

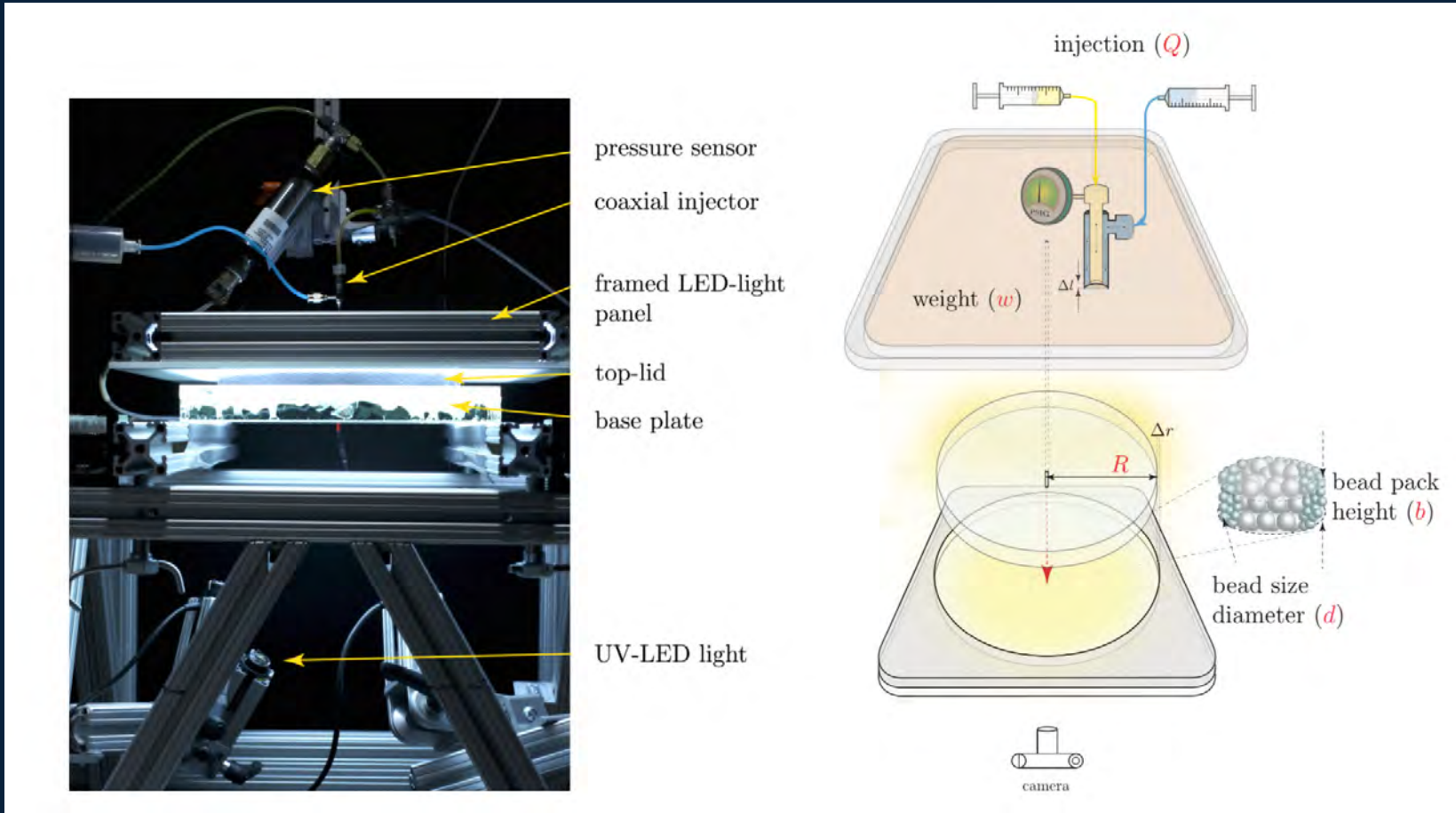
DEM modeling of coupled multiphase flow and granular mechanics: Wettability control on fracture patterns

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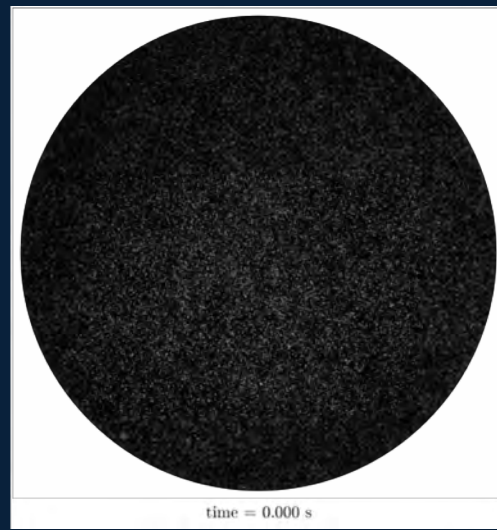
Trojer et al. (*in review*).

Motivation

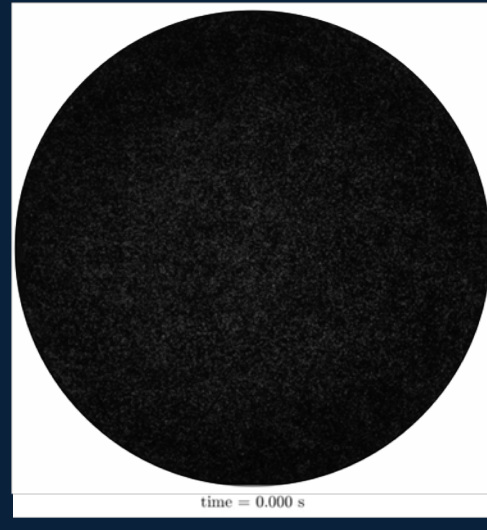
EXPERIMENTAL SET-UP



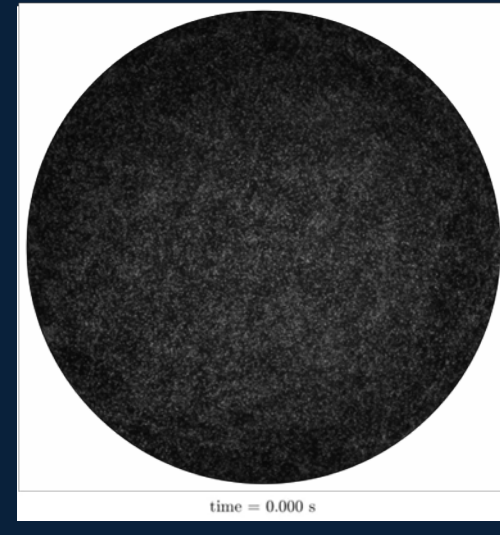
silicon oil - glycerol



water – silicon oil



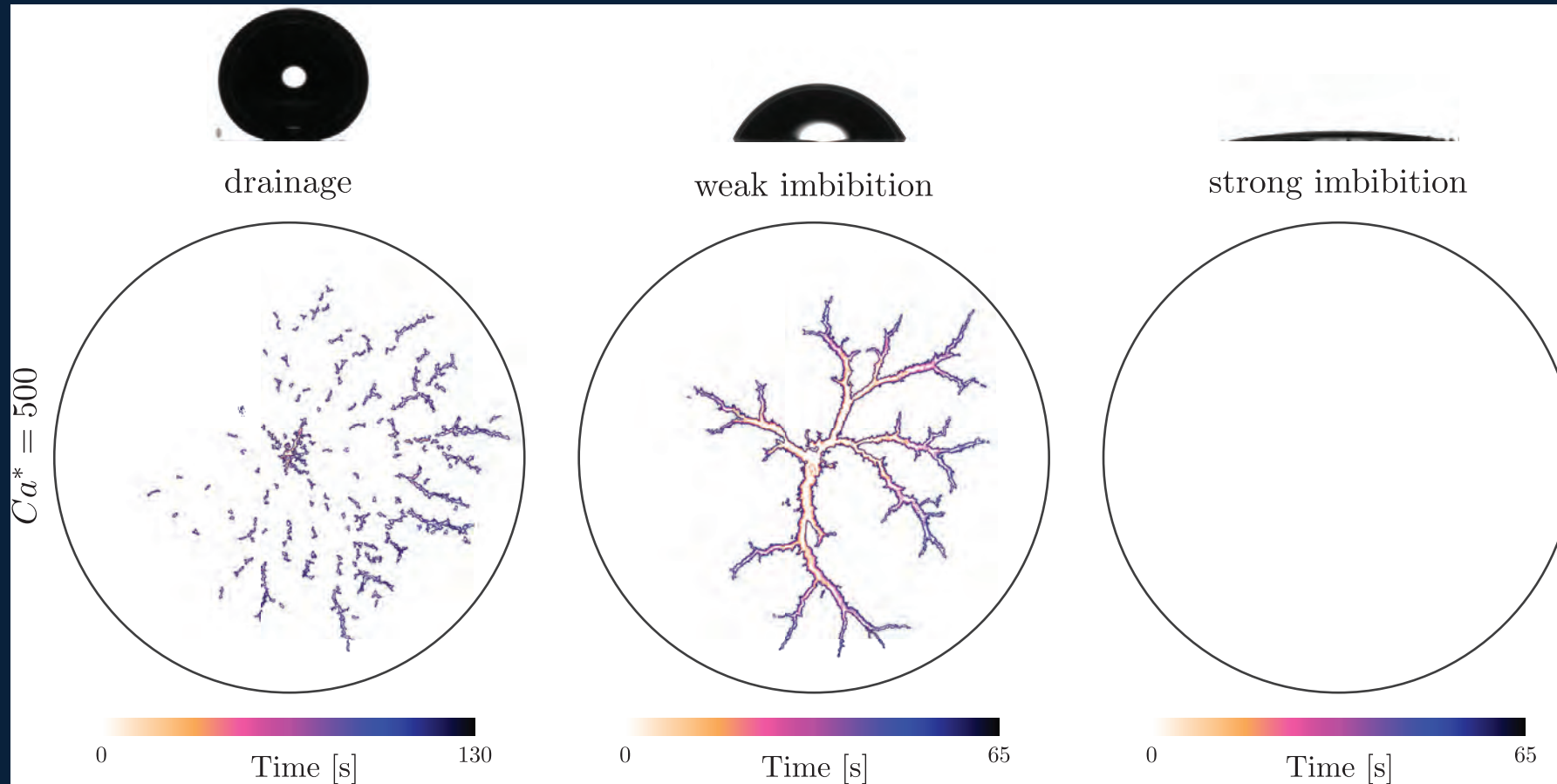
water – fluorinated oil



Trojer et al. (*in review*).

Motivation

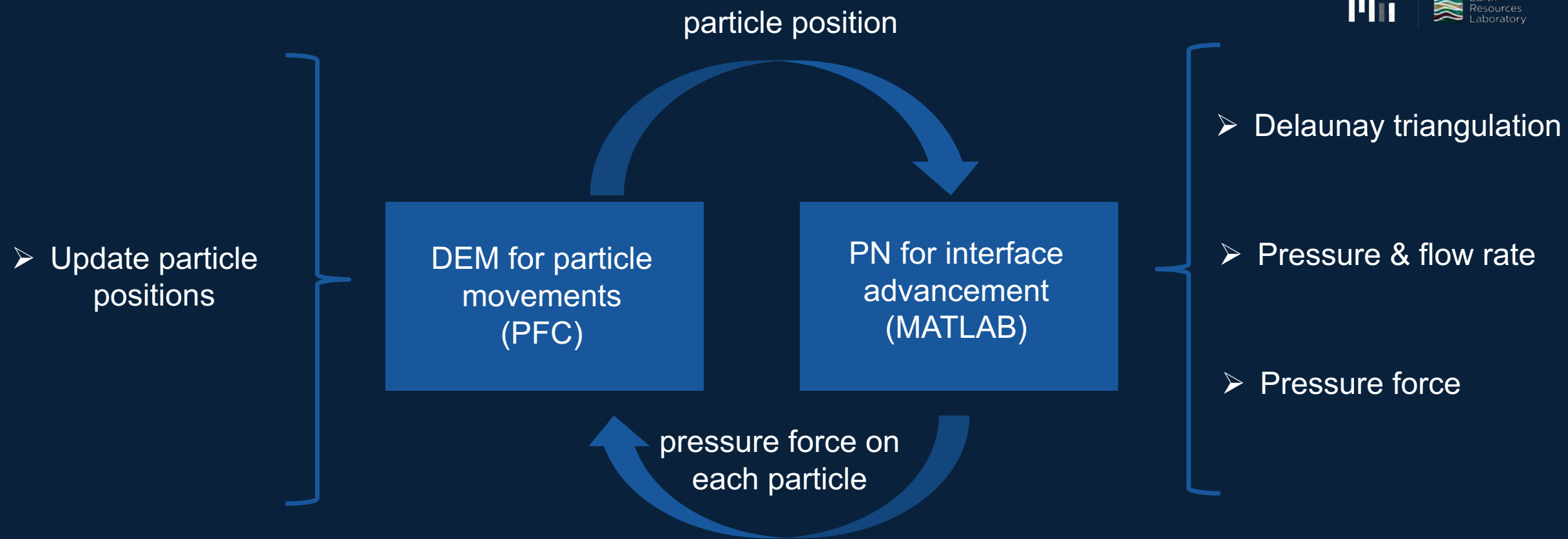
IMPACT OF WETTING ON FRACTURING OF GRANULAR MEDIA



Trojer et al. (*in review*).

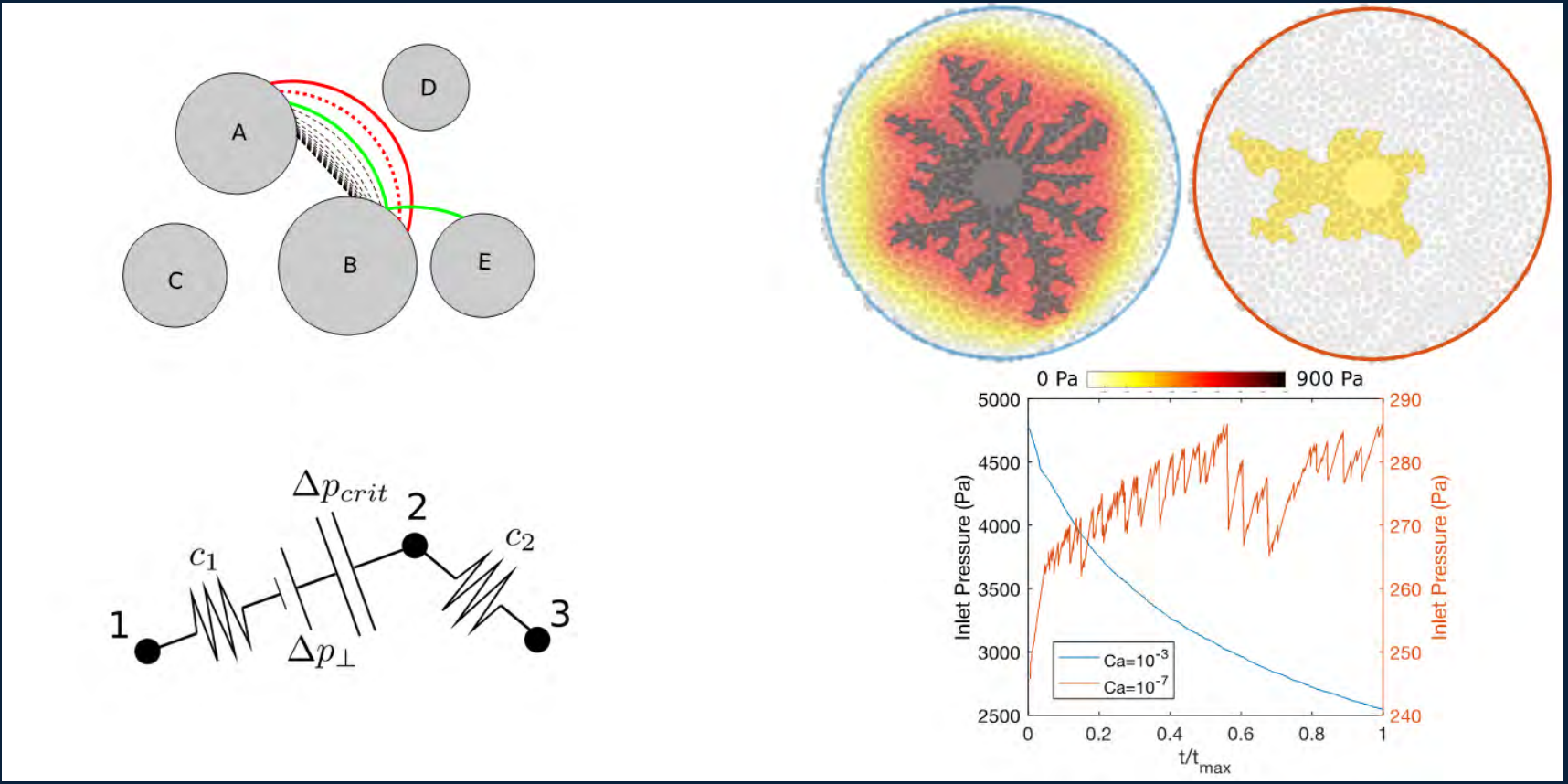
Motivation

IMPACT OF WETTING ON FRACTURING OF GRANULAR MEDIA



Methodology

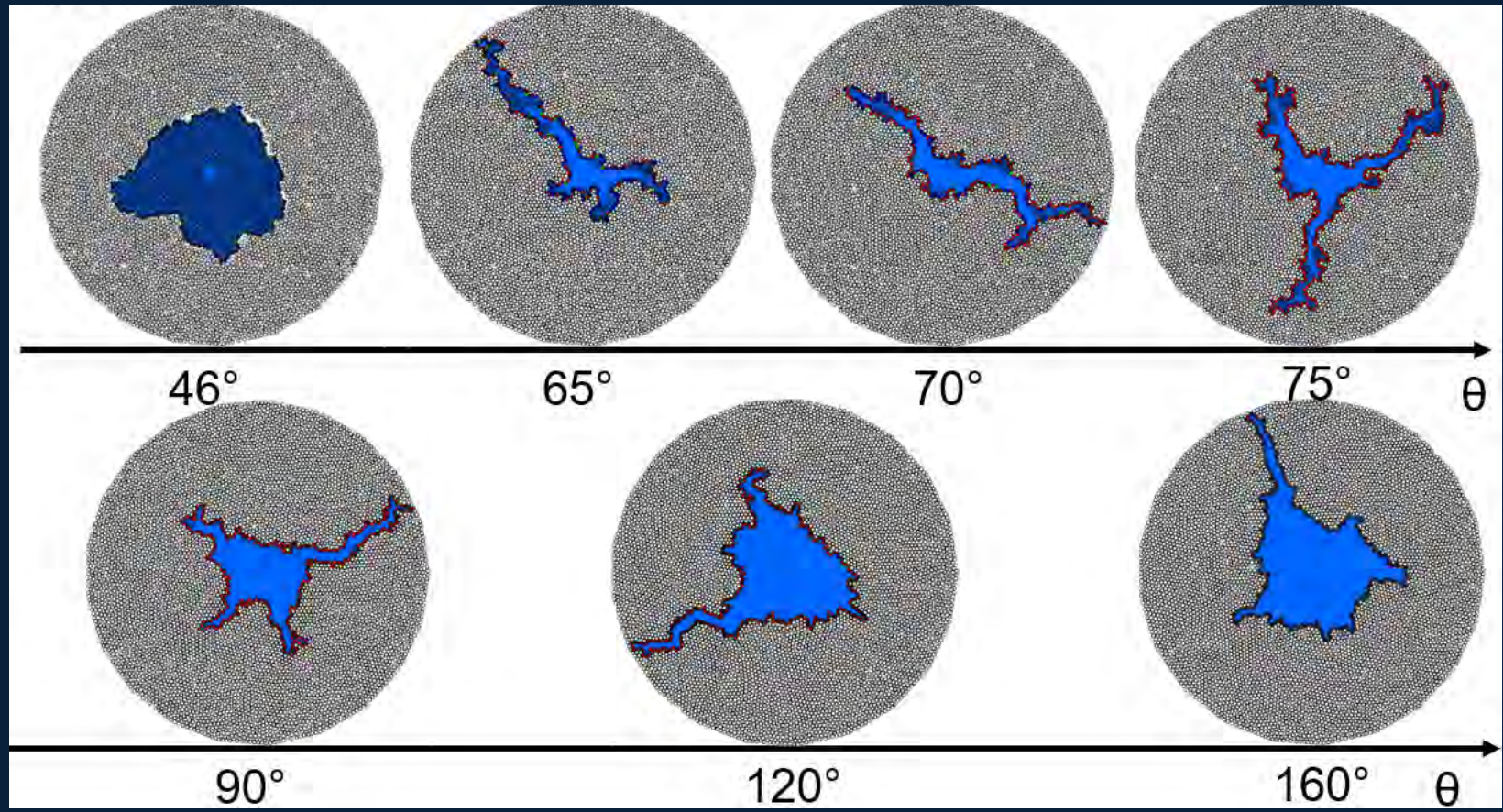
COUPLING SCHEME FOR TWO-PHASE FLOW MODEL



Primkulov et al. (in review)

Methodology

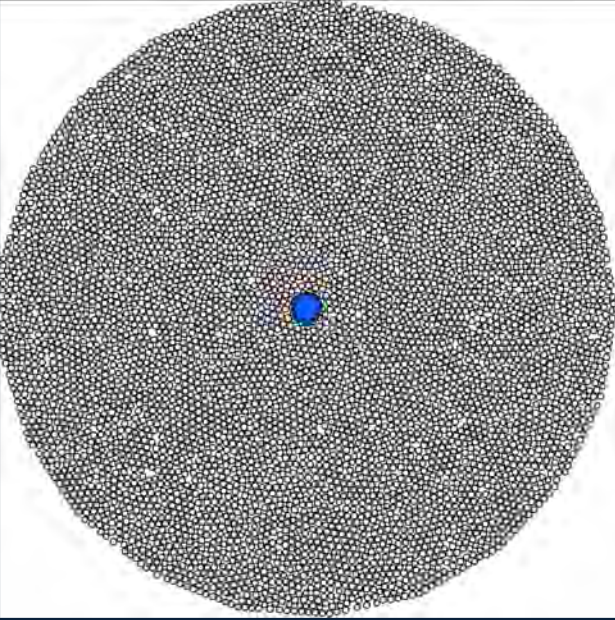
TWO-PHASE FLOW: MOVING CAPACITOR DYNAMIC MODEL



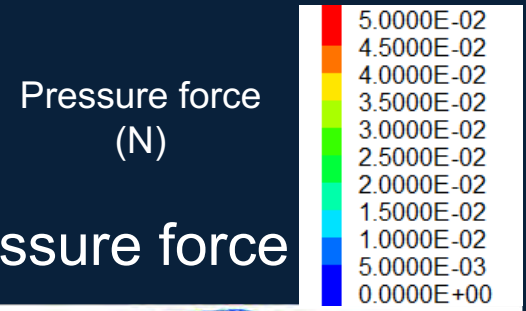
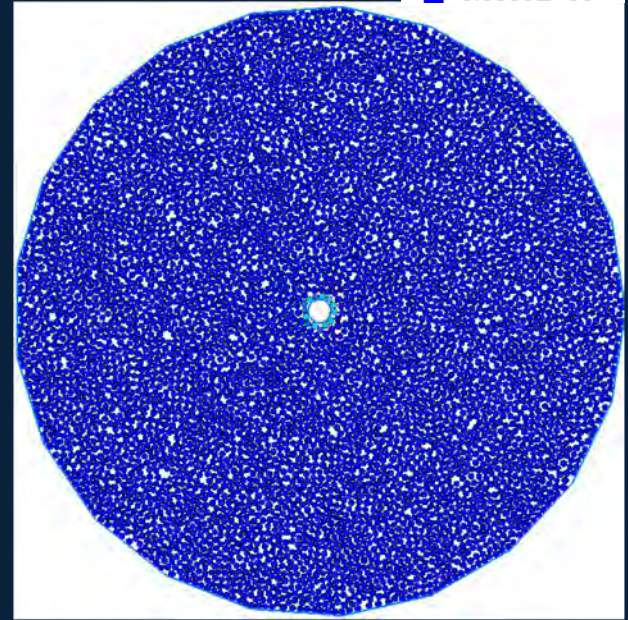
Phase diagram: fracture morphology

IMPACT OF WETTABILITY ON FRACTURE PATTERNS

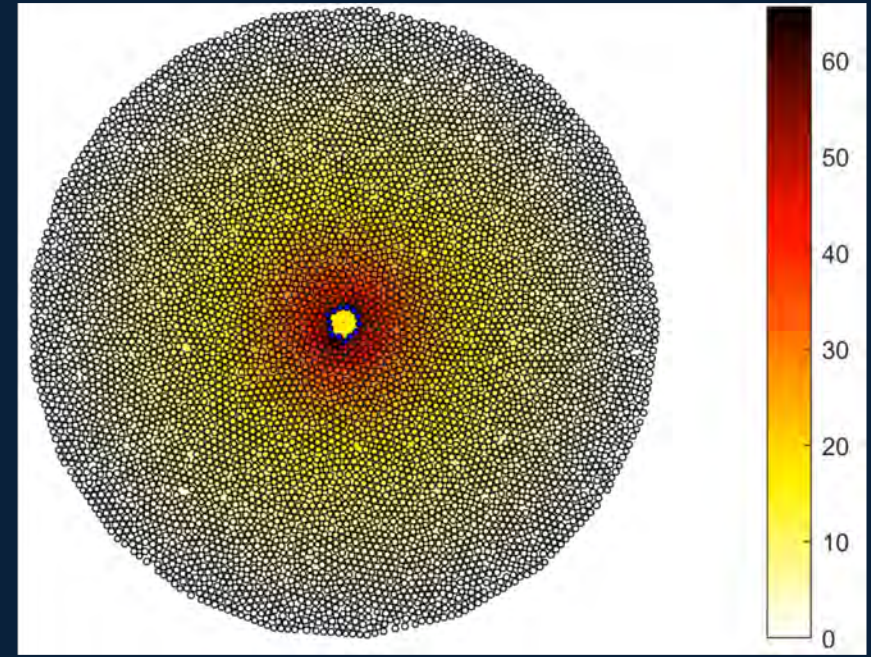
interface morphology



pressure force



pressure field

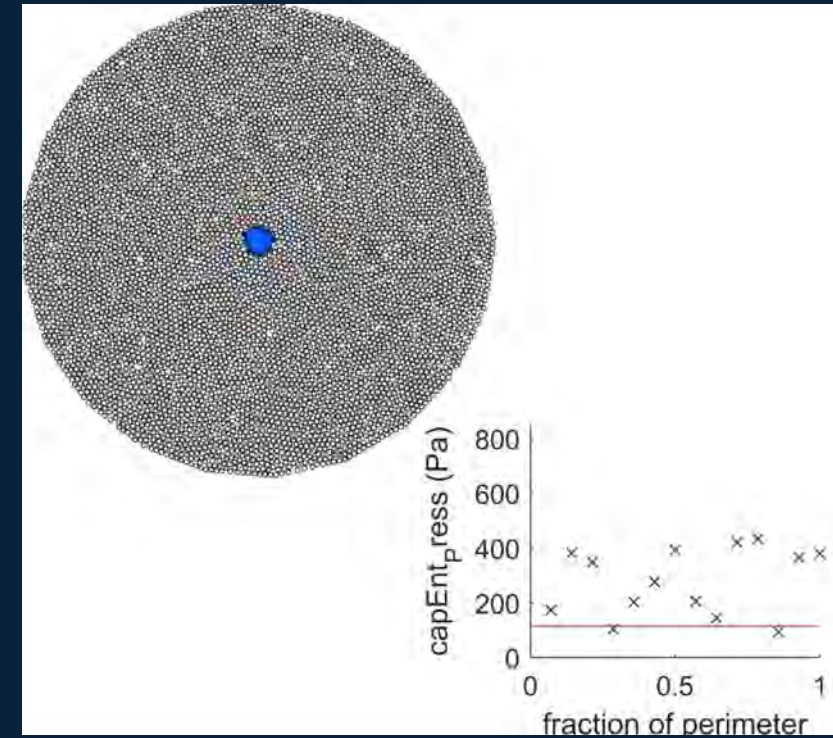
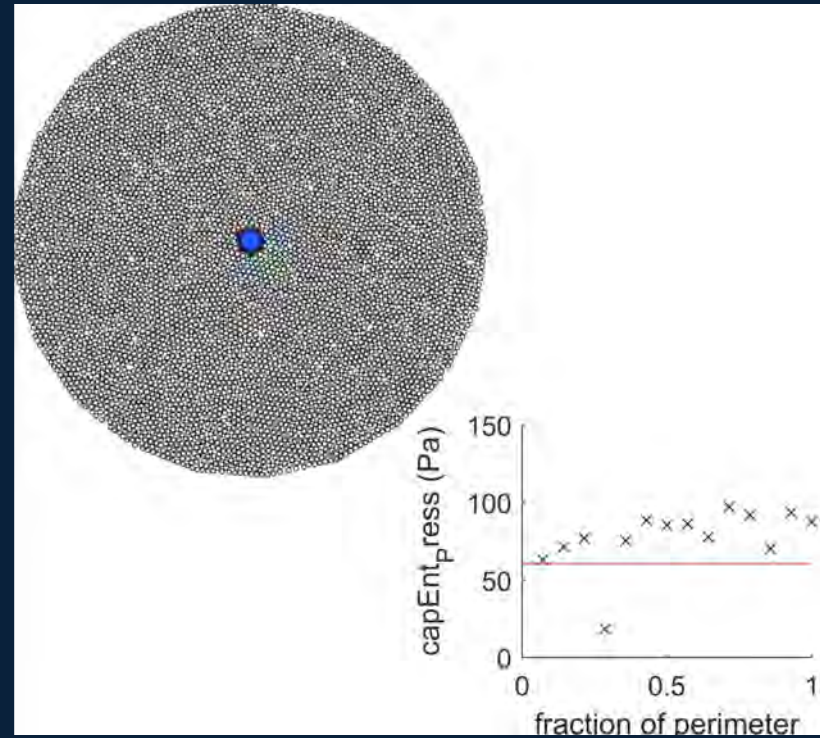
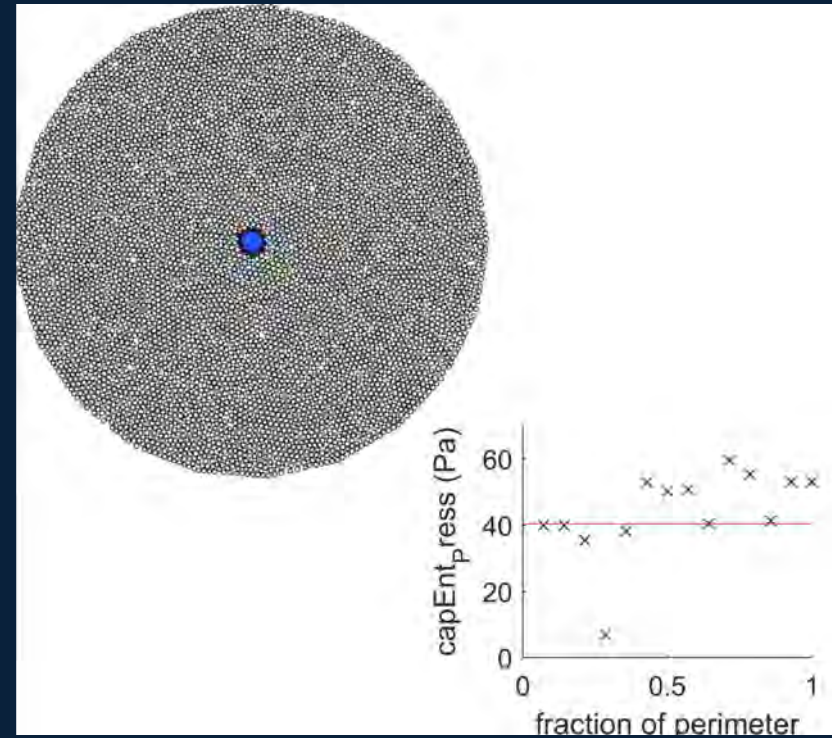


Videos: imbibition displacement ($\theta = 46^\circ$)

$\Theta = 65^\circ$

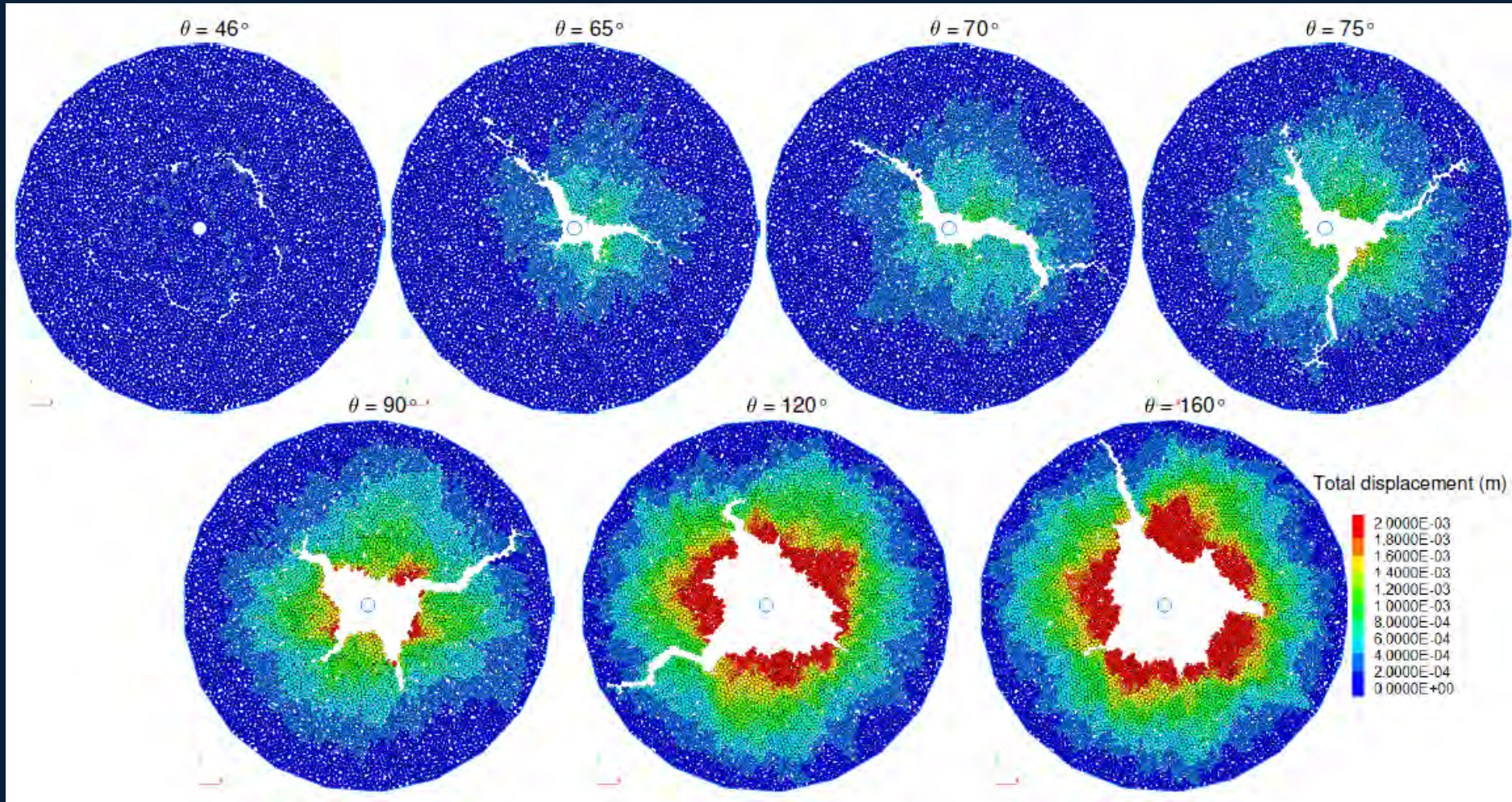
$\Theta = 75^\circ$

$\Theta = 120^\circ$



Videos: capillary entry pressure evolution

— $\Theta = 65^\circ, 75^\circ, 120^\circ$



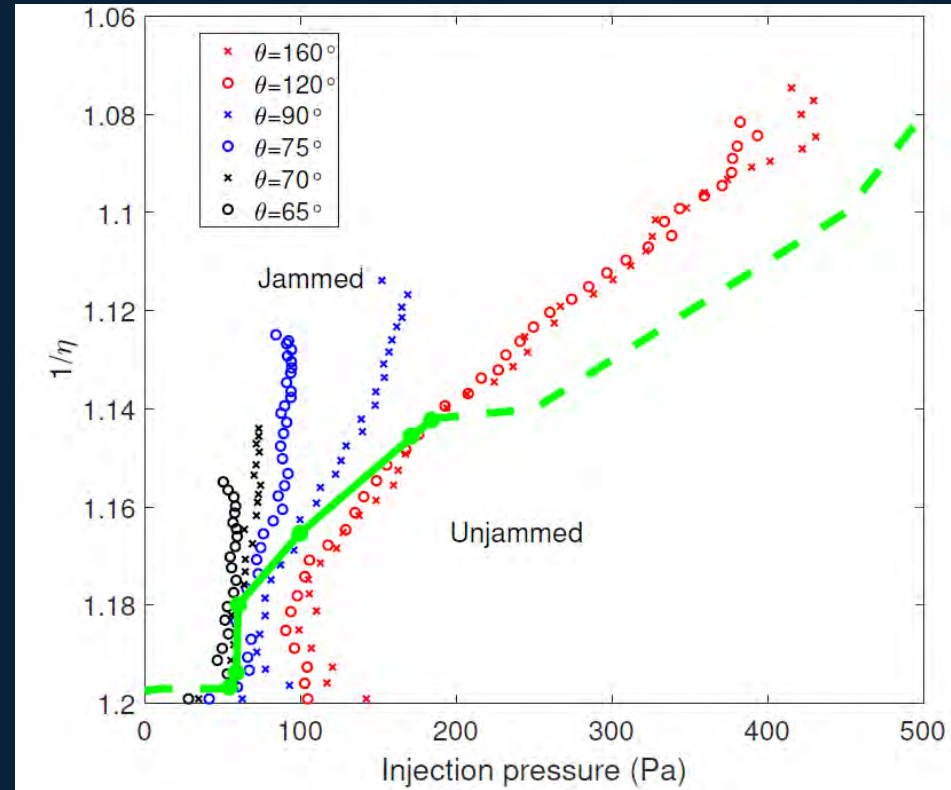
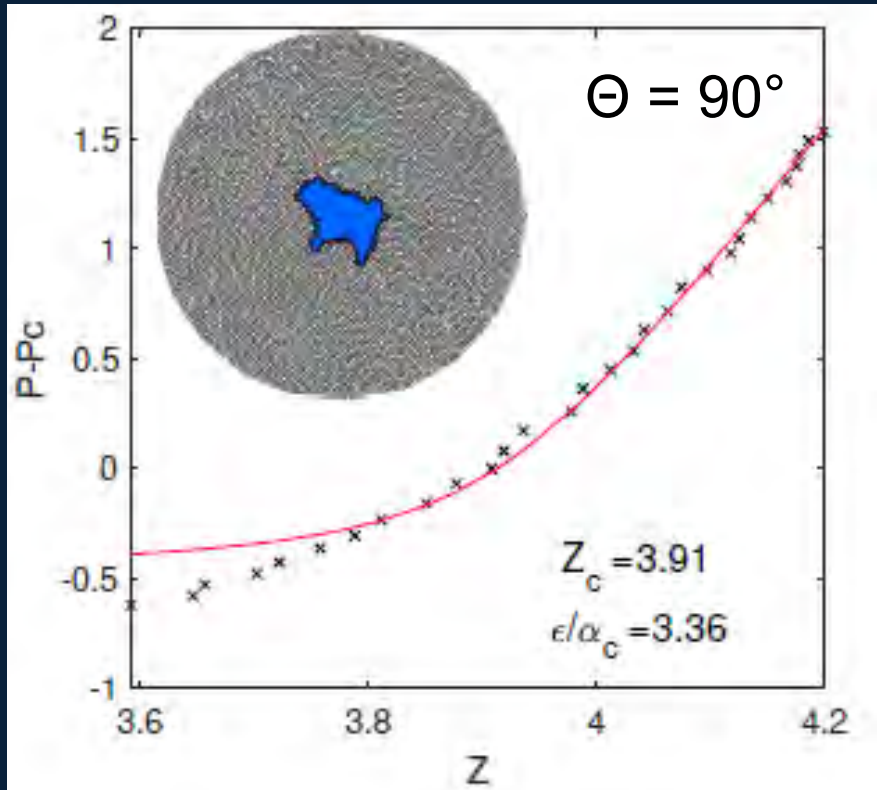
Phase diagram: total ball displacement field

TOTAL BALL DISPLACEMENT FIELD FROM IMBIBITION – NEUTRAL – DRAINAGE DISPLACEMENTS

$$\frac{P - P_c}{P_c} = u + \frac{(4u^2 + 1)^{1/2} - 1}{2}$$

Henkes, S., & Chakraborty, B. (2005) *PRL*.

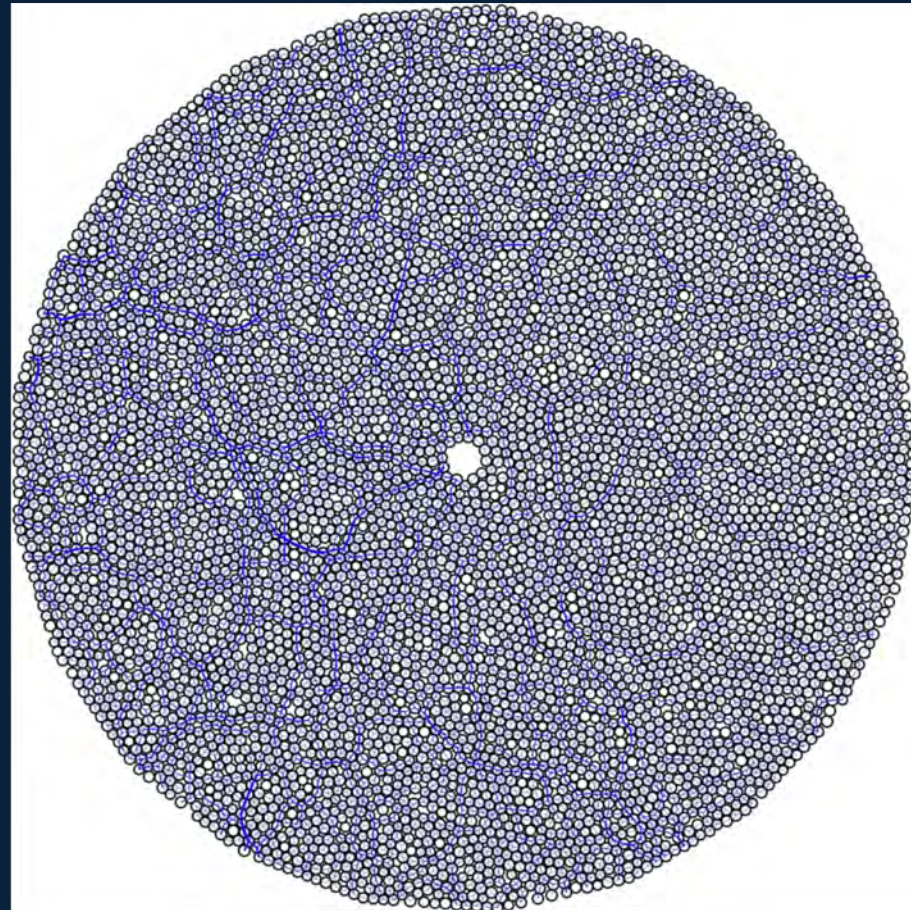
$$u = C(Z - Z_c) \quad C = \epsilon/\alpha_c \quad \text{Majmudar, et al. (2007), PRL.}$$



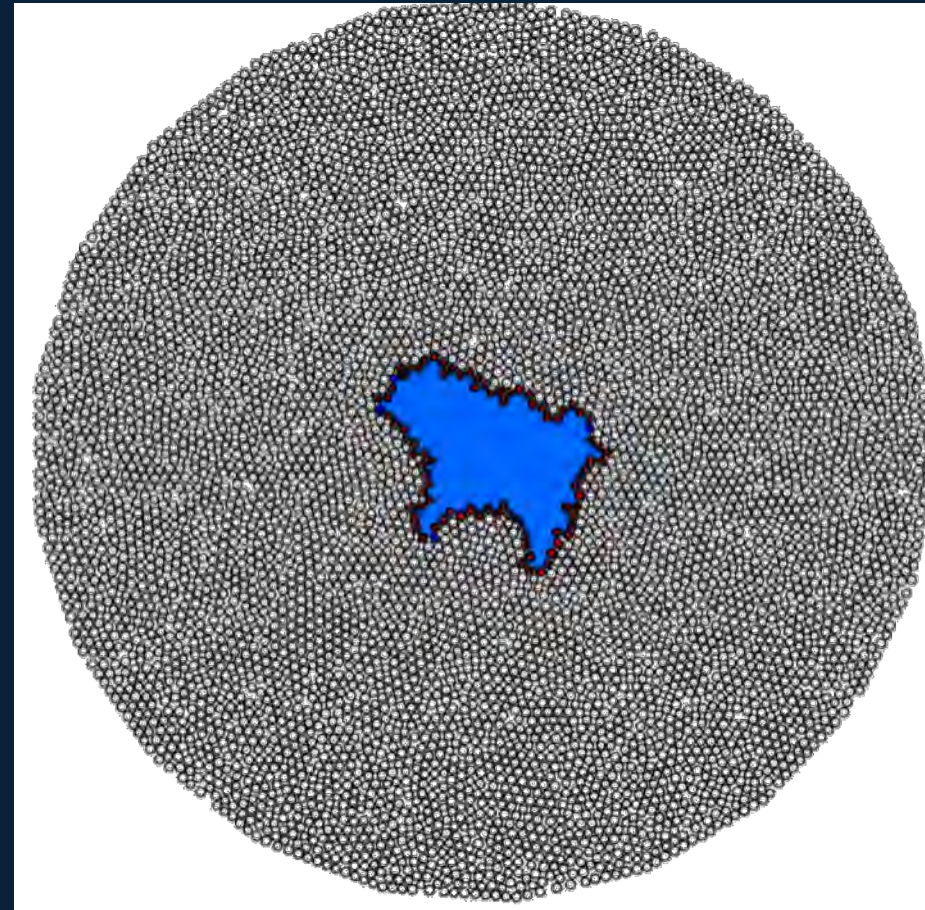
Jamming phase diagram

JAMMING TRANSITION & FRACTURE INITIATION MOMENTS

contact force network



interface morphology



Videos ($\Theta = 90^\circ$): force chain evolution

———— JAMMING TRANSITION – FORCE CHAIN “LOCK-UP” – FRACTURE INITIATION ($\Theta = 90^\circ$)

Conclusion

IMPACT OF WETTABILITY ON FRACTURING PATTERNS

- Three regimes during injection
 - *Pore invasion*
 - *Cavity expansion*
 - *Fracturing*
- Non-monotonic fracture patterns
- Wettability influences T_c
 - *Jamming transition*
 - *Fracturing initiation*
 - *Force chain "lock-up"*

