

# Vertical slow drag of an intruder in a laterally confined granular medium

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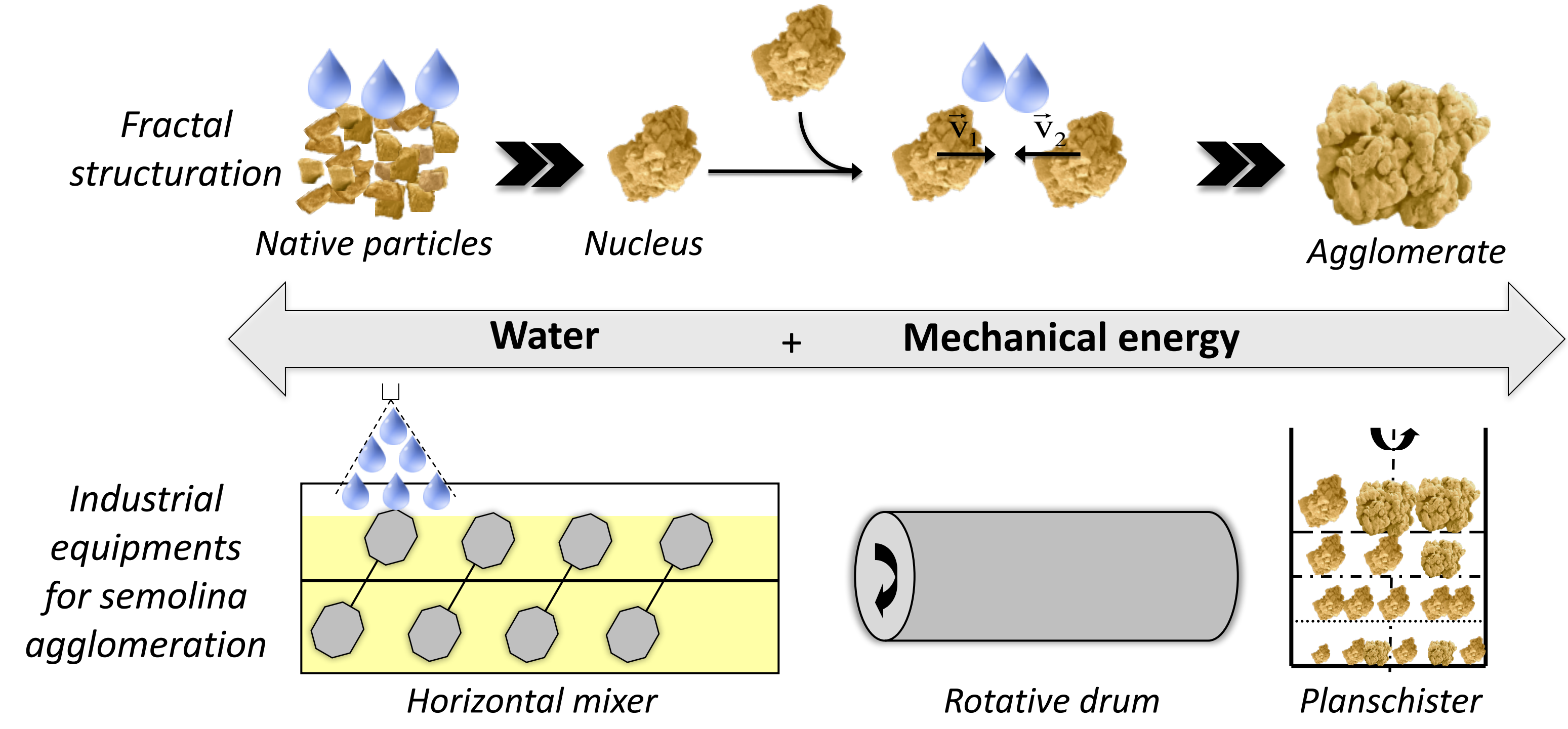
## ISSUES AND OBJECTIVES

During a wet agglomeration process inside a low shear mixer, the main blade function is to induce **mobility of grains** and **homogenization of the liquid** sprayed on the powder. In the case of semolina agglomeration, for couscous manufacture, a better control of this process would help in increasing the **agglomeration yield**.

Concerning the mechanical energy input, the motion of the blade disturbs **the initial static force profile** of the powder bed.

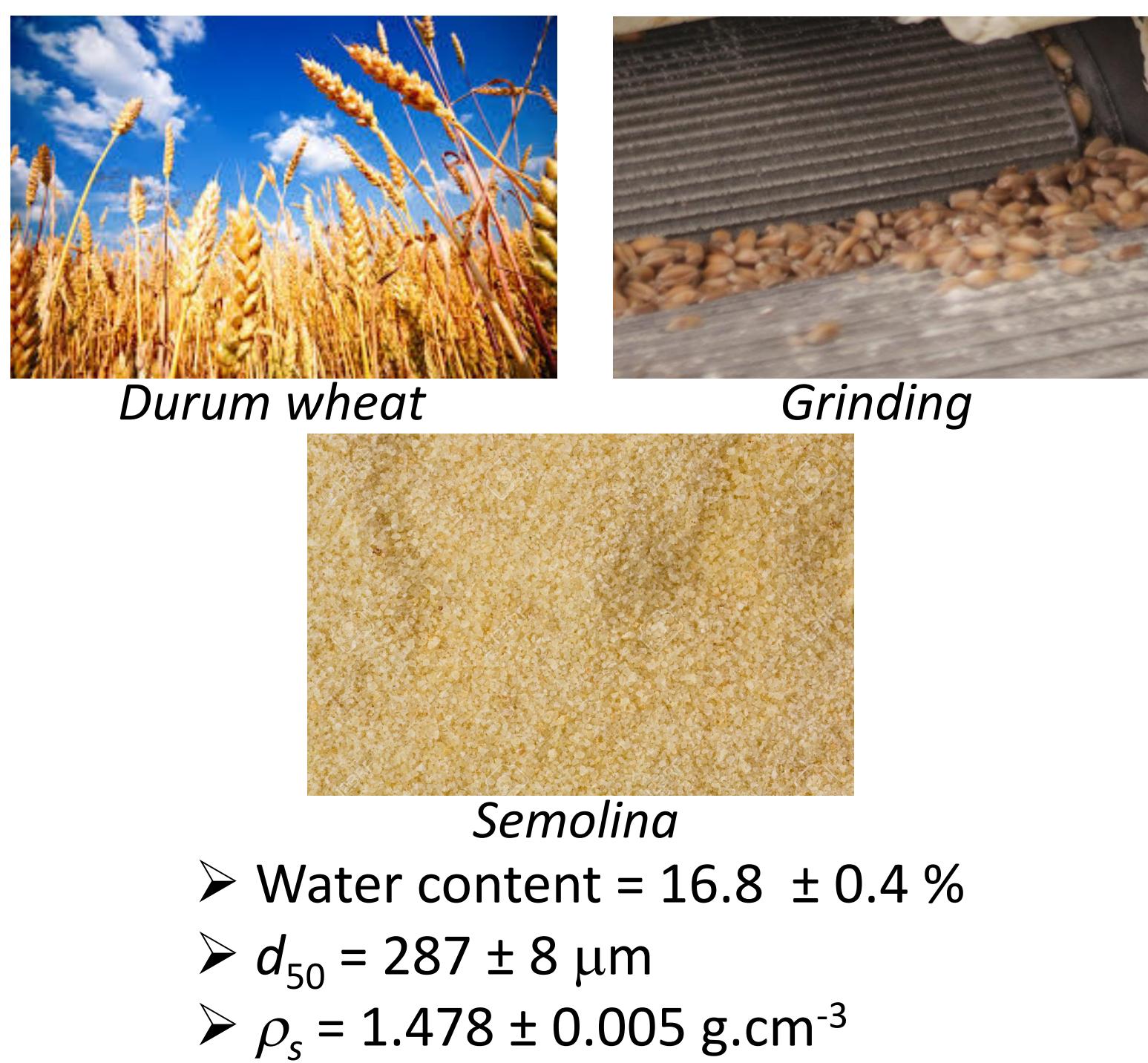
- How this initial mechanical state is disturbed by the blade motion?
- What is the blade influence on particle mobilities?

**Challenge: To achieve a better understanding of the contribution of the mechanical input on the granular flow**

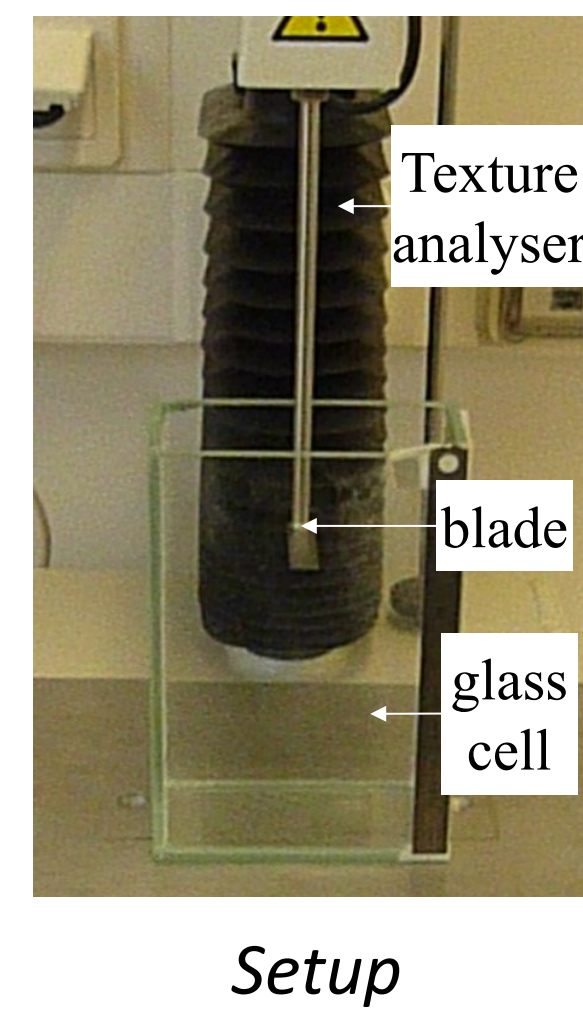


## MATERIALS AND METHODS

### Durum wheat semolina

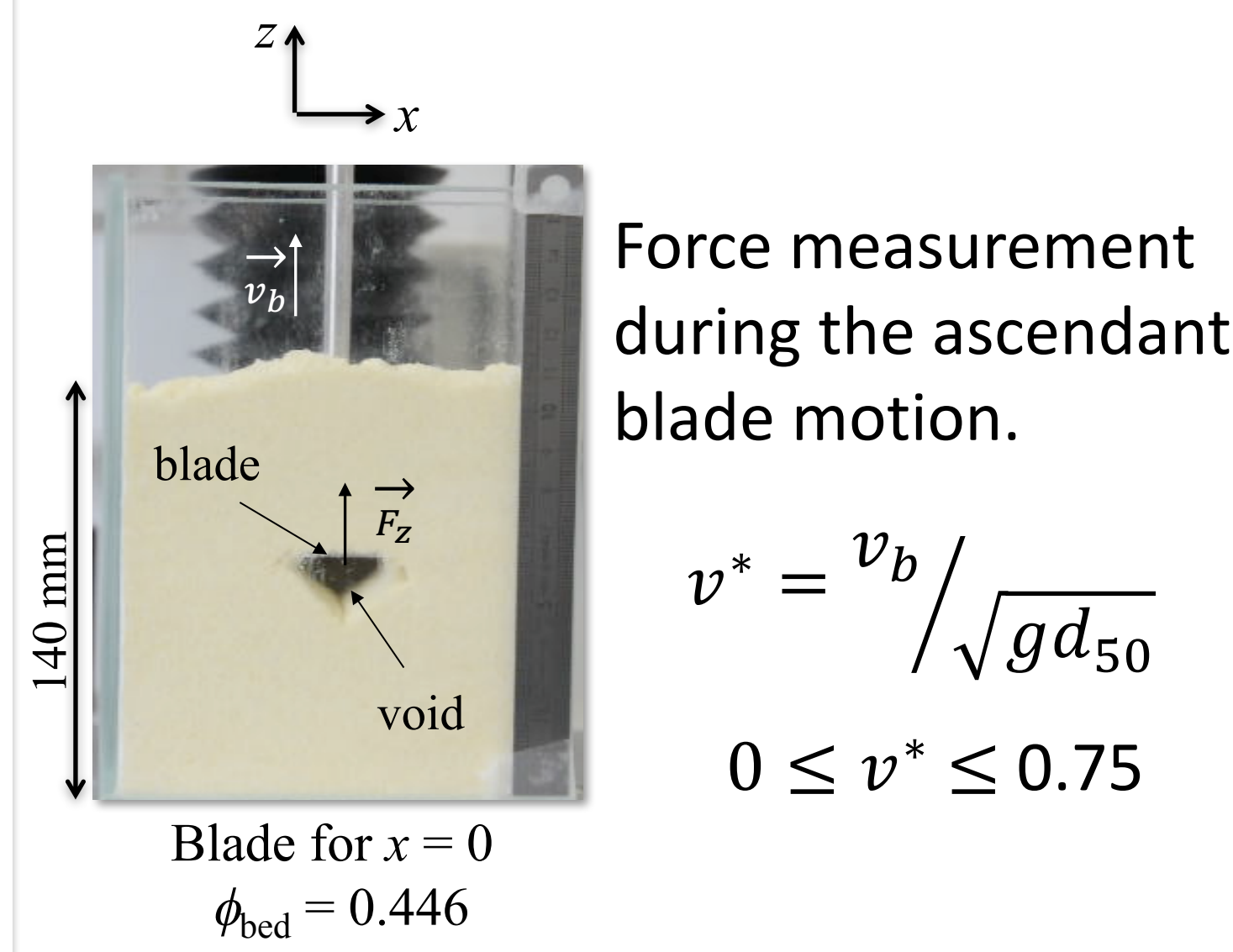


Development of an experimental mixing cell associated with an **unidirectional flat blade**, linked to a texture analyzer.

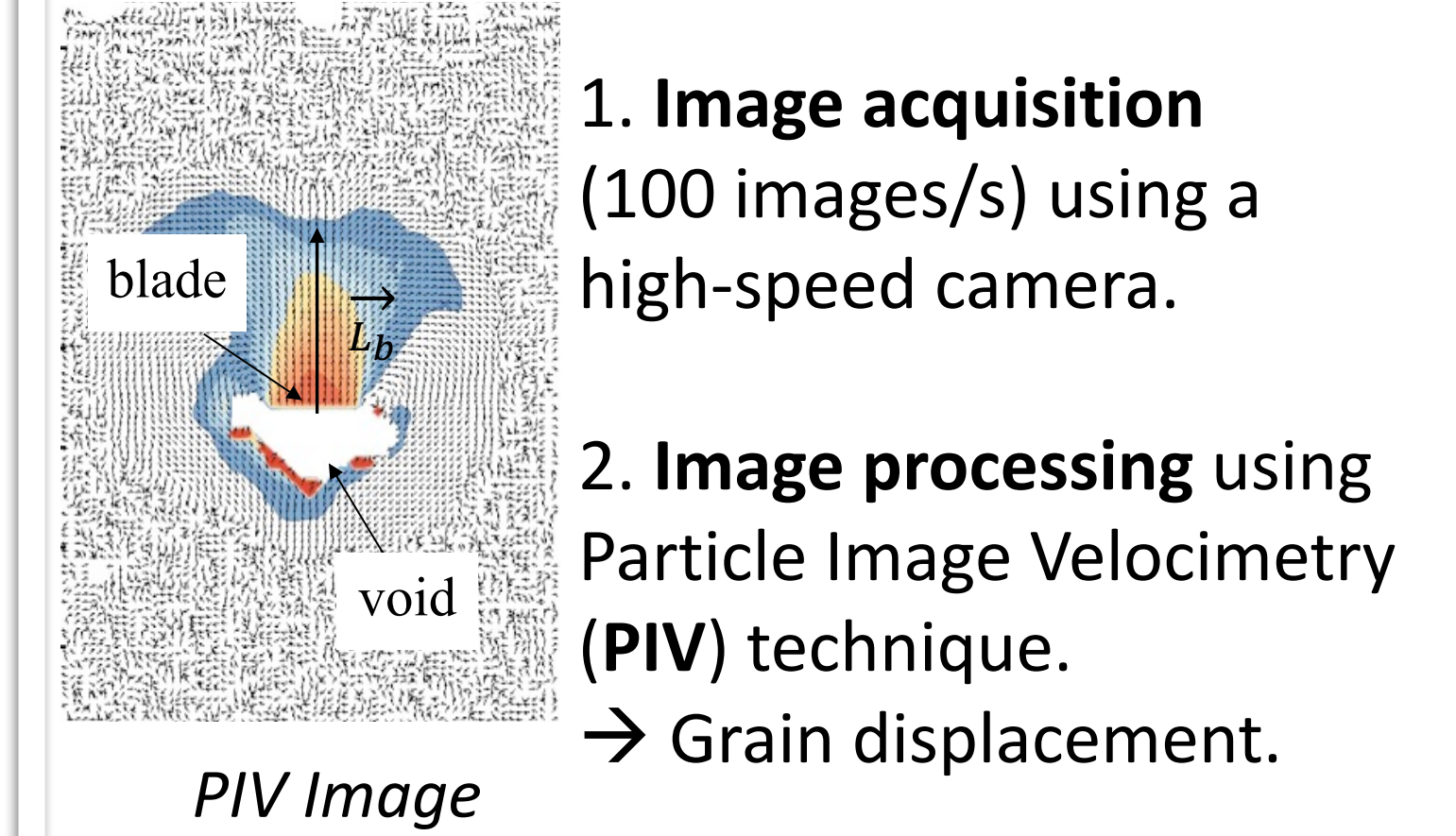


### Original rheophysical device

#### Vertical force

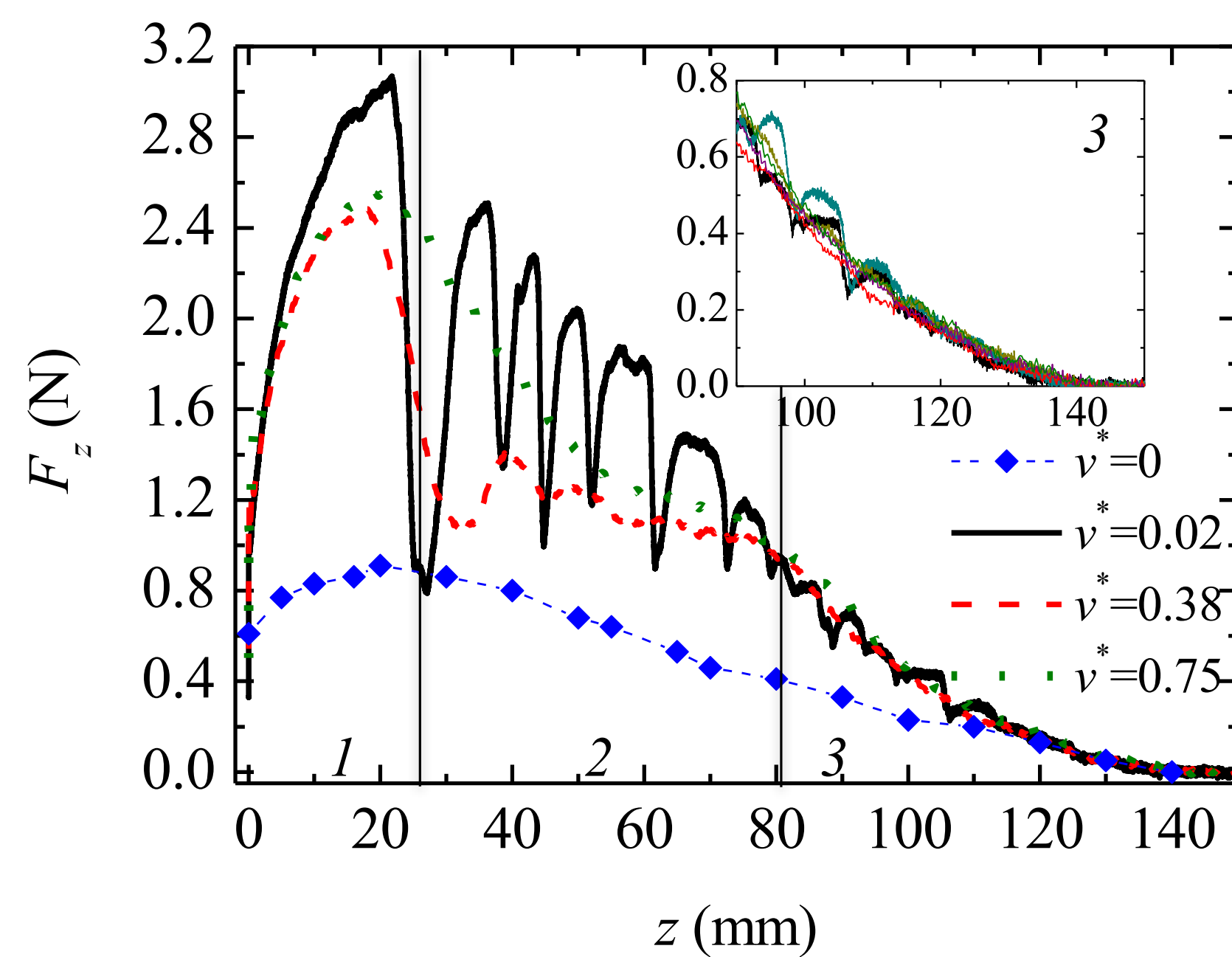


#### Vertical grain displacement



## RESULTS

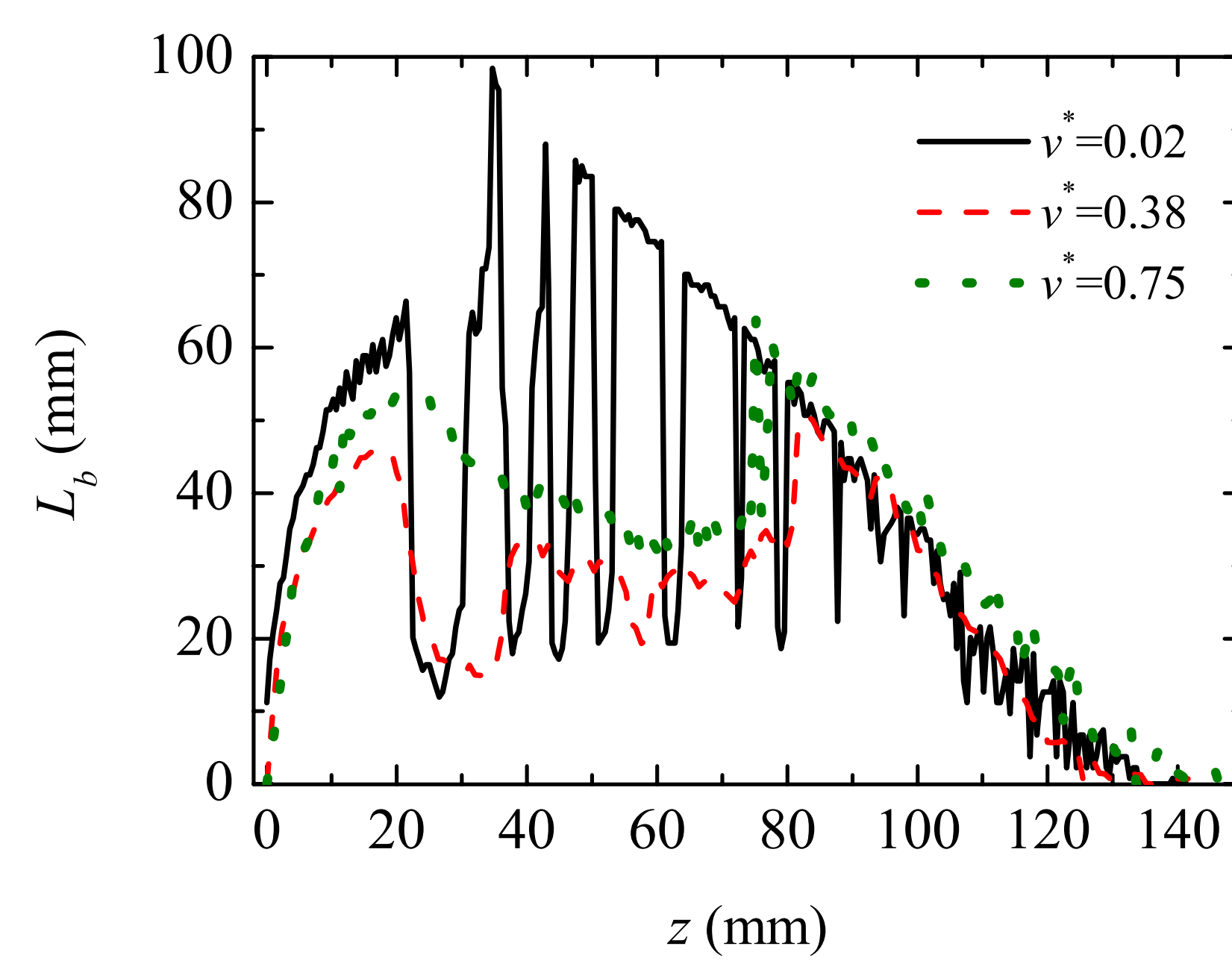
### Vertical force



#### 3 – Relaxation phase

**Progressive decrease of the force** until to reach zero value.  
**Lack of the global stiffness** of the granular medium and **decrease of the mass weighing on the blade**.

### Vertical grain displacement



- The **vertical grain displacement** is limited by the phenomenon of **vault rupture** → 'shear-banding' effect.
- A **dihedral-shape assembly of grains** constitutes a **permanent disturbance zone** induced by the blade motion ⇒  $L_b \neq 0$ .

#### 1- Loading phase

**Sharp increase of the force** until a first maximum ( $F_{\max-z_1} = 2.59 \pm 0.26$  N and  $z_1 = 18.68 \pm 2.41$  mm).

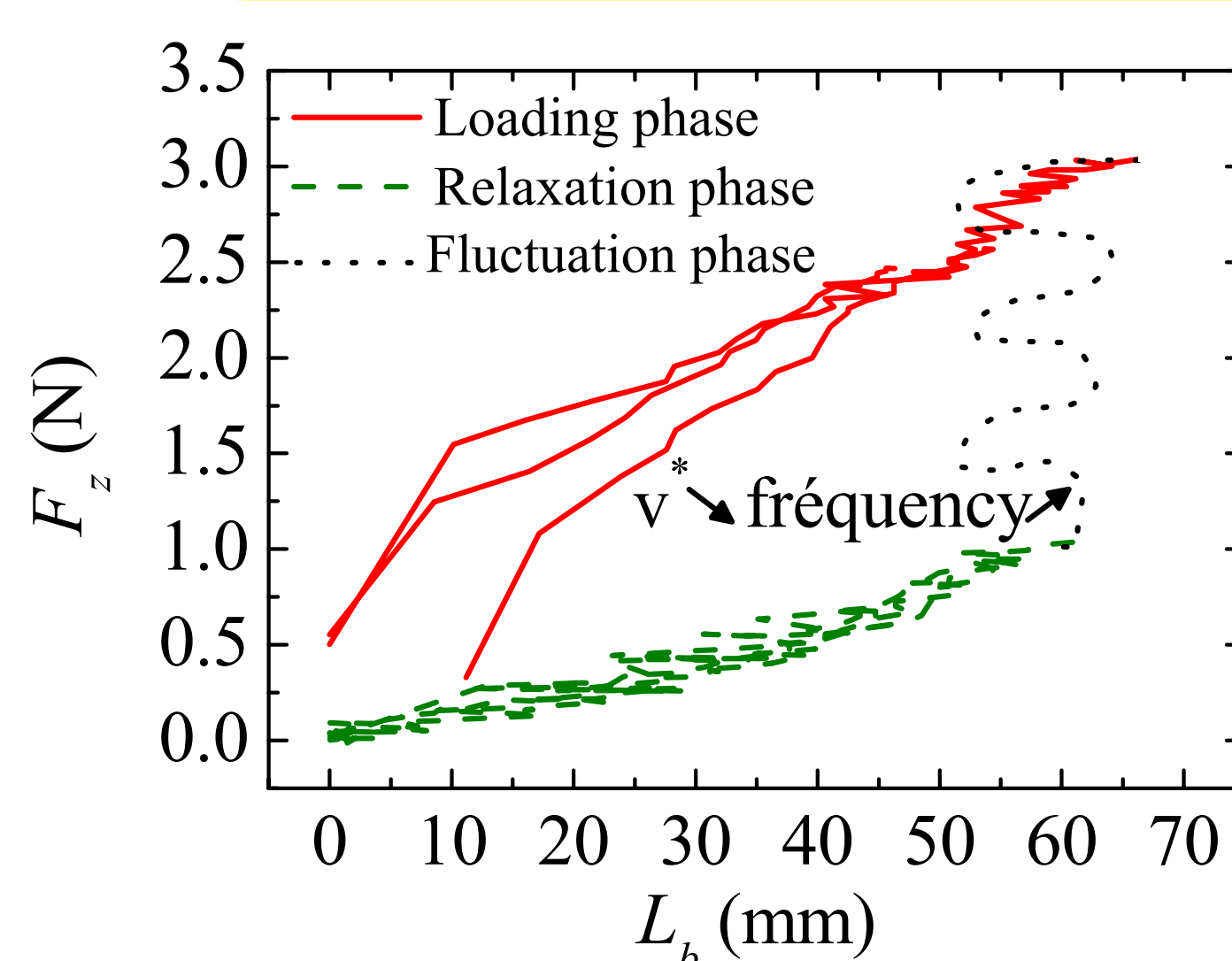
**Void volume creation** below the blade due to the **compaction of the particles** just above the blade.

#### 2 – Fluctuation phase

**Succession phases of loading, compaction, breakage, and relaxation** of the force network mobilized by the transmission of the shear stress.

→ The fluctuations decrease with  $v^*$ .

### Rheological behaviour: vertical force / vertical grain displacement



- **Correlation** between the **vertical force** and the **vertical grain displacement** with a **small phase shift**.
- **Loading** and **relaxation phases** are **independent of  $v^*$** .
- **Fluctuation phase** is **dependent of  $v^*$**  and it is amplified by slow solicitation.

## CONCLUSIONS AND PERSPECTIVES

- ✓ Better understanding of the **granular flow in the neighbourhood of an intruder** vertically moving in a laterally confined granular bed with a free-surface.
- ✓ The coupled analysis of force and PIV images seems to be a good approach for the establishment of **criterion for the design of new mixers**.
- ✓ A **new set-up** is being built to achieve **higher  $v^*$** .
- ✓ **PIV analysis** has to be continued (spatio-temporal correlations of images) in order to identify **characteristic lengths and times**.

