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

Presented By: Joseph Lukas

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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
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Solid Propellant
Micro-Cathode Arc Thruster (μCAT)

- Generation III
Thruster Head Components
How It Works
Arc Discharge – 20 Hz
Magnetic Field

• Without and with a magnetic field
Ion Current

Ratio of Arc Current over Ion Current vs magnetic field

- Magnetic Field Strength (T)
- Ratio of arc current over ion current (%)
Impulse Bit and Velocity

- Impulse Bit vs. Magnetic field strength

- Magnetic field 0T
- Magnetic field 0.17T
- Magnetic field 0.3T

Z, distance from thruster cathode surface (mm)
Development

- Left to Right:
  - μCAT Concept, Generation I, Generation III
Subsystem Properties

- **Impulse bit:**
  - 1 mN-s/pulse

- **Operating Frequency:**
  - 1 - 50 Hz

- **Specific Impulse (Isp):**
  - 2000 - 3000 s

- **Avg. power/pulse:**
  - < 0.1 Watts

- **Thrusters + PPU mass:**
  - < 150g
Contamination

- Fast Ion
- Slow Ion
- Fast Neutral
- Slow Neutral
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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