Parabolic Flight Testing of Regolith Beneficiation for Lunar ISRU. B. Coffman[1], K. Runyon[2], J. Smith[1], F. Rezaei[3], D. Bayless[1], W. Schonberg[1], and D. Han[1], [1]Missouri University of Science and Technology, 400 W. 13th Street, Rolla, Missouri 65409. [2]Planetary Science Institute, 1700 East Fort Lowell, Tucson, Arizona 85719. [3]University of Miami, 1251 Memorial Drive, Coral Gables, Florida 33146. (Contact: handao@mst.edu)

Introduction: Separating lunar regolith particles by chemical composition is important to optimizing subsequent metal extraction. Sorting by iron content is a method of separation that is likely attainable in a lunar environment due to the lack of reliance on gravity as the primary motivating force. Lunar regolith is comprised mostly of plagioclase (diamagnetic), olivine and pyroxene (paramagnetic), and iron micrometeorites (ferromagnetic) mixed with agglutinates [1]. Therefore, designing a lightweight, low power magnetic separator is one of the goals of our ongoing LuSTR21 Project. At LSIC Spring 2024, we will report the progress of the designs of the concept of operations: stationary and mobile for regolith beneficiation [2,3].

Design and Concept of Operations: Figure 1 shows a prototype for the concept of "stationary operation" for the combined magnetic/electrostatic separation.

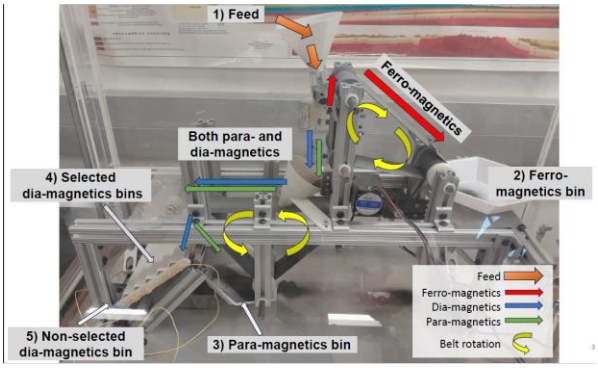
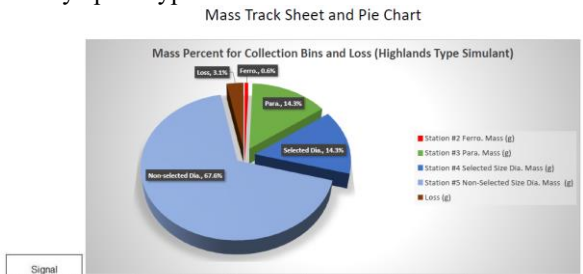


Figure 1. A concept of operation for stationary operation.

Ground Testing Results. Figure 2 shows the mass breakdown of simulants for the operation of the "stationary" prototype.



Signal Frequency 20 Hz	Station #1	Station #2	Station #3	Station #4	Station #5	Loss
Simulant Name	Mass In (g)	Ferro. Mass (g)	Para. Mass (g)	Selected Size Dia. Mass (g)	Non-Selected Size Dia. Mass (g)	(g)
H4W10g814	32.1	0.2	4.6	4.6	21.7	1.0

Figure 2. Mass track sheet and pie chart for the collected simulants at different stations as labeled in Figure 1.

Preparation for Parabolic Flight Testing: Figure 3 shows a wood mock-up of a glovebox to be used for parablolic flight testing. The dimensions of the glovebox is 72-in by 30-in by 30-in.

Figure 3. Team rehearsing in-flight operation for parabolic flight testing with a wood mock-up glovebox.

As of the submission time of this abstract (3/24/2025), our parabolic flight testing is scheduled to be in May 2025 with Zero-G®. We expect to have preliminary results by the time of SRR 2025 (early June 2025).

References:

[1] Papike, J., Simon, S., & Laul, J. (1982) The lunar regolith: Chemistry, mineralogy, and petrology. *Rev of Geophys, 20(4), 761–826.*

[2] Bachle, P., Smith, J., Rezaei, F., Bayless, D., Schonberg, W., and Han, D. (2024) Beneficiation of Lunar Regolith Simulants through Electrostatic Sieving and Magnetic Separation. AIAA SciTech 2024, AIAA 2024-2539.

[3] Bachle, P., Wood, C., Smith, J., Rezaei, F., Bayless, D., Schonberg, W., and Han, D. (2025) Ground Testing of a Magnetic-Electrostatic Separation System for Lunar Regolith Bneficiation. AIAA SciTech 2025, AIAA 2025-2045.