LASER-INDUCED BREAKDOWN SPECTROSCOPY INSTRUMENT FOR ACCURATE IN-SITU PROSPECTING OF SPACE RESOURCES. I. Uwarowa[1], P. Pořízka[2]*, Jakub Buday[3], Jan Novotný[4], Patrik Cebo[5], Tomáš Drobil[6], Petr Sovadina[7], Daniel Holub[8], and J. Kaiser[9], [1]Lightigo Space, Hlavní 104, 66431 Lelekovice, CZ, uwarowa@lightigo-space.com, [2]Lightigo Space, Hlavní 104, 66431 Lelekovice, CZ, porizka@lightigo-space.com, [3]CEITEC Brno University of Technology, Purkynova 123, 61200 Brno, CZ, buday@vutbr.cz, [4]Lightigo, Hlavní 104, 66431 Lelekovice, CZ, novotny@lightigo.com, [5]Lightigo, Hlavní 104, 66431 Lelekovice, CZ, cebo@lightigo.com, [6]Faculty of Mechanical Engineering, Brno University of Technology, Technicka 2, 61669 Brno, CZ, 216891@vutbr.cz, [7]Faculty of Mechanical Engineering, Brno University of Technology, Technicka 2, 61669 Brno, CZ, 216861@vutbr.cz, [8]Faculty of Mechanical Engineering, Brno University of Technology, Technicka 2, 61669 Brno, CZ, holub@vutbr.cz, [9]CEITEC Brno University of Technology, Purkynova 123, 61200 Brno, CZ, jozef.kaiser@ceitec.vutbr.cz. *corresponding author: pavel.porizka@ceitec.vutbr.cz

The space exploration is getting momentum and moving towards research, commercialization, and sustainable presence of humanity in space. The key factor of all those steps is understanding of the environment of the targeted celestial body and capability to use the resources for sustainable exploration. After high-level prospection of the surface of Moon, Mars and further potentially beneficial targets, the analytical instruments (related to other segments of In-Situ Resource Utilization, ISRU) shall provide more detailed, more accurate analysis of the elemental composition.

Laser-Induced Breakdown Spectroscopy (LIBS) meets the challenge of in-situ geological survey of celestial bodies providing detailed analysis on the level of the element composition. The LIBS technique has already proved its capability as a payload on Mars rovers and its use on lunar rovers is foreseen. Laser-Induced Breakdown Spectroscopy (LIBS) is a modern, dynamically evolving analytical method of atomic emission spectroscopy for determining the elemental composition of material. The LIBS method represents an ideal technique for remote (contactless) in-situ elemental analysis with low demands for sample preparation prior to the analysis. Such a versatile nature of LIBS has resulted in a remarkable diversity of applications ranging from online material classification on an industrial scale, to direct terrain analysis to LIBS-based payloads used for space exploration. Thus, LIBS can be adapted to various instrumental arrangement suitable for various segments of ISRU. [1,2]

Lightigo Space is benefiting from its ground LIBS expertise to bring the technology available for small robotic exploration missions. The ISRA (In-Situ Resource Analyzer) instrument has a unique construction and is composed of a main unit (carrying laser and spectrometer-detector assembly) and a modular unit (carrying focusing and collecting optics), which is mountable on the main unit. The latter can be interchangeable depending on the space application (rover payload, mining conveyor, 3D printer, oxygen extractor). Several studies have been carried out to demonstrate the LIBS performance under vacuum conditions and to verify the possibility of LIBS utilization for lunar and asteroid explorations.

Targeted use cases vary from the commercial rovers and mining equipment for the moon resources utilization up to scientific missions to the asteroids. Proof-of-principle analytical methodology (TRL5, Figure 1) will be carried out with the functional breadboard prototype (TRL4) during the ESRIC incubation, until the end of 2024. Lightigo Space targets LIBS flight-ready model (TRL9) by 2030 when the breakthrough of lunar robotic missions is expected.

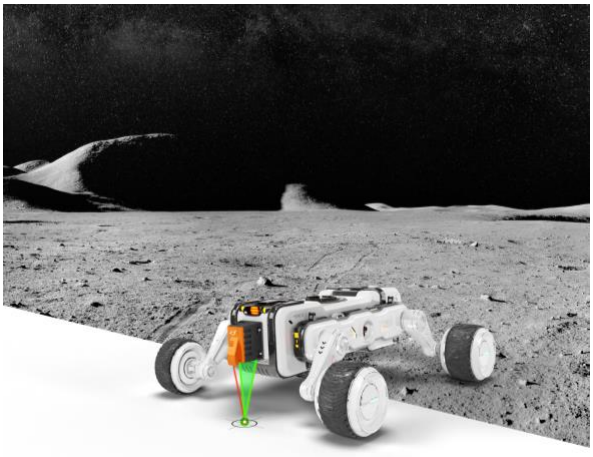

Figure 1: ISRA LIBS payload by Lightigo Space.

References: Use the brief numbered style common in many abstracts, e.g., [1], [2], etc. References should then appear in numerical order in the reference list, and should use the following abbreviated style:

[1] Martin J. Losekamm et al. (2022) *The Planetary Science Journal*, 3-229. DOI: 10.3847/PSJ/ac8cfd.

[2] Koki Yumoto et al. (2023) *Spectrochim. Acta B,* 205:106696. DOI: 10.1016/j.sab.2023.106696.

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