Exploring the Moon with the Lunar Volatiles Mobile Instrumentation – Extended (LUVMI-X) Platform.

J. Biswas[1](j.biswas@tum.de), S. Barber[2], T. Chupin[3], A. Evagora[4], D. Fodorcan[3], J. Gancet[3], C. Gscheidle[1], S. Kubitza[5],M. J. Losekamm, H.K. Madakashira[3], N. Murray[4], J. Neumann[6], T. Pöschl[1], M. Reganaz[7], L. Richter[7], S. Schröder[5], J. Schwanethal[2], S. Sheridan[2], D. Urbina[3], D. Vogt[5], and P. Wessels[6]; [1]Technical University of Munich, Boltzmannstr. 15, 85748 Garching, Germany; [2]The Open University, MK7 6AA, Milton Keynes, United Kingdom; [3]Space Applications Services NV/SA, Leuvensteenweg 325, 1932 Sint-Steven-Woluwe, Belgium; [4]Dynamic Imaging Analytics, MK3 6EB, Milton Keynes, United Kingdom; [5]German Aerospace Center, Institute of Optical Sensor Systems, Rutherfordstr. 2, 12489 Berlin-Adlershof, Germany; [6]Laser Zentrum Hannover e.V., Hollerithallee 8, 30419 Hannover, Germany; [7]OHB System AG, Manfred-Fuchs-Str. 1, 82234 Weßling, Germany

Introduction: The Lunar Volatiles Mobile Instrumentation (LUVMI) Rover is a small, low-mass platform with a selected set of instruments to explore the lunar poles in search for potential water ice [1]. With LUVMI-extended (LUVMI-X), we are extending the platform to address a wider set of scientific goals, carrying more instruments and implementing innovative, modular payload platforms.

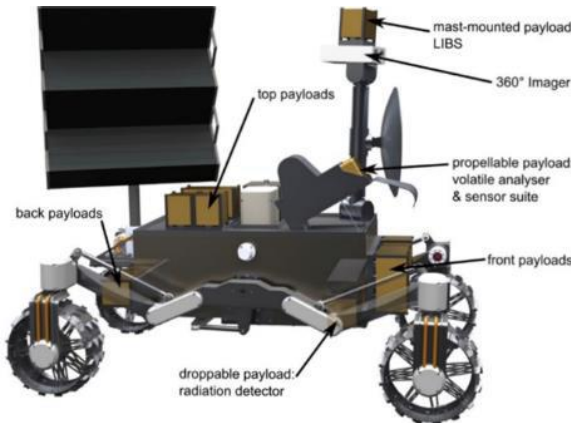

Figure 1: Concept sketch of the LUVMI-X platform

Instruments:

Lunar Volatiles Scout (LVS): The LVS is a small, low-mass instrumented drill for the detection and analysis of volatiles in lunar regolith. It consists of the Volatiles Sampler (VS), a 15-cm core drill that can heat samples in-situ. Released gases are channelled towards the Volatiles Analyser (VA), a miniature ion-trap mass spectrometer with a mass range (m/z) between 10 and 150 for gas analysis. The LVS assembly has a combined mass of less than 2 kg [2].

Volatiles Context Analysis Suite (VCAS): The VCAS is a sensor suite for observation of lunar volatiles that can either be deployed on the lunar surface for long-term exosphere observations or be propelled several meters across the lunar surface to provide measurements from otherwise inaccessible areas. Equipped with a VA mass spectrometer, surface temperature sensors, a dust sensor, and an imager, it can measure released volatiles and provide valuable context information about the state of the volatile deposit.

Volatiles Identification by Laser Analysis (VOILA): VOILA provides a multi-elemental analysis capability to investigate rocks and regolith along the rover's path. Using Laser Induced Breakdown Spectroscopy (LIBS), the instrument provides coverage from 630 nm to 780 nm and is optimized for the detection of hydrogen (656.3 nm) and oxygen (777.4 nm). This will allow the instrument to detect potential areas of high volatiles content for further investigation by the LVS. In addition, it can provide valuable insight into the composition of rocks or regolith, which may be used for future ISRU processes [3].

Radiation Detector (RD): The RD is a combined sensor that comprises a charged-particle detector (CPD) and neutron detector (ND). The CPD will detect solar-wind and cosmic-ray particles with energies larger than 10 MeV to characterize the lunar radiation environment for future manned missions. The ND will detect albedo neutrons emitted from the lunar surface. Analysing the energy spectra of these albedo neutrons can provide indications of possible hydrogen presence in the lunar regolith [4], which would be a clear indication of a volatiles deposit.

Imagers: LUVMI-X features six imaging systems: The NavCam and three HazCams for navigation and hazad detecting, and SurfCam and ContextCam for LVS/LIBS sample context analysis. Both NavCam employ the light-field technology to provide high quality, 3-dimensional images [5].

Platforms:

Rover Platform: The solar-powered LUVMI-X rover features a rocker-bogie-actuated suspension with four independently steerable wheels for maximum mobility. Capable of a 5-km traverse during a lifetime of 14 days on the lunar surface, the platform has a mass of 25 kg, allowing for the accommodation of an additional 25 kg of scientific payloads.

Mounted Payload Platforms: LUVMI-X features a standardized payload interface that allows for the accommodation of a wide array of potential payloads while minimizing interface management.

Deployable Payload Platforms (DP): Not all scientific payloads can be accommodated on a mobile rover or a static lander. Some instruments may need to perform long-term observations at specific locations, be distributed along the surface in a pattern,

need direct contact with the surface, or have requirements that are otherwise in conflict with the rover platform. Leveraging CubeSat technology, the DP present a solution to this problem. Solar-powered and with their own communication system, they provide a standalone platform for long-term payload operation.

*Propellable Payload Platforms (PP):*A simplified version of the DP, the PP can be projected into inaccessible areas to perform measurements for a short duration.

References: [1] J. Gancet et al (2019) *IAC*-19-A3.2C.6.; [2] J. Biswas et al. (2020) *Planetary and Space Science., 182*.; D. S. Vogt et al (2020) *ELS* VIII [4] W. Feldmann (1998) et al, *Science*, 281; [5] N. Murray et al (2020), *ELS VIII*