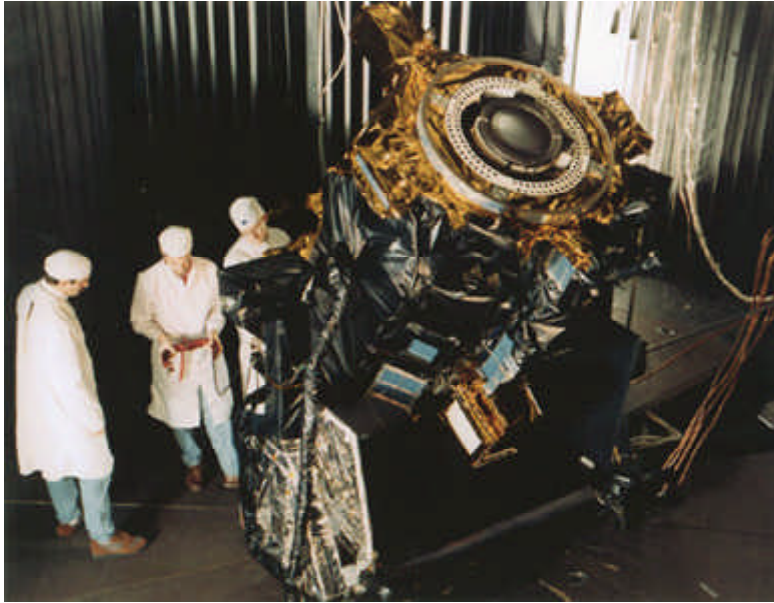


Ion Thruster and Power Processor Developed for the Deep Space 1 Mission

The NASA Solar Electric Propulsion Technology Applications Readiness (NSTAR) Program has provided a single-string primary propulsion system to NASA's Deep Space 1 spacecraft. This spacecraft will carry about 81 kg of xenon propellant for the ion thruster, which can be throttled down from 2.3 to 0.5 kW as the spacecraft moves away from the Sun. The propellant load will provide about 20 months of propulsion at the one-half power throttle setpoint of 1.2 kW. This mission will validate the 2.5-kW ion propulsion system and will fly by the asteroid 1992 KD in 1999. If funding permits, Deep Space 1 also will encounter comets Wilson-Harrington and Borrelly in 2001.

NASA Lewis Research Center's On-Board Propulsion Branch was responsible for the development of the 30-cm-diameter ion thruster, the 2.5-kW power processor unit (PPU), and the Digital Control and Interface Unit (DCIU) that controls the PPU/thruster/feed system and provides data and recovery from fault conditions. Lewis transferred the thruster and PPU technologies to the Hughes Electron Dynamics Division, which was selected to build two sets of flight thrusters, as well as the PPU's and DCIU's. Hughes subcontracted the DCIU development to Spectrum Astro Incorporated. The Jet Propulsion Laboratory (JPL) was primarily responsible for the NSTAR project management, thruster lifetests, the feed system, diagnostics, and the propulsion subsystem integration.

A total of four engineering model thrusters and three breadboard PPU's were built, integrated, and tested. More than 50 development tests were conducted along with thruster design verification tests of 2000 and 1000 hours. In addition, an 8000-hr life demonstration test was successfully completed and demonstrated wear-rates consistent with full-power lifetimes in excess of 12 000 hours.



Ion thruster mounted to its gimbal ring on the Deep Space 1 spacecraft during solar thermal vacuum testing.

Because of funding and schedule constraints, the PPU's and DCIU's fabricated by Hughes Electron Dynamics Division were flight qualified at Lewis. Thrusters were acceptance tested at both Lewis and the Jet Propulsion Laboratory. All the hardware passed the qualification test program and was subsequently integrated onto the Deep Space 1 spacecraft, where the propulsion system completed a compatibility test program that included a thruster firing at full-power in the Jet Propulsion Laboratory's 25-ft space-simulation facility. Deep Space 1 was launched from Cape Canaveral Air Station on October 24, 1998, aboard a Boeing Delta 7326.

Bibliography

Sovey, J.S., et al.: Development of an Ion Thruster and Power Processor for New Millennium's Deep Space 1 Mission. AIAA Paper 97-2778, July 1997.

Rawlin, V.K., et al.: NSTAR Flight Thruster Qualification Testing. AIAA Paper 98-3936, July 1998.

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