NIRVSS ABOARD CLPS. T.L. Roush[1], A. Colaprete[1], A. Cook[2,1], R. Bielawski[2,1], K. Ennico-Smith[1], J. Benton[3], J. Forgione[1], B. White[1], R. McMurray[1], V. Jha[2,1], D. Hoang[2,1], [1]NASA Ames Research Center, Moffett Field, CA 94035-1000 (ted.l.roush@nasa.gov), [2]AMillennium Engineering & Integration Company, c/o NASA Ames Research Center, Moffett Field, CA 94035-0001) [3]Wyle Labs, c/o NASA Ames Research Center, Moffett Field, CA 94035-0001.

Introduction: NASA initiated the Commercial Lunar Payload Services (CLPS) program for flights to the lunar surface. Astrobotic was awarded a NASA contract to accommodate NASA payloads onto their Peregrine lander Astrobotic Mission One (ABM-1) [1]. ABM-1 is scheduled to land near Lacus Mortis, 44°N 25°E, in 2021. The Near-InfraRed Volatile Spectrometer System (NIRVSS) has evolved over time [2,3,4]and was chosen as a NASA payload for ABM-1 and the flight model is scheduled to be delivered to Astrobotic at the end of March 2020.

NIRVSS Scientific Objectives: NIRVSS is a multi-component system enabling observations that characterize lunar surface composition, morphology, and thermophysical properties. Figure 1 shows the two NIRVSS Engineering Test Unit (ETU) structures, the bracket assembly (BA) and spectrometer box (SB). These are connected via electronic, data communication, and fiber-optic cables. These will be attached to the lander payload deck. The system total mass is 3.57 kg and when all subsystems are powered draws nominally 30 W.

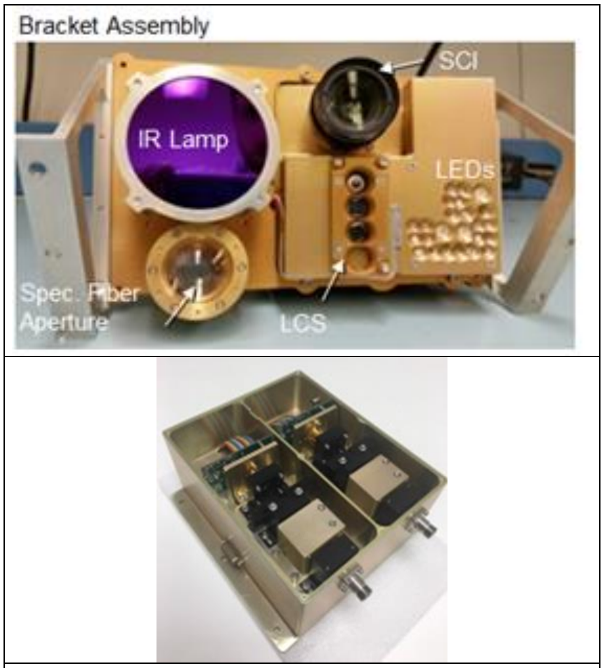

Figure 1. NIRVSS ETU BA with components labeled (A) and ETU SB (B).

The SB contains two commercially modified spectrometers, and controlling electronics (Brimrose Corporation of America). The independent, fiber-optic fed, short-wave (SW) and long-wave (LW) spectrometers cover the 1200-2400 and 2300-4000 nm with spectral resolutions of <20 and <50 nm, respectively. Figure 2 illustrates the compositional capabilities of NIRVSS.

The BA contains: 1) the Science Context Imager (SCI), a 4 megapixel CMOS sensor uses seven LEDs for wavelength discrimination between 340 and 940 nm; 2) the Longwave Calibration Sensor (LCS) with 4 thermopiles and associated filters (6-25, 10, 14, and 25 microns) monitors surface temperature variations down to ≈ 100 K providing an independent capability for thermal contribution removal from the observed spectra; 3) a dual filament tungsten IR LAMP to provide illumination when needed to enable spectral measurements; and 4) a fiber aperture connected to the SB.

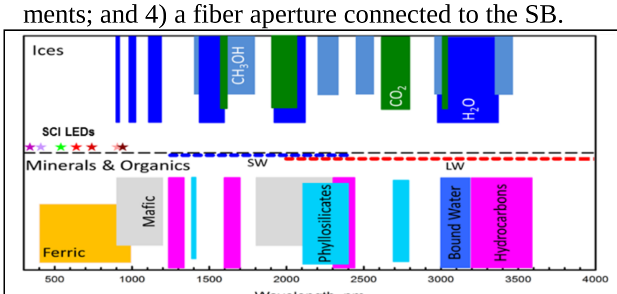

Figure 2. NIRVSS LEDs (stars) and spectrometers (blue and red dashed lines) spectral coverage. The top and bottom panels show spectral features associated with ices and minerals/organics, respectively.

NIRVSS Concept of Operations (ConOps): During pre-launch NIRVSS will be powered to confirm system health and functionality. NIRVSS will not be powered during launch, orbital, or landing phases of the mission. During cruise, NIRVSS will be operated to confirm component functionality with minimal data return. During surface operations NIRVSS will collect data daily. Table 1 provides an overview of the surface observational scientific objectives on each Earth day.

Summary: NIRVSS observations during ABM-1 will provide the ability to monitor variations in surface reflectance properties throughout the mission durations. These observations can be used to address surface composition and any variation of volatiles including water, carbon dioxide, and methane, if present, with time. The spatial context of the spectral observations is provided by the imaging sequences. The surface thermophysical response of the surface under the lander will be measured as solar illumination conditions vary. Data will be delivered to the Planetary Data System (PDS) after end of mission.

Table 1. NIRVSS CLPS ConOps

Earth Day	Hours after landing	Science Objective
1	6	Observe ASAP to document presence / sublimation of exhaust volatiles
2	31	Observations of shadowed surface
3	56	Observations as surface warms
4	81	Observations before surface transition to sunlight
5	106	Observations after transition to sunlight
6	131	Observations of continued surface warming
7	156	Observations as surface begins cooling
8	181	Observations as surface cools
9	206	Observations as shadows grow and surface cools
10	231	Observations in lunar twilight to document volatile condensation

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References: **[1]** Astronomy Now, 2 June 2019 **[2]** Roush, T.L. and 9 others, 2014, https://doi.org/10.1016/j.asr.2014.08.033 **[3]** Roush, T.L., and 9 others, 2015, 46th Lunar Plant. Sci. Conf. abstract 1956. **[4]** Roush, T.L. and 15 others, 2016, https://doi.org/10.2514/6.2016-0228