**INVESTIGATING LUNAR POLAR THERMAL ENVIRONMENTS IN SITU WITH THE LAFORGE INSTRUMENT ABOARD THE CSA LUNAR ROVER MISSION.** B. T. Greenhagen[1], J. T. S. Cahill[1], A. Colaprete[2], K. L. Donaldson Hanna[3], C. M. Elder[4], M. A. Siegler[5], T. Warren[6], K. Ryan[1], and B. Clyde[1], [1]Johns Hopkins Applied Physics Laboratory, [2]NASA Ames Research Center, [3]University of Central Florida, [4]Jet Propulsion Laboratory, California Institute of Technology, [5]Planetary Science Institute, [6]University of Oxford (Email: benjamin.greenhagen@jhuapl.edu)

**Introduction:** The Lunar Advanced Filter Observing Radiometer for Geologic Exploration (LAFORGE) instrument is a multispectral thermal infrared (TIR) imaging radiometer designed to maximize temperature accuracy, especially at very low temperatures. The lunar thermal environment in near-polar areas is extreme; with illuminated regolith experiencing diurnal temperatures of 200–300K, while the coldest permanently shadowed regions are limited to 30–60K. In addition, topography and surface roughness on centimeter and larger scales create thermally complex surfaces illuminated at high polar incidence angles with 100s K differences in relatively close proximities. Fully characterizing these thermal environments and deriving valuable thermophysical and compositional information requires an instrument such as LAFORGE, which is both highly capable and optimized to operate in the polar regions.

**Lunar Rover Mission:** The Canadian Space Agency (CSA) Lunar Rover Mission (LRM) will explore a to-be-named landing site at the lunar south pole. LRM was selected through a CSA Lunar Exploration Accelerator Program (LEAP) call that aims to develop lunar mobility systems technologies and science investigations on the lunar surface, and will be delivered by a NASA-provided Commercial Lunar Payloads Services (CLPS) lander. The LRM, includes a rover (Canadensys) with six instruments. These instruments include a neutron spectrometer (Bubble Technology Industries), two multispectral imagers (Canadensys), a far-ultraviolet imager (Canadensys), a radiation microdosimeter (Teledyne DALSA), and the LAFORGE thermal infrared imager (APL), which is a US contribution funded by NASA.

**LAFORGE:** The goal of LAFORGE is to provide high quality thermal imager with an ability to obtain highly accurate temperature measurements across the full range of thermal environments present at the lunar south pole. To accomplish this, LAFORGE will use the same microthermopile and filter technologies and calibration approach successfully employed at the Moon by the LRO Diviner Lunar Radiometer. JPL has developed and tested new, higher density arrays that will fly on the PREFIRE mission late in 2023. Advances have also been made in custom, high performance infrared filters for planetary applications and have been used on a number of recent instruments including Lunar Trailblazer Lunar Thermal Mapper. Combining these state-of-the-art, heritage technologies with APL's proven expertise in the opto-mechanical design of flight instruments, results in a TIR instrument with unparalleled ability to measure lunar polar surface temperatures, physical properties, and composition.

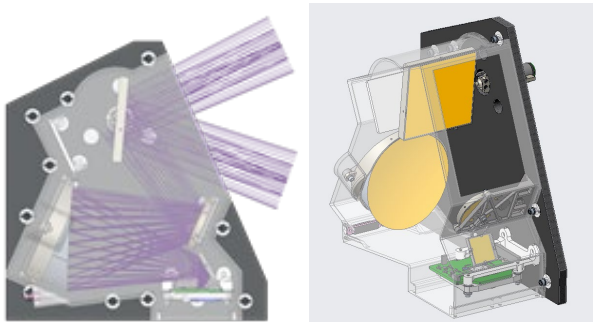

Figure 1: LAFORGE optical ray-trace (left) and mechanical layout (right) during early Phase B.

**Science Objectives:** LAFORGE's four science objectives focus on understanding the surface thermal environment, detailed mapping and characterization of cold traps where volatiles may be stable, constraining the thermophysical properties of the surface regolith and rocks, and investigating relative differences in composition and soil maturity.

**1.** Characterize the time-varying thermal environment of the landing site during seasonal summer

**2.** Map and characterize nearby cold traps (including orbital spatially unresolved micro-cold traps) where water-ice may be thermally stable on the lunar surface or in the subsurface

**3.** Characterize the local thermophysical properties, including the distribution and abundance of rocks, regolith particle size, and packing (i.e., ~density) as measured by thermal inertia and surface roughness.

**4.** Characterize local soil maturity and compositional properties and abundance of silicates and oxides (e.g., ilmenite and/or hematite).

**Current Status:** LAFORGE is currently in Phase B and progressing towards a Performance Review in late 2023, a CDR in summer 2024, and instrument delivery in 2025. The LRM landing site selection activity is currently underway with launch scheduled no earlier than 2026.