Re-deployable Sensor Probe for In-situ Lunar Resource Mapping from Small Landers

10 Second Summary

- LIBS/Raman penetrator mounted on a re-loadable harpoon. The penetrator has optical probe and window, the tether has fiber optics, and the lander houses laser and spectrometer.
- MoonSHOT is aimed at areas of interest within a few to 100s of meters away from the lander. As such, MoonSHOT offers mobility without using a rover.
- The penetrator is launched to a target location and impacts the surface. LIBS and Raman data is then acquired (this takes sec-min).
- The penetrator is reeled back and harpoon is reloaded.

Concept Details

- MoonSHOT analyzing lunar regolith
- MoonSHOT gives mobility and high spatial remote sensing ability to a lander, thus effectively removing the need for rover and sampling devices.

LIBS spectra of JSC-1 and NU-LHT-2M lunar simulants, which approximate mare and highland soil, respectively. Spectra show variable emission line intensities that trace chemical variability among sample grains. Raman spectra of JSC-1 and NU-LHT-2M featuring plagioclase, pyroxene, olivine, ilmenite, quartz, and anorthosite bands.

Science and Performance

TRL 4+

- 4+ years of R&D through NASA SBIR/STTR contracts and private investment
- Alternative designs include ‘grappling hook’ concept to guarantee subsurface access

Equipment

- Dimensions
  - Peak power: 65 W
  - Single acquisition time: 30 ns
  - Signal to noise ratio: 600
  - Resolution (max; real): 0.1 nm
  - Spectra range: 190–1100 nm
  - Spectral bandwidth: < 2 mm
  - Pulse repetition frequency: > 1 kHz
  - Wavelength: 515 nm
  - Spot size: 25 µm
  - Pulse energy/duration: 20 µJ/1 ns

- Sensitivity
  - Elements: K, Ca, Sr, Ba, Mn
  - Sulfides: Pb, F, Cl
  - Oxides: Cr, Ni, Cu, Zn, Rb, As, Cd
  - Water Ice: H, O
  - Phosphates: N, P
  - Silicates: Na, Al
  - Covalent: Si, Ti, Al
  - Ionic: K, Ca
  - Other: C

- Instrument Performance
  - Laser energy/duration:
    - Single laser pulse: 20 µJ/1 ns
    - Wavelength: 515 ± 1 nm
  - Laser repetition rate:
    - Frequency: 1 kHz
    - Pulse repetition frequency: 245 – 950 Hz
  - Laser power:
    - Single acquisition time: 0.1 s
  - Temperature range:
    - Ambient: -45°C to -25°C
    - Temperature (operating): -10°C to 100°C
  - Weight:
    - Model: 18 W
    - Power source:
      - Rated: 3 kg
  - Power source:
    - Rated: 2500 Hz

Potential customers:

- Government: NASA, Exploration Mission
- Private: XOI, Lunar Green, Base
- Commercial: Private lunar logistics operators

Authors:

- Pablo Sobron, Impossible Sensing & SETI Institute
- Molly Fahey, Michael Krainak, Anthony Yu, NASA Goddard Space Flight Center
- Fredrik Rehnmark, Kris Zeczy, Honeybee Robotics
- Alain Wang, Washington University in St. Louis
- Ryan Zeigler, NASA Johnson Space Center