SENSITIVITY TESTING OF THE DEEP SPACE ONE FLIGHT SPARE ION ENGINE

Anita Sengupta, John R. Brophy, Keith D. Goodfellow

Jet Propulsion Laboratory California Institute of Technology
4800 Oak Grove Drive, MS 125-109, Pasadena, CA, 91109, US
Anita.Sengupta@jpl.nasa.gov

ABSTRACT

The Deep Space One (DS1) mission, launch in October of 1998, was designed to validate NASA's 30 cm ion thruster technology for future use on science-based planetary missions. Specific throttle levels (0.5 kW– 2.3 kW) were established prior to the mission for use on orbit and in concurrent ground testing, to define operation and required performance. Although mission operations dictate operation at specific set points, the design of the flight Xenon feed system and power processing unit do provide tolerances on the subsequent flow rate, voltage, and current set points. Such variations are inevitable in any practical spacecraft hardware design; it is therefore critical to understand the effects of such variations on discharge chamber efficiency, thruster performance, and any possible impacts on life / erosion processes within the ion engine.

Testing to determine the sensitivity of the 30 cm engine is ongoing as part of the Extended Life Test (ELT) of the DS1 flight spare ion engine, at the Jet Propulsion Laboratory. The Extended Life Test of the flight spare engine, started in October of 1998, has operated for over 27,300 hours, and processed over 219 kg of Xenon, to date. As part of the ELT program, sensitivity tests are conducted every 1000 to 2000 hours at the minimum, half, and full power points to determine the effect of nominal changes in operating parameters on engine performance characteristics. During sensitivity testing, cathode and main xenon flow rates are varied $\pm$ 3%, beam current is varied $\pm$ 3%, and screen and accelerator grid voltages are varied $\pm$ 5%, from nominal conditions.

Data will be presented to show the effects of these variations on discharge chamber, ion optics, and neutralizer performance, and their effect on double to single ion production, thrust, and beam profile. Key sensitivity parameters will be discussed as well as the change in engine sensitivity over the past 27,000 hours of operation.