



HALFWAVE



**PIGGING PRODUCTS &
SERVICES ASSOCIATION**

WIDE BAND ULTRASOUND IN LINE INSPECTION

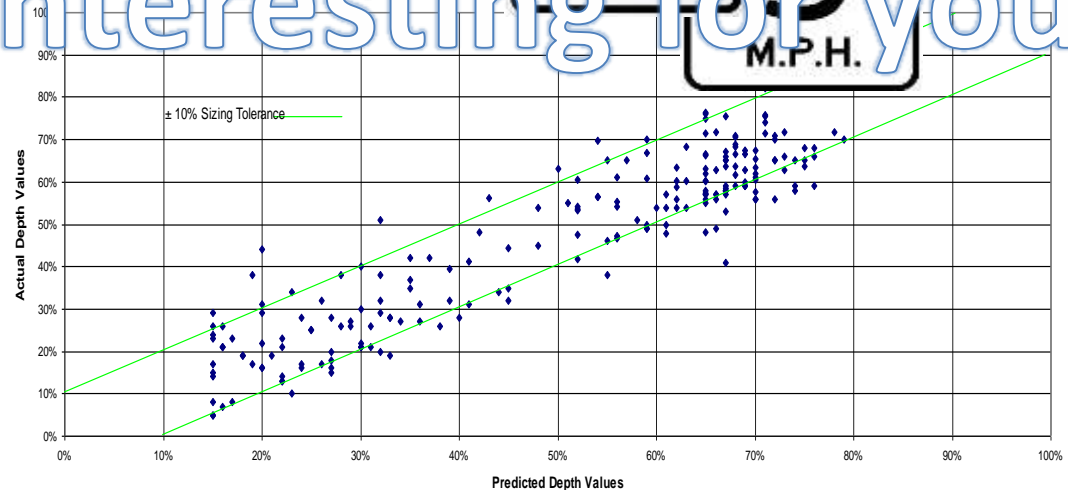
PPSA Annual Seminar, 2017

Craig Hall, Rolf Sporkel, Willem Vos

Who is the presentation for?



This may be interesting for you



Halfwave Background

Through the years





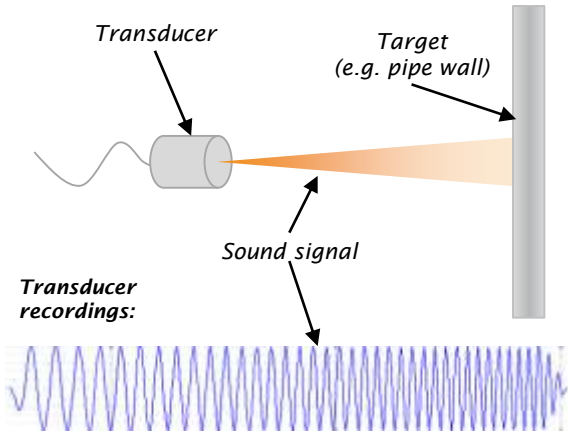
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ACOUSTIC RESONANCE TECHNOLOGY

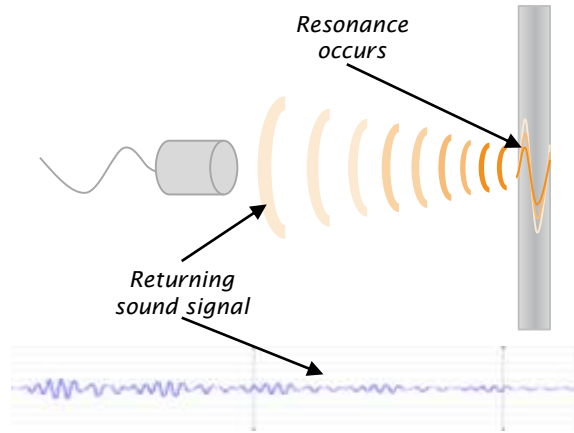
Theory Behind Acoustic Resonance

Basic functionality of Acoustic Resonance Technology (ART)

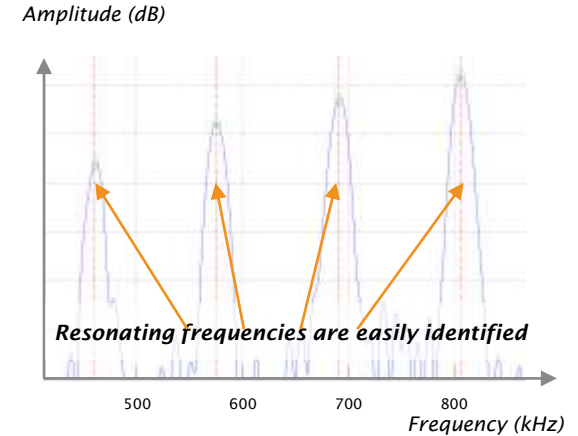
Emitting



Listening



Interpreting



Emitting sound signal towards a target (e.g. pipeline wall)

- Transducer shooting a broadband (multiple frequency) sound signal towards a target
- Signal duration is sufficiently long to generate oscillations in target

Resonance occurs in target - returning sound signal recorded

- As the oscillating target continues to be struck by the sound signal, resonance occurs in the target i.e. oscillations are greatly amplified
- These resonating frequencies are characteristic of the thickness and material of the target
- The tool records the returning sound signal

Identifying resonant frequencies allows for direct measurement of target thickness

- Direct measurement of thickness is revealed in the returning sound signal
- The frequencies that resonate (i.e. become amplified) are used to calculate the thickness of the steel
- time-of-flight (TOF) measurement allows for accurate caliper/geometry measurement

Acoustic Resonance

Not a new technology

- Standard method for WT testing up to the 1970-s
- Images only available in black & white, old text books
- Replaced by pulse-echo on basis of cost, not effectiveness

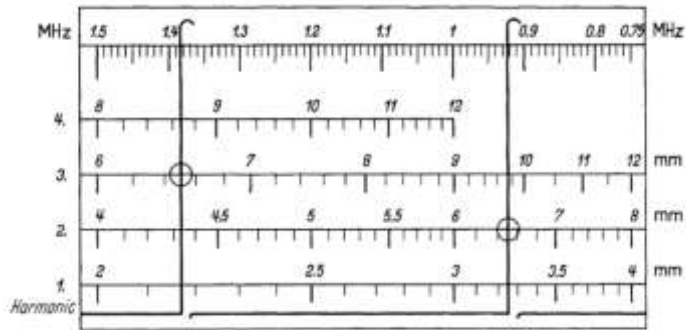
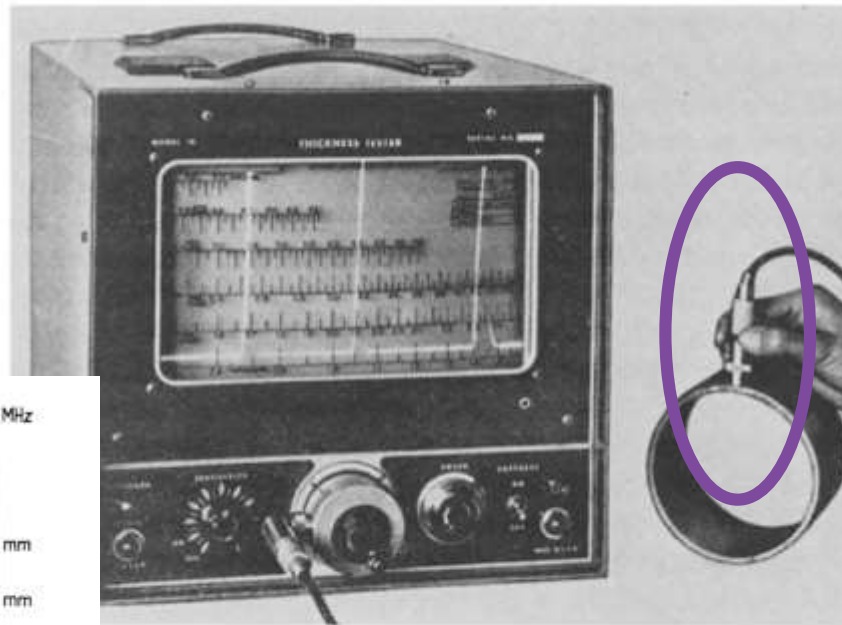


Fig. 11.3 Simplified scale of Vidigage for frequency range 0.75 to 1.5 MHz, with the 1st to 4th harmonic, resonance reading of a thickness of 6.5 mm at the 2nd and 3rd harmonic.



gauge, model 14 (Branson), showing the wall thickness measurement.

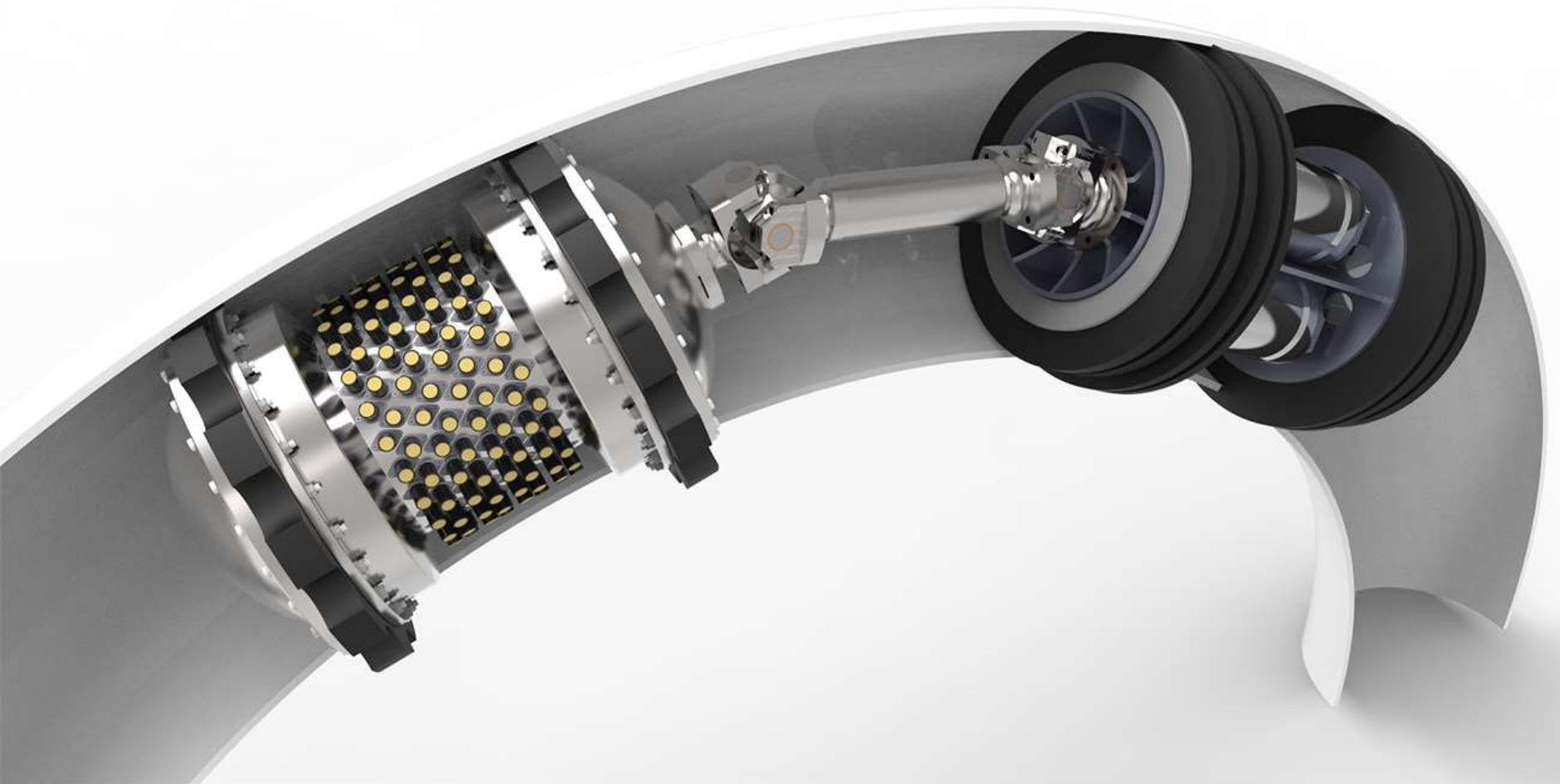
J.Krautkrämer H.Krautkrämer

Ultrasonic

Materials



Berlin Heidelberg New York



ART Scan™

Product Overview

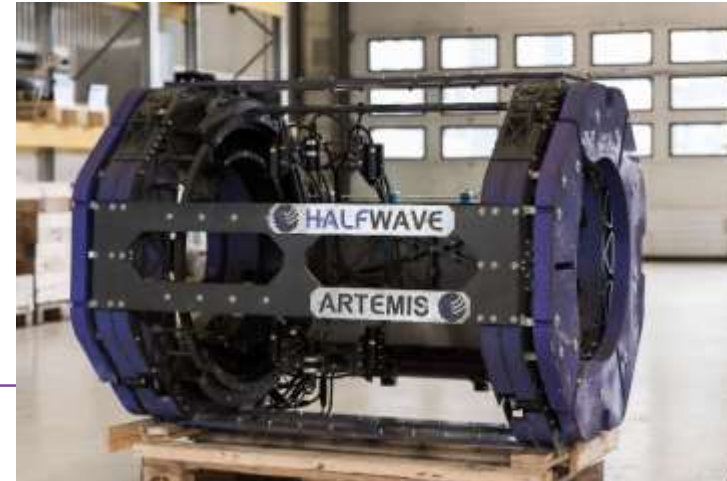
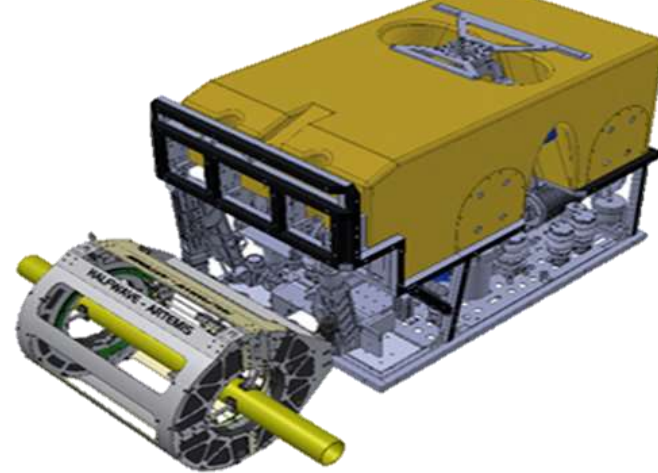
- 16 – 26 inch (128 channel)
- 24 – 30 inch (192 channel)
- 28 – 42 inch (192 channel)
- **36 – 48 inch (512 channel) Q3 2018 NPI**
- **48 – 56 inch (624 channel) Q3 2018 NPI**
- Wall Thickness: more than 100 mm
- Speed range: 0.1 – 5 m/s
- 3 odometers & IMU (gyros & accelerometers)
- Intrinsically safe, pressure and temperature recording, ELF pig tracker
- Reporting done in-house, to POF specs.



ART Scan™

Product Overview

- **Depth rating:** up to 3,000 meters
- **ROV:** Compatible with all types and makes of ROV
- **Weight tooling:** 150 kg / Neutral Bouyancy
- **Spread:** 2 containers (1.2m x 1.5m x 1.5m, 250 kg)
- **Communications:** Fiber through ROV umbilical
- **Pipe diameters:** 6 to 17 inch
- **Data visualization:** Real time
- **Inspection applications:** Rigid and flexible piping
- **Inspection techniques:** TOF & ART
- **Inspection capabilities:** X- 1mm step, Y-1mm step
- **Steel thickness:** 10-100 mm
- **Personnel:** 2 man team for offshore operations
- **USP:** Scans Pipe Through the Coating.



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Differentiation

Key Advantages of Acoustic Resonance

- Direct WT Readings in Gas Lines
- Ability to measure through coating/ wax
- Detection of External Coating Disbondment
- Non-Contact Measurement
 - Dual Diameter Capabilities
 - Bidirectional Capability
 - Low velocity WYE passage
- Higher accuracy : fewer digs vs MFL

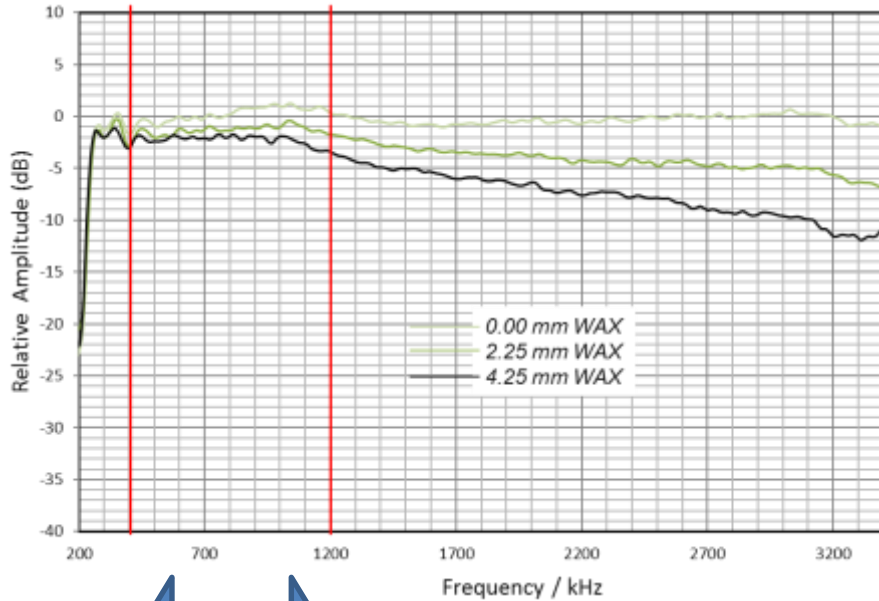




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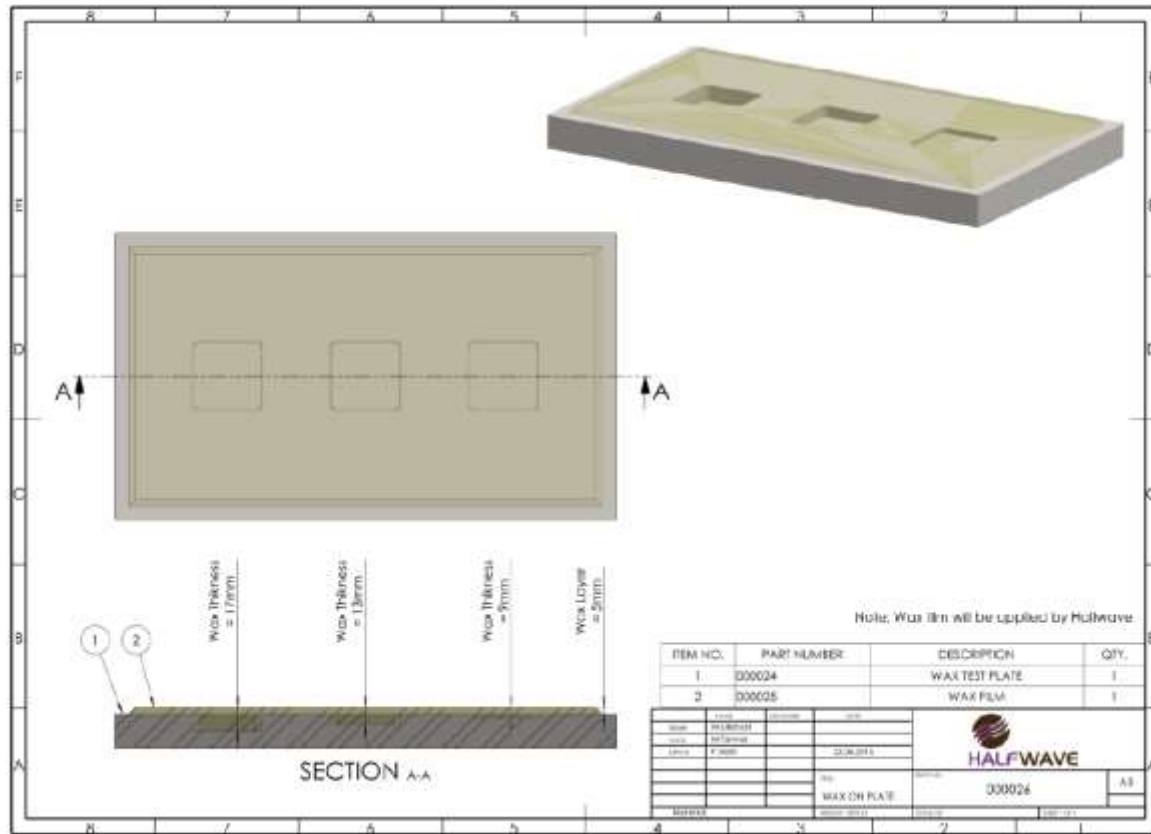
MEASUREMENT THROUGH WAX

Reducing cleaning expenditure



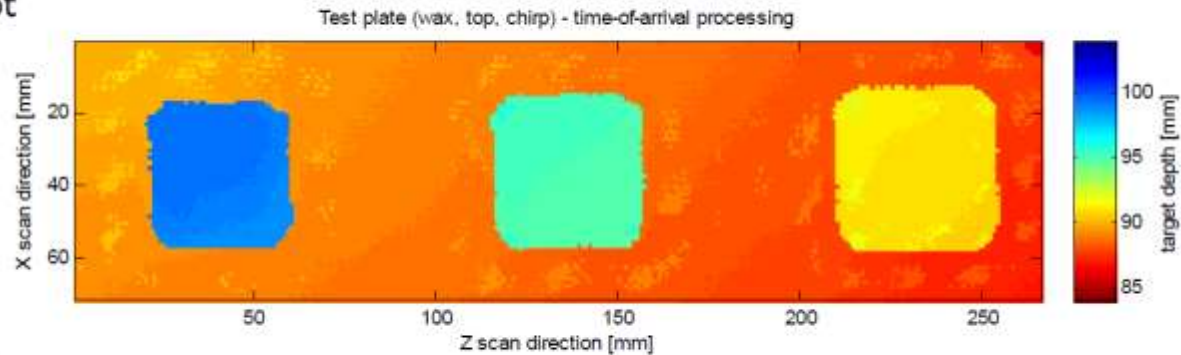
Penetration of Wax Layer

- Chart shows attenuation of sound through wax at different frequencies
- Low attenuation 400kHz to 1,2 Mhz bandwidth (ART Domain)
- ART measures wall thickness through wax
- ART also measures thickness of wax layer
- Traditional ultrasound operates at frequencies of 5 MHz and higher

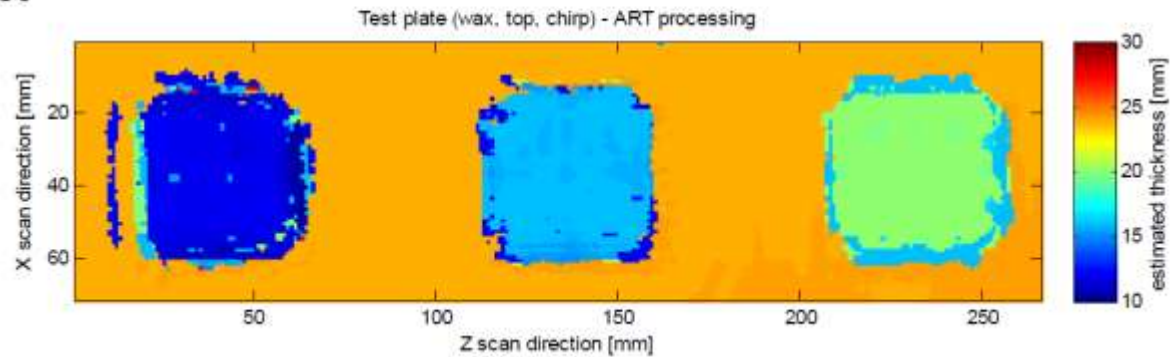


With wax, chirp, top

toa plot



ART plot





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CASE STUDY: 24" CRUDE LINE GULF OF MEXICO

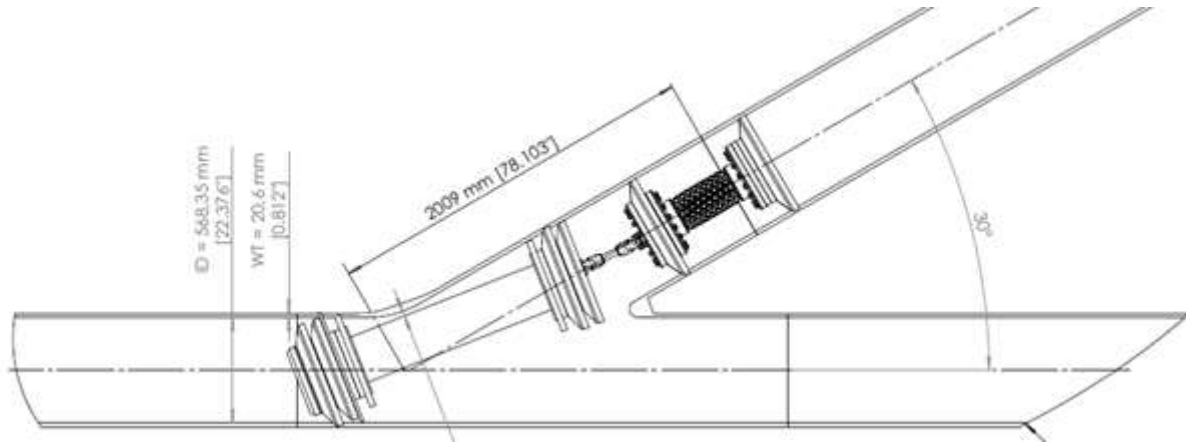
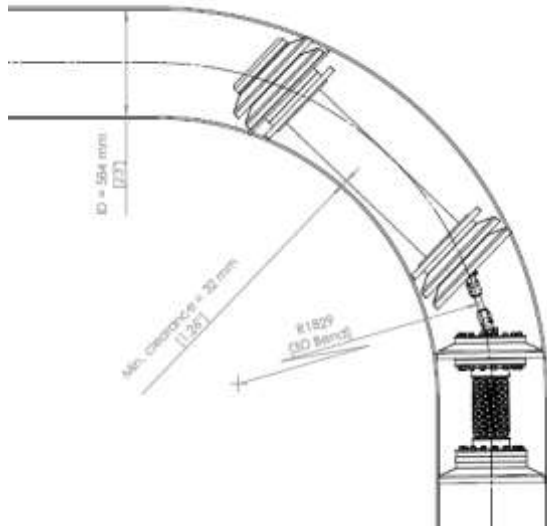
Q3 2016 Operation



24" Crude Line Gulf of Mexico

- 24" x 132,5 km
- Inspection in Crude Oil > 300'000 BPD
- Offshore vertical launch onshore receive
- Challenging Wye Passage (from 3 to 8 ft/s)
- Non Return Valves
- 12.4mm – 27mm wall thickness
- Inspection performed July 2016

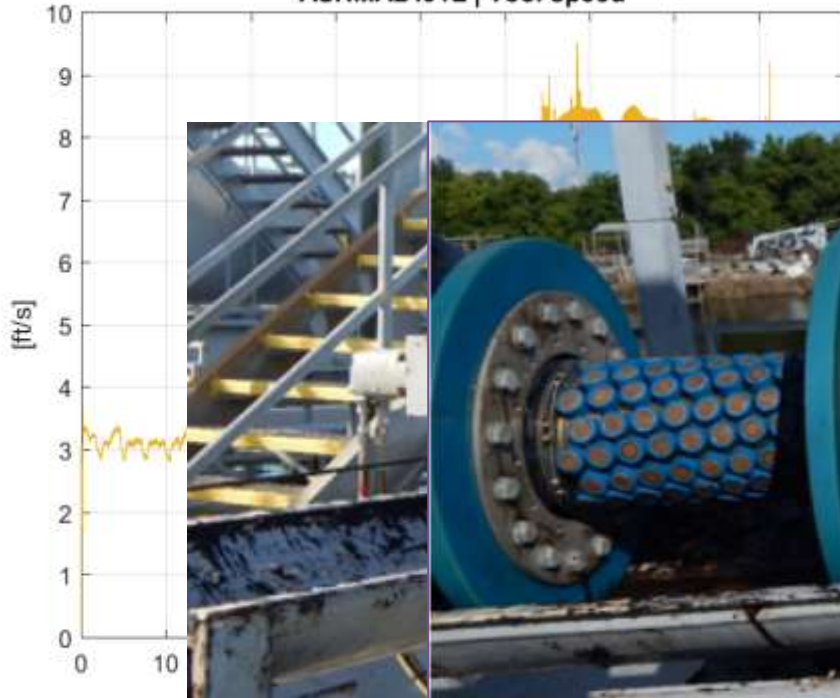
Piggability Evaluation



ART Scan Operations, vertical launch

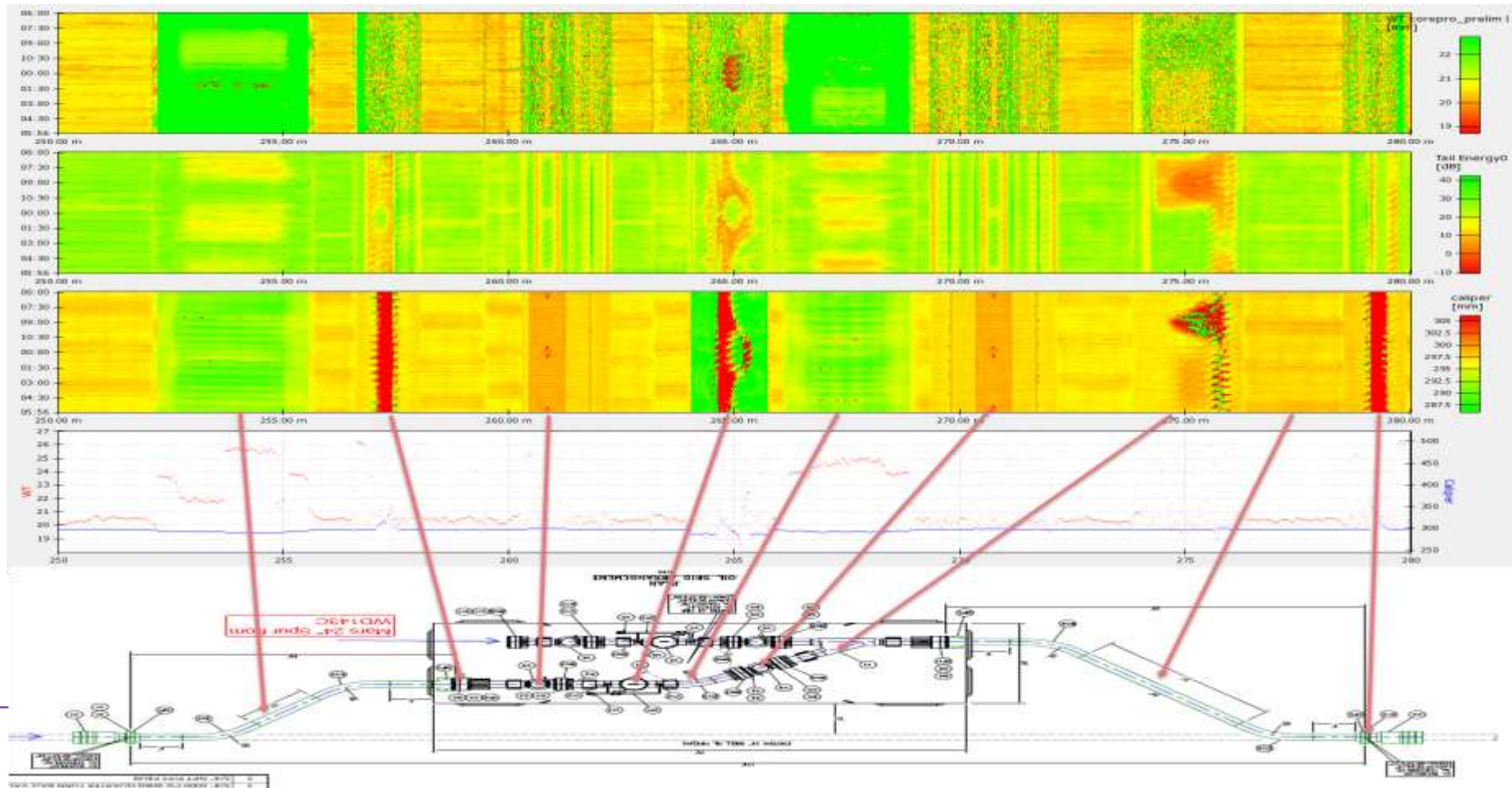


ASHMA2401L | Tool speed



ART Scan Operations, 2 days later







24" Crude Line Gulf of Mexico

- 24" x 132,5 km
- Inspection in Crude Oil > 300'000 BPD
- Offshore vertical launch onshore receive
- Challenging Wye Passage (from 3 to 8 ft/s)
- Non Return Valves
- 12.4mm – 27mm wall thickness
- Inspection performed July 2016

- Field Verification



Excavated Feature (II)

- Corrosion Feature under pipe support detected
- Field Verification
- Nominal WT: 0.985 inch
- 6 o'clock metal loss feature called
- Support removed
- Feature depth verified in field



| | ART Scan | Field verification |
|-------------|---------------|--------------------|
| Nom WT [in] | 24.9 mm | 25.0 mm |
| Depth [in] | 1.4 mm (5.5%) | 1.6 mm (6.2%) |



Verified Feature (II)

- Corrosion Feature under pipe support detected
- Field Verification
- Nominal WT: 0.985 inch
- 6 o'clock metal loss feature called
- Support removed
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| | ART Scan | Field verification |
|-------------|---------------|--------------------|
| Nom WT [in] | 24.9 mm | 25.0 mm |
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CRUDE LINE IN NORTH SEA

Crude Line in North Sea

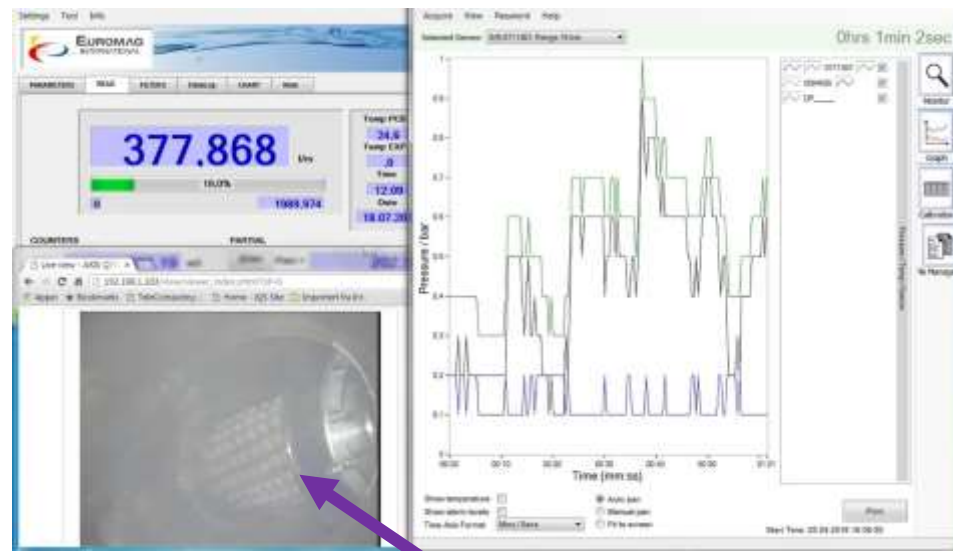
Several challenges

- Low flow speeds
- Wye passage
- Wax deposition
- Plus side: Highly Experienced Operator



Crude Line in North Sea Solutions

- Piggability Study
- Pigging Loop Constructed, Pigging Trials Performed
- Camera Installed
- Over 20 runs performed
- Speeds down to 0.04 m/s

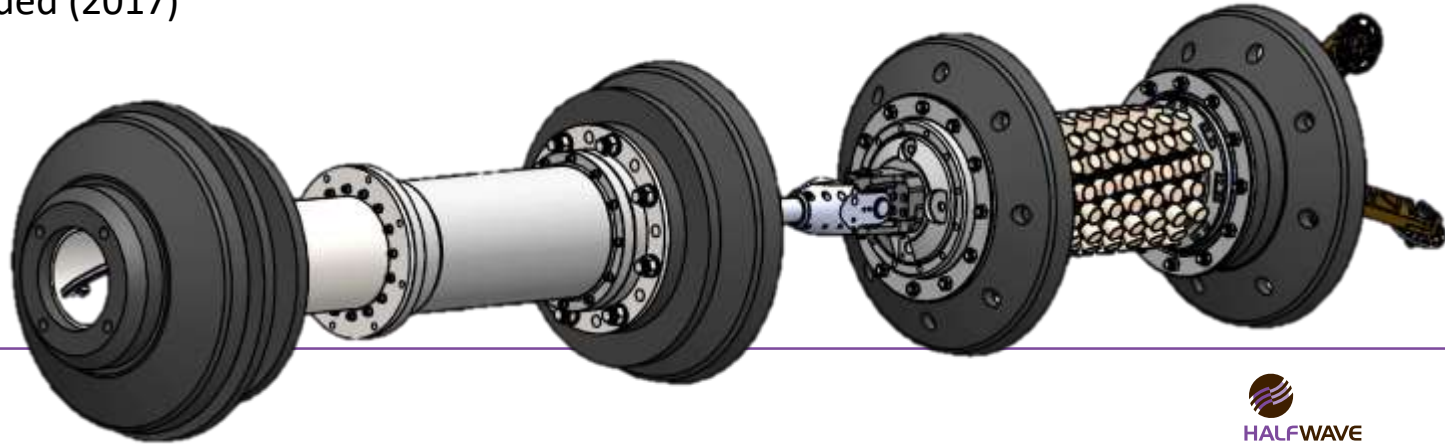


Crude Line in North Sea

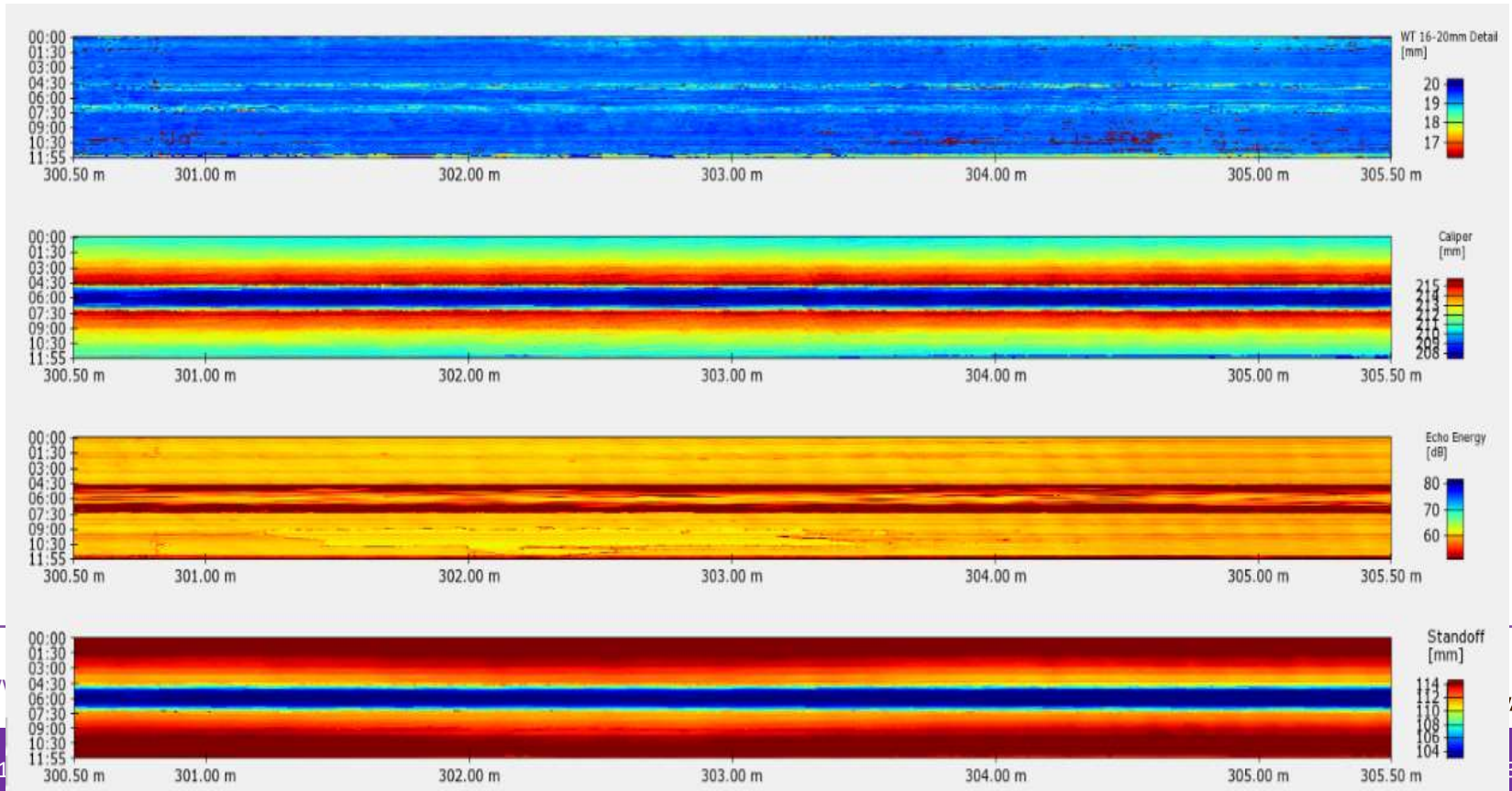
Solutions

- Piggability Study
- Pigging Loop Constructed, Pigging Trials Performed
- Tool Mobilized
- Field Work Completed
- Final Report Issued (2017)

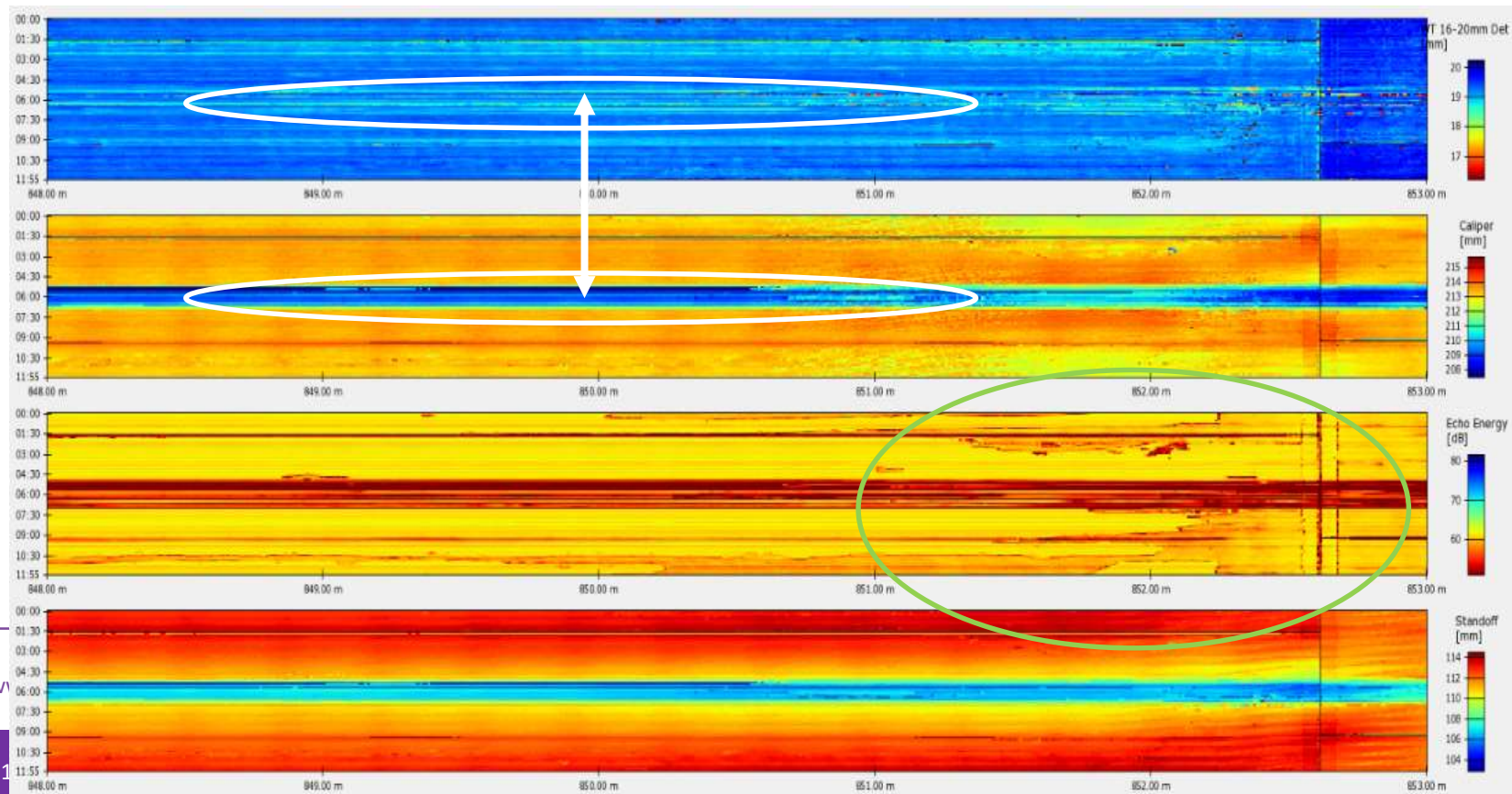
- Samples from report



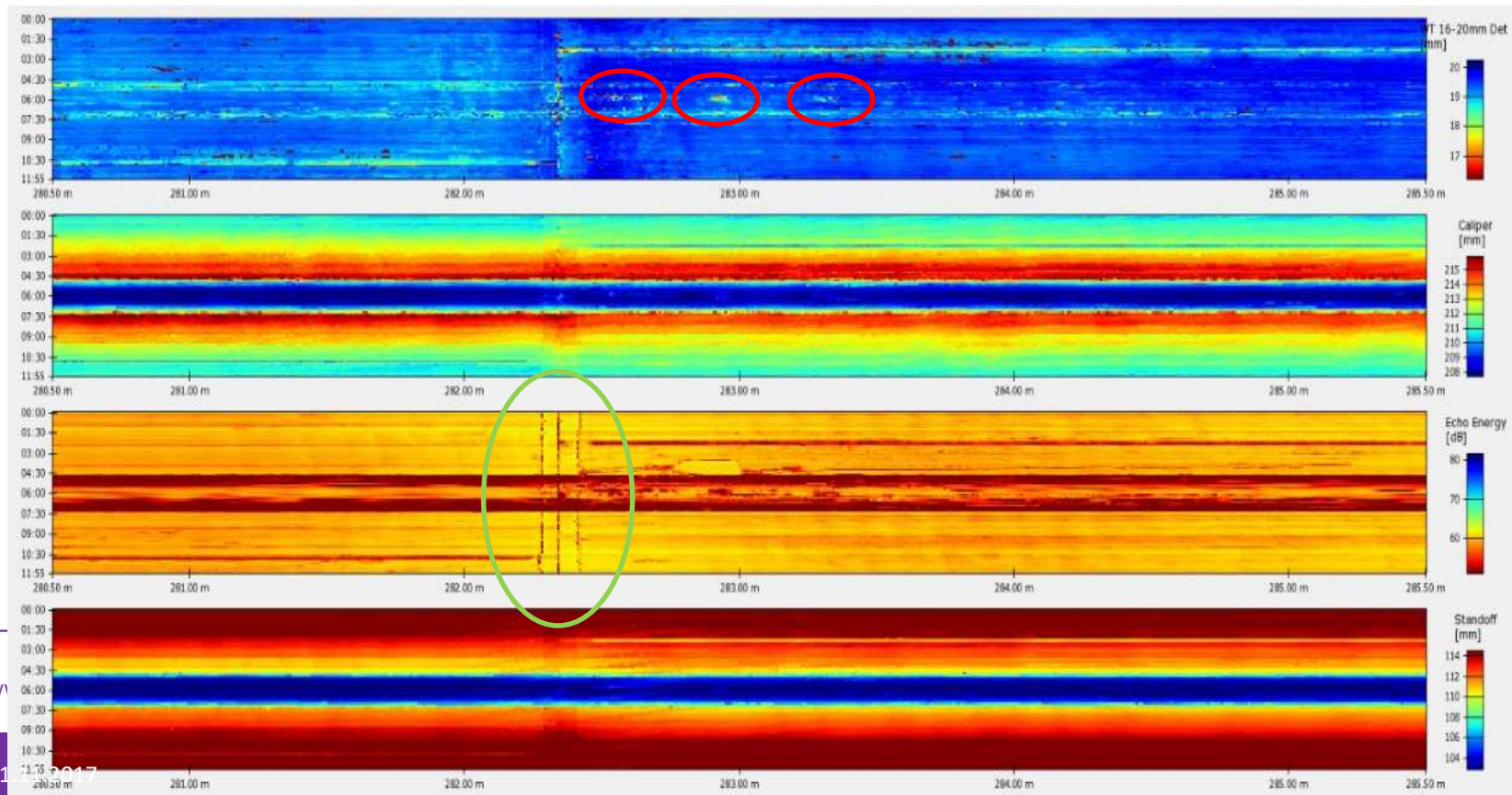
Crude Line in North Sea



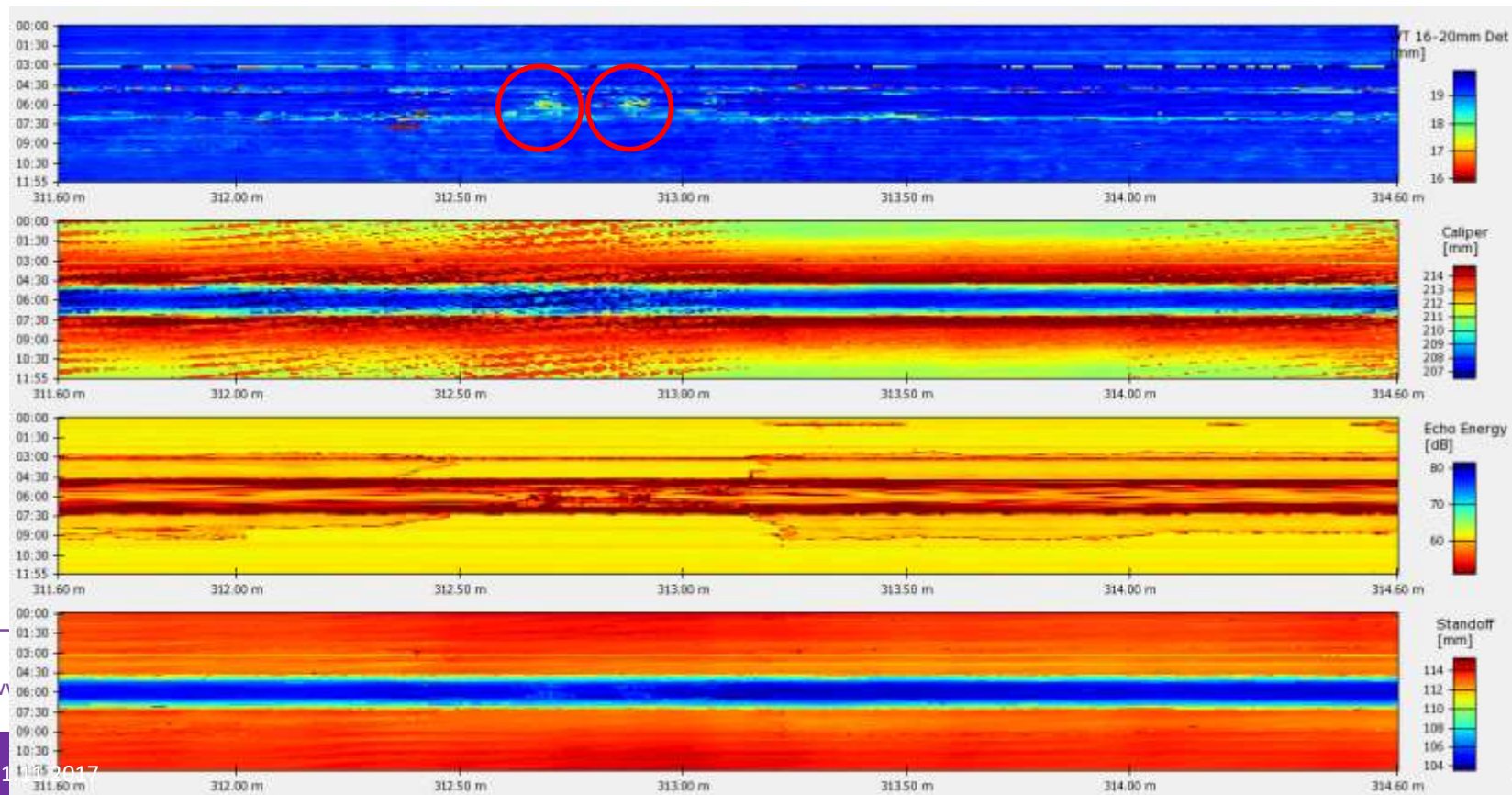
Crude Line in North Sea



Crude Line in North Sea



Crude Line in North Sea



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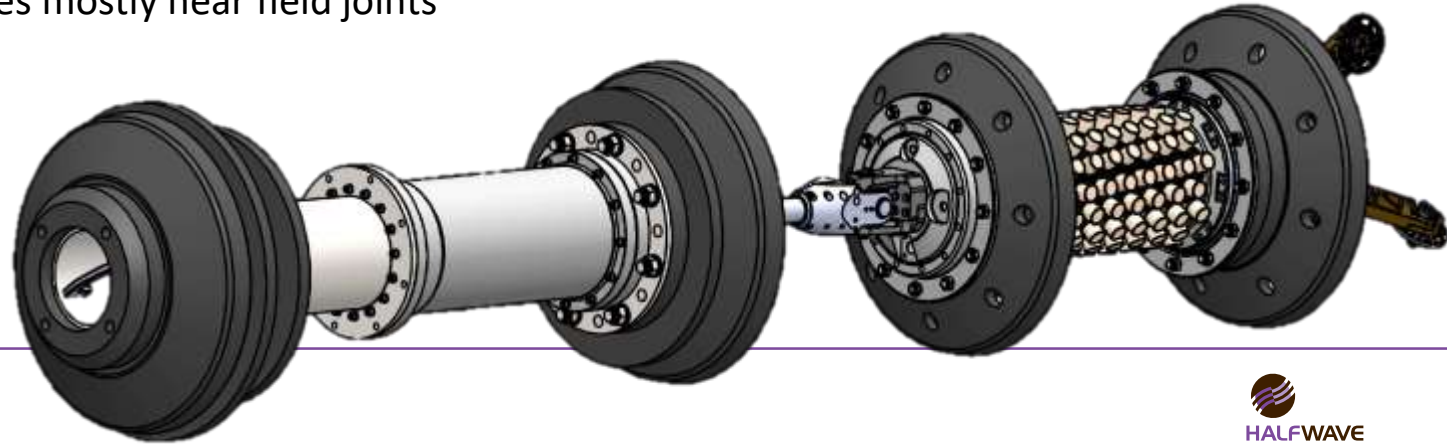
AVE

B3

Crude Line in North Sea

Inspection Results

- Wax detected ~250 m into the line, mostly near 6 o'clock
- Typically about 200 mm wide, narrows to the end of the line
- Several metal loss features found, even under wax
- Internal Features mostly near bottom
- External Features mostly near field joints

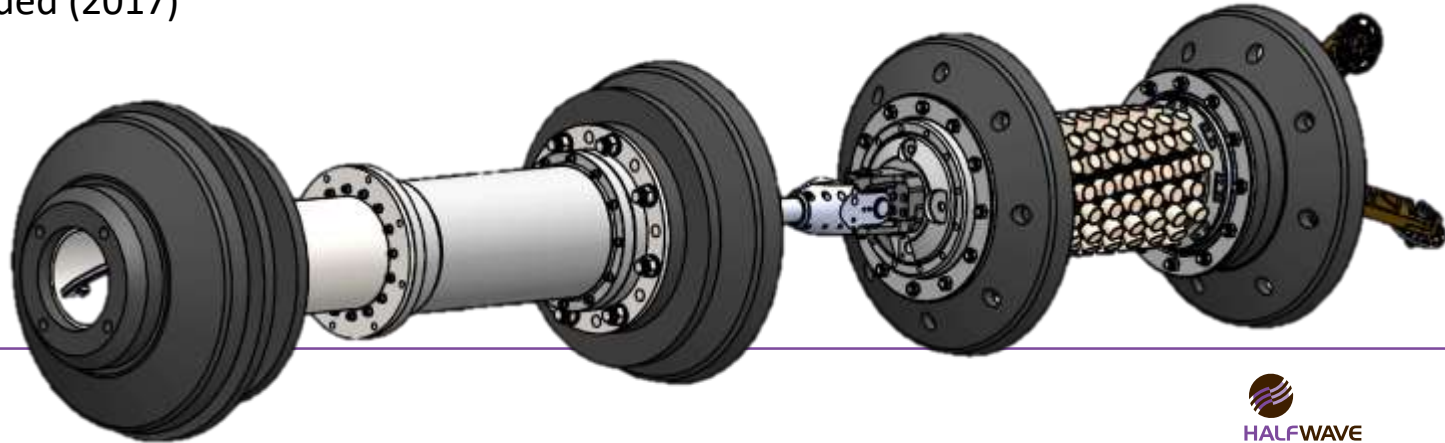


Crude Line in North Sea

Solutions

- Piggability Study
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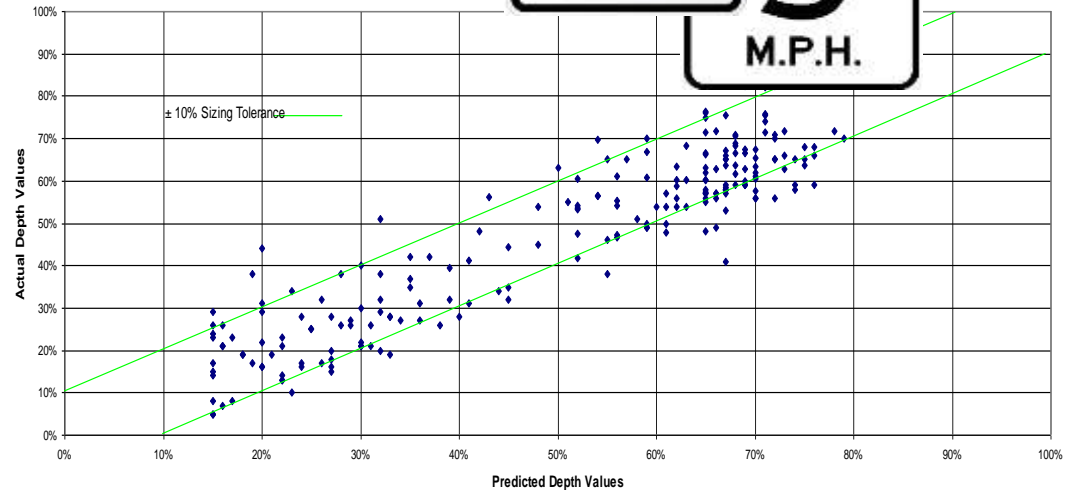
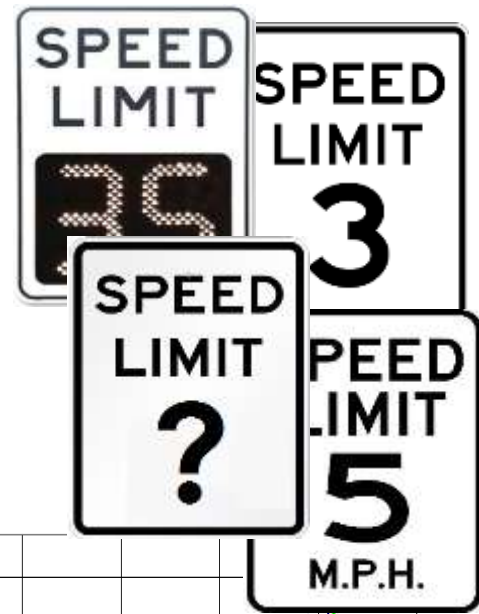
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CONCLUSIONS

Use of Wide Band Ultrasound for In Line Inspection

Conclusion

Use of ART for In Line Inspections





Thank you for your time

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