On the generation and detectability of organic chemistry in hypervelocity impact ice spectra. Zach Ulibarri[1], Tobin Munsat[1], Bernd Abel[2], Richard Dee[1], David James[1], Sascha Kempf [1], Zoltan Kupihar[3], Zoltan Sternovsky[1], [1]IMPACT, University of Colorado, Boulder, Colorado, United States (zachary.ulibarri@colorado.edu), [2]Leibniz Institute of Surface Engineering, Leipzig, Germany, [3]University of Colorado, Dept. of Chemistry and Biochemistry, Boulder, Colorado, United States.

Introduction: Although ice is prevalent in the solar system and the long-term evolution of many airless icy bodies is affected by hypervelocity micrometeoroid bombardment, there has been little experimental investigation into these impact phenomena, especially at the impact speeds seen on airless icy bodies or in fly-by spacecraft. CO_2 has been observed on various moons of Jupiter, Saturn, and Uranus, and is typically thought to have been native to these bodies or brought as C atoms from exogenic sources that are later converted to CO_2 by UV or charged particle irradiation. However, carbonaceous dust particles impacting into water ice may be an important production mechanism for CO_2 on these airless bodies. Further, dust impact simulations such as laser ablation and light-gas gun experiments have successfully created amino acid precursors from base components in ice surfaces, indicating that dust impacts may be a mechanism for creating complex organic molecules necessary for life, but this has yet to be achieved with actual dust impact.

Additionally, there have been no experiments to date that use actual dust impact to determine the survivability and detectability of complex organic chemicals by impact ionization time of flight mass spectrometry on fly-by spacecraft, such as the upcoming SUDA instrument on the Europa Clipper. With the creation of a cryogenically cooled ice target for the dust accelerator facility at the NASA SSERVI Institute for Modeling Plasma, Atmospheres, and Cosmic Dust (IMPACT), it is now possible to study the effects of micrometeoroid impacts in a controlled environment under conditions and at energies typically by either air-less icy bodies or fly-by spacecraft. Ice surfaces are prepared either by vapor deposition or by flash-freezing an aquatic solution of desired composition. Iron or carbonaceous dust is accelerated to 3-50 km/s and impacted onto the surface.

Time-of-flight mass spectra of the dust impact ejecta show that amino acids and even the more fragile di-peptide amino acid chains frozen into water ice can survive impact and be detected in individual spectra. Future experiments will probe characteristic fragmentation patterns that can be used to identify amino acids even after breakup.

CO_2 gas was bubbled through water to saturate it at 23 degrees Celsius, producing a mole fraction concentration of 6.14E-4. Protonated CO_2 was observed in dust impacts between 3 and 15 km/s. Upcoming experiments will reduce concentration to determine the CO_2 detection limit of the ice target system. Following experiments will determine CO_2 and CO production rates from carbonaceous dust impactors into water ice as functions of velocity or other dust characteristics, and future experiments will probe the creation of more complex organic chemistry. Results from recent and ongoing investigations will be presented.