

## **GUH Subsea Expo 2024**

**Non-intrusive inspection of  
complex geometry and pipe in pipe  
systems using Computed  
Tomography**

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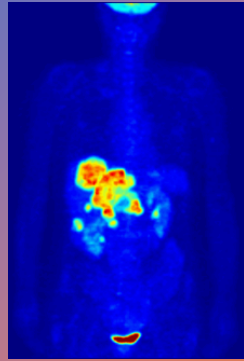


**Nuclear-Radiation-Isotopes - Common perceptions ?**

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## Radiation is present in our daily lives

Typical values for medical applications:

X-Ray of Limbs (0.06mSv)

CT scan (2.1mSv)

Barium Meal (3mSv)

Red Blood Cells (5mSv)

Typical values for travel:

At 20000m - 13 $\mu$ Sv/h

At 12000m - 5 $\mu$ Sv/h

At 0m - 0.03 $\mu$ Sv/h

Cosmic radiation accumulation for a 6-hour flight - 30 $\mu$ Sv

Airport scanners for luggage checks

Annual effective dose (UK=2.2mSv, Norway=4.0mSv) from naturally occurring sources such as:

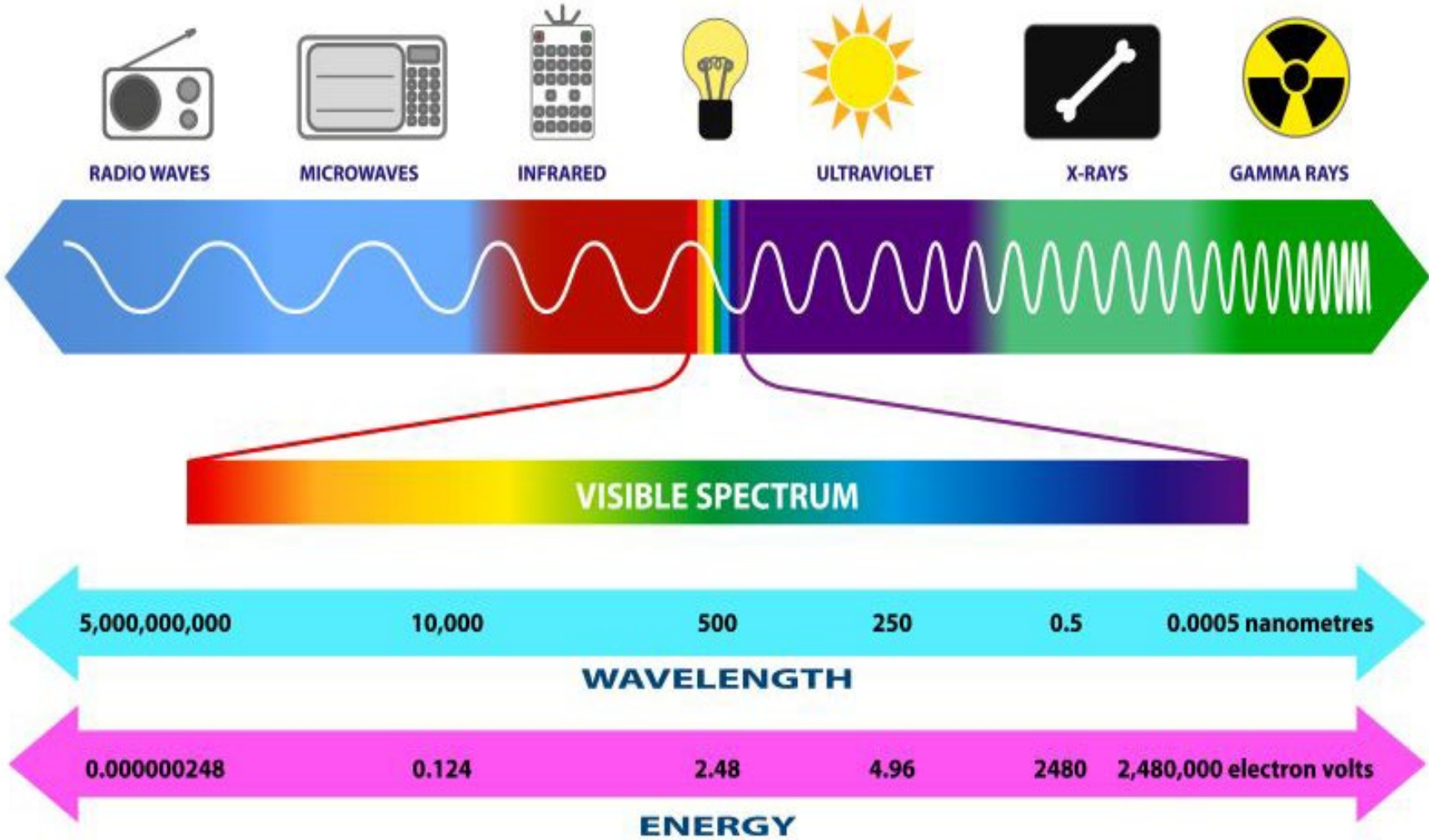
Ingested radionuclides

Emissions and Discharges

Radon Decay

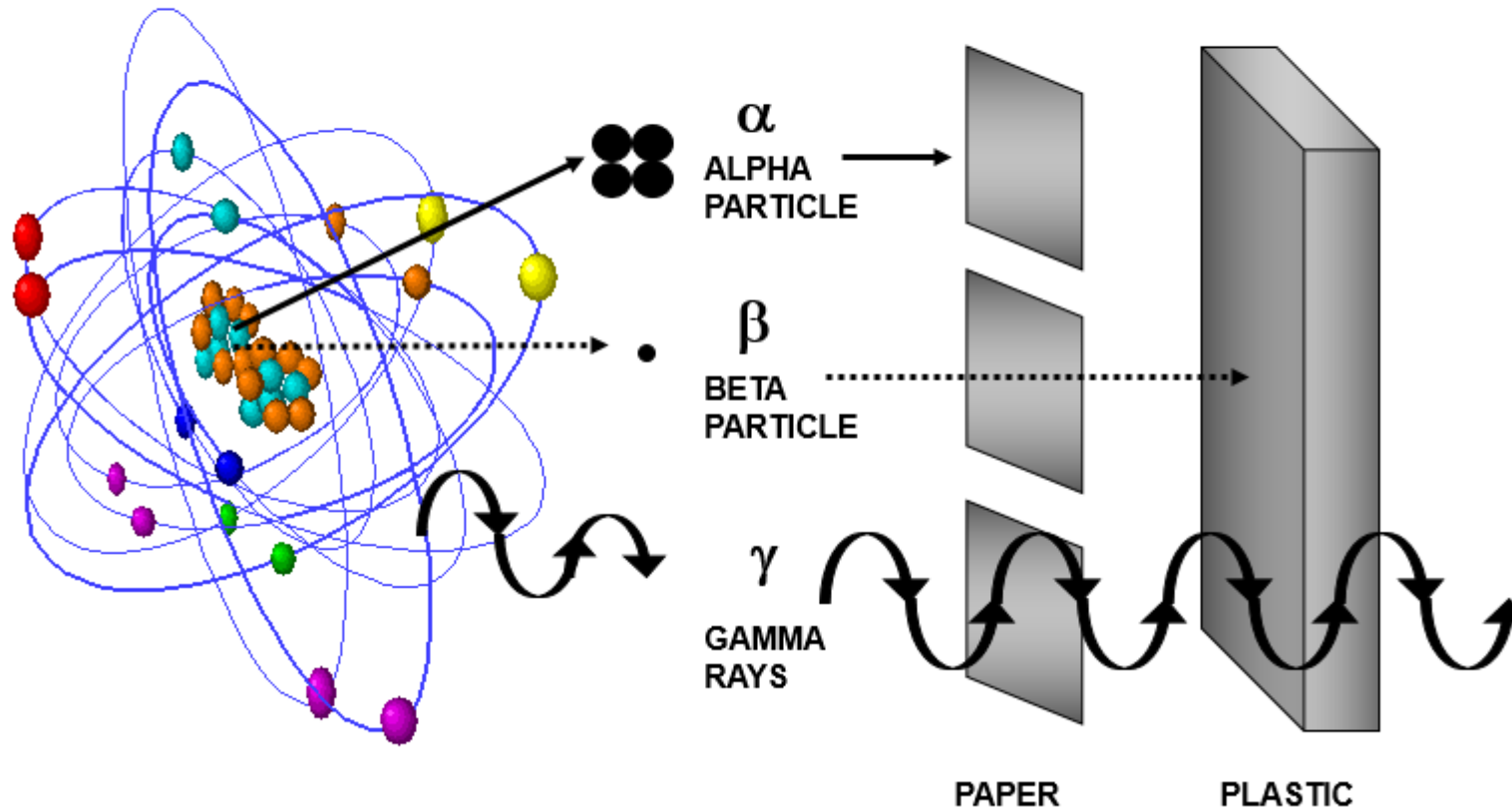


# ELECTROMAGNETIC SPECTRUM



Electromagnetic radiation is a form of energy that propagates as both electrical and magnetic waves traveling in packets of energy called photons. There is a spectrum of electromagnetic radiation with variable wavelengths and frequency, which in turn imparts different characteristics.

# High Energy EM Radiation



Gamma rays – emitted from the nucleus of unstable atomic particle.

Most mined elements are benign & require reactor intervention to create the unstable isotope.

Certain isotopes will emit Alpha & Beta particles. Have charge & mass and will interact with any matter.

## Typical Industrial Radioisotopes

Typical industrial Radio isotopes that are manufactured from a base element or by product of nuclear reaction. i.e. Cs is element Caesium, 137 is the atomic mass number. Caesium is a mono-energetic energy source that is used for Tracerco Discovery CT.

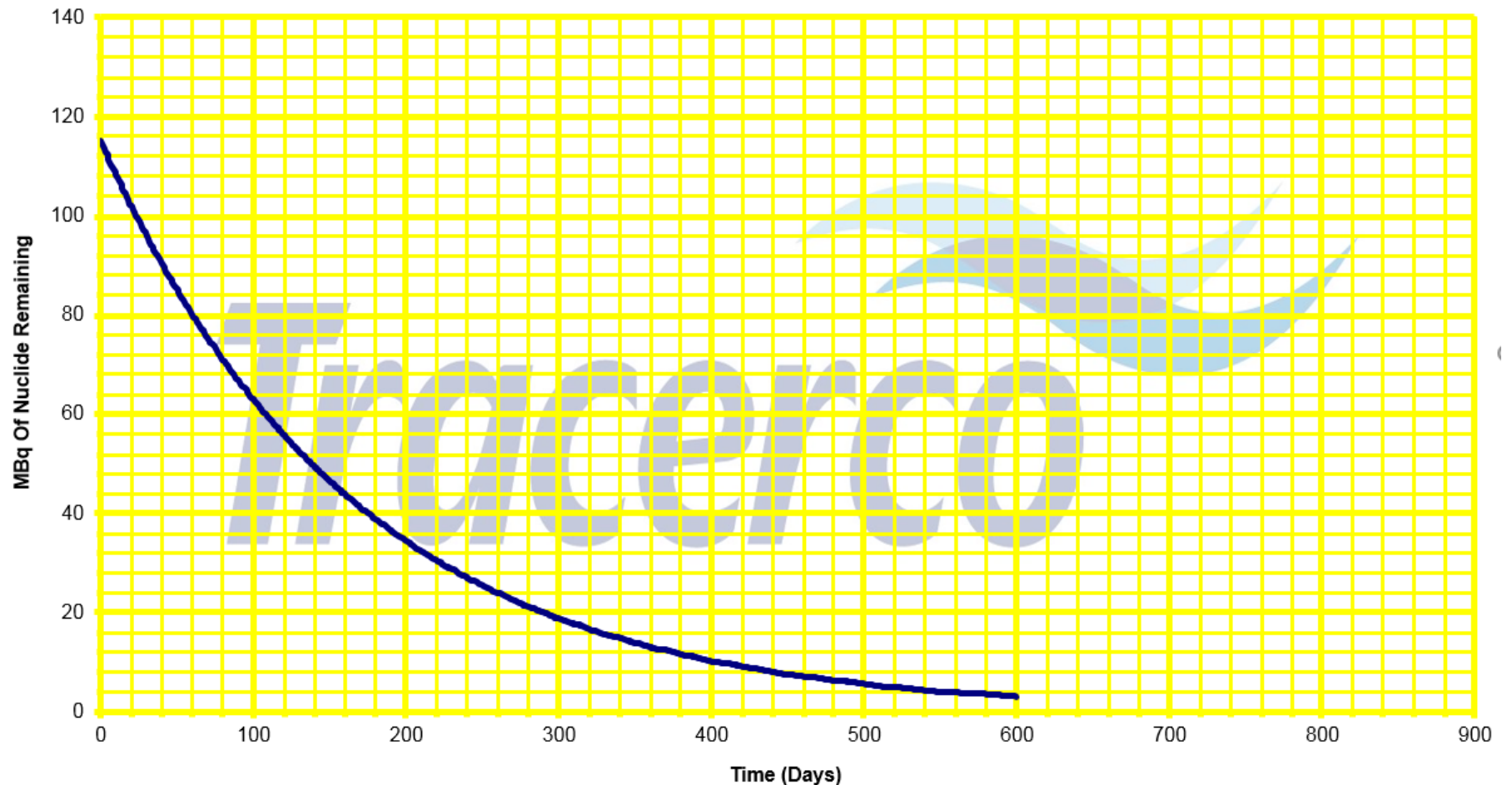
<i><b>ISOTOPE</b></i>	<i><b>RADIATION</b></i>	<i><b>HALF LIFE</b></i>
<b>Cs-137</b>	$\beta, \gamma$	30 Years
<b>Co-60</b>	$\beta, \gamma$	5 Years
<b>Ir-192</b>	$\beta, \gamma$	80 Days
<b>Ta-182</b>	$\beta, \gamma$	115 Days
<b>H-3</b>	$\beta$	12 Years
<b>Ra-226</b>	$\alpha, \beta, \gamma$	1600 Years

# Radiation Decay Chart

The most common measure of radioisotope activity is the SI unit Becquerel (Bq). A becquerel is one decay per second (dps). The Curie (Ci) is the traditional unit of radioactivity and is the unit most commonly used in the United States. One curie is 37 billion Bq.

## Decay Chart for Tantalum 182

115 MBq - Half Life 115 Days

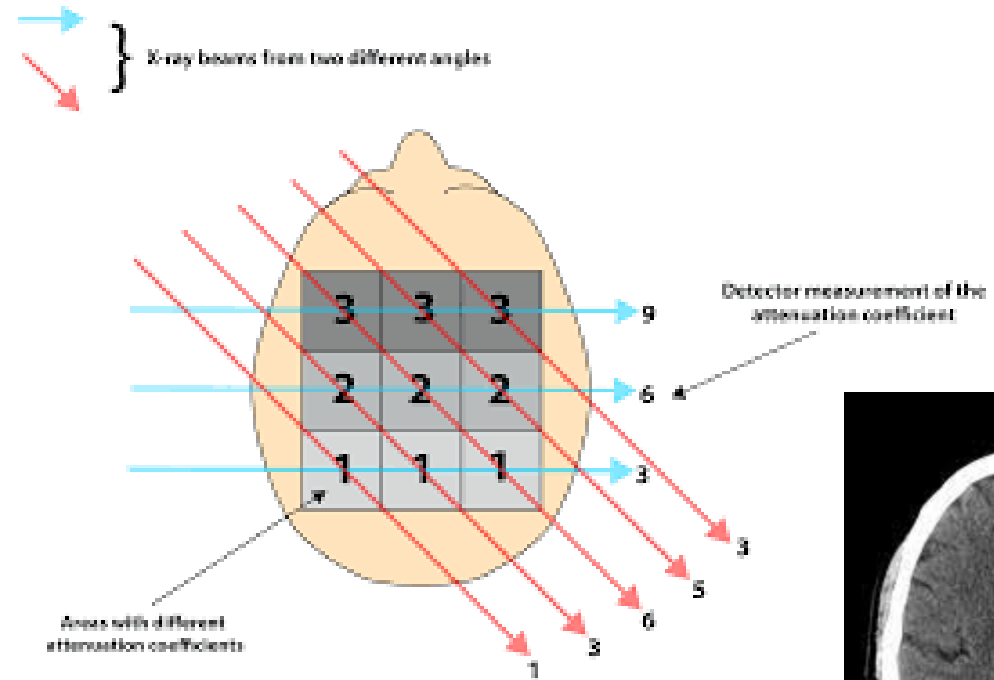
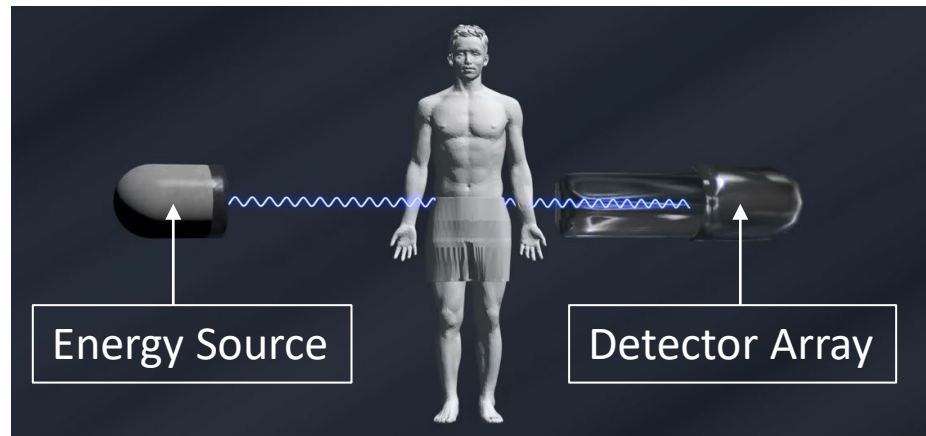




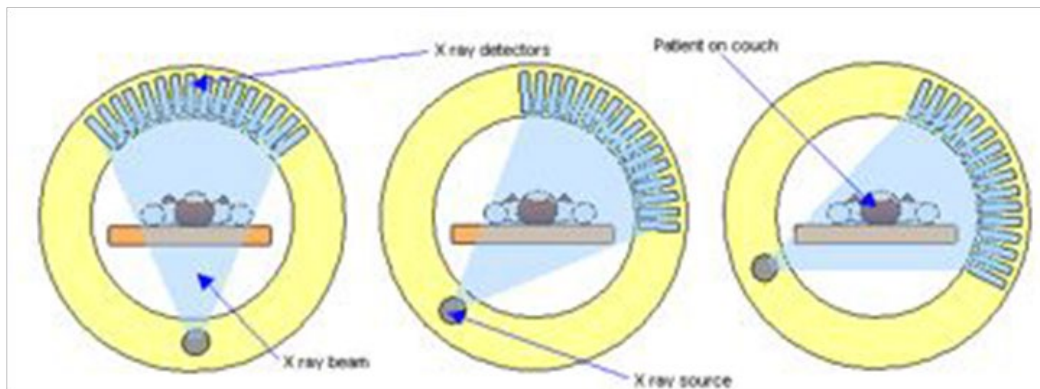


# Computed Tomography Foundations – Medical Application

## Medical CT Scanner for Patient Diagnostics

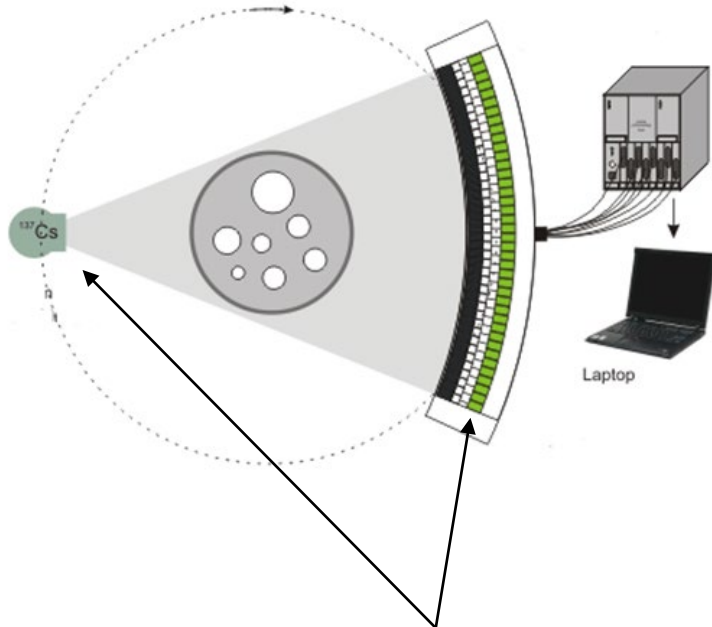


CT 'Sudoku'  
Volumetric  
Pixels 'Voxels'

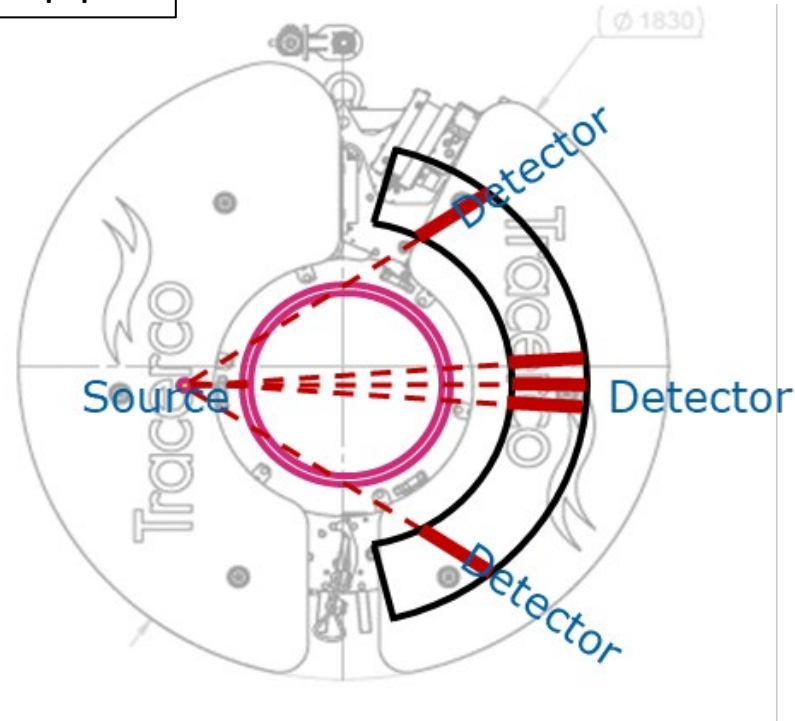


# Technology Transfer - Tracerco Discovery CT Scanner

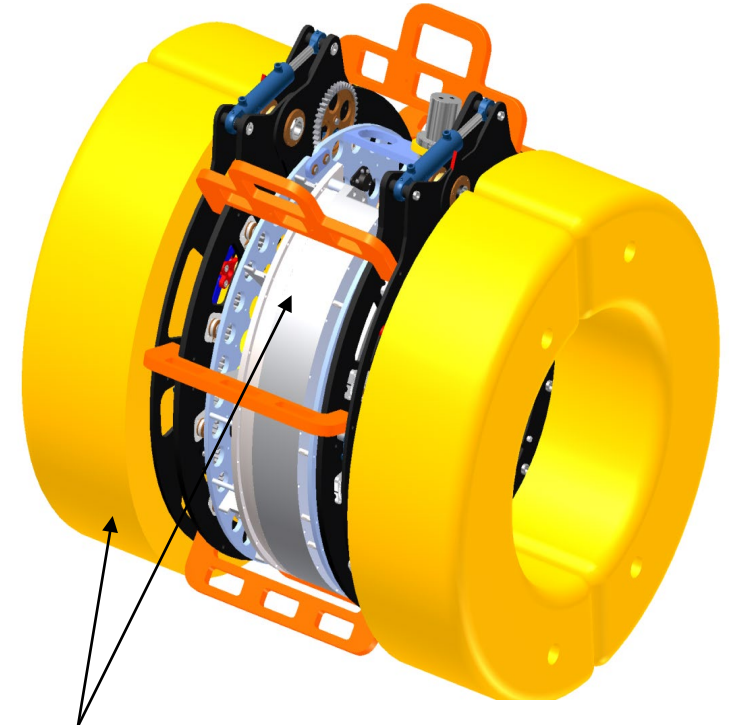
Marinised CT Scanner for tubular & pipes



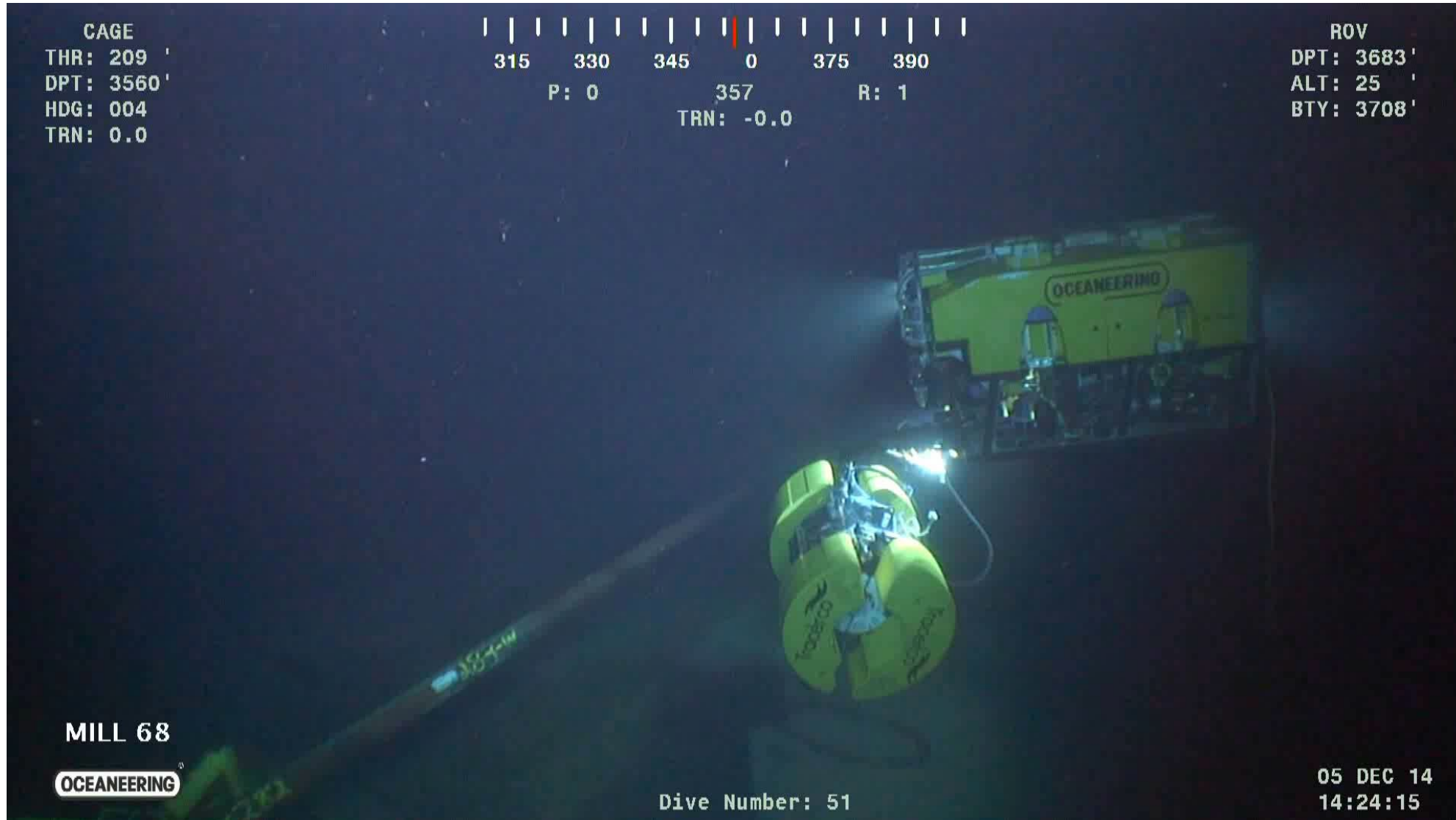
Gamma Energy Source & Detector Array



CT Instrument Body & Buoyancy Modules



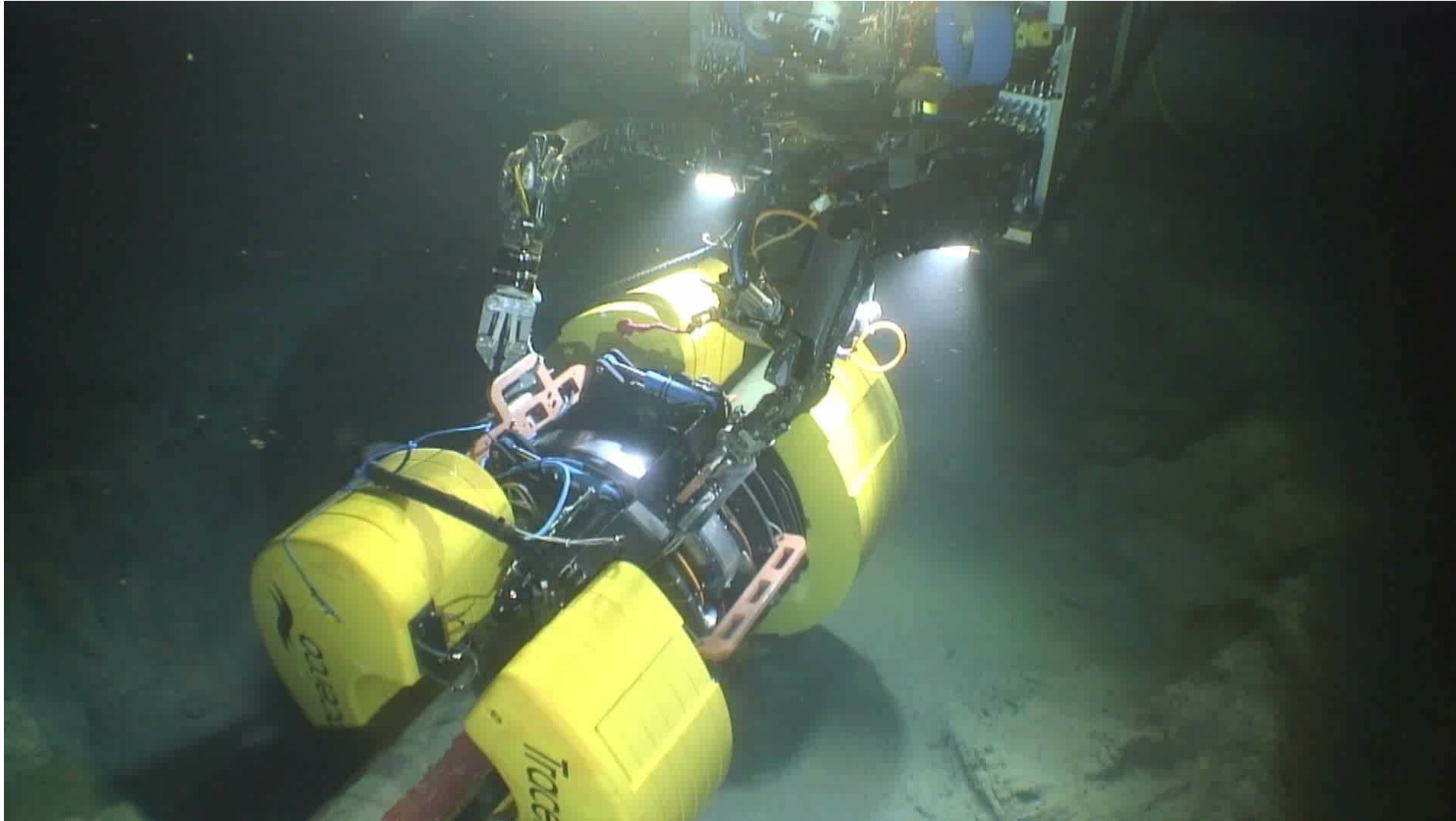
# Tracerco Discovery CT – Deepwater deployment by ROV



# Tracerco Discovery CT – Remote clamping onto pipeline

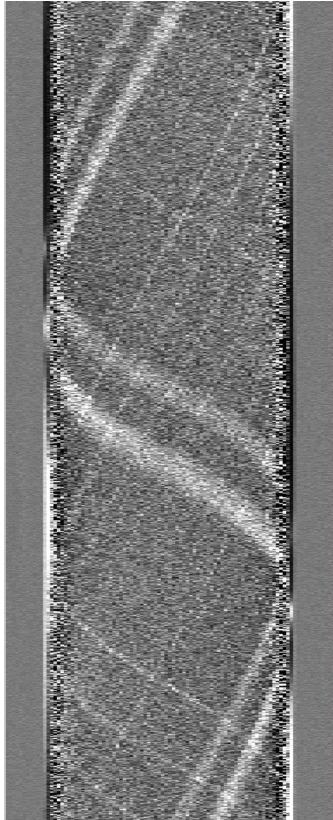


## Tracerco Discovery CT – Real time data acquisition



# Tracerco Discovery CT – Sinogram data visualisation

Raw data after 1 full lap



Anomalies detected in raw data

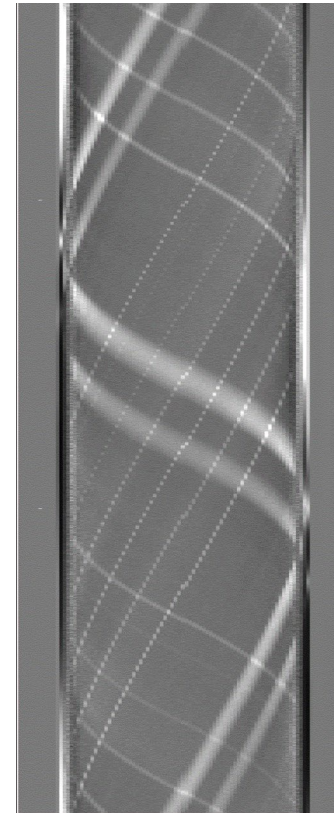
- Real time visualisation of raw projection data enables the operator to detect presence of metal loss anomalies.
- Where an anomaly is detected the scan continues to increase the signal-noise ratio to acceptable level to enable image reconstruction
- If no anomalies are identified the instrument can be indexed to the next adjacent scanning point.



Continue scanning

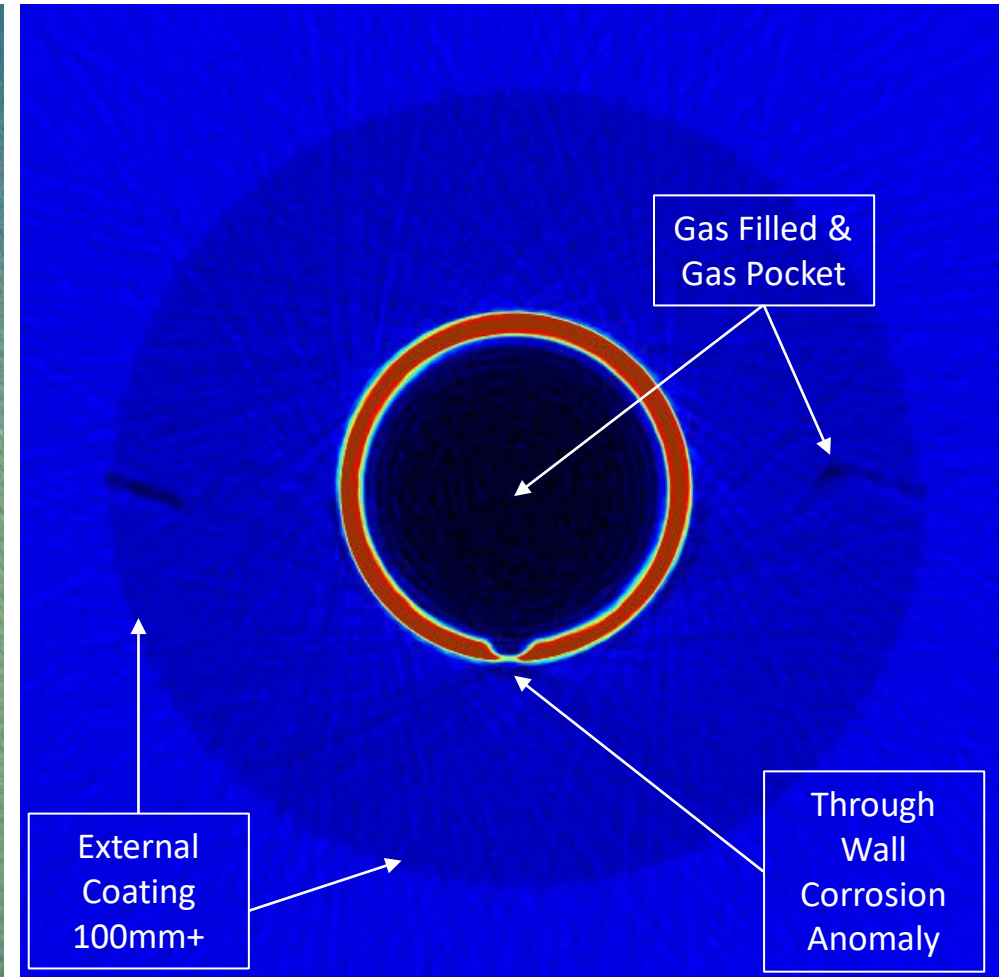
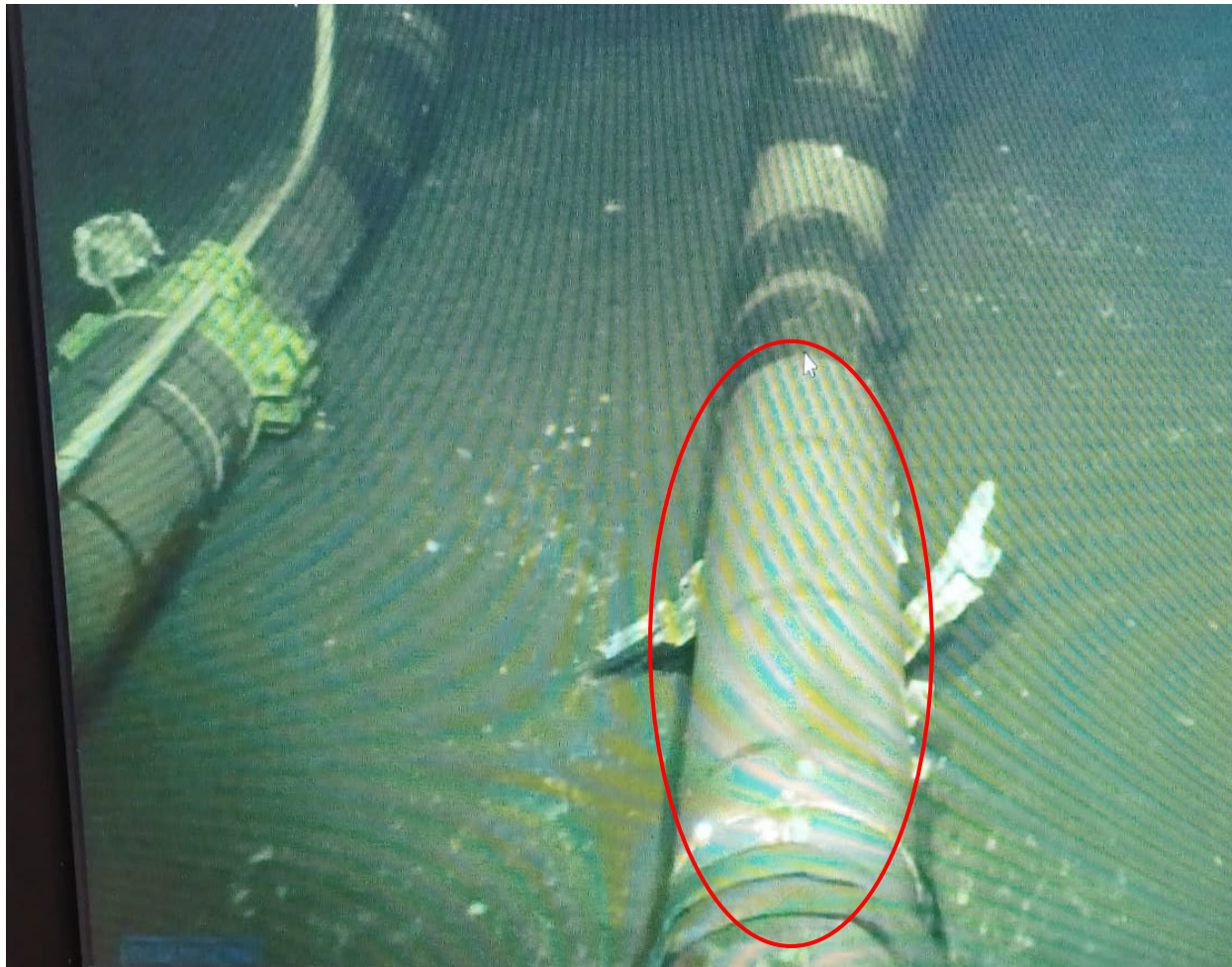


Raw data after >20 full laps

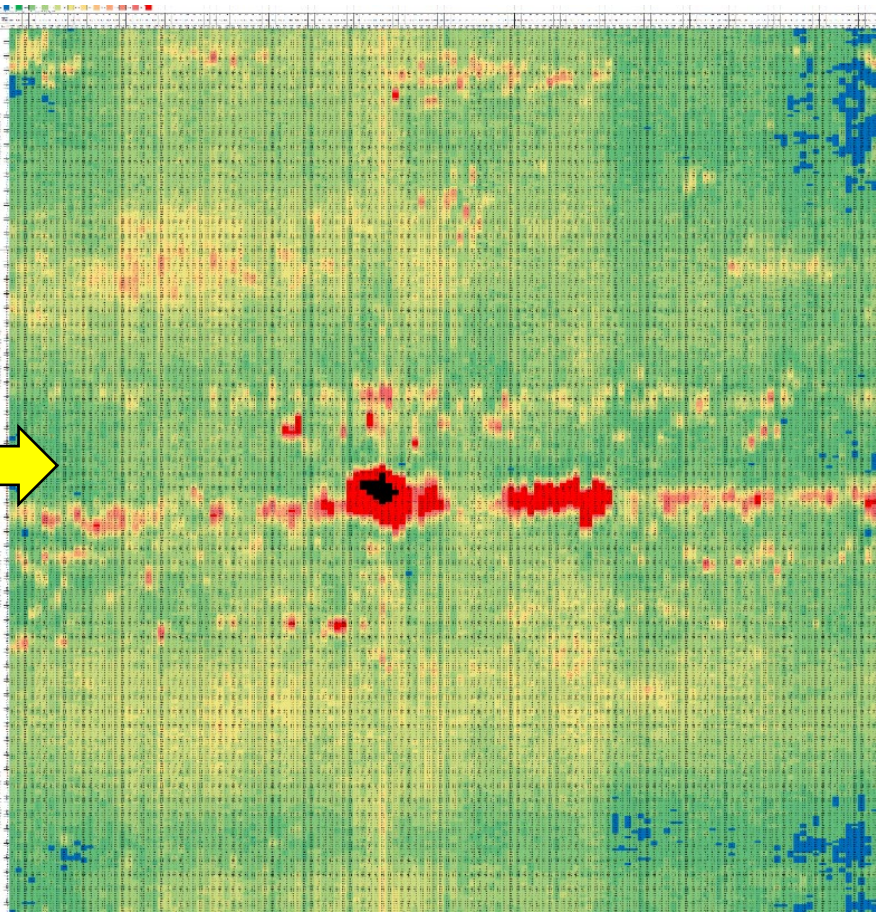
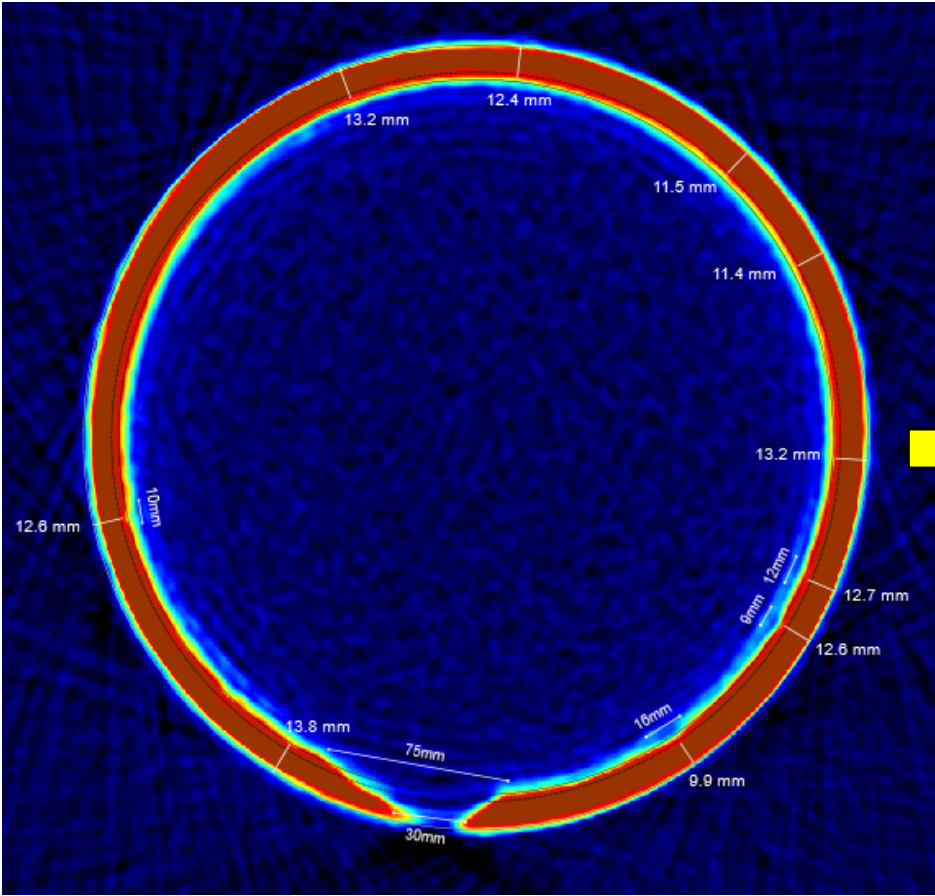


Sufficient data acquired for image reconstruction

# Tracerco Discovery CT – Sinogram to Tomogram reconstruction



# Tracerco Discovery CT – Measurement & Image Stack



0 deg

180 deg

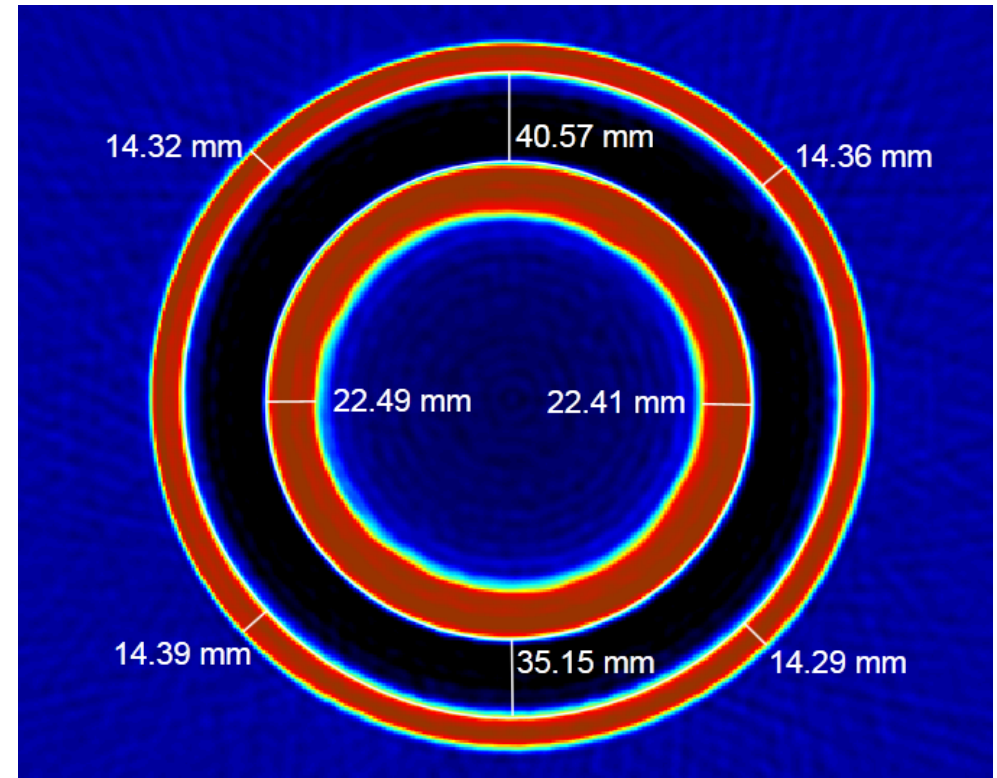
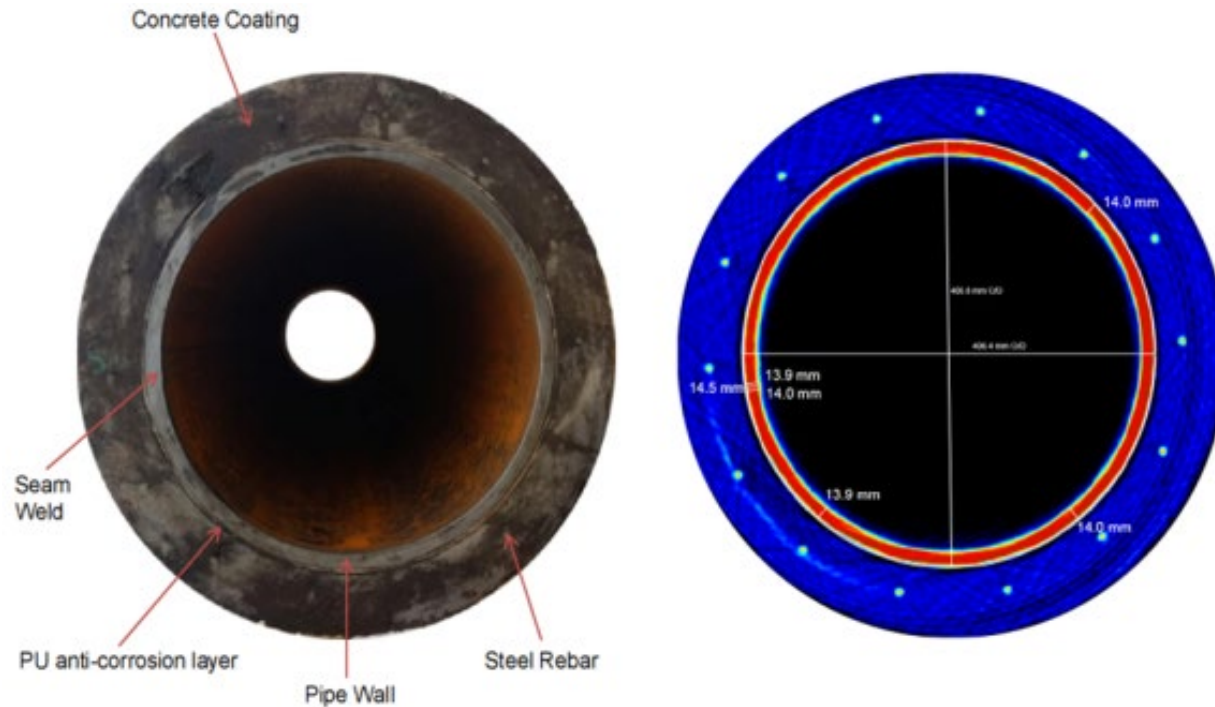
360 deg

Tomogram measurement toolbox and 'C' Scan image stack

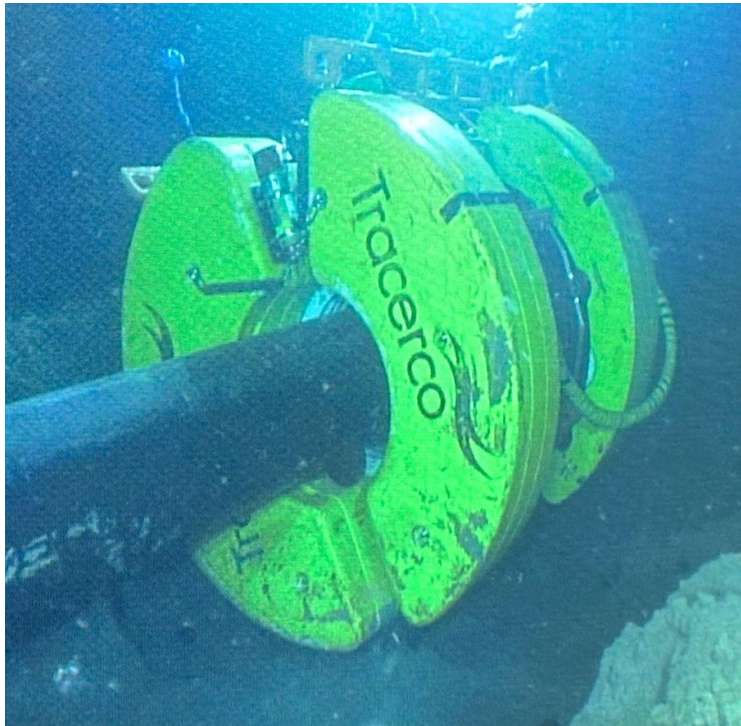


# Tracerco Discovery CT – PiP Integrity Assessment

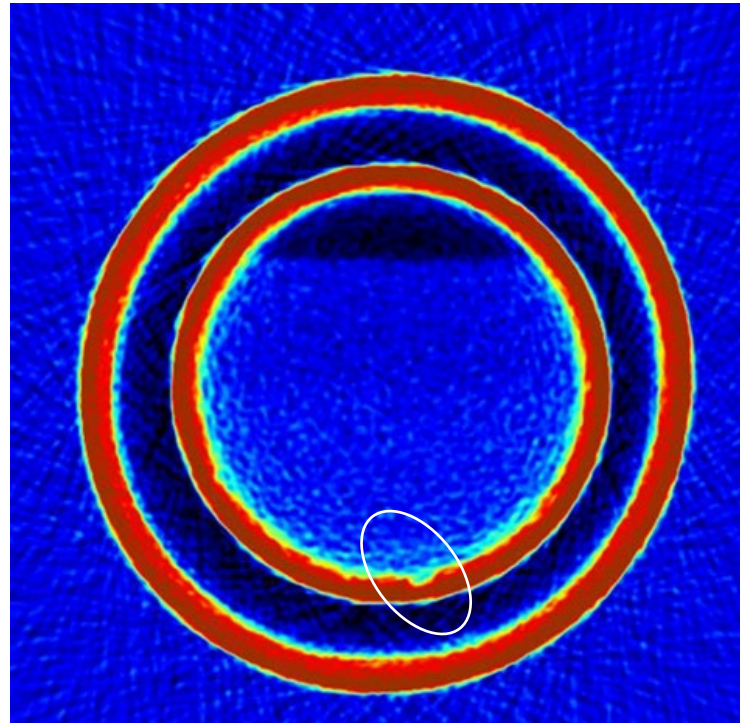
Discovery™ Scan images:



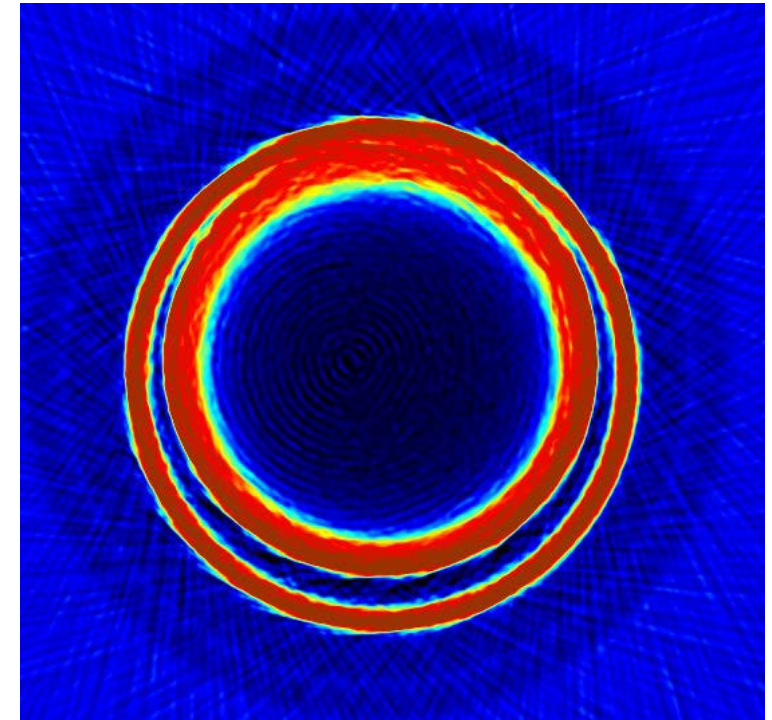
# Tracerco Discovery CT – PiP Inspection



Discovery on PiP Flowline

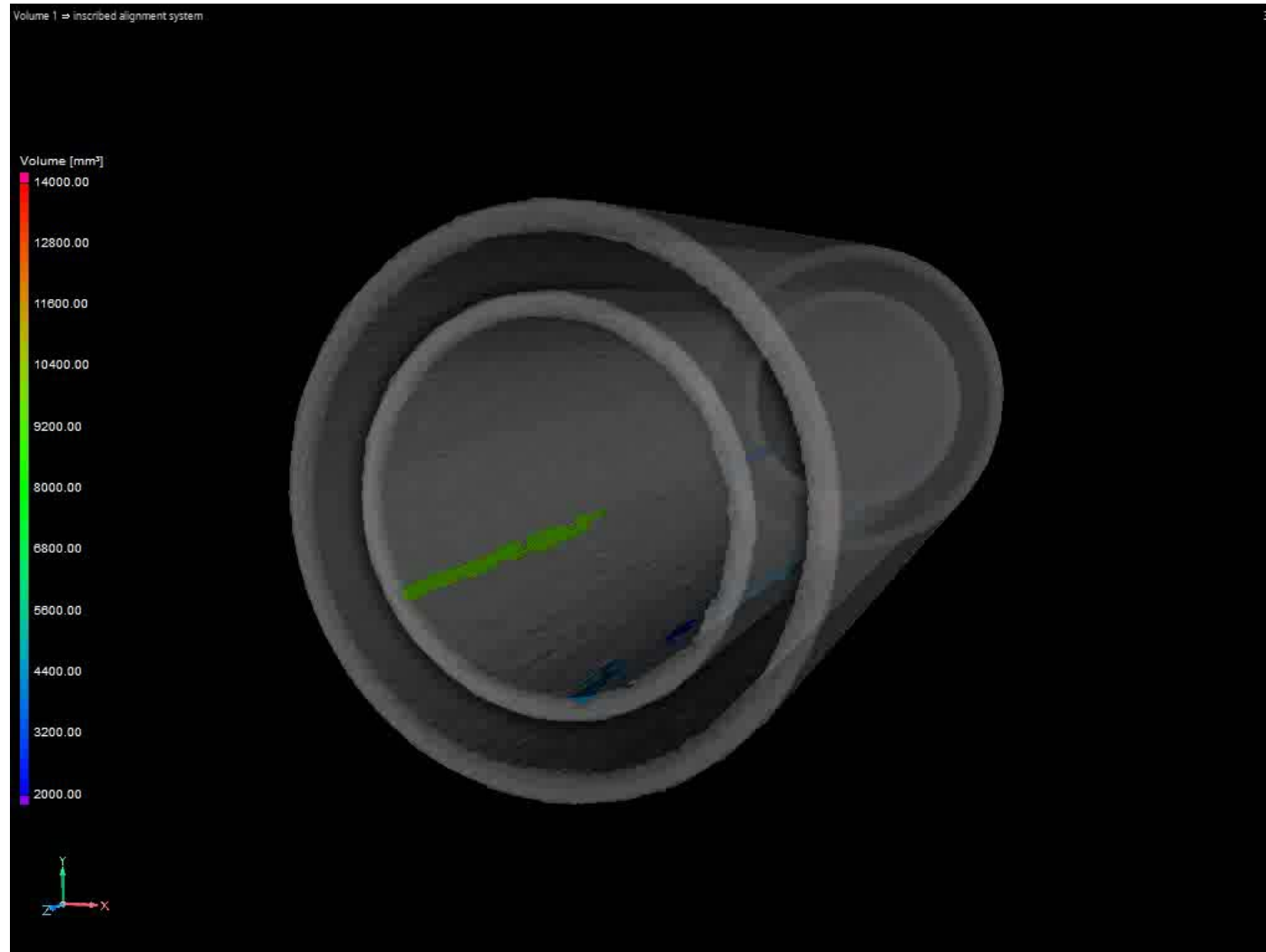


Centralised PiP with gas cap in liquid carrier, annulus integrity good, corrosion anomaly at 6 o'clock.



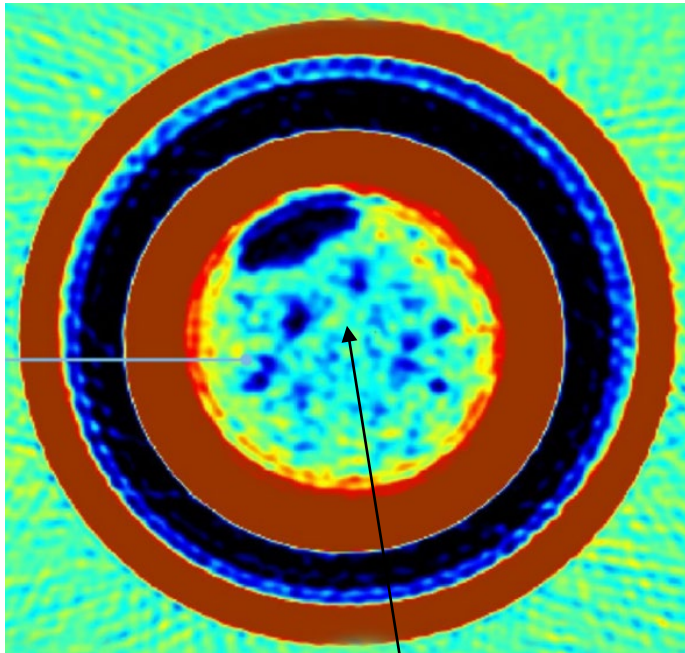
Un-centralised PiP Riser with vibration on touching surfaces

# Tracerco Discovery CT – PiP Integrity Assessment with 3D Tools

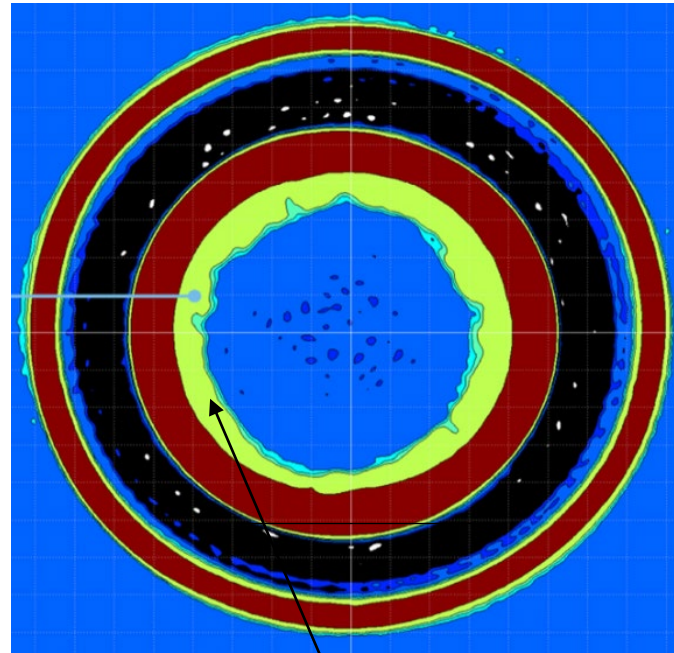


New visualisation and analysis tools.  
Decrease in processing time.  
Deeper integrity insights.  
Value for communicating condition assessments to leadership teams.

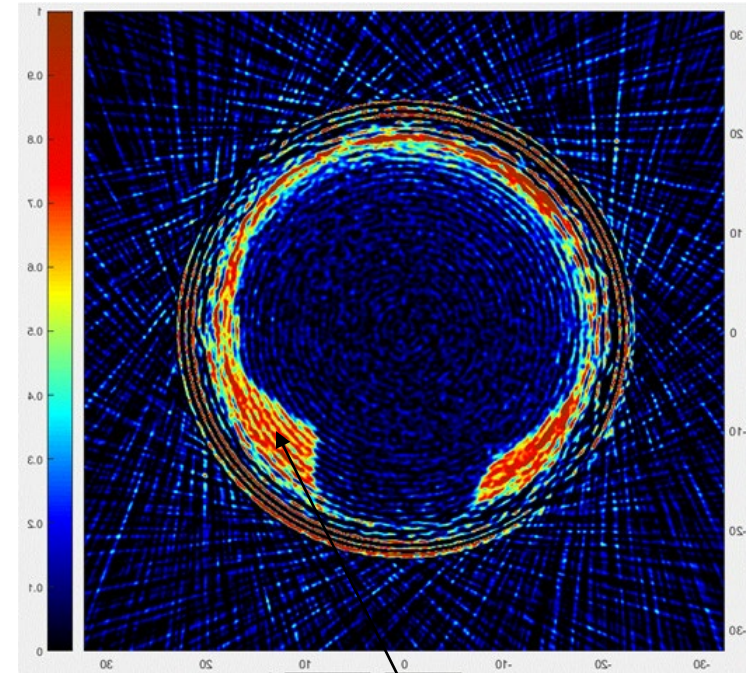
# Tracerco Discovery CT – Flow Assurance Applications



Asphaltene  
@1.2g/cc

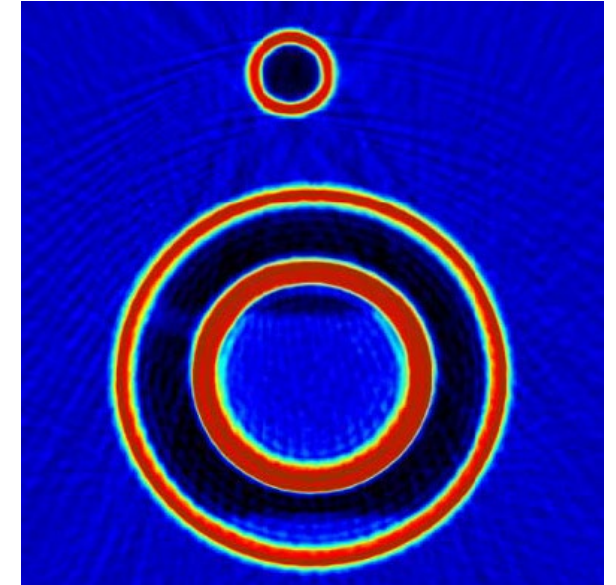
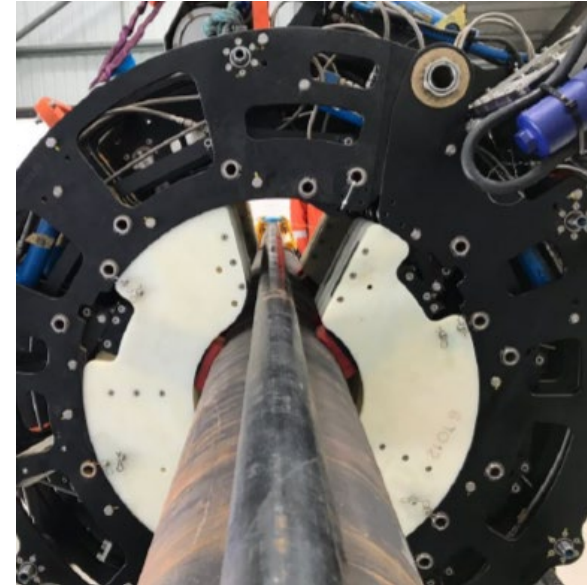
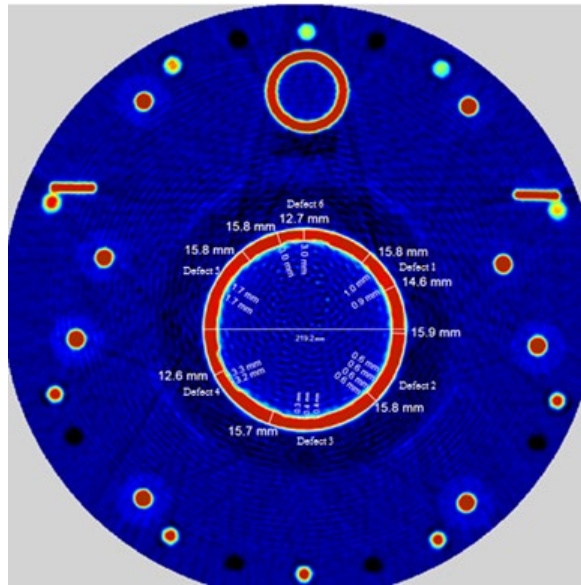


Scale  
@2.3g/cc



Paraffin Wax  
@0.9 g/cc

# Tracerco Discovery CT – Dual 'Piggyback' Pipelines



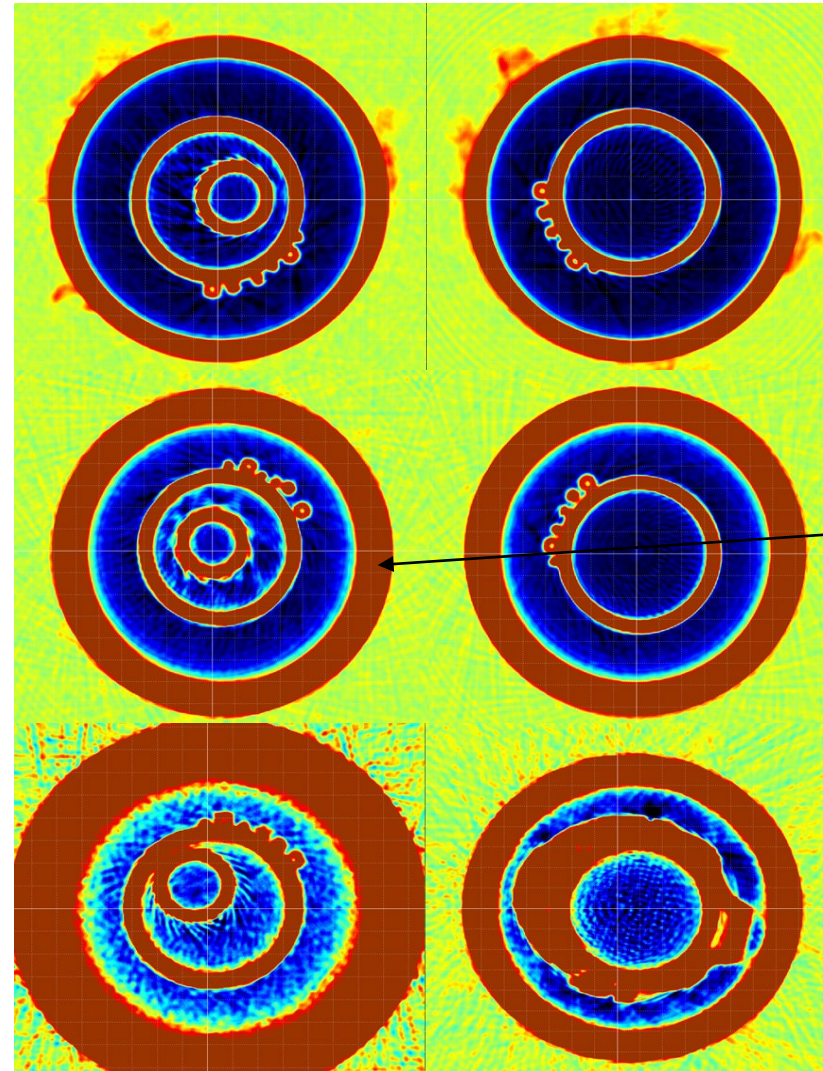
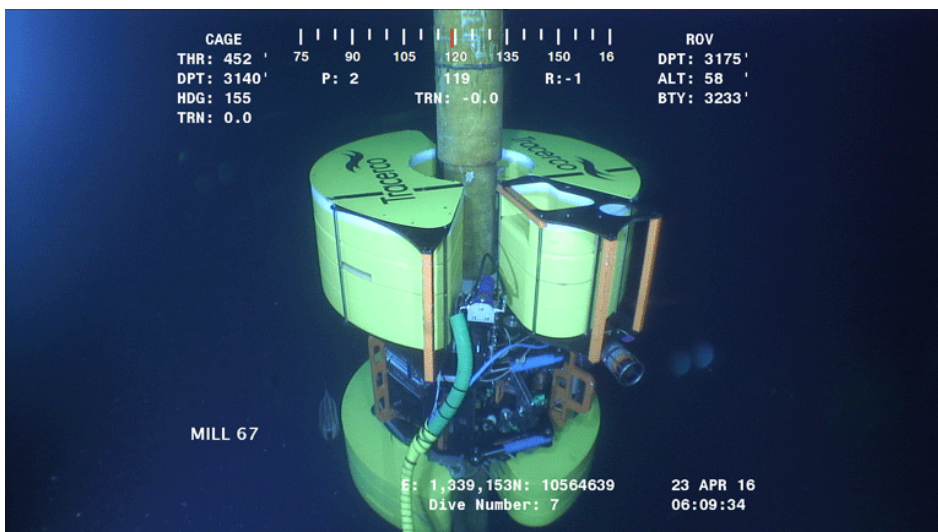
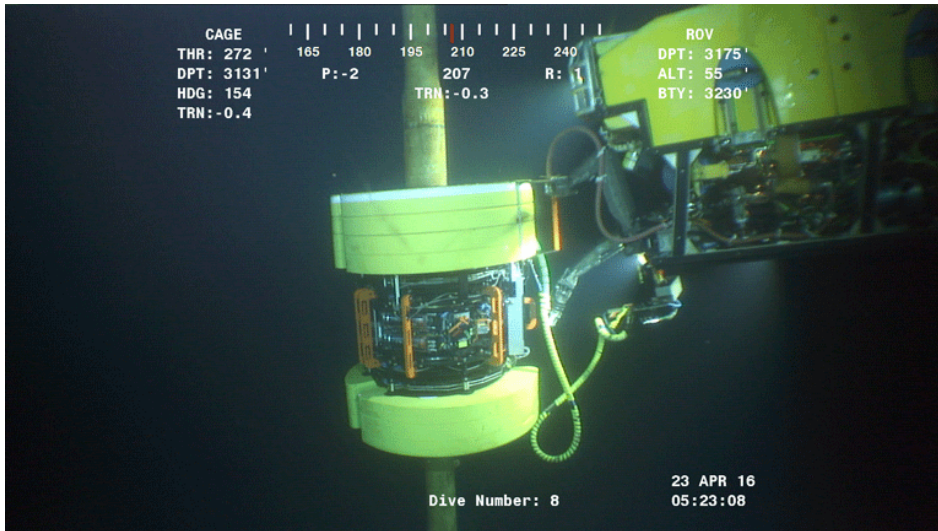
Temporary Polymer clamp/sleeve.

Tomogram Cross Section

Modified 'C' Plate Modification

Tomogram Cross Section

# Tracerco Discovery CT – Top Tension Riser & Artificial Lift



TTR with gas lift inspection for annulus liquid level.

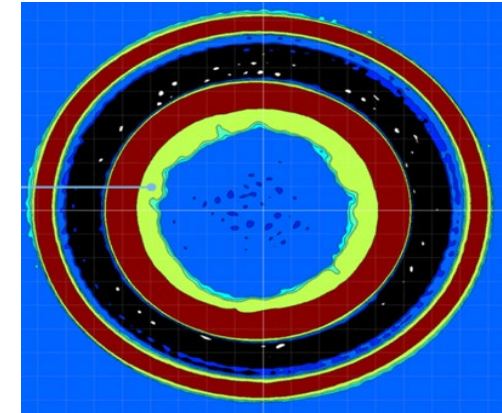
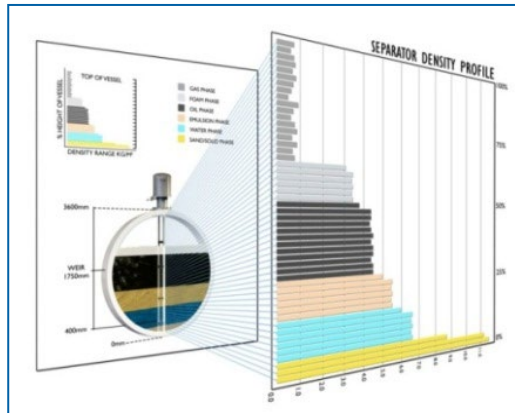
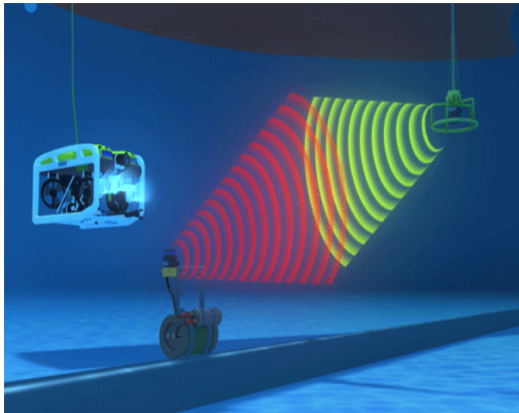
## Summary & Conclusions



- Computed Tomography as a Subsea NDE method is field proven.
- 100% Safety record - minimal exposure/dose rates for all involved workers.
- Integrity measurements and assessment equivalent to MFL ILI technology.
- Proven option for external deepwater inspection of un-piggable riser and flowline systems.
- Can inspect through thick coatings, PiP, dual pipeline and certain bundle arrangements.
- Provides insights to potential production threats.
- Supports flow assurance regimes and monitoring of remediation campaigns.
- Risk reduction compared to intrusive inspection systems or elimination of coating removal.

# SME Radioisotope Technology

Established over 60 years ago, Tracerco are an independent world leading technology company providing unique and specialised detection and measurement solutions.



Experts at seeing inside vessels and pipelines to verify real time process conditions and integrity - Online and non-intrusive :  
Insight Through Innovation



**GUH Subsea Expo 2024**

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