LINEAR ION TRAP MASS SPECTROMETER FOR IN SITU ASTROBIOLOGY. William Brinckerhoff[1], Ricardo Arevalo, Jr.[1], Ryan Danell[2], Friso van Amerom[3], Andrej Grubisic[4], Xiang Li[5], Veronica Pinnick[1], Philip Chu[6], Kris Zacny[6], Steve Rogacki[7], Ryan Miller[7], Darren McKague[7], Florence Tan[1], Stephanie Getty[1], Cindy Gundersen[8], Lars Hovmand[9], Dan Carrigan[10], Mike Barciniak[11], Marvin Noreiga[10], Christa Budinoff[12], Marco Castillo[5], Chris Johnson[1], Ryan Wilkinson[13], and the LITMS Team[1-13], [1]NASA Goddard Space Flight Center, 8800 Greenbelt Rd., Greenbelt, MD 20771; [2]Danell Consulting, Inc., Winterville, NC; [3]Mini Mass Consulting, Hyattsville, MD; [4]Univ. of MD at College Park/CRESST, College Park, MD; [5]Univ. of MD at Baltimore County/CRESST, Baltimore, MD; [6]Honeybee Robotics, Pasadena, CA; [7]University of Michigan, Space Physics Research Laboratory, Ann Arbor, MI; [8]AMU Engineering, Inc., Miami, FL; [9]Linear Labs LLC, Washington, DC; [10]ADNET Systems, Inc., Bethesda, MD; [11]Ball Aerospace, Lanham, MD; [12]Visioneering, LLC, Boise, ID; [13]ATA Aerospace, Greenbelt, MD.

Introduction: A new, highly compact linear ion trap mass spectrometer (LITMS) has been under development building upon the design of the Mars Organic Molecule Analyzer (MOMA) mass spectrometer (MS) onboard the 2020 ExoMars rover. LITMS combines two powerful approaches to organics analysis, pyrolysis and derivatization gas-chomatography mass spectrometry (GCMS) and Mars-ambient laser desorption mass spectrometry (LDMS), linked through a single, highly-miniaturized mass analyzer. The instrument thus enables analysis of (i) volatile/semivolatile organic compounds via electron impact (EI) ionization and (ii) nonvolatile/refractory organic and inorganic content under Mars-ambient conditions via laser desorption ionization (LDI). Compared to MOMA, LITMS features further miniaturization and substantial analytical enhancements identified during the MOMA-MS development but not realized due to schedule or mission architecture limitations. Specifically, the additional analysis capabilities on LITMS include dual RF power supplies to increase mass range compared to MOMA, both positive and negative ion detection, precision sub- sampling of drill cores at fine (≤ 1 mm) spatial scales, and pyrolysis of powdered sample for evolved gas analysis (EGA) of minerals and organics. Here, we present the status of the TRL 6 brassboard of LITMS with initial spectra.

Design: The LITMS concept (**Fig. 1**) embodies the analysis of a drill core sample at fine (sub-mm) spatial scales, by both GCMS and LDMS, to provide comprehensive layer-by-layer and overall gradient composition data. The core is acquired with a rotary/percussive drill and presented to the LITMS sensor via a docking port, with the side of the core exposed in an up-facing PreView Coring Bit window. The core position is manipulated in a Precision Core Sampler (PCS) mechanism, which brings a series of points to the focal point of the laser, under the ion trap inlet. At Mars, LDI is accomplished at ambient pressures using a MOMA-like fast aperture valve. At other bodies, a simplified "open path" inlet with ion optical steering is used. The laser analysis is essentially nondestructive. Points of interest are then positioned for subsampling by a rotating cutter producing up to several mg of fines from a mm-scale layer, which are captured into a pyrolysis oven and subsequently analyzed with GCMS.

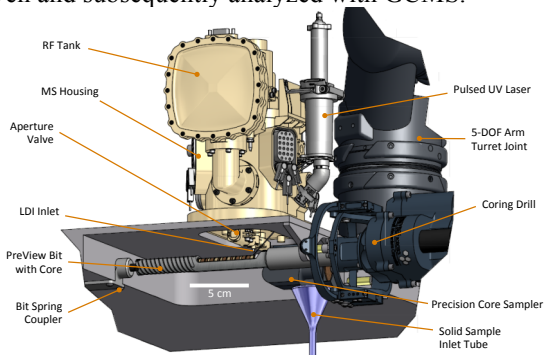

Fig. 1 Linear ion trap mass spectrometer (LITMS) concept showing sensor interfaced to a coring drill with PreView Bit.

Brassboard Intergration and Test: The LITMS brassboard has been developed with high fidelity to a flight design, to support Mars-specific tests of functionality and environmental tolerance (pressure, vibration, shock, and limited thermal). Preliminary benchtop EI-mode spectra (**Fig. 2**) confirm the operation of the sensor system with highly-promising performance specifications. End-to-end tests of the fully-integrated LITMS, with arm-mounted drilling and PCS operation under Mars ambient conditions are scheduled over the next several months, prior to preparation of the system for field deployment in the Atacama.

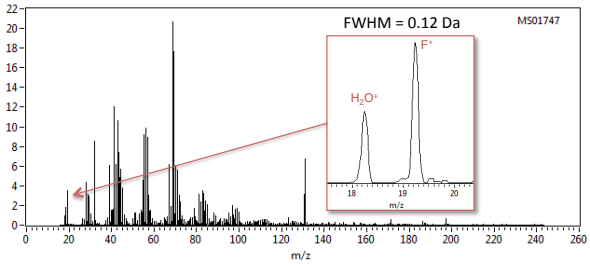

Fig. 2 LITMS brassboard low-m/z range spectrum of perfluoro-tributylamine (PFTBA) calibration gas in the presence of water and hydrocarbon mixture showing low-noise operation of two-frequency RF electronics and ion detectors.

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