Detection of Organic Molecules and D-H Ratios in Laboratory Mass-Spectra of Hypervelocity Dust Impacts Into Ice. Zach Ulibarri[1] (zachary.ulibarri@colorado.edu), Tobin Munsat[1], Bernd Abel[2], Richard Dee[1], Sascha Kempf [1] , Zoltan Sternovsky[1], Michael Voss, [1]IMPACT, University of Colorado, Boulder, Colorado, United States, [2]Leibniz Institute of Surface Engineering, Leipzig, Germany.

Introduction: Since liquid water is regarded as a prerequisite for life, icy ocean worlds such as Europa and Enceladus are the focus of several planned NASA and ESA fly-by missions. Water plumes erupting from Enceladus's surface have been observed, and analysis from the Cassini spacecraft's impact ionization time of flight (TOF) mass spectrometer indicates that the environment around Enceladus is rich with dust from both the ice surface and the subsurface ocean.

While some laboratory work has been performed to match CDA flight spectra, these studies have laser ablated flowing liquid sources rather than impacting actual dust into ice surfaces. However, the University of Colorado dust accelerator at the Institute for Modeling Plasma, Atmospheres, and Cosmic Dust (IMPACT, *impact.colorado.edu*), paired with a cryogenic target capable of creating H_2O ice mixtures, allows for unique and tightly controlled experiments to study hypervelocity dust impacts into ice, providing results more closely aligned with actual spacecraft data than laser ablation. Such experiments will answer significant questions about the survivability and detectability of complex organic chemistry in icy dust grains studied by impact ionization TOF instruments on flyby spacecraft, the ability of such instruments to measure deuterium-hydrogen (D-H) ratios of icy dust grains, and the chemical evolution of icy bodies under dust bombardment.

Experimental Results: Water ice was doped with histidine and bombarded with hypervelocity dust. TOF chemical analysis of the impact plume shows that the amino acid survives the impact process and can be measured directly, even at velocities that exceed typical flyby spacecraft velocity. Furthermore, fragmentation products are fundamentally related to those found in the NIST electron impact ionization mass spectra of histidine. This indicates that even in the event of breakup, it may be possible to use the breakup products as a means to identify the parent molecule. Initial results suggest that histidine is stable at velocities under 5 km/s, with increasing amounts of breakup products at higher velocities, especially beyond 8 km/s. Further work is needed to confirm these initial results.

Similar experiments were performed with ice created with a known D-H ratio. Co-added TOF spectra from the impact plume indicates that the D-H ratio can be measured correctly in the negative ion mode. This means that impact ionization mass spectrometers on future fly-by spacecraft will be able to measure the D-H ratio of icy ocean worlds such as the Galilean moons during the Europa Clipper flybys, or provide new and independent measurements of the ice grains from the Enceladus plume, as the plume vapor ratios have already been measured by the INMS instrument and the surface ratios by IR spectroscopy.

Ongoing experiments will determine if relative concentrations of amino acids can be inferred from impact ionization TOF spectra. Future experiments will probe the creation of organic chemistry from inorganic sources.