**Developing a Large-Scale Lunar Regolith Test Bin with Gravity Offload Capabilities.** L. Weber[1*], P. Easter[1], M. Conroy[2], A. Metke[1], D. Britt[1] [1]The Exolith Lab, University of Central Florida, Orlando, Florida 32765, [2]The Florida Space Institute, Orlando, FL 32826, [*]lucas.weber@ucf.edu

**Introduction:** The increasing interest in Lunar surface exploration is driving the development of new Lunar rovers and hardware. The demand for mineralogically accurate Lunar test beds is increasing alongside this development. Test beds that can recreate many of the conditions on the Lunar surface, at the required size necessary for testing modern Lunar rovers are rare. A test bed with features such as gravity offload, drilling options, and different terrain variations would provide a resource for Lunar hardware testing on Earth. In addition, with NASA's Artemis missions returning to the Lunar South Pole, regolith bins matching the characteristics of the Lunar Highlands are of increased importance. To further the availability of regolith test beds, the Exolith Lab at the University of Central Florida is developing a 100m$^2$ regolith bin offering the mentioned features and more.

Many of the regolith bins currently in operation utilize basaltic dust [1], which is not representative of the mineralogy of the Lunar Highlands. The Exolith Lab produces Lunar regolith simulants which approximate both the mineralogical and geotechnical characteristics of the Lunar Highlands (LHS-1) [2] and Lunar Mare (LMS-1) [3]. At Exolith, we believe it essential that both mineralogy and geotechnical characteristics are represented to the greatest extent possible within a simulant. In cases that require bulk quantities of simulant, Exolith also produces a simplified LHS-1 simulant. An enhanced variant of this simulant will be used inside the regolith bin. This simulant will have a more accurate particle size distribution, including a wider range of coarse Anorthosite and Basalt.

**Design Considerations:** Further research into the effects of Lunar highlands regolith on Lunar hardware will be made possible by the Exolith 100m$^2$ regolith bin. Exolith's regolith bin will have a footprint of 10x10m and a depth of 1m providing ample room to perform drilling experiments. A 4ft tall retaining wall will be built to contain the ~130 tons of Lunar Highlands simulant. The entire regolith bin will be built around a gantry crane which anchors the bin's components. The bridge of the crane will have a 2-ton capacity allowing vehicles up to 1-ton, well within the safety factor, to operate within the regolith bin at Lunar gravity offload mode.

An essential design feature of the bin is the regolith simulant itself, which has an improved particle size distribution. This distribution will include Anorthosite and Basalt exceeding 1mm to more closely match the regolith found on the lunar surface This is essential for testing, as the coarse particle size can be problematic for rover wheels and other hardware.

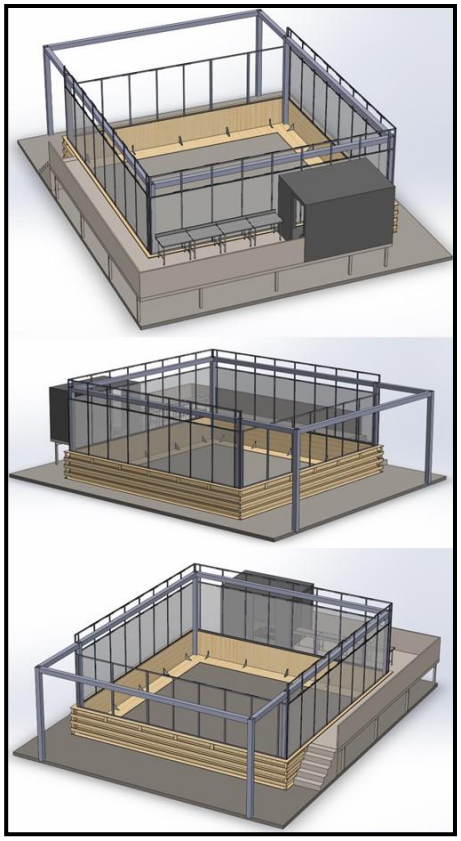

**Figure 1.** Perspective views of Exolith Lab's 100m$^2$ regolith bin design including a NW corner view (Top), SE corner view (Middle), and NE corner view (Bottom)

The top of this structure will be a framework of rectangular aluminum extrusions covered with Lexan polycarbonate. These components will all be sealed with a roof above the crane and placed under negative pressure as part of a dust mitigation system to contain the fine fraction of the simulant which will inevitability be mobilized by rover activities. The particles removed from the dust mitigation system will ultimately be mixed back into the simulant to maintain the bin's particle size diversity. Small dust particles on the Lunar surface can penetrate electronic components, optics, or other intricate parts of the vehicle so replicating this environment on Earth provides higher fidelity testing.

Bordering the regolith bin is an experimental deck and walkway matching the height of the regolith inside. The experimental deck is equipped with shelf space and power for workstations, allowing operators controlling experiments direct and safe viewing of active experiments without requiring access inside bin. Workstations located outside of the bin also serve to keep sensitive equipment away from dust.

Located at the end of the experimental deck is the access point for the regolith bin. This structure will act as a cleaning room, using negative pressure to keep any fine dust in the air or on personal protective equipment (PPE) from escaping the regolith bin. This cleaning room will also include space for donning/removing PPE while entering/exiting the bin.

**Testing Features:** A regolith bin with $100m^2$ of usable space presents the opportunity for features not available elsewhere. Gravity offload is one feature that will be provided, allowing fully equipped vehicles to be tested at $5/6^{th}$ of their Earth weight, mimicking lunar gravity. This will be done through the overhead gantry crane keeping a constant lifting force on the vehicle throughout its testing.

With a 1m depth and $100m^2$ footprint, we will have the ability to set up hills within the bin that can be used for the testing of drills, scoops, trenchers, excavators, dozers, and other mining equipment. This will enable essential ISRU-related site preparation and mining to be tested. Custom surface texture and morphology options are available for customers, with the ability to create craters, hills, boulders, stratigraphy, and other structures. It will also be possible for us to create areas within the bin of different regolith simulant compositions.

Additionally, our regolith bin will be open to private companies who wish to utilize it and will be relatively simple to schedule and use. We are also looking forward to holding rover competitions and educational events within our facility.

**Conclusions:** A $100m^3$ Lunar Highlands regolith bin provides the opportunity for researchers to test Lunar vehicles in similar regolith mineralogy and gravity footprint conditions to the Lunar surface while on Earth. This regolith bin contains a high-fidelity simulant with a particle size and minerology simulating potential Artemis Lunar landing sites. High fidelity simulant coupled with other features such as gravity offload and variable terrain make it possible to recreate many of the aspects of the Lunar surface needed for hardware testing and ISRU studies.

More information about using Exolith Lab's $100m^2$ regolith bin is available by request through exolithlab@ucf.edu.

More information on the Exolith Lab can be found on our website at https://exolithsimulants.com/

**References:** [1] Geotechnical Properties of BP-1 Lunar Regolith Simulant, 2019 Lunar ISRU Workshop, L. Sibille, R. P. Mueller, J. G. Mantovani. [2] Exolith Lab, LHS-1 Spec Sheet (Dec. 2022). [3] Exolith Lab, LMS-1 Spec Sheet (Dec. 2022).