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CRYOGENIC SAMPLE ACQUISITION AND DELIVERY SYSTEM (CRYOSADS) FOR TITAN AND EUROPA

Kris Zacny, zacny@honeybeerobotics.com
Honeybee Robotics, Pasadena, California, United States
Ralph Lorenz, ralph.lorenz@jhuapl.edu
Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland, United States
Fredrik Rehnmark, rehnmark@honeybeerobotics.com
Honeybee Robotics Spacecraft Mechanisms Corporation, Pasadena, California, United States
Tighe Costa, costa@honeybeerobotics.com
Honeybee Robotics Spacecraft Mechanisms Corporation, Pasadena, California, United States
Jameil Bailey, bailey@honeybeerobotics.com
Honeybee Robotics Spacecraft Mechanisms Corporation, Pasadena, California, United States
Nick Traeden, traeden@honeybeerobotics.com
Honeybee Robotics Spacecraft Mechanisms Corporation, Pasadena, California, United States
Zach Mank, mank@honeybeerobotics.com
Honeybee Robotics Spacecraft Mechanisms Corporation, Pasadena, California, United States
Joey Sparta, sparta@honeybeerobotics.com
Honeybee Robotics Spacecraft Mechanisms Corporation, Pasadena, California, United States

We present a novel design of a surface sample acquisition and delivery system for Ocean Worlds, with emphasis on Titan and Europa. The near-term missions that could take advantage of this system, called Cryogenic Sample Acquisition and Delivery System (CryoSADS), are the Applied Physics Lab's Dragonfly relocatable Titan lander (currently undergoing a New Frontiers Phase A study) and Europa Lander (NASA Flagship mission). CryoSADS is funded under NASA's COLDTech program and it will reach TRL 6 in 2019.

To date, a limited number of sampling systems have been developed for Europa and Titan. The optimal system would need to deal with a range of Europa's cryogenic materials: ice and salty ice, and Titan's cryogenic materials: ice, organic solids and liquids, and mixtures thereof. The other environmental constrains include hard vacuum, cryogenic temperature and significant radiation on Europa, and 1.5 bar atmospheric pressure and cryogenic temperature on Titan. In essence, apart from different atmospheric pressure and radiation levels, the two bodies are similar with respect to temperature and gravity.

Most science instruments such as GC/MS, Raman, LDMS require subsurface samples in powdered form. For Europa, these samples should come from greater depths (depths where radiation

alteration is minimal) while for Titan, there are no radiation effects and near surface samples may suffice. The design of CryoSADS is such, that it will be able to reach samples in the 10-20 cm range. Greater depths are possible with the addition of a longer drill bit. The baseline sample volume is 1 cc per each centimeter of depth.

CryoSADS consists of a deployment system, rotary-percussive drill with powder sample acquisition and capture bit, and pneumatic sample transfer and drop-off system. The Weight on Bit will be limited to <40 N because of the low gravity and low spacecraft mass. To enable penetration into cryogenic material with such a low bit-ground contact pressure, the hammer system will deliver 2 J/blow at 20 Hz. To minimize reaction forces and vibration into the lander, the drill will be mounted on vibration isolator.

The pneumatic approach allows extremely fast sample transfer to an instrument, with minimal heating of the sample itself. The gas options include compressed gas from a dedicated tank for Europa's probe and a suction blower for Titan's probe. In essence, the difference between the two options is how the deltaP across the pneumatic system is being generated. On Europa the sample is 'blown' into an instrument by compressed air ("air gun" approach) while on Titan the sample is 'sucked' because of lower pressure generated by a blower ("vacuum cleaner" approach). To enable pneumatic transfer, the drill bit is a combination of a coring bit and a full faced bit. The coring cutters ensure a hole can be started even on a steep incline while the full faced cutter ensures generation of cuttings rather than a core.

CryoSADS is currently undergoing breadboarding and testing in Titan and Europa relevant materials. The test results will drive the final CryoSADS design and architecture. The fabrication of CryoSADS will be performed in the summer of 2018, and end to end tests will continue into 2019. CryoSADS will also undergo vibration and vacuum thermal tests to reach TRL6.