Semi-automated Corrosion Scanner for Pipe Elbow Inspection

Breakthrough in Elbow and Pipe Scanning

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Corrosion Mapping in Pipes (ID)

What about This?

Greatest corrosion potential – Least ability to map and analyse

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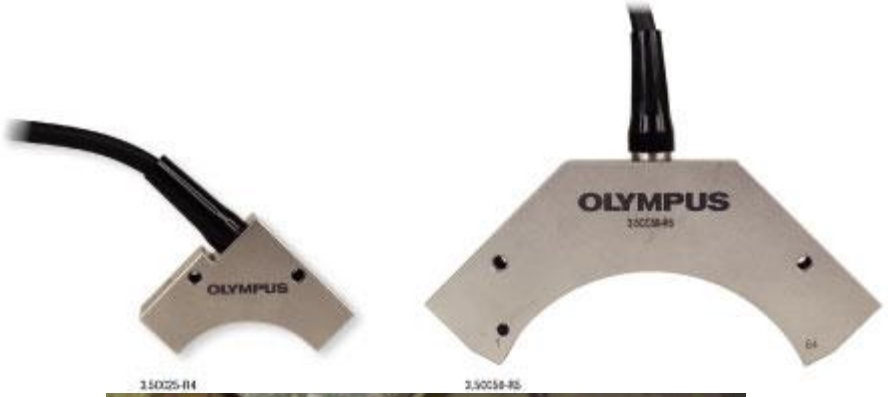
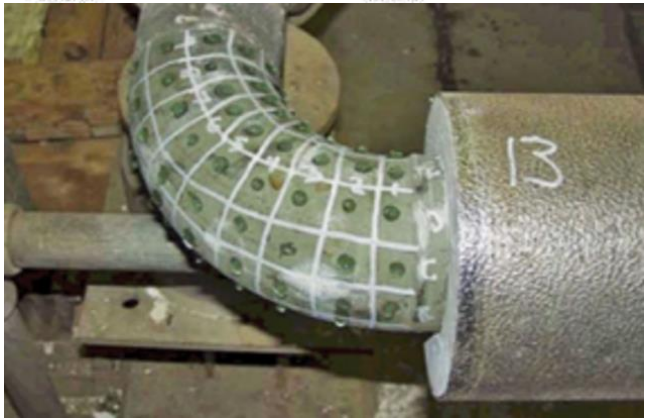
Today we cover

1. Current technologies for pipe bends
2. Phased Array Ultrasonics – how it works
3. Phased Array for Corrosion
4. Developing a solution for Elbows
5. Elbow scanning in action
6. Spin off solutions
7. Conclusion

Common Techniques for Elbow Corrosion

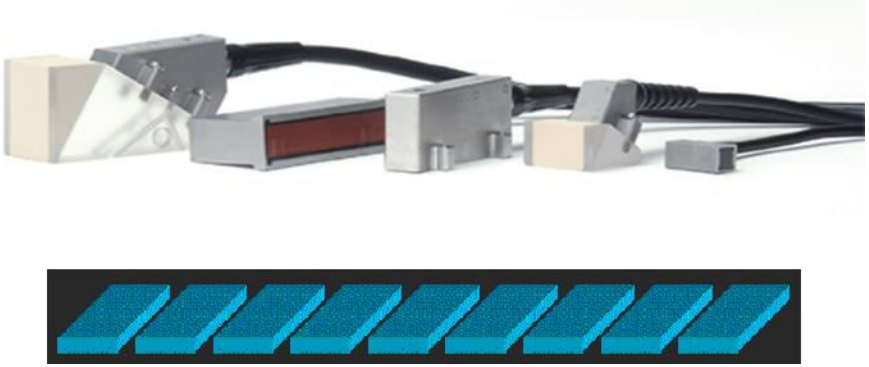
- Ultrasonic Spot Measurement
- Curved Phased Array
- Radiography
- Eddy Current
- Long Range UT





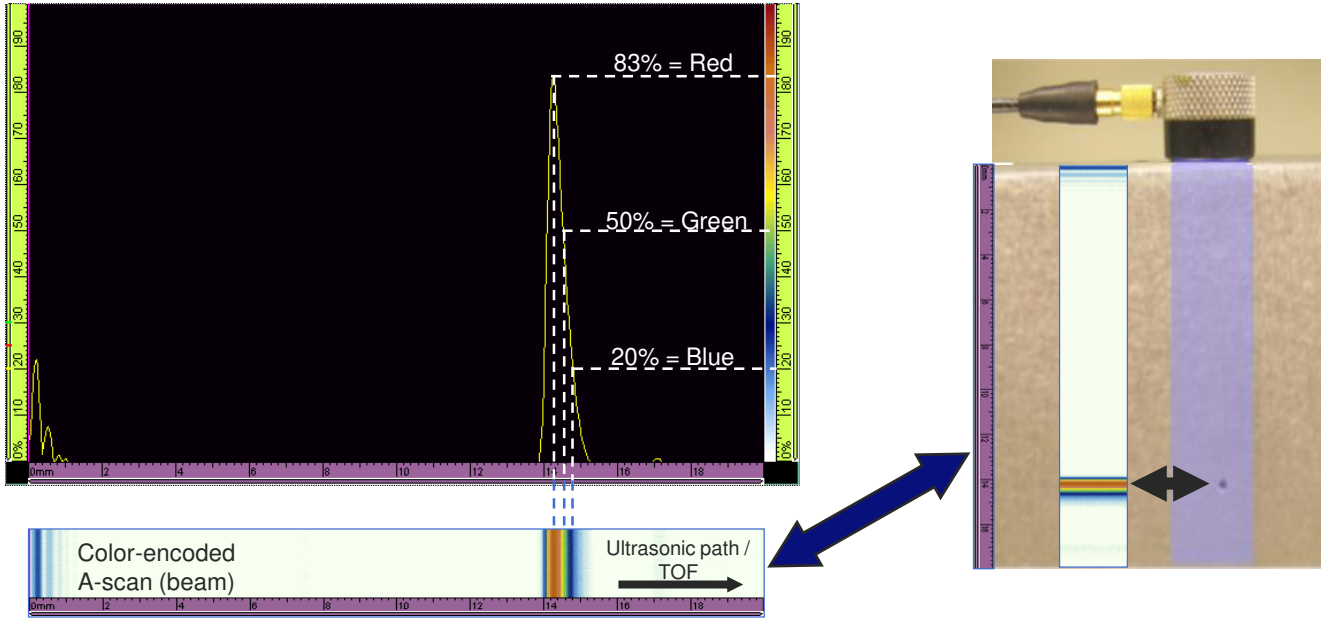
PHASED ARRAY ULTRASONICS - INTRODUCTION

- Array of Elements
- Array is most commonly linear
- Element grouping provides aperture, power, direction
- Programmed electronics sequence send and receive for each element
  - Each selection produces an A scan
- Distinct modes of operation:
  - Linear or electronic scanning
  - Sector or angle beam scanning

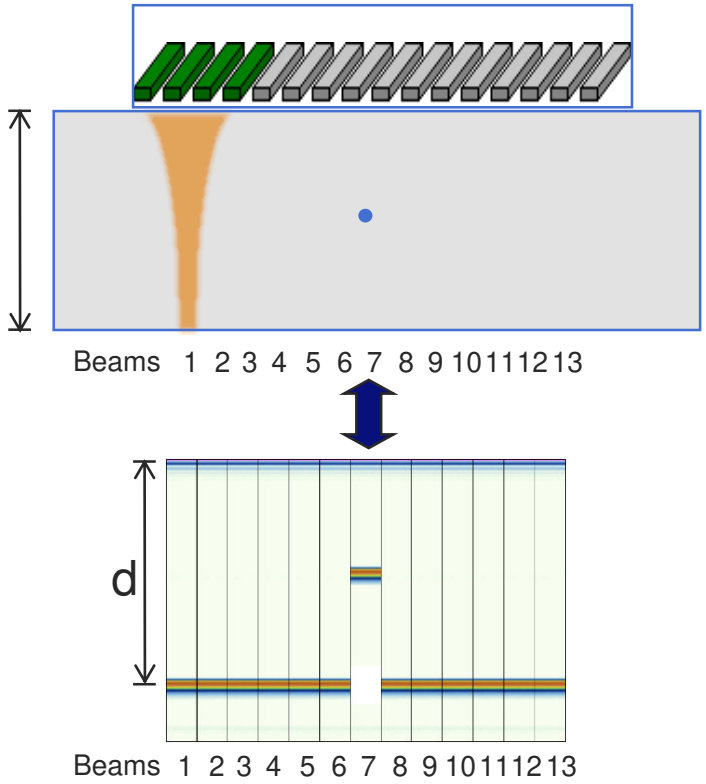


Representing the A Scan

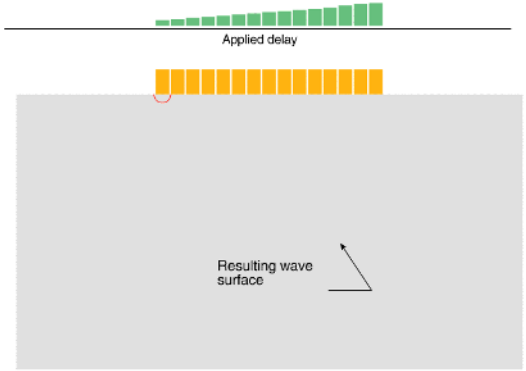
- Each beam has an A scan
- Each A scan is digitized, stored and is the base data of each image

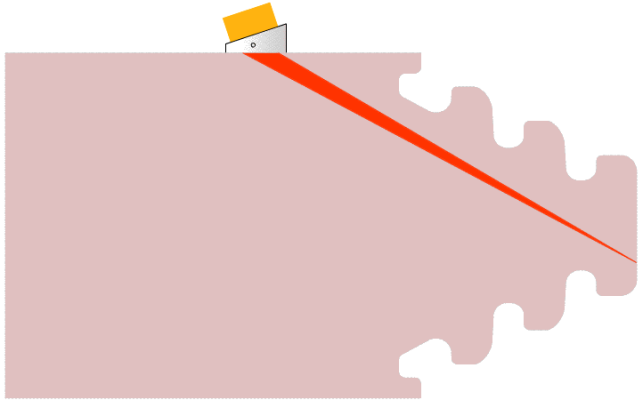


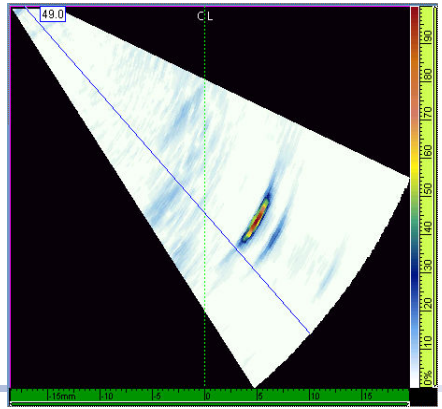
Linear Scan



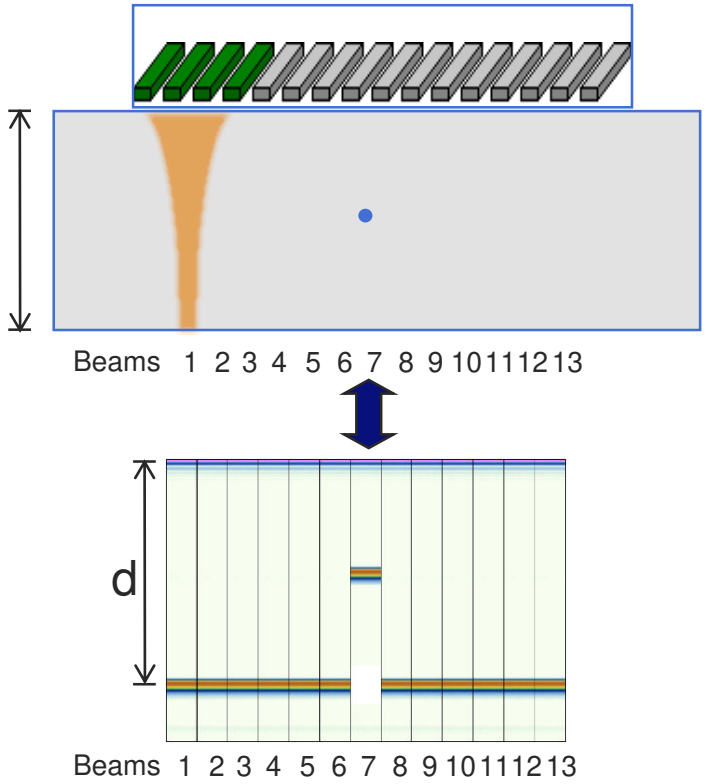
Sectoral Scanning





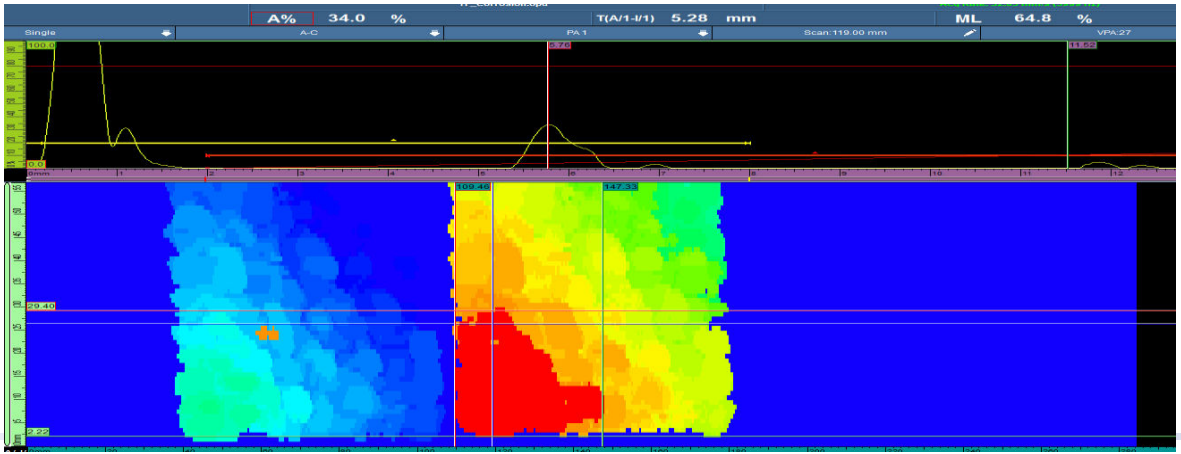


Linear Scan



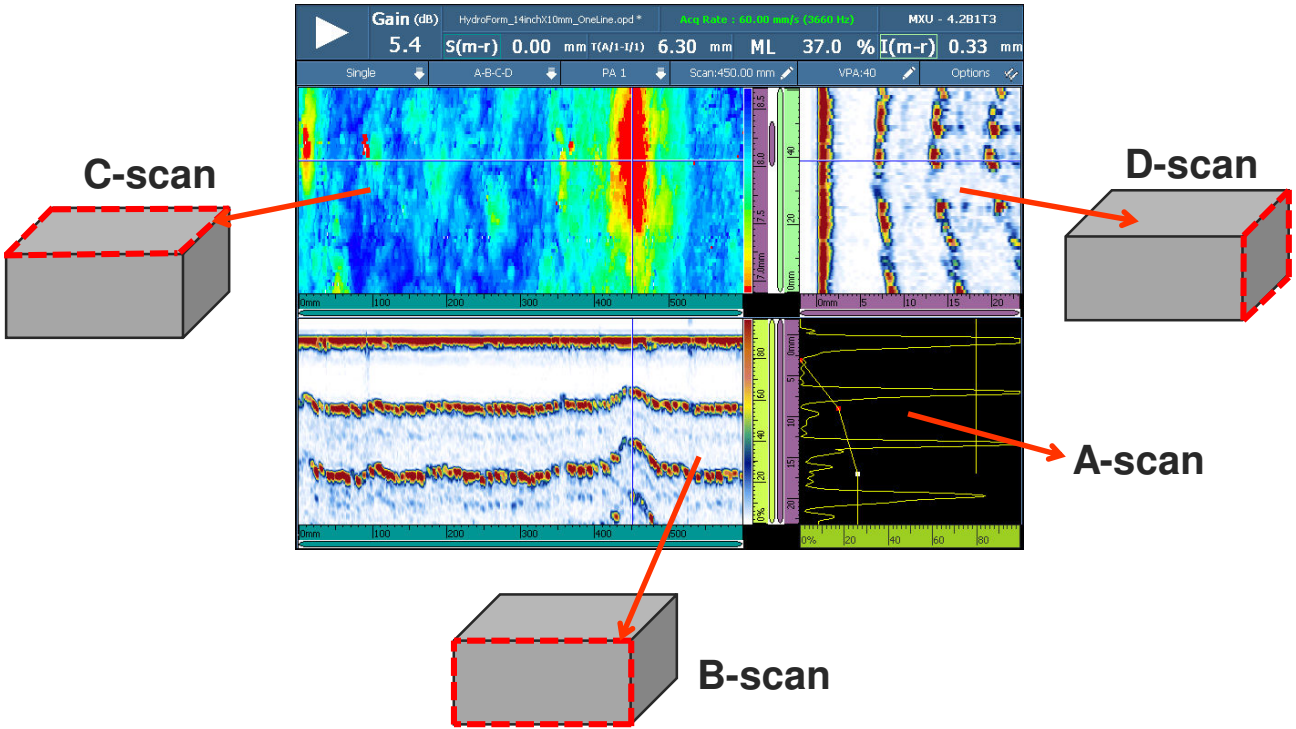
Encoded Scans

- Capture linear probe scan at regular intervals (often 1 mm)
- Colour code thickness (most common) on plan view
- C scan dimensionally correct imaging, length and width sizing
- Allows off line analysis

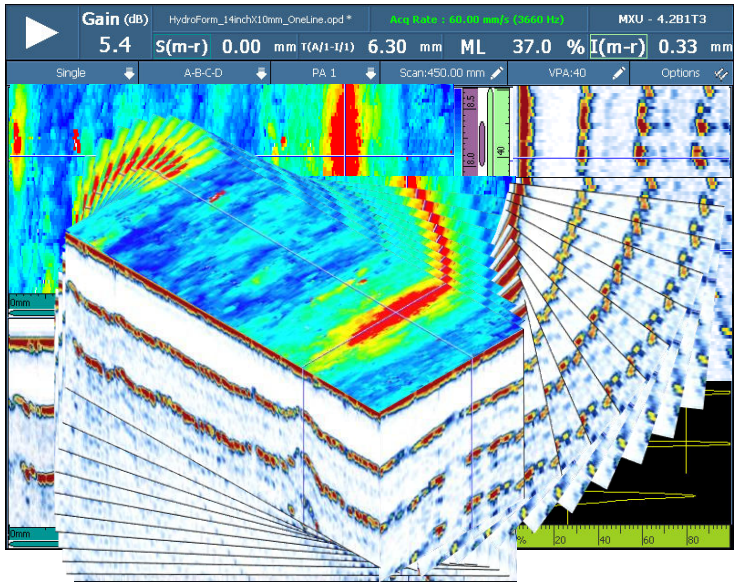


Thickness Data Views

- Corrosion :



Thickness Data Views



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Probe Considerations

- Probe typical 7.5MHz, 1 mm spacing, 64 elements (=up to 64 mm scan width)
- Protection of probe face: “wedge” – usually rexolite, water box or roller
- Coupling to surface: water box adapts best to surface conditions (eg HydroFORM)

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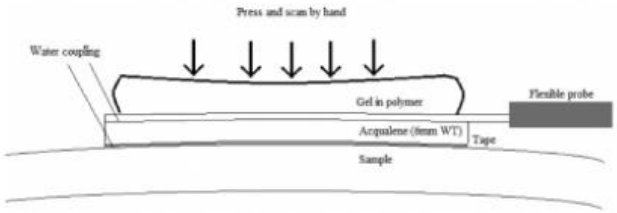
The Problem with Elbows

- Flat probe, curved surface

Solution Key #1:
Flexible Phased Array Probes !

- Development of Array of Elements on flexible circuit
- 7.5MHz, 64 element , 1mm spacing - typical for corrosion probe
- Ability to create a variable radius
- How to deploy?



Solution Key #2:
3D Printed Probe Holder

- Guide for flexible probe
- Guide is same radius as pipe OD
- Water path (like HydroFORM)
- Connection to scan management equipment
- **Easy low cost adaption for each pipe diameter**

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Solution Key #3
Elbow Scanner

- Convenient holder for probe and 3D Wedge
- Encoding of position
- Manage cables and irrigation
- Cambered magnetic wheels
  - Help tracking and pressure on water seal
- Scanning scheme
- Smart indexing system

Scanner Components

Adaptative scanner

Water wedge

Flexible phased array probe

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FlexoFORM Solution

- Fast, easy and complete coverage
- Covers 100% of the elbow surface
- High quality data
  - Increased POD
    - High-resolution data
  - Easy data interpretation
    - Phased array imaging with full C-Scan capability
- Versatile cost effective solution
  - Wide range of diameters
  - Compatible with elbow and pipes

Inspection

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Fast, Easy and Complete Coverage

Wide range of diameters

- 4.5in OD and up with the same probe and scanner
- Cost effective

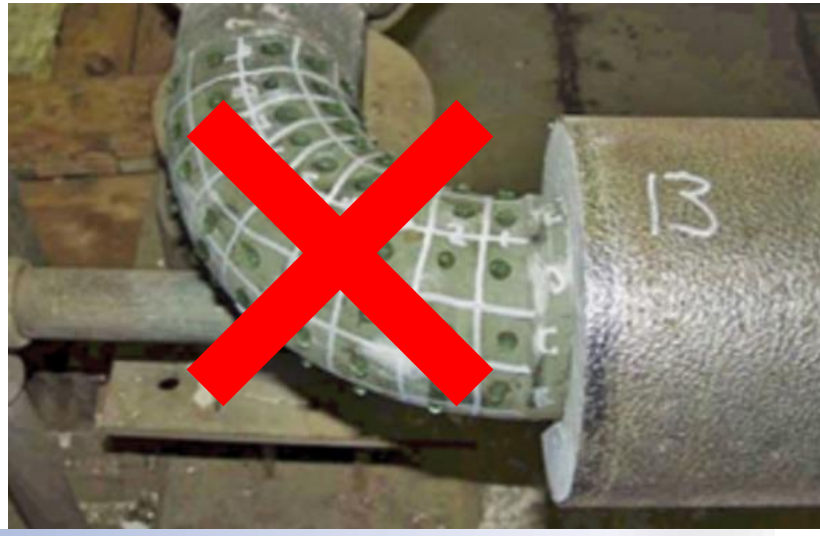
Covers 100% of the elbow surface

- Can fit intrados (concave) as well as extrados (convex)

Fast, Easy and Complete Coverage

Reduced prep and inspection time

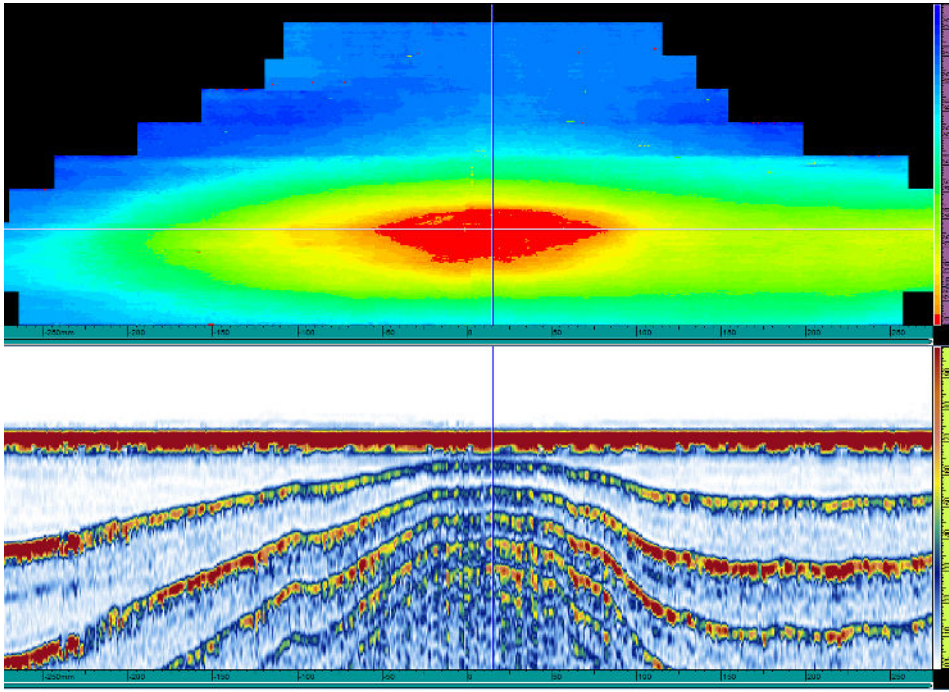
- No need for drawing grids
- Large beam width beam width ensure fast inspection



High Quality Data

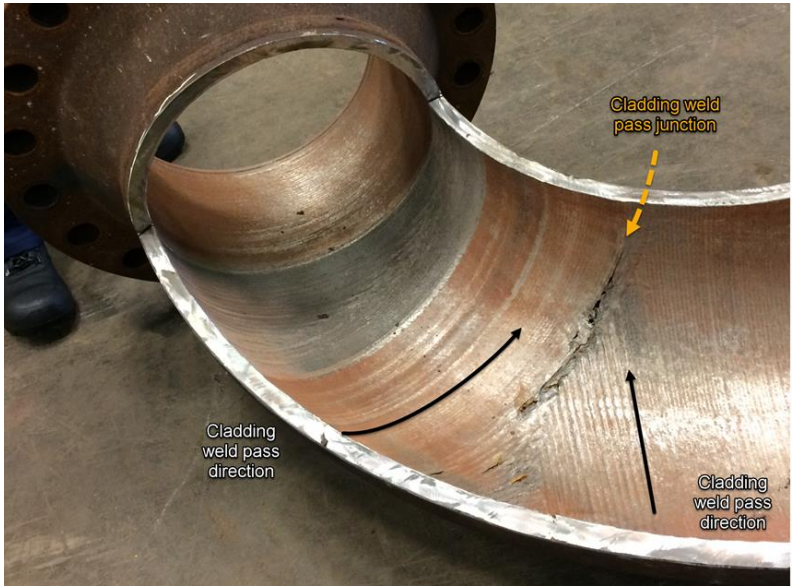
Increased probability of detection (POD)

- Up to 1 × 1 mm scan resolution data points
- Acquired and saved within the same file
- Smart indexer clicker button pauses the acquisition while the scanner is moved to the next scan line, preventing overwriting data



- Example: Flow-Accelerated Corrosion

Internal CRA Cladding

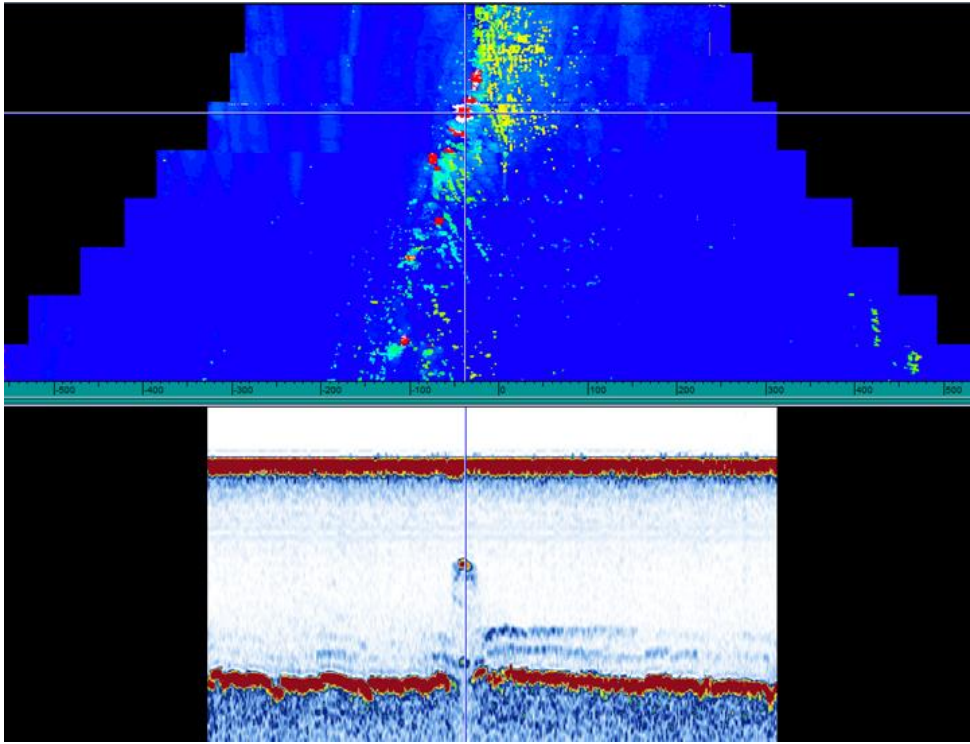


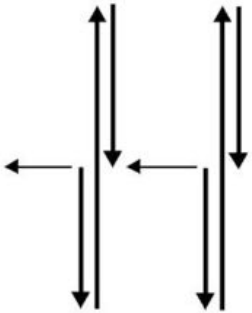
High Quality Data

Easy data interpretation

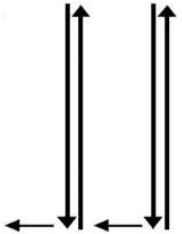
- Phased array imaging with full C-Scan capability
- Help understand damage mechanism
- Essential tool for plant asset operation life evaluation

- Example: Corrosion in Ni clad piping

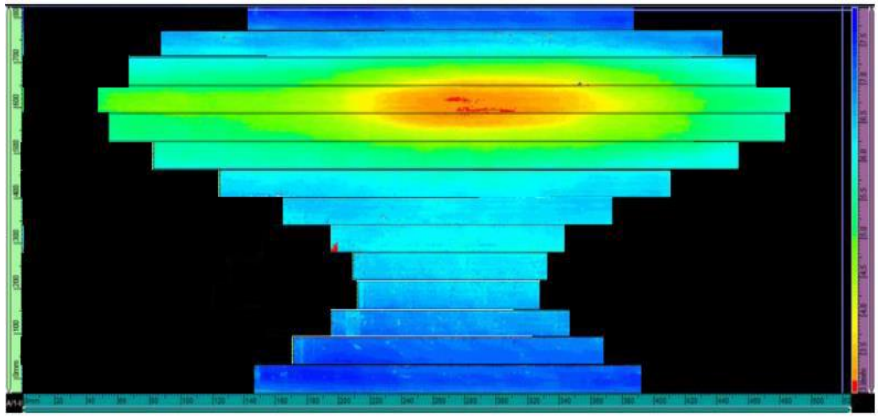


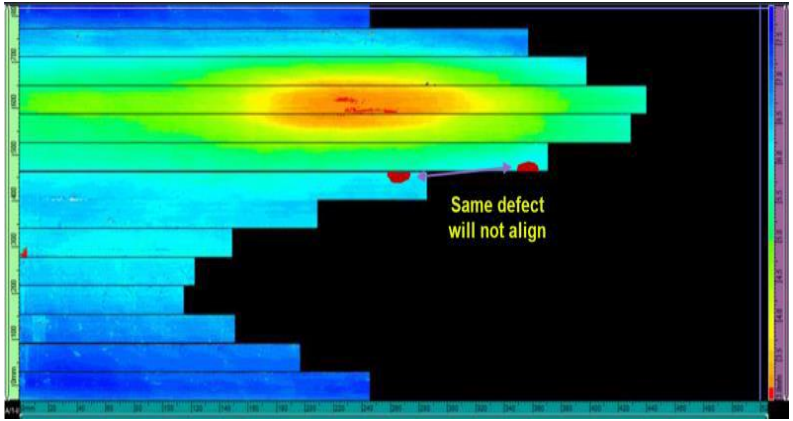


Symmetrical Scan Pattern



Standard Scan Pattern





Bonus: Longitudinal Pipe Scanning

- Slide along pipe vs circumferentially
- Corrosion detection at top or bottom
- Large area coverage - fast

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Small Diameter Pipes

- Pipes too small for scanner solution
- Manually scan
  - Same flexible probe
  - water wedge
  - Miniwheel encoder
- Diameter Range: 1.3” (33mm)’ to 4.5” (110 mm
- Extrados only

- Boiler tube thickness scanning

Automated Scanning

- Wedges designed for map scanners (MapROVER, SteerROVER)
- Same probe
- Diameter 8.625” (220mm) to flat
- Alternative to HydroFORM
  (long scan vs circ scan)

FAQ

- Through Paint Coatings: Yes, can also use echo-echo for thicker paint
- Pipes with contents: Yes
- Flat: Yes
- High temp: Up to 100 deg C
- Welds: Not recommended – can deal with very low or flat caps ok
- Non ferromagnetic materials: Yes but more difficult to manage
- Sizing Accuracy: May require correction factors for precision – particularly small diameters, thick walls. Generally not that critical.

CONCLUSION

- An economical solution for elbow scanning is now available
- The scan results are displayed and managed just like normal corrosion scans
- Flexible probes and 3D printing form a powerful union
- Longitudinal pipe scanning is a useful by-product of this development
- Possibilities are only just starting to be explored

THANK YOU

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