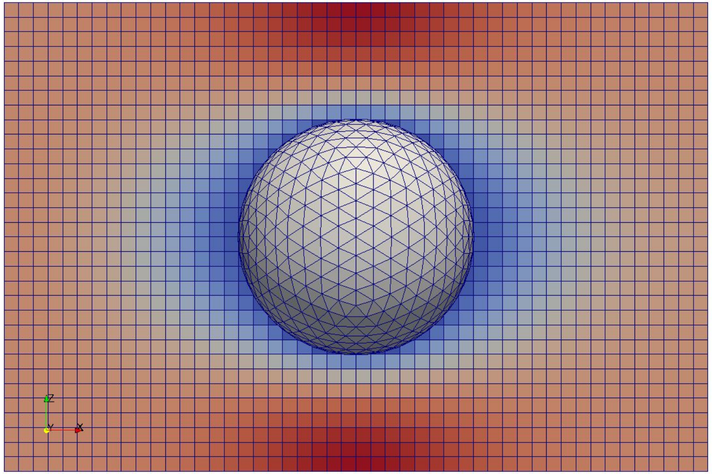
Fine grained fluid coupling with the Immersed Boundary Method

An overview

Chris Knight

Immersed Boundary Method

Fluid flow modelled with Computational Fluid Dynamics



Add forces to fluid Eqs. to impose No-Slip, No-Penetration condition at IB points.

1. Velocity of IB point

$$\mathbf{U}^{\mathbf{IB}}(\mathbf{X}_l) = \mathbf{u}_c + \mathbf{w}_c \times (\mathbf{X}_l - \mathbf{x}_c)$$

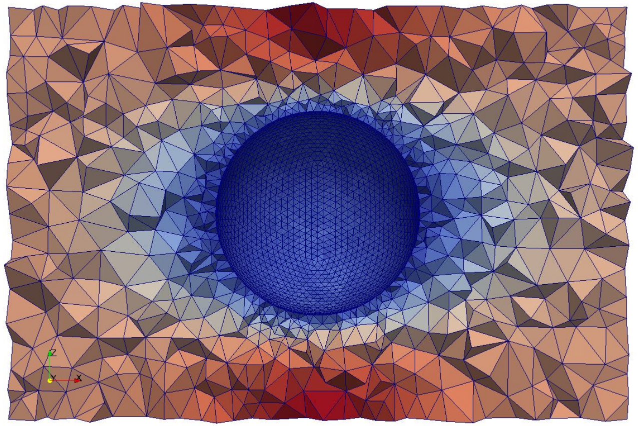
2. Fluid velocity interpolated at IB point

$$\mathbf{U}^*(\mathbf{X}_l) = \sum \mathbf{u}(\mathbf{x})\delta(\mathbf{x} - \mathbf{X}_l)$$

3. Forcing at IB points

$$\mathbf{F} = \frac{\mathbf{U}^{\mathbf{IB}} - \mathbf{U}^*}{\Delta t} - \mathbf{RHS}$$

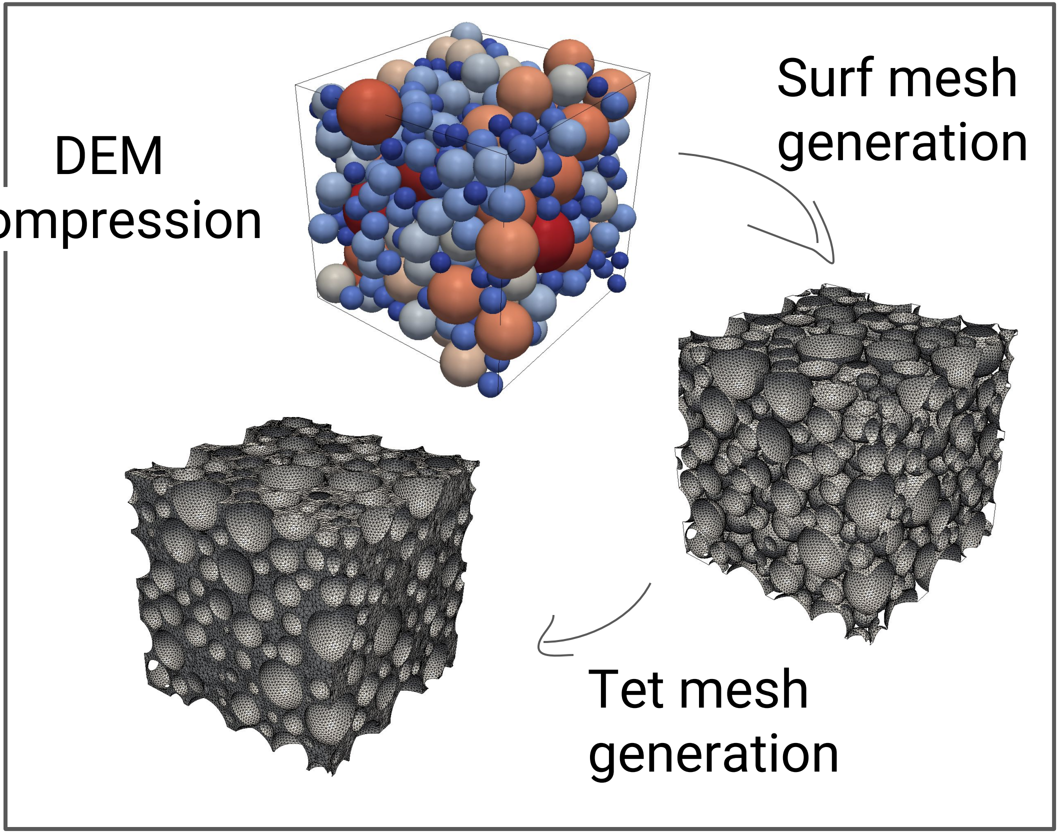
Vanilla CFD with Boundary Fitted Grids



Higher accuracy with conformal meshes 😀

...*but* no dynamics 😒

Good for IBM validation 👌



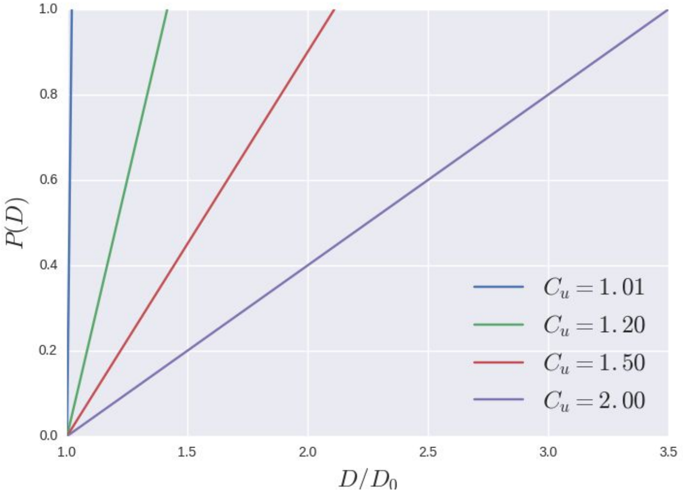
Polydispersity and Drag

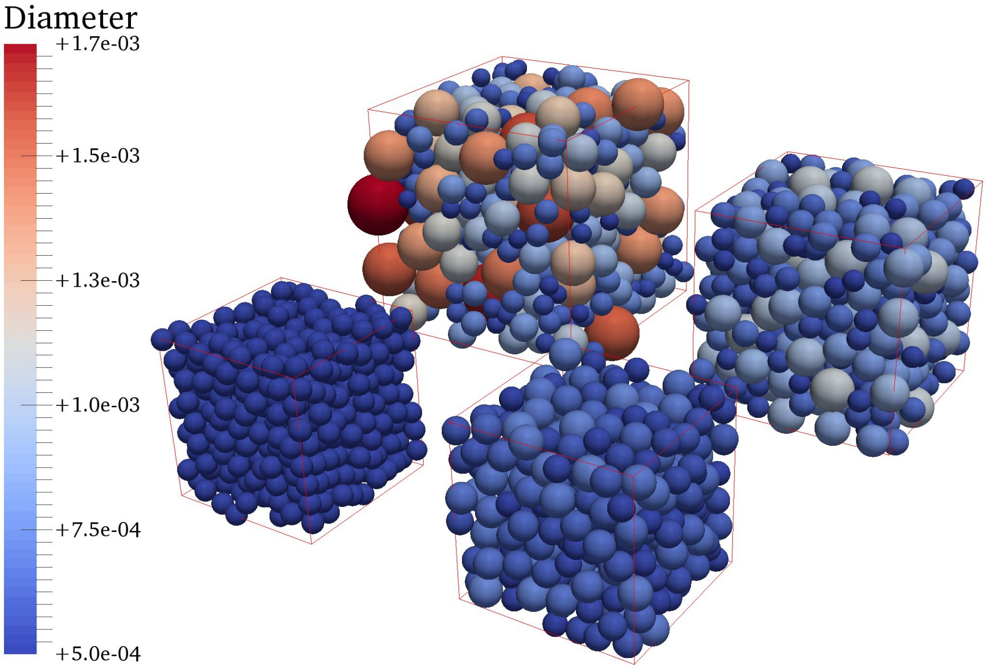
Investigate drag in polydisperse packings with *“linear gradings”*

- Vary uniformity coefficient

$$C_u = D_{60}/D_{10}$$

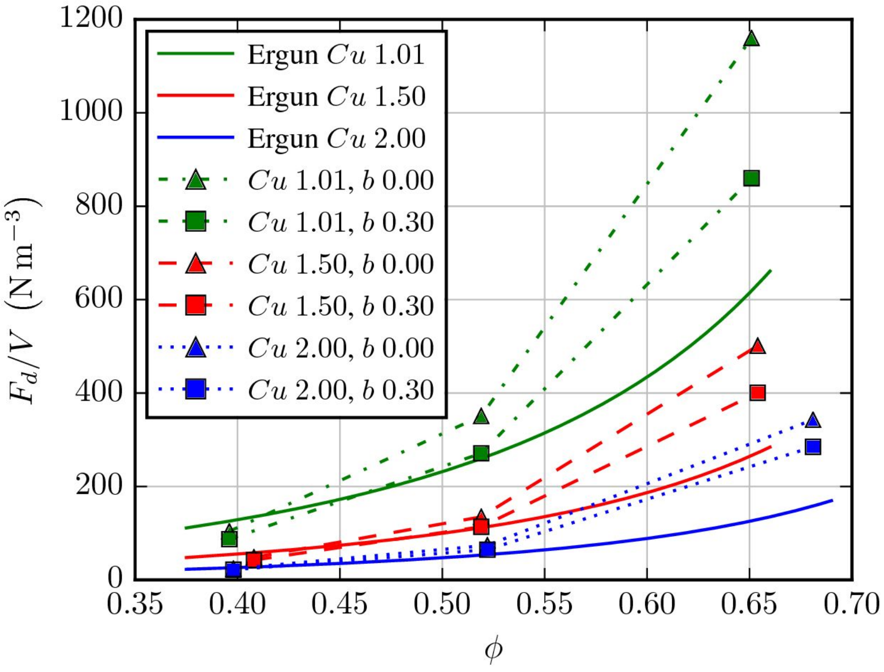
- Vary solids concentration

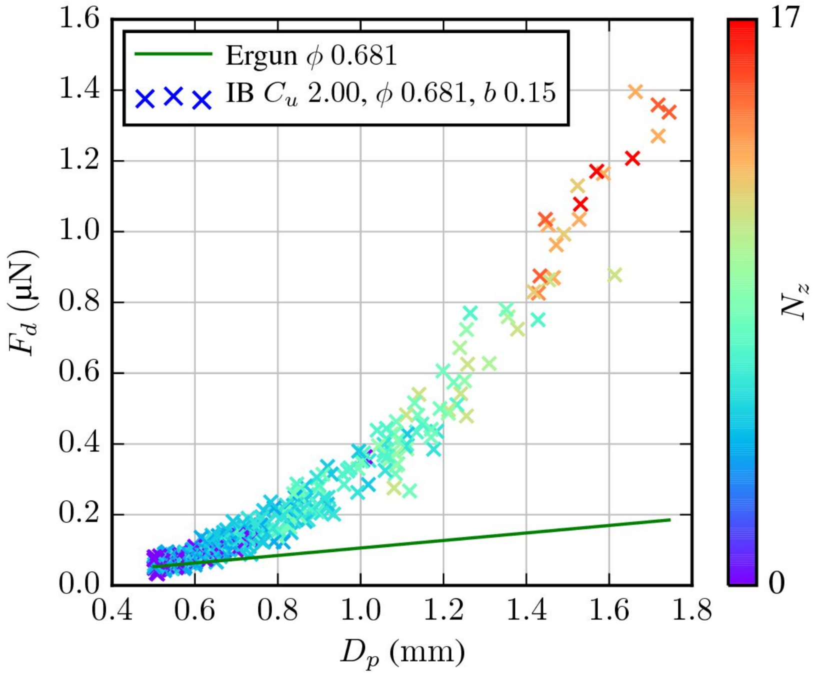




Polydispersity and Drag

Large departure from widely used Ergun 1952 correlation





Acknowledgements

Imperial College London

EPSRC
Engineering and Physical Sciences Research Council

archer

Project Supervisors

Dr. Catherine O'Sullivan[1]
Prof. Berend van Wachem[2]
Prof. Daniele Dini[2]

1. Department of Civil Engineering, ICL
2. Department of Mechanical Engineering, ICL

...and ***thank you*** for listening