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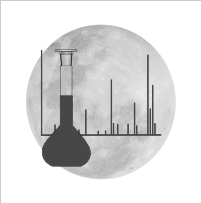

Highlights of Analytical Sciences in Switzerland

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Back to the Moon – *in situ* Chemical Analysis on the Lunar Surface using LIMS

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Swiss instrumentation has a long history in lunar science exploration, making its debut on the lunar surface as part of the Apollo 11 mission in the form of the Solar Wind Composition experiment (SWC), developed at the Physics Institute of the University of Bern. Comprising an ultra-pure aluminum foil sail, the SWC collected solar wind ions and was subsequently returned to Earth for analysis. With the renewed interest in human lunar landings, *e.g.* within NASA's Artemis program, which serves also as a precursor program for Mars exploration, new opportunities to perform more complex scientific experiments on the Moon arise. Such *in situ* experiments are of high interest to the field of planetary sciences, since they can contribute to answering fundamental questions *e.g.* about the evolution of our solar system. Therefore, new precise instrumentation, which *e.g.* can determine the element and isotope composition of lunar rock, is required that would also support the astronauts' on-site work. Such an instrument can facilitate pre-classification and prioritization studies of samples selected for sample return to Earth, as well as *in situ* analysis of samples for which sample return is infeasible (*e.g.* volatiles in lunar permanently shadowed regions).

At the University of Bern, we have been developing a Laser Ablation Ionization Mass Spectrometer (LIMS) that is a candidate instrument for the Artemis program. LIMS offers advantages over currently routinely used chemical analysis techniques on planetary surfaces such as X-ray fluorescence, γ-ray or neutron spectroscopy. One major advantage is the achievable dynamic range, allowing for detection and quantification of main but also trace elements. In combination with high lateral resolution at the micrometer level, this yields a unique parametric set, which currently cannot be replicated by other methods used in planetary research. We present the preliminary flight design of our miniature LIMS system suited to operate on the lunar surface. A cage system containing all relevant components of a flight design was designed and realized to facilitate the evaluation of the laser and optical setup. In anticipation of deployment on the Moon, this setup is currently being used for characterization studies of the system to ensure optimal preparation.

After more than 50 years of Switzerland having been present on the Moon, the next chapter in Lunar exploration is right around the corner.

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Reference

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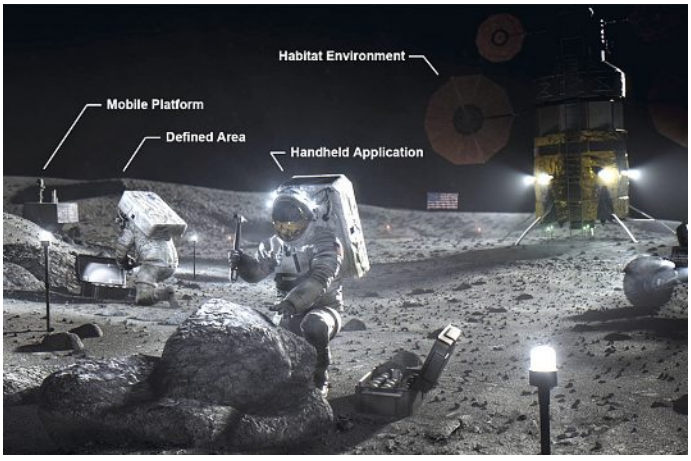
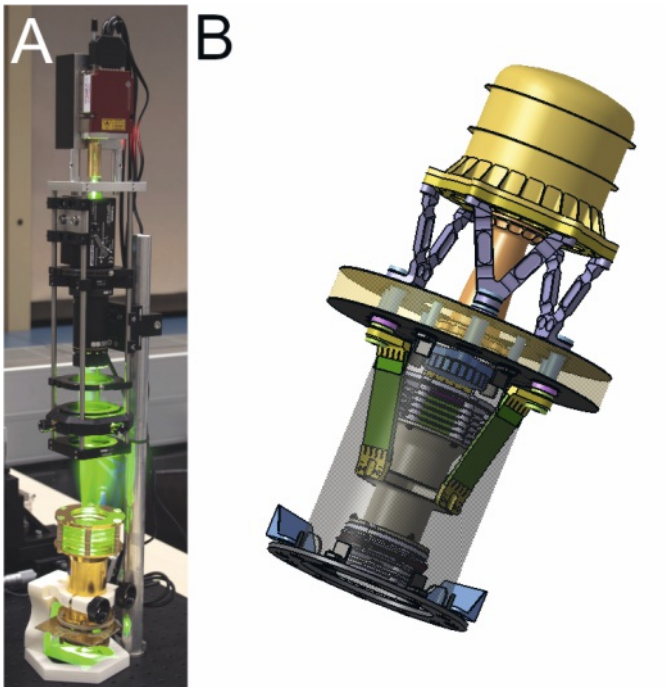


Lunar landing site of a manned mission within NASA's Artemis program. Scientific instruments can be operated within the pressurized habitat or while performing Extravehicular Activities on mobile platforms. Adapted from NASA Artemis III SDT Report.



Laboratory setup to test the laser and optical components of the LIMS (A) and instrument flight design as shown by the CAD drawing (B). For illustrative purposes the TOF mass analyzer has been placed directly under the optical cage. Under operating conditions, it is mounted in a vacuum compartment. The sample introduction system will be attached to the bottom of the flight design.

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