

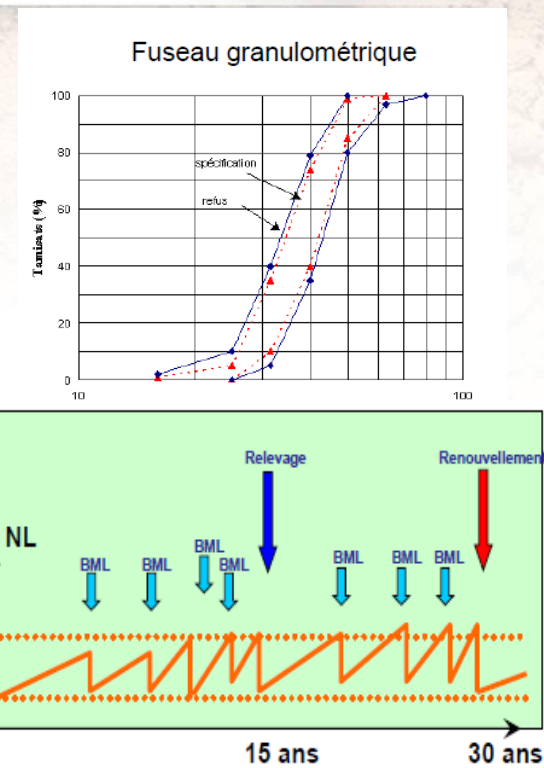
# **Field Ballast Granulometry assessment thanks to image analysis**

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# Context

## Ballast Characterization:

- PSD specification for new lanes  
(EN 13450) – Lab Sieving
- During life service:
  - Maintenance effort increase
  - Field sampling + lab test
  - Indirect assessment (Age, geometry measures)
- New issues:
  - Improve track degradation evaluation
  - Renewal decision need for field testing
  - Ballast volume estimation for re-use
  - More efficient method to assess ballast state



# Context

## Goals of our work:

- Provide site characterization tool (light, cost effective, not train-based)
- Develop image analysis tools for ballast characterization:
  - ❑ PSD of Sound ballast
  - ❑ PSD of fouled ballast
  - ❑ 12% fouling threshold

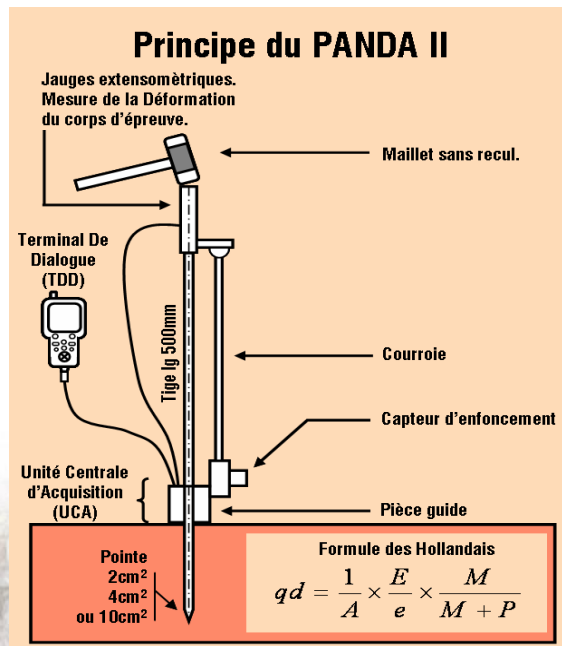
# Field Methodology

## • Panda/Geondoscopy coupling

### PANDA ® Penetrometer

**Goal:** Mechanical Characterization

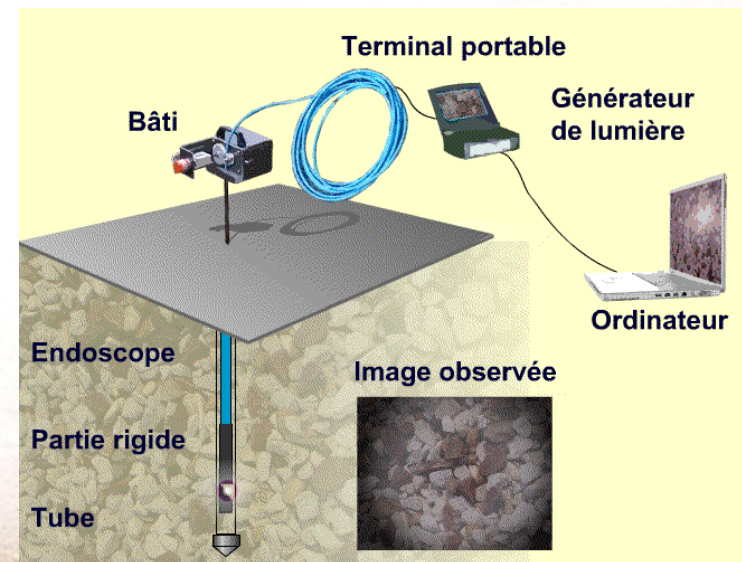
**Principle:** Drive a rod train equipped with a cone .



### Geoendoscopy

**Goal:** Material Identification

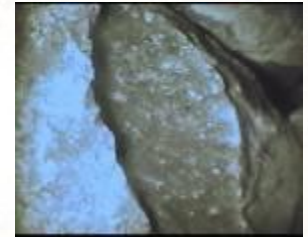
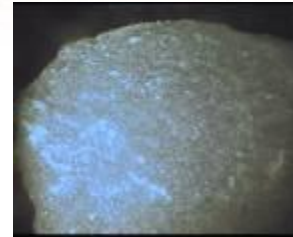
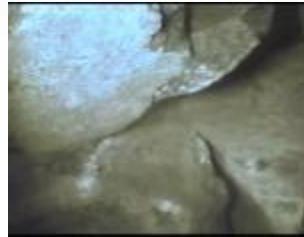
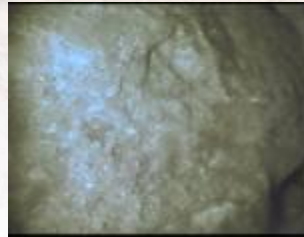
**Principle:** Capture images in small diameter boreholes.



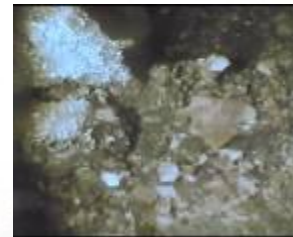
# Layer identification



Clean  
ballast



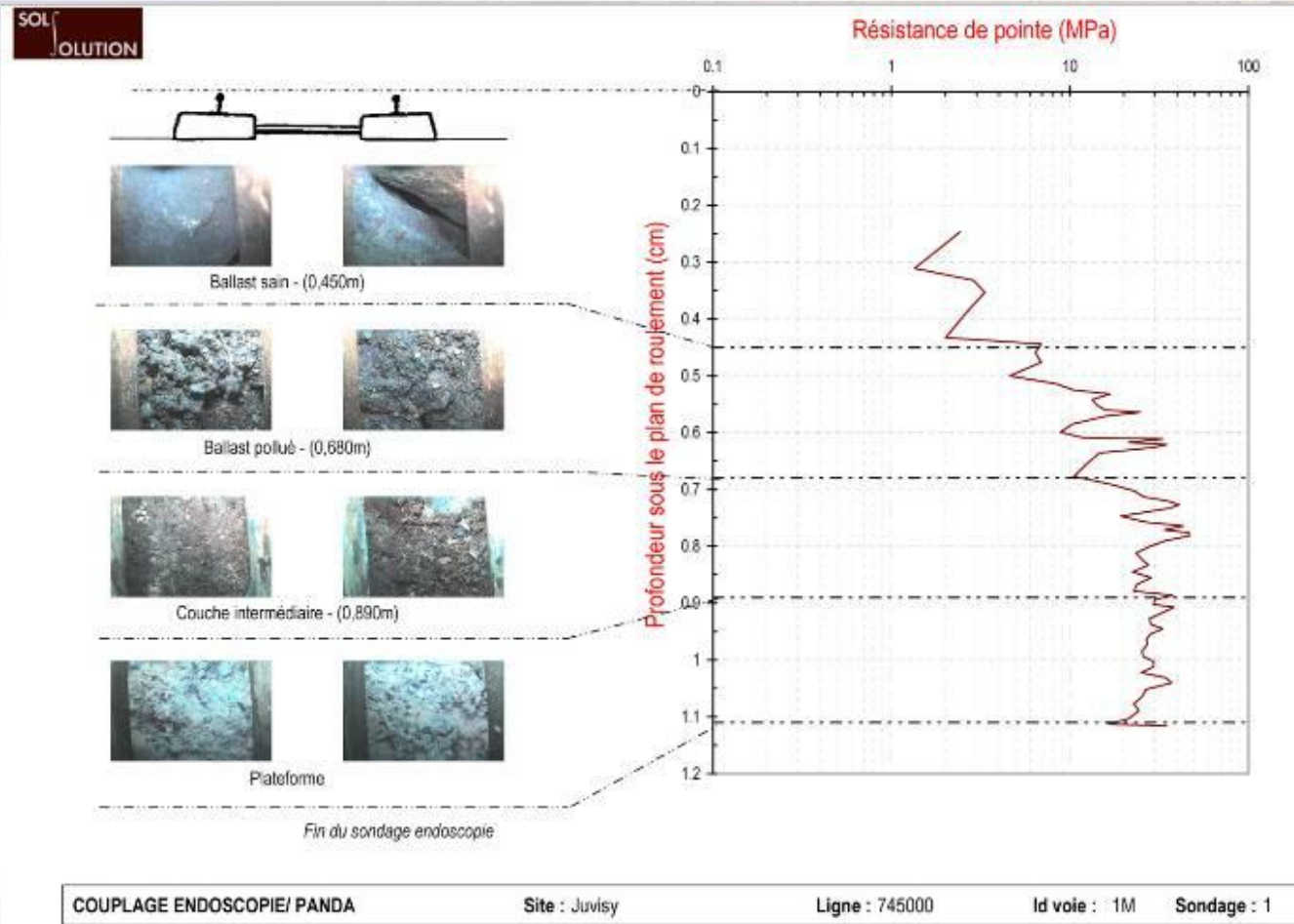
Fouled  
ballast



Subgrade



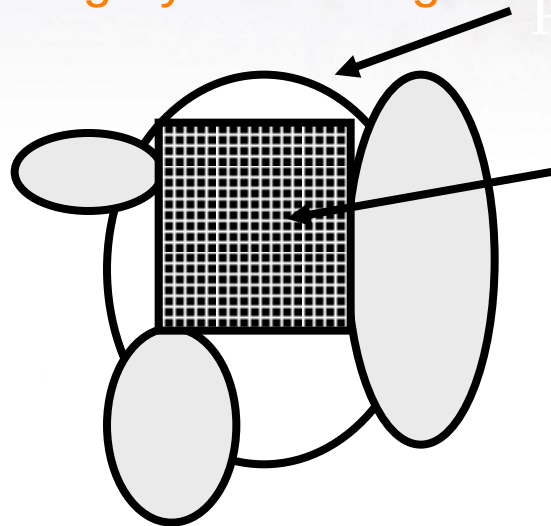
# Layer identification



**Methodology commonly used on the French Network**  
**More than 10,000 tests**

# PSD thanks to Image Analysis

Morphological opening on  
grey level image

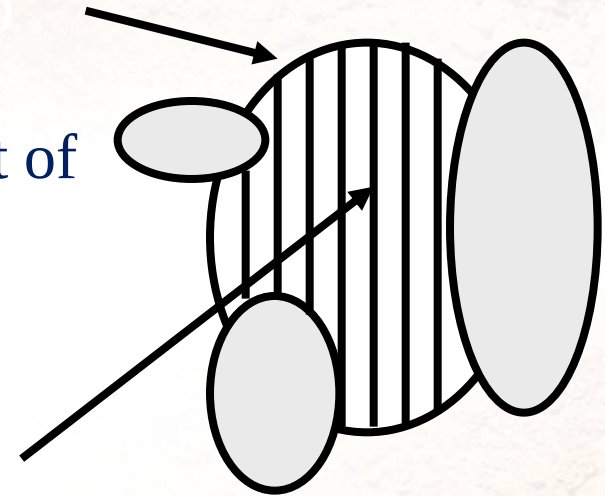


Particle of diameter  $D$

Structuring element of  
size  $d_1 < D$

- Time consuming
- sensible to overlapping and to particle texture

Crossing analysis

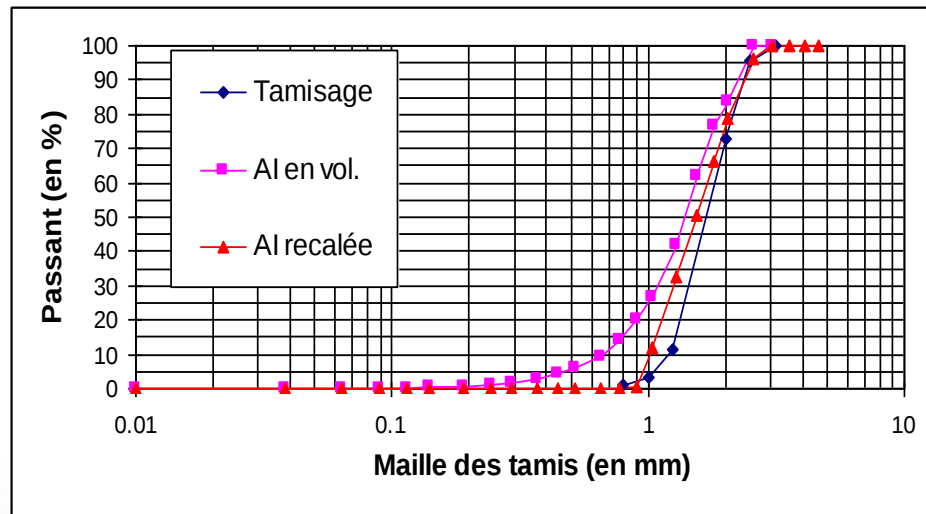
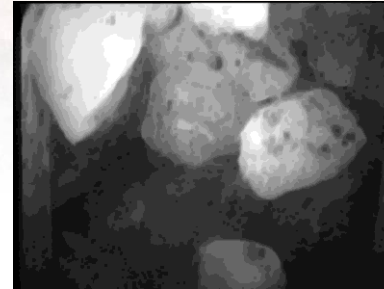
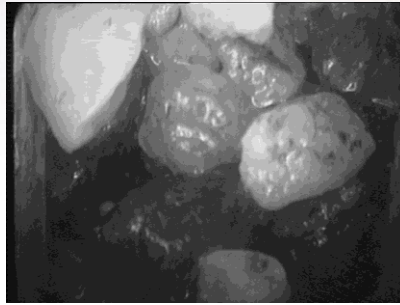


- Sensible to image treatment

Up to 5 mm particles

(Breul, 1999)

# PSD thanks to Image Analysis



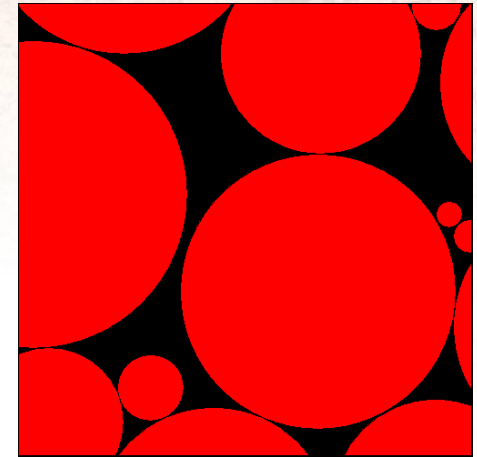
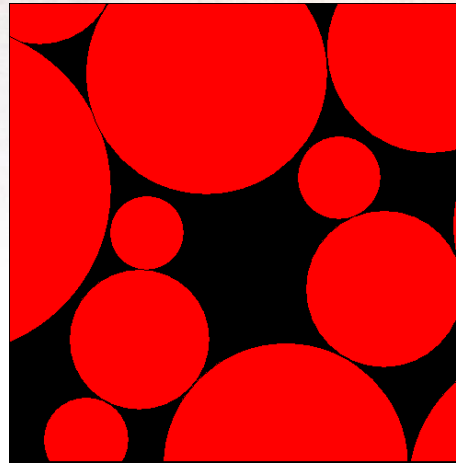
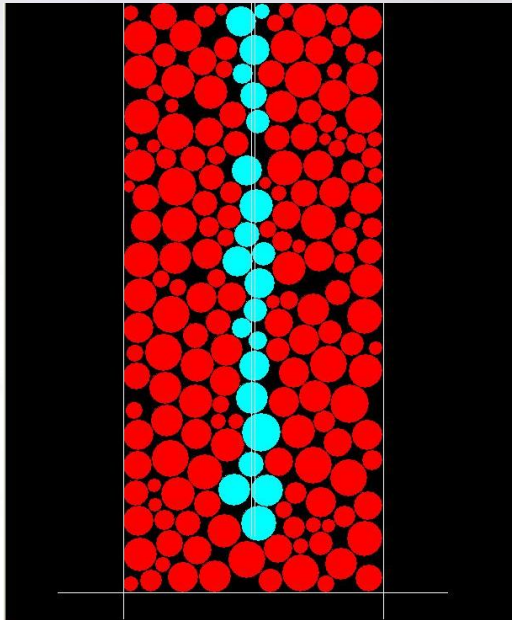
- Existing method up to 5 mm diameter

(Breul, 1999)

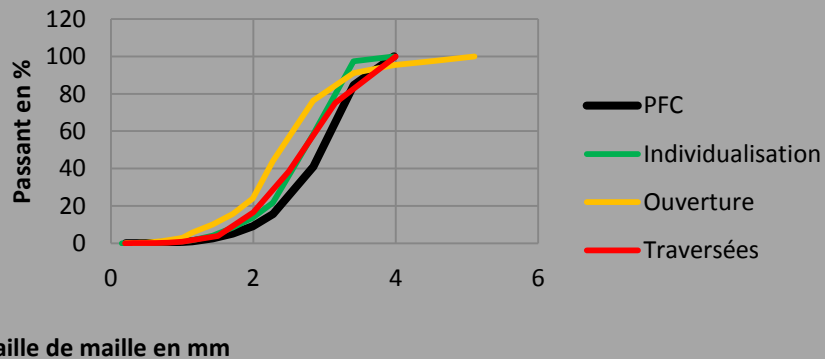
## *Outline of R&D work*

- ✓ PSD for sound ballast
- ✓ PSD for Ballast fouling material
- ✓ Detection of 12% fine threshold

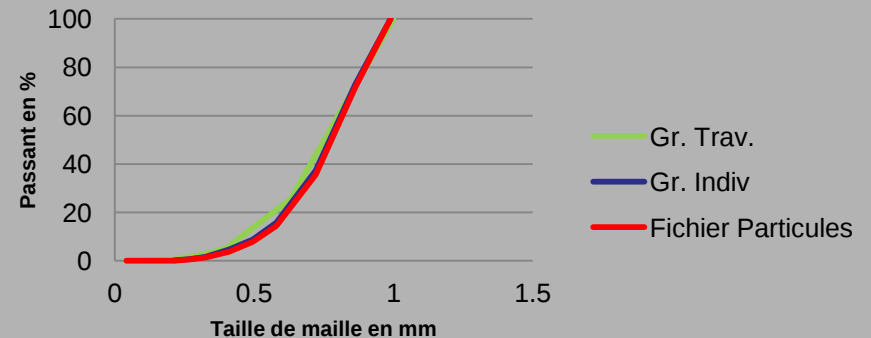
# Ballast PSD: PFC generated images



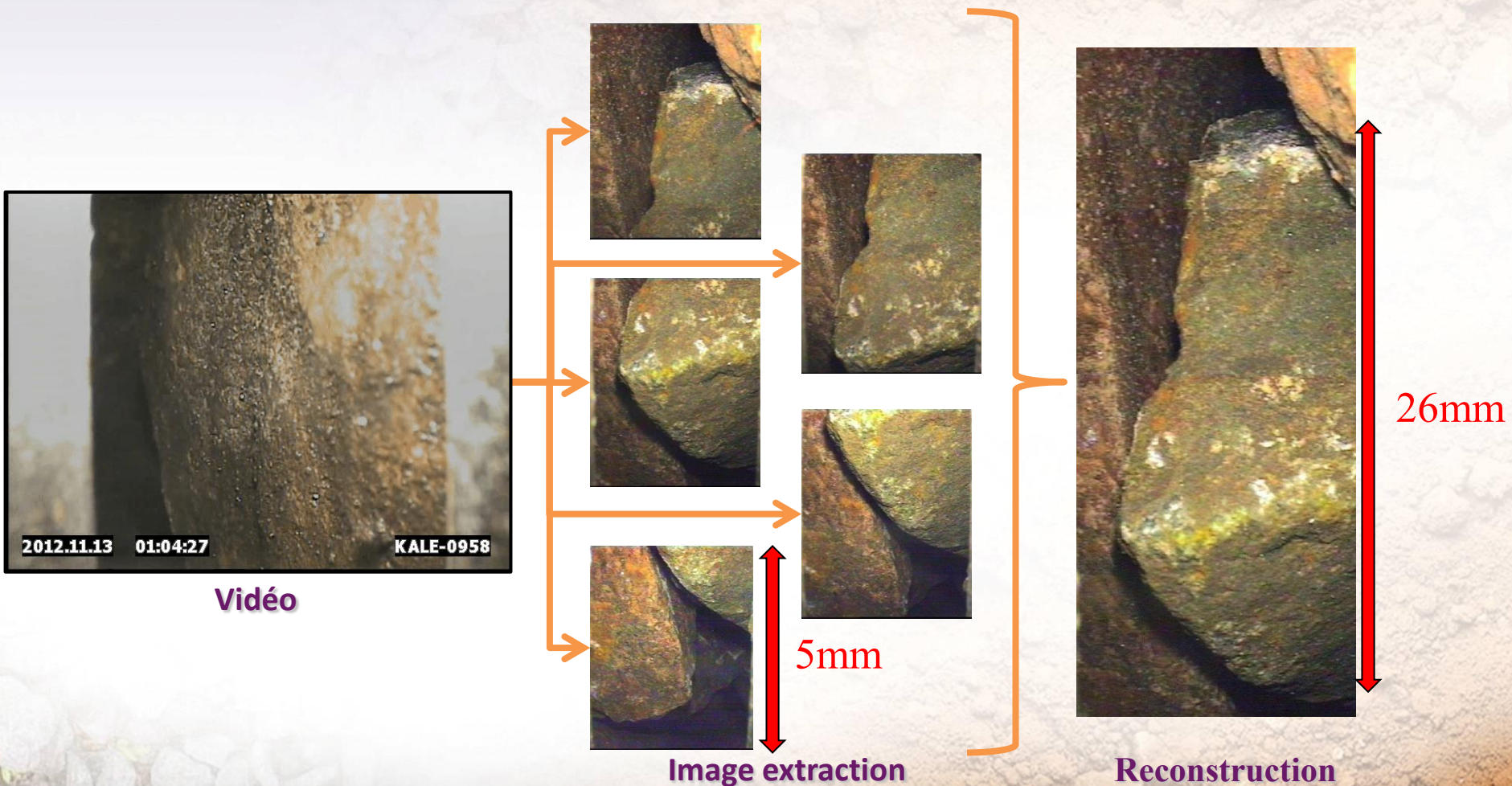
Comparatif granulométries PFC



Test PFC. Diam 0.2 à 1mm



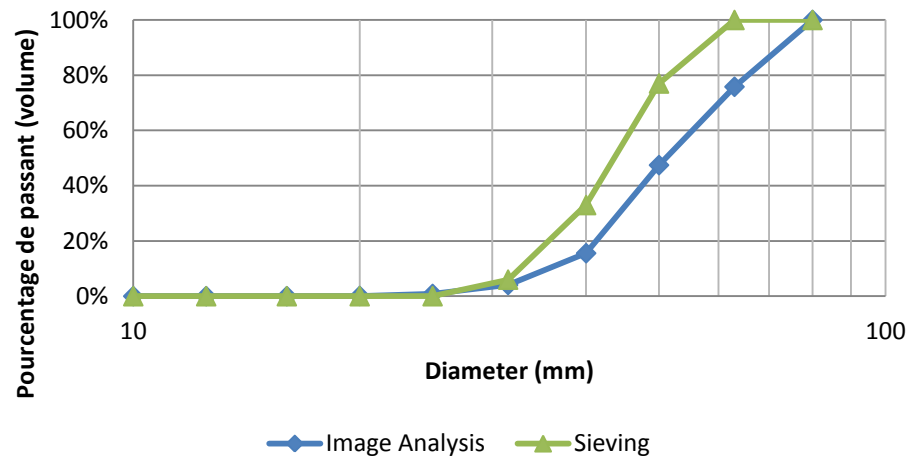
# Ballast PSD: Reconstruction method



# Ballast PSD: Reconstruction method



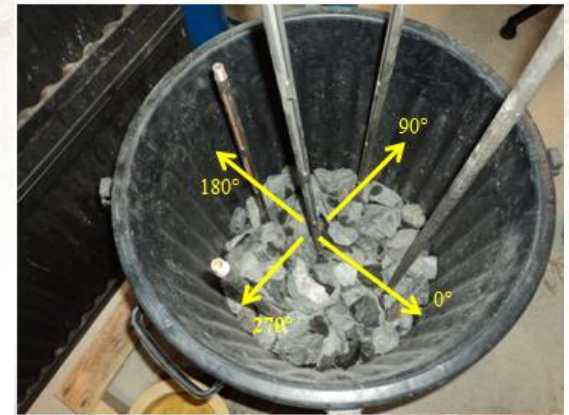
**Sound Ballast PSD**



# Ballast PSD: Reconstruction method

## Sampling Issue:

Representative Elementary Volume (REV): 100 particles (5 m of soundings)

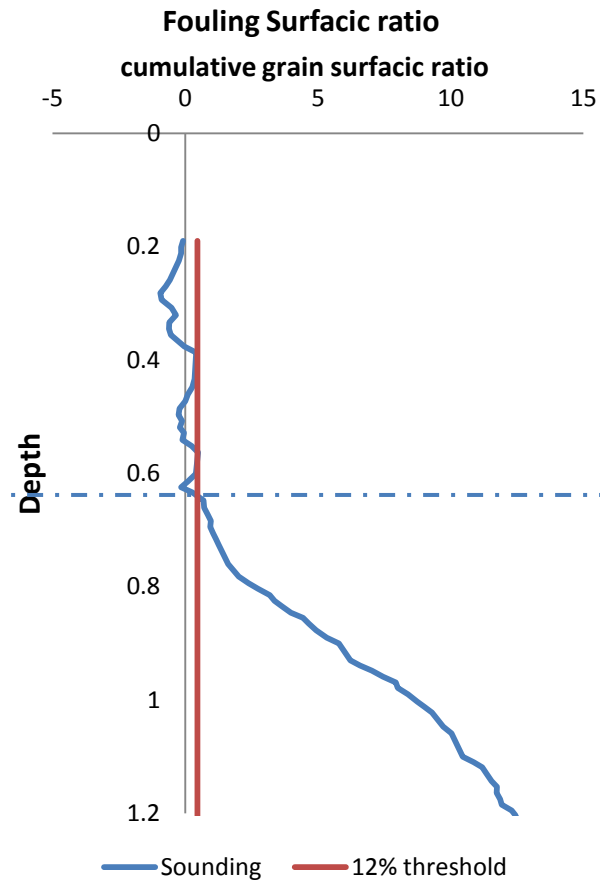
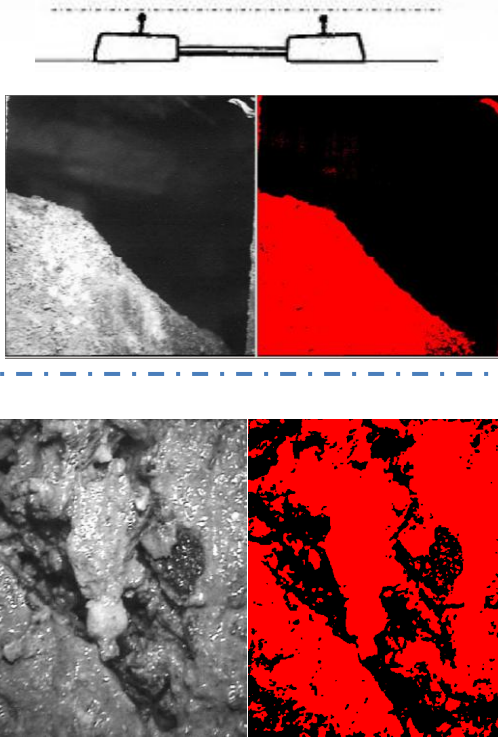


## Over-estimation of big particles:

- Spherical or ellipsoidal model
- Lab sieving biai

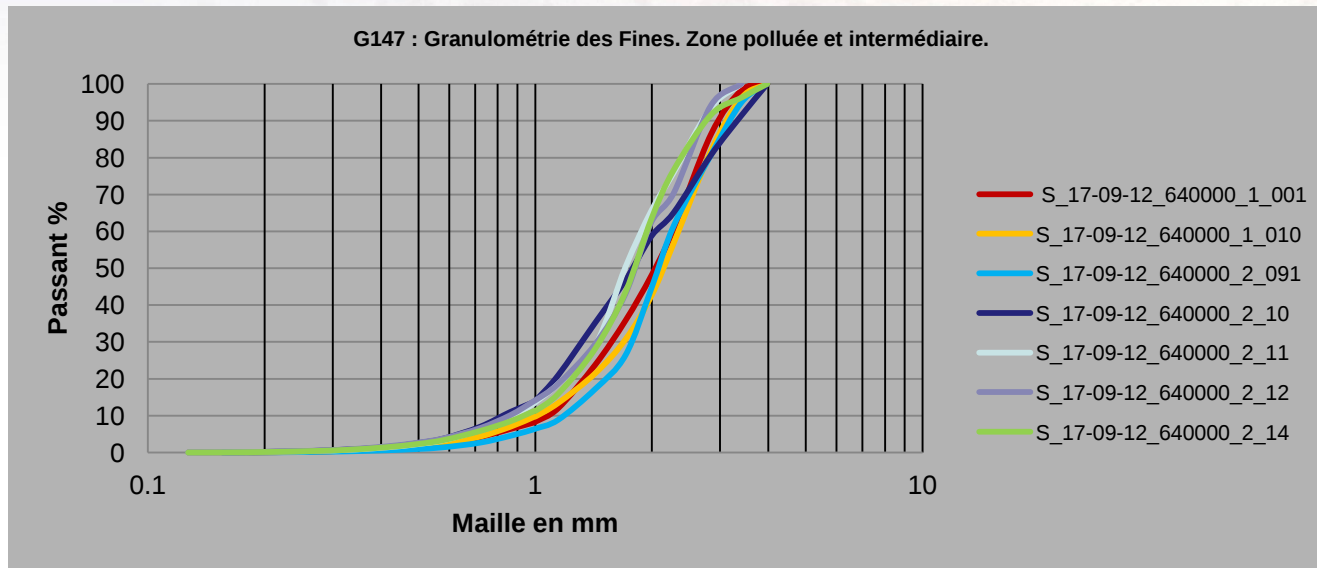
# 12% fouling threshold

- Grain Surfacic ratio (opposite of surfacic void ratio)
- Fouling surfacic ratio= Grain surfacic ratio – mean(Sound ballast surfacic ratio)



# PSD of fouled Ballast

- PSD of fouling materials are very similar (not slurry fouling)



Same ballast at the origin  
+ same loading process  
= similar distribution

## Conclusions & Perspectives

- ✓ Field methodology for railway track characterization
- ✓ Existing Data base of more than 10,000 soundings
- ✓ PSD thanks to Image analysis (in progress)
- ✓ Focus stacking for 3D reconstruction

