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Design and Testing of a Cold Gas Thruster for an Interplanetary CubeSat Mission

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Abstract

A cold gas thruster has been developed by the Texas Spacecraft Laboratory (TSL), University of Texas at Austin (UT-Austin), for an interplanetary CubeSat mission called Interplanetary NanoSpacecraft Pathfinder In Relevant Environment (INSPIRE), under development by NASA's Jet Propulsion Laboratory (JPL). This thruster was primarily constructed using additive manufacturing (3D printing) to produce a single, continuous piece that encompassed all of the propellant pipes, tanks, and nozzles. Additive manufacturing allowed the complex internal geometry of the thruster to be fabricated without substantially increasing the cost of manufacturing or the physical size of the thruster. The thruster will serve as the sole actuator for the INSPIRE attitude control system, and is equipped with four converging-diverging nozzles. The thruster was tested extensively in a vacuum chamber, using a ballistic pendulum at a variety of propellant pressures and temperatures, and was found to produce approximately 60 mN of thrust at 20°C, with a specific impulse of 65 seconds. The two flight thruster units will fly on the two INSPIRE spacecraft in 2016, where they will demonstrate the feasibility of deep-space attitude control for CubeSats.

1. Introduction

The use of small satellites, such as CubeSats, has the potential to greatly decrease the cost and development schedules of future space missions. CubeSats, first standardized by California Polytechnic State University, are formed from 10x10x10 cm cubes (Mehrparvar, 2014), and examples such as the 2014 Firefly mission to study terrestrial gamma ray bursts (Rowland, 2011), have shown that satellites under 10 kilograms are becoming more viable platforms for science missions. Another area in which small satellites may soon become prevalent is deep space missions. No CubeSats have yet been sent beyond Low Earth Orbit (LEO), although several such missions are planned.

The Interplanetary NanoSpacecraft Pathfinder In Relevant Environment (INSPIRE) mission, developed by NASA's Jet Propulsion Laboratory (JPL), will send two CubeSats beyond LEO, with a primary goal of demonstrating small spacecraft survivability in the harsh environment of interplanetary space (Klesh, 2013). A secondary objective of the mission is to study the solar magnetic field. The two spacecraft carry science grade magnetometers, and they will make simultaneous measurements of the magnetic field as they drift apart, to estimate the local turbu-

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