LUNAR TRAILBLAZER: A PIONEERING SMALLSAT FOR LUNAR WATER AND LUNAR GEOLOGY.

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Lunar Trailblazer is a NASA SIMPLEx smallsat mission for understanding the Moon's water and water cycle. Selected in June 2019, the ESPA Grande Lunar Trailblazer spacecraft will be delivered in late 2022/early 2023. Trailblazer is one of the secondary payloads manifested for the 2024 IMAP heliophysics mission rideshare opportunity. Lunar Trailblazer's international team is led by Caltech and managed by JPL. The Ball Aerospace-integrated Lunar Trailblazer smallsat carries two instruments: JPL's High-resolution Volatiles and Minerals Moon Mapper (HVM^3) shortwave infrared imaging spectrometer and the UK-contributed, University of Oxford/STFC RAL Space-built Lunar Thermal Mapper (LTM) infrared multispectral imager. Trailblazer simultaneously measures composition, temperature, and thermophysical properties from a 100-km lunar polar orbit at high spatial and spectral resolution (Table 1; Figure 1).

Lunar Trailblazer's science objectives are to detect and map water on the lunar surface at key targets to (1) determine its form (OH, H_2O or ice), abundance, and local distribution as a function of latitude, soil maturity, and lithology; (2) assess possible time-variation in lunar water on sunlit surfaces; and (3) use terrain-scattered light to determine the form, abundance, and distribution of exposed water in permanently shadowed regions. With simultaneous nested infrared spectral images and temperature data, Trailblazer also (4) collects thermal data to understand how local gradients in albedo and surface temperature affect ice and OH/H_2O concentration, including the potential identification of new, small cold traps. While achieving these objectives, Trailblazer will also attain improved compositional mapping of silicates and improved reconnaissance of potential future landing zones for water resources, thermophysical properties, and composition.

Table 1. Current best estimate Lunar Trailblazer science observing parameters from 100±30 km orbit

HVM^3 imaging spectrometer (delivered by JPL)	
Spatial Sampling	≤ 100 m/pixel
Swath Width	≥ 20 km
Spectral Range	0.6 – 3.6 μm
Spectral Sampling	10 nm
SNR	>200 at 3-μm for low sun (85°) scene
Uniformity	>90% cross track
# Data Cubes*	1000
LTM thermal camera (delivered by University of Oxford)	
Spatial Resolution	≤ 35 m/pixel
Spatial Width	≥ 10 km-swath
Thermal	Temp. retrieval 110-400K (± <5 K) 4 broad bands, 6-100 μm
Composition	7-10 mm 11 channels; < 0.5 mm
SNR	> 50 when sunlit
# Data Cubes*	1000

*Lunar Trailblazer will also present NASA with an option for greater (near-global) coverage under Communication Enhancement Option

Identification and characterization of water and its forms is critical knowledge as lunar exploration moves forward. This presentation will describe the mission-level design and measurement techniques to characterize the Moon's water and geology.

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Figure 1. A schematic of the Lunar Trailblazer observing geometry, HVM^3 instrument, and LTM instrument.