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AA&S Conference 2018

Eddy Current Array for Aircraft

Presented by Graham Maxwell

Olympus Australia NDT Key Account Manager

Material provided by Ghislain Morais
Olympus NDT Canada

RD TECH PANAMETRICS-NDT NDT engineering corporation NORTEC SONIC

Innovation in NDT™

Eddy Current Array

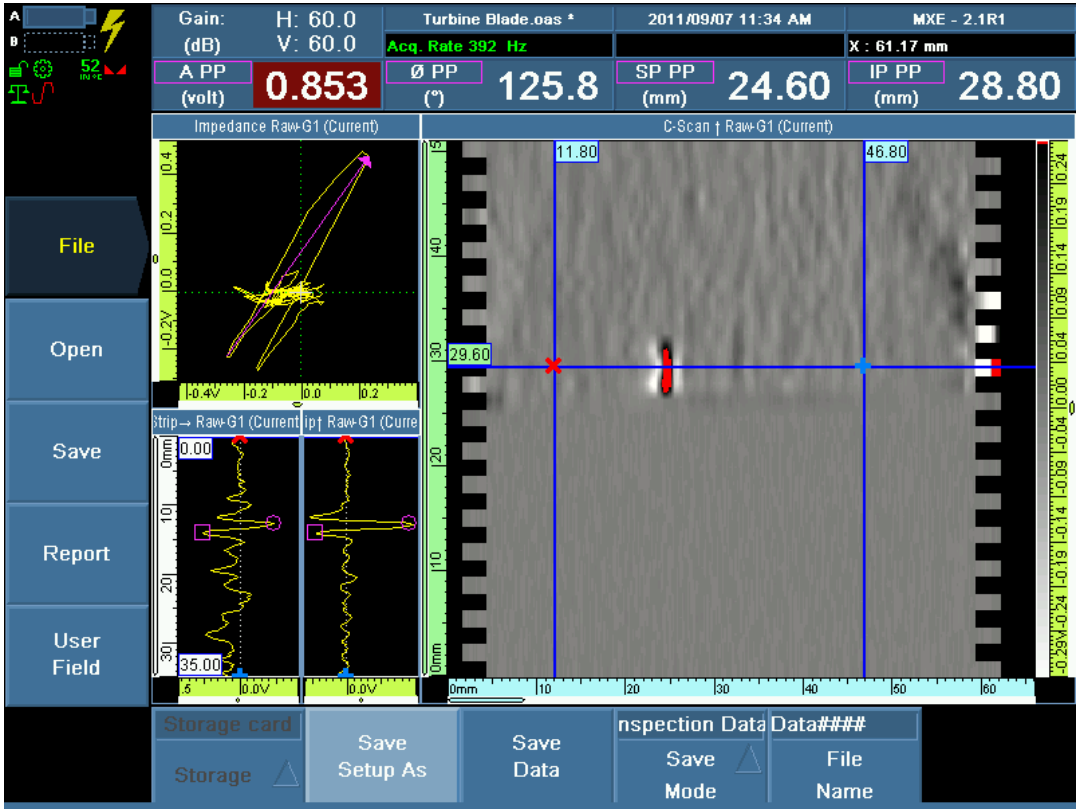
ECA Instrument

OmniScan ECA:

- ✓ Portable (battery operated)
- ✓ Modular (ECA, PA, UT)
- ✓ Up to 32 channel (64 with an external multiplexer)
- ✓ Frequency range: 20 Hz to 6 MHz
- ✓ C-Scan display
- ✓ Data Recording
- ✓ Encoded capability

ECA Advantages

- ✓ Fast
- ✓ Large coverage
- ✓ Easy Imagery
- ✓ Data Recording
- ✓ Encoded capability



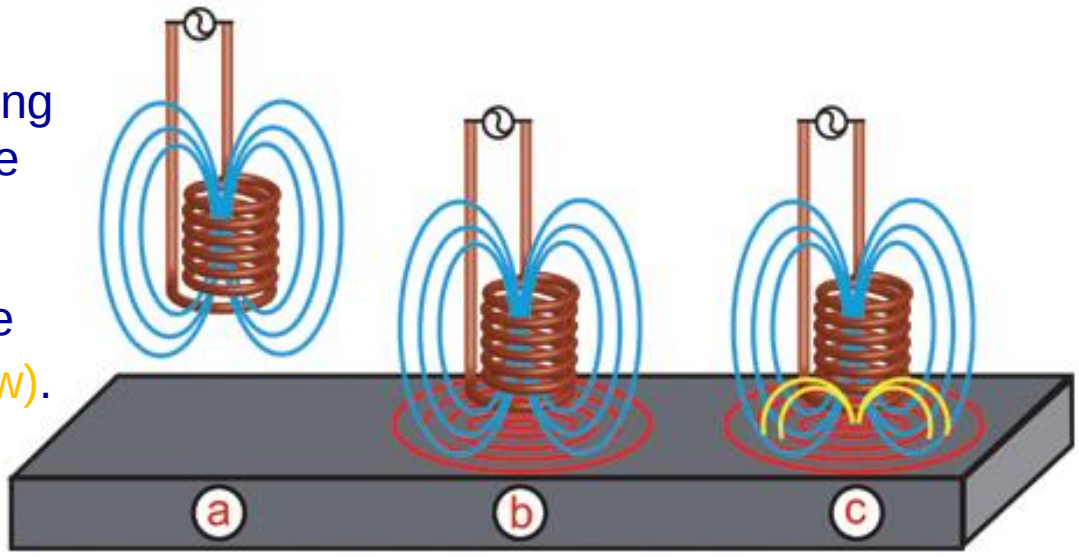
How Does Eddy Current Work?

Basic Principles

a▸ Inducing a current into a coil creates a magnetic field (in blue).

b▸ When the coil is placed over a conductive part, opposed alternating currents (eddy currents, in red) are generated.

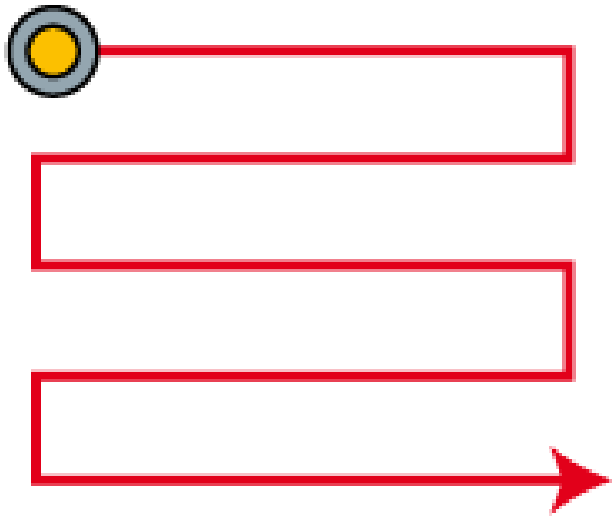
c▸ The defects in the part disturb the path of the eddy currents (in yellow).



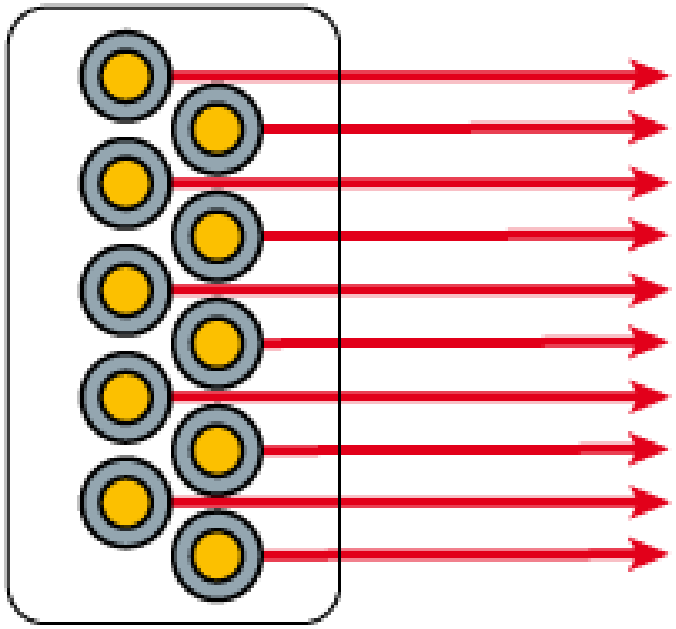
This disturbance is measured by the coil.

Eddy Current **Array** is the same as conventional ECT × **32**

Single coil = raster scan

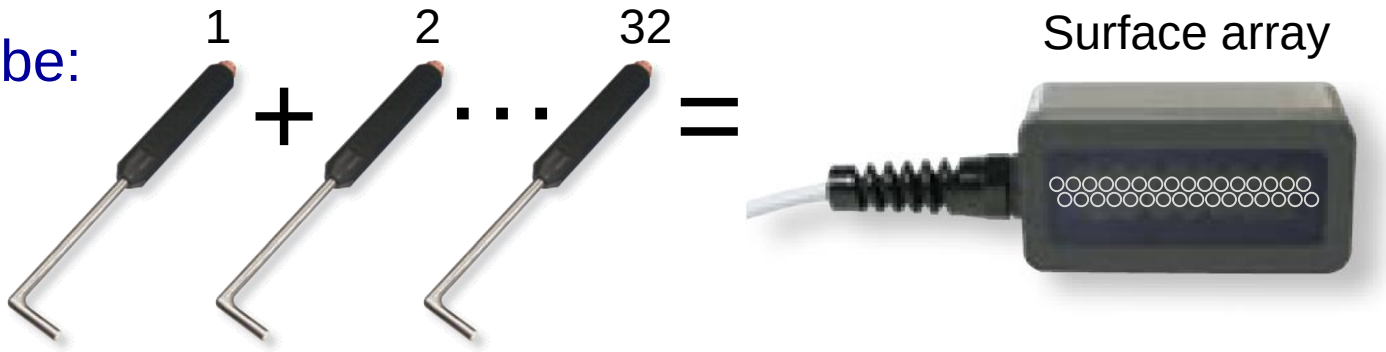


Multiple coils = one-line scan

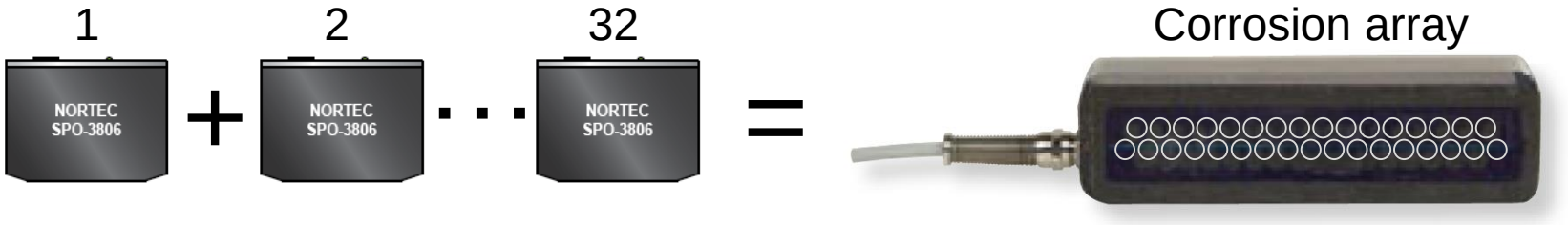


Elements in ECA Probe

- Elements are the individual EC probes used to make the array probe.
- Any type of EC probe can be used as an element. For example:
  - Pencil probe:



  - Sliding probe:

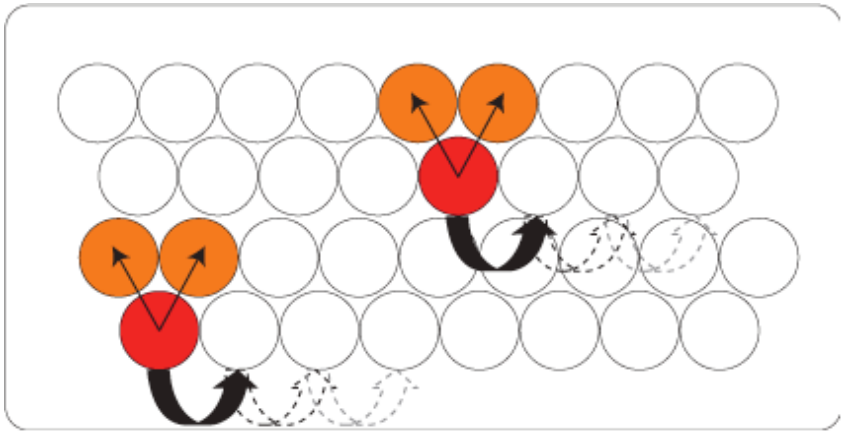


Eddy Current Array

Basic Principles

- ECA technology provides the ability to electronically drive multiple eddy current coils placed side by side in the same probe assembly.

  Data acquisition is performed by multiplexing the eddy current coils in a special pattern to avoid mutual inductance.

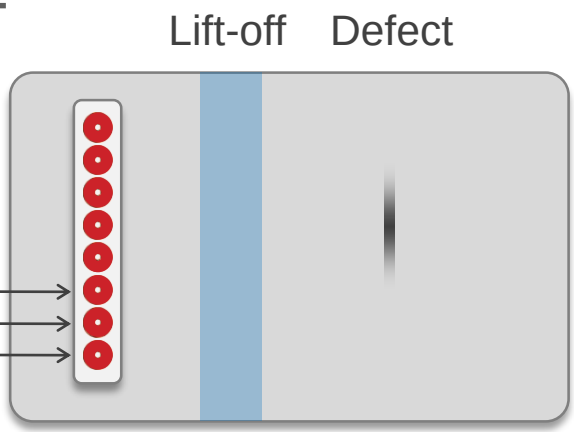


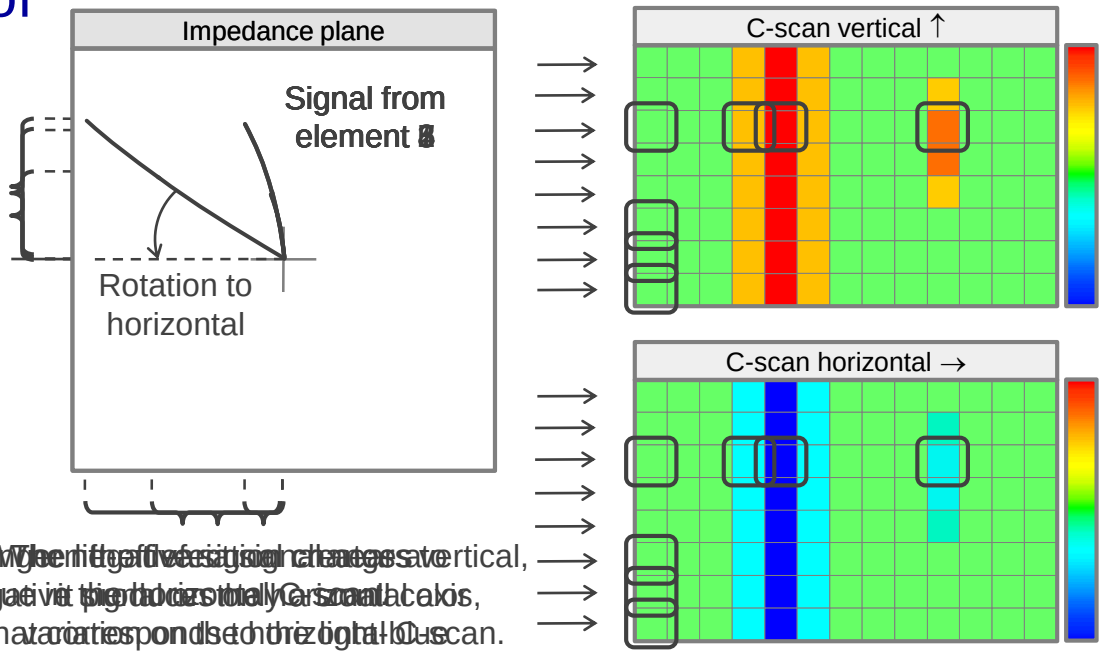
Representation in C-scan

Before calibration

- To calibrate, the signal from each element is rotated in order to bring the lift-off signal to the horizontal axis of the impedance plane.

This is done simultaneously to all elements by changing the lift-off angle

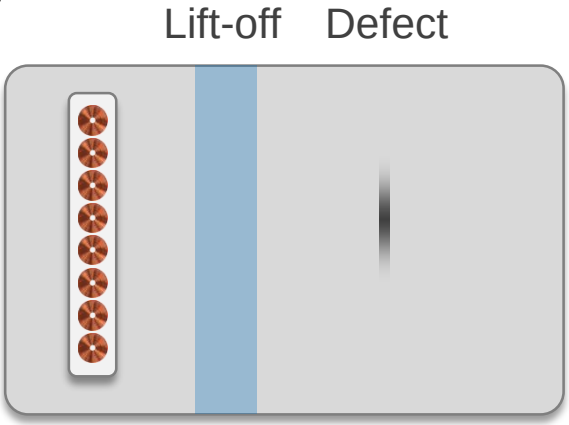


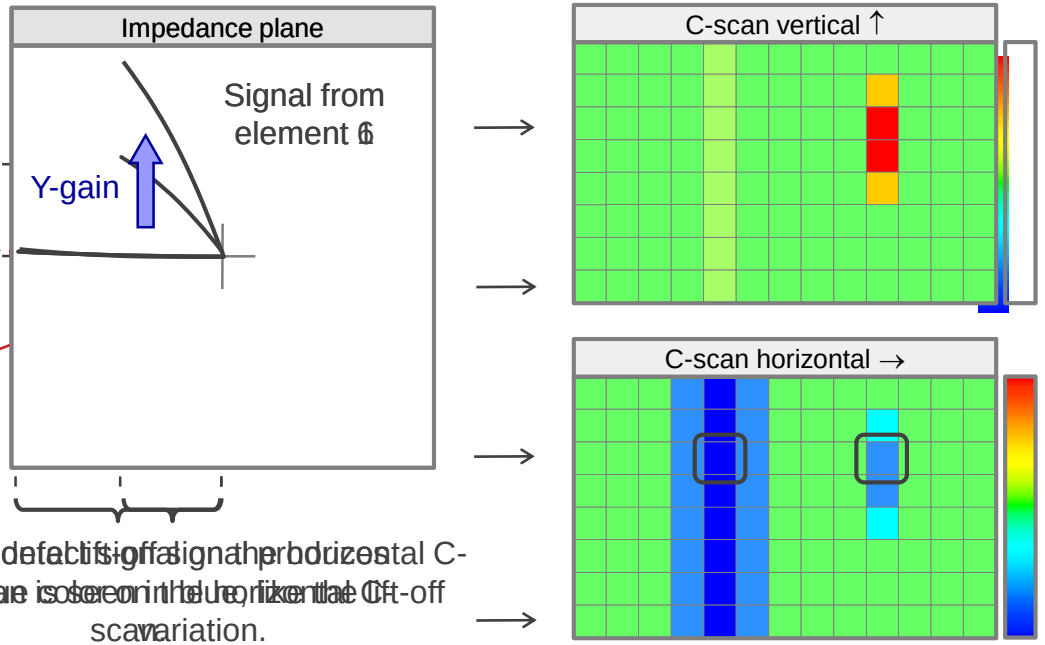


Representation in C-scan

After calibration

- The elements show a horizontal lift-off signal in the impedance plane.
- Defects have a strong vertical component.
- Additional gain may be used on the Y-axis to increase the defect signal and improve the color contrast in the vertical C-scan.





Large lift-off variation may have a small positive vertical component, that creates a yellow color in the vertical Cscan. The defect is easily detected on the vertical C-scan while the small lift-off variations are not seen.

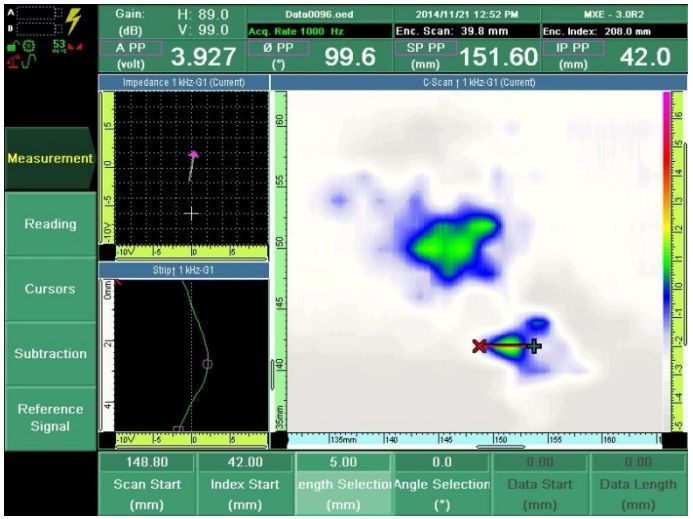
However, a small lift-off variation remains horizontal and are not seen in the vertical Cscan, which is very useful for defect detection.

The horizontal lift-off signal produces a clear dark color in the horizontal C-scan.

The defect signal produces a clear dark color in the horizontal C-scan, like the lift-off variation.

Eddy Current Technology: An Ideal Replacement for Traditional NDT Methods

- Replaces MT and PT for surface breaking flaws in all alloys
- Replaces MOI for subsurface flaw detection in nonferromagnetic alloys
- Detects cracks in a fraction of the time, and the defects can be recorded
- Color palettes (patent rights protected) simulate MT, PT, and RT methods.



The size of cracks can be measured with the cursor.

Environmentally Friendly

No need to clean or remove paint or coatings

- No chemicals used
- No chemical waste generated
- No intensive cleaning required

Inspection Through Paint

With the Eddy Current technique, the surface does not need to be perfectly clean; cracks contaminated by oil or dirt are detected with reliability.

- Eliminates the need to strip expensive coatings
- Inspects surface and subsurface of nonferromagnetic materials without removing the paint
- C-scan provides a reliable image of the condition of the material under the paint

ECA Flaw Detector

OmniScan MX ECA

- Portable and rugged
- Easy to use
- Reliable C-scan imagery
- Continuous mode

Time Savings

- Enables inspection through paint and thin coatings
- No need to clean the part
- Wide coverage (probe size)
- Very fast scanning
- C-scan color imagery
- Defect size evaluation
- Easy archiving (saving data) and post-analysis

Requirements for ECT Inspection

ECA/ECT Flaw Detector

ECA Probe

ECT Standard

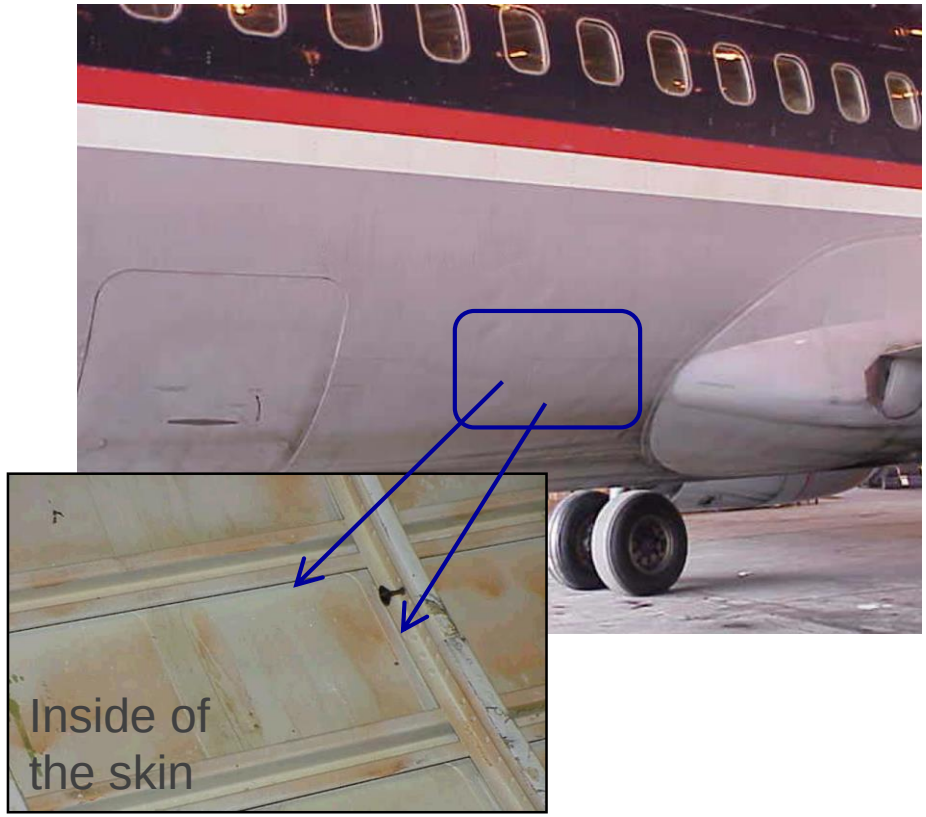
ECT Procedure

NTM manual

Certified ECT Inspector

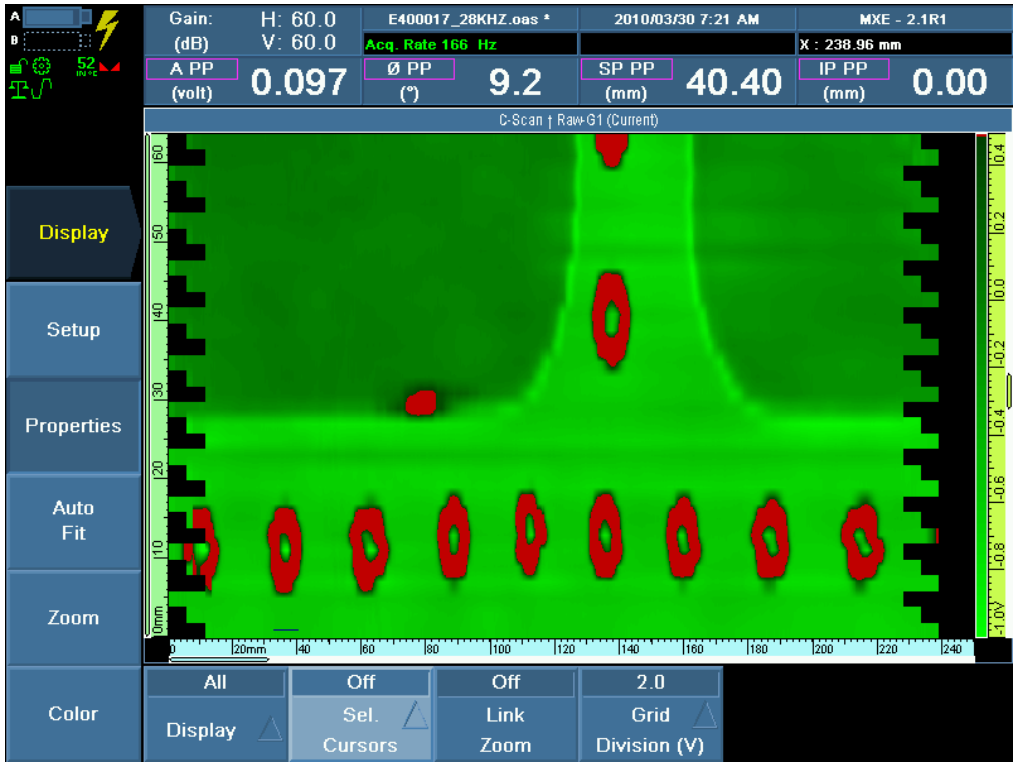
Cracks at the doubler edge on Boeing 737

- The inspection is done from the outside and cracks as small as 6 mm (0.240”) long by 0.25 mm (0.010”) deep located at the edge of the doubler can be detected.
- The procedure is now included in the Boeing 737 nondestructive test manual.
- It is an optional inspection procedure to Part 6, 53-30-25.
  - It uses the SAB-067-005-032 and an encoder.



Cracks at the doubler edge on Boeing 737

- Benefits:
  - Simple manual inspection.
  - Probe positioning is not as important as for typical EC sliding probe inspection.
  - C-Scan allows easy location of the doubler edge for fast and simple detection of the initiating cracks.
  - Better reproducibility.
  - Time saving:
    - » **Normal time: 200 hours**
    - » **With ECA: 48 hour**



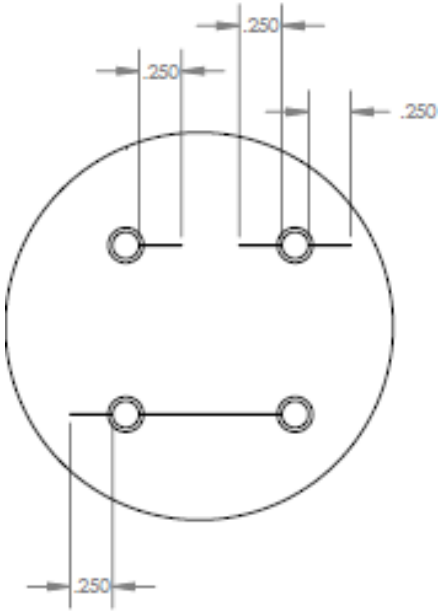
ECA Applications

Surface crack inspection of nonferromagnetic materials

- Wide variety of probes with different coil configurations
- Tree probes are already included in aircraft manufacturers' NTM
- Detects cracks through paint
- Detects cracks in all directions
- Detects cracks as small as 0.030 inches

ECA Applications (cont'd)

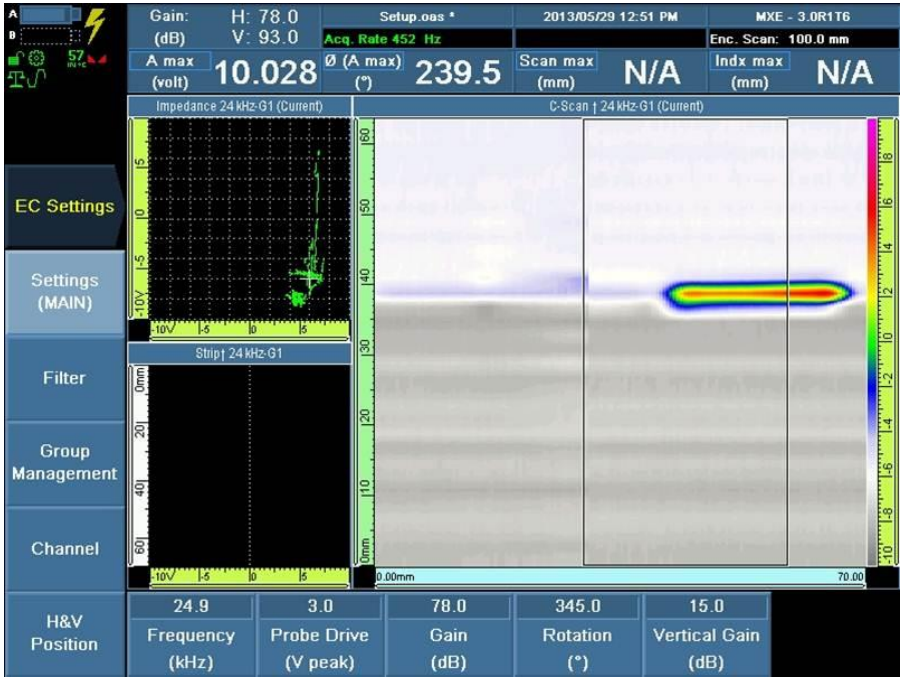
Subsurface-crack fastener inspection of nonferromagnetic materials



- Very good replacement for MOI
- Wide variety of probes with different coil configurations
- Two probes are already included in aircraft manufacturers' NTM
- Detects cracks through paint

ECA Applications (cont'd)

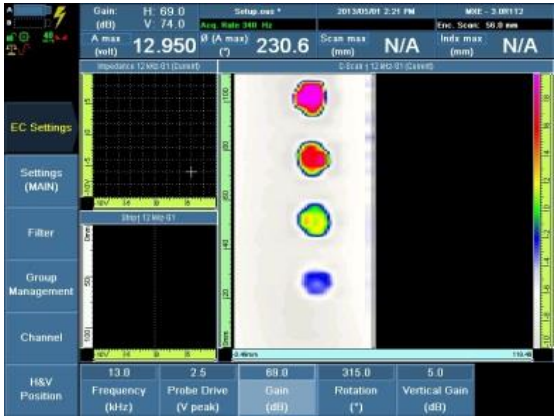
Subsurface-crack CAM mill inspection of nonferromagnetic materials



- Very good replacement for MOI
- Wide variety of probes with different coil configurations
- Two probes are already included in aircraft manufacturers' NTM
- Detects cracks through paint

ECA Applications (cont'd)

Subsurface corrosion inspection of nonferromagnetic materials



Area & depth color calibration

- PINK = 0.5 in. corrosion, 0.0144 in. deep
- RED = 0.5 in. corrosion, 0.0108 in. deep
- YELLOW = 0.5 in. corrosion, 0.0072 in. deep
- BLUE = 0.5 in. corrosion, 0.0036 in. deep

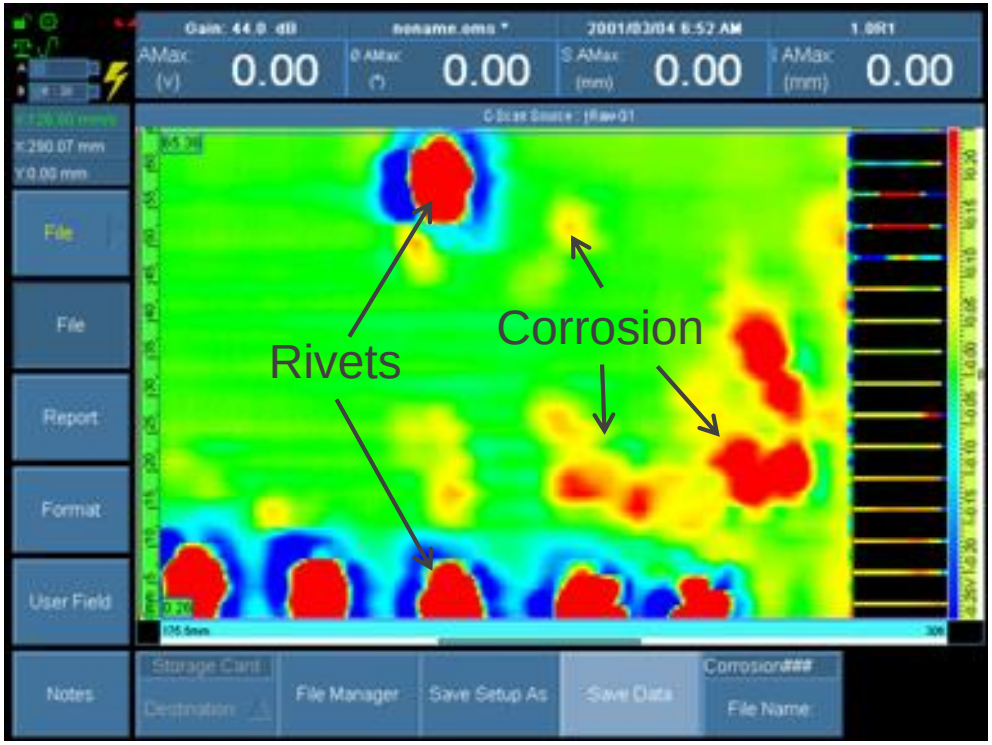
- Very good replacement for MOI
- Wide variety of probes with different coil configurations
- Two probes are already included in aircraft manufacturers' NTM
- Detects corrosion through paint

Corrosion on Airbus A330/340

- Corrosion between the first layer and an internal acoustic panel.
- The procedure uses the SAA-112-005-032 probe which has a low frequency and a large footprint.
- Raster scanning can be done to cover larger area by using the GLIDER manual scanner.

Corrosion on Airbus A330/340

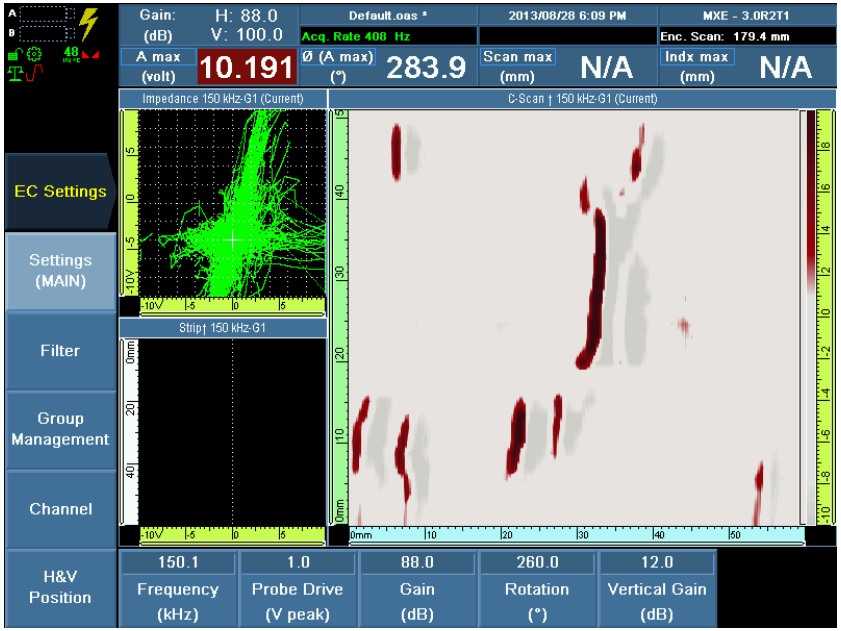
- Benefits:
  - Simple manual inspection.
  - C-Scan allows easier detection of small corrosion in large area.
  - Better reliability.
  - Better reproducibility.
  - Time saving:
    - » Area : 12 m² (1550 ft²)
    - » Normal time: 9 hours
    - » With ECA: 1 hour



ECA Applications (cont'd)

Surface crack inspection of ferromagnetic materials

Red dye penetrant indications



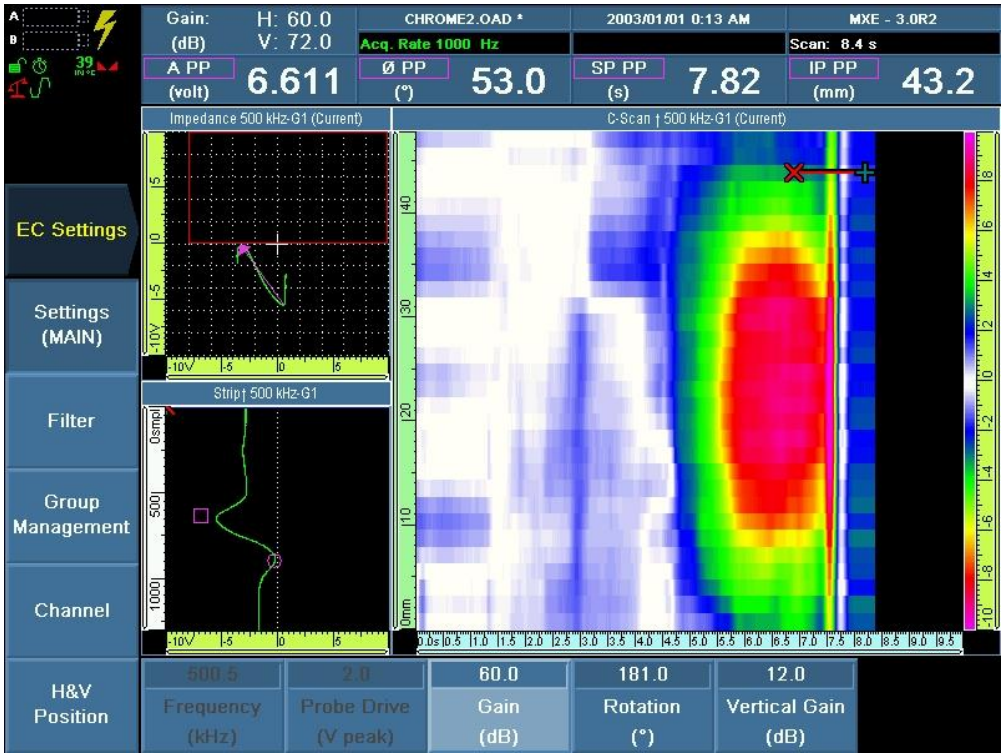
ECA indications with red dye color palette (patent rights protected)

- Very good replacement for MT of steel alloys
- Probes adapt to part geometry
- Detects cracks through paint or coatings
- Detects indications in all directions

ECA Applications (cont'd)

Detection of changes in permeability in tempered steel alloys

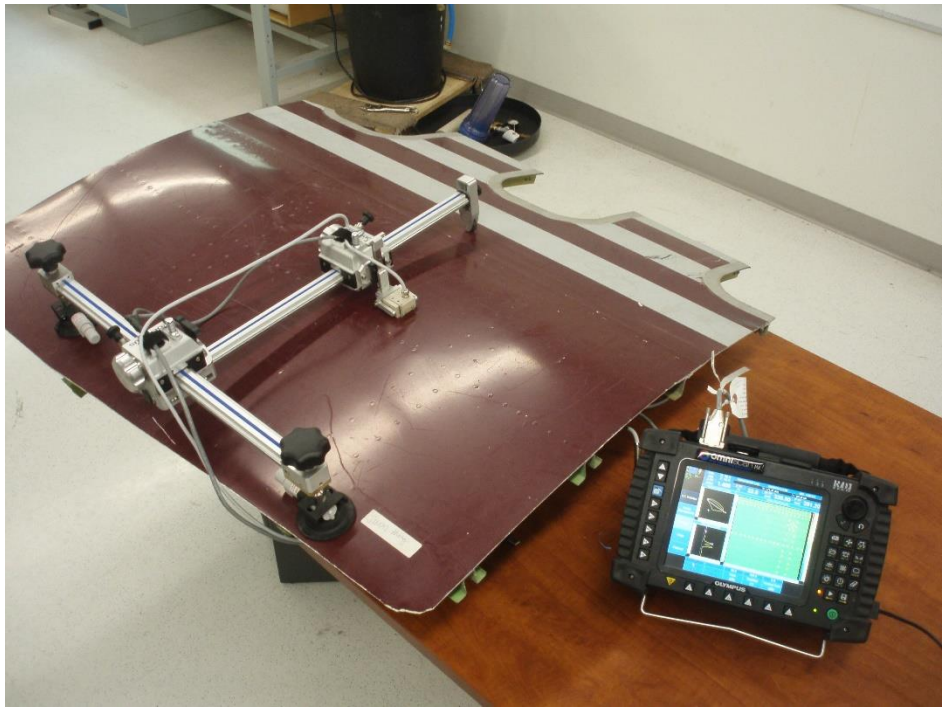
- Good replacement for Nital Etch inspection
- Detects through chrome plating and HVOF
- Sensitive to changes in permeability
- Probes adapt to part geometry

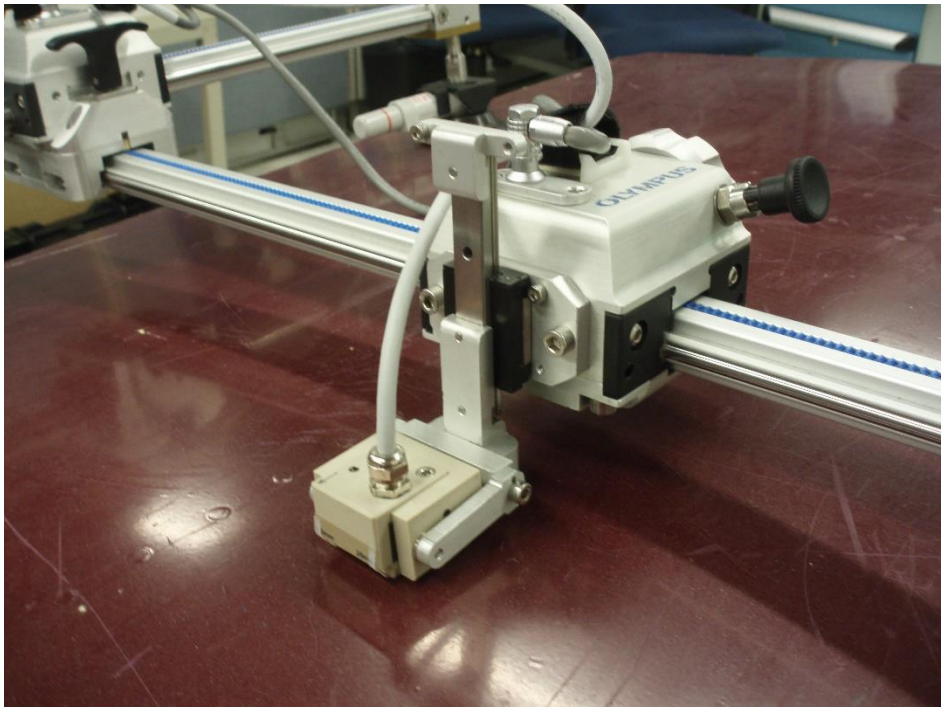


HIGH POTENTIAL FOR SIGNIFICANT COST AND TIME SAVINGS

Raster Scan

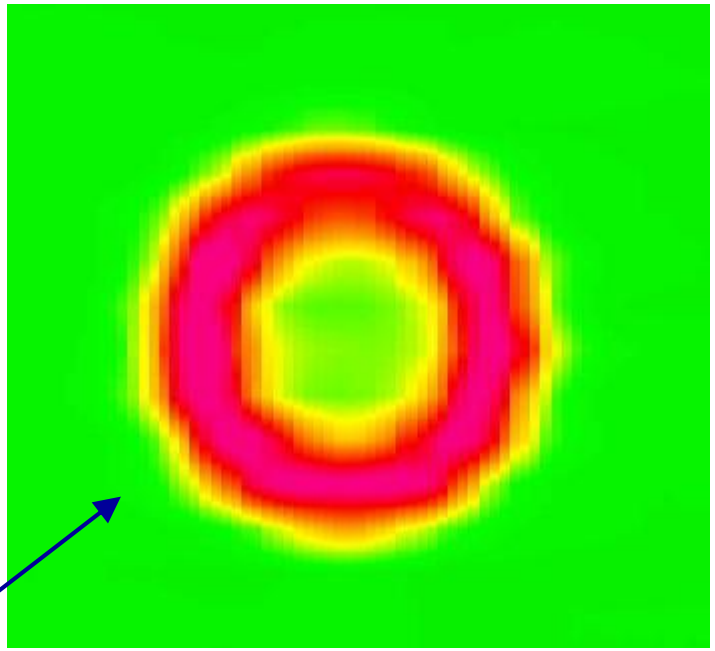
- Available with OmniScan ECA

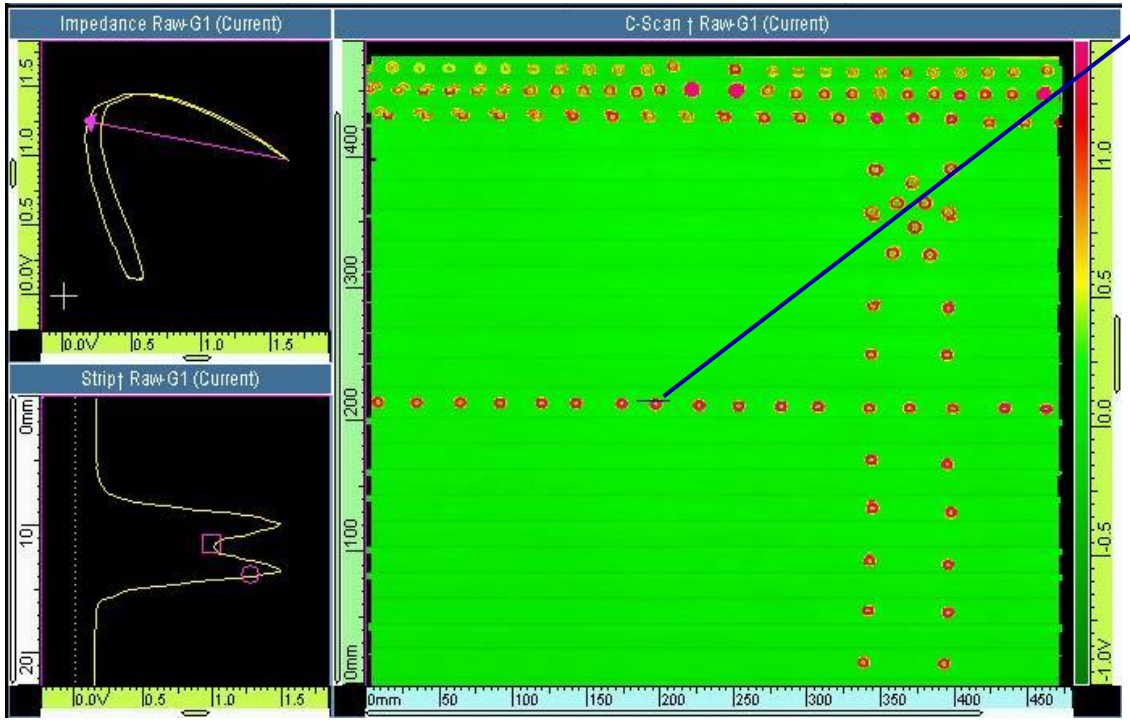




Raster Scan

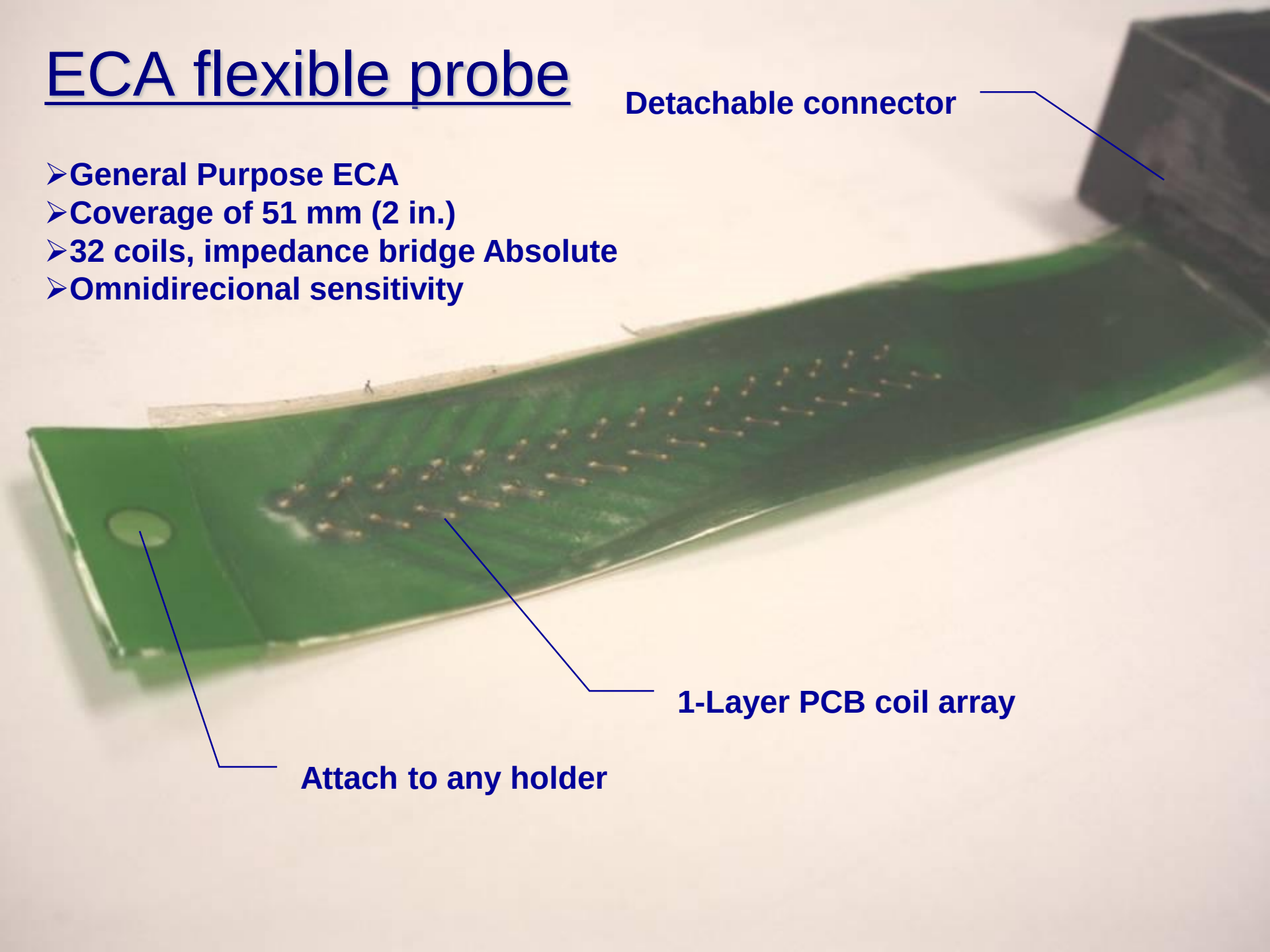
- Fuselage scan :
  - 500mm x 500mm (19,7” x 19,7”)
  - Scan resolution: 0,2mm (0,008”)



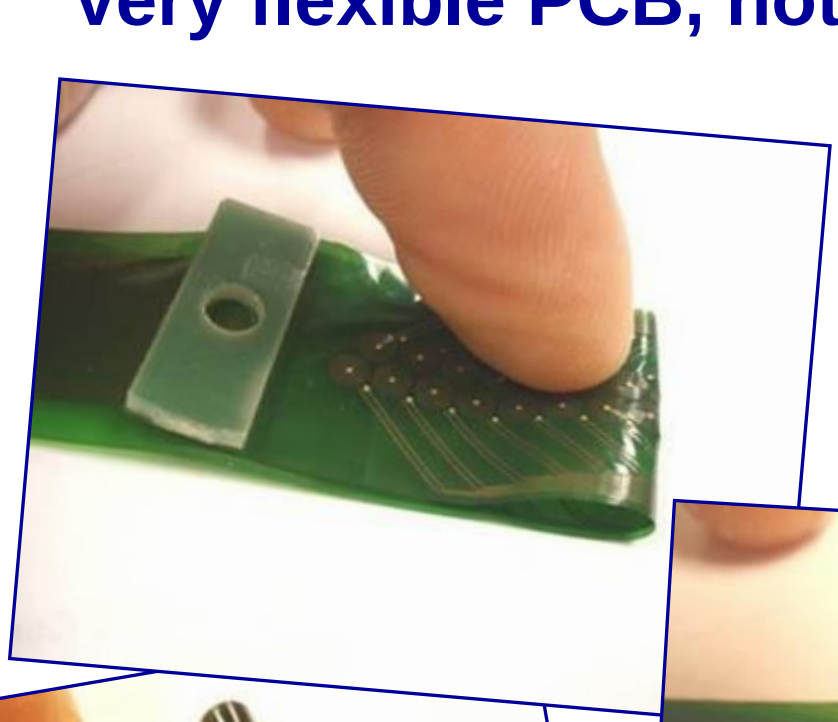


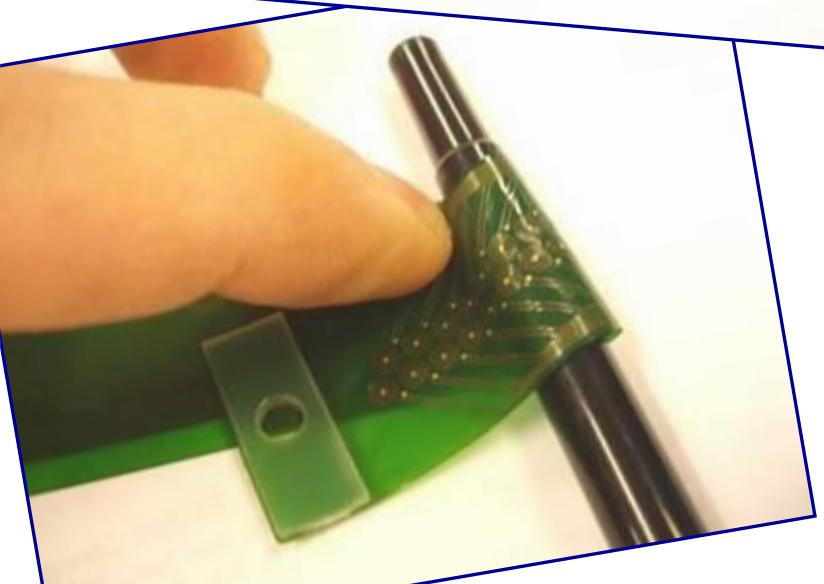
ECA flexible probe

- General Purpose ECA
- Coverage of 51 mm (2 in.)
- 32 coils, impedance bridge Absolute
- Omnidirecional sensitivity

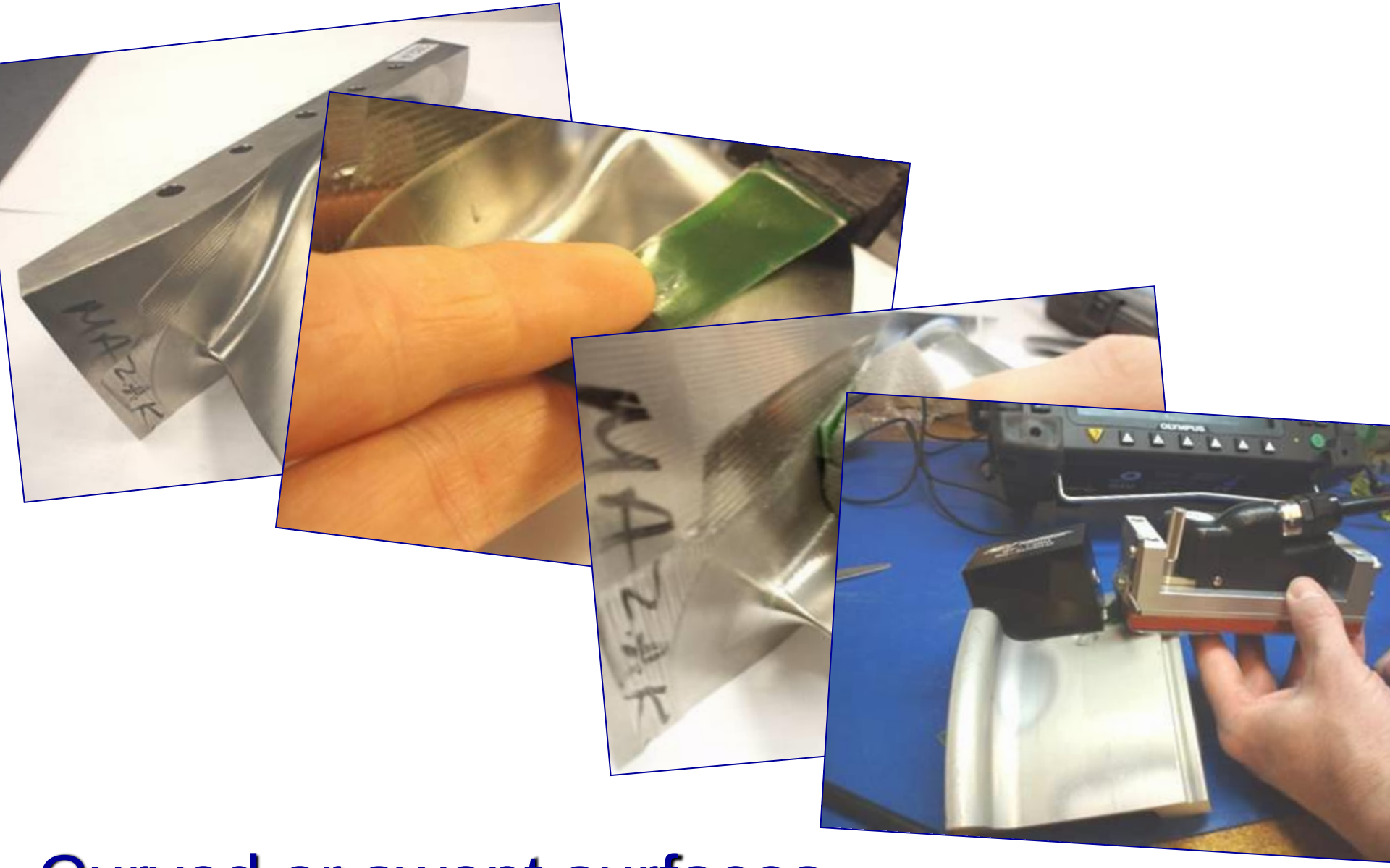


Very flexible PCB, not easily destroyed!





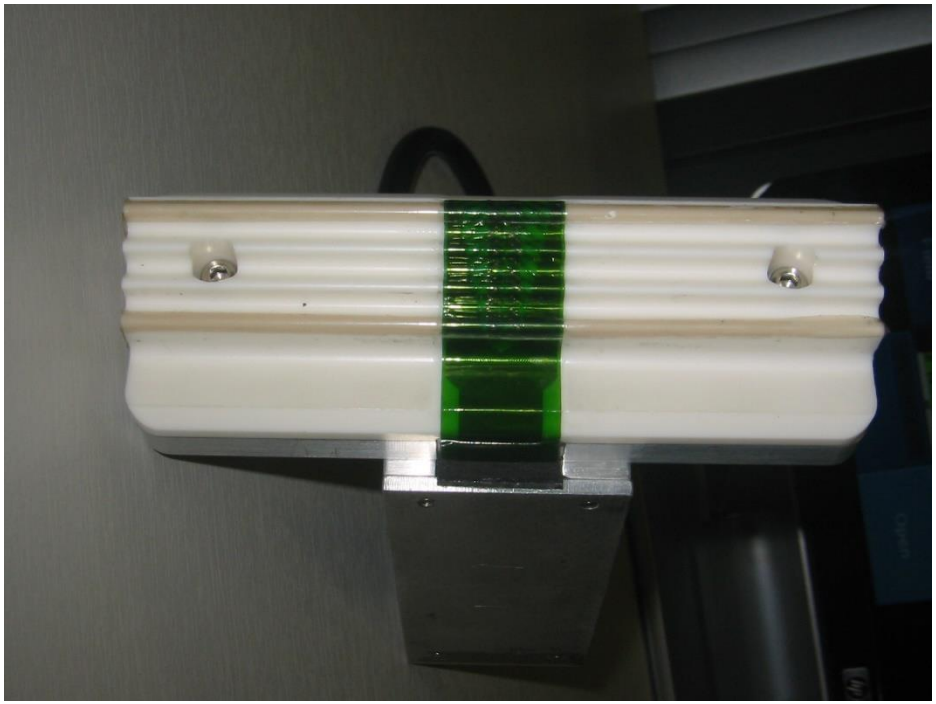
FLEX PROBE: Applications

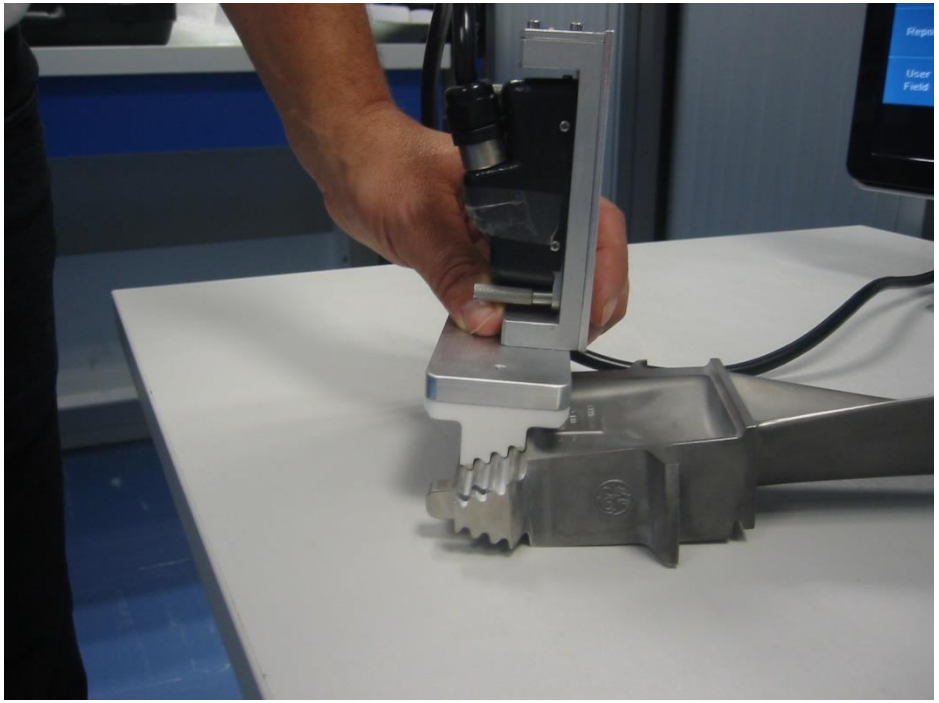


Curved or swept surfaces

Blade root inspection

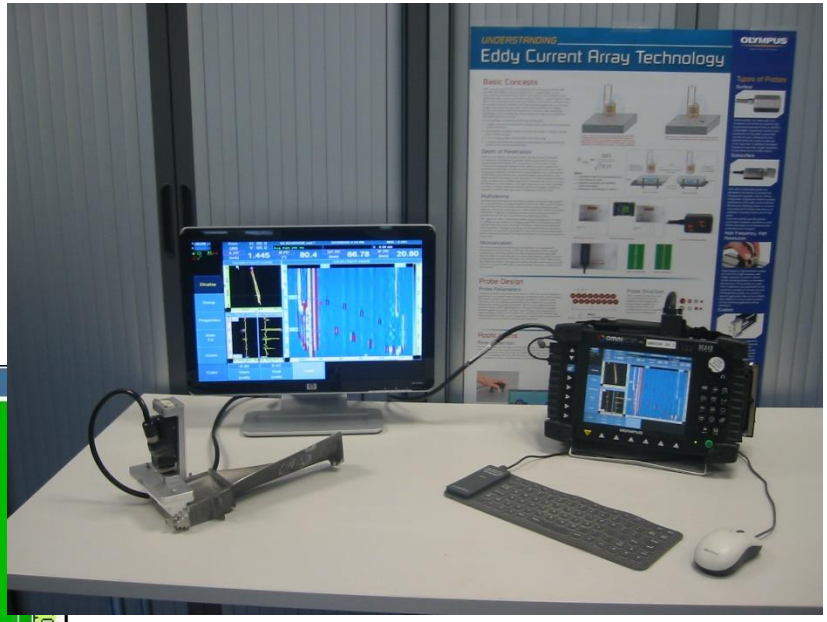
- Gas turbine generator blade
- Notches at different locations
- Inspection in one pass

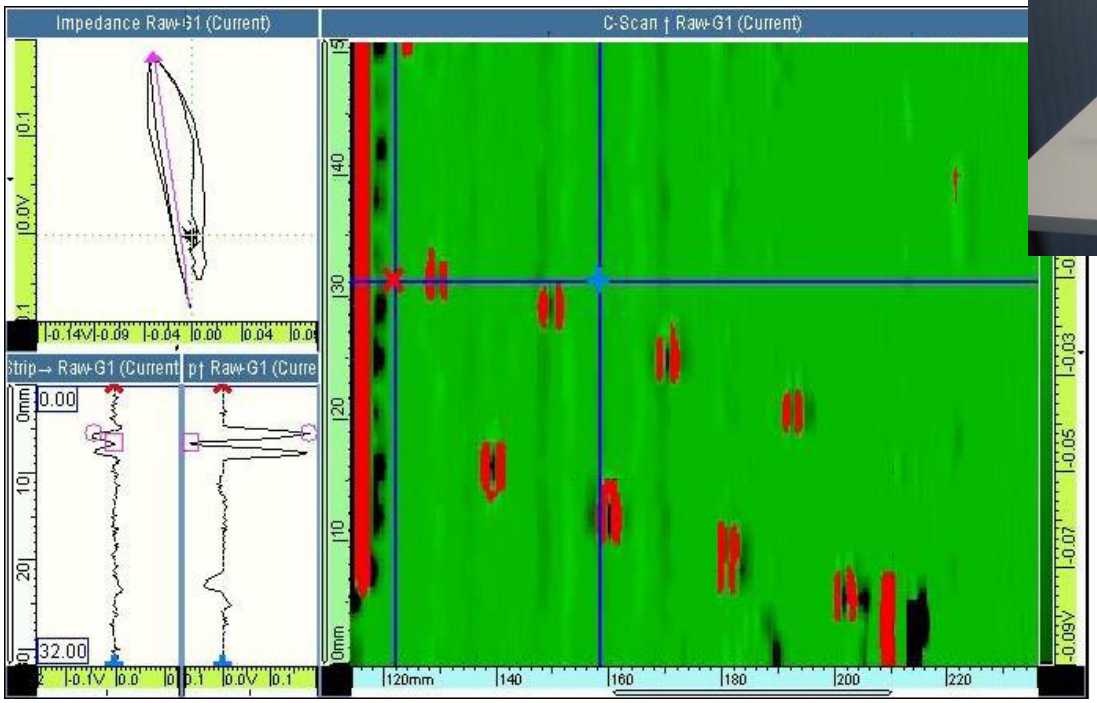




Flexible ECA mounted on a shaped holder

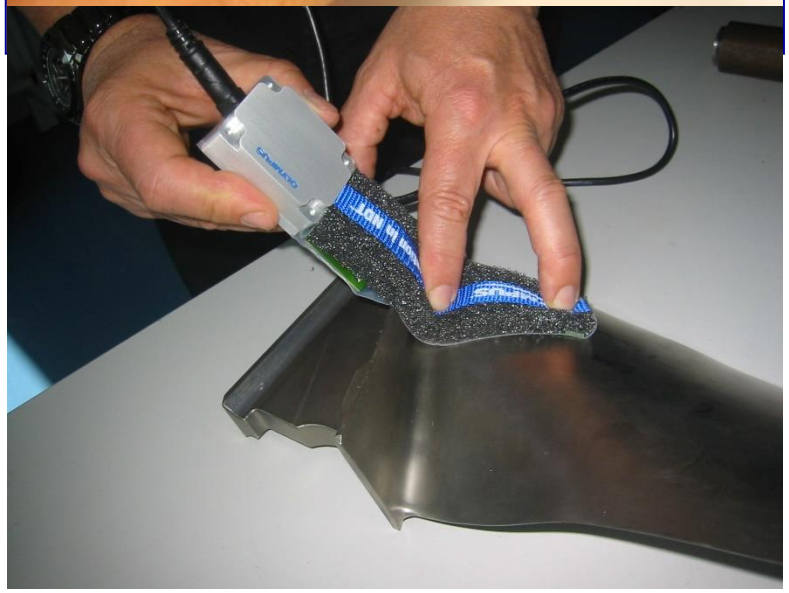
Blade root inspection





Cscan representation of the results

Fan Blade inspection



Conclusion

Eddy Current Array is an ideal replacement for MT, PT, MOI, and Nital Etch inspection methods.

Advantages of ECA

- **Portable**: The OmniScan can be used with a chest harness and two batteries.
- **Lightweight**: The OmniScan weighs only 10.1 pounds with one battery.
- **Easy to use**: The OmniScan 3.0R2 software is fast and easy.
- **Rugged instrument**: The OmniScan has a sturdy casing with protective bumpers.
- **Fast scanning**: Scans at speeds of 4 feet/minute to 30 feet/minute with a 1 to 6 inch coverage, depending on the probe used.
- **100% coverage**: The ECA to ECT probe toggle option of the OmniScan makes it possible to perform 100% coverage inspections with the press of a button.
- **Sizing capabilities**: Evaluates the dimension of indications.

New Aircraft Procedures

- CFM CFM56-7B, 5B, 5A engine blade root inspection
- CFM56-7B engine dovetail slot inspection
- CFM56 all versions, TRF inspection kit
- GE90 engine dovetail slot inspection
- GP7200 engine dovetail slot inspection
- Airbus A330 corrosion inspection

Thank you, and travel safely with Olympus Australia

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