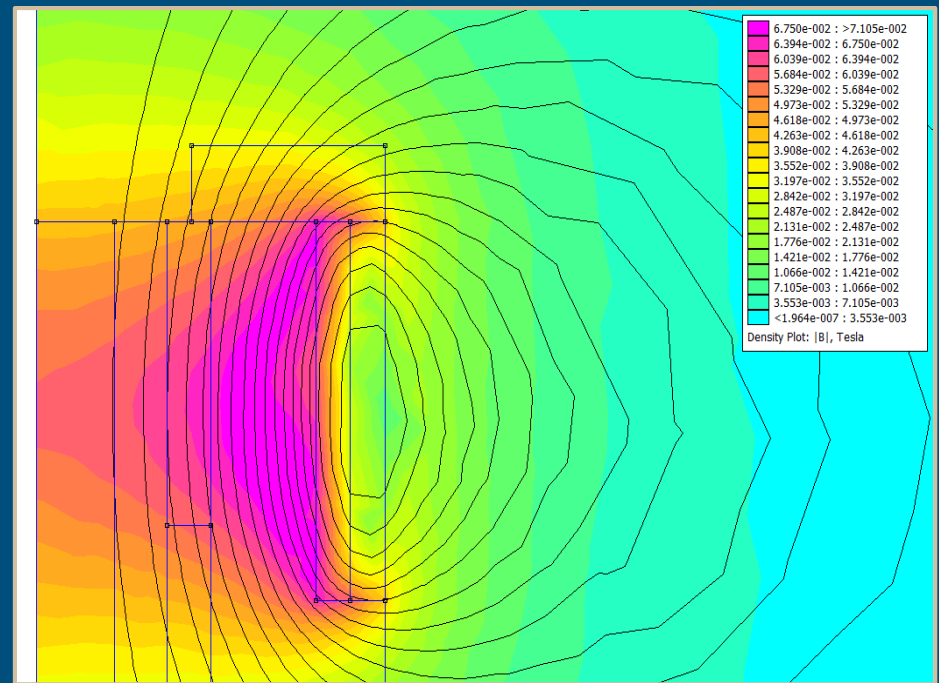
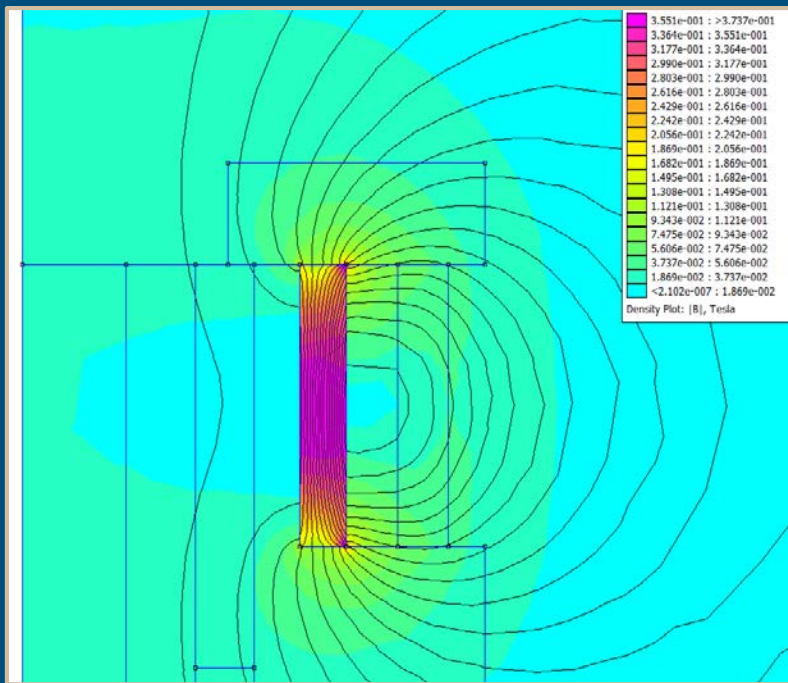
Arc Discharge – 20 Hz



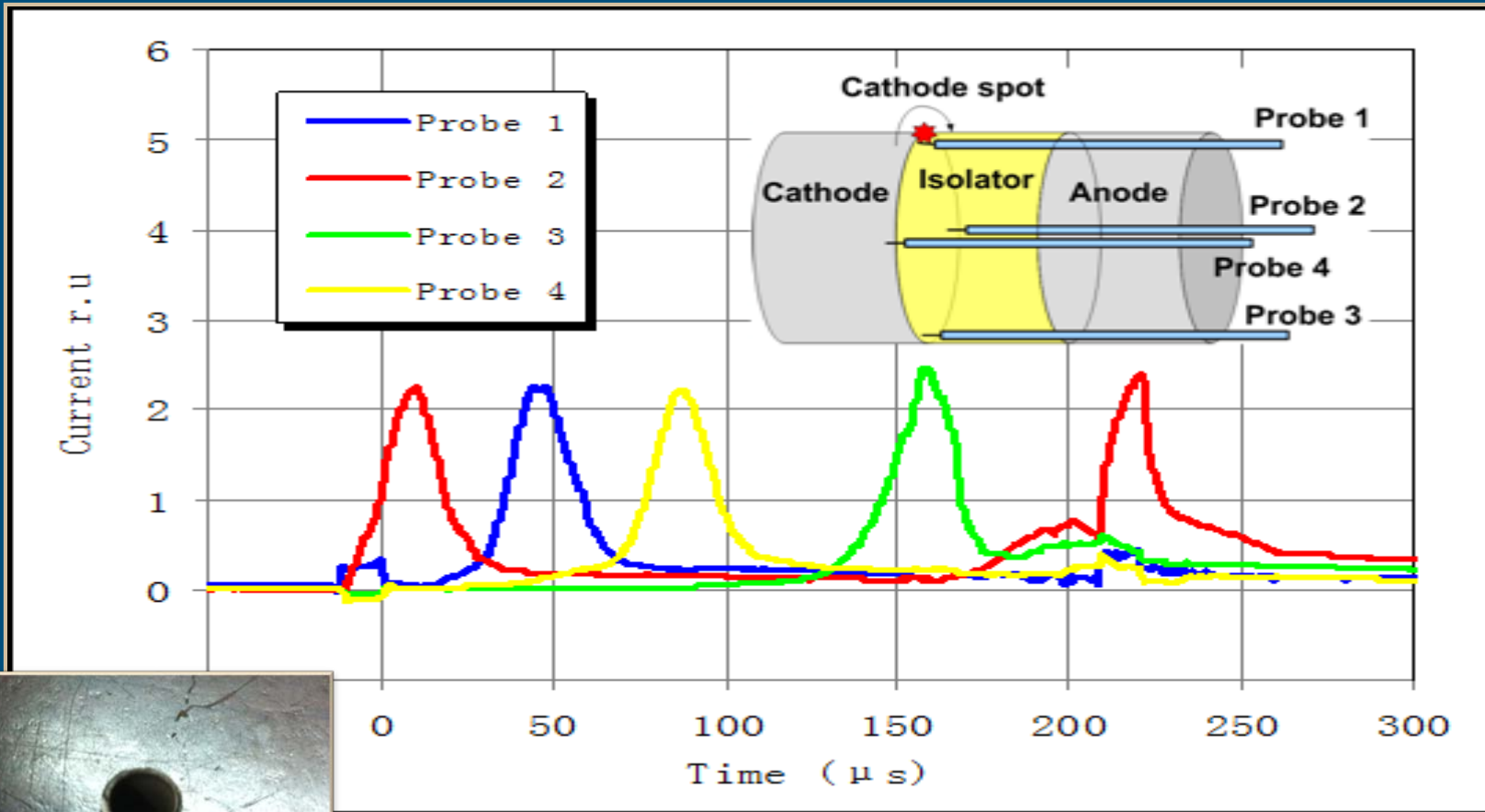


Magnetic Field

- Without and with a magnetic field

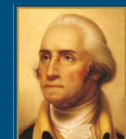
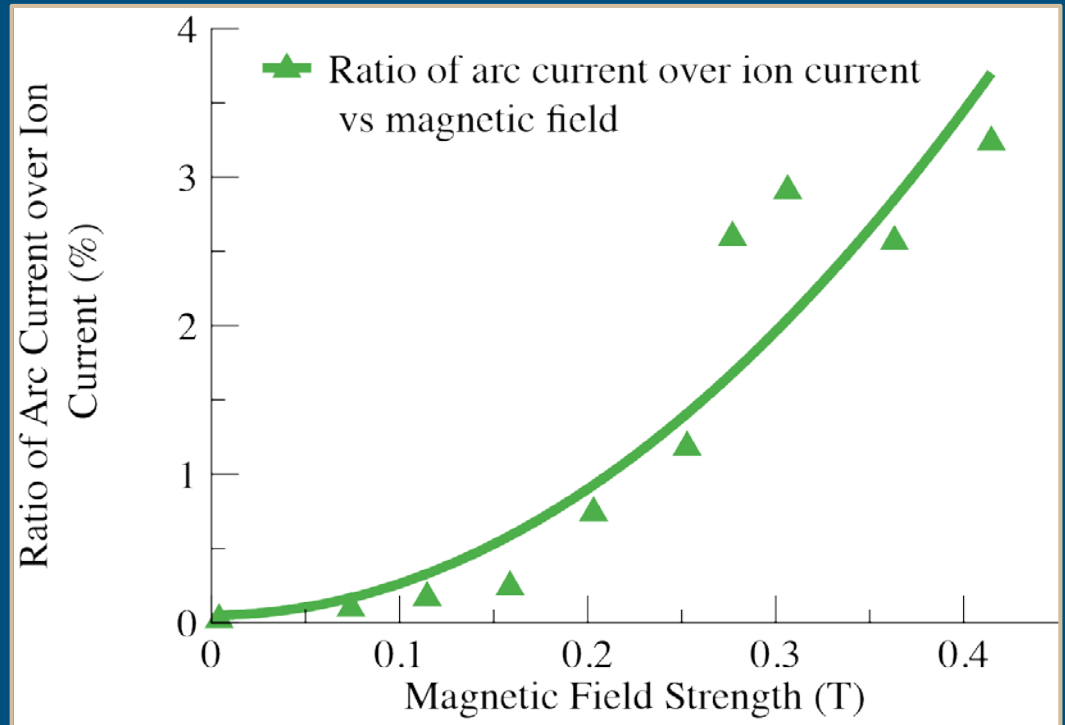
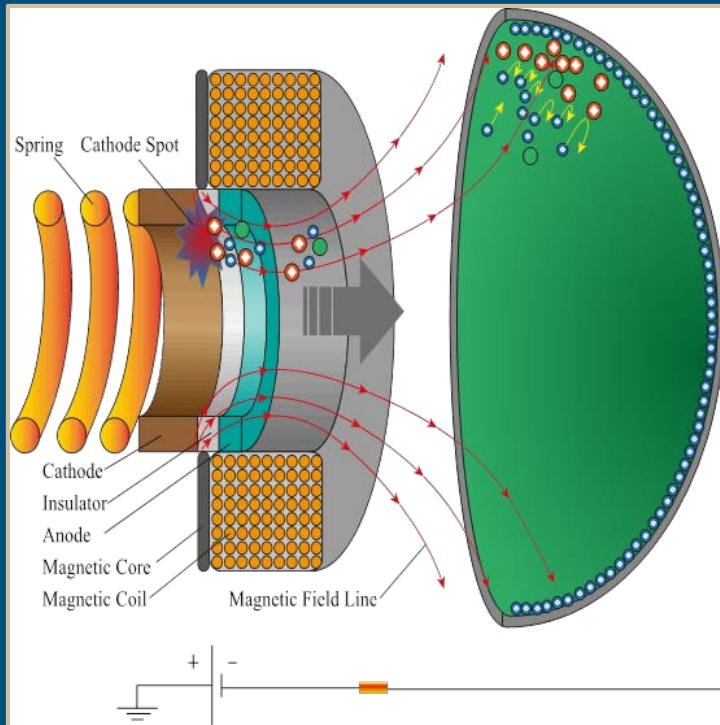


Uniform Erosion



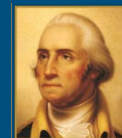
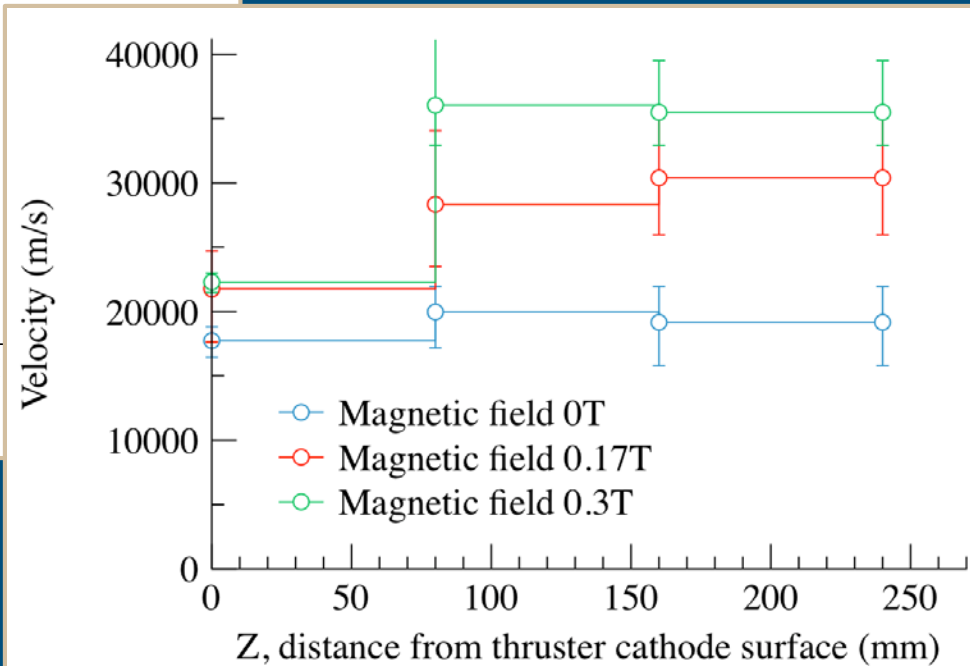
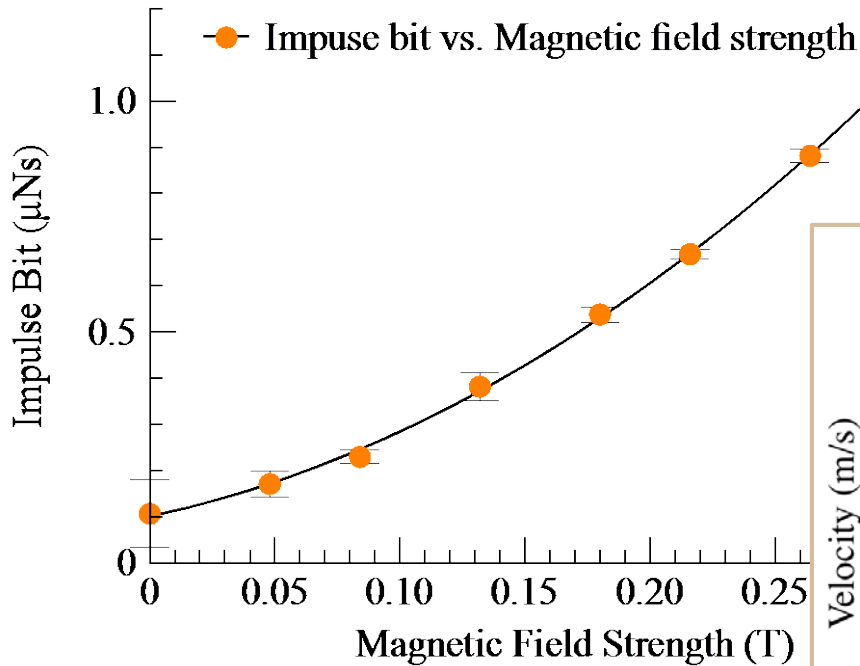


Ion Current





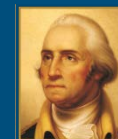
Impulse Bit and Velocity





Development

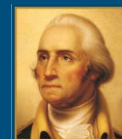
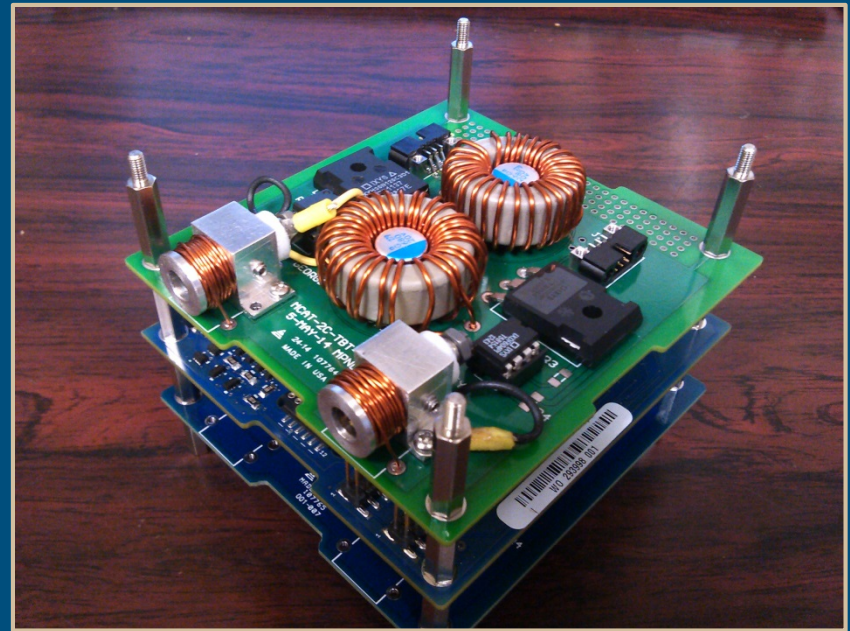
- **Left to Right:**
 - μ CAT Concept, Generation I, Generation III





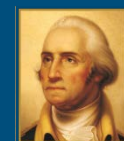
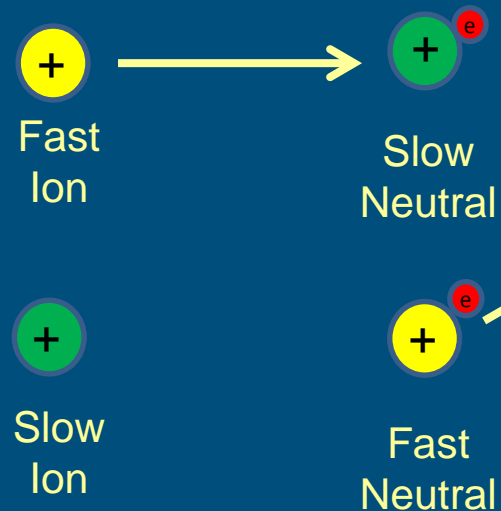
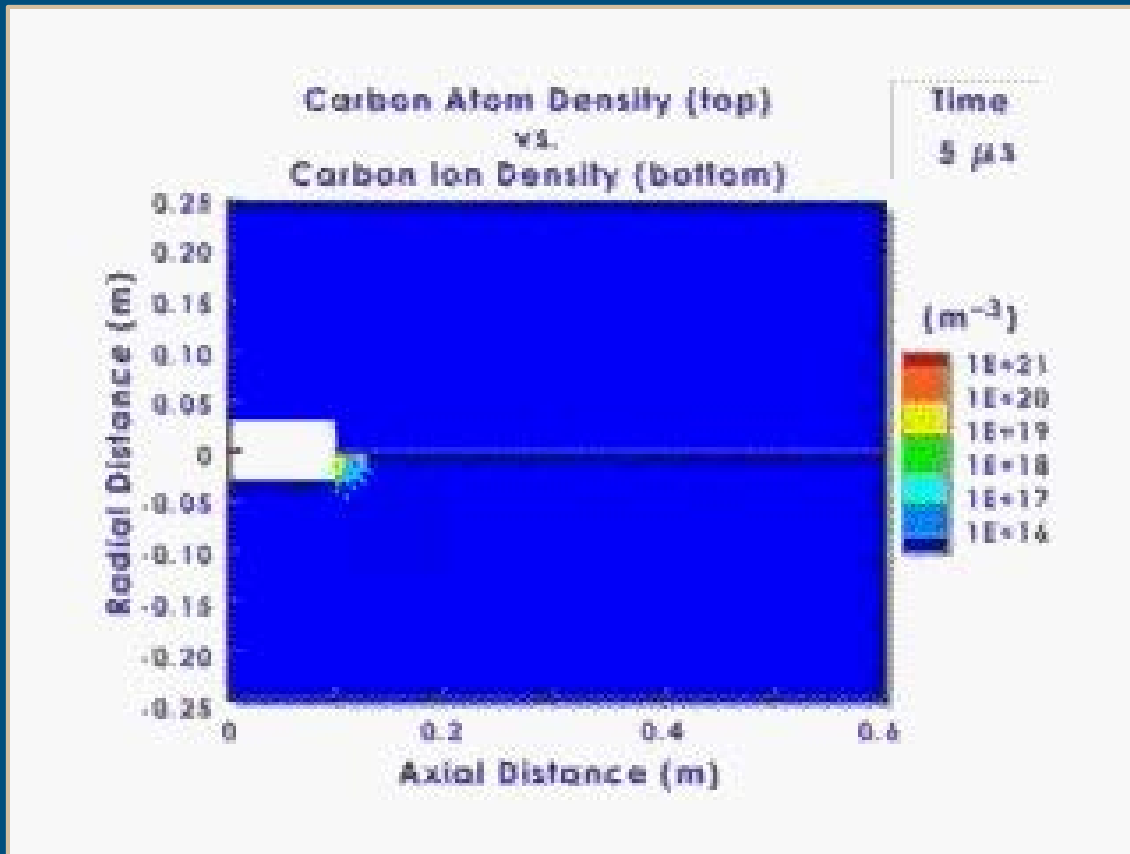
Subsystem Properties

- **Impulse bit:**
 - 1 mN-s/pulse
- **Operating Frequency:**
 - 1 - 50 Hz
- **Specific Impulse (I_{sp}):**
 - 2000 - 3000 s
- **Avg. power/pulse:**
 - < 0.1 Watts
- **Thrusters + PPU mass:**
 - < 150g





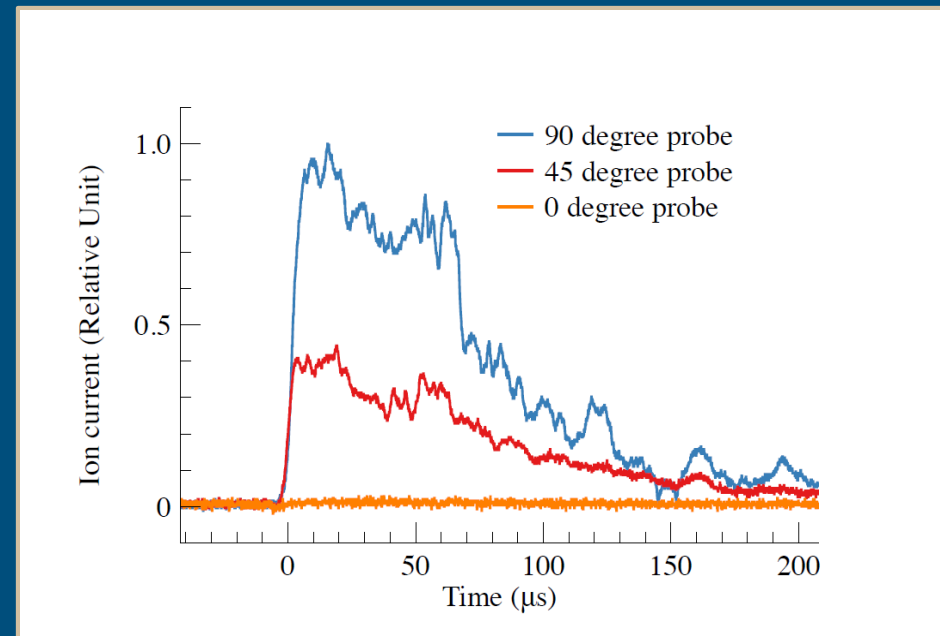
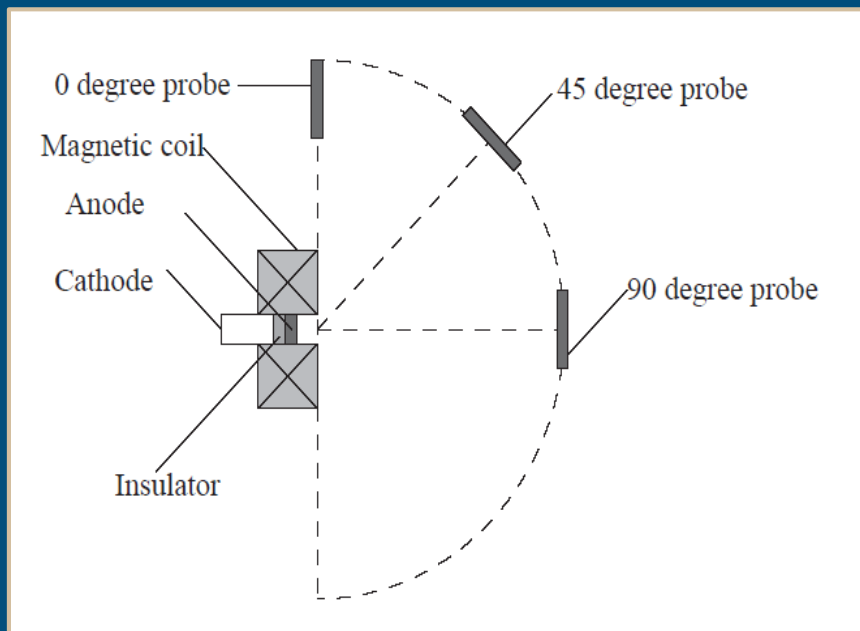
Contamination





Contamination

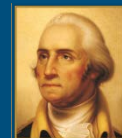
- Experimental setup and results





Current Developments

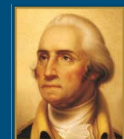
- **Single bus operation**
- **Component miniaturization**
- **Mass reduction**
- **Array/cluster operation**
- **EMI and RFI investigation**



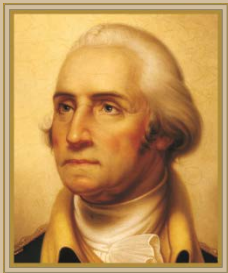


Conclusions

- Scalable electric propulsion
- Mission customizable
- No contamination
- Compact propulsion option for CubeSats
- Researching further optimizations



Questions?



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