



# USE OF X-RAY MICROTOMOGRAPHY TO CHARACTERIZE INTERNAL INTERFACES

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Fuze conference 3 – 5 may 2016

## Objectives of microtomography studies

Apparatus description  
Several applications

## Dedicated characterization

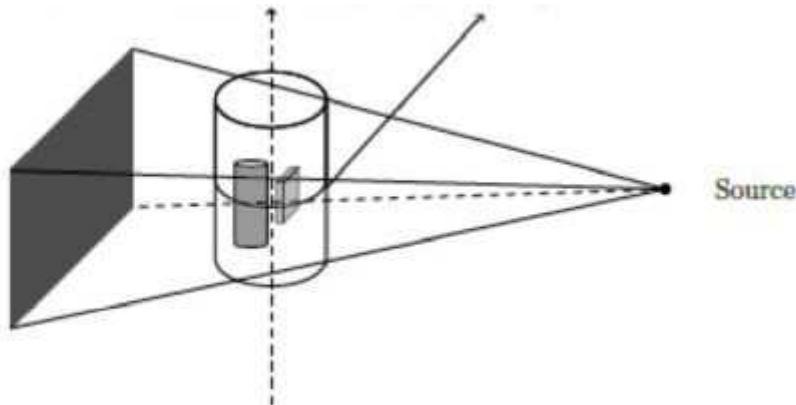
Device and 1.4 s container description  
Results and discussions

# **OBJECTIVES OF MICROTOMOGRAPHY STUDIES**

# MICROTOMOGRAPH DEVICE

## X-ray Tomography new model Skyscan 1172:

- CCD 4000 x 2670, rotation min: 0.01°
- Resolution: 1  $\mu\text{m}$
- Pixel size with magnification max max: 0.8  $\mu\text{m}$
- Object dimension max  $\varnothing$  45 mm H 70 mm
- Tension < 100 Kv, current max 250  $\mu\text{A}$ ,
- power max 10 W



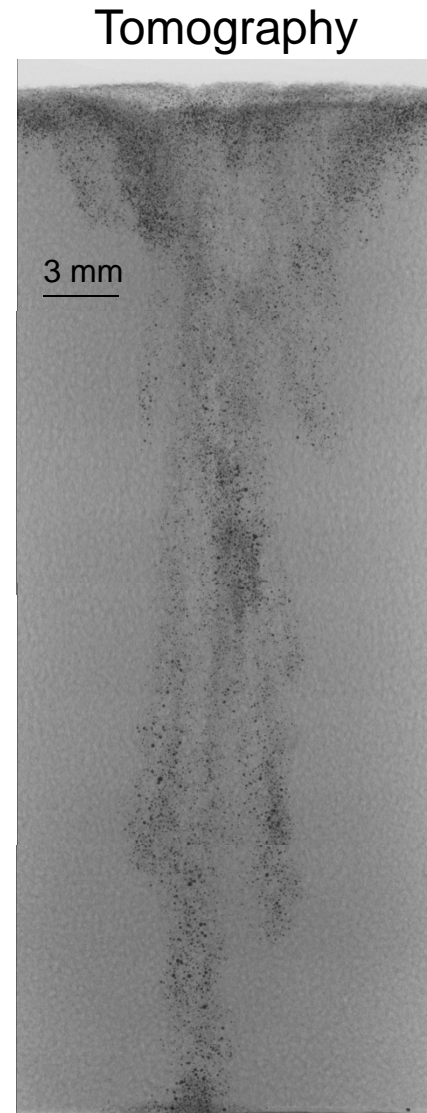
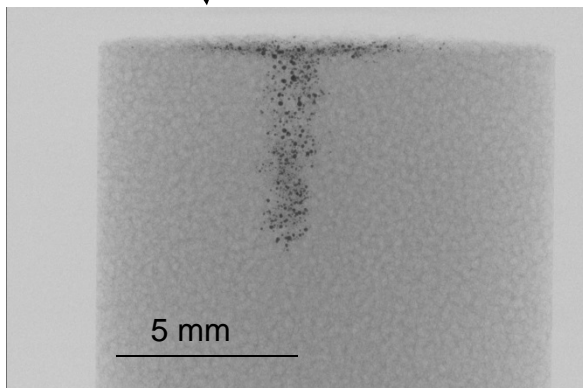
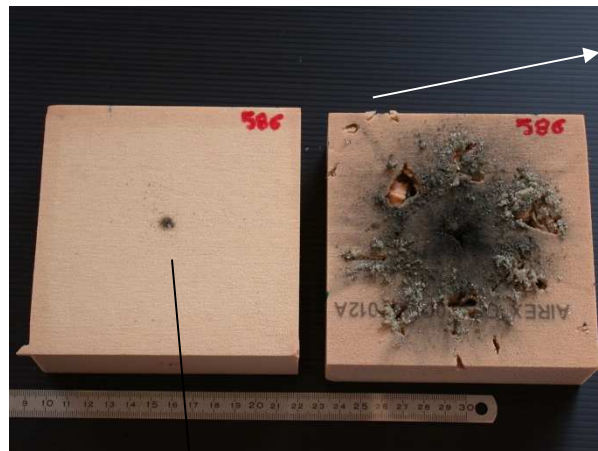
## Former X-ray Tomography model Skyscan 1072:

- CCD 1024 x 1024, rotation min: 0.23°
- resolution: 2  $\mu\text{m}$ ,
- pixel size with magnification max : 1.8  $\mu\text{m}$
- Object dimension max  $\varnothing$  20 mm H 40 mm

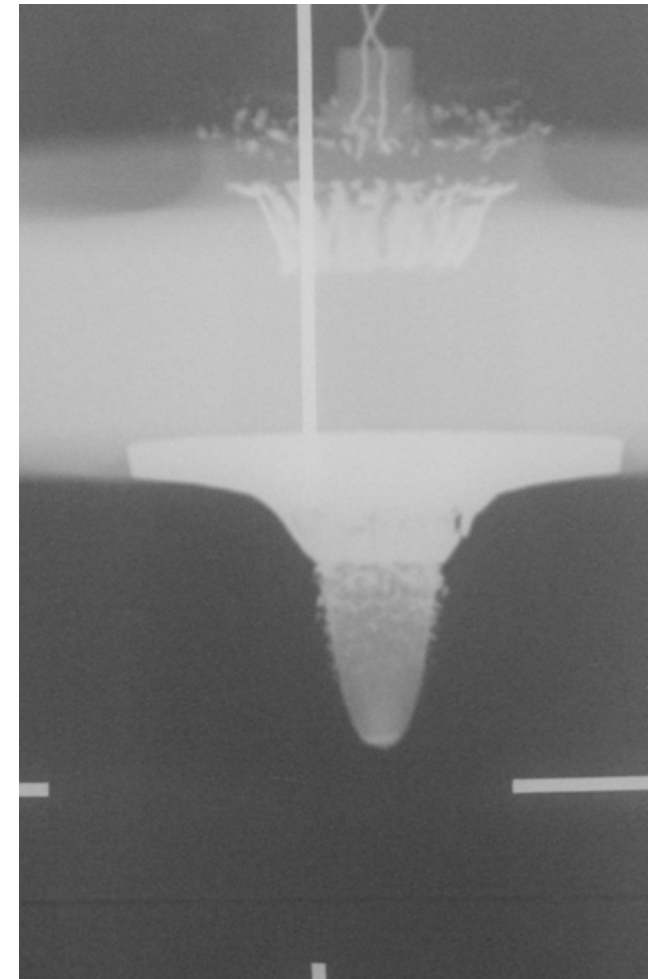


## Tomography benefits / flash X-ray

- Metal particles recovery and analysis
  - Grain size distribution
  - Shape



## Soft flash X-ray

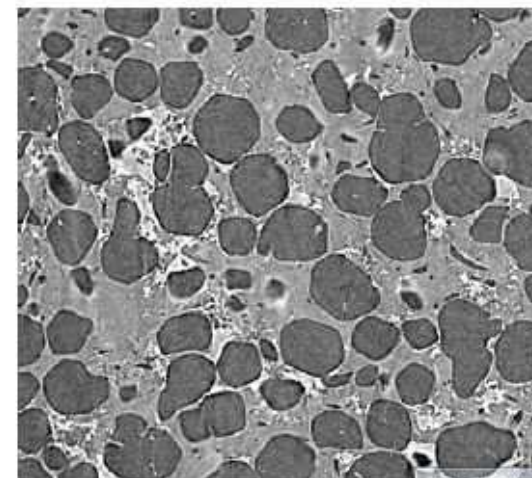
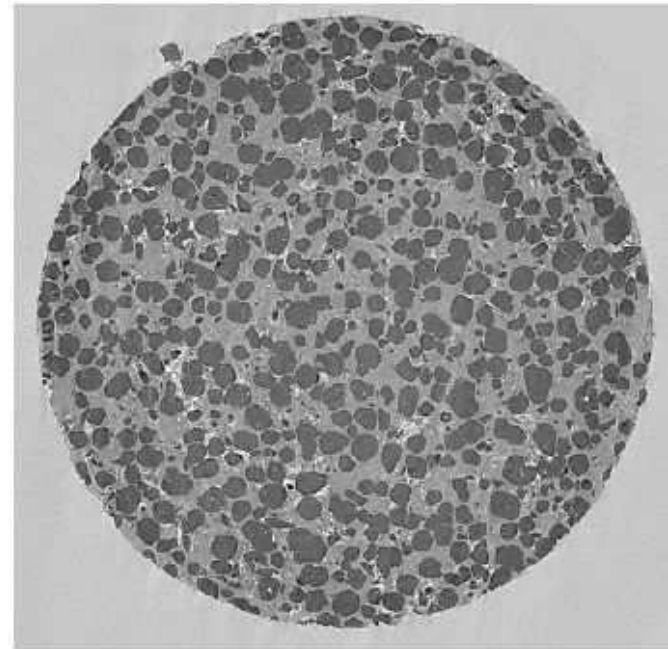
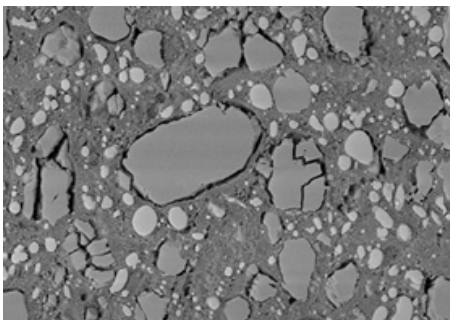
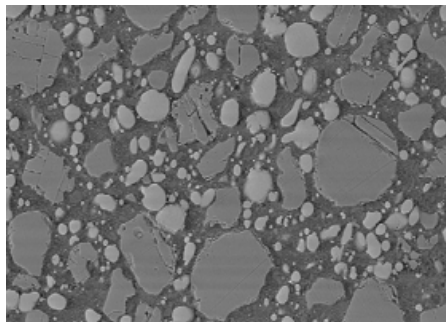


A.Lefrancois et al. APS 2011



## μtomography benefits / metallographic methods

- Pristine and post-mortem analysis of HE
  - 3D defects : debonding, cracks
  - Porosity identification
  - Faster method



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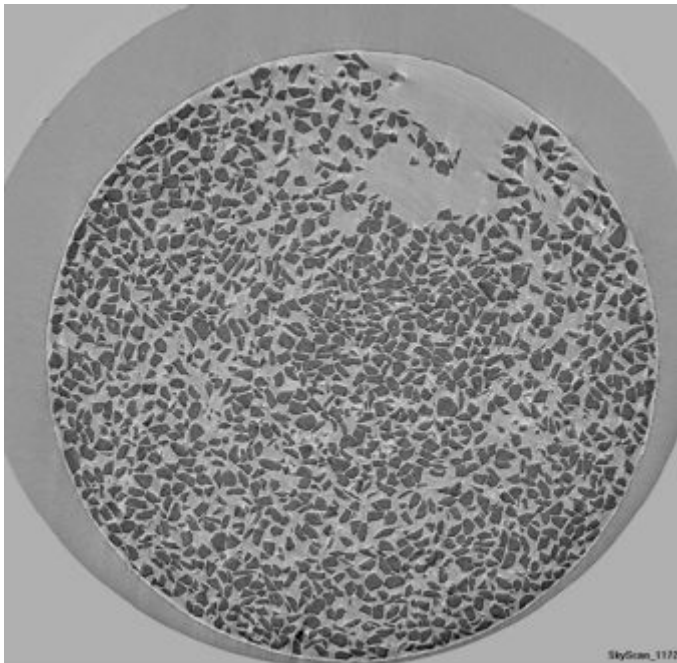
A.Lefrancois et al. ISIEMS 2002

V.Chuzeville et al. IPS 2015

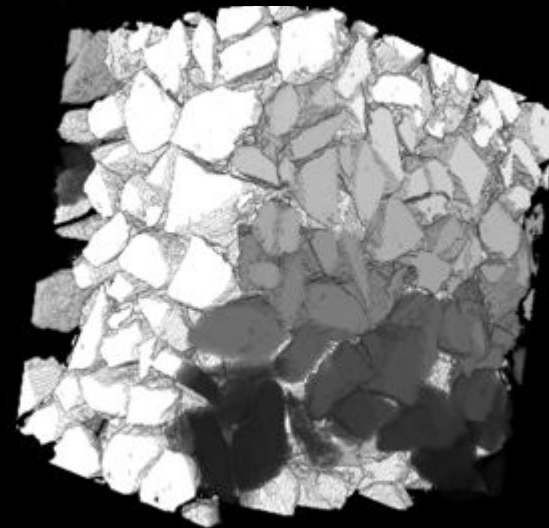
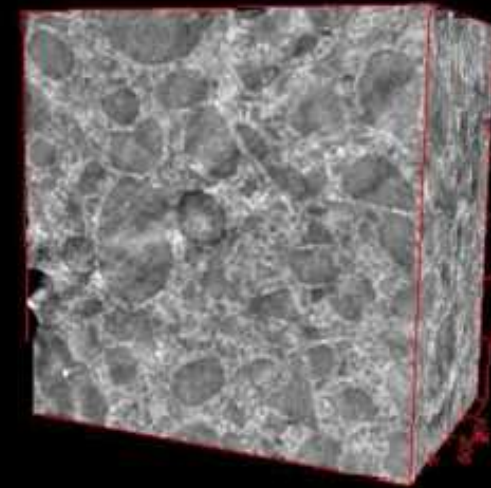
J.Corbel et al. ISL meeting 2016

## Micro- Meso-structural meshing for numerical materials

- Meshing from the material microstructure
  - Reconstruction tools with dedicated segmentation
  - With and without binder
  - Local porosity defects identification

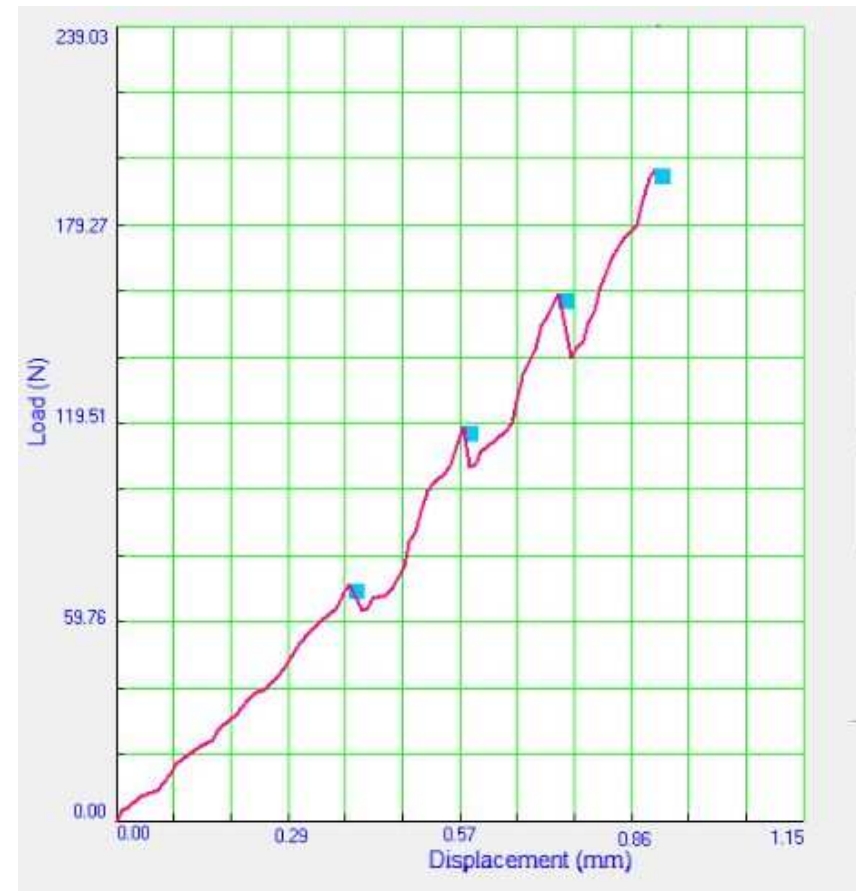
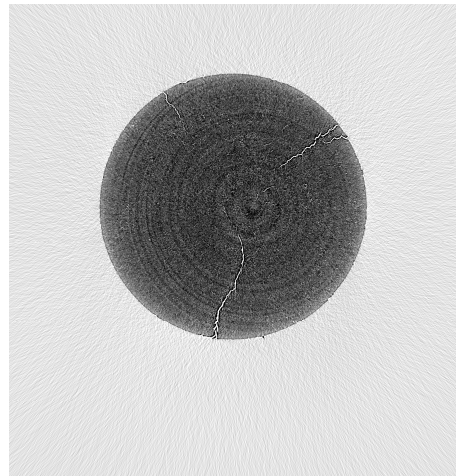


SilyScan\_1172



## Traction test inside the $\mu$ tomograph

- Mechanical and microstructural characterization
  - Direct measurement
  - Local defects identification

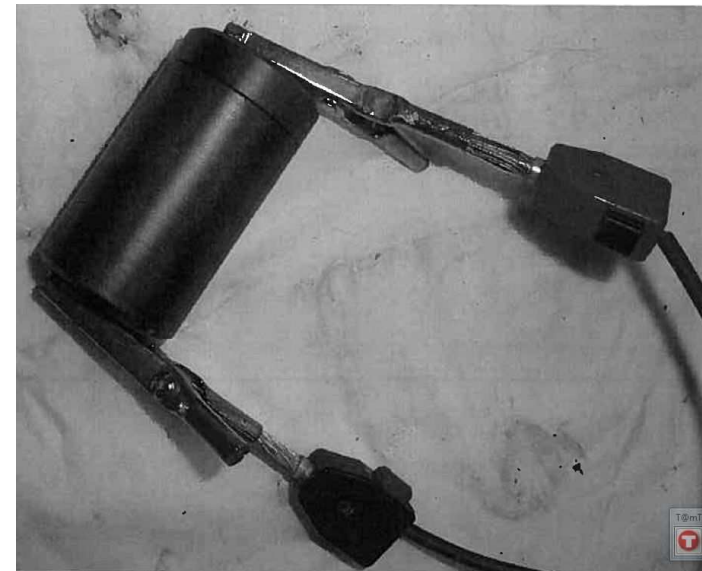
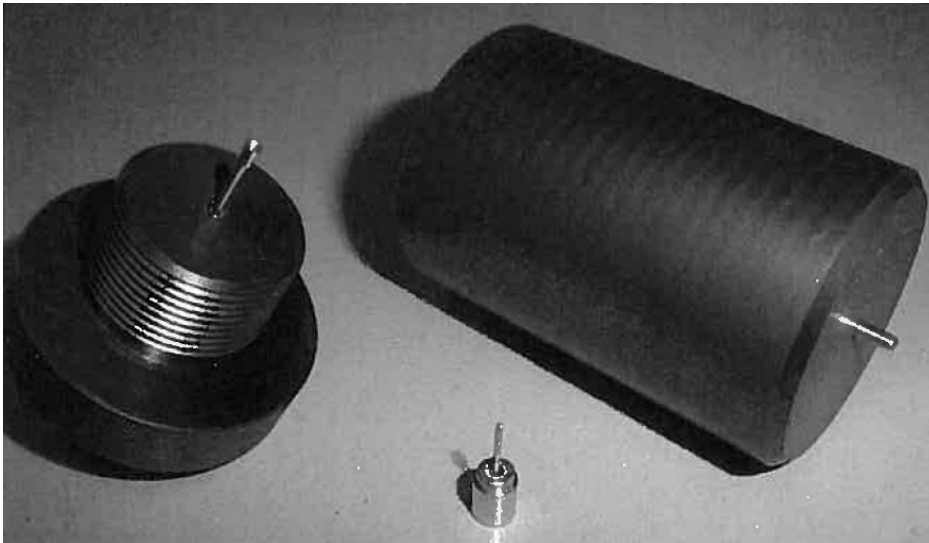




**DEDICATED APPLICATION**

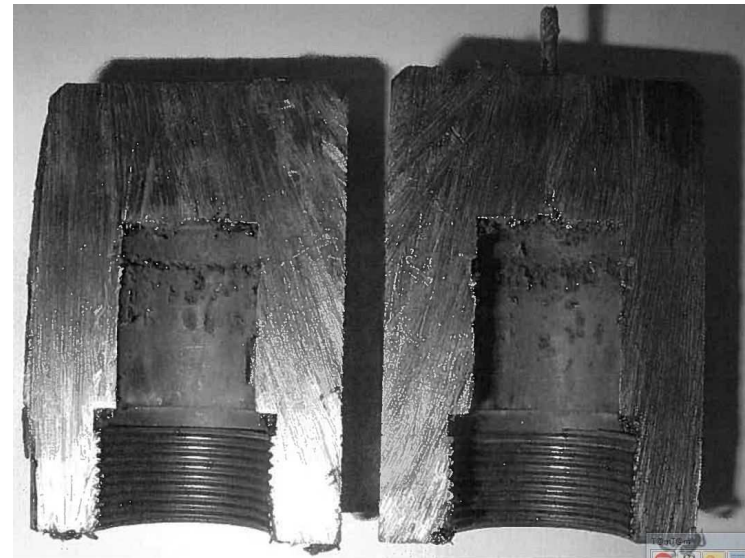
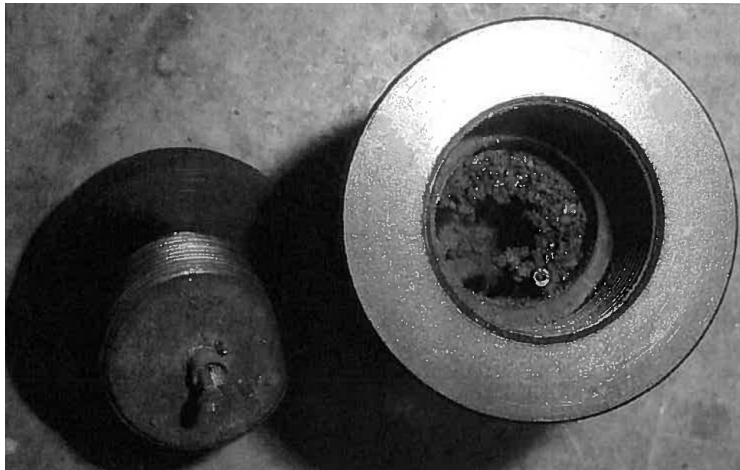
## Objectives

- Characterization after cold thermal cycle
- Development of 1.4s container for safety compliance
  - Contain the frag and blast effects
  - Should not affect the  $\mu$ tomography analysis



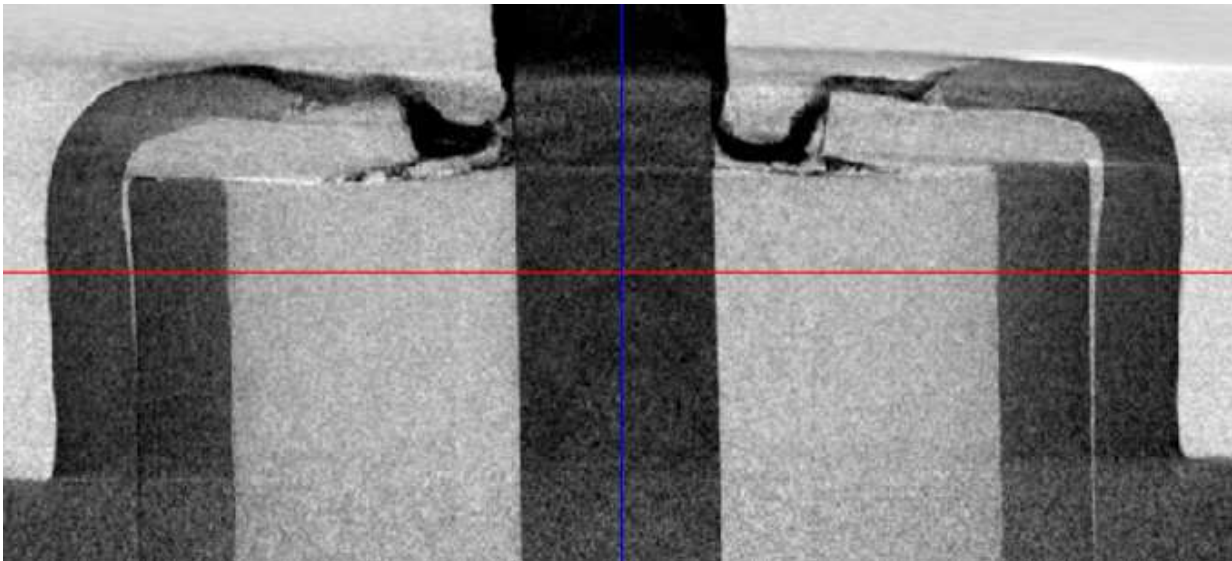
## Validation of the safety container

- Container design with plastic and conductive filler
- Perform several performance tests
- Post mortem analysis and validation for safe use



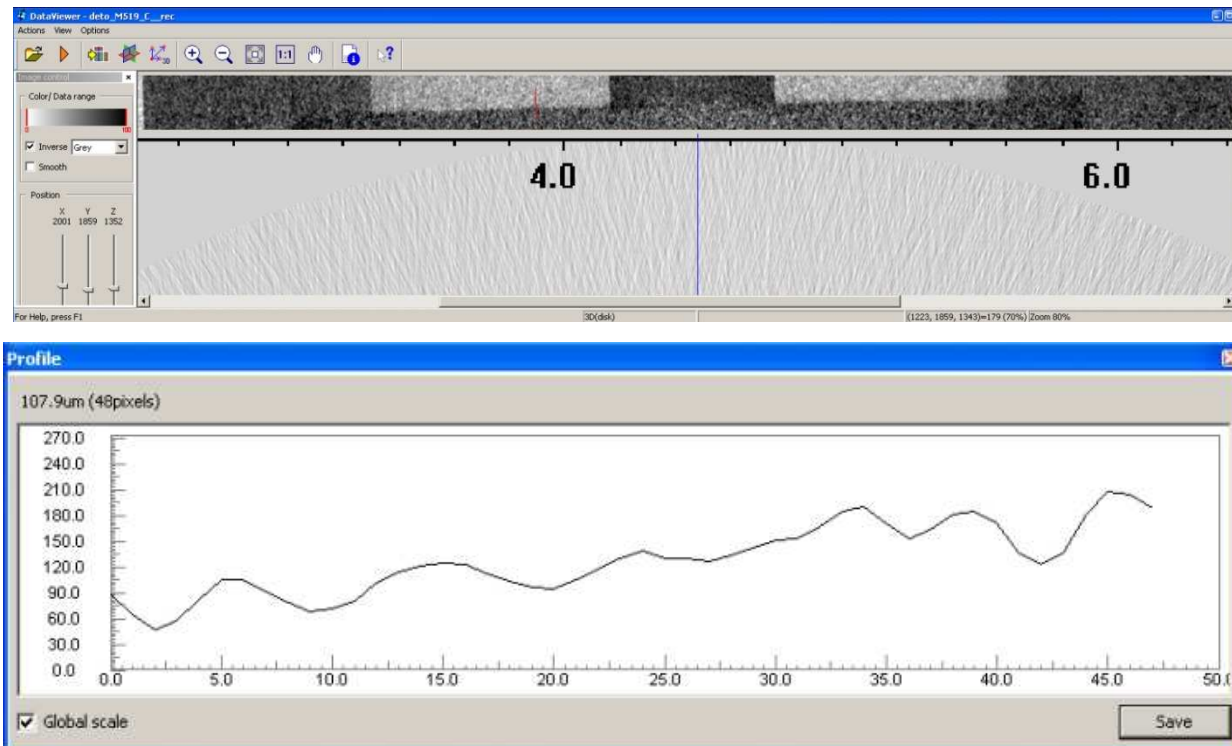
## Gap analysis

- Geometrical gaps induced by the forming process



## Gap analysis

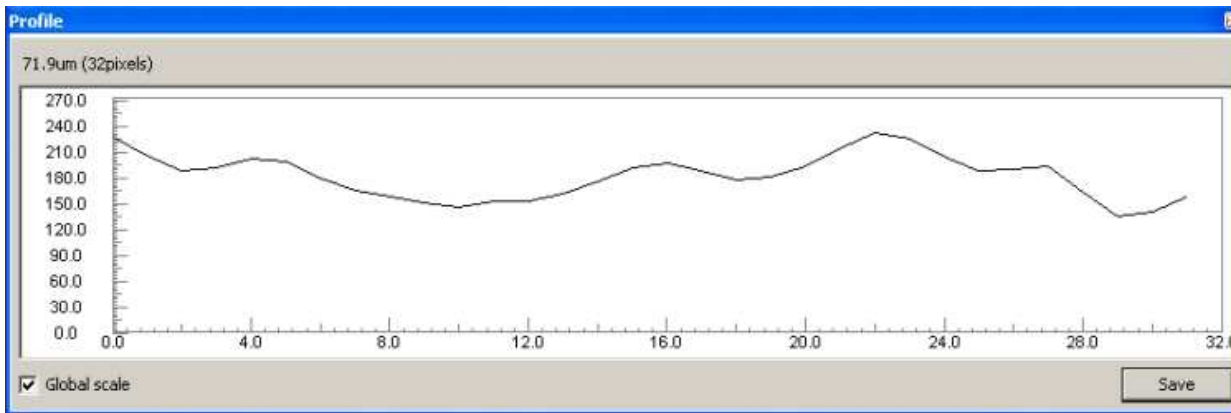
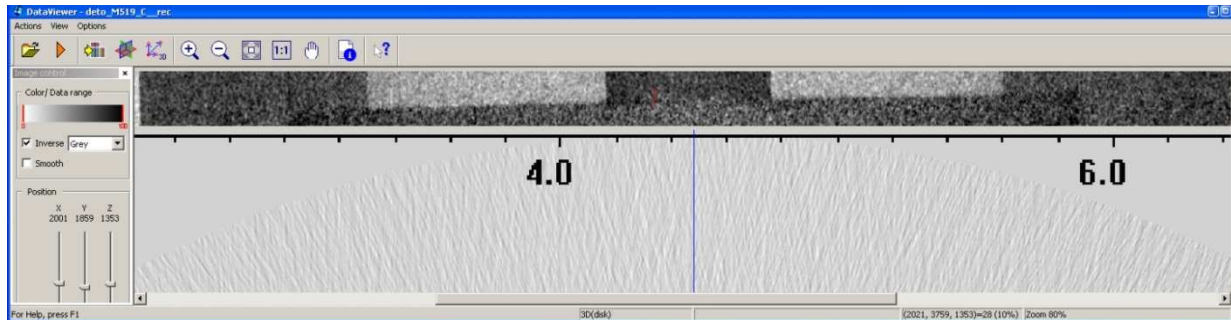
- Interface between inert and energetic material





## Gap analysis

- Interface between inert and energetic material



## Applications

- Several applications for pristine and post-mortem analysis
- Dedicated for dedicated characterization
- Analysis after cold thermal cycle

## Coming soon

- Hot or cold cycle during the analysis to see potential gaps
- Traction/compression inside the  $\mu$ tomograph
- Process characterization, density defects, gaps
- Flyer characterizations, screening test, craters, statistics ...

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