SmallSat Propulsion Activities at NASA Glenn Research Center

Presented by Eric Pencil
NASA Glenn Research Center

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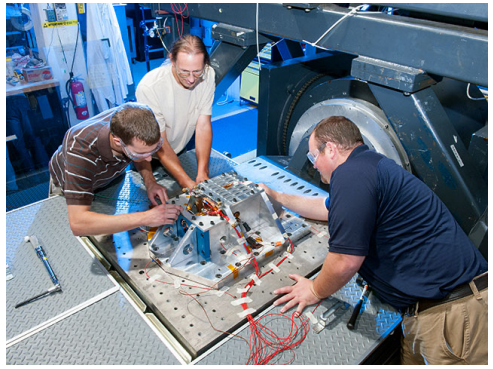
NASA Glenn SmallSat Test Facilities

- **Electric Propulsion Research Building:**
  - Multiple intermediate EP Vacuum Facilities (VF-1, 3, 7, 11, 16)
    Cathode, Medium Power Electric Propulsion, Electrostatic propulsion, Micropropulsion thrust stand
  - Multiple bell jar EP component Vacuum Facilities/Bell Jars
    Cathode, Low Flow Propulsion, Hollow cathode
  - Thermal Vacuum Facility
- **Electric Propulsion and Power Laboratory:**
  - Two Large EP Vacuum Facilities (VF-5, 6)
  - Multiple Intermediate EP Vacuum Facilities (VF-8, 12, 56)
    - Spacecraft interactions, EP System integration
- **Structural Dynamics Laboratory**
  - Environmental Testing
    Sinusoidal vibration (sweep, dwell, chirp, burst), random vibration, shock
  - Structural Characterization Testing
    Resonant Frequency/mode shapes, structural damping, component interface environments

EP Test Operation in EPRB test cell



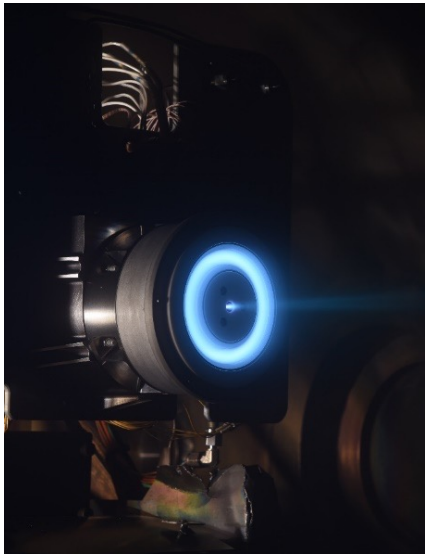
Technicians configure a test setup in SDL

NASA POC: Ernest Williams, ernest.t.williams@nasa.gov

Recent NASA GRC Smallsat Electric Propulsion Test Activities

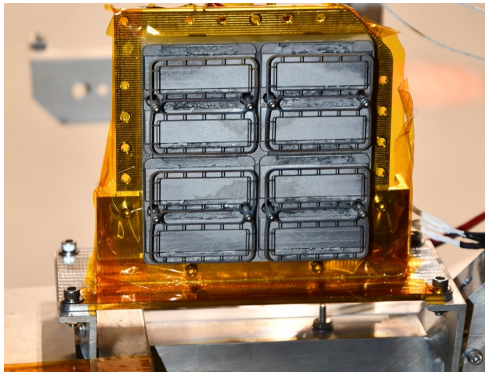
Northrop Grumman NGHT-1X Hall Thruster

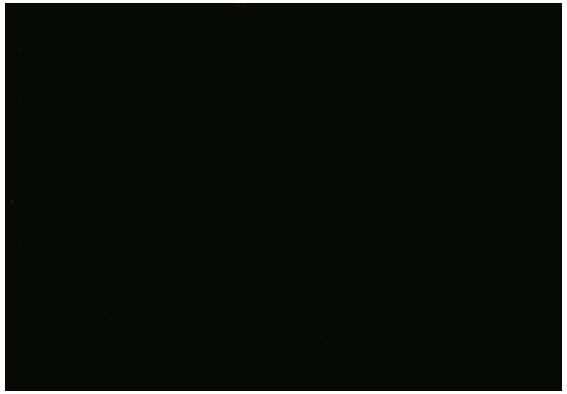
- Licensed GRC technology to achieve >2 MN-s total impulse for GEO / deep space missions and maneuvering without regret
- Completed integrated system tests with long duration wear testing still ongoing; qual and flight acceptance testing in FY25



Benchmark Xantus Metal Plasma Thruster

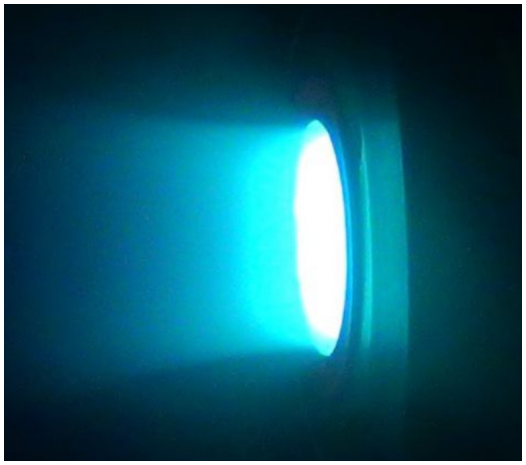
- Impulse testing to support flight applications
- Adaptive firing demo for smoother thrust output





Phase Four Maxwell RF Plasma Thruster

- Life characterization testing
- Thruster design refinements based on test data and lessons learned



GRC POCs

- Programmatics: Eric.Pencil@nasa.gov
- Testing: Thomas.M.Liu@nasa.gov
- NGHT-1X: Gabriel.F.Benavides@nasa.gov
- Xantus: Hani.Kamhawi-1@nasa.gov
- Maxwell: Robert.E.Thomas@nasa.gov

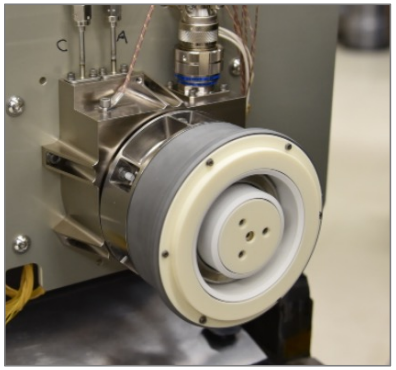
High delta-V, Sub-kW Electric Propulsion System (SSEP)

Project Purpose:

- Address small spacecraft electric propulsion technology gaps and improve reliability for deep space applications
- Collaborate with industry to standardize processes, lower cost, and commercialize advanced technologies

Status:

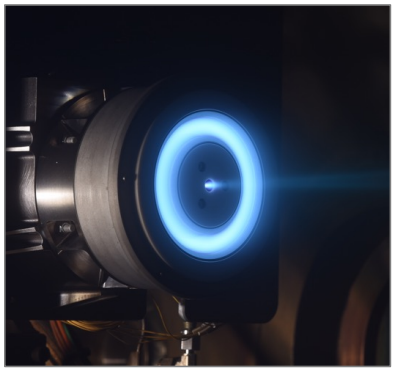
- NASA has developed a high delta-V, sub-kW electric propulsion system (thruster, PPU, and flow control) appropriate for small spacecraft (200-500 kg s/c) missions to the moon, Mars, or beyond
- Northrop Grumman (NG) has licensed and commercialized the technology as the NGHT-1X
- NGHT-1X flight qualification anticipated completed in March 2025
- NG Mission Extension Pod (MEP) satellite servicing spacecraft start launching in 2026 using pairs of NGHT-1X



Northrop Grumman NGHT-1X thruster based on NASA licensed technology.

Capability:

• Nominal PPU power input:	650 → 1,100 W	*extended range 250 → 1,100 W*
• Specific Impulse:	1,500 → 1,700 s	*extended range 1,400 → 1,800 s*
• Total Impulse:	> 2 MN-s	(1.9 mN-s demonstrated to date, life test continues)
• Cycle Life:	> 4,500 cycles	
• Delta-v:	7 → 8 km/s	(depending on available power)
• Lifetime:	7 years (GEO)	>7 years (deep space or LEO)



NGHT-1X operating in NASA GRC Vacuum Facility 8.

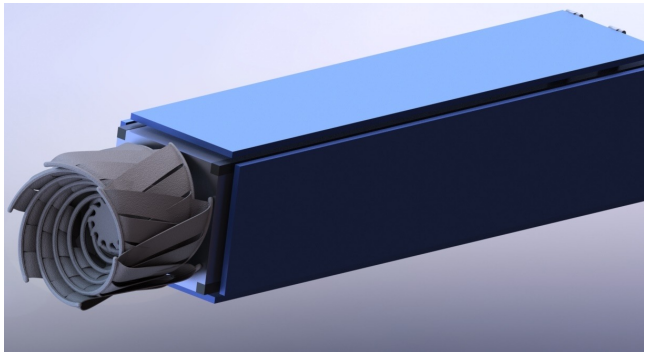
Science & Exploration Applicability:

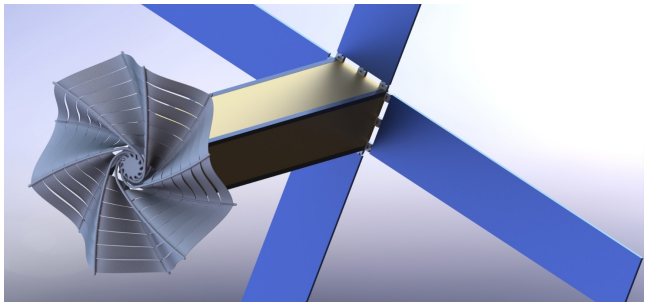
- Low-cost science and exploration small spacecraft missions (moon, Mars, or beyond)
- ESPA-class spacecraft for near-Earth high delta-v national security, commercial, and scientific applications

NASA POC: Dr. Gabriel F. Benavides, gabriel.f.benavides@nasa.gov

Passive Thermally Deployed Shape-Memory Alloy Heat-Pipe Radiators for High-Intensity Small Satellites

- Demonstrate Additively Manufactured (AM) Nickel-Titanium (NiTi) radiators with integral wicking heat pipe networks.
- NiTi shape-memory alloy:
  foldable (origami) geometry that will passively deploy from stowed form
- STMD Small Spacecraft Technology project
  - University Strategic Technology Project (USTP) collaboration with Penn State University
- Goals:
  - High deployed-to-stowed area ratio
  - Lower areal density
  - Low thermal resistance





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