

Magnetic eddy current as a novel technique for the internal inspection of CRA-lined pipe

K. Reber, Innospection Germany GmbH, Stutensee

A. Boenisch, Innospection Ltd., Aberdeen

*PPSA Seminar November 18th 2015, The Ardoe Hotel,
Aberdeen*

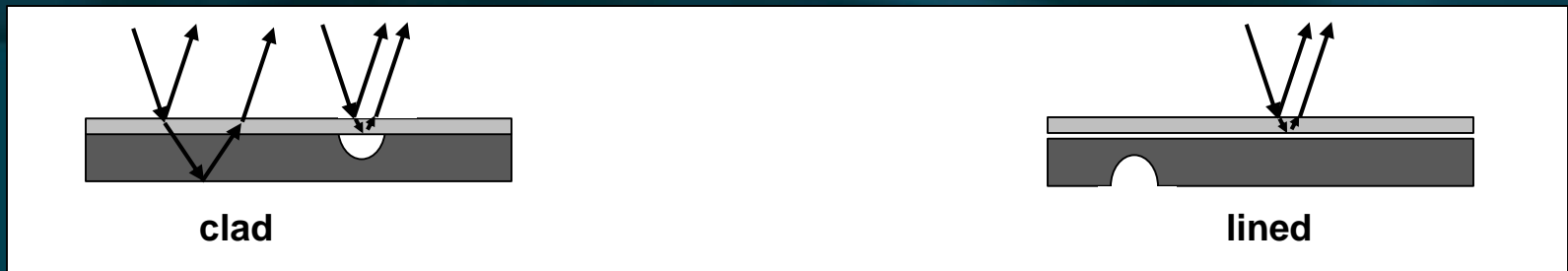
What are clad and lined pipes?

- **Clad pipe:**
 - **Metallurgically clad by**
 - » **Roll bonding**
 - » **Explosion bonding**
 - » **Overlay welding**
 - **Resulting in a metallic bonding between carrier pipe and CRA pipe**
- **Lined Pipe:**
 - **CRA pipe is expanded inside a carrier pipe. Pipe ends are made with overlay welding to ensure weldability.**
- **Typical Defects:**
 - **Many, but mainly internal corrosion of carrier pipe**

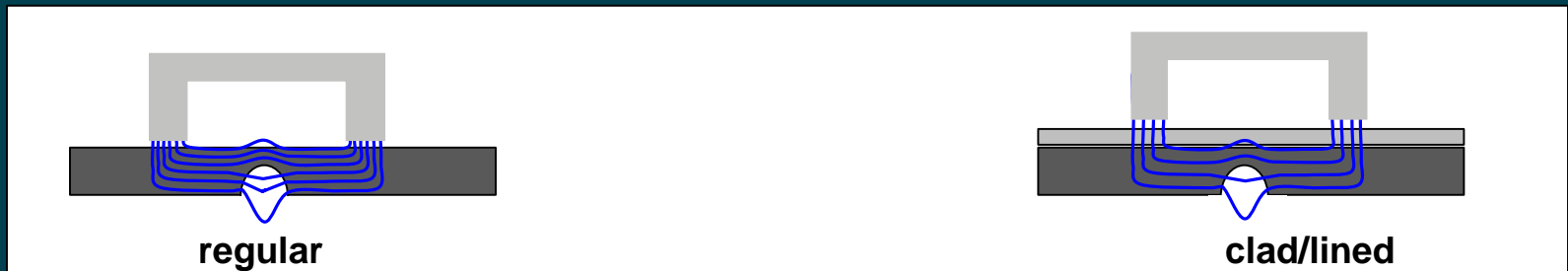


What can standard technology achieve?

Ultrasonic Inspection [1]



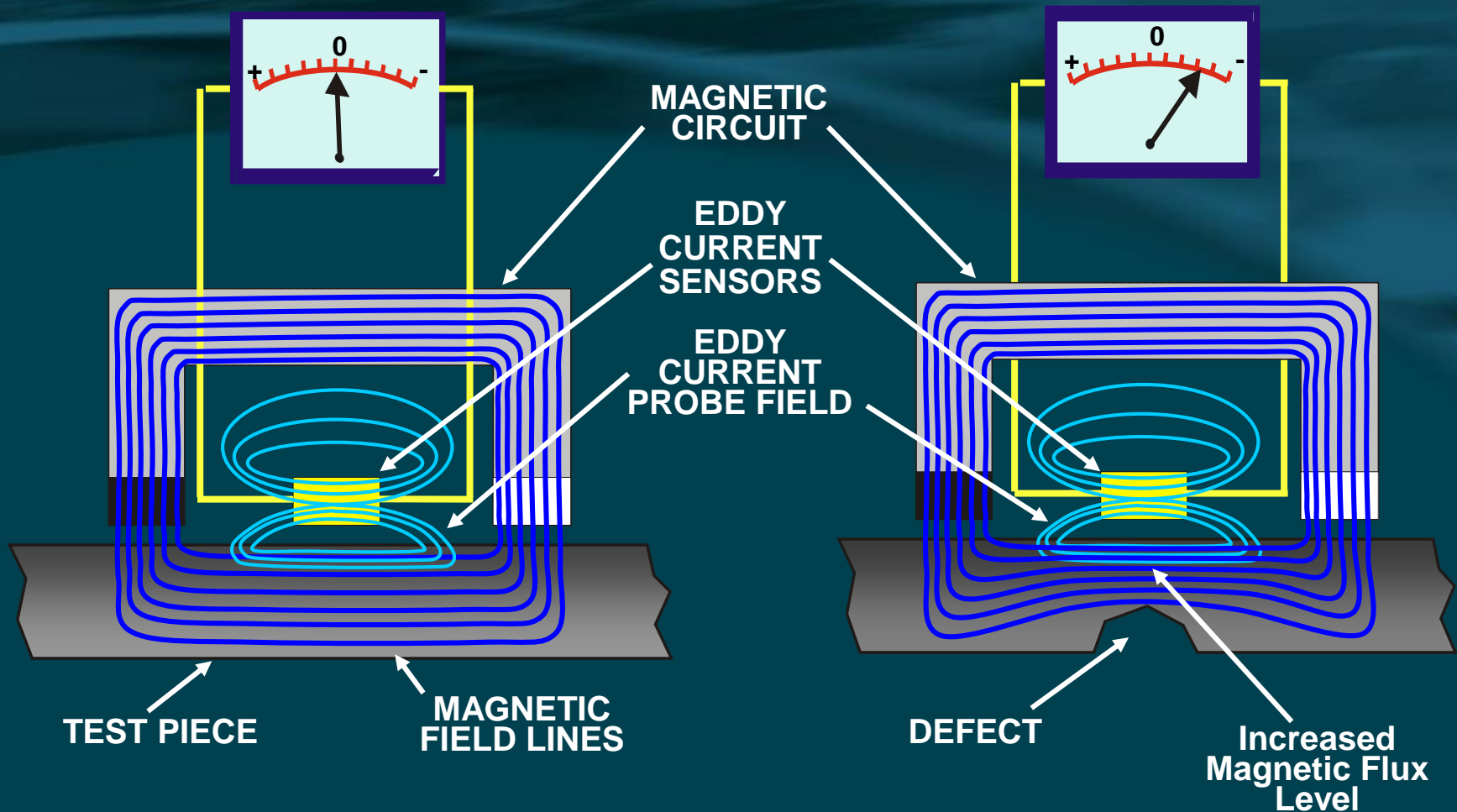
Magnetic Flux Leakage [2]



[1] ILI in CRA-clad and lined pipes, Abdullahi Atto, NDT Global, PPIM Houston 12th to 13th Feb. 2014

[2] In-line Inspection of pipes using corrosion resistant alloys (CRA), M.Sc. Johannes Keuter, Rosen RTRC Lingen, PPSA Seminar Nov. 2014

Magnetically Biased Eddy Current (MEC™)



Test Pipe



	Carbon Steel carrier pipe	CRA-liner
OD	8.625" (219 mm)	
ID		6.765" (171.8 mm)
Thickness	0.812" (20.6 mm)	0.118" (3 mm)
Material	X65	825 Incoloy
Pipe Type	Seamless	Long seam welded

Set-up for testing



Prototype tool

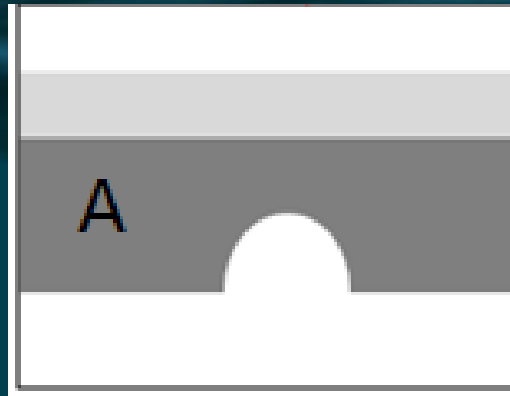


Workshop set-up
for pull tests

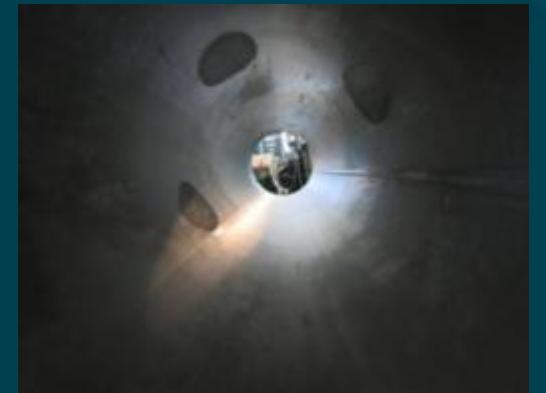
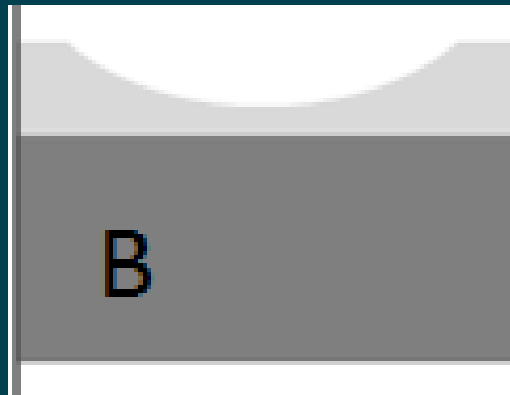
Test Defects

External metal loss

Depth:
20%-80% of carrier pipe
Size:
3mm – 24 mm diameter



Internal erosion
20% to 60% of liner
50 x 100 mm

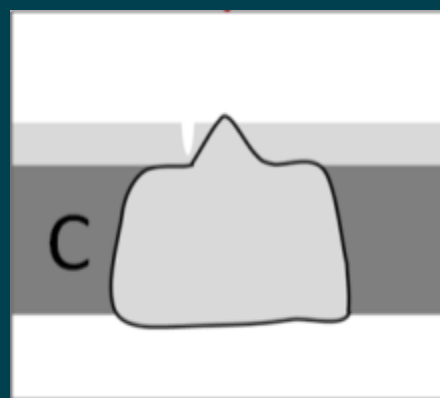


Defects

**Crevice
corrosion**
10%-50%
6-24mm

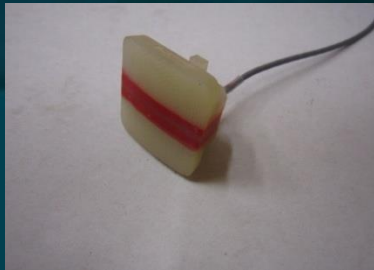


cracking



Adjustable Parameter

- ***Sensor types***



- ***Speed***

- *Varied from 0.02 m/s to 0.75 m/s*

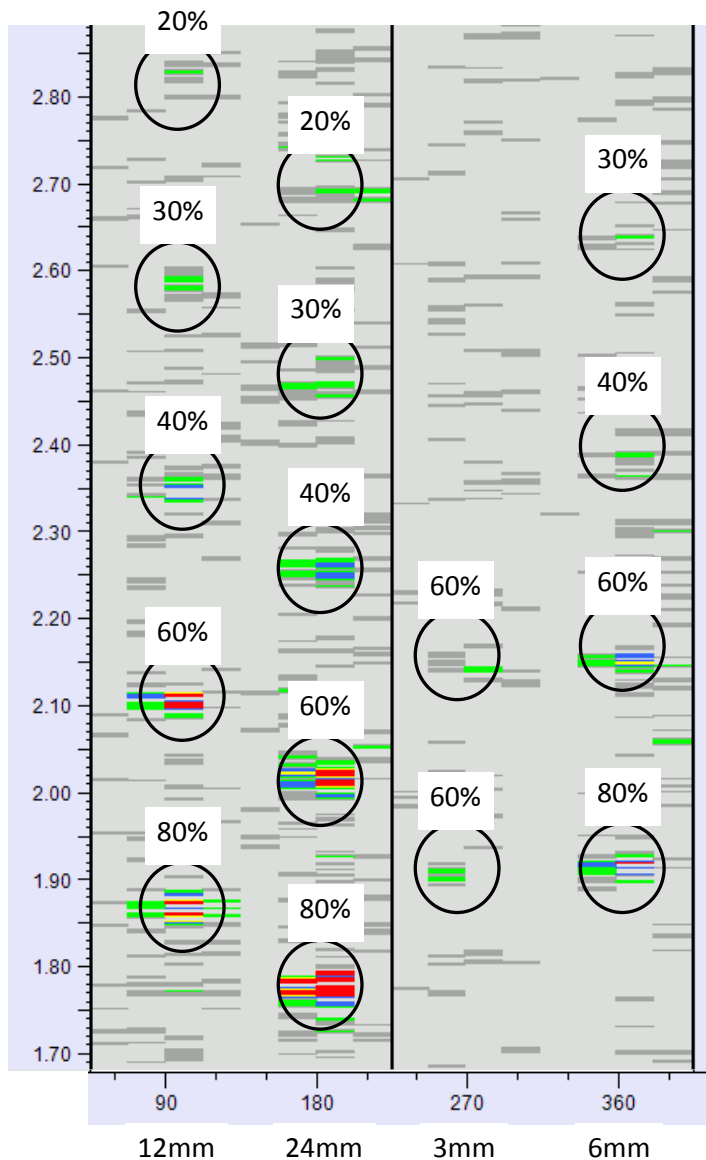
- ***Frequencies***

- *Higher Frequencies more sensitive to near side*

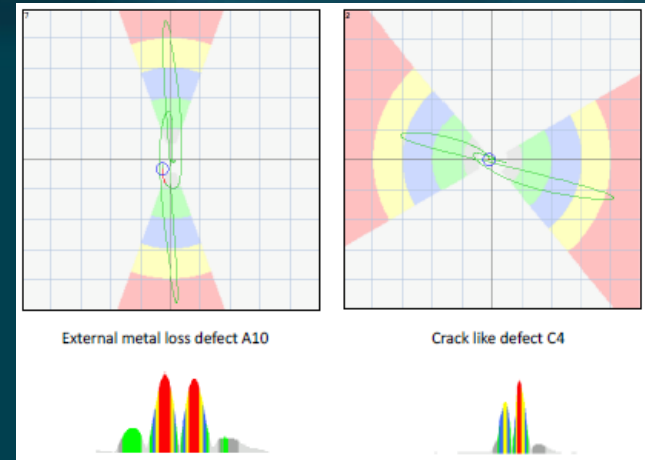
- ***Magnetisation level***

- *Effects of auxiliary magnetisation*

Far-side defects

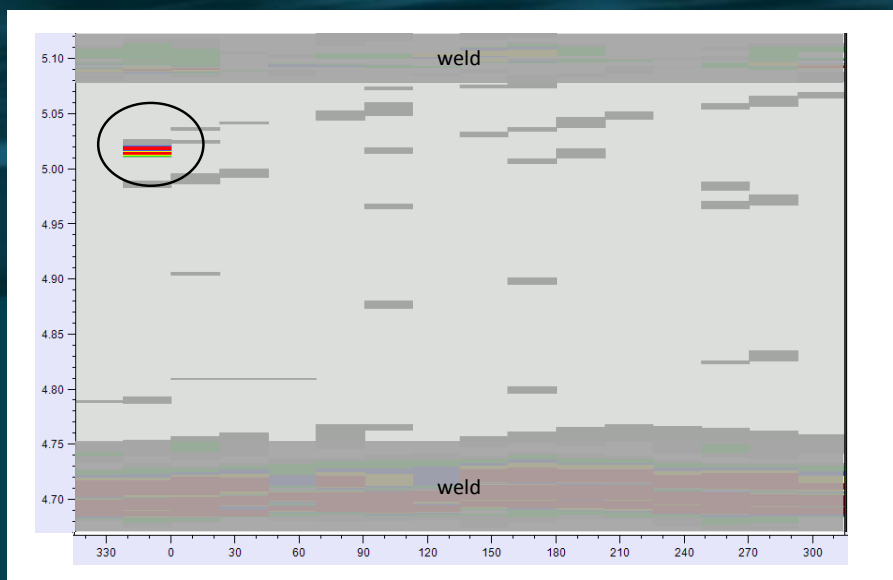


Display of data in form of Amplitude colour mapped C-Scans

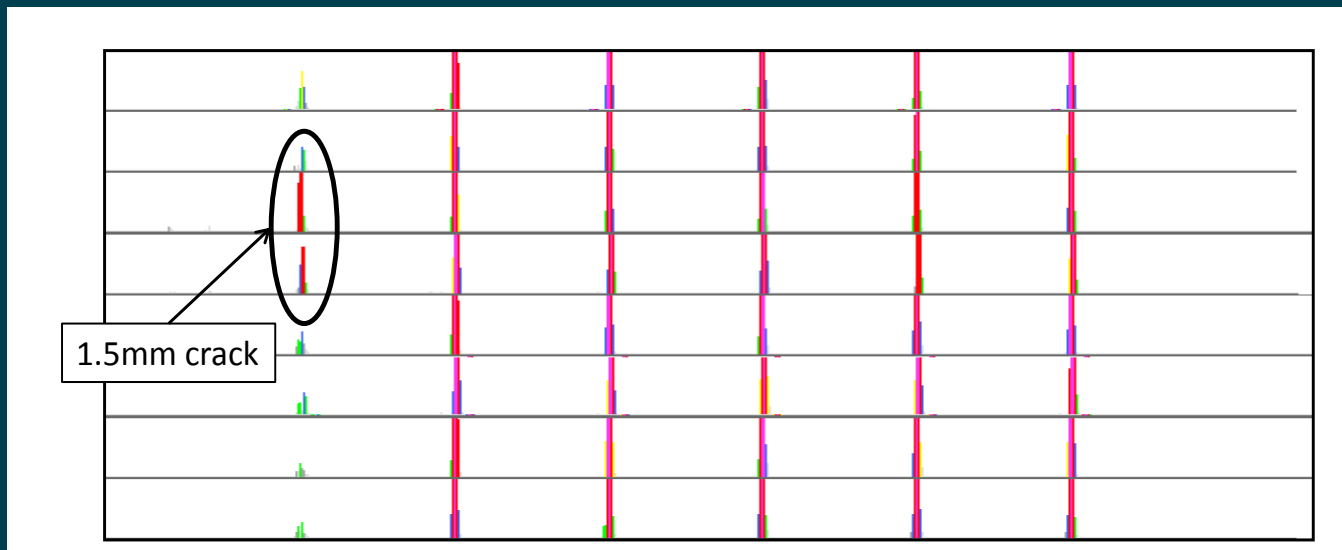
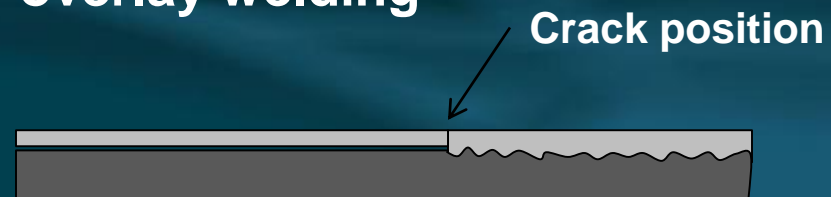


- Display in impedance plane
- Amplitude time view
- Color mapped signals

Crack-like defects in the CRA-layer

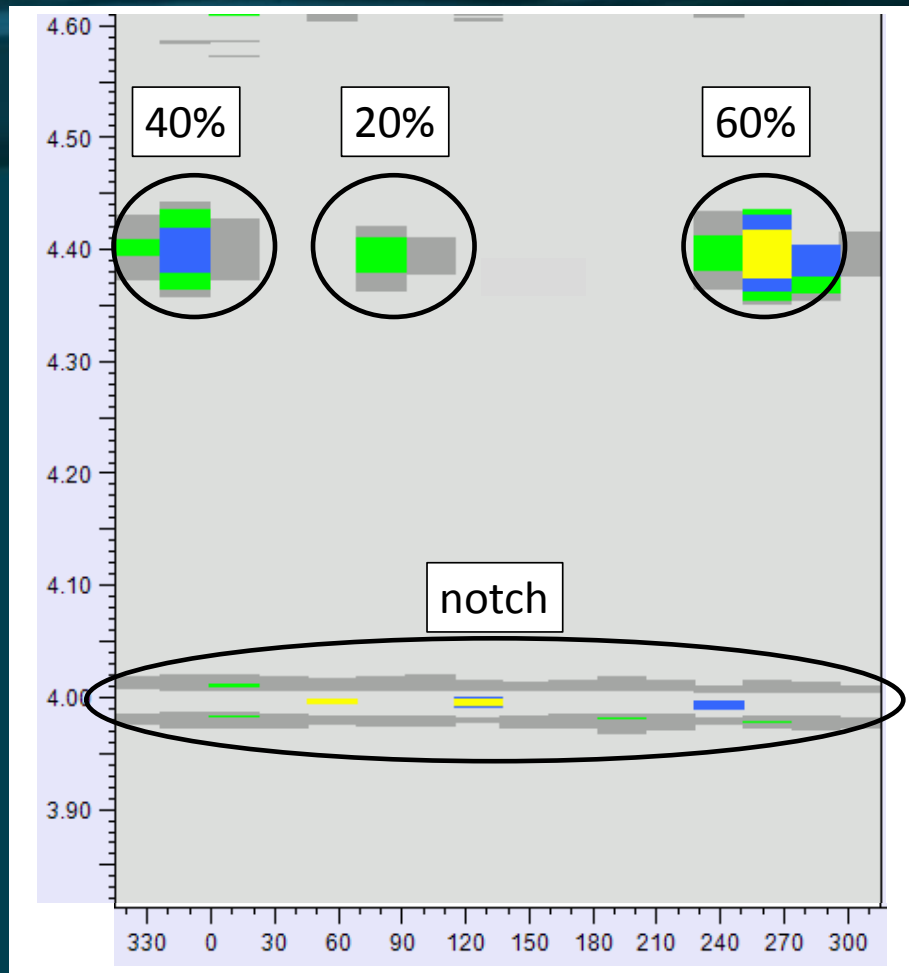


In base material
Potentially found at
interface from liner to
overlay welding



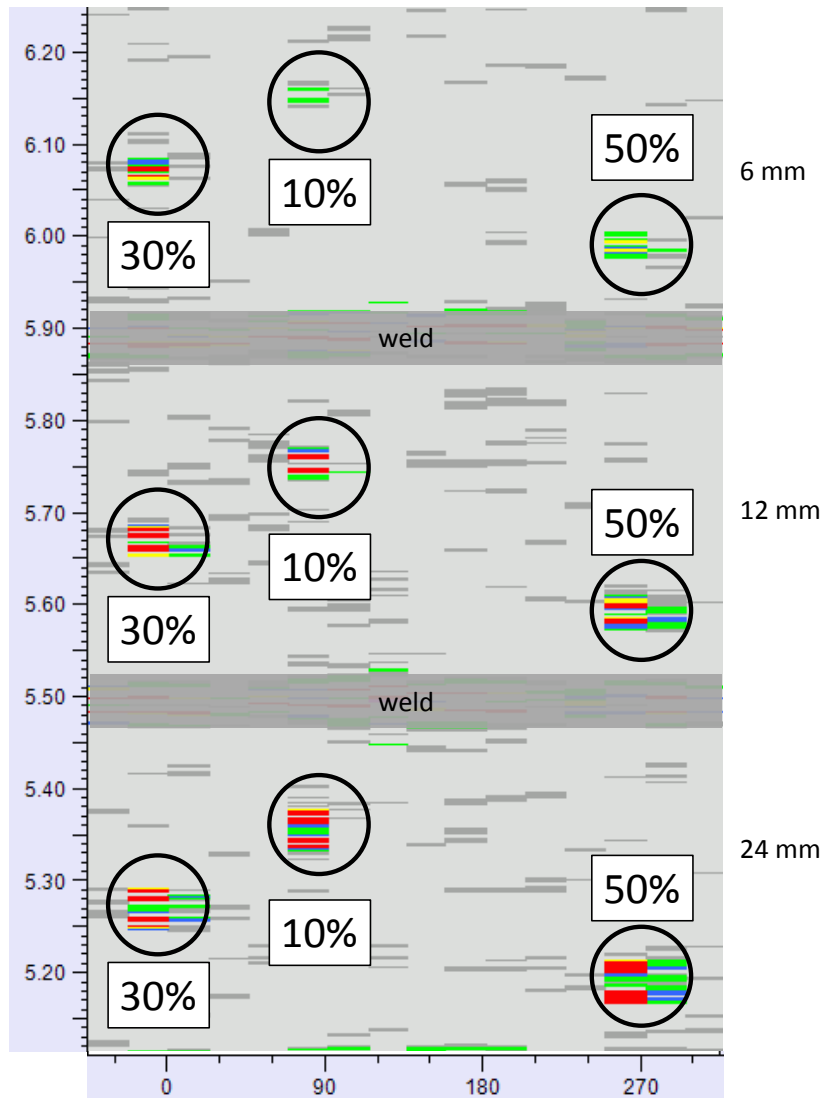
In a girth weld

Erosion type defects

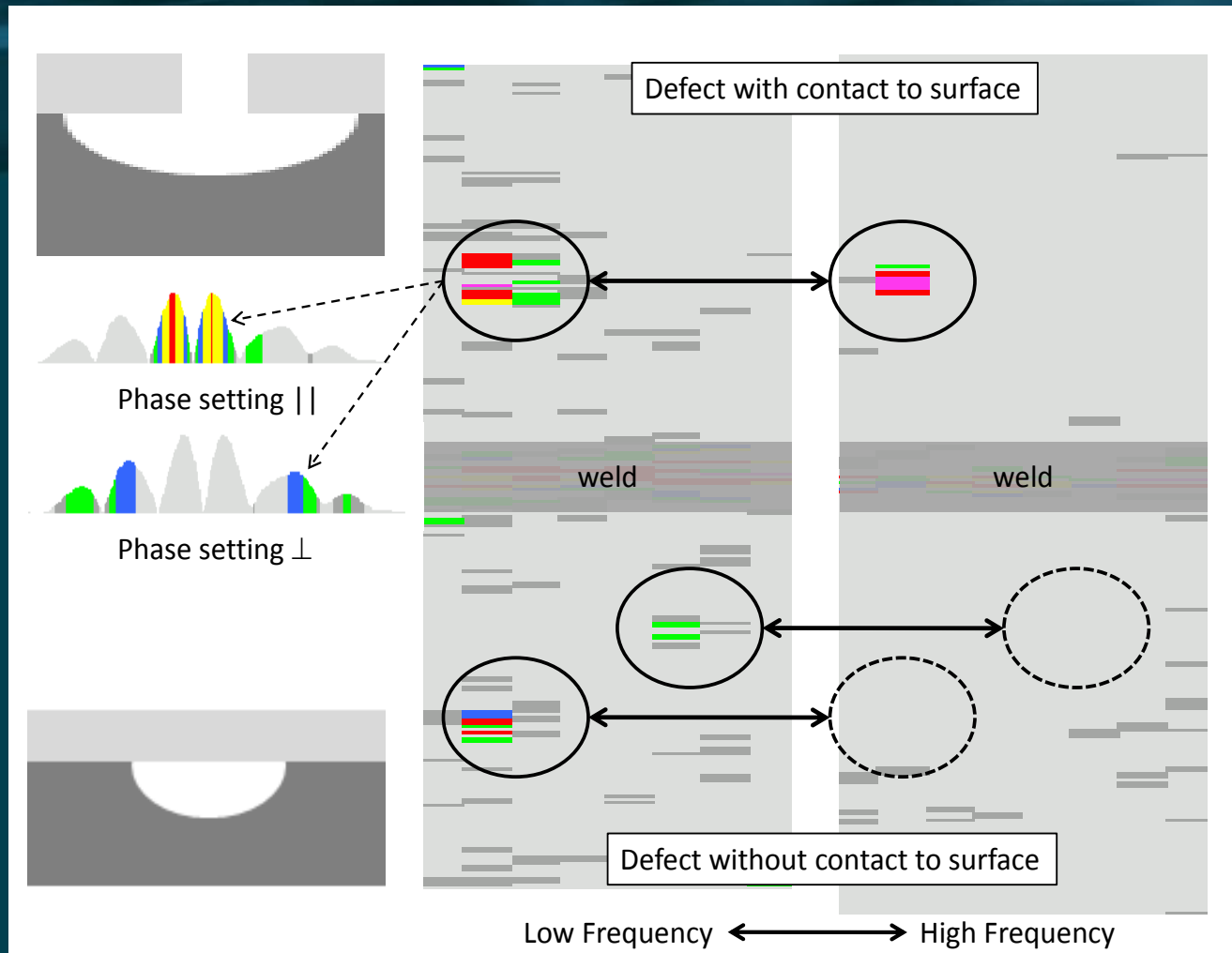


**Roughly linear relation
between signal amplitude
and depth**

Metal loss in the annulus (crevice corrosion)



Defect type assessment using the phase information and multi-frequency measurement



Defect
24mm x 24 mm
with 30% depth
in carrier plus
6x6 mm through
hole in liner

Conclusions



- *The Magnetic Eddy Current inspection technology allows finding and sizing defects in CRA lined pipelines.*
- *In particular*
 - *Defects external on the carrier pipe*
 - *Metal loss on internal side of carrier pipe*
 - *Crack-like defects in the CRA-layer*
 - *Erosion-type defects (gradual thinning) in CRA layer*
- *Technology also seem to be superior in finding small pitting corrosion (3mm diameter) compared to existing inspection technologies.*

Acknowledgements:

The work was supported by Exxon Mobile Upstream Research