Enhancements in Pulsed Eddy Current Examination of Insulated Component

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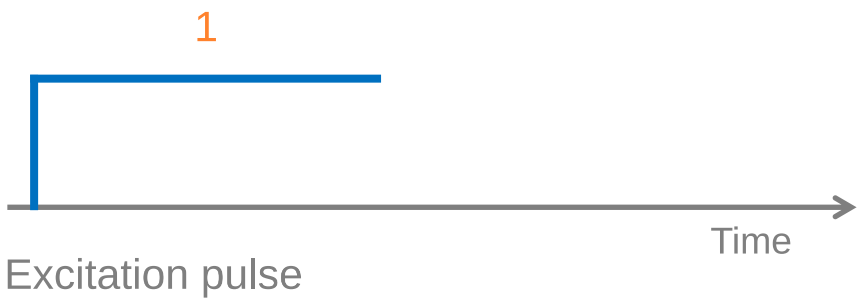
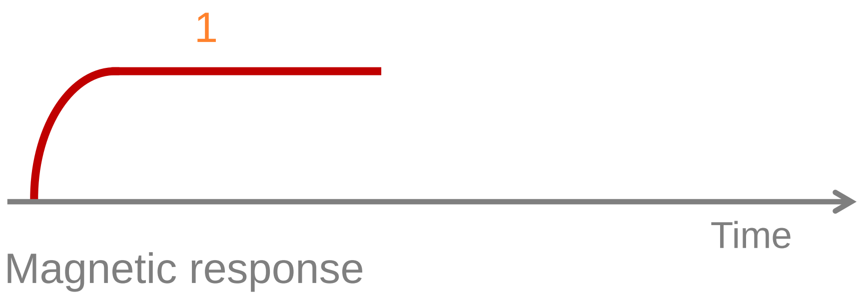
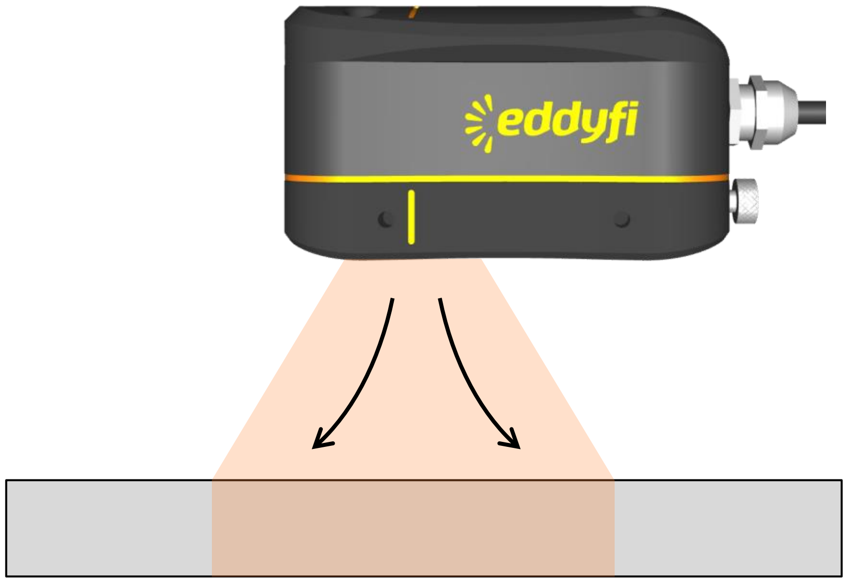
PEC Working Principle (1/3)

- PEC consists in the analysis of the transient eddy current inside a conductive component following a sharp electromagnetic transition. There are 3 phases:
    1. The emission phase (the pulse) during which the probe injects magnetic fields that penetrate and stabilize in the component thickness

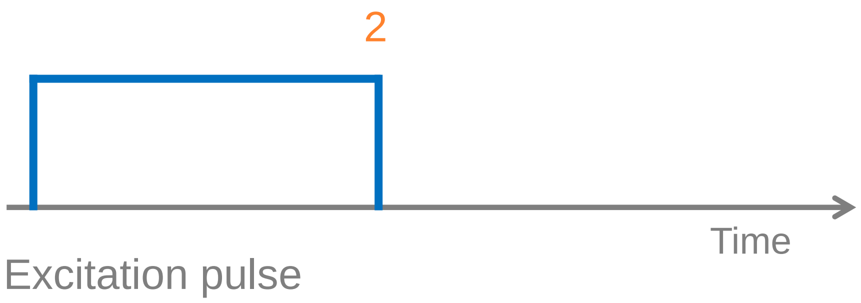


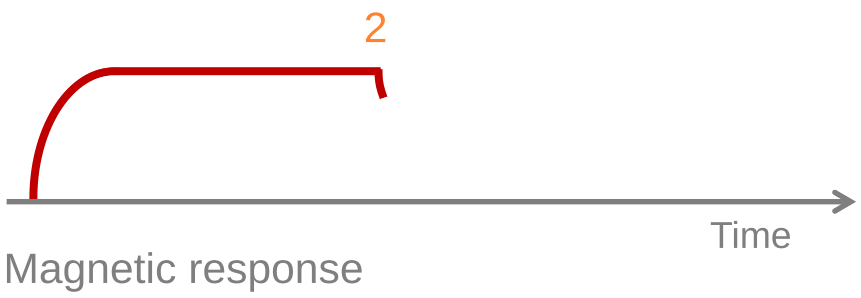




PEC Working Principle (2/3)

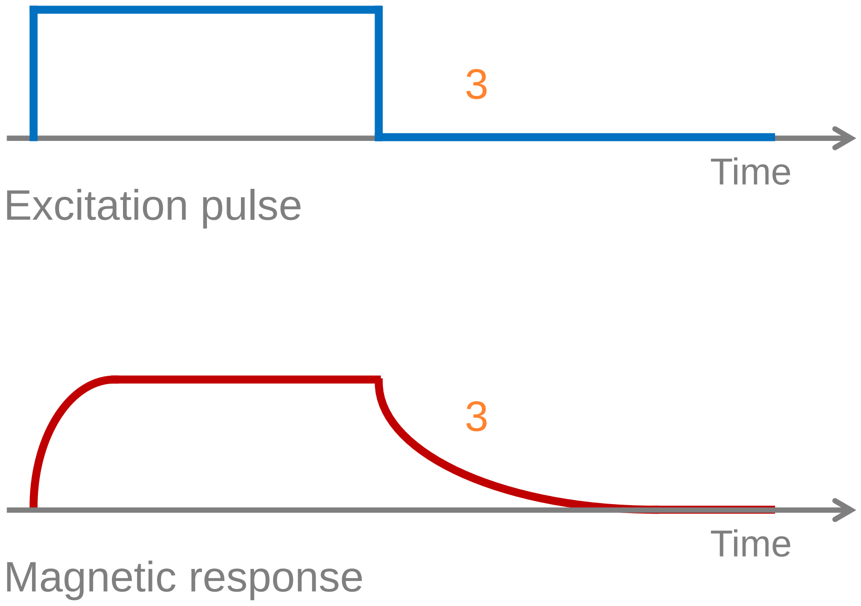
- PEC consists in the analysis of the transient eddy current inside a conductive component following a sharp electromagnetic transition. There are 3 phases:
  2. The cut-off phase which induces strong eddy currents into the component when the magnetic field emission is stopped abruptly

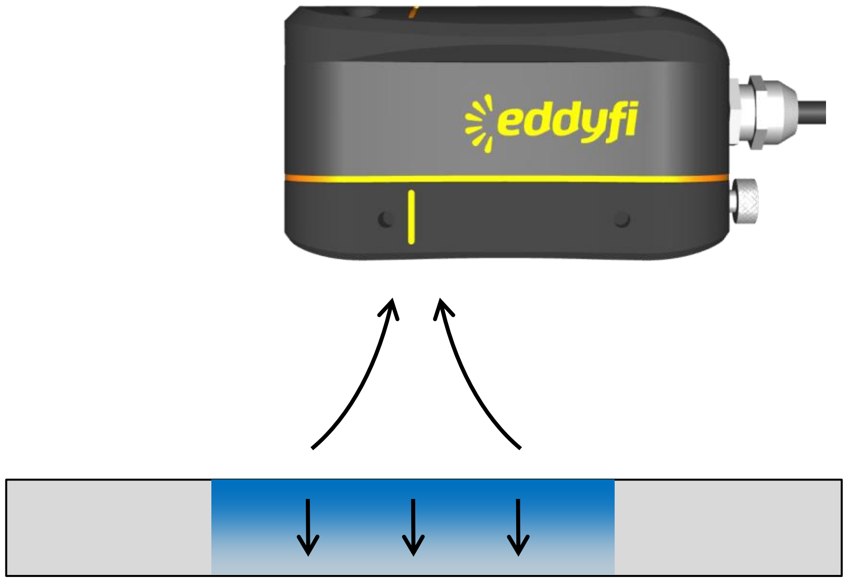




PEC Working Principle (3/3)

- PEC consists in the analysis of the transient eddy current inside a conductive component following a sharp electromagnetic transition. There are 3 phases:
   3. The reception phase during which magnetic sensors measure the decay of the eddy currents as they diffuse into the material thickness

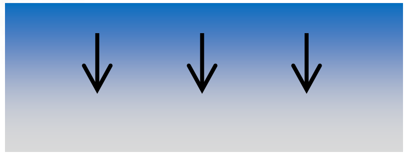


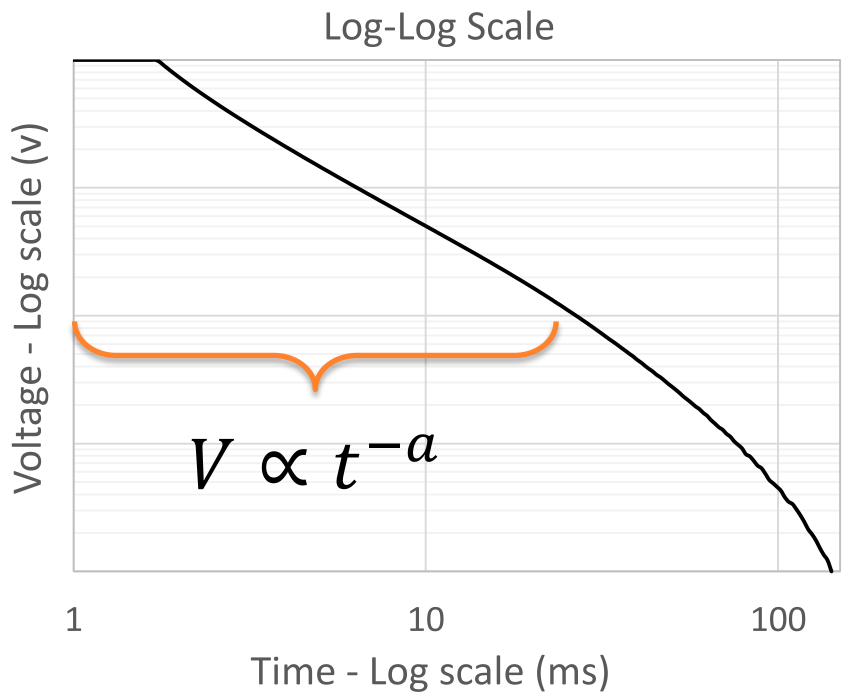


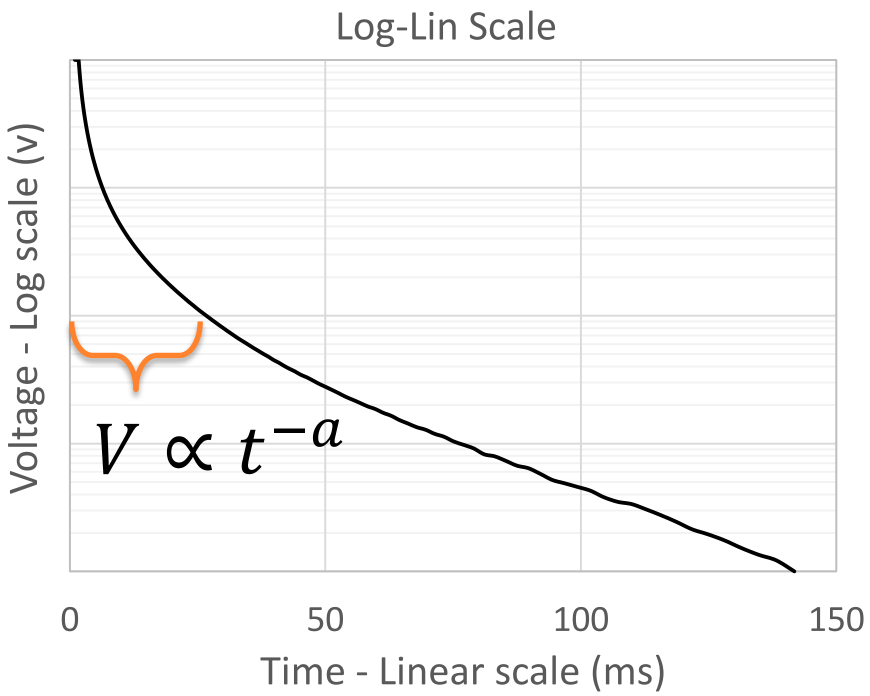
A-Scan in Reception Phase

Early in the A-scan:

- Eddy currents diffuse in the WT as if they are in an infinite wall
- The decay rate follows a “power law” relation that:
  - Produces a straight line in a Log-Log scale



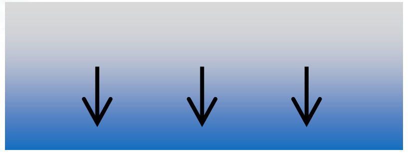


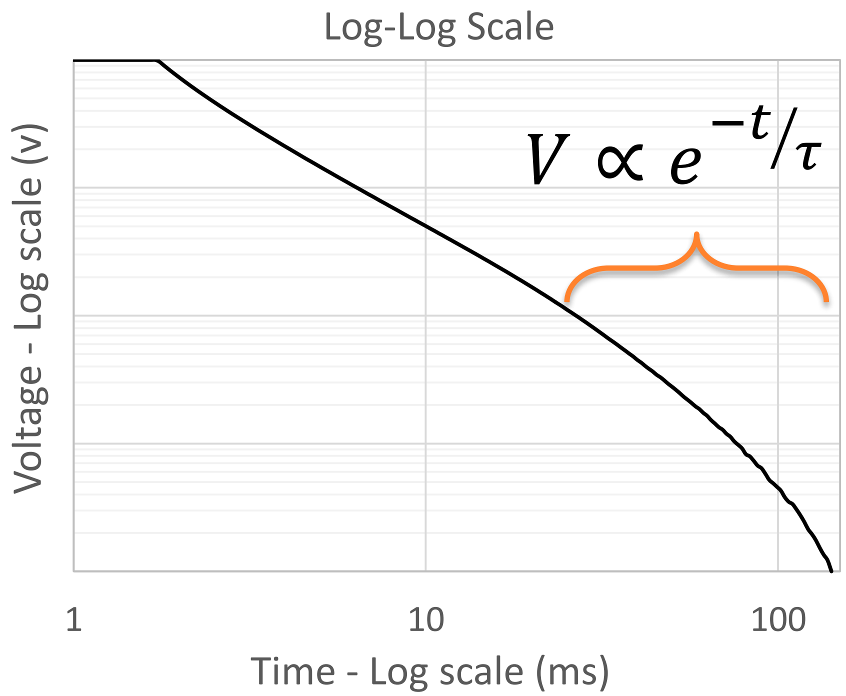


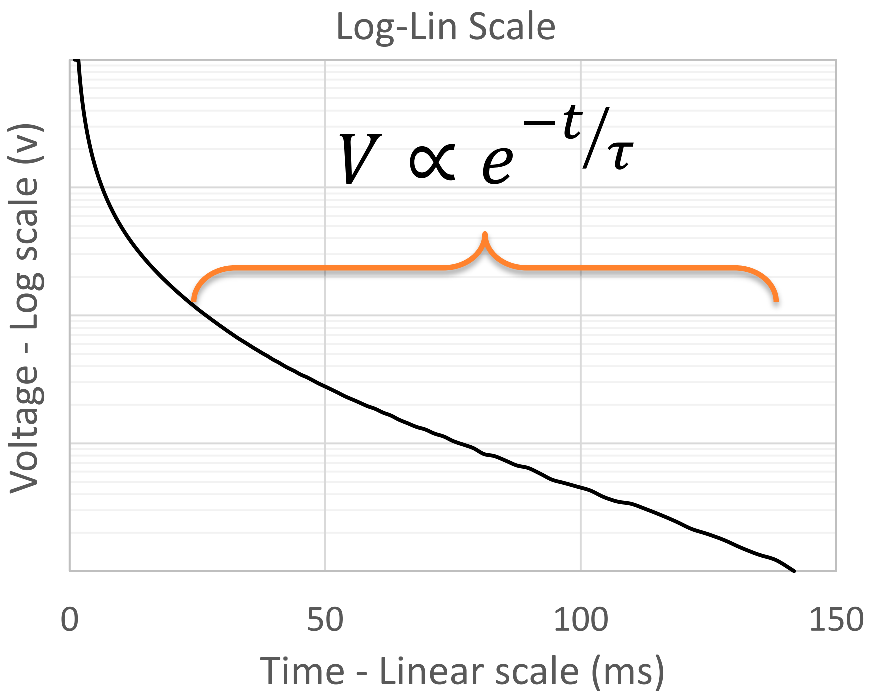
A-Scan in Reception Phase

Later in the A-scan

- Eddy currents reach the far side of the WT
- The decay rate follows an “exponential” relation that:
    - Produces a rapid drop in a Log-Log scale



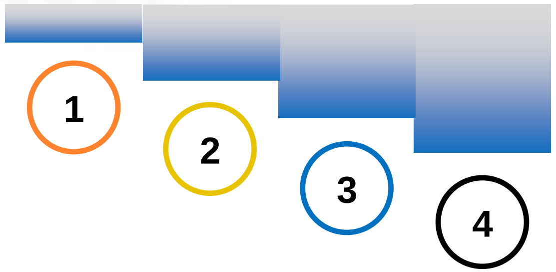


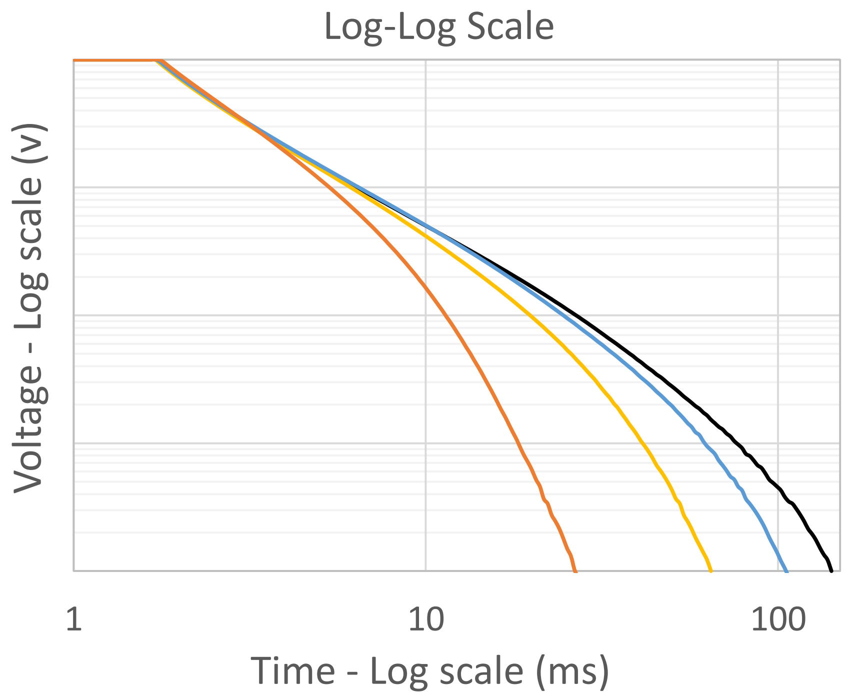


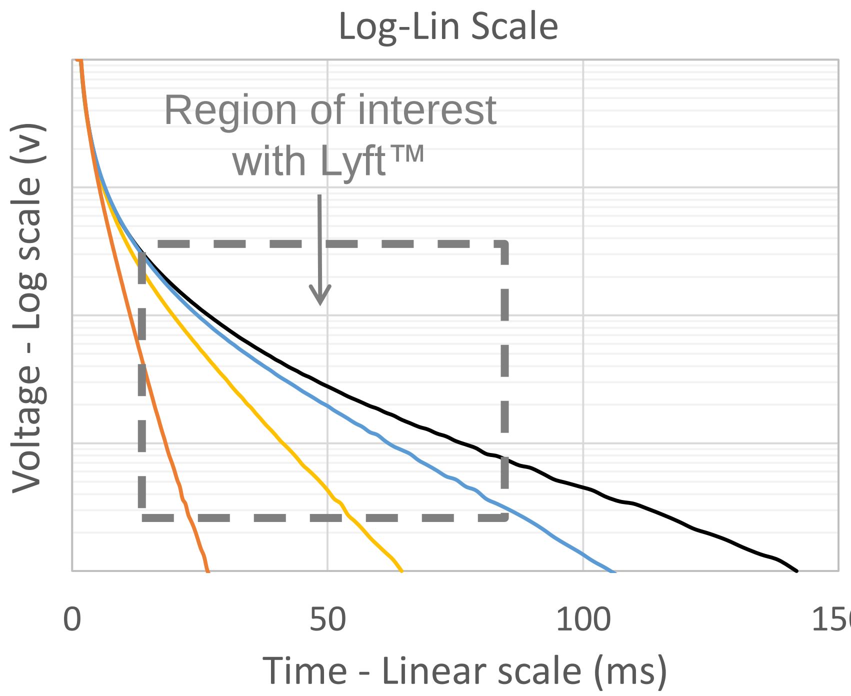
A-Scan in Reception Phase

Thinner wall thicknesses change the shape of the A-scan

- Shorter eddy current diffusion time
- Quicker signal drop in a Log-Log scale
- Different slope in a Log-Lin scale



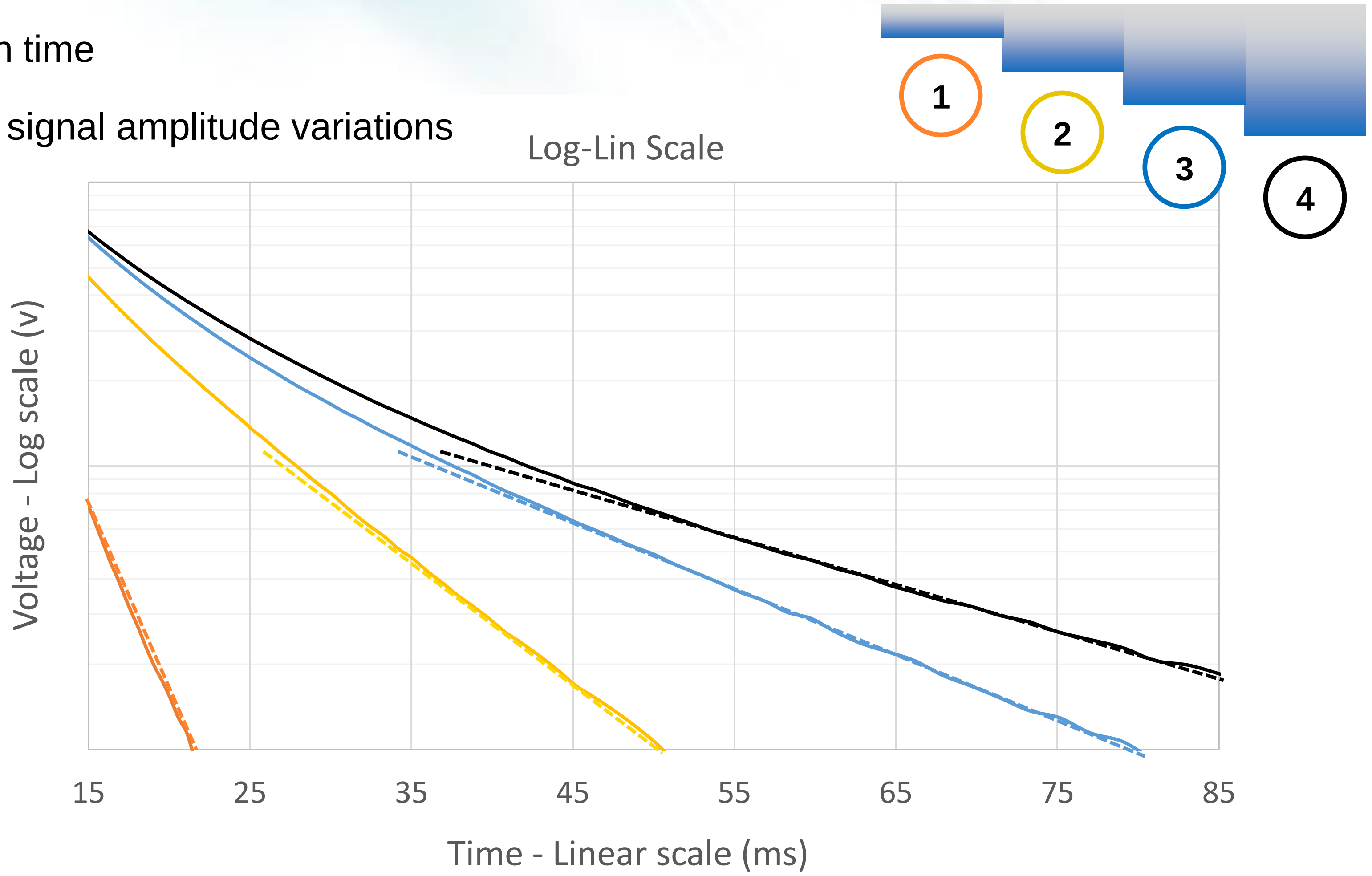




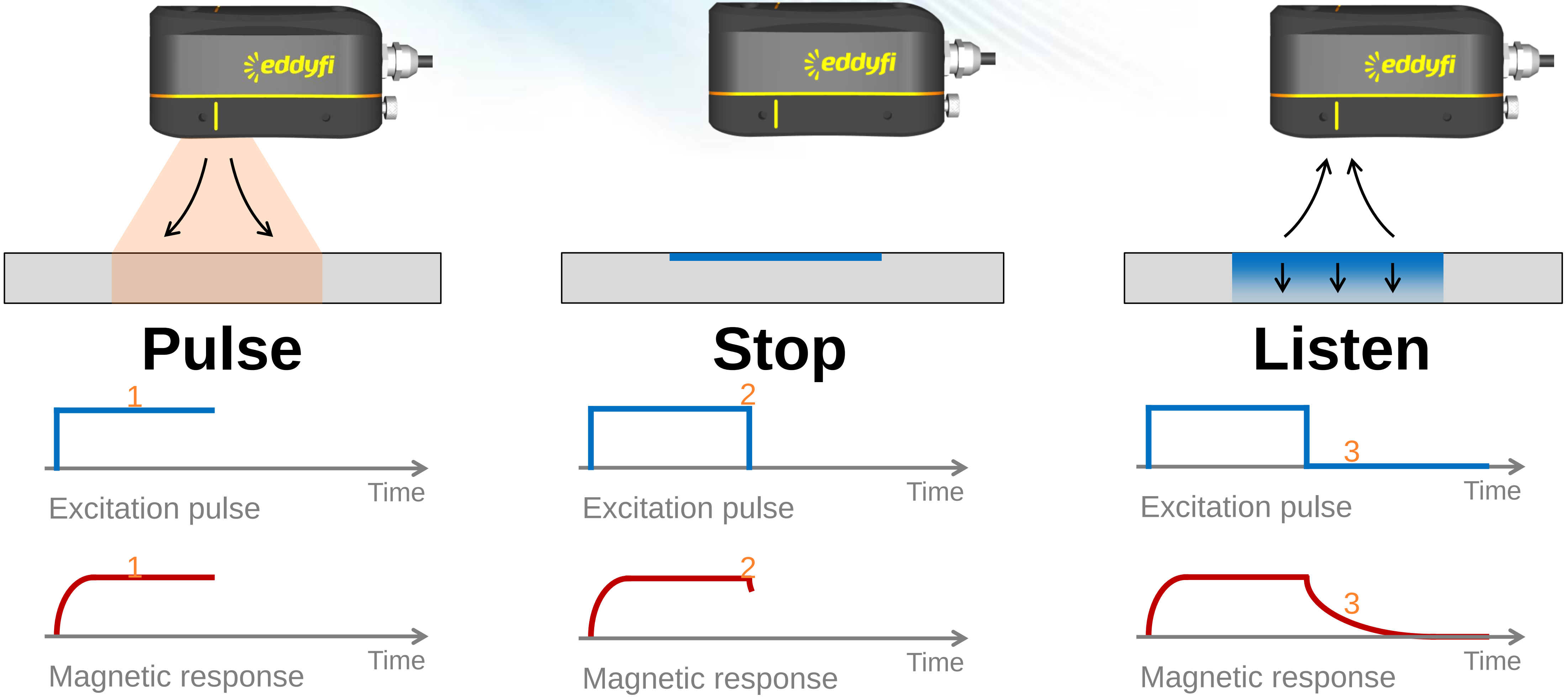
PEC Reinvented

Two major advantages:

- Shorter acquisition time
- Mostly immune to signal amplitude variations

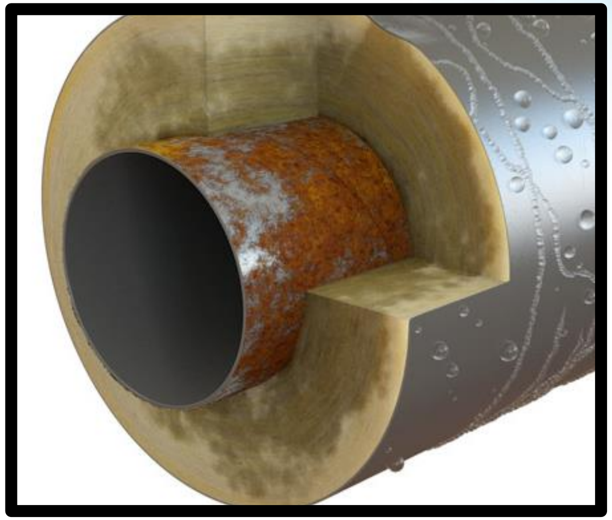


What is Pulsed Eddy Current?



Allows the measurement of wall thickness at high lift off

A World of Applications



Corrosion under Insulation (CUI)

Scab Corrosion

Flow Accelerated Corrosion (FAC)

A World of Applications

Corrosion under Insulation (CUI)

Potential applications include:

- Insulated pipes
- Tanks
- Vessels
- Sphere legs
- **Any carbon steel with insulation or cladding**

Introducing Lyft™ - PEC Reinvented

FAST

- Dynamic mode (unique to Lyft):
  - Probe moving speed up to 100mm/s (4in/s)
  - No need for grid marking the sample, just straight lines

RELIABLE

- Less operator-dependent
- Less affected by lift-off variations and weather jacket overlaps
- Not sensitive to probe motion

VERSATILE

- Galvanized steel weather jacket, and scab/blistering-capable
- Works at lift offs up to 12’’ (300 mm)
- Wall thickness up to 4” (100 mm)
- Through concrete, polymer coating and chicken wire
- Near metallic structures such as nozzles, flanges, pipe supports

Lyft™ system

What Pulsed Eddy Currents doesn't do

Pulsed Eddy Current work best on large corrosion patches, especially at high lift off.

Pulsed Eddy Current does not detect:

- Cracks
- Small pitting

Where does Lyft ™ fit in the NDE Tool Belt?

- Permits expansion of inspection scope and frequency without increasing schedule
- Can inspect in-service components
  - Monitoring without shut down (high or low temperature components)
  - Does not require removal insulation or cladding
- Broader screening permits more focused application of RT and UT

Measuring Defects Through Insulation

What happens when the probe scans over a defect?

Low Lift Off Footprint

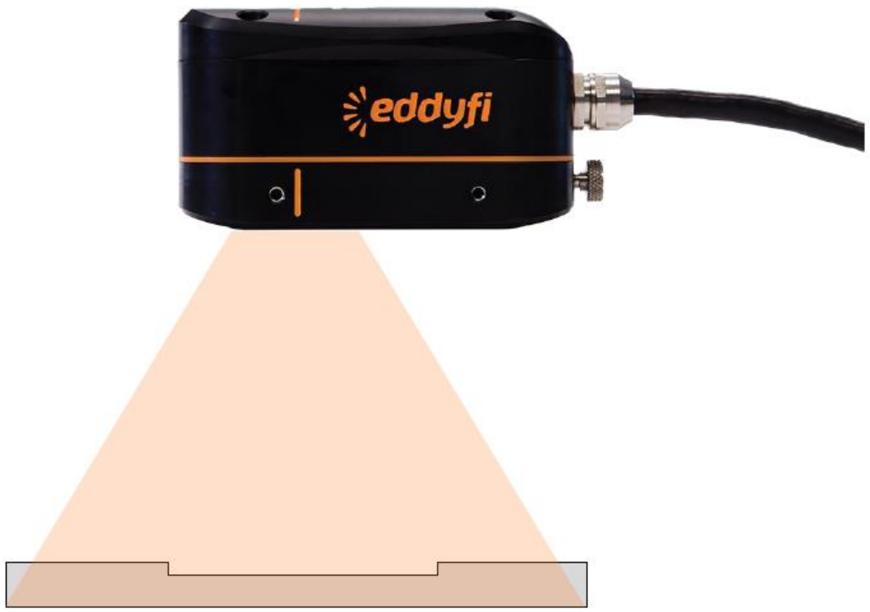
Wall Thickness	2”	1.5”	1”	0.75”	0.5”	0.25”
Wall Relative Thickness	100%	75%	50%	37.5%	25%	12.5%
Measured Thickness	100%	77.2%	49.8%	36.0%	24.9%	13.1%

Measuring Defects Through Insulation

What happens when the probe scans

over a defect?

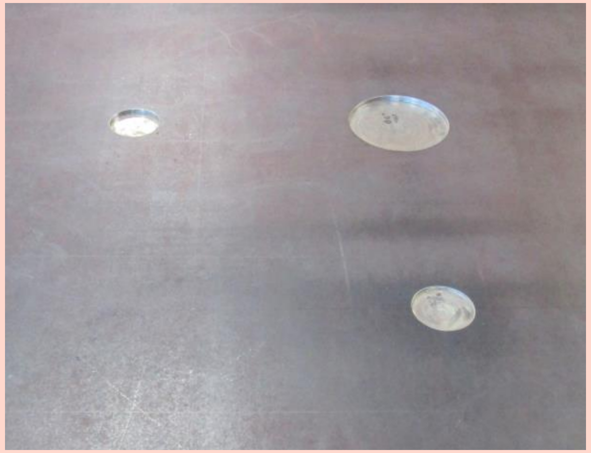
Low Lift Off Footprint

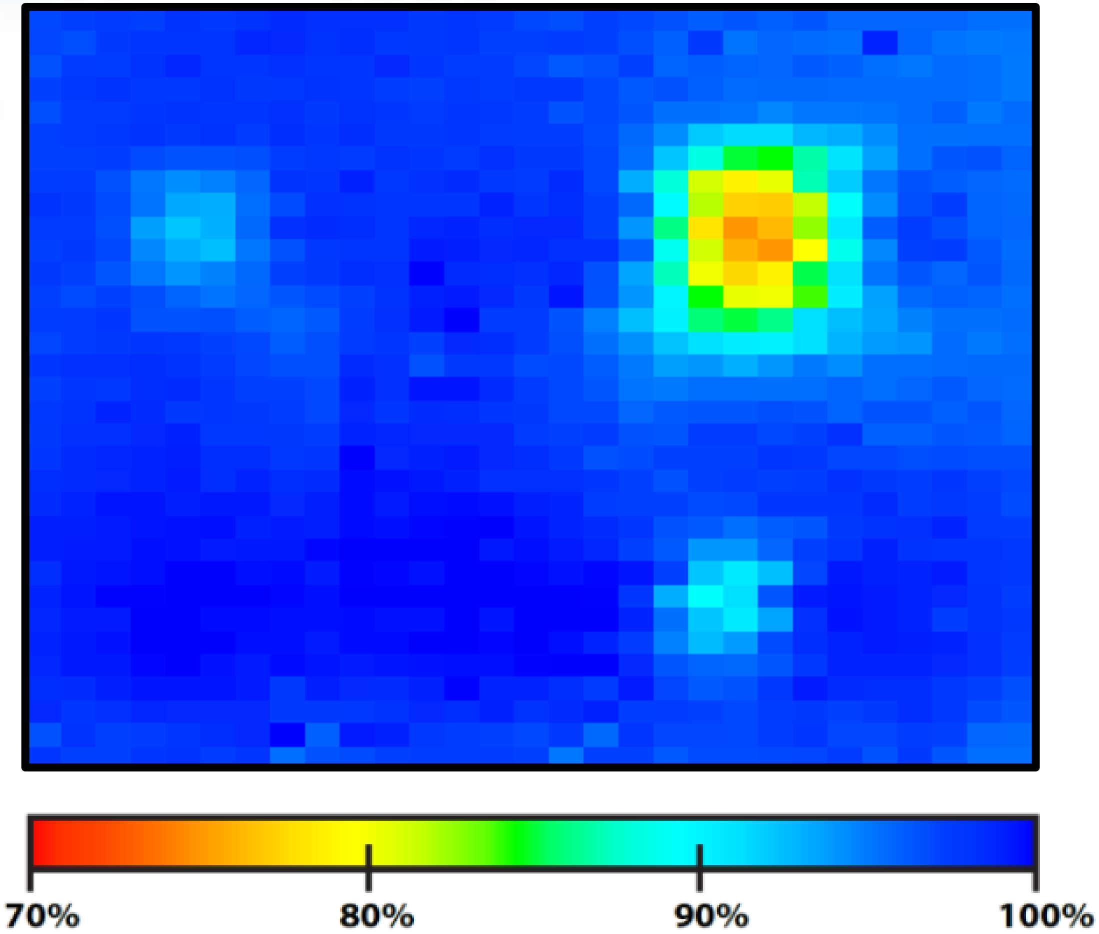


High Lift Off Footprint

Scanning a defect smaller than the footprint leads to ***undersizing***

What is Undersizing?

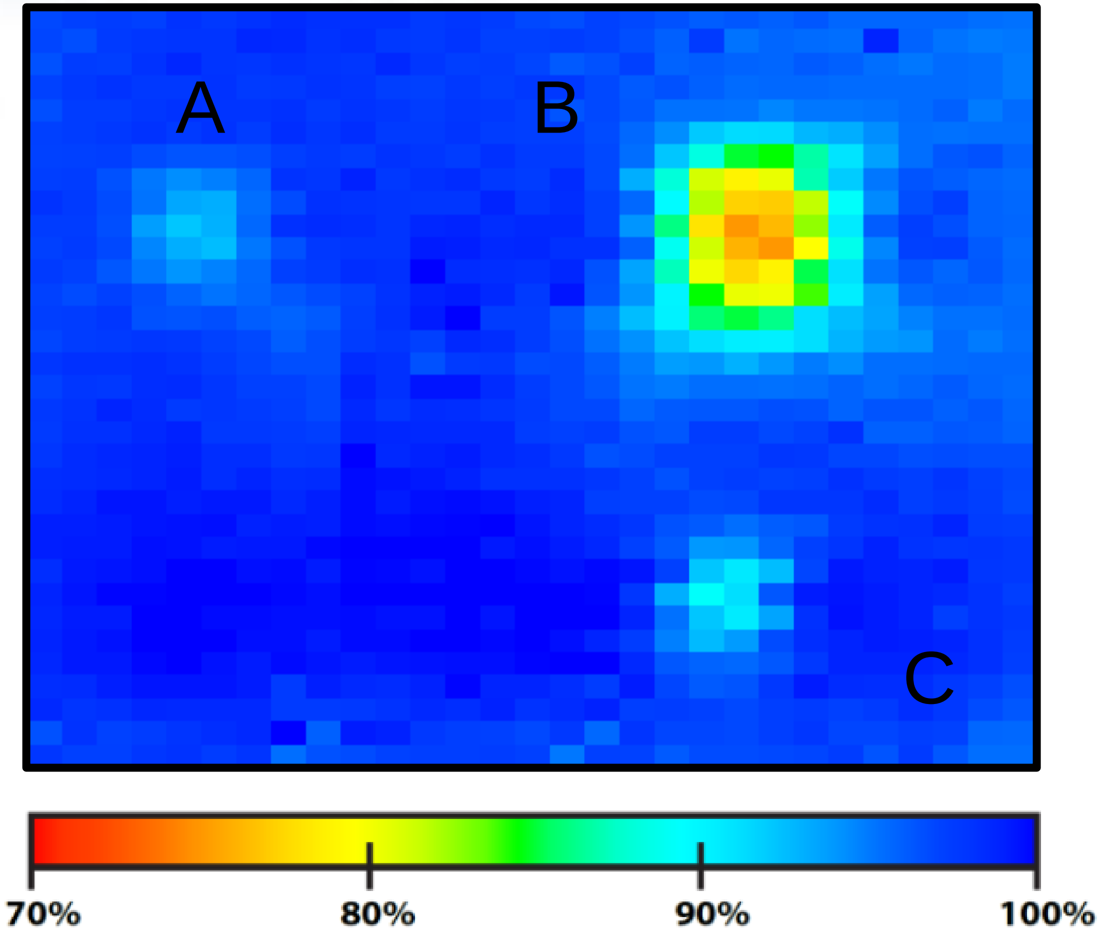
Lab mockup sample – Flat bottom holes	
Plate WT	0.5’’ (12.7 mm)
Insulation height	2’’ (50.8 mm)
Sample	



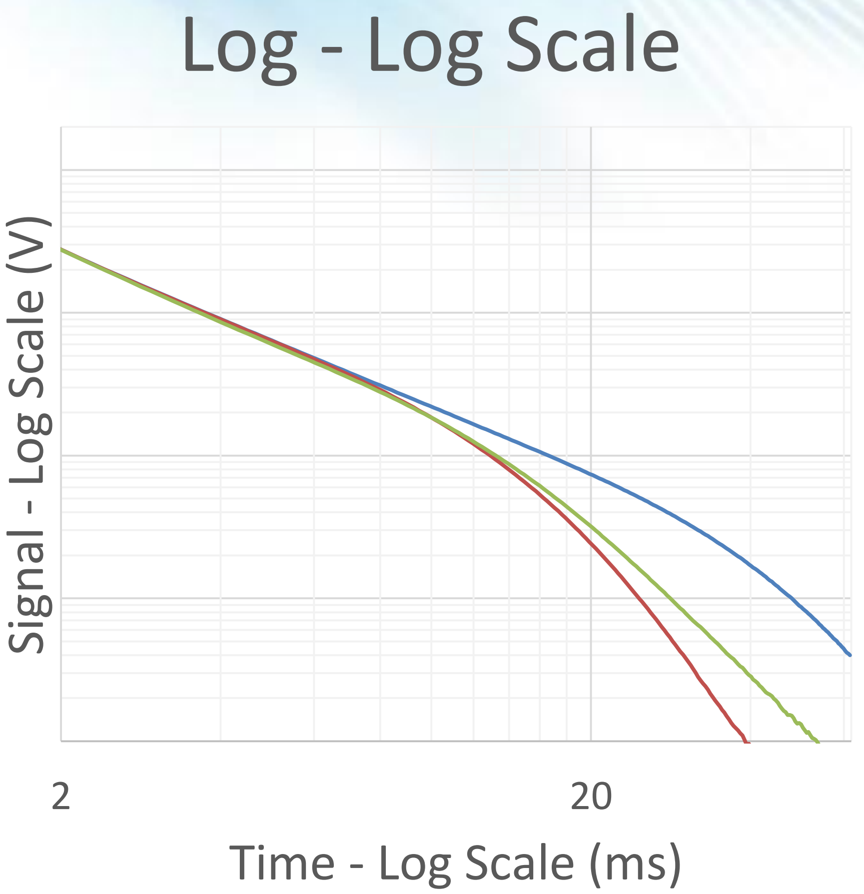
What is Undersizing?

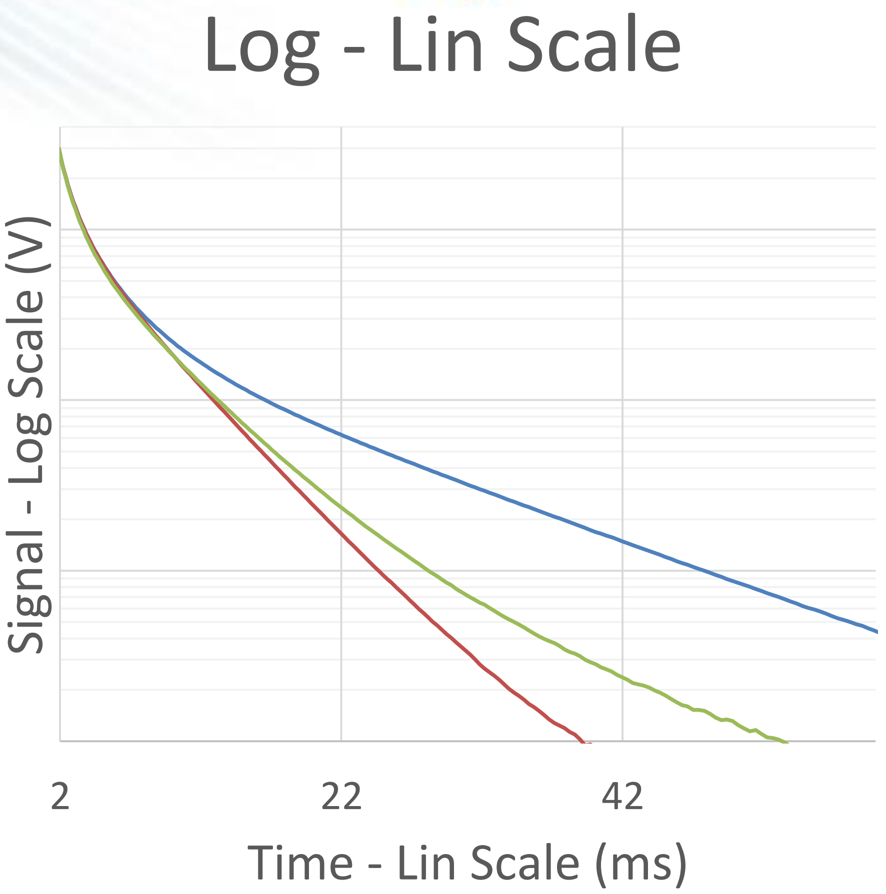
Lab mockup sample – Flat bottom holes	
Plate WT	0.5'' (12.7 mm)
Insulation height	2'' (50.8 mm)

Defect	Diameter	Real WT	Measured WT
A	3''	66%	89.5%
B	6''	33%	66.8%
C	3''	33%	85.7%



What is the signal like when we undersize?





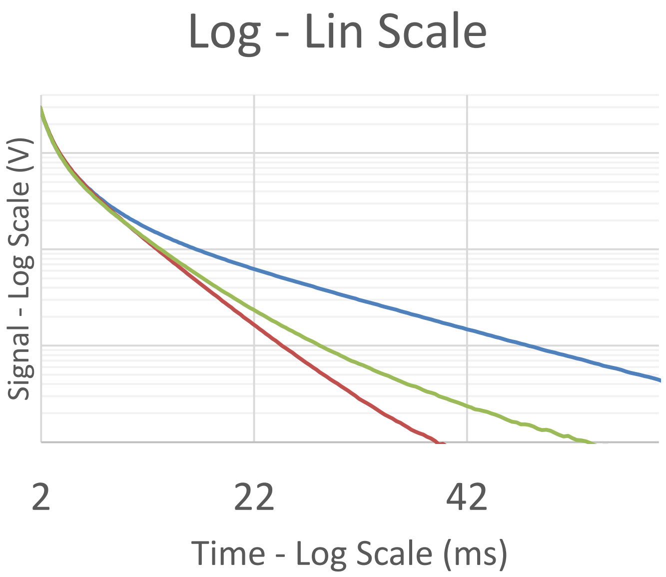
Nominal + Defect = Actual Signal

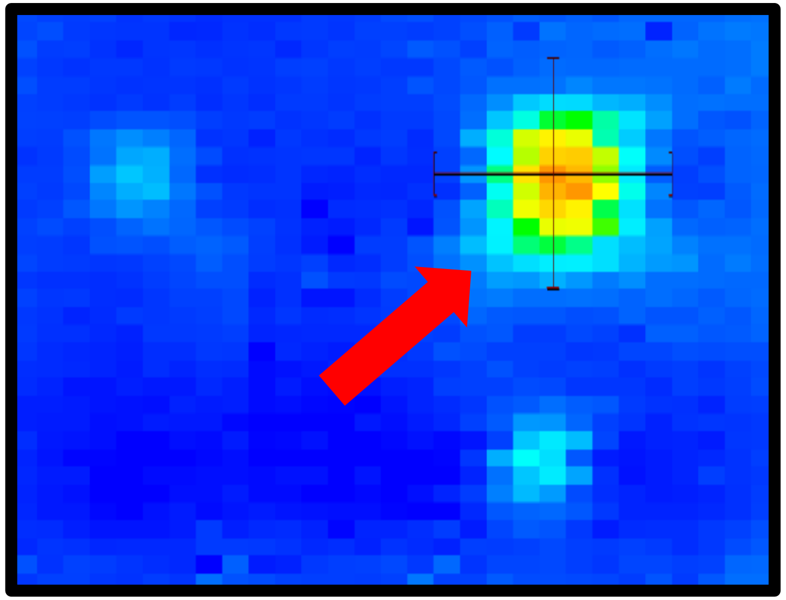
Compensated Wall Thickness

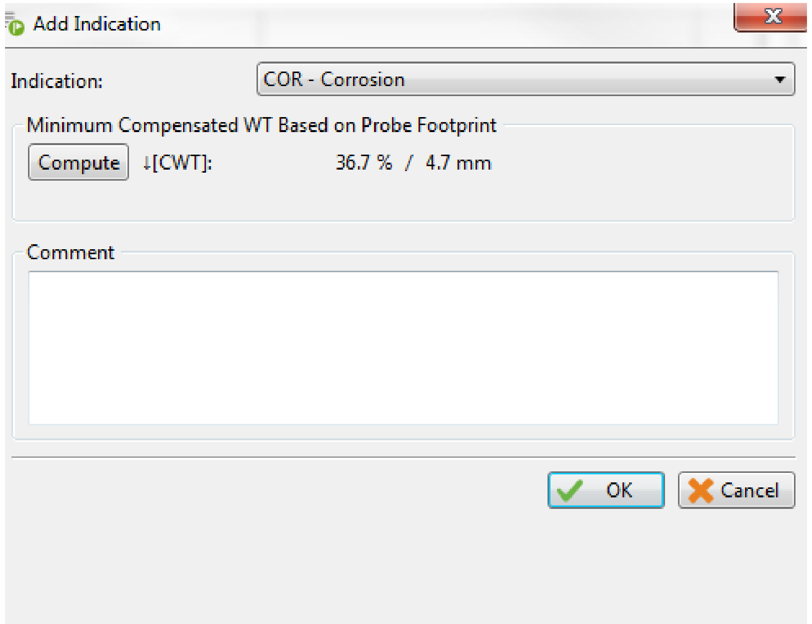
Isolate the **defect** contribution from the signal

We use an analytical equation for each component of the signal

Analyze a defective region rather than a single data point



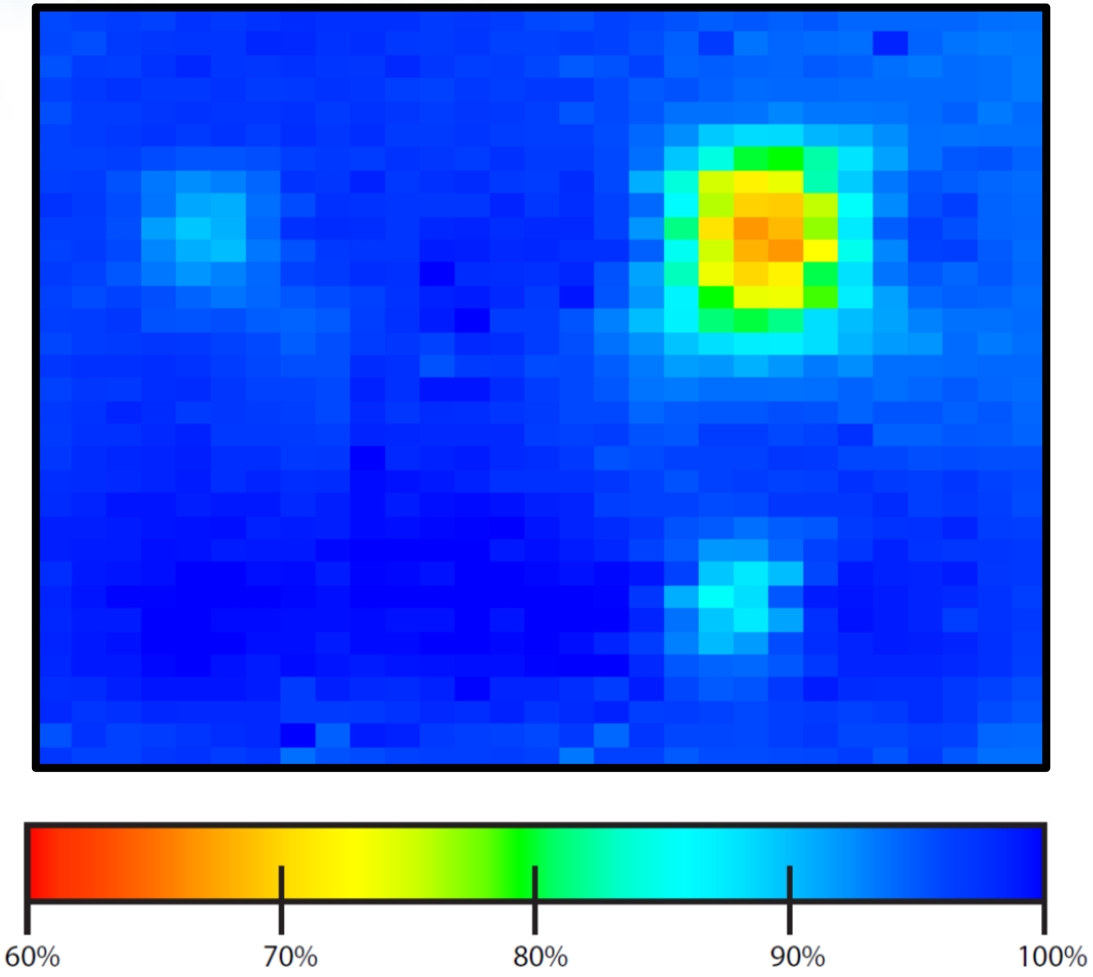




Compensating for the Undersizing Phenomenon

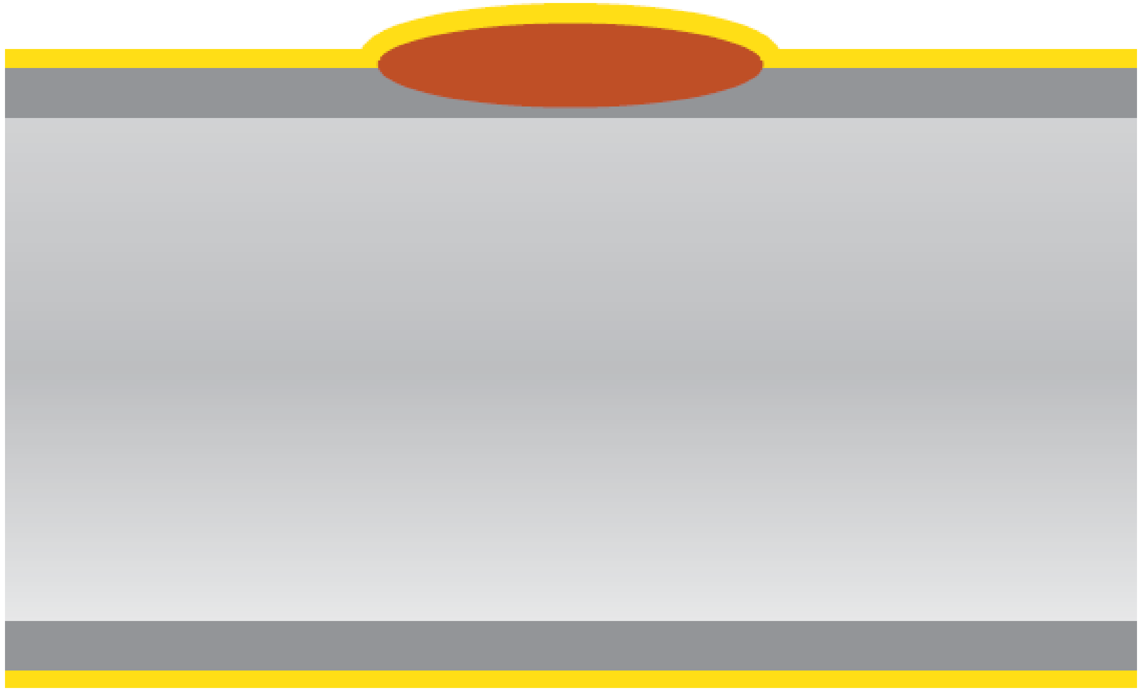
Lab mockup sample – Flat bottom holes	
Plate WT	0.5'' (12.7 mm)
Insulation height	2'' (50.8 mm)

Defect	Diameter	Real WT	Measured WT	Compensated WT
A	3''	66%	89.5%	**67.1%**
B	6''	33%	66.8%	**36.7%**
C	3''	33%	85.7%	**39.8%**



Compensated Wall Thickness on Real Corrosion

Scab corrosion	
Plate WT	0.35’’ (8.9 mm)
Insulation	None
Sample	



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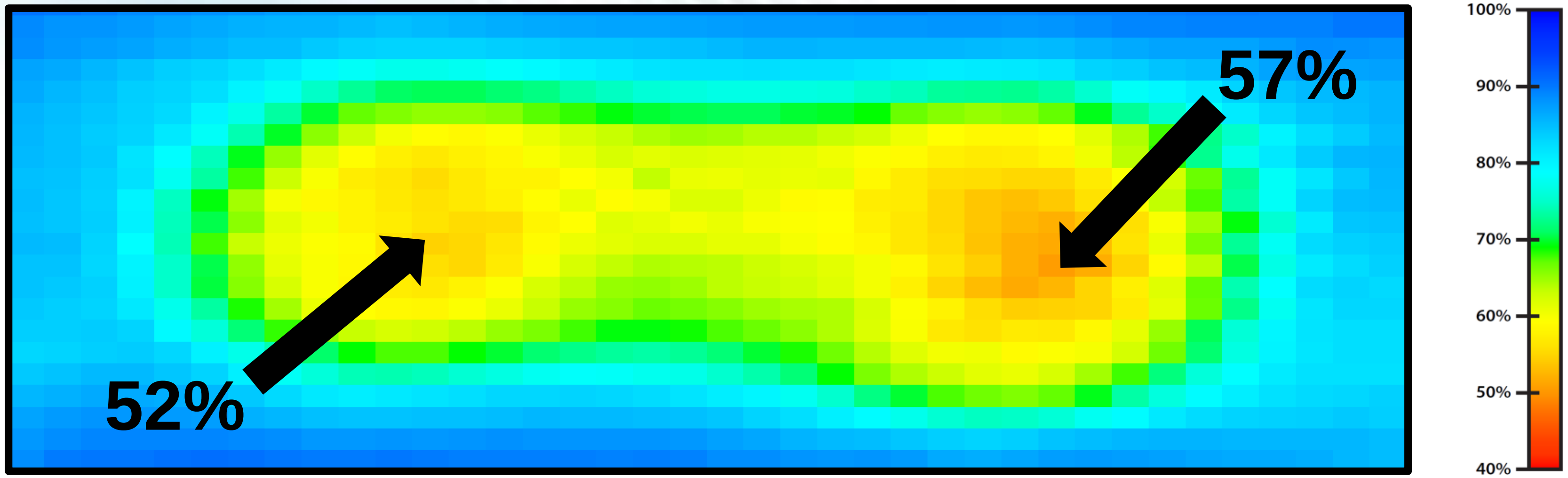

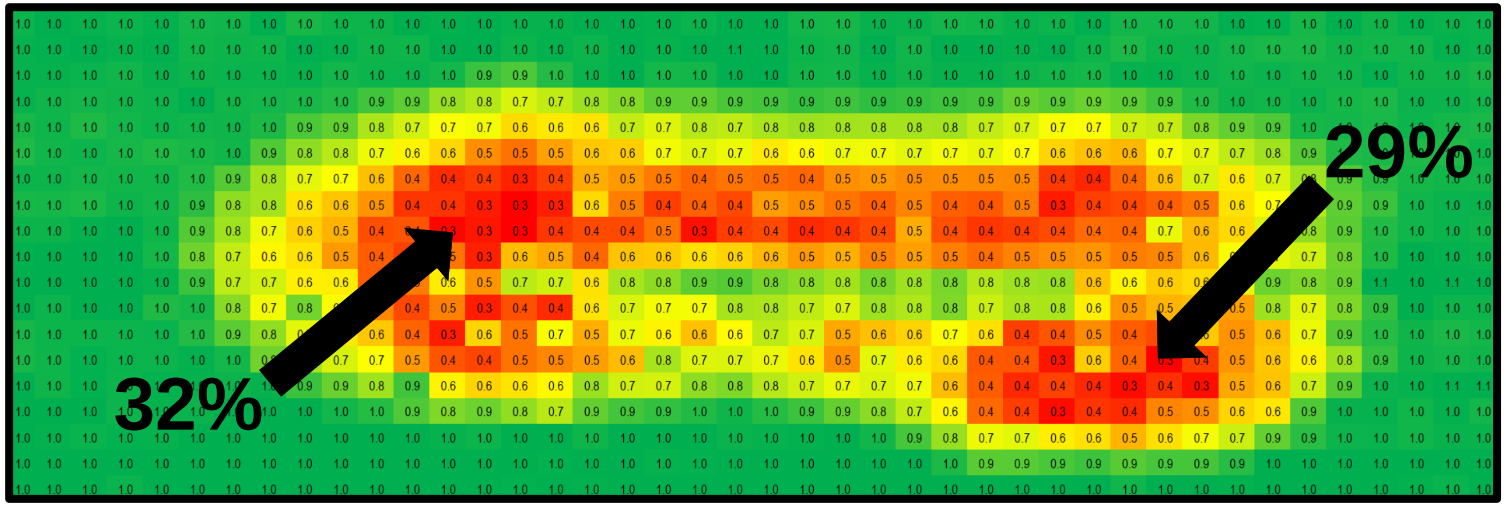

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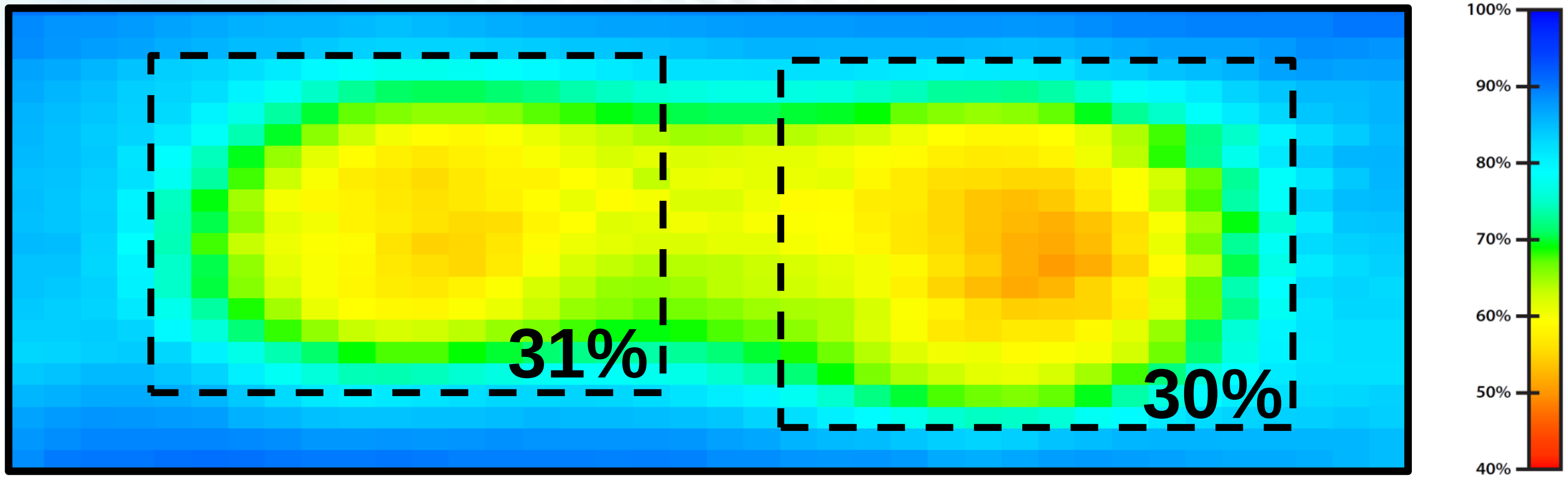

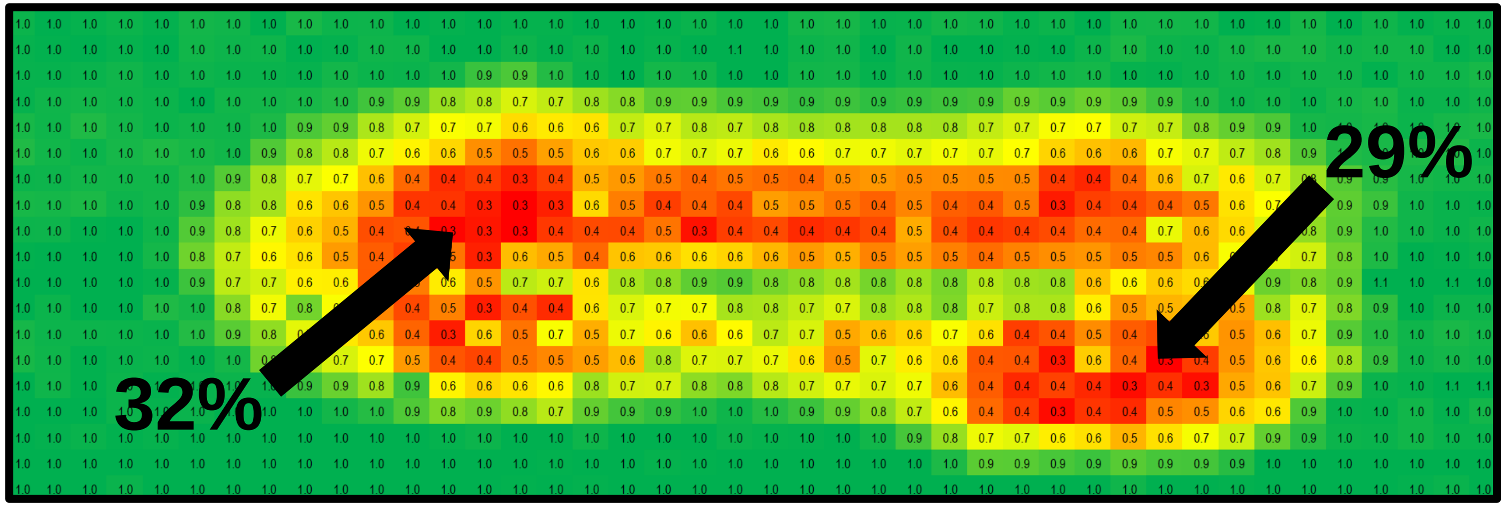

Conclusions

- Lyft™ is a fast, flexible and reliable screening tool which measures wall thickness through insulation and cladding
- Compensated Wall Thickness tool addresses the main weakness of PEC: undersizing
- Compensated Wall Thickness gives optimal results when applied to high resolution, low noise data sets

Questions?

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