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ISRU Research at Imperial College London

A Status Update

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Presentation Agenda

- Research Background at ICL
- Intro to Beneficiation
- Overview of Current Research:
  - Plant simulation
  - Size Classification
  - Electrostatic Separation
- Conclusions

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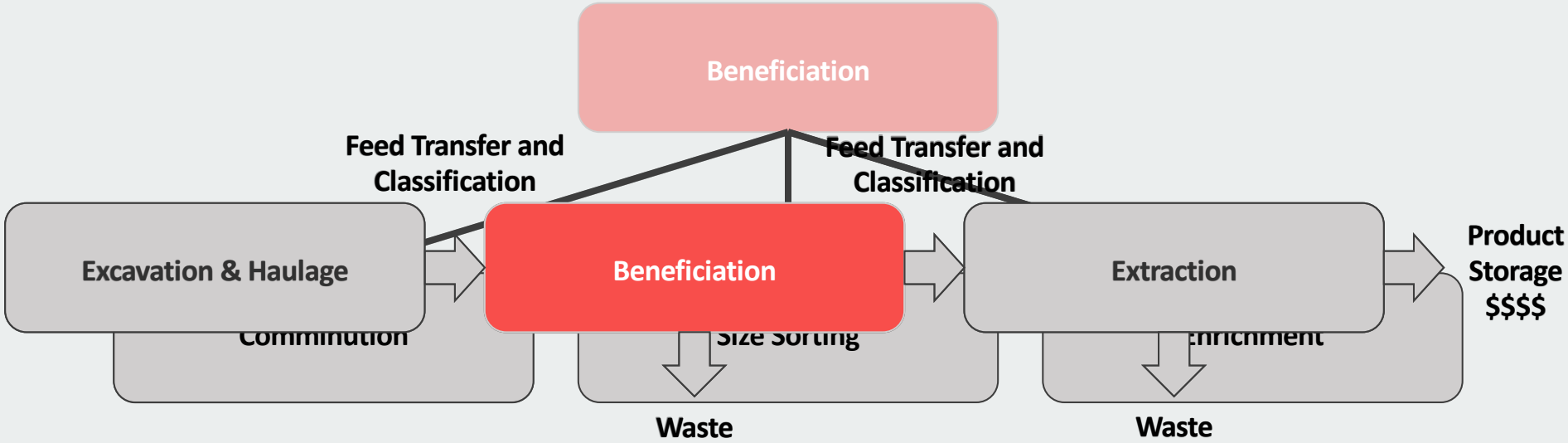
Research Background



Hadler, K., et al. "A universal framework for Space Resource Utilisation (SRU)." Planetary and Space Science 182 (2020): 104811.

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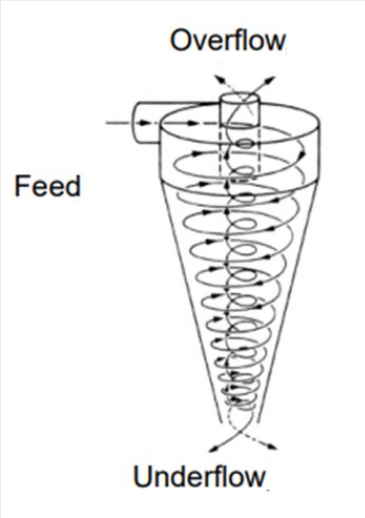
What is Beneficiation?

Size Separation

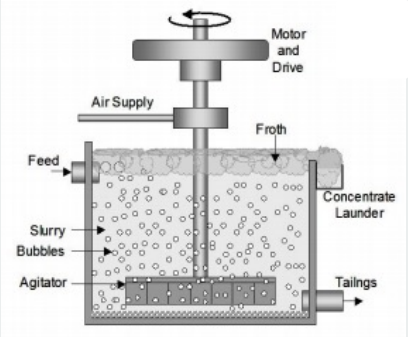
Beneficiation

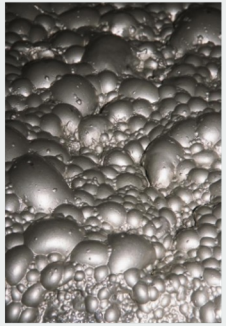
Mineral Concentration



Extremely non-trivial in dry conditions and for fine (<1 mm) particles

Novel methods required for Lunar applications





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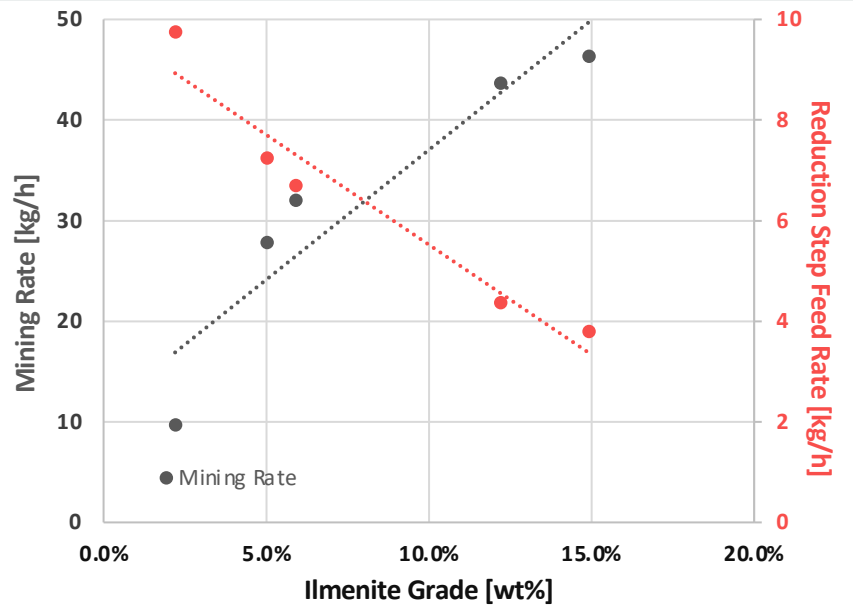
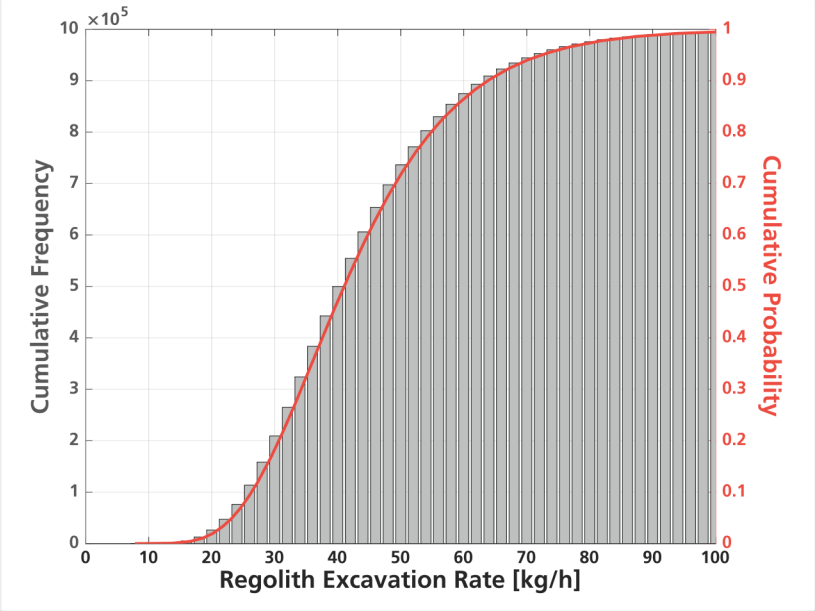
Case for Beneficiation





Cilliers, J.J., Rasera, J.N., and Hadler, K.. "Estimating the scale of Space Resource Utilisation (SRU) operations to satisfy lunar oxygen demand" Planetary and Space Science 180 (2020): 104749.

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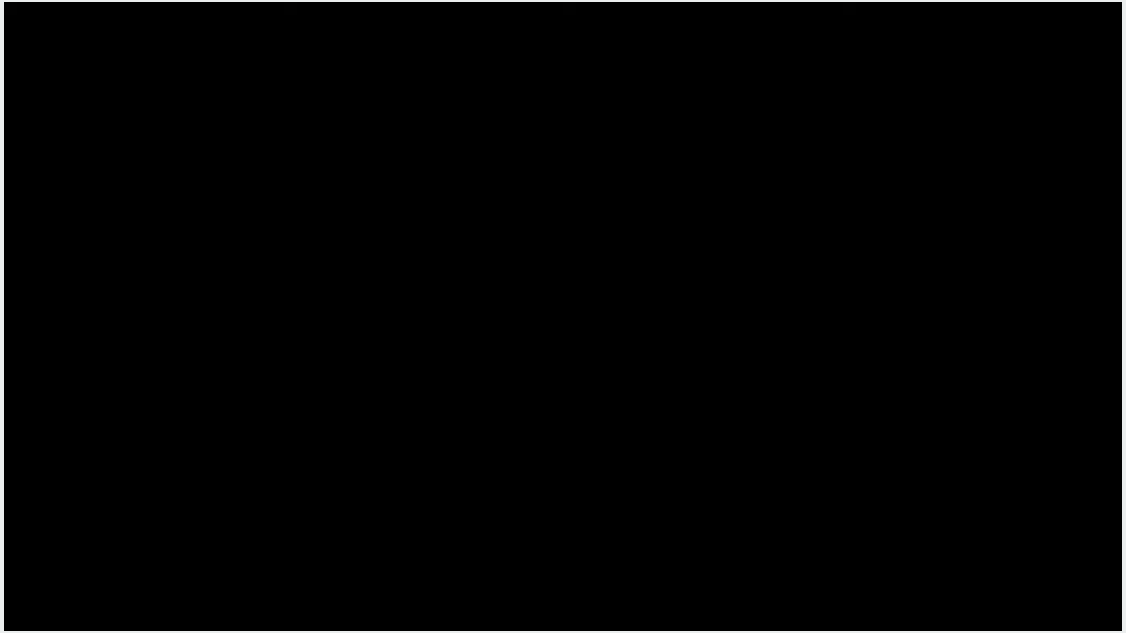
Plant Operation Simulation



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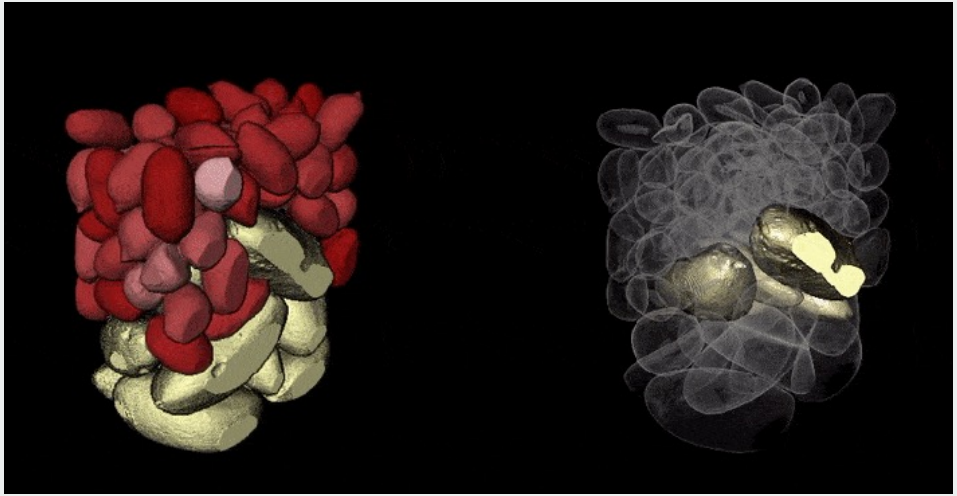
Vibrational Segregation [1/2]

The dry separation of particles by **size** has been shown to happen during the **vertical vibration** of granular beds. This process is called the **'Brazil-nut effect'**.

Many different mechanisms allow the Brazil-nut effect to happen, including:

- **'Void-filling'**
- Convection
- Buoyancy
- Arching effects



Gajjar, P., Johnson, C. G., Carr, J., Chrispeels, K., Gray, J. M. N. T., & Withers, P. J. (2021). Size segregation of irregular granular materials captured by time-resolved 3D imaging. Scientific reports, 11(1), 1-6.

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Vibrational Segregation [2/2]

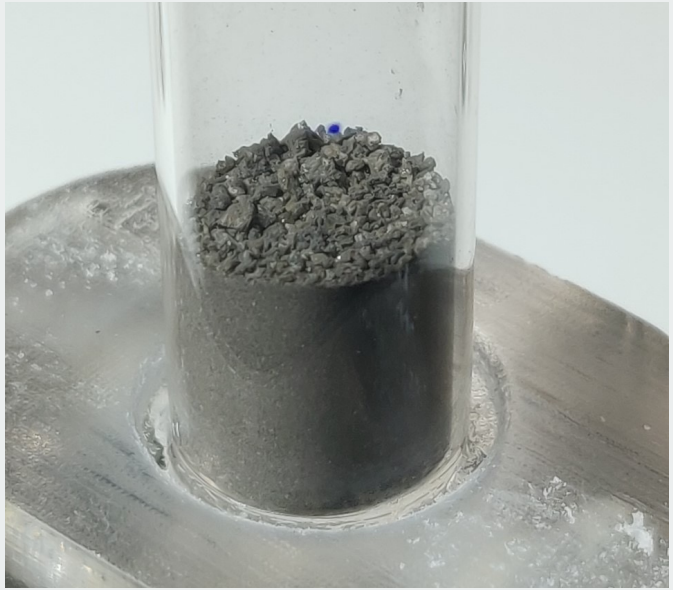
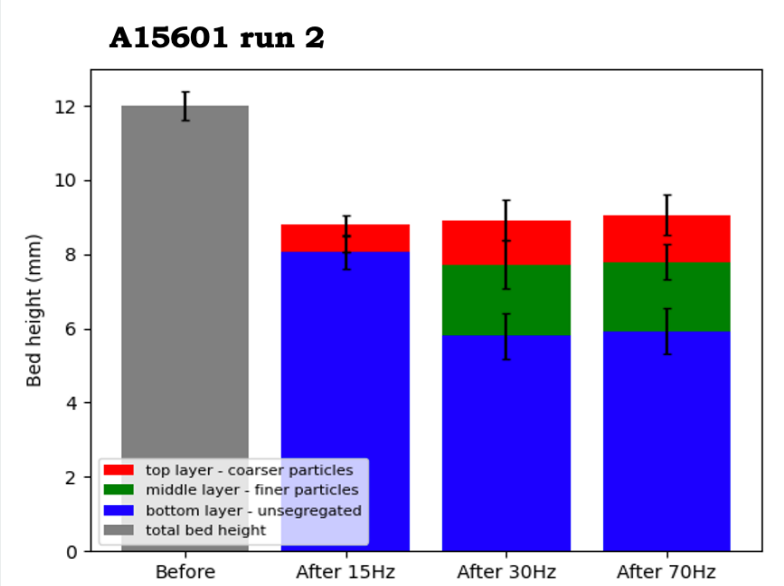
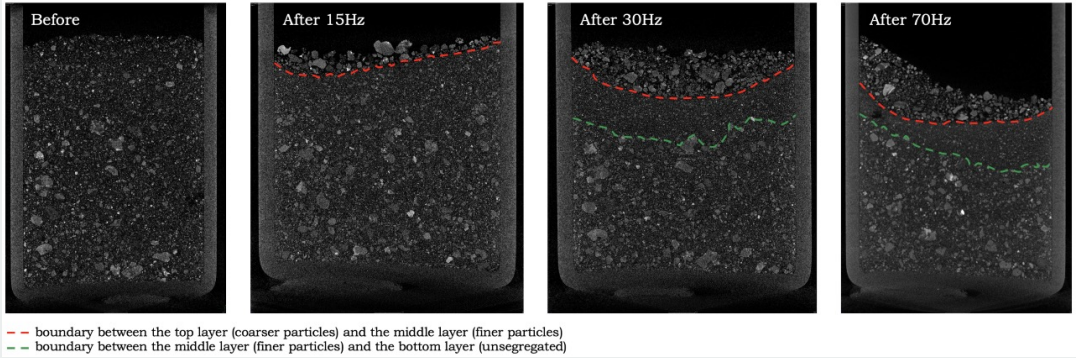


Photo Credit: Beth Lomax, ESA





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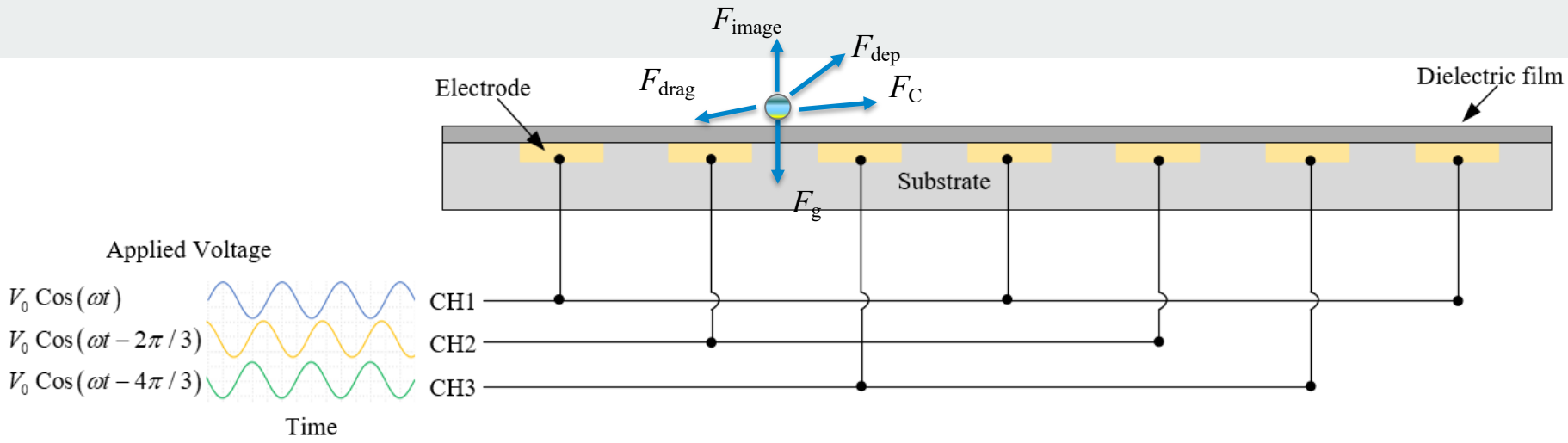
Classification by ETW [1/2]



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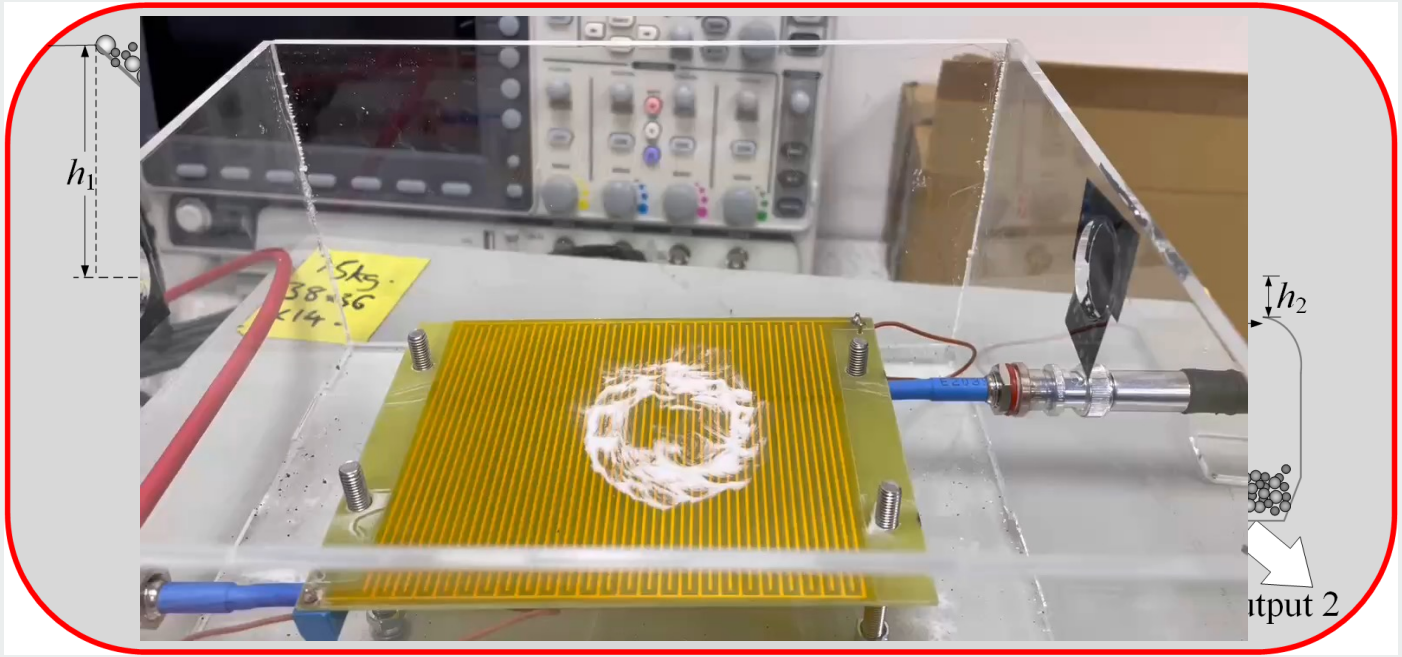
Classification by ETW [2/2]



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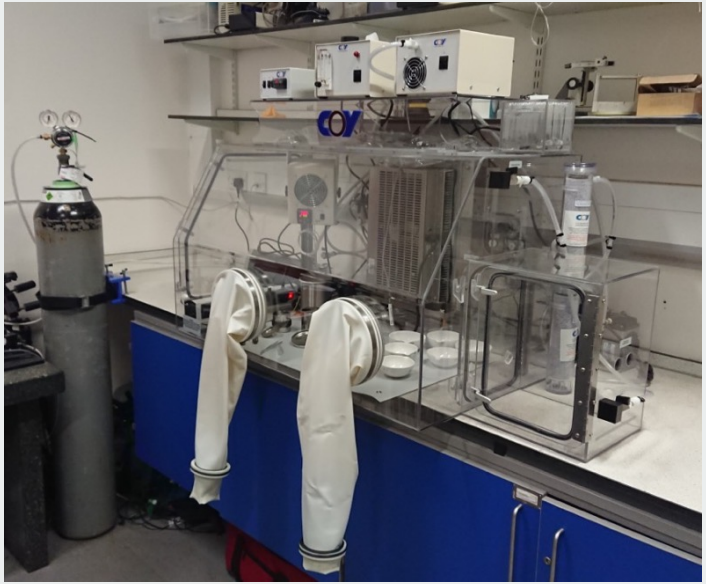
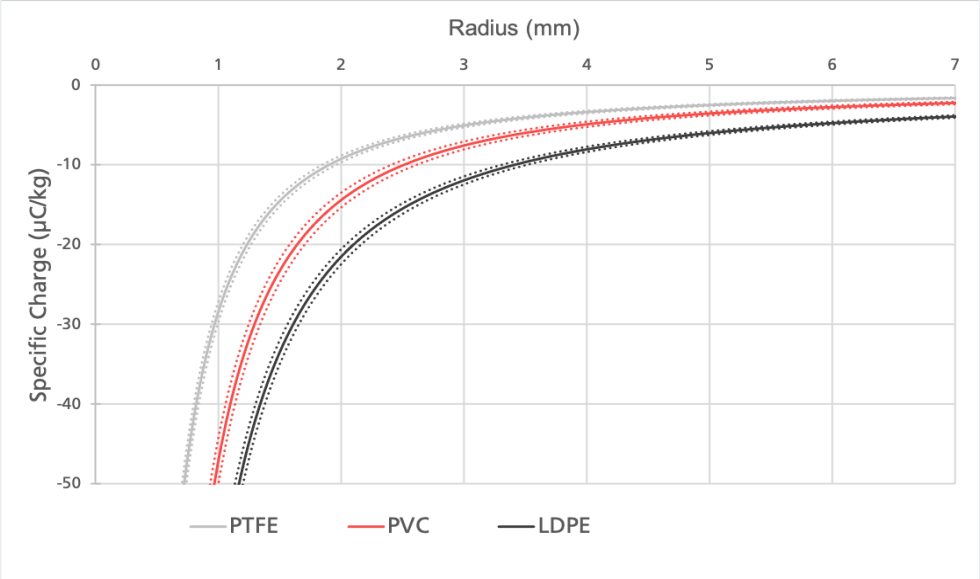
Triboelectric Theory [1/2]





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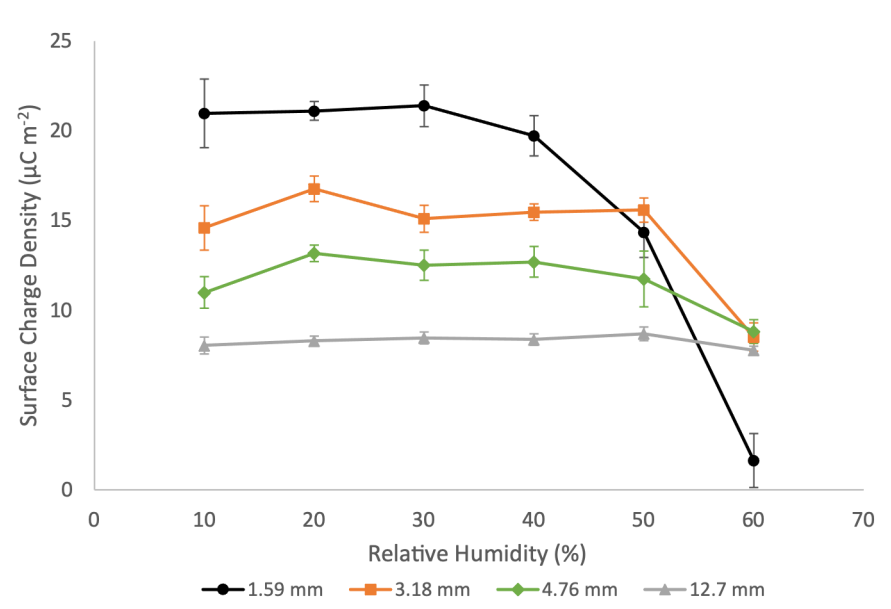
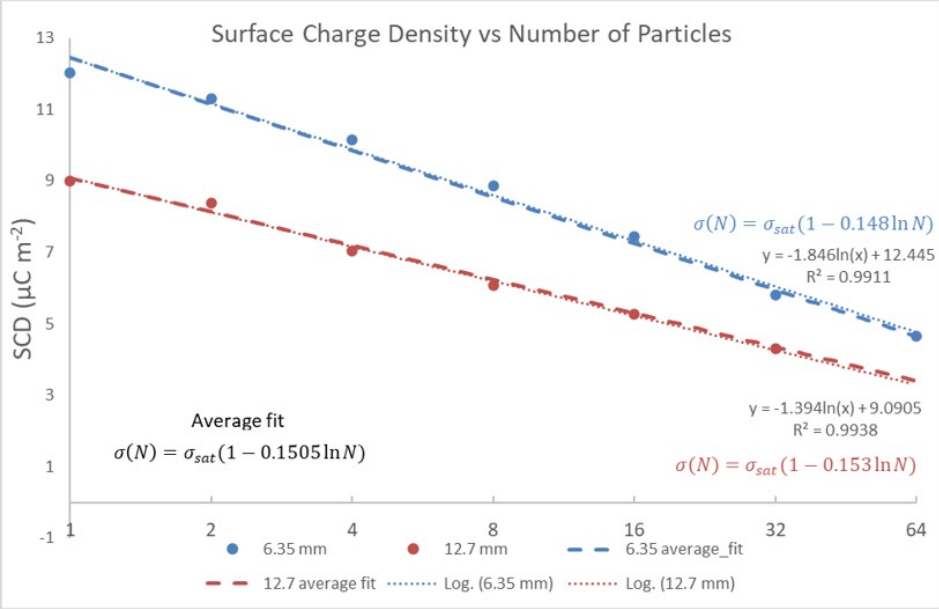
Triboelectric Theory [2/2]





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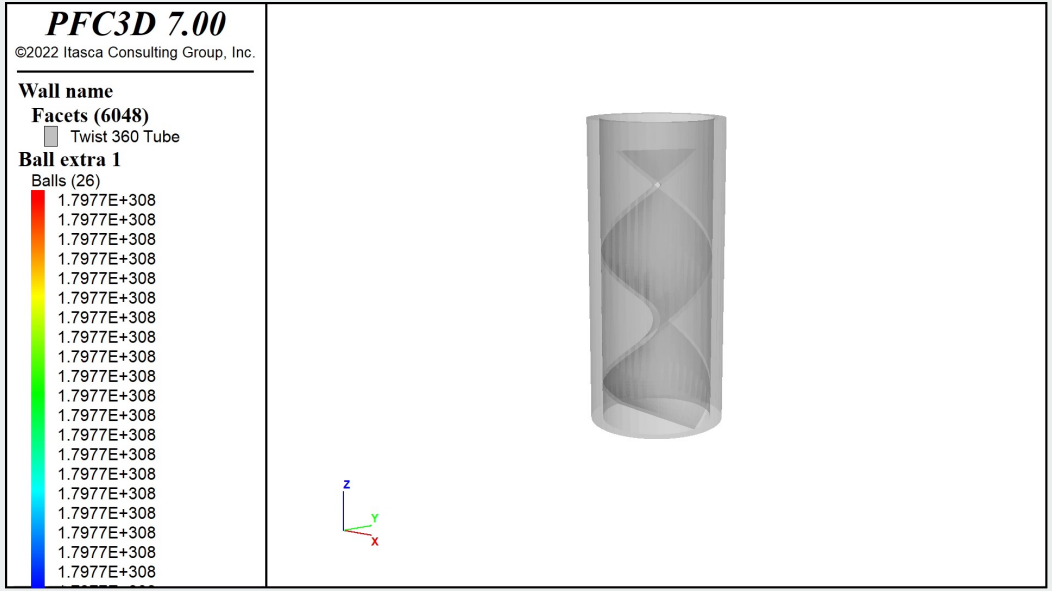
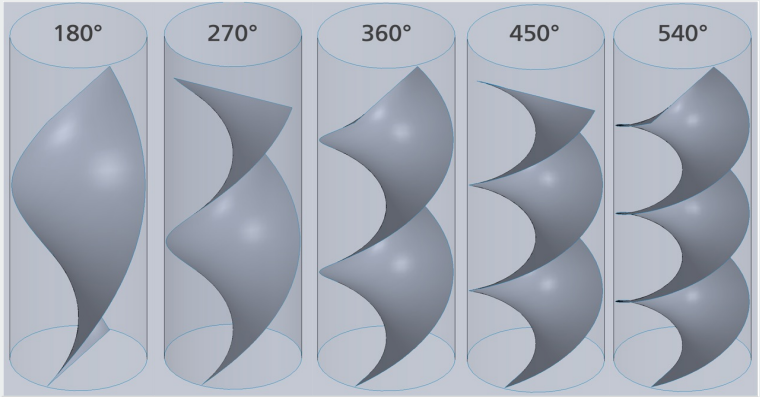
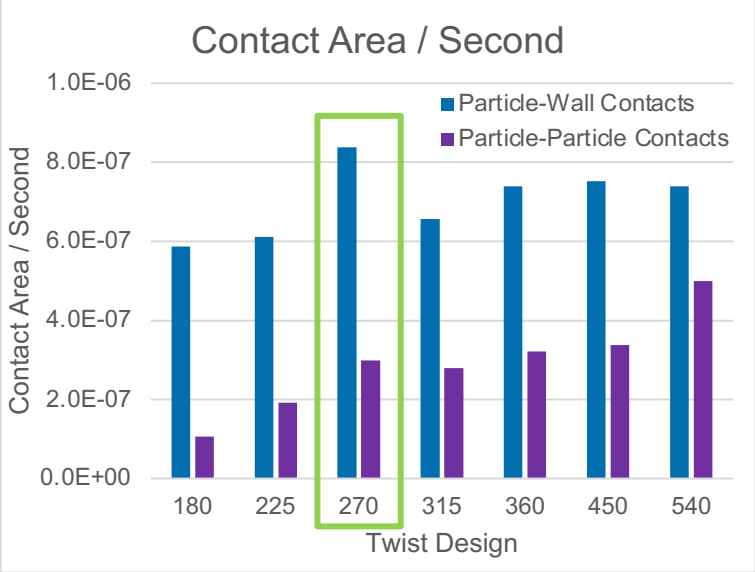
Tribocharger Design [1/2]







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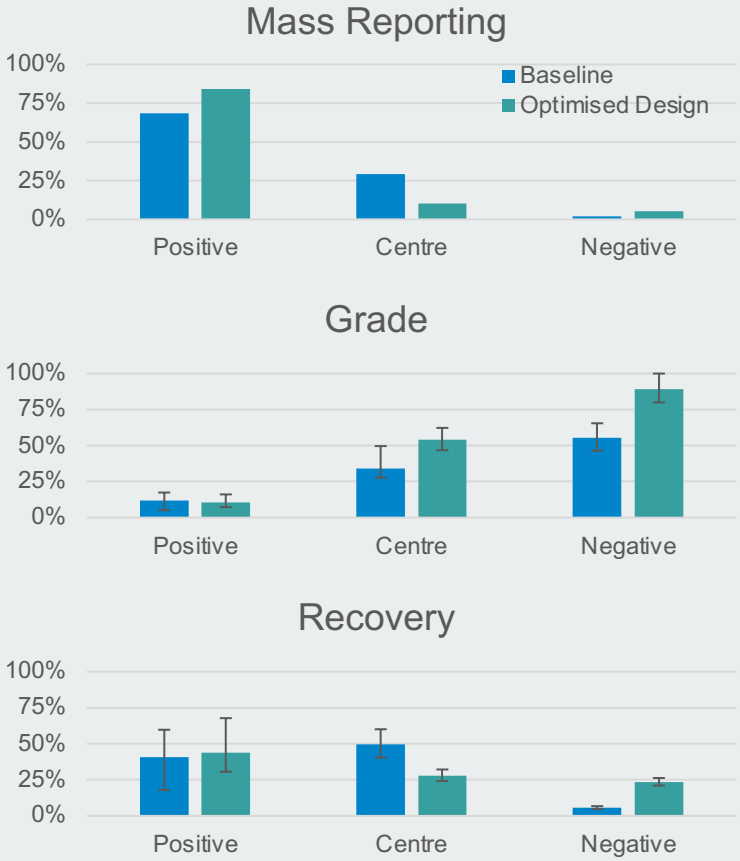
Tribocharger Design [2/2]

No Charging Baffle

Optimised Charging Baffle



Conclusions

- Beneficiation is an critical part of the ISRU flowsheet
- Imperial College focuses on understanding the underlying fundamental physics to inform process design
- Exploring the applications of dry processing for terrestrial and space applications
- Always looking to collaborate!

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Thank you!

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R.D. Cruise, Y. Yu, L. Malone, V. Schein

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