# Regolith flowability in reduced gravity and vacuum

A. Stepanova, PhD candidate Colorado School of Mines, astepanova@mines.edu
C. Dreyer, Colorado School of Mines
R. Garvey, Outward Technologies

## Introduction

Current theories on granular material flow indicate that a sixfold reduction in gravity, as experienced on the Moon, would necessitate a corresponding sixfold increase in the minimum diameter of gravity-fed hardware, resulting in a 36-fold increase in cross-sectional area. Such a dramatic scaling requirement poses a significant technical challenge, rendering traditional regolith feed designs impractical for lunar deployment.

No prior studies have specifically investigated the role of vibration in mitigating clogging, arching in lunar granular flow systems.

This study investigates the flowability of lunar regolith simulant ICON-LHT-1 to improve the design of material-handling systems for future ISRU applications.

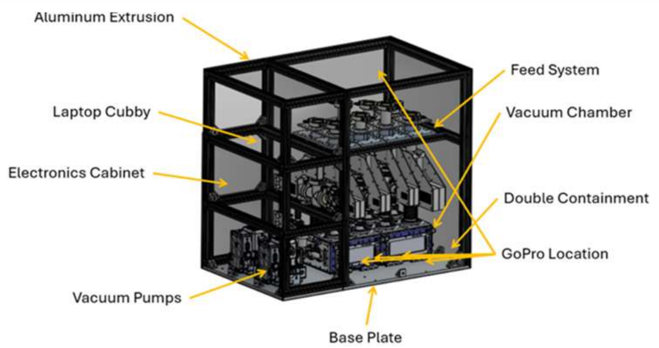
Testing of the system in parabolic flight, May 16,2025.

## Method

Four distinct regolith feed system designs, each incorporating flow-assisting mechanisms, were tested in a vacuum chamber under both terrestrial and simulated lunar gravity conditions using parabolic flight testing. The primary objective was to determine the effectiveness of these designs in mitigating clogging phenomena such as arching, bridging, and compaction, which commonly hinder granular material flow in low-gravity environments.

Key parameters, including outlet size, hopper angle, and external vibration, were systematically varied to identify optimal configurations for ISRU-based hopper discharge regolith conveyance.

Main test apparatus of regolith feed system.

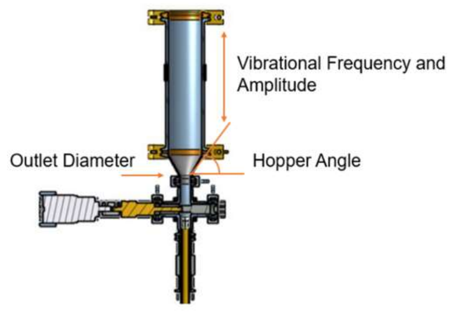



## Conclusion

The outcomes of this research will enhance understanding of the role of vibration in preventing blockages in granular feed systems under lunar gravity. The findings will assess the feasibility of the regolith feed subsystem and, if proven viable, will enable the development of a compact and efficient design optimized for operation in the lunar environment.

The ultimate goal is to develop experimentally-validated models and recommendations for lunar hopper sizing with and without vibration, under reduced gravity and vacuum, for effective and predictable regolith flowability.

Geometric and process parameters in the design of experiments.




## Results

The lunar gravity parabolic flight tests demonstrated the ability of a vibratory feed system to achieve continuous and reliable flow of lunar regolith simulants at controllable mass flow rates. Whenever the vibration system was off, the no flow condition occurred. With the vibration on the flow restarted.

## Acknowledgements

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