PSA vessels welding inspection using TECA technique

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Agenda

- PSA vessel inspection
- TECA Technique
- Project scope
- Inspection
- Results
- Conclusion

PSA vessel inspection

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What is a PSA Vessel?

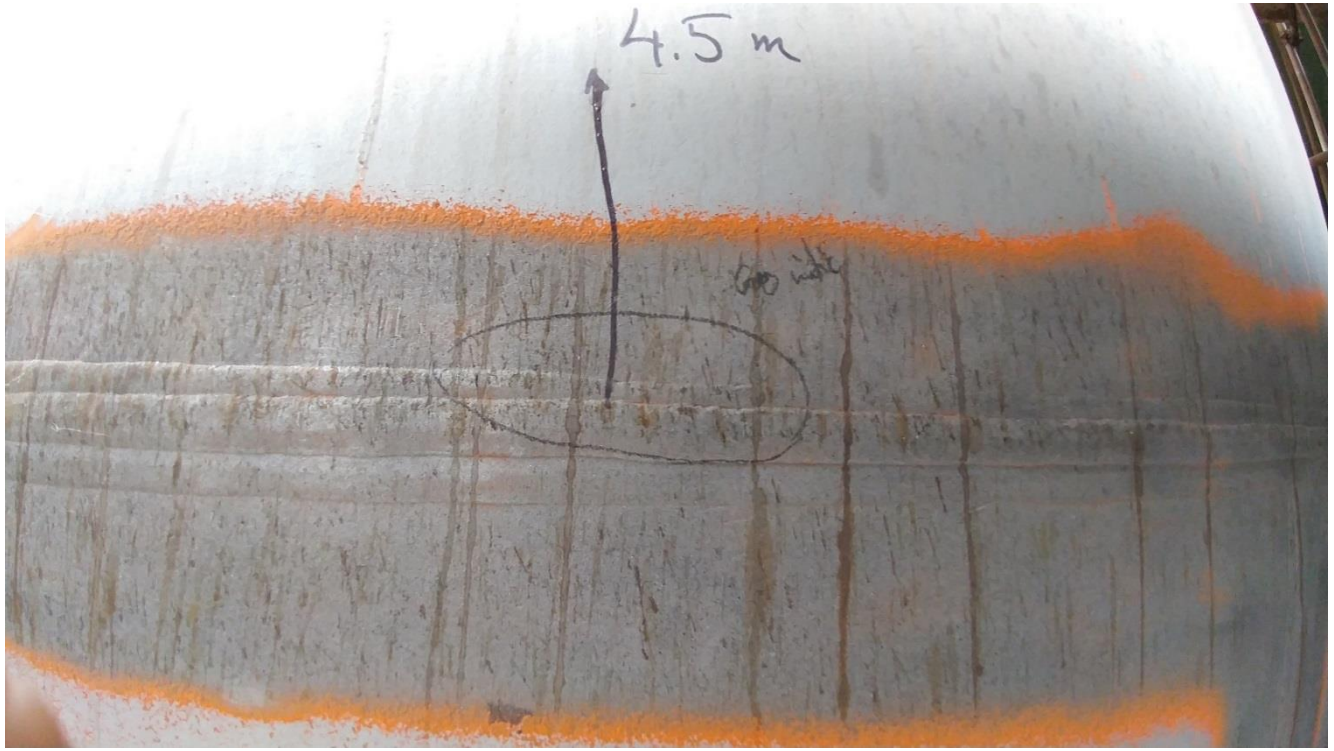
Pressure swing adsorption (**PSA**) is a technology used to separate some gas species from a mixture of gases under pressure according to the species' molecular characteristics and affinity for an adsorbent material. Specific adsorptive materials are used as a trap, preferentially adsorbing the target gas species at high pressure. The process then swings to low pressure to desorb the adsorbed material.

Important point for us: **Pressure cycle**

- Stress which could generate crack

FFS (Fitness For Services) on PSA pressure vessel

- Fitness-for-service (FFS) assessment is a multi-disciplinary approach to determine, as the name suggests, whether equipment is fit for continued service.
- The outcome of a fitness for-service assessment is a decision to run as is, repair, re-rate, alter, or retire the equipment.

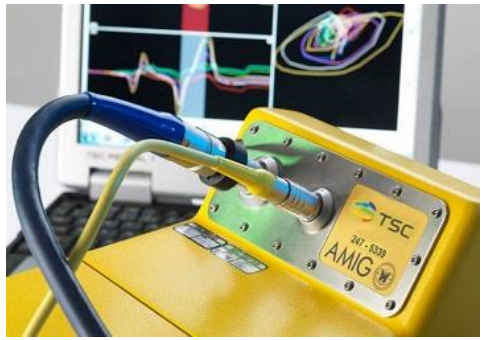


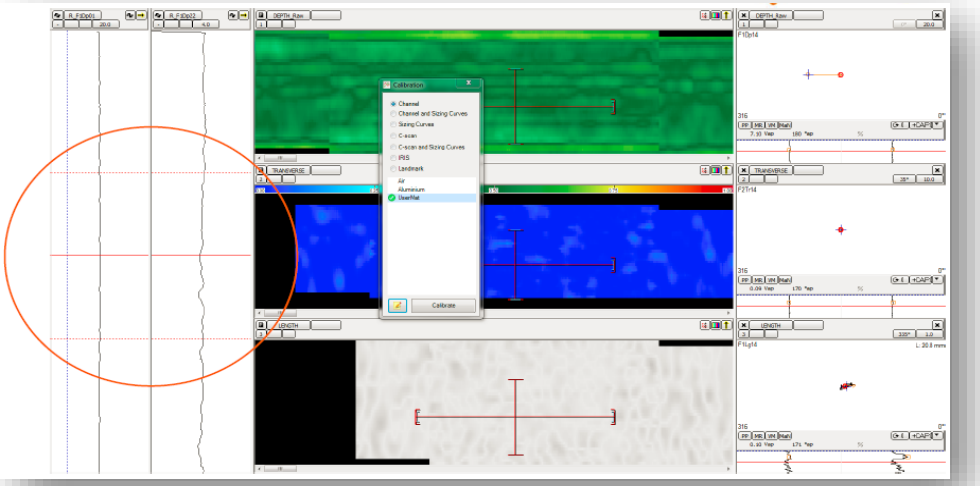
Surface defect detection using MT on carbon steel weld

- **Advantages**
  - Easy use
  - Reasonable cost
  - Easy certification
- **Disadvantages**
  - No traceability
  - No depth sizing
  - Time of application

Alternative solution to MT for weld inspection

- Penetrant testing
- Conventional ET
- ECA
- ACFM
- TECA





TECA Technique

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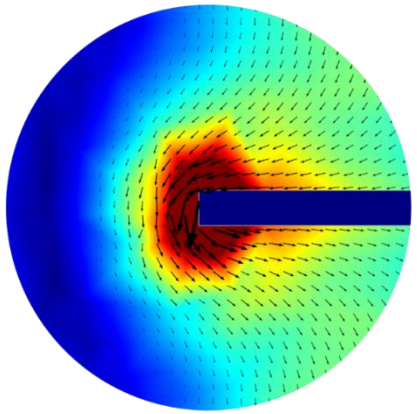
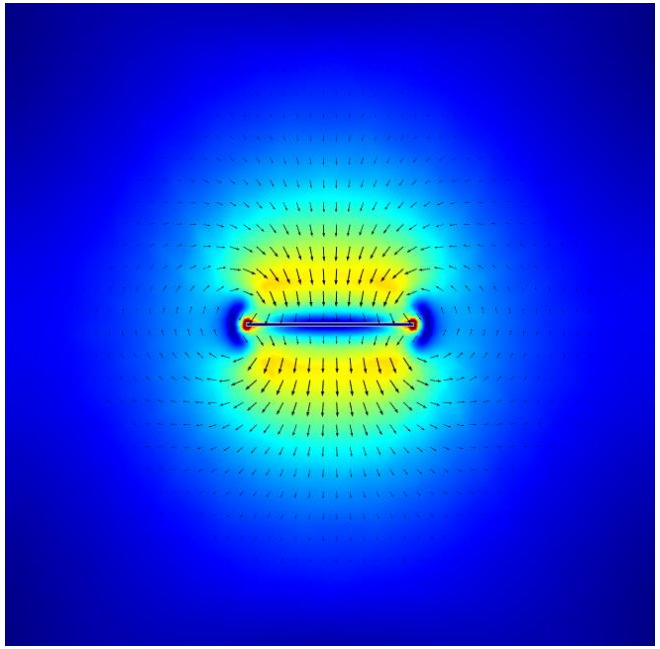
Basic principle

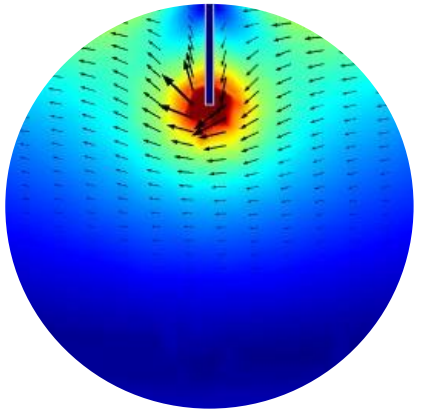
– Coils' arrangement

– Eddy Current density nearby surface indication



Plan view

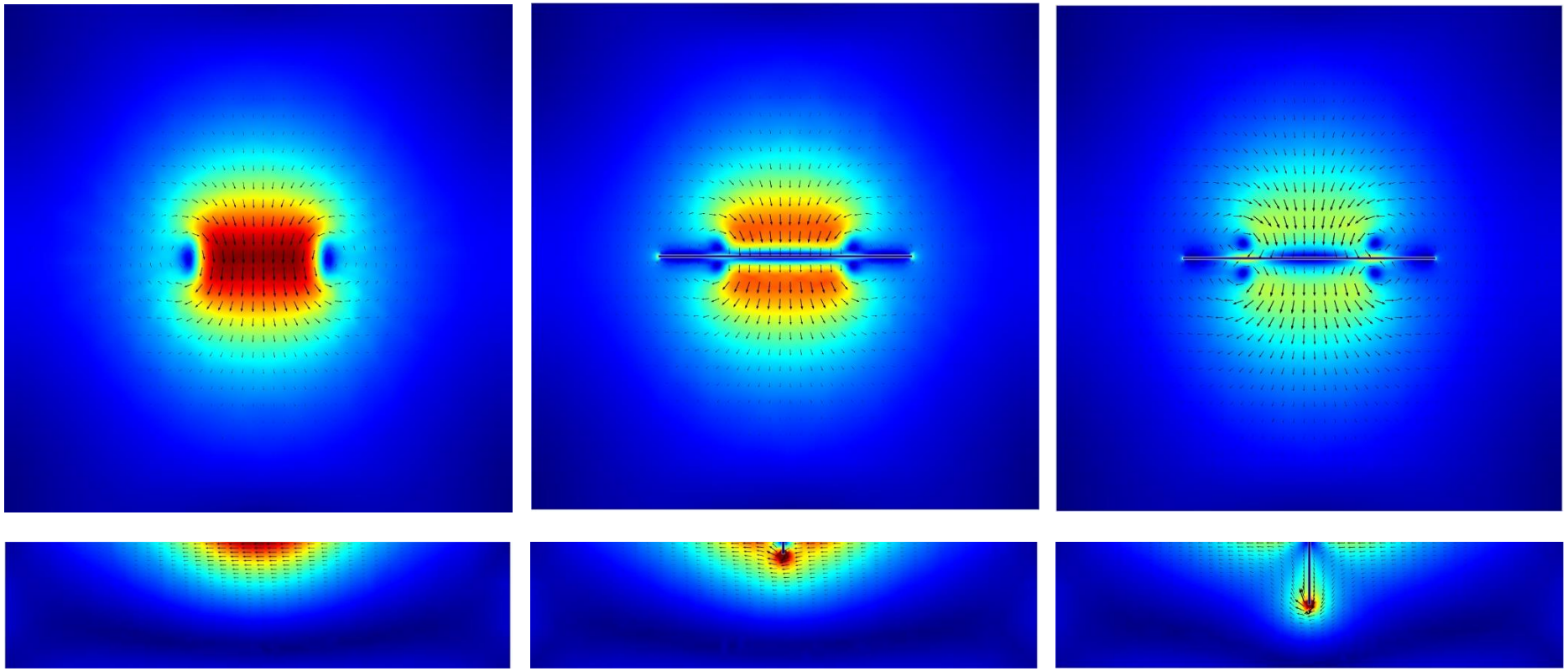




Depth view

Basic principle

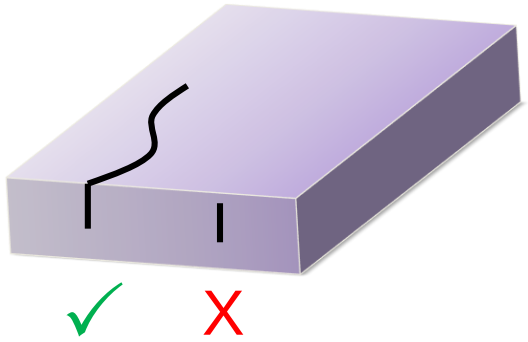
– Eddy Current Density



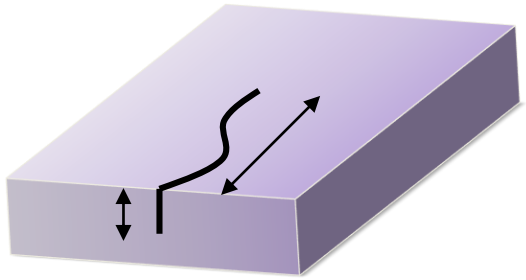
No defect *1 mm deep crack* *5 mm deep crack*

What can it do?

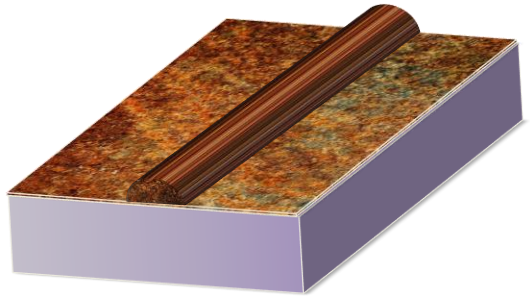
Surface-breaking cracks in CS



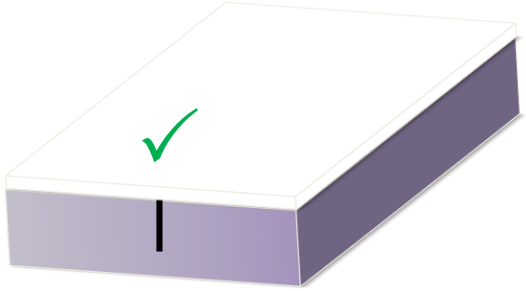
Length and depth sizing



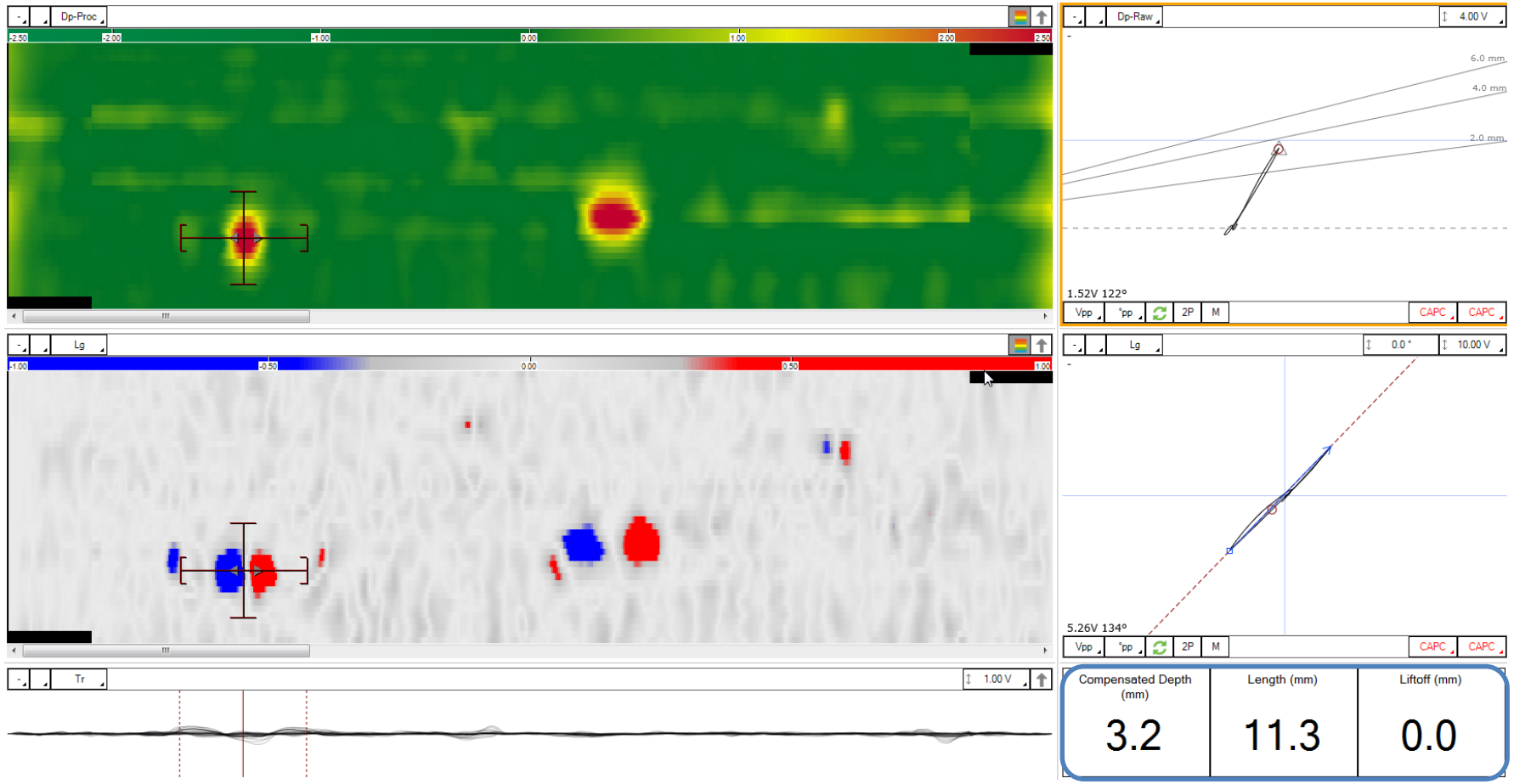
Accommodate weld crown in the ”as is” condition



Lift-off tolerance: coating/paint up to 2-3mm (0.080”-0.120”)



Example


Dp-Proc
Dp-Raw
4.00 V
6.0 mm
4.0 mm
2.0 mm
1.52V 122°
Vpp
°pp
2P
M
CAPC
CAPC
Lg
Lg
0.0 °
10.00 V
5.26V 134°
Tr
1.00 V
Compensated Depth (mm)
Length (mm)
Liftoff (mm)
3.2
11.3
0.0

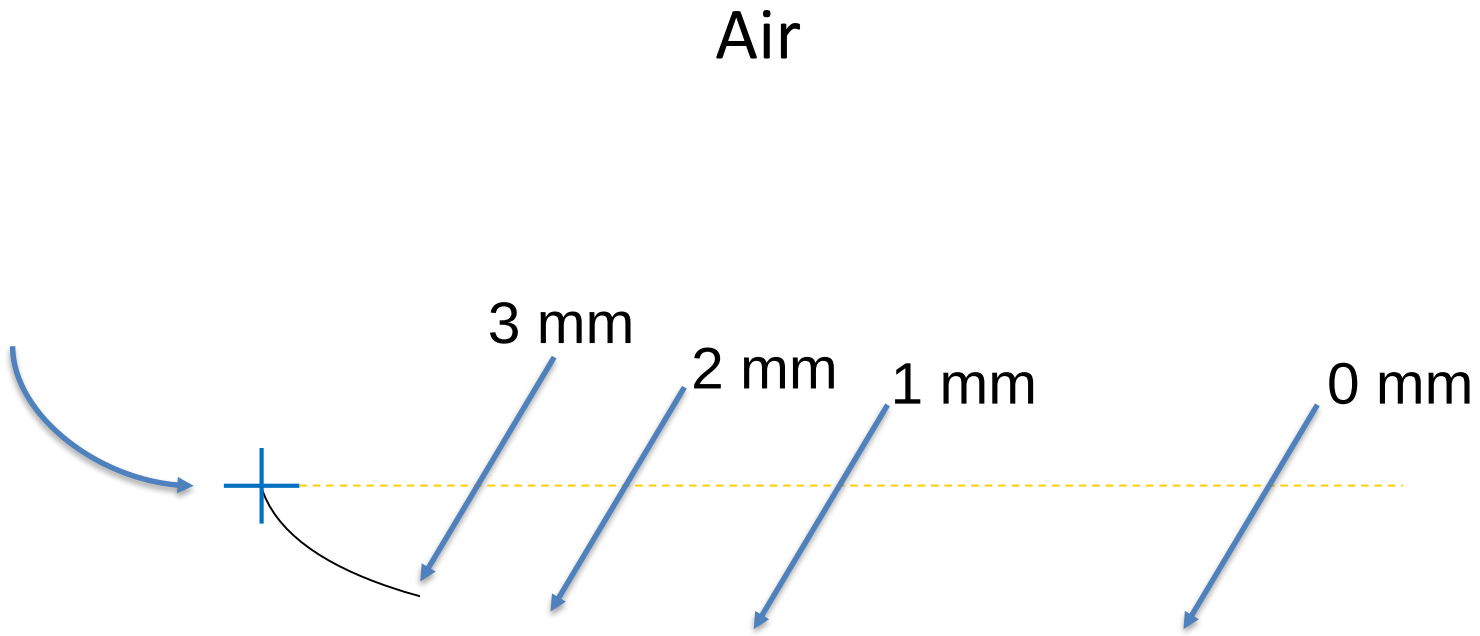
Which cracks can be detected?

- Surface breaking cracks
- Minimum 2 mm long
- Minimum 0.5 mm deep

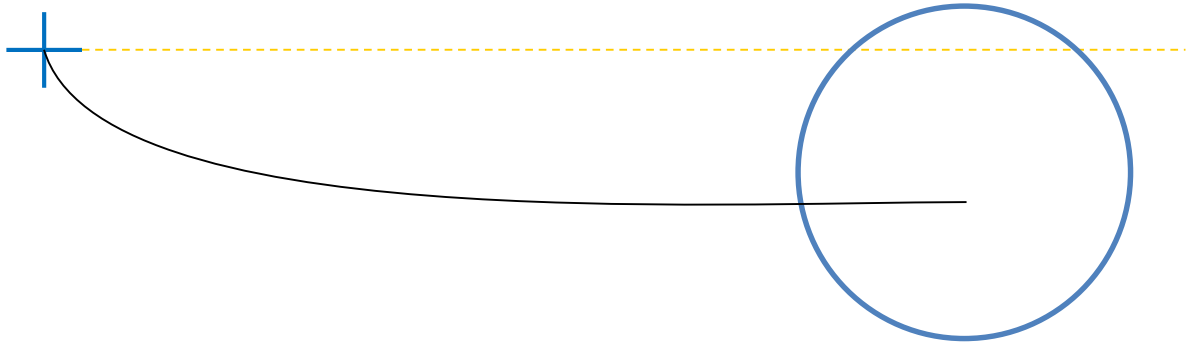
} Depends on Lift-Off and surface roughness

- Detection and measurement of axial cracks
- Detection of transverse cracks

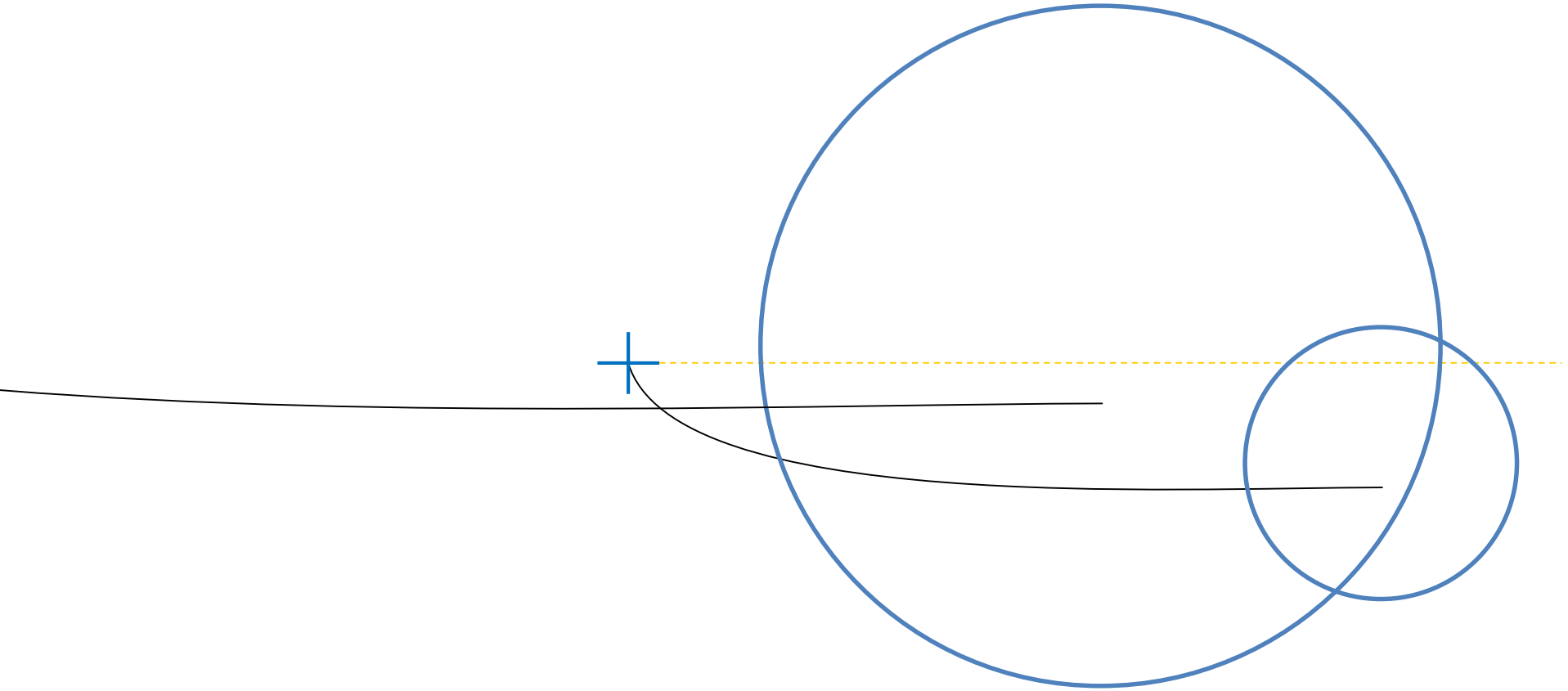
Lift-Off signal on carbon steel



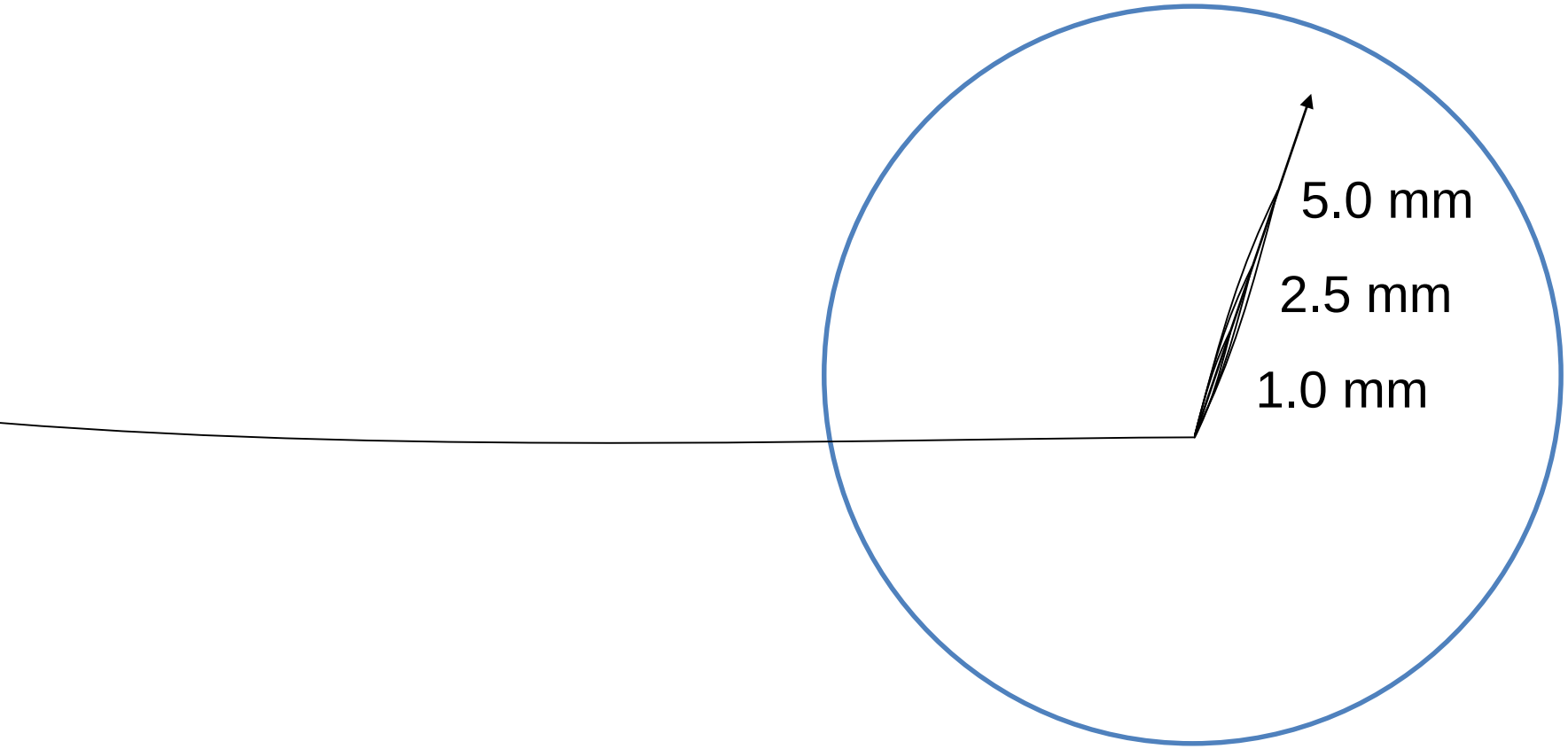
Crack signal on carbon steel



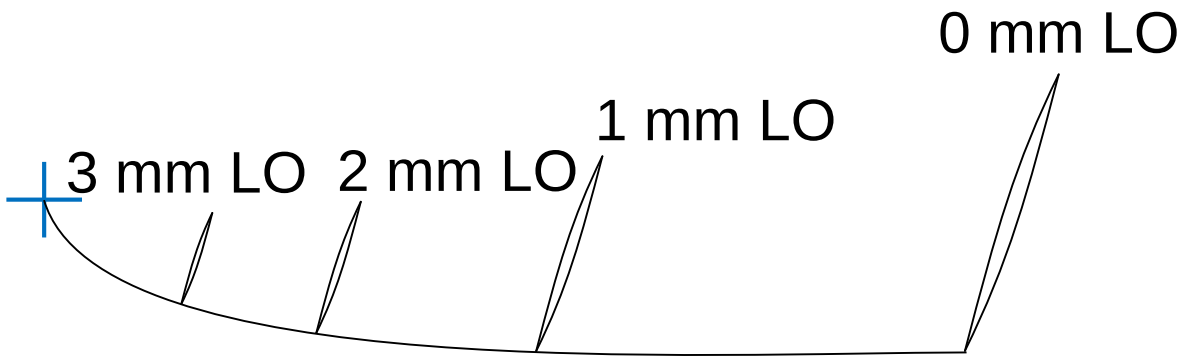
Crack signal on carbon steel



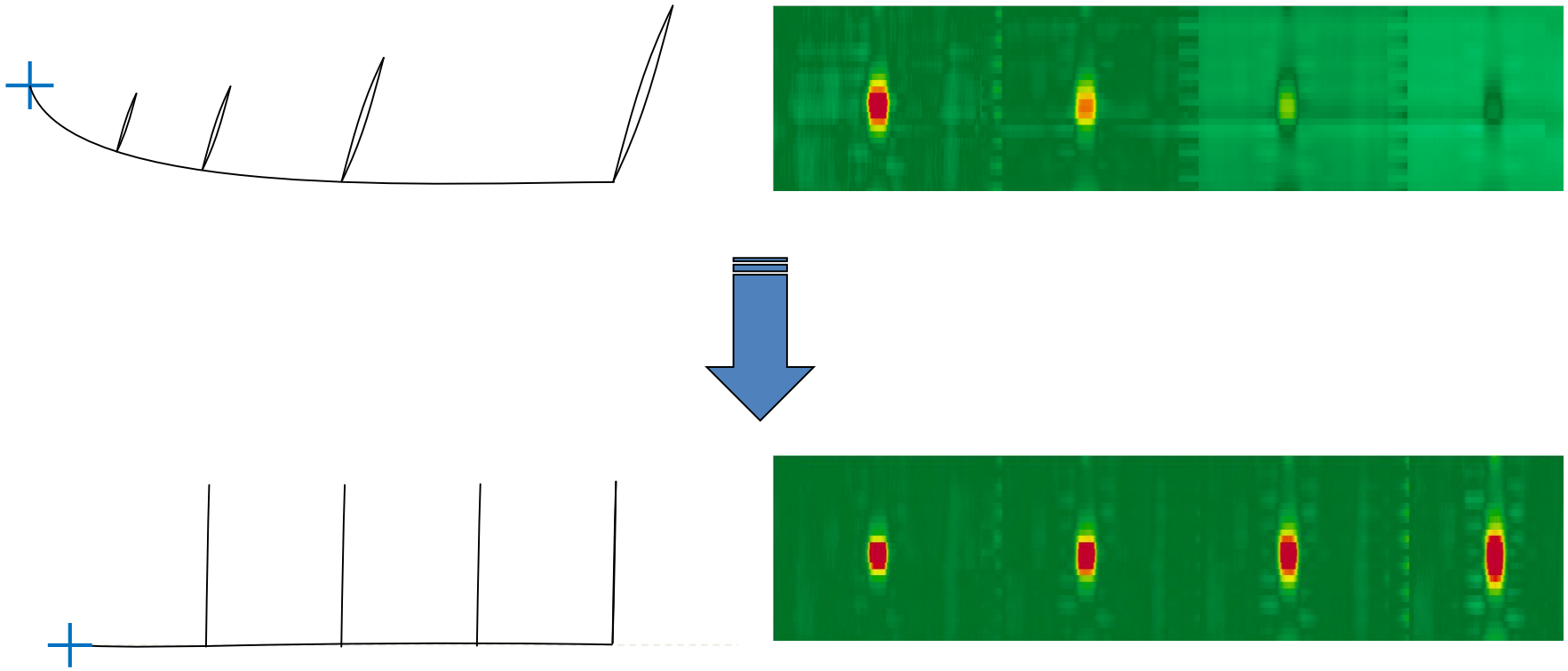
Crack signal on carbon steel



Effect of Lift-Off on crack signal



Automatic Lift-Off compensation



Transverse signal

Sharck Butt Weld (Eddyfi solution)

- 64 channels
- 53 mm (2.09 in) coverage
- 22 fingers (11 x 2 rows)
- Weld cap, toes and HAZ in one pass

Key Benefits

- Single-pass detection of longitudinal and transverse cracks
- Fast - Maximum scan speed of 200 mm/s
- Wide coverage - Cap, toes and HAZ in one go
- Automatic readings - Crack length and depth, liftoff
- Automatic compensation - Live monitoring of liftoff and permeability variations
- Full data recording and archiving capabilities

Sharck Pen probe

- To inspect surfaces that other Sharck probes cannot
- Coverage of 7 mm
- 1 depth/length channel
- Scan speed up to 200 mm/s
  - Recommended at 50 mm/s

Project Scope

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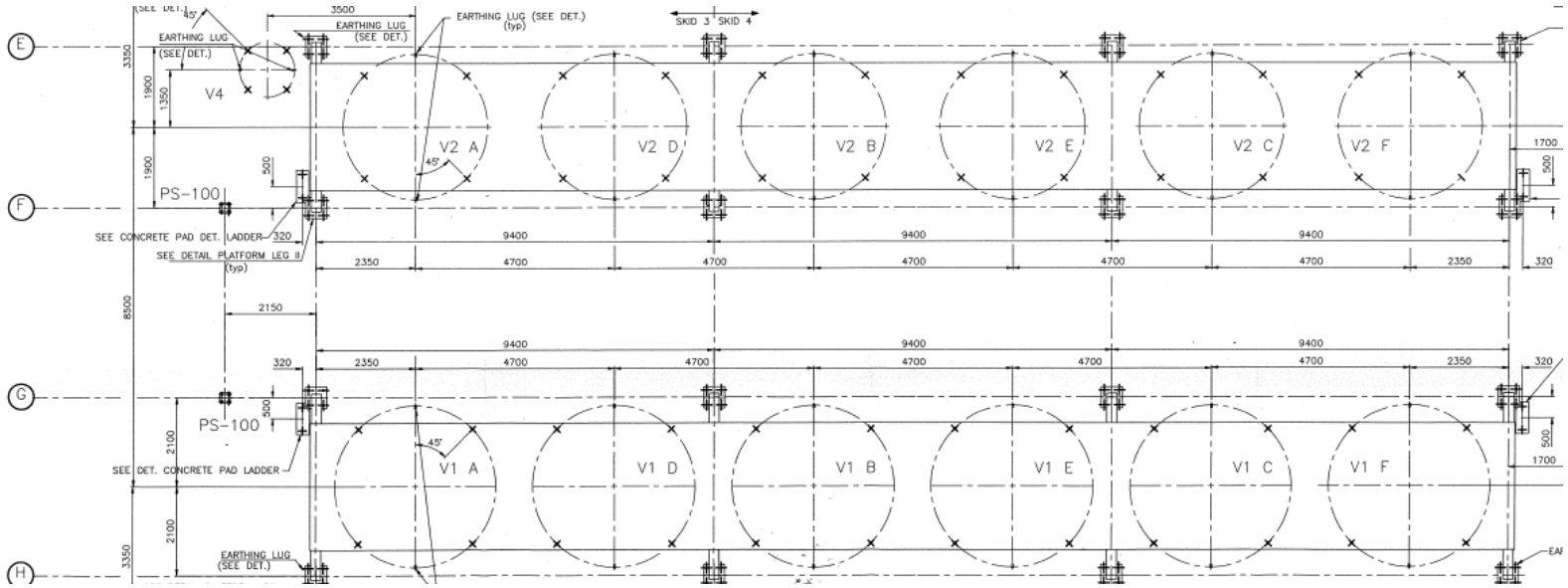
Inspection project

- Location: Middle East
- In service weld inspection of 12 PSA vessel
- Semi-automated inspection using TECA system
- Scope: Detection and characterization of surface indications that could be present in welding and adjacent material.

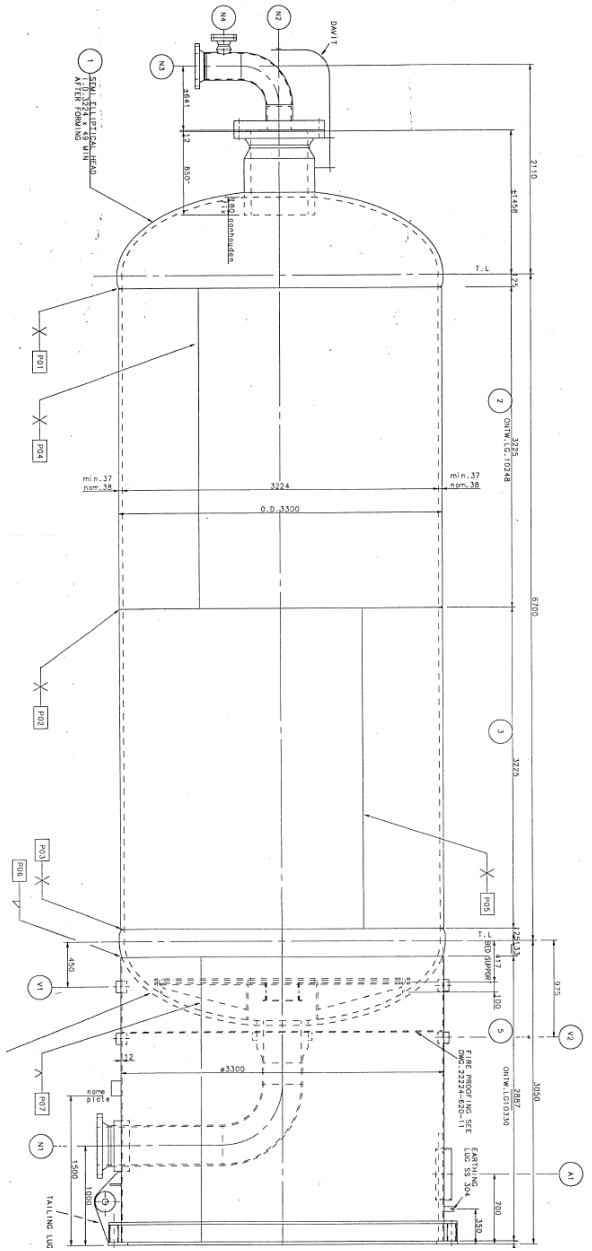


Customer need for TECA inspection

- Quick inspection (Shut down window)
- Data traceability (periodic inspection)
- Flaw sizing

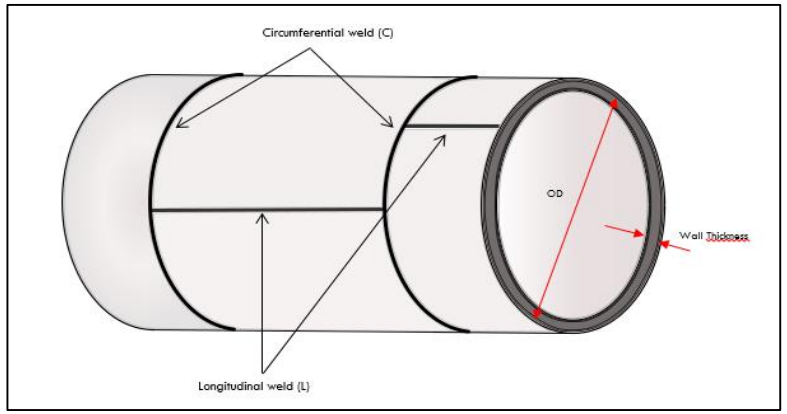
PSA Vessel details

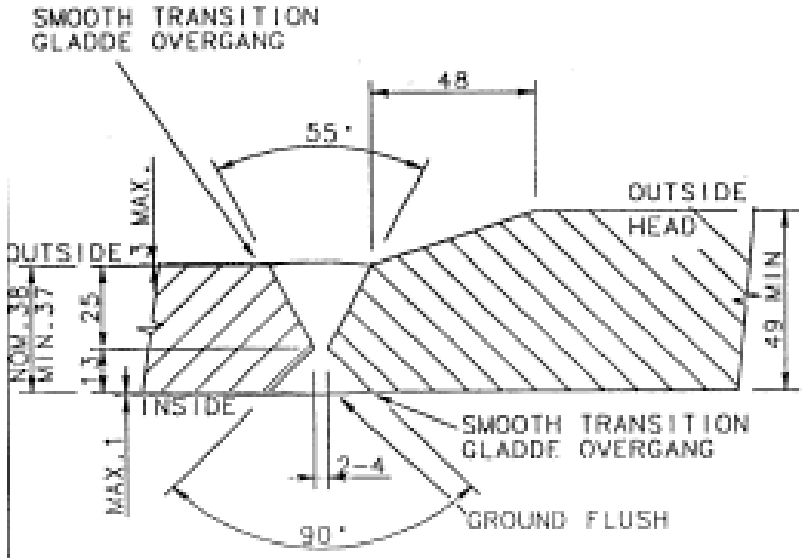
- Material: Carbon steel
- Thickness: body: 38mm, head 48mm
- Weld preparation: Double V
- Diameter: 3,3m
- Height: 9m
- Overall weld length: 37,5m / vessel



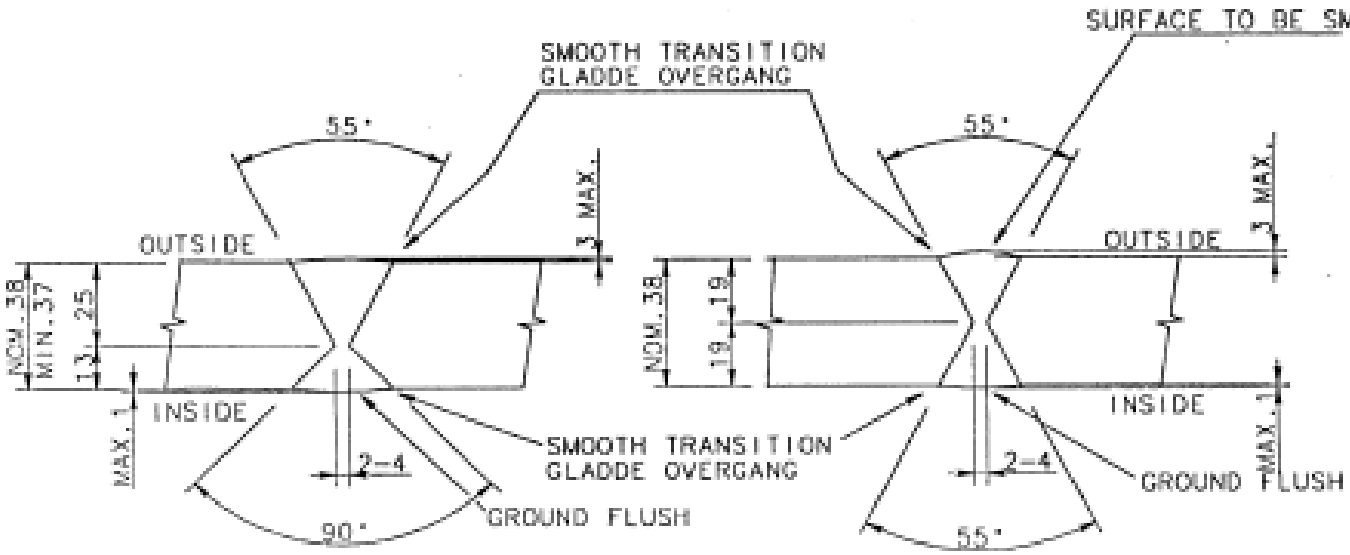
Welds configurations

- Circumferential head weld
- Circumferential body weld
- Longitudinal weld





CIRCUMFERENCE SEAM HEAD P01–P03



CIRCUMFERENCE SEAM SHELL P02

LONGITUDINAL SEAM SHELL P04–P05

Code

- ASTM E3052-16 (Standard Practice for Examination of Carbon Steel Welds Using Eddy Current Array)

Designation: E3052 – 16

Standard Practice for Examination of Carbon Steel Welds Using Eddy Current Array[1]

Inspection

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Details

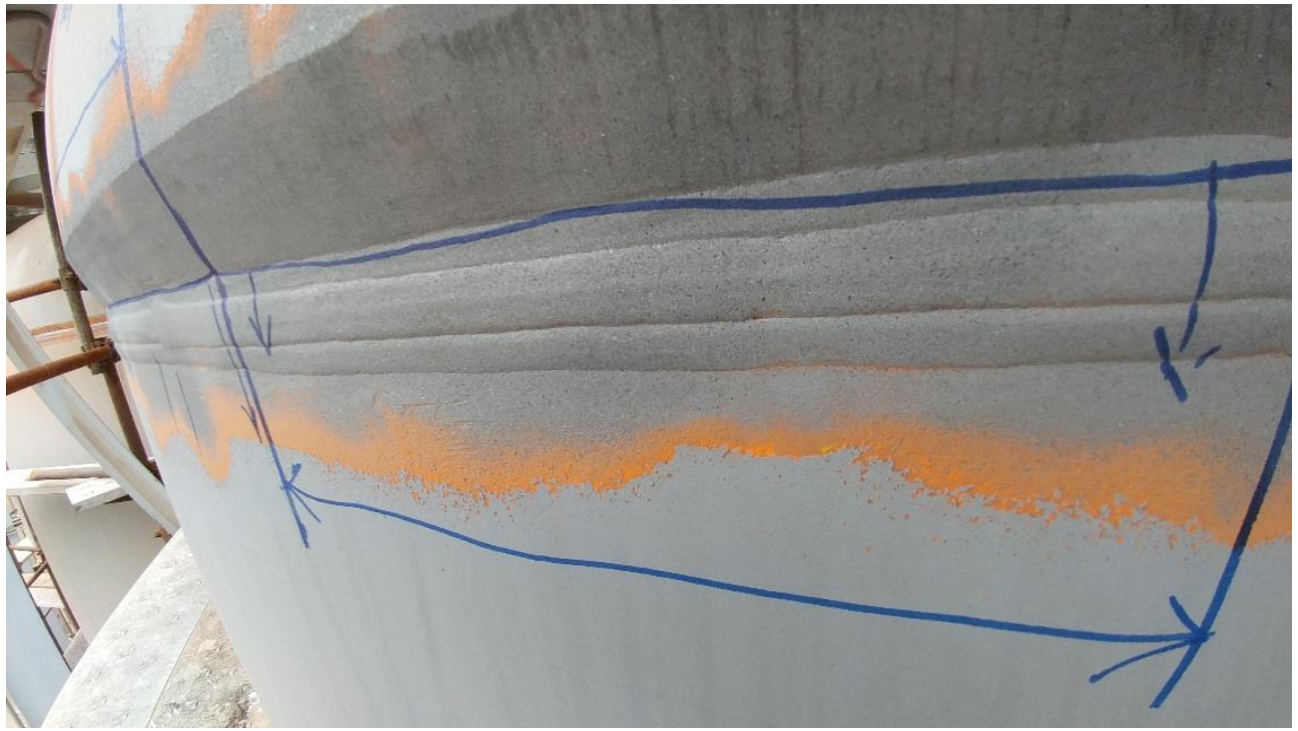
- Inspection of 12 vessel has been done in 4 days
- The refinery stop 2 to 4 vessel per day to allow inspection
- Large weld needed two pass
- Circumferential weld at the junction with the Head need special attention because of the change of thickness

Surface preparation

- Sand Blast
- No preparation

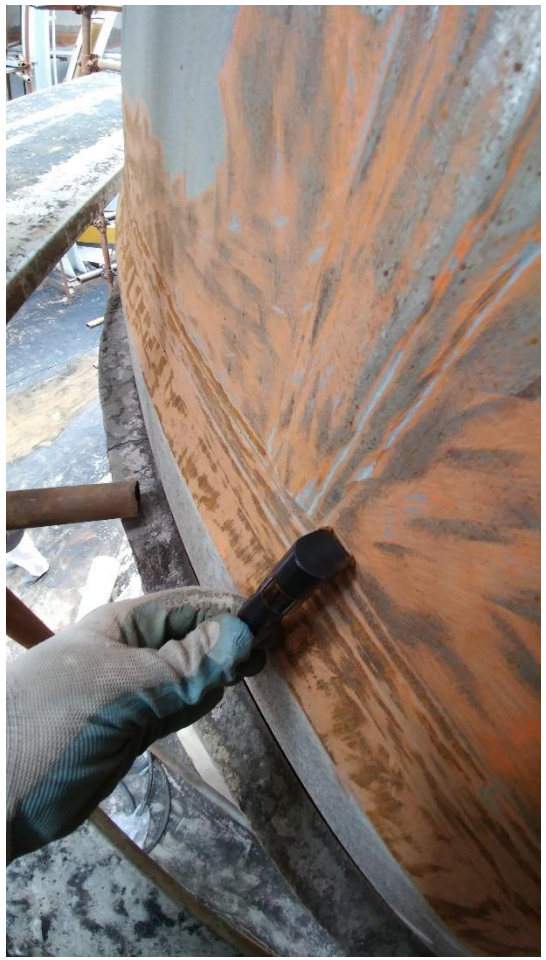
Scan at the thickness change

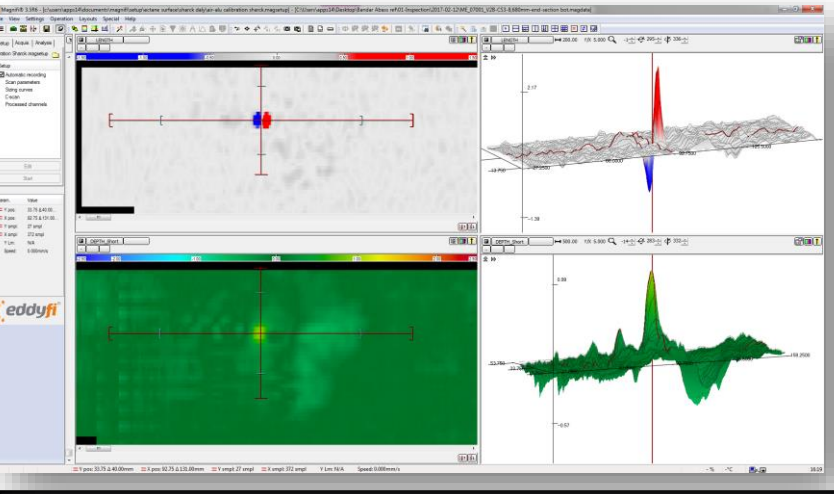
- The top weld of each vessel
- Difficult to fit the probe

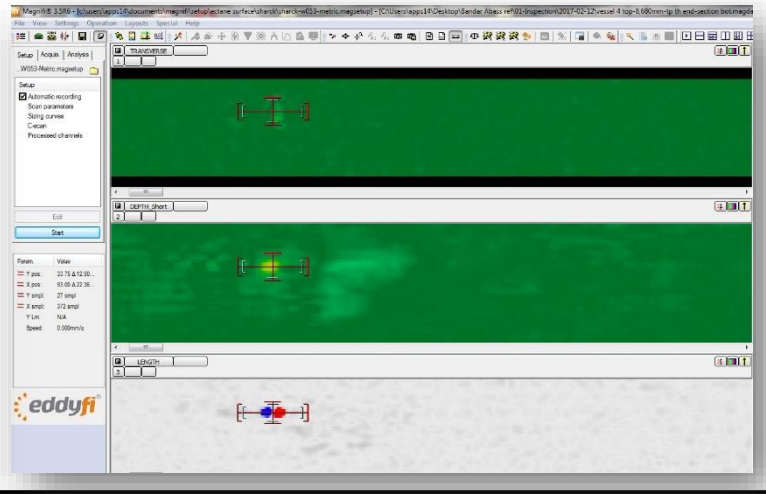


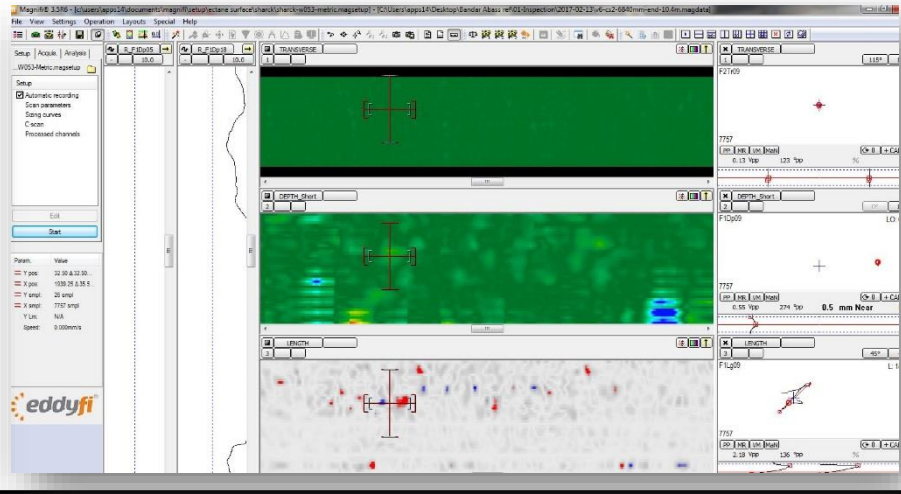
Special scan

- Junction between circumferential weld and longitudinal weld require Single element probe scan









Results

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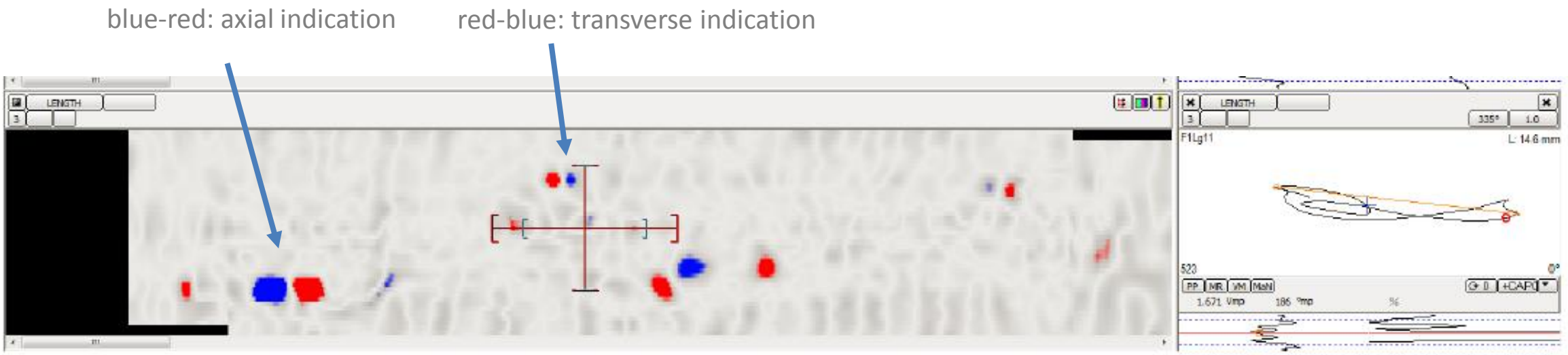
Data interpretation

- Resulting data is assessed based on scans display on Magnifi which consist of three different views (C-Scans) per layout which make interpretation simple.
- There are two layouts useful for data analysis: Axial (for axial cracks) and Transverse (for axial and transverse cracks).
- In order to cover both indications type, the three used C-Scans for the present project are: Length, Depth Short and Transverse.

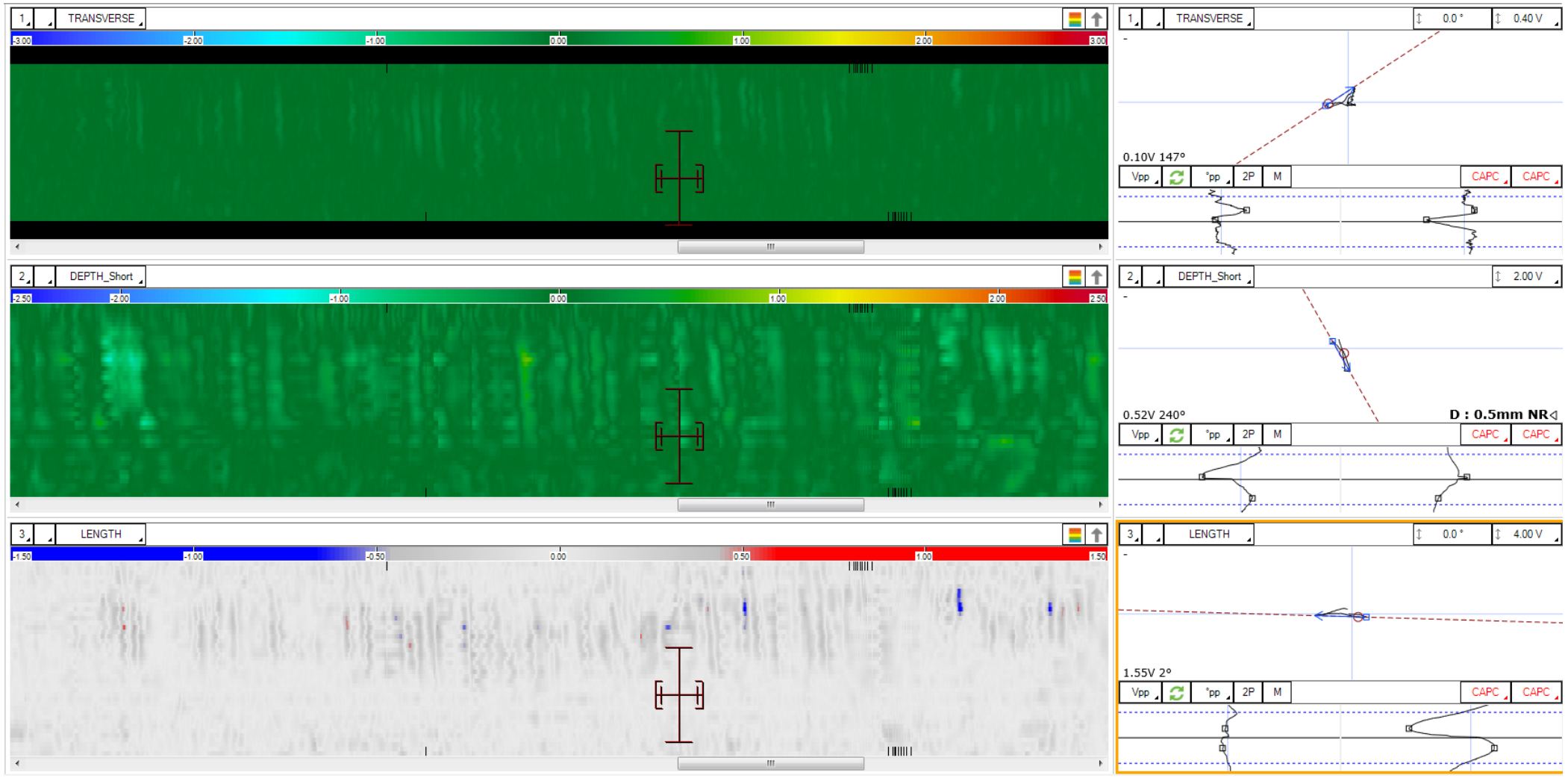
Data interpretation

- In order to call a defect, an indication is needed on **both** "**Depth**" and "**Length**" C-Scans (Axial layout). On the "Length" C-Scan, a differential signal should be going negatively first and then positively after: **blue-red** sequence on C-Scan.

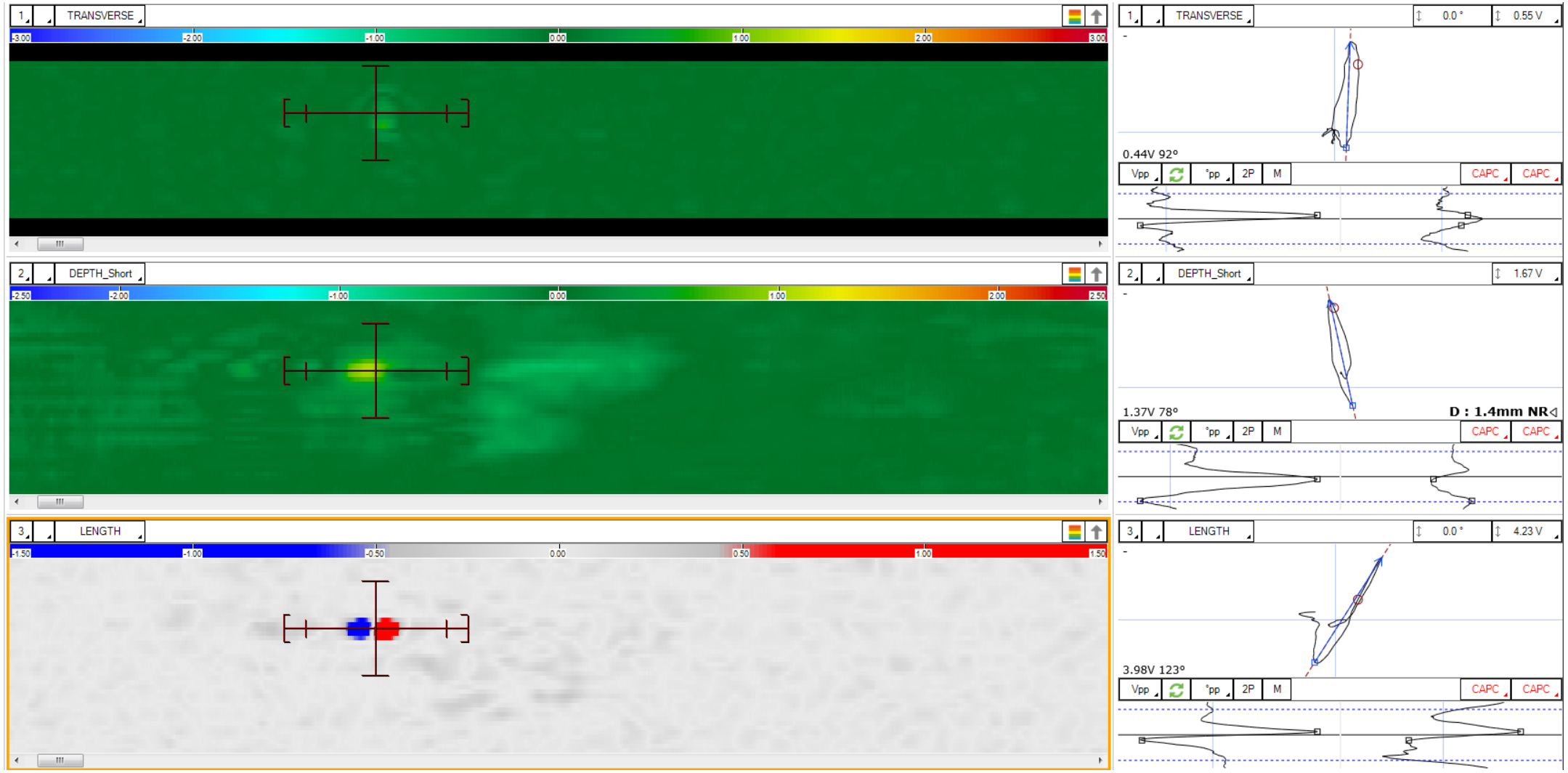
- "**Transverse**" C-Scan should be used for transverse cracks detection. **Length** signal will be **red-blue** (inverse of axial cracks).



Typical scan without indication



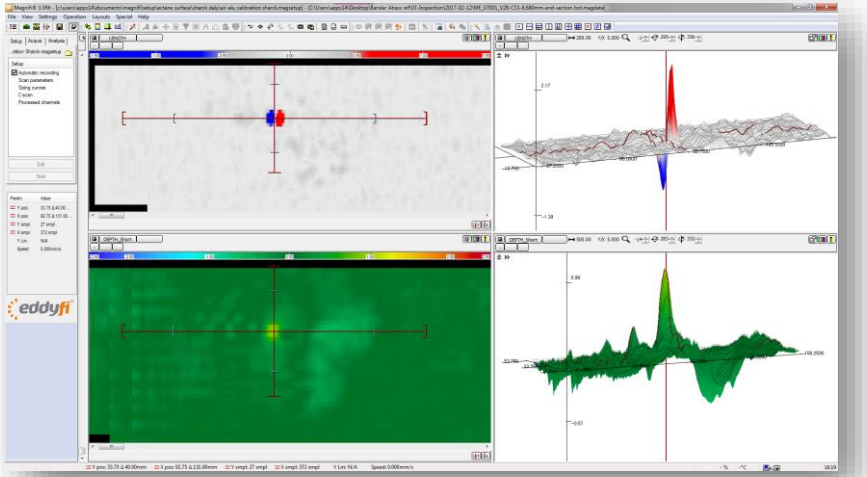
Example of detected indication



Documentation

- A hard copy of all scans
- TECA report for each vessel
- FFS Report including TECA results

ME_07001_V1B	CS1	Accepted, no relevant indications were noticed
	CS2	Accepted, no relevant indications were noticed
	CS3	Accepted, no relevant indications were noticed
	LS1	Accepted, no relevant indications were noticed
	LS2	Accepted, no relevant indications were noticed
ME_07001_V1D	CS1	**Accepted after grinding and ECA retesting**
	CS2	Accepted, no relevant indications were noticed
	CS3	Accepted, no relevant indications were noticed
	LS1	Accepted, no relevant indications were noticed
	LS2	Accepted, no relevant indications were noticed
ME_07001_V1A	CS1	**Accepted after grinding and ECA retesting**
	CS2	Accepted, no relevant indications were noticed
	CS3	Accepted, no relevant indications were noticed
	LS1	Accepted, no relevant indications were noticed
	LS2	Accepted, no relevant indications were noticed



Conclusion

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Conclusions

Benefit vs conventional

- Quick inspection
- Data recording
- Sizing

Technique limitation

- Surface breaking defect only
- Eddy current certified people required
- Software training needed
- Equipment cost


Question?