

CyXplus

Inspection system using submarine NDT testing:
high energy X-Ray tomography

PRECEND

Journée technique Nouvelles technologies CND

▸ CyXplus S.A.S.

▸ ZA de l'AGAVON, 20 av.de Lamartine - 13170 Les Pennes Mirabeau - France

23 nov. 2017

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CyXplus in brief

CyXplus



- ▶ Supplier of Non-Destructive Testing and Measurement equipment, and software for the manufacturing industries



A TechnipFMC Company

- ▶ A global leader in oil and gas projects, technologies, systems, and services
- ▶ 44 000 employees in 49 countries



CyXplus in brief

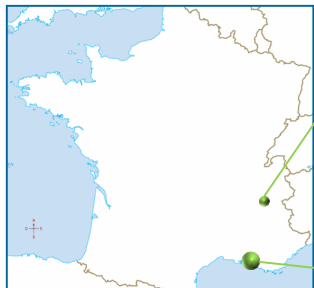
Mission

- ▶ supply Non-Destructive Testing and Measurement equipment and software to the manufacturing industries

Capabilities

- ▶ Design, manufacture and integrate equipment and software
- ▶ Install, commission and support systems all over the world

35-40 employees

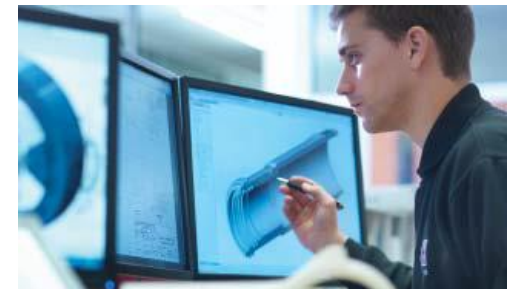


CyXplus Montbonnot

- ▶ Research & Innovation in NDT technologies
- ▶ X-ray Micro-tomography equipment

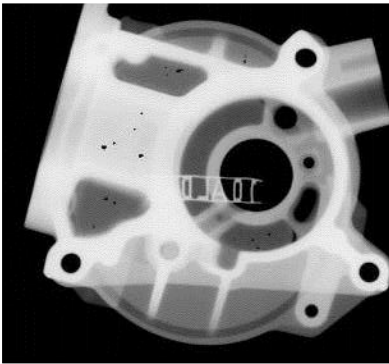
CyXplus Les Pennes Mirabeau

- ▶ Operational Headquarters
- ▶ Engineering and development departments
- ▶ X-ray & Computed tomography equipment
- ▶ After-sales, purchasing, sales, administration/accountancy
- ▶ 1000 sqm workshop
- ▶ HR functions at group level

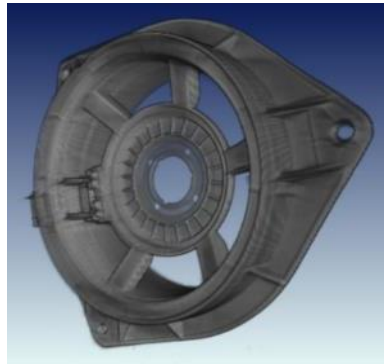


Activities & Technologies

**2D Digital
X-ray**



**Computed
Tomography**



Laser



**Industrial
Vision**



**Automotive
Tire Industry**



**Aerospace &
Defense**



Oil & Gas



Other industries



Products ranges

Tire X-ray inspection

CyXPRT ADR
X-ray

OTRX-1 X-ray

CyXPCR-1225 X-ray

CyXTBR-1527 X-ray



Aerospace & Industry

CyXCT Tomography

CyXray 2D X-ray

CyXCT-160 X-ray/CT

CyXCT-225 X-ray/CT




Oil & Gas

CyXCT Tomography

CyXray 2D X-ray

Control in ATEX env. Leak/Level detection

Pipe inspection 2D X-ray



Custom equipment

Vision/Laser applications

Robotized applications

MedTech 2D X-ray

Industrial at-line CT



Products ranges : CyXCT series



Tomography in less than 1 min with resolution $< 100 \mu\text{m}$

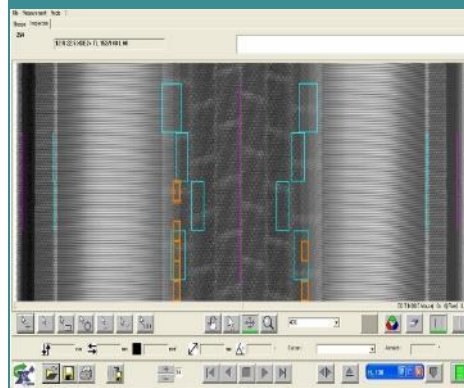
CyXRAY



Acquisition and 2D Exploitation

- Execution of PLC commands
- Detector management
- Image acquisition
- Automatic raw image saving
- LUT and filtering tool, gain, offset
- ASTM E-2737 compliant
- Data export

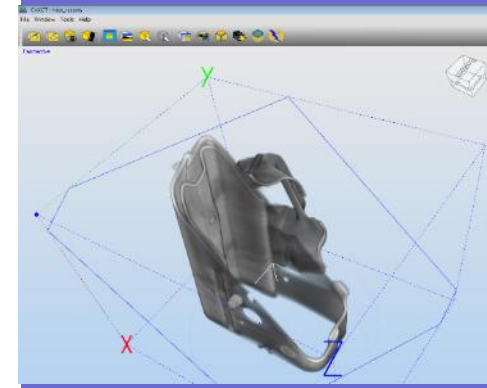
CyXPERT



Automatic Defect Recognition

- Based on proprietary image processing libraries
- Automatic Defect Recognition for in-line X-ray tire inspection
- Short processing time
- Calibration and measurements tools for off-line analysis
- Data export

CyXCT



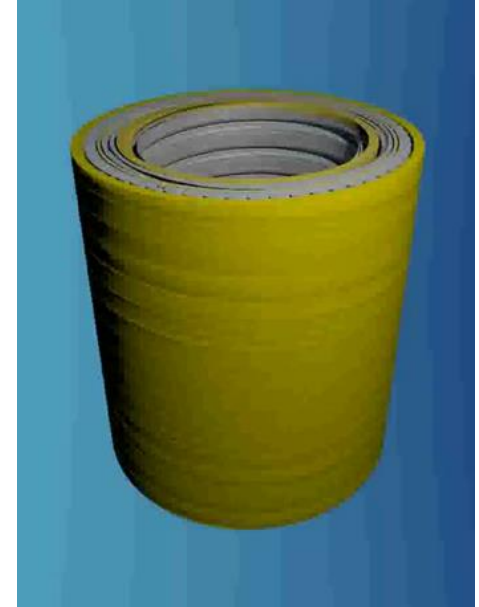
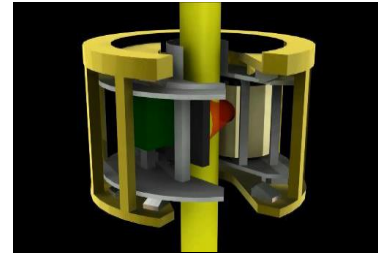
Computed Tomography Reconstruction

- High Accuracy CT calibration
- 3D visualization with measurement tools, movie generation
- Fast CT module for on-the-fly reconstruction during acquisition
- Compatible with PolyWorks™ for CAD comparison

X-ray and CT for large objects

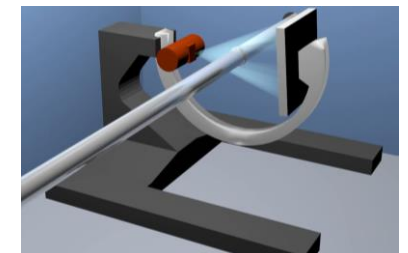
High Energy with Linear Accelerator

2,4,6,9 MeV



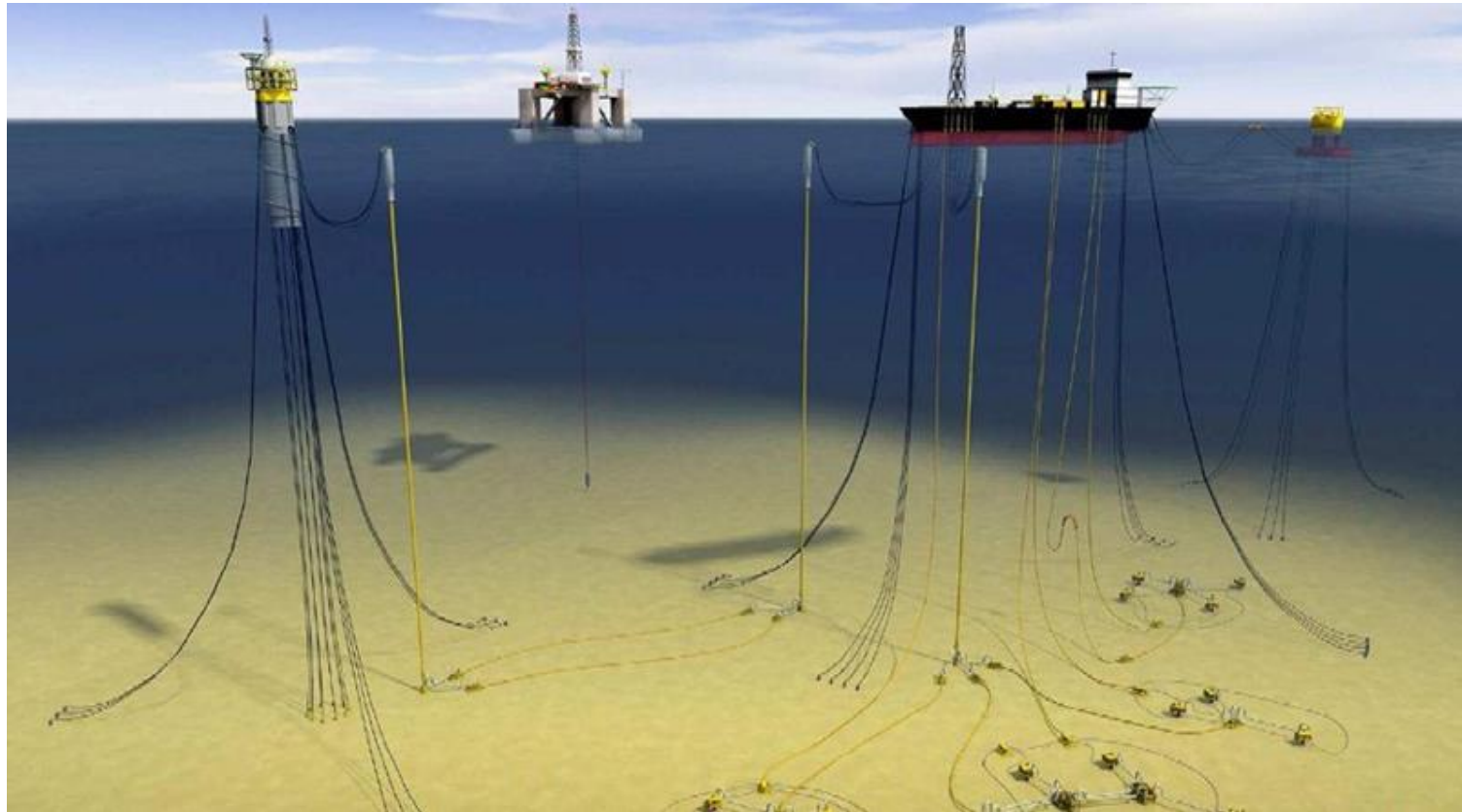
CT for long/tubular objects

Development of specific algorithms

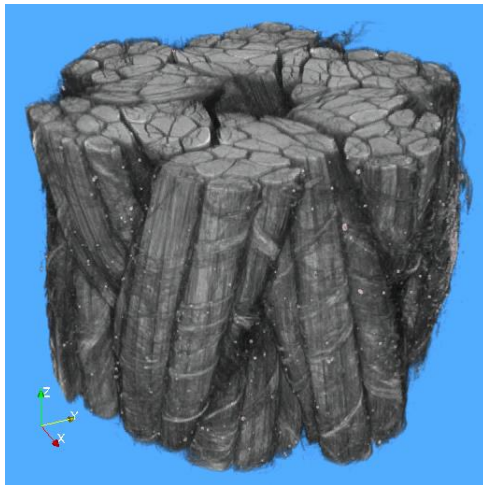
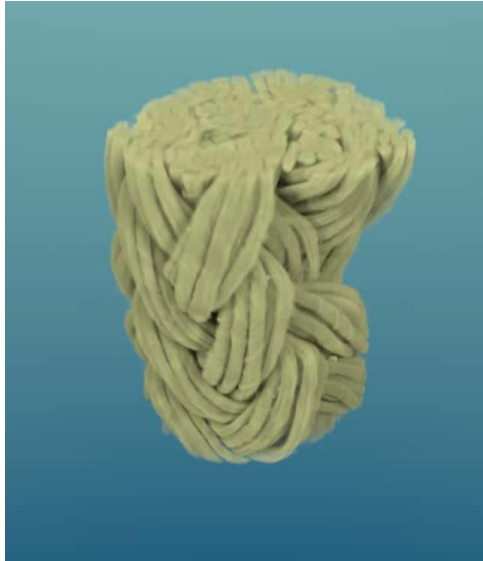


X-ray & Computed Tomography for Flexible Riser

- ▶ Flexible risers have different size and design in function of their use and location

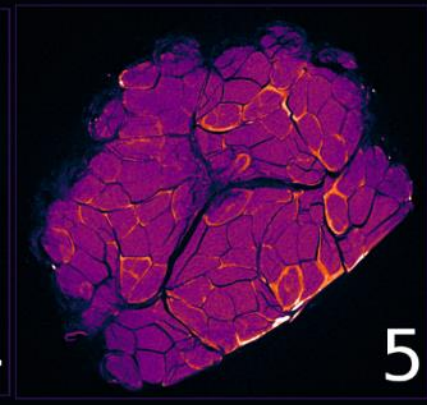
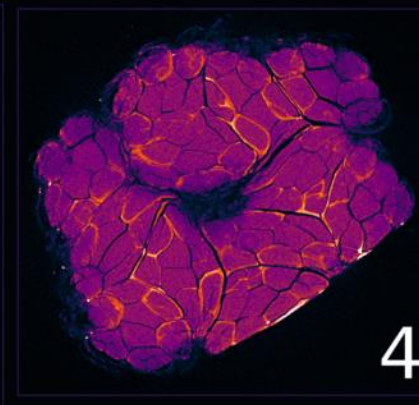
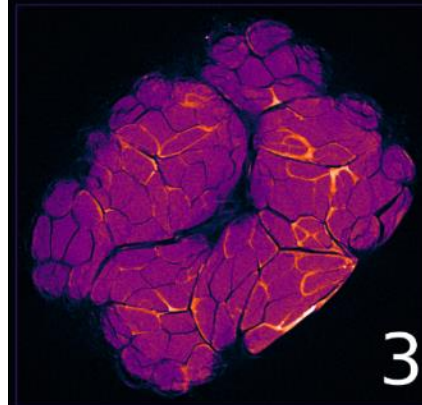
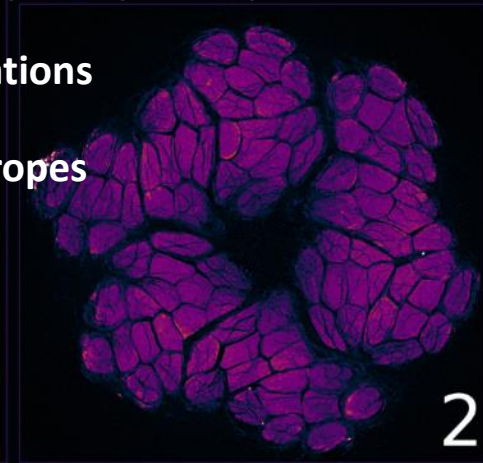
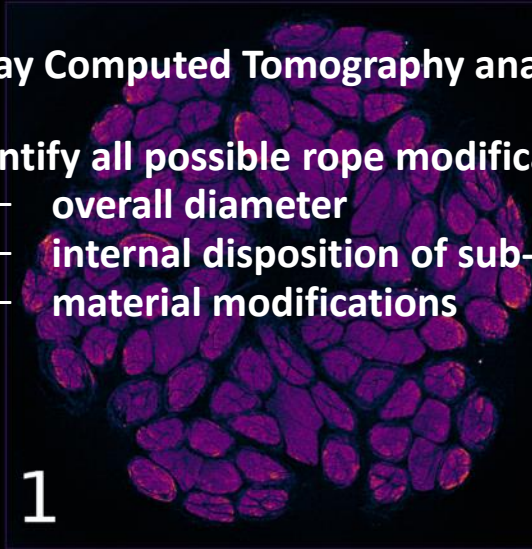


Example of Computed Tomography



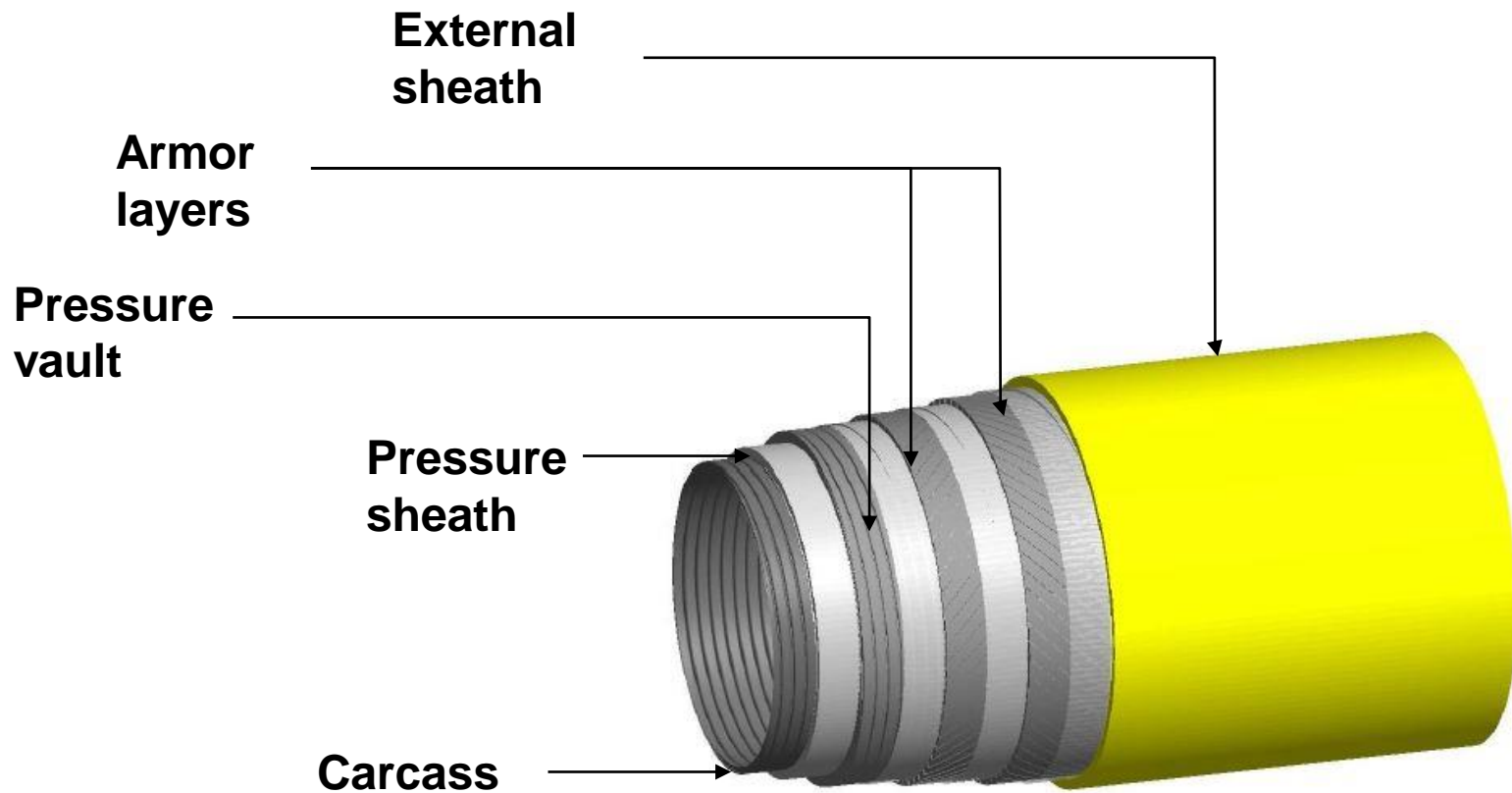
- X-ray Computed Tomography analysis rope samples

- Identify all possible rope modifications
 - overall diameter
 - internal disposition of sub-ropes
 - material modifications



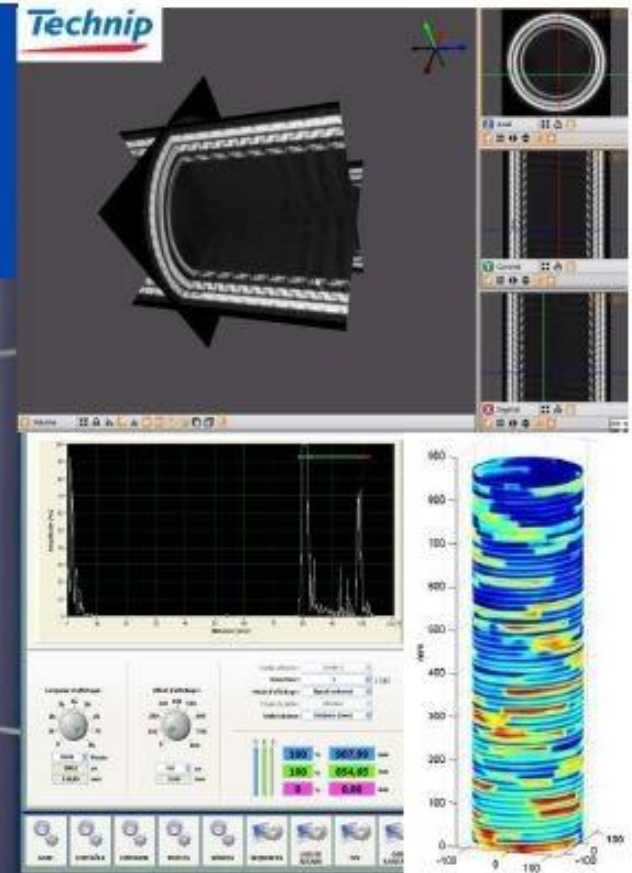
X-ray & Computed Tomography for Flexible Riser

- ▶ Multi layer structure design (thermoplastic, steel, insulation)
- ▶ Various materials, profiles and thicknesses in a single product



IRIS : Integrity Riser Inspection System - subsea NDT

IRIS (a new generation of in-service subsea inspection system for risers) will allow to deploy and operate 3 different NDT technologies in parallel (Ultrasonic Testing, Electromagnetic Testing and X-ray Computed Tomography).



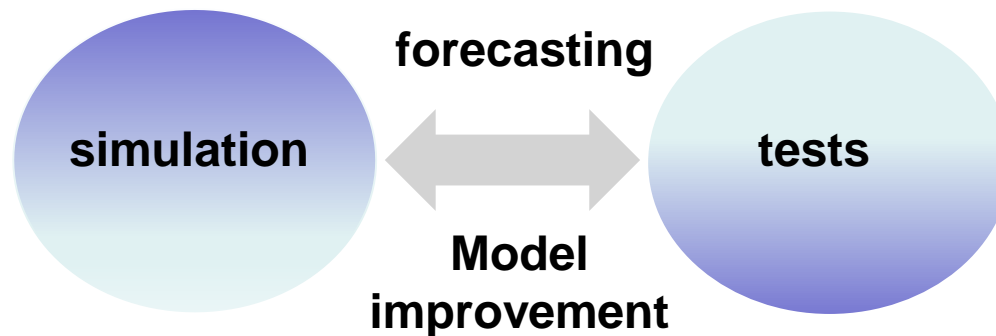
- ▶ Allows to Develop a dedicated inspection strategy for each flexible pipe
- ▶ Operates in parallel multiple NDT technologies

IRIS MAIN FUNCTIONS

- ▶ Deployed from a support vessel
- ▶ Hang up onto the riser (7'' to 18'')
- ▶ Move along the riser independently (crawler function)
- ▶ Perform NDT scans along a generatrix
- ▶ Perform NDT scans of areas on 360°
- ▶ High resolution video system to monitor 360°
- ▶ Allows to inspect risers without stopping the production
- ▶ Xray CT is used to confirm anomalies detected by ET and/or UT



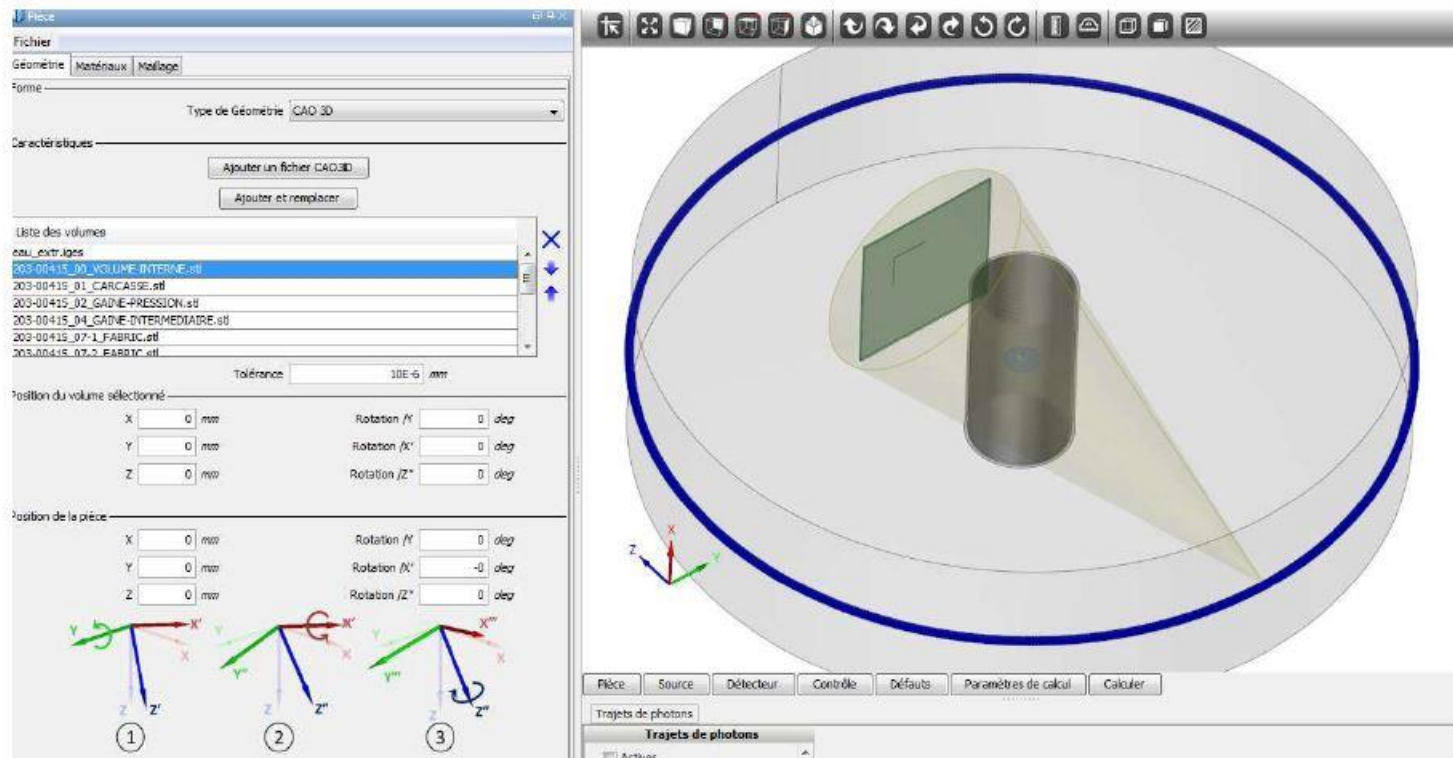
- ▶ Development method
 - Use simulation to predict results and optimize acquisition setup
 - Use real tests to validate / improve model
 - Several iterations for each step



FOCUS ON X-RAY CT

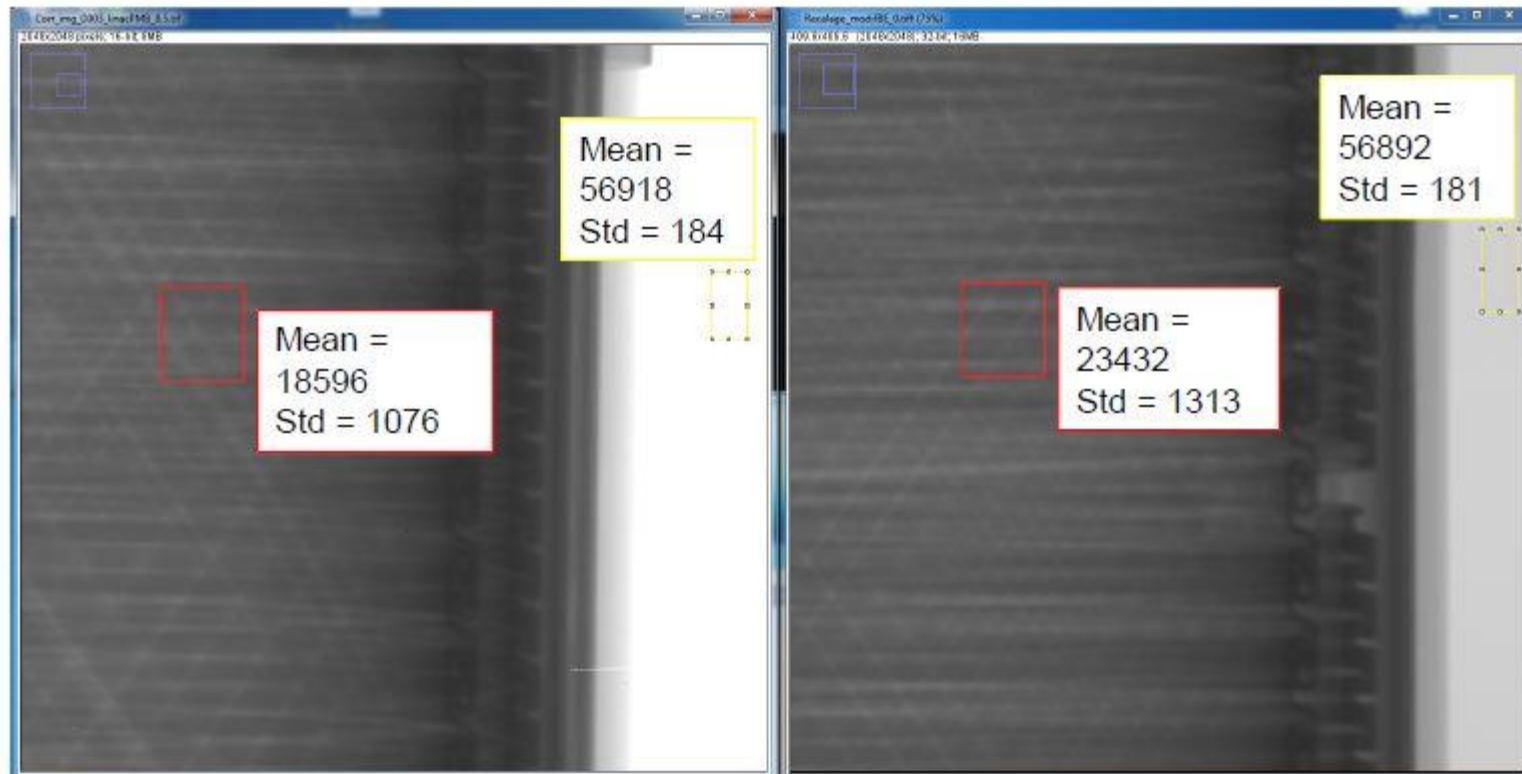
► Simulation

- Different flexible pipes modelisation
- Different acquisition setups
- Different kinds of defects (corrosion, wire break...)



FOCUS ON X-RAY CT

- Evaluation / comparison of image quality (resolution, contrast, signal to noise ratio) in function of conditions
- Comparison between simulation and tests



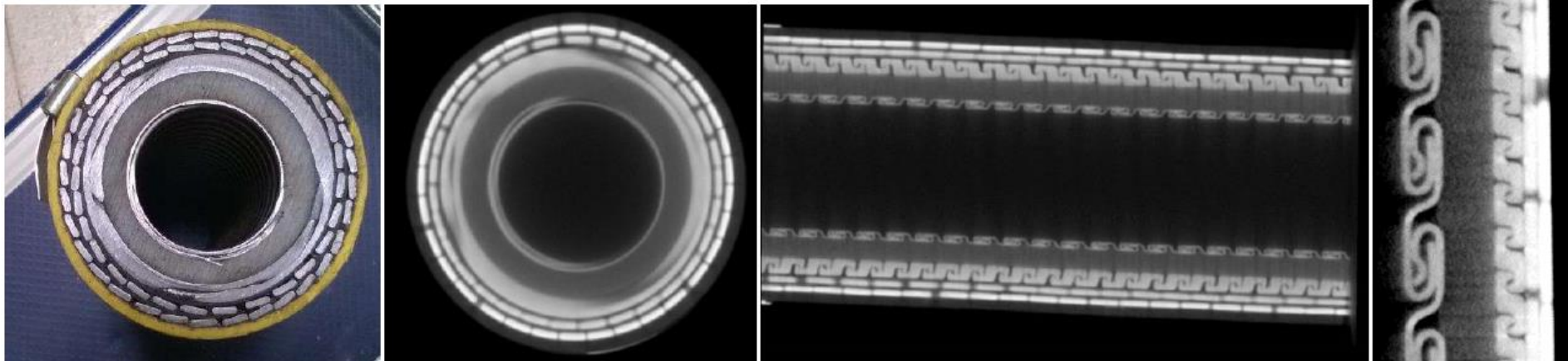
Real radiography

Simulation

Detection objectives

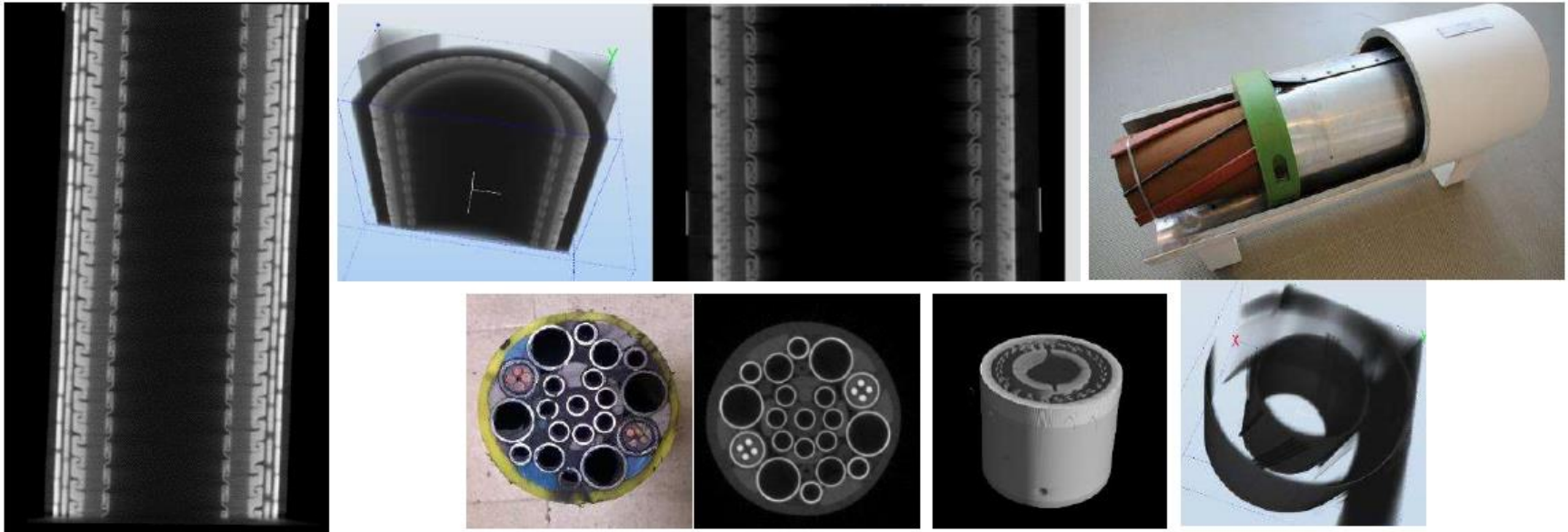
- Annulus flooding detection
- Detection of defects in armour layers (corrosion, transversal break)
- Armour wire layers disarray
- Detection of defects in pressure vault layer
- Defect in pressure sheath

We obtained beautiful tomography with 500 um resolution



Detection objectives

- IRIS has been developed primarily for complex flexible pipe and umbilical structures but is also suitable for inspection of umbilical and rigid pipe



Where we are now:

- The crawler function has been commissioned in 2016.
- ET and UT modules will be validated by the end of 2017.
- First complete prototype integrating the CT/X-Ray module planned for 2018.

High Energy Radiography & Tomography for Oil&Gas application



THANK YOU

