



Session 5 - Prospecting Instruments & Platforms
Wed, June 5, 2024

LASER-INDUCED BREAKDOWN SPECTROSCOPY INSTRUMENT FOR ACCURATE IN-SITU PROSPECTING OF SPACE RESOURCES

Inna Uwarowa

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From University to Lightigo (Space)

Transfer of LIBS technology and commercialization



Lightigo



Lightigo Space

- LIBS for prospecting of Lunar/Martian regolith
- payload for rover/lander

SPECTROSCOPY OF THE UNKNOWN UNIVERSE



Lightigo Space

- laser systems and laser electronics
- optical and spectroscopic instruments (payloads)



CEITEC



BRNO
UNIVERSITY
OF TECHNOLOGY

university

- basic research of LIP under Martian and Lunar conditions
- advanced data processing, machine learning

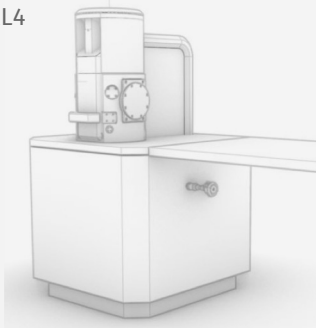
LIBS FireFly

available from 2020
TRL9



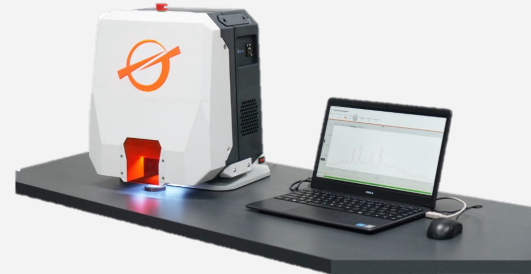
LIBS DragonFly

available from 2025
currently TRL4



LIBS Payload

Selected terrestrial application
available from 2025
currently TRL7-8



IP assets and protection

Licenses

- The vacuum chamber with manipulator
Central European Institute of Technology - CEITEC
- LIBS equipment for chemical analysis in plastics
Czech Plastic cluster

Other products

- **ns laser (available from 2024)**
- **fs laser (available from 2026)**
- SyncRay - digital pulse generator
- MC100 - motorized stage



In-Situ Resource Utilization

Regolith prospecting essential to identify and characterize available resources.

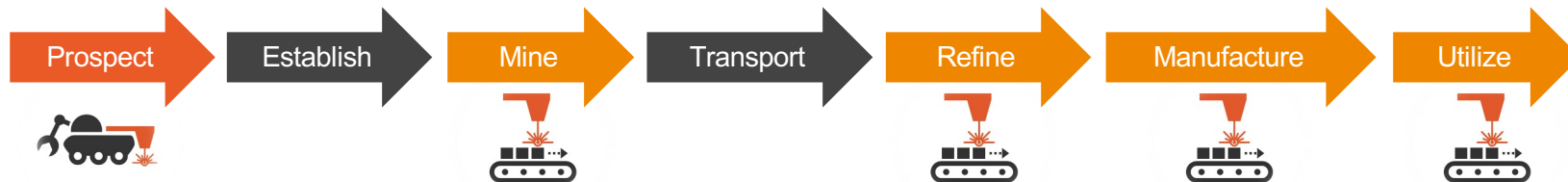
Survey methods:

- remote (telescope),
- flyby (satellite),
- in-situ (lander/**rover**).

Rover mission with a suitable payload necessary for further prospecting.

- Quantification of elements,
incl. volatiles (O, H) and light elements (Li, Be)
- Mineral and rock classification

Space Resources Value Chain and ISRA PAYLOAD





Laser-Induced Breakdown Spectroscopy (LIBS)

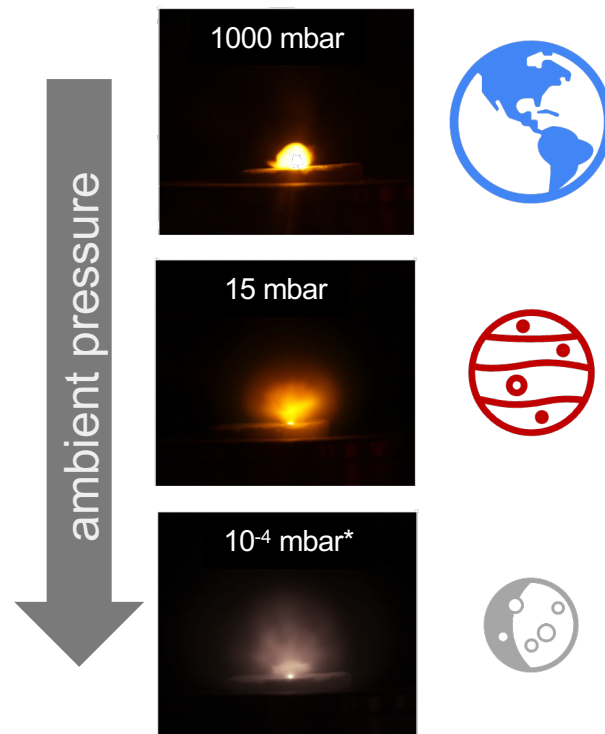
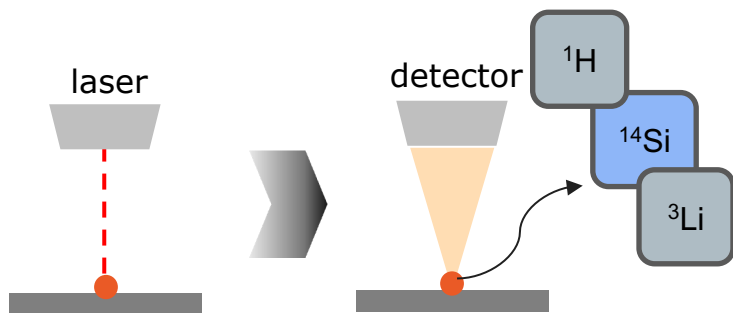
from laboratory to celestial bodies (e.g., payload on rovers/landers)

Moon surface exploration – benefits

- Stand-off analysis (from centimetres to meters)
- In-situ and real-time, no sample preparation
- Quantification of elements, incl. volatiles (O, H, ...) and light elements (Li, Be)
- Mineral and rock classification

Moon utilization – drawbacks

- Extensive optimization for LIBS under UHV
- Non-existing data libraries





Lightigo Space

VISION: In-Situ Resource Analyzer - ISRA Payload

esric
powered by LSA, ESA & LIST



Analyze to utilize



Scan and play
a video on our
website!



LIBS on the Moon

Challenges and prospects

system integration

- 1st stage: lander or rover
- regolith mining and beneficiation



LIBS instrument/payload

- space-grade laser and spectrometer
- dust mitigation - optical emission spectroscopy
- on-board data processing



In-Situ Resource Utilization (ISRU)

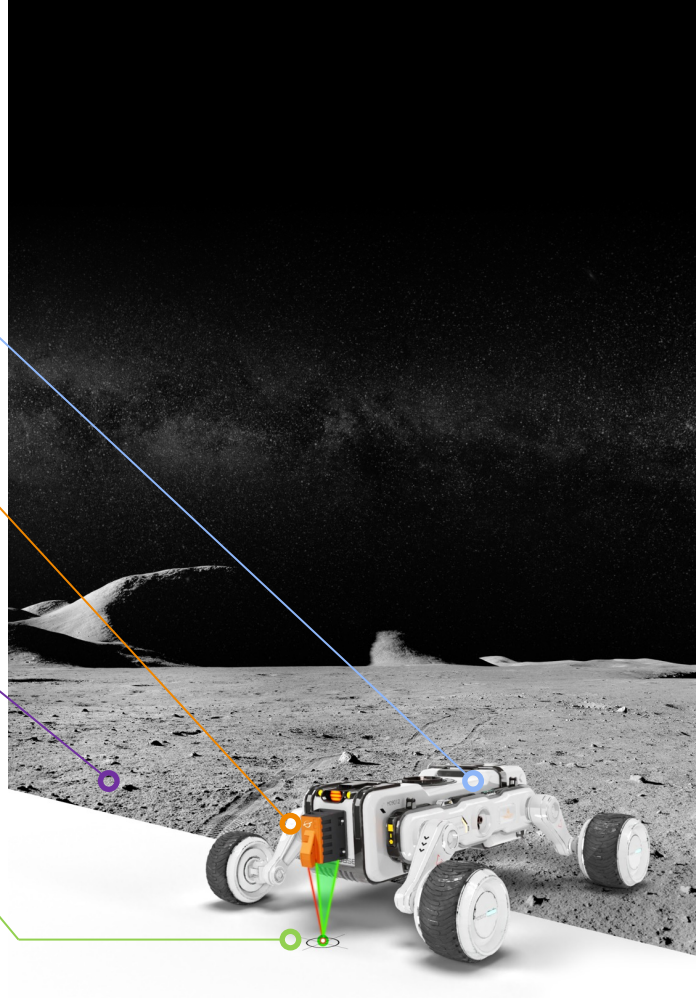
- analysis of Lunar regolith
 - creating data libraries
- implementing LIBS to various segments of ISRU



UNIVERSITY OF HELSINKI

Laser-Induced Breakdown Spectroscopy (LIBS)

- analysis under deep vacuum condition
- advanced data processing (machine learning)
- in-situ and real-time, no sample preparation





In-Situ Resource Analyzer

ISRA Payload

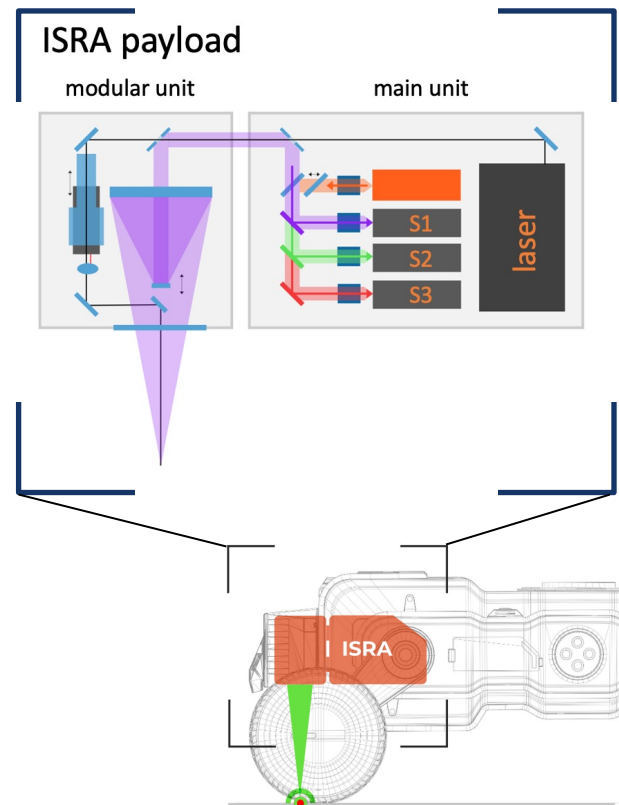


LIBS payload as a 2-unit assembly

- optics and electronics
 - COTS
 - own design and production
- **laser** – space-grade solution
EU HORIZON-CL4-2024-SPACE-01 (submitted)
SPARCLS: SPACeborne Radiation-Cooled Laser for Short-wave infrared
- **spectrometer** – space grade solution
ESA funding and further projects
tailored to application demands

Lander/rover carrying a compact payload

- UniStuttgart, iSpace, Lunar Outpost, Offworld





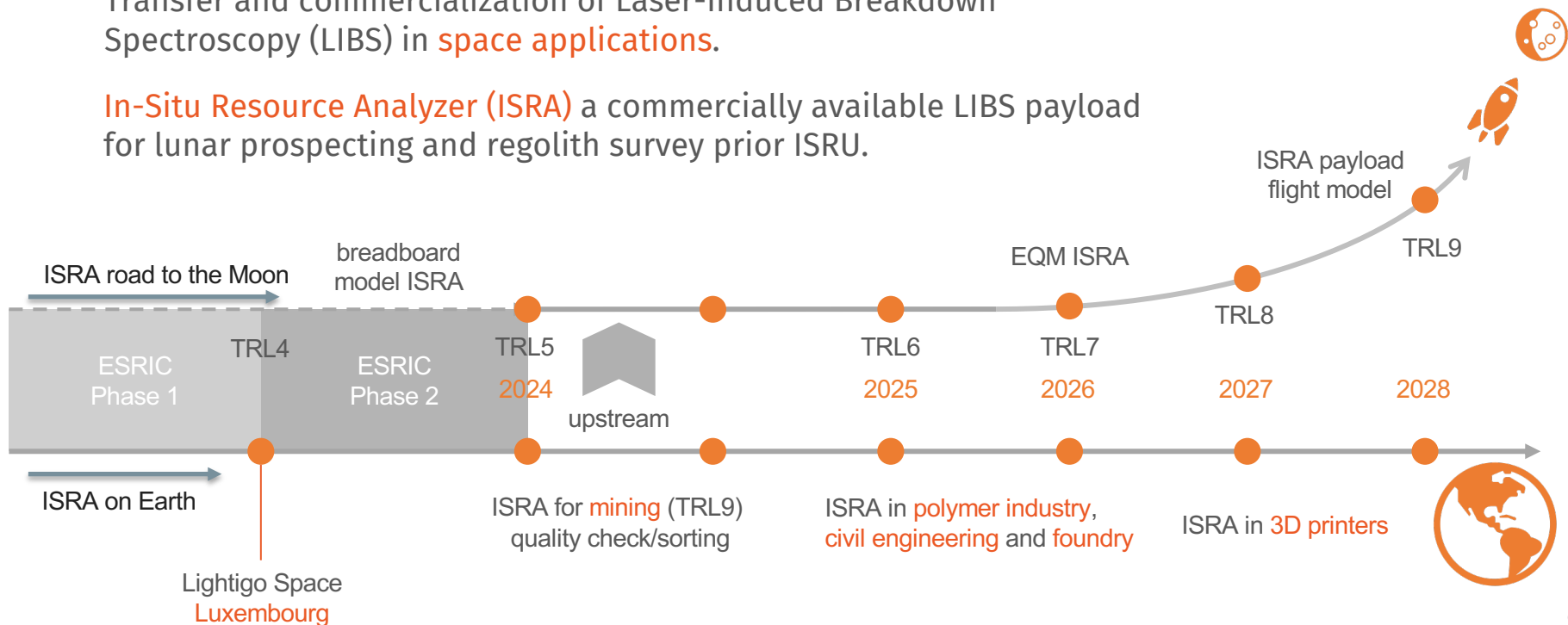
Lightigo Space

VISION: Space applications and Industry 4.0 (Lightigo)



Transfer and commercialization of Laser-Induced Breakdown Spectroscopy (LIBS) in **space applications**.

In-Situ Resource Analyzer (ISRA) a commercially available LIBS payload for lunar prospecting and regolith survey prior ISRU.



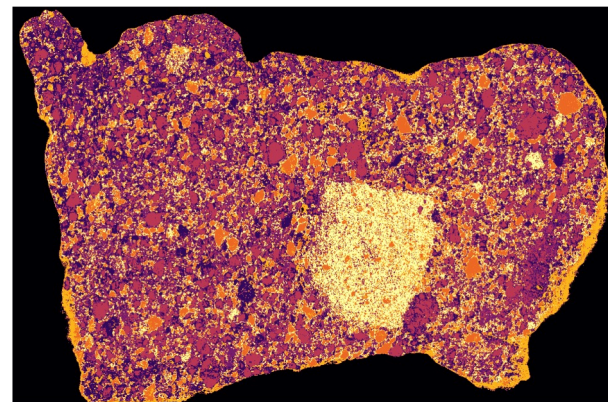
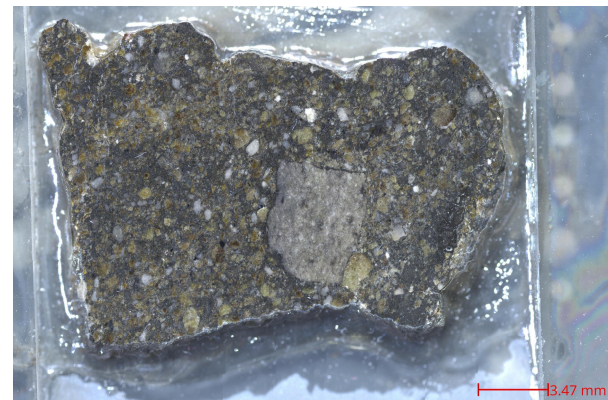


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State of the art analysis of the moon
origin meteorite



- Meteorite sample
- Areas of interest marked:
 - Area 1: 342x448 map, 2 layers
 - Area 2: 423x472 map, 2 layers
 - Whole: 1208x832, 1 layer
- Elements of interest + appearance in LIBS spectra
 - Mn, Na, K, Ba, Sr, Th, Ti, Cr, Zr, S, P, Ca, Al, Fe, Mg, O, Si



4 mm



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Testing LIBS in various simulated conditions

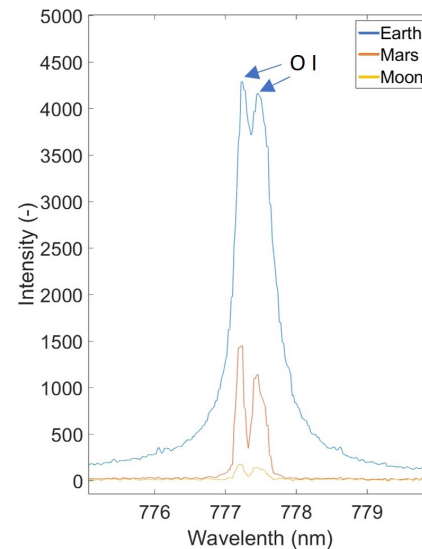
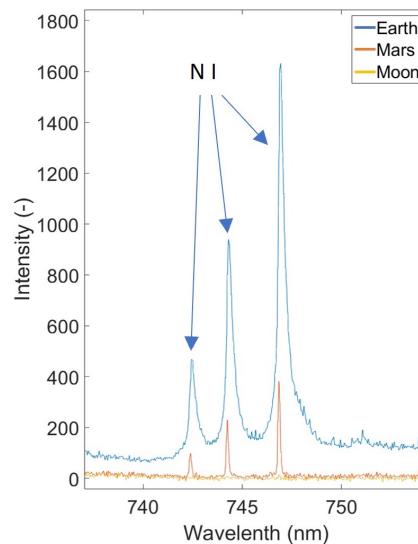
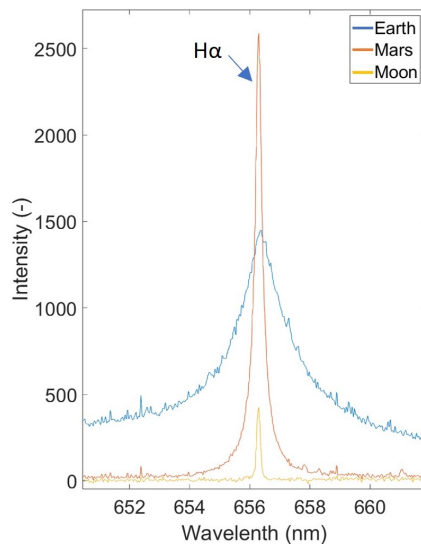


Earth

- 100 kPa
- 1000 mbar

Mars

- 700 Pa
- 7 mbar



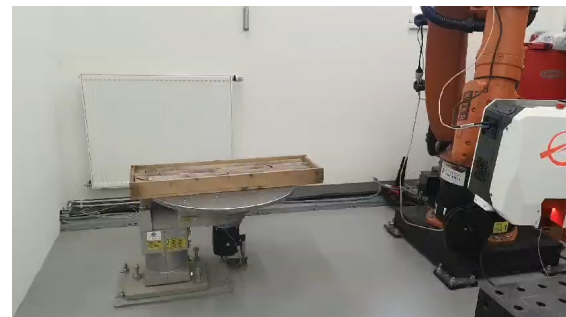
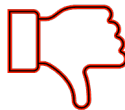


Lightigo Space

Miniaturisation and testing for mining industry

LIBS

- + Multi-elemental analysis
- + No/minimal sample preparation
- + Speed
- + Cost
- + Light elements detection
- Matrix classification
- Matrix effect
- Resolution





Lightigo Space, s.r.o.

Road map to ISRA payload

MOON:

- breadboard (ESRIC incubation, TRL4 - 2025)
- flight-ready model (TRL 8-9, 2030)

EARTH:

commercially available payload (2025) – industry

Current and future needs

- Introduction to the mining industry
- Testing on the simulated conditions on Earth (rover)
- Searching for a flight opportunity in cooperation

Stakeholders and cooperation ISRA payload

- dust mitigation, failure tolerance, lifetime and environmental tests
- space-grade laser and spectrometer/detector development
- lander/rover integration, communication and data storage

Contact info

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The logo features a central circular element containing a detailed image of the Moon. A stylized lightning bolt, colored in shades of blue and red, strikes the Moon from the upper right. This central element is surrounded by concentric circles and a glowing ring, all set against a dark, star-filled background.

LIGHTIGO
SPACE