A FRAMING MULTISPECTRAL IMAGER FOR LUNAR APPLICATIONS: MAHINA COLOR CAMERA.

David T. Blewett[1,*], Brett W. Denevi[1], Heather M. Meyer[1], Charles A. Hibbitts[1], Stanley Ikpe[1], Bryan J. Maas[1], and Shaughn M. London[1]. [1]Space Exploration Sector, Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723, USA. (*david.blewett@jhuapl.edu).

Introduction: Supported by the NASA Development and Advancement of Lunar Instrumentation (DALI) Program, we are developing a simple snapshot multispectral camera that uses pattern filters to eliminate the need for moving parts. The instrument provides a combination of reconnaissance morphologic imaging and spectral parameter mapping, ideal for a lunar lander or rover panoramic or stereo camera.

Science Goals: Our instrument is named the Mahina Color Camera ("Mahina" is the Hawaiian word for "Moon"). MahinaCam will allow missions to the lunar surface to gather key scientific observations on the composition and degree of space weathering for materials at a landing site, distant locations within the field of view, and/or along rover traverses. Conventional RGB imagers provide only morphological images and extremely limited color data [1]. Our baseline filter set is 430, 750, and 940 nm. These wavelengths are similar to those of the classic *Clementine* UVVis camera filters that have been widely used for mapping lunar composition (FeO and TiO_2 content [2]) and optical maturity (the OMAT parameter, [3]).

MahinaCam expands the return of compositional information from any landing site, enhancing the understanding of each site's geology and the processes that have shaped it (e.g., impact cratering, volcanism, space weathering, dust activity, and modification by lander rocket exhaust). MahinaCam maps of the optical maturity parameter for materials at the scale of a lander/rover will chart the evolution of regolith from fresh rock to mature soil. Photometric observations will allow each landing site to become a standard for measurements from orbit. A MahinaCam on a platform that is capable of operation shortly after sunset or before sunrise will be able to search for lunar horizon glow, thus yielding important data on the size of levitated dust particles [e.g., 4].

MahinaCam for a Polar Landing Site. Recent work by S. Li et al. [5] has led to the remarkable discovery of hematite at high lunar latitudes (poleward of ~70°). Hematite is an alteration mineral containing ferric iron (Fe^{3+}). Hematite has a diagnostic absorption band at 840-850 nm, and a spectral shape that is distinctive from other lunar minerals. Thus, a polar version of MahinaCam could include a filter at ~850 nm to permit efficient detection of hematite and investigation of the geological settings where it is found. A stereo imager based on MahinaCam could have different filter sets in the left and right eyes, e.g., L = 430, 750, 940 nm; R = 750, 840, 940 nm.

Instrument and Development Plans: MahinaCam is based on COTS camera components. It employs a CMOS focal-plane array (FPA) with a Bayer-like pattern of filters, but with wavelengths that are specifically tailored for extraction of maximum quantitative information from the reflected visible-NIR spectrum of the lunar surface. The pattern filter is bonded directly to the detector.

We aim to advance the technology readiness level (TRL) of MahinaCam from 4 to 6. We will carry out vibration and shock testing to the levels defined by NASA GSFC-STD-7000A General Environmental Specification (GEVS), which is the standard for PRISM payloads. Thermal vacuum testing will include both thermal cycling to confirm reliability and thermal balance testing (hot and cold cases) to confirm performance in the lunar environment. We will perform a total-dose radiation test on the instrument, both powered off and powered on. The interference filters are rad-hard, and the ruggedized COTS camera is radiation-tolerant by design and testing.

Calibration. We will thoroughly characterize MahinaCam over the full range of expected camera temperatures within the thermal enclosure. The performance of the FPA (quantum efficiency, dark current, read noise) will be measured over the range of operating temperatures that are expected for the final instrument. Calibration of the fully integrated MahinaCam will measure spectral transmission, geometric distortion, and system-level modulation transfer function (MTF). System radiometric performance will be characterized at a set of temperatures over the operational range.

Resource Utilization. We expect MahinaCam to have a mass of <800 g (including the camera chassis/electronics, foreoptics, and a thermal enclosure). The camera is capable of collecting video, which draws ~3.5 W. In normal single-frame operation, the power needs are lower.

References: [1] D. T. Blewett et al. (2023), *Earth Space Sci. 10*, e2022EA002710. [2] P. G. Lucey et al. (2000a), *J. Geophys. Res. 105*, 20,297–20,306. [3] P. G. Lucey et al. (2000b), *J. Geophys. Res. 105*, 20,377–20,386. [4] J. J. Rennilson and D. R. Criswell (1974), *Moon 10*, 121–142. [5] S. Li et al. (2020), *Sci. Adv. 6*, eaba1940.