Flaw Detection Capabilities in Aerospace with Eddy Current Array Technology

Jesse Herrin

CINDE
CANADIAN INSTITUTE FOR NON-DESTRUCTIVE EVALUATION

NDT in Canada
NDTiC 2018
Canada's NDT Conference

June 19 - 21
Halifax Convention Centre
Halifax, Nova Scotia

Agenda

- Common NDT Techniques for Surface Flaws
- Eddy Current Array (ECA) Testing
- ECA Inspection Benefits
- Scan Speed, Signal-to-Noise Ratio, and Sample Rate
- Friction Stir Welds
- Multi-Layer Bolt Holes
- Conclusions

Common NDT Techniques for Surface Flaws

- Liquid or Dye Penetrant Test (PT)
  - Liquid is drawn into surface openings by capillary action
  - Defects become visible under UV light or due to the dye
- Magnetic Particle Test (MT)
  - Very fine ferromagnetic particles are applied to the metal
  - Particles are drawn into flaws which indicates their presence
- Eddy Current Test (ECT)
  - Coils apply EM field into metal, flaws disrupt EC flow
  - Can find defects in ferrous and non-ferrous materials
  - Inspection results can be captured and stored

Eddy Current Array (ECA) Testing

- Multi-coil arrays take EC technology a leap ahead
- ECA probes have multiple coils in the same probe
  - positioned longitudinally, transversely, or off-axis
  - fired at coordinated times
- With an array probe, users can
  - capture more information in a single pass
  - dramatically increase speed, accuracy, and repeatability
- Inspection can now be done in a fraction of the time

ECA Inspection Benefits

- Quick, clean and portable
- Accurate, high quality inspections
- Recordable data
- Greater coverage in a single pass
- No need to store or handle chemicals
- Low total cost of ownership

Scan Speed, SNR, and SR

- ECA detectability is inversely proportional to scan speed
- Slowing down the sample rate (SR) will achieve better signal-to-noise ratio (SNR)
- A high-quality SNR ECA instrument can increase the scan speed ability while maintaining the required probability of detection (POD)
- An ideal ECA solution, consisting of instrument and probe, is one that produces the best SNR to meet these inspections needs

Scan Speed, SNR, and SR

Friction Stir Weld Inspections

- X-ray is time consuming and access can be difficult
- PT requires handling of chemicals and surface prep
- Surface breaking cracks difficult for UT to detect and size
- Grain structure of FSW can mask flaws for UT

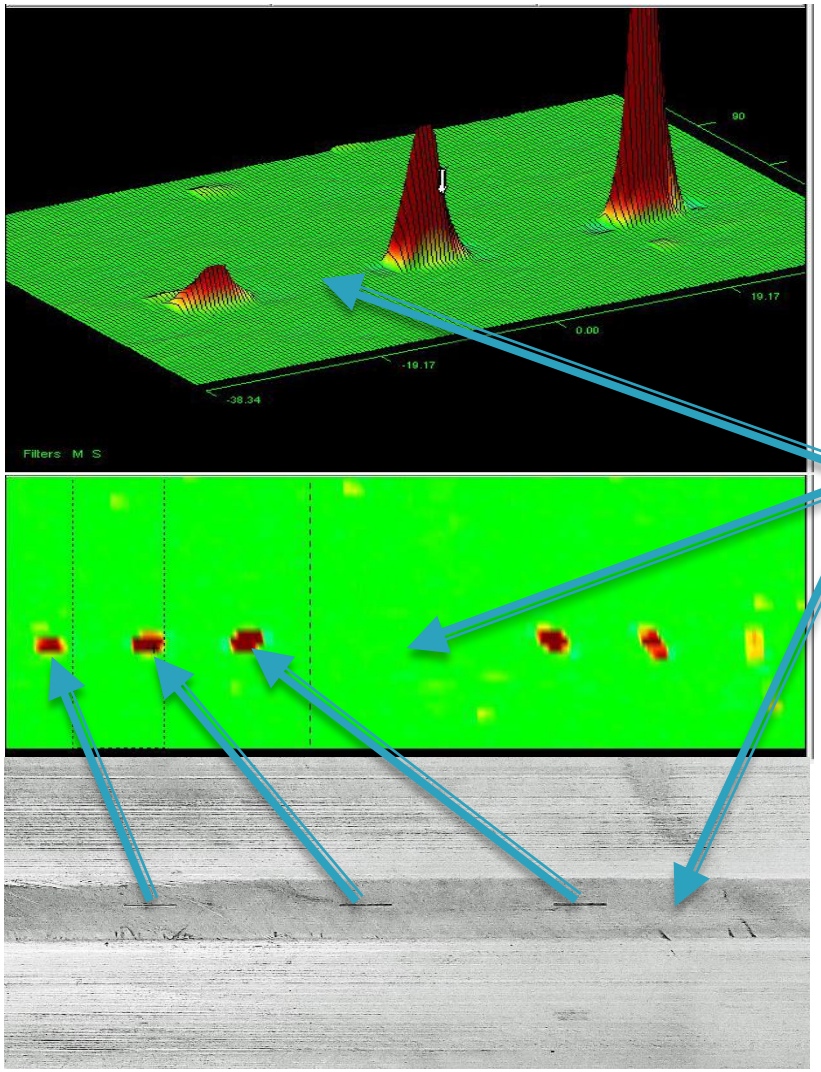
Friction Stir Weld – ECA Solution

- ECA is an ideal technique for FSWs
- A small probe and instrument allows for fast and easy access to FSW seams
- No surface preparation or handling of chemicals required

Surface Crack Detection for FSW with ECA

Superior SNR

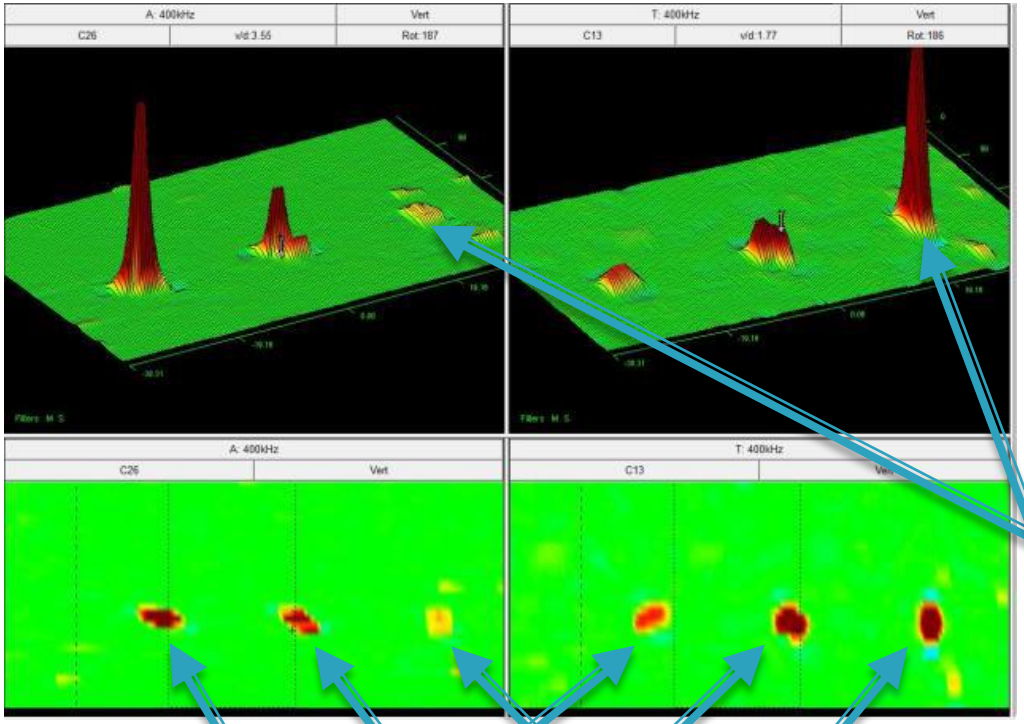
3 axial flaws of varying depth



No FSW Grain Noise

Surface Crack Characterization with ECA

Axial Channel



Transverse Channel

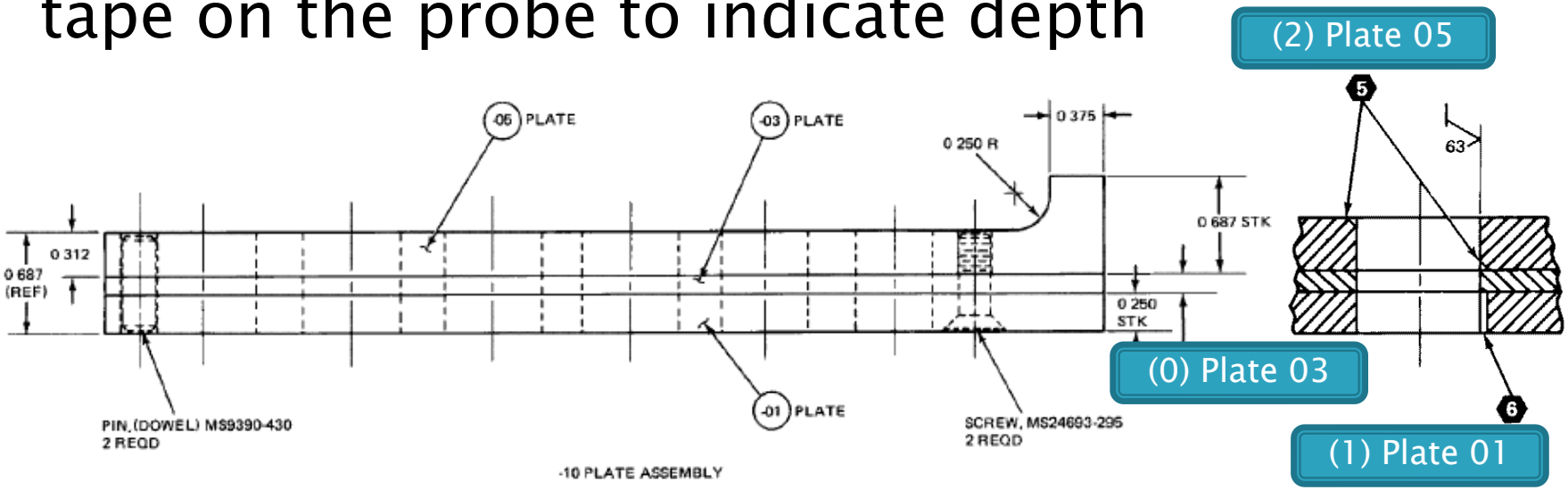
Crack-like Flaw: No Axial, Strong Transverse

3 angled flaws

Friction Stir Weld Inspections

Multi-Layer Bolt Hole Inspections

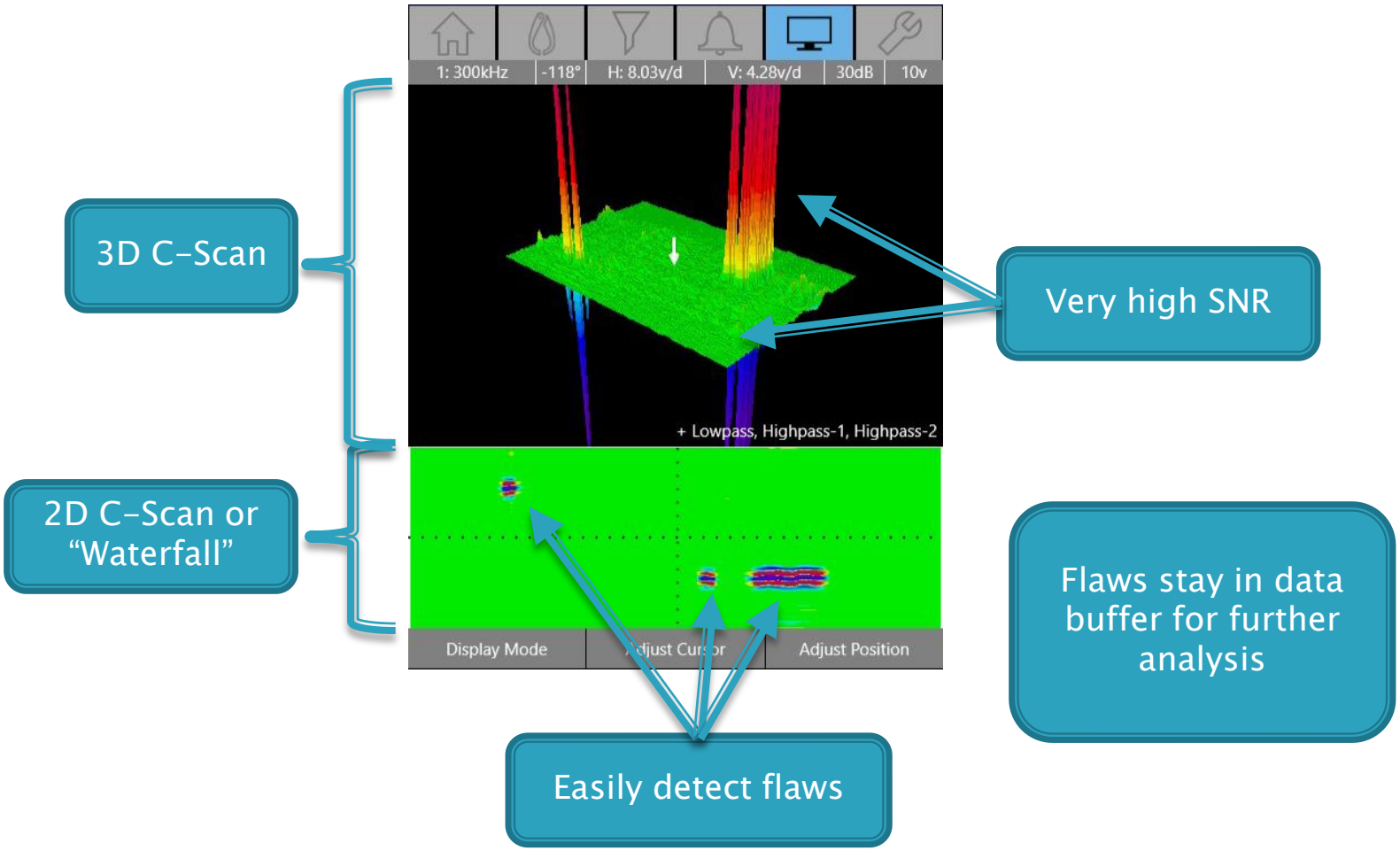
- Difficult to identify the layer in which a flaw occurs
  - Especially when flaw is close to transition between layers
- Current method requires use of a marker or tape on the probe to indicate depth



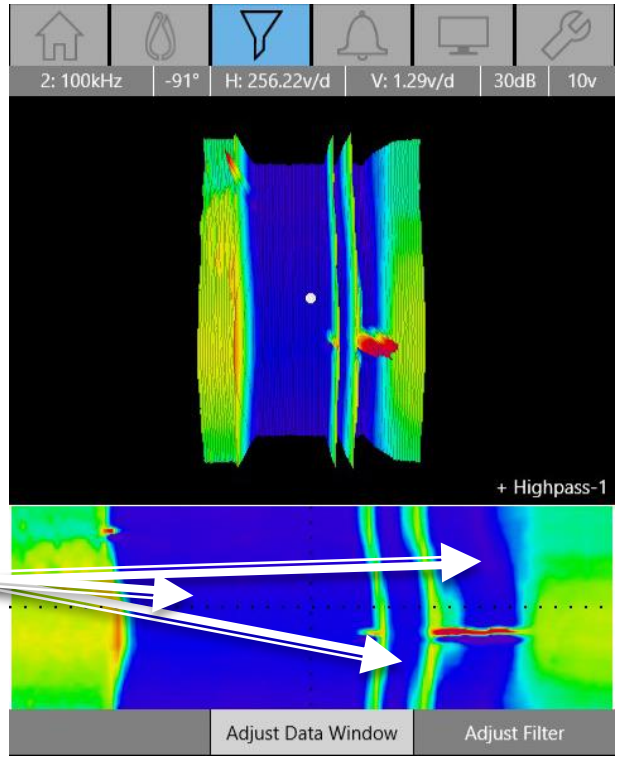
ML Bolt Hole – C-Scan Solution

- C-Scan display allows the user to “see” the different layers
- Better POD and characterization of signals than standard impedance & sweep displays
- Color 2D & 3D C-Scan displays from ECA now being used for bolt hole inspections
- Superior SNR makes flaws easily identifiable

Better POD for ML Bolt Hole Inspections



Seeing Layers in ML Bolt Hole Inspections



3 layers shown in the C-Scan

Easily identify layers

Can see which layer the flaw is located

Multi-Layer Bolt Hole Inspections

ML Bolt Hole – C-Scan Conclusions

- ECA C-scans improve detection capability vs. traditional rotating scanner inspections
- Flaws can easily be assigned to a layer
- Use of an EC instrument with high SNR further improves the POD

Conclusions

- A high-quality SNR ECA instrument can increase the scan speed ability while maintaining the required POD
- With higher noise level there is a greater chance of missing small flaws, therefore a high sample rate is not necessarily good; what is more desirable is a high SNR
- Surface breaking flaws can efficiently be found in FSW using an ECA probe and a handheld ECA instrument in comparison to existing techniques
- During multilayer aluminum bolt hole inspections, it can be determined in which layer flaws exist by using C-Scan and dual frequencies

Thank You

Questions?