

GN-MEBA

Un Bon Coup de Balai

Réunion pédagogique du 7 et 8 décembre 2017

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E. Heripre³, D. Loisnard², E. Rouesne⁴, A. Tanguy⁵, V. Aubin³, F. Latourte², S. Roux¹

1: LMT, ENS Paris-Saclay / CNRS / Université Paris-Saclay

2: EDF R&D, Site des Renardières

3: MSSMat, CentraleSupélec / CNRS / Université Paris-Saclay

4: CEA, Saclay

5: LMS, Ecole Polytechnique / CNRS / Université Paris-Saclay

6: ONERA, Université Paris-Saclay

7: Centre des Matériaux, MINES ParisTech / CNRS



EquipEx
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université
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ONERA
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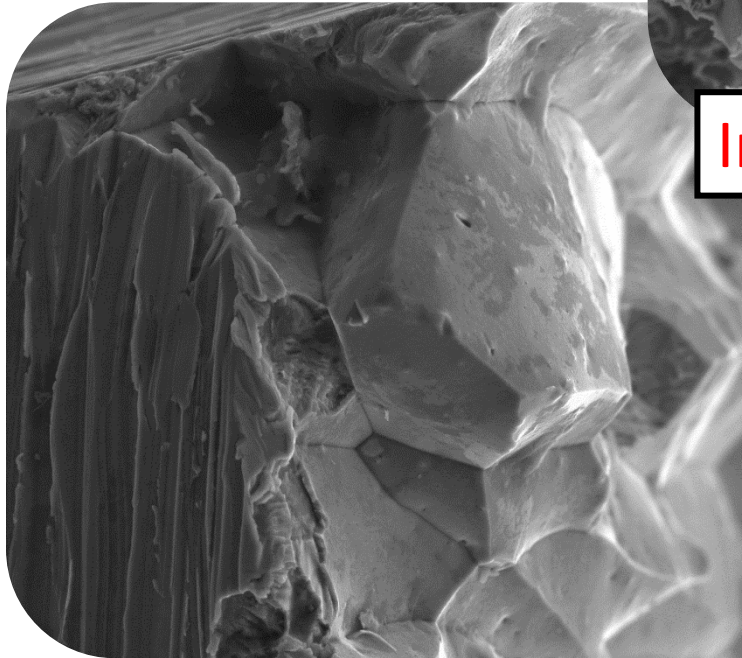
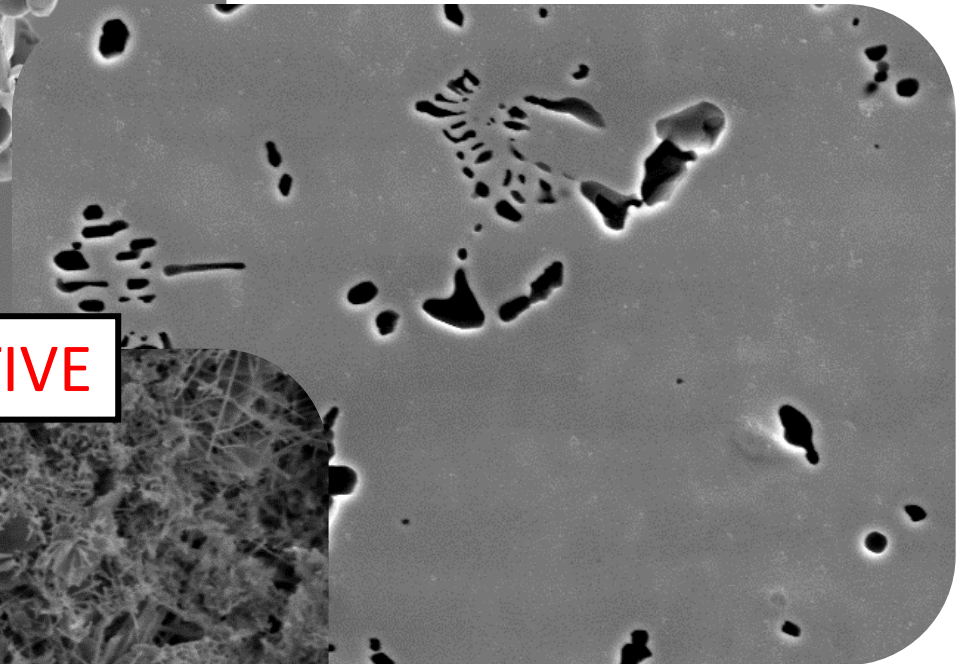
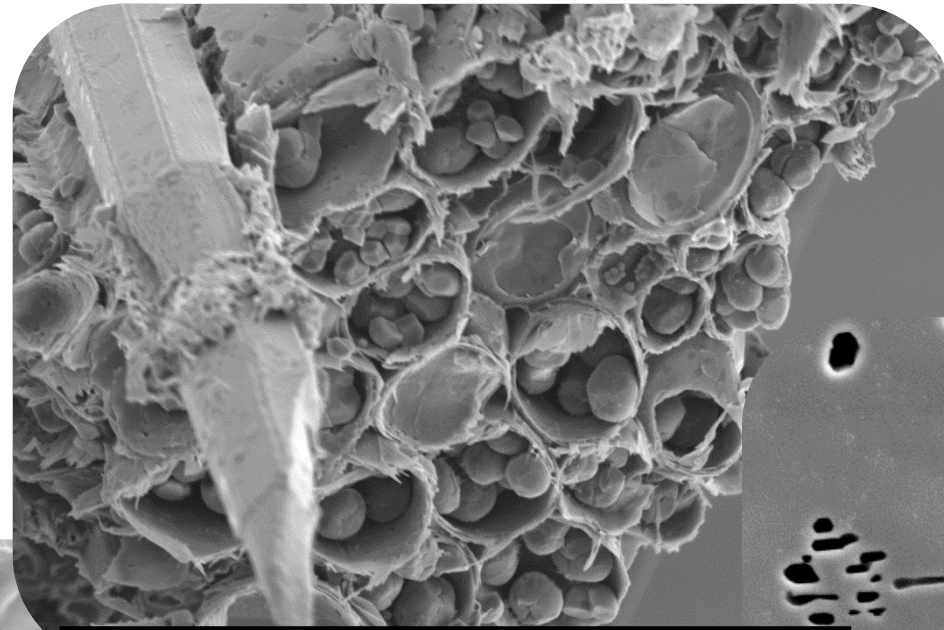


CentraleSupélec
école
normale
supérieure
paris-saclay

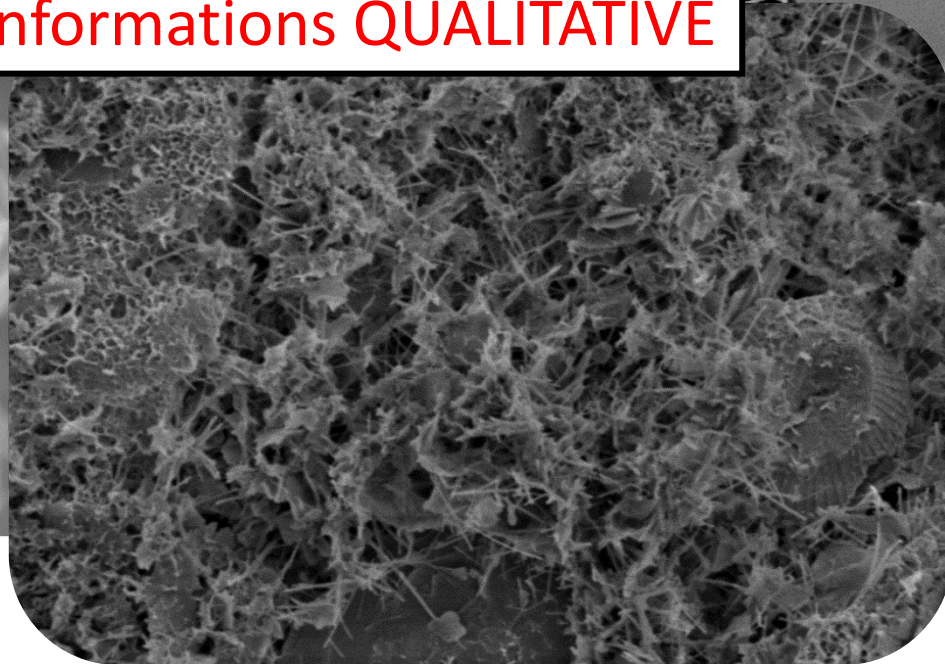


Introduction

Observation MEB



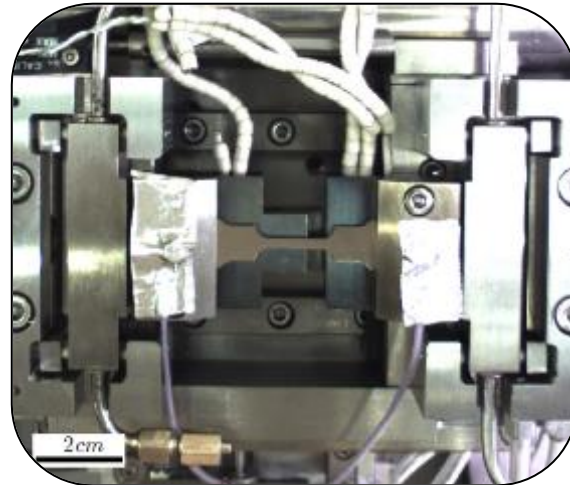
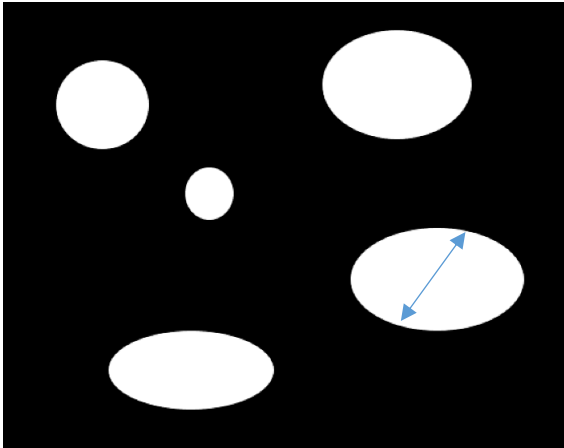
Informations QUALITATIVE



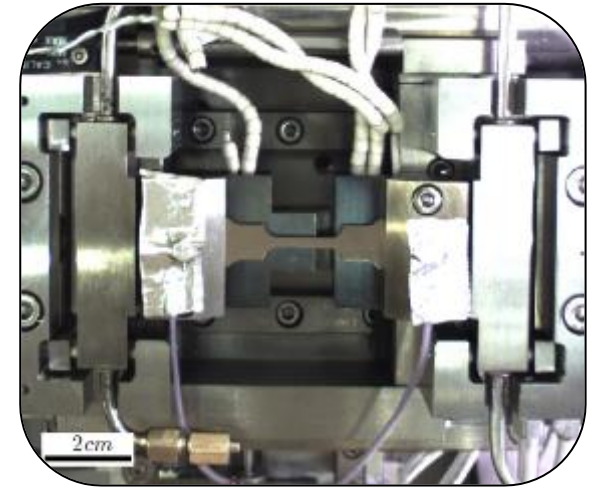
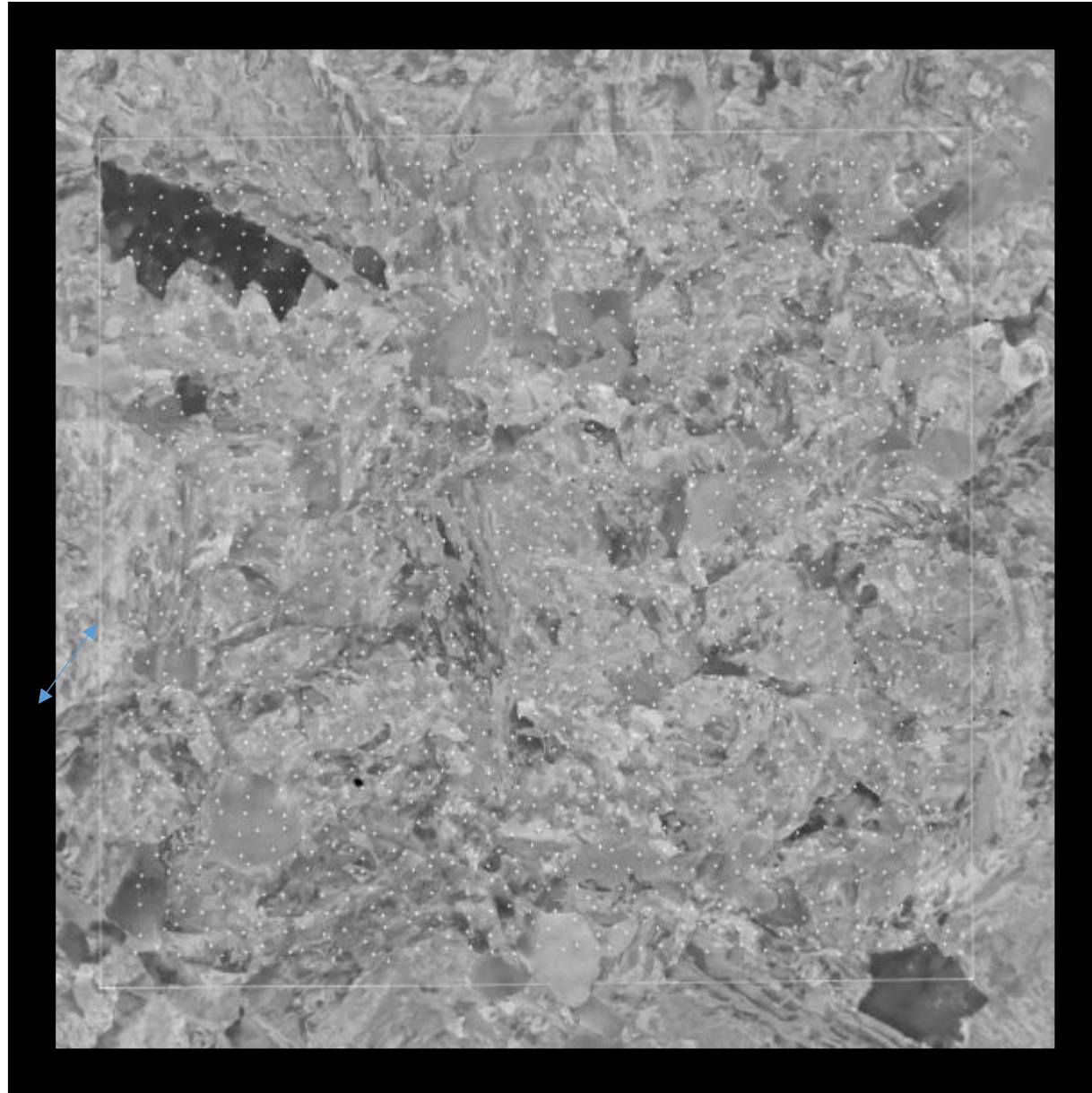
Introduction

De plus en plus

Informations QUANTITATIVES

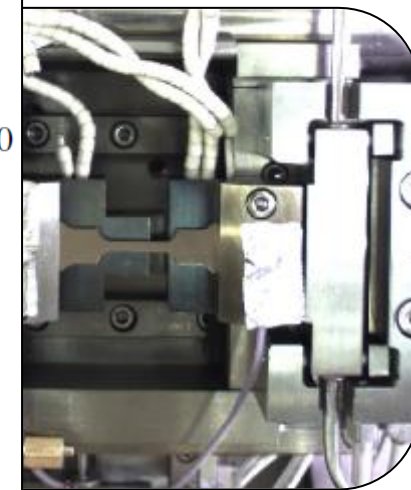
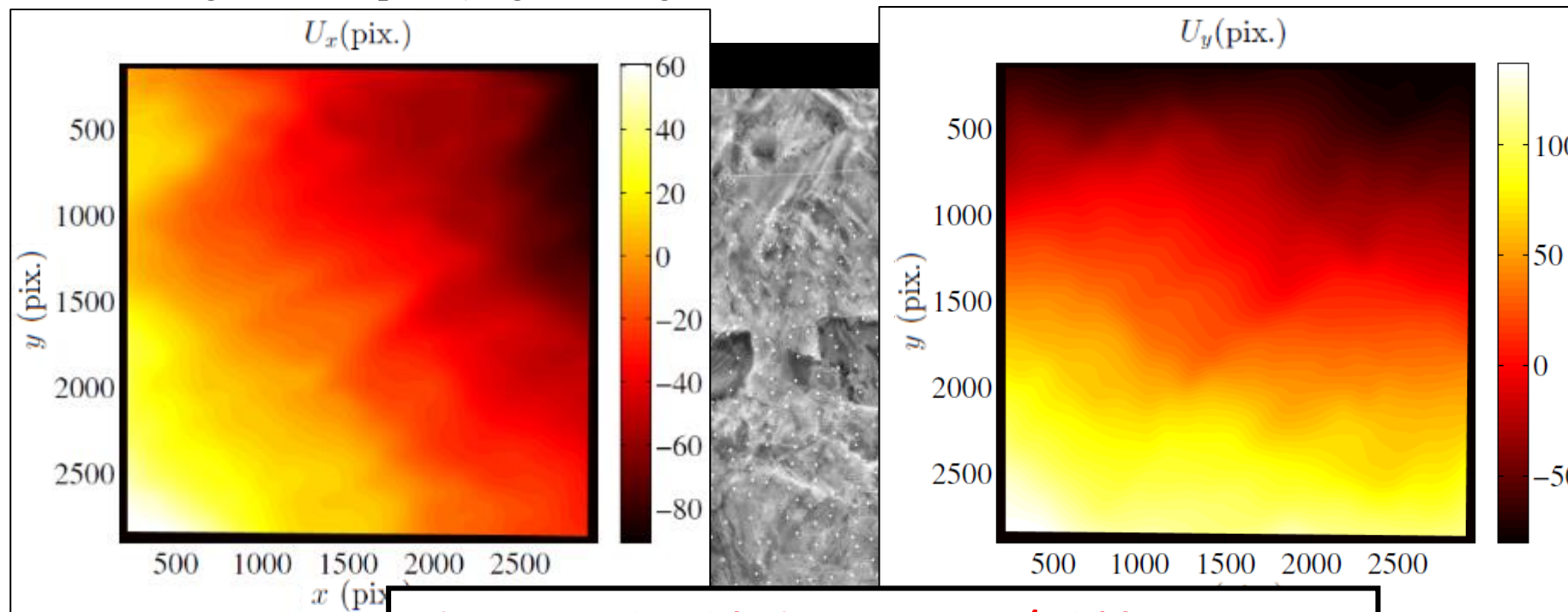


Corrélation d'image numériques (Digital Image Correlation : DIC)

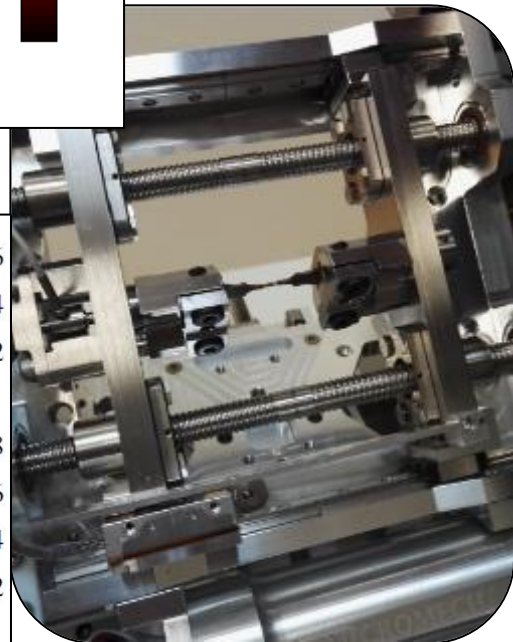
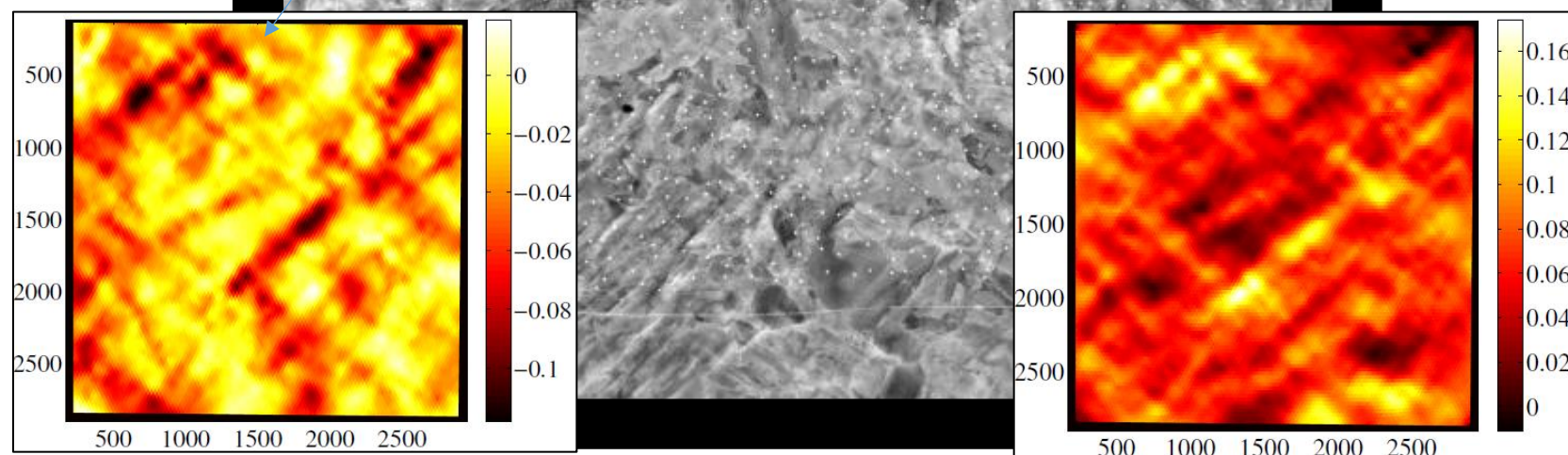


[In-situ tensile test, Qiwei SHI, EDF R&D MMC / LMT](#)

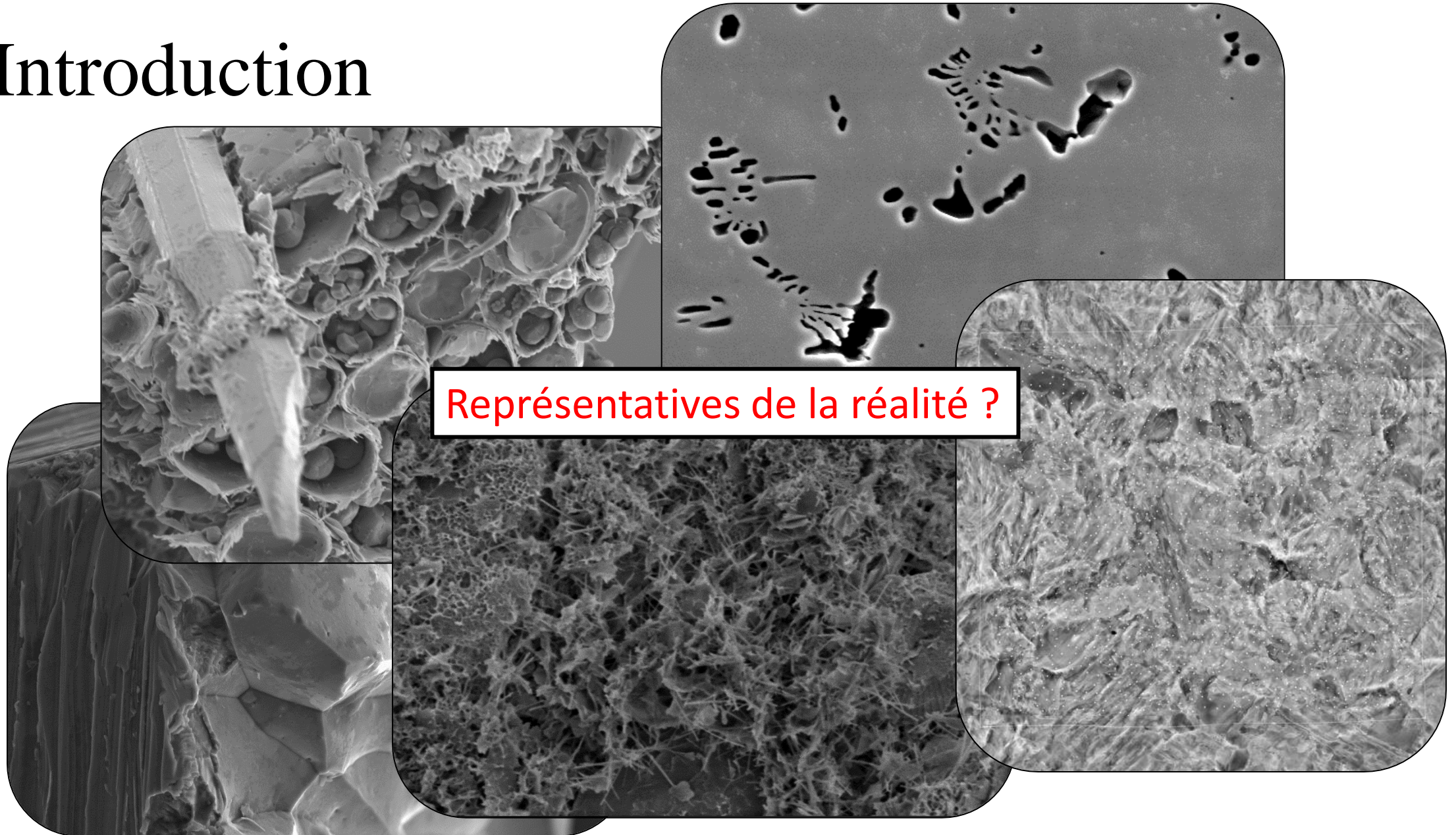
Corrélation d'image numériques (Digital Image Correlation : DIC)



Champs de déplacement / déformation

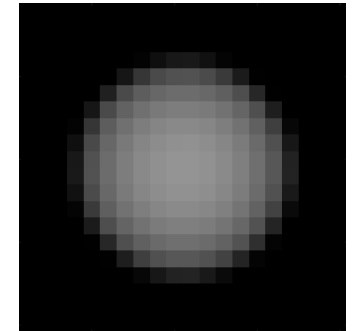


Introduction

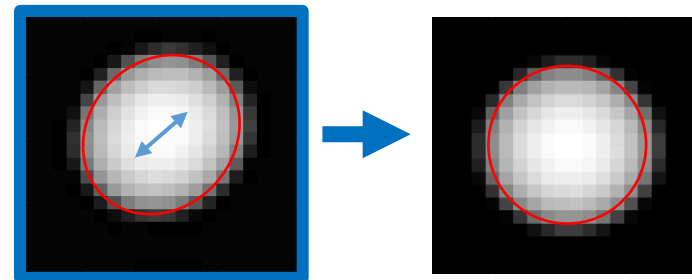


Sommaire

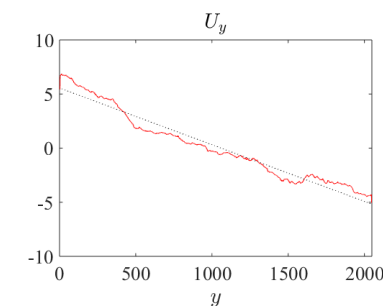
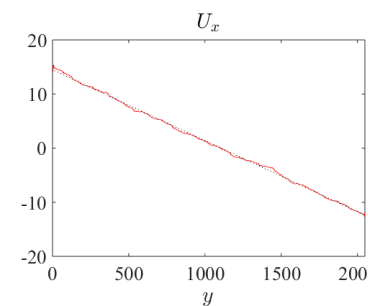
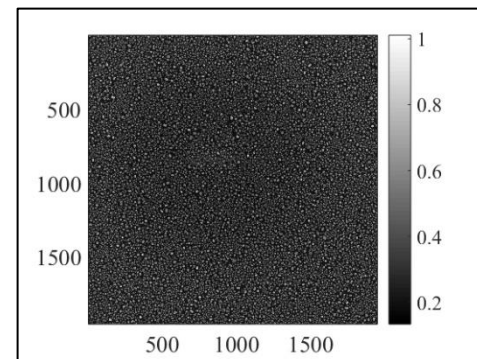
1) Formation d'une image en MEB et ses imperfections



2) Détection et correction

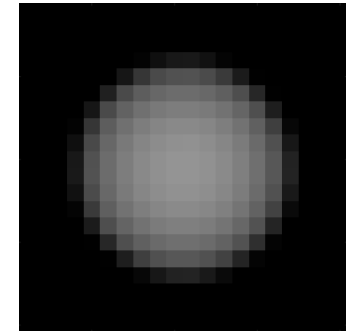


3) Exemple

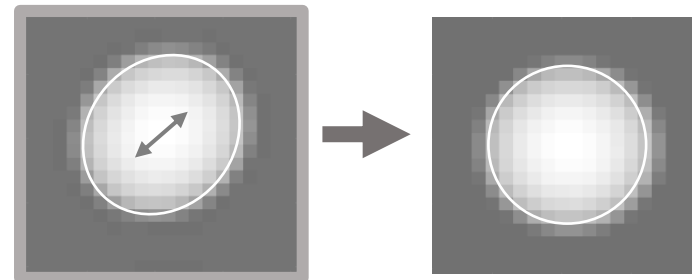


Sommaire

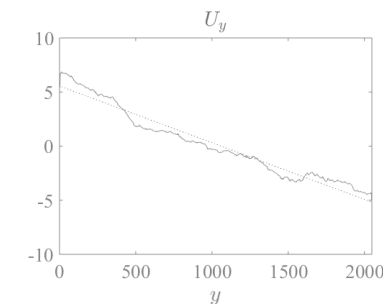
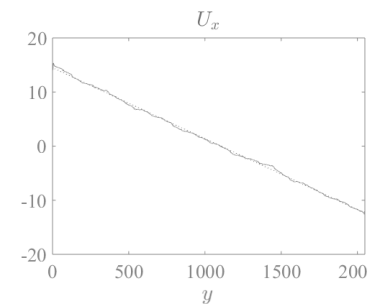
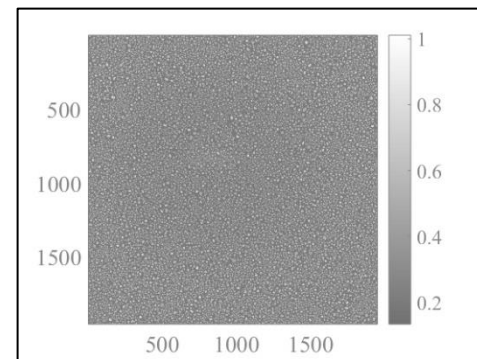
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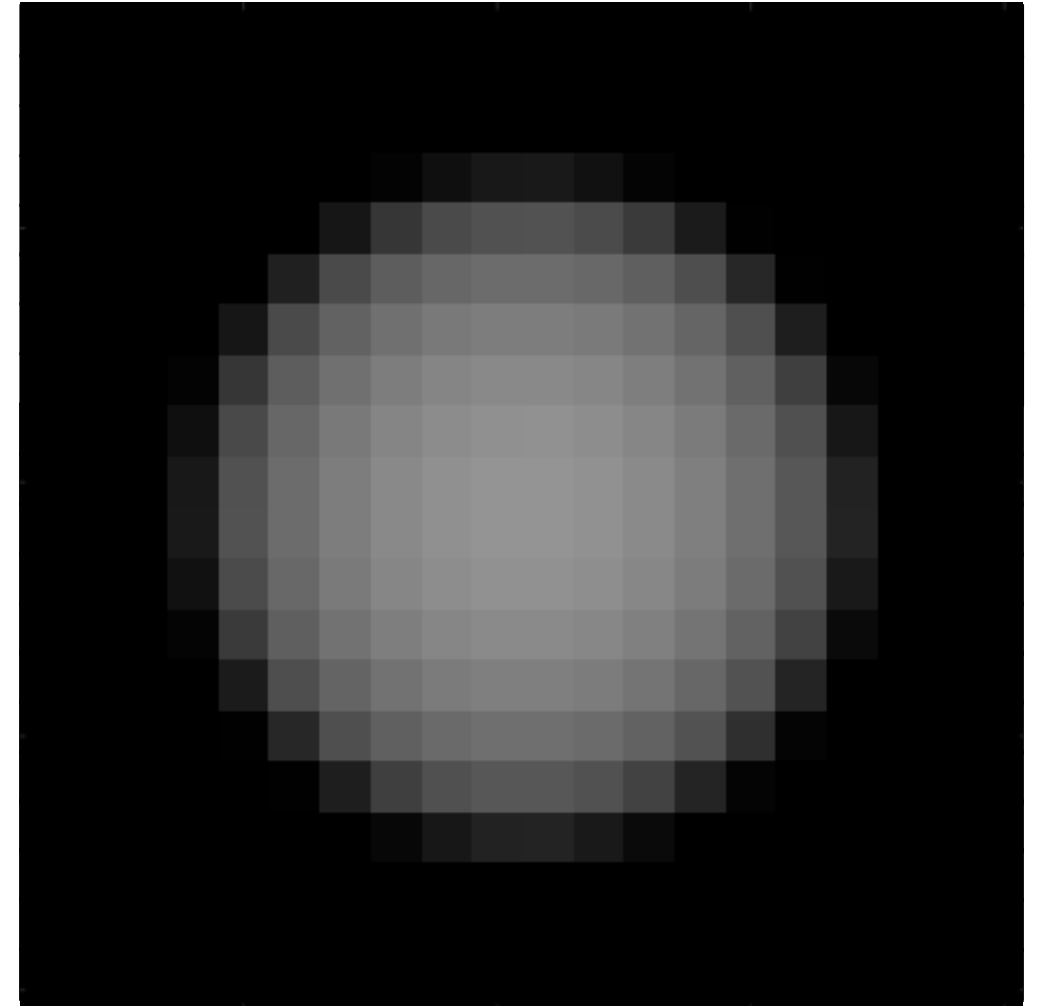
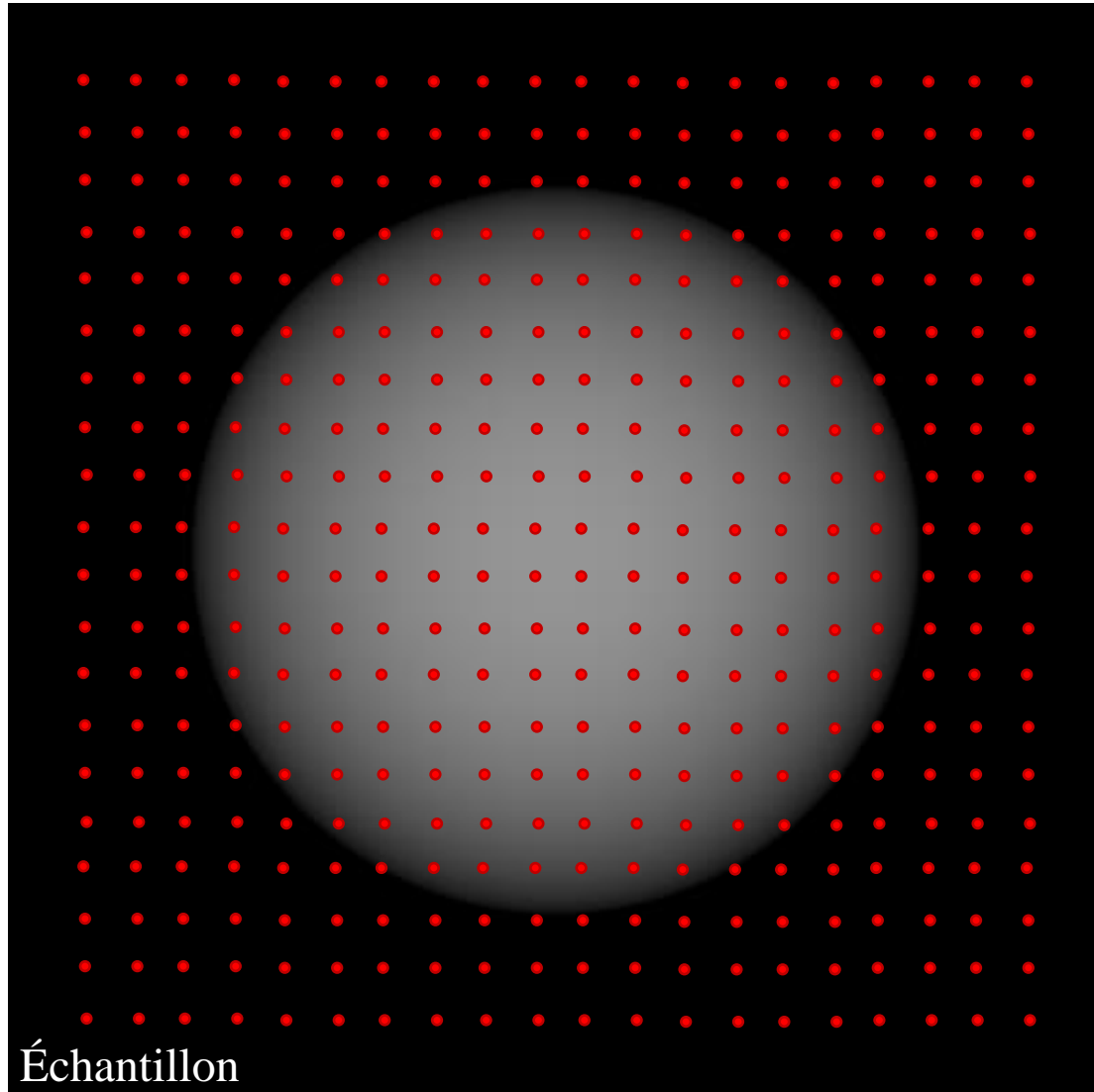
2) Détection et correction



3) Exemple



Formation d'une image en MEB

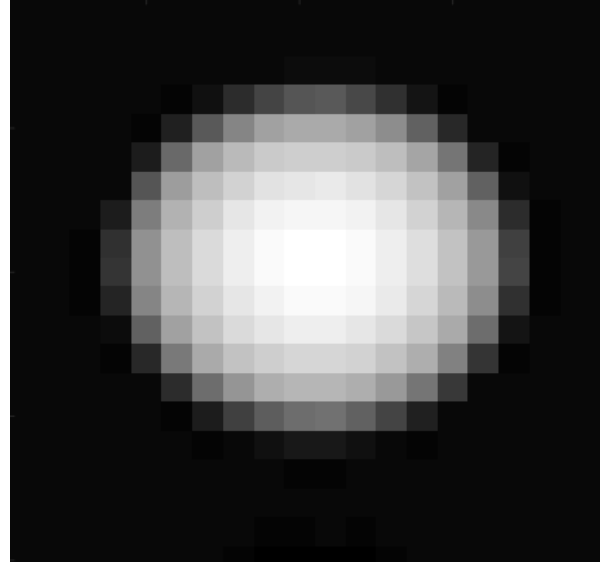
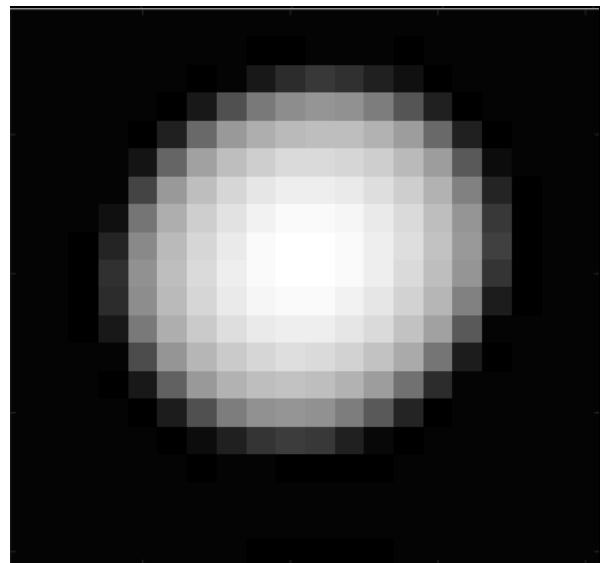
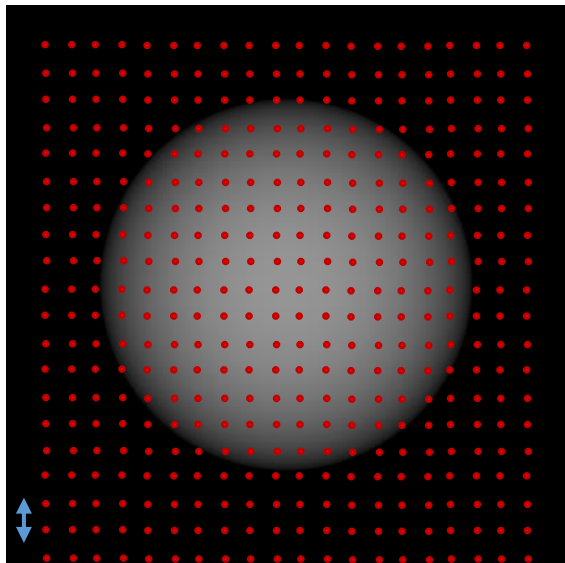
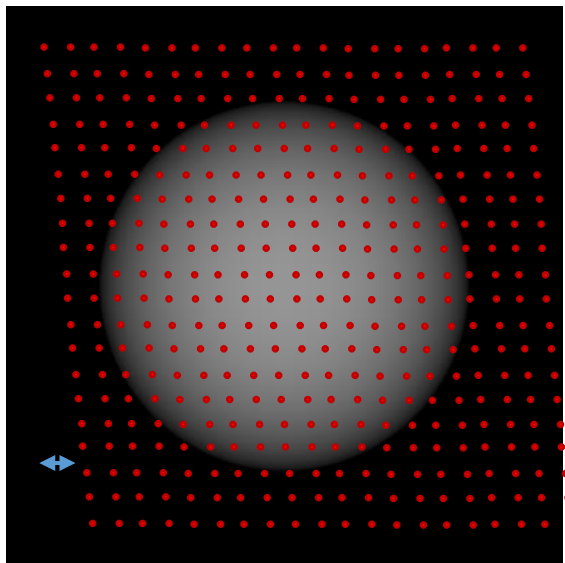


Imperfections

Correction

Exemple

Imperfection de balayage



- **Déviaton de faisceau / échantillon**
- Mauvaise calibration

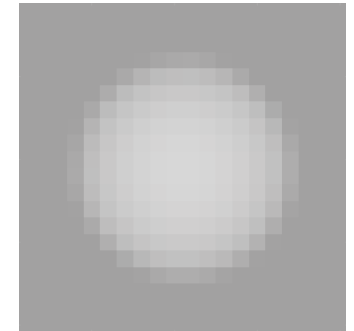
Imperfections

Correction

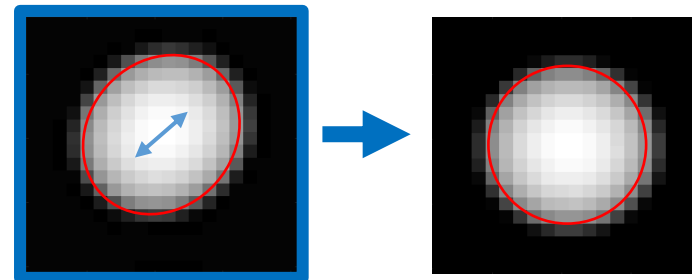
Exemple

Sommaire

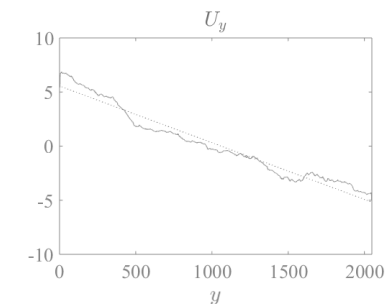
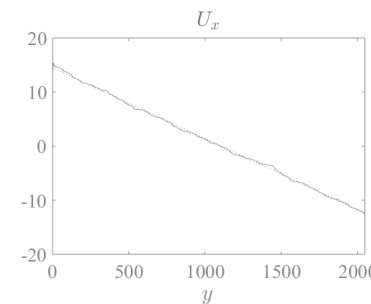
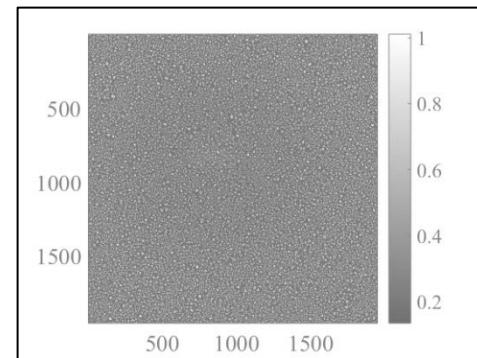
1) Formation d'une image en MEB et ses imperfections



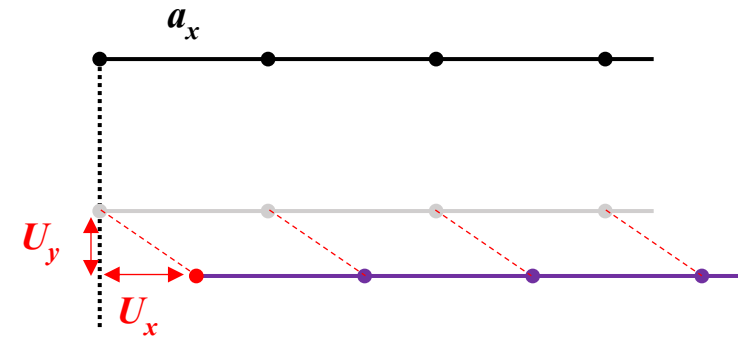
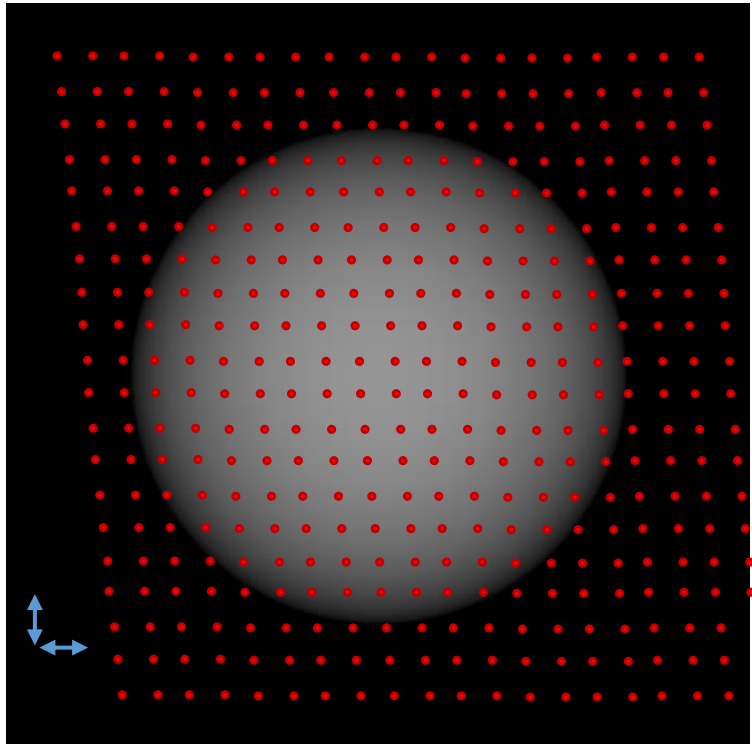
2) Détection et correction



3) Exemple

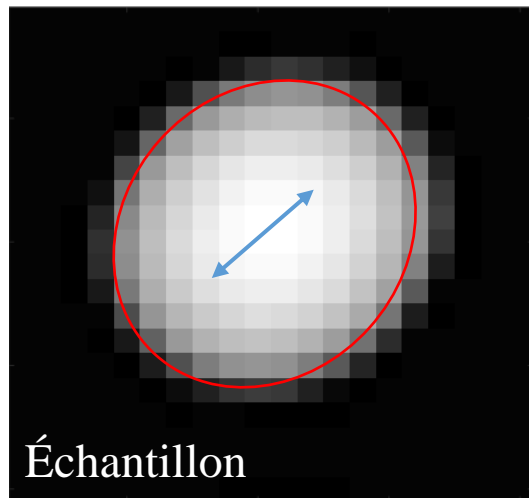


Hypothèse



Chaque ligne de balayage est correcte mais sa position dans l'espace peut être corrigée

Une image insuffisante pour correction



Échantillon réel

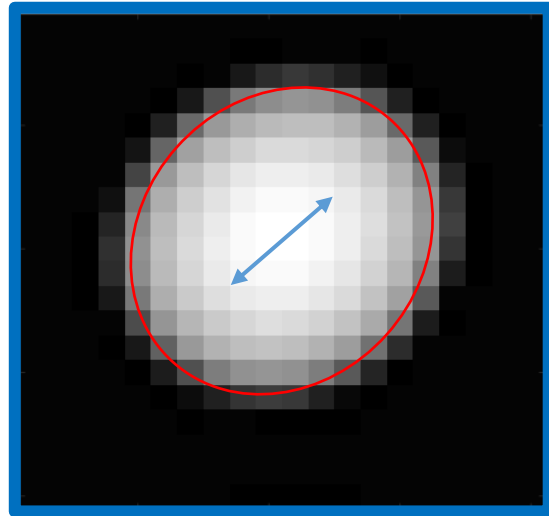
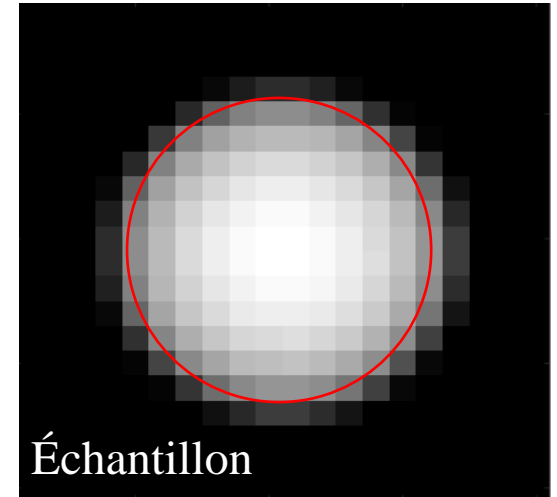
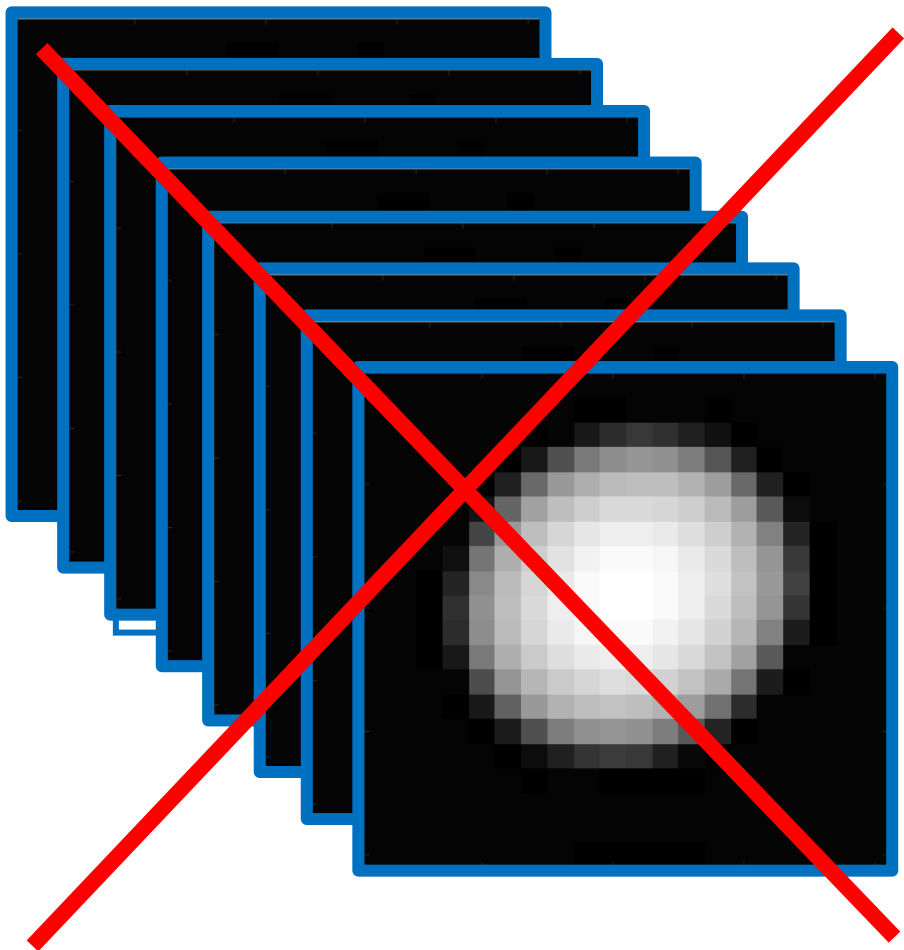


Image obtenue

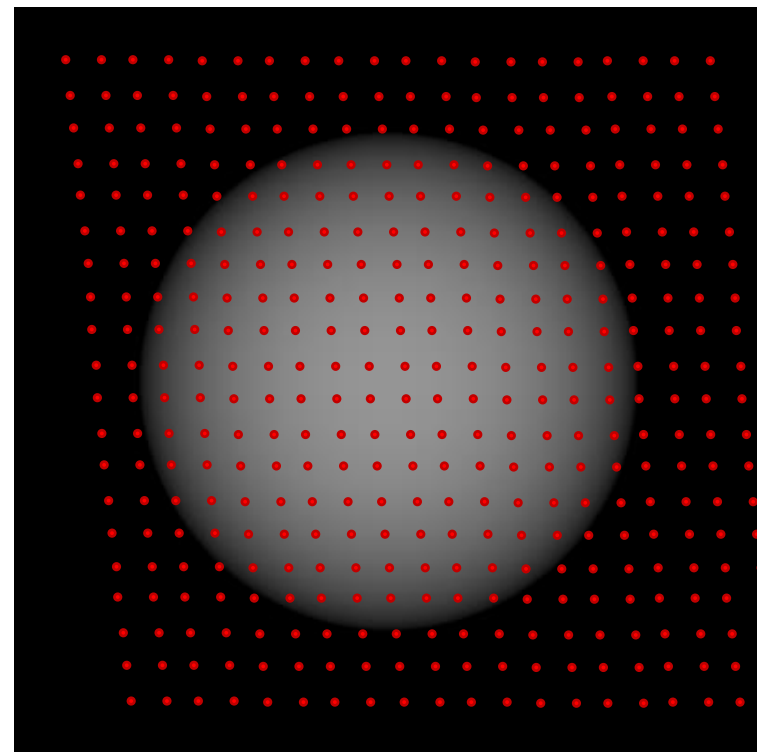


Défauts de balayage

Multiplier les images ?



Défauts non complètement aléatoire

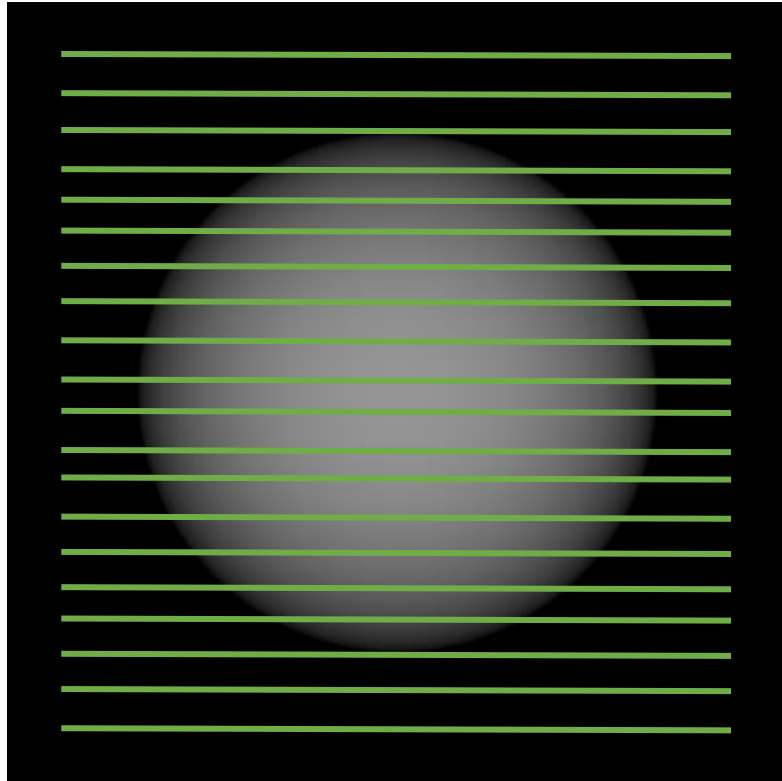


Imperfections

Correction

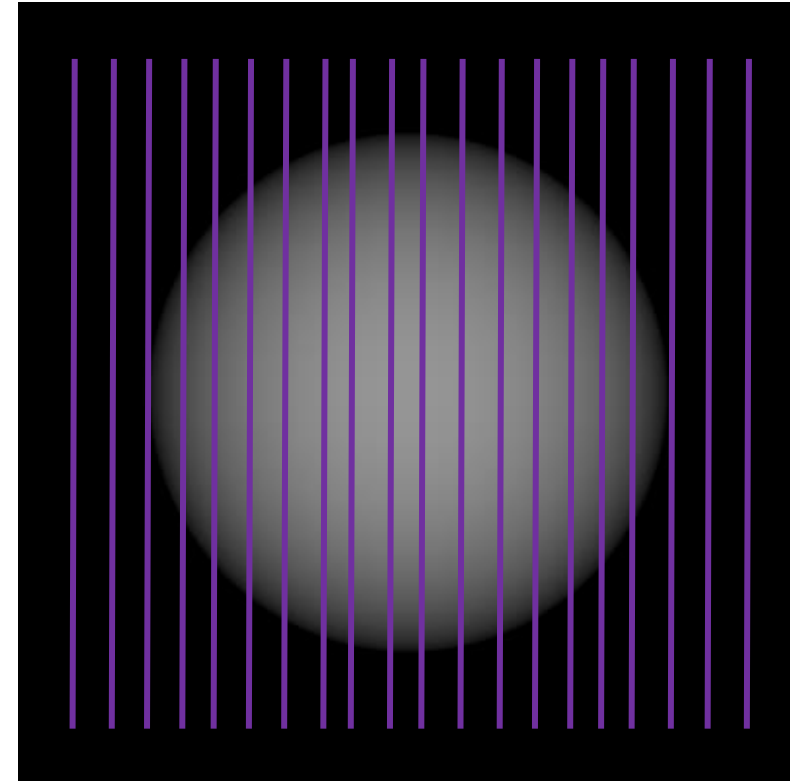
Résultats

Changer les conditions d'acquisition



Scan 0°

- Lignes correctes
- Position des lignes à corriger



Scan 90°

- Colonnes correctes
- Position des colonnes à corriger

Imperfections

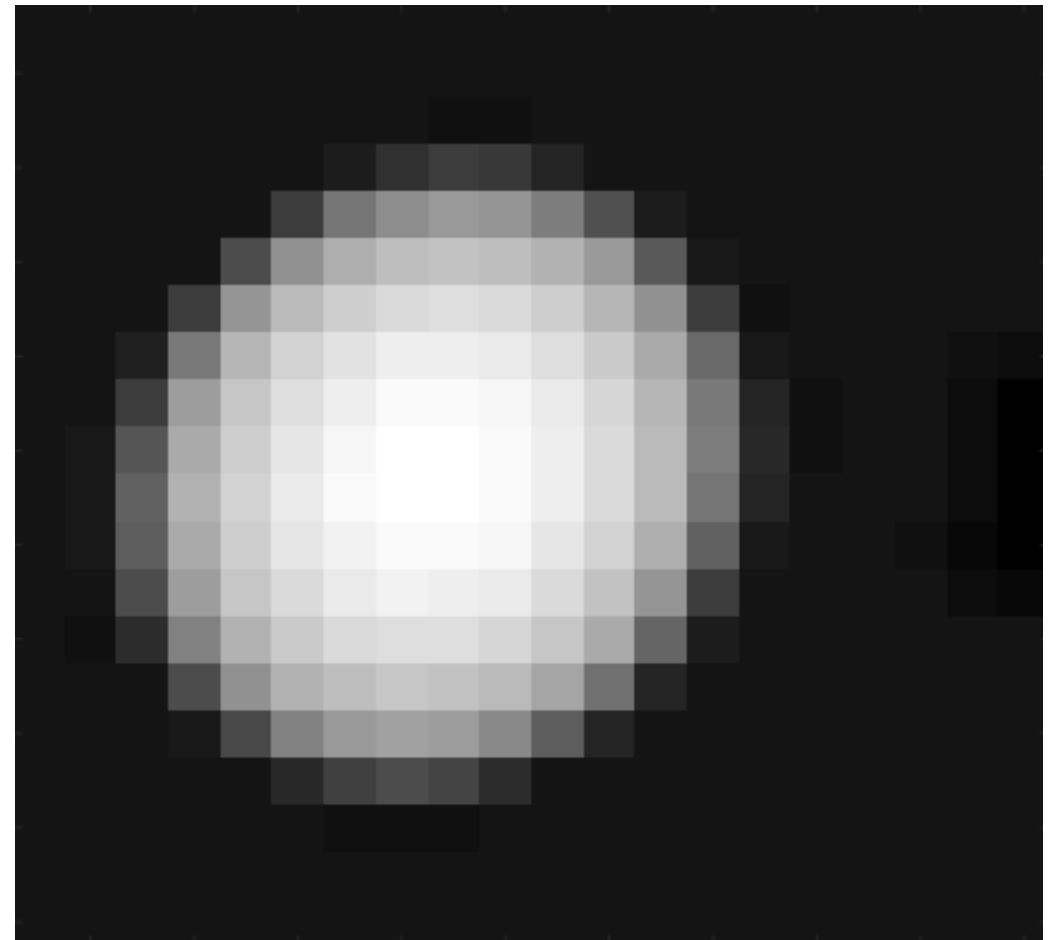
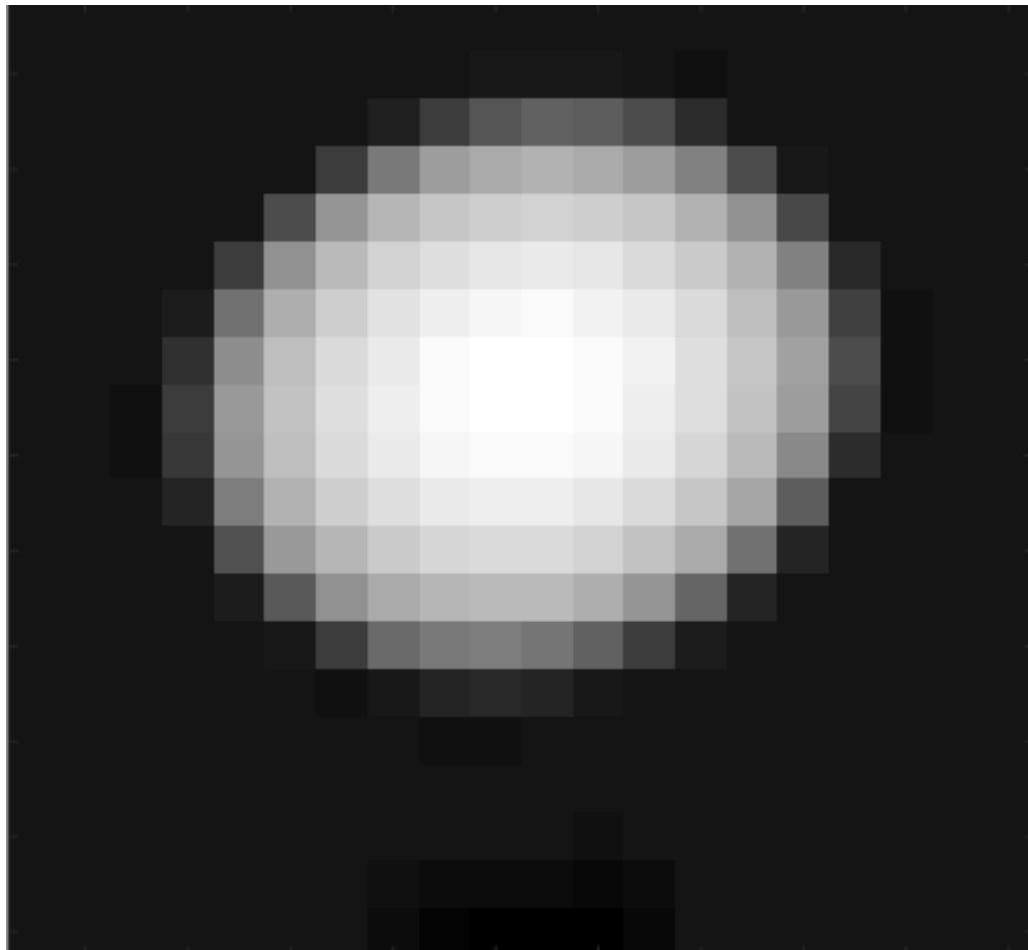
Correction

Résultats

Correction

Scan 0°

Scan 90°



Imperfections

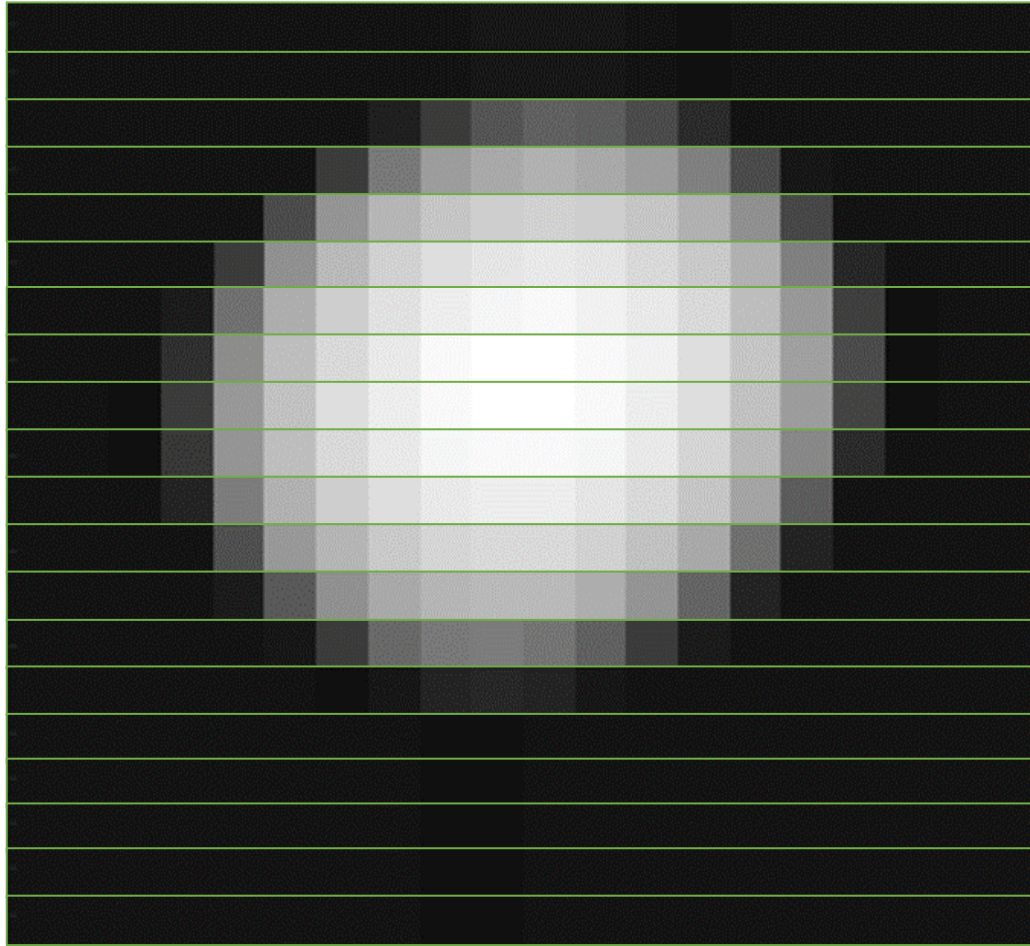
Correction

Résultats

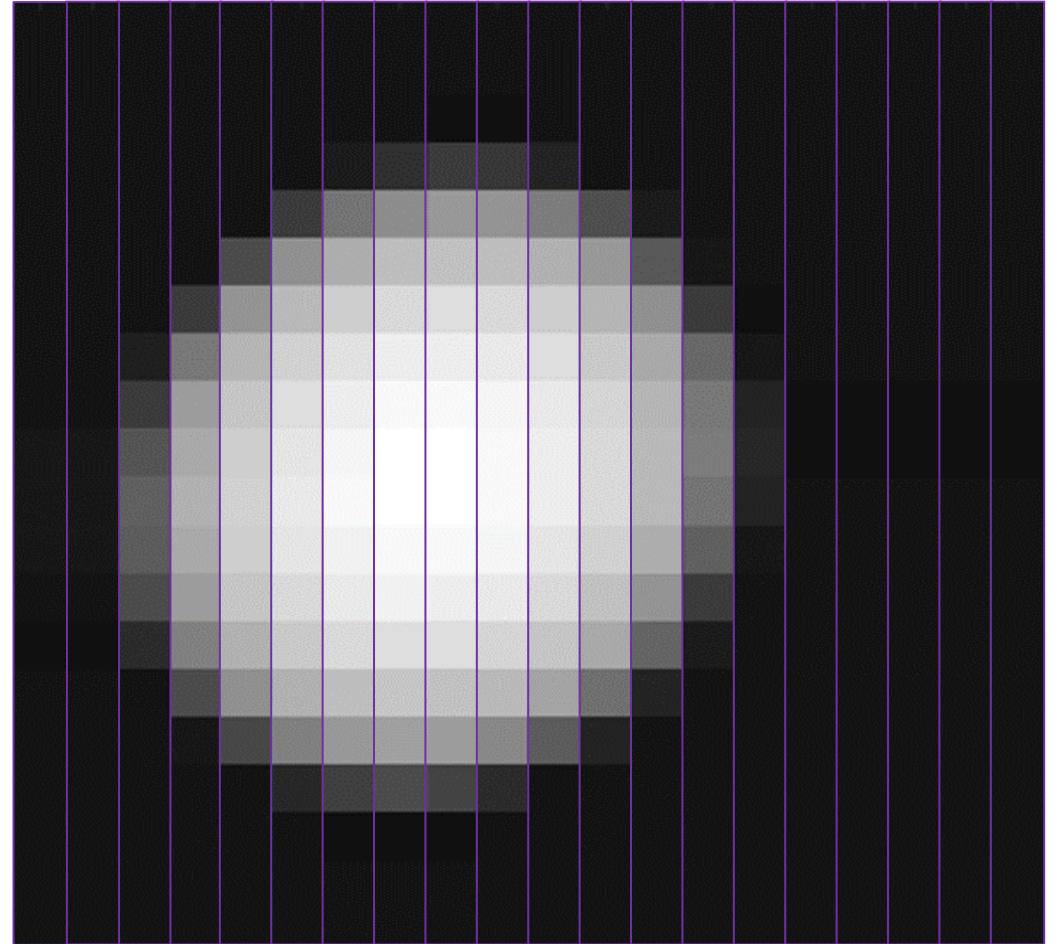
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Correction

Scan 0°

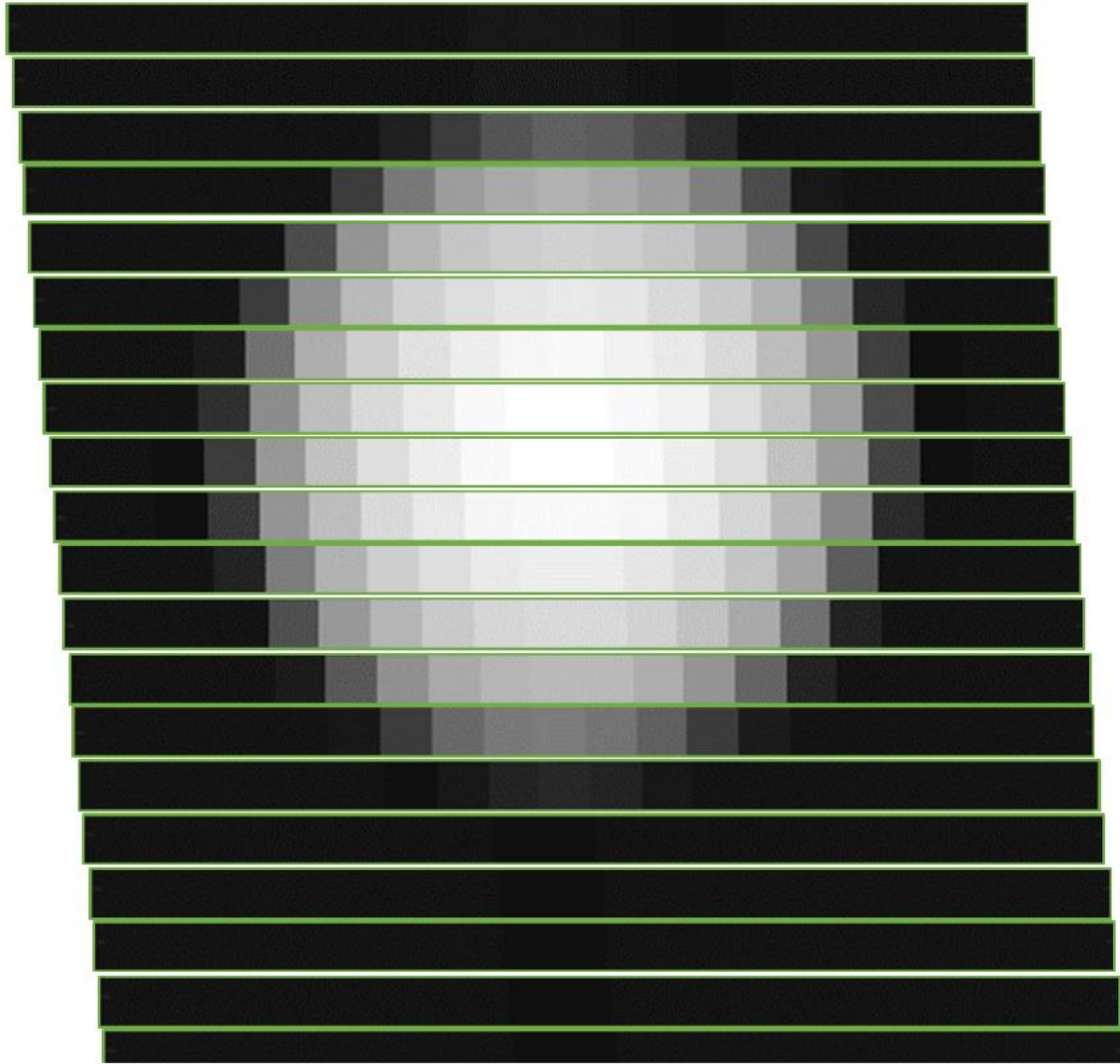


Scan 90°

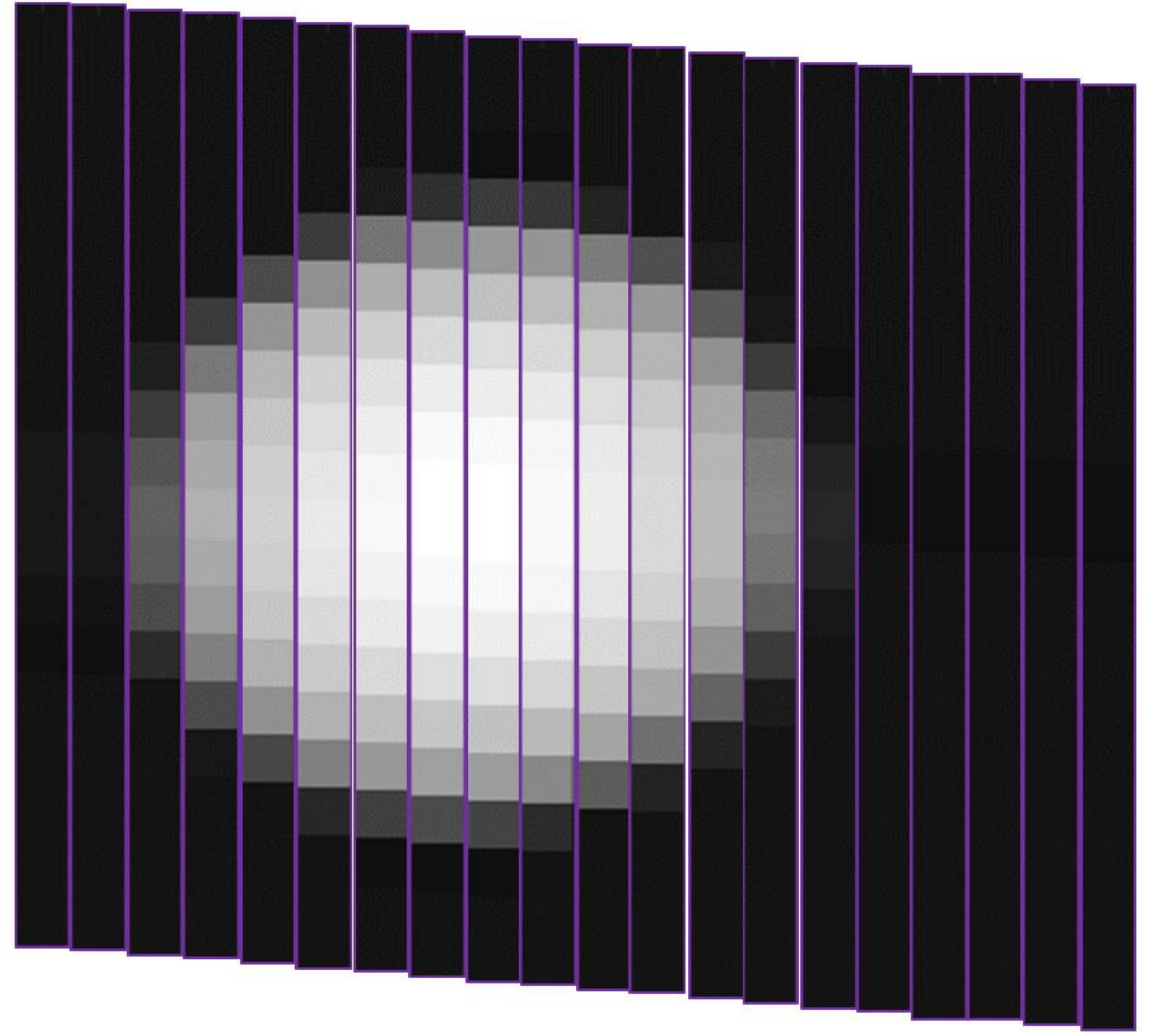


Correction

Scan 0°



Scan 90°



Imperfections

Correction

Résultats

18

Scan 0°

Scan 90°

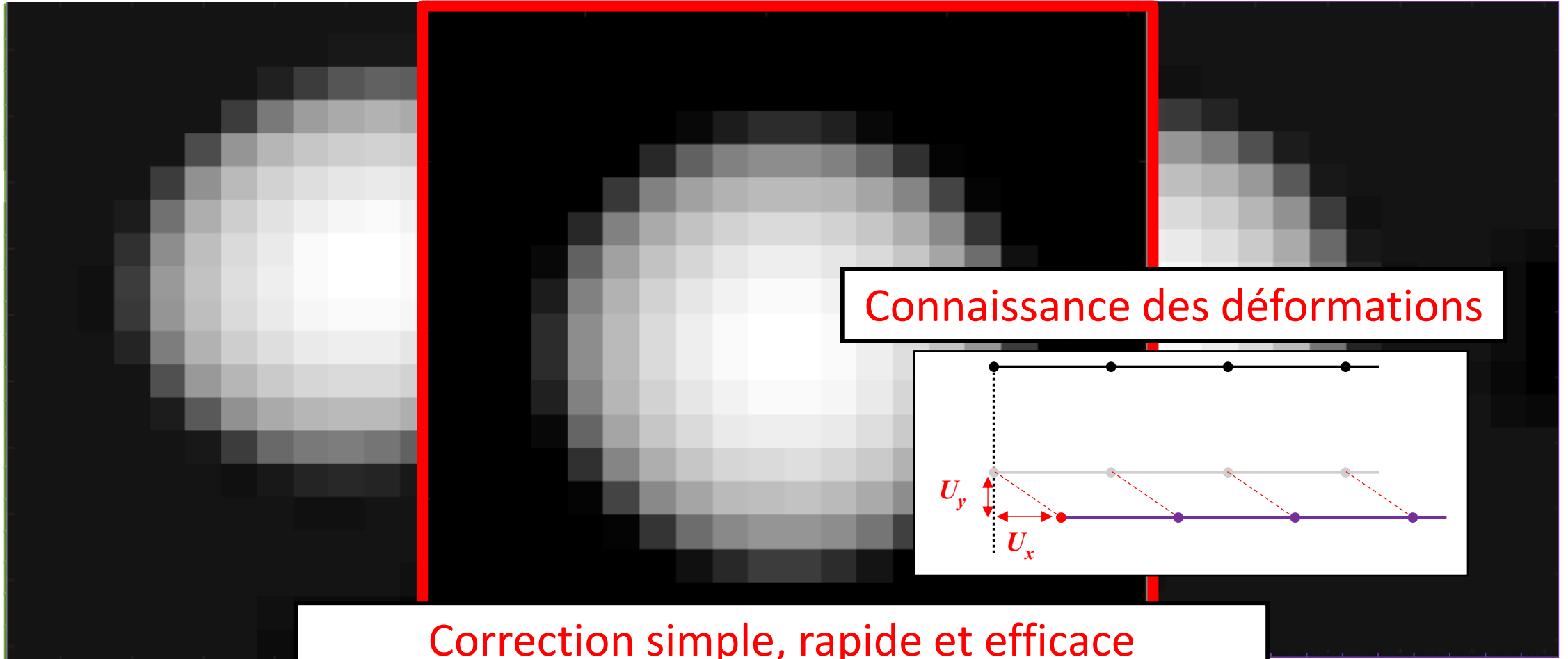


Connaissance des déformations

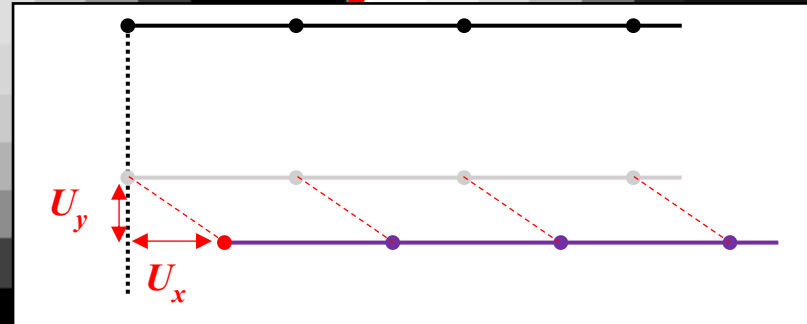
Correction simple, rapide et efficace
permettant de se rapprocher de l'image réelle

Scan 0°

Scan 90°



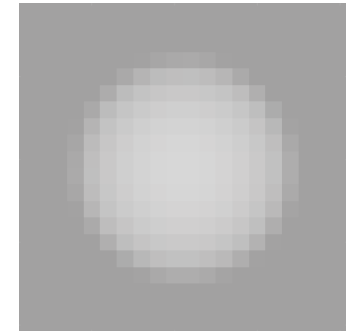
Connaissance des déformations



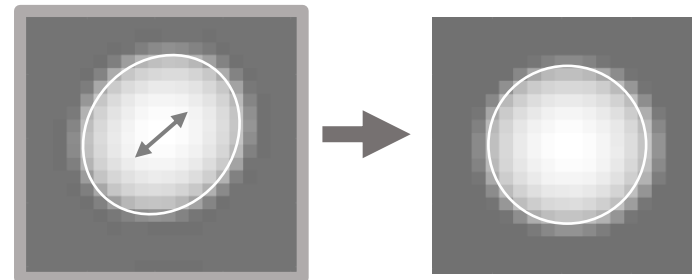
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Sommaire

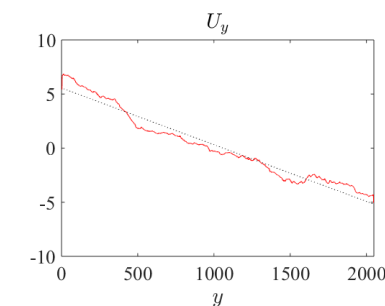
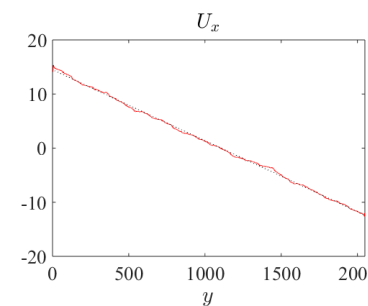
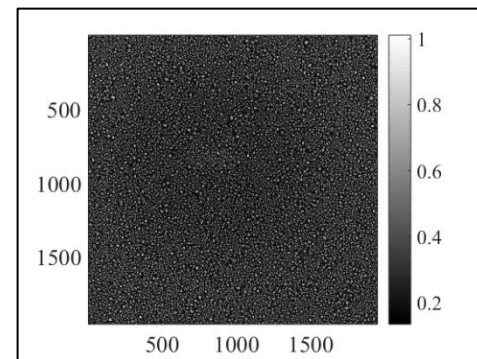
1) Formation d'une image en MEB et ses imperfections



2) Détection et correction



3) Exemple



Echantillon

Scan 0°

Scan 90°

Fabrication

Echantillon fourni par LMS :

- **Démouillage de film d'or sur Si**
- Taille de bille visée : 50nm

Observation

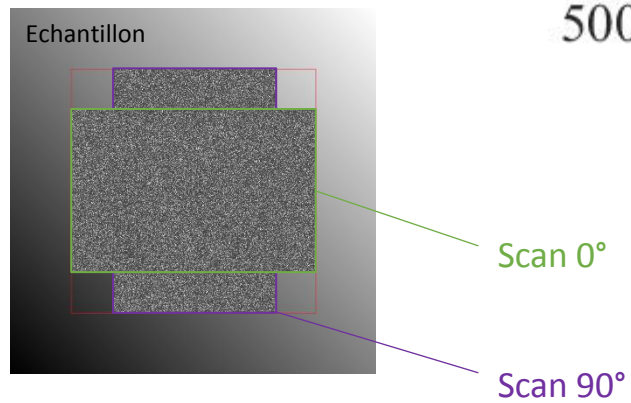
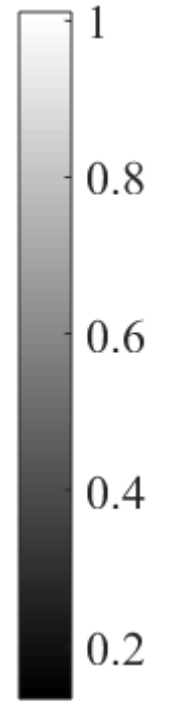
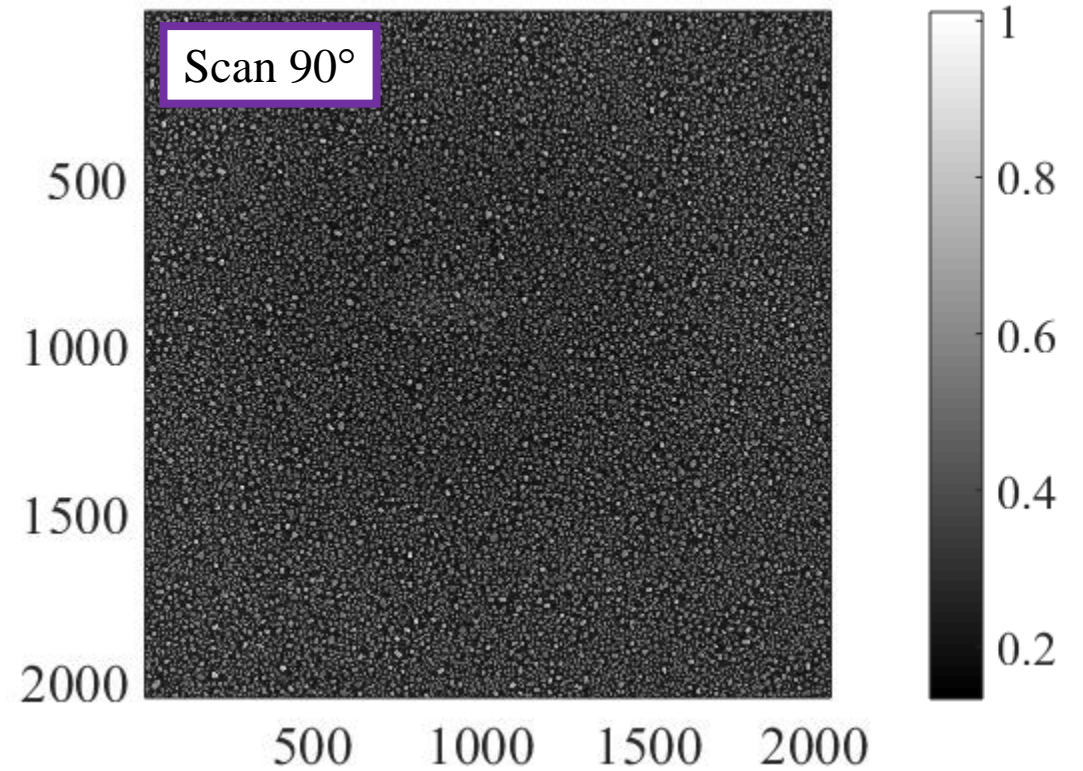
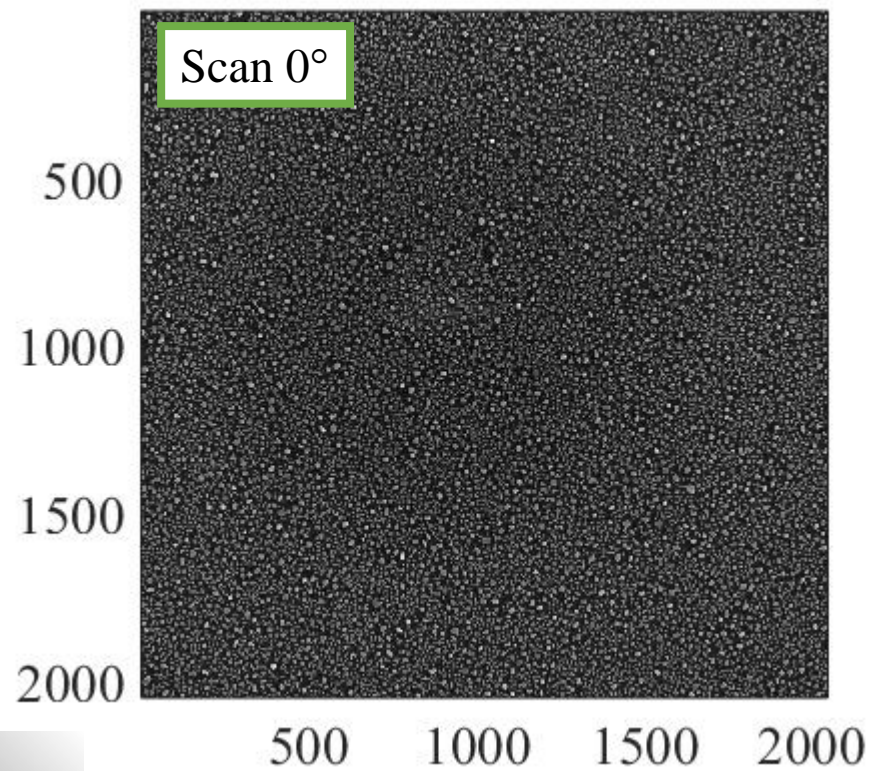
HV : 20kV / Curr : 0,40nA

WD : 4mm

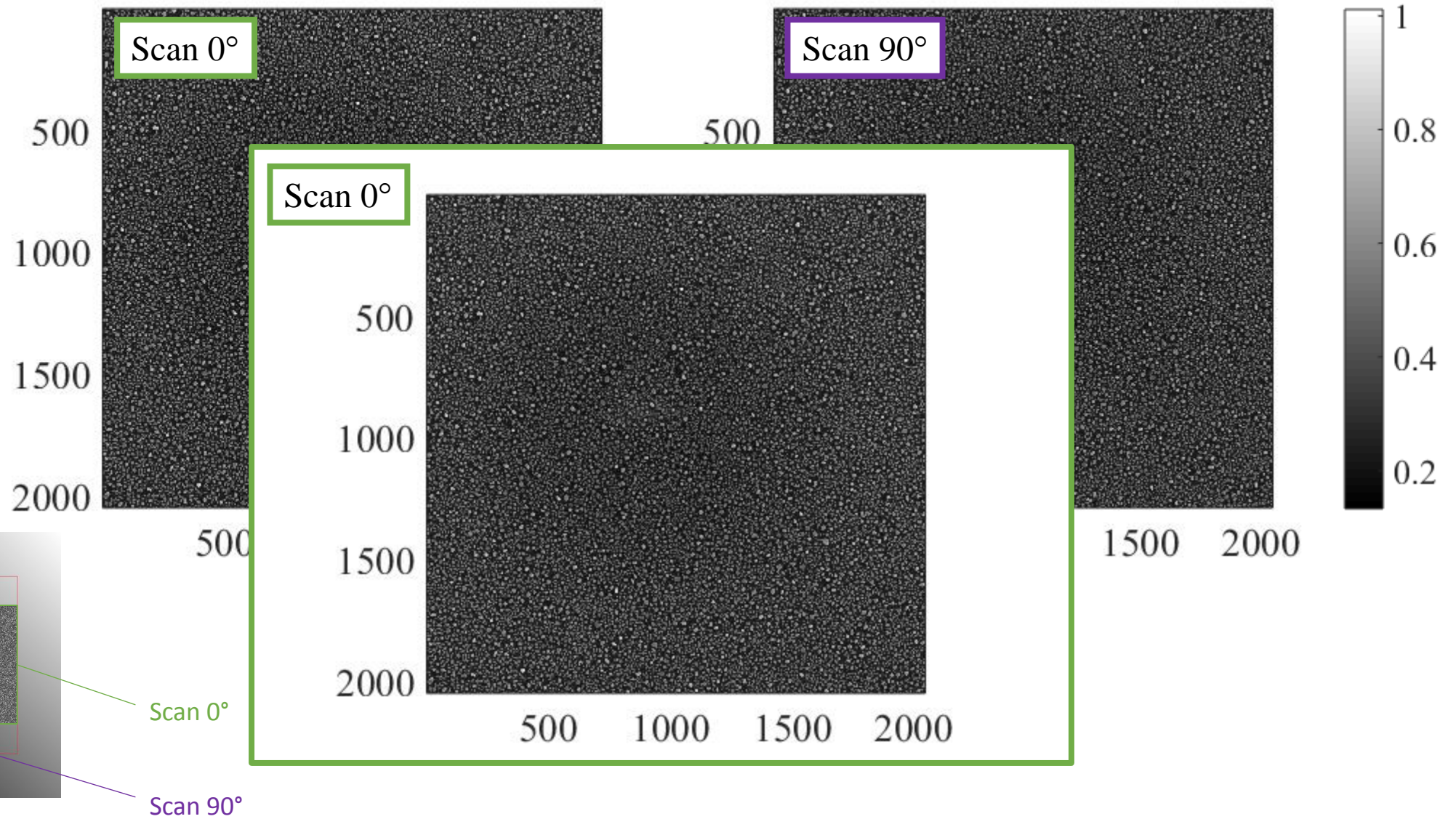
Mag : \approx x8000

Res : \approx **3000x2200**

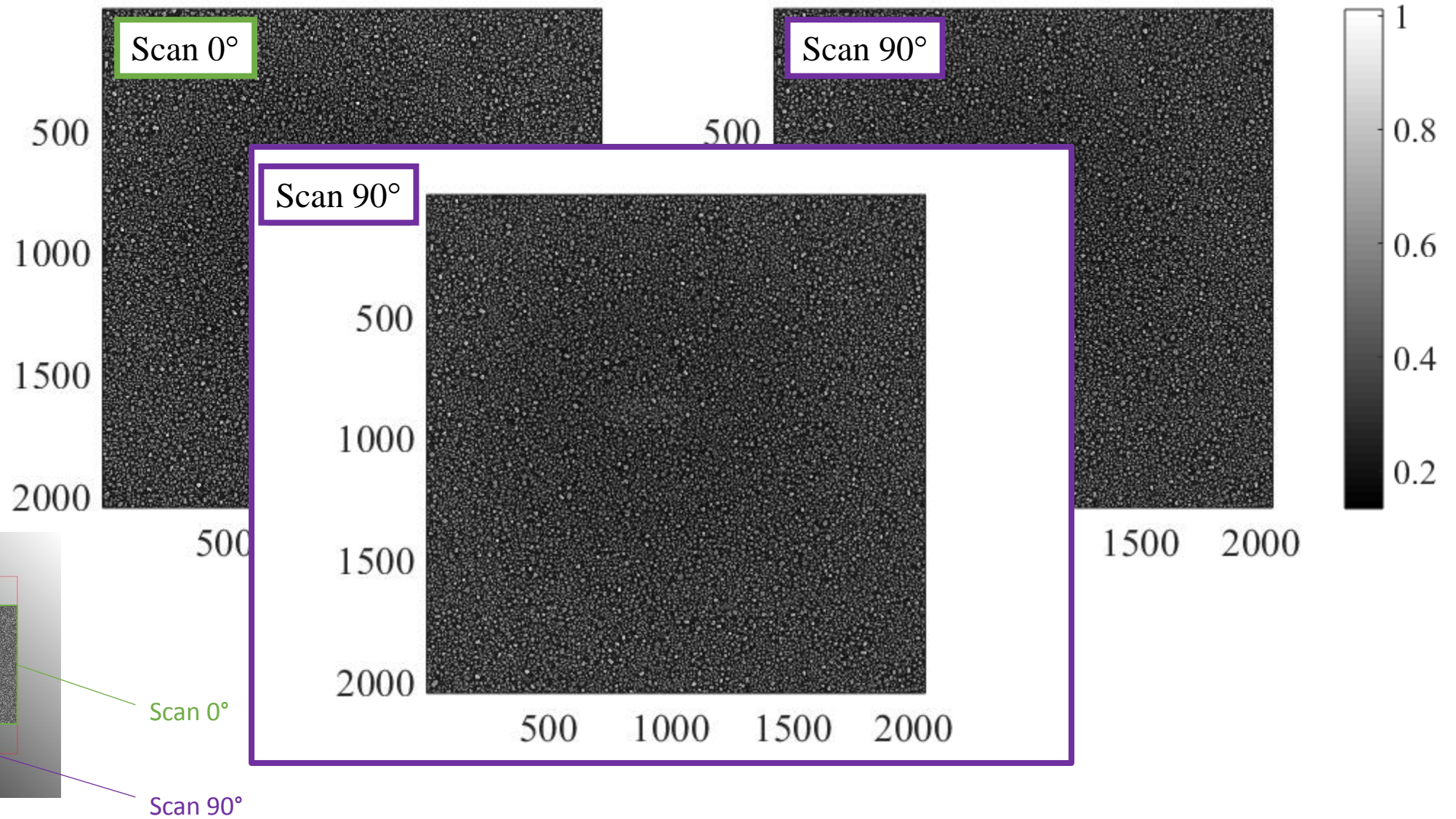
Découpage zone d'intérêt



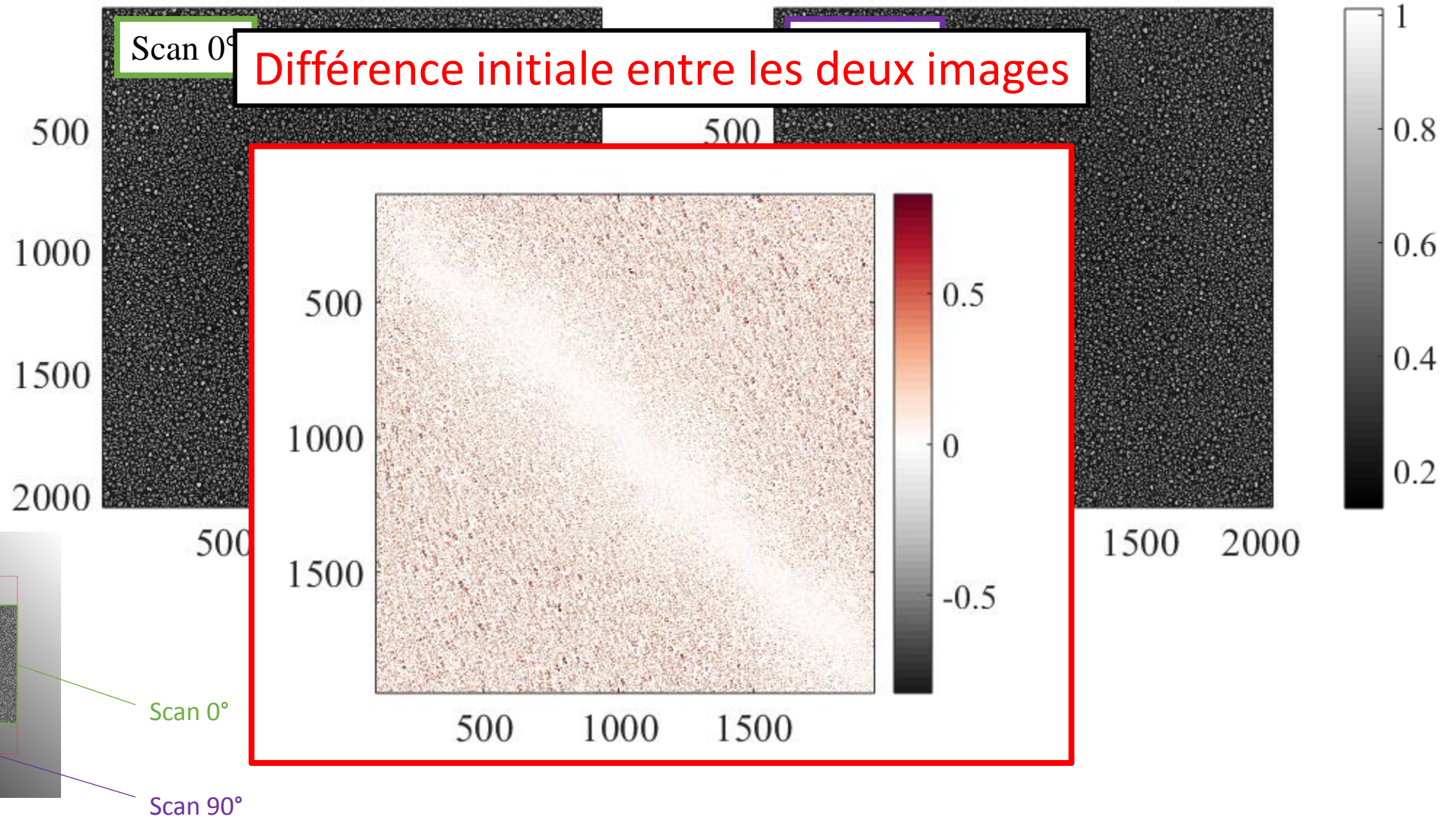
Découpage zone d'intérêt



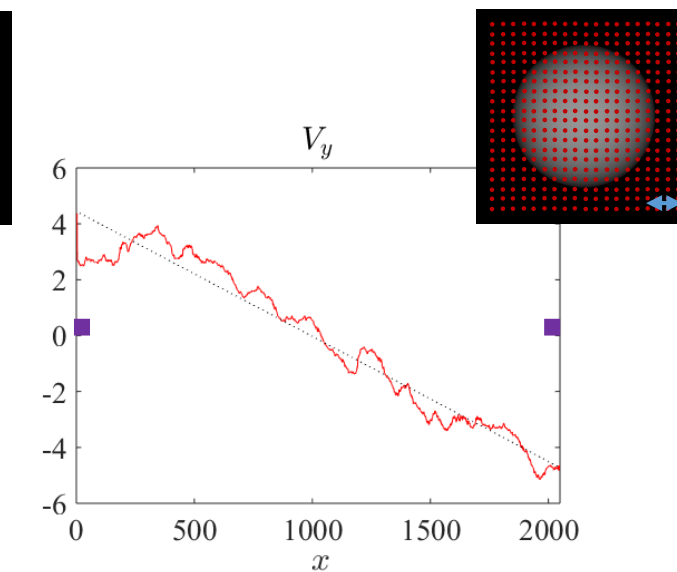
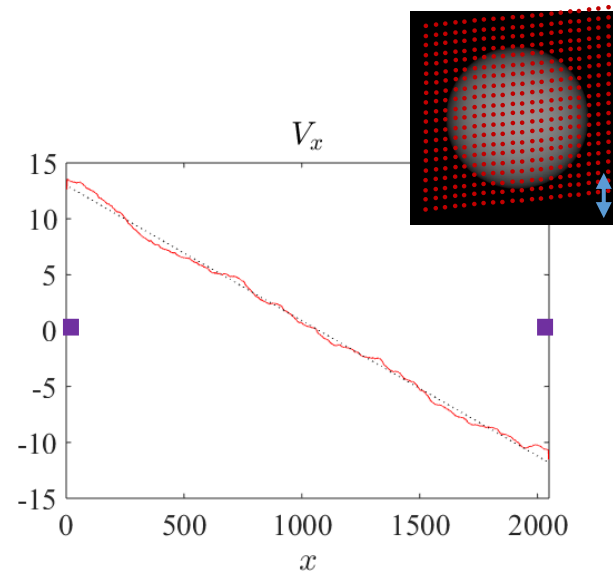
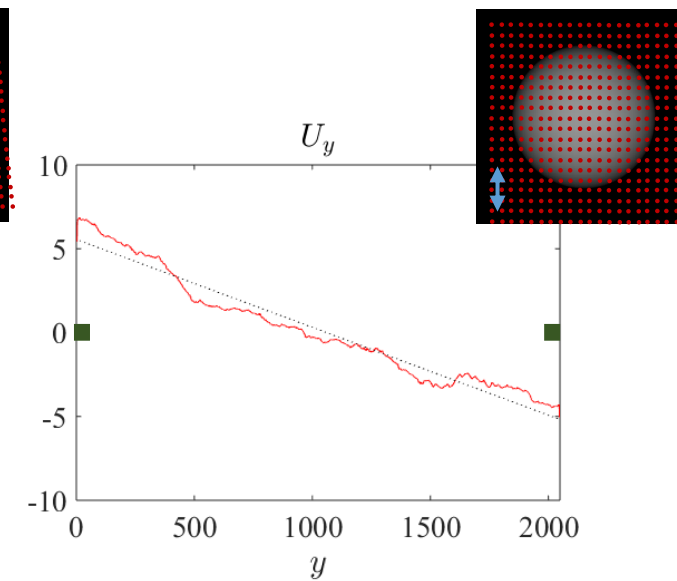
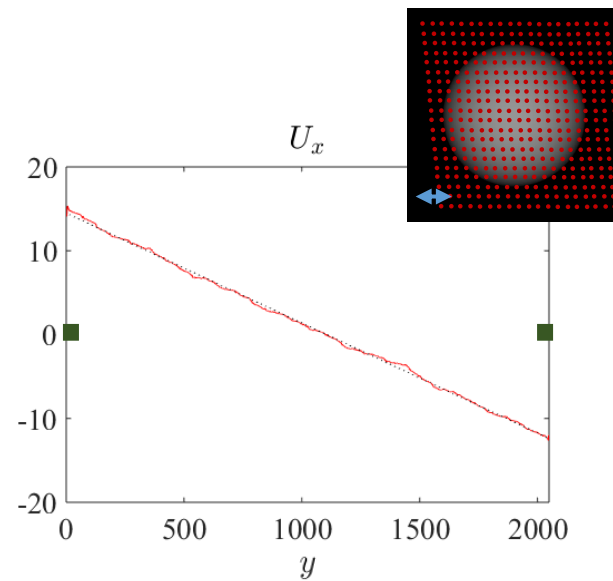
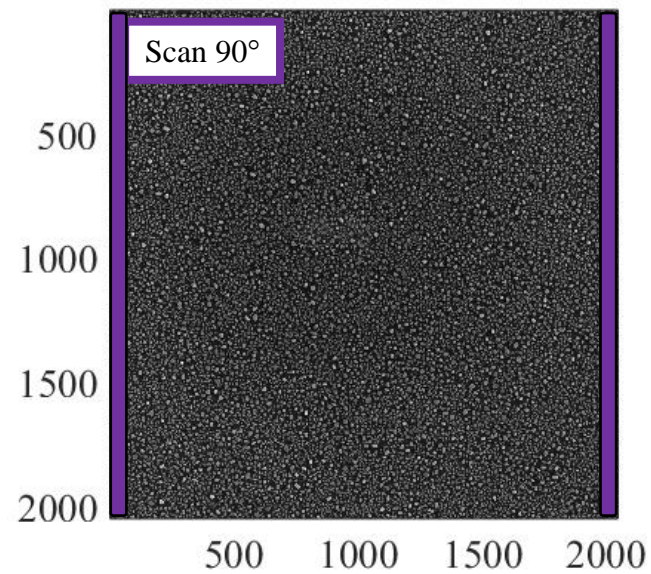
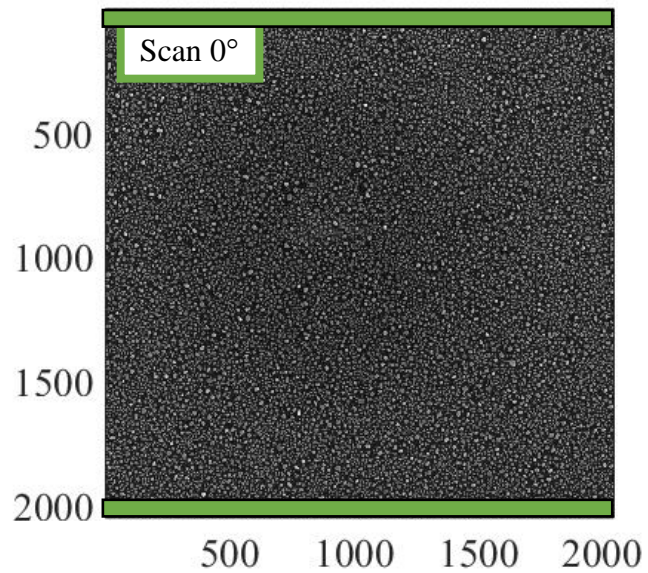
Découpage zone d'intérêt



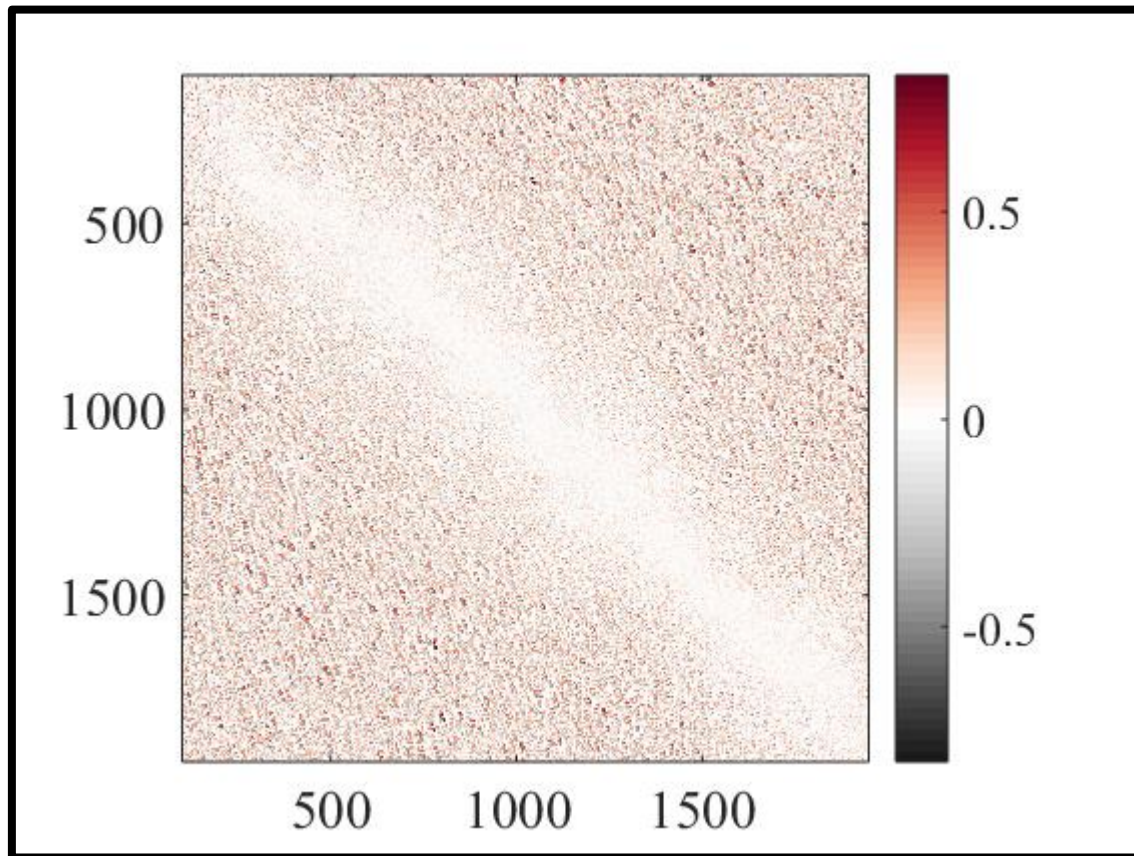
Découpage zone d'intérêt



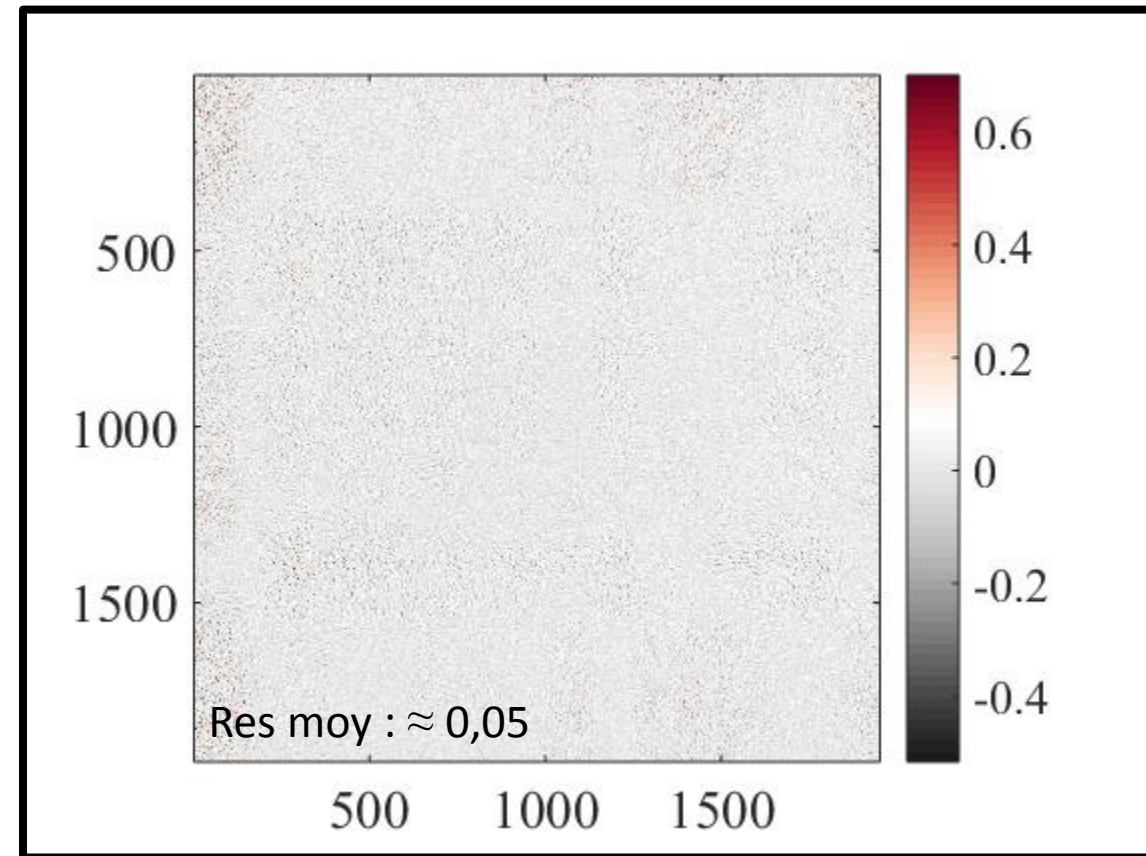
Correction ligne par ligne



Différence initiale entre les deux images



Différence après correction



Différence ini

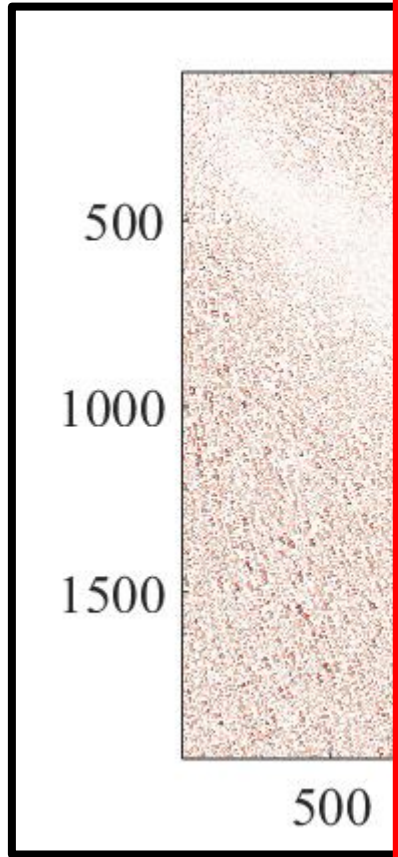
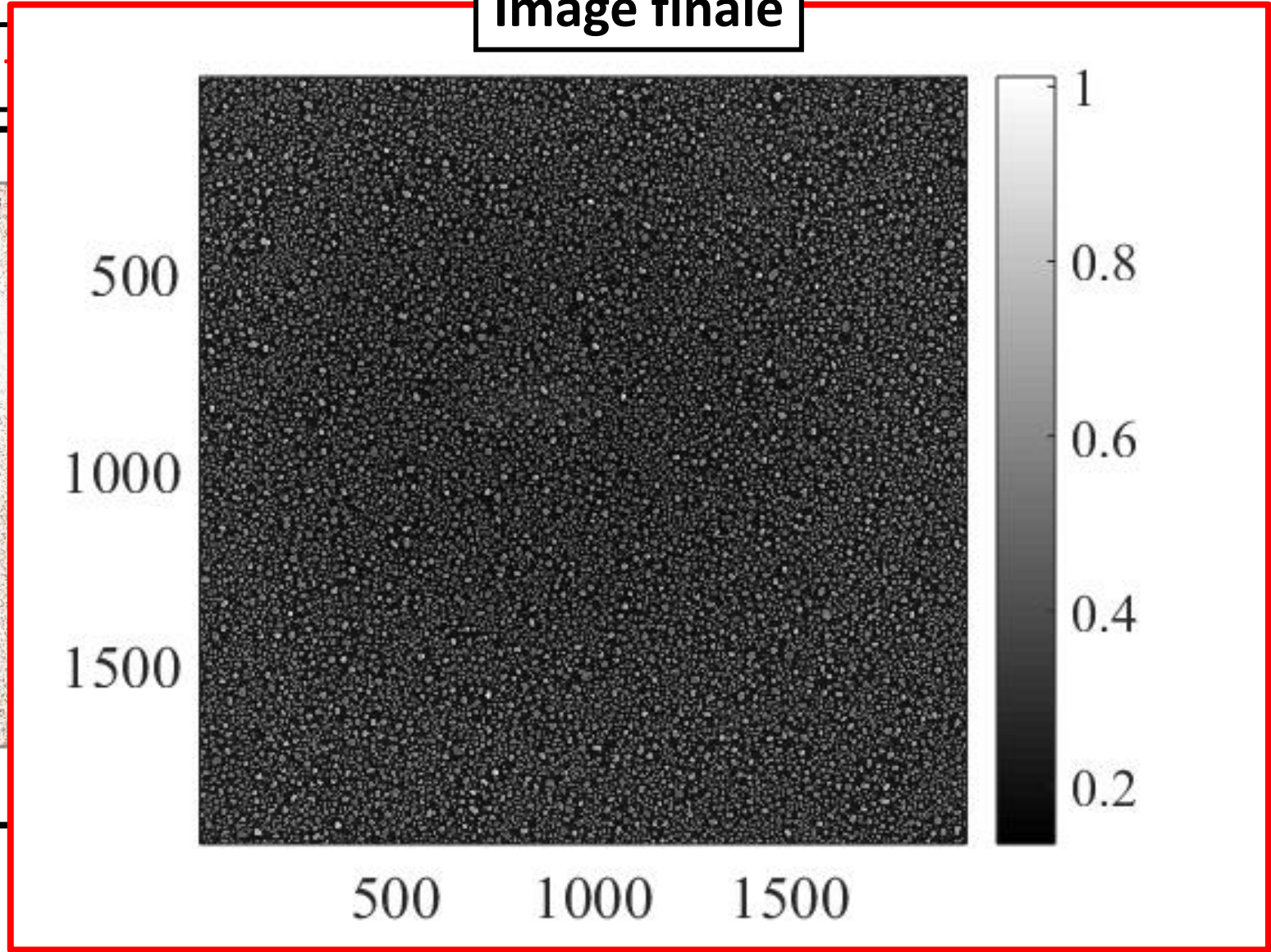
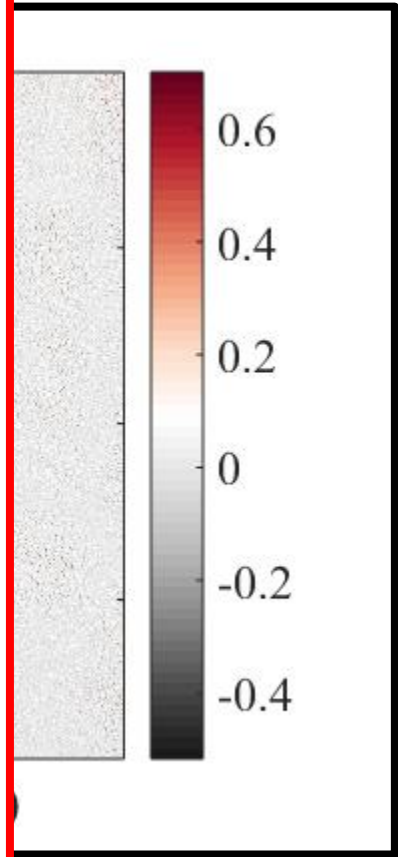


Image finale



rection



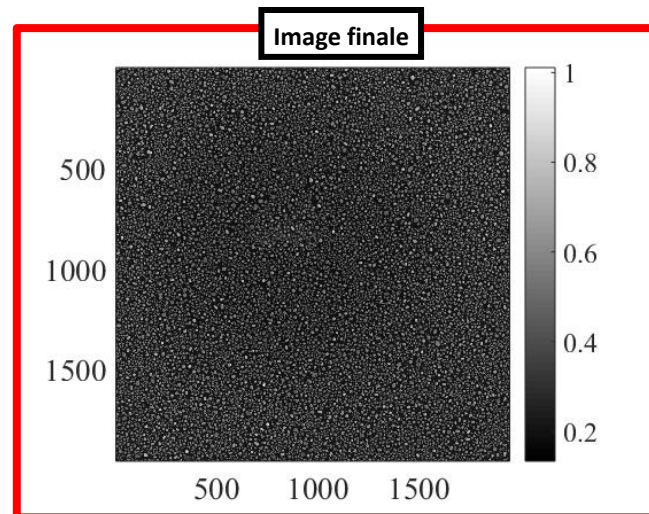
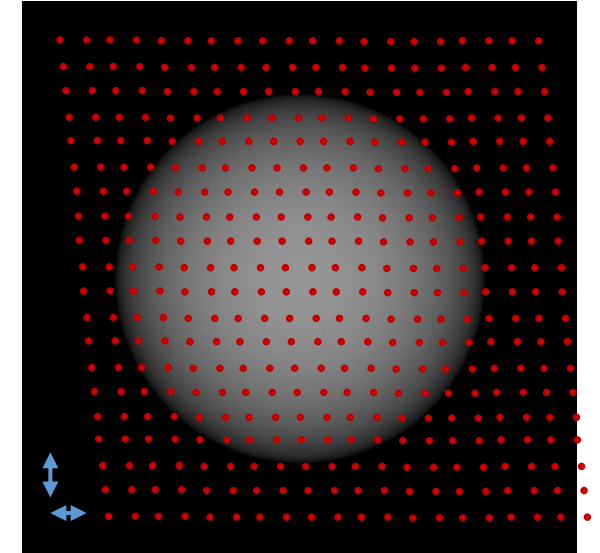
Imperfections

Correction

Exemple

Conclusion

- Observation MEB : Imperfections des balayages
 - Déviation faisceau / échantillon
 - Analyse quantitative
- Proposition d'une correction simple, rapide et efficace





Merci pour votre attention

