NASA's Evolutionary Xenon Thruster (NEXT)

In-Space Propulsion Technology Project

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 Technology Project. NEXT is producing engineering model system components that will be validated (through qualification-level and integrated system testing) and ready for transition to flight system development.

NEXT's Customers

NEXT is appropriate for a wide range of solar system exploration missions, as well as other NASA science applications. NEXT offers Discovery, New Frontiers, Mars Exploration and outer-planet missions more science by reaching difficult destinations using less propellant. NEXT may also shorten the mission trip time by avoiding the multiple planet fly-bys that chemical propulsion spacecraft need for a boost.

Scope of the Project

NEXT is an integrated project comprised of several elements:

Next generation ion thruster technology

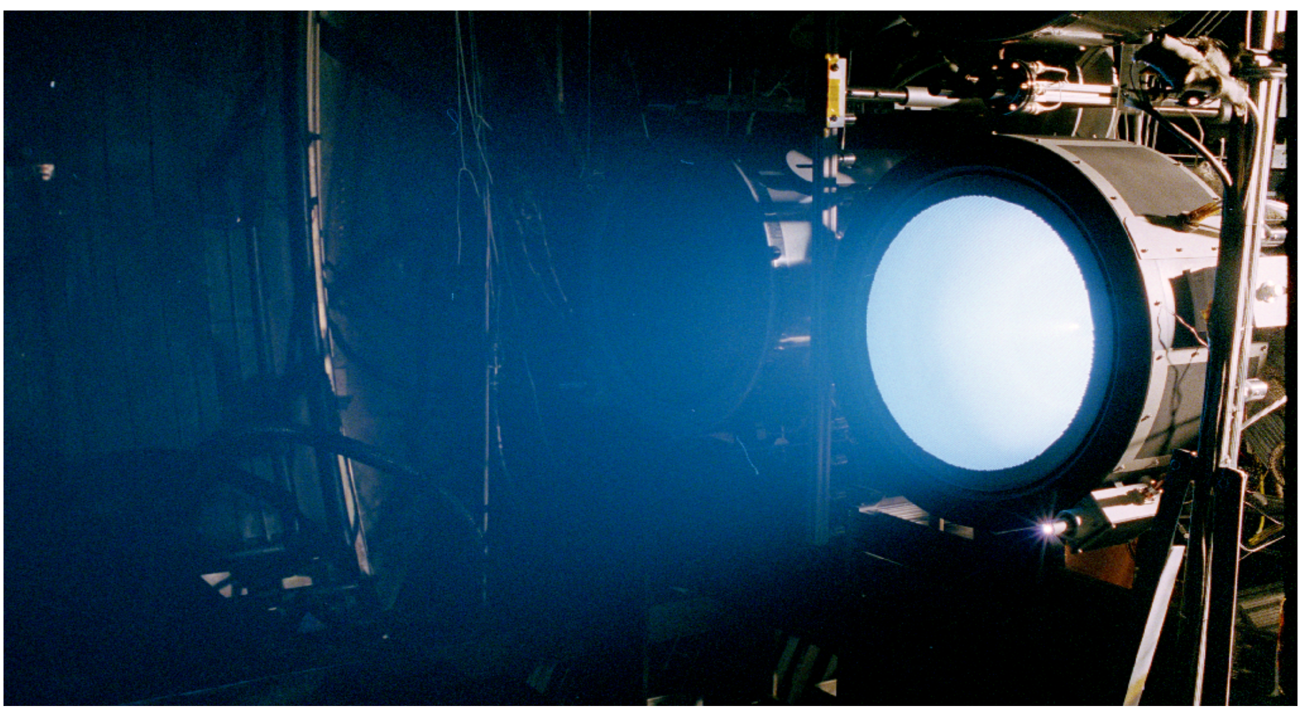
NEXT combines the best elements of NSTAR with cutting-edge design to yield a thruster with unparalleled specific impulse, throttling range, specific mass, and life capability.

Power processing unit (PPU) technology

By combining NSTAR topologies with an advanced modular beam supply, the PPU will be highly efficient over a broad throttle range, with a lower specific mass.

Xenon feed system technology

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. The use of modular feed system assemblies will greatly simplify the job of integrating the feed system with the spacecraft

Ion propulsion system validation

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.

Flight readiness preparation

NEXT is building on the strengths and lessons learned of NSTAR, conducting validation tests to flight qualification levels, and iterating proven engineering model designs.

Beyond State-of-the-Art (SOA)

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

- 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 that of NSTAR, so fewer thrusters are needed.
- NEXT PPU and PMS technology provides mass, volume and performance benefits over NSTAR.

The Future of NEXT

The first phase of the NEXT project was completed in 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 provided insight into thruster wear mechanisms that were factored into the final design.

The second project phase has advanced 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 in time for anticipated mission decisions.

Thruster

The engineering model thruster design has been advanced to the prototype model stage by Aerojet. Design and fabrication of one PM thruster has been completed. Full performance, thruster has been successful, completing the validation of the design.

Life validation of the NEXT thruster is being achieved through a combination of test and analysis. Thruster life is being characterized through a long duration test of an EM thruster configured with critical PM thruster components. The on-going test and supporting analyses indicate that the NEXT thruster has demonstrated a xenon throughput of over 900 kg, which is over 3 times the mission-based requirement of 300 kg.

Power Processing Unit

The L3 Comm Electron Technologies Engineering Model PPU development incorporates flight packaging and associated thermal, vibration, and electromagnetic interference environmental testing. The EM PPU has been completed and is in the test validation process.

Propellant Management System

Aerojet has fabricated 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 was fabricated using flight-equivalent components and successfully subjected to the tests associated with spacecraft propulsion system development: qualification-level functional/performance, thermal-vacuum, and vibration.

System Integration

JPL, working with ATK (formerly Swales Aerospace), has fabricated a breadboard gimbal to demonstrate the technical approach and its compatibility with the ion propulsion system. Gimbal validation was highlighted by the successful thruster/gimbal vibration testing. The highlight of Phase 2 is an integrated system ground demonstration in both single-string and three-string modes. Single-string testing focuses on demonstrating functional and performance requirements of the system. Three-string performance testing has been completed, showing that performance and environmental interactions between operating units are insignificant.

For more information about NASA's Evolutionary Xenon Thruster (NEXT) and the In-Space Propulsion Technology Project, visit:
http://spaceflightsystems.grc.nasa.gov/SSPO/ISPTProg/