PROTOTYPE OF A MULTI-STAGE SIFTER FOR MECHANICAL SEPARATION OF LUNAR REGOLITH. K. Najdecki[1], I. Rapa[1], K. Kyć[1], K. Kurek[1], [1]AGH University of Krakow, AGH Lunar Resources Initiative, al. Mickiewicza 30, 30-059 Kraków, Poland, spaceteam@agh.edu.pl

Introduction: The multi-stage sifter is the core component of the DISTOBEE system (DIgging, STOring, and BEnefication) designed for the processing of lunar regolith. Developed through a collaboration between SpaceTeam AGH and AGH Space Systems for the ESA/ESRIC "2nd Space Resources Challenge", this unit enables the precise particle size separation required for effective In-Situ Resource Utilization (ISRU) on the lunar surface. During the design and construction phase, the sifter was engineered to meet a strict mass limit of 20 kg, while maintaining a target processing capacity of 12 kg/h.

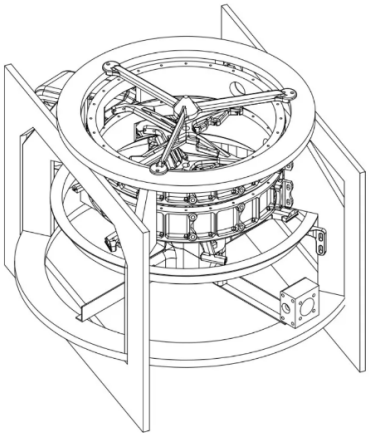
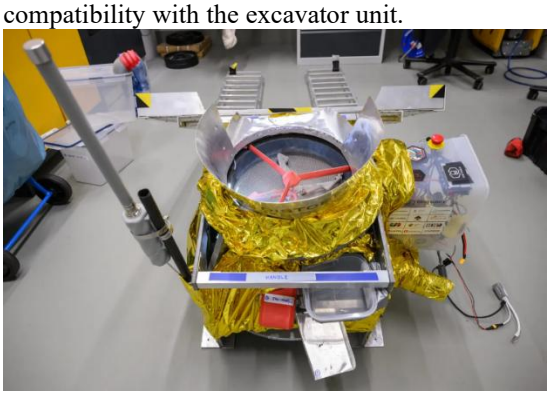


Fig.1. 3D visualization of the multi-stage sifter prototype

The DISTOBEE system contains an excavating and transport mechanism with a multi-stage sifter, which is responsible for separating lunar regolith into specified fractions. The project of a multi-screen sifter seeks to develop a highly controllable and efficient screening process. It addresses specific functional requirements related to particle size separation, a critical step in regolith beneficiation processes for In-situ Resource Utilization (ISRU) on the lunar surface. The device features a three-stage cylindrical design inclined at a small angle, equipped with circular sieves of varying mesh sizes.

Lunar regolith is fed into the sifter from the top and successively separated by grain size as it progresses through the stages. The efficiency of the sieving process is enhanced by the combined action of rotary brushes and vibratory motion which together support continuous material flow and effective particle separation. Once collected in separate bins, the processed regolith can be directed to further applications. Overall, the sifter's design (Fig.1.) ensures high efficiency and reliable performance under lunar conditions, which is essential for effective material processing and further utilization.

Structure and design: The multi-screen sifter designed for the "DISTOBEE" system is a cylindrical, three-stage device inclined at a small angle, enabling efficient separation of lunar regolith fractions. To make the screening process as controllable and efficient as possible, multiple technical solutions were implemented. The excavated material is delivered to the sifter via a hopper that ensures a connection between the excavator and the screening unit during material transfer. Each stage of the sifter is equipped with a circular screen of a specific mesh size: 1000 µm, 500 µm, and 100 µm. Conical chutes positioned beneath the sieves guide the material back to the center of the sieve to maintain consistent distribution during screening. The structure integrates electric vibrators mounted directly on the screens allowing for amplitude and frequency control. To prevent mesh blinding, the integration of rotary brushes powered by a geared motor is implemented as a solution for active sieve maintenance. At each layer, a dedicated bin collects a specific fraction of the processed lunar regolith. The entire assembly is contained within a compact, protective shell that minimizes dust accumulation and ensures modular compatibility with the excavator unit.



.Fig.2. Prototype of the multi-stage sifter

Field Testing at the LUNA Facility: The prototype (Fig.2.) was validated through field testing at the LUNA facility in Cologne, Germany. This analog environment allowed the system to be tested under mission-relevant conditions using the EAC-1 lunar regolith simulant. During the tests, the multi-stage sifter was operated in a continuous mode to evaluate the stability of the separation process. This provided critical data on the system's ability to handle material flow and validated the effectiveness of the multi-stage separation and recirculation design. The demonstration was conducted during the final stage of the "2nd Space Resources Challenge".