THE INCHWORM DEEP DRILLING SYSTEM FOR KILOMETER SCALE SUBSURFACE EXPLORATION OF EUROPA (IDDS). S. Rafeek1,2, S. P. Gorevan1, P. W. Bartlett1,3, and K. Y. Kong1,
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Introduction: The Inchworm Deep Drilling System (IDDS) is a compact subsurface transport system capable of accessing regions of astrobiological interest deep below the surface of Jupiter’s moon, Europa. The IDDS answers Focus Investigation Area 1 as an innovative concept for implementing subsurface exploration of Europa. The concept is being developed at Honeybee Robotics to reach depths on the order of one kilometer with no tether or umbilical of any kind. The device’s unique, inchworm-burrowing method appears capable of achieving this near-term depth goal and it is foreseeable that the IDDS will be capable of autonomously drilling to tens of kilometers below the surface. Logical applications of the concept also include accessing the proposed subsurface oceans on Ganymede and Callisto, subsurface water ice on Mars, and Lake Vostok on Earth. The conference presentation will communicate the IDDS concept and how it can enable the search for prebiotic and biotic chemical processes on Europa by bringing proper instrumentation to the subsurface ocean for in-situ investigation and/or returning samples to the surface. Currently, a proposal for breadboarding the IDDS is pending for the Research Opportunities for Space Science’s Astrobiology Science & Technology Instrument Development NRA.

The Basic IDDS Conceptual Framework: The IDDS is largely a convergence of concepts from two previous devices designed and produced by Honeybee Robotics. The planetary surface burrowing mole concept extends our work on a tethered subsurface sampler effort conducted in 1993 for Dr. Paul Mahaffy at NASA GSFC[1]. And the inchworm burrowing method is a direct application of our work on the Welding & Inspection Steam Operations Robot (WISOR), a steam tunnel-walking robot provided for the Consolidated Edison Corp. of New York. The IDDS robot is between 10 and 15 centimeters in diameter and 1 meter in length. Two symmetrical segments comprise the IDDS, each with a drill bit and a set of three shoes. Figure 1 below shows a rendering of the concept.

The IDDS gets around problems posed by tethers or umbilicals through the employment of drilling techniques developed by Honeybee Robotics for the Athena Mini-Corer that require no more power than that offered by a radioisotopic thermoelectric generator (RTG) or a successor technology. The high reliability, power density, and output duration of next generation power supplies such as the Sterling Power System (SPS) state a strong case for their use in a kilometer-deep burrowing device.

Burrowing Method: Once deployed by a lander on the surface, the IDDS autonomously drills into the ground under its own power. The inchworm motion of the device’s two segments both walks it forward and provides the thrust necessary for drilling. Feet on each segment grip the walls of the hole. Flights along the body pass cuttings to the rear. Sampling and analysis take place once the proper depth is achieved, and since the burrowing method is independent of gravity, the IDDS can then return to the surface. The estimated burrowing rate projects a mission duration on the order of weeks.

Accommodating Scientific Functions: Once the IDDS burrows to the depth specified, it can perform in-situ analysis as well as sample acquisition. With data and samples stored on board, the IDDS can reverse its burrowing process and return to the surface. Various in-situ observations and tests such as imaging and spectroscopy can be facilitated by the IDDS. Once samples are brought into the IDDS by the sample acquisition hardware, treatment of the samples such as baking for a GCMS is feasible as well. As a novel access technology, the IDDS enables the direct search for Europa’s possible past, present or future biotic activity.