

Advanced NDT Techniques – Is Training Certification and Knowledge Equal to Technology

By: Colin Bird

colinrbird@outlook.com

CRB Inspection



My History

Metallurgist at Rols Royce to NDT Development Engineer/Consultant.

Advanced Techniques

How do NDT technicians or NDT engineers progress and stay up to date with advancing technology.

Who is teaching FMC, PCI, Array Electromagnetic techniques, Long Range UT, highly processed thermographic imaging techniques, digital radiography image processing, etc.

What Are Levels 1, 2 and 3

Level 1 – A person who follows a written set of instructions with no deviation allowed. They calibrate and collect data.

Level 2 – A person who can write a written instruction from an approved procedure, perform an inspection and analyse the data, development experience but not the majority. Some level 3s have further education to degree level and have

Level 3 – A person who can interpret a standard and write a procedure analyse data and act as a supervisor. Their physics knowledge can be missing making it more difficult for them to self develop with new technologies.

NOTE Level 3s Does not mean that they can write standards, develop inspection methods, write technical justifications or design qualification strategies. They are examined at the same level as that of Level 2 technicians but in more subjects.

Examples of Highly Processed Data

FMC is one of a number of Array data capture methods

TFM is one of a number of many data processing methods for FMC type data.

Ultrasonic Phase correlation v colour displays are also offered by at least two instrument manufacturers.

Eddy-current Array techniques and signal processing,

Flux Leakage

Long Range UT

Visual with image processing

Digital imaged radiography

Examples of Advanced NDT Technology

Array Eddy Current.

What are we taught.

How to use a single probe.

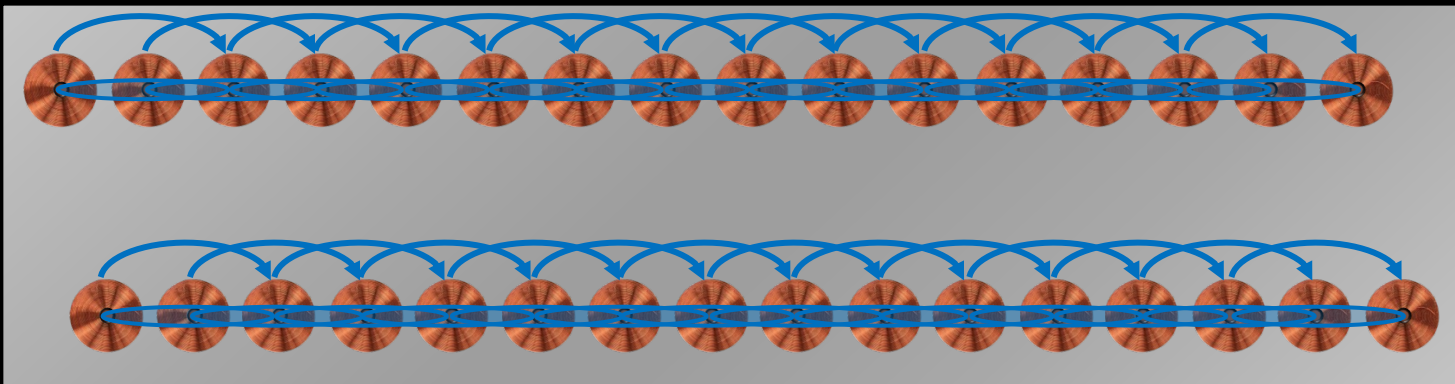
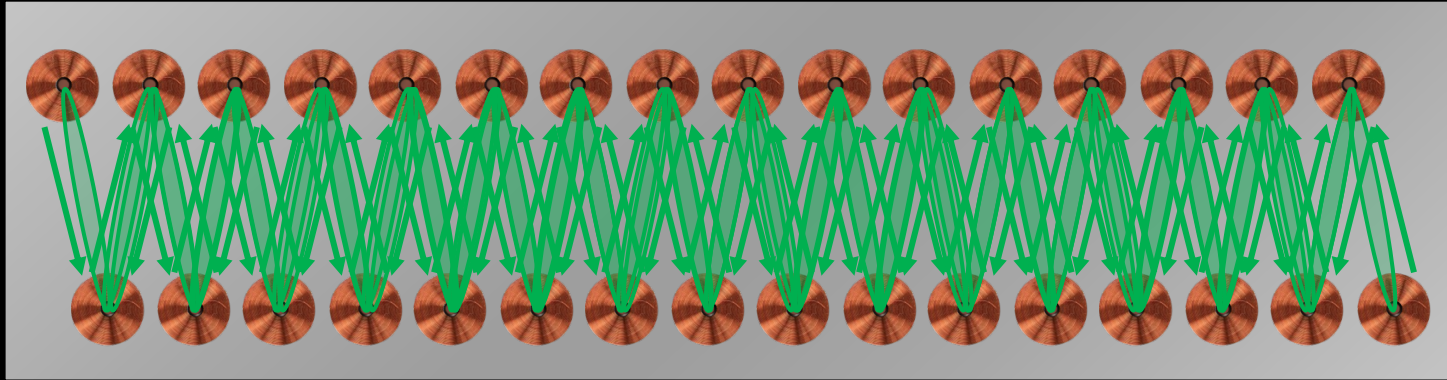
The shapes of the electromagnetic field for a single coil.

Data analysis. AI. It is already deployed in tube inspection.

If you do not understand complex electromagnetic fields how can you design a test piece or write a reliable procedure or design a qualification programme. Level 3?

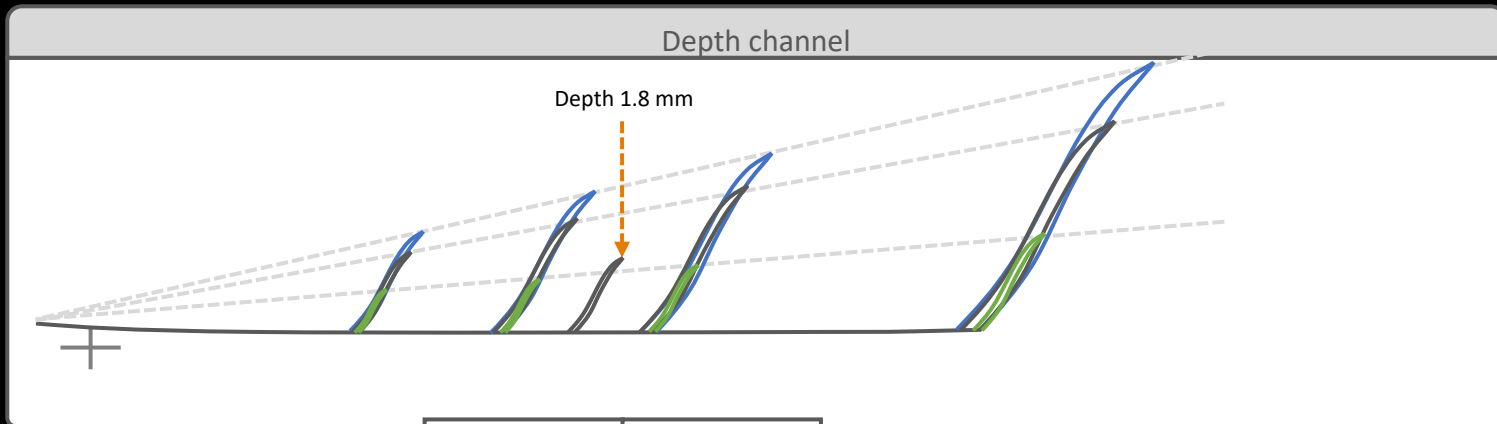
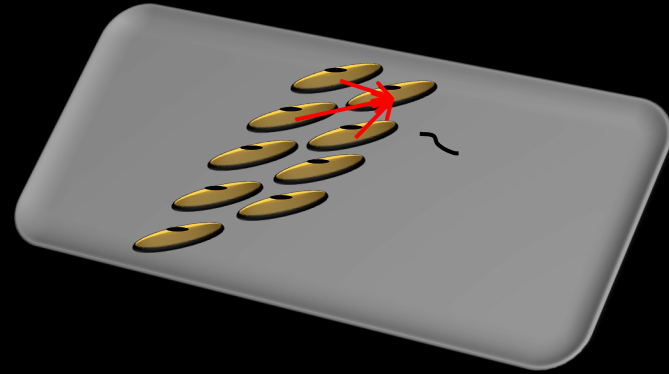
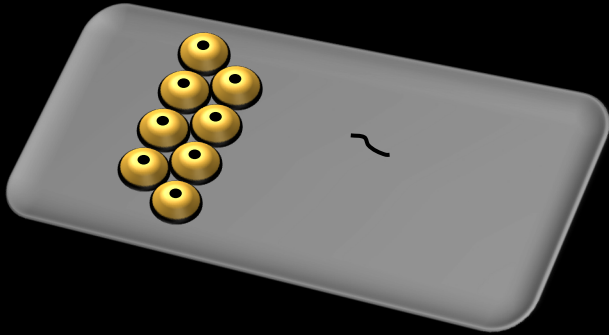
Arrays DO NOT behave like single coils the field patterns are more complex. The coils can be absolute pitch catch or pitch catch tangential (Shark). What direction is the field and current in. what is the effect of liftoff, what is the depth of penetration. Depth of penetration v coil separation and orientation. Minimal application standards for arrays – **Level 3?**

EC Array Field Patterns



Examples of Advanced NDT Technology

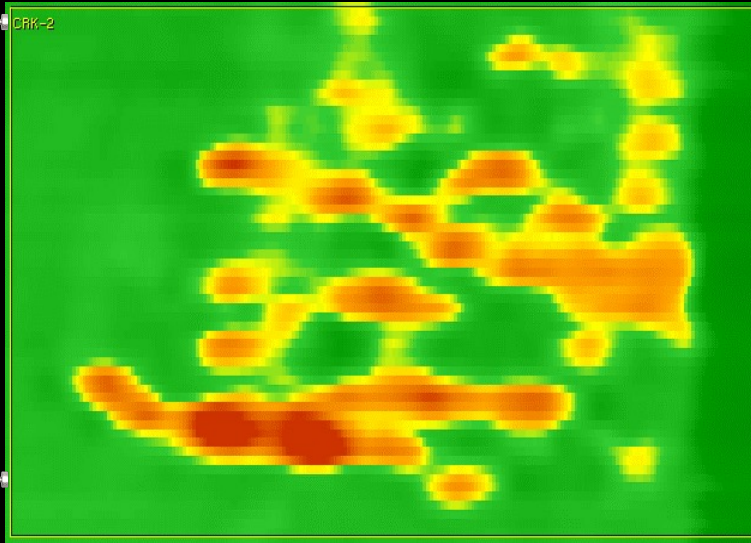
Array Eddy Current.



Depth (mm)	LO (mm)
1.8 mm	1.4 mm

Examples of Advanced NDT Technology

Array Eddy Current for SCC Detection – Replacement for MPI.



Examples of Advanced NDT Technology

Ultrasonic Arrays FMC.

What are we taught.

How to use a single probe.

The shapes of a single beam of ultrasound.

Beam spread.

Near Zone.

Ultrasonic FMC data DOES NOT necessarily have a near zone. **Level 3**

Ultrasonic FMC data DOES NOT necessarily have a beam spread, **Level 3**

It does NOT have a single direction.

There are NO standards detailed enough to write a procedure from. **Level 3 ?**

We are taught about normal incidence detection of defects. (Semi taught).

What is the amplitude relationship of array ultrasound with range. It is NOT 6dB double distance. You cannot do 6dB sizing.

Examples of Advanced NDT Technology

Ultrasonic Arrays FMC.

What wave modes are generated by FMC transmission. – All simultaneously

What are PCI or Auto Correlation plot displays and what are they useful for.

What happens if there is a curved meniscus of couplant under the probe.

We are taught about normal incidence detection of defects.

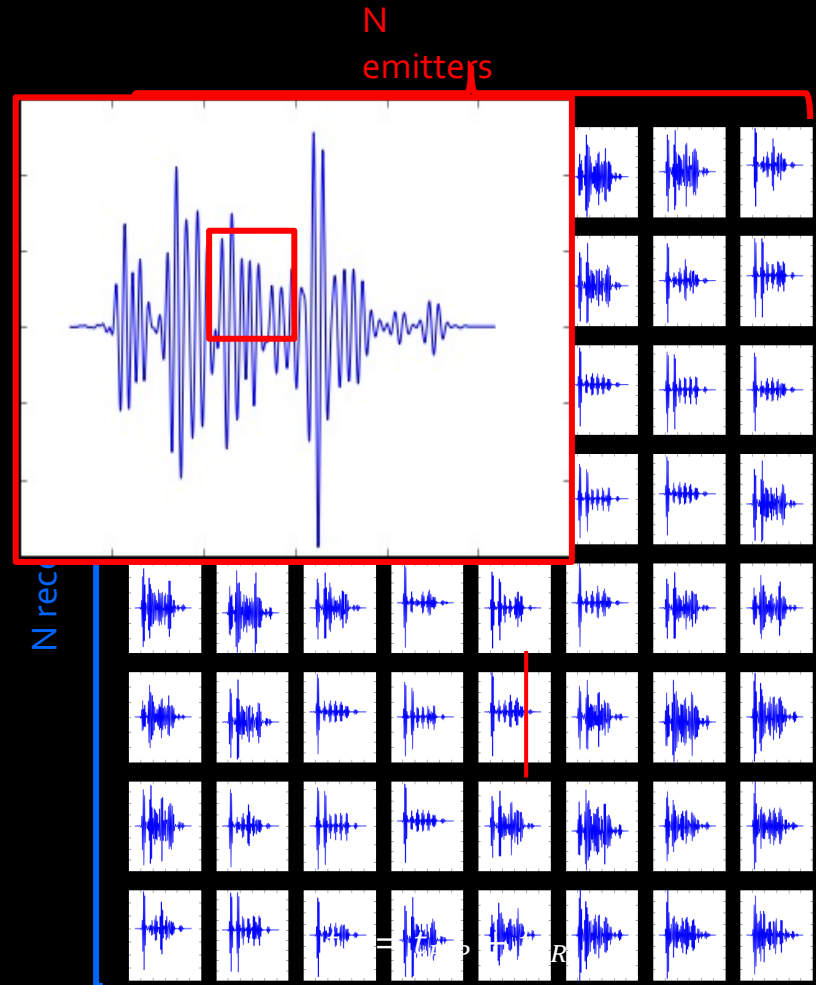
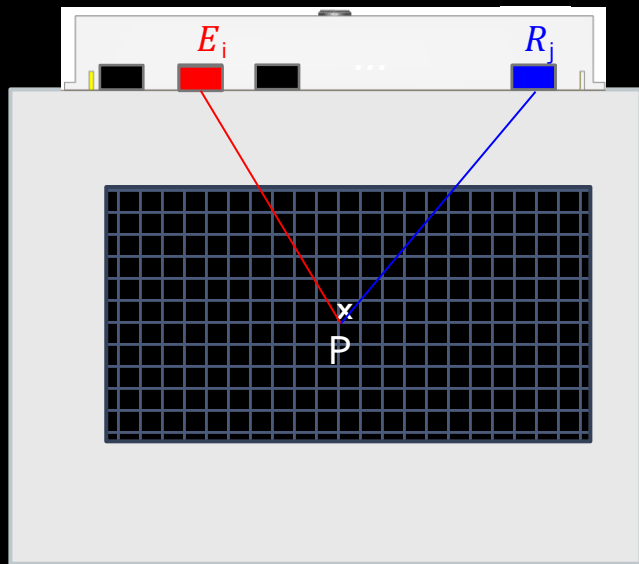
What is the amplitude relationship of array ultrasound with range. It is NOT 6dB double distance. You cannot do 6dB sizing.

How can we create test pieces to simulate defects of trials to ensure we know what real defects we can detect when the level 3 probably does not understand the algorithms used to create the images.

Examples of Advanced NDT Technology

Technology

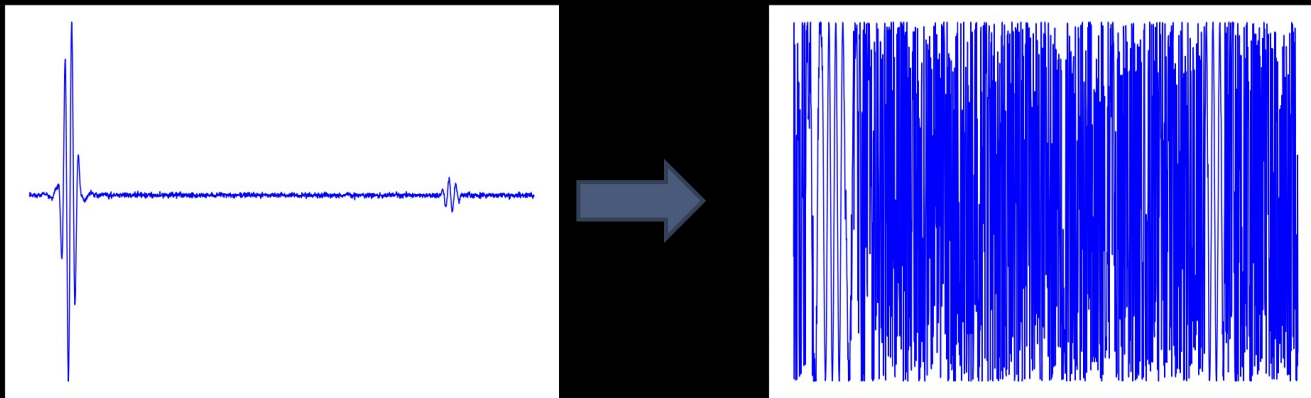
Ultrasonic Array – Alternate Signal Processing.



Examples of Advanced NDT Technology

Ultrasonic Array – Alternate Signal Processing Phase Coherence Imaging.

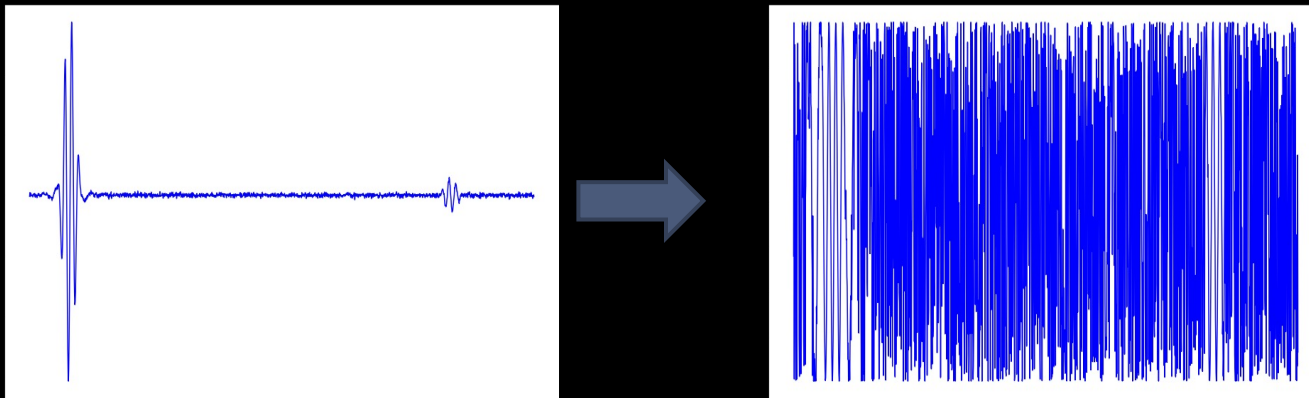
- The PCI image is transformed from a amplitude vs time signals of the FMC into phase vs time
- The phase is obtained by dividing the signals by the modulus of their Hilbert transform (analytical signal).



Examples of Advanced NDT Technology

Ultrasonic Array – Alternate Signal Processing Phase Coherence Imaging.

- The PCI image is transformed from a amplitude vs time signals of the FMC into phase vs time
- The phase is obtained by dividing the signals by the modulus of their Hilbert transform (analytical signal).

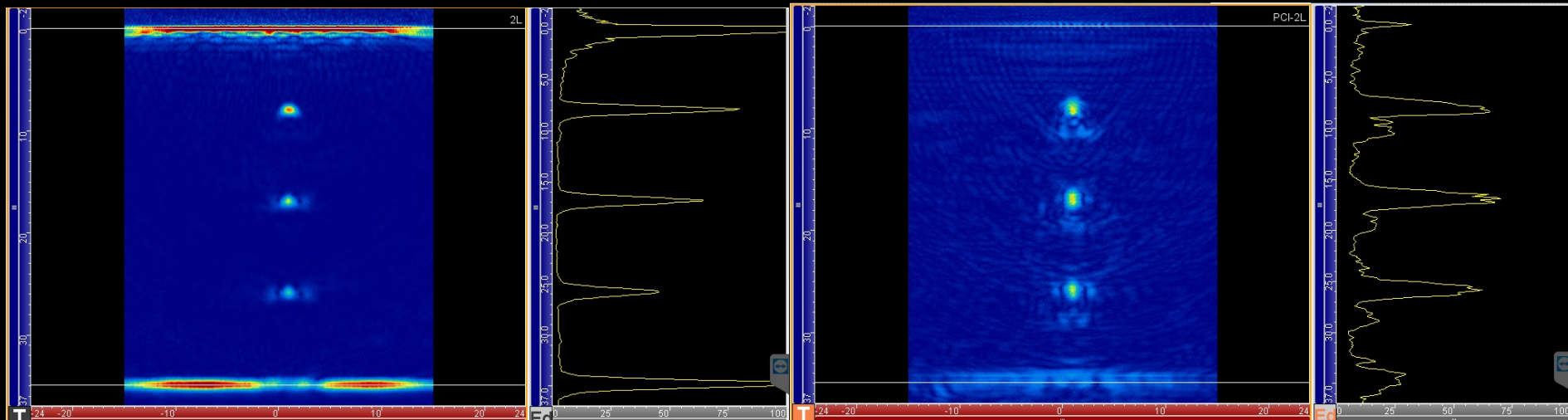


Examples of Advanced NDT Technology

Technology

Ultrasonic Array – Alternate Signal Processing Phase Coherence Imaging.

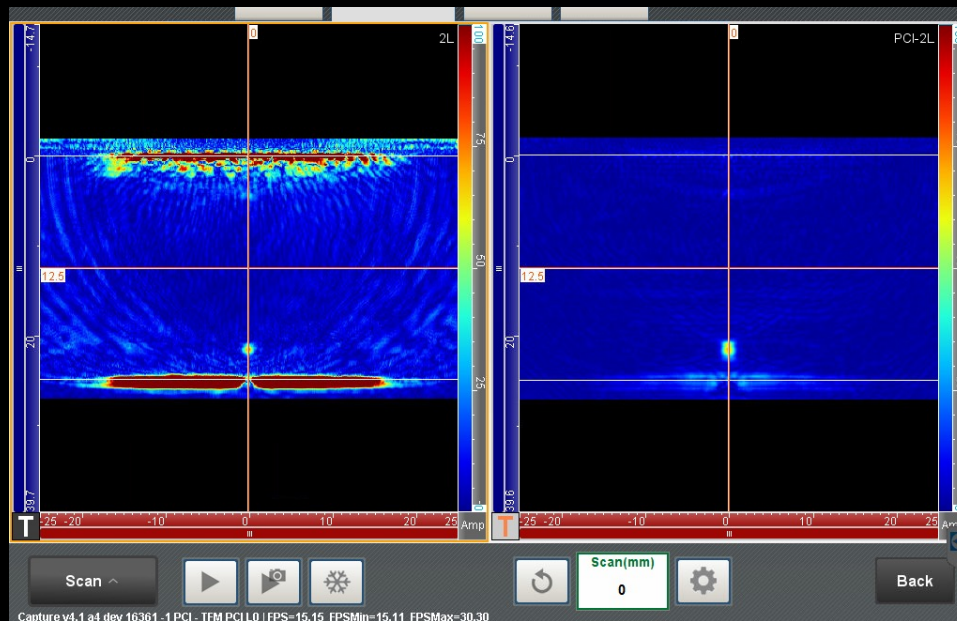
- We can see that PCI removes the front and backwall echoes pretty much entirely



Examples of Advanced NDT Technology

Ultrasonic Array – Alternate Signal Processing Phase Coherence Imaging.

- By removing the front and backwall echoes near surface defect detection is improved.
- I have also seen improvements with SCC detection due to the small point source detection capability.
- However planar defects – Back wall echoes are reduced or eliminated.



Examples of Advanced NDT Technology

Long Range UT

What are we taught. It is Ultrasound but KHz not MHz

MHz ultrasound is not dispersive in the real world. Does the average Level 3 understand dispersive waves.

Are they taught about the modes that are generated and the physics of what causes loss of signal strength or what interaction causes flaw detection.

Are they taught what happens to the energy as it goes around bends in pipes.

How do we control and Qualify New NDT Technics/Technologies

You require NDT engineers to design NDT trials and test pieces.

If the person designing the trial does not fully understand the technology they cannot design a trial.

e.g. I saw a UT level 3 teacher demonstrate PCI for detection of SCC. Asked a few questions and it was clear he did not understand either what PCI is or how it apparently was effective on his particular sample.

I suspected the claim. I have confirmed that PCI is not always effective with SCC and it depends upon the morphology of the SCC.

But to test the reliability you need to create appropriate trials.

Who Can Supply the Education

Not NDT Schools –

Education starts with who teaches the teachers. So first to be educated should be the potential trainers. The training schools and teachers are not in a position to self tech. They do not do development work. For this reason they cannot know the technology limitations.

Equipment Manufacturers –

Yes Up to a Point

The job of equipment manufacturers is to sell equipment – Not train.

Clearly their advantage to train and sell more equipment but this is not their speciality.

They do know the software and tools within their own equipment and will have performed trials with their own equipment.

Who Can Supply the Education

Universities and Colleges – UK ICNDT

Universities and or colleges may know the academic nature of the equipment but will not know the processing within the instruments and software. They deliver academic courses. However many colleges and universities in UK do NDT research and training and therefore at the leading front with some new technologies.

A Combination of Universities and Equipment manufacturers

Why –Academic - Broad academic knowledge of the subject – Limitations and Advantages

Equipment manufacturers – The algorithms included in the equipment. Limitations and properties. Plus knowledge of the use of the equipment.

Conclusions

1. Level 3 is not an advanced NDT engineer
2. We need advanced NDT engineers to correctly and fully apply advanced NDT techniques.
3. We need advanced NDT courses
4. Who can supply them

Universities with the assistance of Instrument manufacturers.

Coordinated by National NDT societies and ICNDT