INRS CT SCANNING FACILITY: A POWERFULL NON DESTRUCTIVE 3D AND 4D INVESTIGATION TOOL

Mathieu Des Roches, Jr. Eng.

Lab CT Scan

Laboratoire multidisciplinaire de tomodensitométrie pour les ressources naturelles et le génie civil

NDT in Canada
NDTiC 2017
Canada's NDT Conference
June 6 - 8
Centre des congrès de Québec
Québec City, Québec

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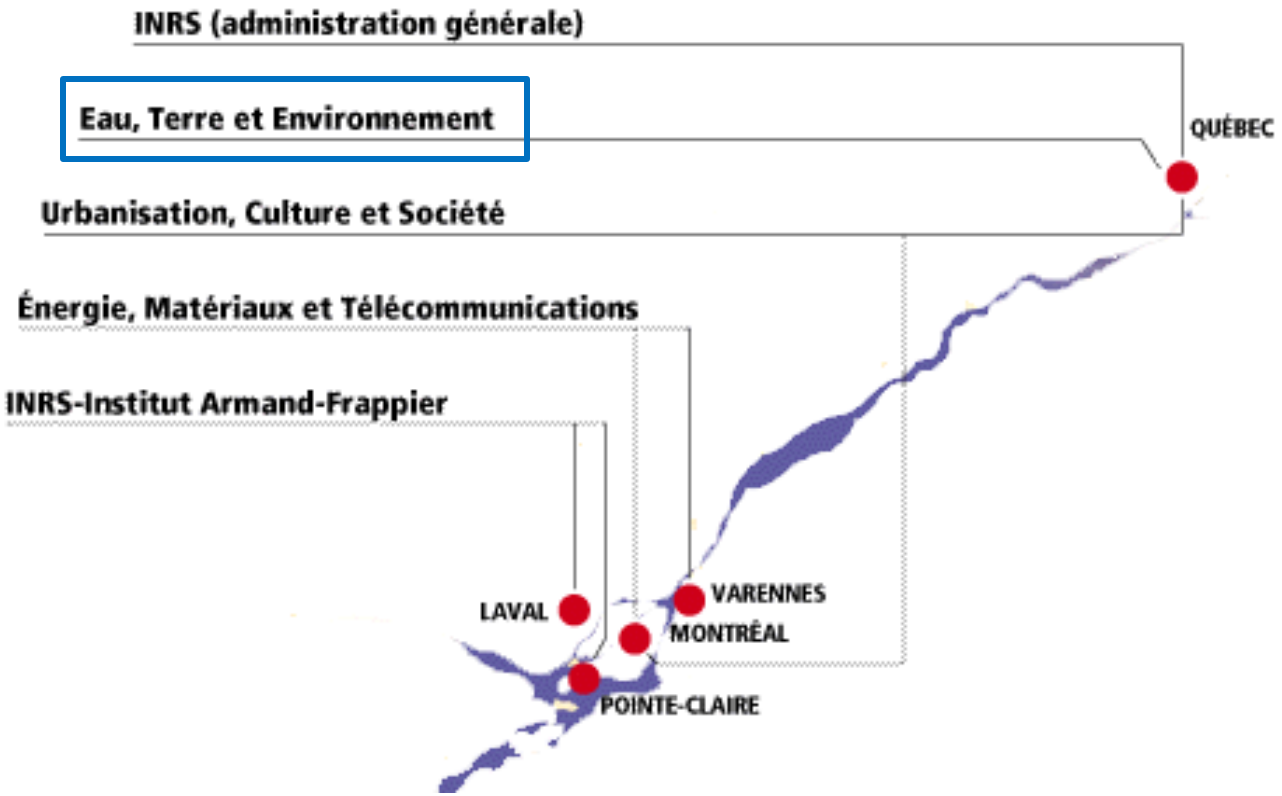
UNIVERSITÉ DE RECHERCHE
A RESEARCH UNIVERSITY

Presentation overview

- What is INRS?
- CT-scan laboratory
- CT-scan principles
- Projects overview
- Case study 1: Longhorn beetles -> next speaker
- Case study 2: Rupture process of suspension clamps

What is INRS?

Institut Nationale de la Recherche Scientique (INRS)



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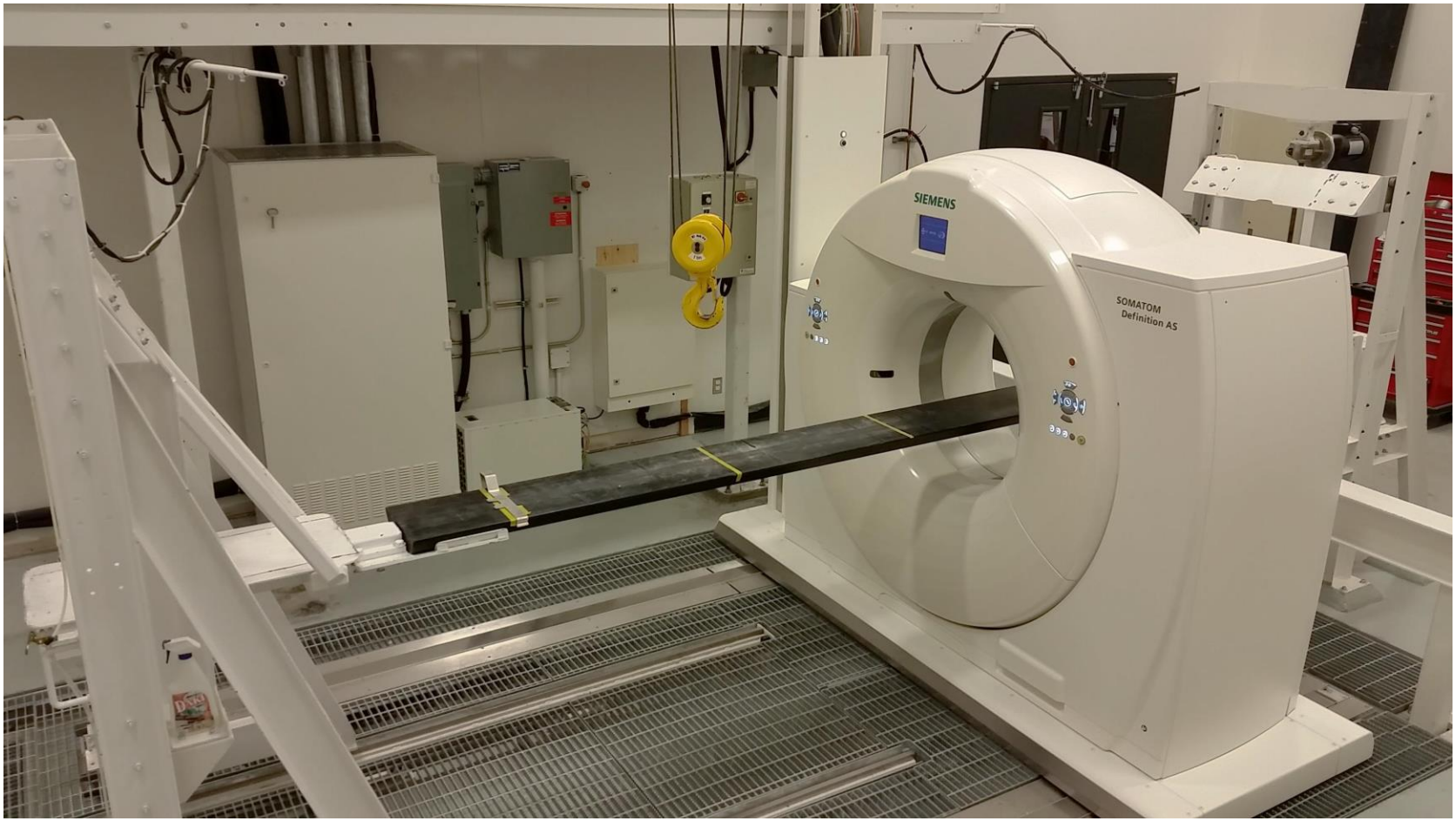
The CT-scan laboratory



Siemens SOMATOM Definition AS+ 128

- Temporal resolution: 150 milliseconds
- Spatial resolution: 97 x 97 x 400 microns

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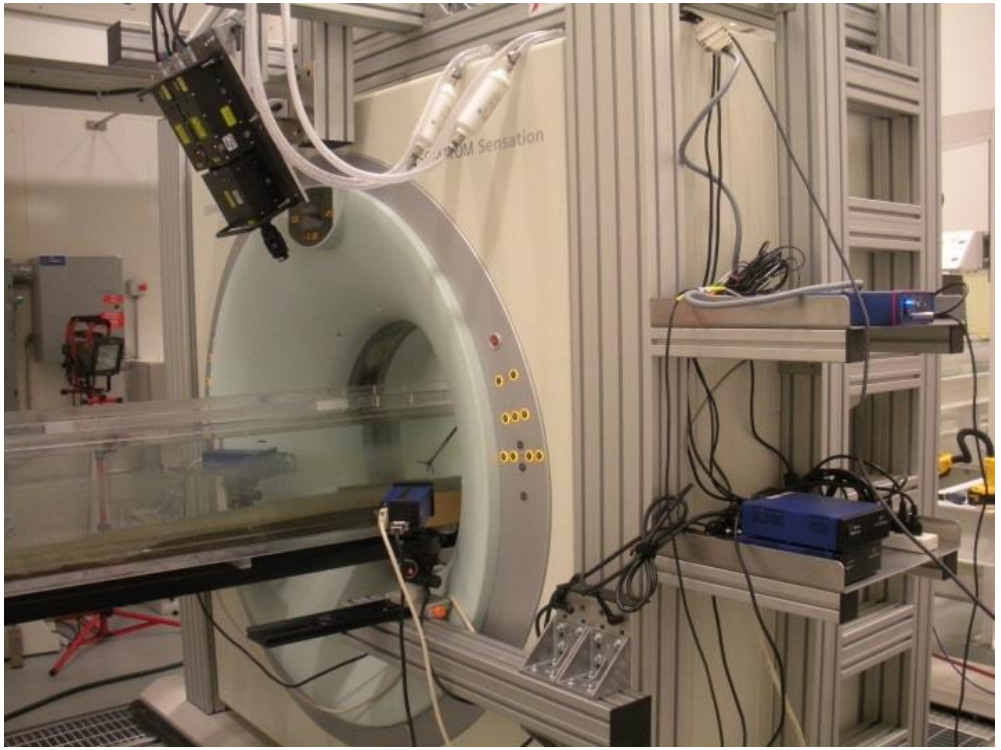
The CT-scan laboratory



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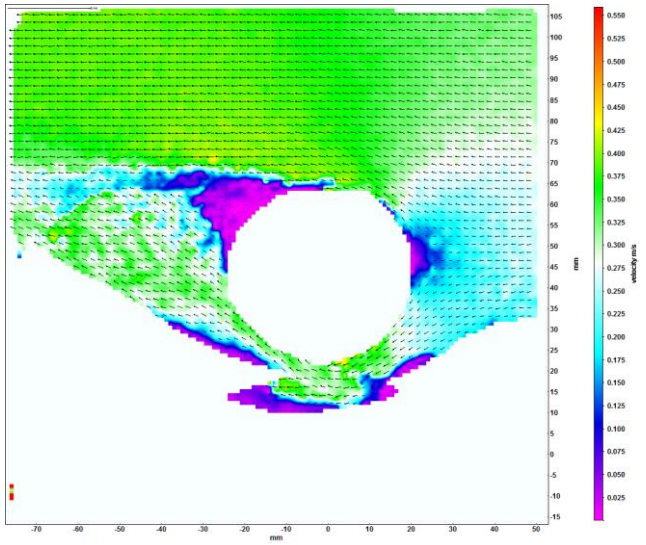
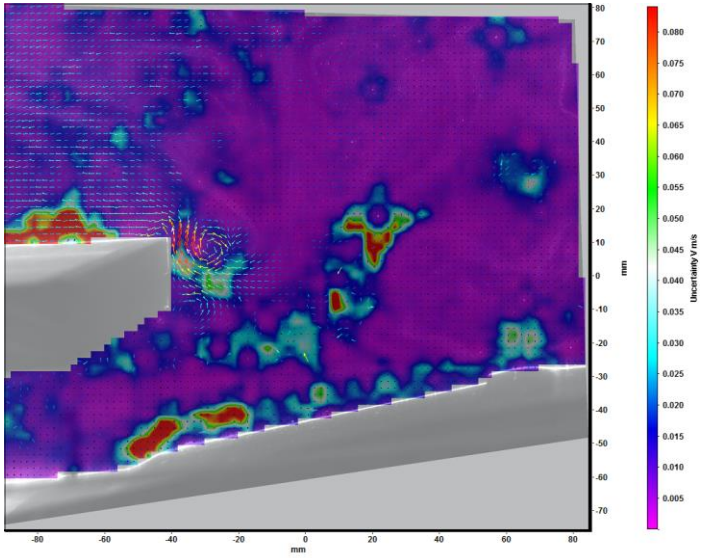
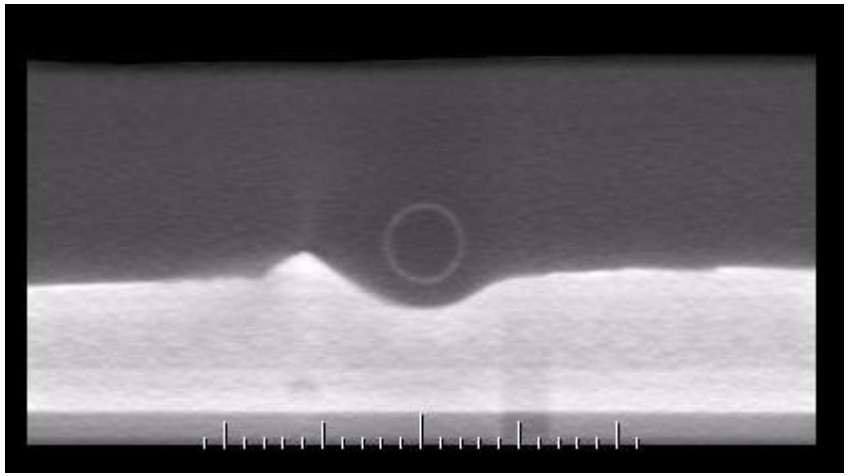
The CT-scan laboratory
PIV measurements







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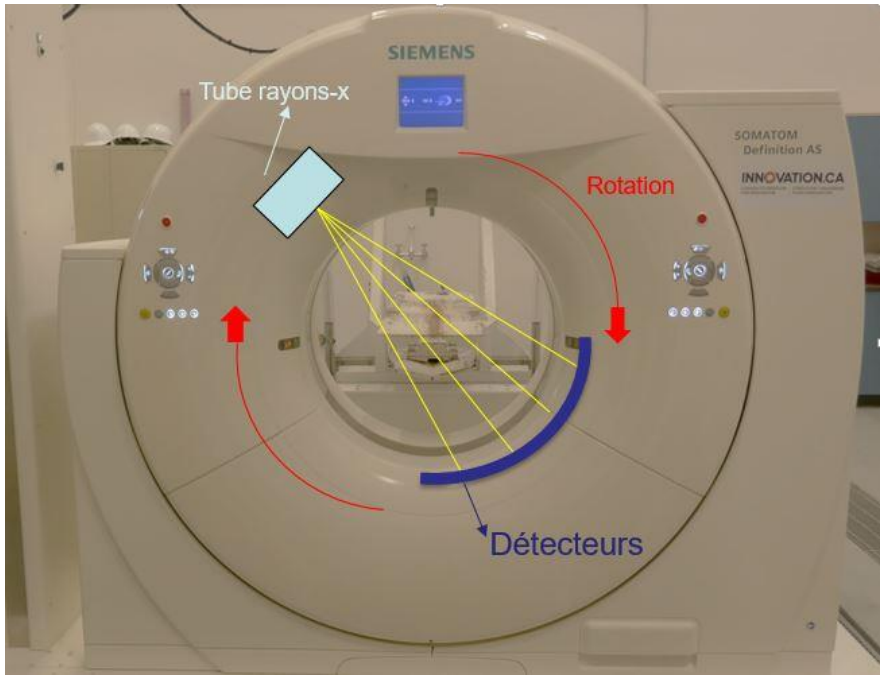
The CT-scan laboratory

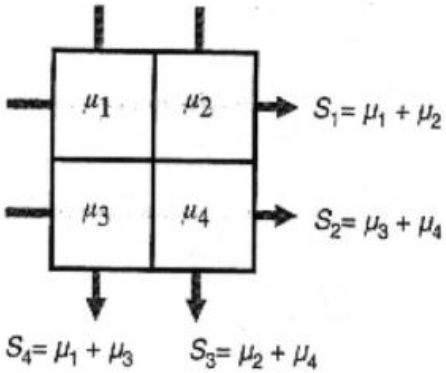
Common terms:

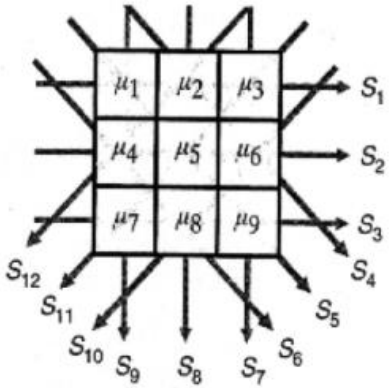
TACO	(Tomographie Axiale Calculée par Ordinateur)
CT Scan	(Computerized Tomography)
CAT Scan	(Computer-Assisted Tomography)
TDM	(Tomodensitomètre)
Medical scanner	

Radiography
X-ray

CT-scan principle:



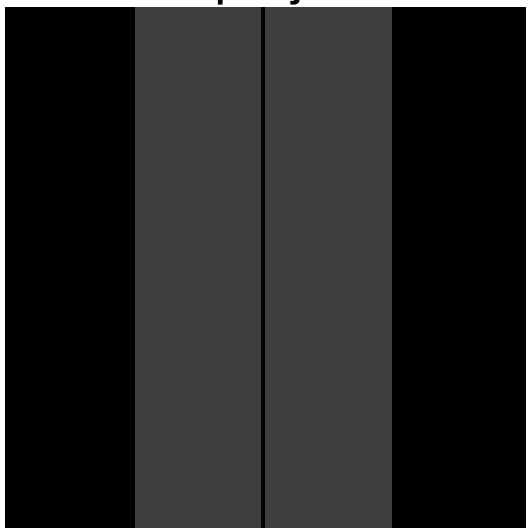




Principe de la tomodensitométrie:

Image reconstruction

Back projection



$$\mathrm{HU} = \frac{\mu(x,y) - \mu_{\mathrm{w}}}{\mu_{\mathrm{w}}} \times 1000$$

Iterative (work in progress)
OSC-TV

Reference:
GPU-Accelerated Few-view CT Reconstruction Using the OSC and TV Techniques
Dmitri Matenine, Sami Hissoiny, and Philippe Després

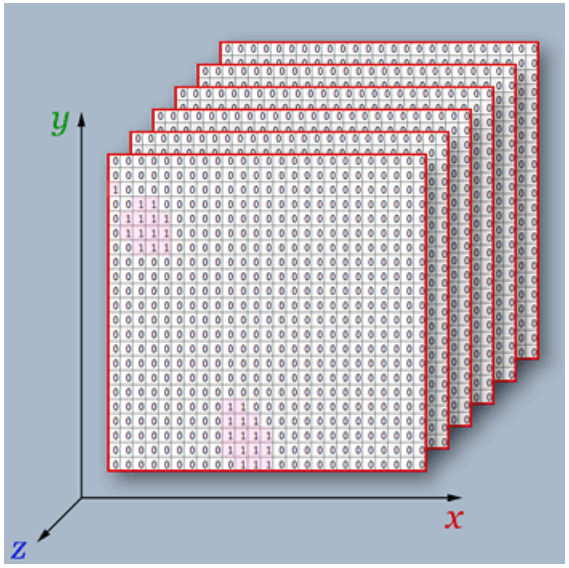
CT-scan output

Data format

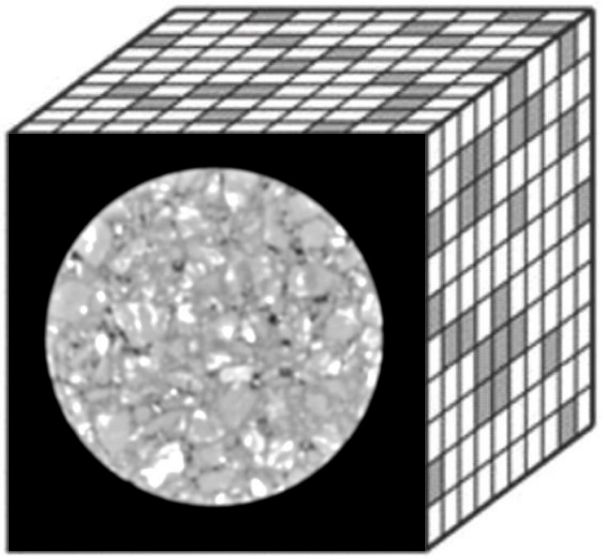
DICOM axial images

512kB per image
About 300MB per samples of 35cm

Density measurements (HU)



Concatenate into a 3D matrix



Black: low density
White: high density

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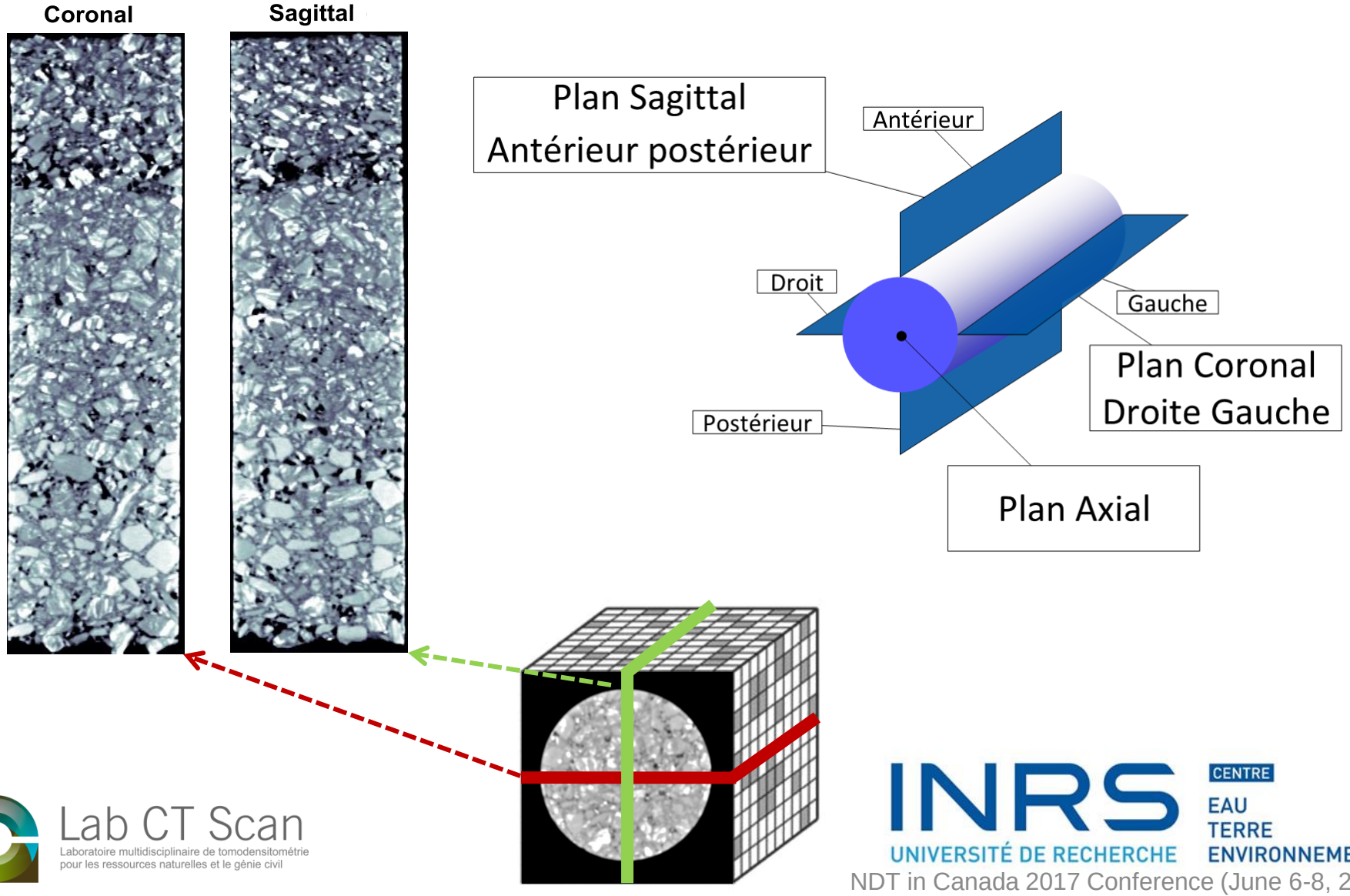
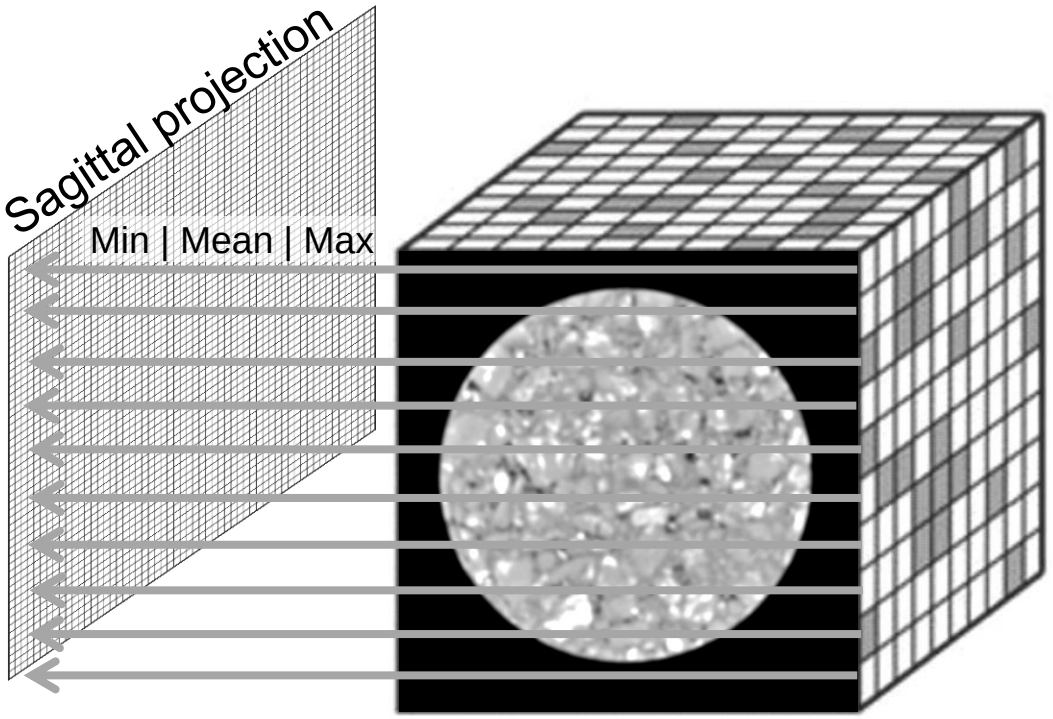
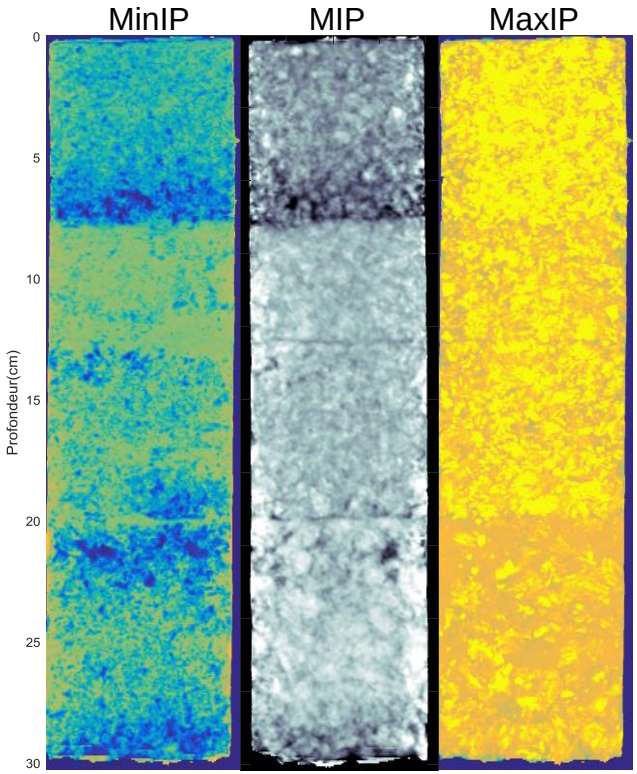
Standard terminology



Projections

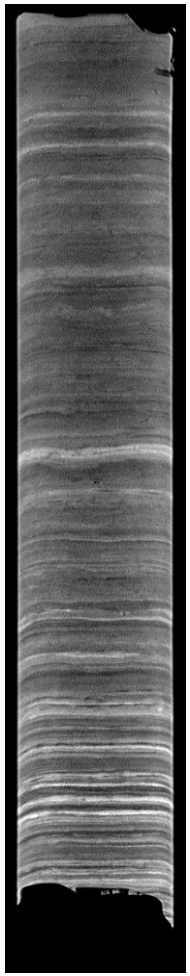
See through a sample

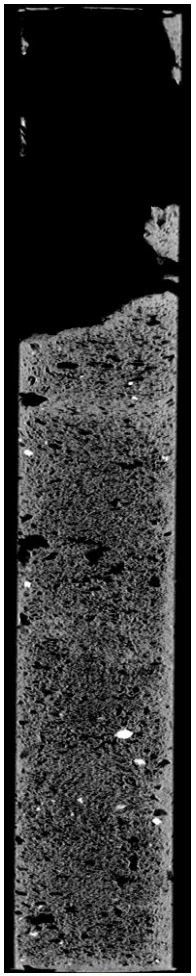


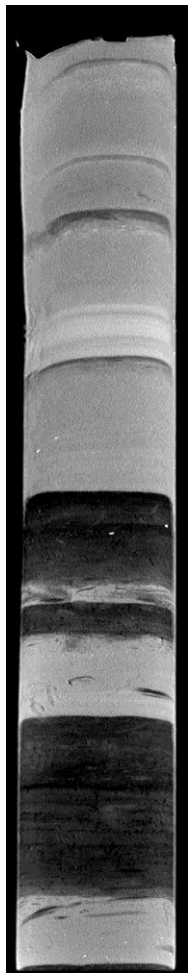


Mean intensity projection (MIP) ≈ radiography

Projects overview
Marine sediments core analysis







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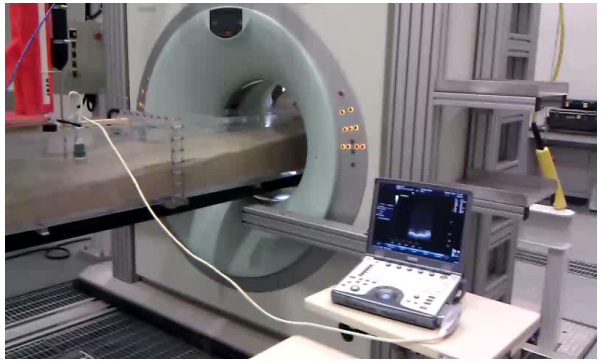
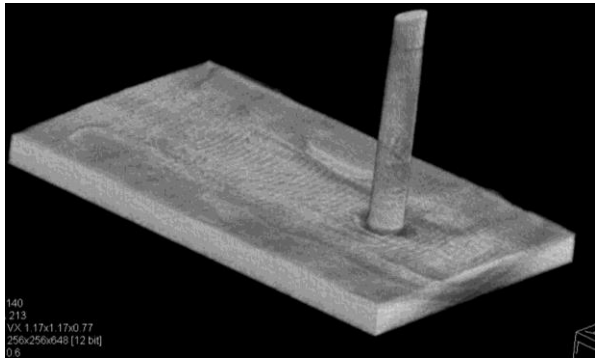
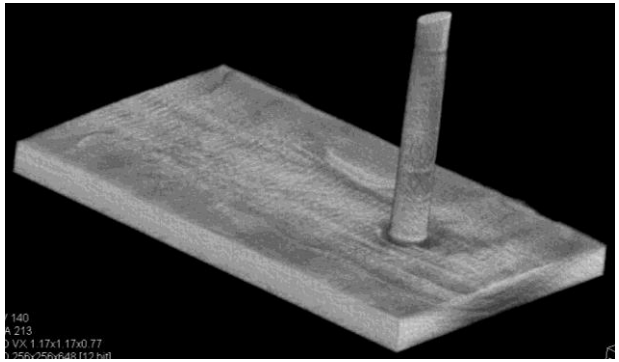
Projects overview
Dynamic experiment (4D) : erosion of a slender pile

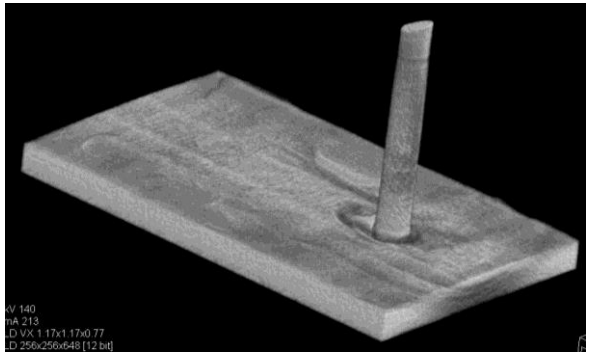




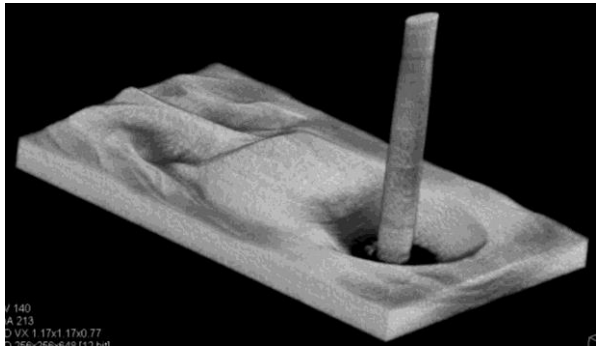
4 cm/s 10:20



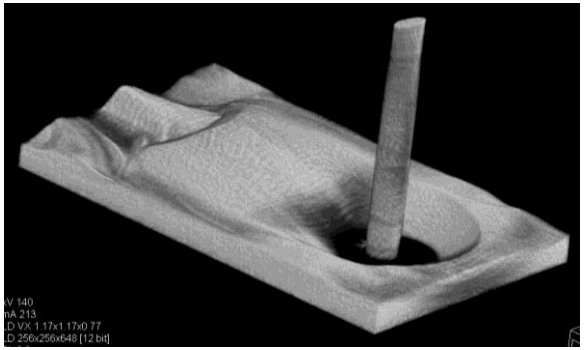
7 cm/s 11:00



14 cm/s 12:00



21,4 cm/s 12:50



30 cm/s 13:00

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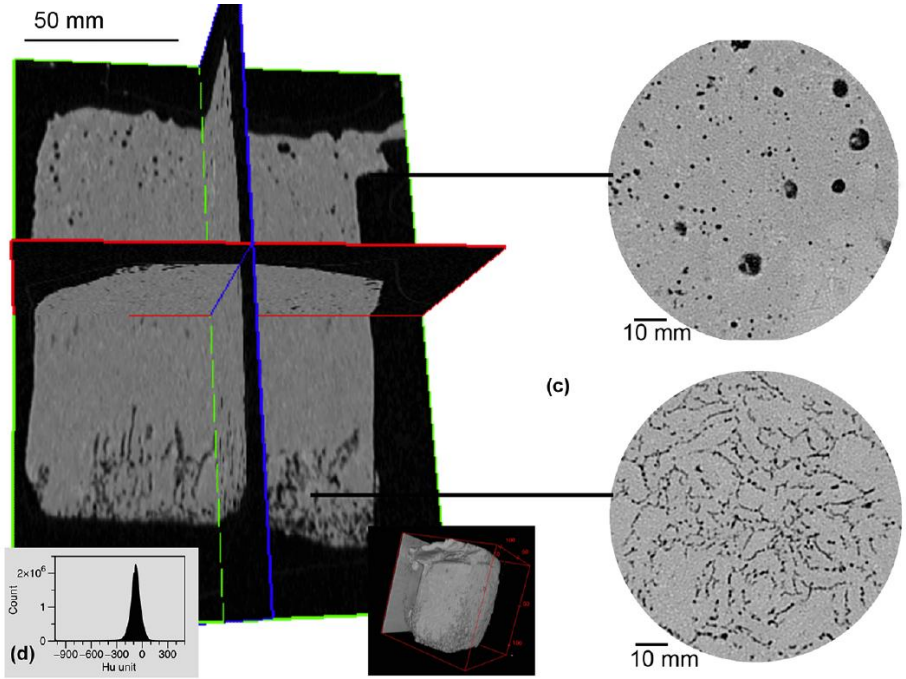
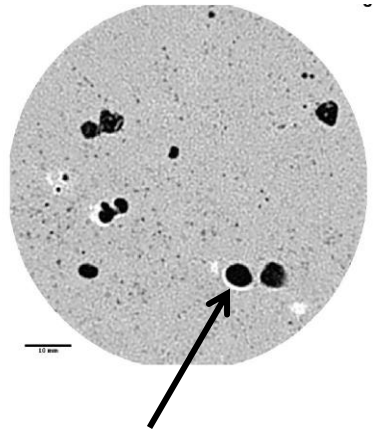
Projects overview

Sea ice core scanning

Results

- Identify ice structure type (snow ice, frazil, columnar)
- Porosity distribution





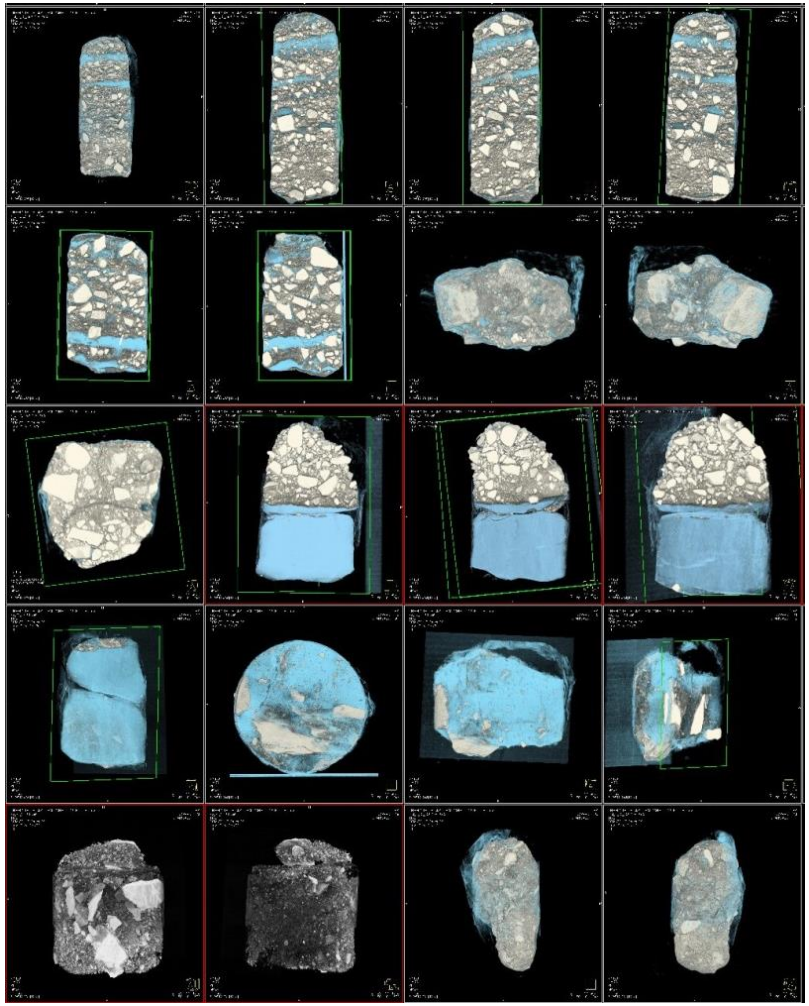
Reference:

Imaging air volume fraction in sea ice using non-destructive X-ray tomography

Odile Crabeck, Ryan Galley, Bruno Delille

Projects overview

Permafrost scanning



Benefit

- Identify ice structure type
- Buildings and roads design

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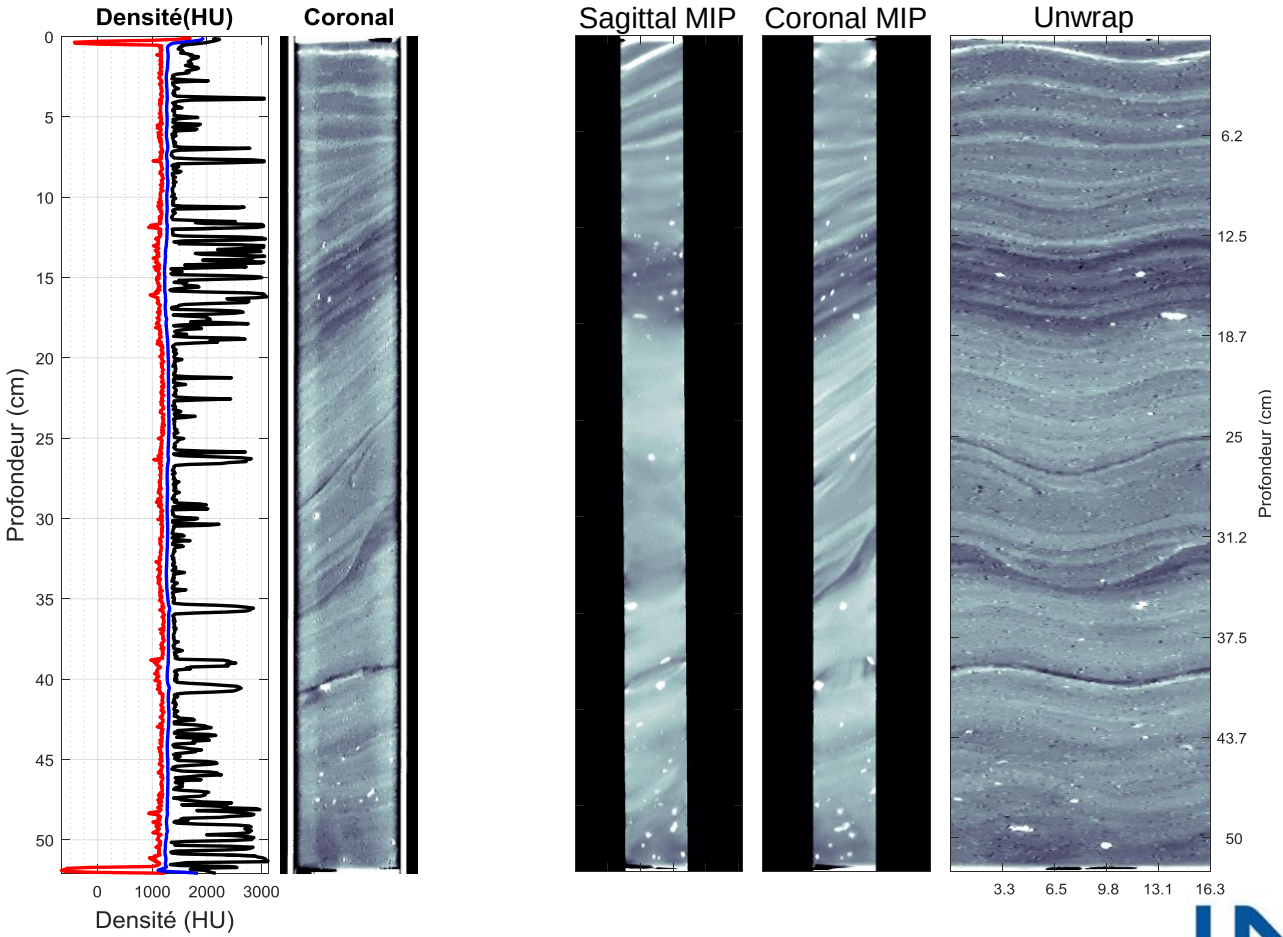
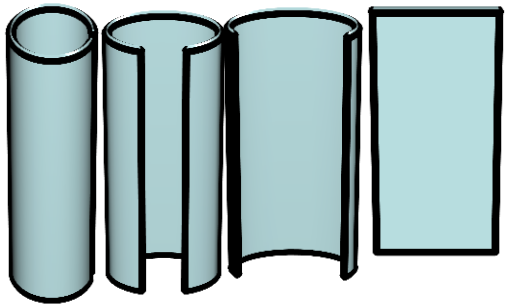
Projects overview

Sediment core scanning

Evaluate risk of landslide



Unwrap outer surface



Sinus amplitude is related to slope

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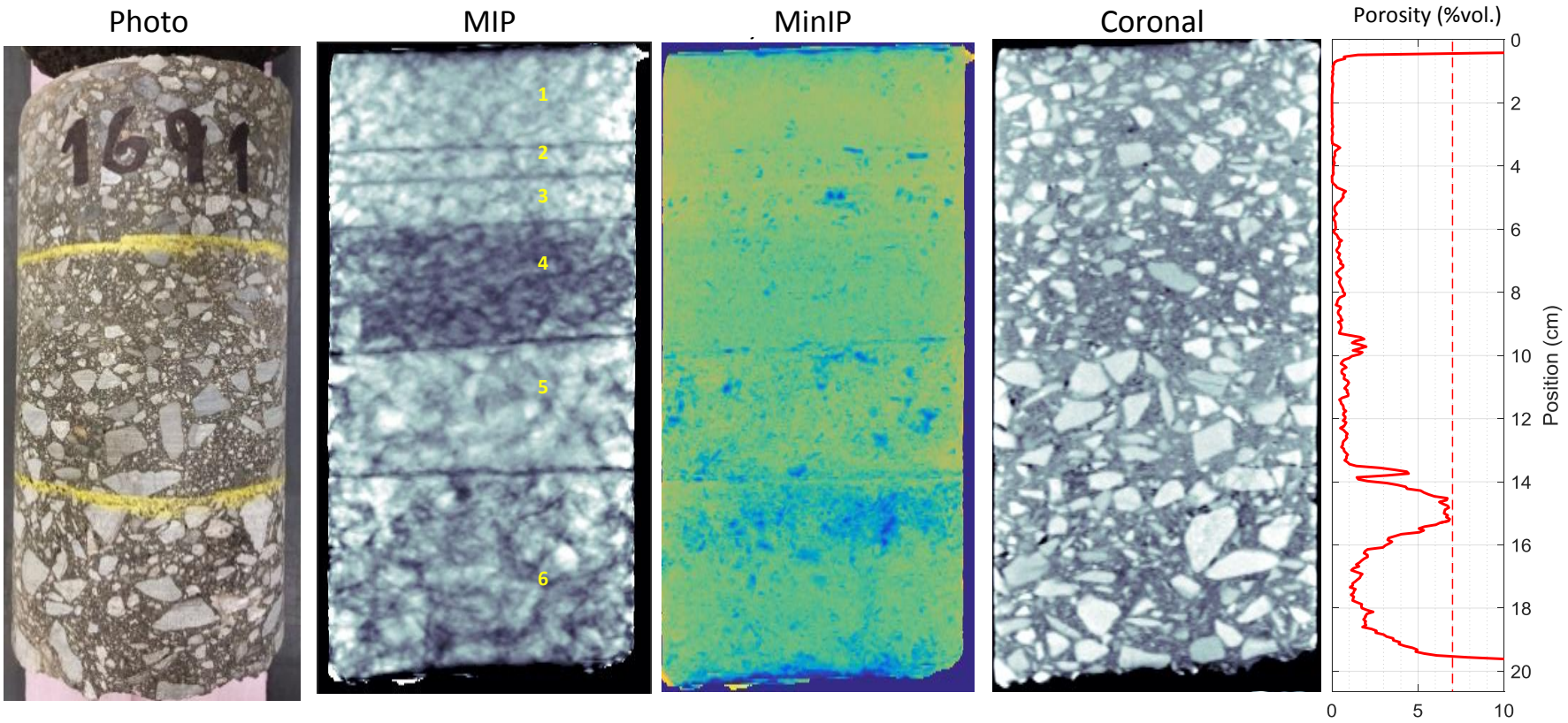
Projects overview

Asphalt core scanning



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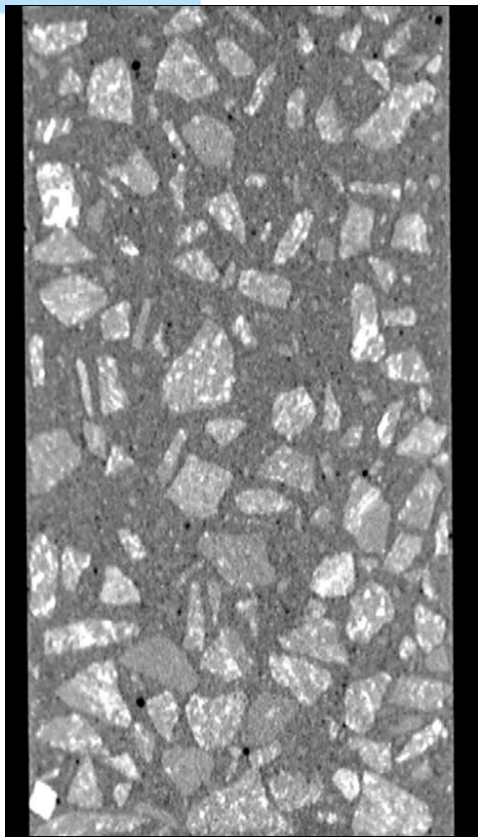
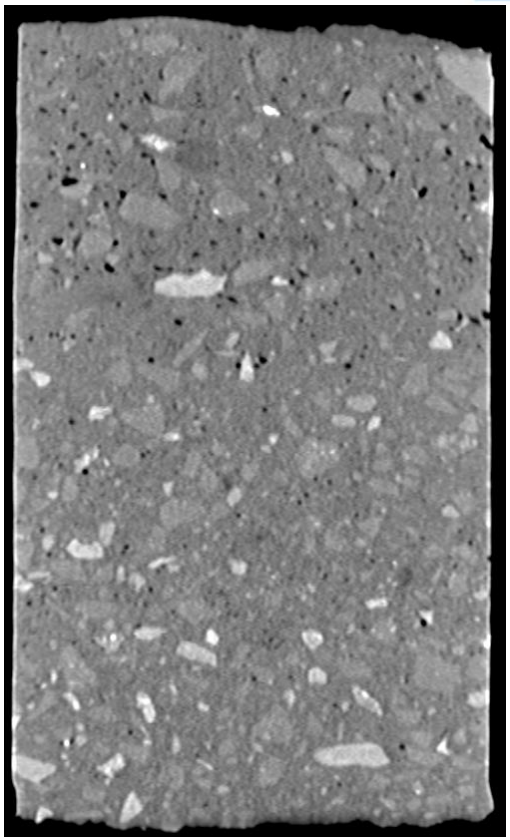
Projects overview

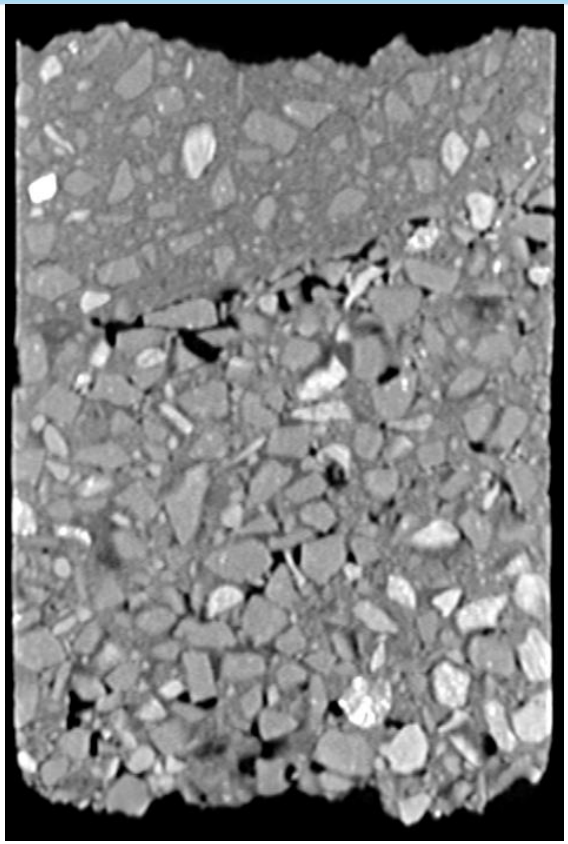
Concrete core scanning



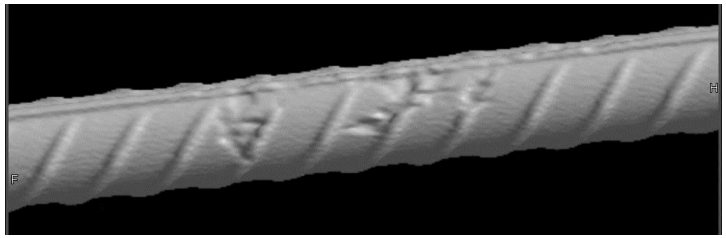
Segregation due to vibration



Void distribution



Concrete repair



Corrosion on reinforcement bar

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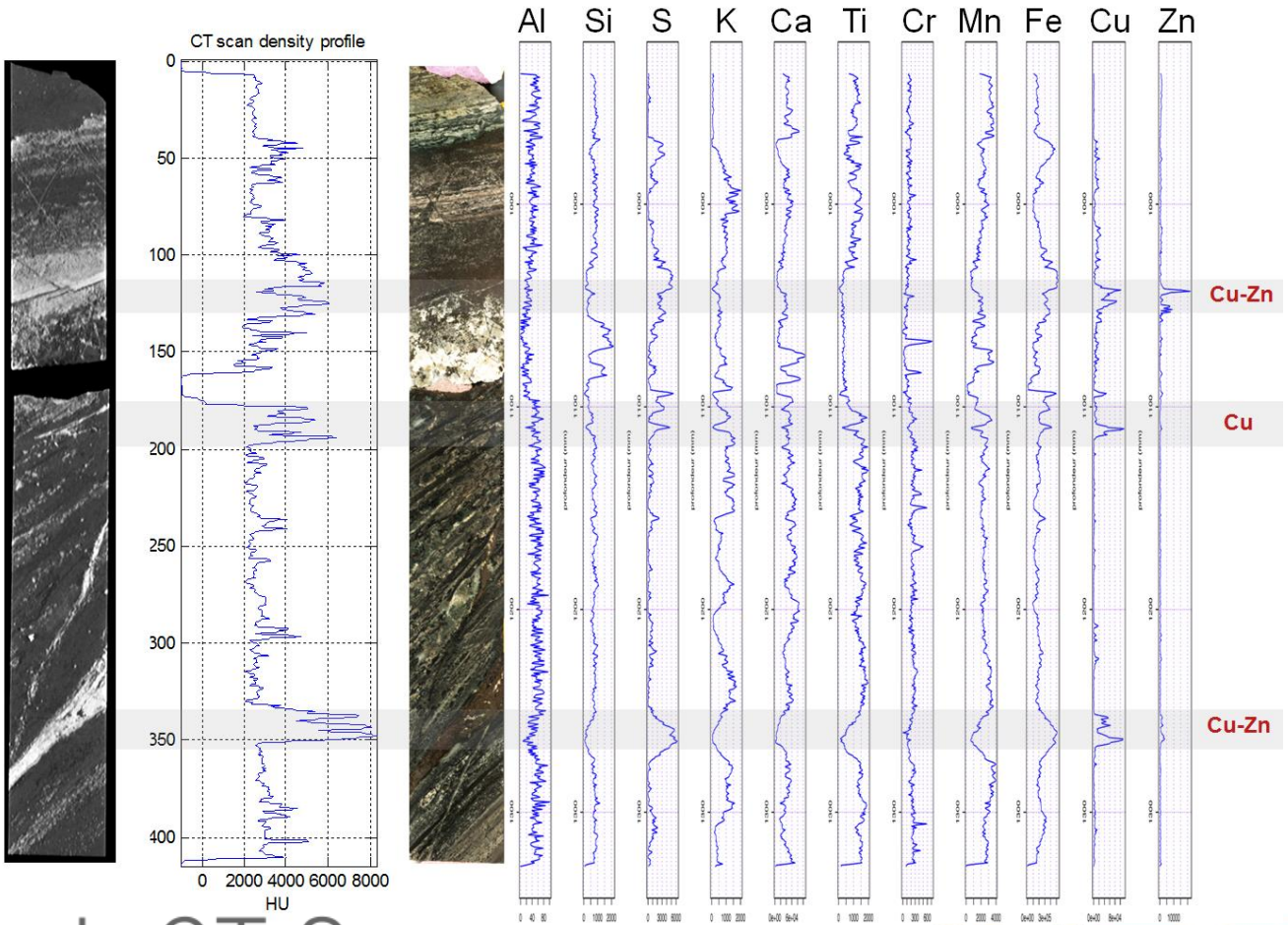
Projects overview

CT and ITRAX core scanner data



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Case study: Rupture process of suspension clamps

- Used in electricity transportation
- Support high voltage cables

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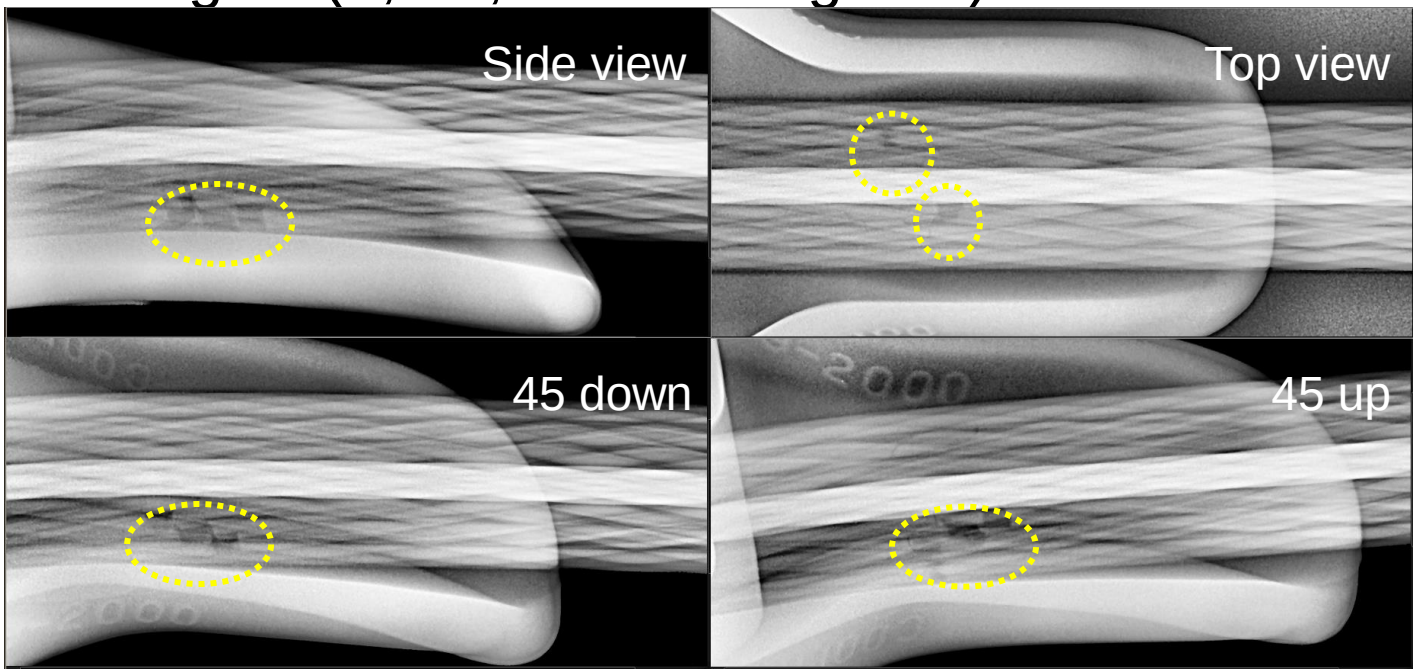
Case study: Rupture process of suspension clamps

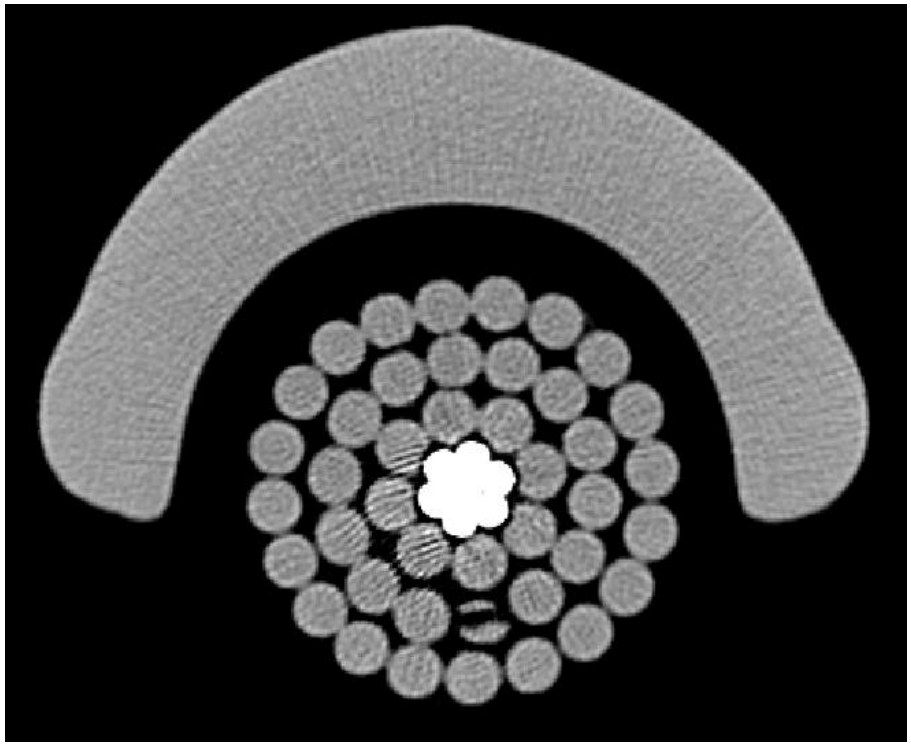
- Simulation on a conductor fatigue testing bench

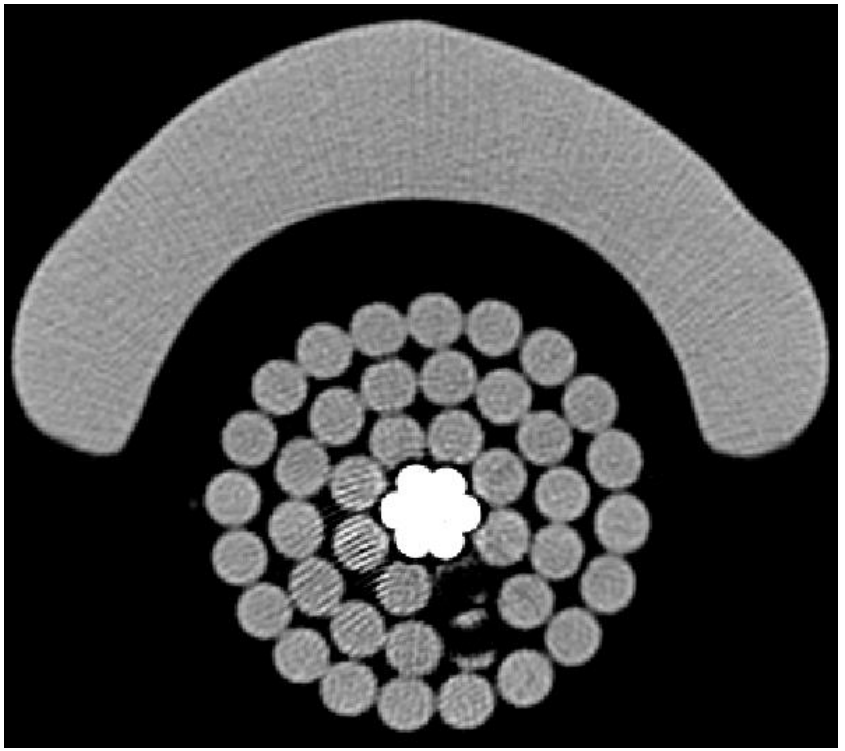
- Radiography
  - 4 angles (0, 45, 90 135 degrees)



Case study: Rupture process of suspension clamps

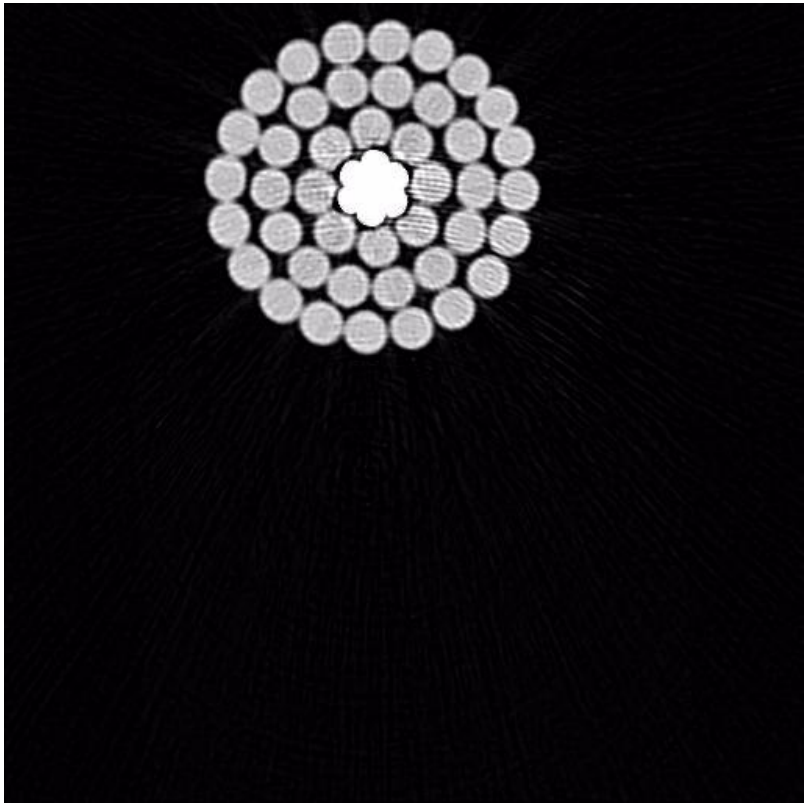
- CT-scan broken wire visualisation





Case study: Rupture process of suspension clamps

Visualisation of the volume



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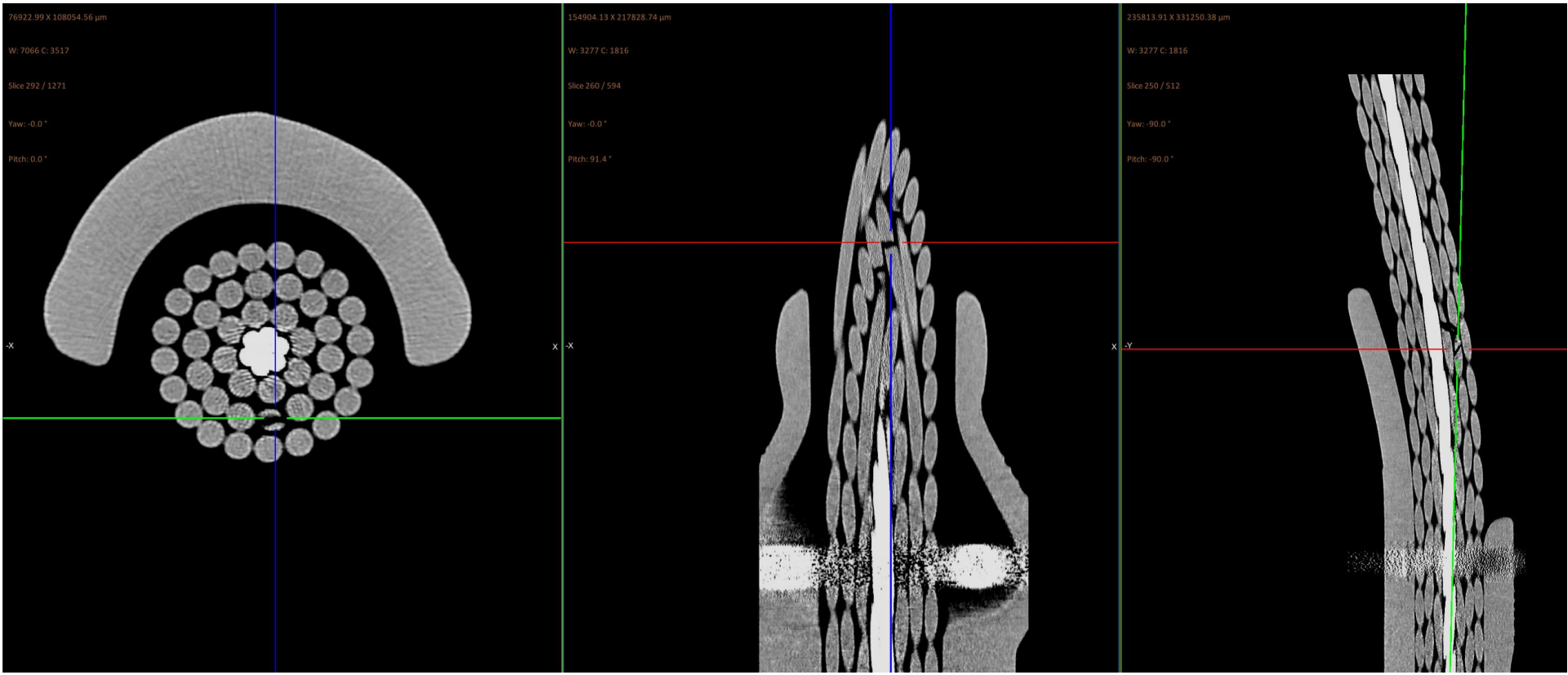
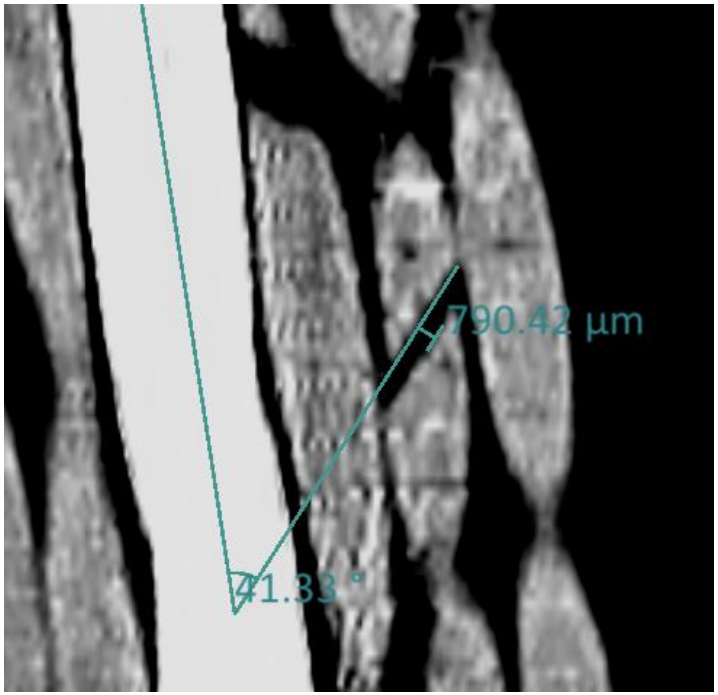
3D location of the failure

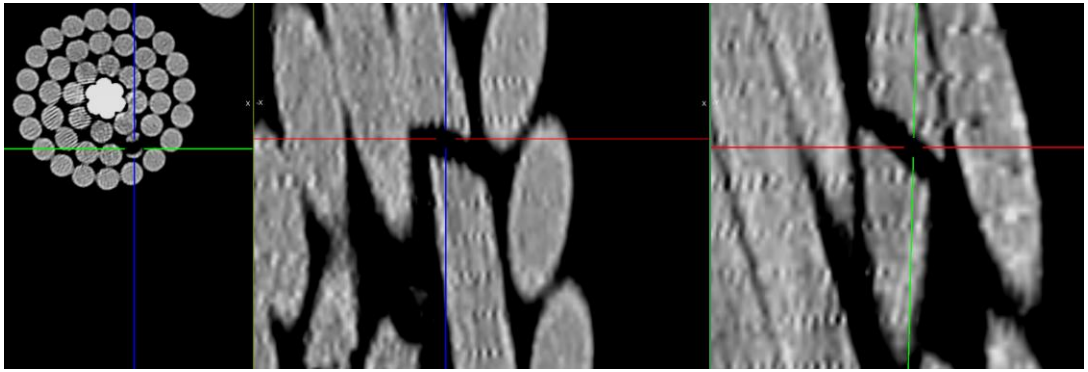


Case study: Rupture process of suspension clamps

Wire broken



Misalignement



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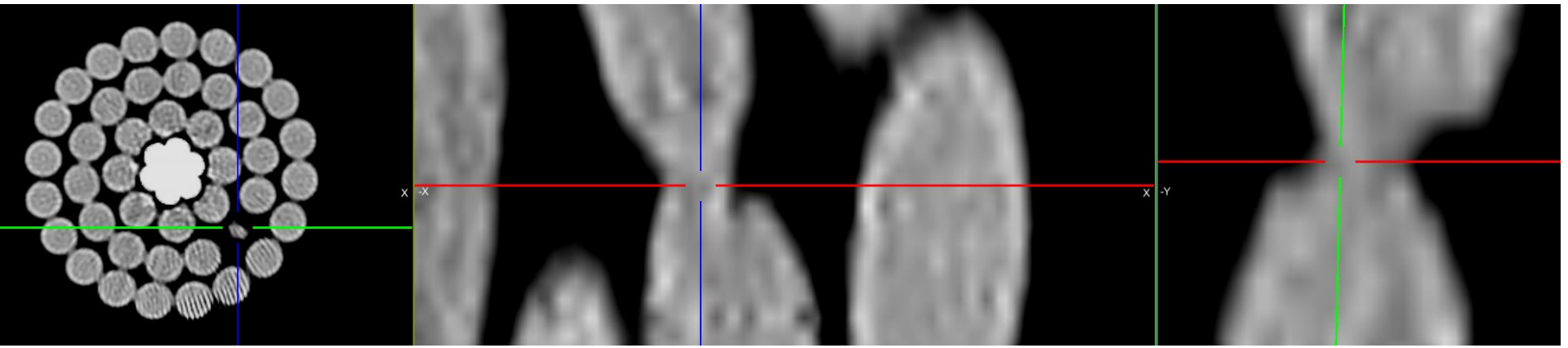
Case study: Rupture process of suspension clamps

Wire not broken : reduction of area



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Case study: Rupture process of suspension clamps

CT-scan inspection benefit

- Quantify accurately the amount of broken wire
- Locate the failure in 3D
- Measure failure orientation
- Identify the presence of wire area reduction (‘’striction’’)
- Optimize the radiography technique

Conclusion

- INRS CT scanner is highly versatile (industrial configuration)
- Resolution and power suitable for many applications
- Can help in the development of other NDT techniques

Lab CT Scan

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pour les ressources naturelles et le génie civil

Thanks for your attention

Questions ?

ctscan@ete.inrs.ca

Website: ctscan.ete.inrs.ca

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