AN ULTRA-COMPACT IMAGING SPECTROMETER FOR THE LUNAR SURFACE: UCIS-MOON. A. A. Fraeman[1], H. A. Bender[1], W. Chen[1], I. M. McKinley[1], C. D. Smith[2], M. S. Gisbon[2], M. L. Eastwood[1], D. R. Thompson[1], R. O. Green[1], B. L. Ehlmann[1,2], D. L. Blaney[1], P. Mouroulis[1] [1]Jet Propulsion Laboratory, California Institute of Technology (afraeman@jpl.nasa.gov), [2]Sierra Lobo, Inc., [3]Division of Geological & Planetary Sciences, Caltech

Introduction: We are developing an ultra-compact imaging spectrometer (UCIS) [1, 2] for use in future landed or rover missions to the Moon under the Development and Advancement of Lunar Instrumentation (DALI) program. Our instrument, named UCIS-Moon, is a short wavelength (SWIR) imaging spectrometer that will collect reflectance spectra between 600 – 3600 nm at a spatial resolution from centimeters to meters, when mounted on landed mission mast. Spectra from this wavelength range detect common lunar minerals, OH species, molecular H_2O, water ice, and organics (Fig. 1). Data from UCIS-Moon will therefore provide information about lunar volatiles and geology. To achieve the instrument's science goals at the lunar surface, we have developed a specialized thermal design that will permit UCIS-Moon to operate in the challenging surface lunar thermal environment at all times of day and within permanently shadowed regions.

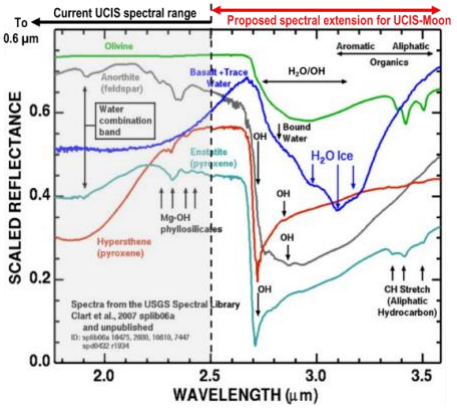

Fig. 1: Laboratory measurements showing the character and diversity of volatiles distinguishable with spectral range of UCIS-Moon

Design: UCIS-Moon is a compact Offner imaging spectrometer that accommodates a 600-pixel-cross track field CHROMA focal plane array provided by Teledyne Imaging Sensors Inc (Fig. 2) [4]. The expected optical performance characteristics are summarized in Table 1.

Table 1: UCIS-Moon instrument characteristics

Platform	Lunar lander/rover
Wavelength range	600-3600 nm
Sampling	10 nm
Spectrometer architecture	Offner
FOV	≥ 30 degrees
IFOV	1.15 mrad
SNR	>100 @ <2500 nm >50 @ >2500 nm
Spectral uniformity	<5% (req. <10%)
Spatial uniformity	<5% (req. <10%)

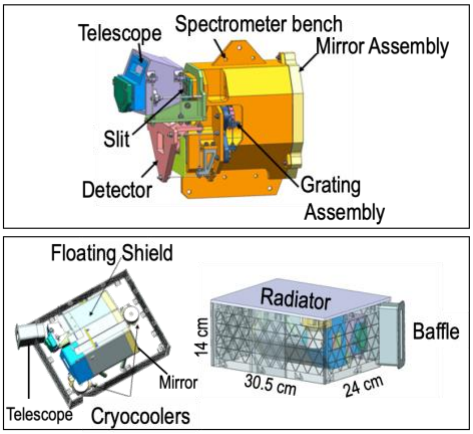

Fig. 2: UCIS-Moon optical design and thermal housing

Depending on location and time of day, lunar surface temperatures range from ~100 – 400 K, and are even lower in permanently shadowed regions [3]. UCIS-Moon's performance is tied directly to its operating temperature, and we completed thermal subsystem design trade studies that accommodate these challenging thermal environments (Fig. 2).

Future work: At the conclusion of the DALI program, UCIS-Moon be at TRL6. In addition to design work, the long-lead time hardware (Fig. 3) acquired through this DALI effort (focal plane array, grating, mirrors, etc.) will enable it to be included in future Payload and Research Investigations on the Surface of the Moon (PRISM) calls at significantly reduced cost and schedule.

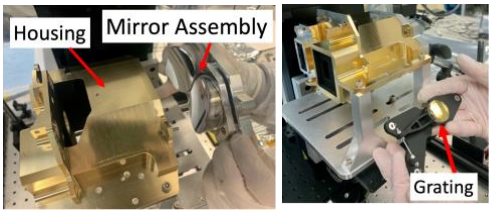

Fig. 3. UCIS-Moon is currently undergoing warm assembly. Left: Mirrors being installed into spectrometer housing. Right: Grating being installed in housing.

References: [1] Van Gorp, et al. (2014) Journal of Applied Remote Sensing, 8. [2] Blaney, D. et al. (2014) LPSC, abs. #2037. [3] Williams, J-P. et al. (2017) Icarus, 283, 300-325. [4] Haag, J., et al. (2020), SPIE Proceedings.