INSPECTION INTELLIGENCE NDT GLOBAL

ULTRASONIC GEOMETRY PROVEN ACCURACY FOR RELIABLE ASSESSMENT

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TYPICAL GEOMETRY DEFECTS

TECHNOLOGIES EXPLORED

Caliper based Inspection

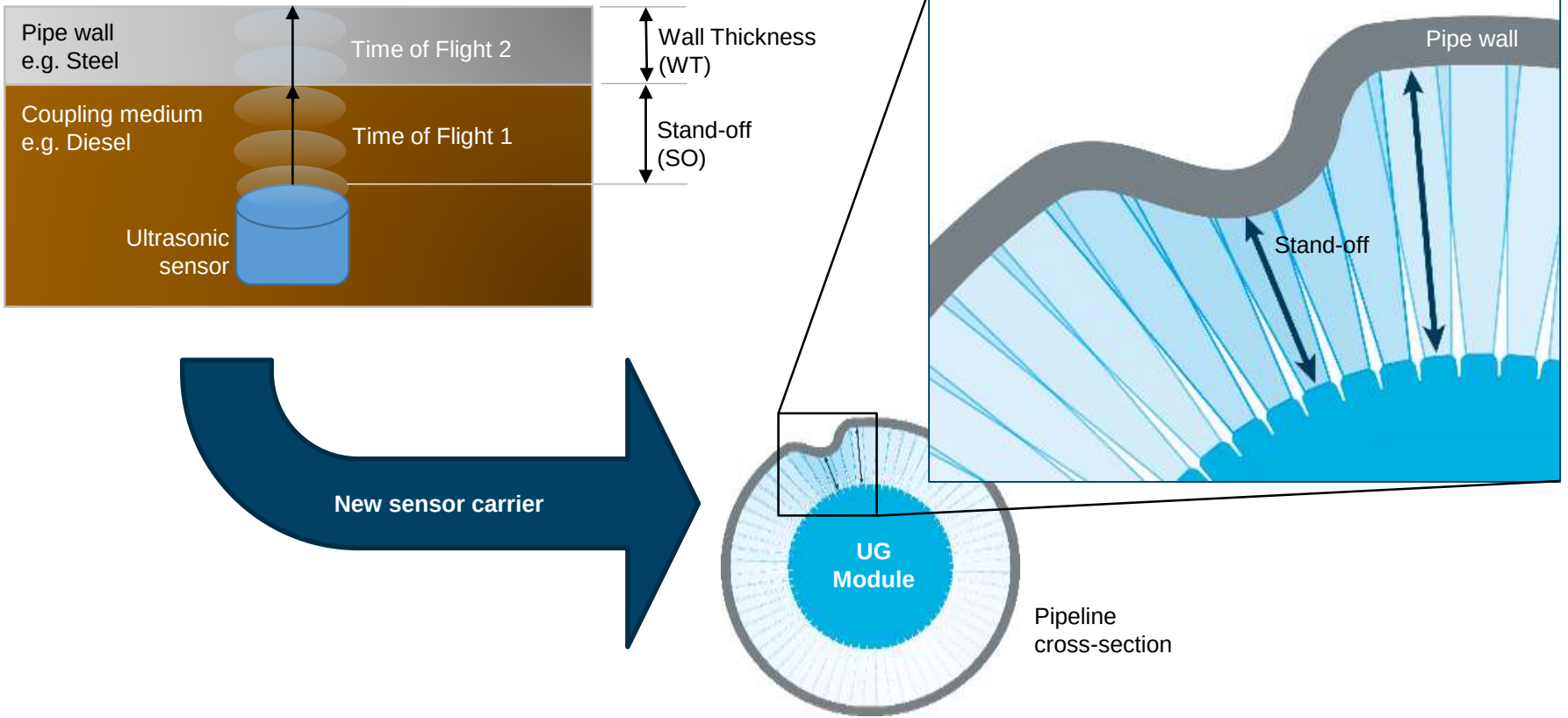
- mechanical sensing

source: internet ROSEN / ENDURO

Ultrasonic Geometry Inspection

- ultrasonic sensing

THEORY OF APPLICATION



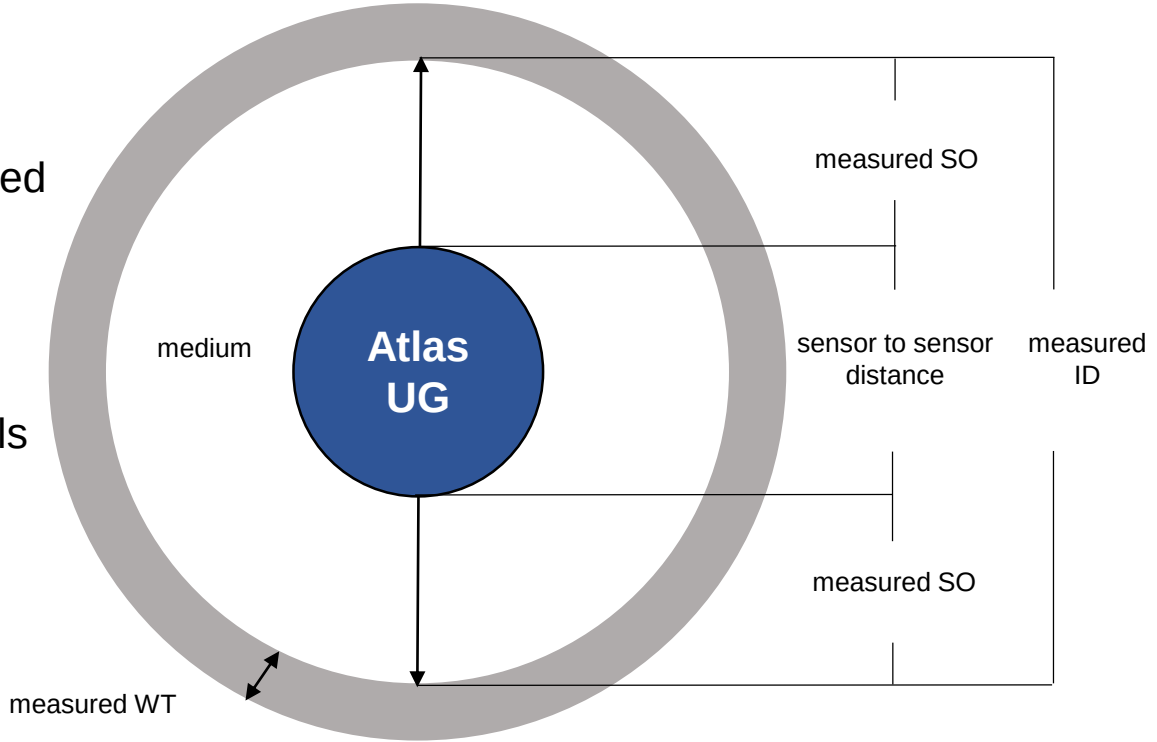
ADVANTAGES

Direct measurement

- Measure ID
- Nominal OD or WT not required
- WT sampling
- Welded fixtures visible

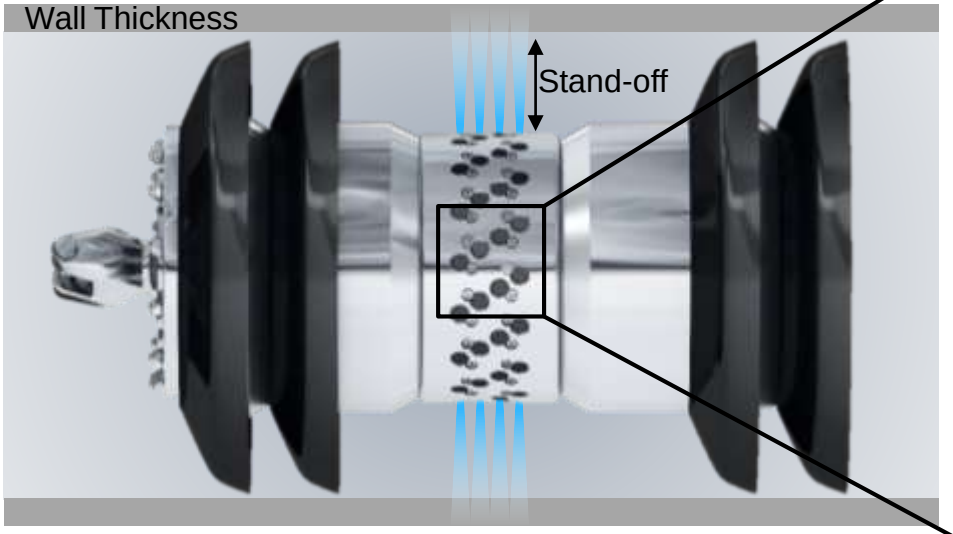
No sensor calibration

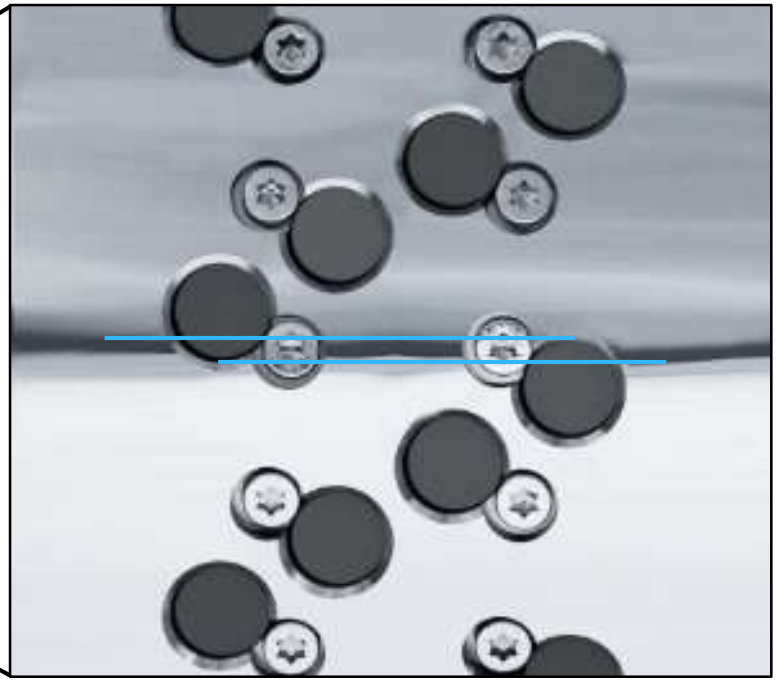
- Same baseline for all channels
- Real full circumference scan



ATLAS UG SETUP

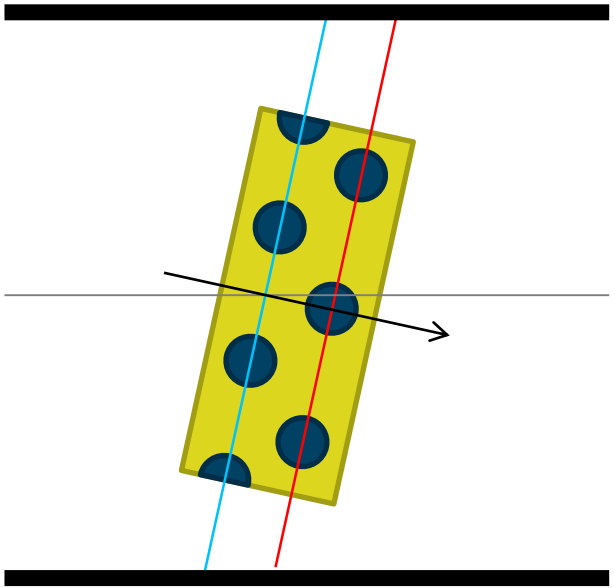
- Multiple sensor ring module arrangement
- Stainless steel body with embedded sensors





- Sensor overlap (coverage redundancy)
- Circumferential resolution down to 8 mm

ATLAS UG 3D



3D tool position and orientation

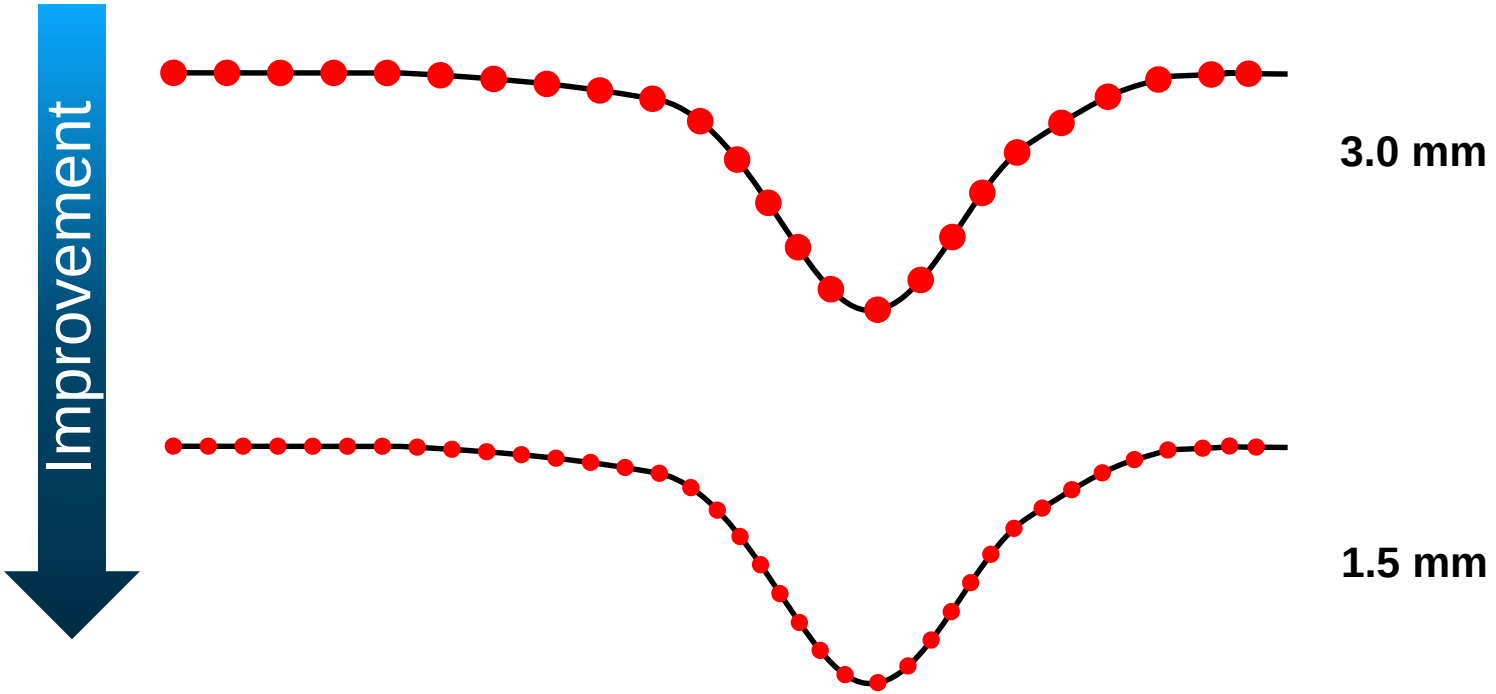
- get the data for every single ring
- calculate
  - center position
  - orientation
  - tilt angle
- apply coordinate transformation to data

➢ ability to handle

- ✓ tilt
- ✓ decentralization
- ✓ vibration

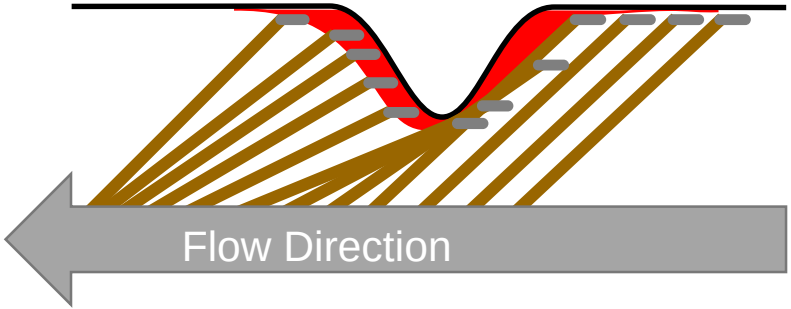
ATLAS UG CAPABILITY

Axial resolution down to 1.5 mm.

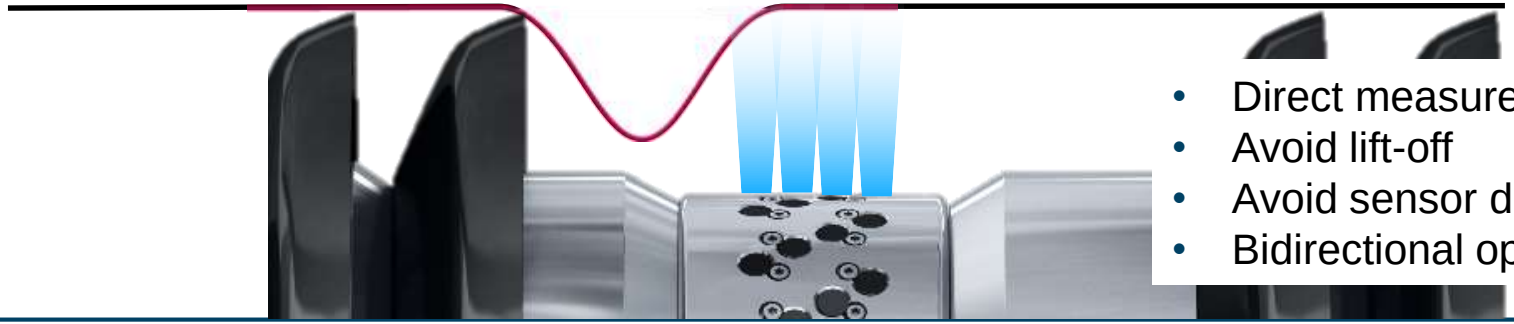


ADVANTAGES – NON CONTACT

- Lift-off due to speed (higher depth)
- Incorrect shape due to deflection of arms



Accurate shape acquisition

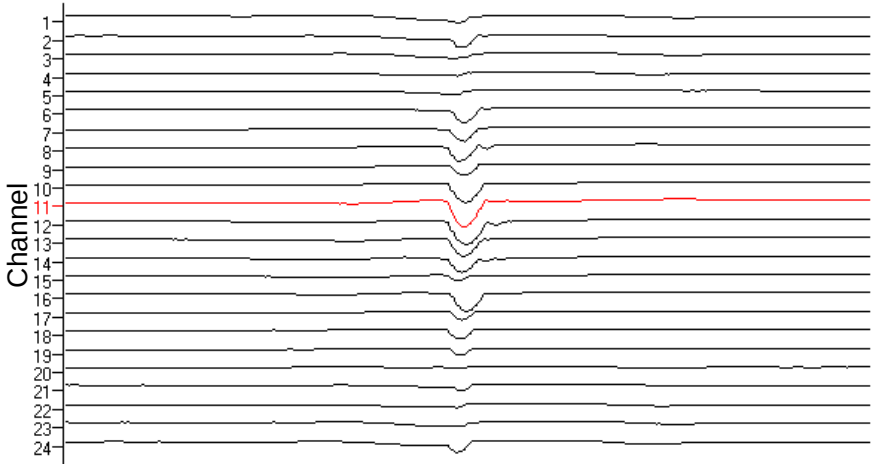


- Direct measurement
- Avoid lift-off
- Avoid sensor damage
- Bidirectional option

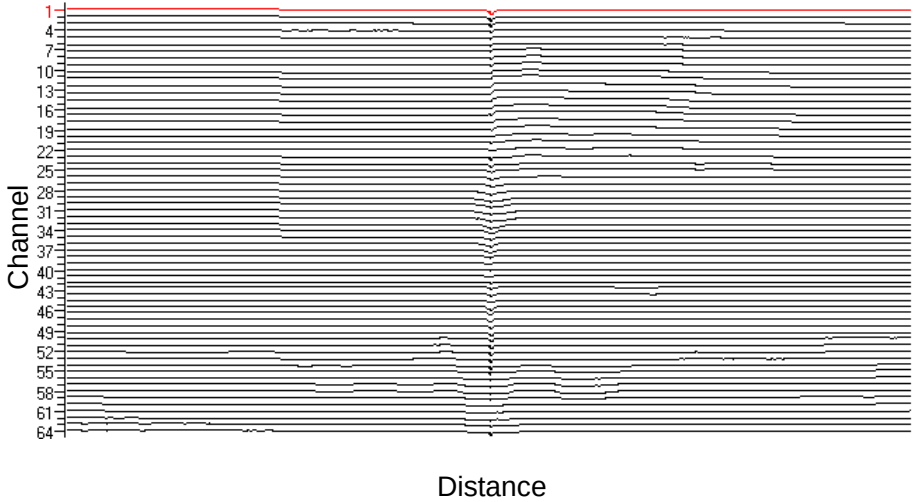
OVER SPEED EFFECT

- Mechanical Caliper rebound effect on girth welds: lift-off effect could be miss interpreted as excessing root penetration.

Mechanical Caliper speed: 2.5 m/s



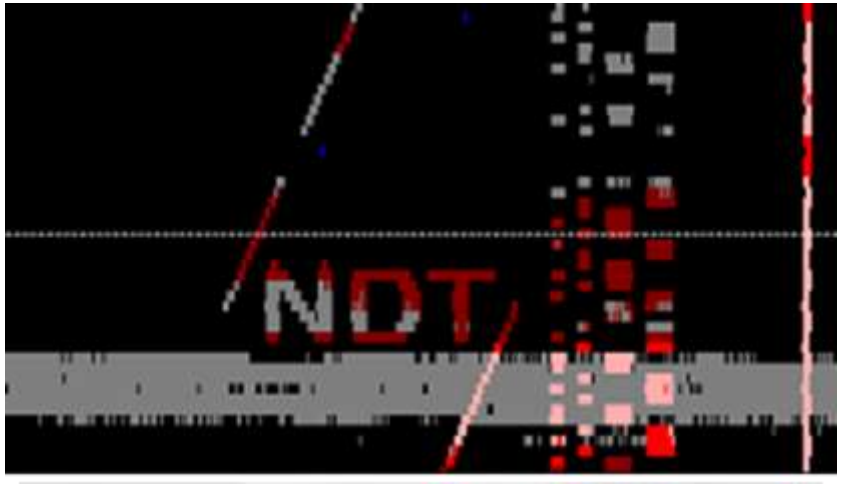
Ultrasonic Geometry speed: 3.0 m/s



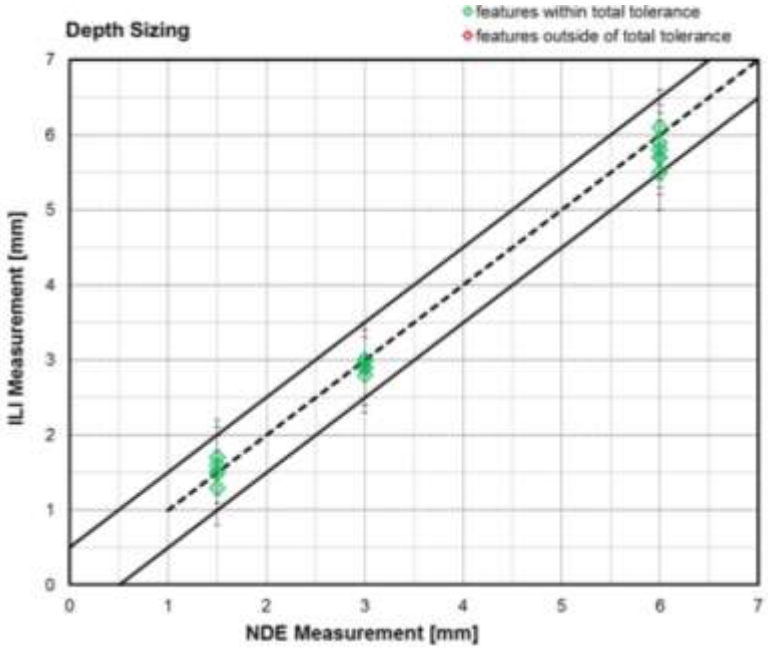
ADVANTAGES – WALL THICKNESS DATA

Detection and identification

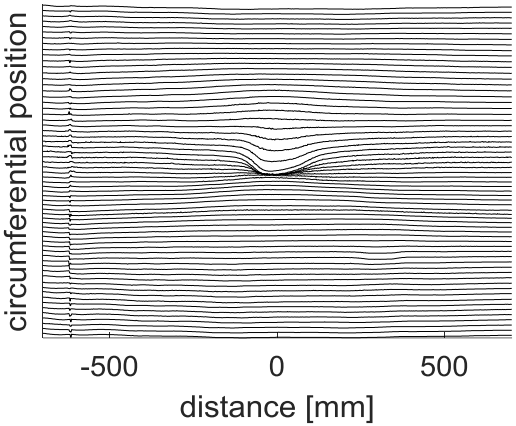
- Welded sleeves
- Patches
- Welded fixtures
- Corrosion

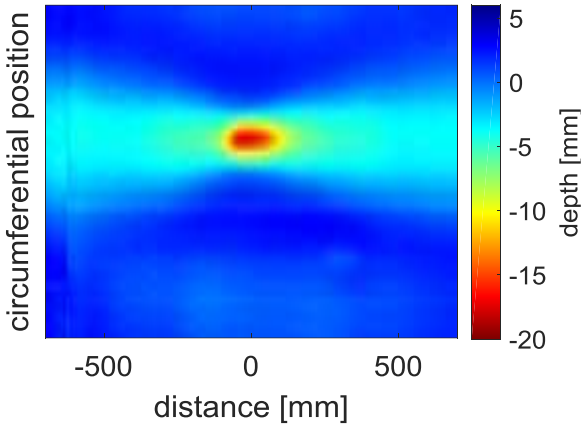


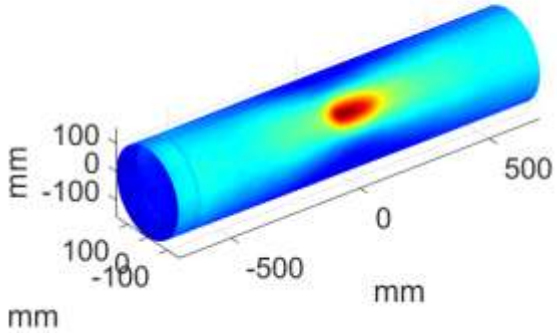
TESTING AND SPECIFICATION



ILI DATA

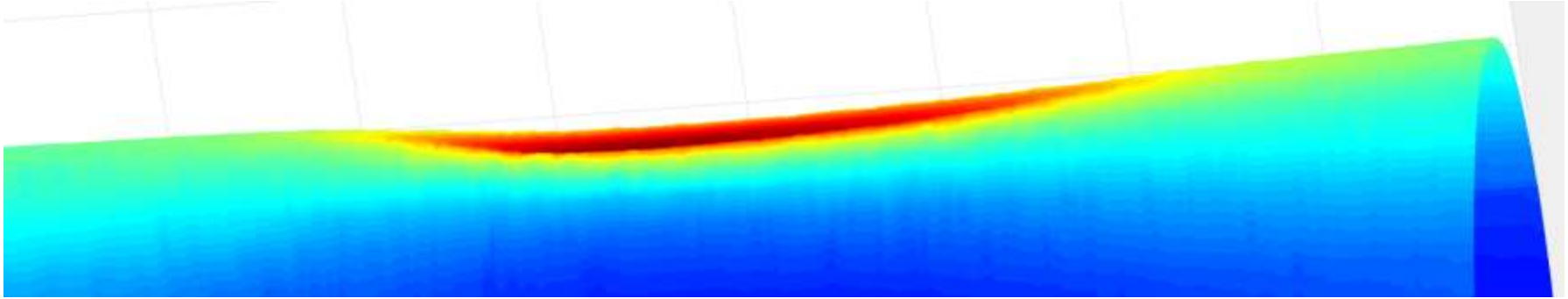






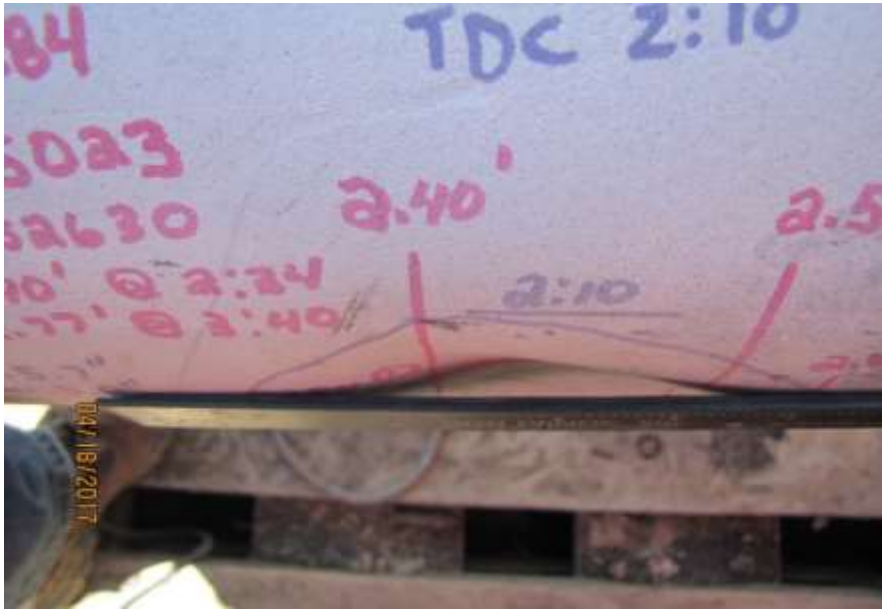
NPS	12"
type	dent
depth	14.0 mm
length	343 mm
width	144 mm
o'clock position	5:55

ILI DATA

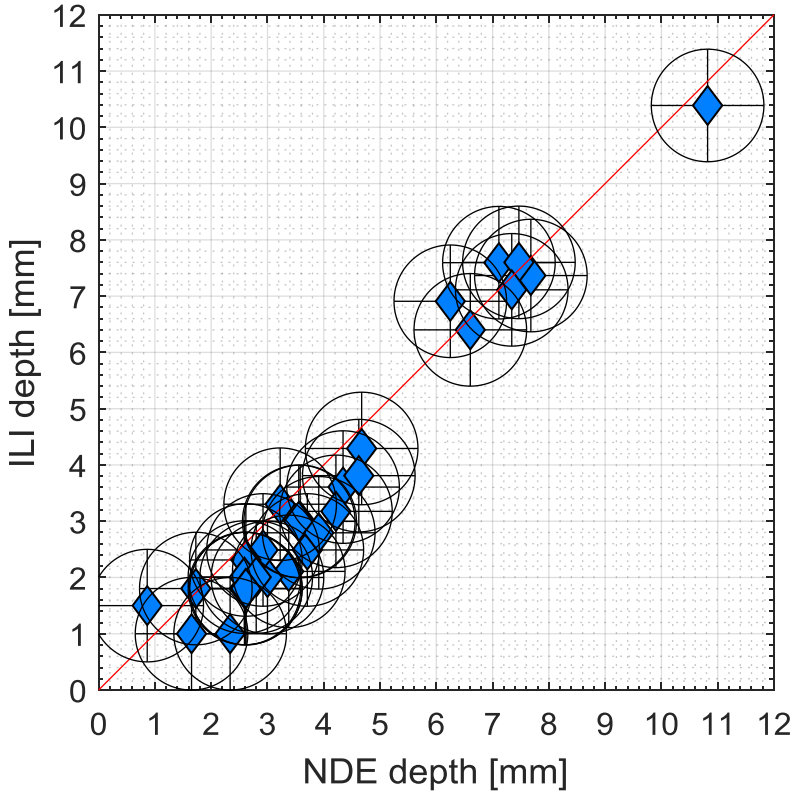


FIELD VERIFICATION

	ILI	NDE
NPS	10"	
type	dent	
depth	10.4 mm	10.8 mm
length	116 mm	149 mm
o'clock position	2:34	2:10



FIELD VERIFICATION RESULTS



- **Dig verification results record**
  - 29 dig reports
  - 29 within specification
  - ILI tolerance: ± 1 mm
  - NDE tolerance: ± 1 mm

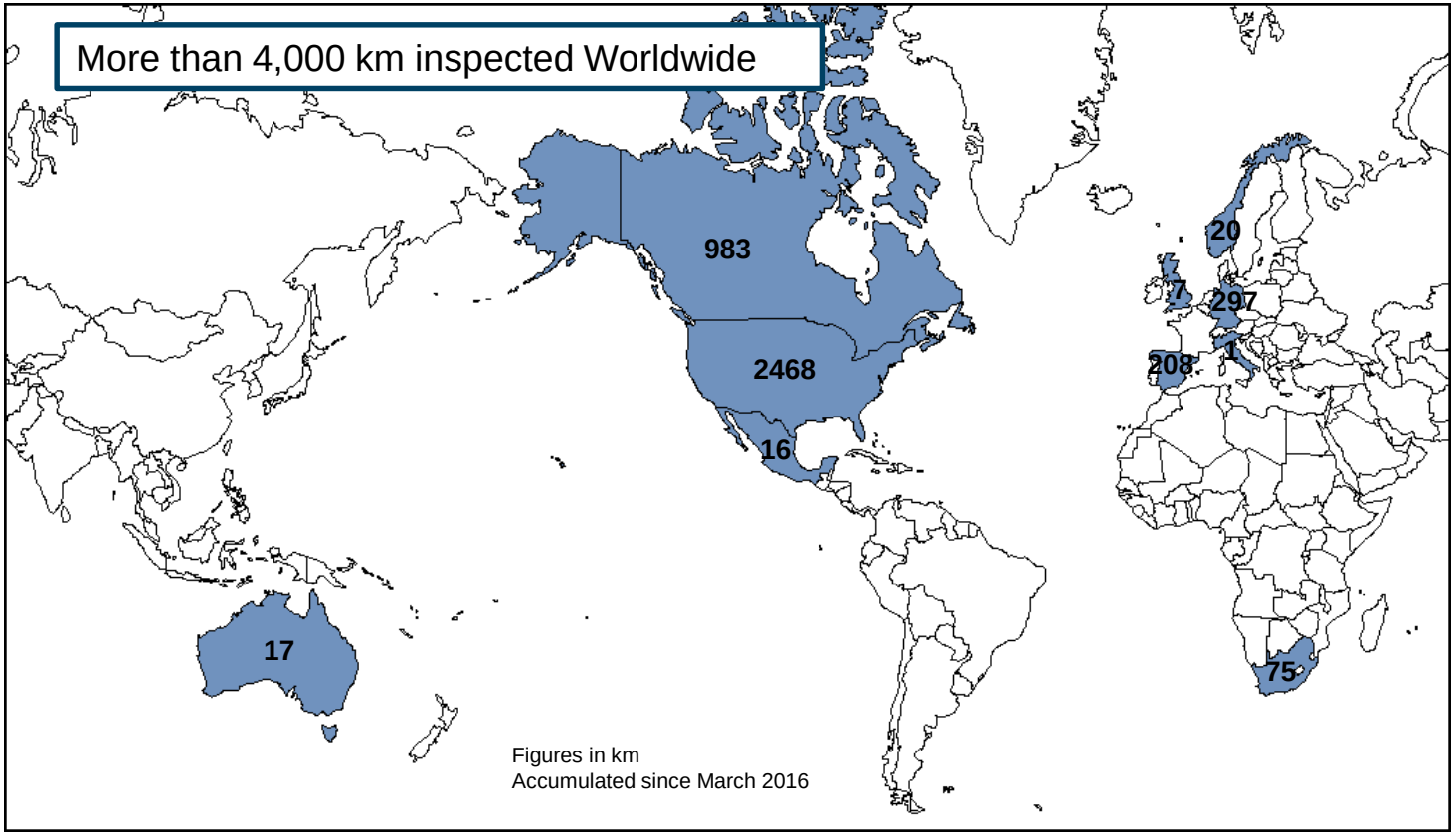
PERFORMANCE SPECIFICATION

Evo Series 1.0 Atlas UG

Detection threshold for dents and ovalities at ≥ 90% POD with 80% certainty		2 mm	0.079 in
Detection threshold for dents and ovalities ≥ 90% POD with 90% certainty		2 mm	0.079 in
Dent sizing accuracy with 90% certainty	Depth	± 1 mm	± 0.04 in
	Length	± 6 mm	± 0.24 in
	Width	± 15 mm	± 0.59 in

1. Depth in percent can be calculated dividing the Depth (mm/in) by OD (mm/in), absolute value is provided as direct measurement NDT method
2. Depth sizing accuracy based on 1.5mm (0.06 in) axial sampling and 15mm (0.59 in) circumferential resolution

ULTRASONIC GEOMETRY INSPECTION RECORD



COMBINED INSPECTIONS

Geometry &

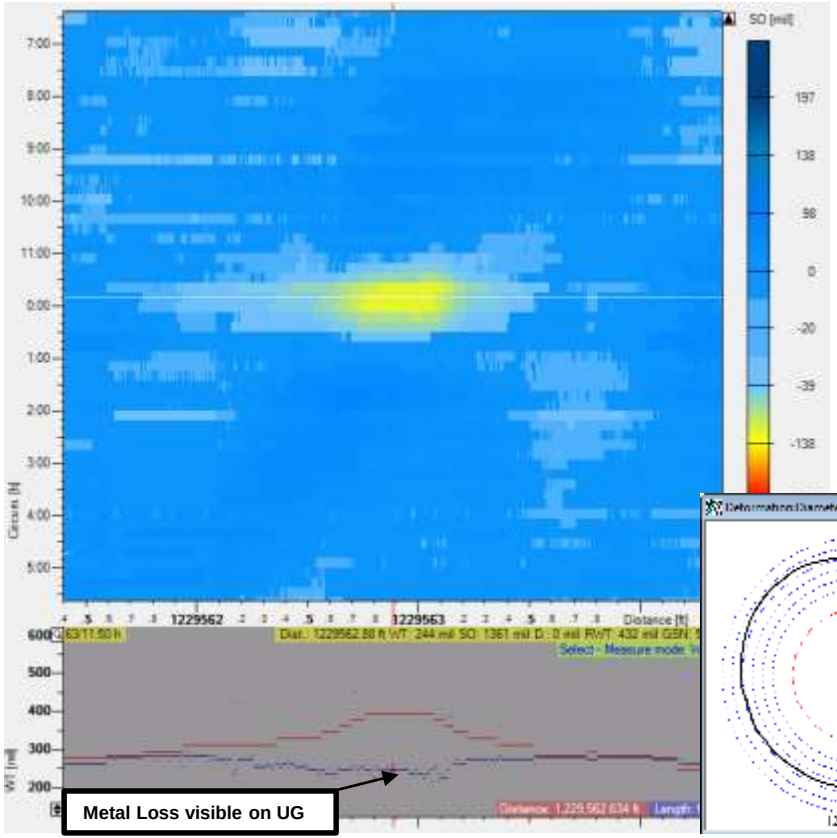
- crack inspection
- corrosion inspection

in a single run

Identify combined anomalies

- interaction threads
- intrinsic data correlation
- > 280 features reported
  - 17 verified

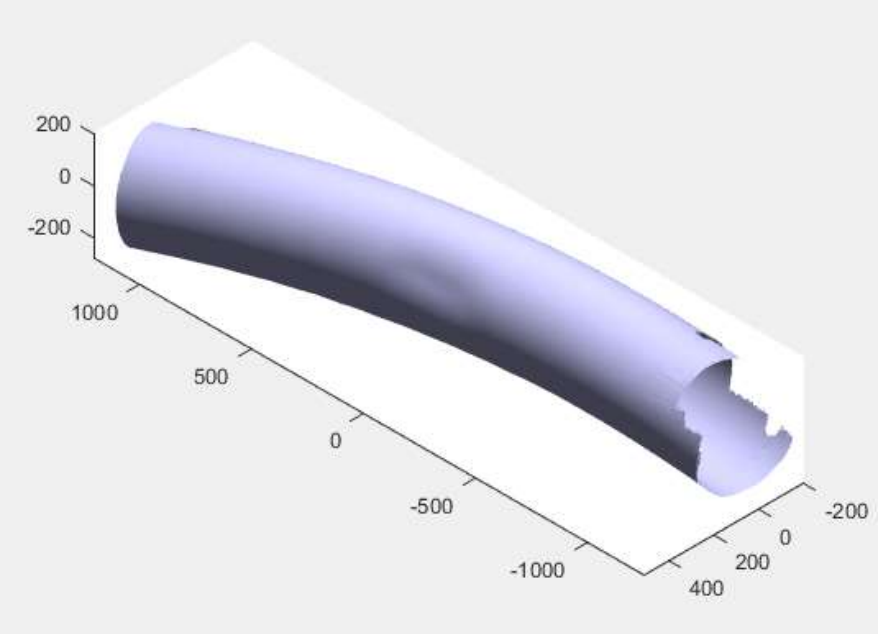
DENT & EXTERNAL METAL LOSS



Dent value	ILI	NDE
Depth (mm)	3.0	3.6
Orientation	00:04	00:00
Type	Dent & External Metal Loss	

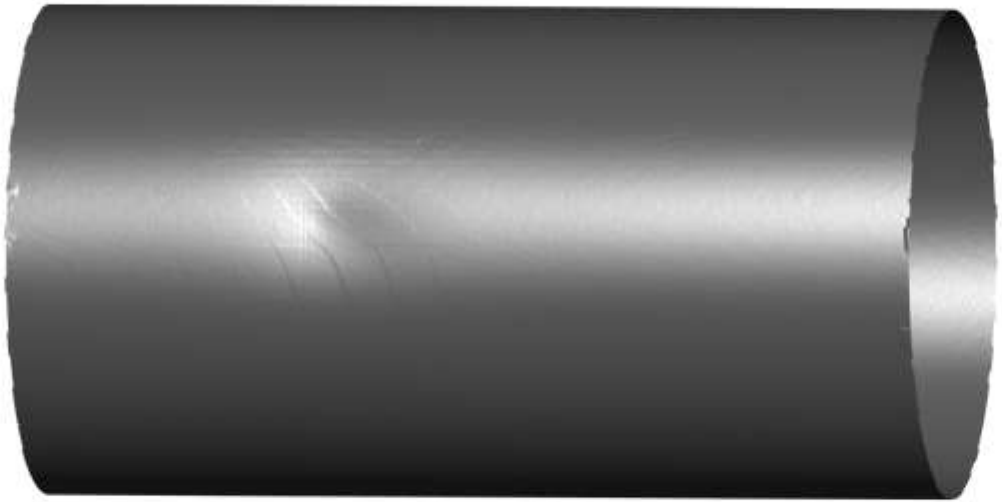
VERIFICATION BY LASER SCAN

Scan procedure

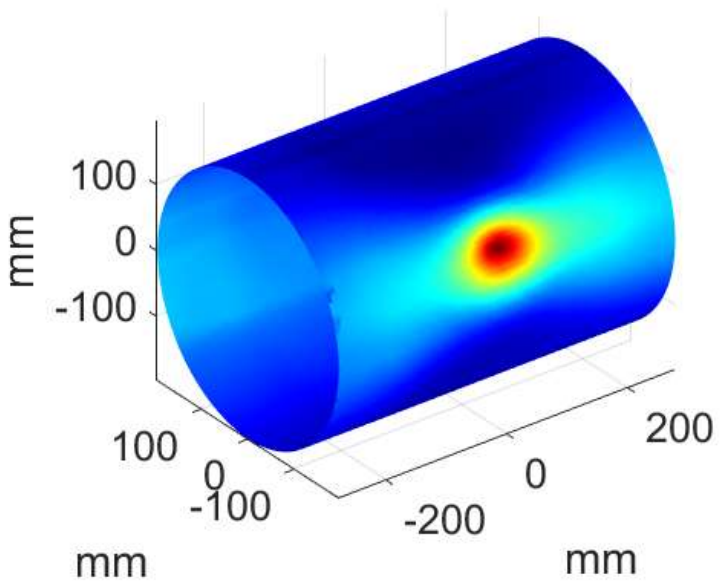


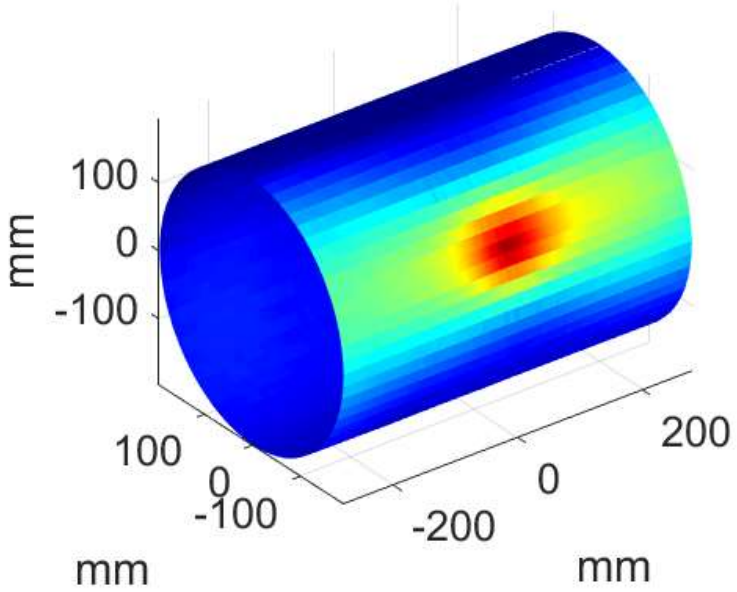
Scan result

LASER SCAN DATA

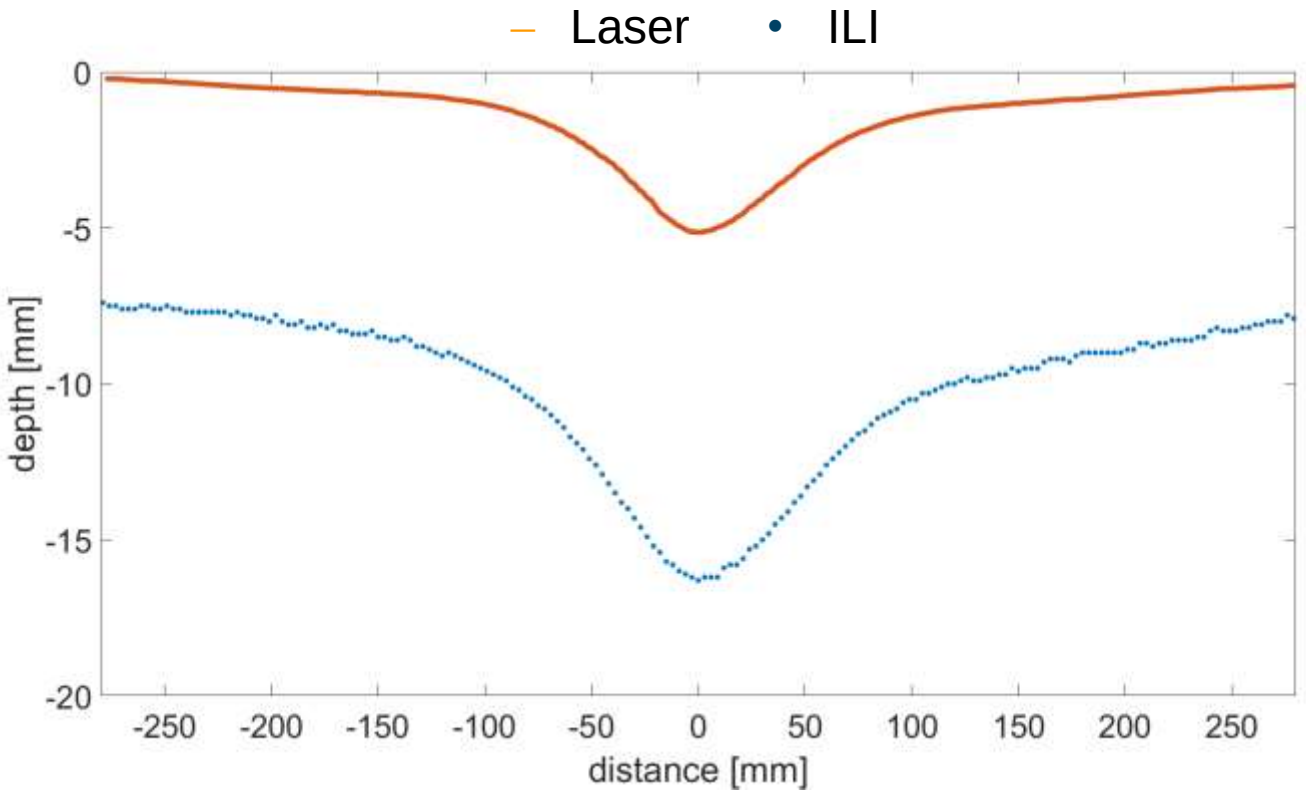


LASER & ULTRASONIC DATA

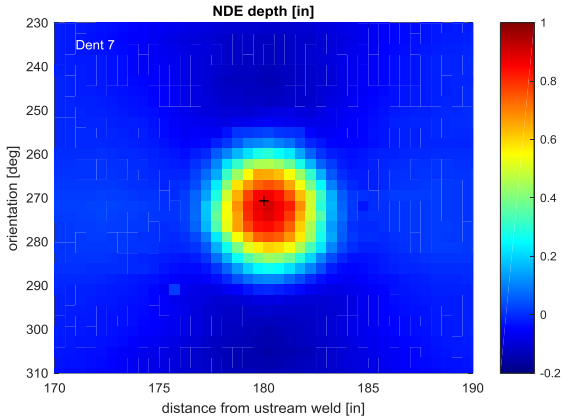


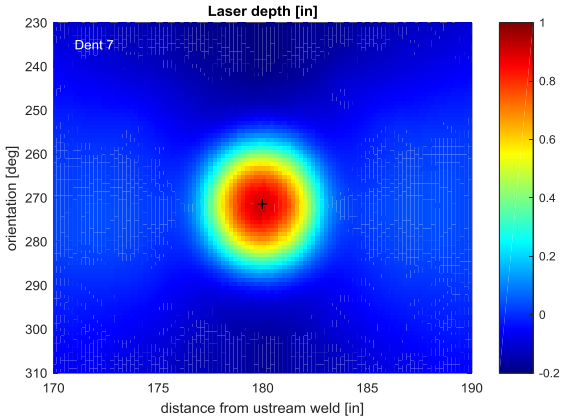


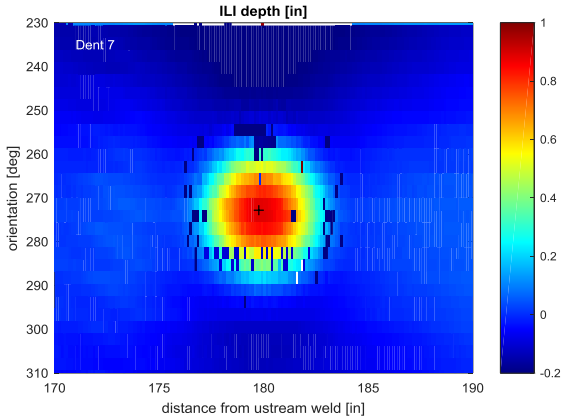
COMPARISON


Laser
ILI
0
-5
-10
-15
-20
depth [mm]
-250
-200
-150
-100
-50
0
50
100
150
200
250
distance [mm]

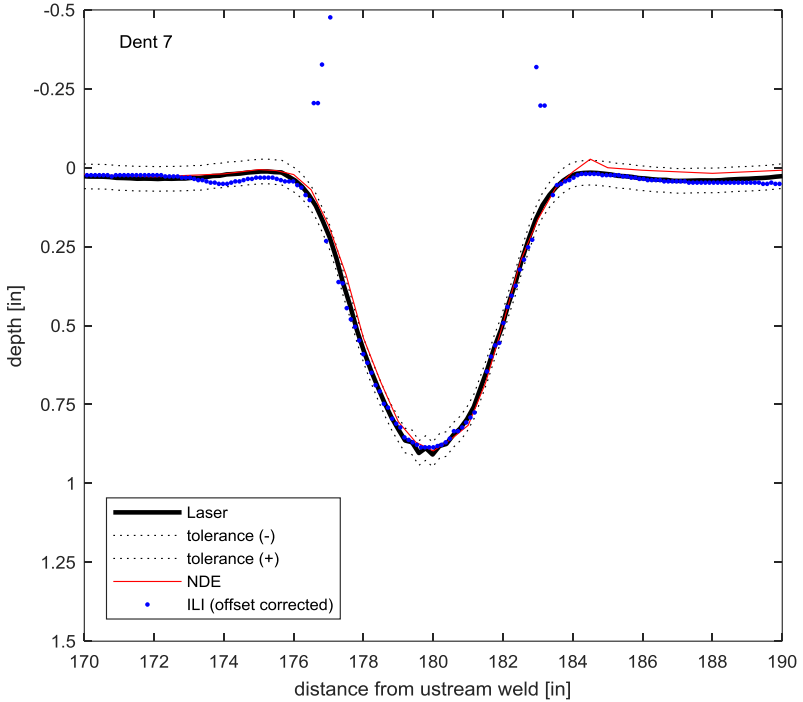
NDE – LASER SCAN – ULTRASONIC DATA

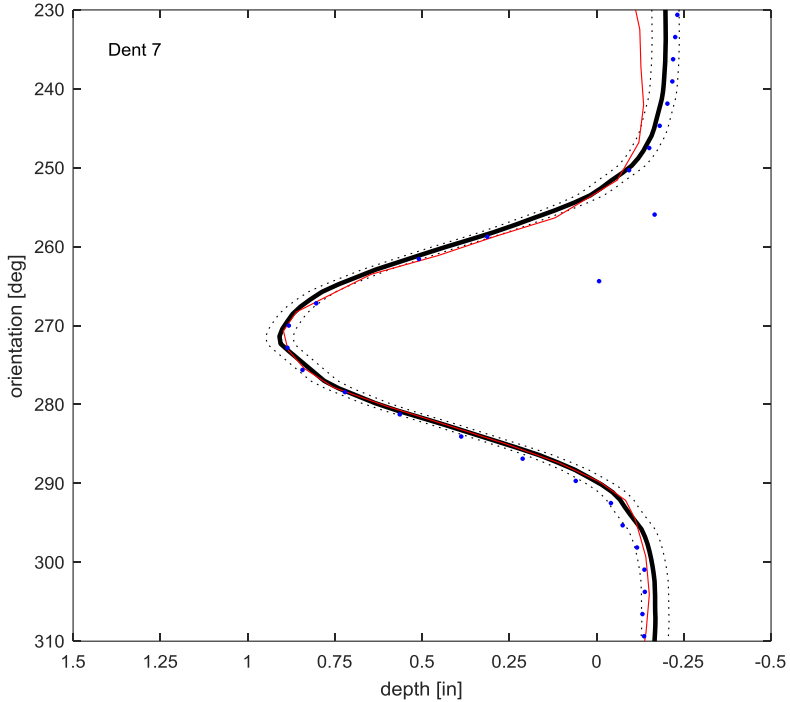






NDE – LASER SCAN – ULTRASONIC DATA

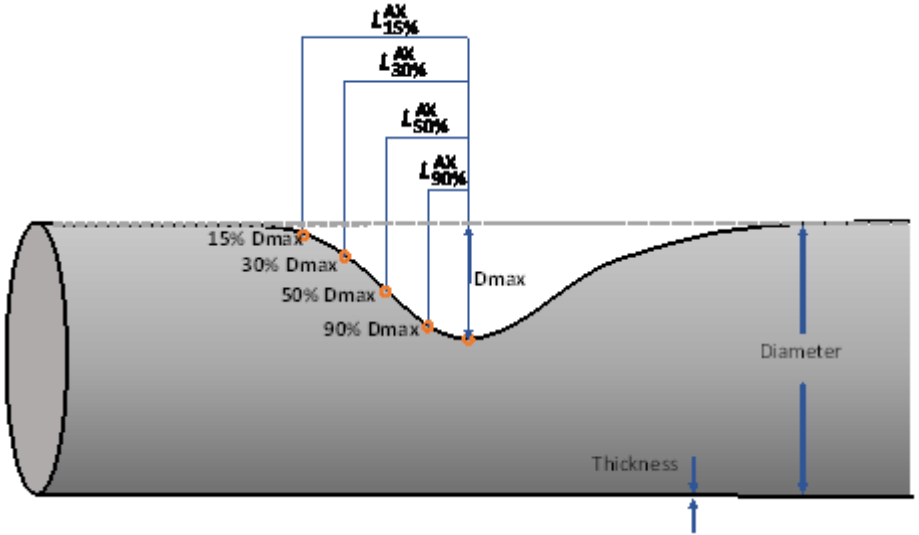




BENEFITS OF SUPERIOR DATA QUALITY

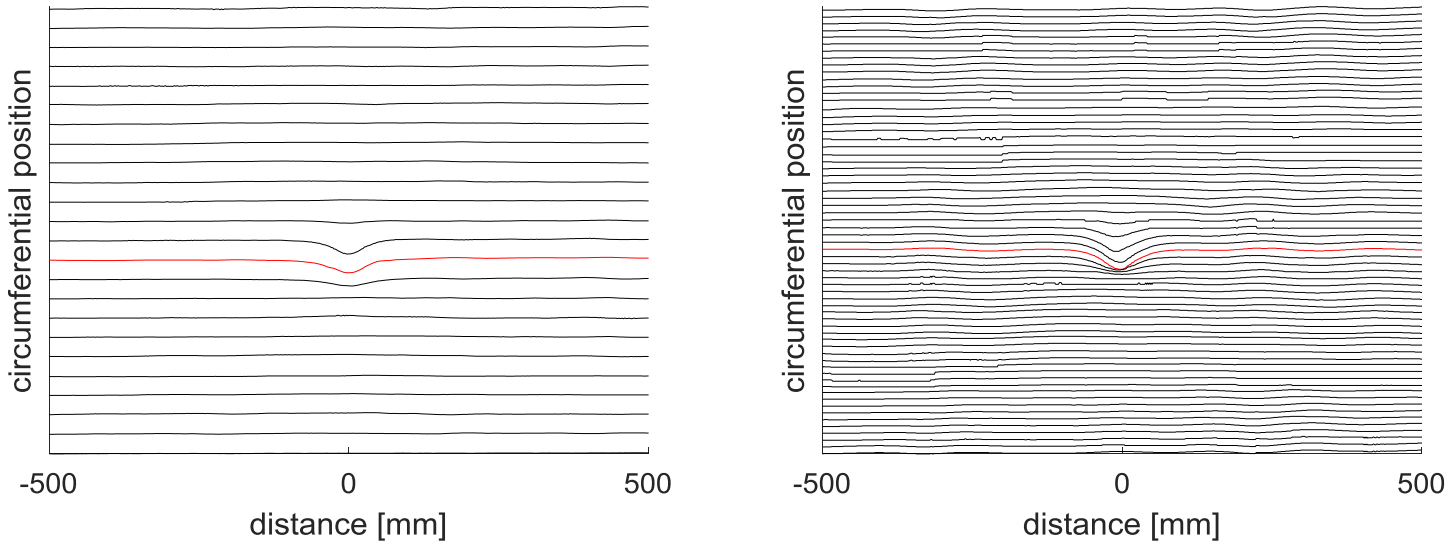
DENT ASSESSMENT

- Progress in assessment methods
  - from singular assessment parameter, e.g. depth
  - to shape based assessment
- Fatigue life assessment (MD4-9)
  - based on axial and circumferential shape parameters
- Strain calculation
  - based on 3D data

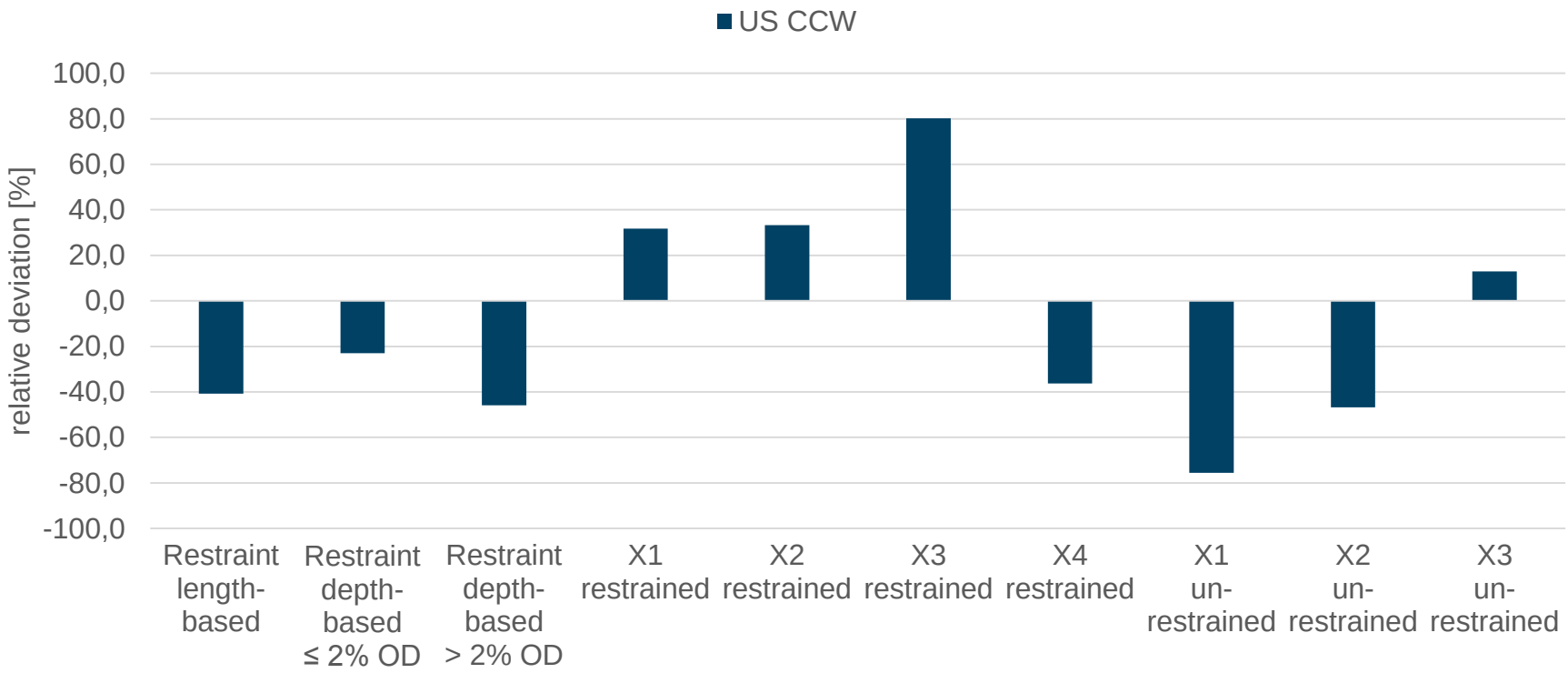


COMPARISON

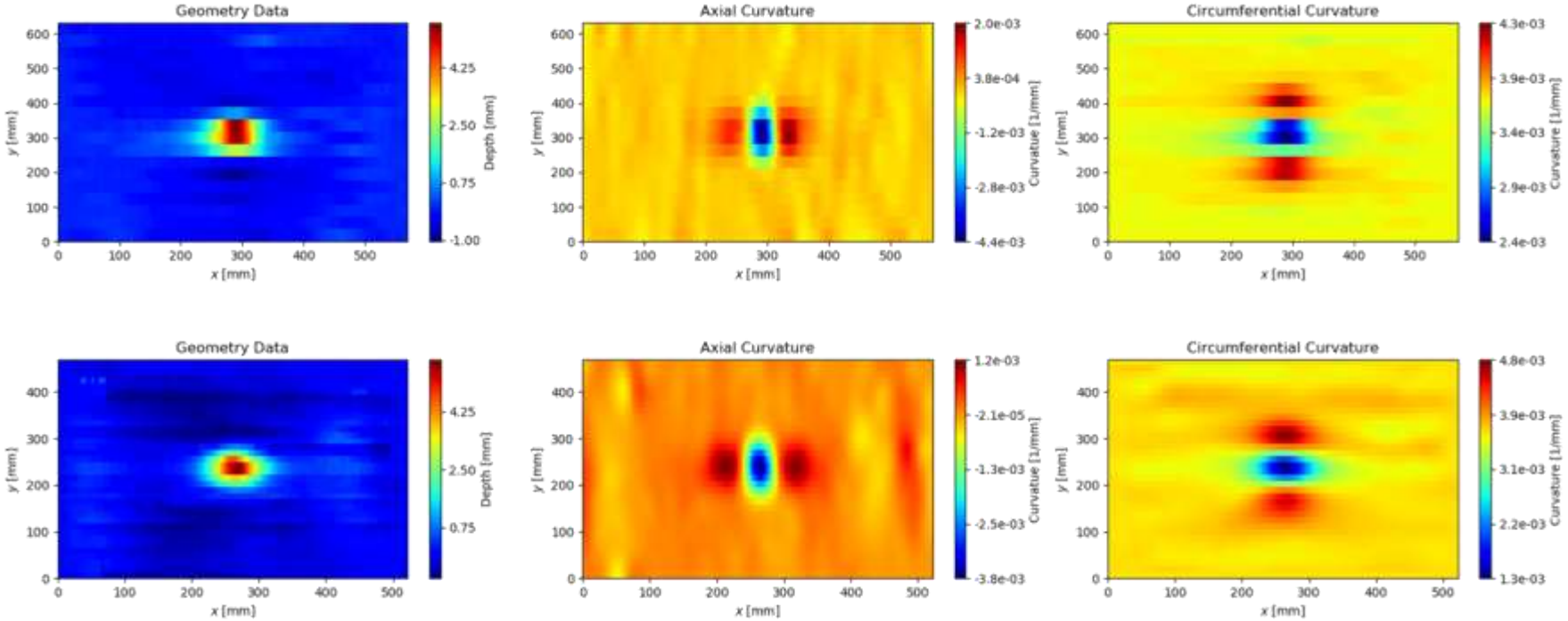
Type	Channels	Depth	Length	Width
Mechanical	24	5.0 mm	132 mm	107 mm
Ultrasonic	64	6.1 mm	108 mm	32 mm



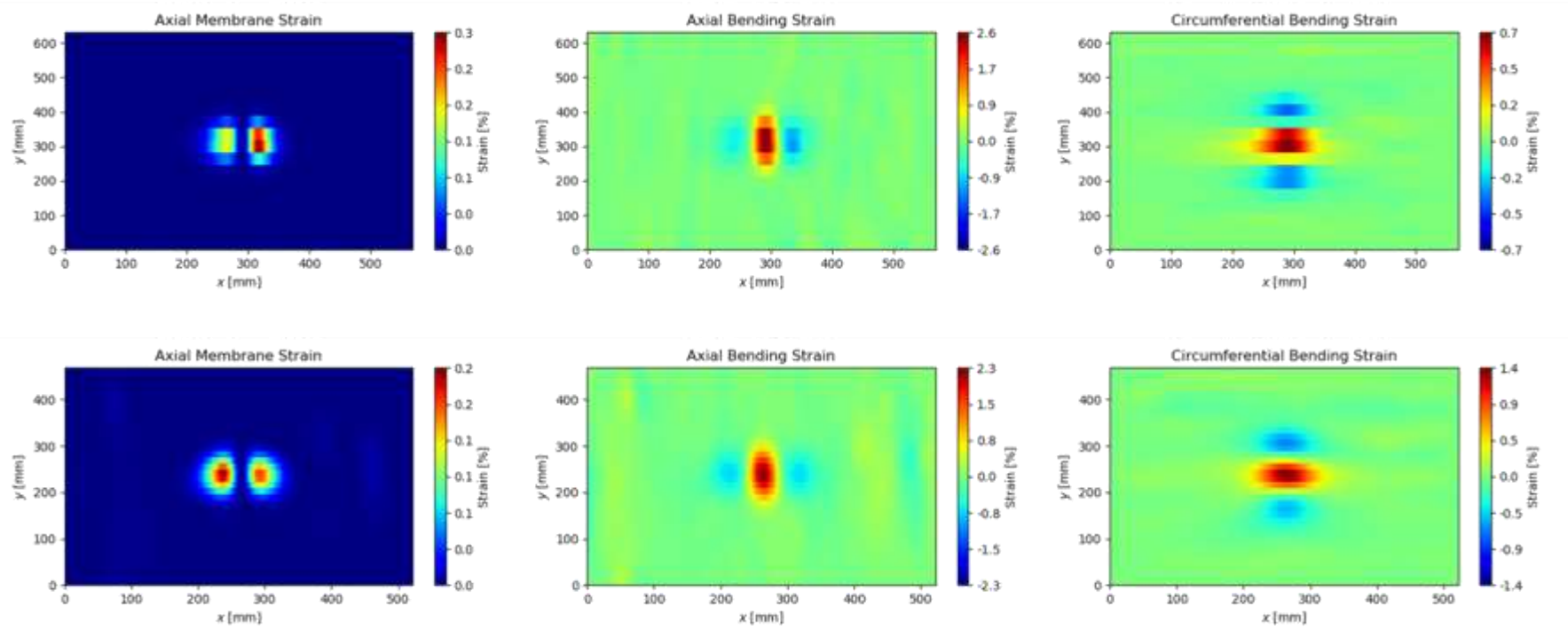
PRCI MD4-9 ASSESSMENT PARAMETERS



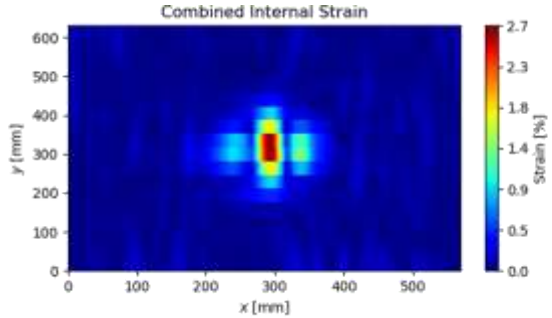
STRAIN ASSESSMENT

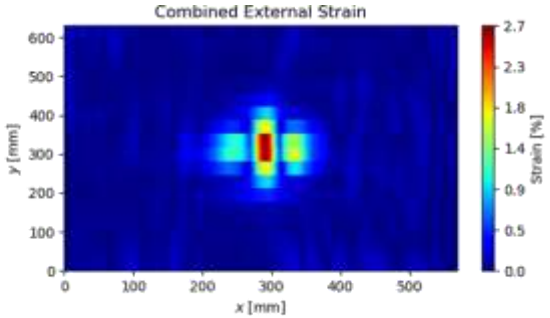


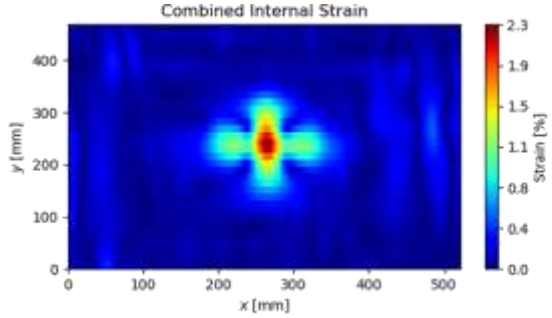
STRAIN ASSESSMENT

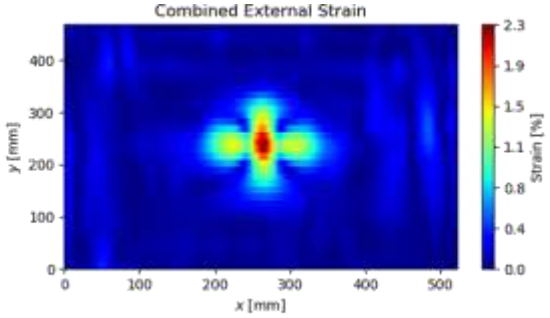


STRAIN ASSESSMENT









STRAIN ASSESSMENT

Strain parameter	Mechanical	Ultrasonic	Rel. Deviation
Axial curvature	$- 4.4 \cdot 10^{-3}$ [1/mm]	$- 3.8 \cdot 10^{-3}$ [1/mm]	16 %
Circ. curvature	$+ 4.3 \cdot 10^{-3}$ [1/mm]	$+ 4.8 \cdot 10^{-3}$ [1/mm]	10 %
Axial membrane	0.3 %	0.2 %	50 %
Axial bending	2.6 %	2.3 %	13 %
Circ. bending	0.7 %	1.4 %	50 %
Combined internal	**2.7 %**	**2.3 %**	**17 %**
Combined external	**2.7 %**	**2.3 %**	**17 %**

SUMMARY

- **Ultrasonic geometry measurement – Atlas UG**

• non contact	→	robust, immune to exaggeration
• high precision	→	state of the art &
• high resolution	→	progressive assessment methods
• combined inspection	→	single run: geometry & corrosion
	→	single run: geometry & crack
	→	interacting threads

THANK YOU!

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