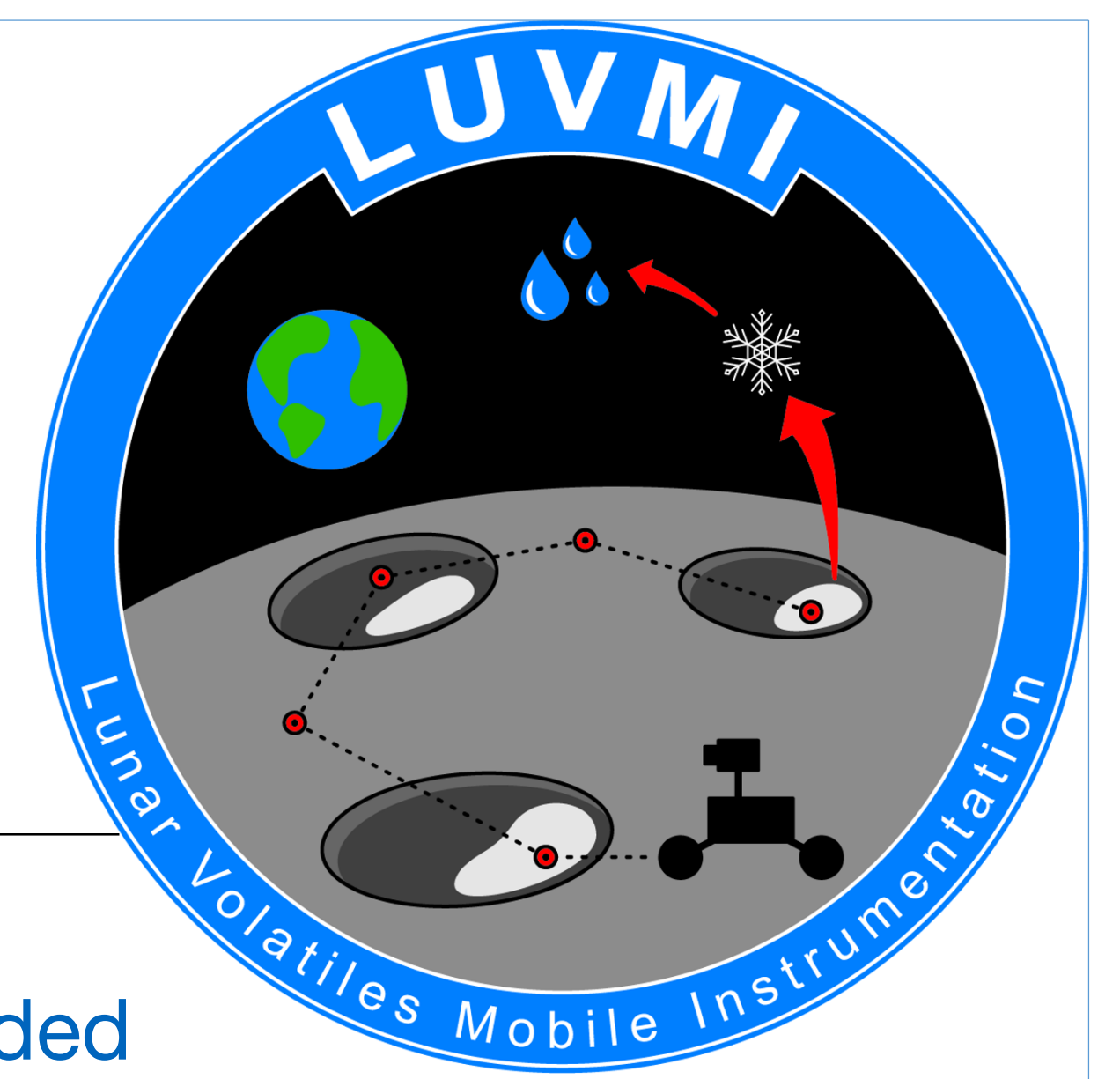


Characterization of the Lunar Volatiles Scout for In-Situ Volatiles Extraction and Analysis

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Introduction:

Multiple remote sensing missions have confirmed the existence of volatiles on the lunar surface and have provided data on the global distribution, possibly indicating significant deposits near the lunar poles. However, ambiguities remain in the interpretation of this data and local distribution, chemical composition, physical state, and extractability of this potential resource remain unknown. Future surface investigations need mobility to address the expected heterogenous volatiles distribution and be affordable enough to justify exposure to hazards inherent to polar permanently shadowed regions.

The Lunar Volatiles Scout (LVS) is a small and compact **instrument for the in-situ extraction and analysis of volatiles** that can be accommodated on small lunar rovers. Recent thermal-vacuum testing of an integrated prototype of the LVS successfully demonstrated the extraction of volatiles from icy regolith simulants, the determination of their abundance, and the analysis of chemical species.

Instrument Description:

Ion Trap Mass Spectrometer:

- Mass range: m/z 10 to 200
- Mass resolution: 2
- Reference gas system for in-situ calibration
- For more information: see **poster 34**

Augered Drill Shell:

- For eased insertion
- Insertion force: < 30 N
- Drill depth: 15 – 20 cm

Heating Element:

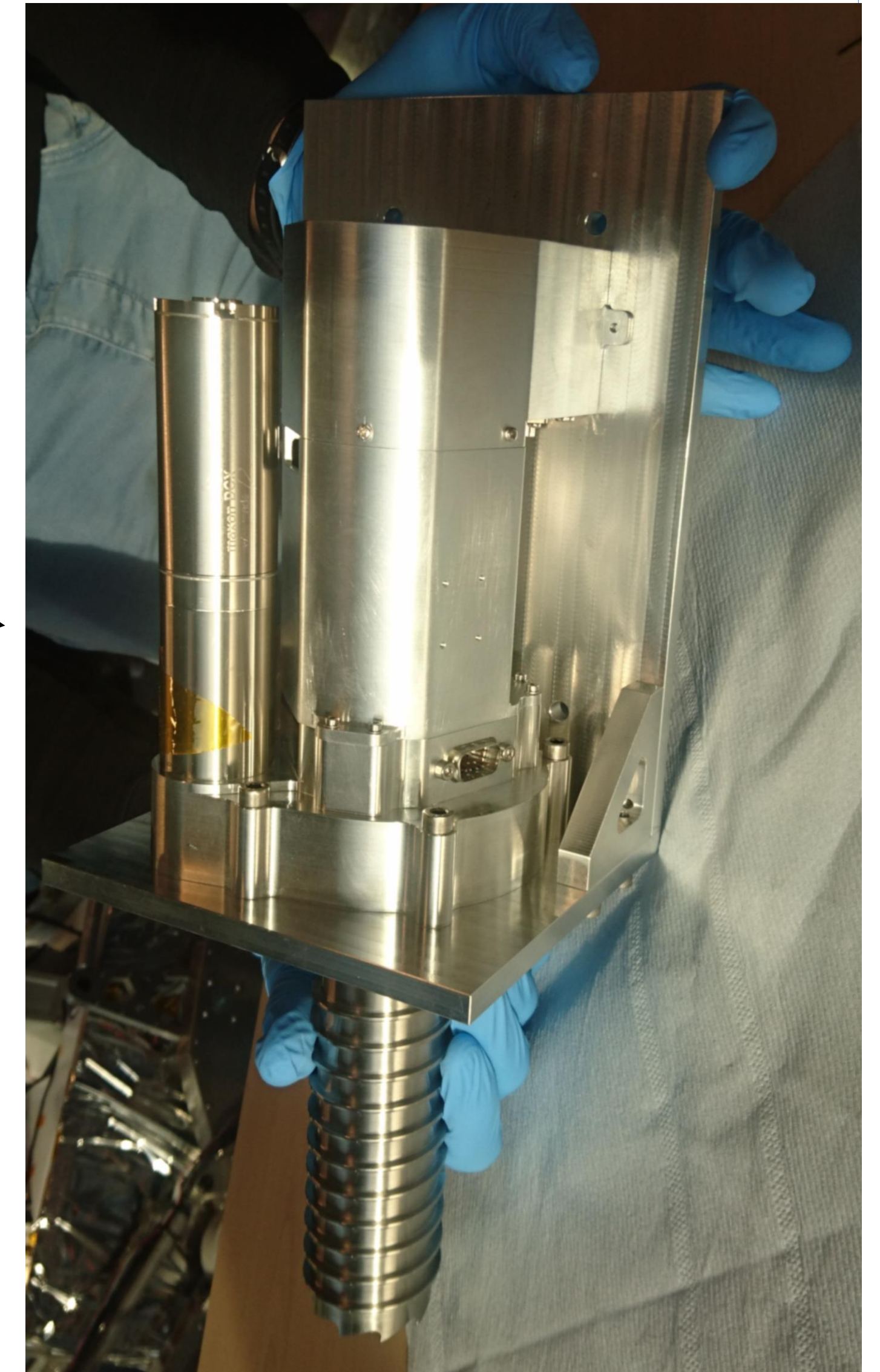
- For volatiles extraction
- Temperatures up to 600°C

Gas Measurement System:

- Pirani pressure sensors
- Orifice gas flow measurement
- Pressure range: 10^{-3} ... 10 mbar

Instrument Prototype:

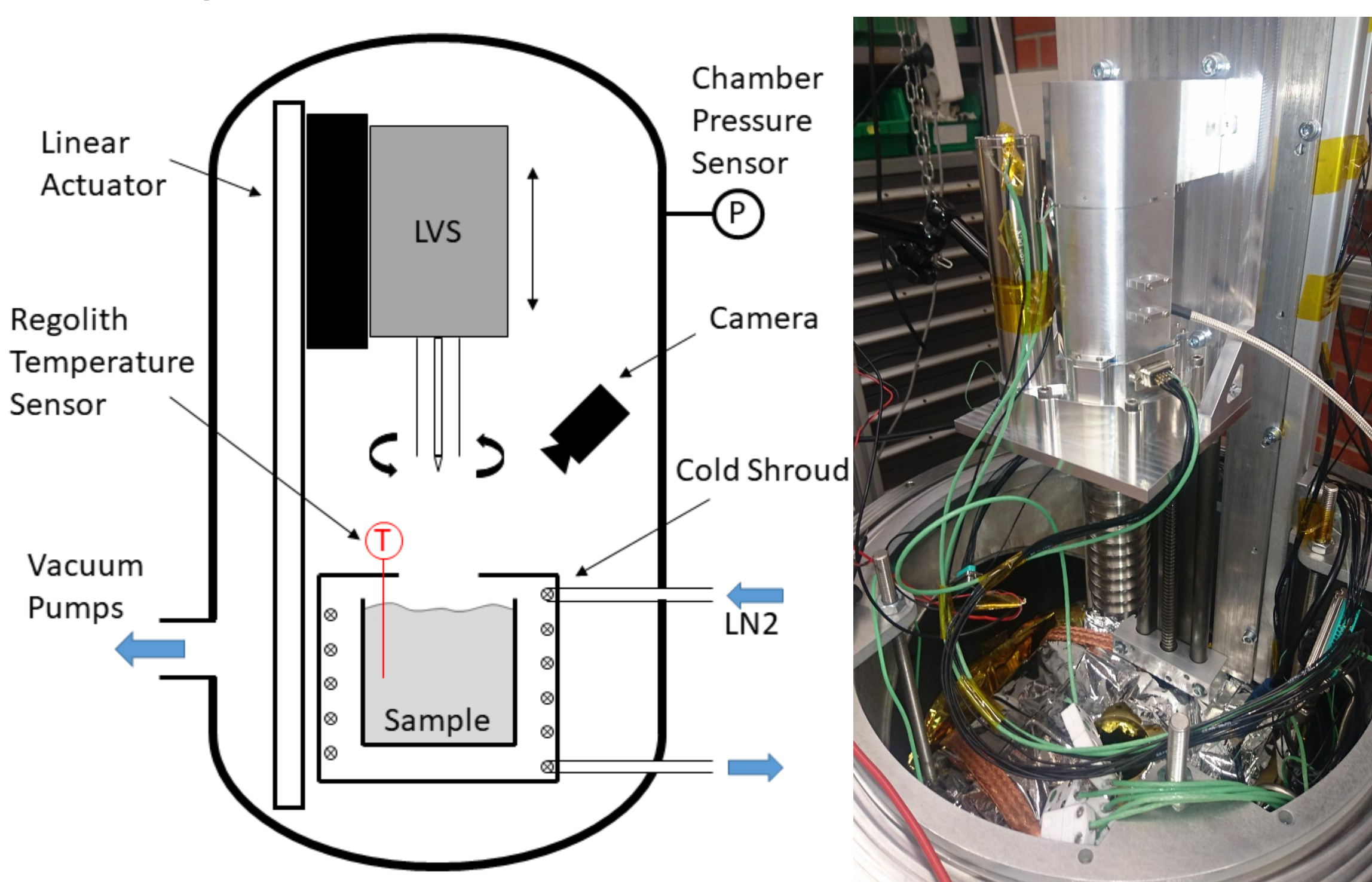
- Instrument mass: 1.9 kg
- Power consumption: < 20 W
- Technology readiness level: 5 - 6



Test Setup:

Simulated Lunar Conditions:

The test setup consists of the LVS mounted on a linear actuator above a sample container in a thermal-vacuum chamber.



Regolith Simulant Sample:

Simulated lunar samples were prepared with JSC-1A in a 10 l container. The samples were hydrated by mixing with up to 5 % water and then frozen to -50°C to prevent outgassing in vacuum.



Test Procedure:

After mounting and freezing the samples, the thermal-vacuum chamber was evacuated. The drill was activated and lowered by the linear actuator into the regolith. Once inserted, a constant heating power of 15 W was applied to the heating element for 90 min, while the pressures were observed.

Results:

Volatiles Abundance:

- Successful extraction of water from frozen hydrated regolith.
- Achieved pressures > 10 mbar
- Different water contents distinguishable in pressure profiles.

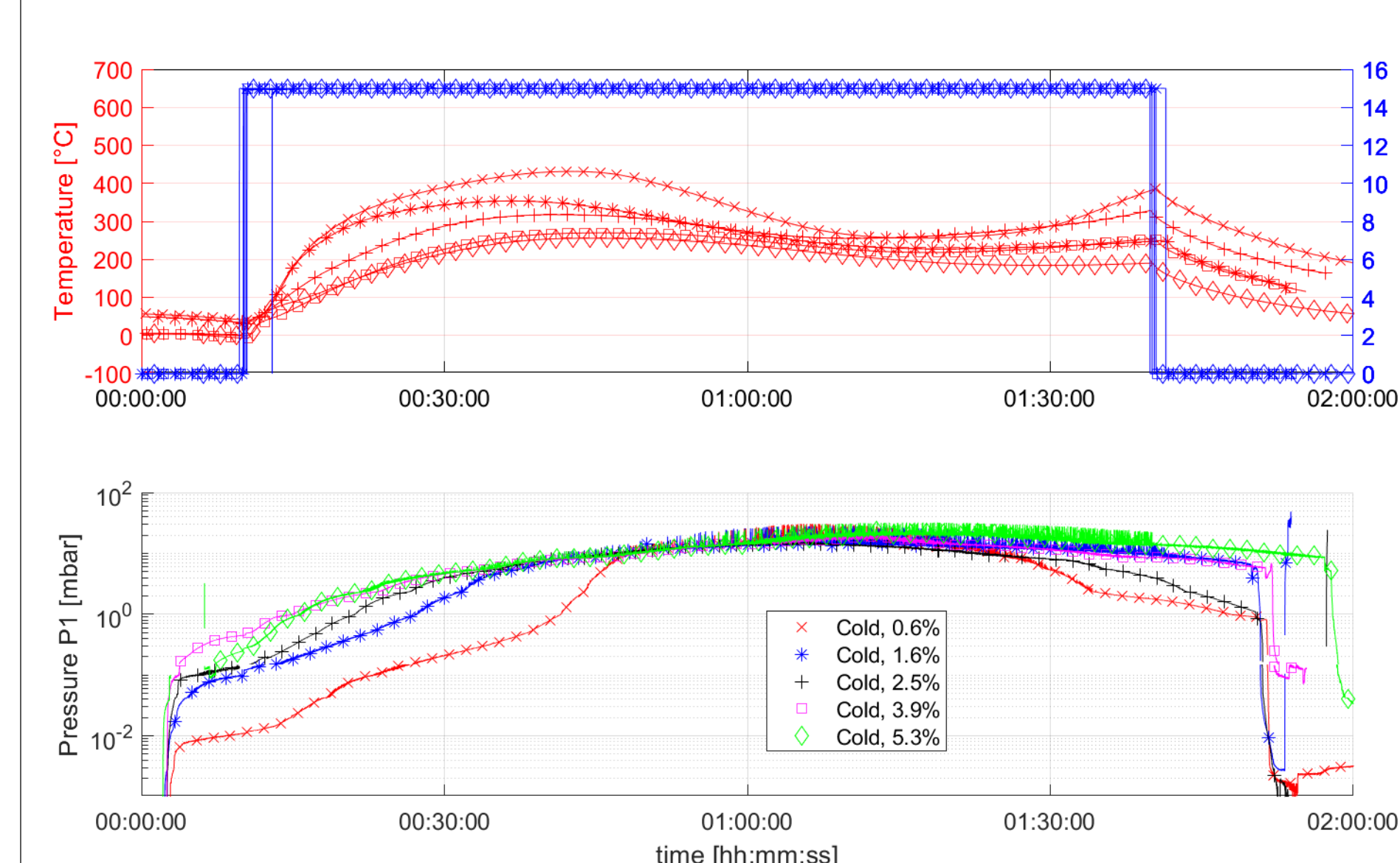


Figure 1: Heating element temperature and drill shell pressure for samples with different water contents.

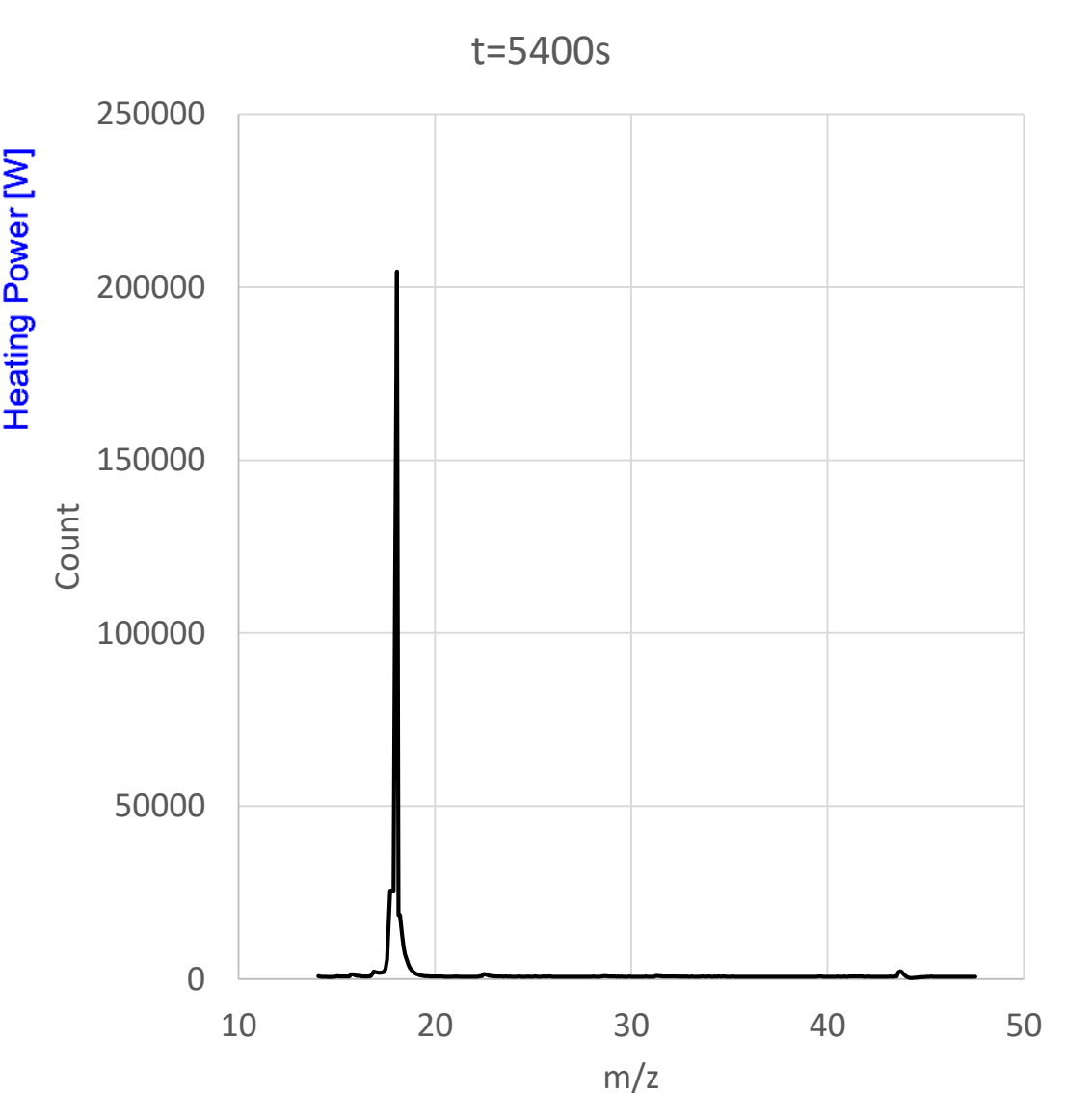


Figure 2: Typical mass spectrum seen during testing.

Volatiles Analysis:

- Successful detection of released water (Figure 2)
- Continuous analysis of released volatiles during testing

Future Work:

- Investigate if relative concentrations of volatiles can be measured in samples that contain multiple species.
- Investigate if the chemical phases of volatiles can be determined.