

SER3NE – A Small Mission To The Moon. S. C. Werner¹, J. Bartholomäus², Ö. Karatekin³, E. Klioner², A. Kohfeldt¹, K. Lingenauber⁴, and the SER3NE Team, ¹University of Oslo, Norway (stephanie.werner@geo.uio.no), ²Technical University of Berlin, Germany, ³ Royal Observatory of Belgium, ⁴Institute for Planetary Research - DLR, Germany.

Introduction: Selene's Explorer for Roughness, Regolith, Resources, Neutrons and Elements (SER3NE) is a small satellite mission performing gamma-ray and neutron spectroscopy (University of Oslo), near-infrared spectroscopy (Royal Observatory of Belgium and Royal Belgian Institute for Space Aeronomy), and laser altimetry, roughness, and albedo observations (Institute for Planetary Research - DLR) at unprecedented spectral and ground resolution. The aim is to characterize the lunar surface to unravel its volatile origin and delivery processes, to uncover the geological processes that shaped the Moon, to prospect lunar resources for ISRU at future landing sites, to determine the exact neutron lifetime and the orbital evolution of the Earth-Moon system.

The SER3NE space segment consists of the SER3NE satellite platform, the communication relay, the payloads, the orbit. The satellite platform (Technical University of Berlin) is based on the modular TUBIX20 architecture and specifically its latest iteration, the QUEEN satellite. Originally designed for Low Earth Orbit, and adapted for the challenges of the SER3NE mission, it is flexible in hardware and software integration while aiming at single-failure tolerance for all non-payload subsystems. The system is structured around a network of cold-redundant computational nodes, each tailored to specific subsystems and payloads, and a centralized data bus, facilitating seamless communication across the system. To ensure the desired global coverage and resolution for all instruments the satellite will orbit the Moon on a eccentric polar orbit with a slowly, naturally drifting argument of perilune over the mission lifetime of one year. The payload suite consists of three instruments:

1. GRNS (Gamma-Ray and Neutron Spectrometer)
2. S3LA (SER3NE's Laser Altimeter)
3. LIPS (Lunar Infrared Point Spectrometer)

GRNS is to determine the elemental specific composition of the lunar surface by measuring the distribution to resolve the induced gamma rays and neutrons of varying energies in the range of to 100keV to 8 MeV. The analysis shall provide global maps of major rock forming elemental abundances and the presence of hydrogen. The orbit of the spacecraft and the construction of the detector and its electronics will be crucial for making SER3NE's GRNS spectral and ground resolution (30km/pxl) better than previous observations.

LIPS collects lunar reflectance spectra in the wavelength range 2.6 μm to 3.6 μm with a spectral resolution of 31 nm to covers the prominent asym-

metric hydration absorption features caused by OH, molecular H₂O and water ice, including the needed thermal correction. An additional thermal channel is considered in the mid-infrared to obtain the lunar surface temperature directly and hence to improve the thermal correction. The spatial resolution of the instrument will be better than 100 m/pixel. LIPS may have optional channels of SWIR (0.9 μm -2.5 μm) to study mineral compound in this spectral range.

S3LA is a precision instrument to measure surface topography with high accuracy and operates by emitting laser pulses toward a target surface and analysing the time-of-flight of the returned signals to determine elevation with <5 cm range precision. S3LA is a single photon counting laser altimeter, which enhances measurement capability by detecting individual photons reflected from the target surface and offers distinct advantages, particularly in mapping permanently shadowed regions, measuring small-scale surface features, and supporting precision navigation.

Revealing temporal variability in hydrogen speciation and abundances if detected and confirmed will provide clues on a potential lunar water cycle. As such, some surface water or hydrated products appear to be time dependent, suggesting active creation and destruction of chemical bonds that can be driven by solar processes and/or mobility of volatiles on the surface in response to thermal gradients. Therefore, the combination of GRNS, for hydrogen detection, LIPS, for investigating hydrated minerals, and S3LA, for providing the local high resolution topographic context are essential. Furthermore, GRNS and LIPS will provide mineral resource distribution across Moon and will be able to characterise temporal variability and its correlation with mineralogy and soil maturity. SER3NE shall peek into permanently shadowed regions, identified, and further defined by S3LA, using the scattered reflected light in regions of high hydrogen abundances.

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