AFES November Technical Talk #2:
Deploying the world's most compact ultrasonic evaluation tool to evaluate casing and cement integrity

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Tim Farrar, Cased Hole Analyst

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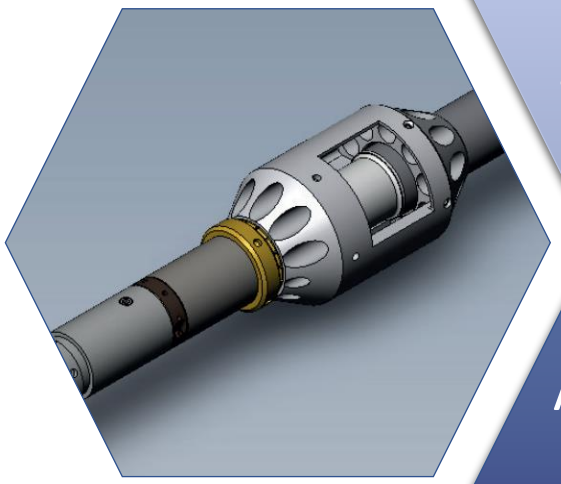
ALT Advanced Logic Technology founded 1993

READ and ALT to move the ABI into the O&G industry

READ Cased Hole founded 1990

ABI developed for mining Industry 25+ Years ago



ABI- 43
The worlds most compact Ultra Sonic Logging tool

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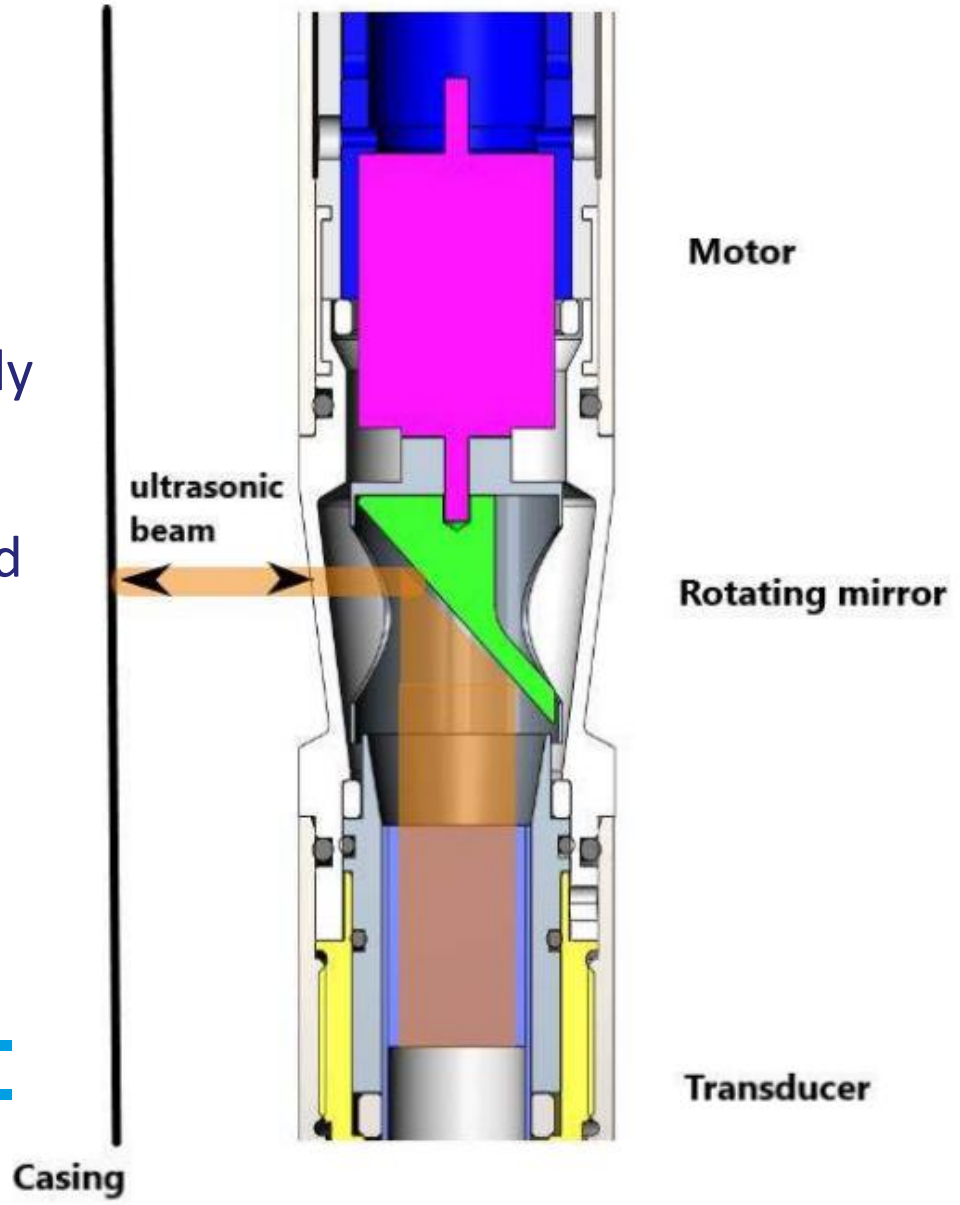
How does it do it?

- The ABI generates an ultrasonic energy wave which is generated a specially designed Piezoelectric ceramic crystal
- The acoustic wave propagates along the axis of the tool body and is reflected perpendicular to this axis via a mirror
- The mirror is mounted to a drive shaft motor and is rotated through 360°
- Sampling rates of 72,144 & 288 measured points per revolution are available.



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Casing Integrity Mode

Field exchangeable acoustic head

QL43 ABI HEAD OHCO-L
OPEN HOLE & CORROSION

Open hole up to 21" depending on borehole
Corrosion 5½" x 15"
minimum of 5 mm thickness

QL43 ABI HEAD CO-S
CORROSION SMALL PIPE DIAMETER

3" x 5½"
minimum of 3 mm thickness

QL43 ABI HEAD CO-XXS
CORROSION 2⅞ TUBING

2⅞"
depending on borehole conditions with a minimum of 3 mm thickness

Cement Evaluation Mode

QL43 ABI HEAD CE-L
CEMENT (in development)

5½" x 15"

QL43 ABI HEAD CE-S
CEMENT SMALL PIPE DIAMETER (in development)

2⅞" x 5½"

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ABI-43 – Integrity Mode

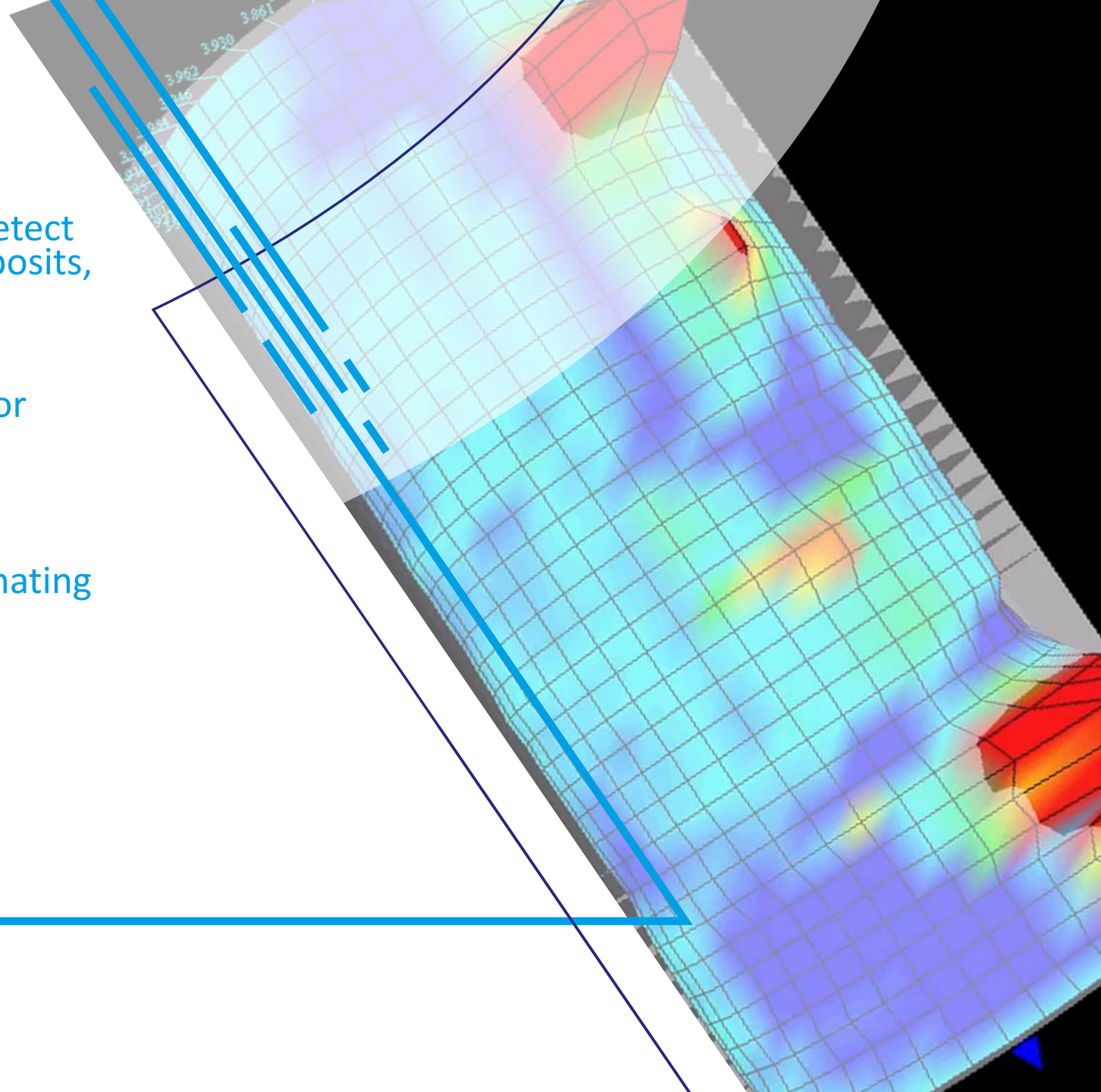
Temperature rating*	170°C (338°F)
Pressure rating	10,000 psi (700 Bar)
Tool diameter	1 11/16 in (43 mm)
Tool length	248 in (6.3 m)
Tool weight	65 lb (29.5 kg)
Logging speed**	Nominal 30 ft/min (9 m/min)
Azimuthal resolution	Standard 72 ppt - 36 ppt post processing
Caliper resolution	0.003 in (0.08 mm)
Casing thickness resolution	0.03 mm
Vertical resolution	Standard 1 in
Inclination accuracy	±0.5°
Frequency	1.2 MHz
Ultrasonic Acoustic sensor	Fixed transducer and rotating focusing mirror
Collimated Acoustic beam	Focal distance diameter 0.12 in (3 mm)
Output***	Internal radius; Amplitude
Borehole fluid	Water, water based mud, brine, oil (oil based mud not applicable)
Materials	Corrosion resistant throughout

ABI-43 – Cement Mode

Temperature rating*	170°C (338°F)
Pressure rating	10,000 psi (700 Bar)
Tool diameter	$1\,{}^{11}/_{16}$ in (43 mm)
Tool length	248 in (6.3 m)
Tool weight	65 lb (29.5 kg)
Logging speed**	Nominal 30 ft/min (9 m/min)
Azimuthal resolution	Standard 72 ppt - 36 ppt post processing
Vertical resolution	Standard 1 in
Inclination accuracy	±0.5°
Depth of investigation	Casing to cement interface
Frequency	0.5 MHz
Ultrasonic Acoustic sensor	Fixed transducer and rotating focusing mirror
Collimated Acoustic beam	Focal distance diameter 0.12 in (3 mm)
Primary curves	360° unwrapped CADI image; CADI average
Output	Cement Attenuation Decay Index (CADI)
Borehole fluid	Water, water based mud, brine, oil (oil based mud not applicable)
Materials	Corrosion resistant throughout

Applications

- Internal inspection of casing and tubing to detect various forms of damage, including scale deposits, holes and drilling wear
- Accurate and direct measurement of casing or tubing thickness
- External evaluation of the casing and tubing condition, detecting external corrosion originating from the formation or annuli
- 360° Cement Bond Map for detailed Cement evaluation



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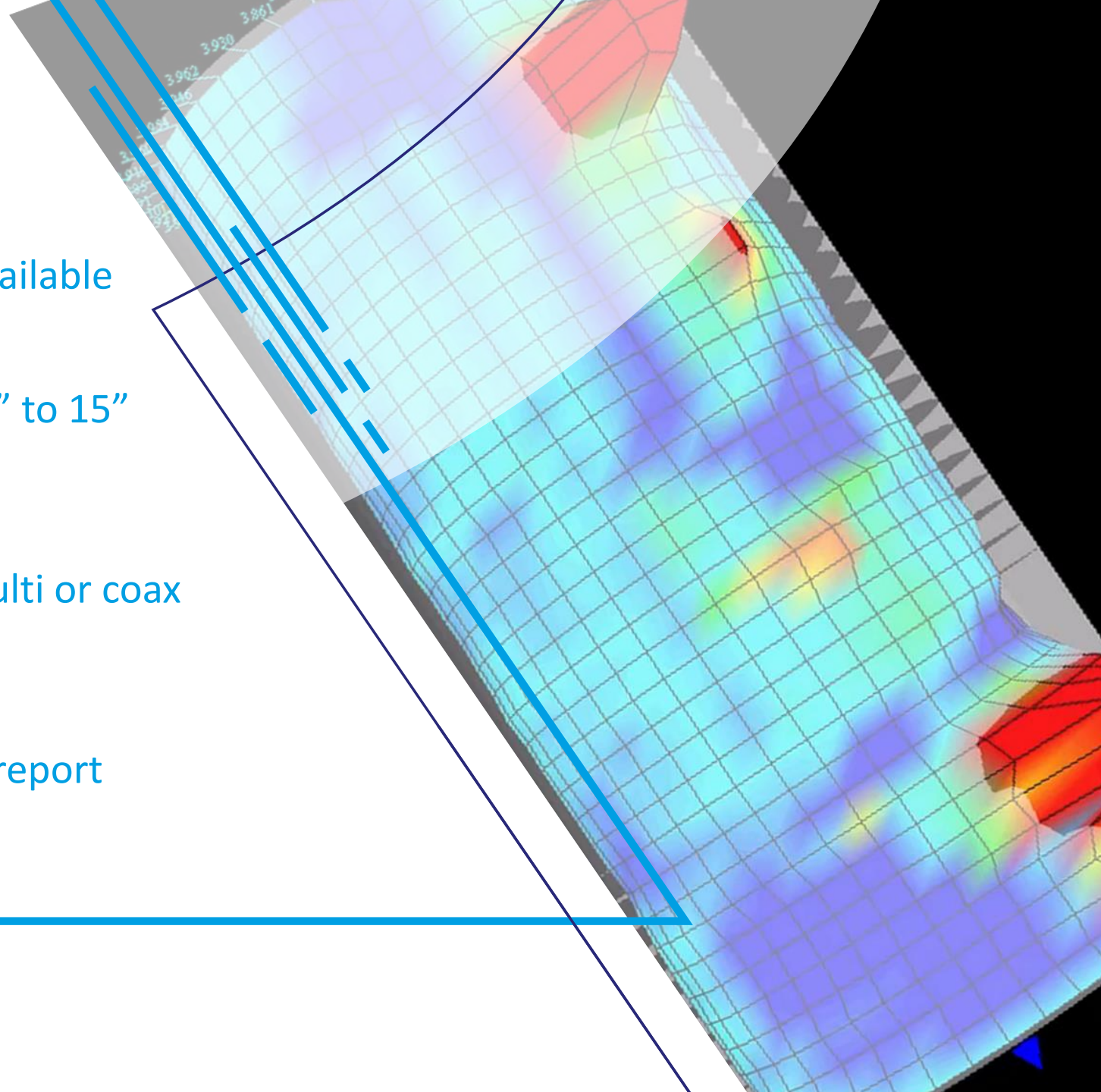
Benefits

- Most compact tool of its kind currently available
- Extensive measurement range from 2 7/8” to 15” tubulars
- Deployable on electric line with mono, multi or coax cables
- Comprehensive range of log analysis and report services available from READ ANSA



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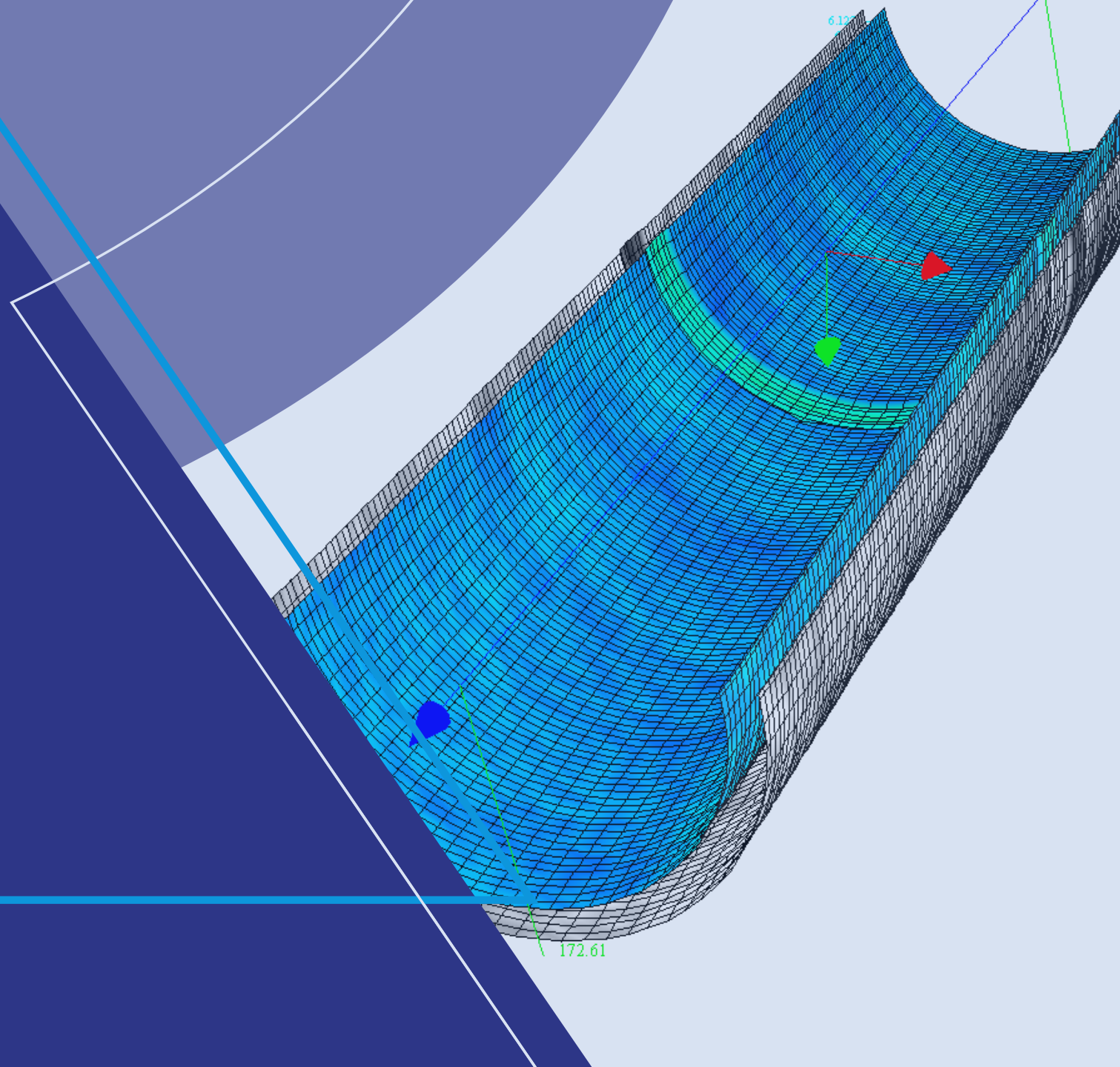
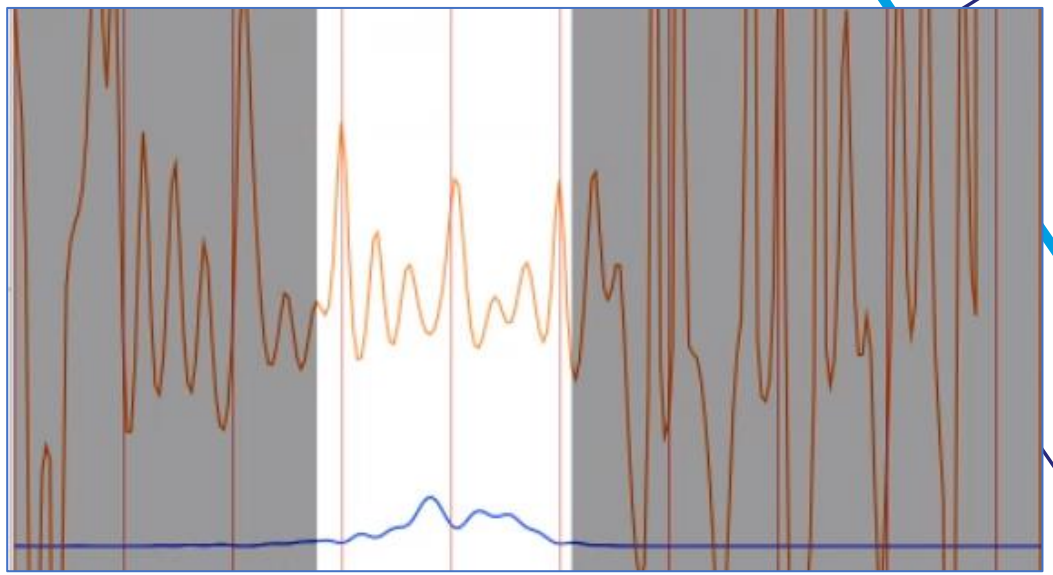
Case Study #1
Casing Integrity



Corrosion logging

- New tubing logged in a test well in Europe
- Data recorded in a single pass over 2420 m
- 72 trace data sent to surface
- 36 trace data stored to DDS



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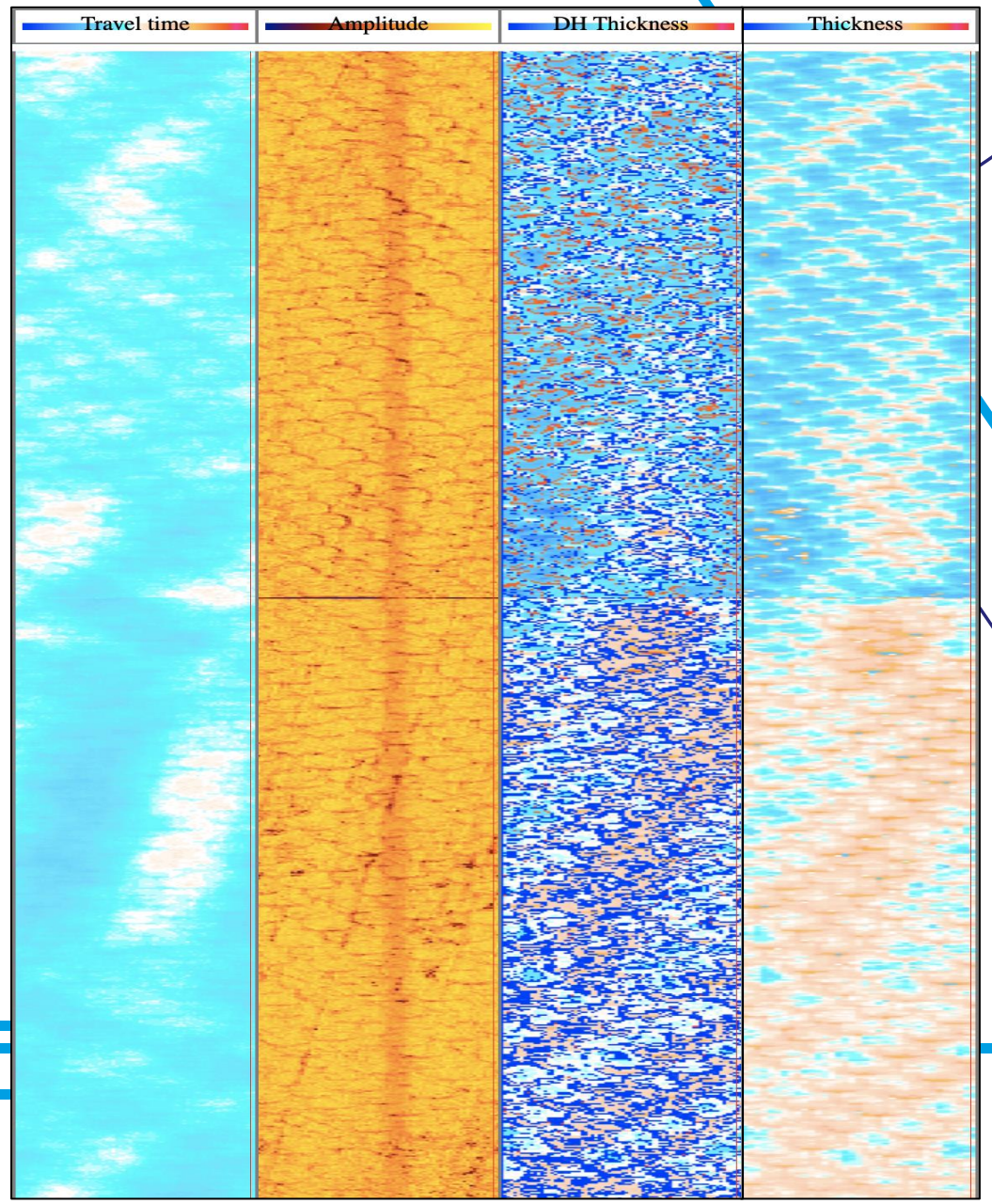
Corrosion logging

- Noise on the downhole calculations
- Clear contrast between joints in reprocessed efforts
- Manufacturing patterns clearly visible in processed data



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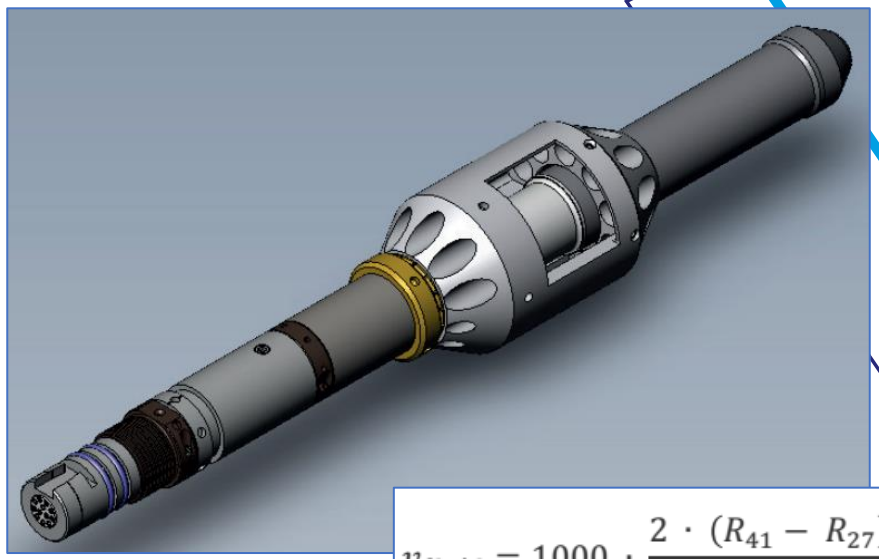
Corrosion logging

- Using the transit time we can also generate an ID
- Need to know the acoustic velocity in our wellbore fluid
- Utilise a velocity ring kit



$$v_{fluid} = 1000 \cdot \frac{2 \cdot (R_{41} - R_{27})}{TT_{41} - TT_{27}}$$

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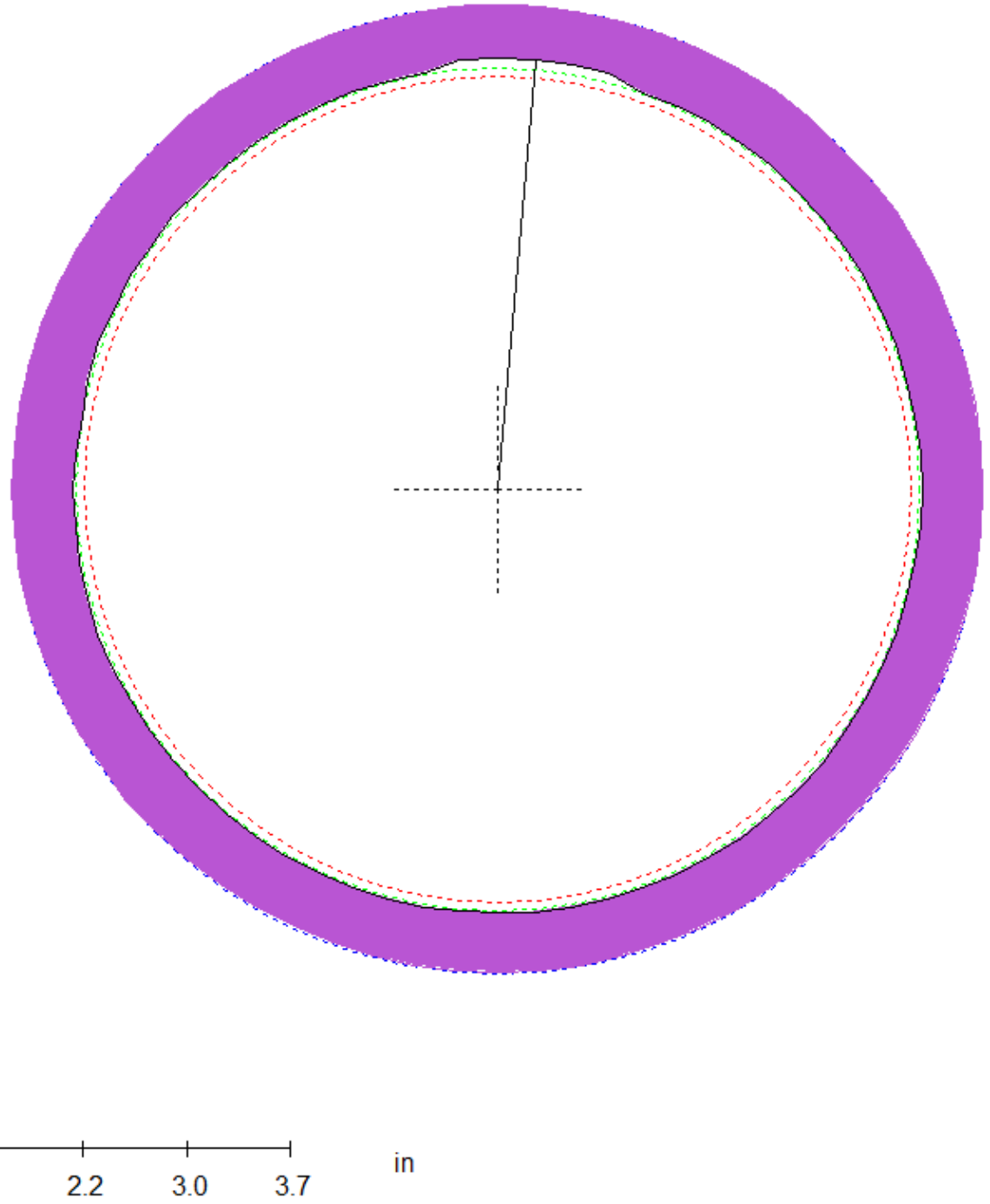
Corrosion logging

- Combination of ID, thickness and OD allows for calculation of a true percentage penetration

- Allows for clearer determination of whether a feature is related to damage or manufacturing



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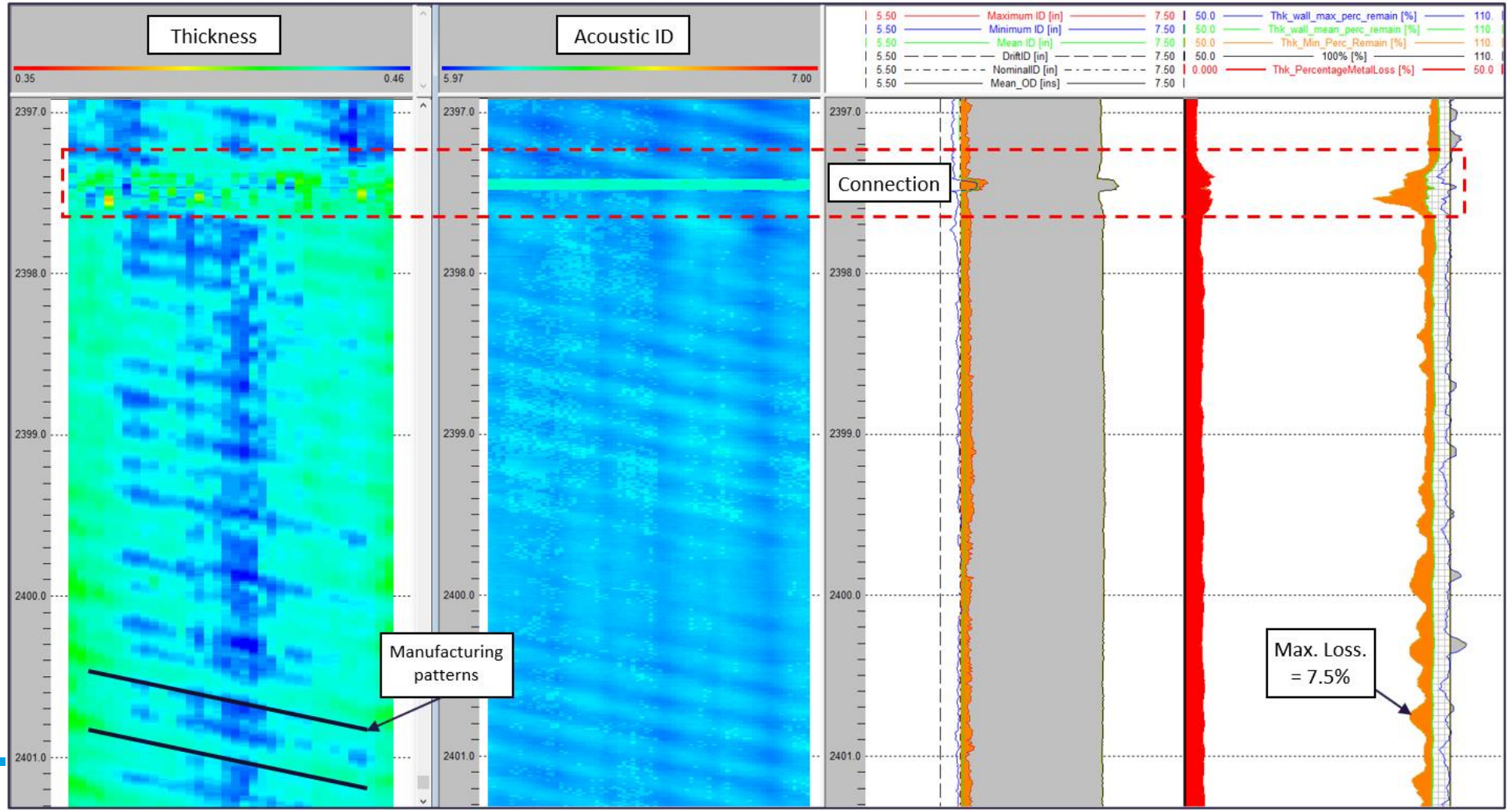
Corrosion logging



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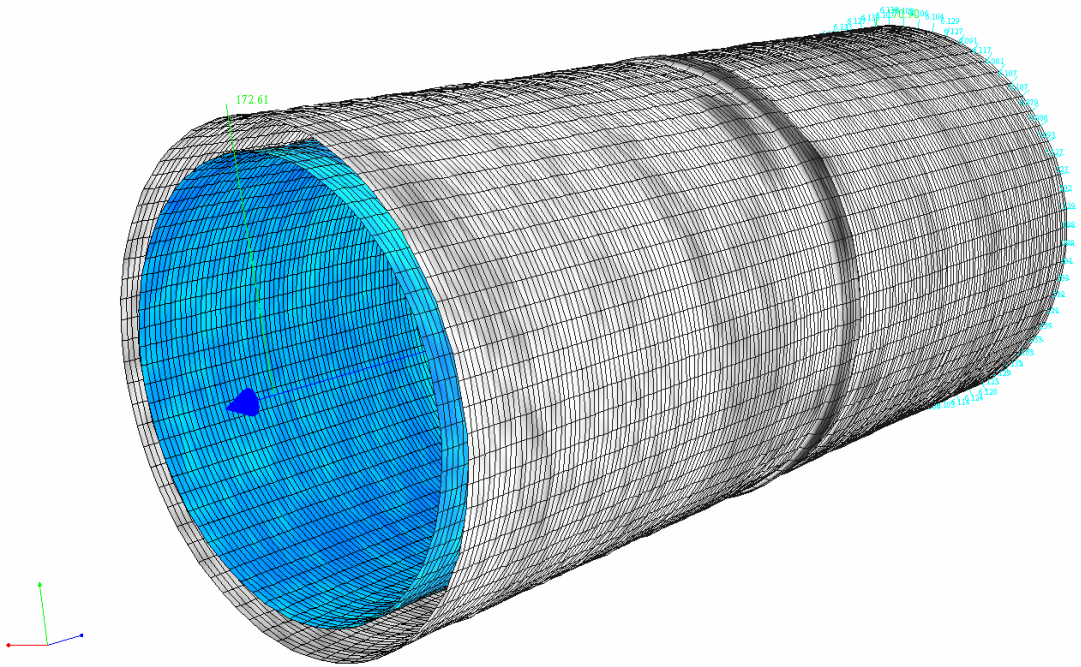
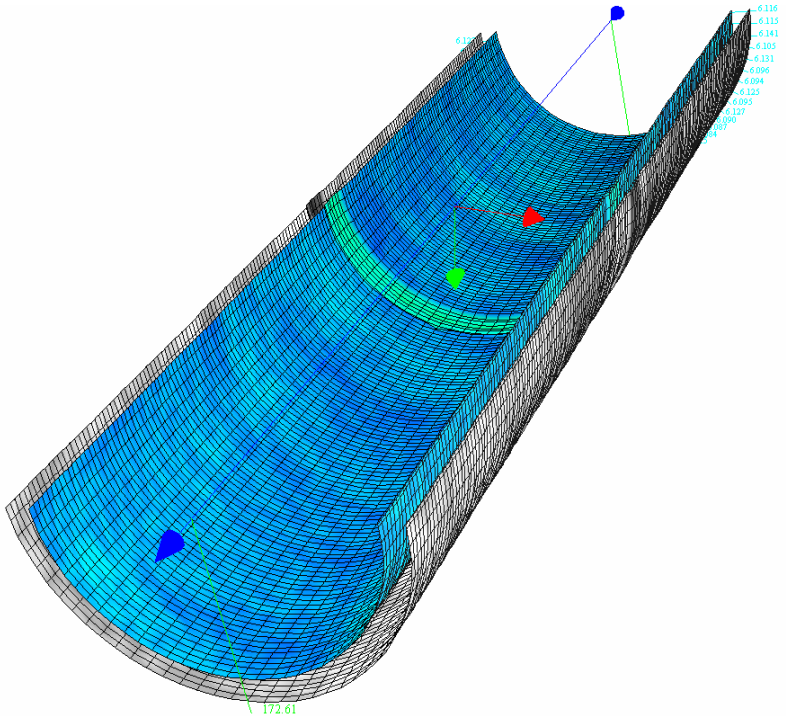
Corrosion logging





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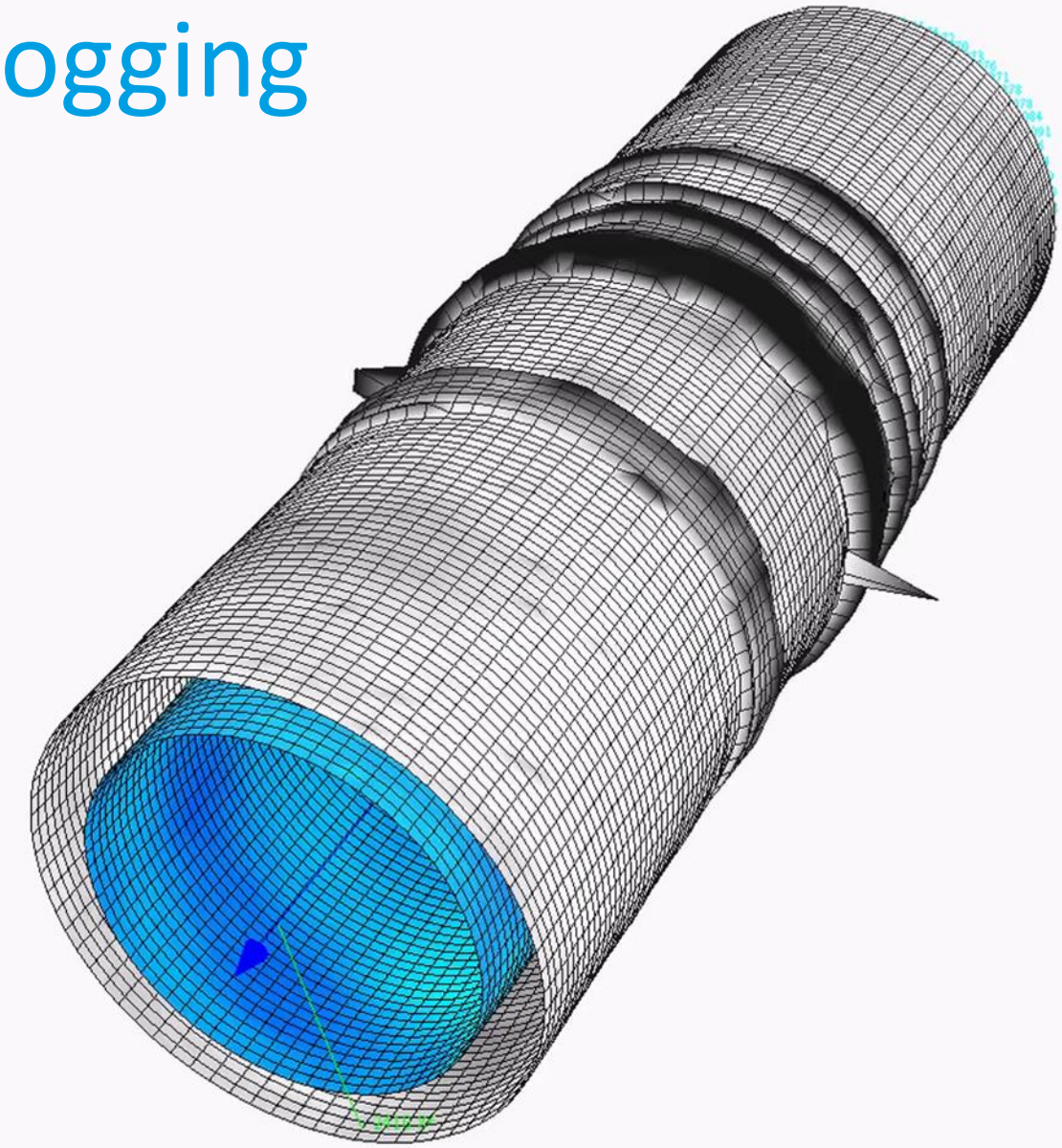
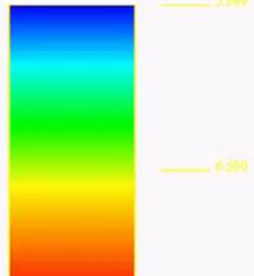
Corrosion logging





Corrosion logging

Thickness

Max. Pen. % based on nominal values	≤0%	0 - 10%	10 - 20%	20 - 30%	30 - 40%	> 40%

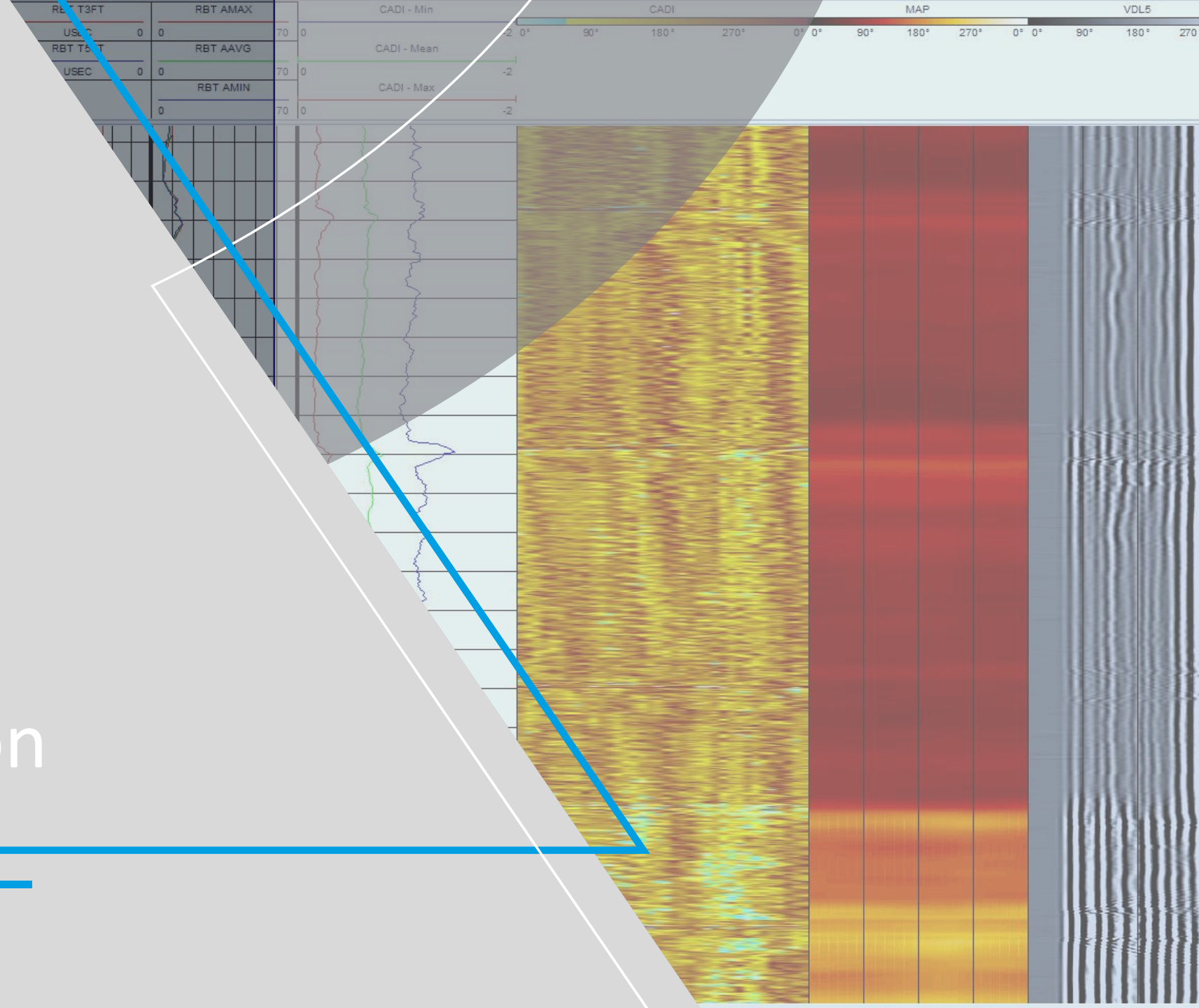
Ref.	Bottom (m)	Top (m)	Length (m)	Min. Thk. (")	Dep. Min. (m)	Max. Thk. Loss (%)	Max. Thk. (")	Dep. Max. (m)	Mean. Thk. (")	Completion item
1	2420.13	2410.58	9.55	0.422	2419.75	6.8	0.462	2413.15	0.441	Partially logged joint
2	2410.52	2409.90	0.62	0.381	2410.01	-	0.475	2410.02	0.431	Float collar
3	2409.79	2397.68	12.11	0.419	2400.78	7.5	0.467	2400.31	0.440	
4	2397.24	2385.36	11.89	0.427	2389.02	5.7	0.469	2396.56	0.440	
5	2384.87	2372.94	11.93	0.421	2383.17	7.1	0.472	2384.39	0.443	
6	2372.46	2360.99	11.47	0.410	2370.54	9.5	0.472	2372.46	0.443	
7	2360.56	2349.00	11.56	0.425	2350.43	6.2	0.469	2355.96	0.443	
8	2348.53	2336.96	11.57	0.406	2337.50	10.4	0.470	2348.14	0.443	
9	2336.22	2324.10	12.12	0.423	2326.29	6.6	0.471	2335.54	0.442	
10	2323.99	2313.33	10.66	0.410	2317.93	9.5	0.466	2316.18	0.442	

IDs

Max. Pen. % based on nominal values	≤ 0%	0 - 20%	20 - 40%	40 - 60%	60 - 80%	80 - 100%

Ref.	Bottom (m)	Top (m)	Length (m)	Max. ID (")	Dep. max. (m)	Max. pen. (%)	Min. ID (")	Dep. min. (m)	Mean ID (")	Median ID (")	Completion item
1	2420.12	2410.50	9.62	6.178	2410.68	9.3	6.040	2410.71	6.109	6.109	Partially logged joint
2	2410.36	2409.99	0.37	7.695	2410.21	-	5.955	2410.21	6.211	6.207	Float collar
3	2409.91	2397.52	12.40	6.194	2399.10	11.0	6.053	2409.81	6.110	6.109	
4	2397.38	2385.14	12.24	6.194	2385.35	11.0	6.058	2392.79	6.101	6.101	
5	2385.00	2372.74	12.26	6.183	2375.47	9.8	6.048	2372.95	6.106	6.105	
6	2372.62	2360.79	11.82	6.186	2371.88	10.2	6.052	2360.81	6.102	6.101	
7	2360.66	2348.83	11.83	6.188	2348.87	10.4	6.057	2354.83	6.103	6.103	
8	2348.68	2336.54	12.14	6.195	2338.88	11.1	6.053	2343.27	6.101	6.101	
9	2336.01	2323.94	12.07	6.168	2335.83	8.2	6.056	2335.80	6.107	6.108	
10	2323.83	2312.30	11.54	6.183	2317.75	9.8	6.068	2323.62	6.110	6.110	

Case Study #2
Cement Evaluation



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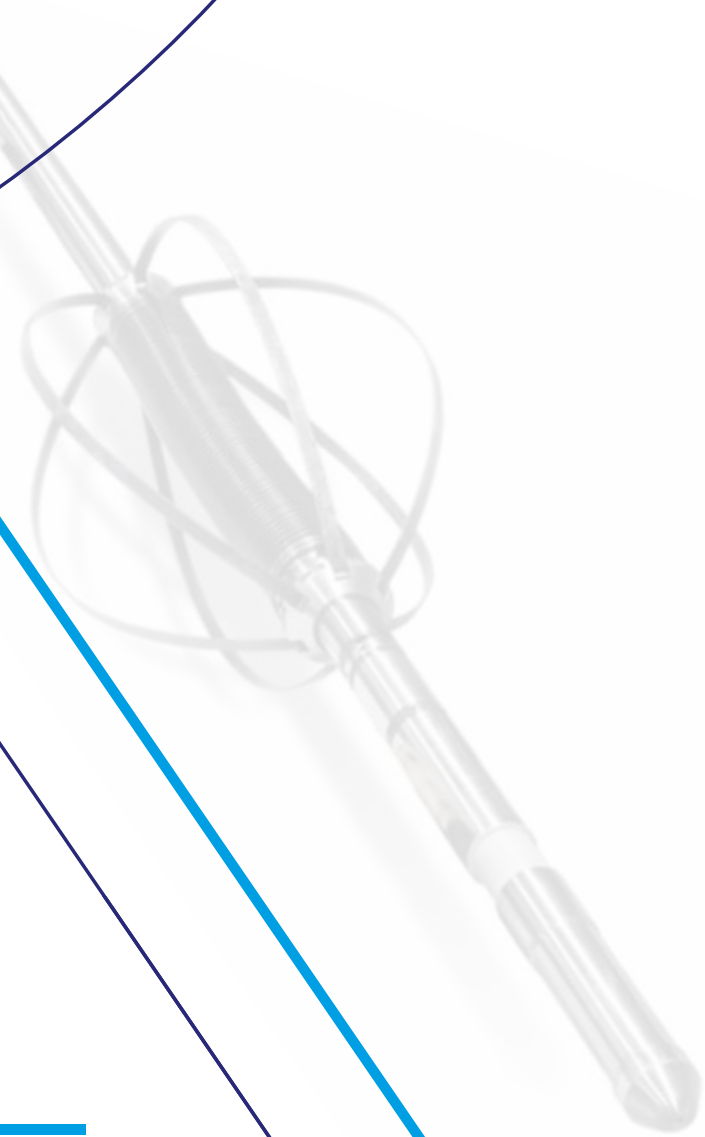
Cement logging

- Onshore well in Europe
- Data recorded in 2 passes from 1200 m
- Processing at surface clears the image
- Run alongside and RBT



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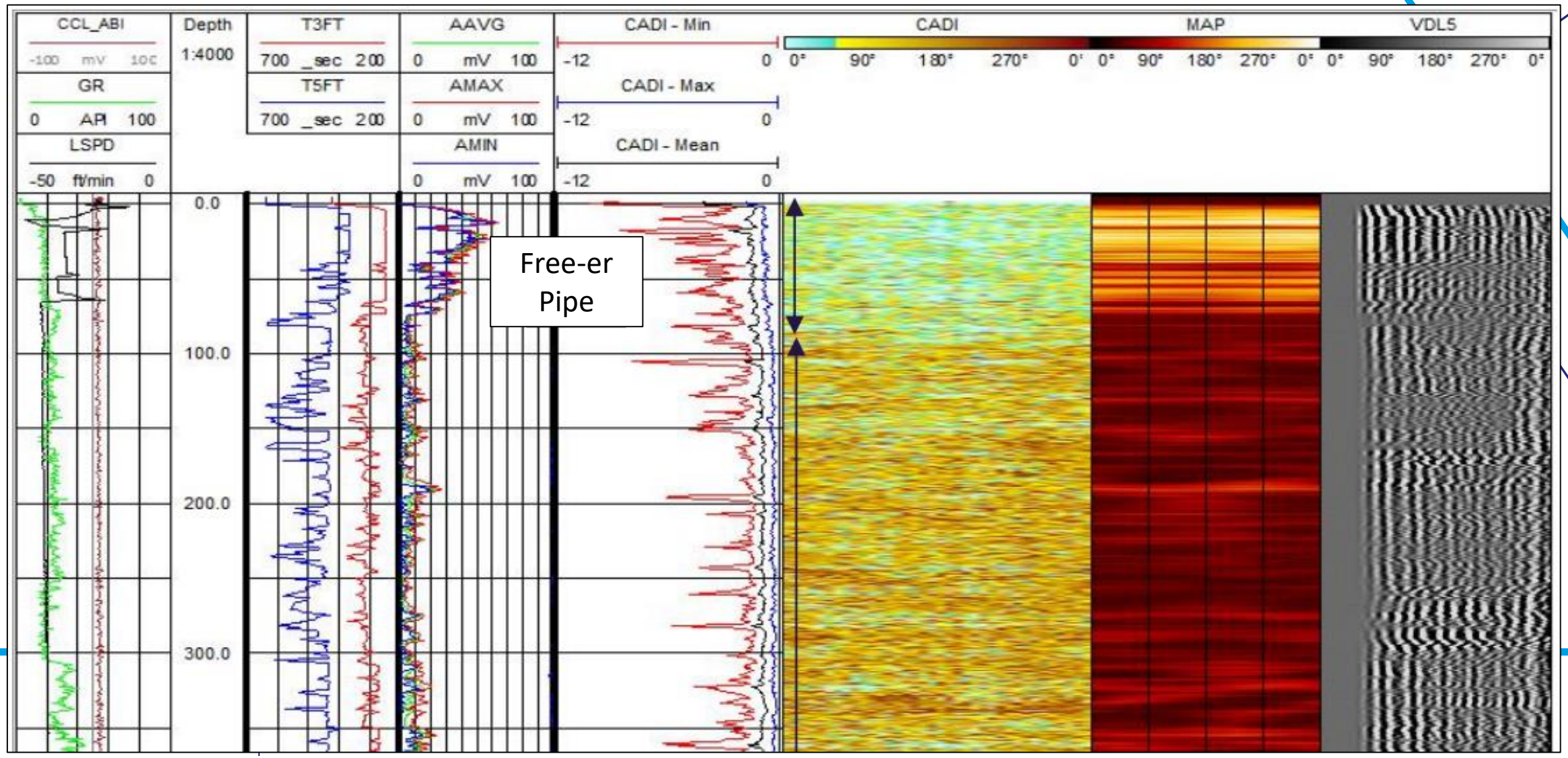
Cement logging



Bonus Case Study
Formation Creep

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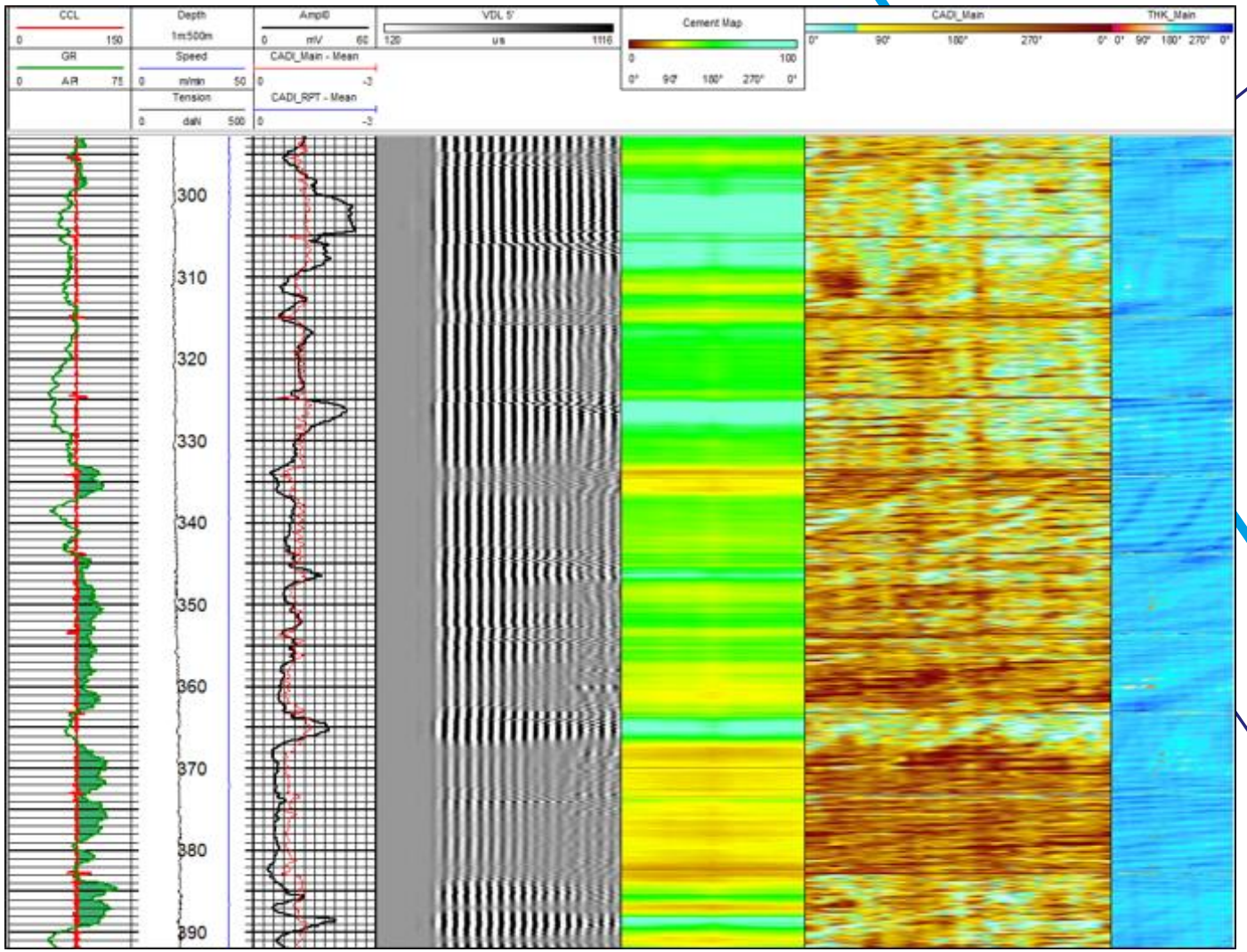
Formation Creep

- Dampening of the casing detected between 367 & 384 m
- Correlation between the GR indicating the presence of clay formation
- Thickness map generated from cement head



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Summary

- Slimline tool
- High radial resolution data
- Complete breakdown of casing corrosion
- Qualitative assessment of non-specialised data

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Thank You

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TECHNICAL DATA SHEET

ABI-43 Integrity Mode

Acoustic Borehole Imager

The ABI-43 is an ultra-compact scanning solution for borehole casing and cement evaluation. This state-of-the-art technology provides 360° data coverage and 3D imaging of the casing/tubing wall, delivering accurate ID, OD and thickness measurements. The tool employs ultrasonic pulses that are generated from within the 1 $^{11}/_{16}$ (43mm) tool body and directed using a rotating internal mirror, therefore no moving parts are exposed to the well environment.

The ABI-43 emits an ultrasonic beam towards the formation, and records the amplitude and travel time of the reflected signal. The amplitude record is representative of the impedance contrast between casing and fluid. The travel time is used to determine accurate borehole diameter data, which makes the tool ideal for casing inspection. For integrity/corrosion mode logging, the corresponding Acoustic Sensor, employing sophisticated algorithms and real time processing, is implemented to extend the tool's application for casing thickness measurement and corrosion evaluation.

Applications

- Internal inspection of casing and tubing to detect various forms of damage, including scale deposits, holes and drilling wear
- Accurate and direct measurement of casing or tubing thickness
- External evaluation of the casing and tubing condition, detecting external corrosion originating from the formation or annuli
- Casing and tubing deformation analysis

Benefits

- Most compact tool of its kind currently available
- Extensive measurement range from 2 $^{7}/_{8}$ in to 15 in tubulars
- Deployable on electric line with mono, multi or coax cables
- Suitable for all well deviations, including horizontal
- Comprehensive range of log analysis and report services available from READ ANSA

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Specifications

Temperature rating*	170°C (338°F)
Pressure rating	10,000 psi (700 Bar)
Tool diameter	$1\ ^{11}/_{16}$ in (43 mm)
Tool length	248 in (6.3 m)
Tool weight	65 lb (29.5 kg)
Logging speed**	Nominal 30 ft/min (9 m/min)
Azimuthal resolution	Standard 72 ppt - 36 ppt post processing
Caliper resolution	0.003 in (0.08 mm)
Casing thickness resolution	0.03 mm
Vertical resolution	Standard 1 in
Inclination accuracy	±0.5°
Frequency	1.2 MHz
Ultrasonic Acoustic sensor	Fixed transducer and rotating focusing mirror
Collimated Acoustic beam	Focal distance diameter 0.12 in (3 mm)
Output***	Internal radius; Amplitude
Borehole fluid	Water, water based mud, brine, oil (oil based mud not applicable)
Materials	Corrosion resistant throughout

*With Gamma Ray - CCL reduced to 125° (257°F).
**When combined with DDS (memory sub).
***Primary curves: 360° unwrapped internal radius and amplitude images; internal radius min-max-average; 360° unwrapped thickness image; thickness min-max-average.

TECHNICAL DATA SHEET

ABI-43 Cement Mode

Acoustic Borehole Imager

The ABI-43 is an ultra-compact scanning solution for borehole casing and cement evaluation. This state-of-the-art technology provides 360° data coverage and 3D imaging of the cement behind the completion. The tool employs ultrasonic pulses that are generated from within the 1 $^{11}/_{16}$ (43mm) tool body and directed using a rotating internal mirror, therefore no moving parts are exposed to the well environment.

The ABI-43 emits an ultrasonic beam towards the formation, and records the amplitude and travel time of the reflected signal. The amplitude record is representative of the impedance contrast between casing and fluid. The travel time is used to determine accurate borehole diameter data, which makes the tool ideal for casing inspection. While in cement logging mode, the in-house developed acoustic sensor is optimised to receive signals from the interface between the completion and the formation, allowing for higher resolution and greater fidelity data to be acquired at the area of interest. Complementary completion ID and casing thickness data are also acquired, albeit to a lower resolution. The CADI (Cement Attenuation Decay Index) generated is a qualitative index directly related to the cement bonding.

Applications

- Cement evaluation

Benefits

- Most compact tool of its kind currently available
- Extensive measurement range from 2 $^{7}/_{8}$ in to 15 in tubulars
- Deployable on electric line with mono, multi or coax cables
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