



# CONCEPTUAL DESIGN OF THE REGOLITH SIZE SEPARATION DEVICE

Damian Pietrusiak  
Przemysław Moczko  
Jakub Wróbel

Marek Wilgucki  
Oskar Fryckowski

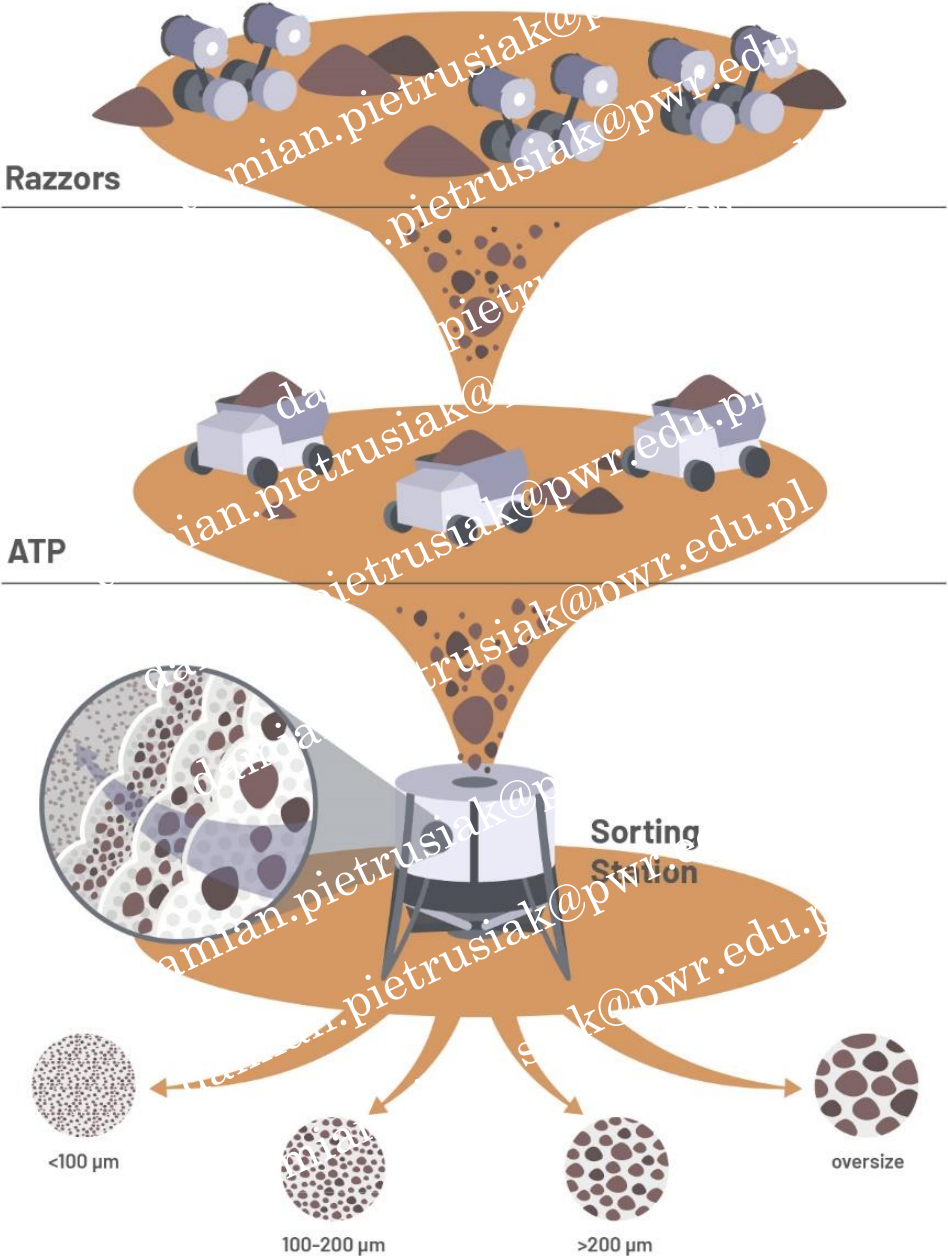
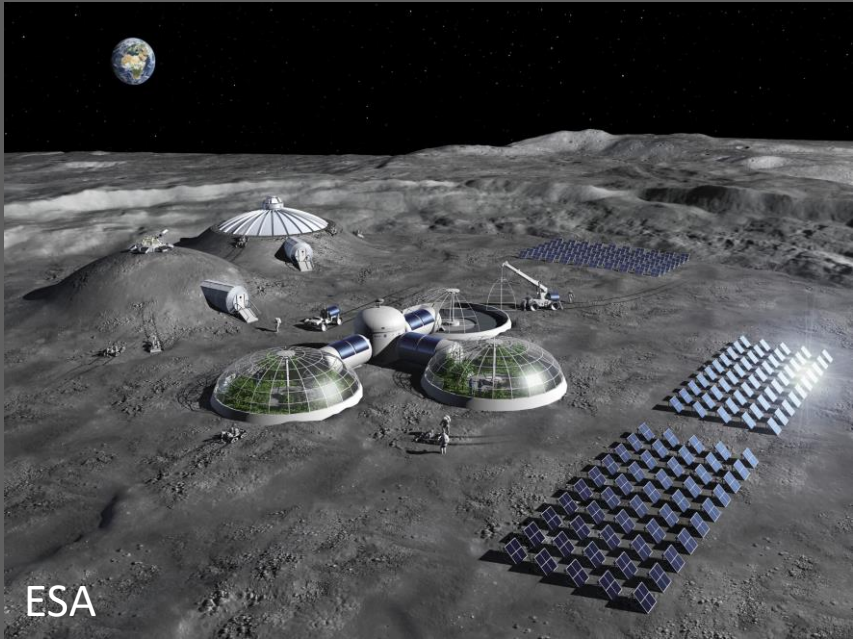


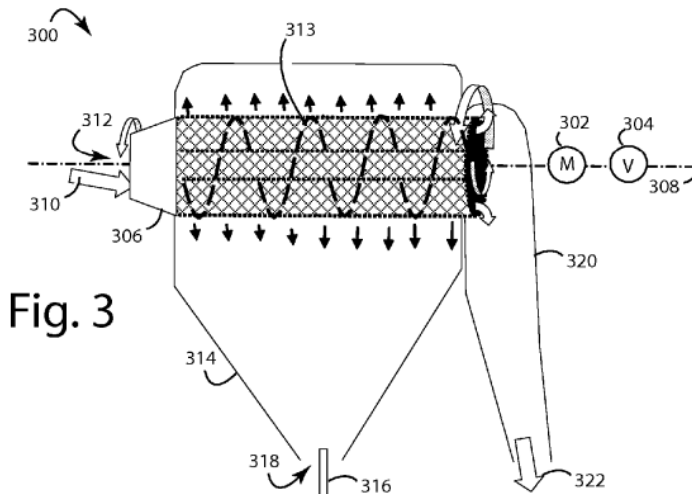
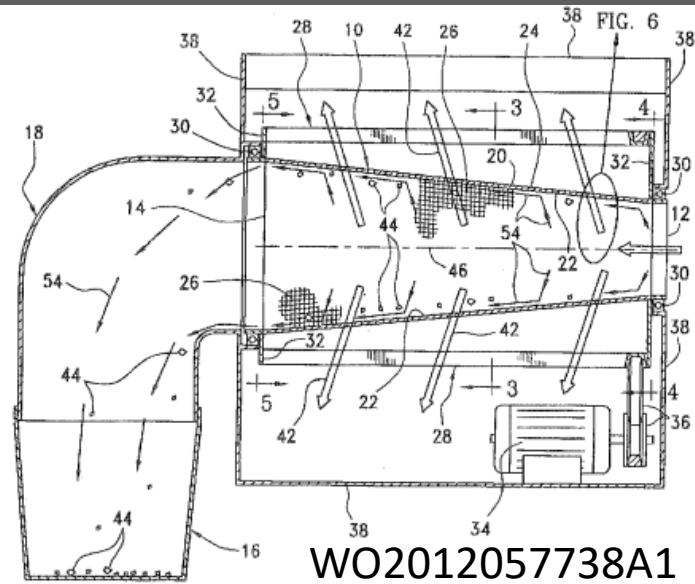
***„size separation of bulk materials in microgravity conditions is one of the most overlooked issue”***

Rasera et. al. The beneficiation of lunar regolith for space resource utilization: A review, Planetary and Space Science 186 (2020) 104879



Lunar Landing Site Preparation – Astroport

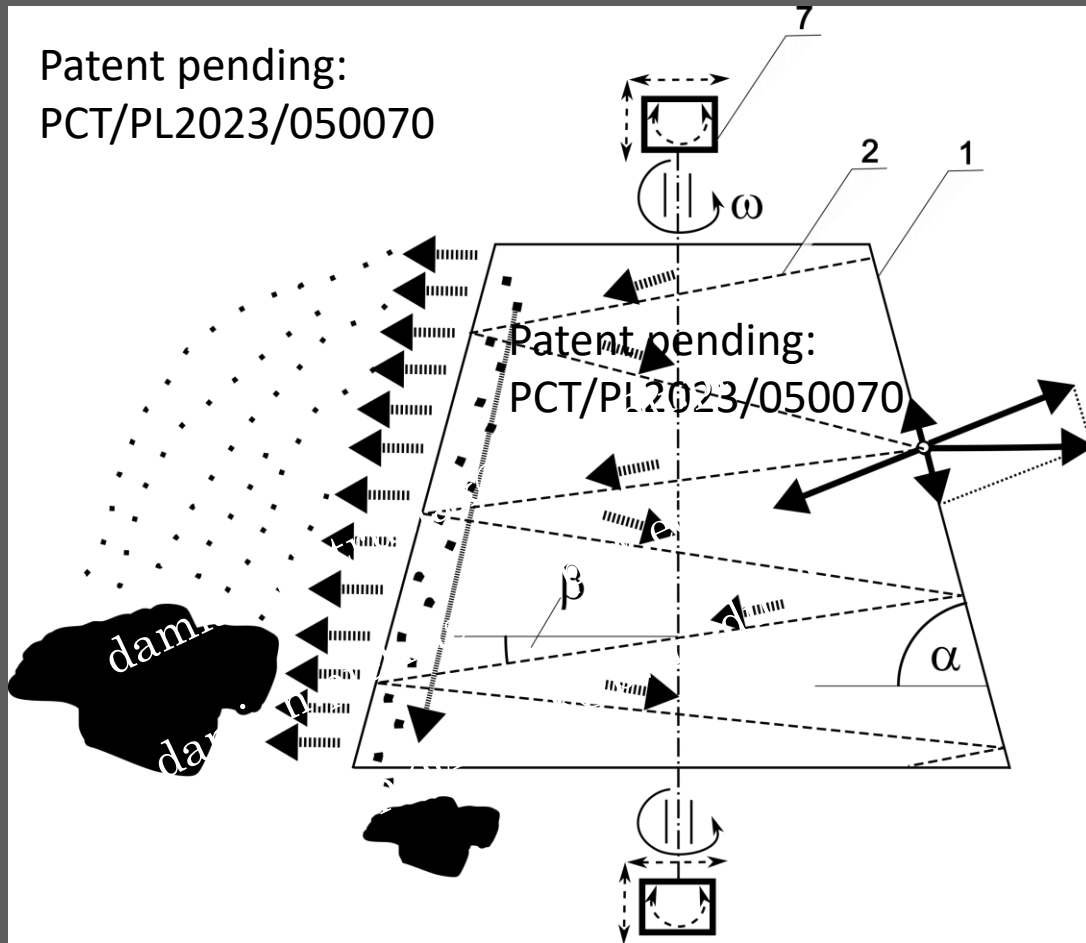




US 2016/0082478

- *Difficult control of material flow*
- *Interaction of two rotating components*
  - *Two drives*
  - *Possible wear (clearance control)*





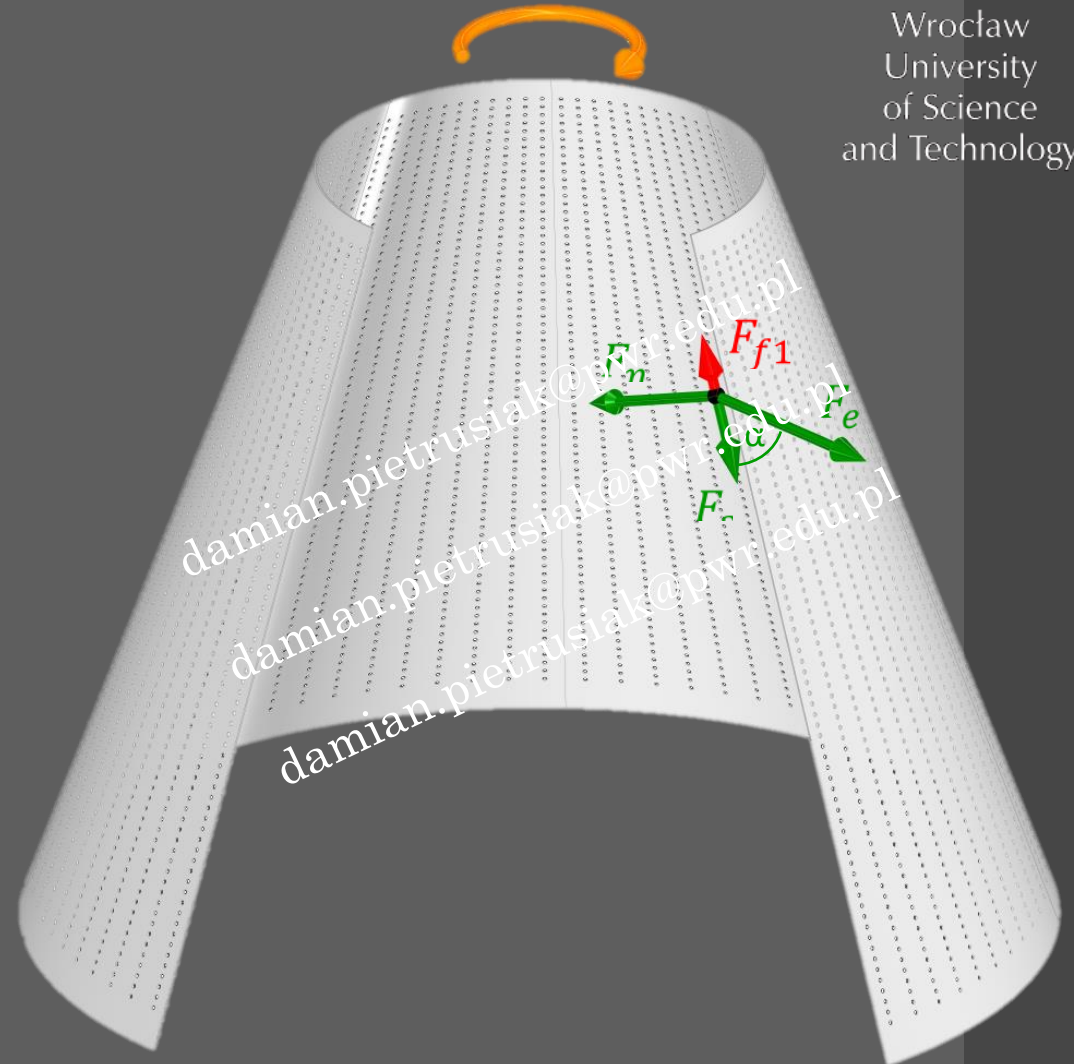
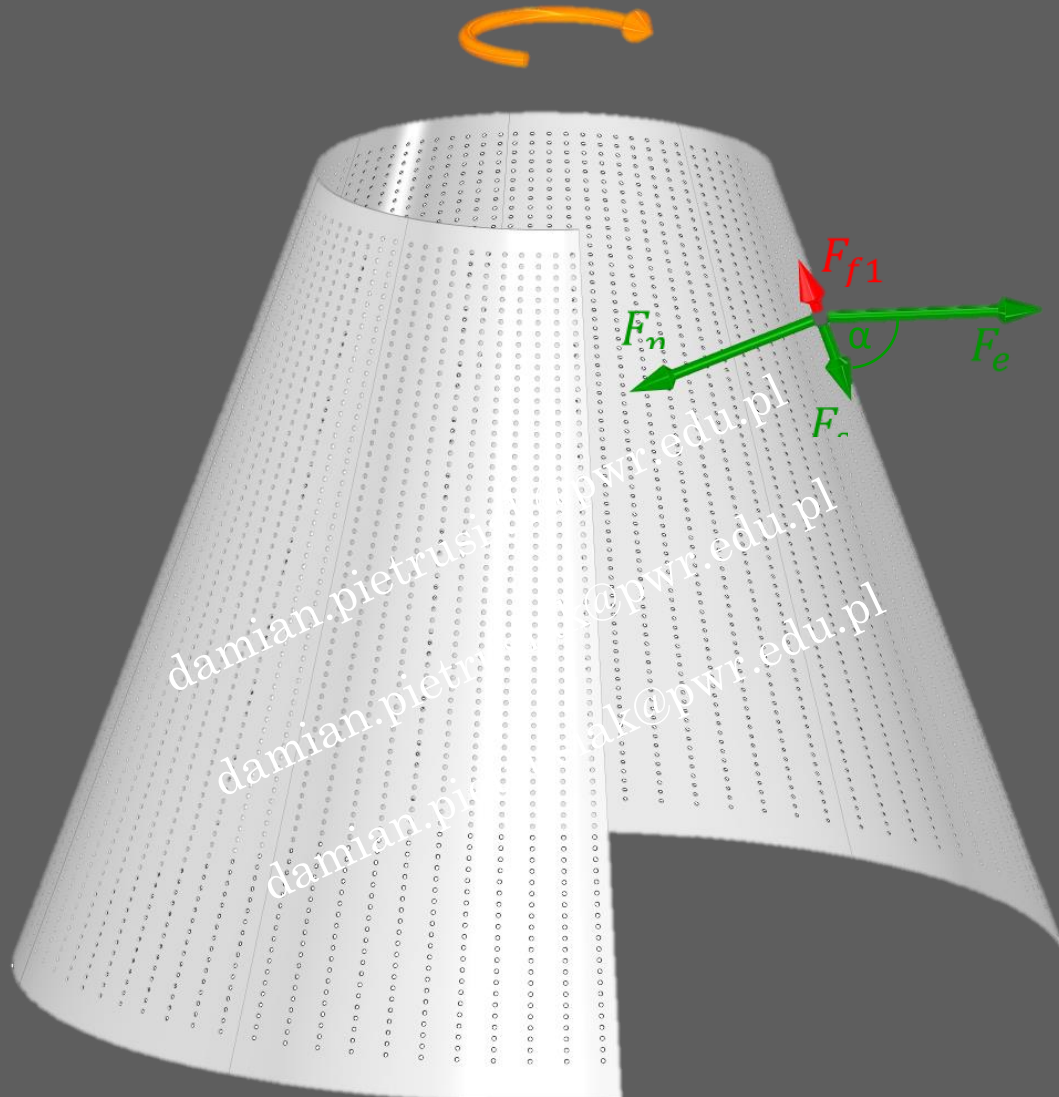
- ***spiral integrated with cone – no relative motion***

- ***centrifugal force as a main „driver”***

- $\omega$  - angular velocity
- $\alpha$  - cone angle
- $\beta$  - spiral angle

$\omega / \alpha / \beta$  - ratio can be defined for any gravity conditions  
(Moon, Mars, asteroids)

7 – additional vibration motion for enhanced sieving

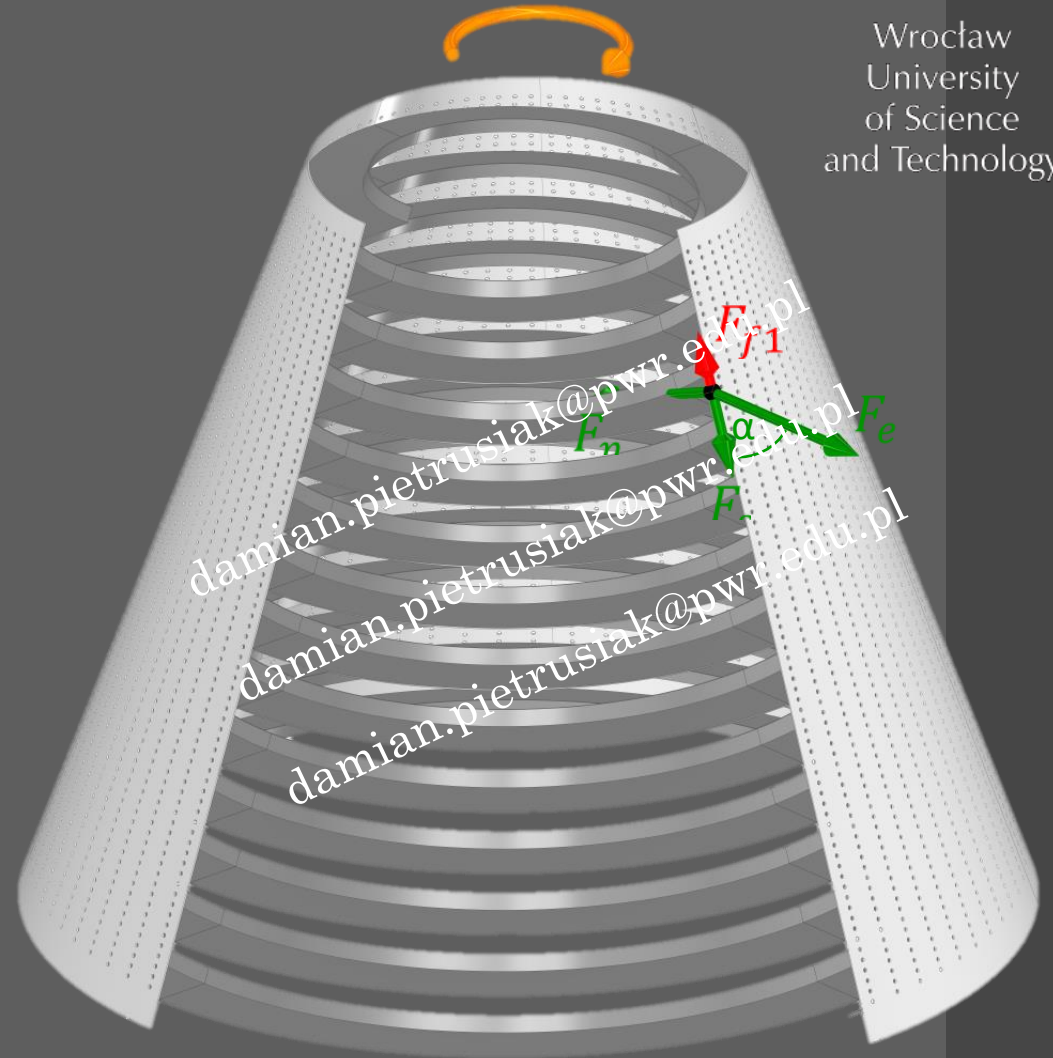
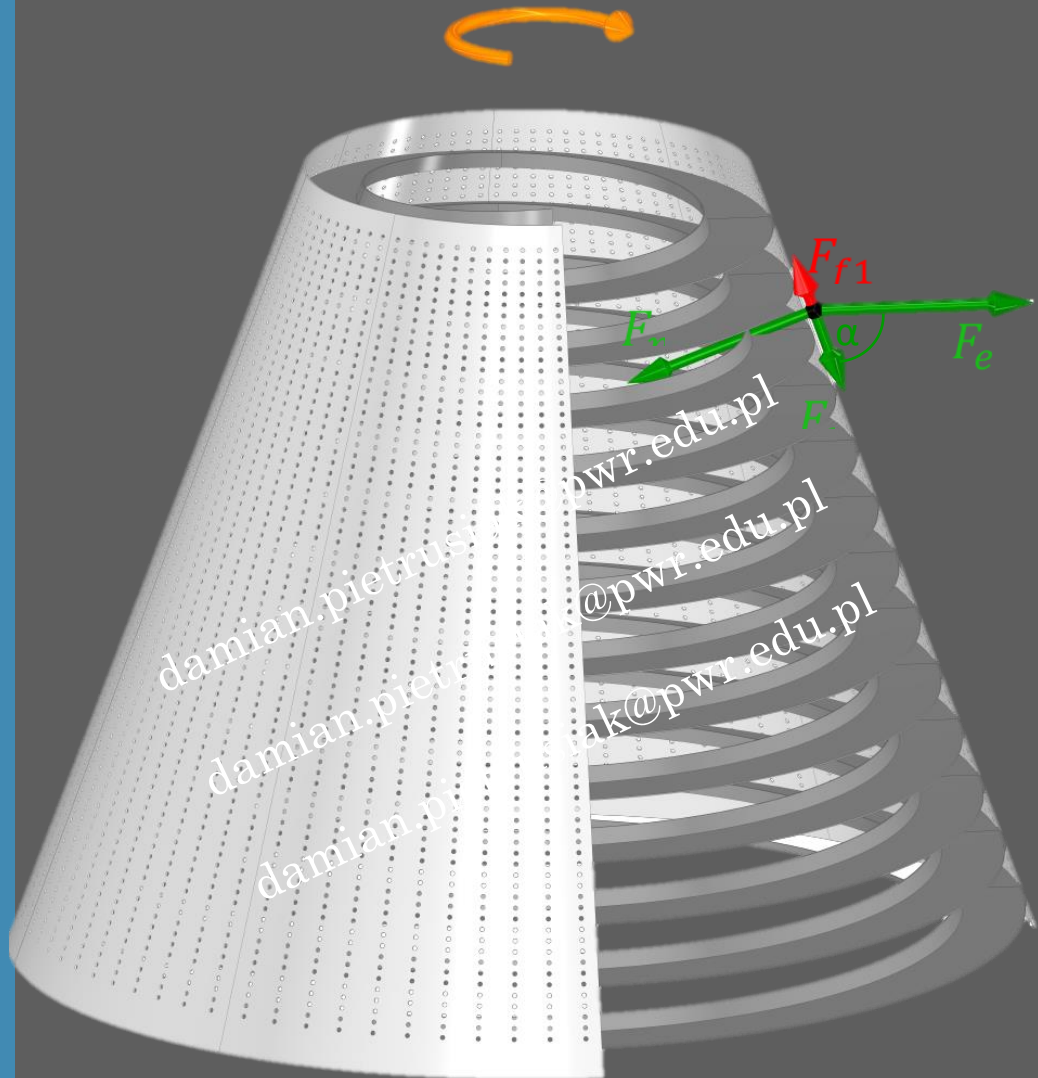


## Operation Principle

Spiral pathway controls of the particle motion through the cone

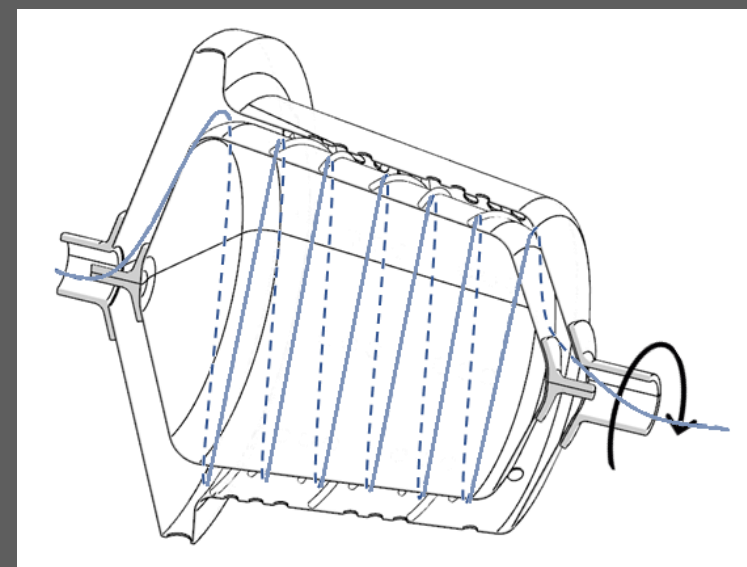
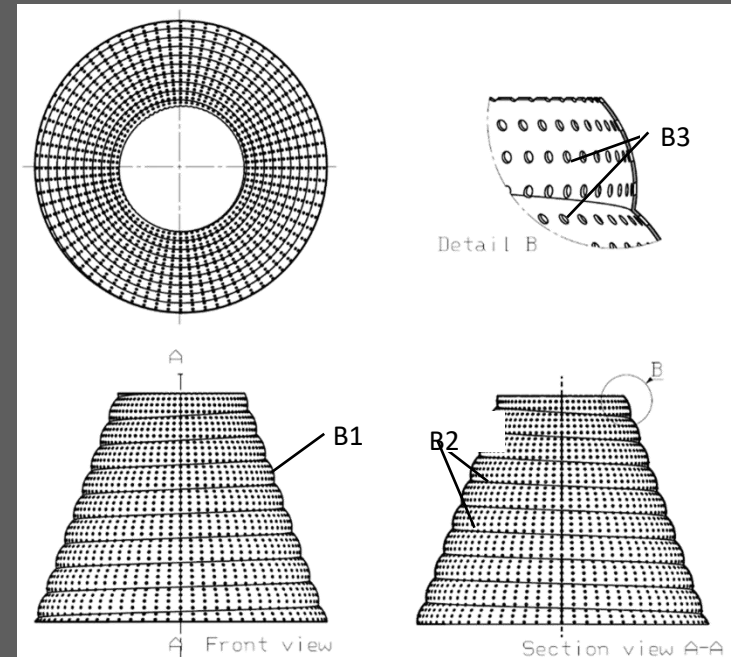
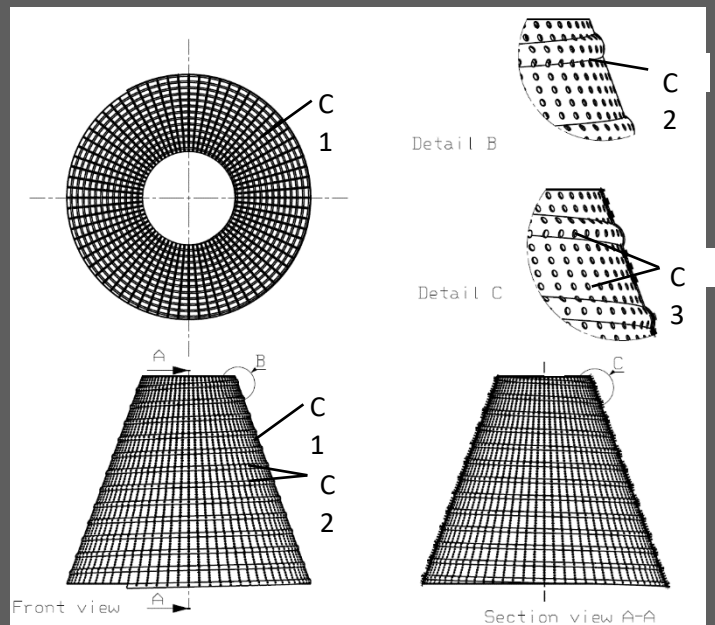
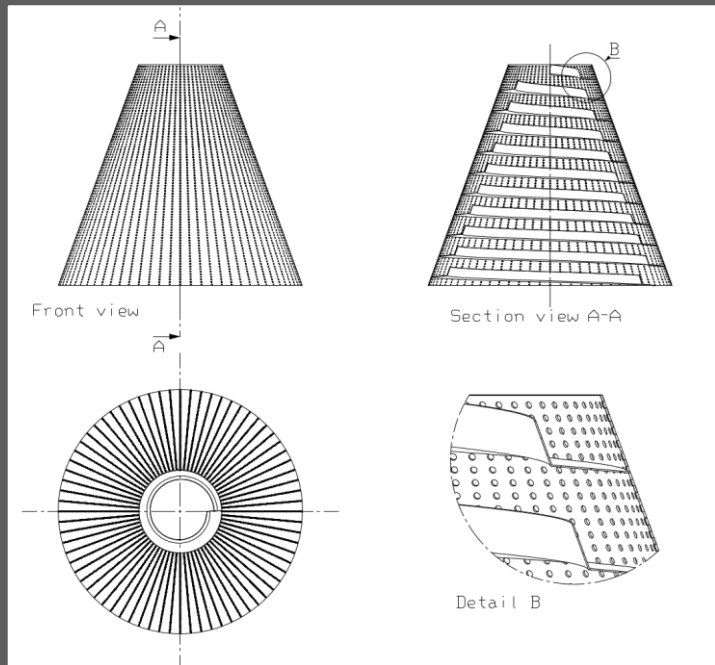


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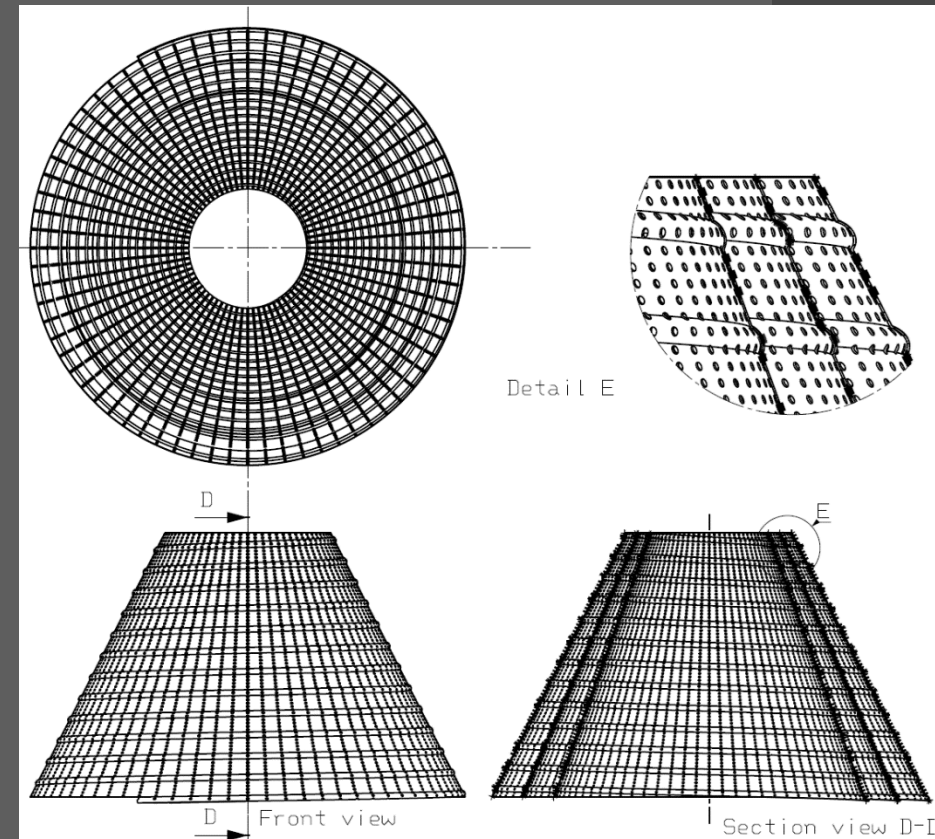
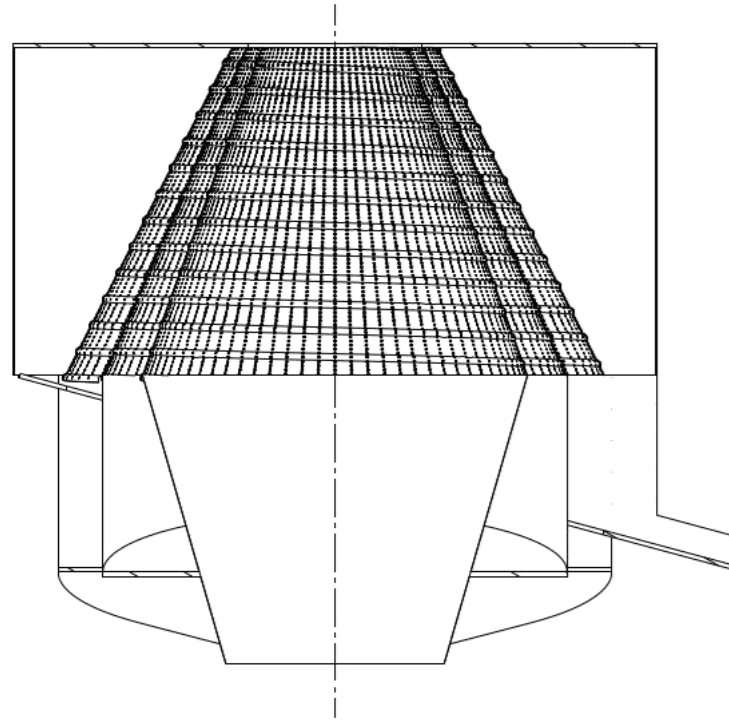
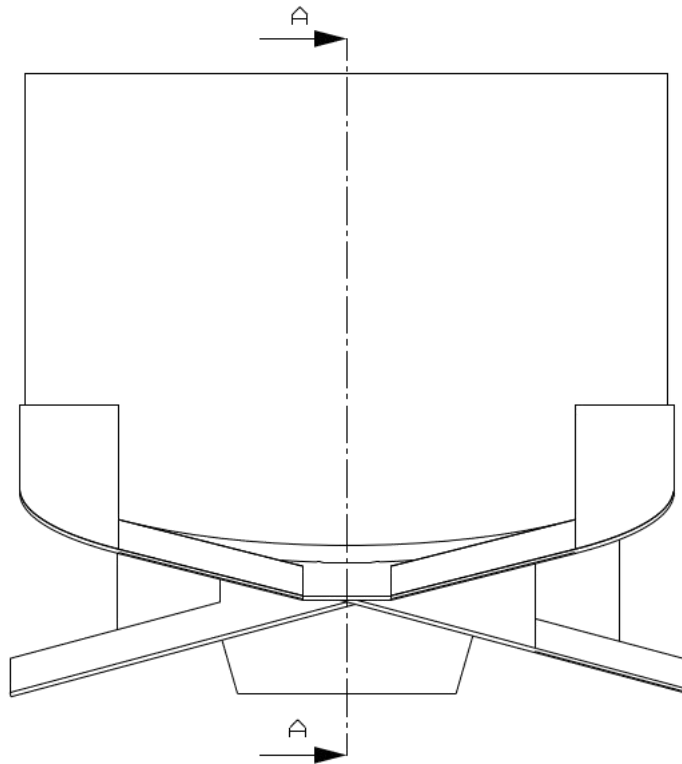


## Examples of impellers



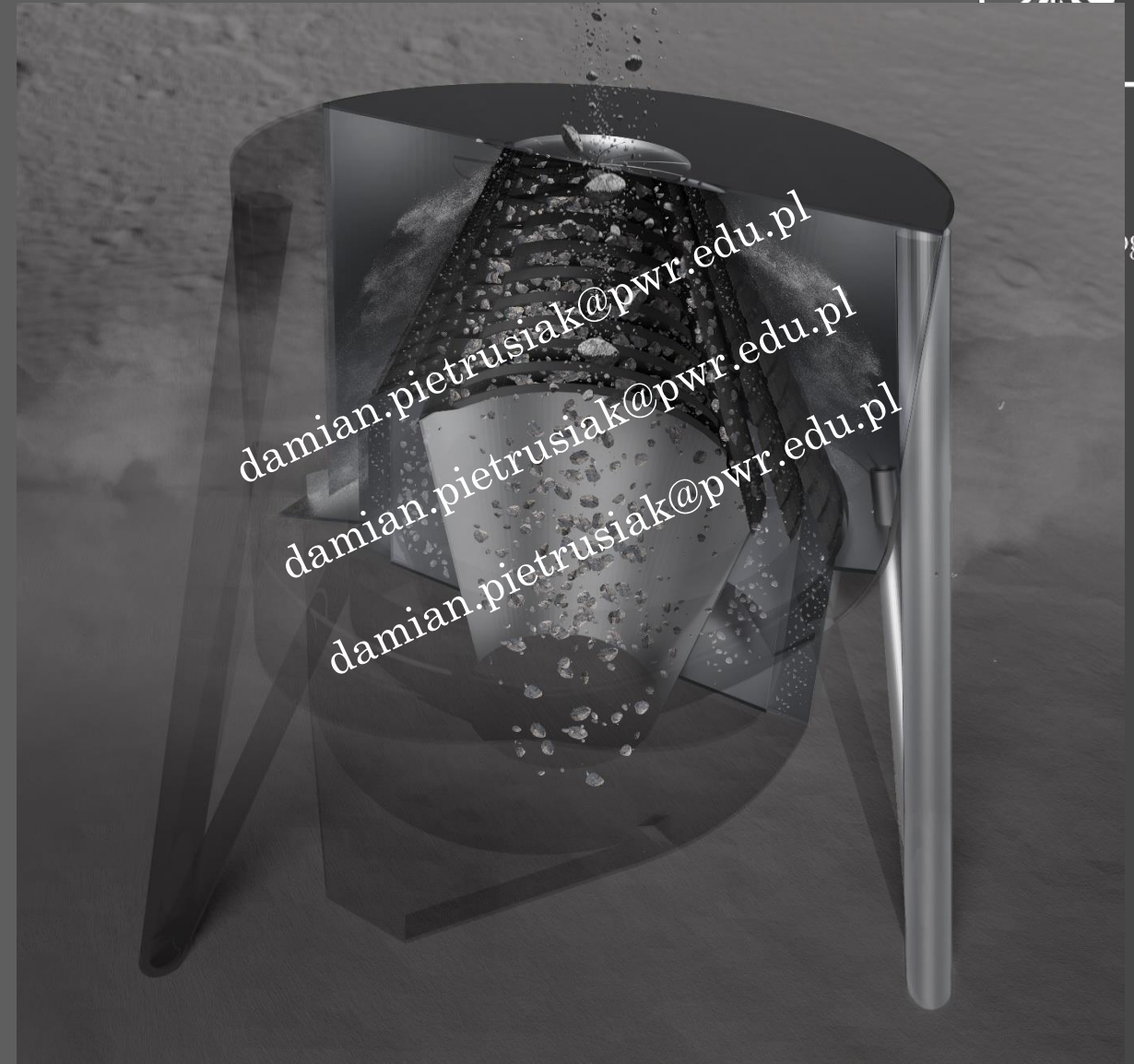
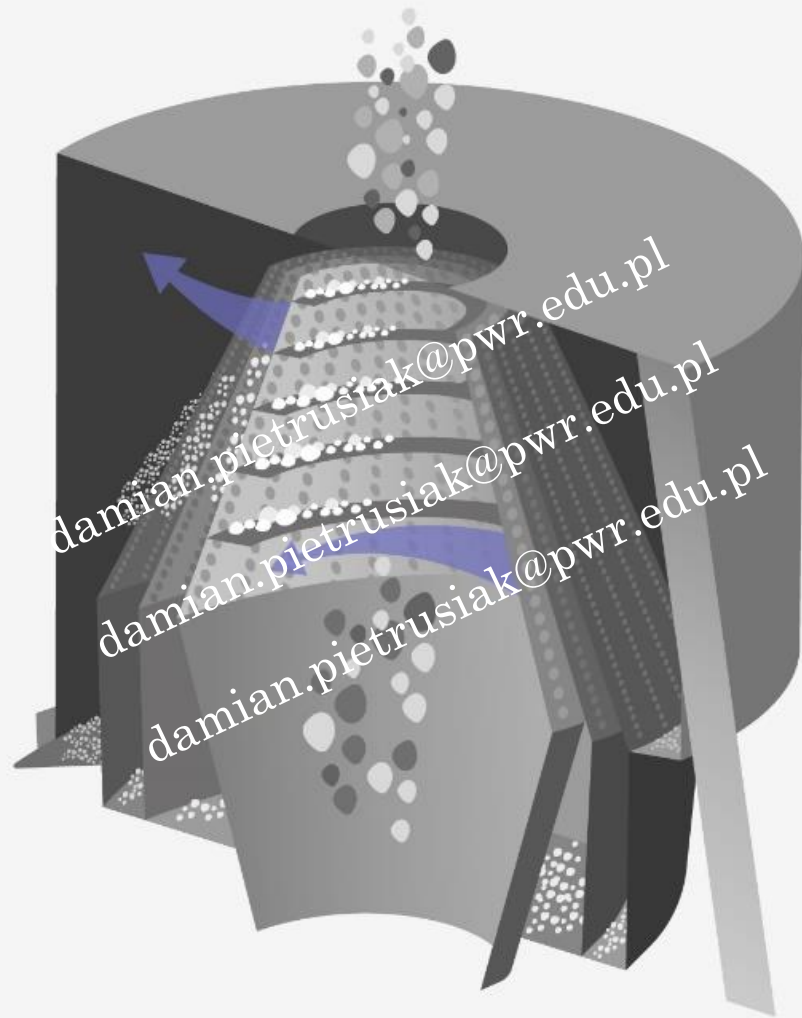
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Patent pending:  
PCT/PL2023/050070

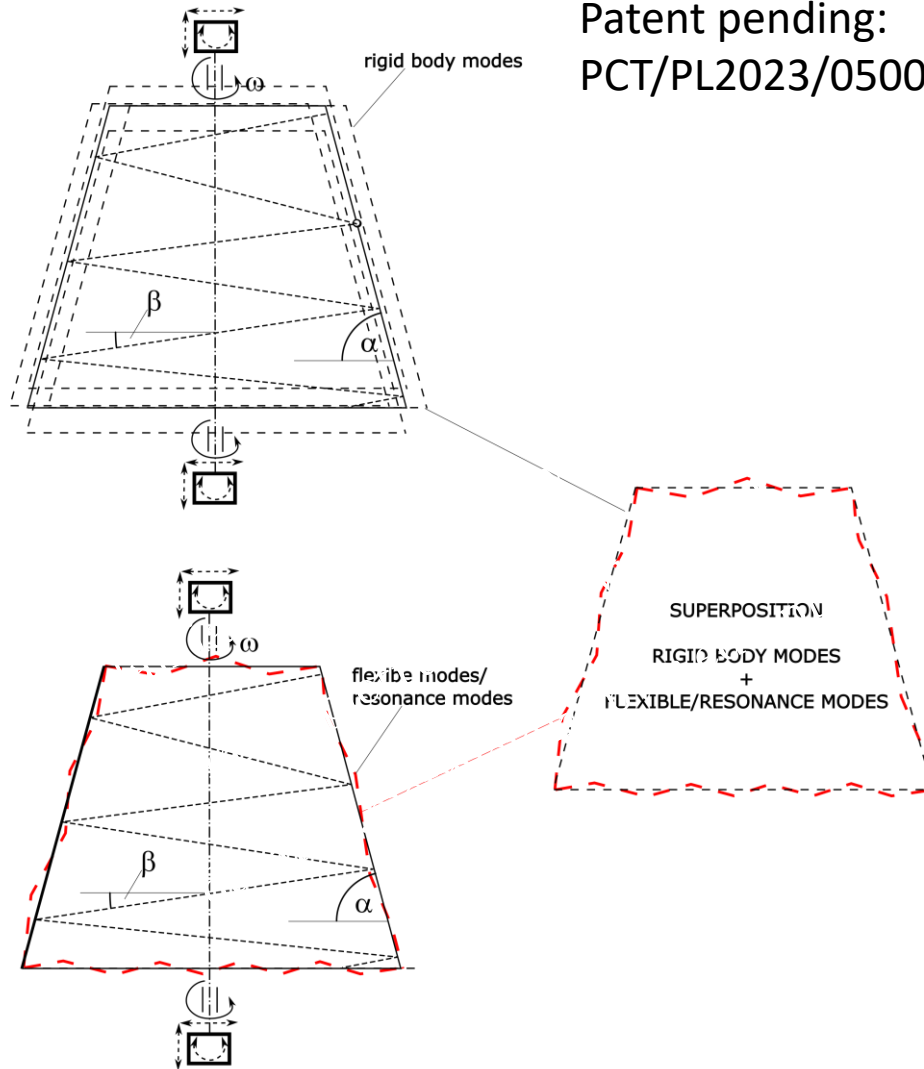


Patent pending:  
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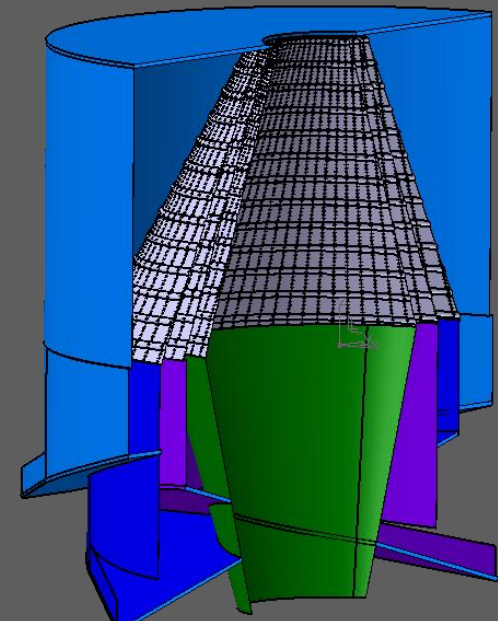
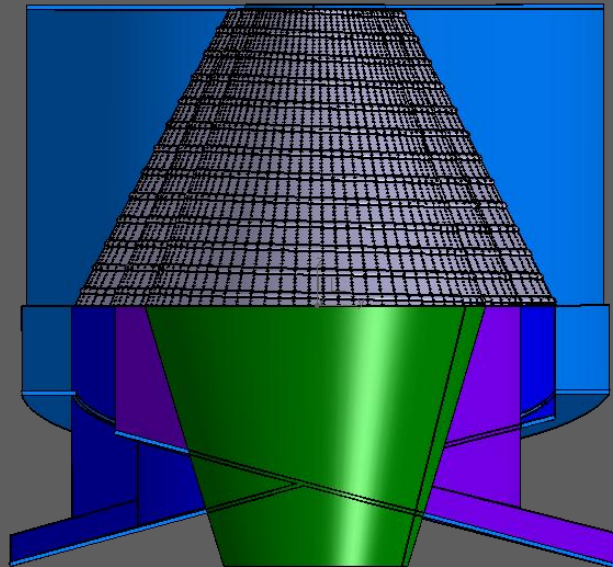
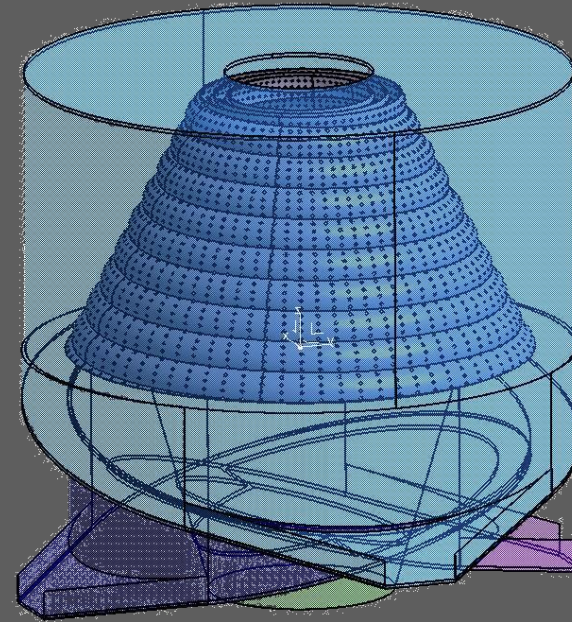
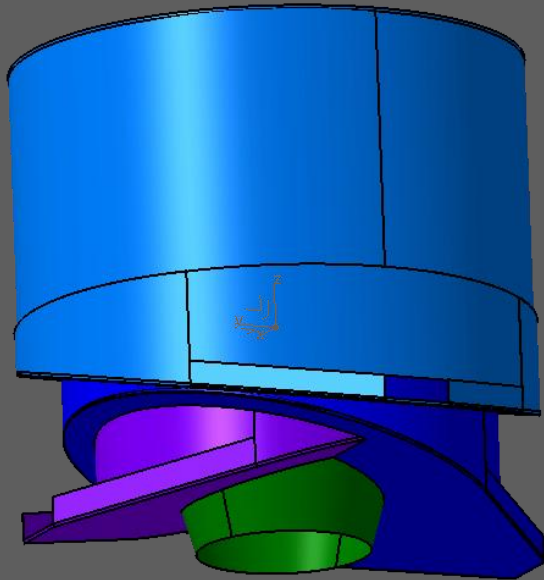


Patent pending:  
PCT/PL2023/050070



- *Design combining global vibrations (rigid body modes) with structural vibrations (flexible resonance modes)*

- sieving enhancement
- sieving screen cleaning/clogging prevention





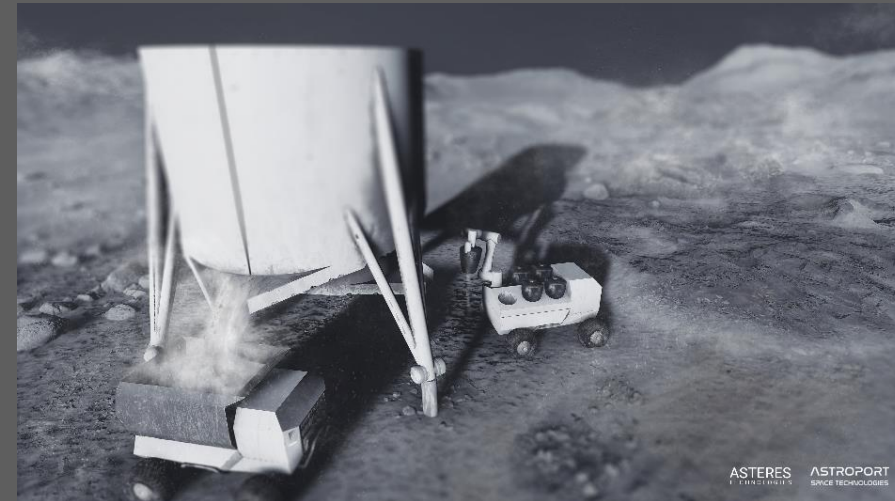
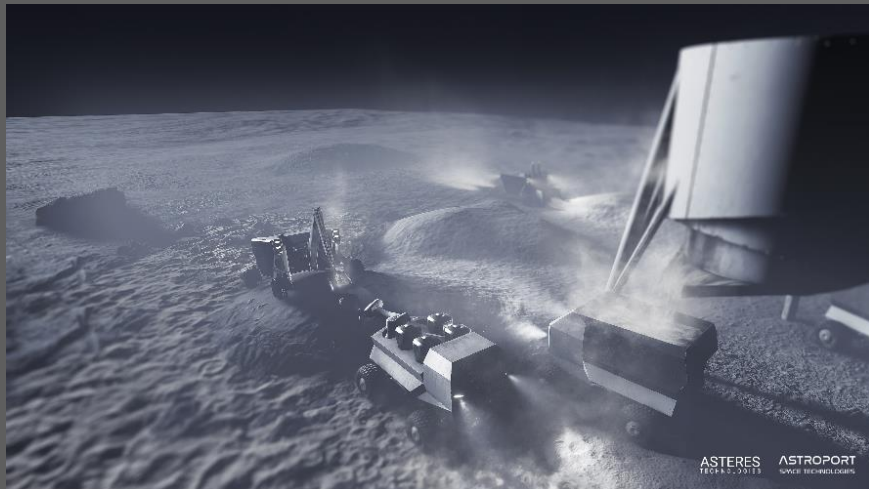
# Lunar Landing Site Preparation – Astroport

## Concept of Operation



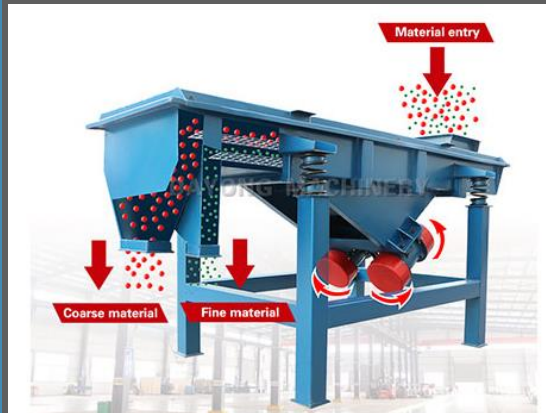
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**FOUR  
POINT**  
INDUSTRY 4.0

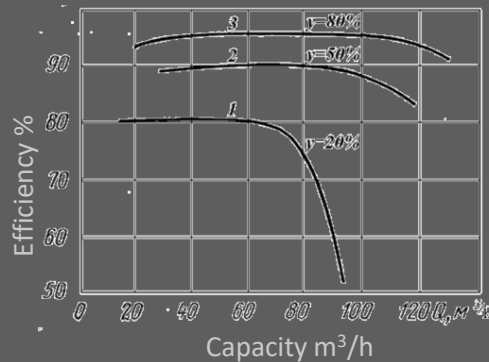


## Current state of the art

### Linear Vibrating Screens

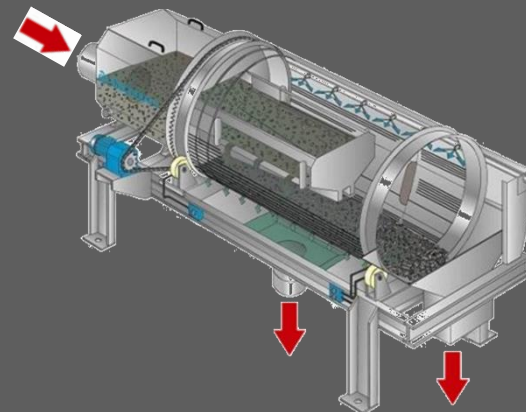


www.cy-mach.com

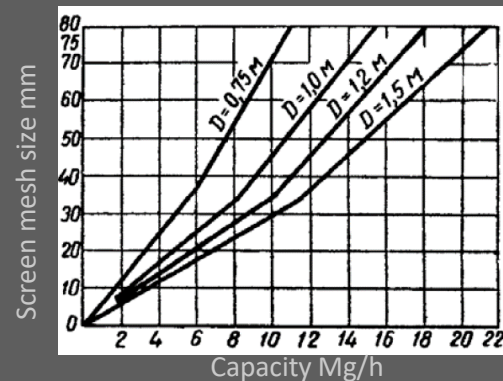


Average output  $Q = 280$  kg/min  
Rated power  $P = 2.2-3$  kW

### Drum Screens



www.gefa.com



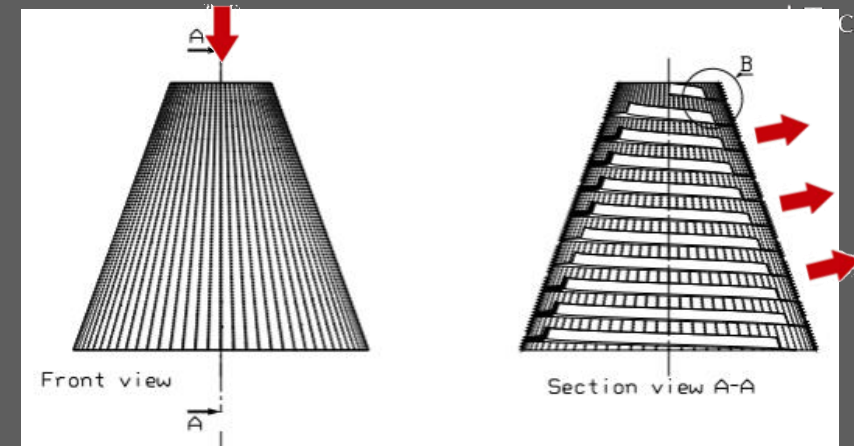
Average output  $Q = 14$  kg/min  
Rated power  $P = 1,2$  kW

## Assumptions

Separator dimensions:

Conical part height = 1.5 m

Average diameter = 1 m



RASSOR output  $Q = 100$  T/year [1]  
Required siever output = 0.27 kg/min

[1] Muller R.P. et. al. Design of an Excavation Robot: Regolith Advanced Surface Systems Operations Robot (RASSOR) 2.0, 15th Biennial ASCE Conference on Engineering, Science, Construction and Operations in Challenging Environments, Earth and Space 2016



## Power calculations

### Geometrical assumptions

- Conical drum height = 1.5 m
- Average diameter = 1 m
- Maximum rpm = 120 1/min
- Start time = 5 s

### Input data

Rotating components mass:

- conical drum = 40 kg
- inlet, outlet, helix, shaft = 16 kg
- regolith = 12.3 kg

Total moment of inertia =  $14.5 \text{ kg/m}^2$

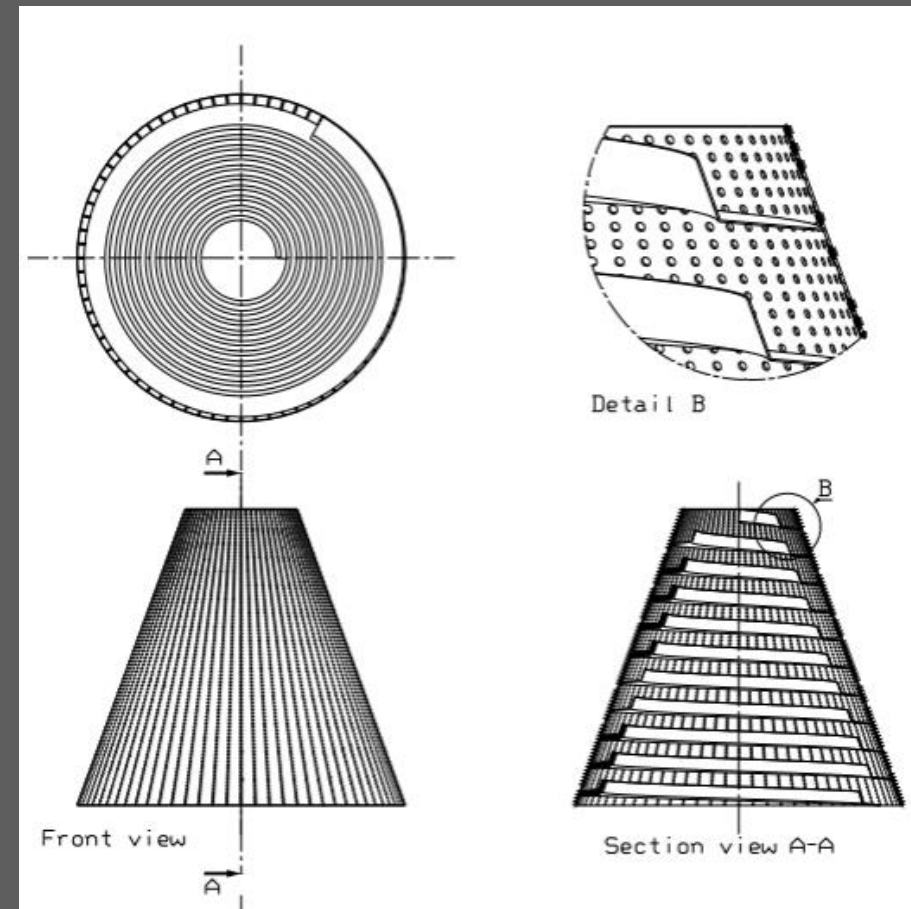
Maximum rpm = 120 1/min

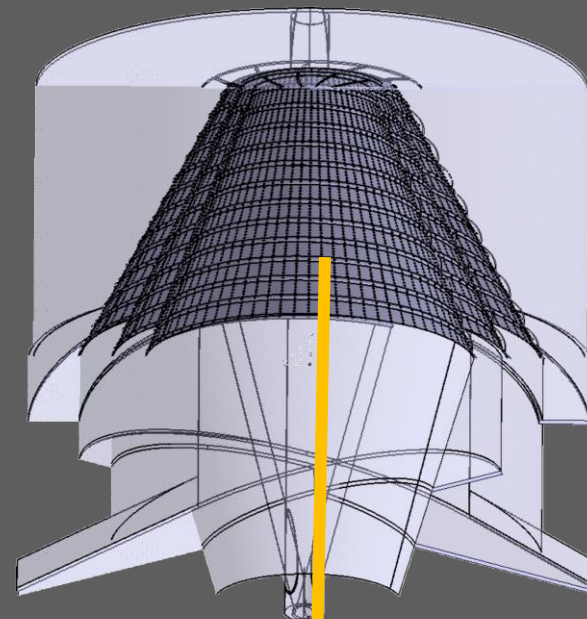
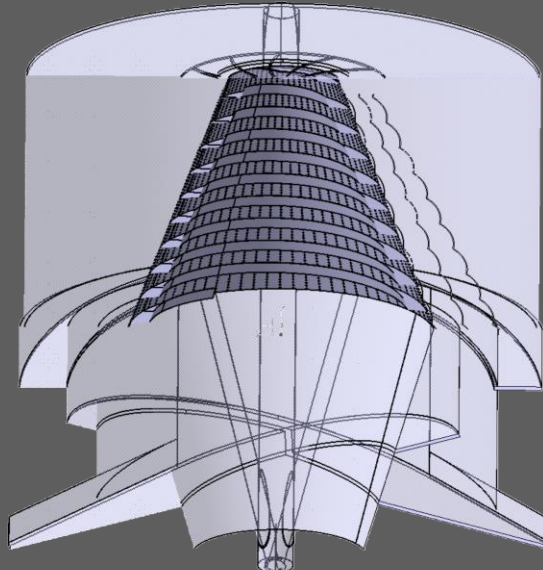
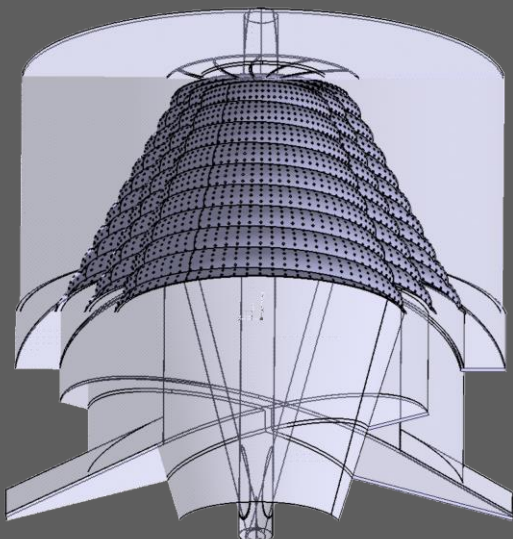
Start time = 5 s

## Power requirement

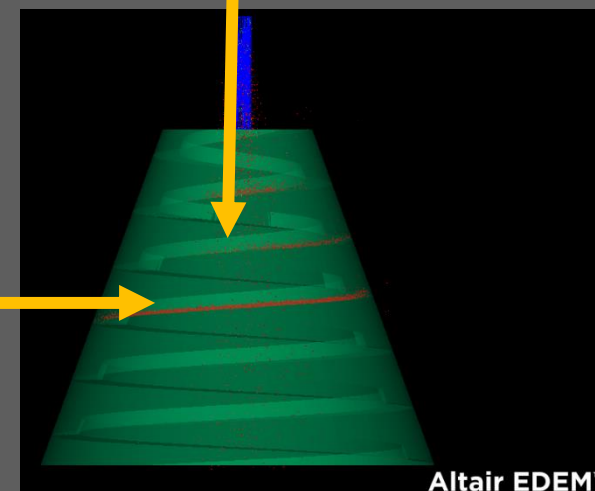
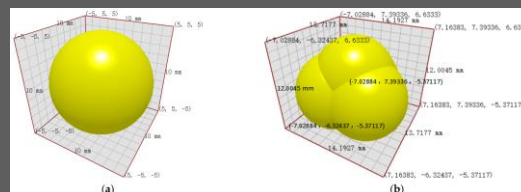
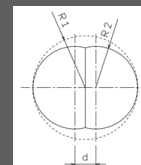
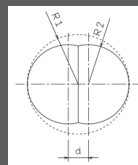
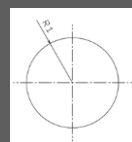
Total power requirement for start up and operation

$$P = 0,55 \text{ kW}$$

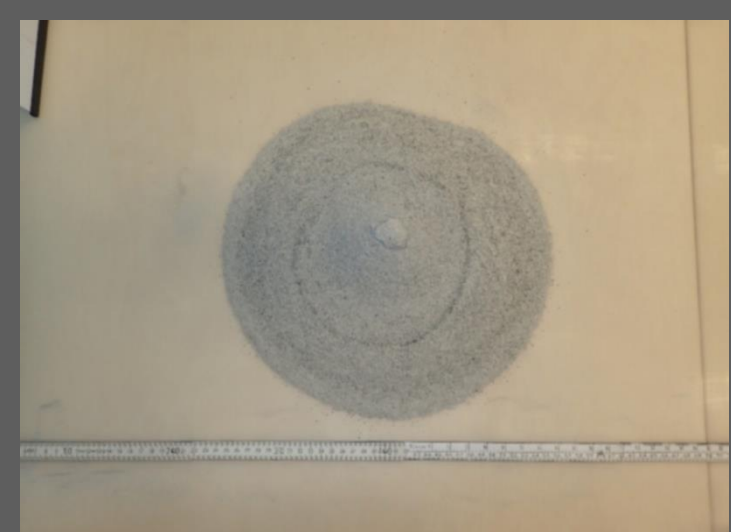
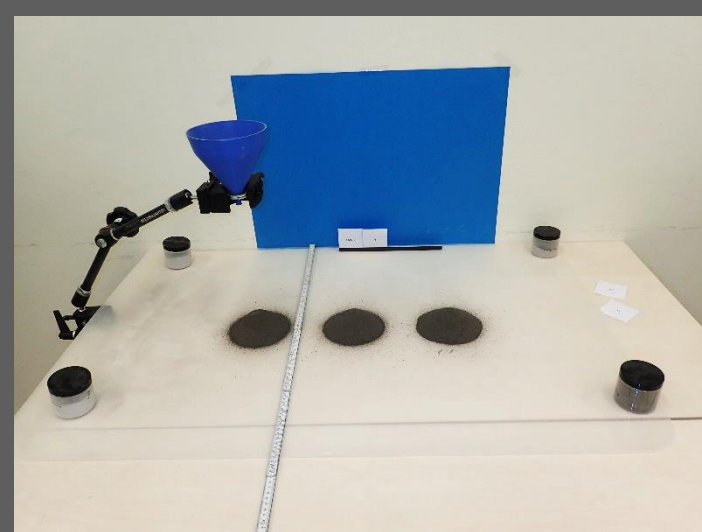
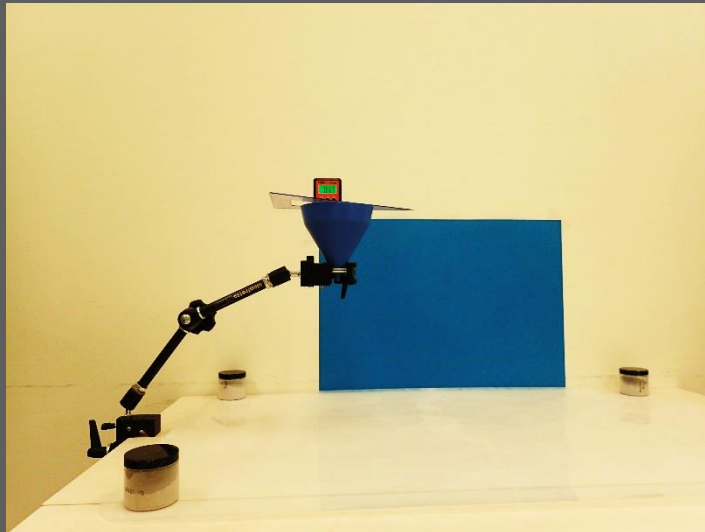
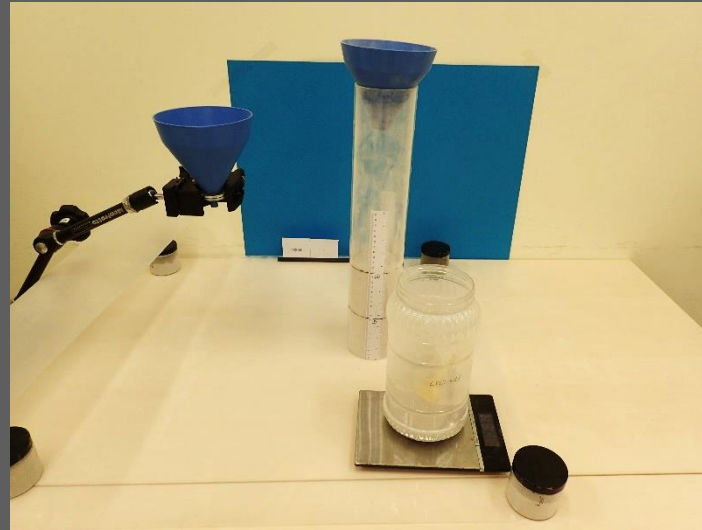
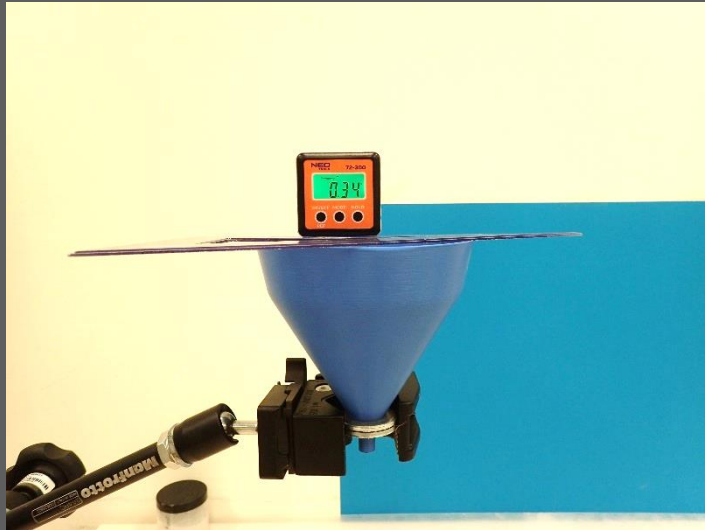




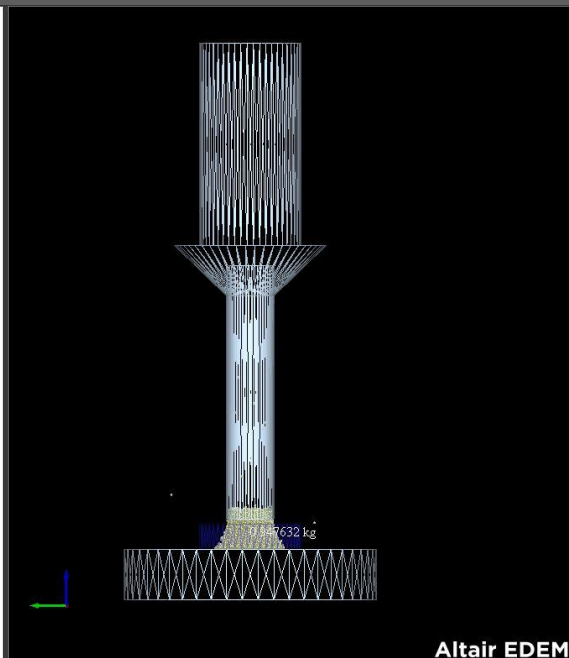
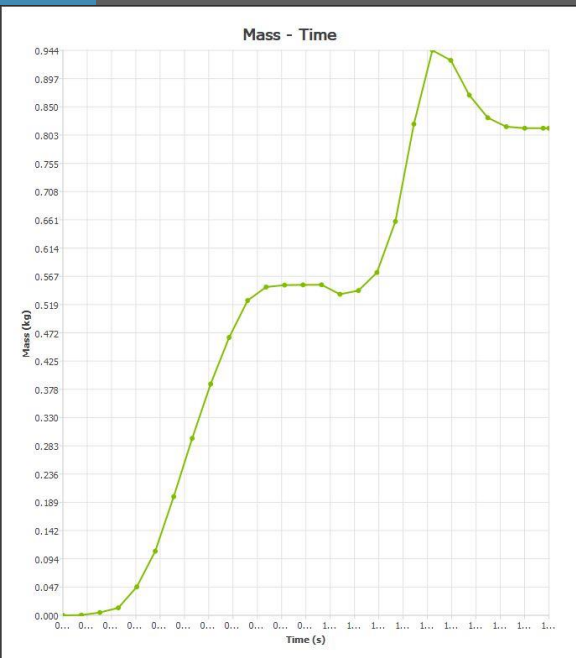
### Discrete Element Method simulations



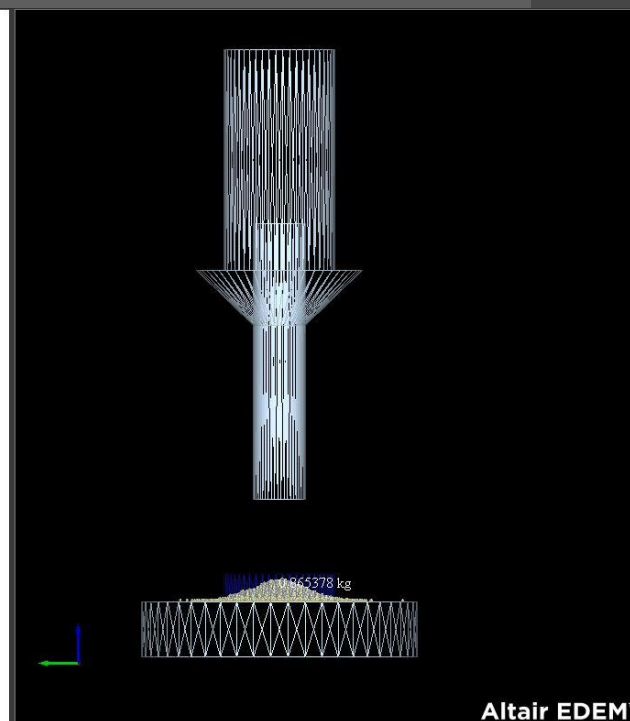
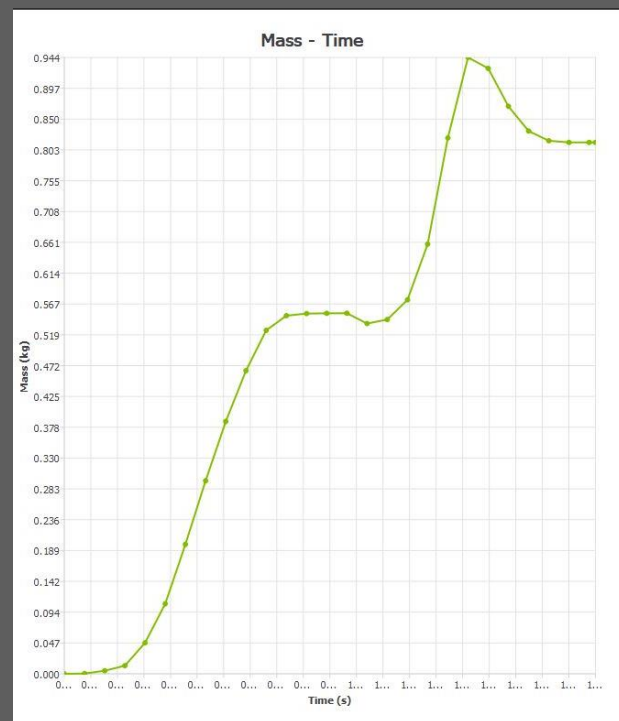
Altair EDEM™

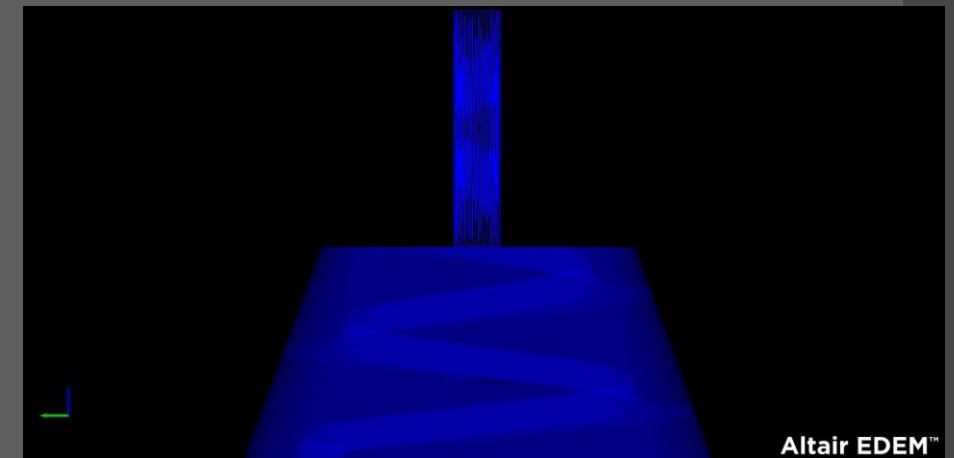
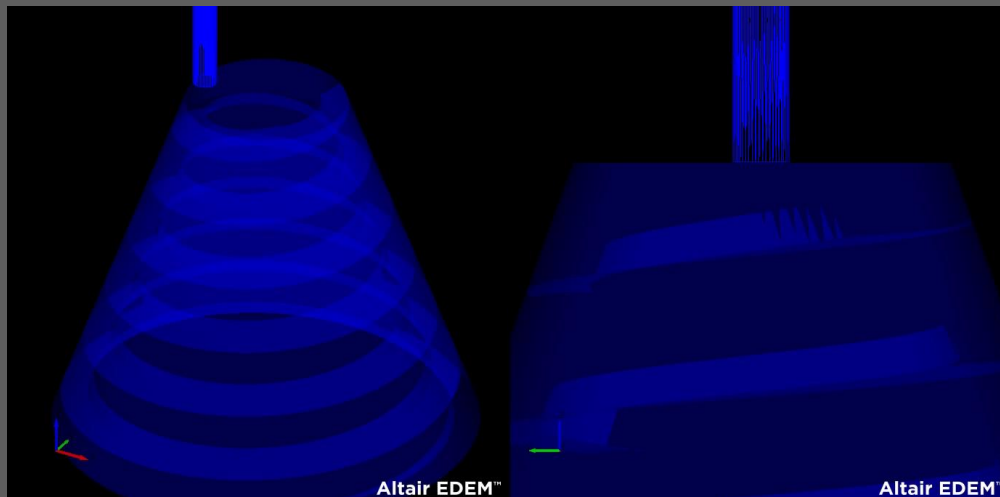
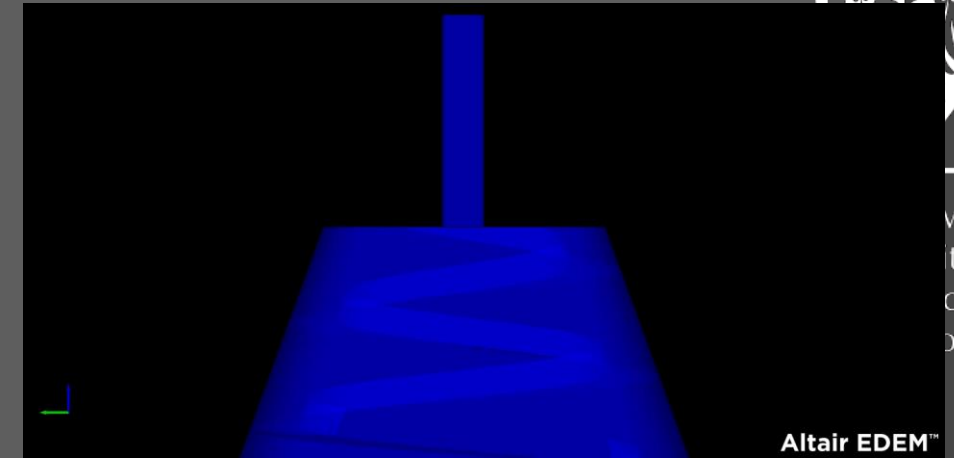
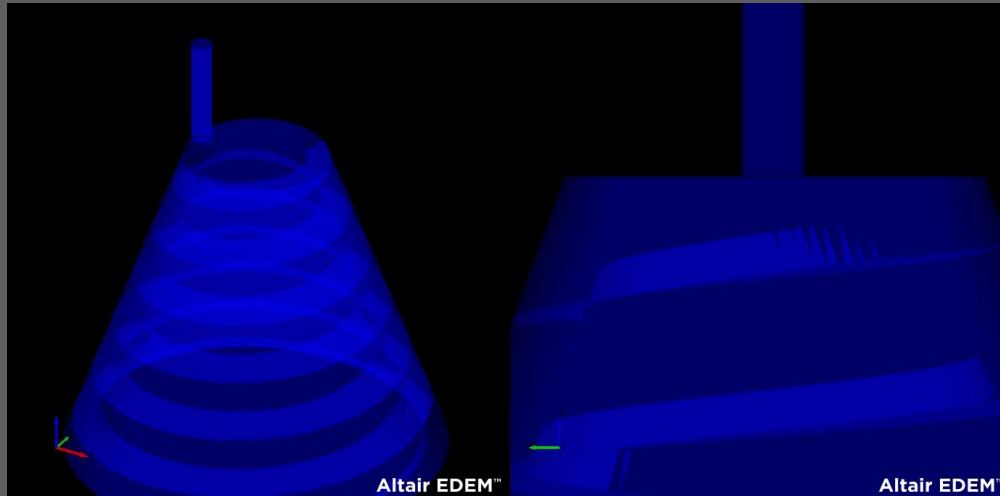






LHS - 1  
LHS - 2  
LHS - 1E  
LMS - 1  
LMS - 2  
LSP - 2  
AGK - 210





**NEXT STEP -> DEM/FEM coupling for interaction analysis (EDEM/ABAQUS)**





***„size separation of bulk materials in microgravity conditions is one of the most overlooked issue”***

**Rasera et. al. The beneficiation of lunar regolith for space resource utilization: A review, Planetary and Space Science 186 (2020) 104879**

### **BUT FIRST!!! .....APPLICATION ON EARTH**

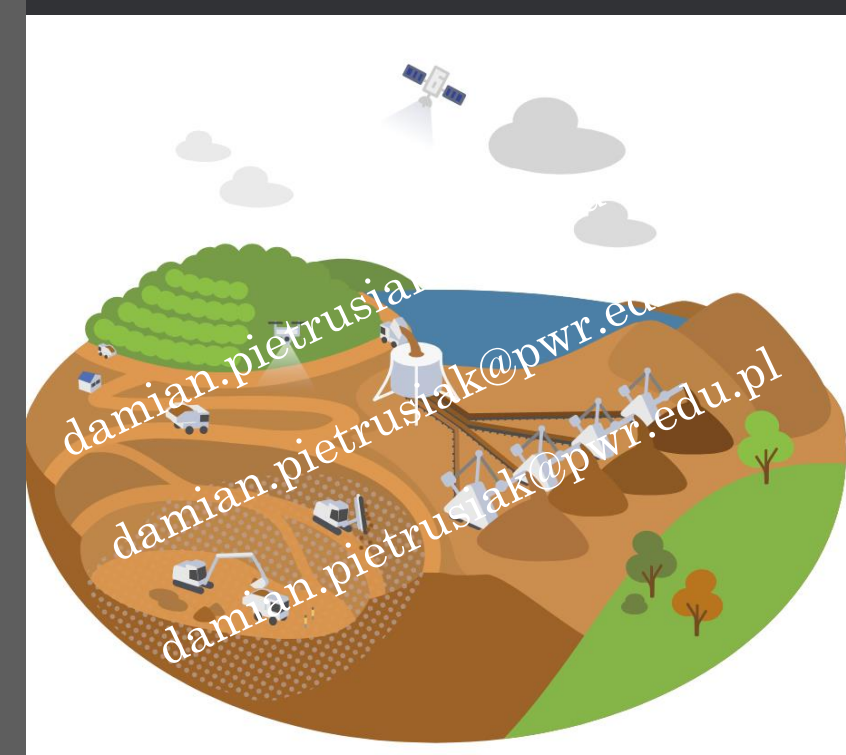
- ***necessity of excavation of the hard access, low-grade deposits [1]***
- ***that implies the necessity of excavation of more tone of deposits and overburden, in general, what leads to more water usage for processing [2]***
- ***large part of excavation and processing take place in areas of difficult water access [3]***
- ***water usage in all technological processes should be significantly reduced before 2030 [4]***

[1] Spooren et. al. Near-zero-waste processing of low-grade, complex primary ores ... : Technology development Trends, Resources, Conservation & Recycling 160 (2020)

[2] Michaux et. Al. Study of process water recirculation in a flotation plant ..., Minerals Engineering 148 (2020)

[3] Moreno et. al. Separation of particles of different surface ... Minerals Engineering 160 (2021)

[4] Sustainable Development Goals, United Nations, 2023



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**Thank you for your attention!**

**Questions?**

**[damian.pietrusiak@pwr.edu.pl](mailto:damian.pietrusiak@pwr.edu.pl)**