the FUTURE is NEXT in Ion Propulsion

NASA's Evolutionary Xenon Thruster (NEXT) project is developing next generation ion propulsion technologies under the aegis of NASA's Science Mission Directorate In-Space Propulsion Program, implemented by the Marshall Space Flight Center. NEXT will produce engineering model system components that will be validated (through qualification-level and integrated system testing) and ready for transition to flight system development.

Scope of the Project

NEXT is an integrated project comprised of several elements:

- *A next generation ion thruster project.* NEXT combines the best elements of NSTAR with cutting-edge design to yield a thruster with unparalleled specific impulse, specific mass, and life capability.
- *A power processing unit (PPU) project.* By combining NSTAR topologies with an advanced modular beam supply, the PPU will be highly efficient over a broad throttle range, with a much lower specific mass. The NEXT PPU can supply both NEXT and NSTAR thrusters, which permits hybrid configurations that can take advantage of NSTAR's low-power performance.
- *A xenon feed system project.* The NEXT propellant management system (PMS) uses Proportional Flow Control Valves to maintain tight flow control capability, reduce end-of-mission propellant residuals, and significantly reduce mass and volume. This design will be directly applicable to other electric propulsion systems, including NSTAR-based systems.
- *An ion propulsion system validation project.* NEXT will validate system components in a wide range of configurations by testing in single- and multi-string configurations. NEXT will also demonstrate such key elements as system control algorithms (through a hardware/software-based control unit simulator) and a breadboard thruster gimbal.
- *A flight readiness project.* NEXT is building on the strengths of NSTAR, conducting validation tests to flight qualification levels, and iterating proven engineering model designs. A variety of redundancy approaches will meet mission needs without violating system validation.

Performance characteristics of NEXT vs. NSTAR SOA.

	NEXT	NSTAR SOA
Thruster Power Range, kW	0.5-6.9	0.5-2.3
Max. Specific Impulse, sec	>4100	>3100
Max. Thrust, mN	236	92
Max. Thruster Efficiency	>70%	>61%
Max. PPU Efficiency	95%	>92%
PPU Specific Mass, kg/kW	3.6	5.5
PMS Single-String Mass, kg	6.3	11.4
PMS Unusable Propellant Residual	1.00%	2.40%

Beyond State-of-the-Art (SOA)

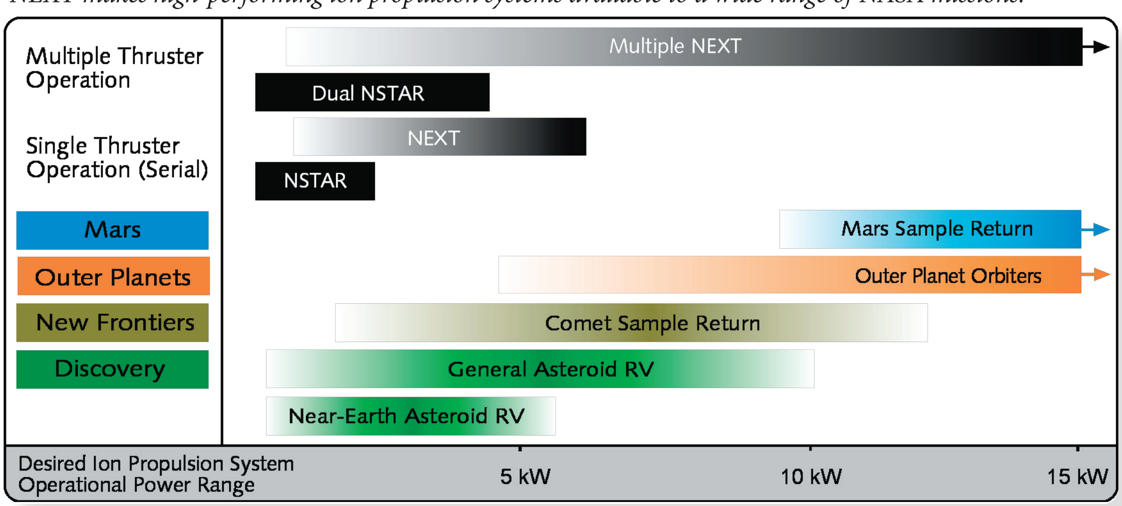
The NEXT components and thruster system are a giant step beyond NSTAR:

- NEXT thruster performance exceeds single or multiple NSTAR options over most of the thruster input power range. Higher efficiency and specific impulse, and lower specific mass, will reduce the wet propulsion system mass and part count.
- NEXT thruster Xenon propellant throughput is more than twice NSTAR's, so fewer thrusters are needed.
- NEXT PPU and PMS technology provides mass and performance benefits vs. NSTAR.

NEXT's Customers

NEXT is appropriate for a wide range of solar system exploration missions, as well as civil/commercial applications. NEXT offers Discovery, New Frontiers, Mars Exploration and outer-planet missions a larger deliverable payload mass and a smaller launch vehicle size. And NEXT is designed to support solar-powered spacecraft, with deep throttling to accommodate changes in input power over the mission trajectory.

NEXT makes high-performing ion propulsion systems available to a wide range of NASA missions.



John H. Glenn Research Center
at Lewis Field

The Future of NEXT

Phase 1 of the NEXT project was completed in August 2003. At that time, engineering model thrusters, a breadboard PPU, and a breadboard feed system were fabricated and validated in component-level and single-string integrated system tests. A 2000-hour thruster test—completed in October 2003—provided insight into thruster wear mechanisms that will be factored into the final design.

Phase 2—October 2003 to 2007—will advance the technology maturity of the thruster, PPU, and PMS designs demonstrated in Phase 1. The prototype model (PM) thruster and engineering model PPU and PMS (with component, subsystem, and system-level testing) will achieve most of the criteria associated with Technology Readiness Level 6.

The highlight of Phase 2 will be integrated system testing in both single-string and three-string modes.

Thruster

The engineering model thruster design will be advanced to the prototype model stage by Aerojet. The design and analysis of qualification-level hardware will include full thermal and structural analyses, design for producibility to minimize thruster recurring costs, and reduced mass. Two PM thrusters will be assembled to support thruster-level performance and environment testing and integrated system testing.

Prototype Model Thruster Inspection

Power Processing Unit

The L3 Comm Electron Technologies Engineering Model PPU design will incorporate flight packaging and associated thermal, vibration, and electromagnetic interference environmental testing. The EM PPU will include an input/output module that will connect to the Digital Control Interface Unit (DCIU) Simulator, which will control the ion propulsion system. The Phase 1 breadboard PPU will be modified similarly, thus providing a second fully functional unit for integrated system testing.

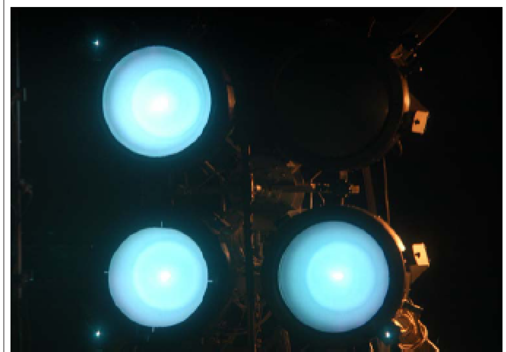
Propellant Management System

Aerojet will fabricate multiple high-pressure and low-pressure assemblies. This will permit the EM PMS to support single-string and three-string system integrated testing. One of each assembly will be fabricated using flight-equivalent components to support tests associated with spacecraft propulsion system development: qualification-level functional/performance, thermal-vacuum, and vibration.

System Integration

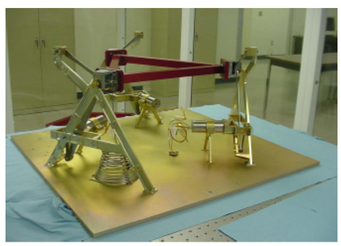
JPL will fabricate a breadboard gimbal in Phase 2 to demonstrate the technical approach and its compatibility with the ion propulsion system. The thruster/gimbal assembly will undergo random vibration testing to validate the thruster and lightweight gimbal design. The DCIU Simulator will be expanded in Phase 2 to include control of both PMS and the PPUs. The highlight of Phase 2 will be integrated system ground demonstration in both single-string and three-string modes. Single-string testing will focus on demonstrating functional and performance requirements of the system. The three-string testing will investigate environments and performance to determine if interactions take place between operating units and if operating units affect non-operating units.

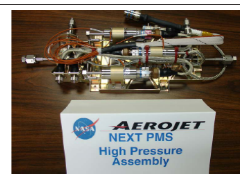
Three NEXT EM Thrusters at full power in Multi-Thruster Array Test.

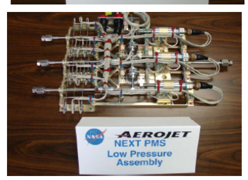


Life Validation

Life validation of the NEXT system will be achieved through a combination of test and analysis. Thruster life will be assessed through a life test of an EM thruster—configured with critical PM thruster components—in which a minimum of 185 kg of Xenon will be expended. Component-level tests and detailed thruster modeling and analysis will also be performed. PPU and PMS component and subsystem life will be validated through analyses.







NEXT Breadboard Gimbal and EM PMS assemblies have been completed.

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