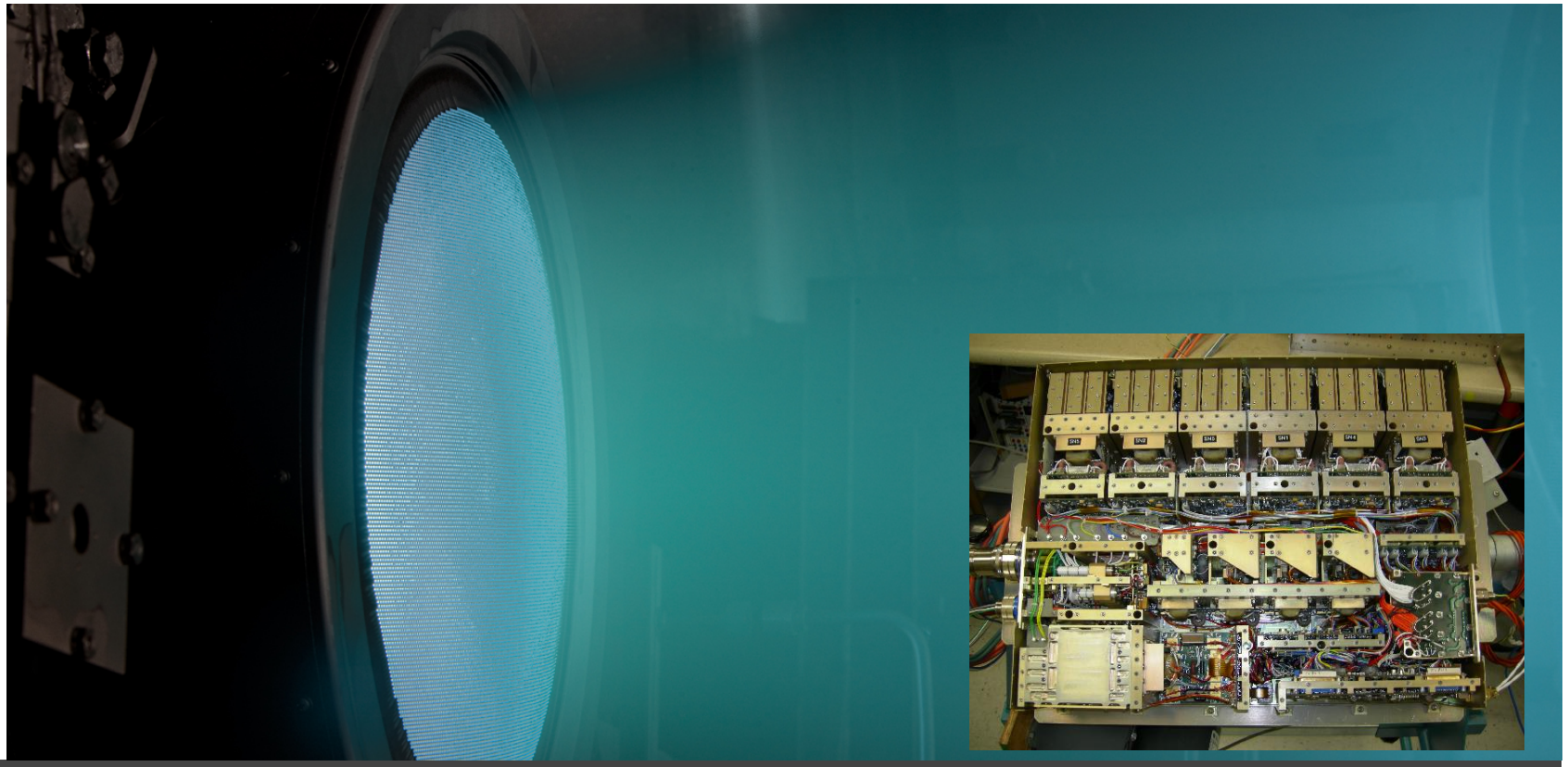


NEXT Thrusters & Power Processing Units

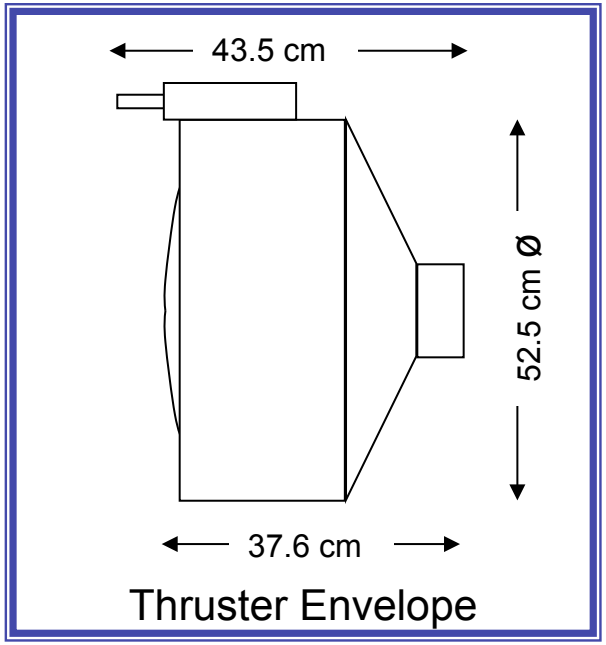
Scott W. Benson, NASA Glenn Research Center
Discovery Technology Day
April 9, 2014

NEXT GFE Project Approach

- PSD considering providing 2 NEXT thrusters and 2 NEXT Power Processing Units (PPU) as GFE to Discovery
- NASA GRC is formulating a possible procurement to complete development of the PPU to TRL6 and to provide PPU and thruster flight hardware
  - Industry Day held in December with substantial industry attendance
  - RFI issued with multiple positive responses received
- As described in RFI, NASA GRC is pursuing a cost-shared development that results in dual-use of the NEXT thruster and PPU technologies
- If a mission using NEXT is not selected, GFE hardware would be preserved for future PSD mission use

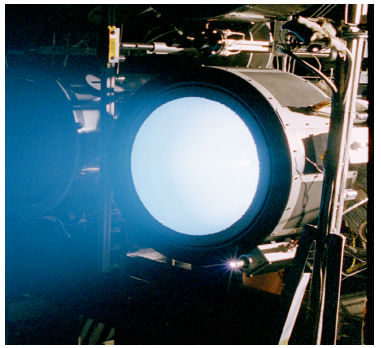
There is no explicit or implied commitment for future procurements in this presentation.

NEXT Thruster Characteristics



Thruster Envelope

- Thruster characteristics and capabilities established with high-fidelity Prototype Model (PM) unit
- Extended Throttle Levels test-demonstrated and in definition
  - Provides higher thrust-to-power capability


PM1 Thruster

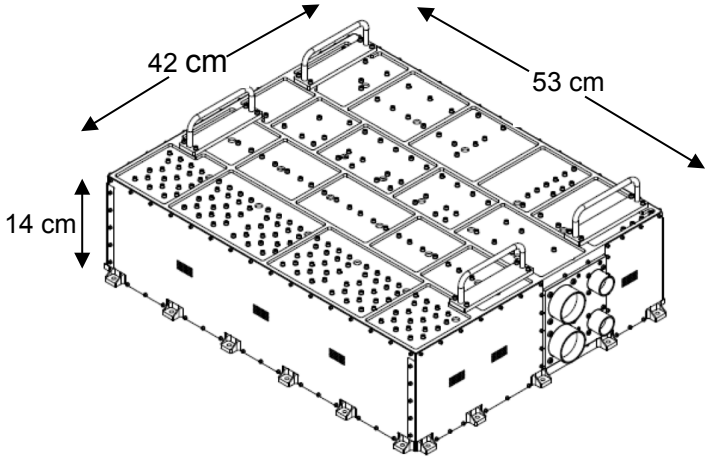
Performance Characteristics	
Thruster Power Range, kW	0.5-6.9
Max. Specific Impulse, sec	4190
Thrust, mN	26-236
Max. Thruster Efficiency	71%
Max. Beam Current, A	3.52
Max. Beam Voltage, V	1800
Mass (with harness), kg	13.5

Lifetime Capability
- Thruster long duration test voluntarily terminated in March 2014, fully functional over throttling range
  - 918 kg demonstrated xenon throughput
  - 51,184 hr of operation
  - 35.5 MN-sec total impulse
- >600 kg throughput capability after applying 1.5x qualification factor
- Thruster lifetime margin for missions using > 400 kg throughput should be determined through analysis of a specific mission throttle profile

NEXT PPU Characteristics

- PPU GFE procurement allows for further development of existing design or new path based on demonstrated design
- Characteristics of existing design shown
  - Planning values for consideration only

Performance Characteristics		
	Existing	Planning
Input Power Range, W	630 - 7240	700 - 7375
Peak Efficiency	95%	93%
Conducted Waste Heat, W_T	75 - 340	160 - 520
Primary Power Input Voltage, V	82 - 160	TBD
Housekeeping Input Bus, V	28	28
Housekeeping Power, W	16 - 28	16 - 33
Mass, kg	33.9	+20% MGA
Power Output to Single Thruster		



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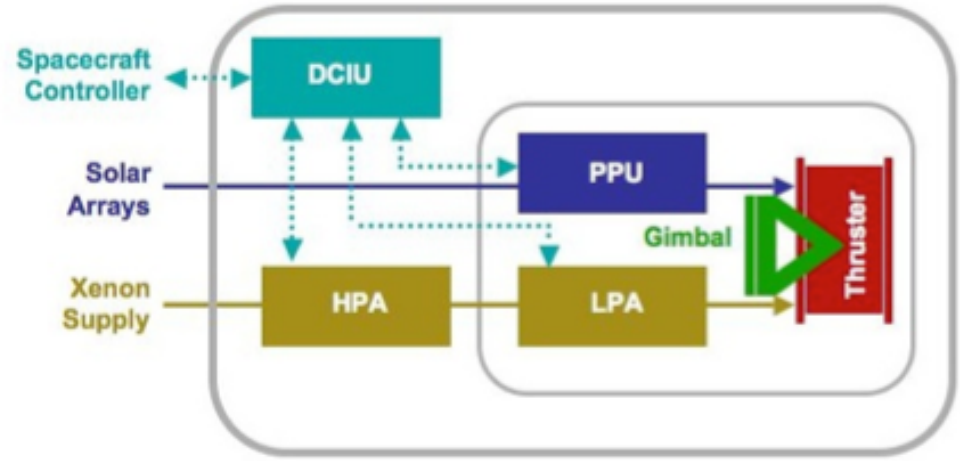
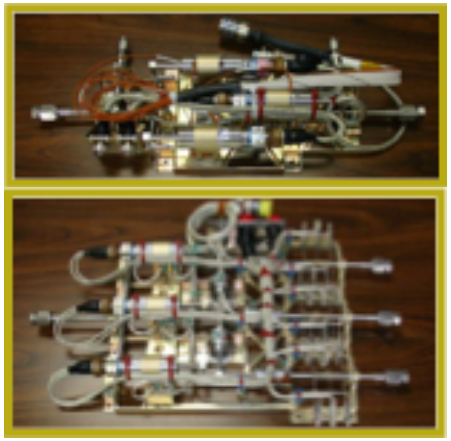
NEXT Implementation

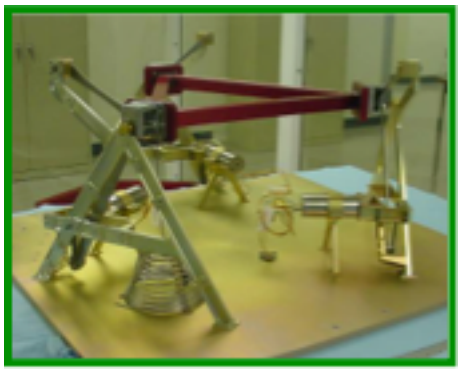
- NEXT-based ion propulsion system (IPS) for Discovery
  - Thruster & PPU GFE
  - IPS architecture to be defined by mission
  - Xenon Feed System, Gimbal and Control Interface to be provided within PI-cost
- NEXT technology project also developed;
  - Xenon feed system – TRL 6
  - Gimbal – TRL 5
  - DCIU simulator



DCIU – Digital Control Interface Unit
HPA – High Pressure Assembly
LPA – Low Pressure Assembly



HPA/LPA – Aerojet-Rocketdyne



Gimbal– ATK

TRL Status

- Four independent TRL assessments of NEXT technology
- Thruster: TRL 6 (3 of 4)
  - Prototype Model unit
  - Performance and Functional demonstration, alone and in IPS
  - Thermal characterization and qual-level thermal-vac testing
  - Qual-level vibration testing on NEXT gimbal
  - Lifetime demonstration by test and modeling
- PPU: TRL 4 (3 of 4)
  - Engineering Model unit
  - Performance and Functional demonstration, alone and in IPS
  - Operations in ambient and vacuum across a range of allowable flight temperatures
  - Component failures prevented completion of qual-level environmental testing

Development Schedule

- GFE hardware procurement preparations in progress
- Target schedule:
  - Contract award: October 2014
  - Development phase complete: September 2016 (prior to target date for mission selection)
    - PPU at TRL 6
    - Any design updates to thruster formalized
  - Flight hardware delivery by June 2018
    - PPU and thruster hardware deliveries not necessarily tied together

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AO Library Content

- Anticipated AO Library Content
  - Detailed thruster characteristics
  - Baseline throttle table
  - Extended throttle table and supporting information
  - Detailed PPU characteristics (existing design)
  - PPU development planning (to be updated as procurement is formalized)
  - Thruster and PPU requirements
  - Thruster and PPU interface definition
  - Control functionality guidance

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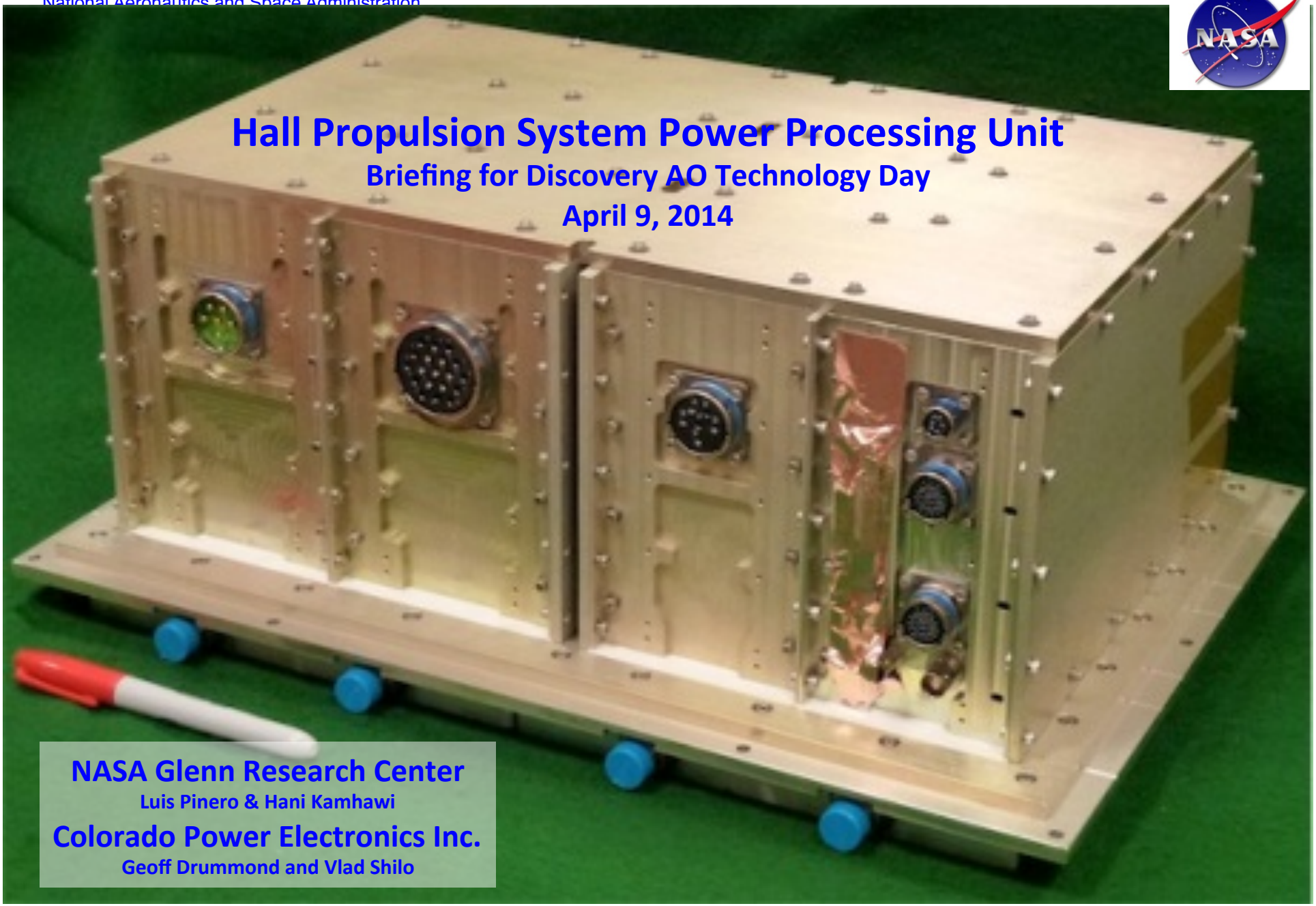
Contact Information

- GRC Project Manager:
  - Scott W. Benson/GRC, 216-977-7085, Scott.W.Benson@nasa.gov



Hall Propulsion System Power Processing Unit

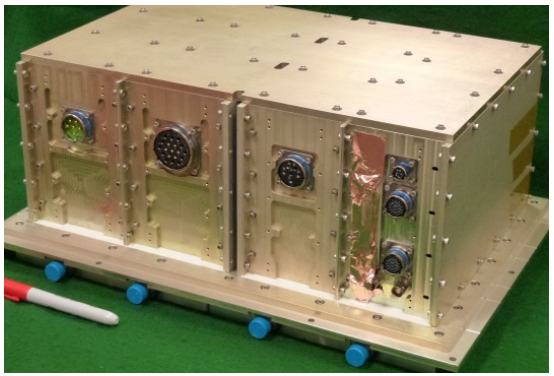
Briefing for Discovery AO Technology Day

April 9, 2014

NASA Glenn Research Center
Luis Pinero & Hani Kamhawi
Colorado Power Electronics Inc.
Geoff Drummond and Vlad Shilo

Hall Propulsion Power Processing Unit

- PSD's In-Space Propulsion Technology (ISPT) Program has been working with a promising SBIR project to develop a low-cost 4.5-kW class wide output range Hall Power Processing Unit (PPU) for Discovery-class planetary missions.
  - Colorado Power Electronics (CPE) has successfully developed a PPU and is poised to take the design to flight certification (TRL 6+) by September 2016.
  - QM PPU will incorporate control electronics for the PPU power modules, VACCO TRL 7 xenon feed system, and thruster/PPU telemetry.
  - CPE has submitted a cost proposal and NASA programs have committed funding to start the effort by next month.



- Designed to operate several Hall thrusters:
  - NASA's High Voltage Hall Accelerator (HIVHAC), Aerojet-Rocketdyne XR-5 (BPT-4000), Space Systems Loral SPT-140.
  - Thruster acquisition and Hall propulsion system development to be addressed by mission proposal teams.

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Schedule a 1-on-1 session or contact GRC POC for more info.