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LUNAR ICECUBE: PIONEERING TECHNOLOGIES FOR INTERPLANETARY SMALL SATELLITE EXPLORATION

Abstract

Lunar IceCube is a small satellite mission whose objective is to prospect for water in solid, liquid, and vapor forms and other volatiles from a low-perigee, highly inclined lunar orbit. The mission is a partnership between Morehead State University, NASA Goddard Spaceflight Center, JPL, the NASA Independent Verification and Validation Center (IVV) and the Busek Space Propulsion Company. The mission is sponsored by NASA's Advanced Exploration Systems (AES) under the Next Space Technologies for Exploration Partnerships (NextSTEP) program. Lunar IceCube, a 6U CubeSat, will be deployed during lunar trajectory by the Space Launch System (SLS) on NASA's Exploration Mission-1 (EM-1). Lunar IceCube will use an innovative RF Ion engine to achieve lunar capture and ultimately a science orbit (that is inertially locked, highly elliptical, with 100 km periapsis) to investigate the distribution of water as a function of time of day, latitude, and regolith composition in the context of lunar mineralogy. EM-1 is the maiden voyage of SLS and will carry 13 secondary payloads, all 6U CubeSats, to Earth-escape where they will carry out a variety of beyond-LEO missions.. Lunar IceCube will include the Broadband InfraRed Compact High Resolution Exploration Spectrometer (BIRCHES), developed by GSFC- a compact version of the successful New Horizons instrument designed with the high spectral resolution (5 nm) and wavelength range (1 to 4 m) needed to distinguish forms of water, including ice. The mission will complement the scientific work of other missions by focusing on the abundance, location and transportation physics of water ice on the lunar surface at a variety of latitudes. Lunar IceCube, while primarily a science mission, will demonstrate technologies that will enable future interplanetary exploration with small satellite platforms including radiation-hardened subsystems, a precise ranging transponder/transceiver, a capable attitude determination and control system, a high power solar array and an innovative electric propulsion system (EP). The EP (Busek BIT-3 Iodine fueled engine) generates 1.2 km/s of delta-v and, combined with an innovative low energy manifold trajectory, allows the spacecraft to reach lunar orbit from Earth escape with minimal energy. The 13 secondary payloads to be deployed on EM-1, including Lunar IceCube, will usher in a new era of solar system exploration with small satellite platforms. The presentation will discuss several unique challenges and potential solutions related to interplanetary smallsat development and mission formulation.