

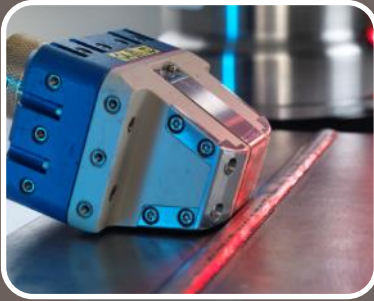


TSC
SUBSEA

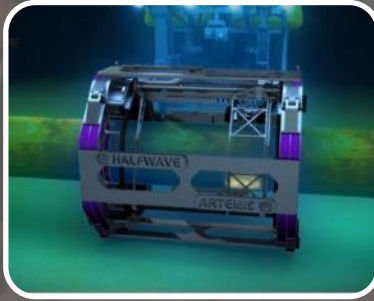


**Expanding Applications &
Capabilities of Remote Inspections**

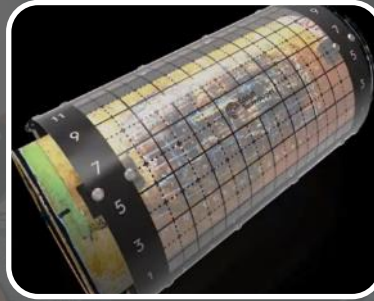
TSC Subsea Technologies



ACFM™
Alternating
Current Field
Measurement



ART™
Acoustic
Resonance
Technology



SPECTA™
Subsea
Pulsed Eddy
Current
Array



SPA™
Subsea TFM
Phased
Array

ART™

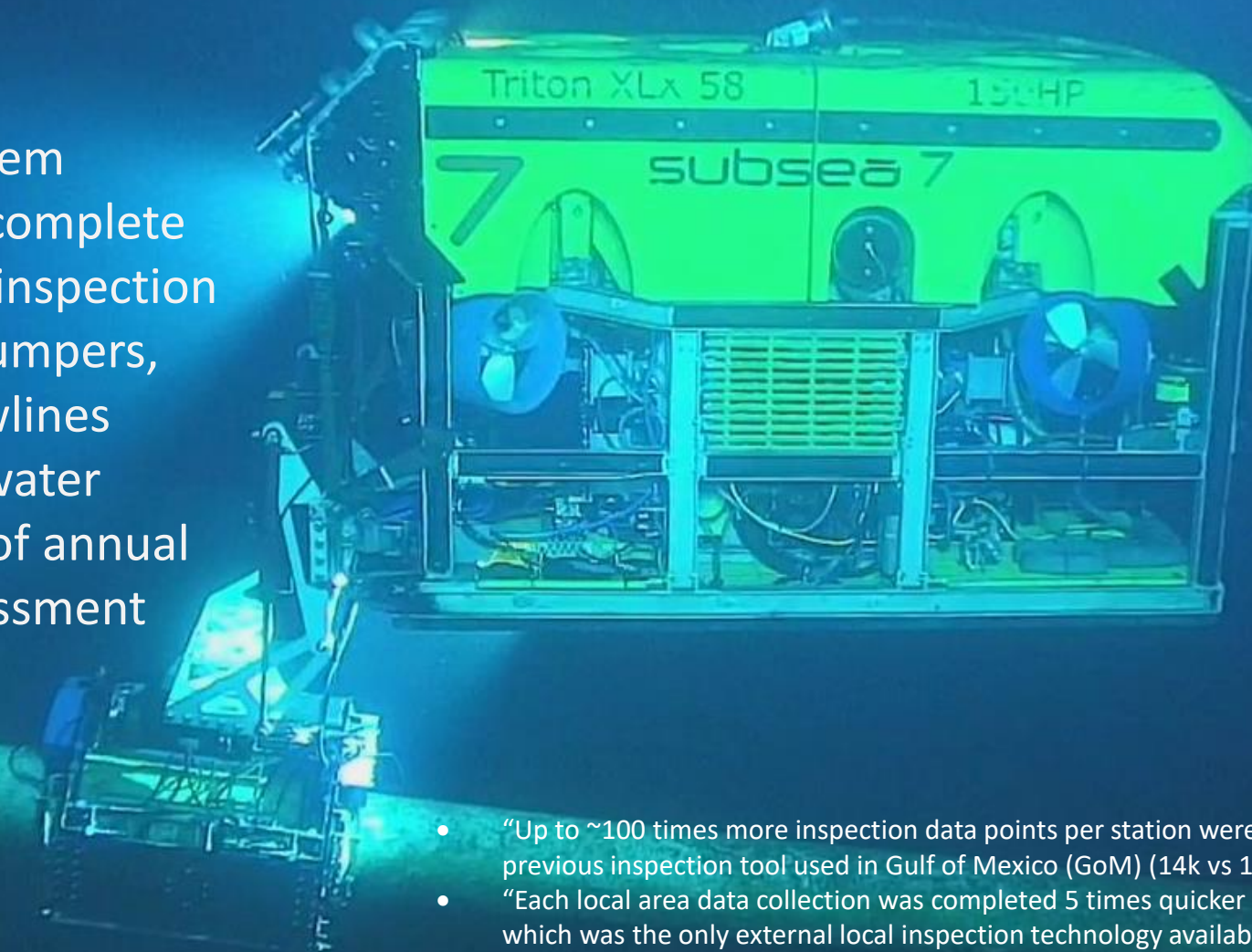
 **HALFWAVE**

ARTEMIS 

Multi-Asset Inspection Campaign | US GoM

Background:

- ARTEMIS® system contracted to complete wall thickness inspection of numerous jumpers, risers, and flowlines across 6 deepwater assets as part of annual corrosion assessment program

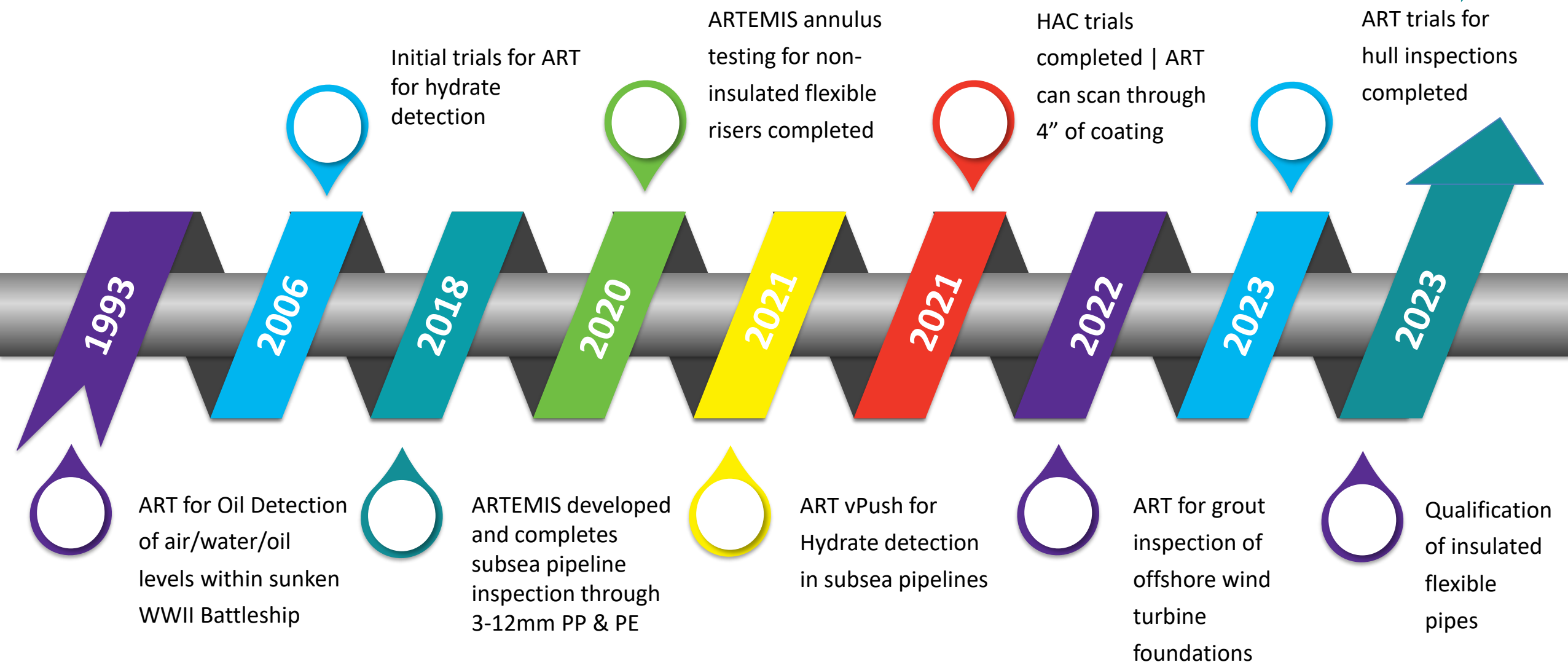


Campaign:

- 16 Subsea Jumpers
 - 9 Risers
 - 9 Flowlines
 - 114 scans completed
 - Record 10k ft depth achieved
- “Up to ~100 times more inspection data points per station were collected and analyzed compared with the previous inspection tool used in Gulf of Mexico (GoM) (14k vs 1300k data points per line).”
 - “Each local area data collection was completed 5 times quicker compared with the previous tool used in GoM which was the only external local inspection technology available for deepwater production systems at that time.”

ART Milestones

200+ ARTEMIS
inspections completed



From Oil & Gas to Offshore Wind

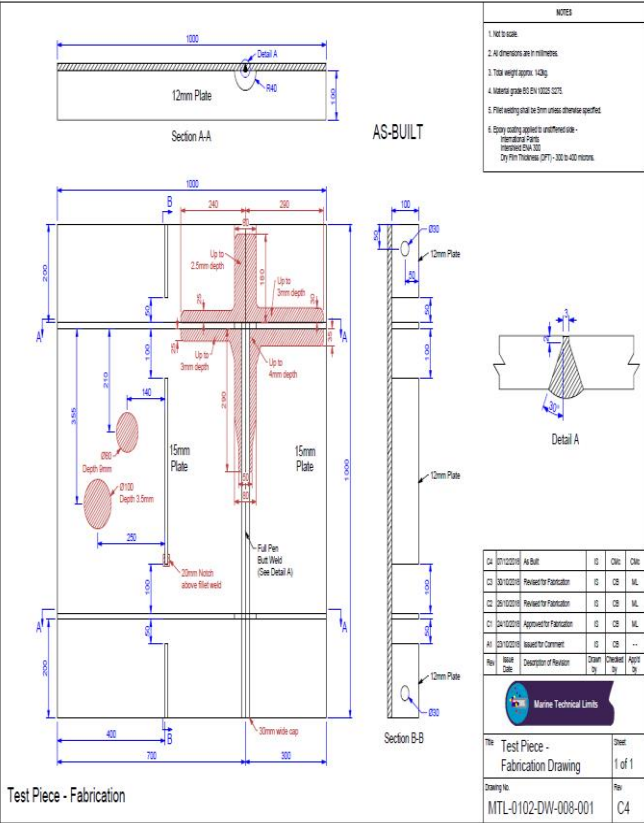
A grayscale photograph of an offshore oil rig, specifically the 'North Cormorant', viewed from a distance. In the foreground, the back of a person wearing a white hard hat is visible, looking out towards the rig. The rig is a complex of steel structures with various platforms and cranes. The sky is overcast, and the sea is visible in the background.

ART Guide

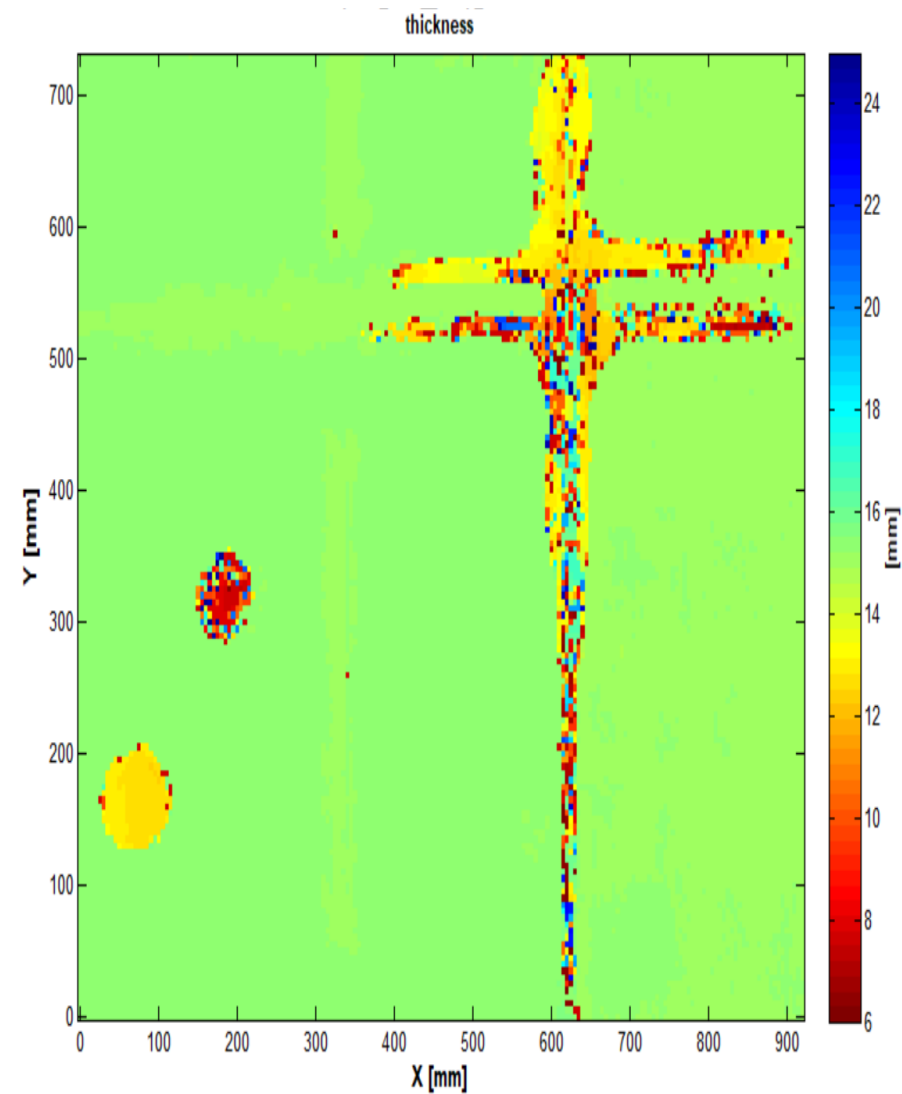
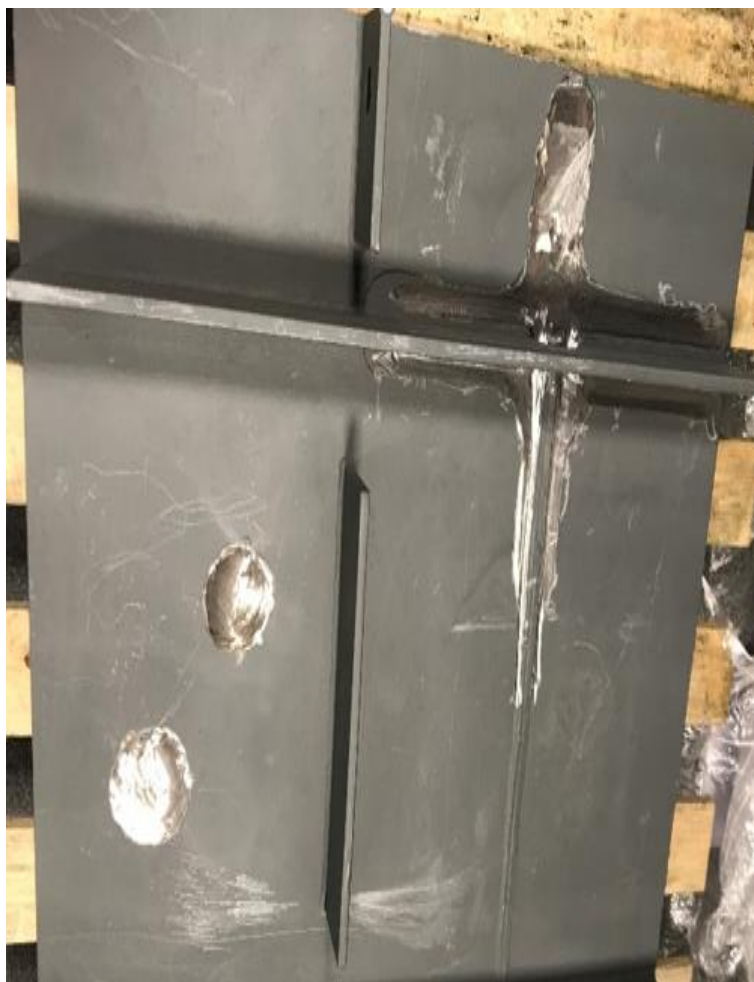
Prior Single Skin Hull Testing

As built drawing

Image of plate underside



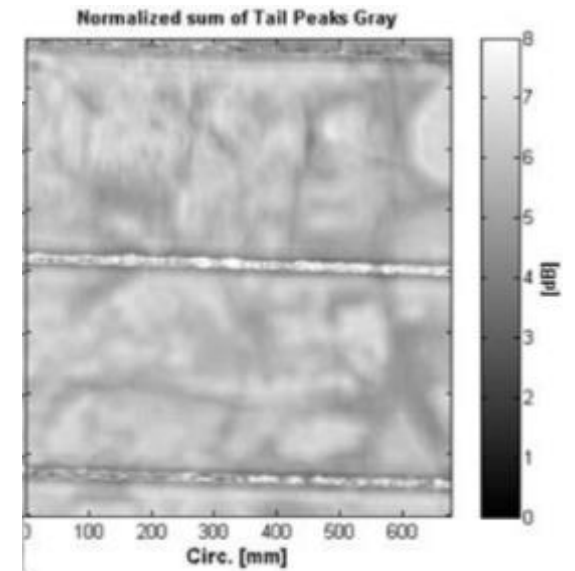
Initial Factory Testing



ART[®] GUIDE



Sponsored development with Norwegian operator to fill technology gap for ROV deployed external inspection of grouted connection inside pile sleeves designed to detect and confirm grouting presence and to detect typical failures that may occur over time.. on offshore jacket structures, wind turbines or anywhere that two steel interfaces are connected using grout.



From Offshore Wind to Marine Markets

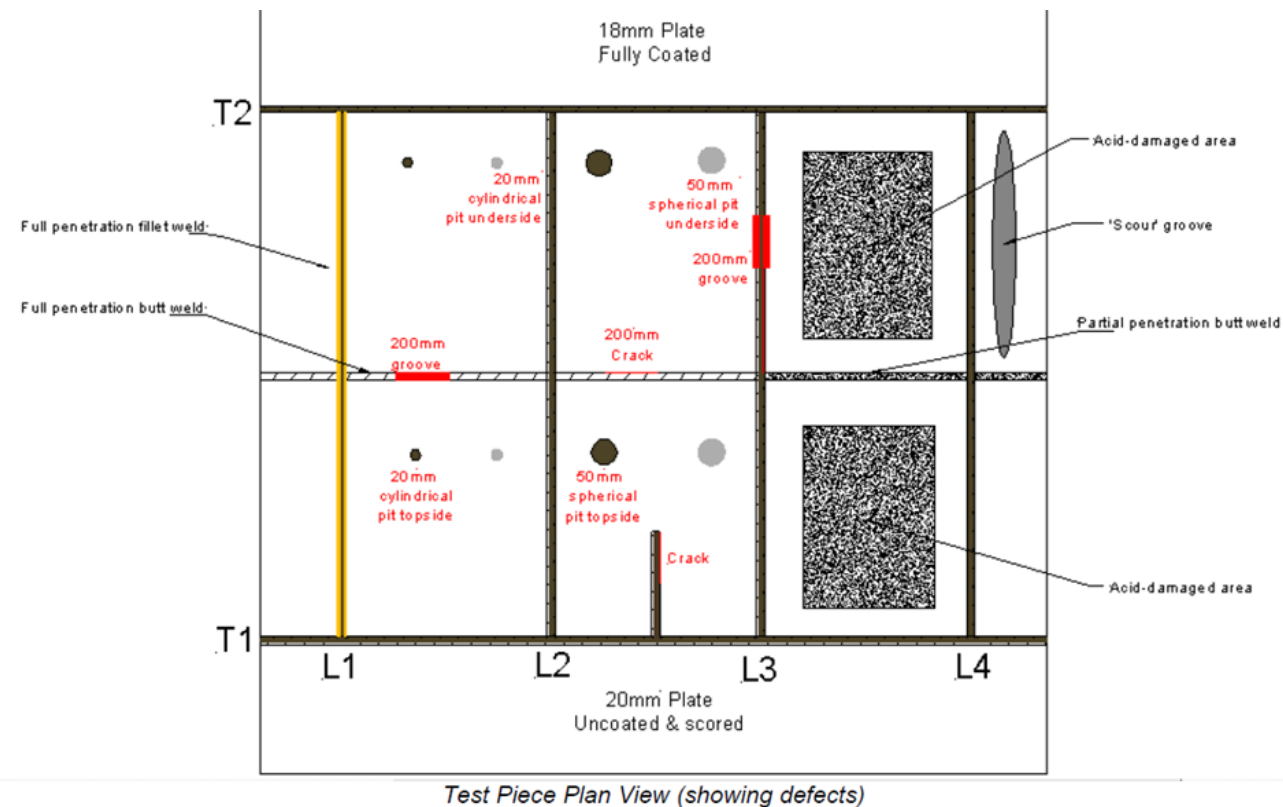
A grayscale photograph of an offshore oil rig, the North Cormorant, situated in the ocean. The rig is a complex structure with multiple levels, scaffolding, and a crane. A worker wearing a white hard hat is visible in the foreground, looking out towards the rig. The sky is overcast, and the water is calm.

HullScanner Trials

HITS Single Skin FPSO Hull Trial

- Expand on initial discussion with HITS – art identified as potential tech, thru coating etc.
- TSC performed a blind test on a purpose made test piece that represents a single skin ship hull.
- Purpose of the trial was to evaluate the capability of Acoustic Resonance Technology (ART) to inspect ship hulls for wall thickness.
- Trial was performed at Forth Engineering test facility in Flimby, Cumbria.

Blind Testing at Forth Engineering



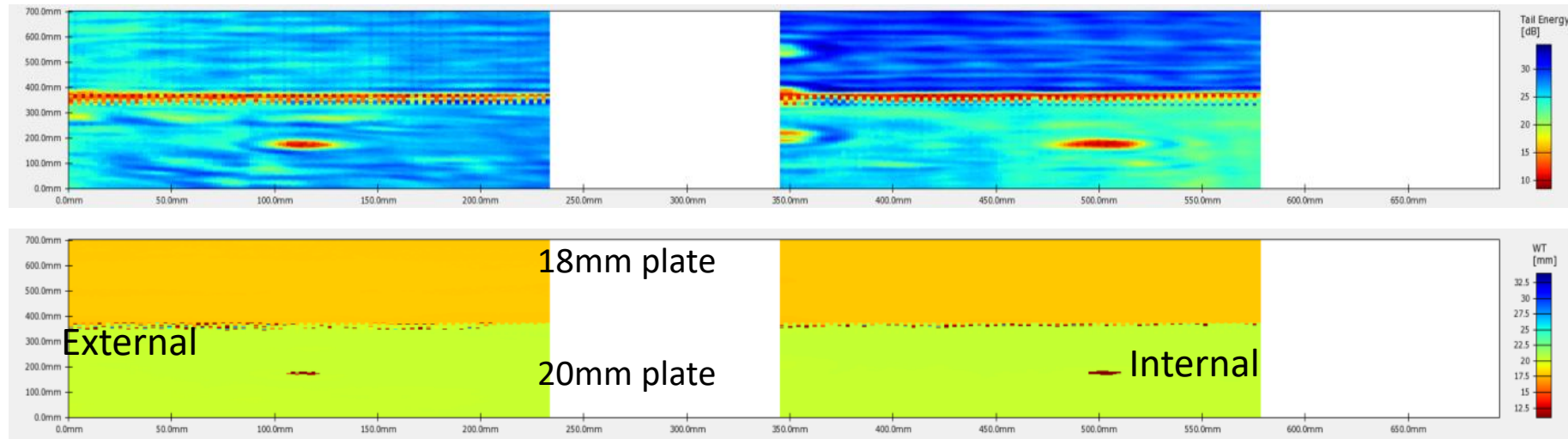
3m x 3m



Hull Inspection Techniques & Strategy (HITS) Factory Acceptance Test (FAT)

Blind Testing Results

Defect no	X Pos [mm]	Y Pos [mm]	Length [mm]	Width [mm]	Reference WT [mm]	Remaining WT [mm]	WT Loss [mm]	WT Loss [%]	Location
1	105.7	163.7	19.6	15.9	20.3	10.4	9.8	48.5	Topside
2	167.8	494.6	17.5	15.9	20.4	10.8	9.6	47.0	Underside





Case Study: ART for Hull Inspections

Problem:

- Current inspection methods are time consuming and require coating removal due to highly reflective coatings
- Vessel out of service for extended periods
- Looking for alternative inspection methods

Why ART?

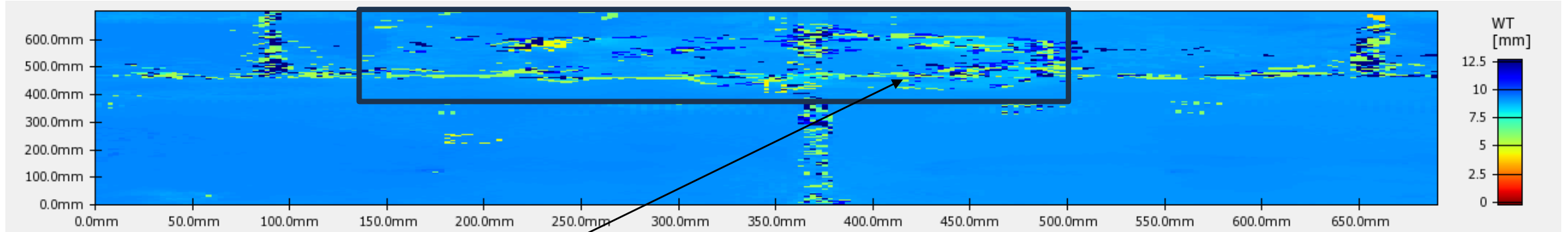
- ART technology is field proven for quantitative inspection of unfavourable coatings and known for inspection speed
- TSC Subsea Robotics systems already recognised/accepted for UWILD for spot readings and crack detection

Results

- Internal and external defect mapping successfully completed
- Next steps to integrate into hull crawler

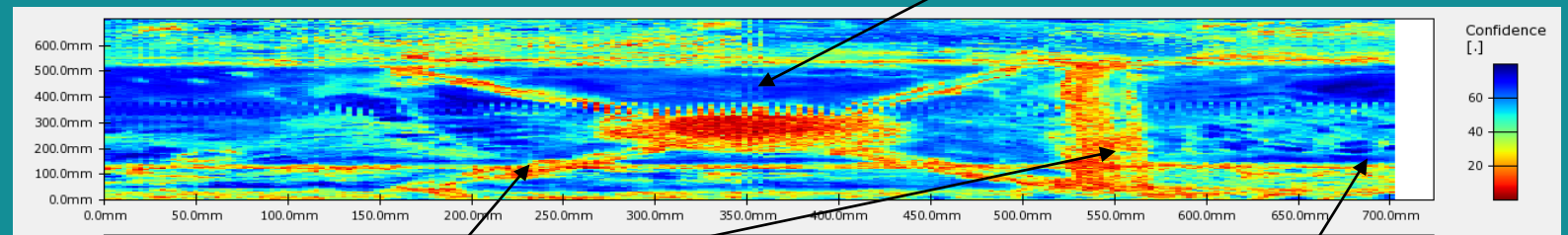
Sample of Navy Hull Results

Scan 1



External feature area.

Scan 2 at Overboard Discharge



Internal stiffeners

Overboard discharge

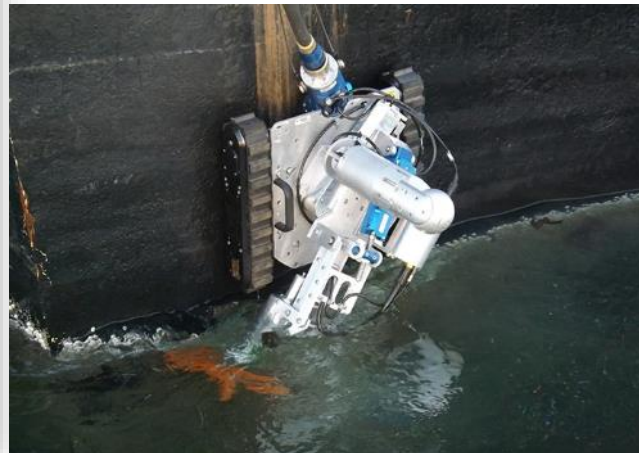
Long weld

Crawler Advancements



MagCrawler™ Inspection

- Toppide or subsea, internal or external
- Large diameter circumferential & Fillet welds
- Multi-tech capabilities: ACFM®, PEC, ART, PA & ToFD



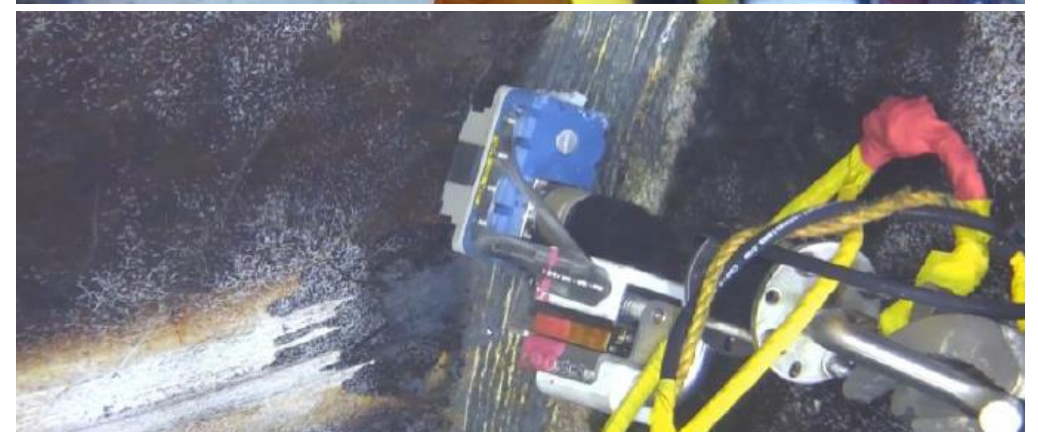
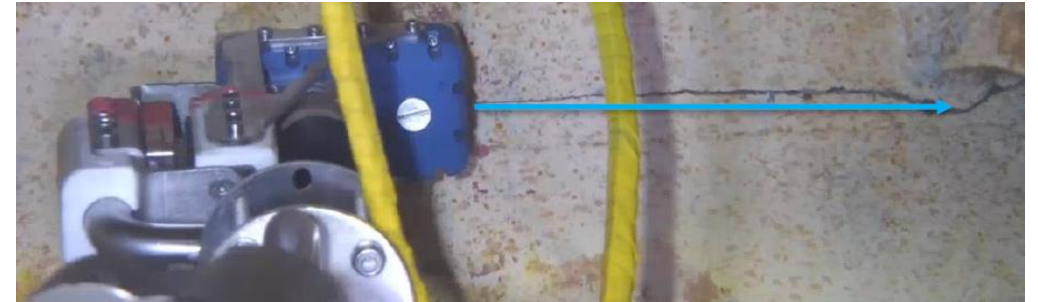
GOM SPAR – ACFM Gusset Plate Inspections

Background:

- SPAR located in Gulf of Mexico
- WROV CVI found (5) crack like indications requiring further investigation

Results:

- 5 Scans Completed
- Only 1 of 5 locations found to be a surface breaking, through-wall crack



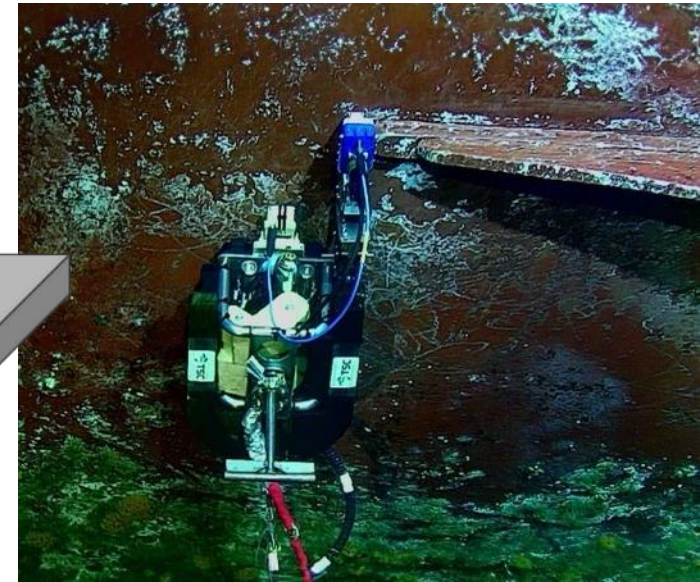
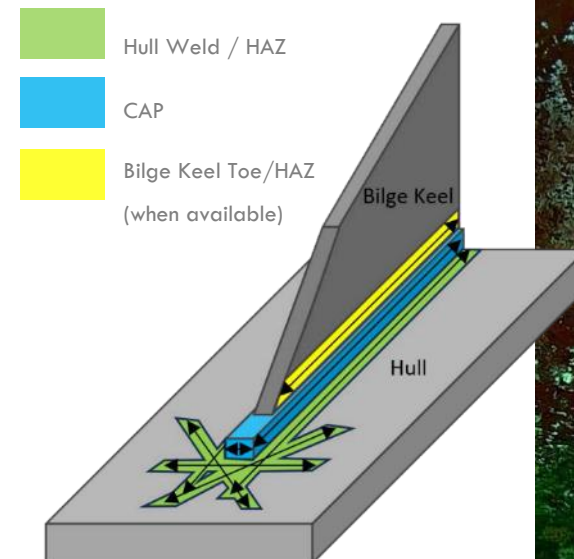
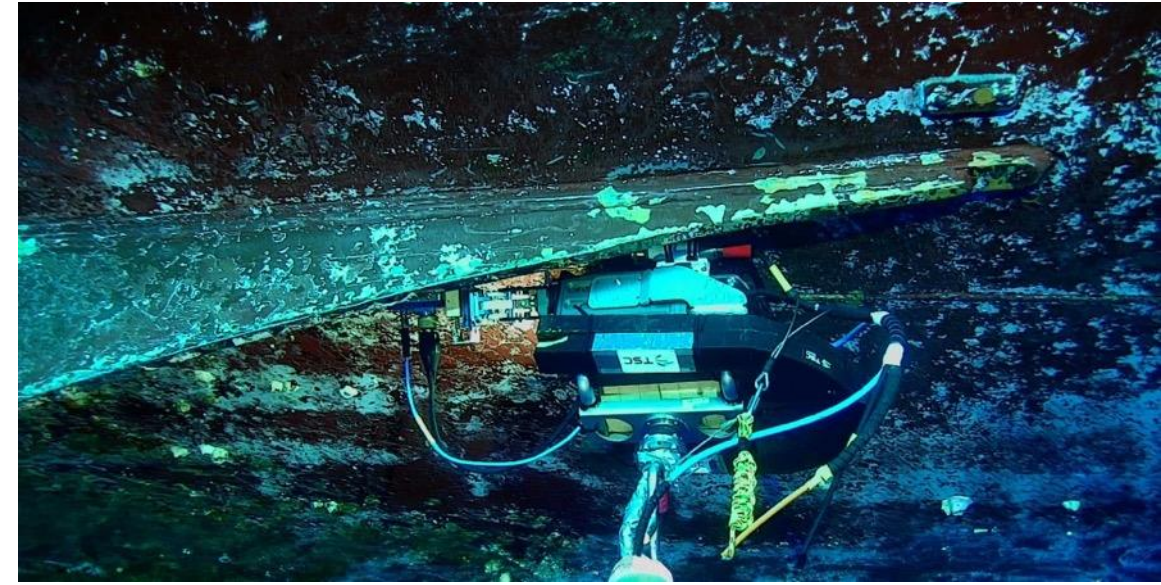
FPSO Bilge Keel Weld Inspection with ACFM

Introduction:

- In-service underwater bilge keel weld inspection on Petrobras FPSO.
- To determine the presence or absence of surface-breaking defects.
- Regular inspections of the structural hull and bilge welds are crucial to identify cracks and defects resulting from dynamic loading.

Challenges:

- Inspection must be conducted when the FPSO is in service.
- It must be a diverless solution due to safety concerns.
- The FPSO creates strong underwater currents.
- Must be a proven and robust NDT technology.
- The hull and bilge are coated in Epoxy.



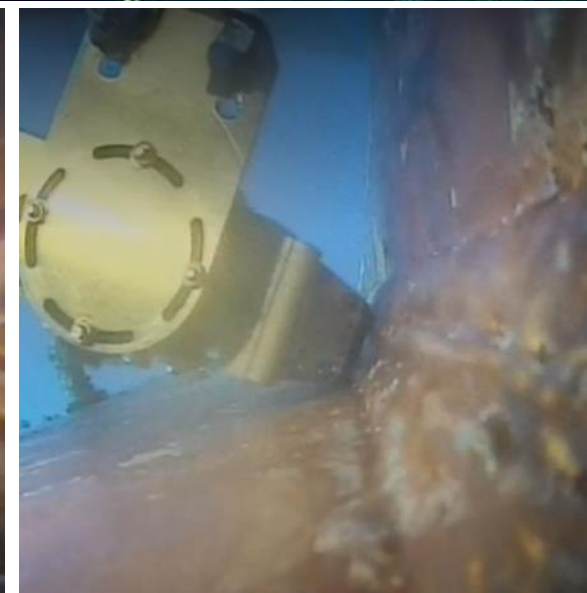
FPSO Bilge Keel Weld Inspection with ACFM

Solution:

- ROV deployed robotic MagCrawler.
- Alternating Current Field Measurement (ACFM®).
 - DNV, Bureau Veritas, and ABS approved.
 - Crack detection and sizing through coatings.
 - Accurate and auditable inspection data.
 - High Probability of Detection (PoD).
 - Array probe for greater coverage and efficiency.

Result:

- MagCrawler was easily positioned by the ROV.
- Consistent scanning speed and a well-planned scan pattern ensure reliable inspection data.
- All areas of concern were scanned, with no defects above the reporting threshold detected.
- The client was pleased with the inspection and had confidence in the inspection process.



A grayscale photograph of an offshore oil rig, the North Cormorant, situated in the ocean. The rig is a complex structure with multiple levels, cranes, and scaffolding. In the foreground, the back of a person wearing a white hard hat is visible, looking out towards the rig. The sky is overcast and the sea is calm. The text "From Offshore to Onshore" is overlaid in a teal color at the top of the image.

From Offshore to Onshore

Tethered Solutions

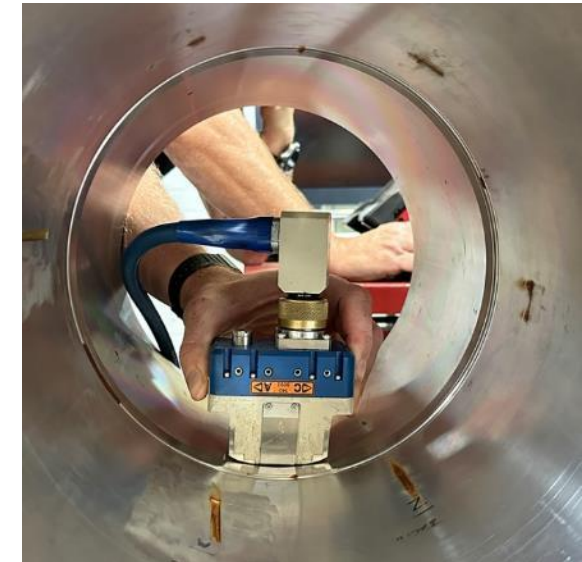
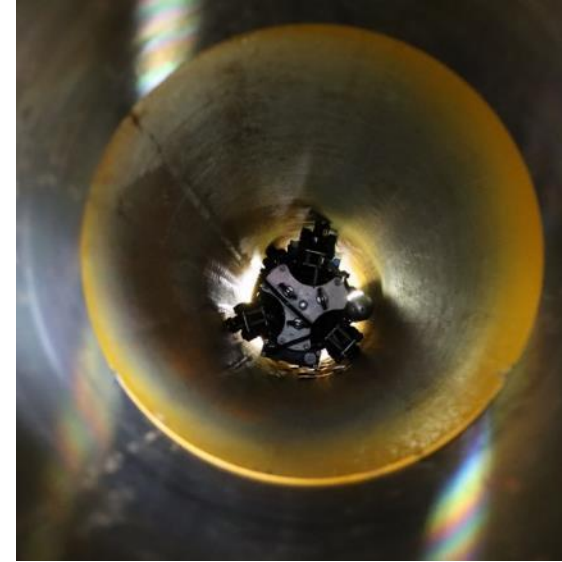
Tethered In-line Inspection (ILI) Solution

Introduction:

- Internal inspection of an unused riser on a North Sea offshore platform as part of a recommissioning project.
- The duplex riser consisted of:
 - 110 m vertical pipe with recessed welds every 10 m.
 - Wall thickness of 50 mm.
 - 3 x 90-degree bends.
- Validate the presence of possible cracking and corrosion.
- Areas of concern were mainly located around the circumferential welds.

Challenges:

- Surface and volumetric inspection required.
- Navigate the pipe and perform a 360-degree axial scan around the welds.
- Partially flooded with anti-corrosion products at elevated temperatures.
- One-way entry and retrieval.
- Full mock-up FAT before the offshore campaign.



Tethered In-line Inspection (ILI) Solution

Solution:

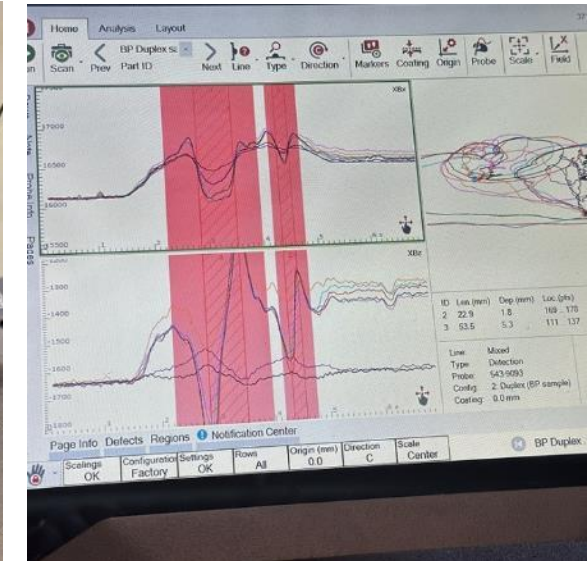
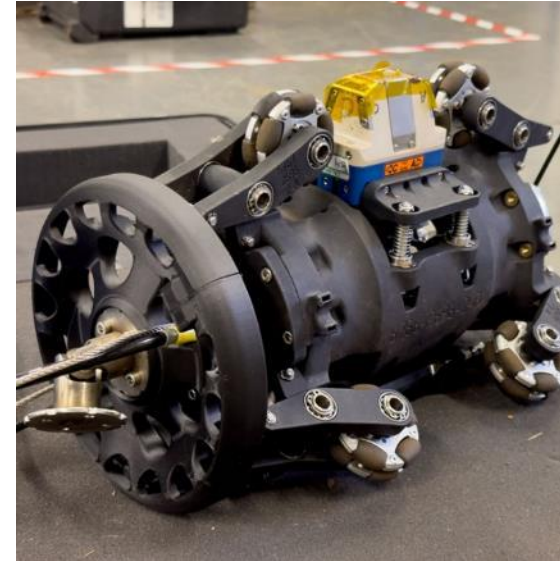
- Dual NDT technologies: ACFM for crack detection and SPA for volumetric inspection.
- Custom 360ID robotic scanner capable of travelling longitudinally with 360-degree axial rotation.
- Technology bottle housing ACFM or SPA circuitry and a custom winch for umbilical support.

Result:

- All 13 recessed welds were fully inspected, with no anomalies found above the minimum reporting threshold.
- No corrosion pitting was detected above the minimum reporting threshold.
- Successful inspection gave client confidence needed to proceed with their development project and re-commission the riser.

"I have nothing but praise for the project, from engineering all the way through to execution."

- Project Engineer



ACFM Setup

Internal Laser Inspection of 16" Onshore Pipeline

Challenges:

- Incident required shut-in of pipe
- Total inspection length of 600 meters
- Visual and laser scanning
- One way entry and retrieval
- 4-week mobilization timeline

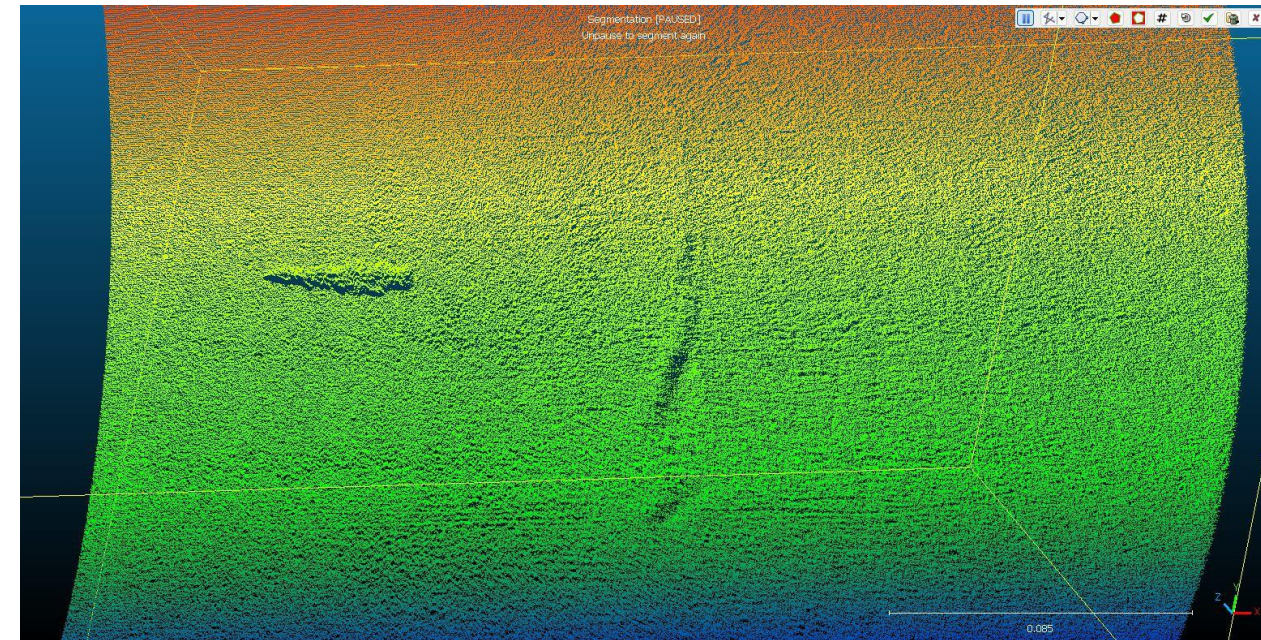
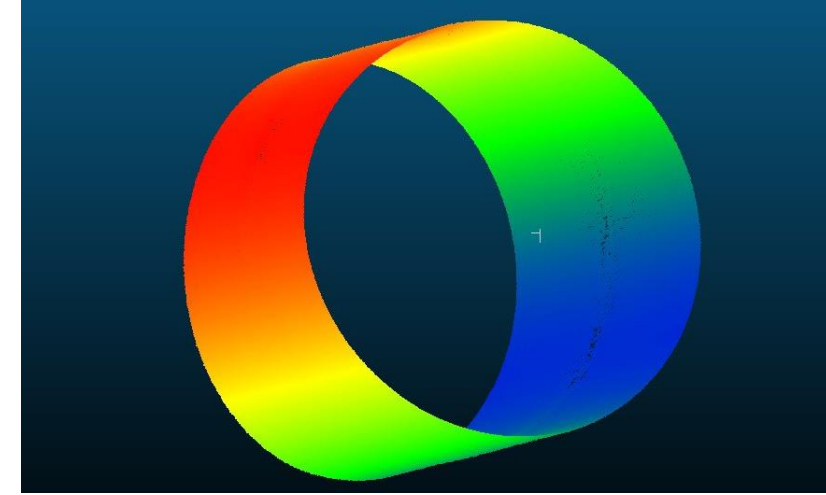
Solution:

- Internal Crawler
- Combined HD Visual and Laser Scan technologies.



Internal Laser Inspection of 16" Onshore Pipeline

- 600m visual inspection
- Laser scan based on visual identification of anomalies
- The inspection allowed the pipeline operator to confirm pipeline integrity and resume flow



Thank You!

Contact Info

Rolf Sporkel

Norway

+47 41519668

rsporkel@tscsubsea.com

Jonathan Bancroft

U.K.

+44 (0) 7710 390438

jbancroft@tscsubsea.com

Paul Chittenden

USA

+1 713.440.8868

pchittenden@tscsubsea.com