In-situ studies of the lunar water cycle using a CLPS-delivered ion-trap mass spectrometer (PITMS)

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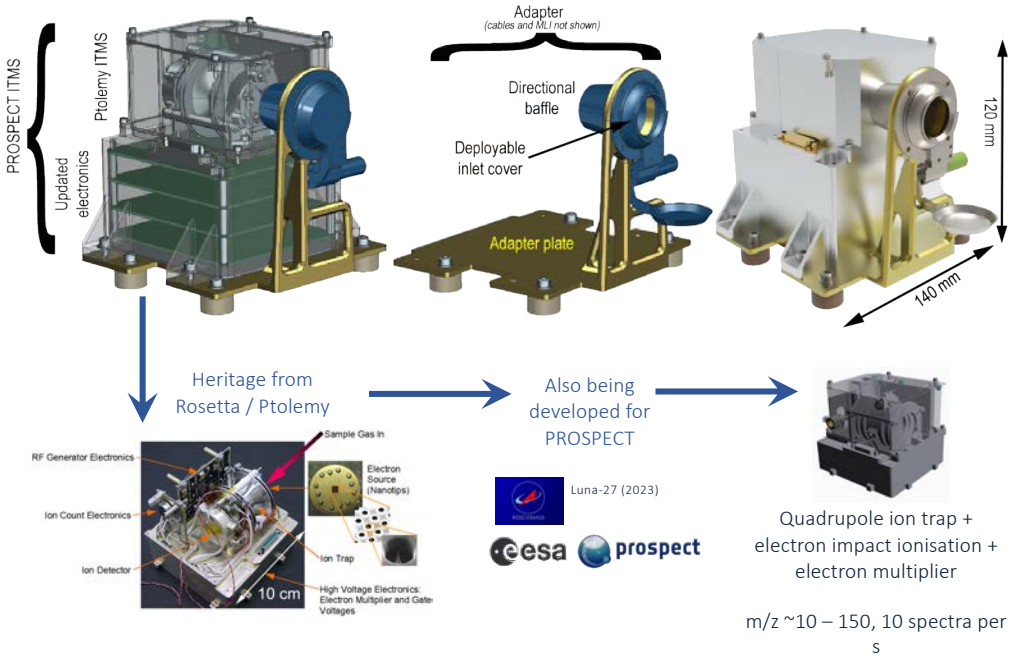
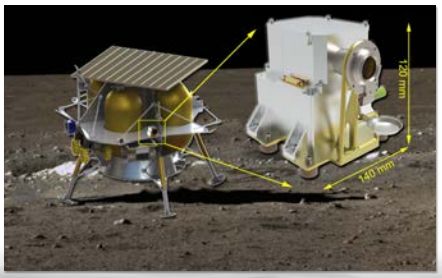
- Characterize the lunar exosphere from the surface after descent and landing, and throughout the lunar day, to understand the release and movement of volatile species
- Leverage the PROSPECT program and develop the ITMS as a standalone mass spectrometer suitable for commercial lunar landers
- PITMS will consist of a PROSPECT-derived ITMS sensor and front-end electronics, newly developed controller and power supply boards, and a GSFC wrapper
- Lander-friendly: low resource (<2 kg, 4-8 W), simple interfaces, passive, landing site agnostic

Science & Exploration Objectives	Investigation Goals	Requirements	Mission requirements
Decadal Survey: Understand the composition and distribution of volatile chemical compounds on the inner planets (p. 118) SCEM report: Goal 8a. Determine the global density, composition, and time variability of the fragile lunar atmosphere before it is perturbed by further human activity Lunar SKGs: Theme 1-C, Regolith 2: Quality/quantity/distribution/form of H species and other volatiles in nonpolar mare and highlands regolith	Measure the time-resolved neutral species load of the lunar atmosphere during a lunar day	Mass range 2-110 Da Ability to quantify trace species better than the upper limits established by LACE: He: 2000 cm-3 Ar: 1E6 cm-3 N2: 800 cm-3 CO: 1000 cm-3 CO2: 1000 cm-3 CH4: 10000cm-3 OH/H2O: not yet determined	Locate MS baffle pointing away from lander to minimize lander outgassing Ability to turn mass spec on and off multiple times over the course of the mission Ability to pre-heat the mass spec (Power??) Landing site anywhere on the Moon Lander lifetime 1 lunar day cycle
Lunar SKGs: III-D-4 Descent / ascent engine blast ejecta velocity, departure angle and entrainment mechanisms	Measure the abundance and deecay of the temporary atmosphere created by the landing disturbance	Time resolution of ~1 measurements / min directly after landing for a period of 1 hr	



PITMS is manifested on the Astrobotic Peregrine-1 mission

- Developed through the NASA-Provided Lunar Payloads (NPLP) Program
- Launch to Laccus Mortis in mid 2021!
- Operations commence soon after touchdown with the release of a dust cover
- ITMS continually scans m/z 10 to 150 at 10 Hz; mass spectra integrated on the ground to build S/N
- Expect to monitor decay in exosphere from its post-landing peak, punctuated by any stimuli that create transient increases



PITMS will be uniquely positioned to assess the volatile components of the lunar regolith and exosphere and observe their behavior from dawn to dusk, addressing NASA science and exploration goals.