POSSUMD: PORTABLE OPTICAL STATE-OF-THE-ART SPECTROMETER FOR UNDERSTANDING AND MITIGATING DUST. A. Vidwans[1,2], J. J. Gillis-Davis[2,3], [1]Department of Energy, Environmental, and Chemical Engineering, Washington University in St. Louis, MO 63130, [2]Department of Physics, Washington University in St. Louis, MO 63130, [3]McDonnell Center for the Space Sciences, Washington University in St. Louis, MO 63130. (abhay.vidwans@wustl.edu).

Introduction: The Portable Optical State-of-the-art Spectrometer for Understanding and Mitigating Dust (POSSUMD) enables science and exploration by acquiring data essential to resolving dust mobilization and mitigation challenges. POSSUMD provides *quantitative measurements of lunar mobilized dust* (e.g., size distribution, particle concentration, velocity, particle trajectory, height, settling velocity, and sedimentation rate). Adequate in-situ measurements of these dust parameters have yet to be acquired, leading to a poor understanding of dust mobilization mechanisms and nebulous test parameters for dust mitigation technology development.

Dust mitigation strategies must be seriously considered during mission design and development because dust accumulates on sensitive power components and optical elements; thus, reducing their performance and lifetime. Dust concerns were troublesome for Apollo, but they did not jeopardize mission success due to the relatively short mission length. Hence, dust mitigation strategies enabled by the critical dust mobilization parameters provided by POSSUMD will ensure dust-sensitive components' longevity during extended Artemis missions and base camp habitation. Near-surface dust characterization would also advance our theoretical understanding of the lunar dust-plasma environment.

Design and Calibration: The design of POSSUMD is two-fold: selection of the COTS spectrometer and design of the inversion algorithm.

Calibration of spectrometers. Various COTS multispectral spectrometers are available, featuring different spectral ranges (380 – 5000 nm), sensitivities, integration times, and power requirements. Each sensor will measure lunar dust simulant aerosols [1,2]. Research-grade aerosol instrumentation will provide real-time reference dust size distribution as spectra are collected. The accuracy and precision of each calibrated sensor will then be evaluated and compared. The strengths of each COTS spectrometer will contribute to the prototype POSSUMD instrument.

Inversion algorithm theory: POSSUMD measures dust particle characteristics by *light scattering* (Fig. 1). A polychromatic light source illuminates particles falling through the sensor's field-of-view, and the scattered light is measured as a function of wavelength by a state-of-the-art miniature spectrometer. The wavelength-dependent spectrum, coupled with laboratory calibrations, is inverted to extract dust parameters, such as particle size (anticipated individual particle size range ~100 nm – 500 µm)

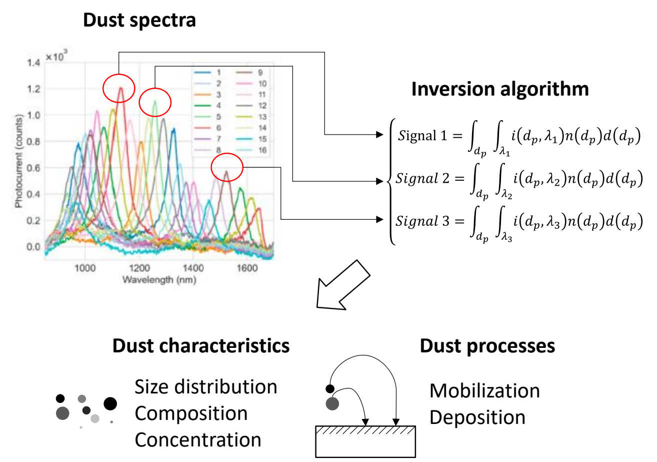

Figure 1. *POSSUMD illuminates dust particles passing through its sensing region with polychromatic light and rapidly obtains the spectra (vis-NIR). Spectral peaks are converted to particle characteristics using an inversion algorithm based on light scattering theory and laboratory light scattering measurements. Spectra image from [3].*

Inversion algorithm development: The light scattered by a dust particle is a complex function of size, shape, and composition and is a crucial input parameter. The initial inversion algorithm will use Mie Theory to estimate this function. Next, with experimental trials, we will advance the algorithm by measuring the light scattered by dust simulant particles of varying composition and morphology to provide uncertainty bounds for the post-inversion measurements.

Target Environments: POSSUMD, currently at TRL 3, is designed to measure particles without a gas flow through the instrument, enabling its use in the vacuum environments of the Moon, Mercury, and asteroids. A reconfigured POSSUMD can monitor dust and trigger mitigations in crew quarters that may experience high dust concentrations.

References: [1] Vidwans A. et al. (2022) *Planet. Space Sci., 210*, 105392. [2] Wang Y. et al. (2015) *Aerosol Sci. Tech., 49(11)*, 1063-1077. [3] Ou F. et al. (2022) *Sensors, 22(18)*, 7027.