

# SPACE RESOURCES ROUNDTABLE 2025



Wrocław University  
of Science and Technology

D. Pietrusiak<sup>1</sup>, P. Moczko<sup>1</sup>, J. Wróbel<sup>1</sup>, M. Pawłowski<sup>1</sup>,  
M. Baranowicz<sup>2</sup>

<sup>1</sup>Wrocław University of Science and Technology, POLAND;  
[damian.pietrusiak@pwr.edu.pl](mailto:damian.pietrusiak@pwr.edu.pl)

<sup>2</sup>White Raven Academy sp. z o.o., POLAND

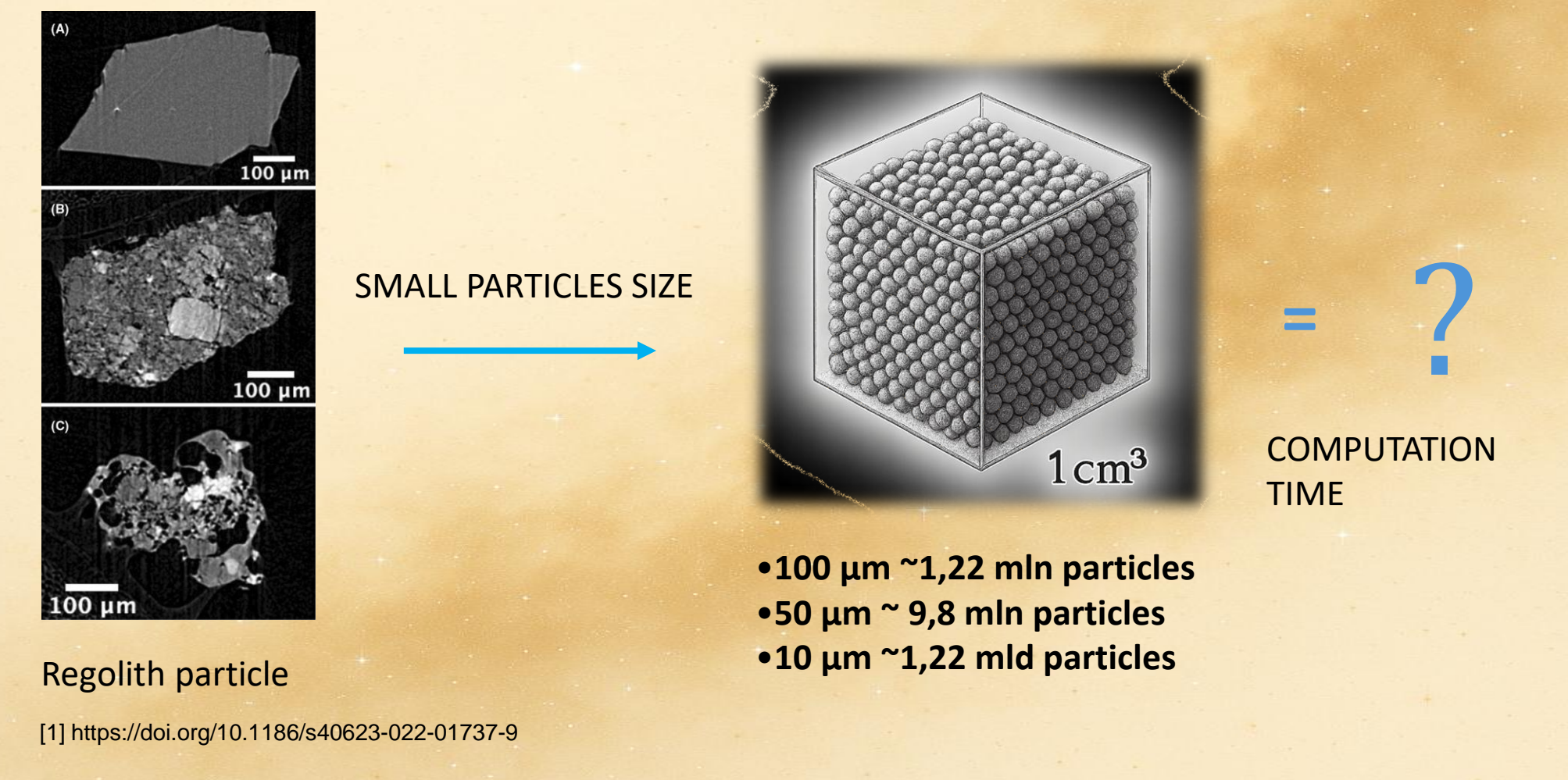


## EXPERIMENTAL TESTING AND NUMERICAL CALIBRATION OF THE REGOLITH SIMULANTS DISCRETE ELEMENT MODELS

### MOTIVATION

- Simulation accuracy
- Computation time

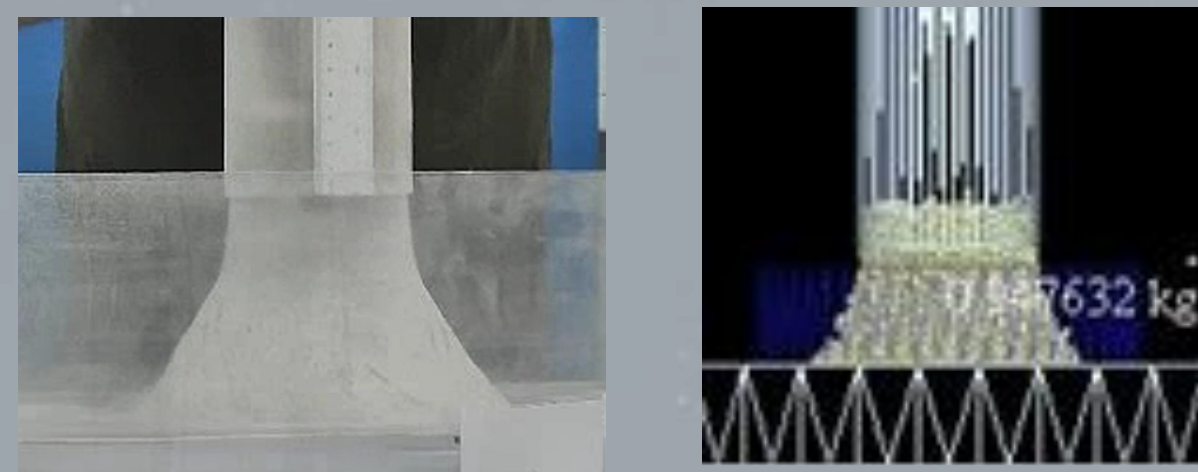
APPLICATION/SIMULATION SCALE: SMALL → EXTRA LARGE



### TESTING AND CALIBRATION

#### MODEL PARAMETERS

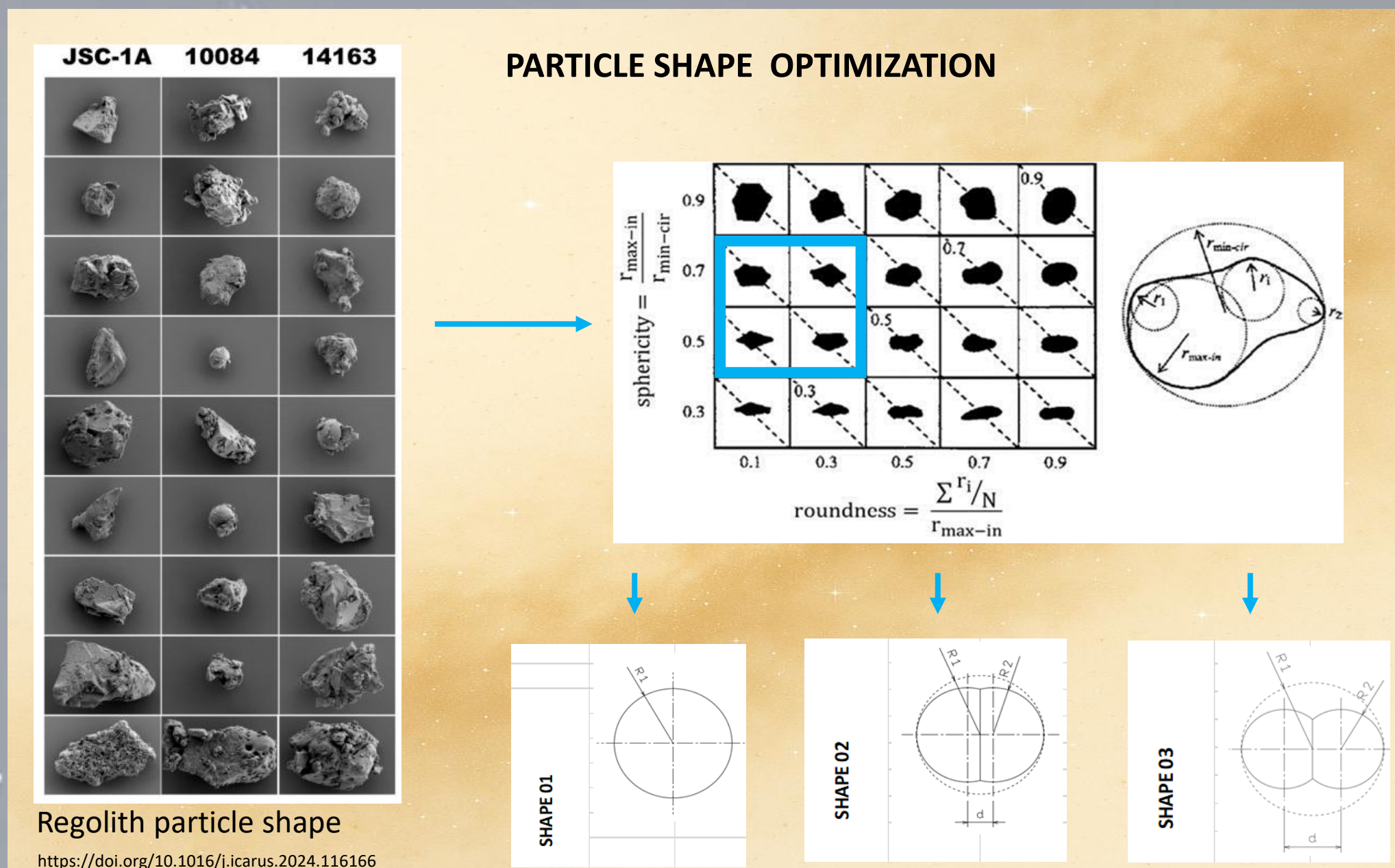
- Level of pipe filling (2 levels)
  - Granulometric composition (4 levels)
  - Particle size (5 levels)
  - Particle to particle rolling friction (6 levels)
  - Particle to particle static friction (6 level)
  - Coefficient of restitution (6 levels)
- 17280 COMBINATIONS !!!**



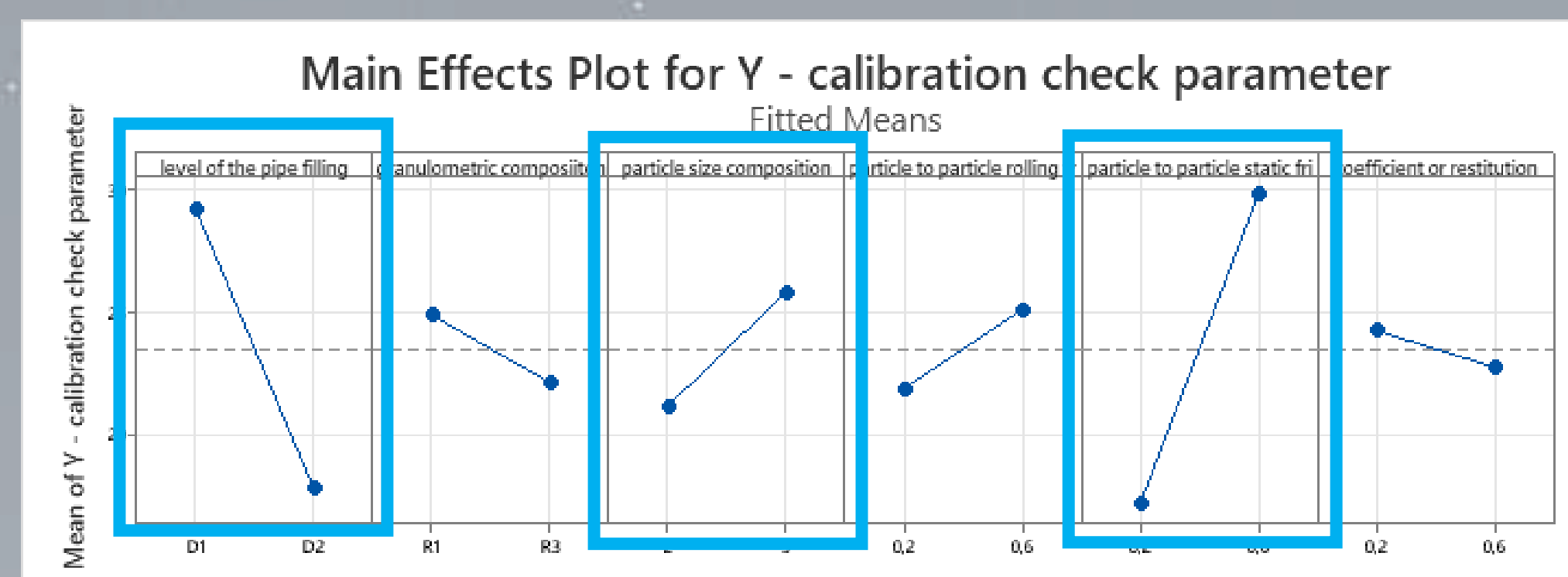
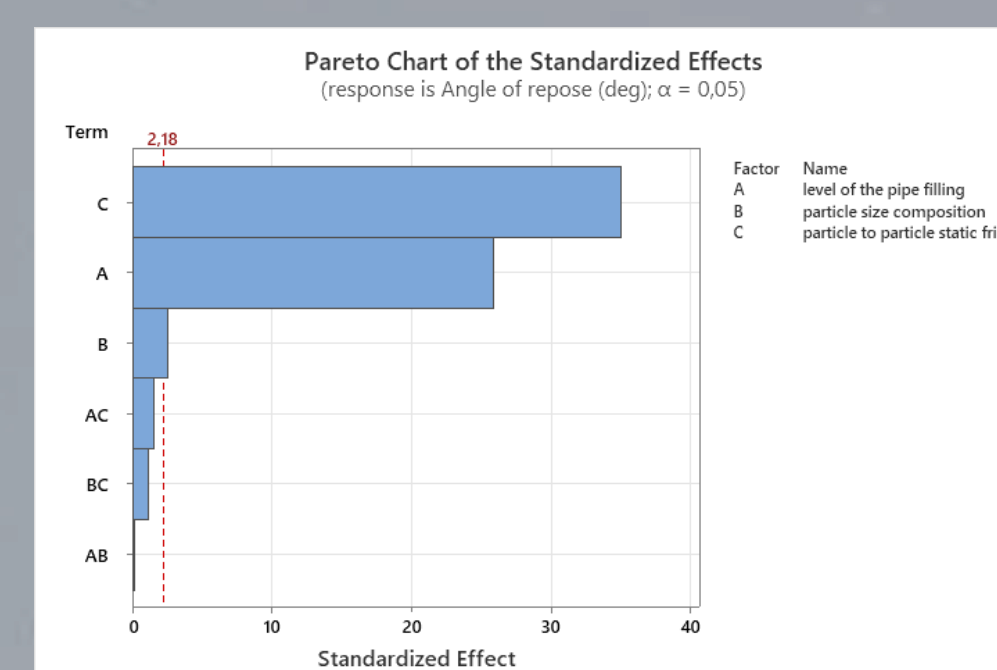
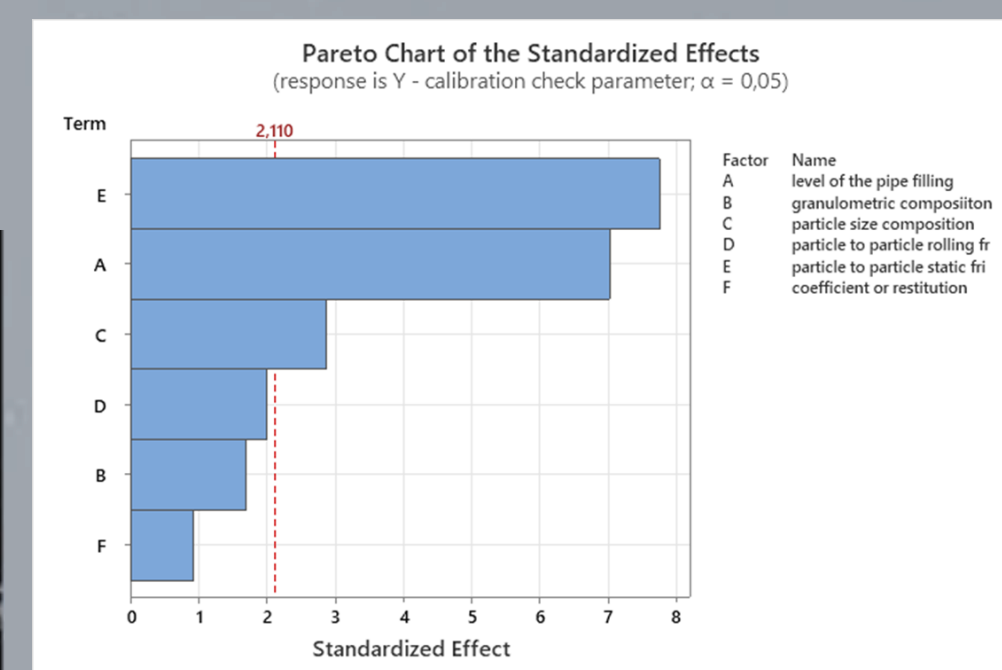
STATIC ANGLE OF REPOSE



In purpose to obtain the highest quality models, all the experiments and numerical models calibration are supported by **Design of Experiment (DoE)** approach. As a first step the Screening Design was conducted with use of the Plackett-Burman plan. That required 24 simulation trials. On that basis the Main Effects Plot allow to identify parameters of the highest influence on the model. As a next step Full Factorial test with Center Points was designed (20 trials). Eventually, **Cube Plot** representing the **parameters influence** on the Static Angle of Repose with total number of **44 simulations** was obtained.

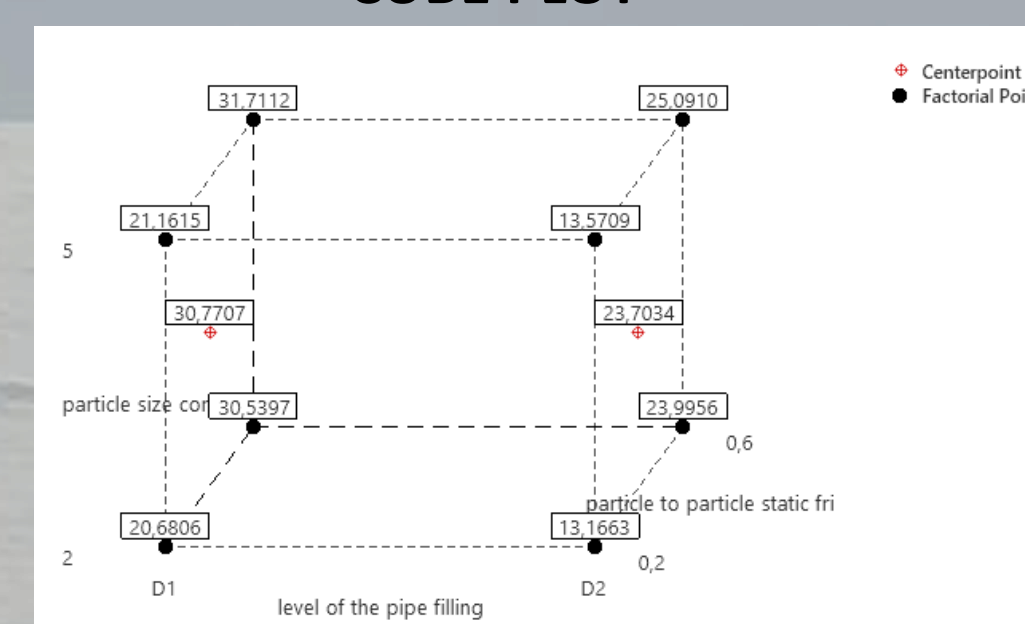
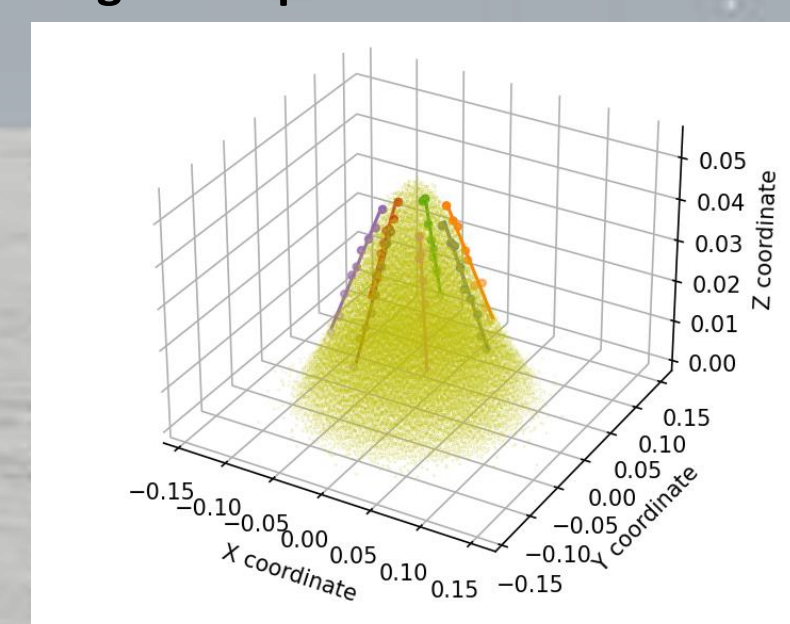


#### DESIGN OF EXPERIMENT

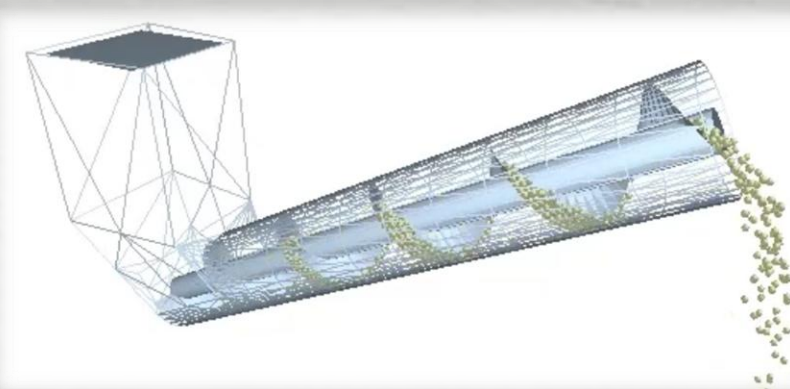


Angle of repose automatic measure

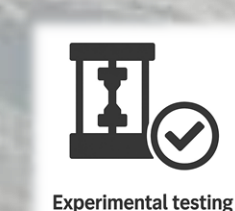
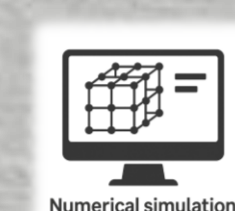
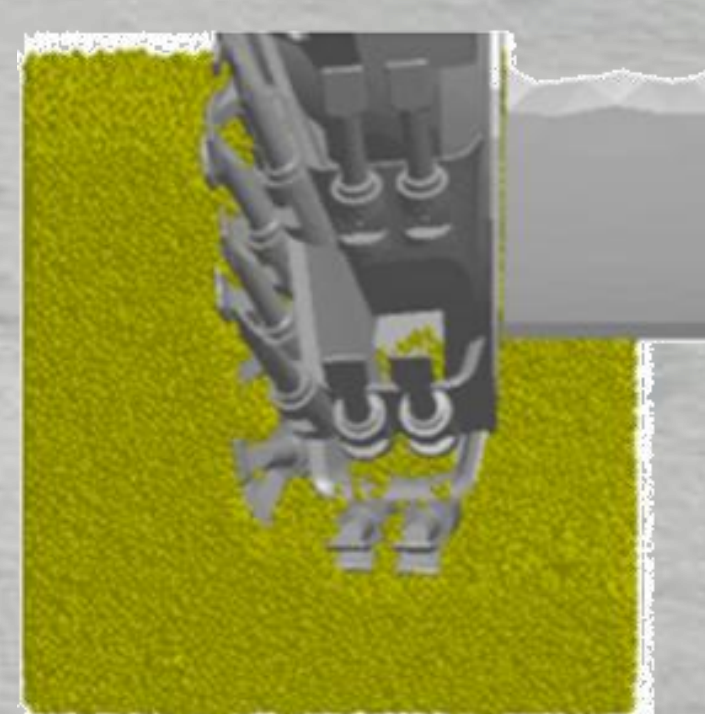
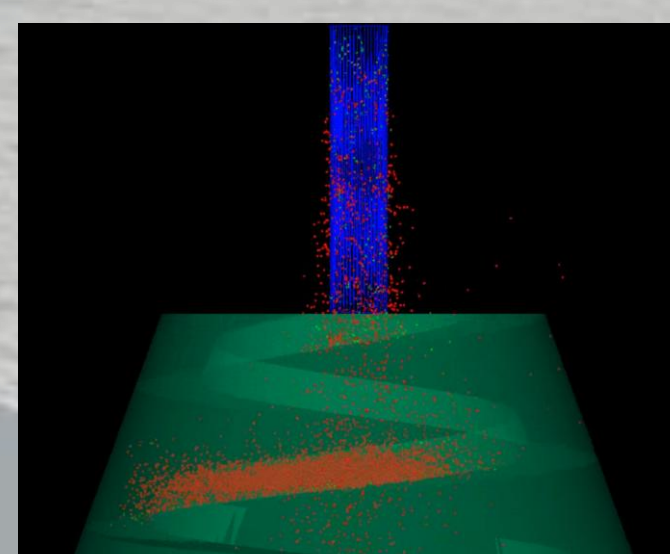
CUBE PLOT



### APPLICATION



#### MULTI – PARAMETERS PROCESS MODELING



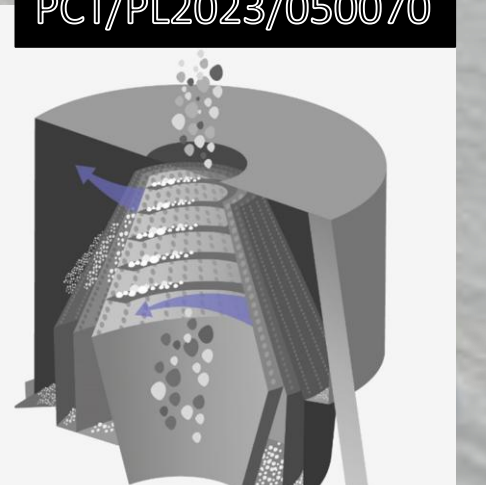
model calibration

experimental  
validation

#### REGOLITH SIEVER



Patent pending:  
PCT/PL2023/050070



- gravity/no gravity adjustment
- possible to include physical phenomena of:
  - electrostatics/tribocharging
  - particles heat transfer
  - equipment wear
  - particles fracture/breakage
  - ...

Database for medium and large scale DEM simulations of several types of the regolith simulants