National Aeronautics and Space Administration

FY24 Strategic Initiatives Research and Technology Development (SRTD)

Mini Imaging Spectrometer for Mars Helicopter and Small Spacecraft Missions

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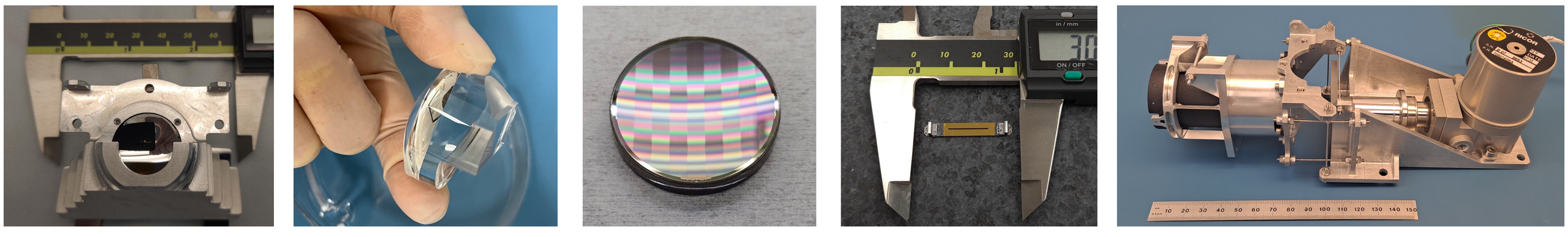
Strategic Focus Area: Micro Instruments for Mars Helicopter and Small Spacecraft Missions | **Strategic Initiative Leader:** Yonggyu Gim

Objectives: Develop a miniaturized pushbroom infrared imaging spectrometer that can operate within the resource constraints of the Mars Science Helicopter and other small platforms. It must have a total mass <3 kg while maintaining a signal-to-noise ratio >200 across the spectral features of key minerals to study the surface composition of Mars at unprecedented scales (>10 km spatial coverage and <10 cm spatial sampling).

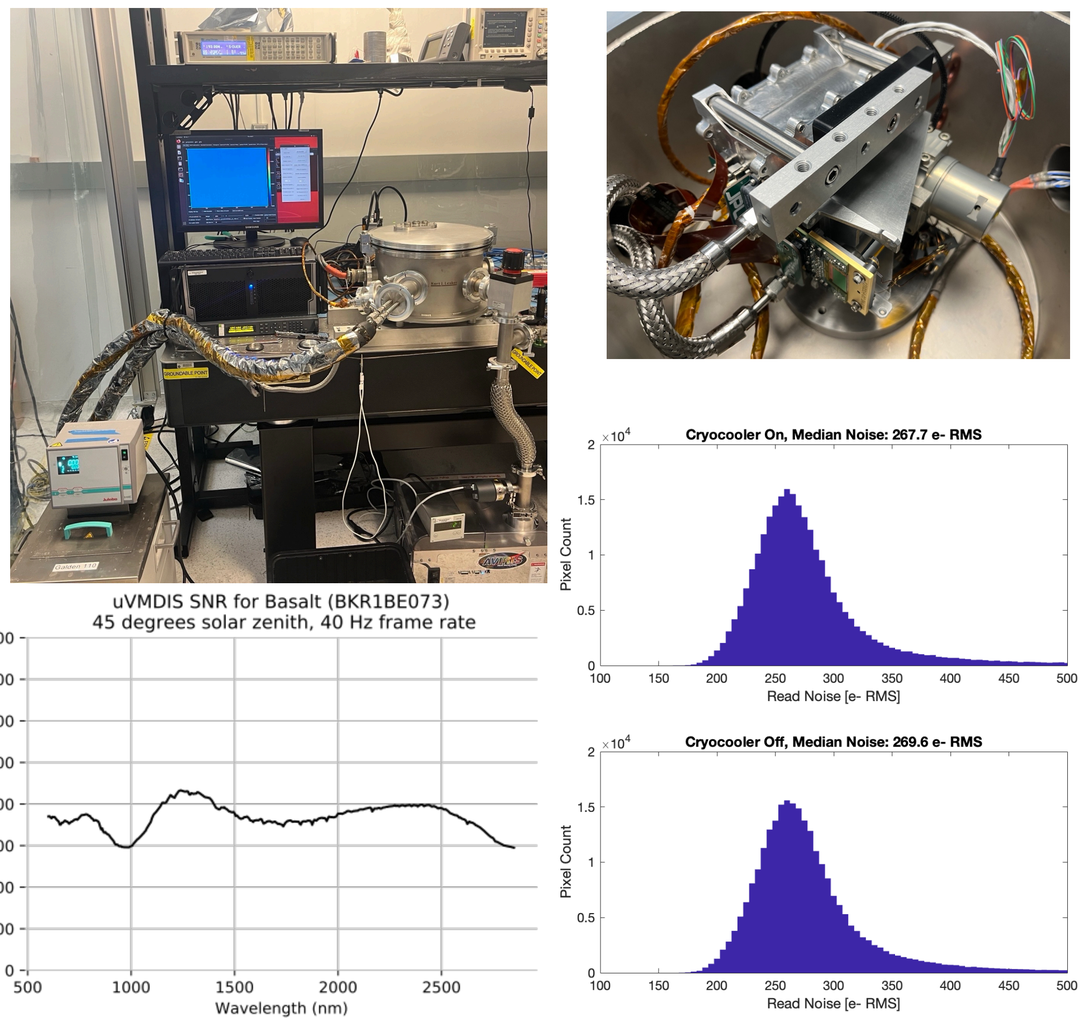
Background: The micro-Visible Mid-wavelength Imaging Spectrometer (μVMDIS) combines a high-throughput f/1.9 Dyson spectrometer and two-mirror telescope, a tactical Stirling cryocooler with heritage in the Mars orbital and surface environments, and a digital-output detector array with associated low-mass and low-power electronics.



Left to right: two-mirror telescope assembly, Dyson lens, MDL e-beam grating, MDL slit, and mechanical assembly

Approach and Results: In FY24, we fabricated the all of the optical, mechanical, thermal, and electrical components required for a prototype instrument, including the narrowest slit that JPL's Microdevices Lab has fabricated.

Next, the detector, electronics, and cryocooler were operated in a vacuum chamber to assess their electromagnetic compatibility and performance. The FPA shows very high dynamic range of 10^4, and its read noise is unchanged whether the cryocooler is off or on, showing it is immune to the cooler's electromagnetic noise. While we could not achieve the intended operating temperature of the FPA in this configuration, we are able to derive the thermal resistance and heat rejection temperature needed for the flight design. Optical testing is also still in work.



Clockwise from top left: Thermal-vacuum test steup; view of the electronics, detector, and cryocooler under test; the detector achieves low read noise, even with the cryocooler active; results indicate that μVMDIS will meet its predicted SNR for a typical Mars scene.

Significance/Benefits to JPL and NASA: The results of this work are intended to provide the evidence needed to support future planetary science proposals, ranging from a helicopter-borne version for exploring the surface of Mars to an orbital version that could be adapted to a wide variety of planetary missions.

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Publications:

P. Sullivan et al, "A Comparison of Imaging Subsystems for Analog- versus Digital-Output Detector Arrays," IEEE Aerospace Conference, 2023, doi: 10.1109/AERO55745.2023.10115911.

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