THE CANADIAN LUNAR ROVER MISSION TO THE SOUTH POLAR REGION OF THE MOON: A STATUS REPORT. G. R. Osinski[1], E. A. Cloutis[2], M. Lemelin[3], P. Edmundson[4], C.-E. Morisset[5], M. Picard[5], T. Lamarche[5], B. T. Greenhagen[6], M. B. Smith[7], L. L. Tornabene[1], J. T. S. Cahill[6], T. Colaprete[8], A. Cunje[1], M. Daly[9], K. Donaldson Hanna[10], C. Elder[11], R. Flemming[1], J. Hackett[4], C. Hardgrove[12], C. D. K. Herd[13], D. Lees[8], D. Lim[8], S. J. MacEwan[7], Z. Mirmalek[8], C. D. Neish[1], J. Newman[4], L. Preston[14], M. Siegler[15], A. Sirek[16], D. Williams[16] and the LRM team, [1]Dept. Earth Sciences, University of Western Ontario, ON, Canada (gosinski@uwo.ca), [2]C-TAPE, University of Winnipeg, MB, Canada, [3]Département de géomatique appliquée, Université de Sherbrooke, QC, Canada, [4]Canadensys Aerospace Corporation, ON, Canada, [5]Canadian Space Agency, Saint-Hubert, QC, Canada, [6]Johns Hopkins Applied Physics Laboratory, MD, USA, [7]Bubble Technology Industries Inc., ON, Canada, [8]NASA Ames Research Center, CA, USA, [9]Dept. of Earth and Space Science and Engineering, York University, ON, Canada, [10]University of Central Florida, FL, USA, [11]Jet Propulsion Laboratory, CA, USA, [12]School of Earth and Space Exploration, Arizona State University, AZ, USA, [13]Dept. of Earth and Atmospheric Sciences, University of Alberta, AB, Canada, [14]Dept of Space and Climate Physics, University College London, UK, [15]Planetary Science Institute, AZ, USA, [16]Leap Biosystems, ON, Canada.

Introduction: The Moon is a high priority destination for the Canadian planetary science community and industry. In February 2019, the Canadian government announced $2.05 billion in funding for 3 lunar science and exploration initiatives: the development of Canadarm3 for the Lunar Gateway, the Lunar Exploration Accelerator Program (LEAP), and Junior Astronauts, an education and public outreach initiative. The flagship of the LEAP initiative is the Canadian Lunar Rover (Fig. 1), which will not only be Canada's first rover mission, but also the first ever Canadian-led planetary exploration endeavour. Canadensys Aerospace Corporation (Canadensys) was selected in November 2022 as the prime contractor for this mission, at which point Phase B of mission development began. The overall goal is to land a 35 kg Canadian rover in the south polar region of the Moon on a future NASA Commercial Lunar Payload Services (CLPS) launch. The goal is that the rover will be able to operate inside of permanently shadowed regions for up to one hour and survive at least one lunar night.

Previous reports on the Canadian Lunar Rover Mission (LRM) were presented at the 2023 [1] and 2024 [2] Lunar and Planetary Science Conferences. Since then, the Preliminary Design Review (PDR) was successfully completed in June 2024 and the mission entered Phase C in July 2024. In this contribution, we provide a status report on the Canadian Lunar Rover Mission. For a more detailed overview of LRM, see [3].

Science Objectives: There are 3 overarching science objectives for the LRM:

1. Lunar polar geology and mineral resources;
2. Lunar polar shadow, cold-traps, and volatiles;
3. Environmental monitoring for engineering to ensure the health of future astronaut.

Science Instruments: The Canadian Lunar Rover will carry 6 science instruments (Figs. 1, 2): the stereo camera (StereoCam), the Multispectral Imager (MSI), the NISA-1000, the Lunar Hydrogen Autonomous Neutron Spectrometer (LHANS), the Radiation Micro-Dosimeter, and the Lunar Advanced Filter Observing Radiometer for Geologic Exploration (LAFORGE). The latter is provided by NASA and accommodated by the rover as part of an international Canadian Space Agency – NASA agreement. This instrument complement has undergone some changes since the initial concept presented in 2023 [1] and further changes during Phase B (as presented in [2]).

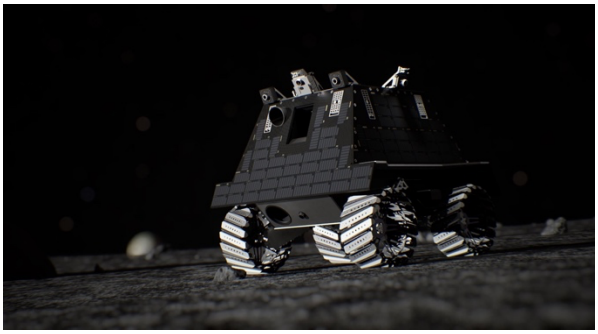

Fig. 1. A virtual reality (VR) mock-up of the current design of the Canadian lunar rover.

StereoCam. StereoCam consists of a pair of NISA RGB cameras mounted near the top of the rover with overlapping FOVs (Figs. 1, 2). The FOV of each camera is 144° horizontal and 104° vertical and will be mounted pointing at 20° below the horizontal. The horizontal separation between the cameras is 40 cm. Its FOV partially overlaps with that of NISA-1000 and LAFORGE.

Multispectral Imager (MSI). The MSI will examine regolith and rocks in close proximity to the rover (up to ~1 meter from the front of the rover). It will provide information on the physical structure of regolith, rock textures, and composition. MSI is a panchromatic NISA-based camera and its FOV is illuminated by six pairs of LEDs (to provide multispectral data). It is mounted on the front of the rover in a forward and downward-looking direction, with a horizontal FOV of 35°, and vertical FOV of 26°. MSI will be mounted pointing at 45° below the horizontal (Fig. 2).

NISA-1000: This new instrument is a forward-looking camera mounted near the top of the rover to be equipped with a long-pass IR filter that allows reflected ambient sunlight to be sensed (Fig. 2). It has a horizontal FOV of 26°, and a vertical FOV of 20°, and will be mounted pointing at 14° below horizontal. Two filters are currently under consideration and are actively being tested to maximize sensitivity to minerals and water ice: one centered at ~970 nm (FWHM: ~50 nm) and one centered at ~1035 nm (FWHM: ~100 nm).

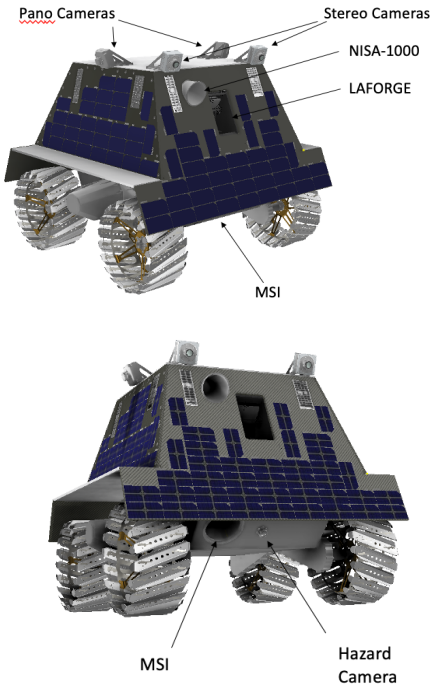

Fig. 2. Instrument placements on rover exterior.

Lunar Hydrogen Autonomous Neutron Spectrometer (LHANS). This is a combined neutron and gamma-ray instrument developed by Bubble Technology Industries from Chalk River, Canada, with the overall goal of detecting hydrogen as a proxy for water ice in the south polar region of the Moon. Hydrogen sensitivity comes predominantly from neutron spectroscopy. The instrument also has the capability to detect other elements (e.g., Ti, Fe, Ca, P, K, Th, and U) as a secondary goal, largely using gamma-ray spectroscopy. The LHANS will measure the thermal neutron signal using a thin scintillator crystal coupled to an array of photodetectors. The epi-thermal neutron, fast neutron, and gamma-ray data will be collected using a larger scintillator crystal with a smaller cross-sectional area, also coupled to a photodetector array.

Radiation Micro-Dosimeter. Total ionizing dose (TID) absorbed in silicon will be recorded throughout the mission using a UDOS007 micro-dosimeter hybrid microcircuit manufactured by Teledyne.

LAFORGE. The Lunar Advanced Filter Observing Radiometer for Geologic Exploration (LAFORGE) instrument is being provided by the Johns Hopkins Applied Physics Laboratory through a partnership with NASA. LAFORGE is a multispectral thermal infrared (TIR) imaging radiometer designed to maximize temperature accuracy, especially at temperatures below 100K. The goal of LAFORGE is to provide high quality thermal imaging with an ability to obtain highly accurate temperature measurements across the full range of thermal environments present at the lunar south pole, including PSRs (i.e., better than 5K accuracy at 40K and 2K accuracy at 65K).

In addition to these 6 science instruments, the rover also has two side-looking RGB cameras (Pano Cameras), and the RGB forward and downward-looking Hazard Camera (HazCam) with a wide field of view (FOV) (Fig. 1). The Pano Cameras consist of two Nano-Compatible Immersive Situational Awareness (NISA) RGB cameras mounted on either side of the rover (Figs. 1, 2) with a FOV of 186° horizontally and 186° vertically. HazCam is a single NISA camera mounted near the bottom of the rover in a forward-looking direction, mounted at 45° below horizontal. It will be used primarily for navigation, as well as for target identification and contextualization of MSI data, with which it has an overlapping FOV.

Landing Site Analysis: The identification of potential landing sites for the Canadian Lunar Rover is the subject of ongoing investigations by the Landing Site Selection Working Group, a subset of the LRM team. At a meeting held in April 2023, the number of potential sites (each measuring 5 x 5 km) was reduced to 13. This down-selection was driven to a large extent to maximize operation time while staying in close proximity to area with near surface modeled ice stability. Following this, detailed geomorphological maps were created of the 13 sites. A workshop held in May 2024 resulted in the selection of 6 sites, with two of these being a combination of two overlapping 5 x 5 km sites. The final location will be determined with NASA and the other payloads that will be manifested on the same CLPS flight as the Canadian Lunar Rover.

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References: [1] Osinski G. R. et al. (2023) *54th Lunar and Planetary Science Conference* (abstract #2487). [2] Osinski G. R. et al. (2024) *55th Lunar and Planetary Science Conference* (abstract #1728). [3] Osinski G. R. et al. (2024) In: *75th International Astronautical Congress* (IAC), Milan, Italy, 14-18 October 2024, IAC-24.A3,2B,12,x89577.