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THE LUNAR POLAR HYDROGEN MAPPER MISSION

Abstract

The Lunar Polar Hydrogen Mapper (LunaH-Map) is a 6U CubeSat selected for flight on the Space Launch System (SLS) Exploration Mission 1 (EM-1) through NASA's Science Mission Directorate under the Small, Innovative Missions for Planetary Exploration (SIMPLEx) program. Results from previous scientific missions to the Moon have identified the presence of water/frost within permanently shadowed regions (PSRs) at the poles, however, there remains uncertainty about the bulk (non-surficial/frost) abundance of these enrichments and whether these small-scale enrichments are pervasive throughout lunar south pole PSRs. Placing constraints on the bulk hydrogen abundance within PSRs will help point to specific processes and delivery sources for polar volatiles, and can help resolve mechanisms operating over long time scales (e.g. solar wind) from other, much shorter time scale delivery mechanisms (e.g. passing asteroids or comets). Hydrogen enrichments between 500 to 600 ppm at a spatial scale of 5-15 km could provide robust evidence for discerning hypotheses regarding transport processes of polar hydrogen enrichments.

The LunaH-Map spacecraft is equipped with gimbaled solar arrays, 3 reaction wheels, a star tracker, an X-Band radio, a command and data handling system, power control system, neutron spectrometer array, and a low-thrust propulsion system. The current mission science phase achieves 282 orbits over two lunar days and preliminary analysis of the miniature neutron spectrometer (Mini-NS) sensitivities shows the mission will be capable of identifying small-scale (<15 km^2) regions of hydrogen enrichments on the order of 600ppm +/- 120ppm. Communication with Earth will be achieved via the Iris radio, to be used on the MarCO spacecraft at Mars, and will be coordinated with the Deep Space Network. Spacecraft operations, telemetry and science data analysis will be conducted at the Mission Operations Center at Arizona State University (ASU). After deployment from SLS EM-1, LunaH-Map will maneuver and perform a lunar flyby targeting the Earth-Moon L2 point and eventual capture by the Moon within two months. Upon lunar capture the spacecraft will spiral down to an elliptical low-altitude science orbit with perilune at the South Pole. During the science phase, the Mini-NS will measure neutron counts about the perilune (lowest altitude passes) of each orbit to enable mapping of hydrogen enrichments within PSRs. The mean perilune altitude is designed to achieve between 10 to 15 km above terrain poleward of 85S throughout the science phase, but will vary depending upon the final SLS EM-1 launch date and trajectory.