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2007 FAIR

Dynamics of Granular Matter Under Localized Stress

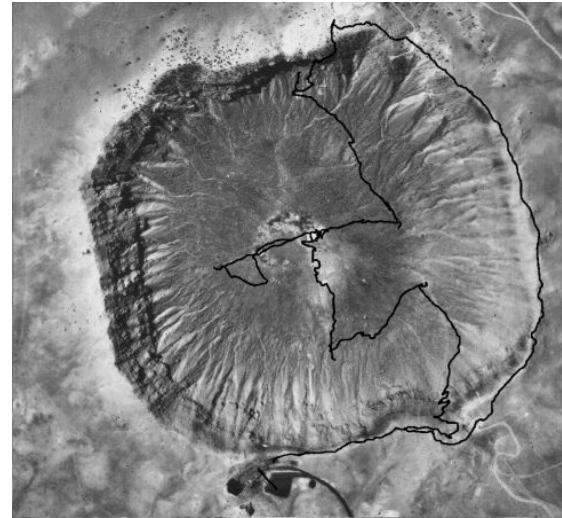
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Professor Corey O'Hern, Yale University

Thanks to Steven Slotterback, Krisztian Ronaszegi, Andrew Pomerance, and Don Martin for their assistance with this project.

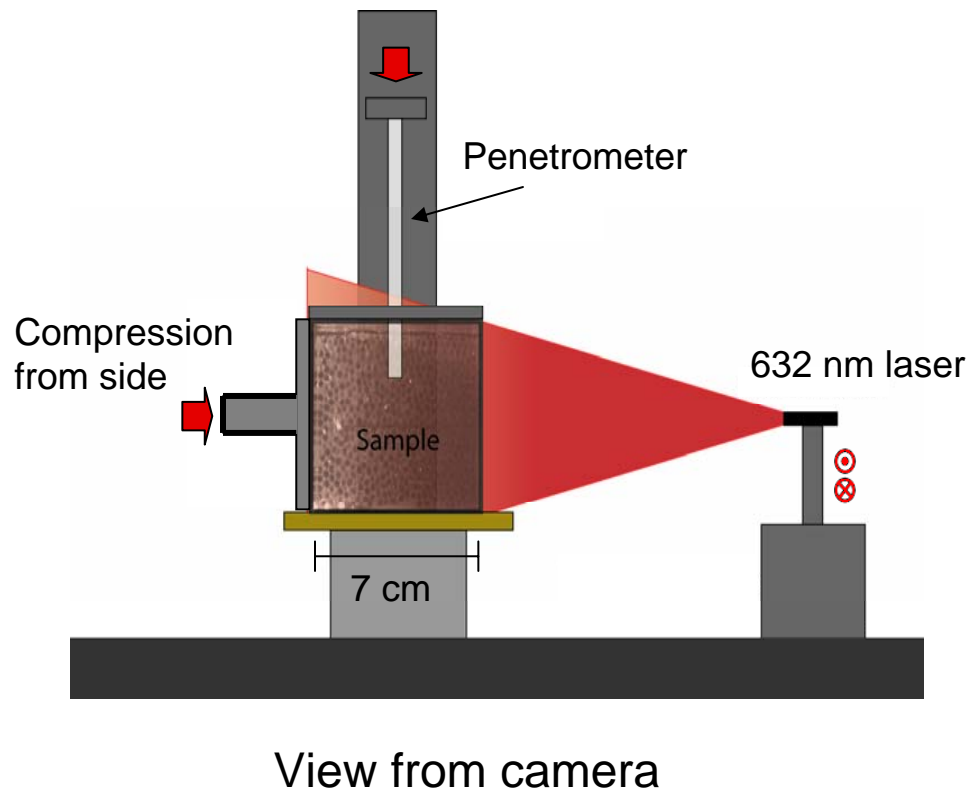
Background

- Granular material: Can act like a solid or a liquid but is not subject to thermal fluctuations

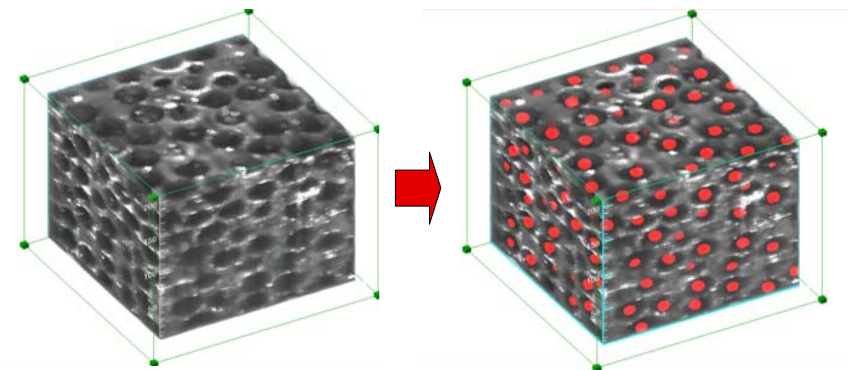


- Question: Does the granular failure region contain information about the initial conditions of the material?

Experimental Methods

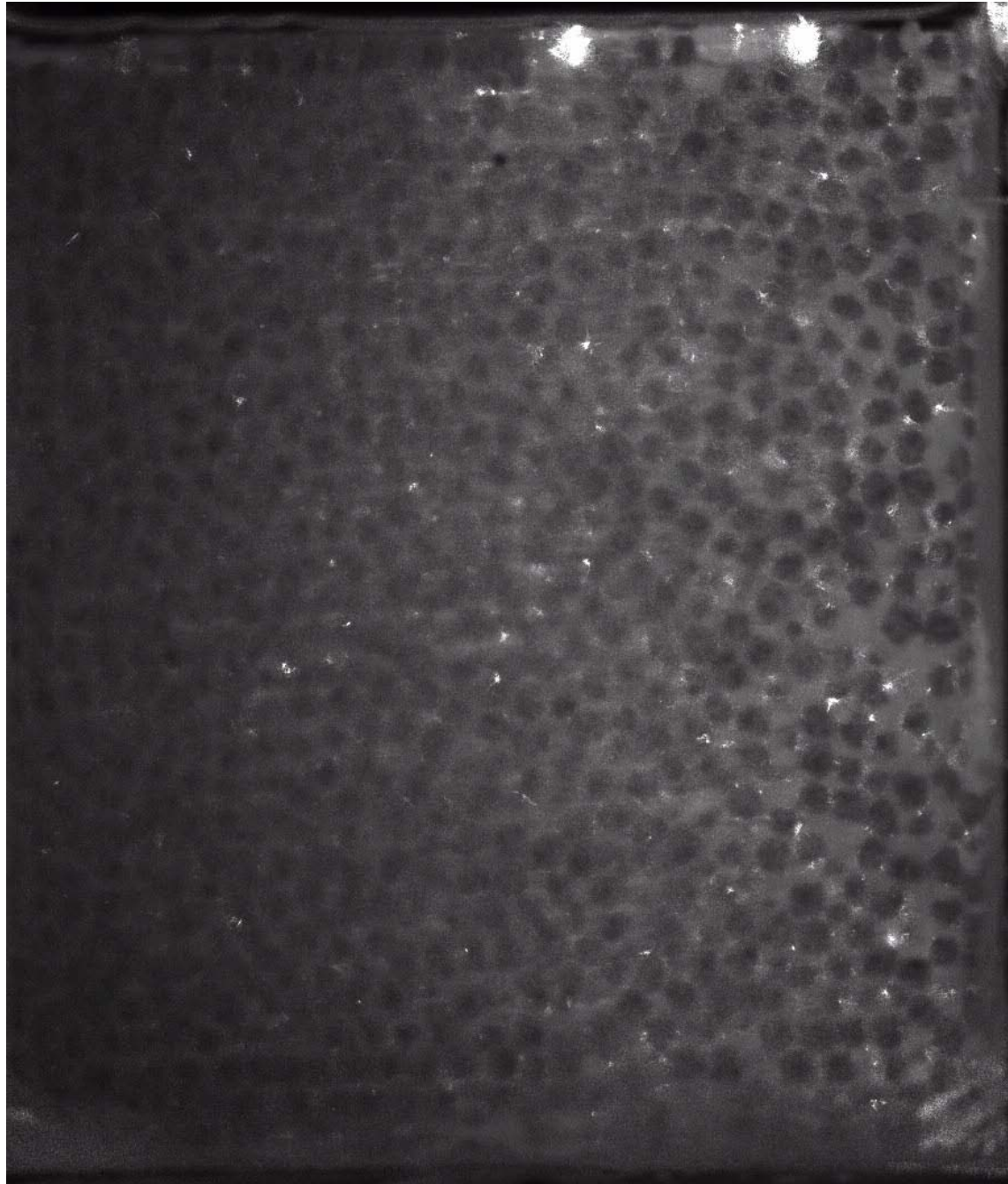


Particle extraction

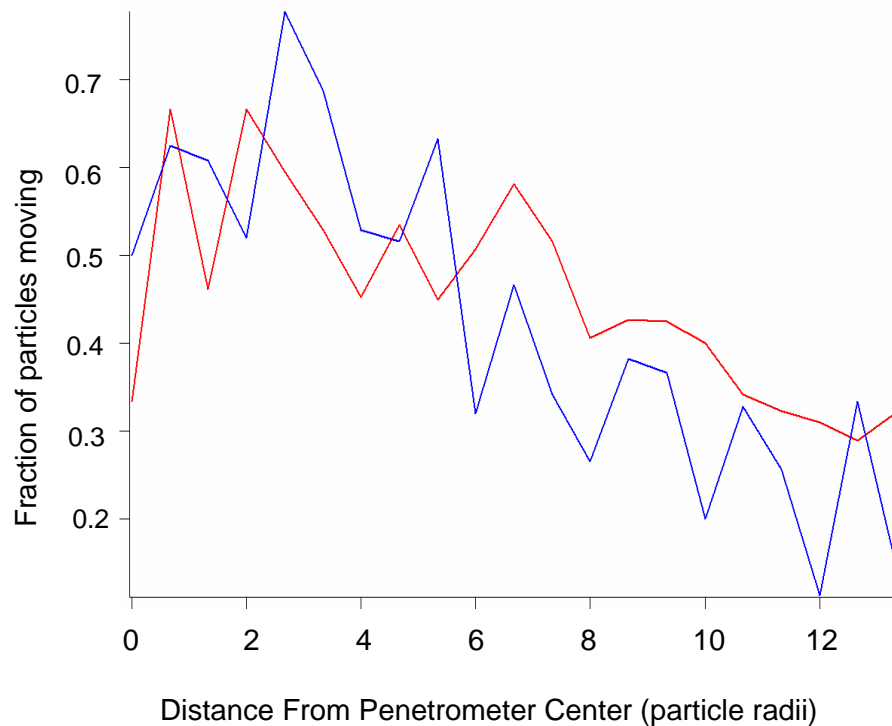


Section of original 3D image, approx. 2 cm on each side

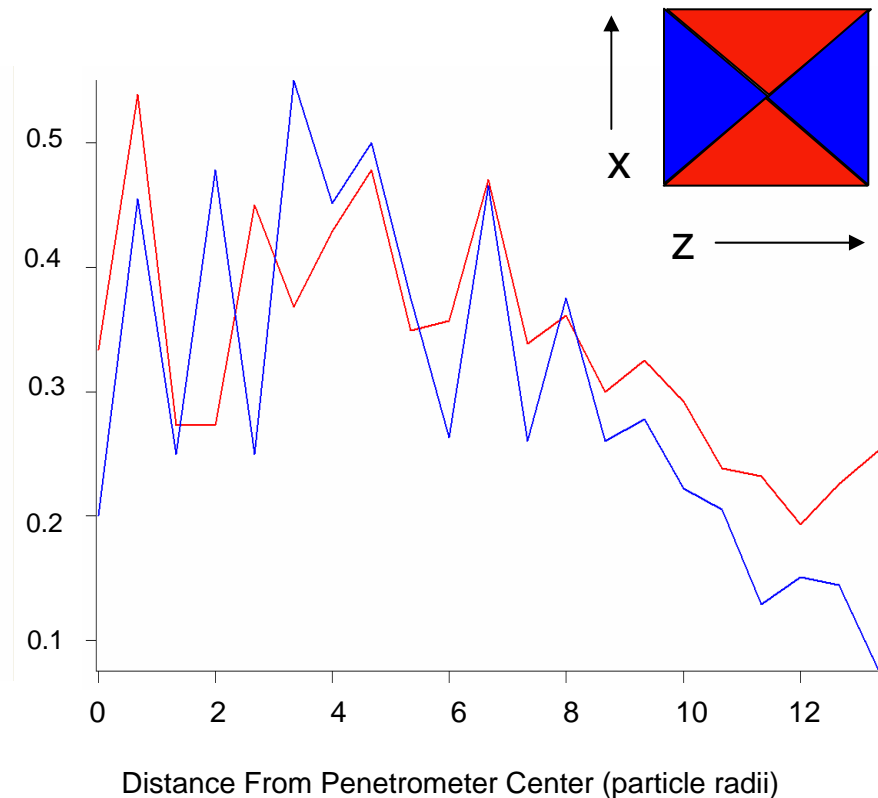
Extracted particle centers over original, roughly 300 particles



Result: Density Dependent Symmetric Deformation Field



Percentage of particles with detectible movement for a compressed sample as the penetrometer is inserted 2.3 cm.



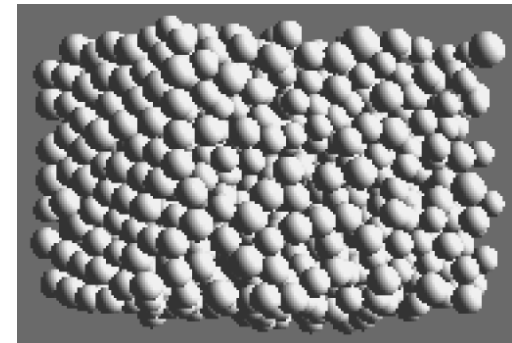
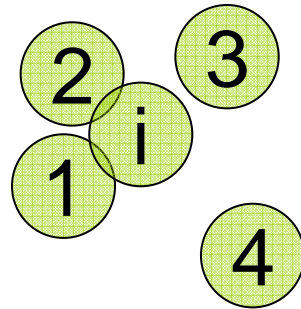
Percentage of particles with detectible movement for an uncompressed sample as the penetrometer is inserted 2.3 cm.

Can we predict individual particle motion?

- We use experimental data as starting conditions for MD simulation
- Radii and positions must first be adjusted slightly to account for experimental uncertainty

$$\mathbf{F}_i^{\text{tot}} = m_i \mathbf{g} + \sum_j \mathbf{F}_{n_{ij}} + \mathbf{F}_{t_{ij}}$$

$$\boldsymbol{\tau}_i^{\text{tot}} = -\frac{1}{2} \sum_j \mathbf{r}_{ij} \times \mathbf{F}_{t_{ij}}$$



Solve equations of motion subject to experimental boundary conditions

Section of sample after adjustment of radii and positions