VACUUM SEALABLE CONTAINER (VSC) AND ASTRONAUT LUNAR DRILL (ALD) FOR ARTEMIS.

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Introduction: NASA's Artemis Program is under development to send first woman and next man to the Moon. Artemis will utilize a suite of new technology for Lunar exploration, including new space vehicles, new space suits, and new Astronaut Tools. Honeybee Robotics has been working with NASA JSC to develop a new Vacuum Sealable Container (VSC) and new Astronaut Lunar Drill (ALD) for the upcoming Artemis missions.

Vacuum Sealable Container: Sample return continues to be the "Holy Grail" of space exploration, allowing for the analysis of materials using Earth-based laboratories instead of needing to miniaturize and ruggedize instrumentation for space. The Apollo missions to the Moon had several kinds of Sealable Containers which brought back Lunar samples for analysis [1]. These samples are still being analyzed, fifty years later. The VSC requirements are different from that for Apollo containers and as such, new development was required.

One major difference between Artemis samples and those from Apollo is the desire to bring back volatiles which may be part of lunar regolith. The VSC is designed to withstand a high-pressure differential caused by sublimating volatiles.

Because of the new, stricter sealing requirements, additional features have been added to the VSC. For example, the seal on the container is required to be more robust, thus required more force to actuate, and the seal must be locked in place with a secondary mechanism.

Astronaut Lunar Drill: The ALD is designed to be a multi-functional platform for Lunar sample acquisition. The drill builds on lessons learned from the Apollo Lunar Surface Drill (ALSD), as well as Honeybee's long history of mechanized sample acquisition devices for space [2]. The main functionality of the ALD is Deep Core Regolith Drilling. Additional functionality includes Surface Rock Coring (SRC), and GeoTech Tools (GTT).

The ALD is a rotary-percussive drill designed with deep drilling in mind. The ALD is currently designed to have decoupled rotary and percussion subsystems to allow for maximum battery life and reduced fatigue on the crewmember. Honeybee drill technology will automatically engage the percussion when needed to drill at maximum efficiency. The mechanized drill stand helps improve drilling efficiency; the system utilizes advanced drilling algorithms which only require the crewmember to hold a single switch. Additionally, the stand aids in extraction of deep cores, something which was a problem on Apollo.

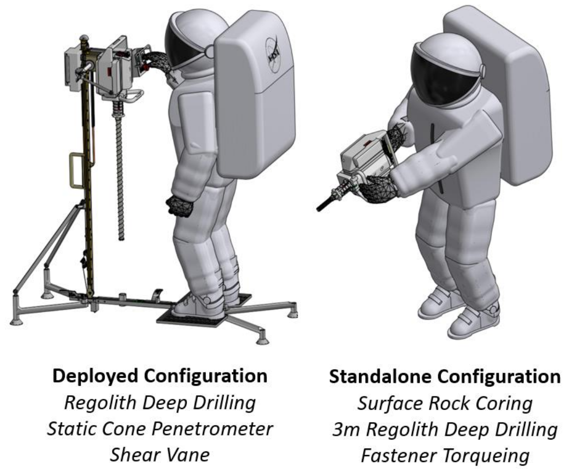

Figure 1. Astronaut Lunar Drill.

The SRC functionality of the ALD utilizes Honeybee's Eccentric Tube Core Breakoff technology to collect and retain rock core samples. This technology has also been infused into the Perseverance rover mission. The ALD is removable from the stand to allow crewmembers to collect samples from large boulders. Bringing back rock cores samples instead of full rocks allows for a wider variety of samples to be returned to Earth for study and puts them in a uniform form-factor for effective sealing and analysis. SRC bits will utilize the power of the drill's percussion system to drill hard Lunar rocks and expedite sample acquisition.

The mechanized stand on the ALD allows for additional attachments for taking geotechnical measurements with a Static Cone Penetrometer (SCP) and a Shear Vane (SV). With the stand, the ALD can take SCP measurements with the touch of a button, storing data for return to Earth. SV measurements utilize the ALD's Rotary motor to spin the vanes in a controlled manner, getting clean data untampered by human error.

References: [1] Bar Cohen and Zacny (2009), Drilling in Extreme Environments - Penetration and Sampling on Earth and Other Planets, Wiley. [2] Bar-Cohen and Zacny, Advances in Terrestrial and Extraterrestrial Drilling, CRC Press. [3] Myrick (2003), Core Break-off Mechanism. US Patent No. 6,550,549

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