A COMPACT LASER MASS SPECTROMETER FOR BIOSIGNATURE DETECTION IN PLANETARY ICE. S. A. Getty[1], A. Grubisic[2], X. Li[3], T. Cornish[4], K. Uckert[5], B. Farcy[3], and W. B. Brinckerhoff[1], [1]NASA Goddard Space Flight Center (Stephanie.A.Getty@nasa.gov), [2]University of Maryland, College Park, [3]University of Maryland, Baltimore County, [4]C&E Research, Inc., [5]New Mexico State University.

Introduction: The exploration of icy worlds in the outer solar system is strongly motivated by the anticipated presence of habitable conditions in a salty subsurface ocean. The search for an active biosphere beyond Earth, however, focused on such remote moons as Enceladus and Europa, will require a multifaceted *in situ* investigation that also fits within very modest resources. This is particularly true for a mission such as the Europa Lander, which will be required to assess habitability indicators of the surface environment *and* search for signs of extant life *at the same time*. A mass spectrometer that is targeted to the chemical analysis of trace biosignatures and habitability indicators within a low-mass package [1] is a compelling approach to this task – and will enable detection of unexpected chemistries as well.

Laser Time-of-Flight Mass Spectrometry for Ocean Worlds: The MOMA (Mars Organic Molecule Analyzer) gas chromatograph and laser desorption/ionization mass spectrometer is central to the ExoMars life detection payload that is slated for launch as a joint ESA-Roscosmos mission in 2020 [2]. To build upon the fundamental advantages of the laser desorption/ionization (LDI) technique of detecting and analyzing complex organic molecules directly from a planetary surface sample, we are developing a laser time-of-flight mass spectrometer capable of analyzing species across a wide mass range and over a broad range of chemical structures. The MACROBE (Molecular Analyzer for Complex Refractory Organic Biosignatures at Europa) instrument combines the ability to detect trace biosignatures directly from water ice or mineralogical powders with a detailed analytical mode that interrogates an ice residue for the presence of such biomolecules as lipids, nucleobases, amino acids, and even biopolymers like peptides (if present).

The laser technique employed by MACROBE uses two wavelengths to probe structural details of the organic species detected. This is known as two-step laser mass spectrometry (L2MS) [3] and is used here as a complement to traditional ultraviolet LDI. In single-wavelength mode, MACROBE will be sensitive to parts-per-million levels of organics and salts in a planetary ice sample, and in L2MS mode, will be capable of subsequently distinguishing between organic structural candidates for a given mass peak without the need for high resolution mass analysis. In a single instrument package, MACROBE is therefore able to provide detailed understanding of the biomolecular, organic, and inorganic composition of an icy sample on an Ocean World, in direct support of the goals of a mission targeting habitability and the search for biology.

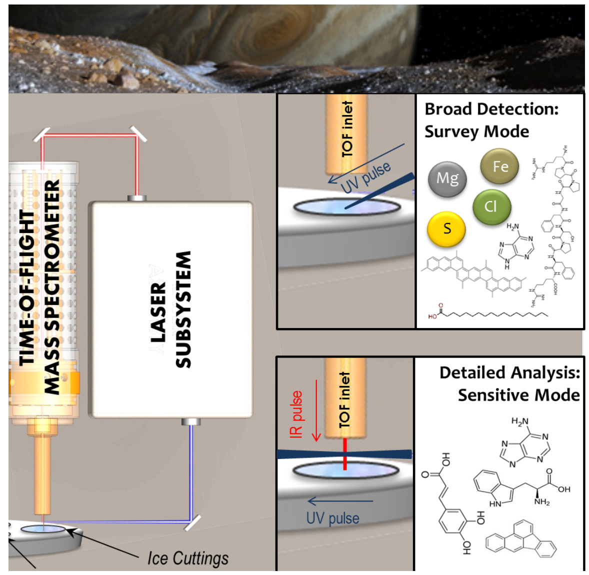

Figure 1. MACROBE combines broad and detailed analytical modes to provide insights into the chemical and biochemical composition of planetary ice samples.

The use of a time-of-flight mass analyzer provides several key benefits to a discovery-driven mission: (1) the mass range of 1-150,000 Da (or higher) is unmatched by any other analyzer and would enable the detection of any complex biopolymers, (2) the particular electric field profile of our reflectron enables a simple pulsed-gate implementation of fragment (mass spectrometry-mass spectrometry, or MS/MS) analysis of complex species that can help to inform the structure of any candidate biosignatures for greater confidence in our *in situ* findings [4], and (3) the analyzer itself is extremely lightweight, providing greater flexibility for radiation shielding allocations, such as for the Europa Lander.

References: [1] Getty S. A. *et al.* (2014) *IEEE Aerospace Conf Proceedings*. [2] Brinckerhoff W. B. *et al.* (2013) *IEEE Aerospace Conf Proceedings*. [3] Getty S. A. *et al.* (2012) *RCMS* **26**, 1. [4] Cornish T. J., Cotter R. A., and Todd, P. J. (1994) *RCMS* **8**, 781.

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