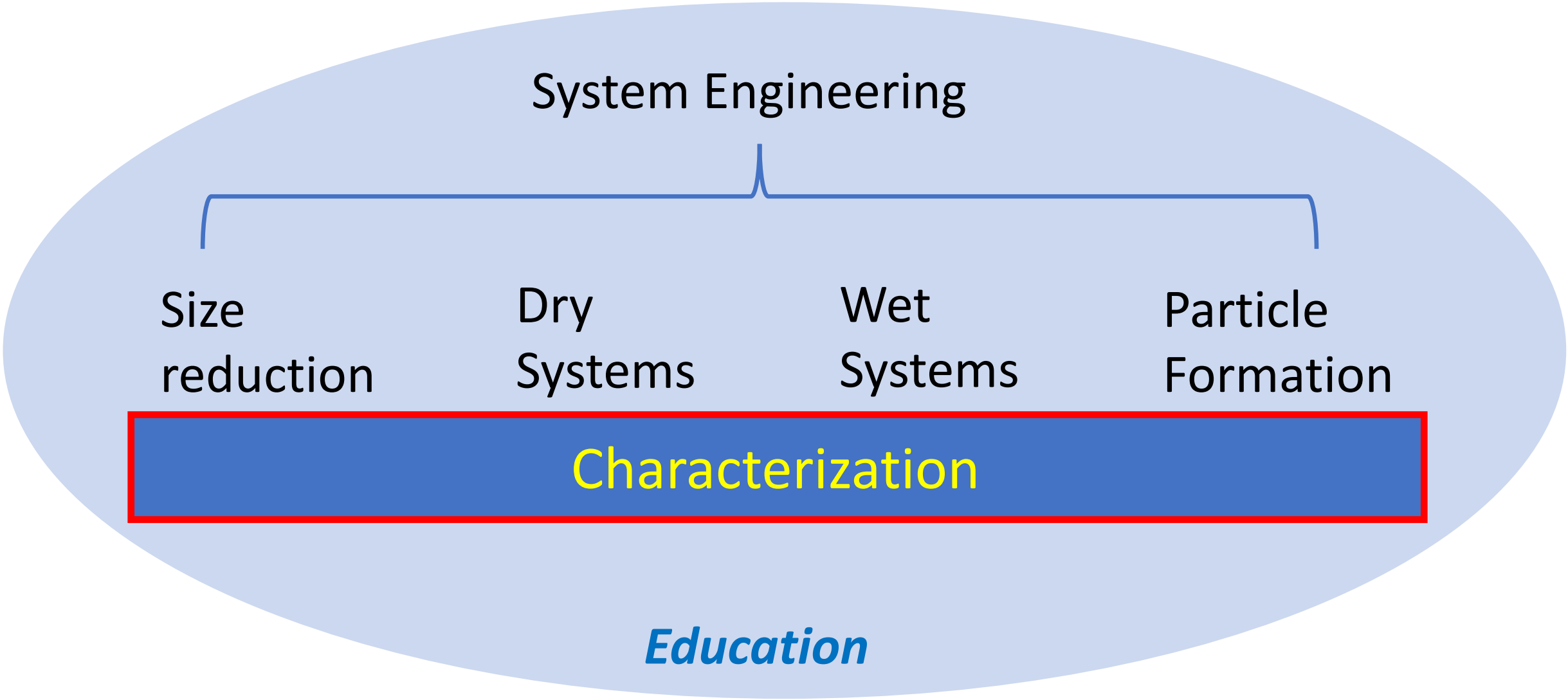
New developments and directions in characterization

Wilson Poon

School of Physics & Astronomy
and
The Edinburgh Complex Fluids Partnership (ECFP)
The University of Edinburgh


System Engineering
Size reduction
Dry Systems
Wet Systems
Particle Formation
Characterization
Education

Some new directions and developments …

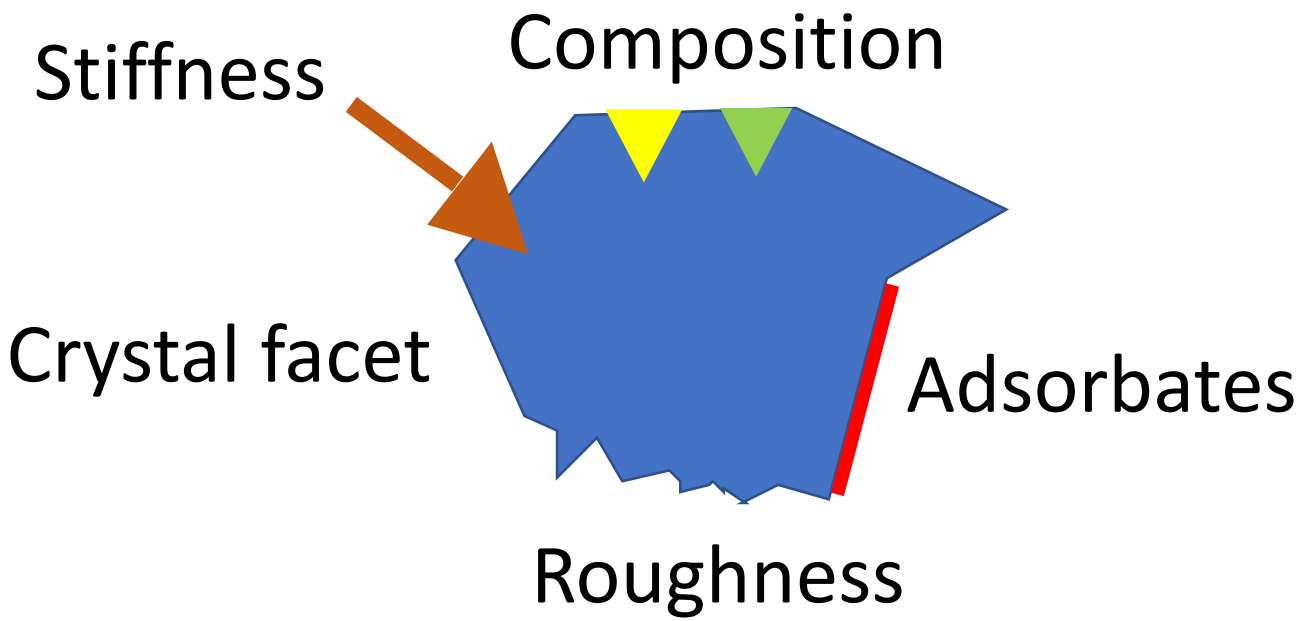
… in wet suspensions characterization

Members: see slides of commissioned review for much more!

1. Wet-dry convergence of interest
2. Turbid wet systems
    (a) Sizing
    (b) Flow imaging

1. Wet-dry convergence

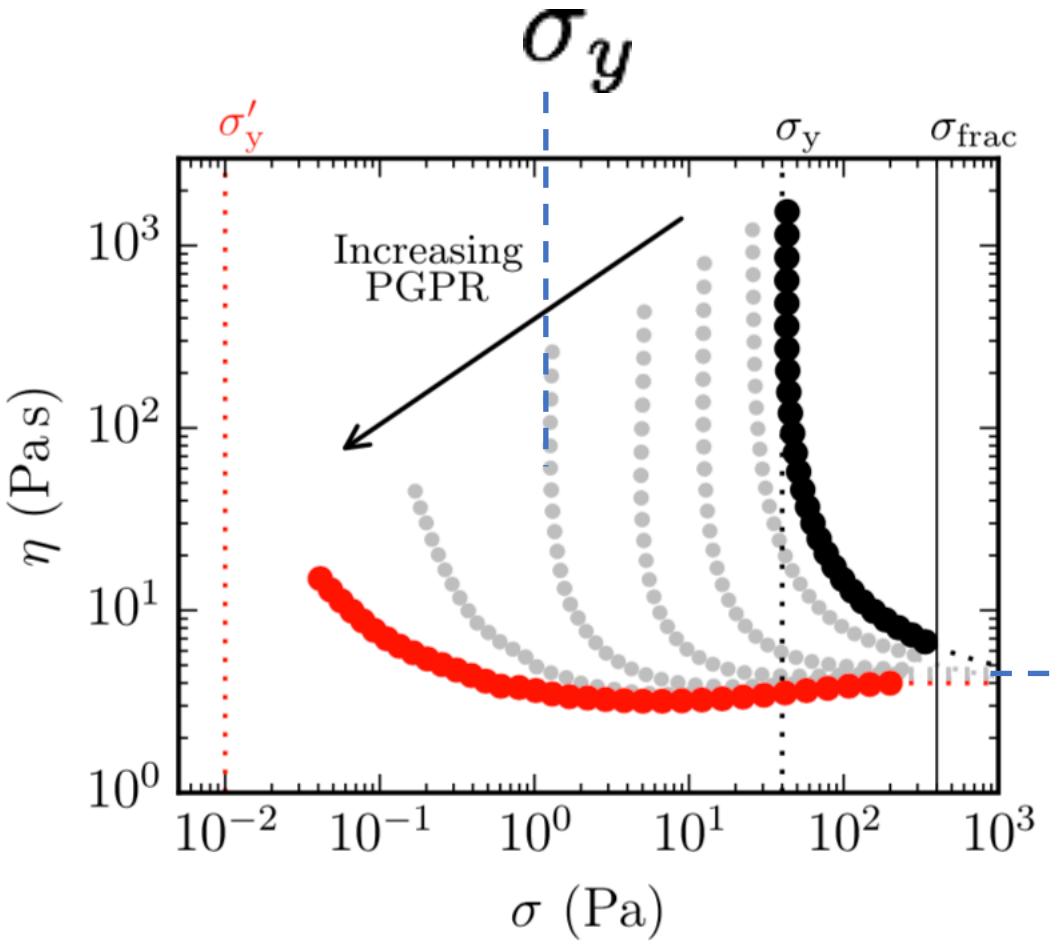
Surface properties are crucial for multiple applications of *powders*



Different dry milling methods gives different surface properties
Kinetics of powder reconstitution is sensitive to surface properties

New: importance of surface properties for suspension rheology

Flow curve of molten chocolate



Both are controlled by interparticle *friction* … which is modified by surfactant additives

η_∞

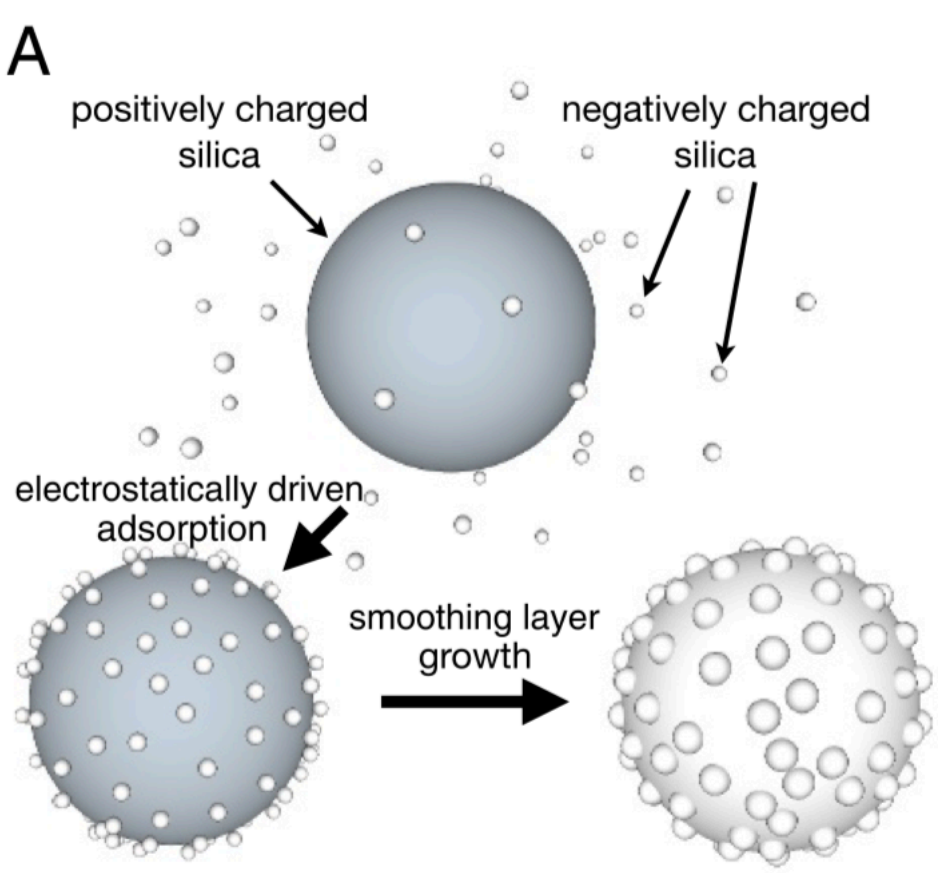
↓ increasing lecithin

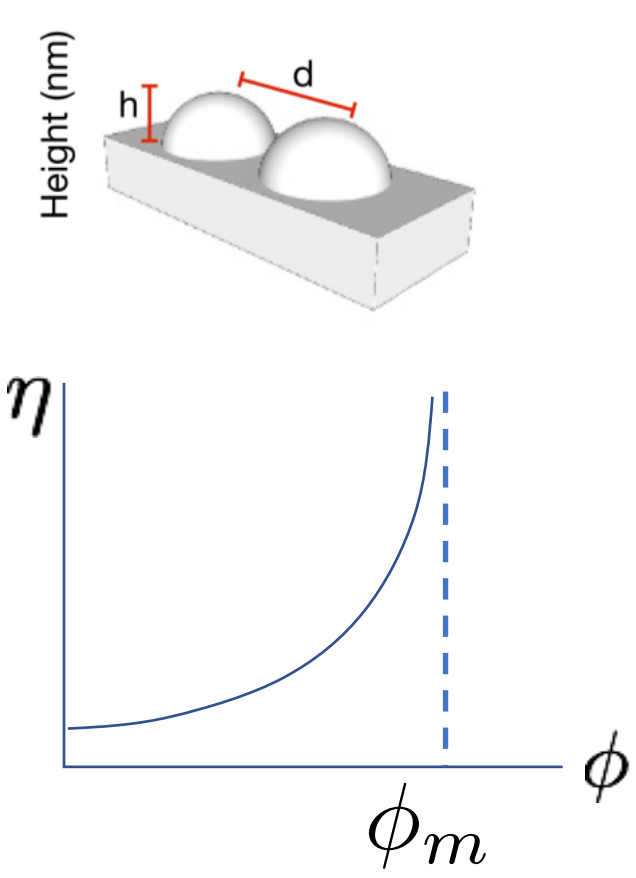
Blanco et al. *PNAS* **116** (2019) 10303

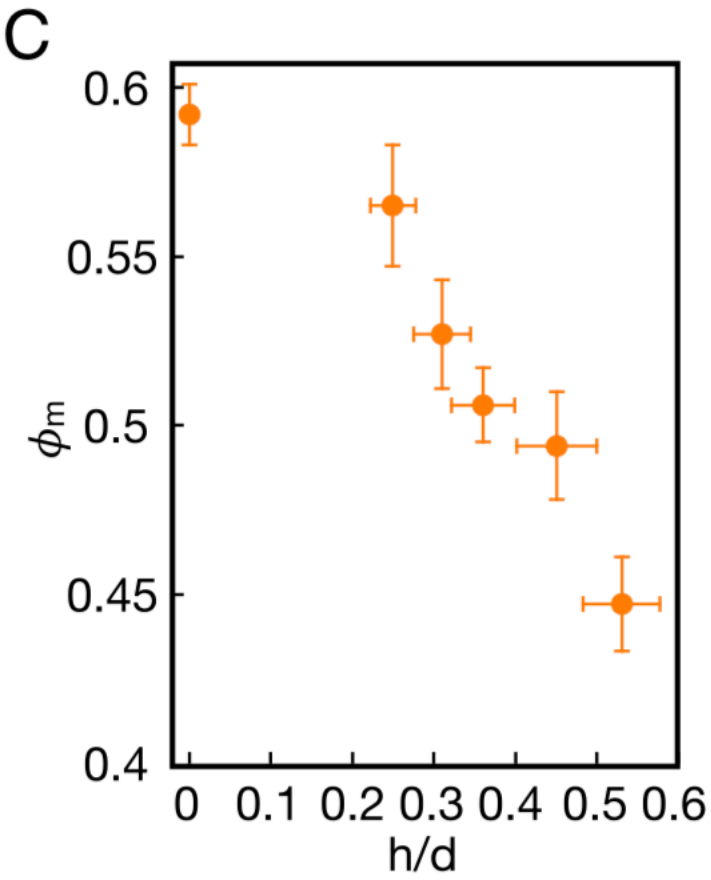
Roughness-dependent tribology effects on discontinuous shear thickening

Chiao-Peng Hsu[a,b], Shivaprakash N. Ramakrishna[b], Michele Zanini[a], Nicholas D. Spencer[b], and Lucio Isa[a,1]

[a]Laboratory for Interfaces, Soft Matter and Assembly, Department of Materials, ETH Zurich, 8093 Zurich, Switzerland; and [b]Laboratory for Surface Science and Technology, Department of Materials, ETH Zurich, 8093 Zurich, Switzerland





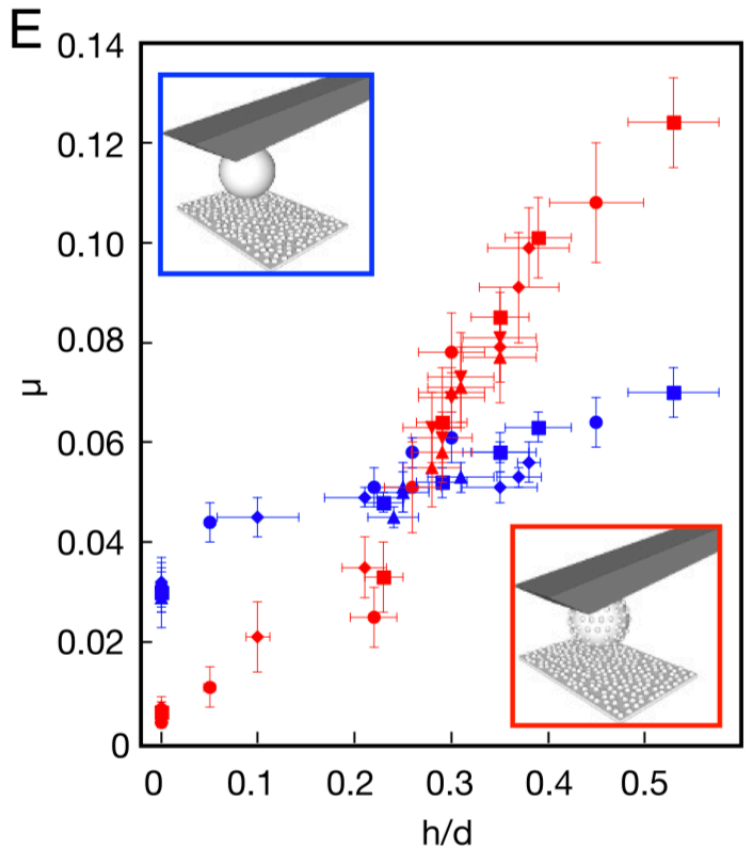


Particle contacts are here to stay for suspension rheology

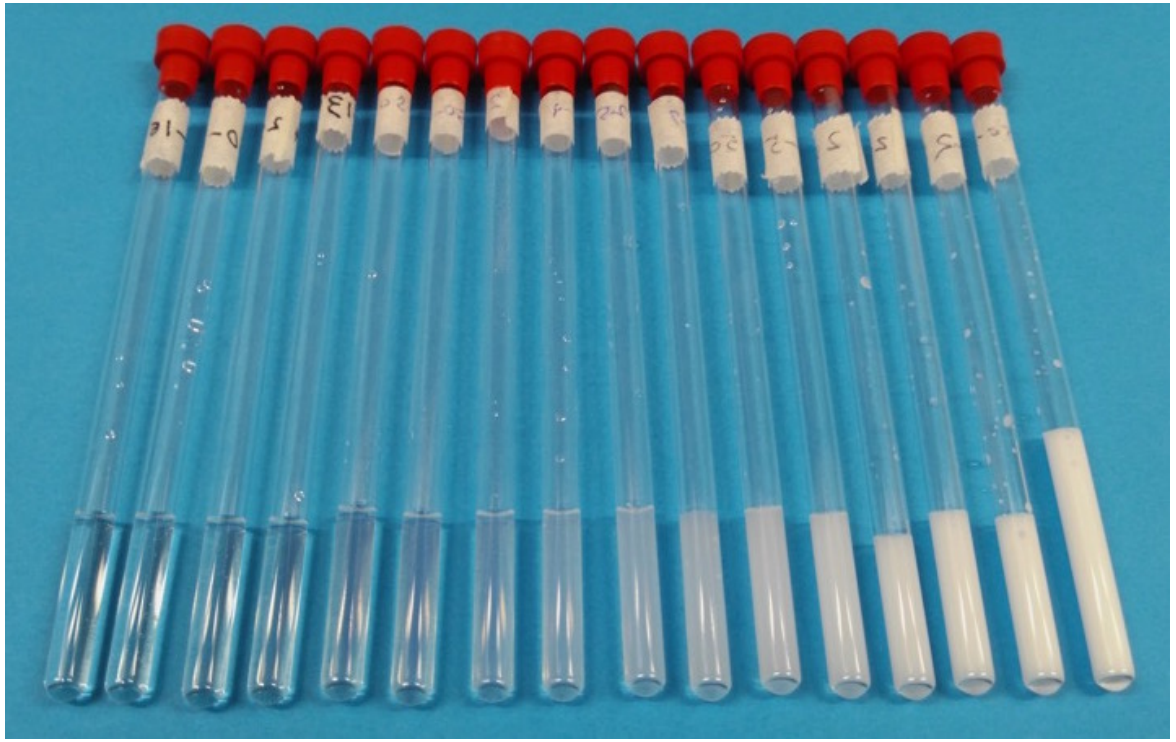
→ wet-dry convergence in the need to characterize particle surfaces carefully

→ the importance of tribological characterization

→ dialogue with tribologists should lead to important advances



2(a) Turbid wet systems: sizing



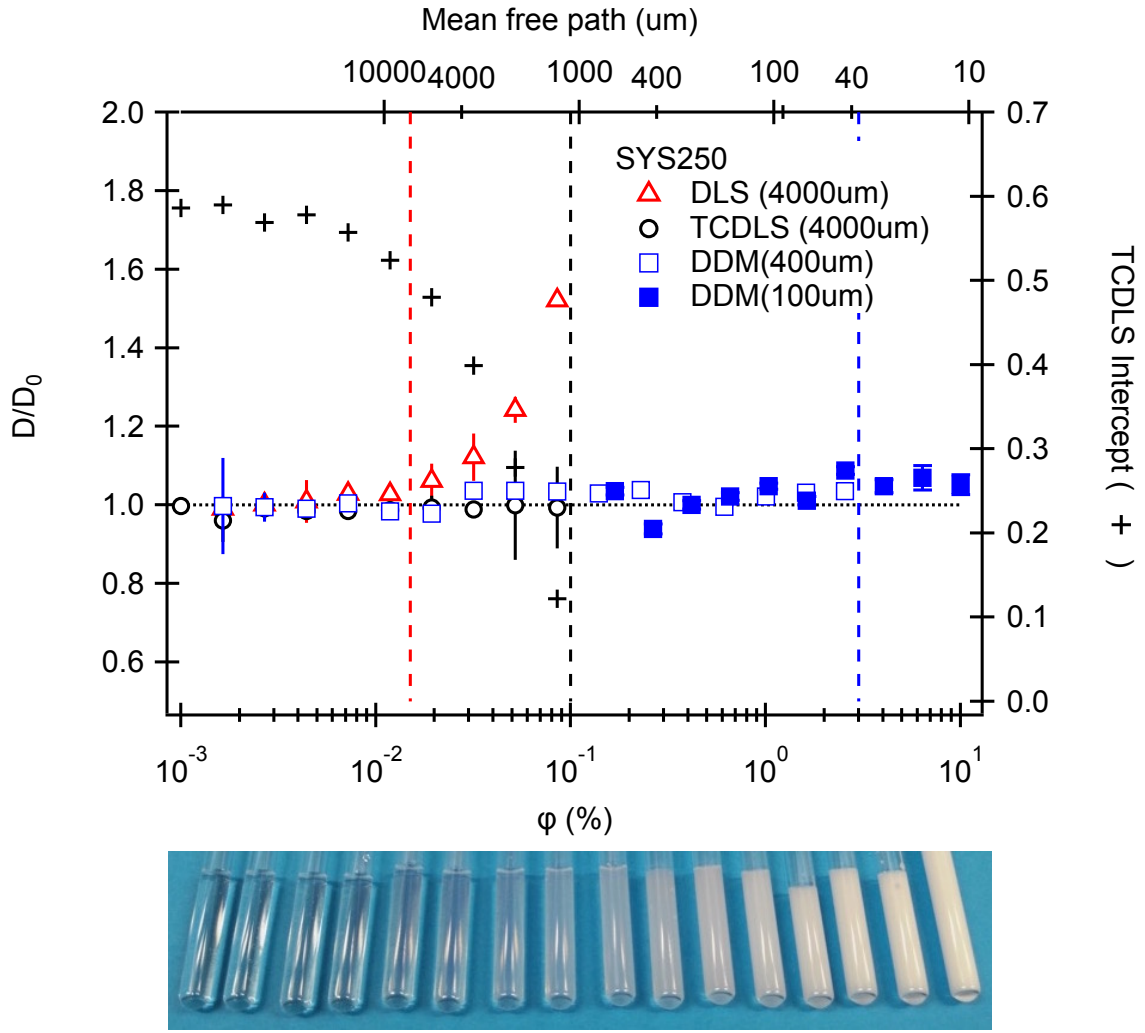
125 nm polystyrene in water, ϕ = 0.0001% to 10%

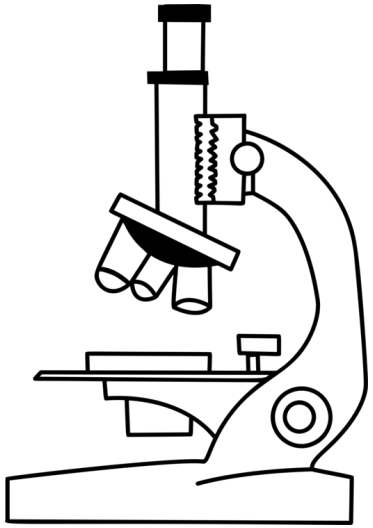
Dynamic light scattering (DLS): diffusivity → diameter

OK Dodgy Wrong

New technique (1): Differential dynamic microscopy (DDM)

Vincent Martinez (Edinburgh)





+ fast camera takes low-res movie
+ clever data processing
(Correlate images in Fourier space)
→ diffusivity → size

Egelhaaf S.U., Poon W.C.K. (2013) Dynamics of Colloids and Macromolecules. In: Roberts G.C.K. (eds) *Encyclopedia of Biophysics*. Springer, Berlin, Heidelberg, https://doi.org/10.1007/978-3-642-16712-6

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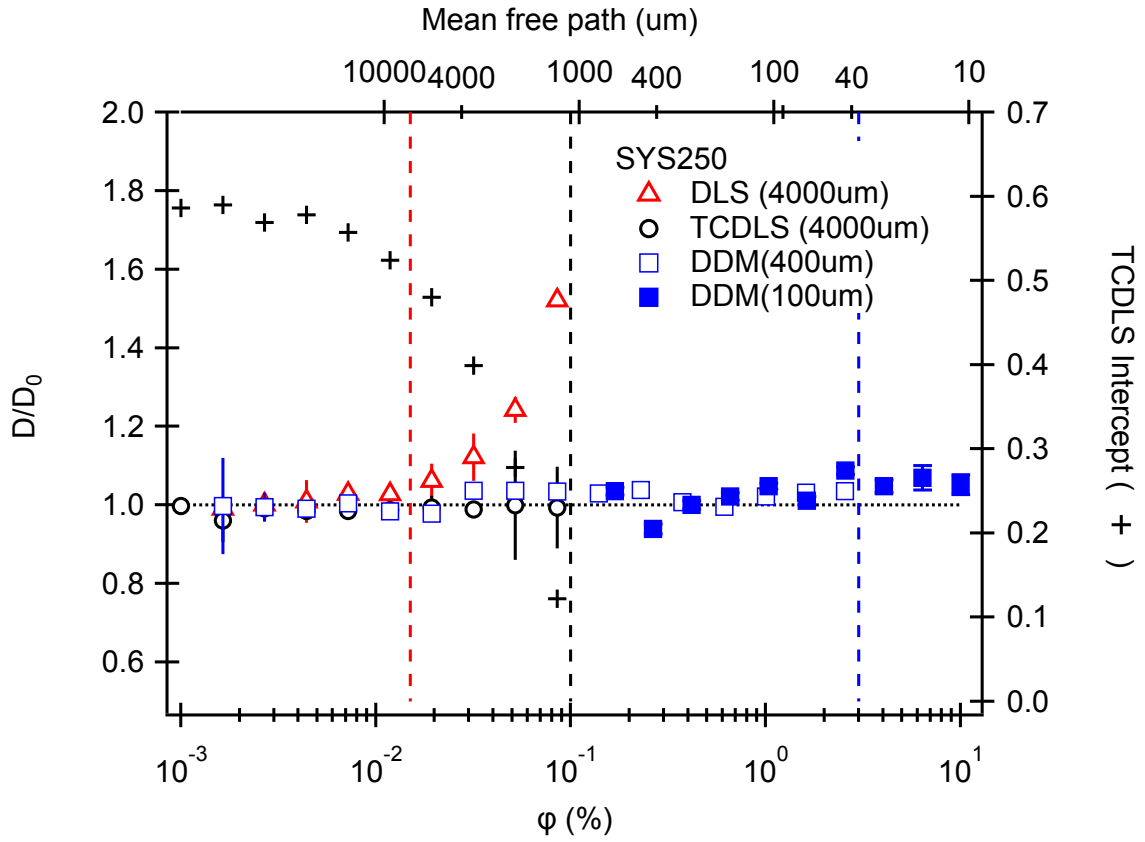

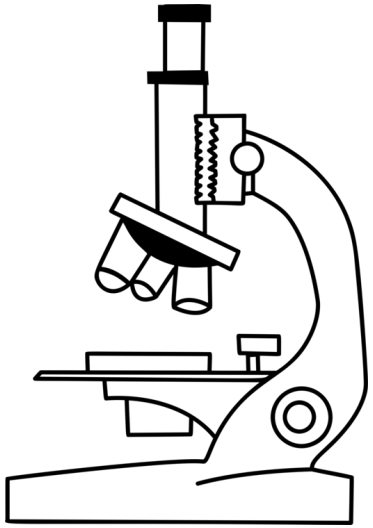

Vincent Martinez (Edinburgh)

Tiffany Wood (Edinburgh)

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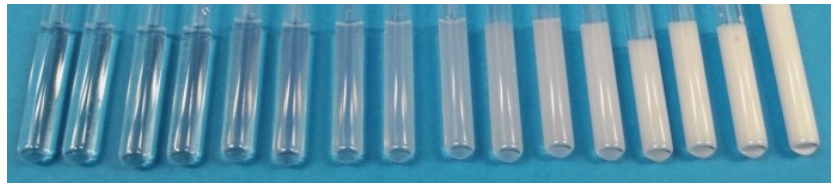

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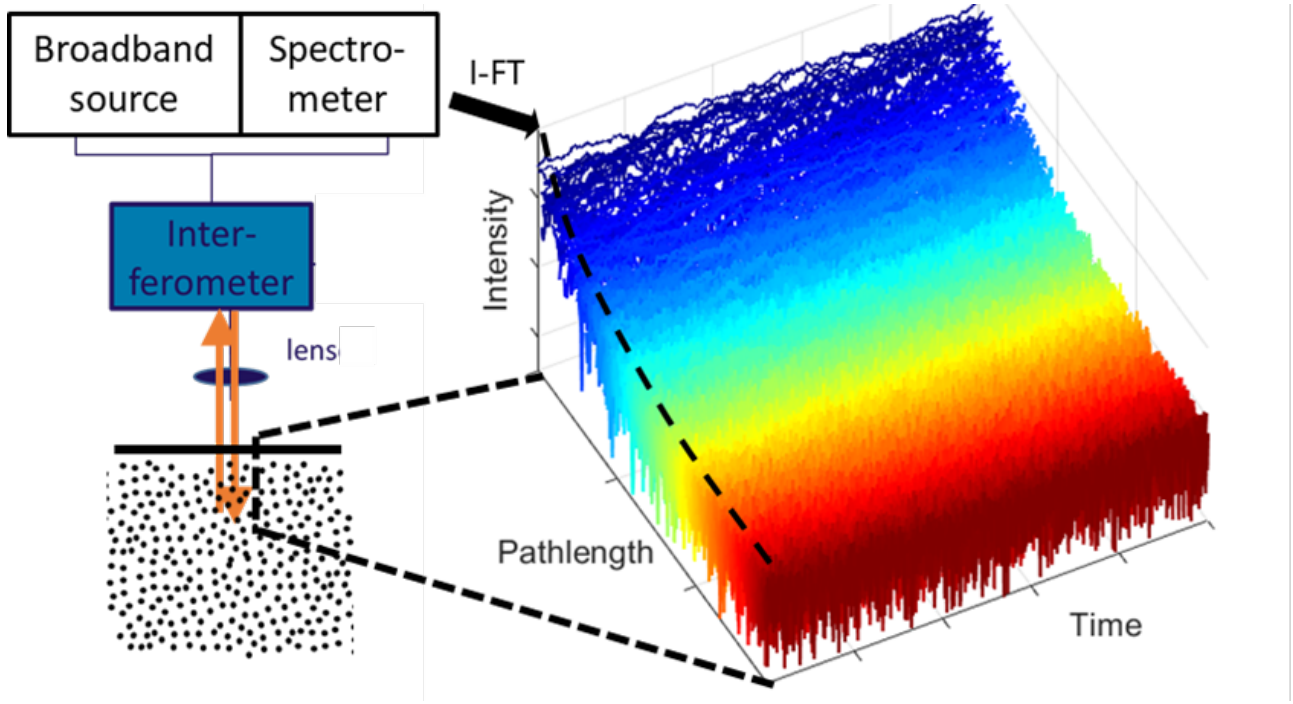
New technique (2): Spatially-resolved DLS

Low-coherence interferometry → signal from particles at different depths
→ Optical Coherence Tomography for biomedical imaging
→ rejection of multiple scattering



Rut Besseling

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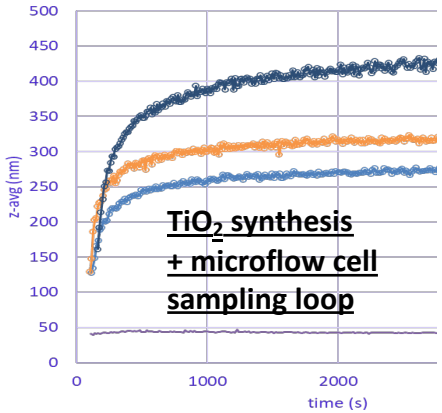
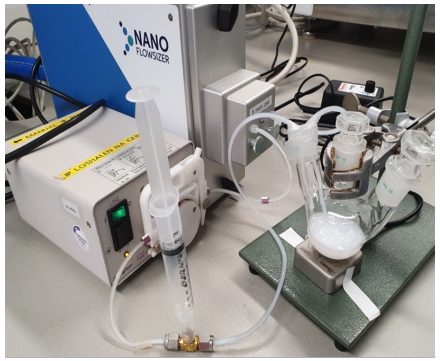
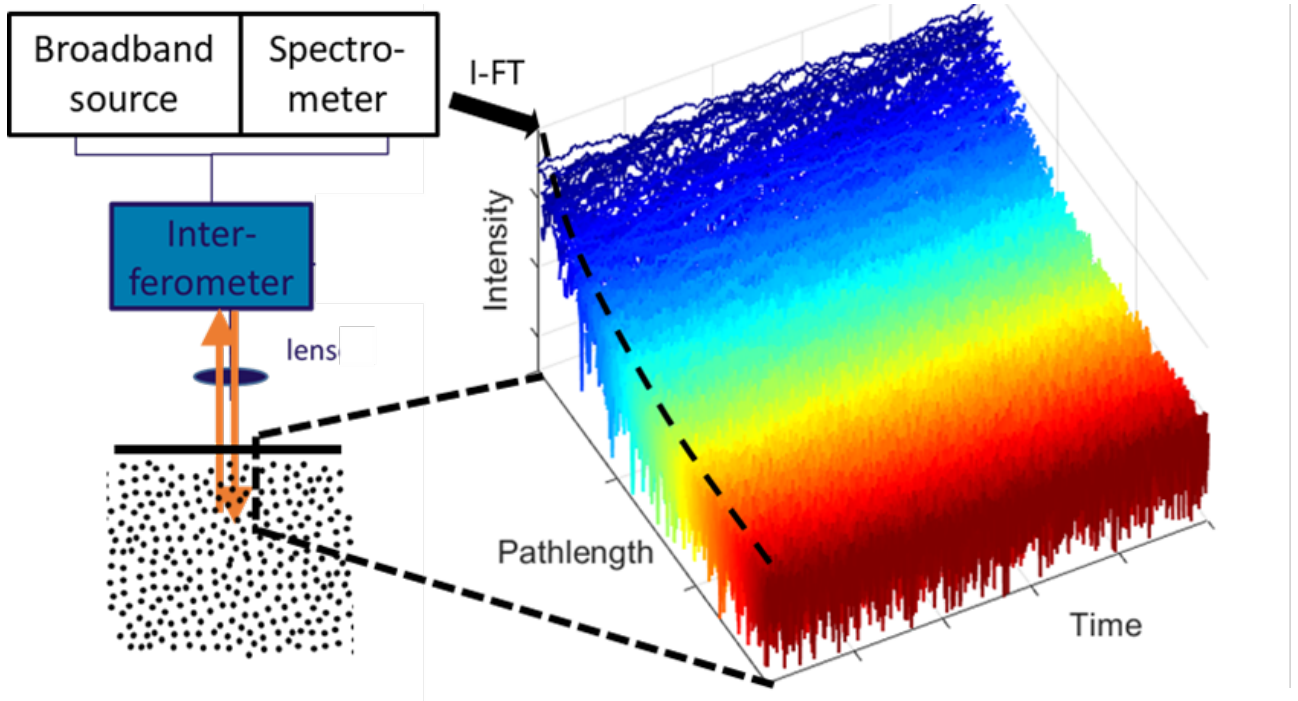
→ flow correction for real-time in-line use







Rut Besseling

Detailed science explained in webinar available to members on IFPRI website

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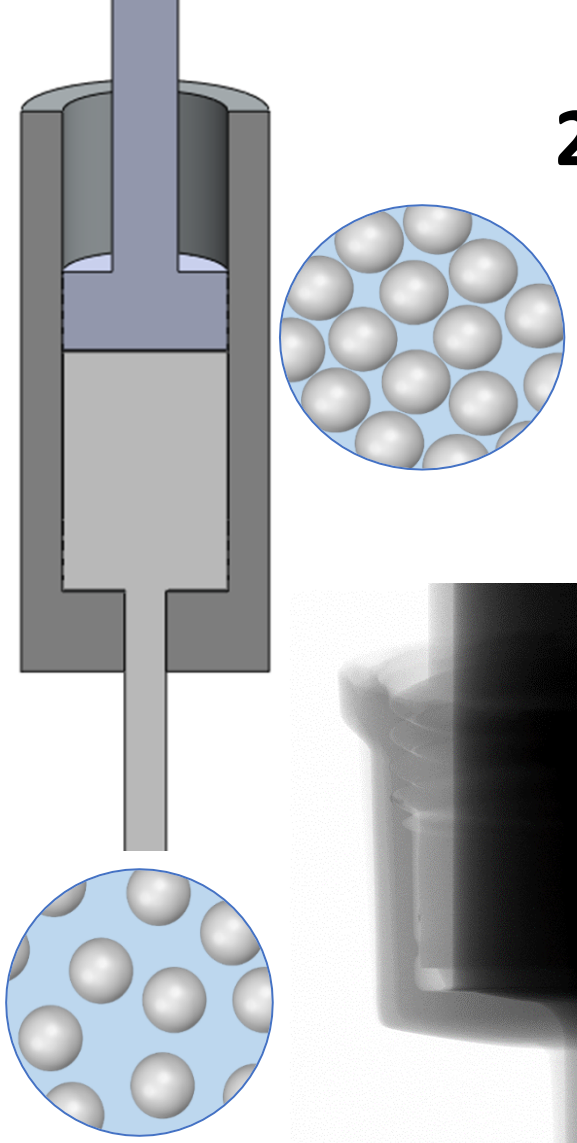
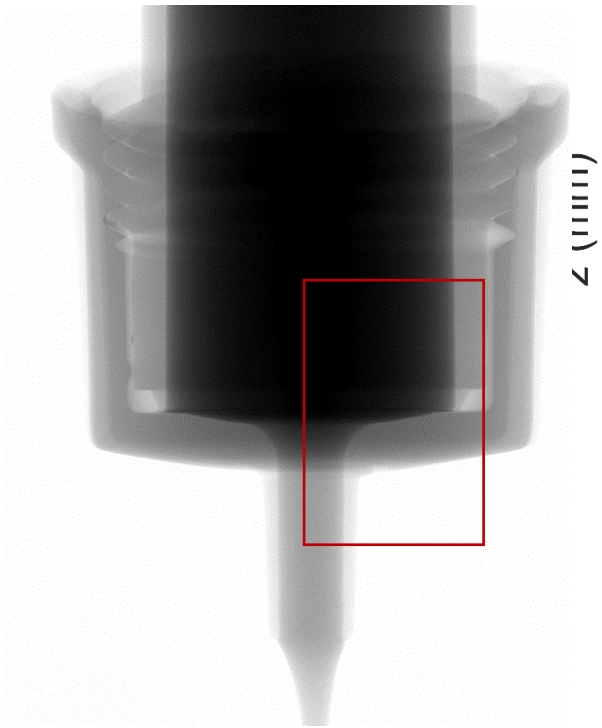
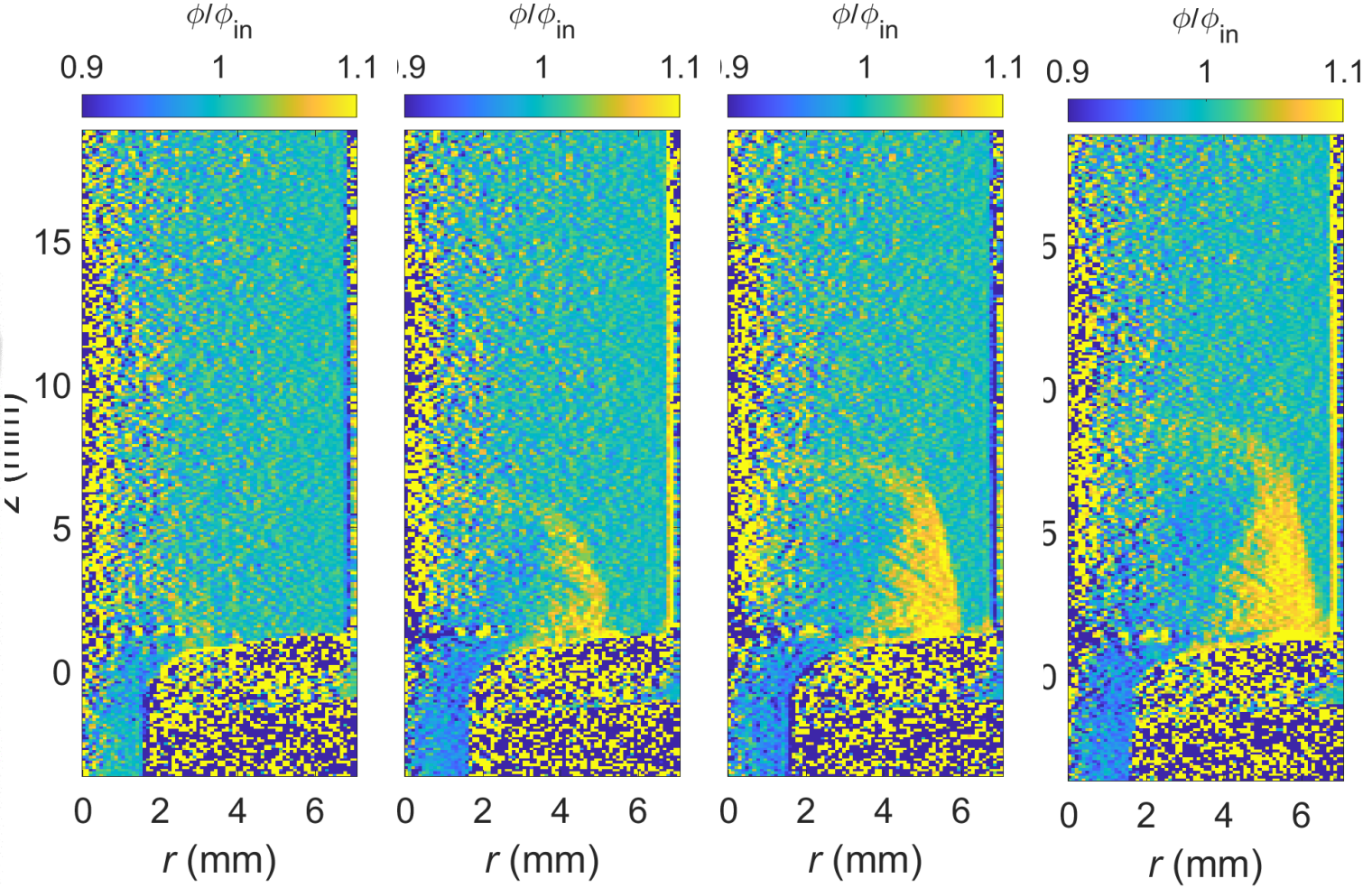
2(b) Turbid wet systems: flow imaging



Dewatering



Real-time X ray tomography of die extrusion



Rory O'Neill (Edinburgh) and Guillaume Ovarlez (Solvay-CNRS Laboratoire du Futur, Pessac)

Summary

1. Characterization underpins all areas of particle technology
2. Wet-dry convergence on the importance of surface & tribology
3. Two new optical techniques
4. Real-time X ray tomography of flows in complex geometries

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Other areas that have caught my attention:

- use of acoustics
- machine learning especially in image analysis

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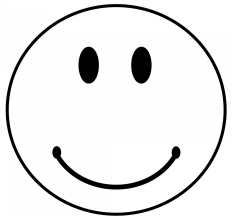
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