Return to Menu

Lunar Flashlight

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Sponsoring Program(s)

Human Exploration and Operations Mission Directorate
Advanced Exploration Systems

Project Description

The Lunar Flashlight is a Jet Propulsion Laboratory project, with NASA Marshall Space Flight Center (MSFC) serving as the principal investigator and providing the solar sail propulsion system. The goal of Lunar Flashlight is to determine the presence and abundance of exposed lunar water ice within permanently shadowed regions (PSRs) at the lunar south pole, and to map its concentration at the 1–2 km scale to support future exploration and use. After being ejected in cis-lunar space by the launch vehicle, Lunar Flashlight deploys solar panels and an 85-m^2 solar sail and maneuvers into a low-energy transfer to lunar orbit. The solar sail and attitude control system work to bring the satellite into an elliptical polar orbit, spiraling down over a period of 18 months to a perilune of 30–10 km above the south pole for data collection. Lunar Flashlight uses its solar sail to shine reflected sunlight onto the lunar surface, measuring surface reflectance with a four-filter point spectrometer. The spectrometer measures water ice absorption features (1.5, 1.95 μm) and the continuum between them (1.1, 1.9 μm). The ratios of water ice bands to the continuum will provide a measure of the abundance of surface frost and its variability across PSRs. Water ice abundance will be correlated with other data from previous missions, such as the Lunar Reconnaissance Orbiter and Lunar Crater Observation and Sensing Satellite, to provide future human and robotic explorers with a map of potential resources. The mission is enabled by the use of an 85-m^2 solar sail being developed by MSFC (figs. 1 and 2).

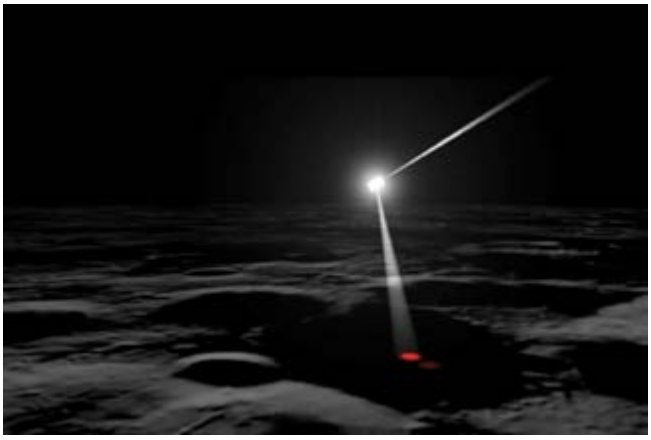

Figure 1: Artist concept of the Lunar Flashlight mission over the lunar surface.

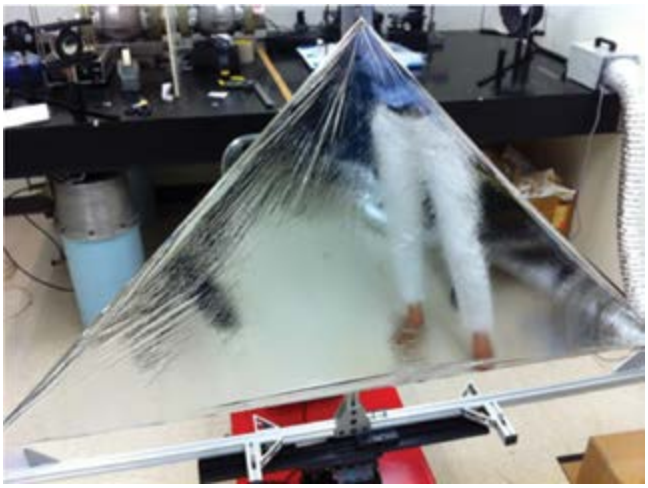

Figure 2: Reflectivity testing of the material that will be used to build the Lunar Flashlight solar sail.

Lunar Flashlight will be a secondary payload on the Space Launch System (SLS) Exploration Mission 1, the first planned flight of the SLS and the second uncrewed test flight of the Orion Multi-Purpose Crew Vehicle. The Lunar Flashlight flight system is based on a '6U' CubeSat form factor, with a stowed envelope slightly larger than 10×20×30 cm and a mass of <12 kg.

The solar sail propulsion system, the primary technology innovation to be flown on the spacecraft, is based on the successful NanoSail-D solar sail developed and flown by MSFC in 2010 (fig. 3). The sail system consists of four 7.3-m stainless steel booms wrapped on two spools (two overlapping booms per spool). The booms will pull the sail from its stowed volume as they deploy. The sail material will be 3 µm CP1, an aluminized polyimide.

Figure 3: The fully deployed 10-m^2 NanoSail-D solar sail.

Anticipated Benefits

Surface water ice and other volatiles, if they exist in sufficient quantities, would be extremely useful for in situ extraction and utilization by future human and robotic missions. Understanding the composition, quantity, distribution, and form of water/H species and other volatiles associated with lunar cold traps is identified as a NASA Strategic Knowledge Gap for Human Exploration. These polar volatile deposits could also reveal important information about the delivery of water to the Earth-Moon system. The scientific exploration of the lunar polar regions was one of the key recommendations of the Planetary Science Decadal Survey.

Potential Applications

The Lunar Flashlight mission will demonstrate a low cost capability for obtaining lunar measurements. In developing a long-lived, deep-space capable nanosatellite bus and solar sail propulsion system, the Lunar Flashlight flight system straddles the line between current interplanetary spacecraft and traditional Earth-orbiting CubeSats in terms of cost, risk, and capabilities.

Notable Accomplishments

Lunar Flashlight successfully completed its Mission Concept Review and System Requirements Review in August 2014. Solar sail packaging was characterized, reflectivity testing was conducted, and the boom deployer system designed at MSFC. The mission science goals underwent a nonadvocate peer review in June 2014.

References

Alhorn, D.; Casas, J.; Agasid, E.; et al.: "NanoSail-D: The Small Satellite That Could," 25th Annual AIAA/USU Conference on Small Satellites, Ogden, UT, 2011.