

Managing Technical and Logistical Challenges on a Deepwater Gas Field: Tamar Pipeline Pre-Commissioning and Baseline Inspection Project



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PPSA Annual Seminar, Aberdeen, UK
19th November, 2014



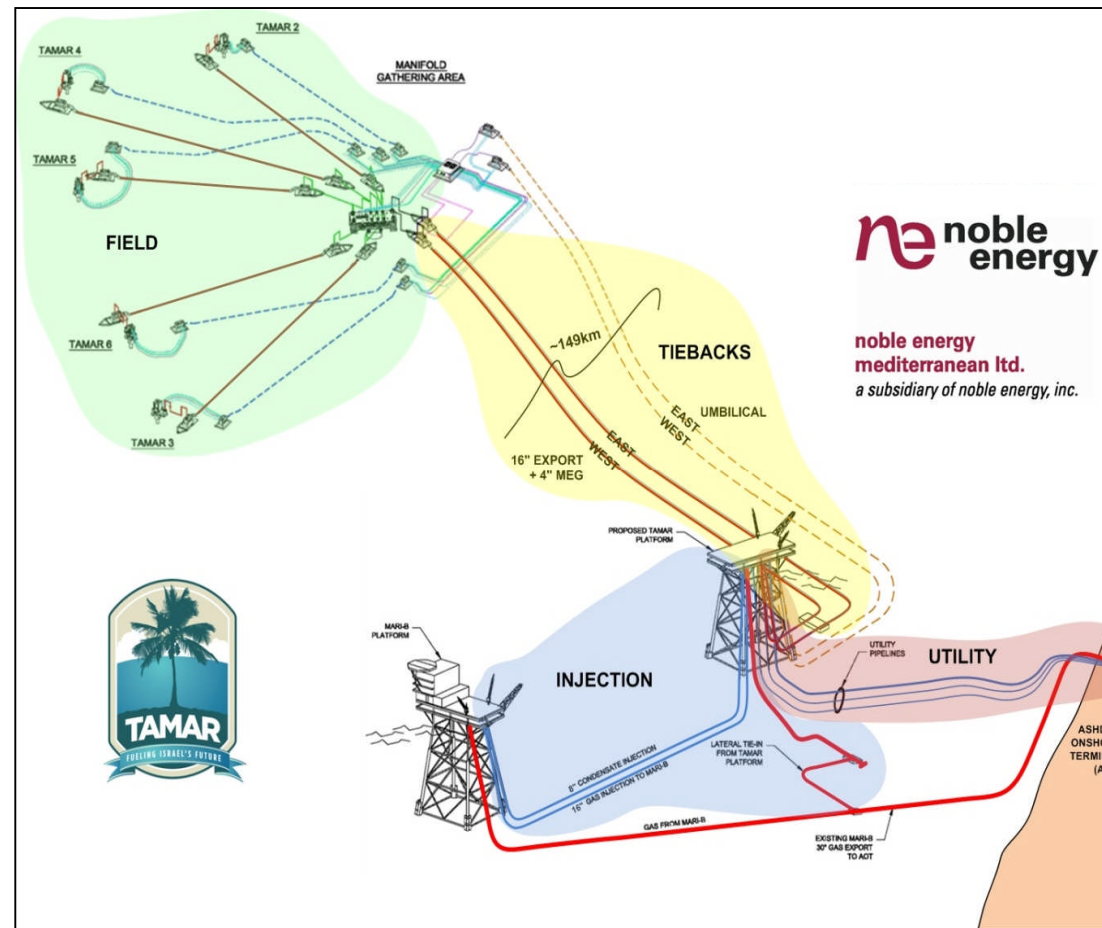
Contents

- Tamar: Project Overview
- Pipeline Pre-Commissioning
- Ultrasonic Wall Measurement (UTWM) Baseline Inspection
- Close & Questions

Tamar: Project Overview

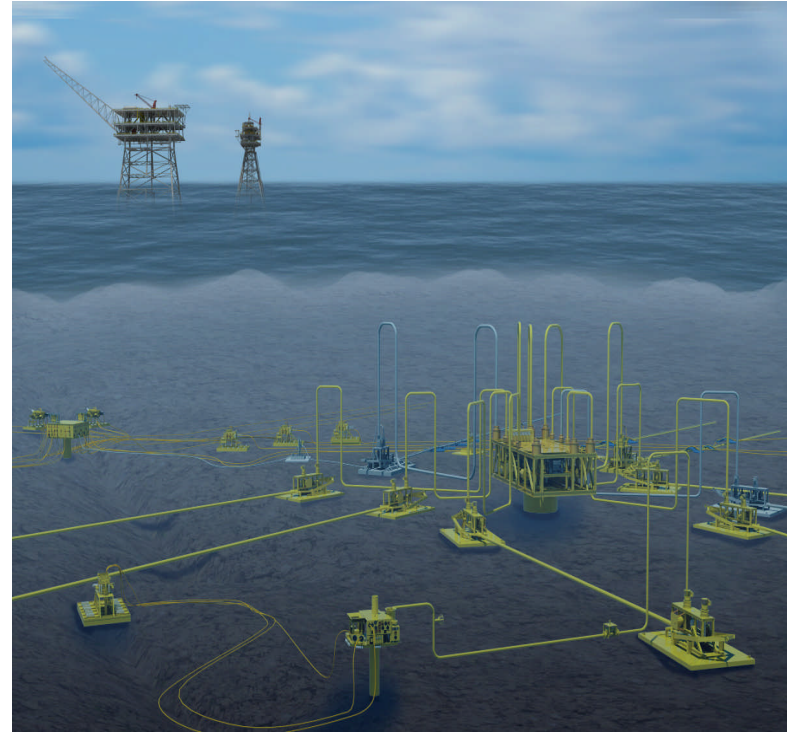
TAMAR Field Overview

- **In-Field**
 - 10" Flowlines x 5 (3 mile ea.)
 - Jumpers & Manifold
- **Tiebacks**
 - 16" x 2 (90 miles ea.)
 - 4" MEG
- **Injection**
 - 8" Condensate Injection
 - 16" Gas Injection
 - 30" Gas Export Riser
- **Utility**
 - 10" Condensate
 - 6" MEG
 - 6" MEG/Produced Water
- **Maximum field water depth 1700m**



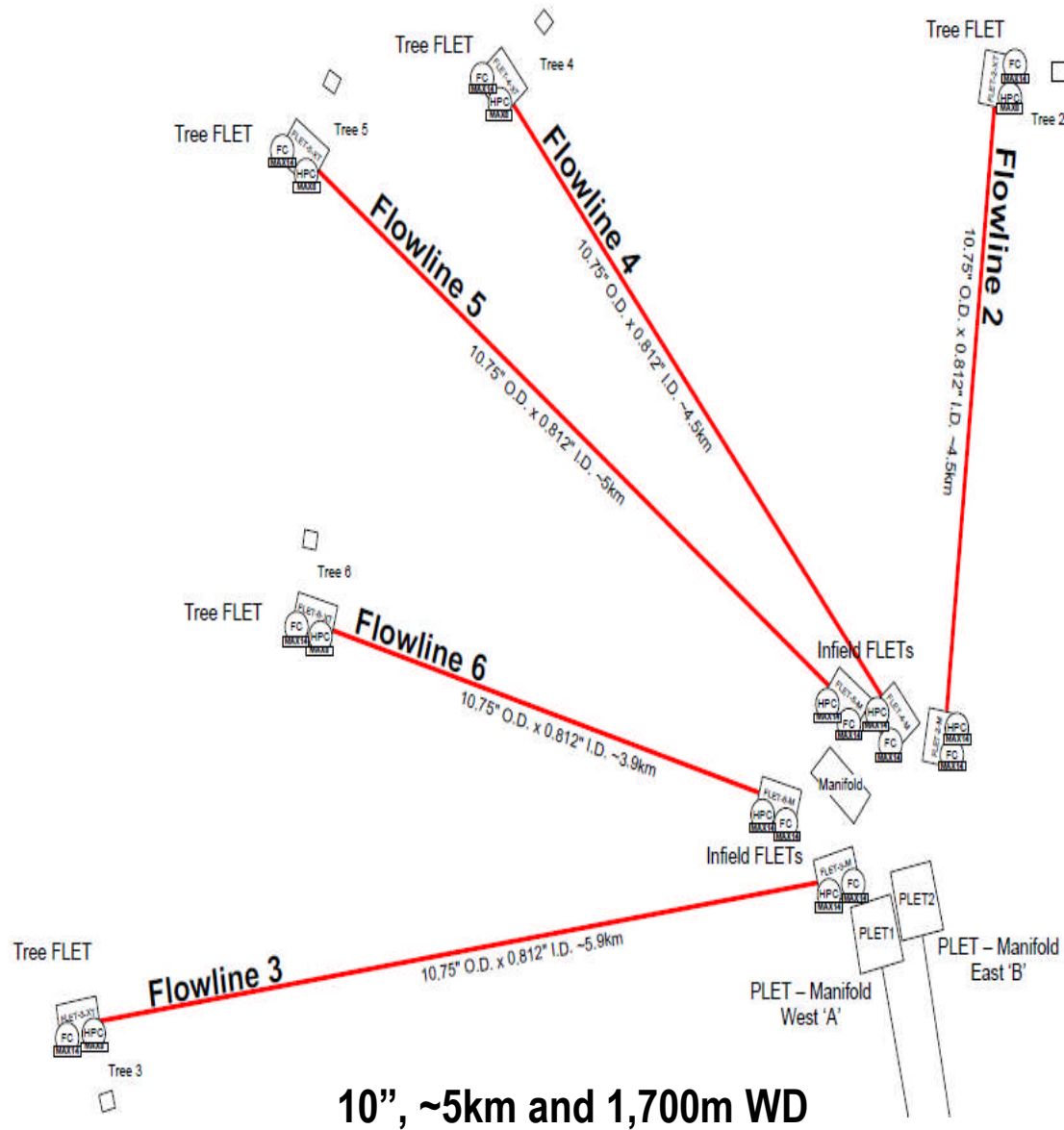
TAMAR Project Overview

- Scope of Work
 - Pre-commissioning of all subsea pipelines, flowlines, jumpers and risers
 - Caliper and Ultrasonic baseline inspection of 16" tieback lines
 - Bundled within one pre-commissioning contract award



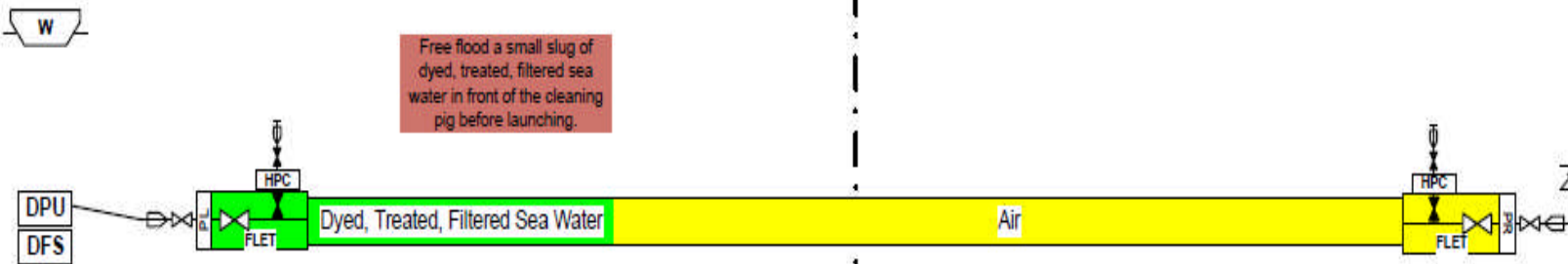
Pipeline Pre-Commissioning – Selected Highlights

Infield Flowlines

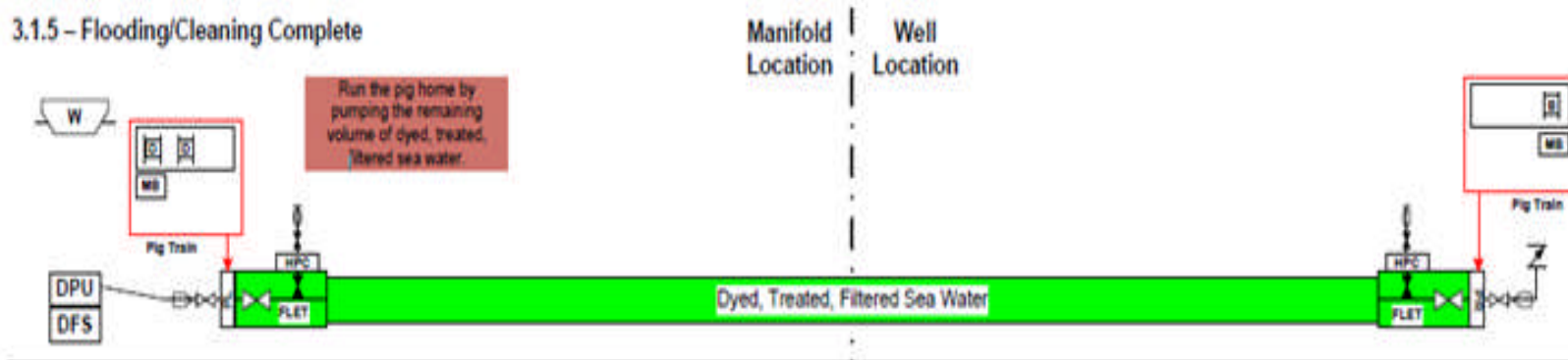


Infield Flowlines – flood, clean, MEG launch, test

3.1.3 – Flooding/Cleaning Start



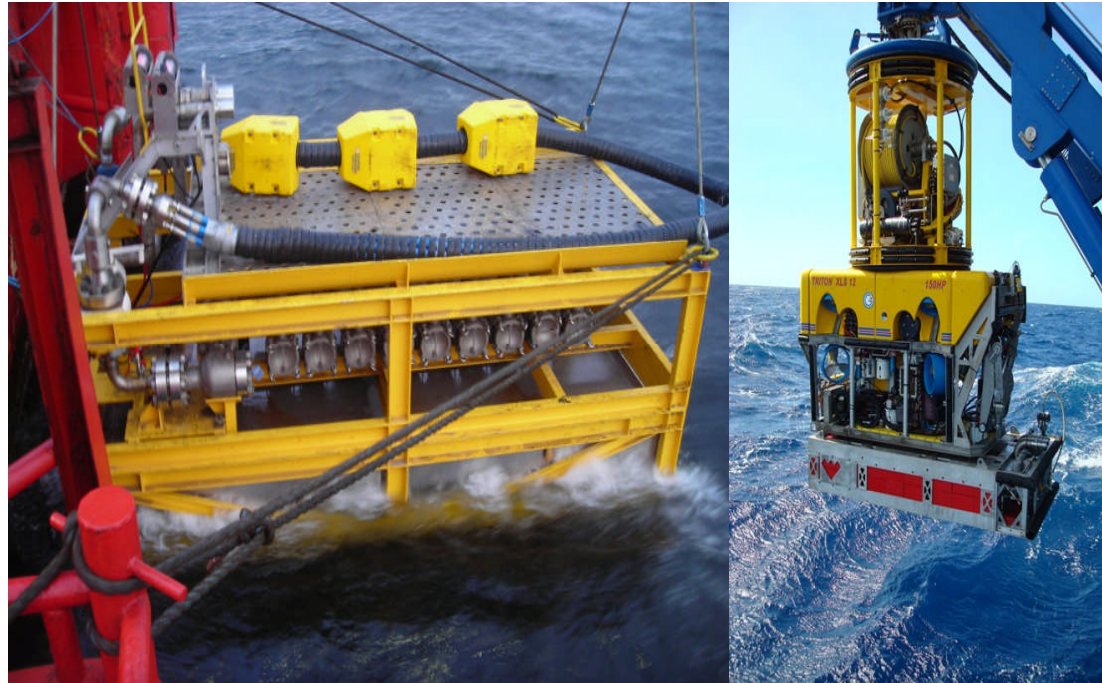
3.1.5 – Flooding/Cleaning Complete



3.1.6 – Dewater Preparation



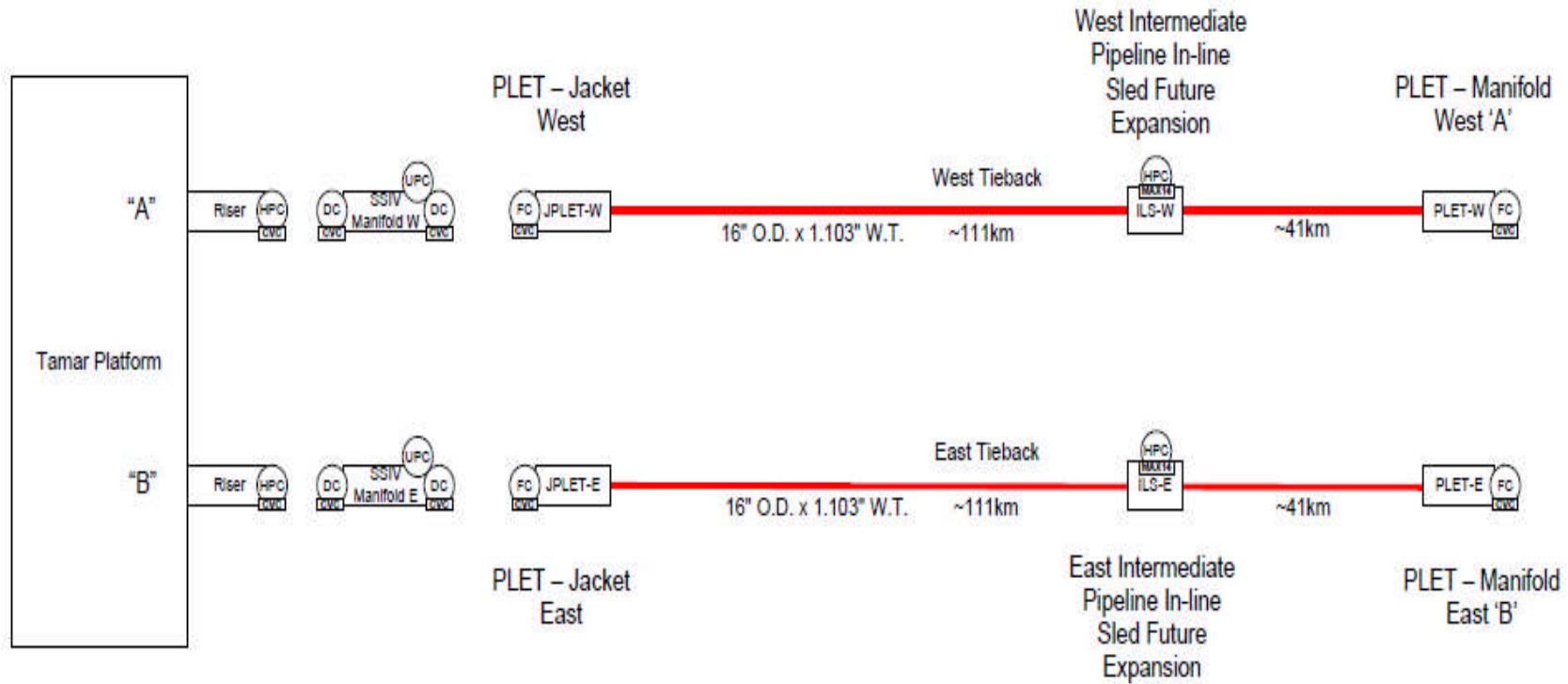
Infield Flowlines – Denizen skids



Tie Back Lines

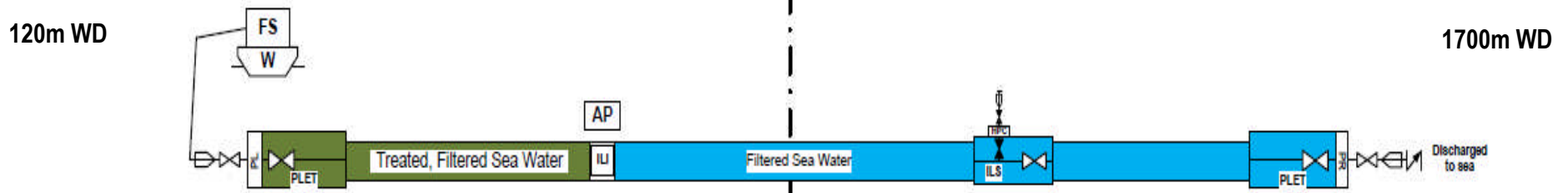
120m WD

1700m WD

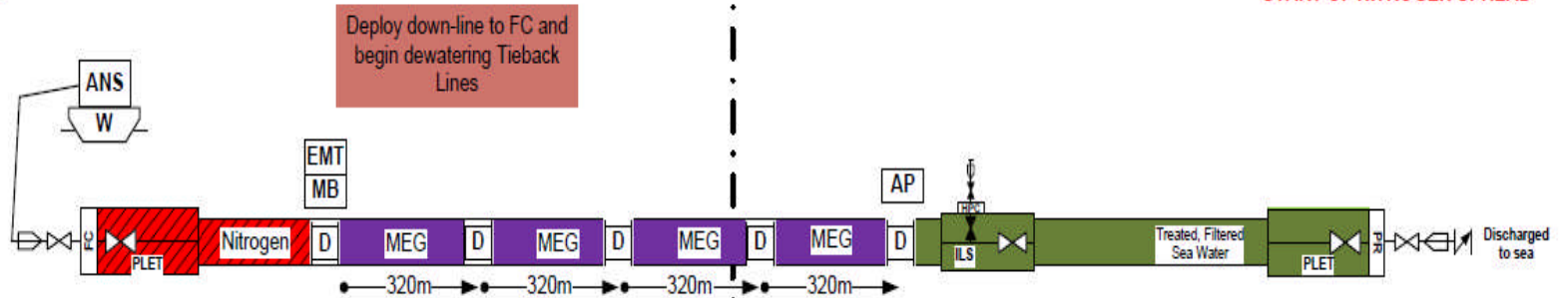


Tie Back Lines – ILI Run and Dewater

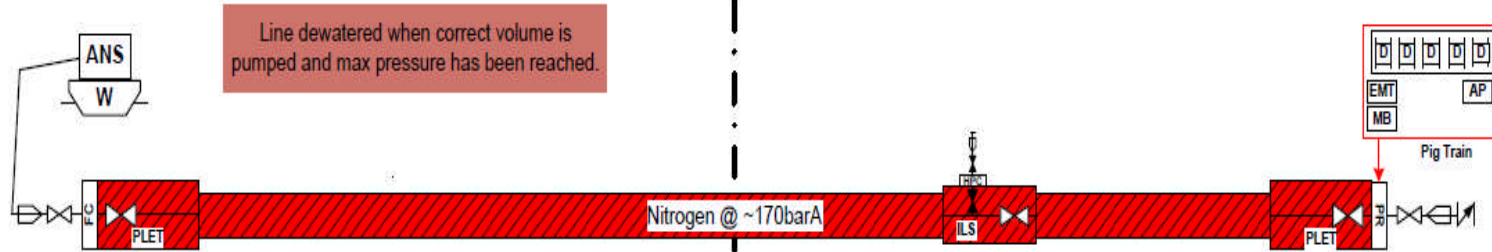
3.4.7 – Inspection – ILI Duration



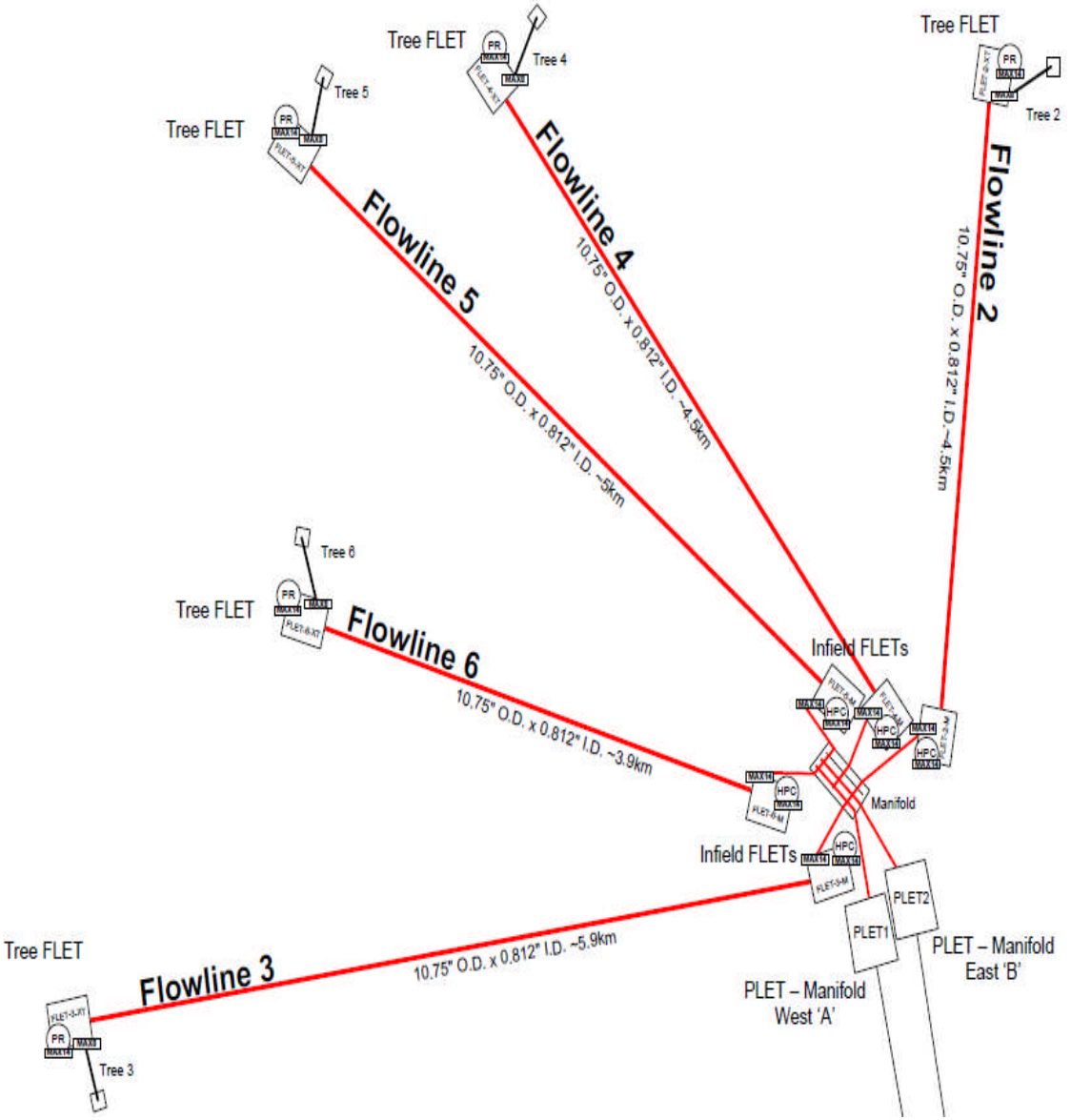
3.5.6 – Start



3.5.7 – Dewatered

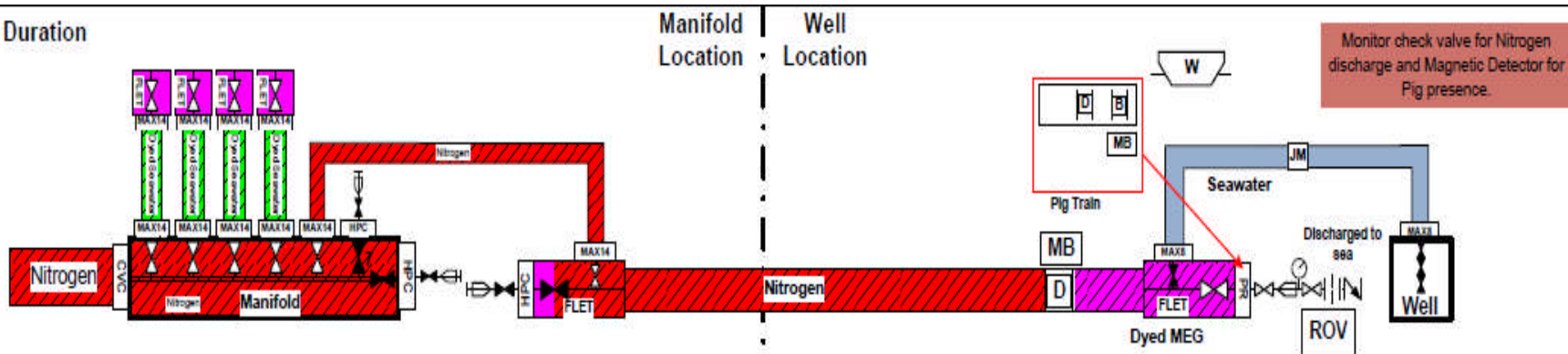


Infield Flowlines – Field Hook Up

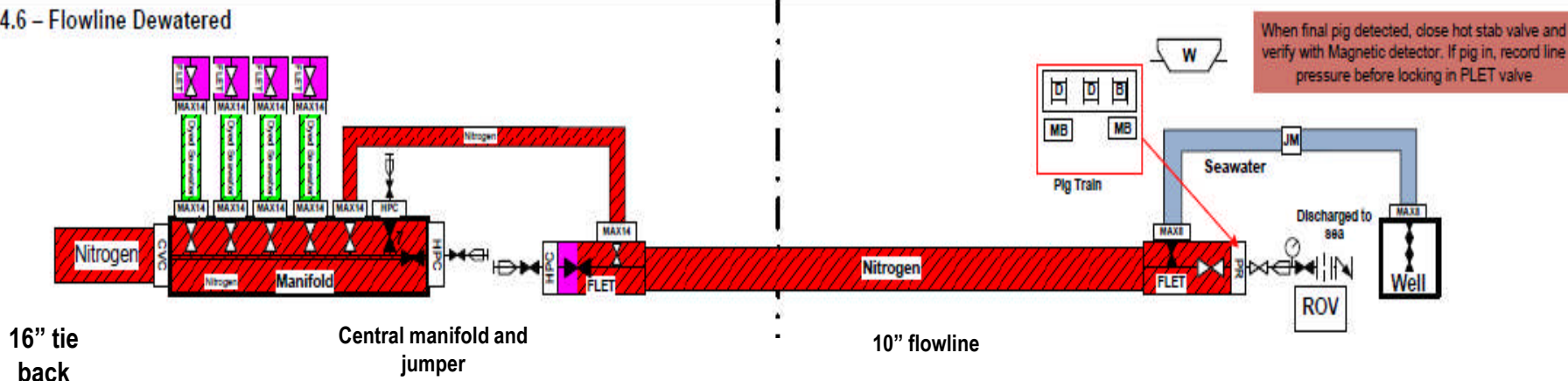


Infield Flowlines – Dewatering

3.4.5 – Duration

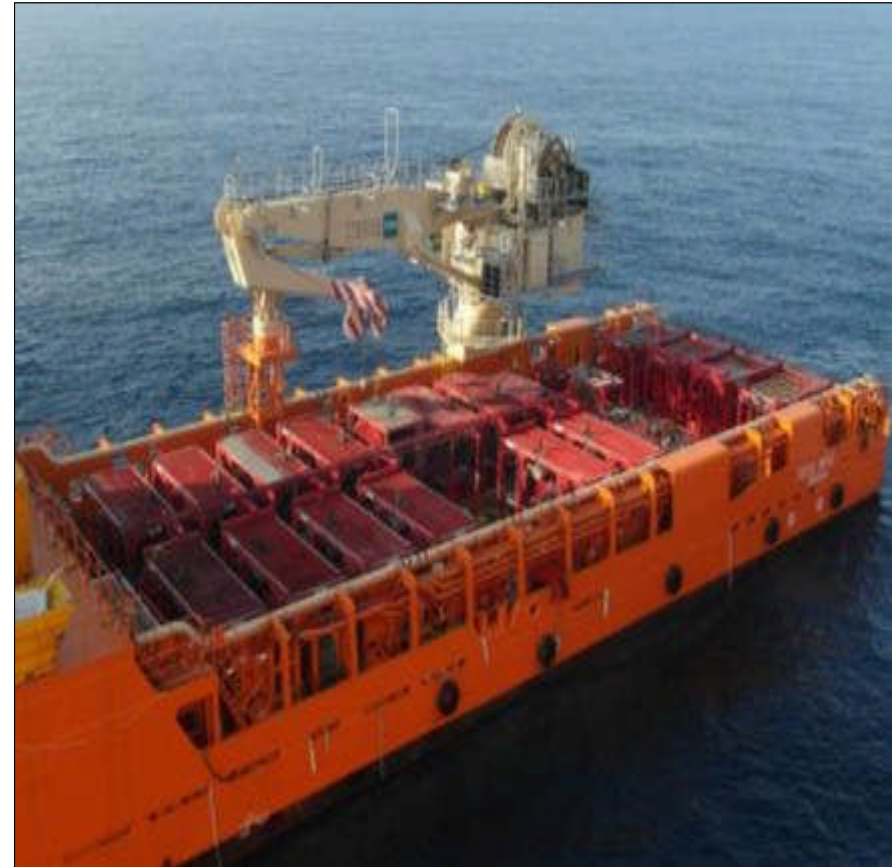


3.4.6 – Flowline Dewatered



Pre-Commissioning Highlights

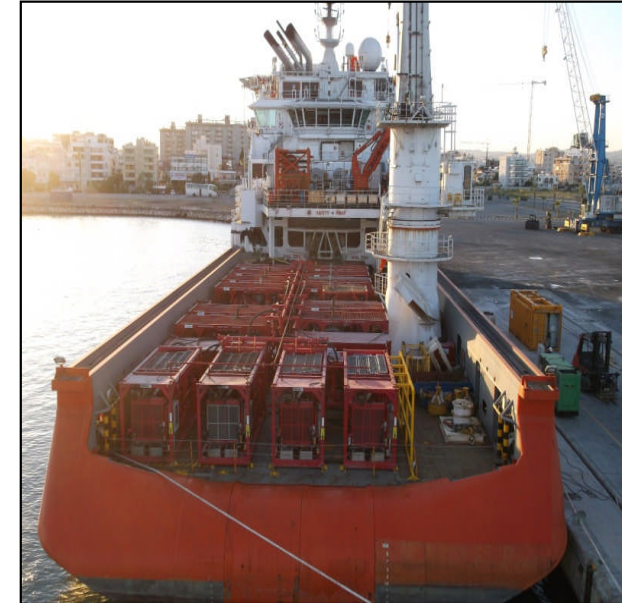
- Large vessel based high pressure nitrogen spread
 - 9000 HP
 - >230bar
 - ~5,000scfm continuous working flowrate
 - ~20 days continuous pumping
 - 110,000,000scf of N2
 - equivalent to >700 standard LN2 tanks



EMAS Lewek Falcon

Pre-Commissioning Highlights

- Infield flowlines completed entirely subsea
 - Flood, clean and test completed subsea with Denizen
 - MEG train launch completed subsea with Denizen
 - Dewater, condition and N2 inert completed with reservoir from tieback lines
 - Completing the majority of the operation from shallow water thus mitigating deep-water risk
 - No deep-water downline (coil, hose) intervention required
- Consequent savings in vessel space and schedule duration



Ultrasonic Wall Measurement (UTWM) Baseline Inspection

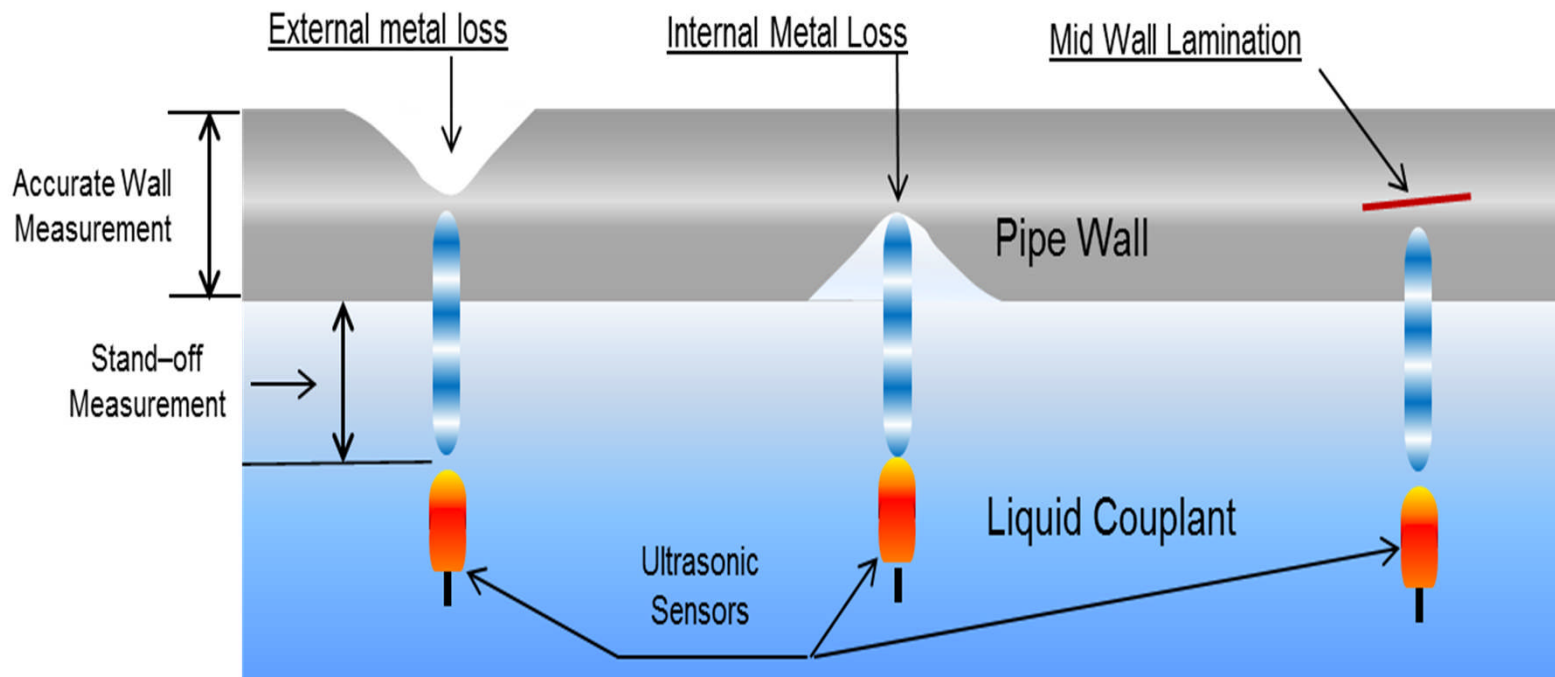


2nd Gen Ultrasonic Wall Measurement (UTWM) Tool



Operating Principle for Ultrasonic Wall Measurement Tool

- Based on inducing ultrasound compression waves into the pipe wall
- UT transducers are positioned at a 90° angles to the pipe wall
- Use an impulse-echo mode - transmits an acoustic wave and receives return echoes
- Echoes represent the locations of the internal/external pipe wall and other metallurgical anomalies such as laminations



Detectable Anomalies by UT

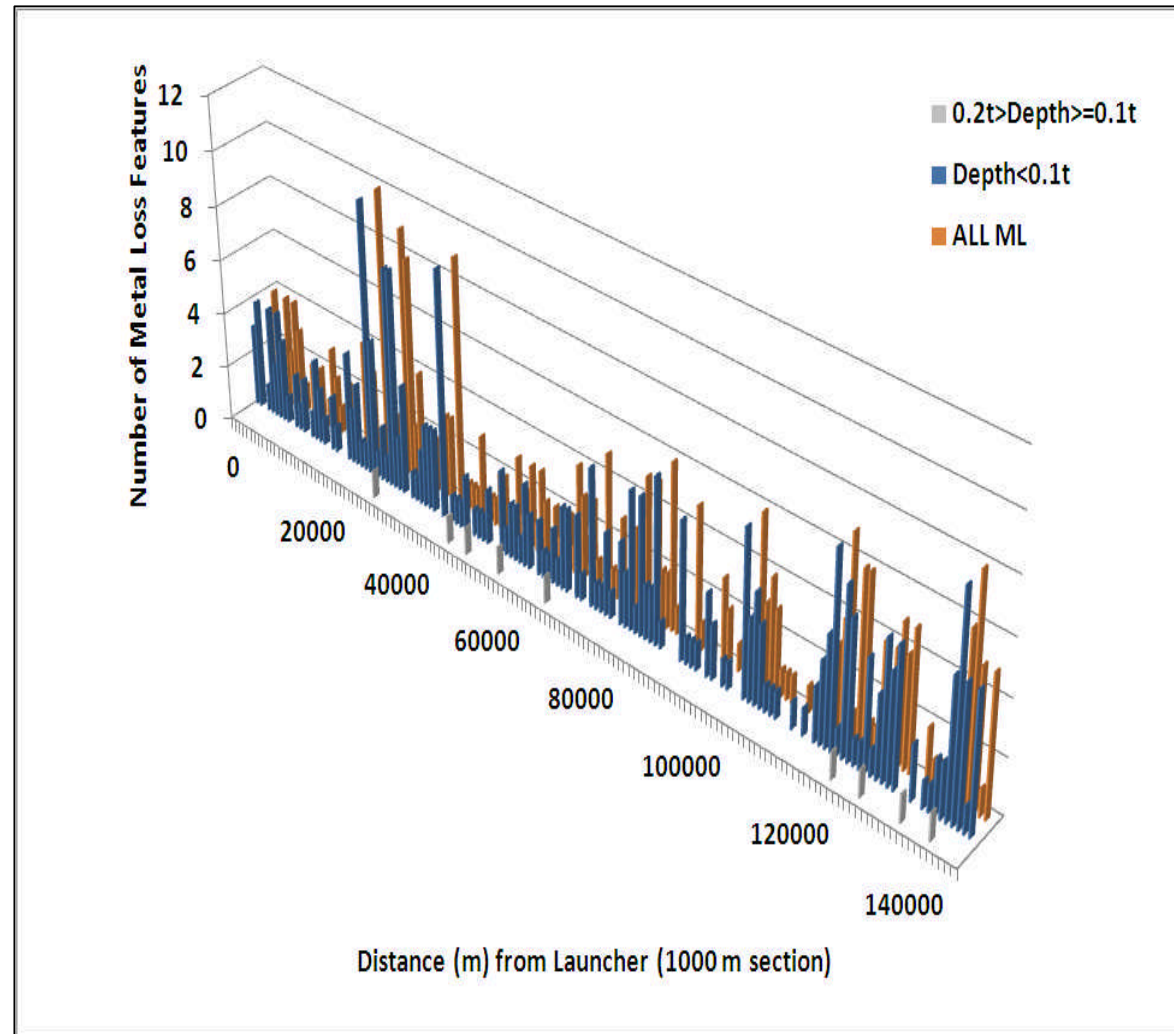
- Internal / External metal loss
- Channeling Corrosion
- Blisters / Inclusions
- Dents*
- Ripples
- Gouge / Notch
- Laminations
- Cracks*
- Wall thickness variations
- Usable on bends, tees, and valves



Advantages of UTWM

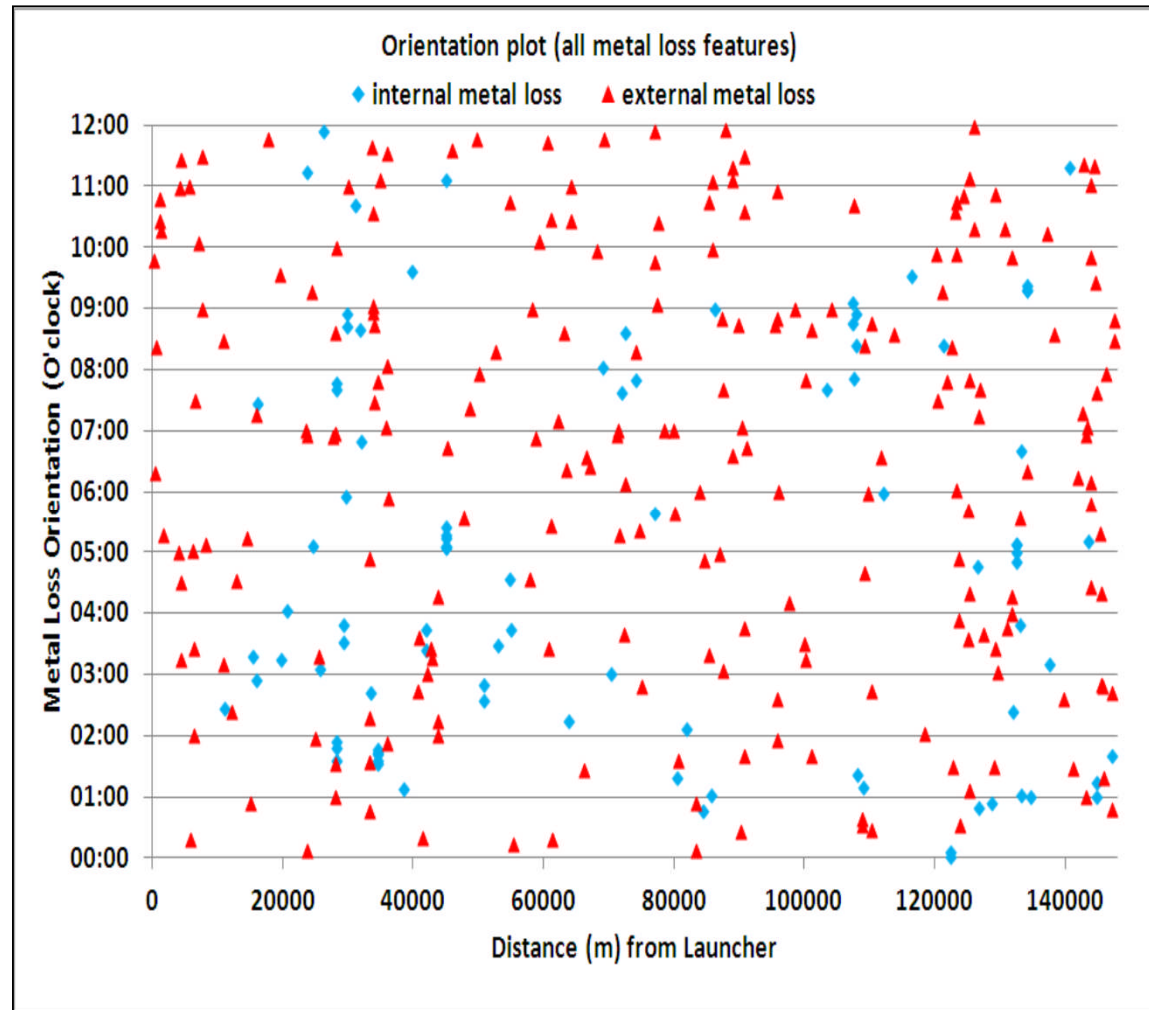
- Better depth sizing (+/- 0.2mm)
- Direct Wall thickness measurement
- Wall thickness capability up to 60 mm
- Mid-wall (material / manufacturing) anomalies detected
- 'River bottom profile' for level 2 assessments – DNV, RSTRENG or for FEM.
- Pipeline Uprating

Metal Loss Distribution (TAMAR)



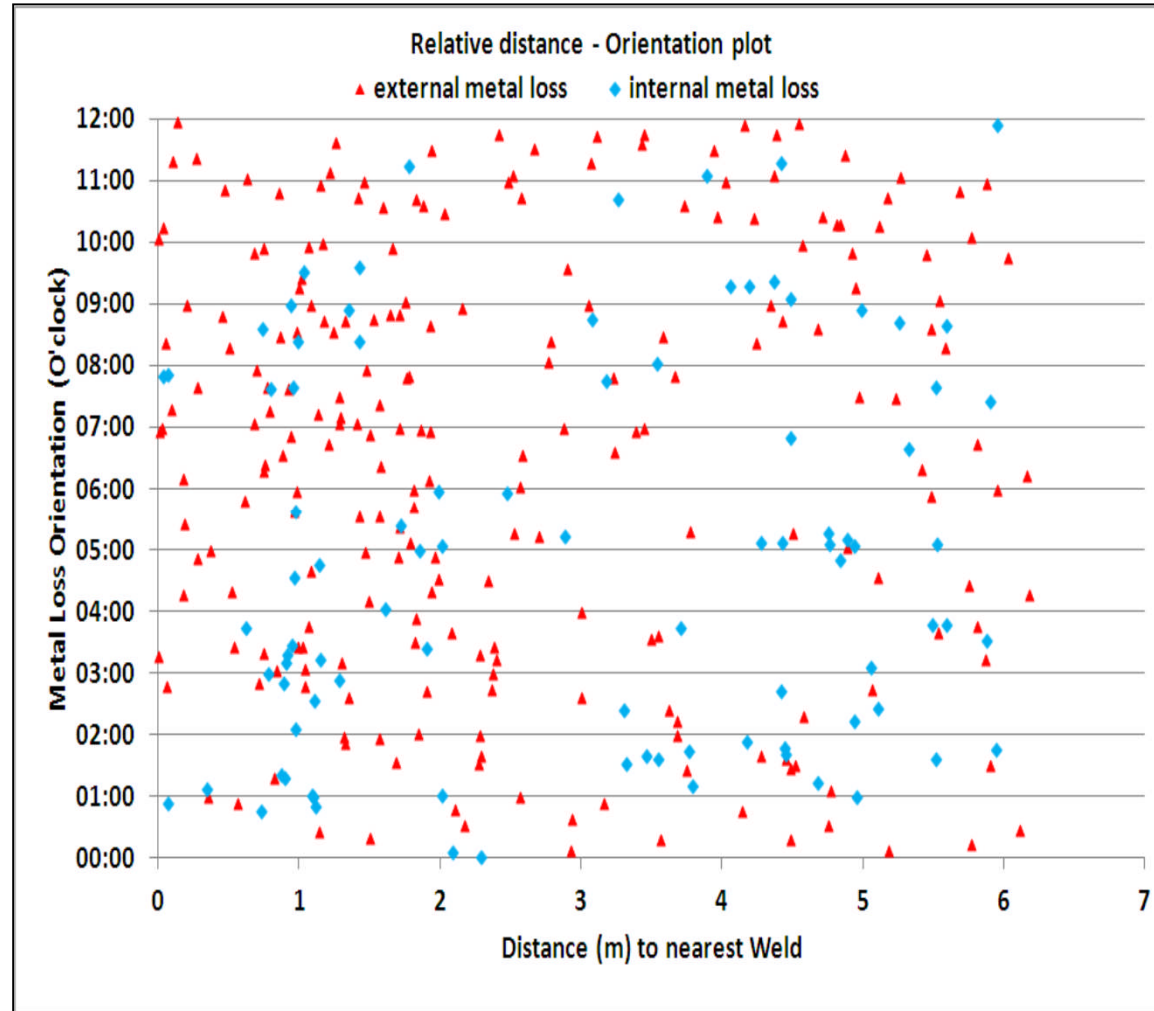
- > 300 x Metal Loss defects detected – all low level

Metal Loss Orientation Plot (TAMAR)



- Random distribution of ML
- All defects base-lined for next survey

Metal Loss Distance to Girth Welds (TAMAR)

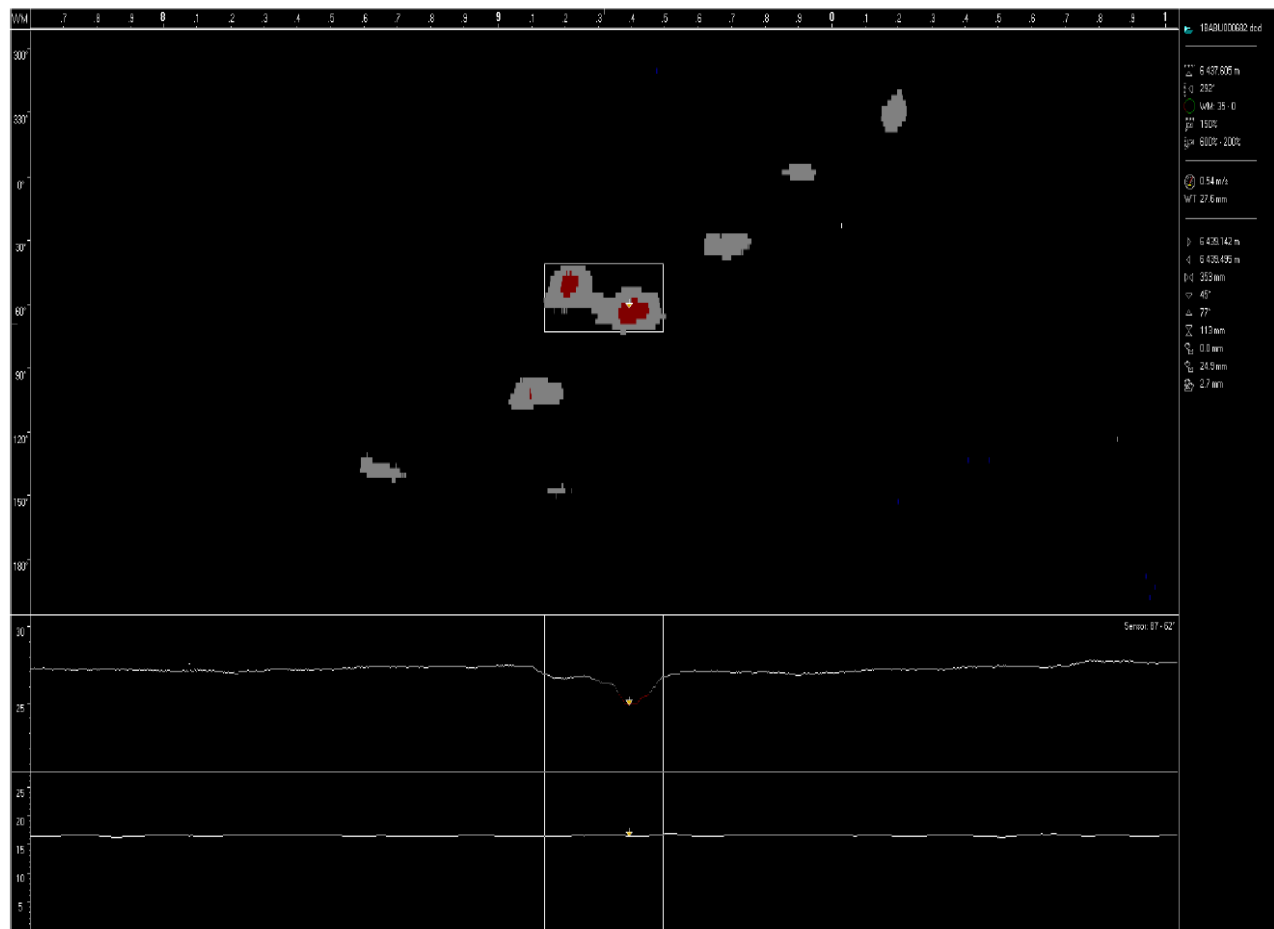


- Anomalies equally spaced in spools

Tamar UTWM Features

- Low-level Metal Loss

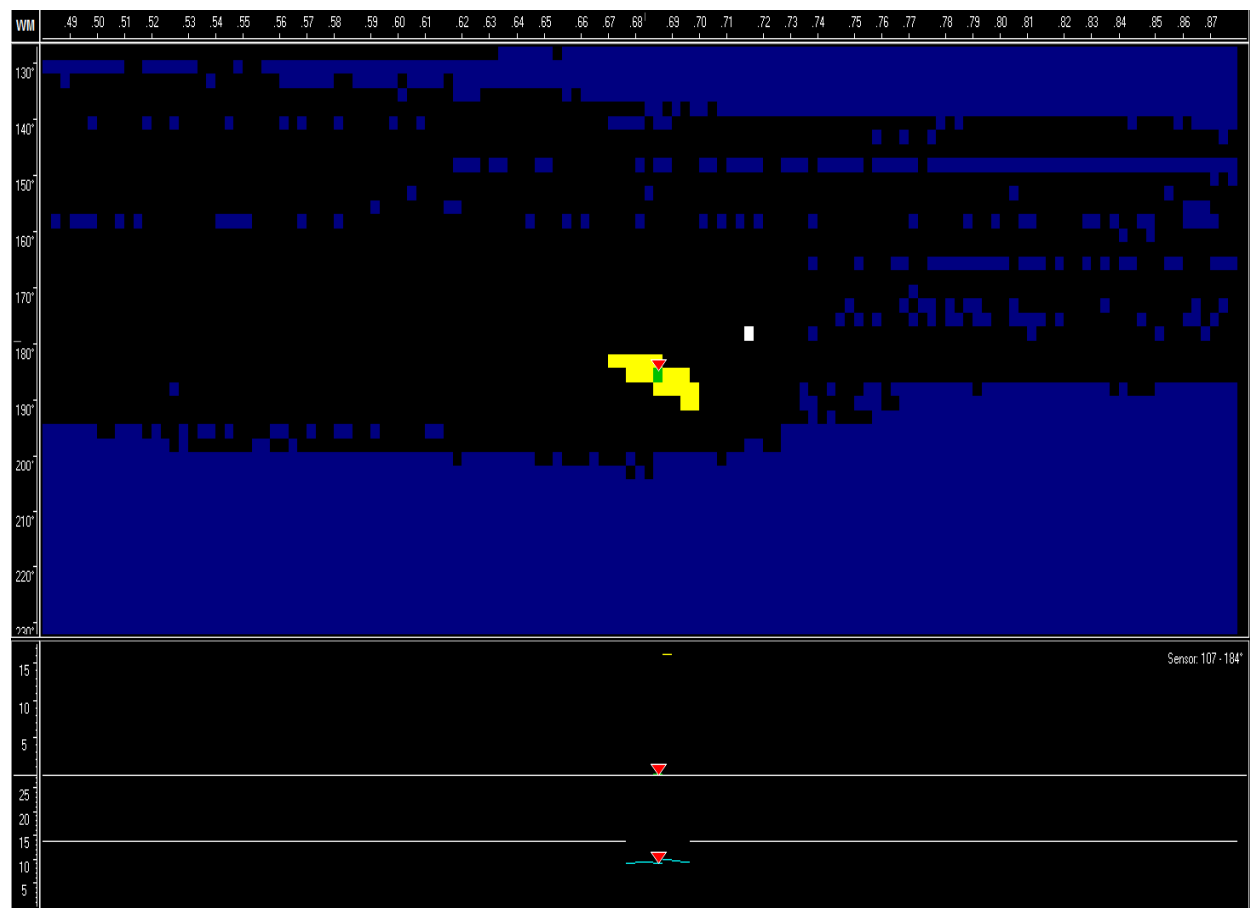
Insp. Sheet Number	#	Absolute Distance, m	Joint Number	Comments	Depth, % WT	Length, mm	Width, mm	Orientation, hrs : mins	Wall Side	ERF
1	19	6439.1	5380	general metalloss	9.8	353	113	2:15	ext	0.778



Tamar UTWM Features

- Inclusion

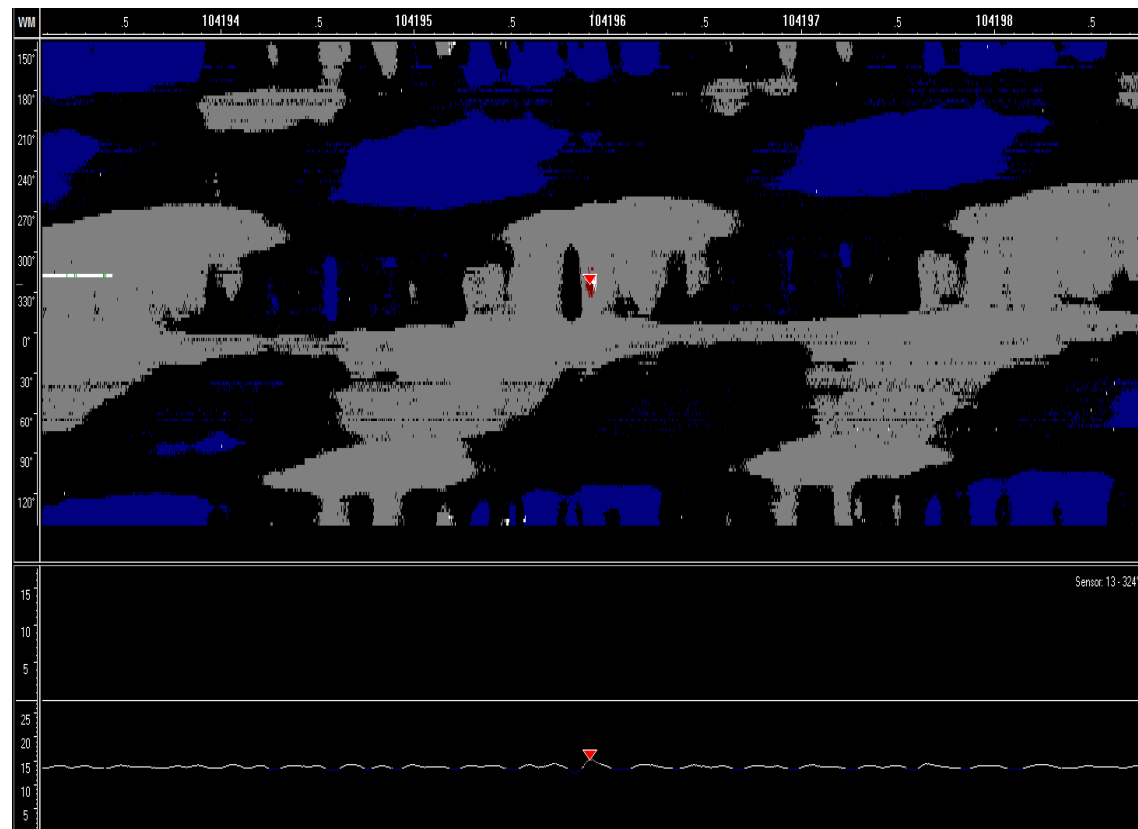
#	Joint Number	Absolute Distance, m	Relative Distance, m	Comment	Local Wall Thickness, mm	Length, mm	Width, mm	Orientation, hrs : mins	Type
202	62430	76741.4	1.3	inclusion	27.1	30	39	4:15	mid



Tamar UTWM Features cont...

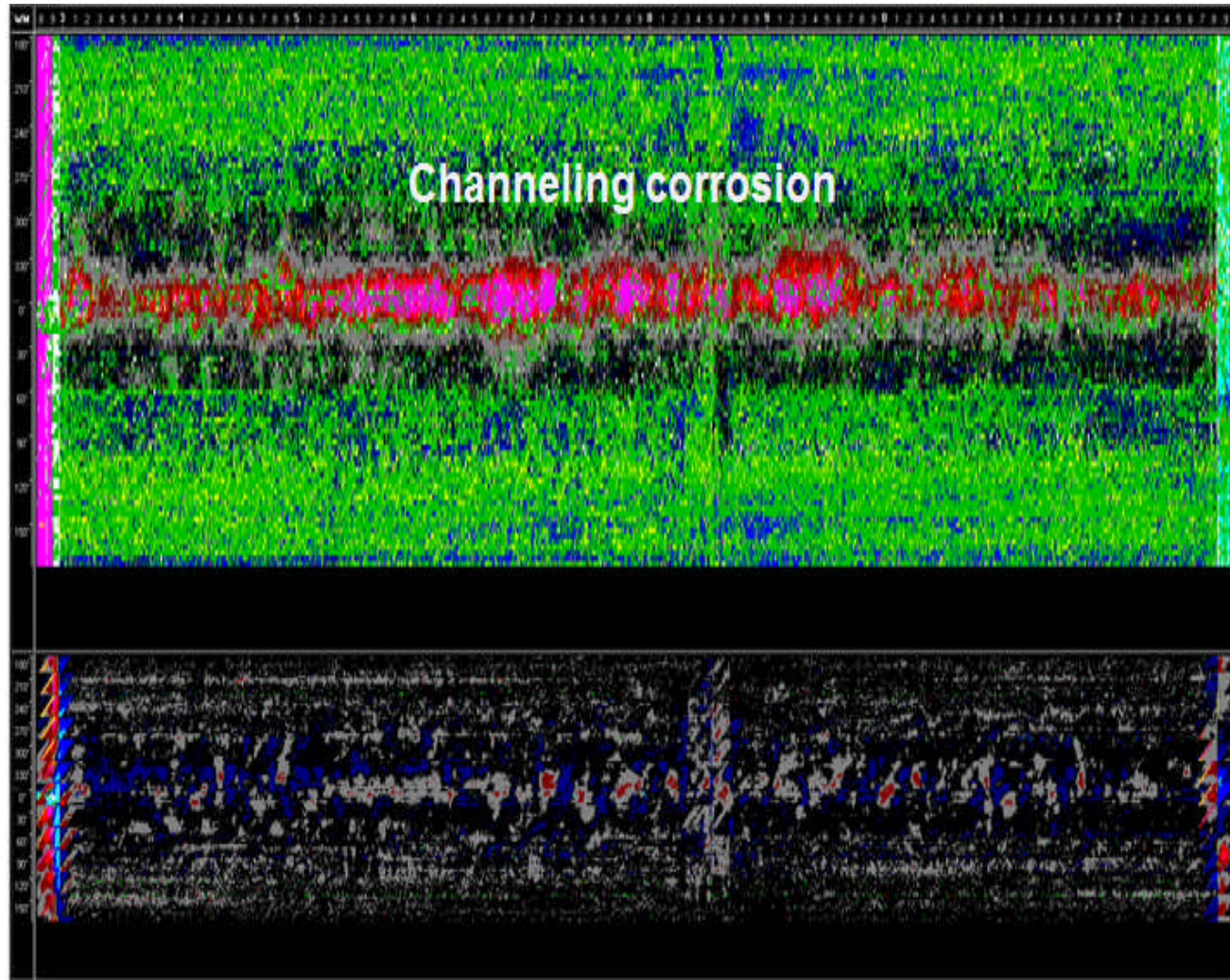
- Wall Thickness Variations

#	Joint Number	Absolute Distance, m	Relative Distance, m	Comment	Local Wall Thickness, mm	Depth, % WT	Length, mm	Width, mm	Orientation, hrs : mins	Type
330	84770	104168.9	7.6	wall thickness variation	27.7	9.7	85	128	11:00	int/ext



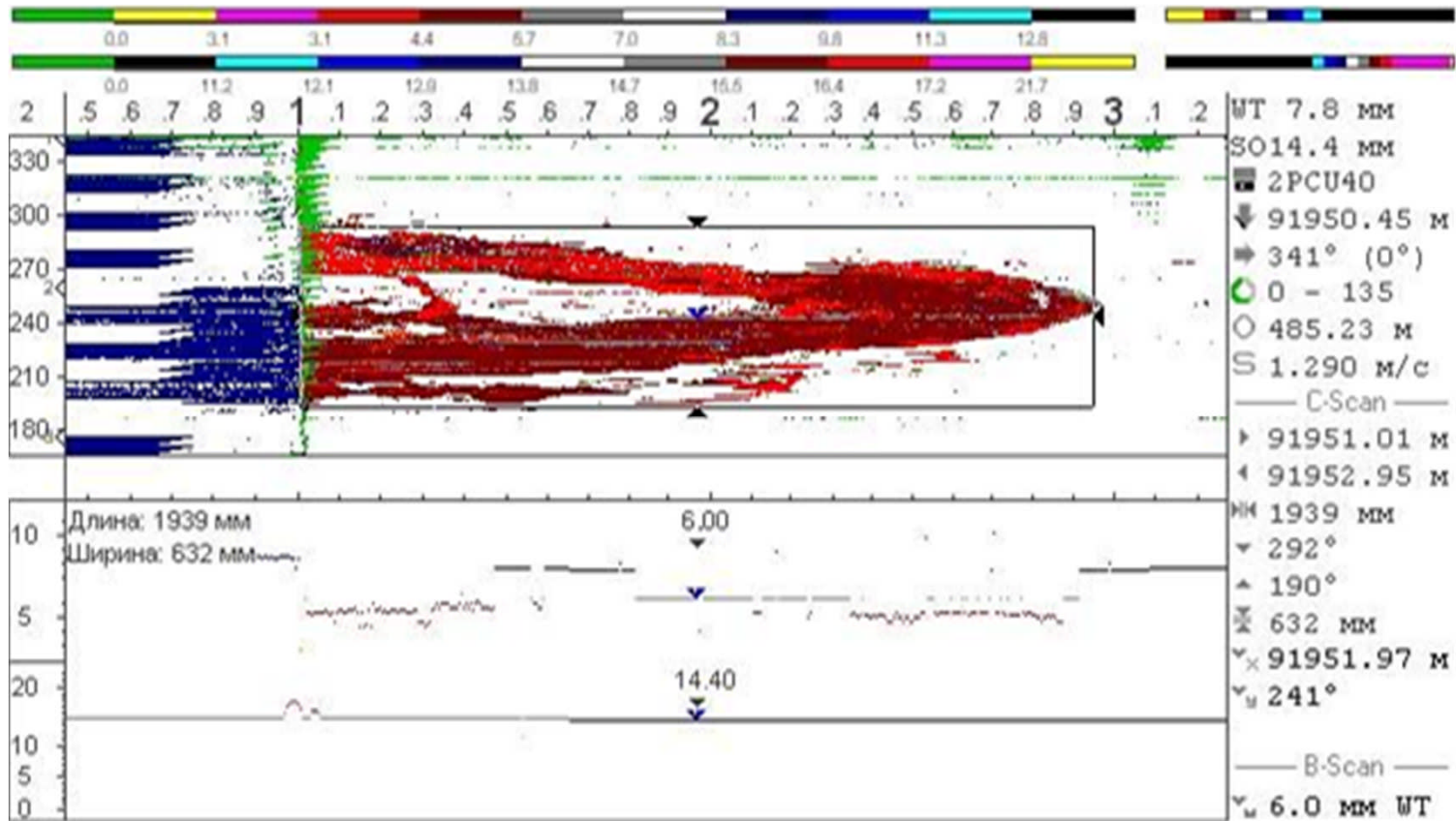
Typical UTWM Features

- Channeling Corrosion



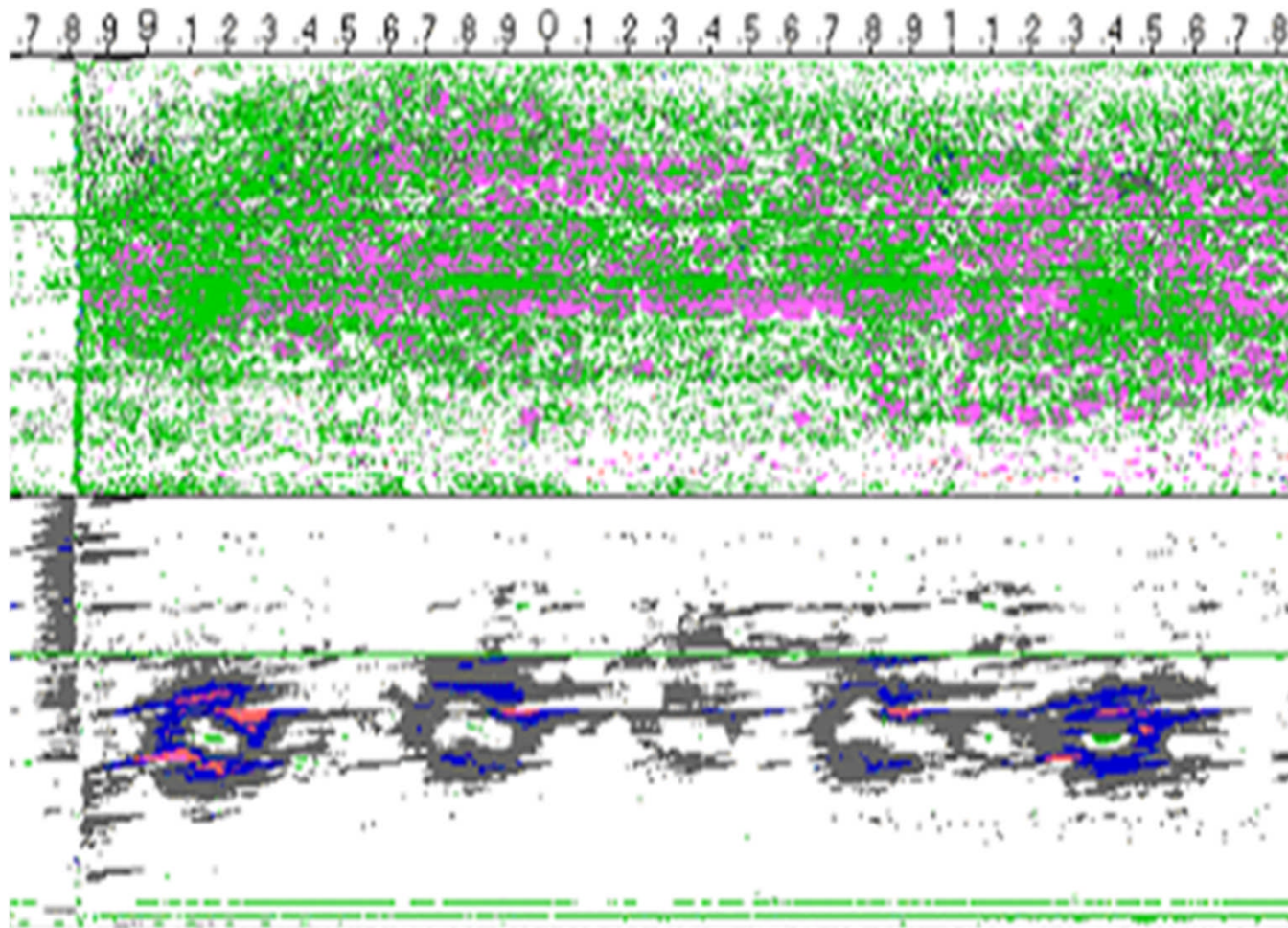
Typical UTWM Features

- Surface Breaking Lamination

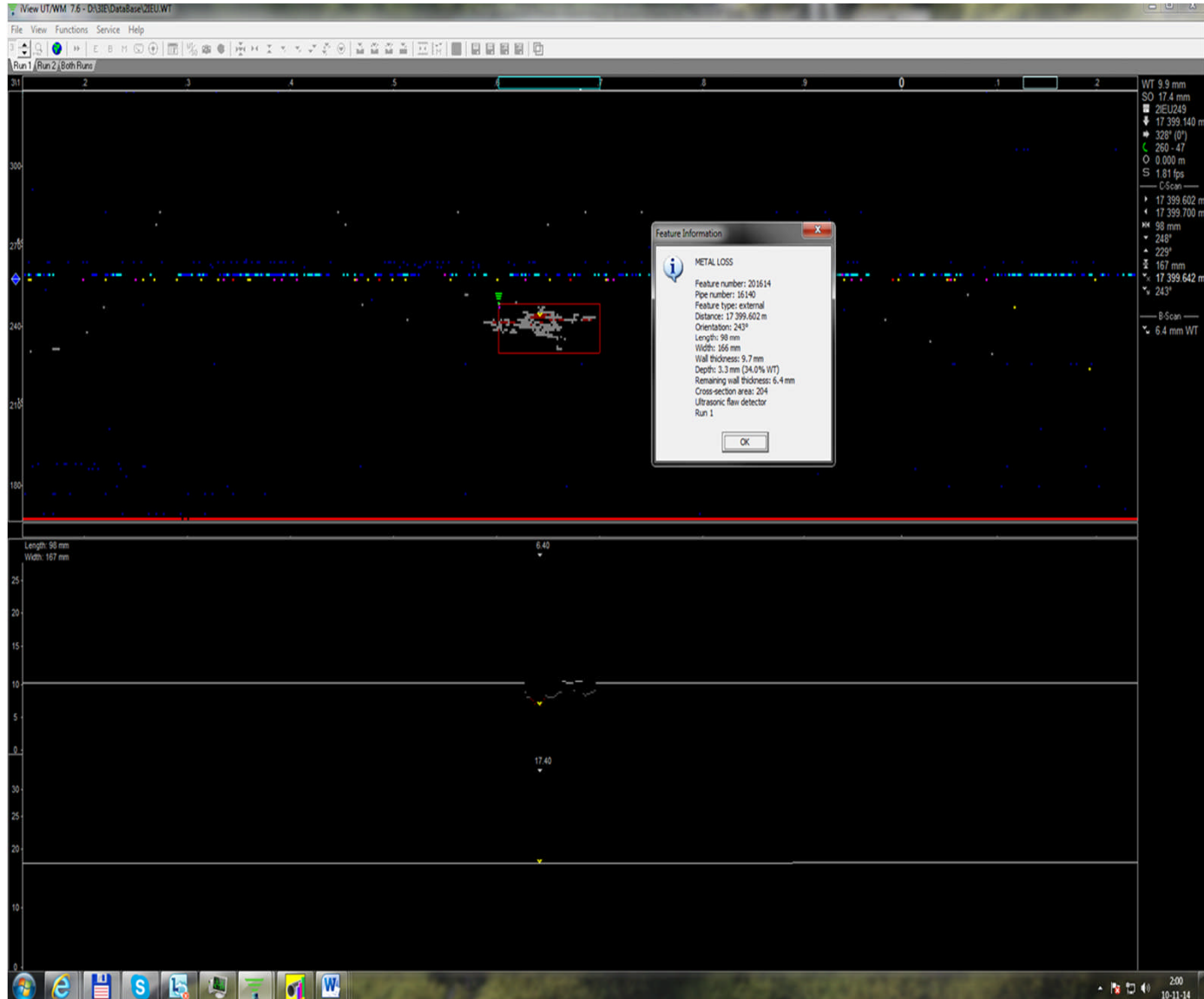


Typical UTWM Features

- Hydrogen Induced Lamination

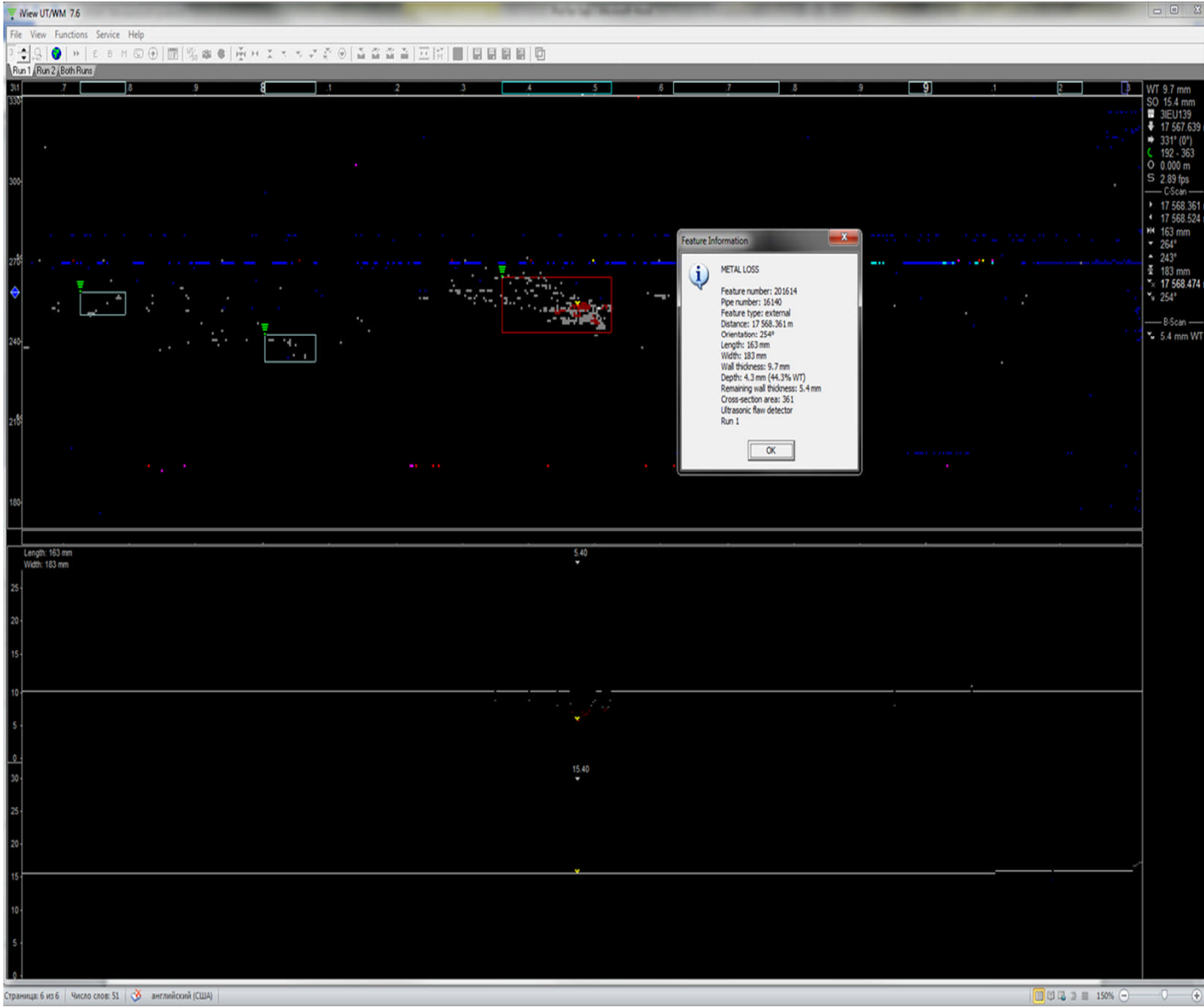


Typical UTWM Run Comparisons – 1st Run Metal Loss depth 34%

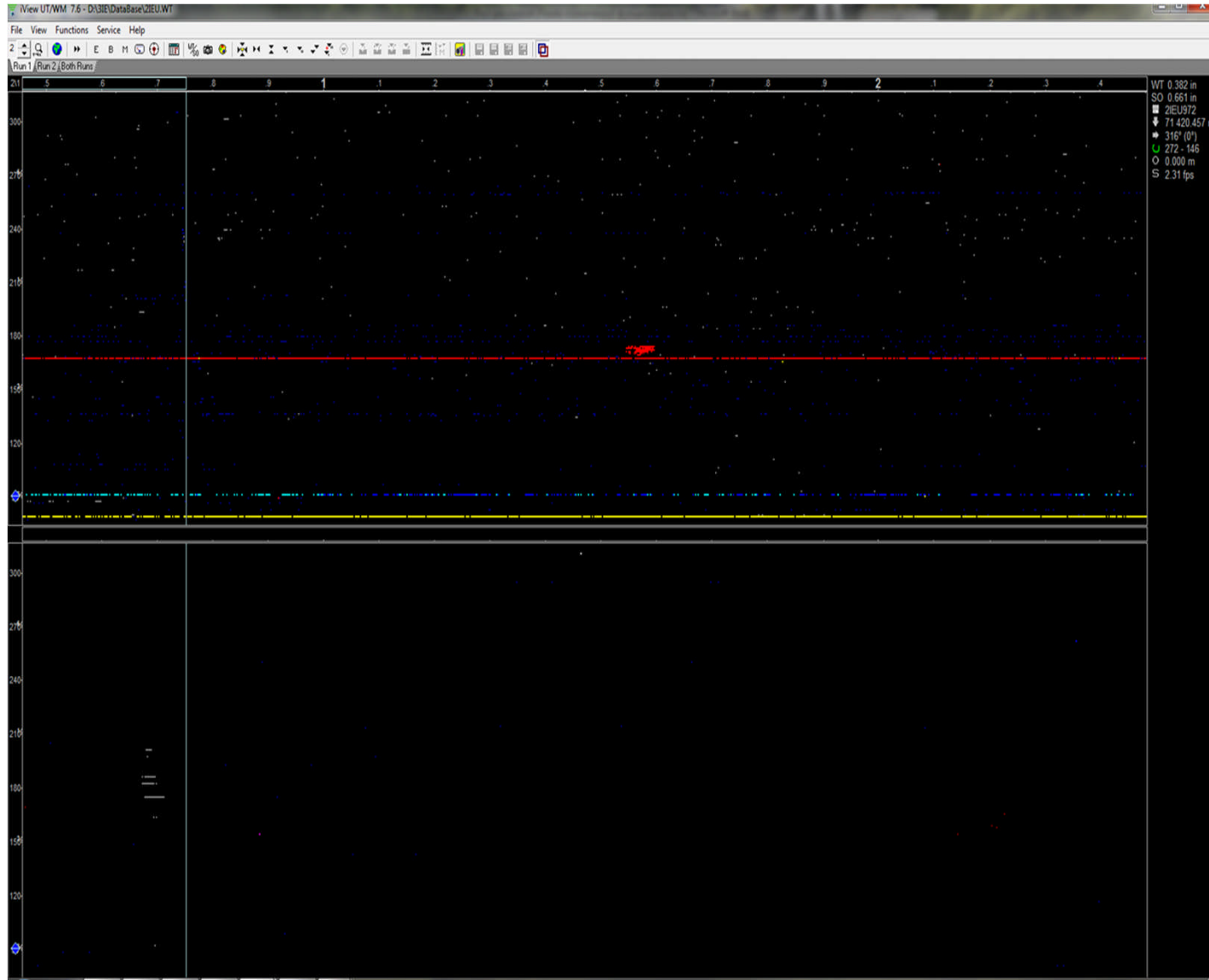




After 3 Years – 2nd Run Metal Loss Depth 44%

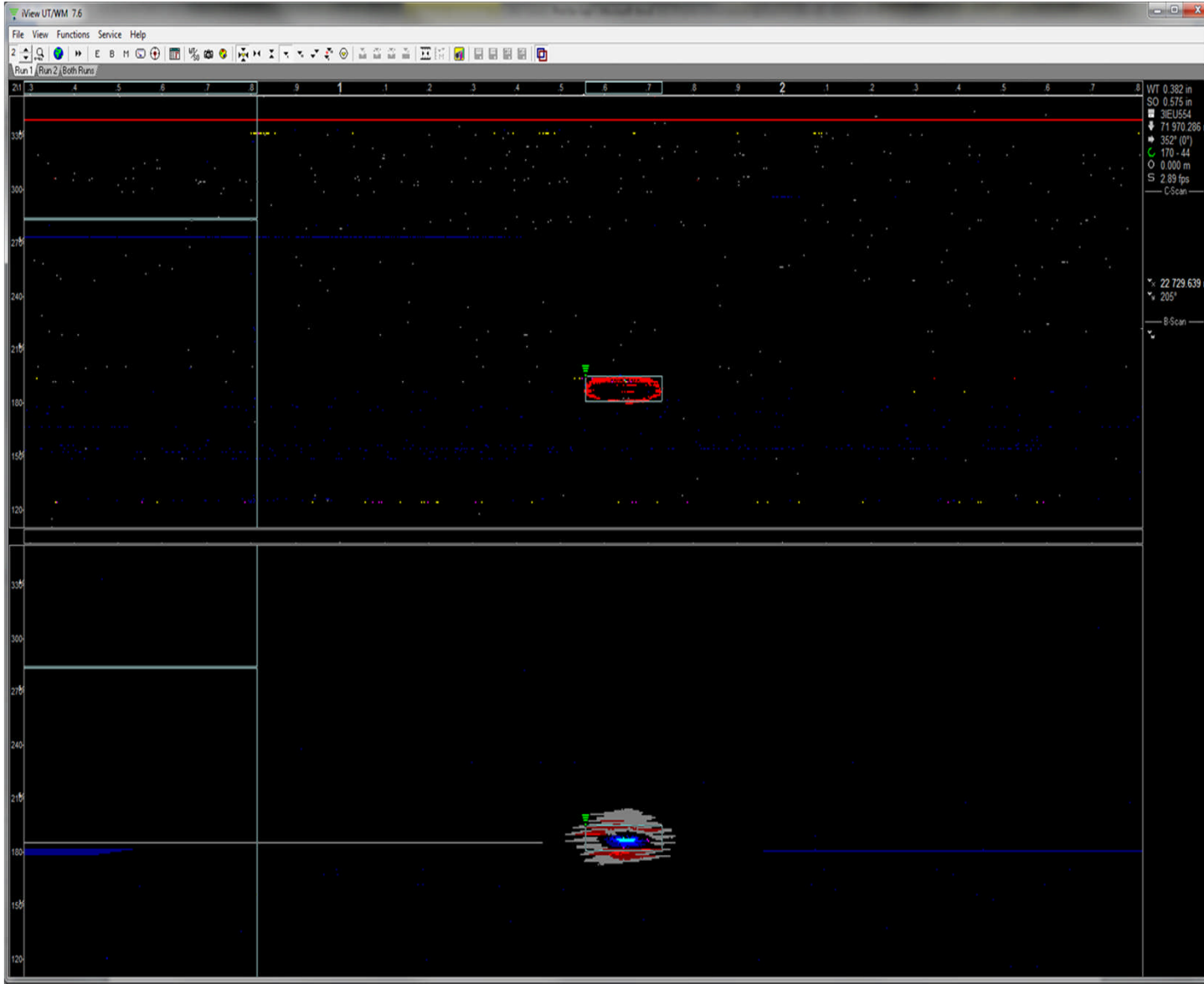


Typical UTWM Run Comparisons – 1st Run Small Lamination





After 3 Years – 2nd Run Growth of Lamination



Summary

- Pre-commissioning operations provides the ideal window to capture baseline inspection data using the most appropriate technologies.
- UT technologies offers a more comprehensive approach to baseline surveys to support long term pipeline integrity management.
- Certain material / manufacturing anomalies also tend to grow due to pressure cycling or in sour service environment becoming integrity threats.
- UT tools are able to detect and appropriately size laminations for anomaly assessments.

Close & Questions