Overview of the Volatiles Investigating Polar Exploration Rover. T. Fong[1], B. Bluethmann[2], and L. Bridgwater[2]. [1]NASA Ames Research Center, Moffett Field, CA, [2]NASA Johnson Space Center, Houston, TX. (Contact: terry.fong@nasa.gov)

Introduction: The Volatiles Investigating Polar Exploration Rover (VIPER) is a lunar volatiles detection and measurement mission. VIPER will be launched to the Moon in late 2023 as a payload on the Commercial Lunar Payload Services (CLPS) flight provided by Astrobotic's Griffin lander. The VIPER rover is a solar powered, mobile robot designed to traverse up to 20 km during a mission lasting up to four lunar days.

After landing in a south polar region, the VIPER rover will travel to investigate a range of Ice Stability Regions (ISRs) across scales from 100s of meters to kilometers and conduct surface and subsurface assessment of lunar water and other volatiles. VIPER includes a suite of rover-mounted instruments (three spectrometers and a drill), which the VIPER science mission team will use to characterize the nature of the volatiles and to create global lunar water resource maps.

Mission Objectives: While the existence of lunar volatiles has been known since the Apollo era, it is only during the last 20 years that the extent and form of these volatiles has been better understood. It now appears likely that economically significant amounts of water ice may exist at the poles of the Moon, however, the distribution, physical state, and accessibility of this water is still not sufficiently characterized to determine if it would provide an economically viable resource for a variety of uses.

To evaluate the potential for lunar polar volatiles to be utilized, VIPER has two primary objectives: (1) Characterize the distribution and physical state of lunar polar water and other volatiles in lunar cold traps and regolith to understand their origin; and (2) Provide the data necessary for NASA to evaluate the potential return of In-Situ Resource Utilization (ISRU) from the lunar polar regions.

Rover Design: VIPER is a four-wheeled planetary rover with active suspension (Figure 1). Active suspension provides capabilities including changing vehicle ride height, traversing comparatively large obstacles, and controlling load on the wheels. All-wheel steering enables the vehicle to point arbitrarily while roving, e.g., to keep the solar array pointed at the sun while in motion. The offset steering combined with active suspension improves driving in soft soil.

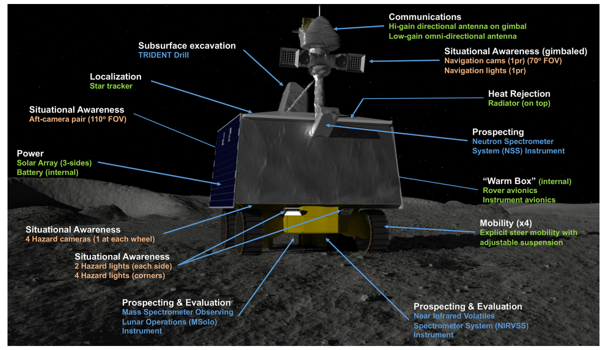

Figure 1. The VIPER planetary rover includes a prospecting and evaluation payload for lunar volatiles, navigation sensors, power and thermal management, and Direct-to-Earth communications.

The VIPER rover's software is split between onboard Rover Flight Software (RFSW) and off-board Rover Ground Software (RGSW). RFSW runs onboard the rover on radiation hardened (RAD 750) and radiation tolerant (AiTech SP0-S) avionics. RFSW utilizes NASA's Core Flight System and provides low-level hardware interfaces, basic mobility control, waypoint driving, odometry, basic error checking, and device/payload services. RGSW runs at mission control on Earth using commodity desktop computing. RGSW is implemented as an ensemble of Robot Operating System 2 (ROS2) nodes and performs navigation, mapping, and generation of rover driver decision support data.

The VIPER rover is electrically powered and relies upon batteries and three approximate 1 m^2 solar arrays (one each on the port, starboard, and aft surfaces). The rover operates with Direct-to-Earth (DTE) communications using an omni-directional low-gain / low-bandwidth antenna and a steerable high-gain / high-bandwidth antenna. Eight cameras, including a stereo pair mounted on a pan/tilt gimbal are used to support remote driving. An inertial measurement unit, star tracker, and joint encoders provide data for localization, attitude, and body rate estimation.

During surface operations, the rover follows a specific surface traverse plan, primarily by teleoperation via individual position (waypoint) commands set several meters ahead of the vehicle. The rover operates with constant DTE communications while in the Sun and in shadows (for short periods of time).