

Exploring for Lunar Volatiles: The VIPER Mission Instrument Package

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Abstract

NASA anticipates launching several exploration missions to the lunar surface in 2023 and 2024. Three of these missions carry the Mass Spectrometer Observing Lunar Operations (MSolo) instruments designed to detect lunar volatiles in lunar ice. One mission, the Polar Resources Ice Mining Experiment–1 (PRIME–1) will land in the south lunar pole area. PRIME–1 also includes a drill named TRIDENT (The Regolith and Ice Drill for Exploring New Terrain). PRIME–1 will be an initial test mission.

A more advanced mission, the Volatiles Investigating Polar Exploration Rover (VIPER) is scheduled for late 2024. VIPER will explore the south lunar pole near the Nobile Crater. VIPER is part of the overall lunar ARTEMIS Mission profile. VIPER carries a one-meter drill assembly used to provide samples to several onboard instruments. In particular, the MSolo will be used for volatiles detection and support physical ice characterization.

For the VIPER mission, the rover will explore for about 100 days and cover a planned distance of up to 20 km. In addition to a TRIDENT drill, VIPER carries the Neutron Spectrometer System (NSS), the Near-Infrared Volatiles Spectrometer System (NIRVSS) and the MSolo. NSS searches for potential water ice in the lunar regolith. TRIDENT will then drill and collect samples. NIRVSS distinguishes between water hydrogen and hydroxyl and to analyze the different types of minerals and ices that might be present. NIRVSS also carries a broad-spectrum camera for imaging regolith-soil composition and a longwave sensor for regolith surface temperature. MSolo, as a commercial off-the-shelf mass spectrometer modified for the extreme environmental conditions of the lunar south pole, has a very critical role. It will distinguish between derived gasses from the regolith and those potentially introduced by the lander. Together with the NIRVSS instrument, MSolo can detect, analyze and report on key volatile components of anticipated lunar ice.