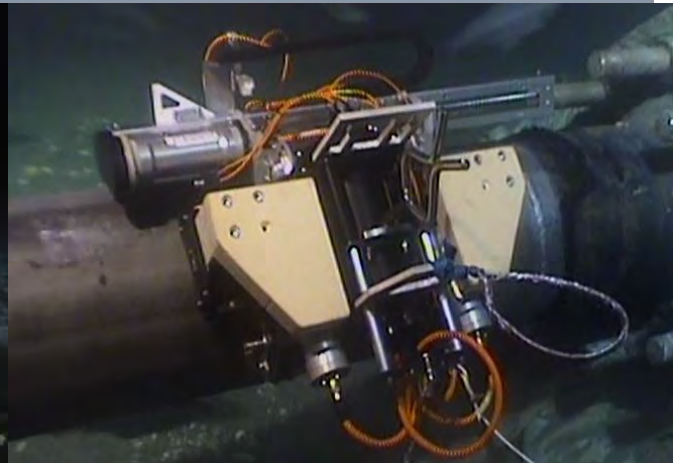
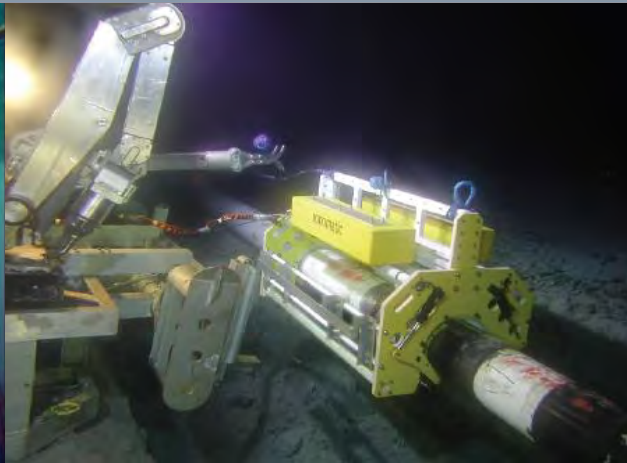


sonomatic®

innovative inspection technologies

Robotic Inspection of Subsea Assets



Subsea Inspection

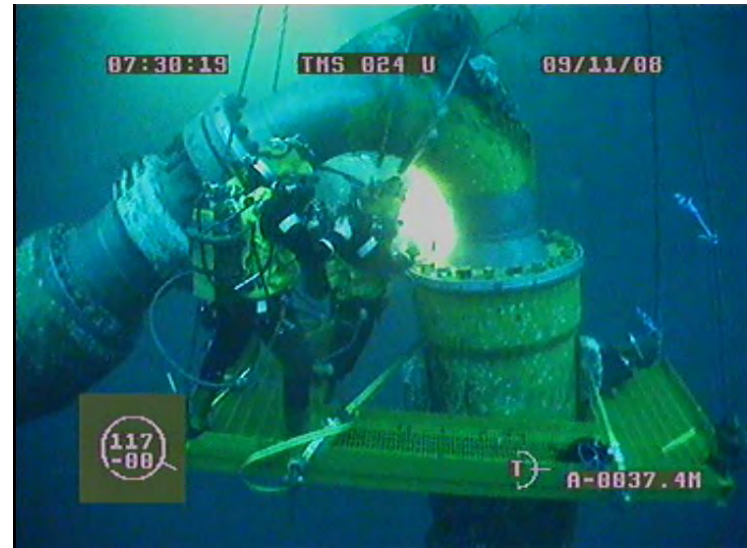
Many assets installed in the Gulf of Mexico are going to require significant investment in life extension programs in the next 10-20 years. Regulators are insisting that purely theoretical modeling will not be enough to justify life extension. Inspection will be required to validate theoretical calculations.

This highlights the importance of Subsea inspection.

Inspections By Asset Type

Subsea Pipelines

- Unpiggable Pipelines
- ILI Verification
- Dead Legs
- Risers
- Steel Cantenary Riser touch down point

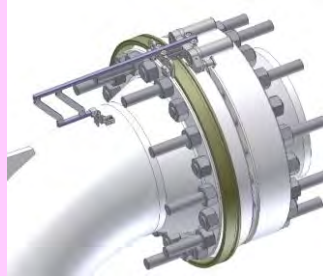
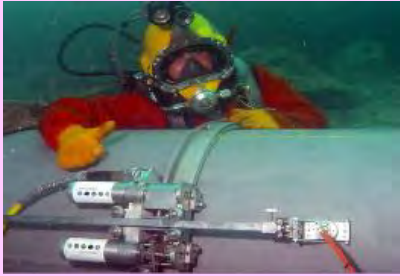


Structural

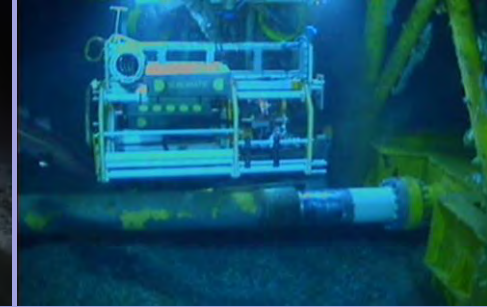
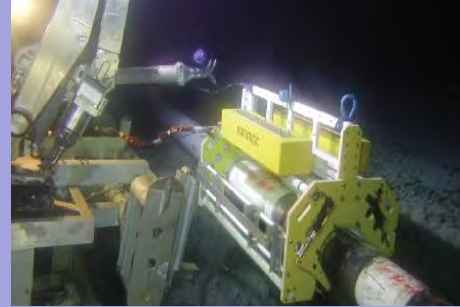
- Tension Leg Platform Girth weld inspection
- Merlin Connectors in situ inspection
- SPAR Ballast Tanks
- Caissons

Subsea Robotic Tools

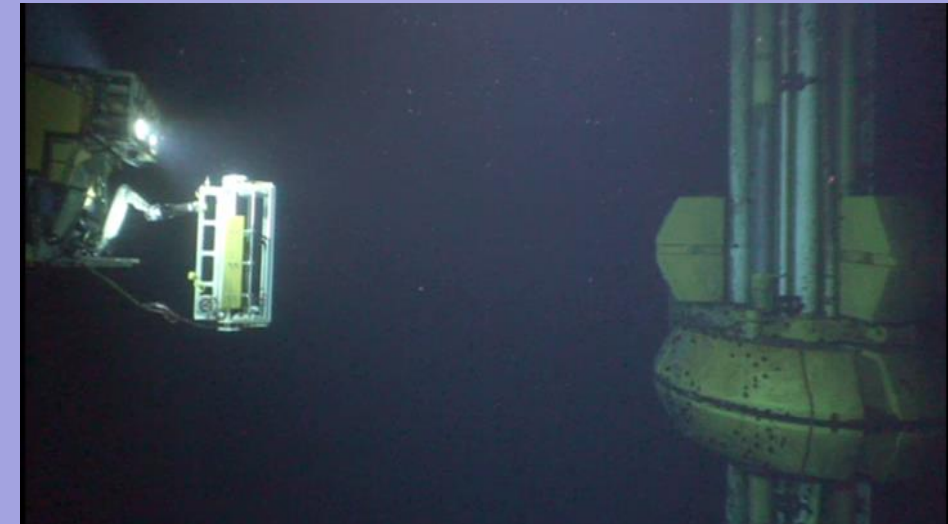
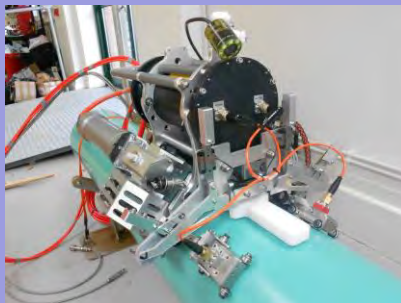
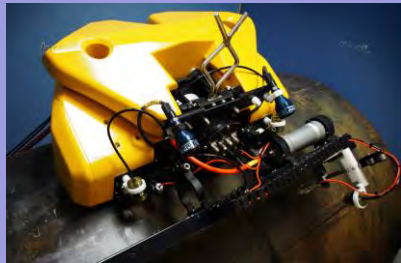
Nautilus



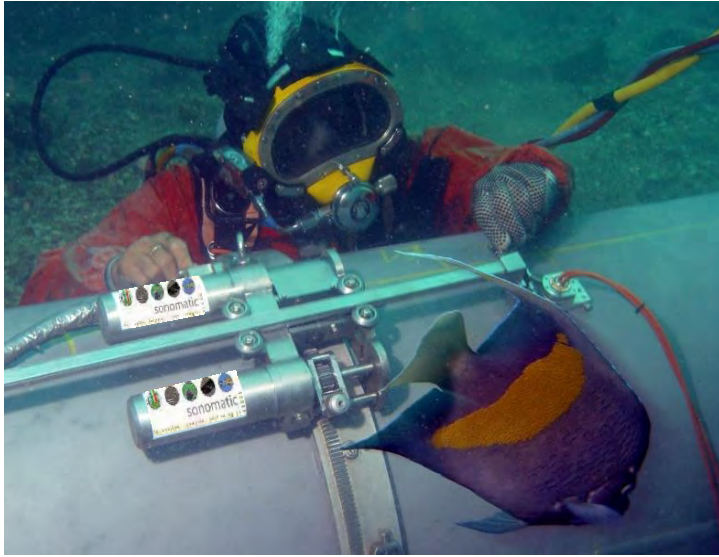
ROV-IT



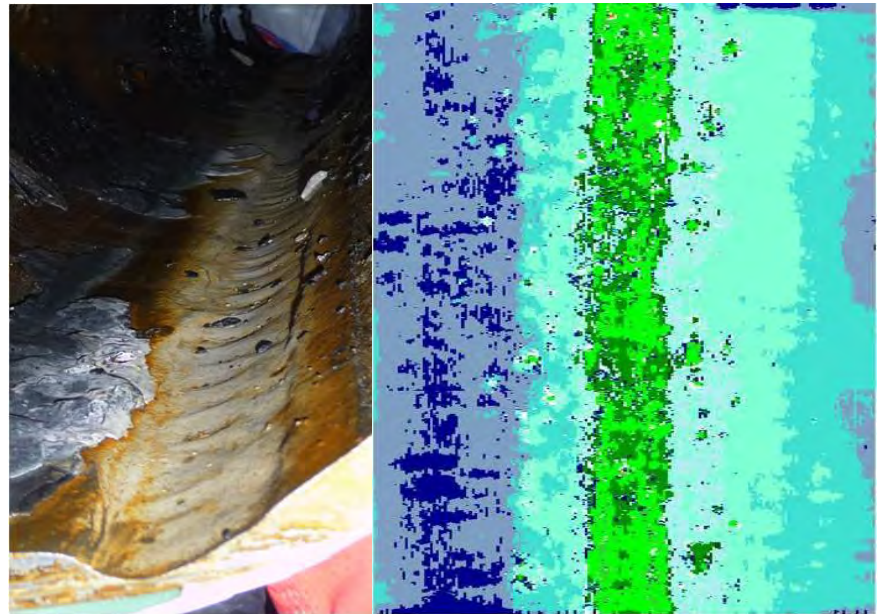
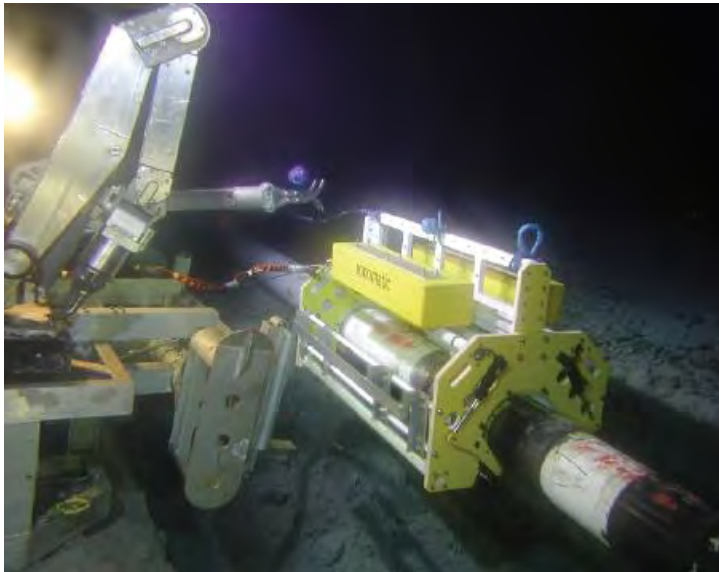
Mag Rover



Subsea Pipeline Inspection

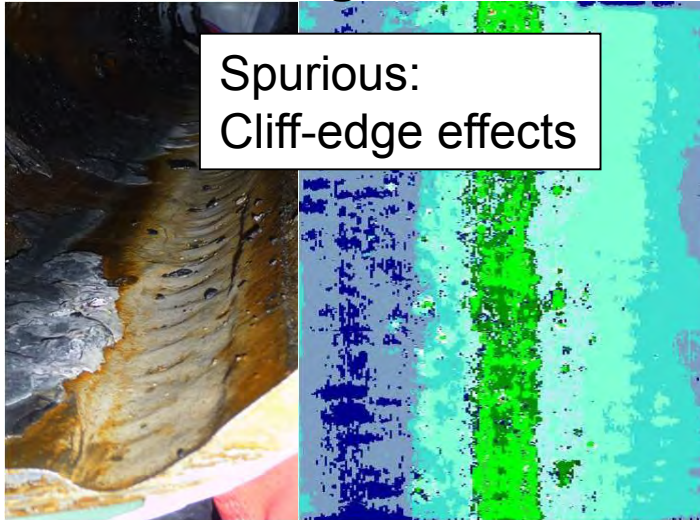


- Diver and ROV Deployed tools make it possible to carry out fully automated inspections to depths of 9500ft
- ILI Verification of critical indications
- Sampling inspection of unpiggable pipelines make it possible to justify continued operation of pipelines.
 - Factors which can make lines difficult to pig, Low flow conditions, Wax buildup
 - Acquisition of high quality quantitative data allows for use of statistical methods as part of Fitness for service evaluations

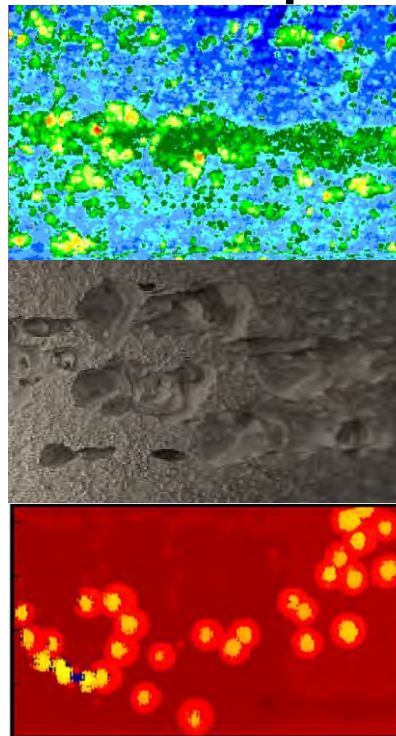


Imaging Degradation Mechanisms

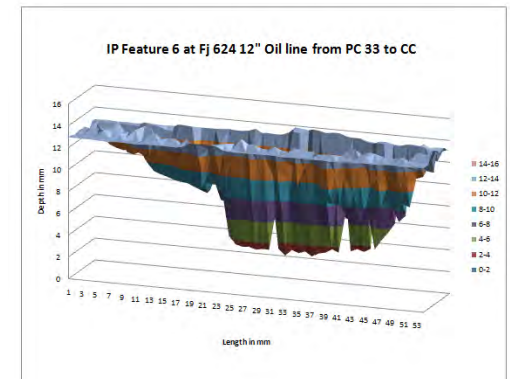
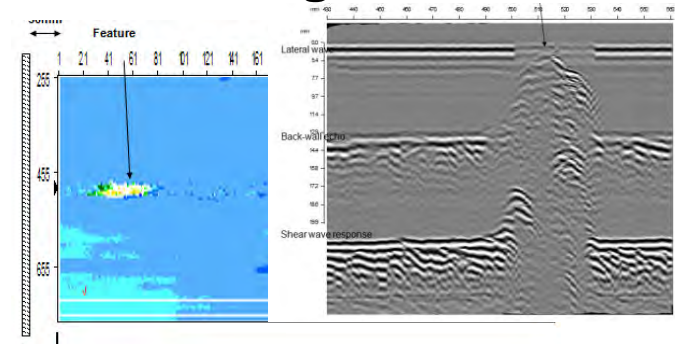
Channeling corrosion



Interacting corrosion pits

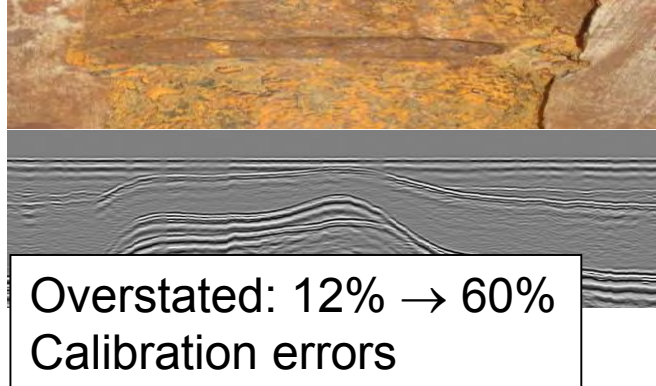


Knife edge corrosion



Interpreted as needle pits

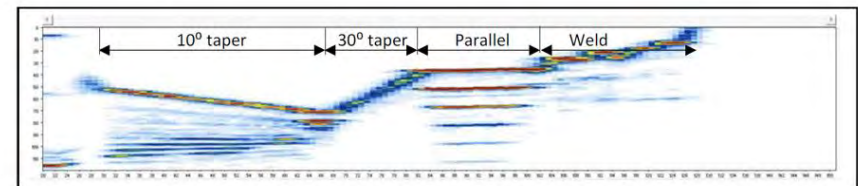
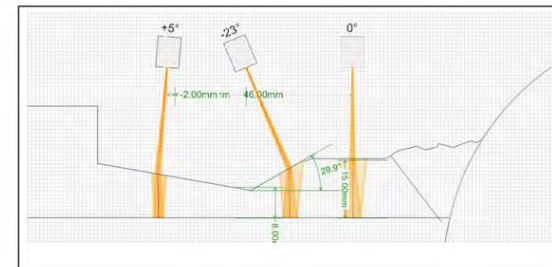
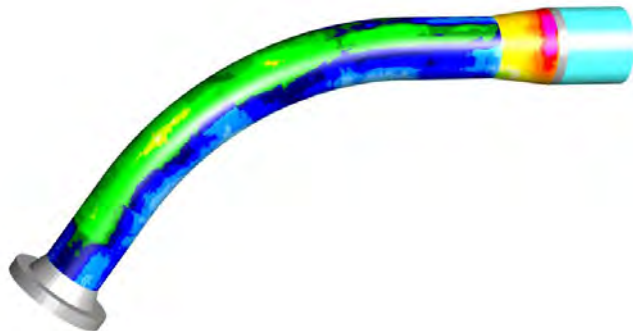
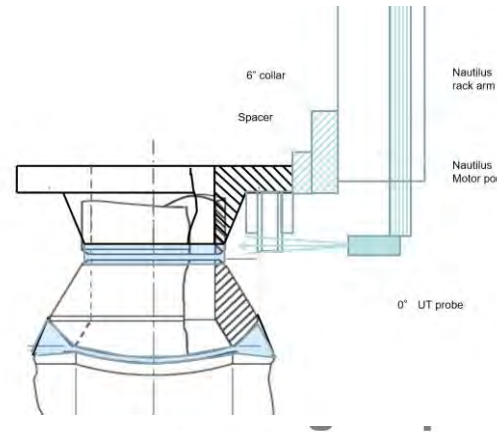
Preferential weld corrosion



Calibration flaws:
Representative?

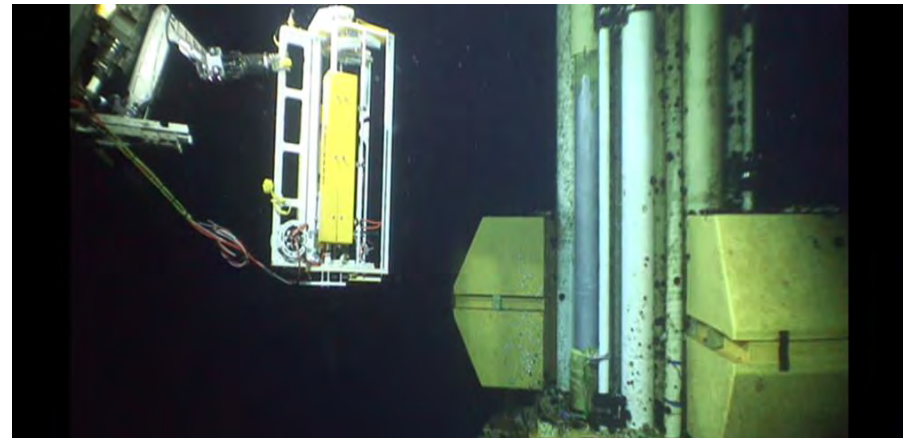
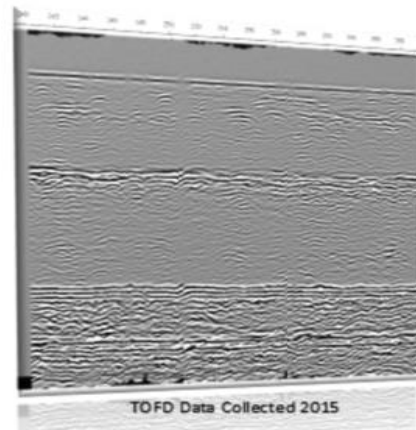
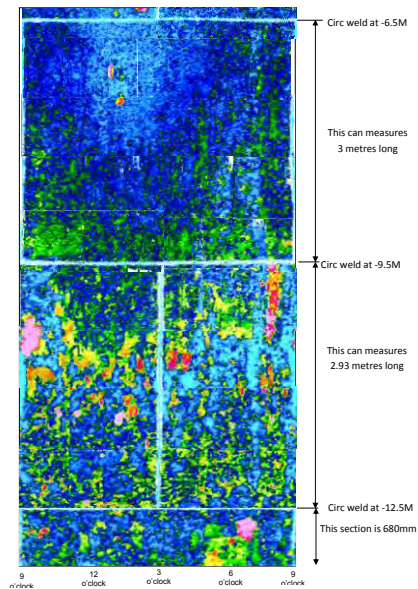
Dead Legs

- Subsea dead legs often experience degradation because inhibitors cannot be used effectively
 - Corrosion is unpredictable and often random.
- Often present challenging inspection geometries.



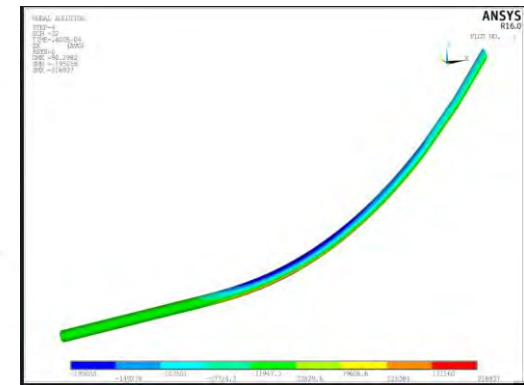
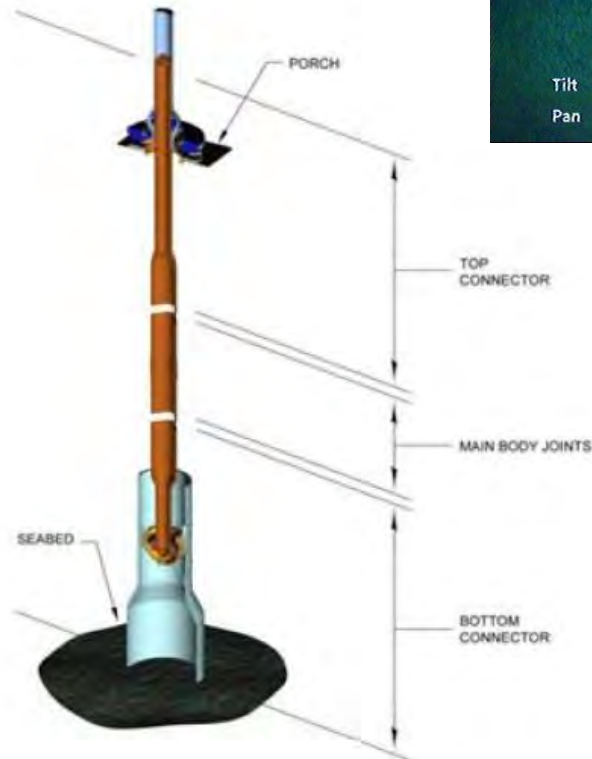
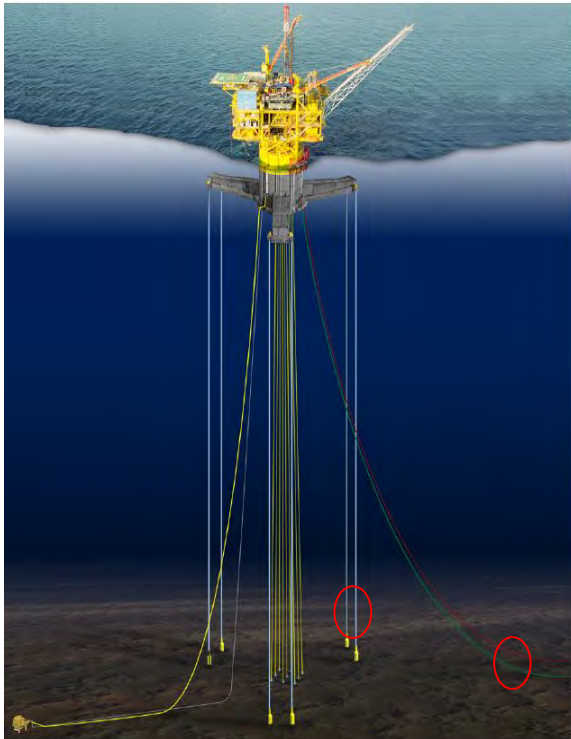
Caisson and Risers

- Robotic tools allow inspection of Caissons and Risers to confirm extent of corrosion/preferential weld corrosion.
- Risers are often subject to stresses which can lead to stress corrosion cracking in weldments
 - ROV deployed tools can be used to deploy fully automated Phased Array and TOFD inspection of Welds

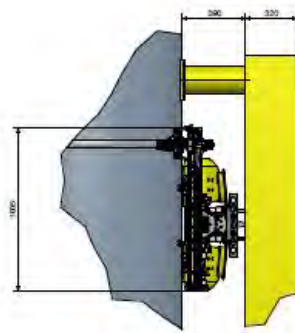
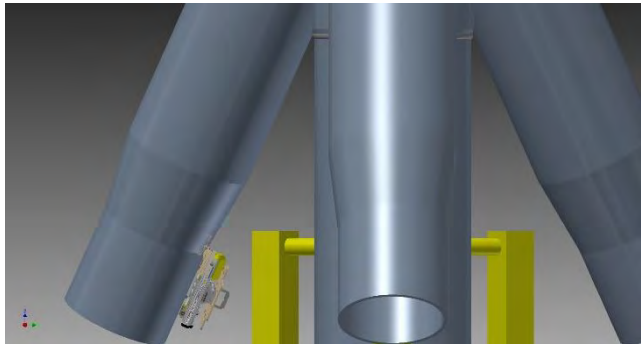


Life Extension Tension Leg Platforms

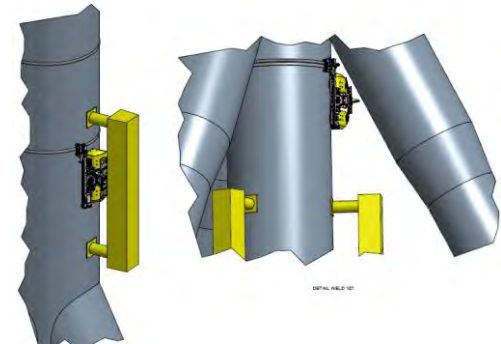
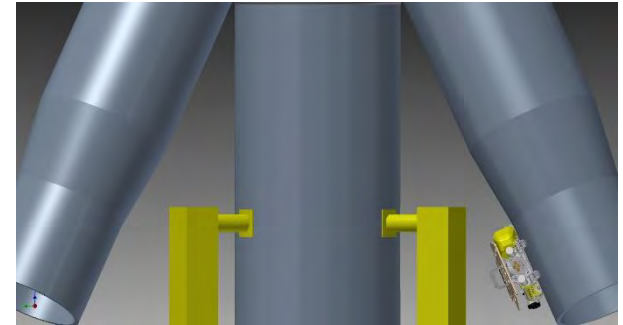
- Inspection Challenges include Inspection of Critical girth welds on TLP
- Inspection of critical welds on Steel Centenary riser touch down points
- Inspection required to depths of 5000ft



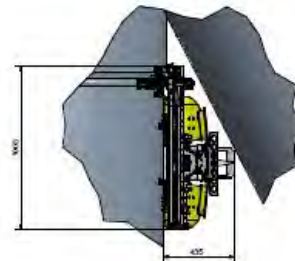
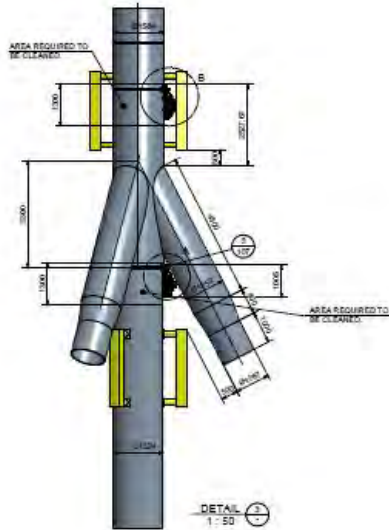
MAG-Rover Case Study Structural Inspection



DETAIL B
1 : 10

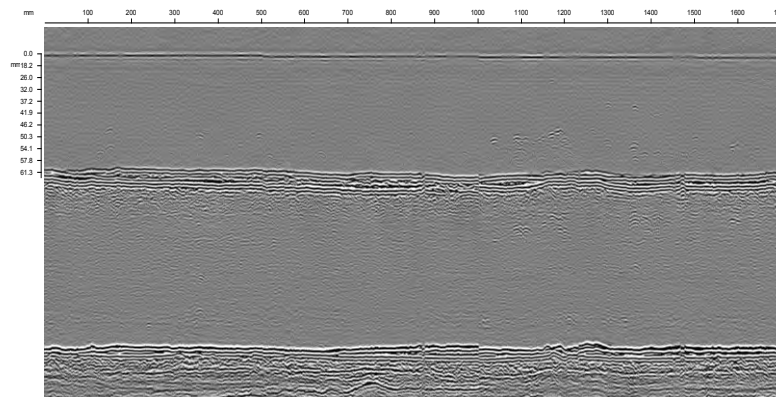


DETAIL A 10'

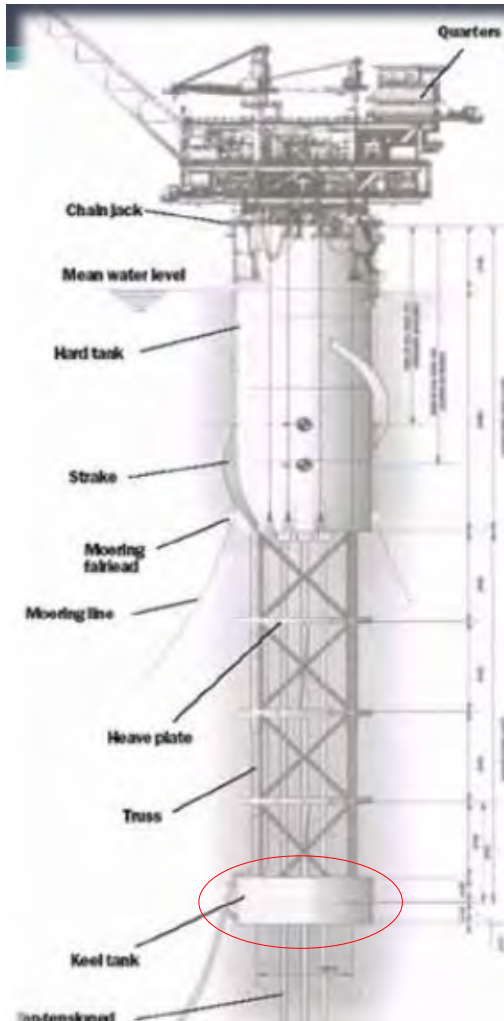


DETAIL A
1 : 10

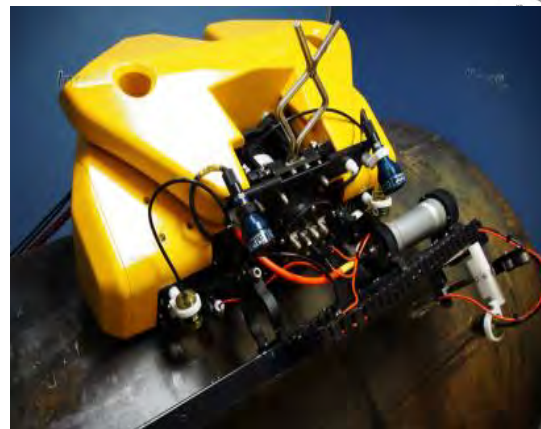
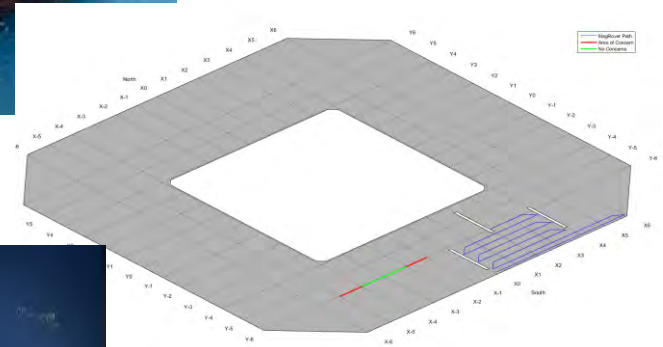
MAG-Rover Case Study



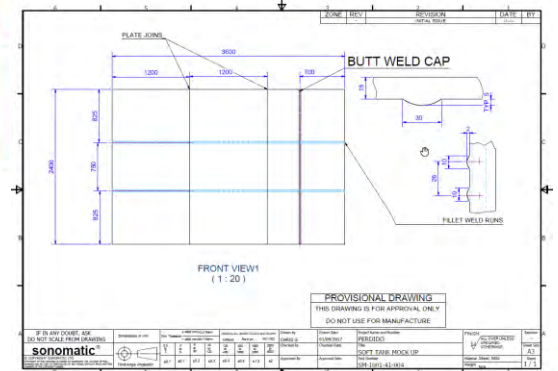
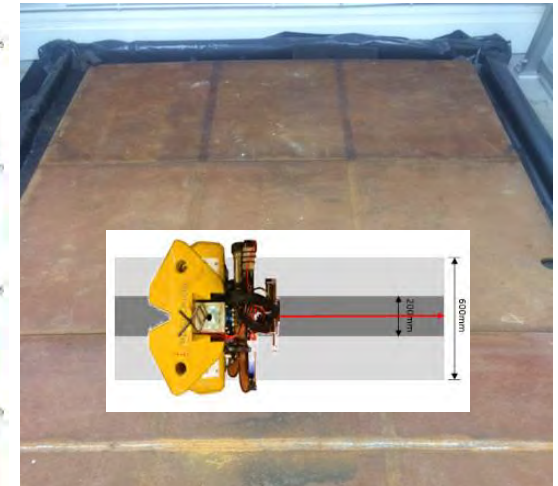
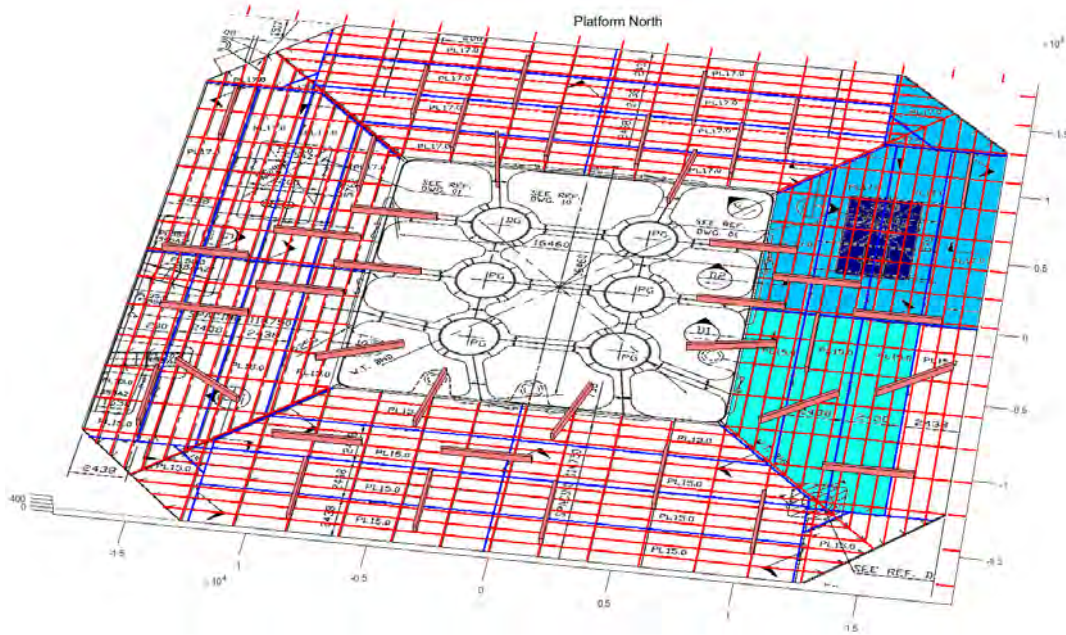
Life Extension Spar platform ballast-tank



- Two Primary Inspection challenges
 - Tracking Location of Tool on Tank
 - Locating and Tracking internal fillet welds



Navigation

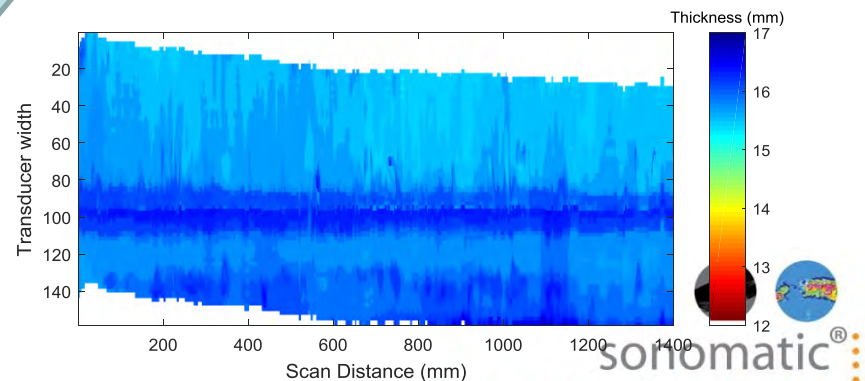
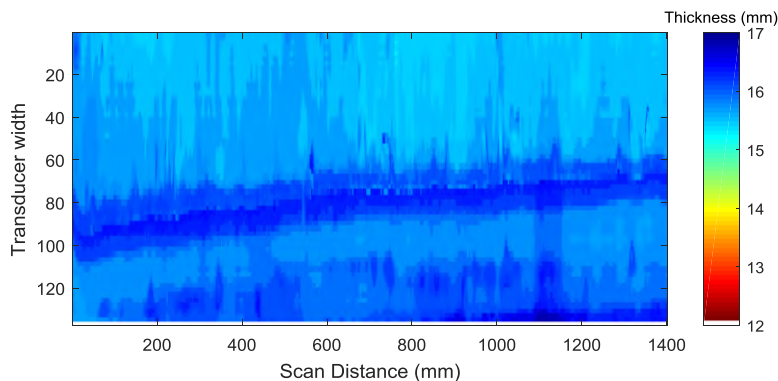
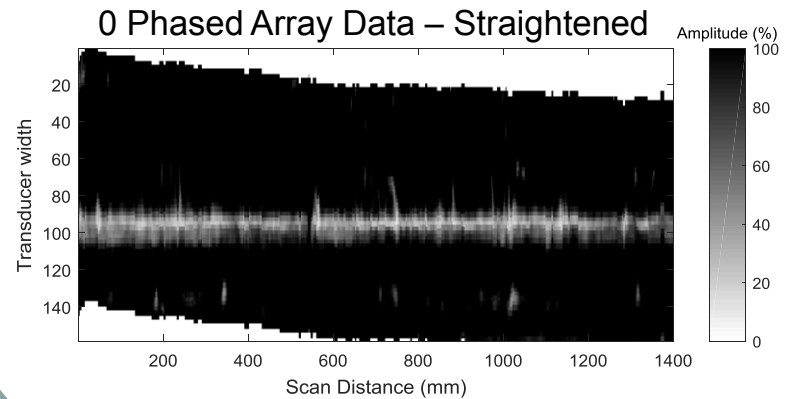
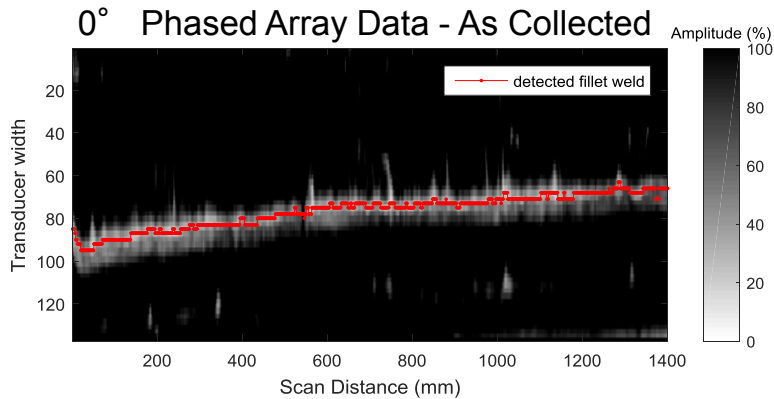


Weld Tracking

The 0° ultrasonic phased array data provides valuable information for tracking welds during data collection.

Example: Stiffener fillet weld.

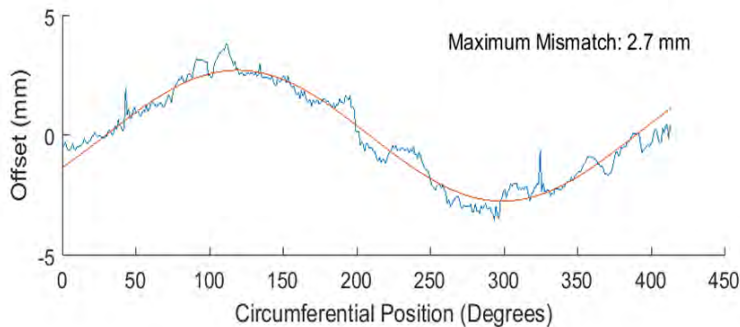
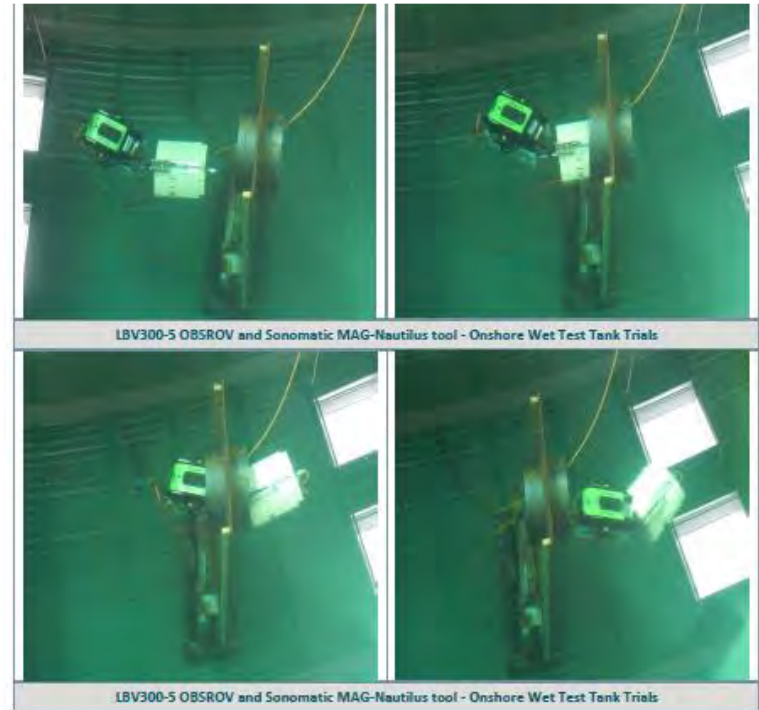
- Currently the welds can be imaged ultrasonically which allows manual adjustments to scanner heading to be made in real time during data collection.
- It is possible to detect the fillet weld through automated signal processing. Currently this is done post data collection.
- This may be used to trace the fillet weld, straighten the collected data or be used to provide feedback for close loop drive control and automated weld following during data collection.



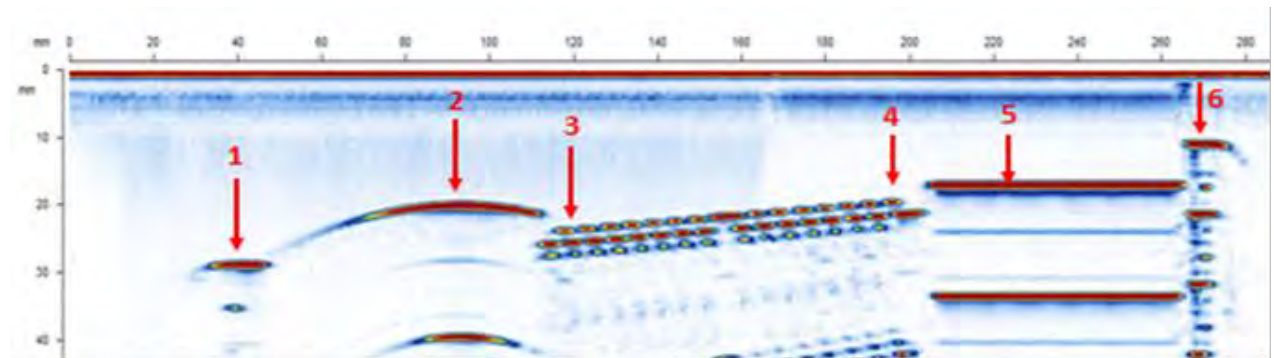
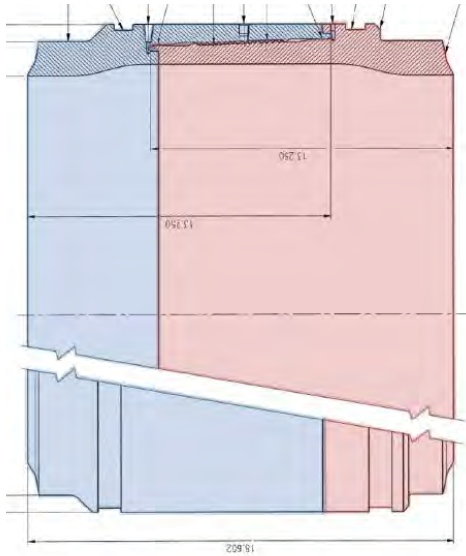
Subsea robotics

Challenging Access Application

- Inspection of critical welds on conductors inside a gravity base structure
- Depth 140 m
- Only accessible through 625 mm diameter openings
- Up to 60 m travel past openings
- Deployed to the entrance to the gravity base by work class ROV (provides power and comms)
- Mini ROV for deployment through openings into each compartment for conductor inspection
- 230 welds inspected (TOFD and PE)
- Weld misalignment inspection (0 deg)



Merlin connectors



www.sonomatic.com