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# Development and Applications of DEM Digital Twins of Powder Systems

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# Digital Twins - Clarification

- Data exchange from real equipment to digital twin
- In this case not real time
- Copy of the real piece of equipment



Fig 2: GranuFlow (left) and digital twin of the GranuFlow (right).



# Application of Digital Twins for a New DEM Calibration Methodology

## Direct Testing

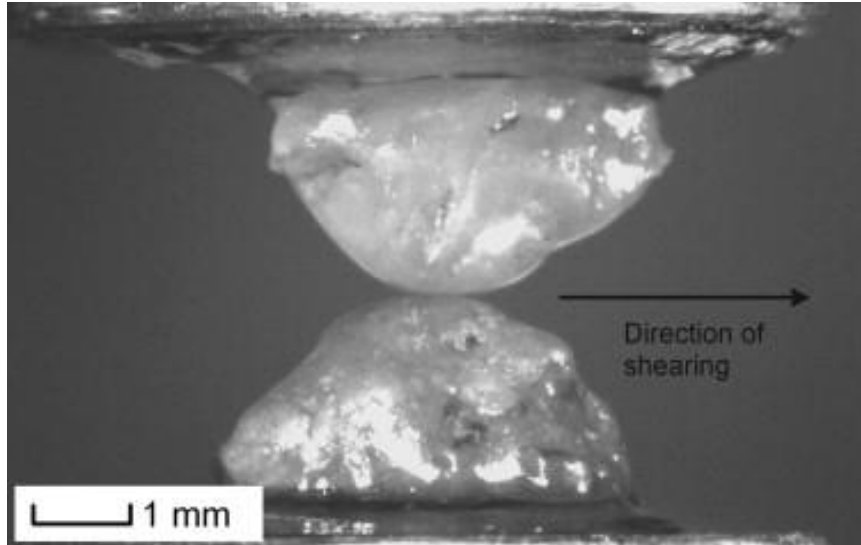


Fig 3: Direct measurement of frictional properties.  
Senetakis K, Coop MR, Todisco MC. The inter-particle coefficient of friction at the contacts of Leighton Buzzard sand quartz minerals. Soils and Foundations. 2013;53(5):746-55.

## Bulk Calibration

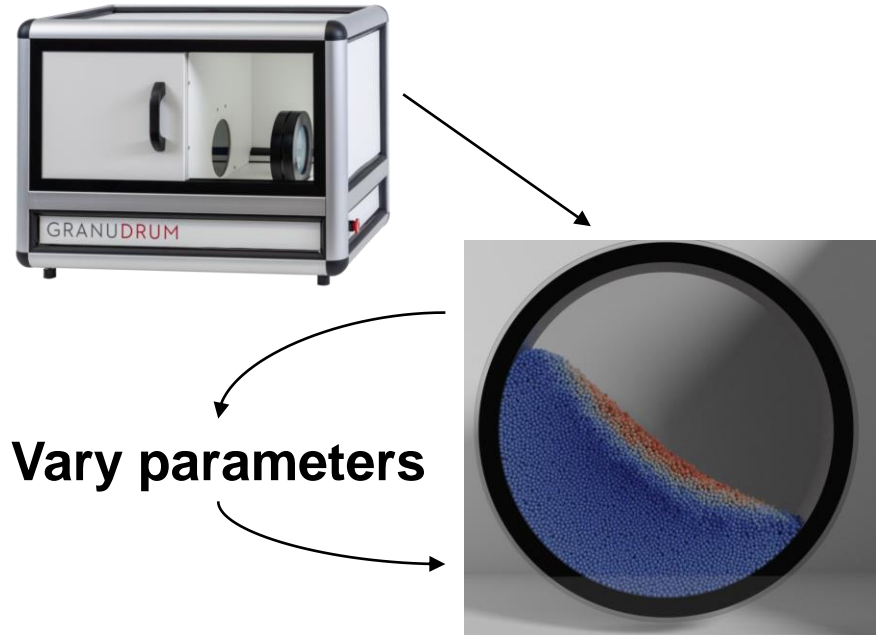
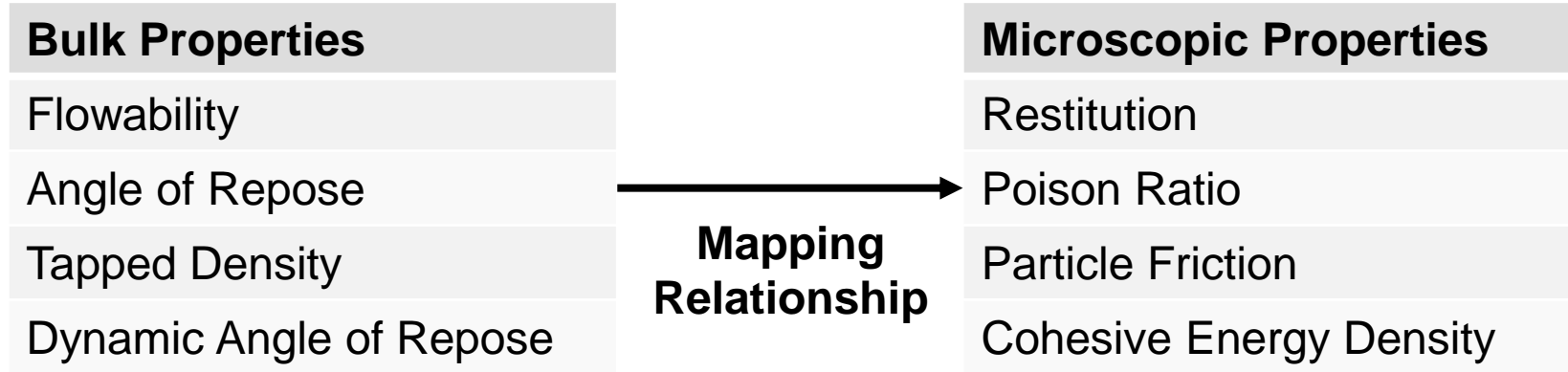


Fig 4: Bulk calibration diagram.

# Mapping Relationship



# Digital Twins of Powder Characterisation Tools

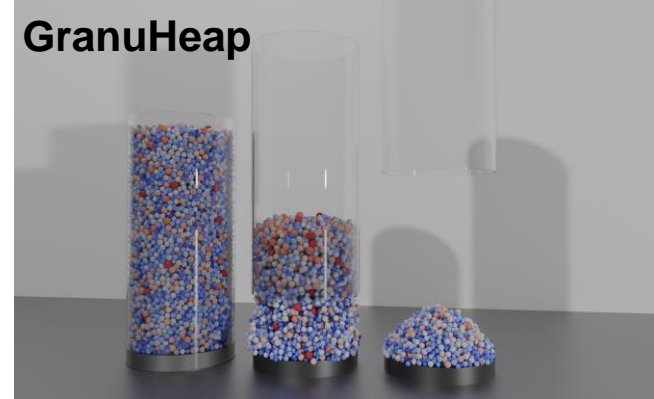
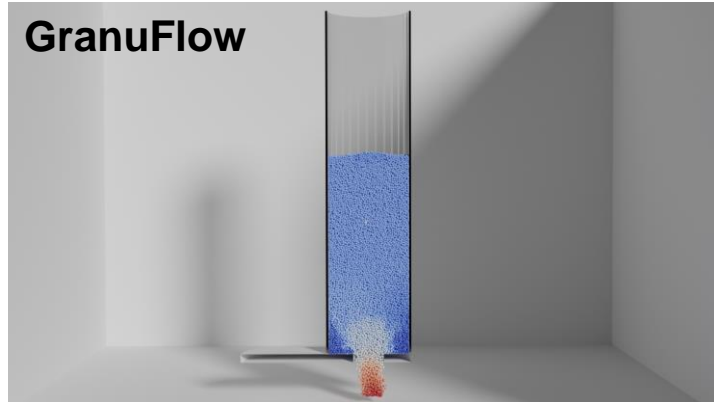
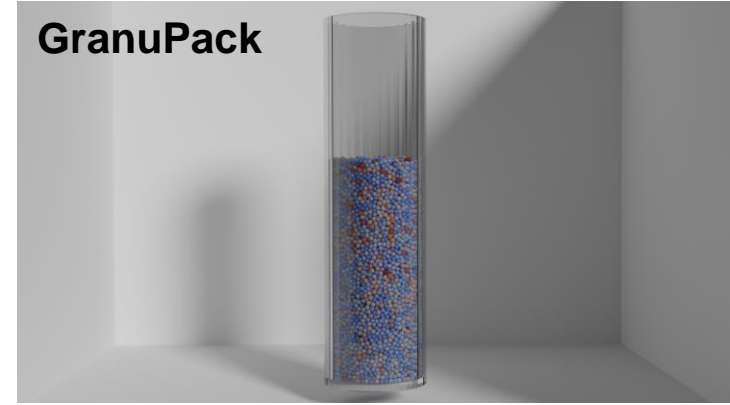
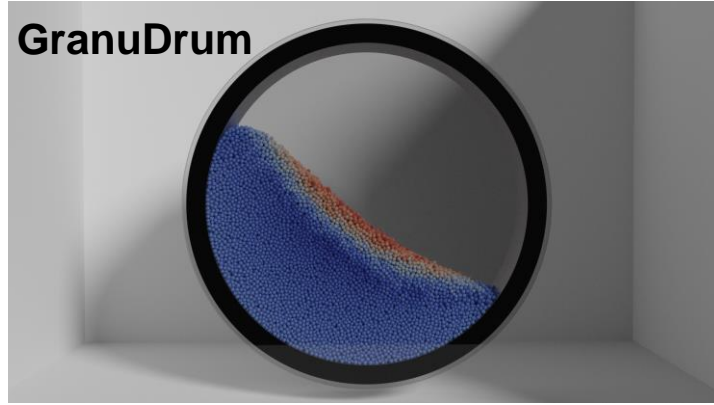
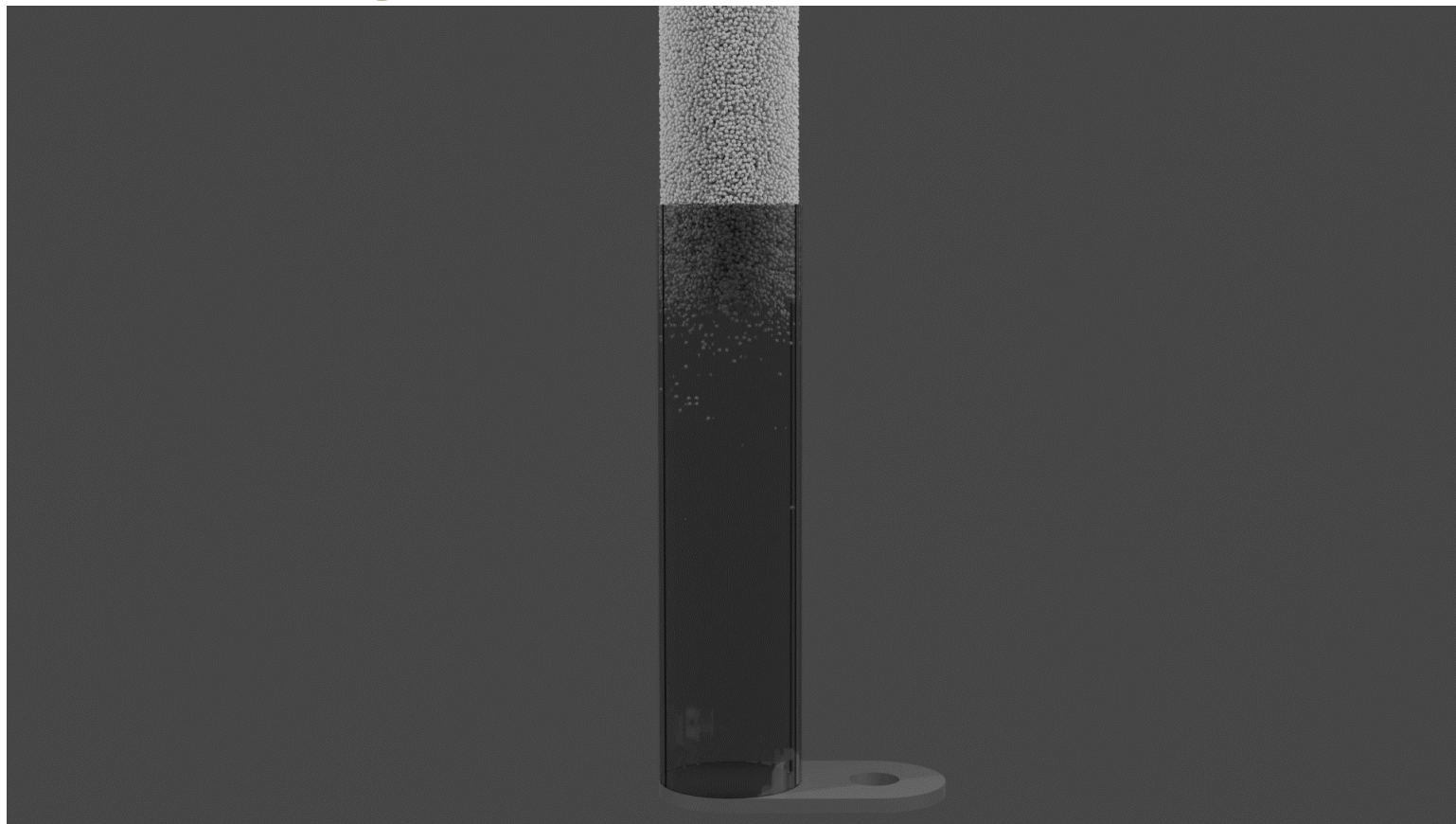


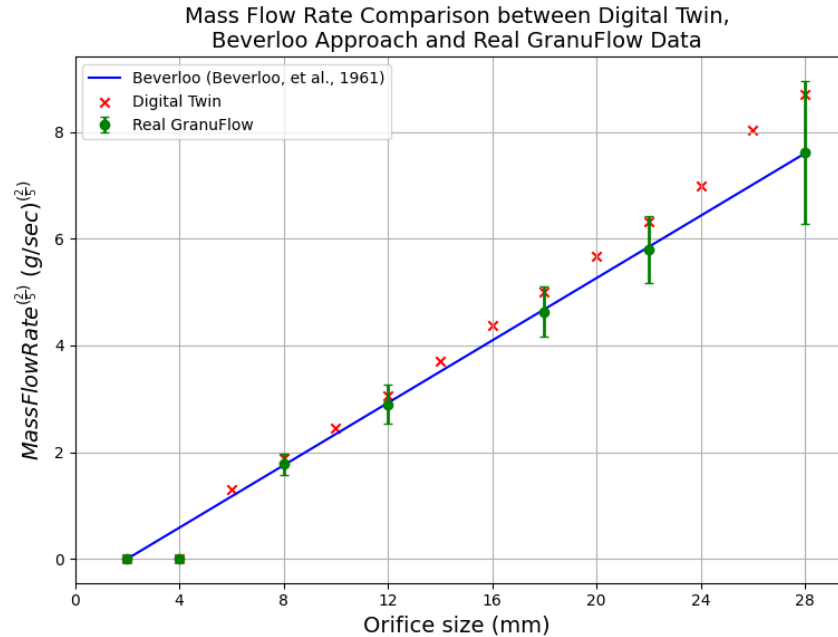
Fig 5: Currently finished digital twins.



# GranuFlow Digital Twin



# Validation



Error between Real GranuFlow and Digital Twin for different combinations of rolling and sliding friction

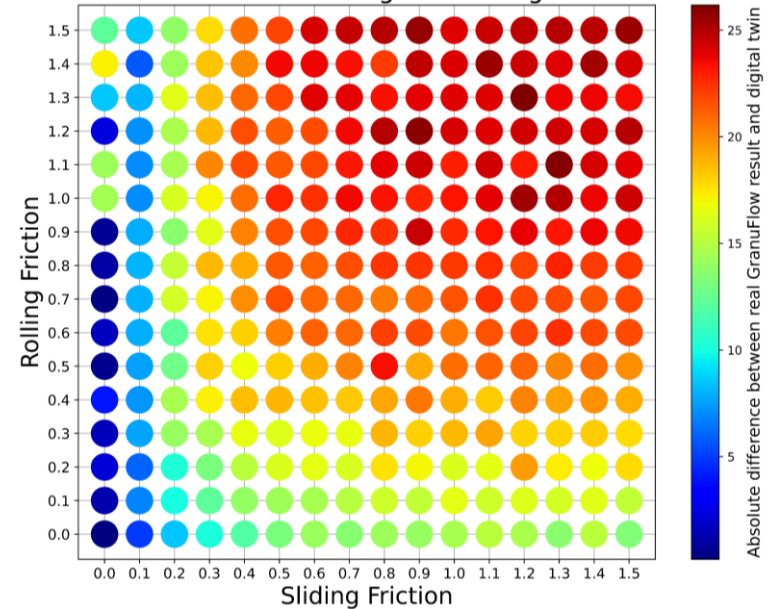


Fig 5: Validation of GranuFlow digital twin results with data from a real GranuFlow and the Beverloo approach.



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Beverloo, W. A., Leniger, H. A. en van de Velde, J. (1961) "The flow of granular solids through orifices", *Chemical Engineering Science*, 15(3), bll 260–269. doi: 10.1016/0009-2509(61)85030-6

# Results

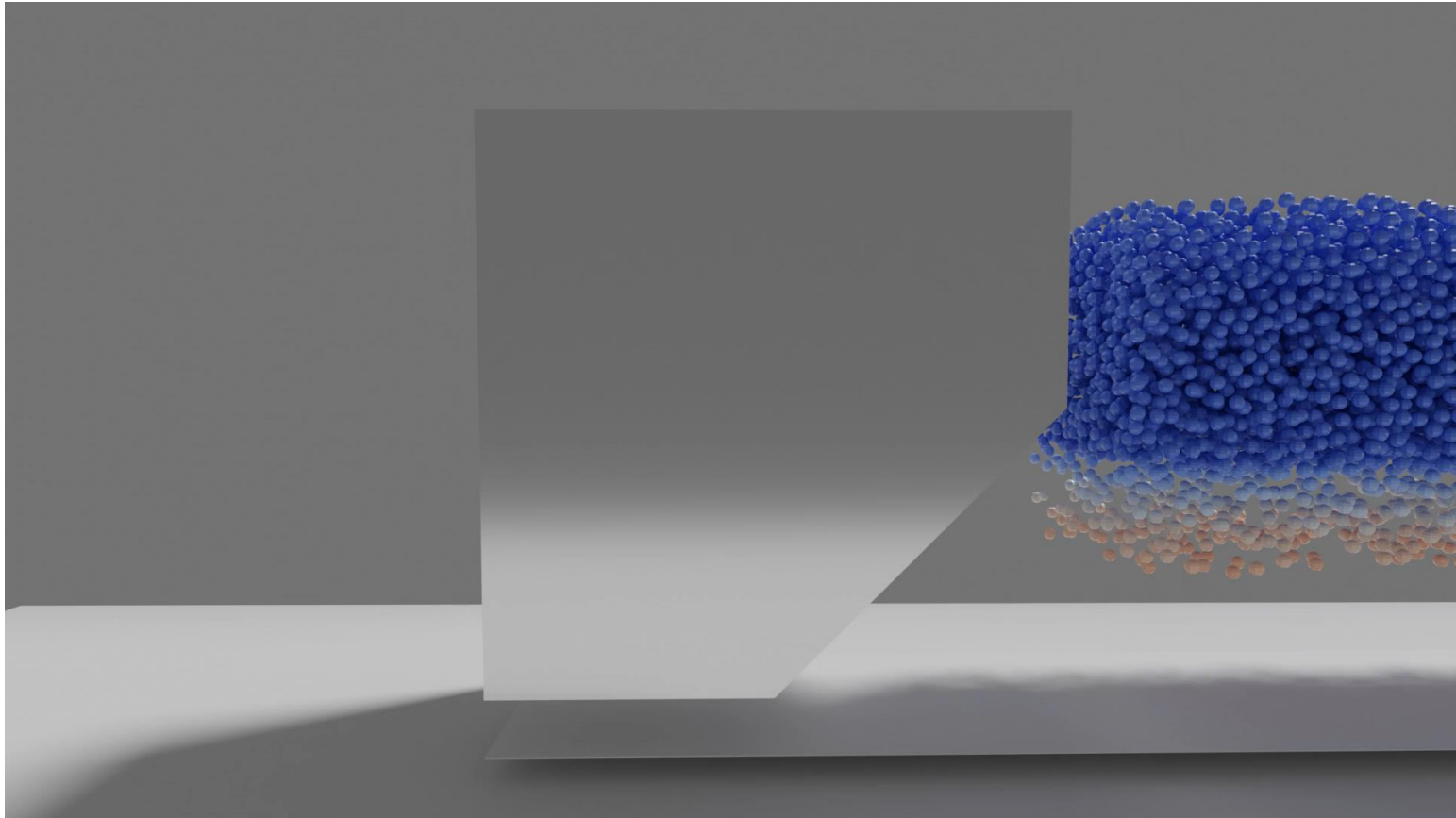
Variation of Dynamic Angle of Repose with DEM Parameters for largest particle size and restitution of 0.9.



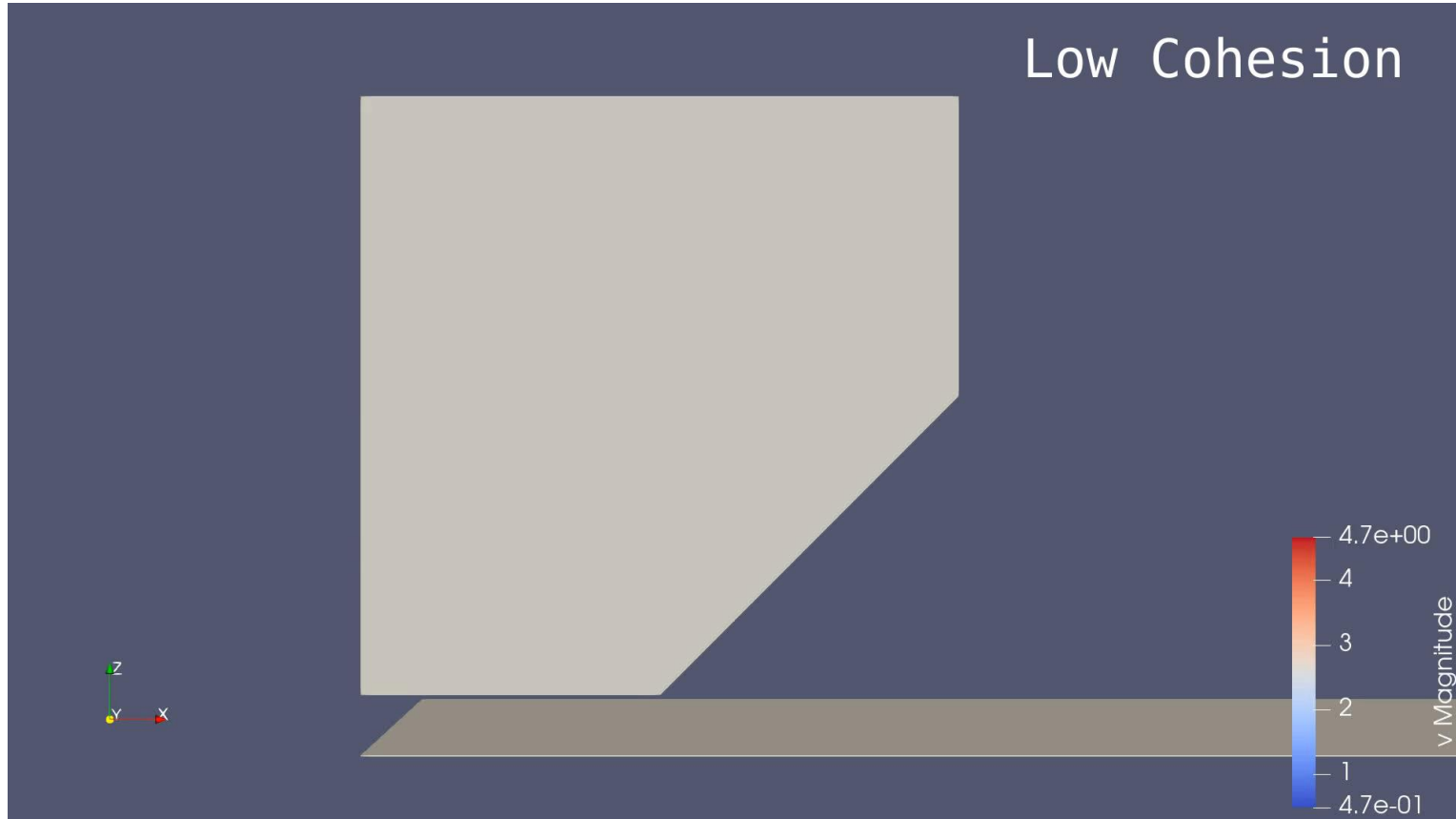
Fig 5: Results of a parameter study looking at the change in dynamic angle of repose due to different values for DEM parameters.



# Additive Manufacturing Spreader Digital Twin



# Effects of Cohesion



# Future Work

- Develop an automated way of finding optimal height and blade speed using the additive manufacturing spreader digital twin.
- Develop a way of mapping the bulk properties measured to the microscopic parameters in powder simulation.
- Develop the GranuCharge and implement electrostatics contact model into DEM.



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# Any Questions?

Get in contact if you want to know more!

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