**PPSA Seminar**
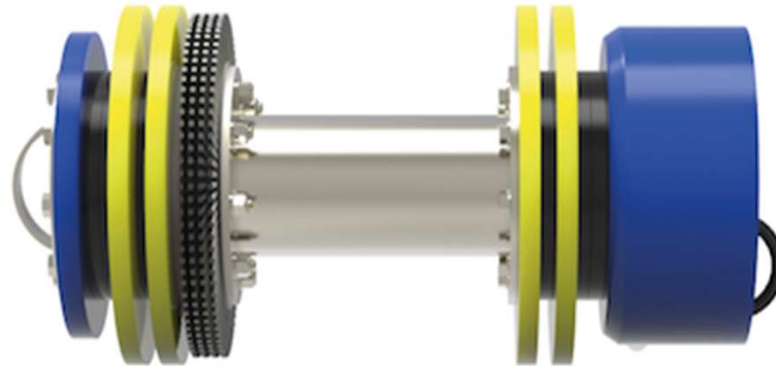
Aberdeen 8th November 2017

Paul Clayton – Business Development Manager

making simple **smart**

# i2i Pipelines – the company

- Formed in 2015, links to Manchester University.

- Currently 20 employees, based at the Manchester Science Park & Houston, TX.

- Sensor Technology Company providing Big Data on pipelines via machine learning and digital IOT.

- Core Skills in providing fast solutions for non-disruptive inspection in complex pipelines.

www.i2ipipelines.com

# About i2i

- **Our Vision:**

  - *" To simplify pipeline inspection so it becomes a low risk, low cost and regular non-disruptive activity, leading to enhanced integrity management that benefits from big data analytics and digital technologies"*

- **Our Objectives:**

  - To build and deploy simple operational tools with smart sensors.
  - To make smart pigging a non-specialist activity, performed by the operator.
  - To develop machine learning for rapid data analysis and automated reporting.
  - To collect big data (including flow assurance and integrity) to allow predictive maintenance strategies.

# Technology Gap

**Cleaning pigs** are run frequently but collect no data.
- Little disruption to Ops.
- Low cost.
- Low risk.

**Intelligent Pigs** are complex, disruptive and too expensive to be run frequently.
- More risk of getting stuck.
- Require specialist personnel.
- Inconvenience – gauging, cleaning & handling equipment.
- Operating windows, scheduling.

2 extremes when collecting data

**Result:**
- Costs are high and inspection is infrequent.
- Less data to monitor or trend anomalies (ILI intervals can 5-15yrs).
- Sometimes no data on critical assets (small diameter or "unpiggable").

**Way Forward:**
- Simple Smart tools.
- Combine the benefits of simple design with an inspection capability.
- Inspection without disruption.
- No specialist personnel.
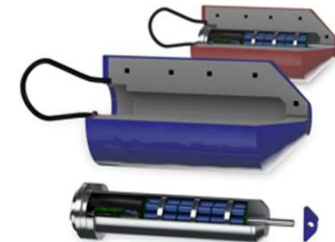
# The Inspection Technology

- **Based on Electromagnetic Inspection technology:**
  - PCBs have a generating coil and receivers.
  - Wired together into any size array.
  - Different sizes allow different levels of stand off.
  - Sensitive to internal defects only.
- **Benefits:**
  - Can operate at a large stand off and are not sensitive to lift off.
  - Can work in any medium including uncleaned pipe.
  - Less sensitive to speed variations.
  - Very sensitive to pits, internal metal loss and open circumferential cracking.

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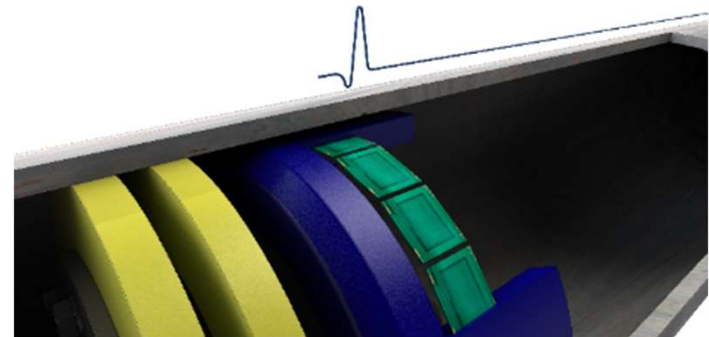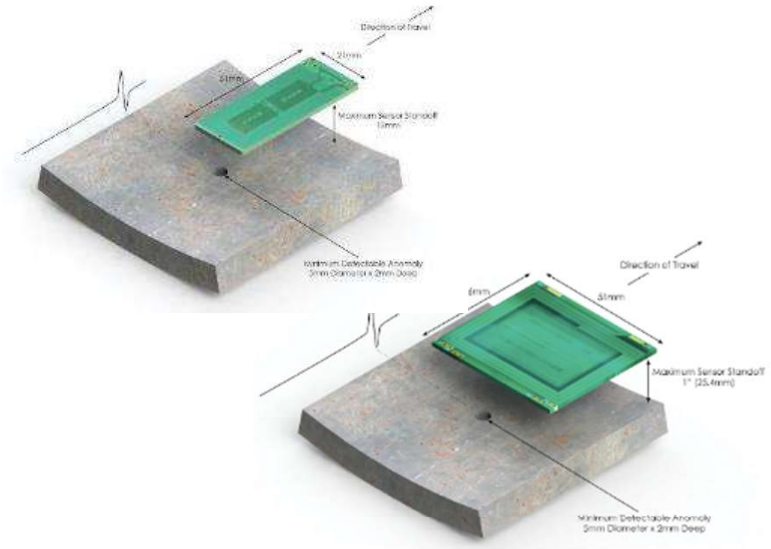
# Case study 1 – a world first ?

- The Challenge:
    - Inspect 2 x 10" pipelines, platform – FPSO.
    - 4.3Km and 2.5Km.
    - Multiphase.
    - >75°C.
    - WT: 12.7mm.
    - Pipe In Pipe.
    - Flexible riser.
    - Constant operational pig damage.
    - Receive in a pigging valve.

- The Solution:
    - SmartFoam™

# Pigging history - Operational pig damage

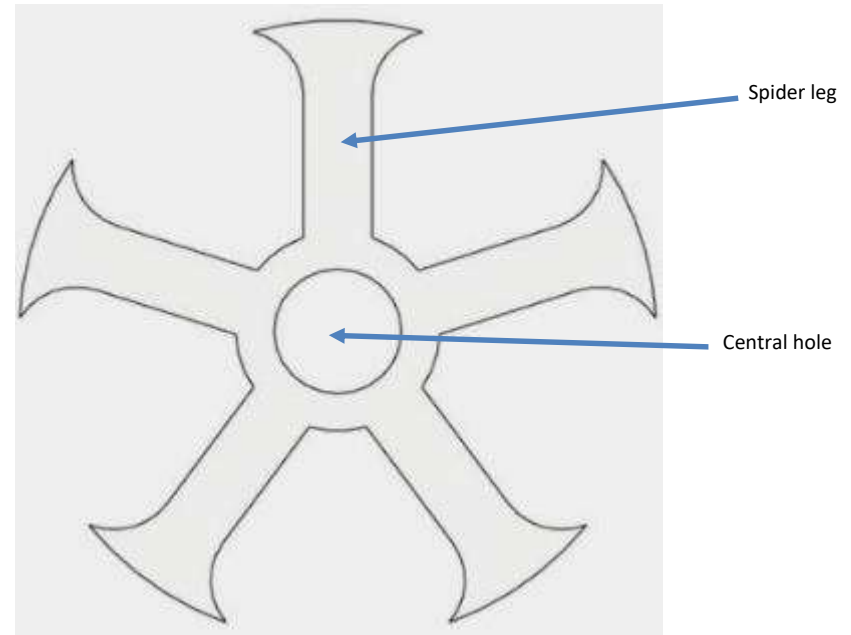

Client routine pig prior to launch


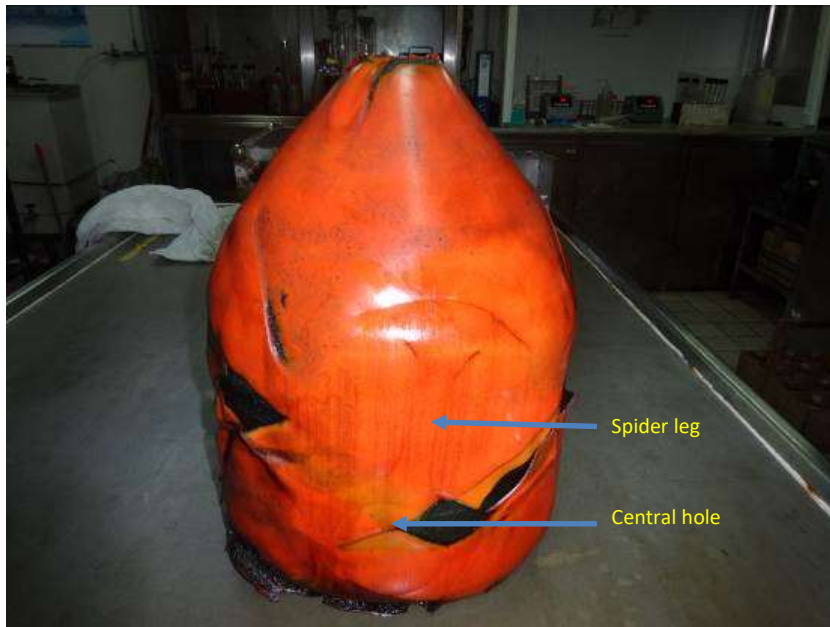
Client routine pig at receive

# Client operational pig damage



Client pig c/w impression on nose
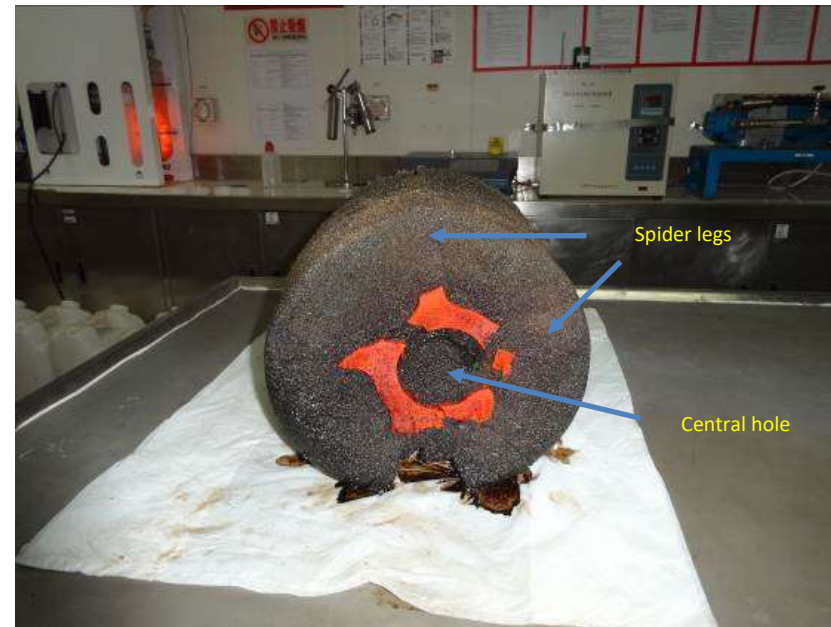


Spider leg

Central hole

Design of pig catcher in valve cavity

# Tell-tale marks - showing pig tumbling ?



Impression on SIDE of one client pig



Impression on REAR of separate client pig

# Tell-tale marks - showing pig tumbling ?

# Pig design reviewed, suggestions made…

- Produce a dummy tool with a longer sealing length to mitigate tumbling.

- Less pointed nose.

- Ballast the pigs with weights to simulate the on board PV, then proceed to live run.

- Full review of receive process in pigging valve.

- Recommend trials, client offered use of their test loop…

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# Isometric of client test loop

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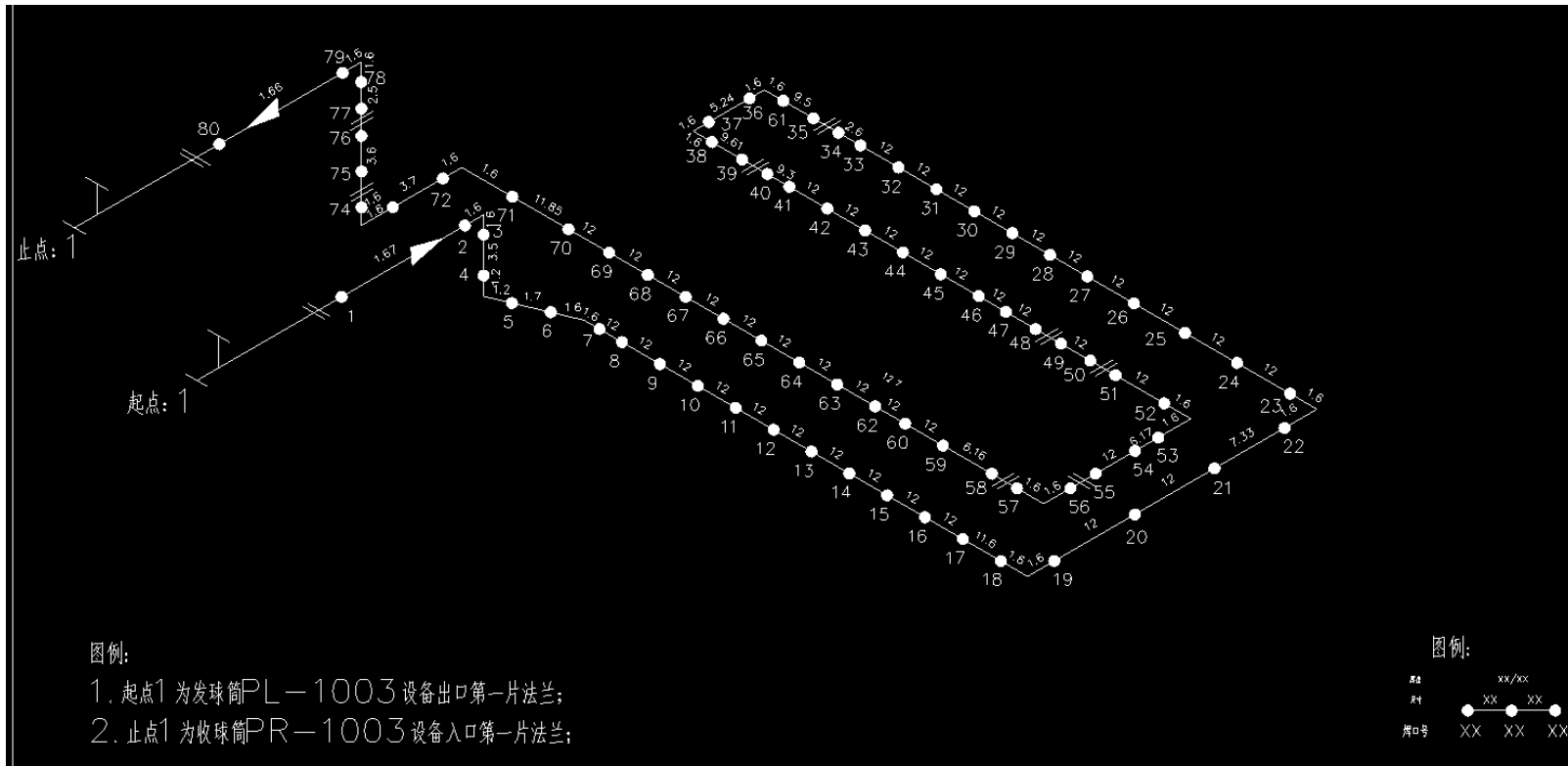
# Pig testing in client test loop



- In dry dock, Tianjin, China

- Multiple diameters

- Multi product

- 700m loop

- Bends / expansion loops /multi dia

- Ability to add wax
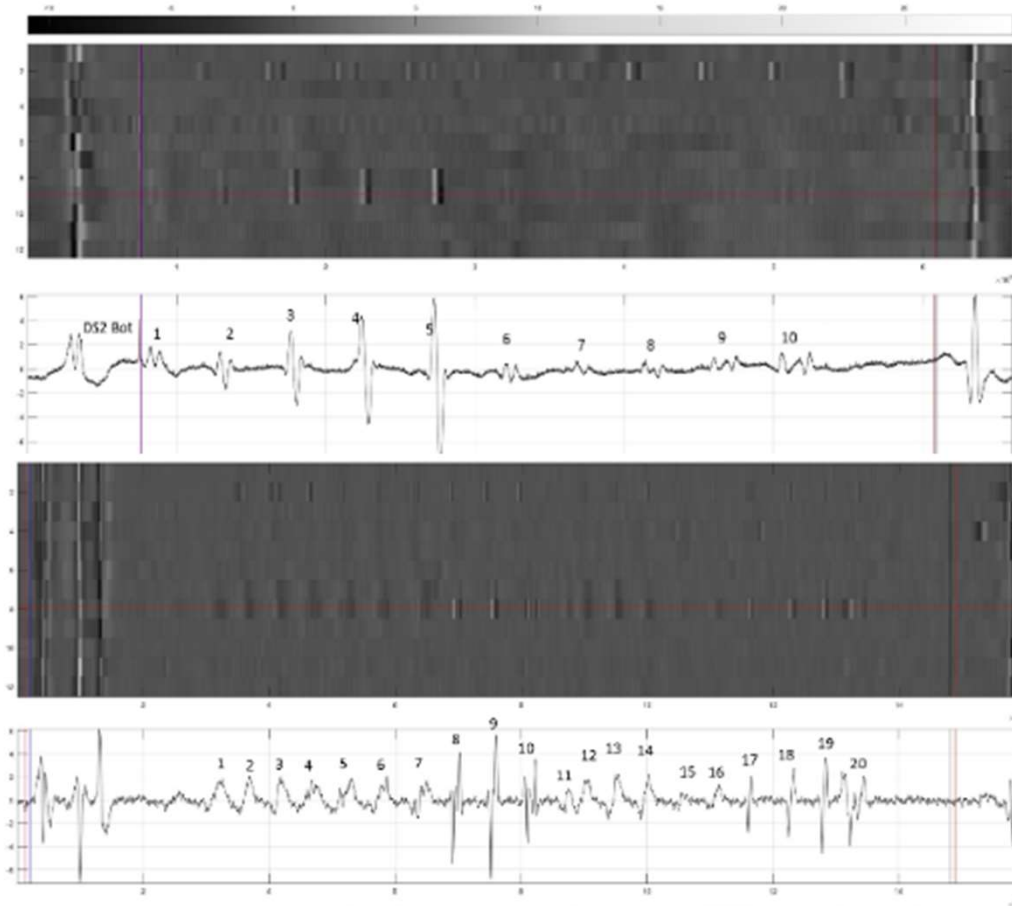
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# Defect spool in test rig for blind test
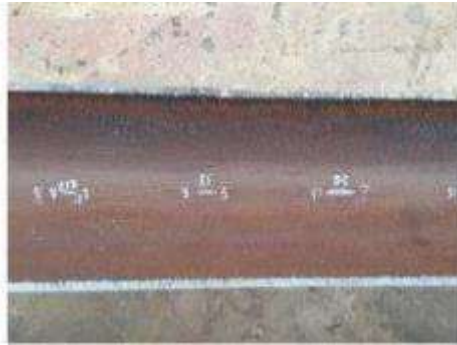


- Multiple internal defects to POF category

- Client QA'd

- Test conducted blind

- Included inspecting through wax

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# Test results – client defect spools



- Result: 97% POD

- L, D, W within spec.

- Design and capability APPROVED

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# Pilot dummy SmartFoam™ (line 1)

www.i2ipipelines.com

# Pilot tool at receive (line 1) – tell tale marks on front



Central hole

Spider leg

# Pilot dummy SmartFoam™ (line 2)

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# Launcher (line 1)

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# SmartFoam™ overview



345mm
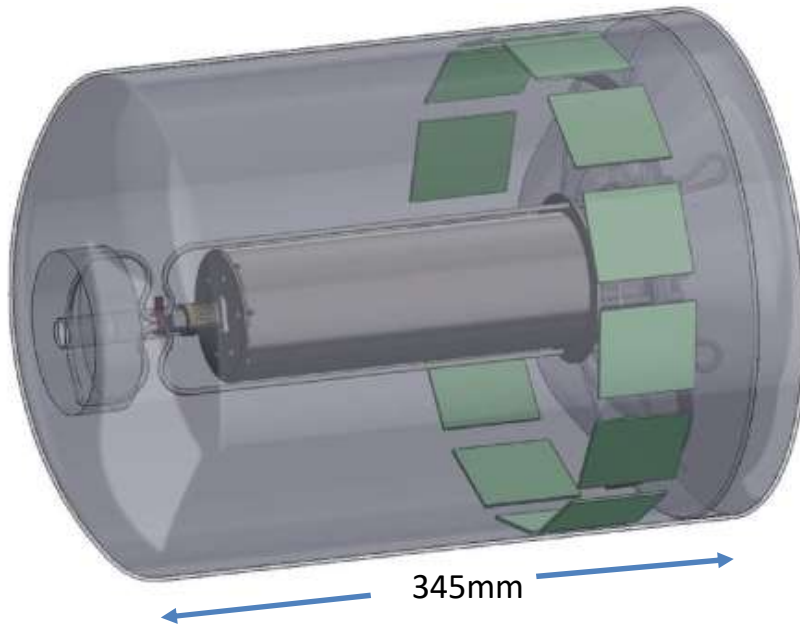
| | |
|---|---|
| NUMBER OF SENSORS | 13 |
| SENSOR TO PIPE WALL STAND OFF | 8mm |
| MAXIMUM SENSOR STAND OFF | 25mm |
| MINIMUM DETECTABLE ANOMALY | 2mm DEEP x 5mm DIAMETER AT MAX 25mm |
| MINIMUM CIRCUMFERENTIAL SIZING | ≤ 46mm |
| MINIMUM LONGITUDINAL SIZING | ≤ 41mm |
| SCAN RESOLUTION | 1.5mm at 2m/s |
| MAX RUN TIME | 6 HOURS |
| **ADDITIONAL FEATURES** | |
| PRESSURE SENSOR | NO |
| TEMPERATURE SENSOR | NO |
| XYZ MAPPING | YES |
| **OPERATING RANGES** | |
| MAXIMUM PRESSURE | 140 bar (2000 psi) |
| MAXIMUM TEMPERATURE RATING | 90°C  (194°F) |
| MAXIMUM SPEED | 6m/s |
| MINIMUM BEND RADIUS | 1.5D BEND |

# FPSO (receive)

# Receive pigging valve in turret on FPSO



Effective pig receiver length
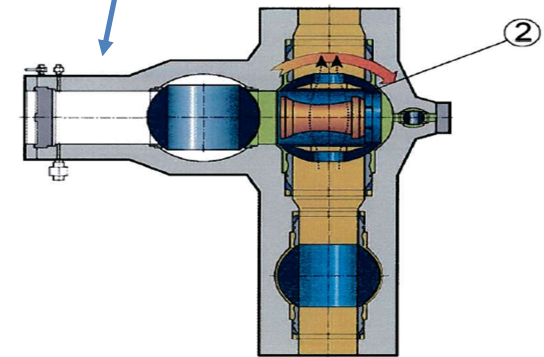
# Pigging valve receive procedure
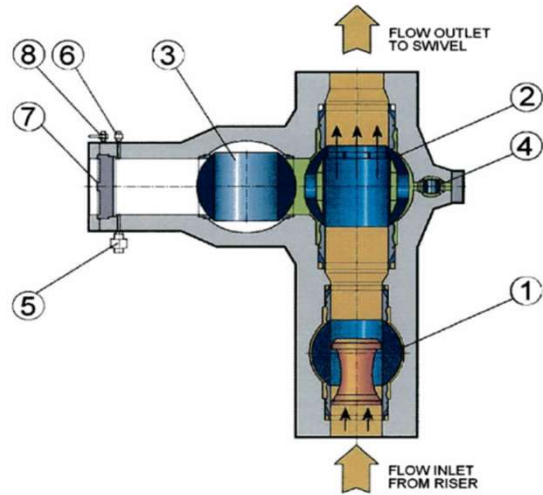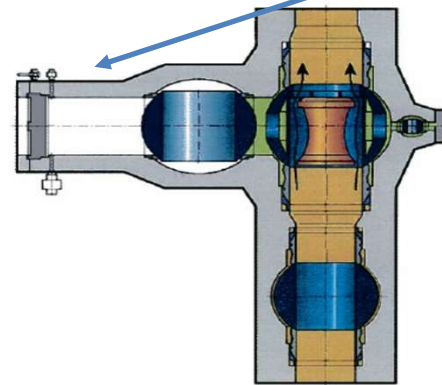
# Pigging valve receive procedure
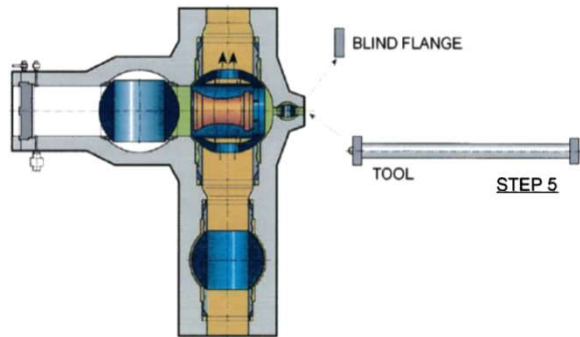


STEP 4

BLIND FLANGE

TOOL          STEP 5
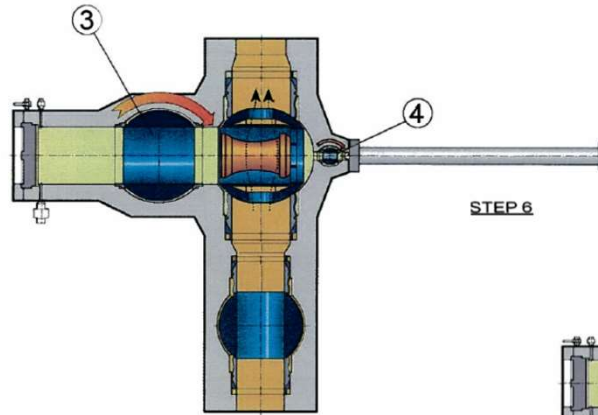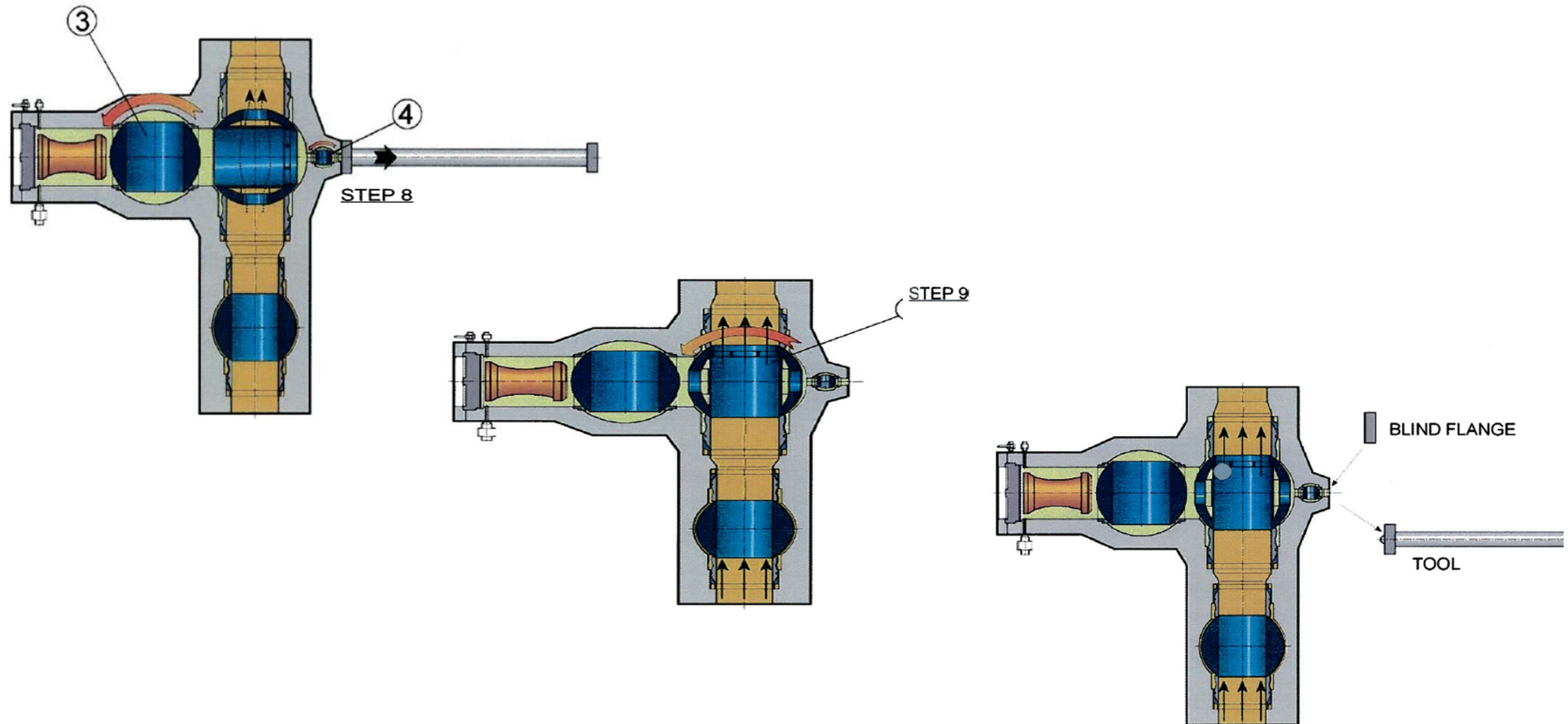
③

④

STEP 6

# Pigging valve receive procedure
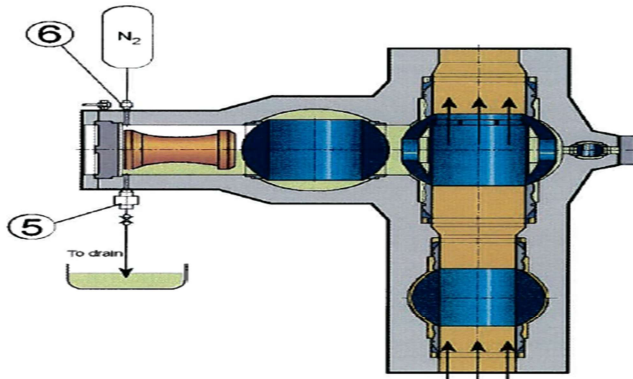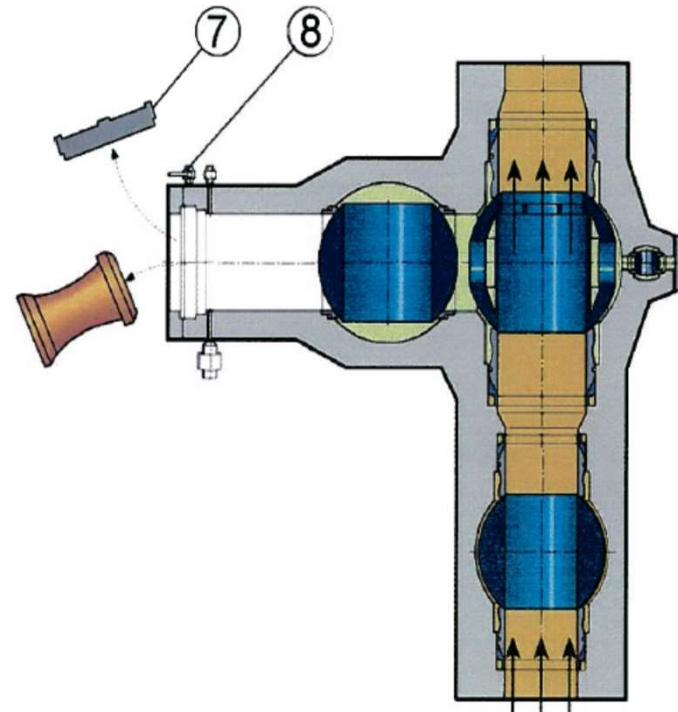


STEP 7

STEP 8

STEP 9

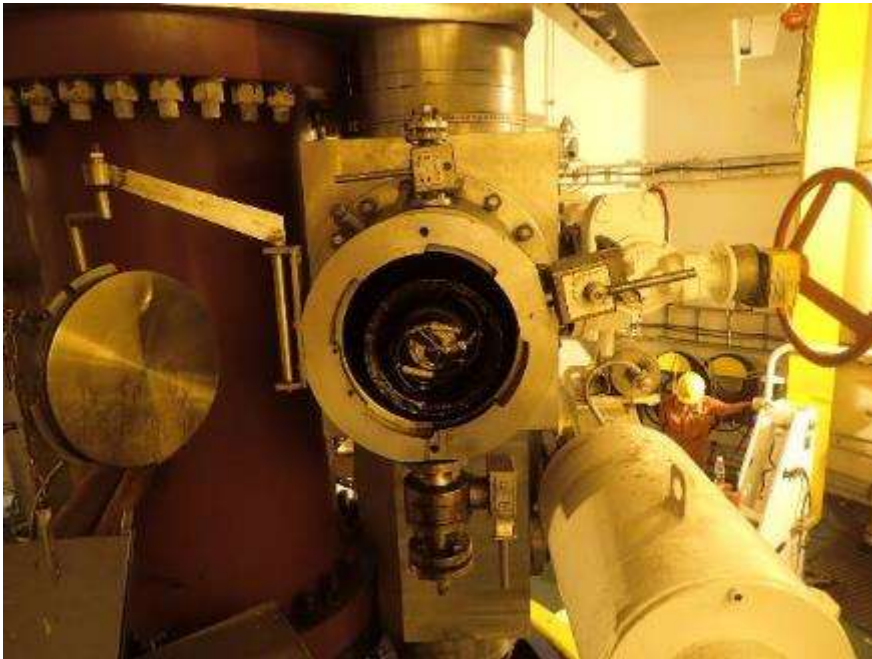BLIND FLANGE

TOOL
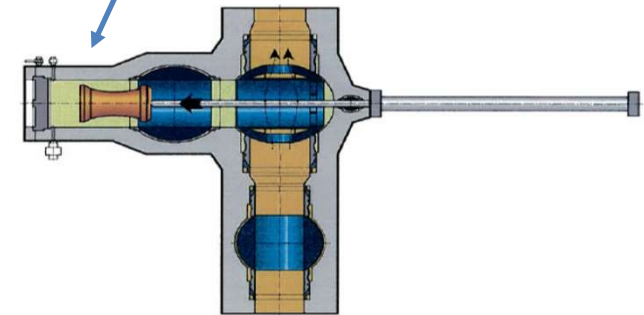
# Pigging valve receive procedure



STEP 10

STEP 11

# Recovery of SmartFoam™



Hartmann valve has an interlock that is integrated on the side of the pigging ball valve that is locked and secured through a bayonet system.
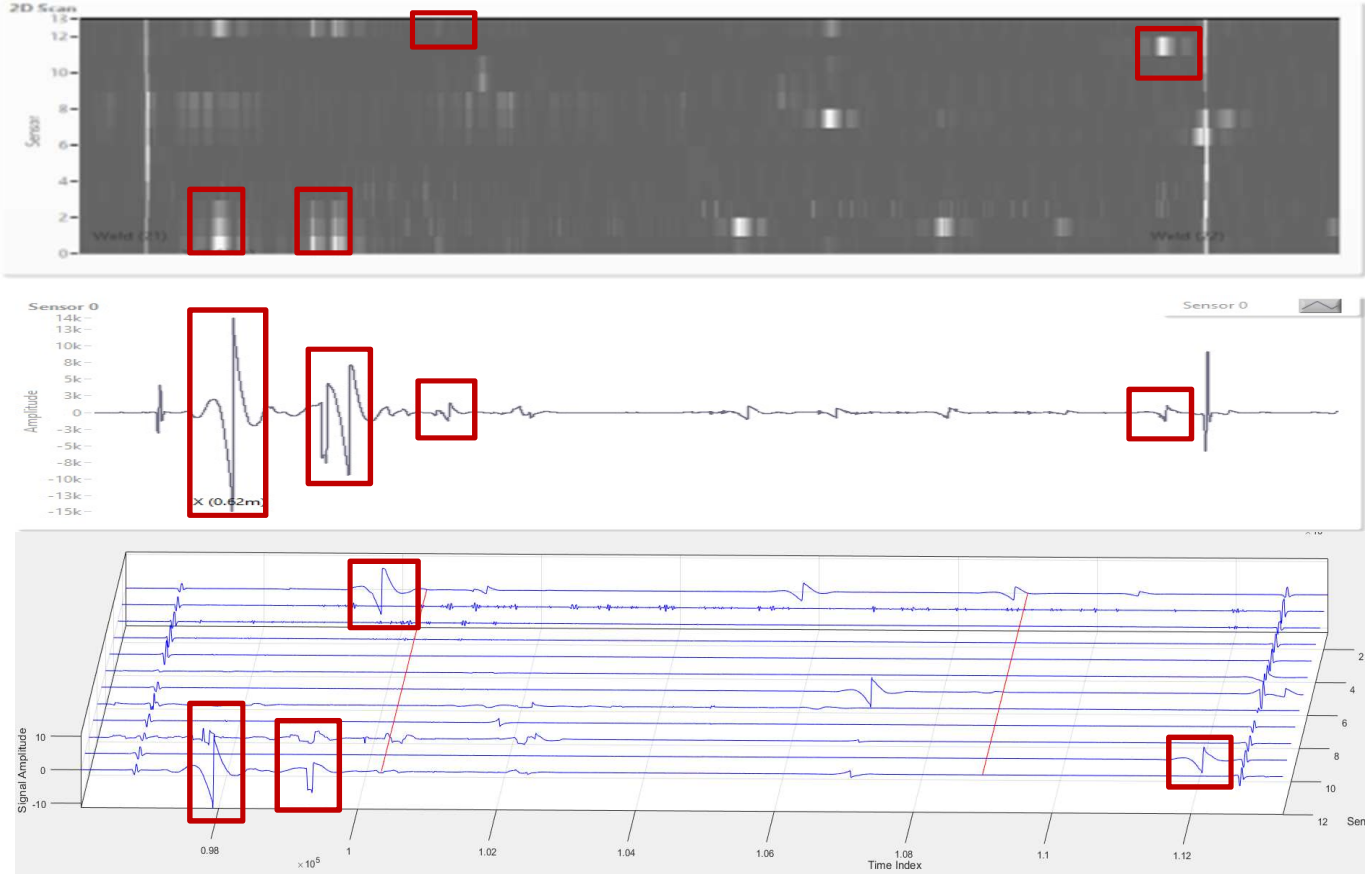
# SmartFoam™ following recovery

www.i2ipipelines.com

# Pressure vessel removed from SmartFoam™ for download
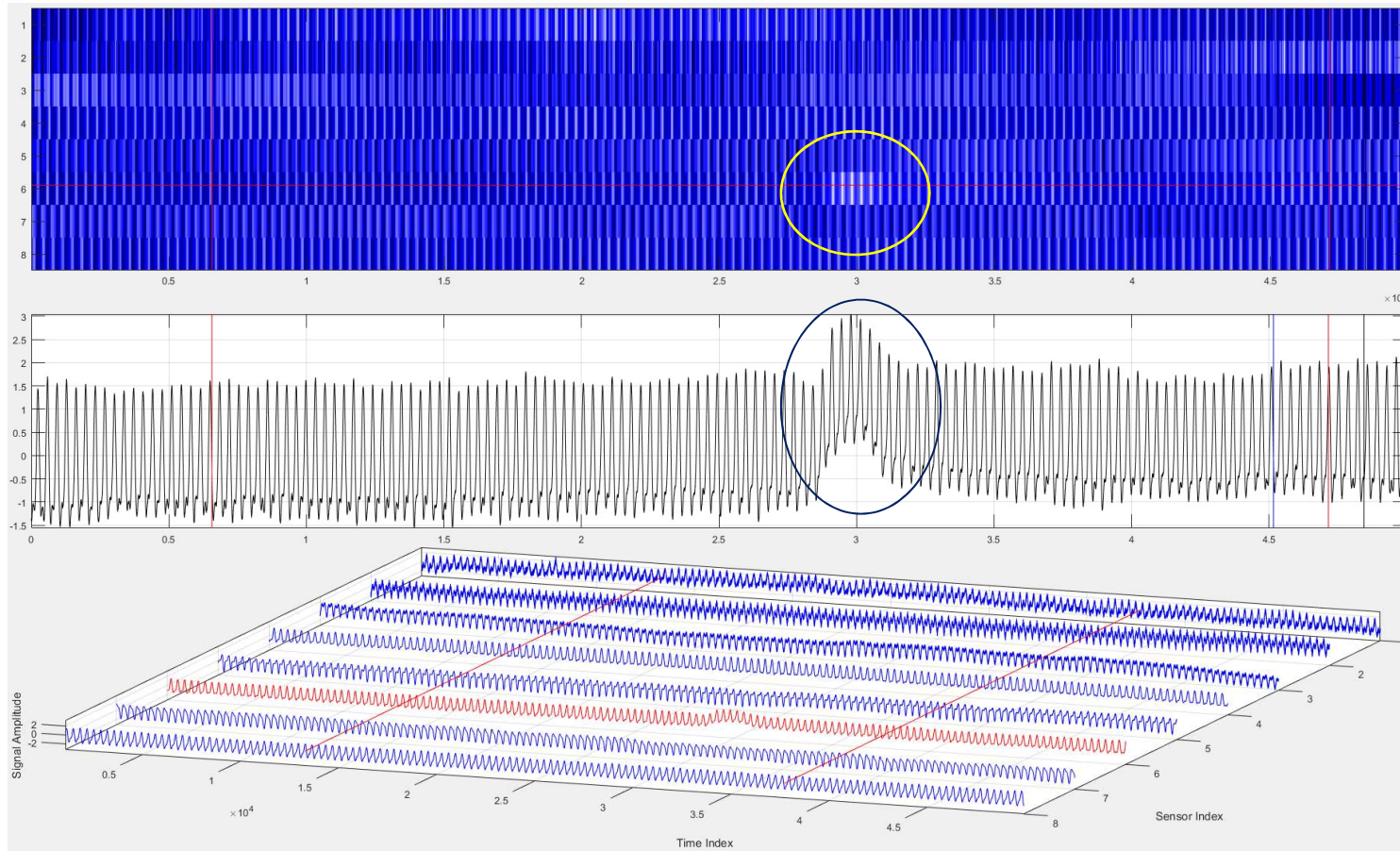
www.i2ipipelines.com

# Pipeline Data

# Flexible riser data

# Case study 1 - summary

- First ever successful intelligent pig run in to an FPSO's turret based pig

   valve receiver ?


- Data gathered over entire pipeline length in first pipeline with a simple ILI tool based on a foam pig with embedded sensors.


- Report delivered.


- Interesting and unexpected data from the flexible riser.

# Case study 2

- The Challenge:
  - Inspect 12" x 50Km pipeline.
  - Platform to shore.
  - Badly dented down to 253mm.
  - Short notice due to contracted ILI vendor withdrawing.
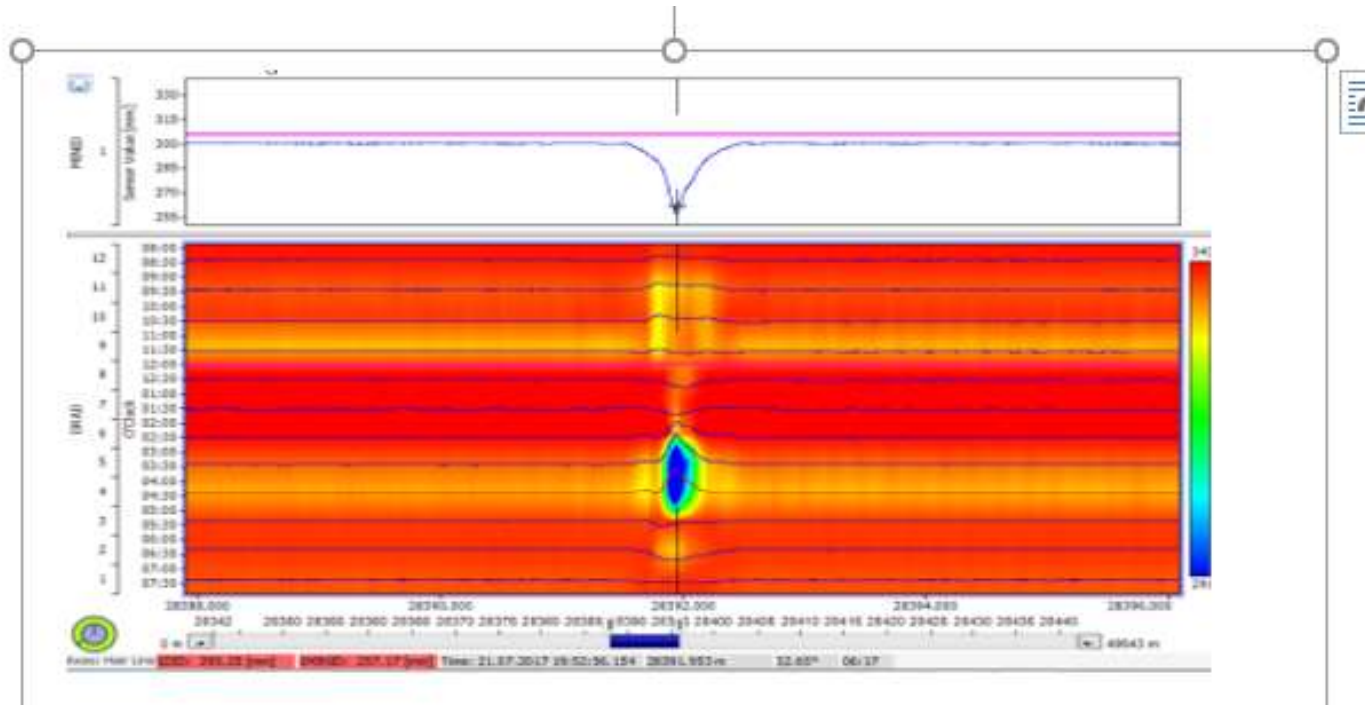
- The Solution
  - Pioneer™

# Gauge plate damage from existing cleaners

# ILI vendor Calliper reported very large dent

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# Offshore launch of Pioneer™



Local technicians trained to commission and load tool in less than 1 day !

# Onshore receipt of Pioneer™ tool



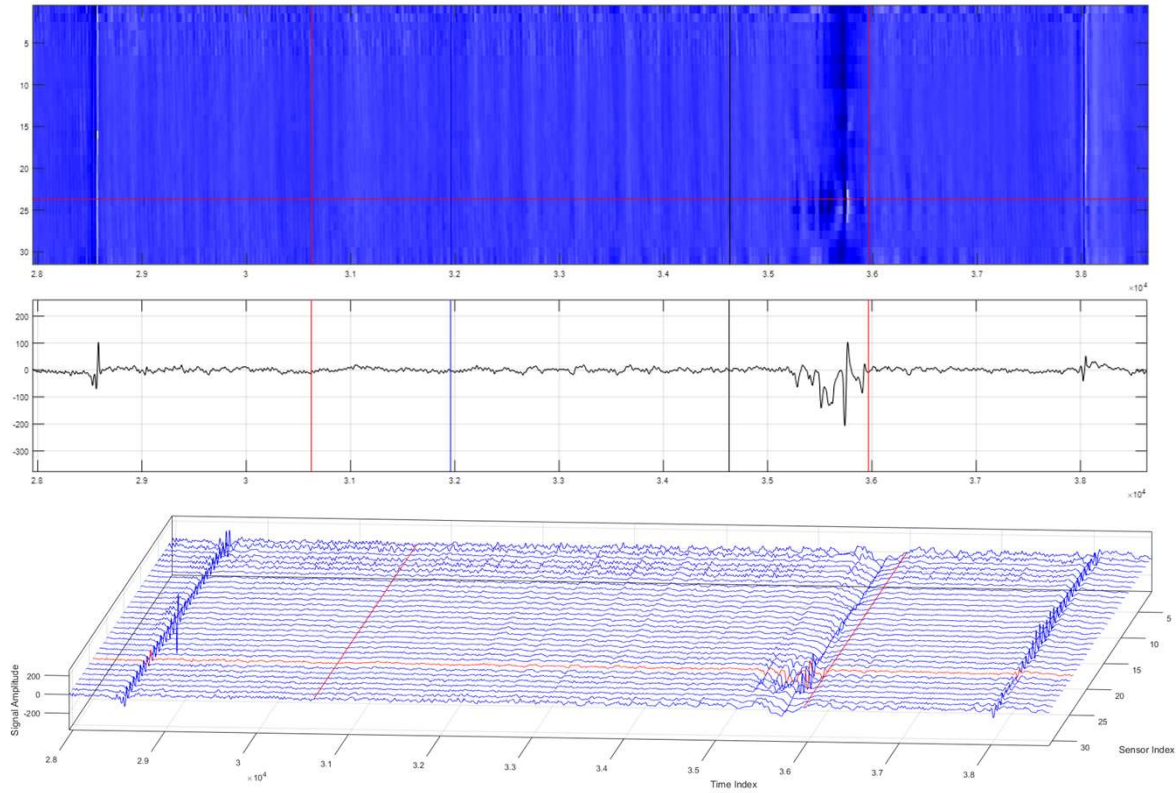Very little debris recovered in front of tool

# Pioneer™ following run

www.i2ipipelines.com

# Simplistic data download from Pioneer™

# Features reported: Dent

# Features reported: Internal Metal Loss

www.i2ipipelines.com
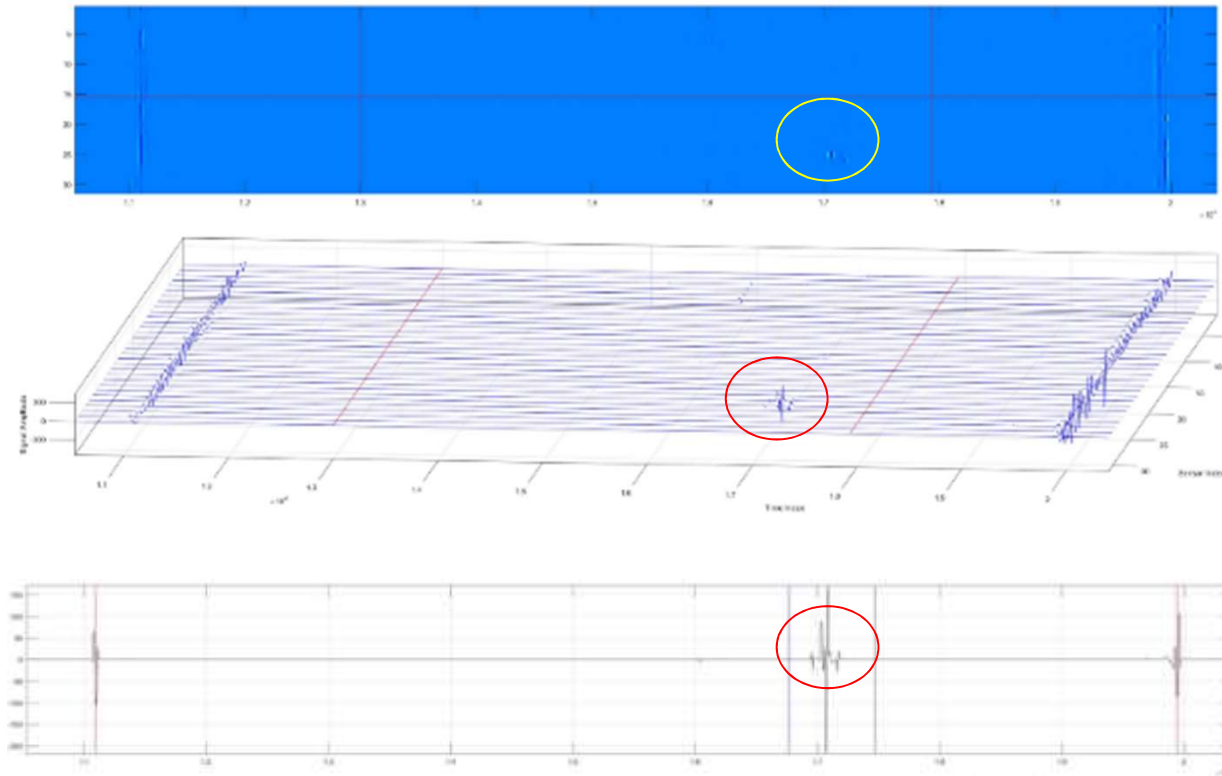
# To conclude and in summary…

- Cost effective solutions exist for the most challenging inspection needs.

- If you can safely run a cleaner, you can inspect the line.

- Keep it simple, make it Smart.