EXPECTED MEASUREMENTS OF THE LOCAL PLASMA AND DUST ENVIRONMENT FROM THE CLPS/ROLSES RADIO RECEIVER.

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Introduction. It is an exciting time in lunar exploration with NASA's Commercial Lunar Payload Service (CLPS) delivering science investigations to the surface of the Moon. In 2023, two CLPS science delivery missions are planned: The Peregrine lander from Astrobotic Technology Inc (PM-1) and the NOVA-C lander from Intuitive Machines Inc (IM-1). The presentation herein focuses on a science payload on the IM-1 missions called 'Radio wave Observations at the Lunar Surface of the photoElectron Sheath' (ROLSES). The payload is planned to be delivered close to the south pole at Malapert A (~80S). Figure 1 is an illustration of the NOVA-C lander.

Figure 1. IM-1's NOVA-C lander

The ROLSES radio. ROLSES will deploy a set of 4 radio antennas from the lander to then sense the radio and plasma wave environment between 2 kHz and 30 MHz. The ROLSES science objectives include: (1) Measure the electron density in the local near-surface plasma via local electron plasma oscillations, (2) observe solar and planetary radio waves from a lunar surface observatory, especially now heading into the active solar maximum period, (3) detect terrestrial natural auroral and human-made radio emissions, to thus assess the Earth as a 'noisy' radio source, (4) sense interplanetary and 'slow moving' lunar dust via grain contacts with the antenna, (5) search for the weak galactic background radiation, and (6) assess the radio frequency interference (RFI) from the lunar lander, and thus determine the suitability of the lander as a radio observation platform.

In this presentation, we will focus further describing Objective (1) and (4), which may be interconnected.

Measuring the local electron density. Specifically, the environmental plasma close to the lunar surface is greatly modified by the underlying surface potential (See [1] and references therein). ROLSES can measure the electron density in the near-surface environment via the natural plasma oscillations that occur in all plasmas. A primary oscillation occurs at a very specific and narrowband frequency called the electron plasma frequency, f_{pe}, and this plasma oscillation is directly related to the square root of the local electron density [2]. Thus, as the ROLSES radio senses this electron plasma frequency, it thus obtains a direct measure of the local plasma electron density at the IM-1 landing site.

Surface Potential. While not addressed in the original ROLSES proposal, we present herein new techniques to estimate the underlying surface potential given the ROLSES measurements. To obtain the solar wind-to-surface potential drop, we require the additional measurements of the electron density from an upstream monitor in the solar wind like THEMIS-ARTEMIS, the Wind Spacecraft, etc.

Specifically, the upstream monitor will provide the electron density in the unaltered solar wind, while ROLSES provides a measure of the electron density as modified by the underlying lunar surface. We show that a comparison of the two densities can allow for an estimate of solar wind-to-surface potential drop – the measurement being especially unambiguous when the underlying surface is negative.

Models and past ALSEP/SIDE observations suggest that the surface potential may become strongly negative close to and across the terminator, creating an electron density dropout that varies as the exponential of the surface potential. Immediately nightside of the terminator, the solar wind will be obstructed by the surface to form the beginning of the plasma wake/void region, thus creating very strong negative surface potentials [3]. The electron density dropout from this strongly negative surface can be sensed by ROLSES.

Surface Potential-Dust Correlation. Observations by LEAM and Surveyor also hint at the possibility that lofted dust activity from the lunar surface may increase near and across the terminator [4]. Such electrostatically lofted dust can be sensed by ROLSES as impulsive radio events via grain-antenna contacts.

Thus, ROLSES will have the capability to perform a first-ever correlative study of the near-surface electron density, solar wind-to-surface potential drop, and lofted dust flux. While it has long been speculated that the surface potential and lofted dust are interconnected, the ROLSES lunar surface radio has the unique capability to examine the assertion.

References. [1] Stubbs, T. J., et al. (2014), Planetary Space Sci, 90, 10. [2] Chen, F. F. (1984), *Introduction to plasma physics and controlled fusion, Vol 1 Plasma Physics,* Plenum. [3] Farrell W. M. et al. (2010), J. Geophys. Res., 115, E03004; [4] Colwell J. E. et al. (2007), Rev. Geophys, 45, RG2006.