The science instrumentation for the Rashid rover of the Emirates Lunar Mission. S.G. Els[1], S. Almaeeni[2], H. Almarzooqi[3], on behalf of the ELM development and science team, [1]Mohammed Bin Rashid Space Centre (PO Box 211833, Dubai, UAE, sebastian.els@mbrsc.ae), [2]Mohammed Bin Rashid Space Centre (PO Box 211833, Dubai, UAE, sara.almaeeni@mbrsc.ae), [3]Mohammed Bin Rashid Space Centre (PO Box 211833, Dubai, UAE, hamad.almarzooqi@mbrsc.ae).

Introduction: The Emirates Lunar Mission consists of the "Rashid" rover whose objective is to scout the lunar surface during the course of one lunar day. Thereby, Rashid shall foster the national capabilities to develop the technologies to conduct lunar surface exploration. For more details on the mission profile, objectives and development process we refer to [1]. The secondary goal of the Rashid rover is to conduct scientific investigations of the lunar surface. The Rashid science objectives cover both fundamental science as well as engineering topics to enable future missions to the lunar surface, or other airless solar system bodies. Hence, the Rashid rover will carry a suite of instruments, which will collect data covering a wide range of the physical properties at the lunar surface. In this paper, we will outline the initial requirements for the science program and describe the selected scientific instruments of the Rashid mission.

Rover main design: The Rashid rover totals a mass of 10kg and, with a footprint of approximately 0.5m x 0.5m, it is a very compact rover. On its roof, a deployable mast is fitted which elevates the rover's main camera to a height of just under 70cm above ground. Mobility of the rover is provided by means of four wheels with grousers. Two identical 2048x2048 px CMOS wide field cameras, each covering a field of view of 85^o are mounted on the rover. As already noted, the main camera is gimbaled at the top of the mast, thus providing 360^o visibility and delivering the main operational awareness for rover drive operations. The second wide field camera is fixed to the rear of the rover. This camera provides a closer view of the rover tracks imprinted in the lunar soil. It also acts as redundant camera in case of a failure of the main camera.

Science requirements: The two optical cameras will deliver a wealth of data which will be also exploited scientifically. But the design goals for Rashid reach further. To develop the incorporation of a substantial scientific payload into the rover, the high-level science requirements for the Rashid mission were set as follows. 1) The science system shall make use of the rover's mobility; and 2) the science system shall be able to achieve its objectives at (almost) any location on the Moon. While the reasoning behind requirement 1) is obvious, it is noted that requirement 2) stems from the fact that the lunar delivery would be provided by an external entity, and at the onset of the mission development it was not clear if, and by how much, the ELM could influence the selection of the landing site.

Science instruments: The following provides a brief summary of the instruments which are being developed for the Rashid rover.

Microscopic imager (CAM-M): The CAM-M camera is an optical imager which will obtain high resolution images of the lunar surface. It is mounted statically at the front of the rover, pointing slightly ahead of its main body. CAM-M uses the same detector as the other optical imagers, and will achieve a spatial resolution of approximately 30mu/px (non-Bayer pixel). This spatial resolution will allow to resolve the majority of particles of the typical regolith size distribution.

Langmuir probe system (LNG): The rover's physical dimensions are as such that Rashid will be embedded in the densest part of the lunar electron sheath [2], which makes it a suitable platform to measure the sheath's properties. The LNG system consists of four cylindrical Langmuir probes which are mounted at different heights on the rover body, thereby tracing the electron densities between approximately 15cm and 65cm above ground. By using its drive capabilities, Rashid might thus be able to conduct a 3D mapping of the electron densities in the landing area.

Thermal imager (CAM-T): Over recent years, thermal imaging cameras have become commercially available as compact, lightweight and low cost packages. Even the most basic thermal cameras provide sufficient sensitivity to conduct sensible studies of the thermal properties of lunar surface features. Hence, Rashid will be equipped with an 80x64 px thermopile array, covering a field of view of approximately 38^{o}x31^o. This will allow to resolve thermal features at cm scales in the vicinity of the rover.

Material Adhesion/Abrasion Determination (MAD): The mechanical effects of dust are known to be a main concern for any lunar surface mission. Therefore, Rashid will conduct an experiment to test in-situ different materials for their adhesive and abrasion properties wrt to lunar regolith. To do so, different material samples will be mounted on the outer circumference of a wheel. The collection of dust on these samples will be monitored by means of the mast mounted main camera, which will be able to

resolve mm size particles, scratches, and contamination on the wheels.

Science collaboration and data archive: The science program of ELM is a joint effort by an international consortium of academic institutions, as well as industrial partners, under the leadership of MBRSC. This consortium is developing the testing and calibration of the instruments, as well as preparing for the science operations and data processing. The science data collected by Rashid will be made available after the mission to the entire science community for further exploitation.

Summary The Emirates Lunar Mission rover "Rashid" will be equipped with a substantial suite of scientific instruments. The main focus of the selected instrumentation is to investigate the microscopic structure of the lunar surface soil, the lunar electron sheath, and the interaction between them. Also, thermal properties of larger than cm size surface features will be addressed, as well as certain aspects of material suitability for lunar surface missions.

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References:

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