



12272

Hydrodynamic theory of wet particle systems:

Modeling, simulation & validation based on microscopic and macroscopic descriptions

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STW + DFG

msm

Project

History: 1st contact in 2007

Proposal 2011 – Accepted 2012 – started ...

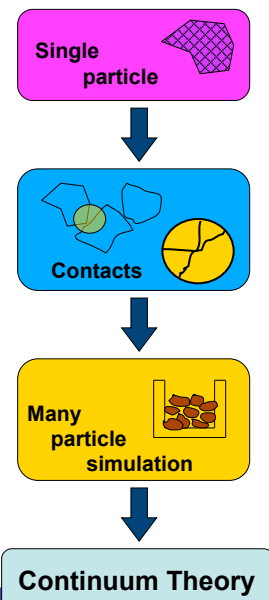
- Freiberg: Prof. R. Schwarze + Team
- Dortmund: Prof. S. Turek + Team
- Twente: Prof. S. Luding + Team

Goals ...

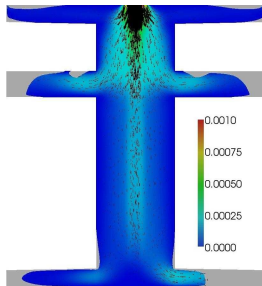
- hydrodynamic description
- wet particle systems
- constitutive relations (stress-strain)
- validation
- particle-based modeling
- ...

Why?

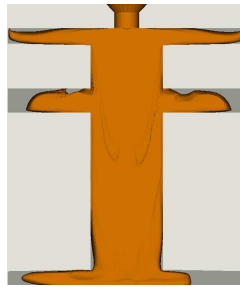
- Particle Methods (Micro-Details)
- Micro-Macro Transition
- Continuum Theory (Applications)



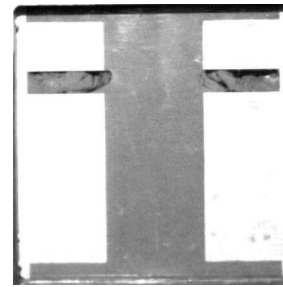
Topics ...



(a) granular flow



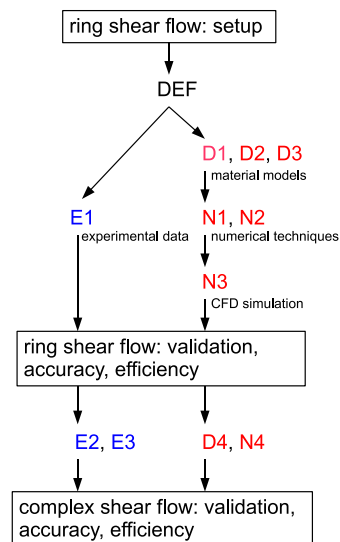
(b) final core (cfd)



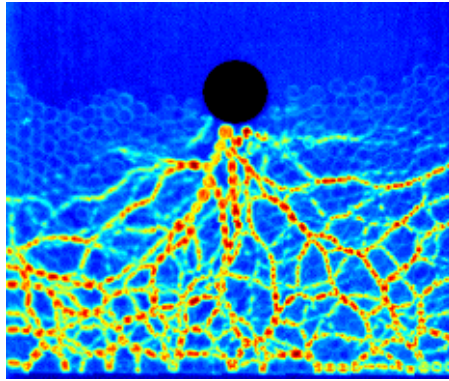
(c) final core (experiment)

Example: core shooting by R. Schwarze

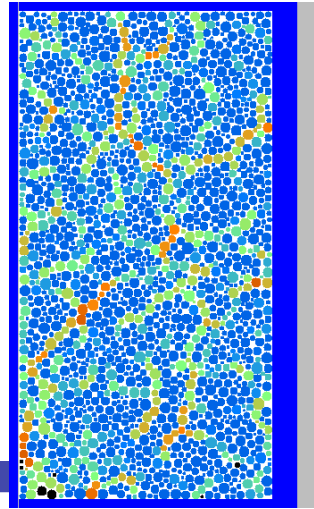
Plan ...



Force-chains experiments - simulations



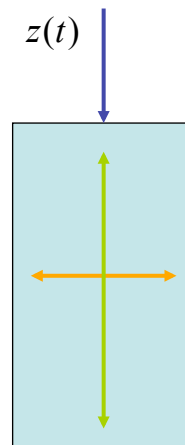
2D Exper. Behringer, Duke, USA



Biaxial box set-up

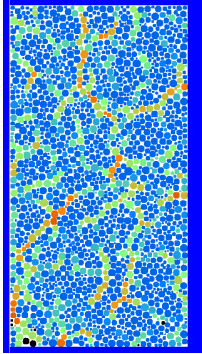
- Top wall: strain controlled
- Right wall: stress controlled

$$\sigma_{xx} = \text{const.} \rightarrow$$

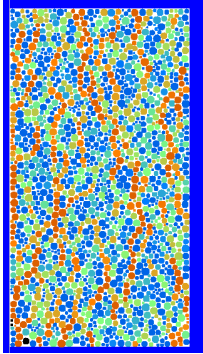


Simulation results (closer look)

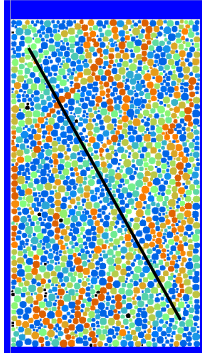
$\varepsilon_{zz}=0.0\%$



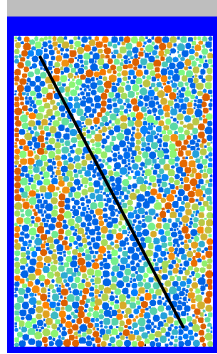
$\varepsilon_{zz}=1.1\%$



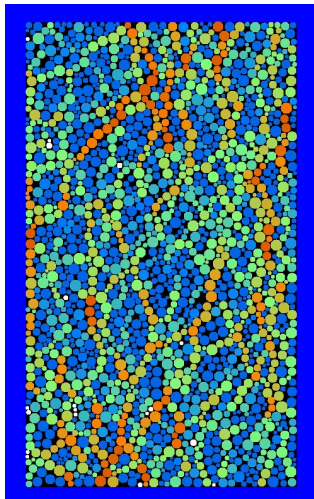
$\varepsilon_{zz}=4.2\%$



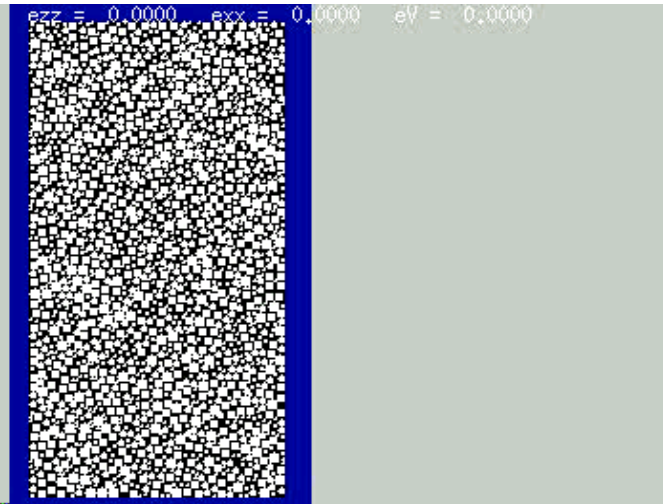
$\varepsilon_{zz}=9.1\%$



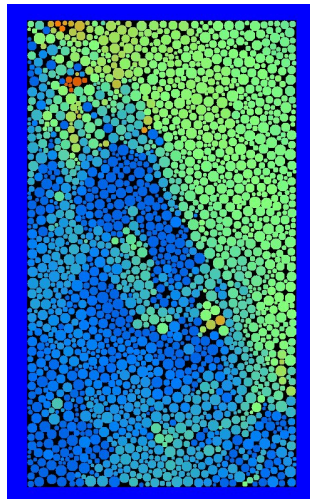
Bi-axial box (stress chains)



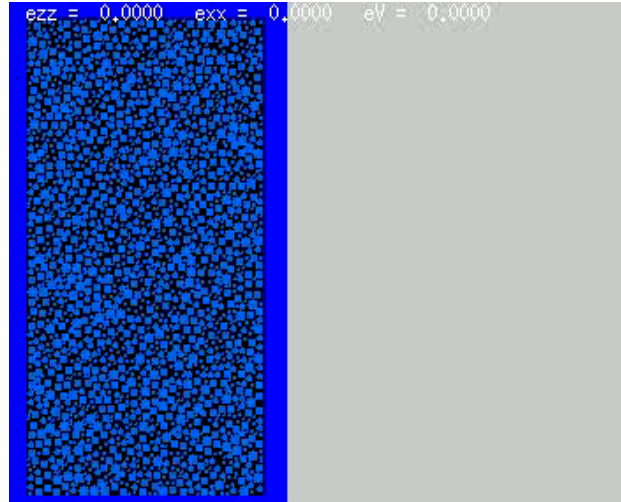
Bi-axial box (stress chains)



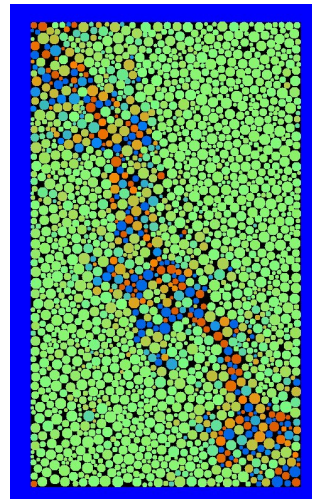
Bi-axial box (kinetic energy)



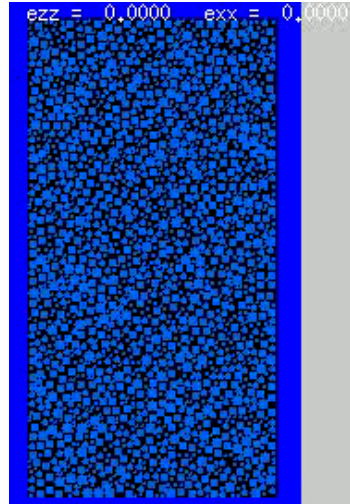
Bi-axial box (kinetic energy)



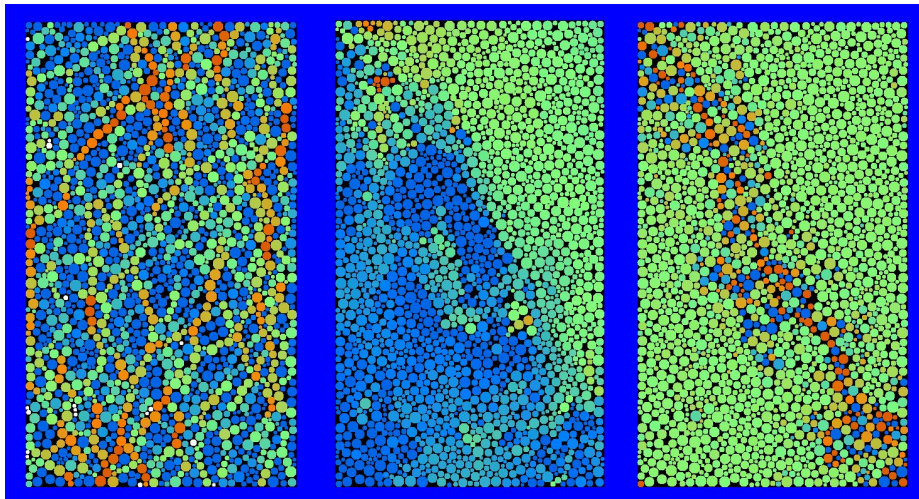
Bi-axial box (rotations)



Bi-axial box (rotations)



Multiple micro-mechanisms



inhomogeneity & anisotropy, instabilities & structures, rotations

Themes worked on?

- Particle Simulations vs. Continuum Models
- rheology, viscosity, stress measurements
- micro-macro transitions, ...
- experiments for validation, ...

Program:

13:30 - 13:45 "Introduction to Hydrodynamics of wet particle system ",
Stefan Luding, University of Twente, The Netherlands

Herma van Kranenburg, STW

13:45 - 13:55 " Simulation of wet granular materials in split bottom
shear cell ", *Sudeshna Roy*, University of Twente, The Netherlands

13:55 - 14:05 " MercuryDPM: Accomplished and future ",

Chris de Jong, University of Twente, The Netherlands

Short Coffee break

14:15 - 14:25 " DEM simulation of weakly wetted granular material ",
Anton Gladky, TU Bergakademie Freiberg, Germany

14:25 - 14:35 " Efficient FEM-multigrid solver for granular materials",
Saptarshi Mandal, TU Dortmund, Germany

(more) Coffee -> UC Meeting