Z5.05-3809 - Cryogenic Thermal Management Systems for Lunar Outpost Mobile Autonomous Prospecting Platform (MAPP) Rover

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NON-PROPRIETARY DATA

IDENTIFICATION AND SIGNIFICANCE OF INNOVATION

- Mobile robotic systems for lunar surface operations are essential to provide ground-truthing of orbital sensor data sets, create depth profiles and advance modeling efforts while augmenting remote sensing data and advancing the Science Mission Directorate's Strategic Goals and Objectives of enabling sustainable long-term exploration and utilization of space resources.
- The small, lightweight (10kg) Cryogenic-Operation, Long-Duration Mobile Autonomous Prospecting Platform (COLD-MAPP) lunar rover addresses these goals by extending lunar rover operation duration through multiple lunar day/night cycles and into permanently-shadowed regions.
- COLD-MAPP uses novel thermal control technologies to achieve this, such as cryo-capable wheel hub motors, an Earth-radiation thermal collector, and a drill hole heat pipe system to survive a thermal range of -230C to +150C.
- Enables robotic sampling and instrument transport/placement missions to locales too harsh or dangerous for human operation.

TECHNICAL OBJECTIVES AND WORK PLAN

Technical Objectives: -Develop cryo-capable mobility drive system that can survive the lunar night and operate in permanently-shadowed regions. Phase I will use thermal and mechanical modelling to develop the concept for a preliminary design, to be constructed in Phase II. -Generate preliminary designs for the Earthheat and DrillHeat concepts using thermal and materials modelling. -Develop a thermal management system to maintain thermal balance of rover, over the specified range of thermal conditions and using cryo-characterized materials.
Work Plan Summary: -Perform a detailed thermal analysis of the lunar day, night, and PSR environments to characterize thermal sources, sinks, and physics of heat transfer to manmade hardware in these regimes. -Analyze thermal balance of rover at component, subsystem, and system levels; determine necessary thermal conditions for operation and survival. -Design wheel drives, thermal pathways, and preliminary systems for capturing the radiated warmth of Earth and stored solar energy captured in subsurface regolith.
Proposed Phase I Deliverables: -Documented analysis methodology of thermal transfer mechanisms to rover hardware in lunar night and PSRs. -Catalog of cryo-capable rover materials. -Analysis and design of rover wheel drives and thermal management system -Preliminary designs of EarthHeat and DrillHeat systems.

TRL

Estimated

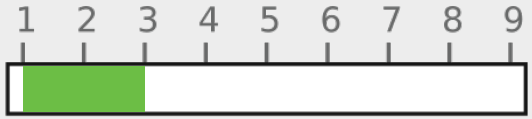
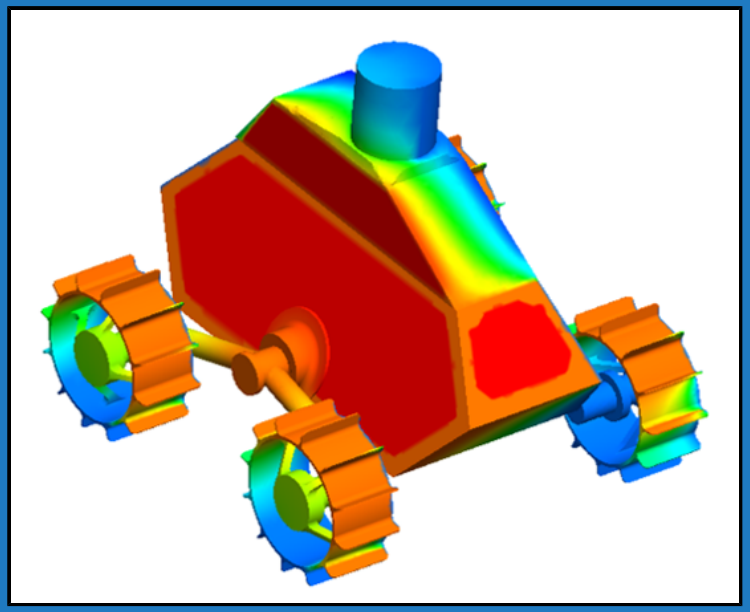


IMAGE TITLE: COLD-MAPP



NASA APPLICATIONS

NASA applications for the COLD-MAPP are to provide mobility capabilities to instruments and payloads, and add value over a static lander deployment. These payloads include ISRU prospecting instruments and surveying sensors, which can be deployed in flexible and cost-effective campaigns to accelerate the exploitation of ISRU resources. The EarthHeat and DrillHeat thermal collectors can be incorporated into the lunar-night survival strategy for a variety of surface hardware including landers and rovers.

NON-NASA APPLICATIONS

Non-NASA commercial applications for the COLD-MAPP include applications in both the current terrestrial mining industry, as well as in future space-based ISRU commercial concerns. As NASA pursues public-private partnerships, catalogs of demonstrated, high-TRL thermal solutions will serve to retire risk and accelerate schedules of future commercial missions and payloads solicited via CLPS.

FIRM CONTACTS

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