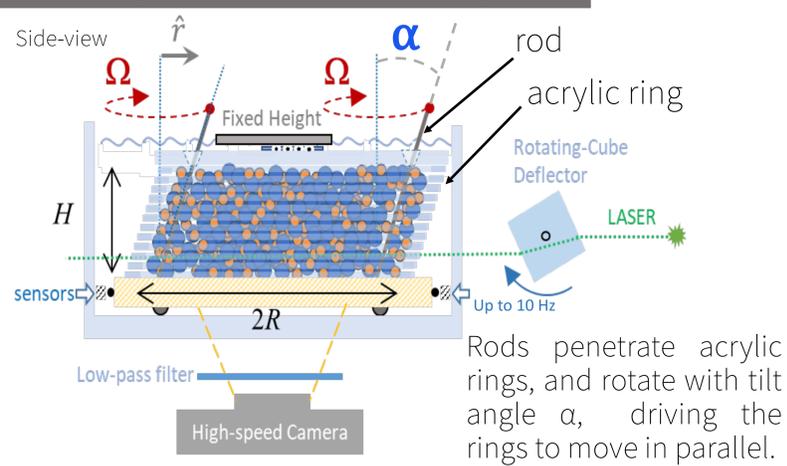


# "Caging effect" in granular flow under a circular shear

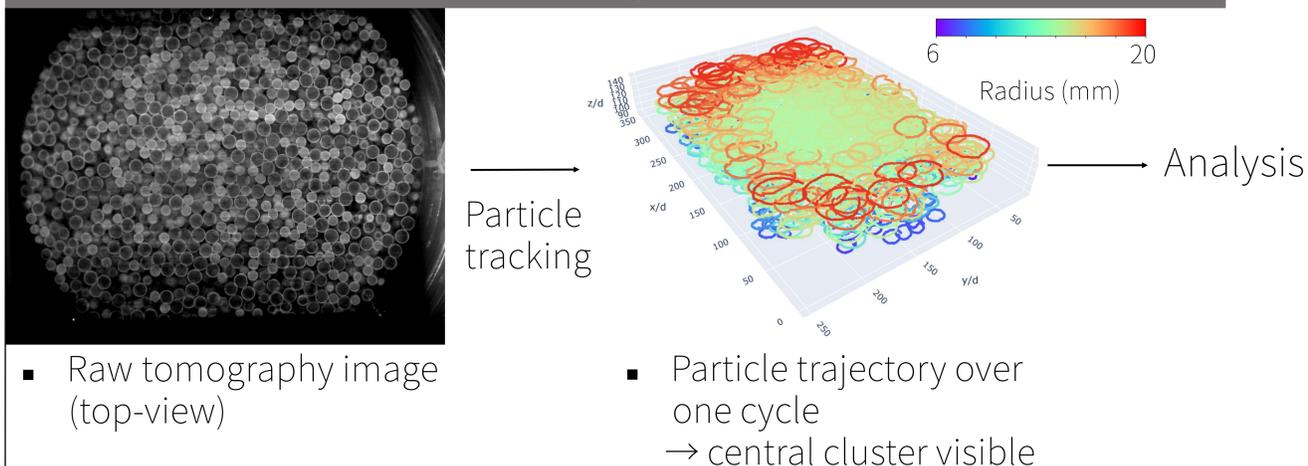
Intermediate clustering phenomenon in granular shear, influenced by two physical parameters.

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## Experiment setup



## Working Flow

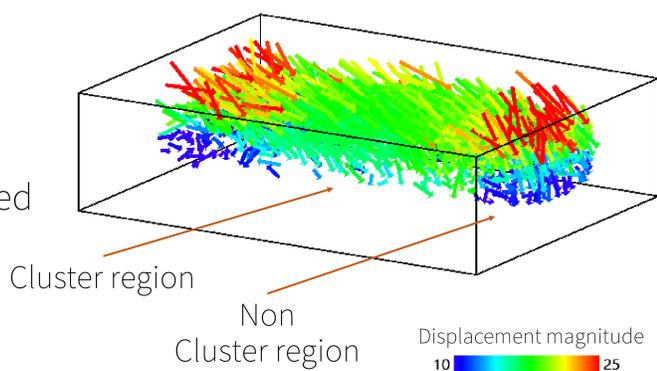


## Features

## Particle velocity distribution and non-affine displacement

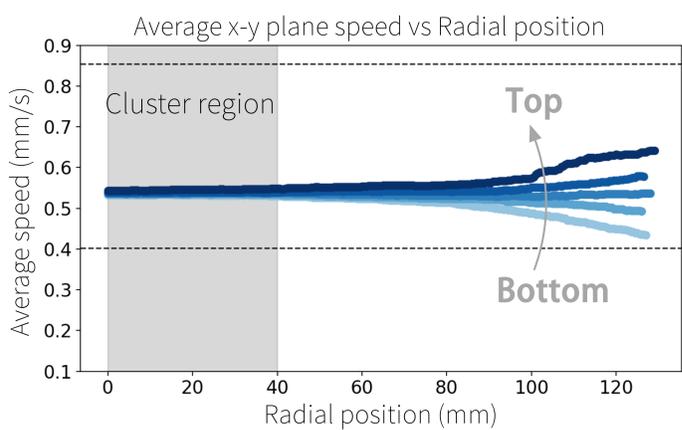
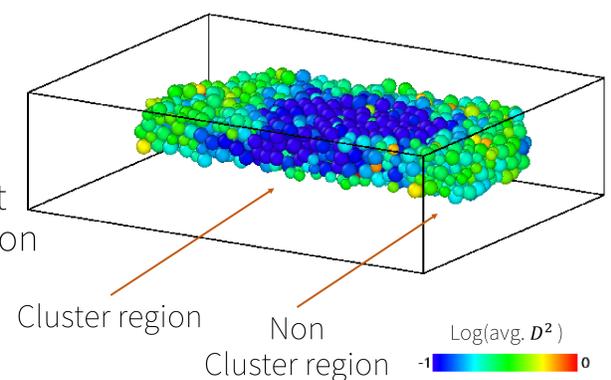
### Velocity distribution analysis

- Trajectory motivated speed analysis
- Sliding-window radial binning for statistics

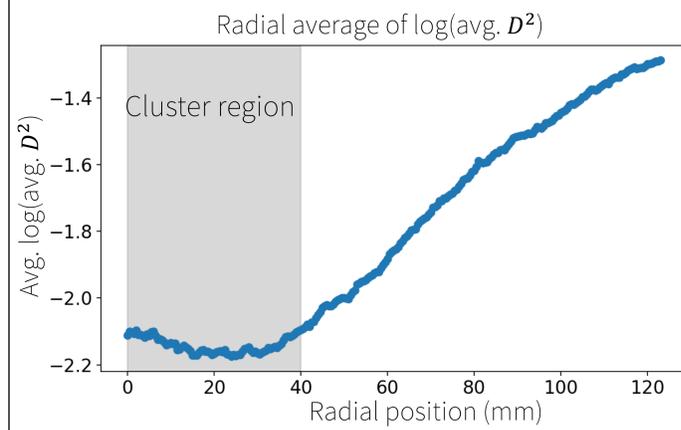


### Non-affine displacement analysis

- Plastic rearrangement of particle configuration →  $D^2$
- Commonly used in shear band analysis



- No speed gradient in central cluster  
 → Cluster particles are not subjected to shear flow from the boundary.

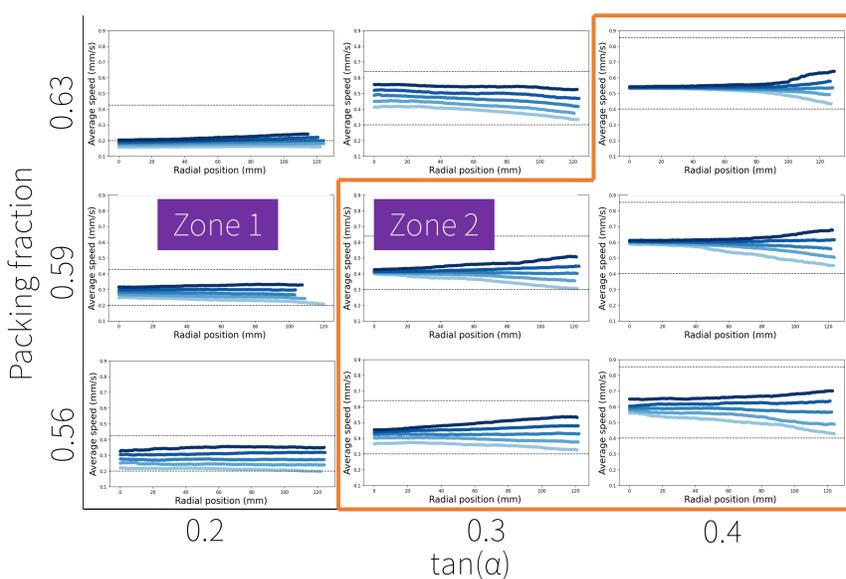


- Low  $D^2$  in central cluster  
 → Cluster particles seem to remain their configuration.

## Influencing Parameters

## Packing fraction & Shear strain

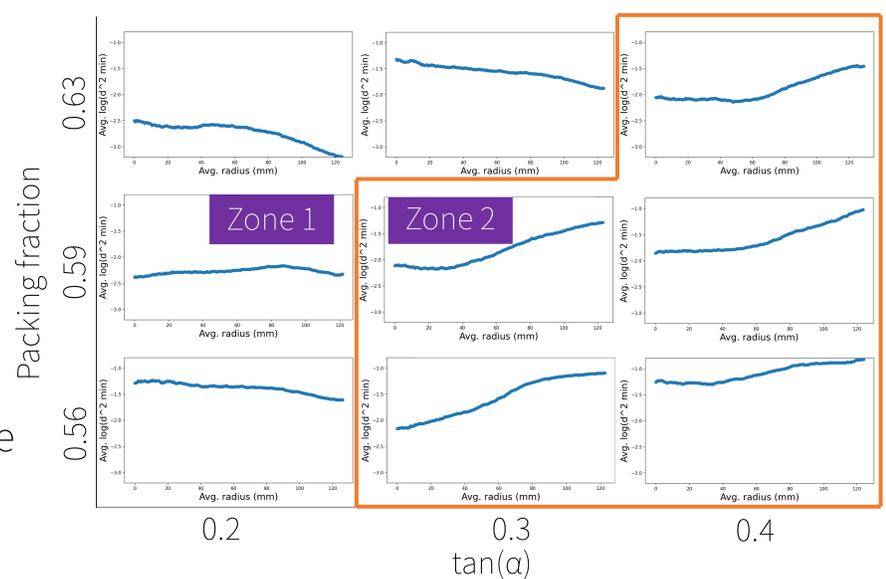
Results from the velocity distribution perspective



**Packing fraction:** degree of particle packing density.  
 **$\tan(\alpha)$ :** represents the magnitude of the maximum applied shear strain.

Emergence of cluster is sensitive to both physical parameters!

Results from the non-affine displacement perspective



## Conclusion

The cluster structure shows low non-affine displacement and vertical velocity gradient, resembling an "rigid body". Its emergence is associated with packing fraction and shear strain, offering a new direction for granular flow studies.