

OLYMPUS

Your Vision, Our Future



Eddy Current Array inspection Johannesburg 2018

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- **EC/ECA testing and equipments**
- **Areospace applications**
- **Other applications**



Historique théorie

$$e = |\Delta\Phi|/|\Delta t| \quad \text{or} \quad \Phi = Li \quad \text{donc} \quad |\Delta\Phi| = L |\Delta i|$$

$$J_x = J_0 e^{-\left(x\sqrt{\pi\mu\sigma f}\right)} \sin\left(2\pi f t - x\sqrt{\pi\mu\sigma f}\right)$$

$$\theta = 57 \frac{x}{\delta} \quad J = 100 \cdot \exp\left(-x/\delta\right) \quad \delta = 50 \sqrt{\frac{\rho}{f\mu_r}}$$

$$U^2 = R^2 I^2 + L^2 \omega^2 I^2 = (R^2 + L^2 \omega^2) I^2$$

$$\text{D'où} \quad U = I \sqrt{R^2 + L^2 \omega^2}$$

$$\text{Donc} \quad Z = U / I = \sqrt{R^2 + L^2 \omega^2}$$

History

Yesterday

Today

Tomorrow



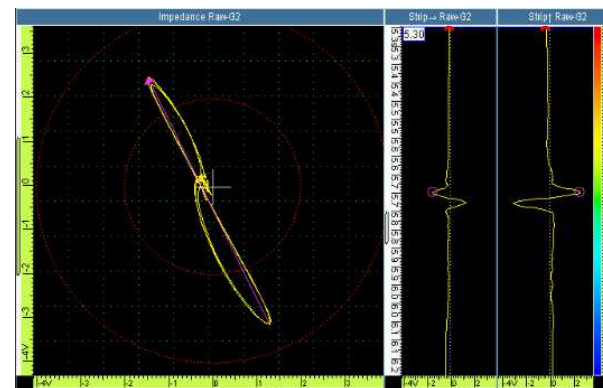
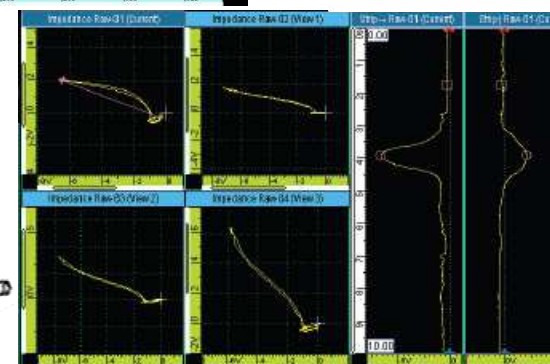
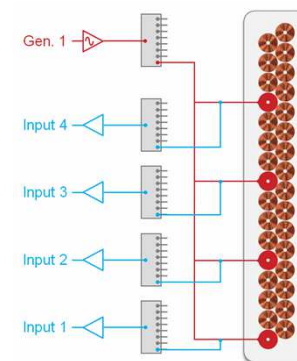
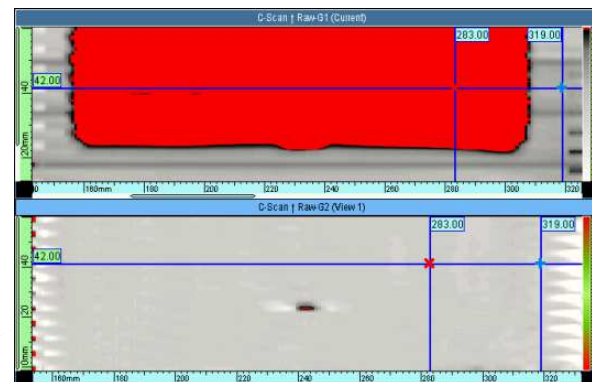
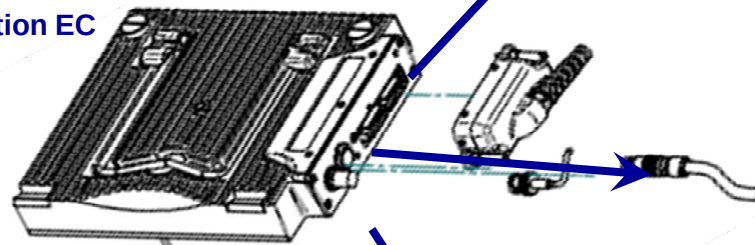
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EC Testing

Equipment

OMNI-P-ECA4-32

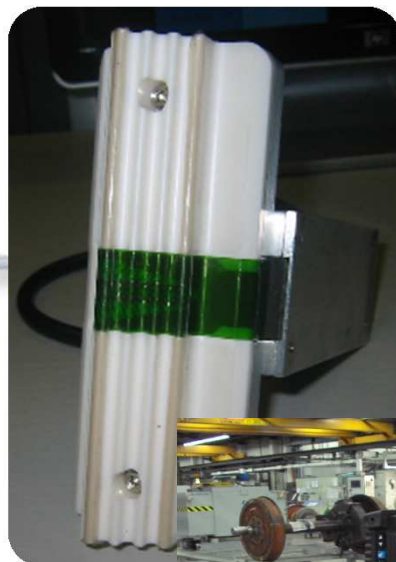
- Conventional and Array ECT
- 4 input channel
- 32 channels
- 64 channels with external multiplexer
- 1-Analog output
- Frequency range from 20Hz to 6MHz
- Dual Frequency operation ECA
- 8 Frequency operation EC
- 2-Encoder input
- 3-Alarms output



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ECA probes application

- Aircraft Corrosion
- Tubes inspection
- Gaz Turbine
- Pipe
- Rails
- Dovetail
- Train axis
- Doubler edge
- Weld
- FSW
- Blade



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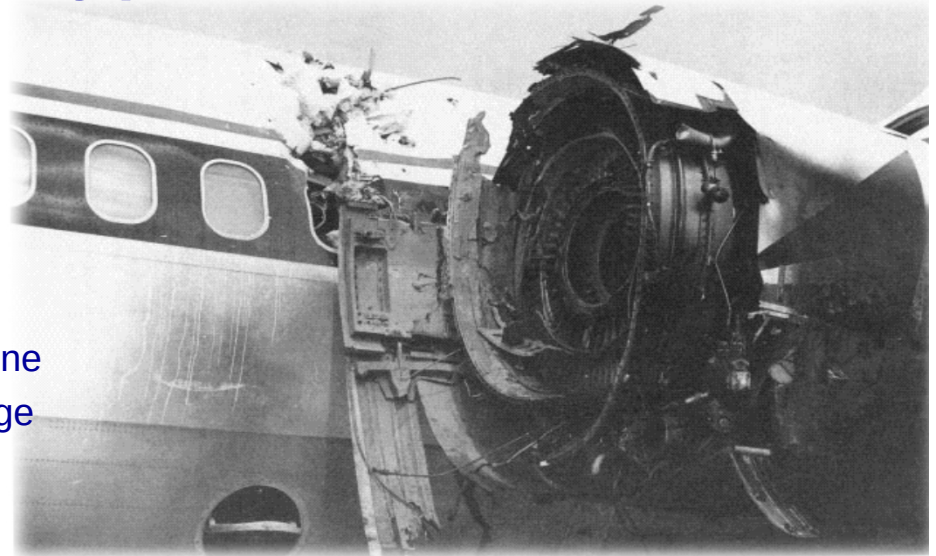
AEROSPACE INDUSTRY : VM OLYMPUS SOLUTION

FAA policy on rotating parts

Historic : accident, pensacola, florida

- Engine failure on take-off roll
- Pilot aborted take-off
- Stage 1 Fan Disk separated; impacted cabin
- Life Limit: 20,000 cycles. Failure: 13,835 cycles.

⇒ Represented second major premature failure of a engine disk in service due to unanticipated and undetected damage



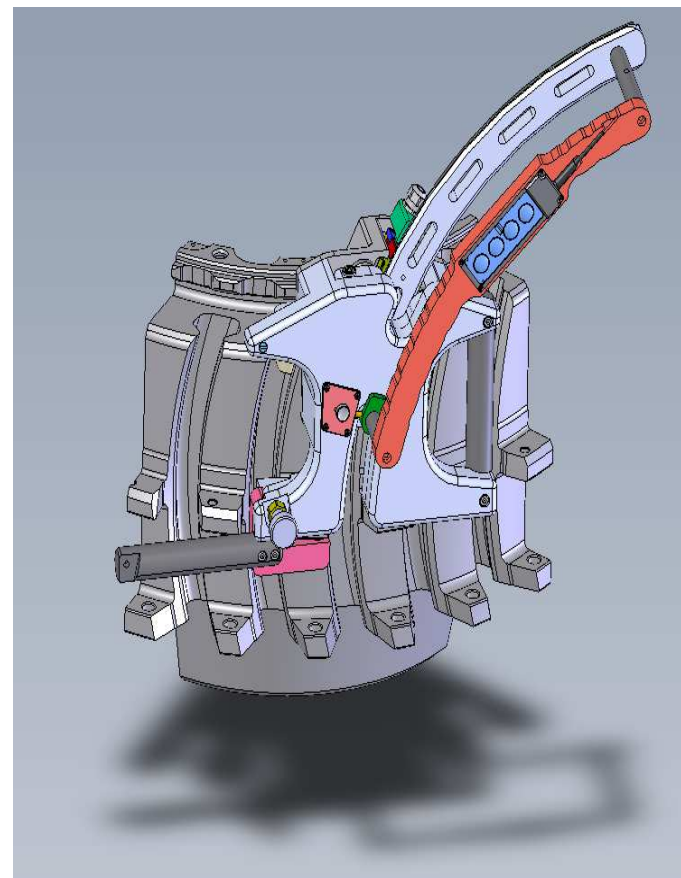
➤ Spawned FAA Enhanced In-Service Inspection and Robust Manufacturing Initiatives

**Eddy current inspection
on disk**

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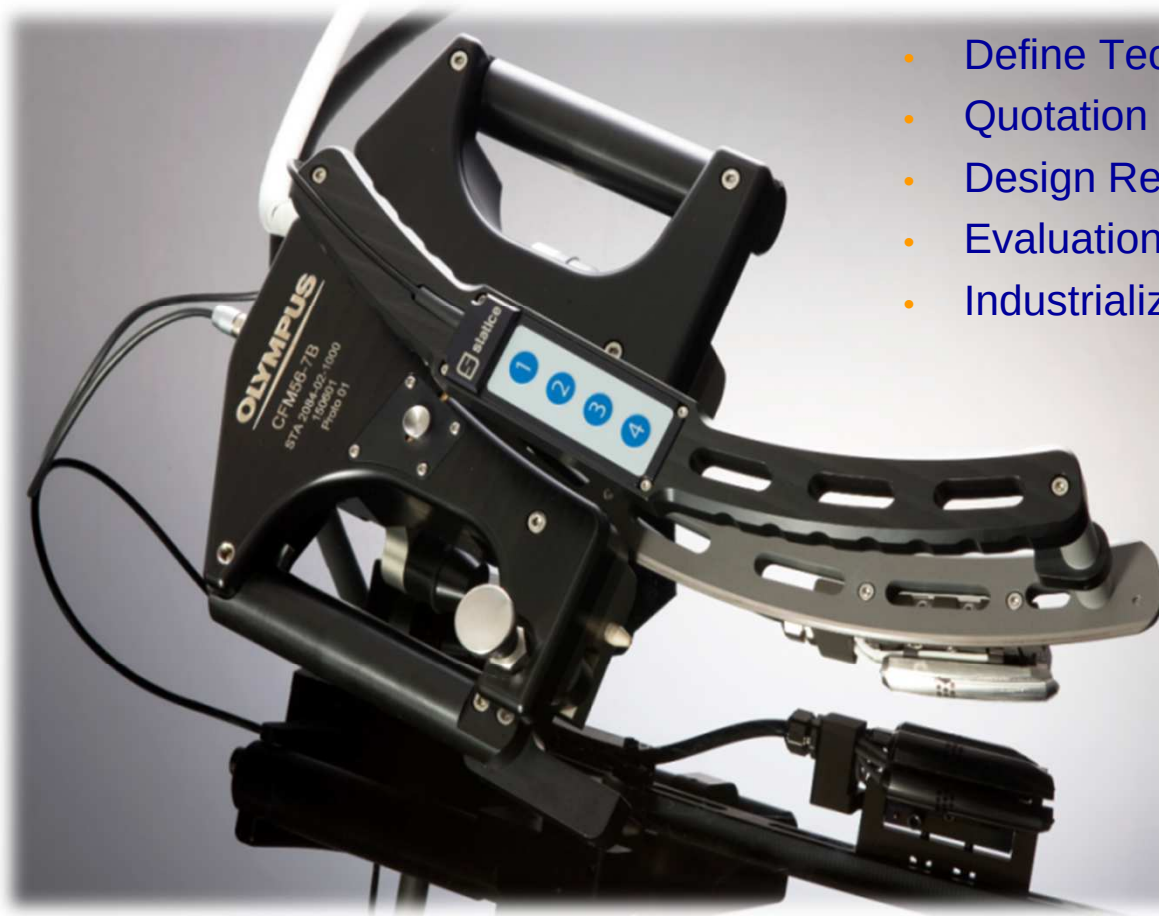
Fan Disk ECA INSPECTION

□ MAKING THE KIT FUNCTIONAL



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Making the Kit Functional, Kit conception



- Define Technical Specifications
- Quotation through NDT integrator Company
- Design Review Meetings
- Evaluation of Proto 1
- Industrialization

- Performance validation
- Documentation validation
- Application qualification



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Project Management , Human factor

➤ Cost

- Investment Cost nearly 10 Times Cheaper
- Operation Cost : 90 Minutes from Start to Report

➤ Operator Stand Point

- New Skills, New technology
- Direct False Call Analysis

➤ The Key Factors

- Encoded Acquisition
- Guided Scanner



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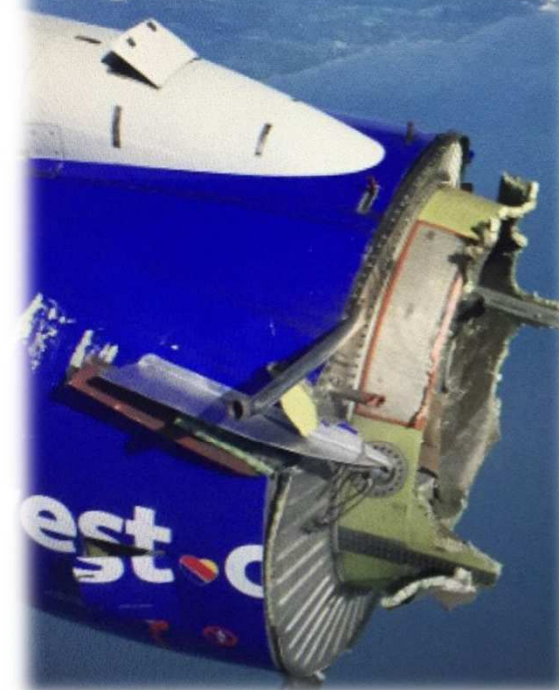
CFM56-7 Fan Blade ECA inspection

Faulty engine blade on Southwest Airlines jet broke free and smashed a HOLE in the hull of the plane moments before it was forced to make an emergency landing

- ❖ Faulty engine blade on Southwest Airlines jet 'showed signs of fatigue'
- ❖ A Southwest jet was forced to make an emergency landing on August 27 /2016
- ❖ It had been flying from New Orleans, Louisiana, to Orlando, Florida
- ❖ National Transportation Safety Board is investigating the mid-air incident

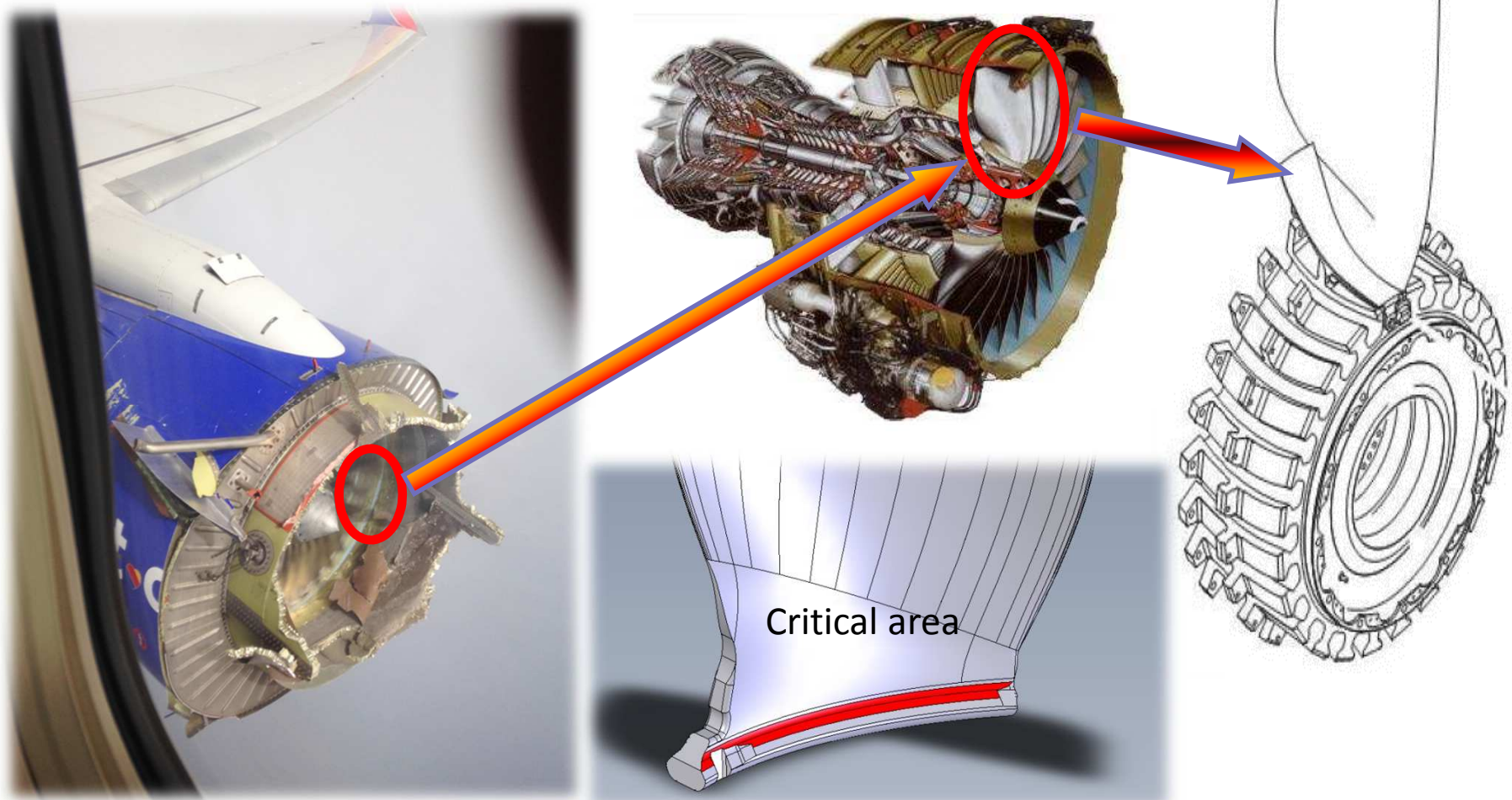
- ❖ Represented second major premature failure of a engine blade in service due to unanticipated and undetected damage

CFM56-7 Fan Blade ECA inspection



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CFM56-7 Fan Blade ECA inspection

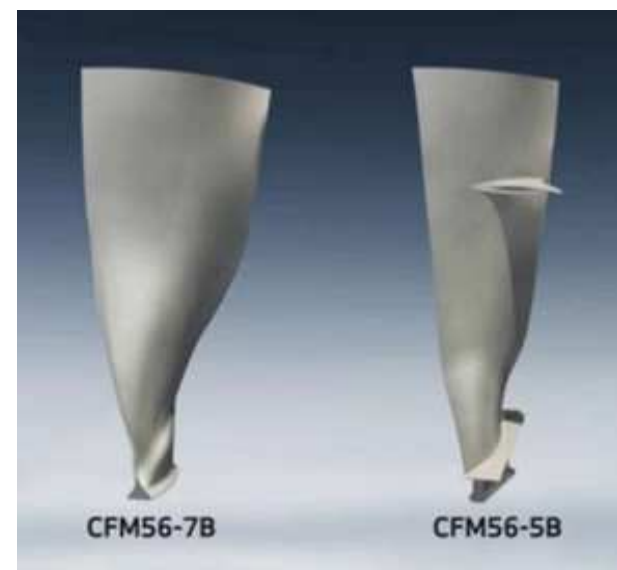


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Federal Agencies Recommendations

- NTSB Report recommended :
 - Changes in inspection methods, shop practices
 - Fracture mechanics based on damage tolerance
- Spawned FAA Enhanced In-Service Inspection and Robust Manufacturing Initiatives

■ Eddy current inspection on Fan blade



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CFM56-7 Fan Blade ECA inspection

First Step

Given the severity of the problem, the first step was the development of a very simple ECA inspection means but quickly available...

Solution :

Omniscan ECA + ECA flexible probe + 3D printer probe holder



For this step we have delivered :

- 6 omniscan ECA
- 24 ECA flex probe
- 12 ECA cable

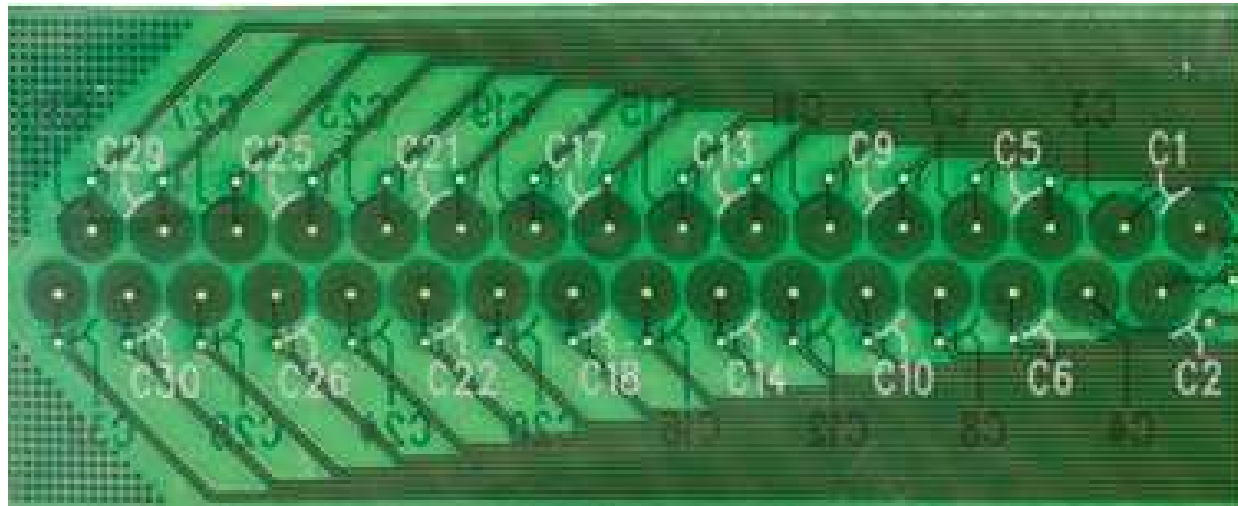
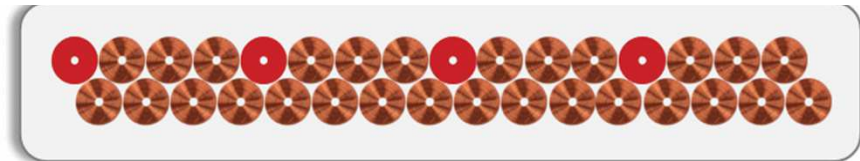


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ECA - Flexible Probe

➤ **Two mode**

Absolut
Need a encoder

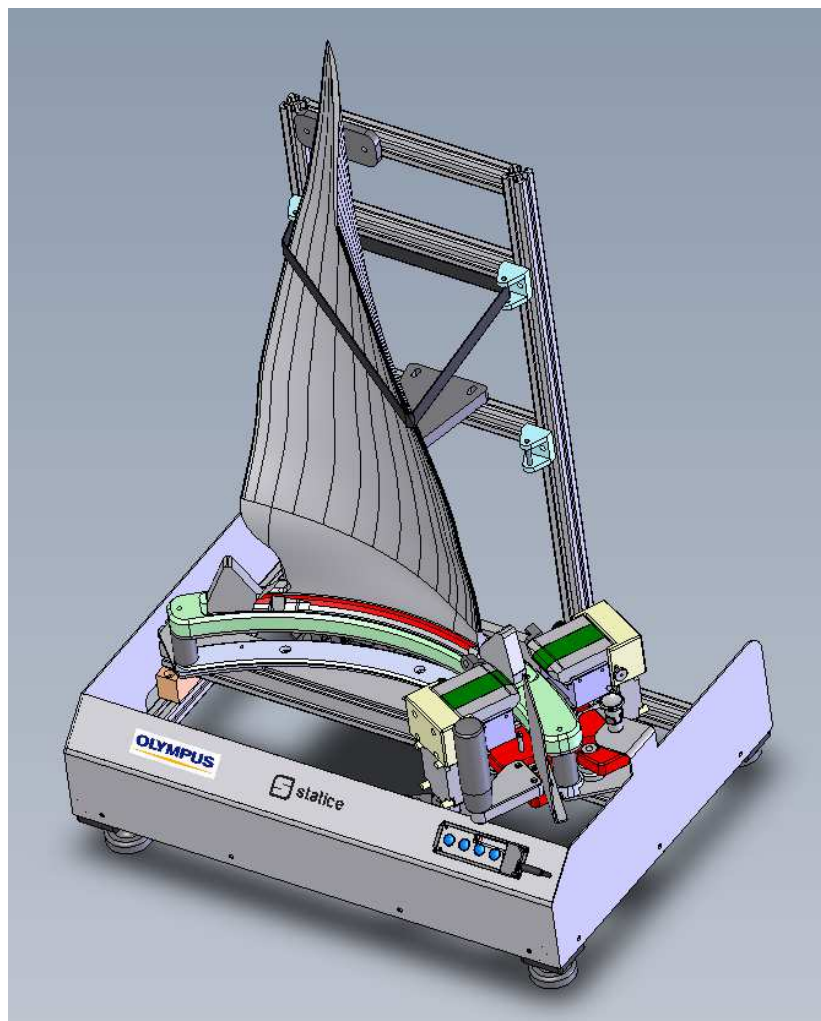


Reflection

More sensitive to small defects



CFM56-7 / 5 Fan Blade ECA inspections



Second Step

The second step is the development of a industrial ECA inspection Kits for two engines CFM56-7 and CFM56-5 ,

Solution included for each version :

- Omniscan ECA
- 2 x ECA flexible probe
- mecanical system
- Iplex probe holder
- Blade sample
- Case Pelicase
- Setup on USB key
- Certificate



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Project Management ,the OEM Responsibilities



OLYMPUS JOB

- Designs the part and the global inspection system
- Study EAC solution and tool
- Create a setup and tests the tool on customer samples
- Develops Inspection Application to service the products
- Validation steps
- Assisting the engine manufacturer to demonstrates to the Aviation Authorities the ability to guaranty the certified life span

CFMI JOB

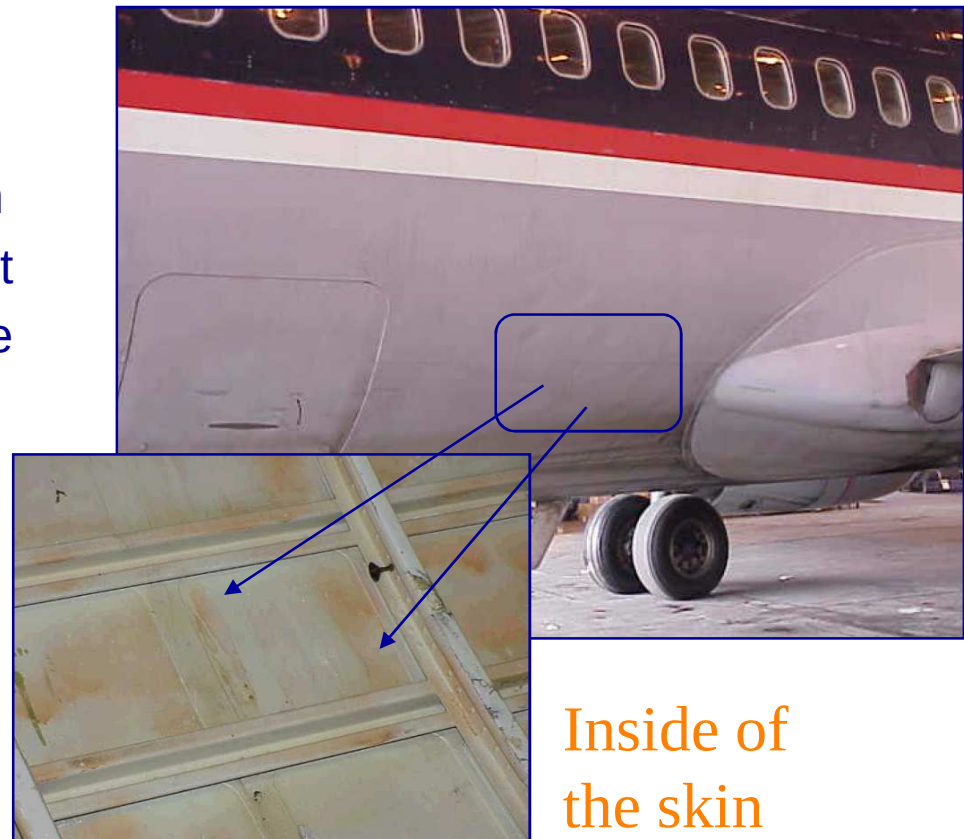
- The Engine Manual
 - OEM issues the Engine Manual with all Inspection Requirements
 - The Manual Specifies an Inspection Application for all Areas
- The Standard Practice Manual
 - The OEM issues a Manual of the Suitable Method for the Required Inspection
 - Customer training

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Boeing 737 Skin crack detection at doubler edge

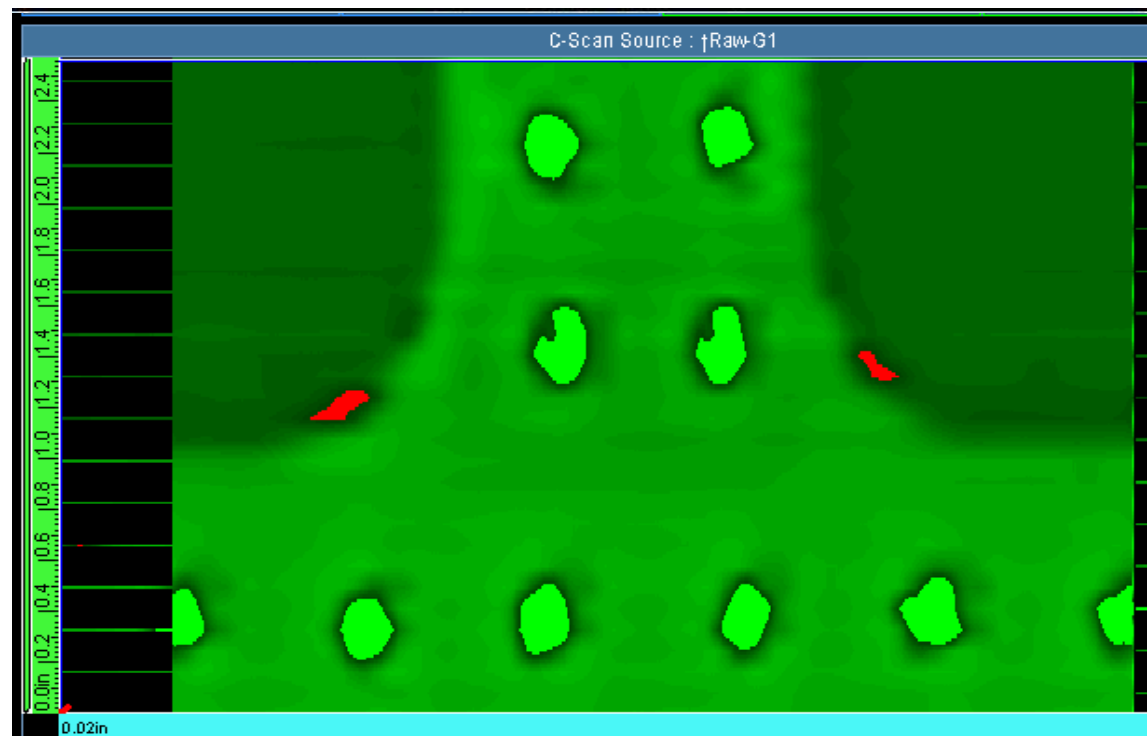
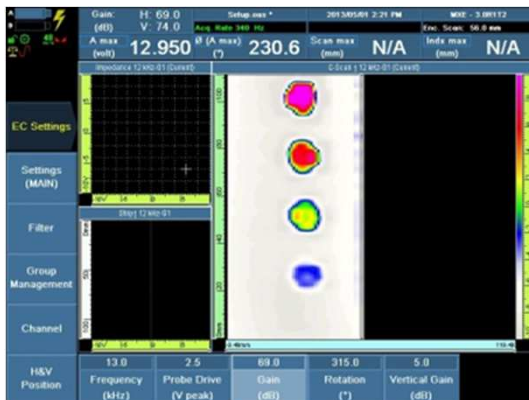
- The inspection is done from the outside and crack as small as 0.240" long by 0.010" deep located at the edge of the doubler need to be detected.
- Benefits:
 - Simple manual inspection
 - C-Scan allows easy location
 - of the doubler edge for fast
 - and simple detection of the initiating cracks
 - Better reliability
 - Better reproducibility
 - Time saving:
 - » Normal time: 200 hours
 - » With ECA: 48 hour



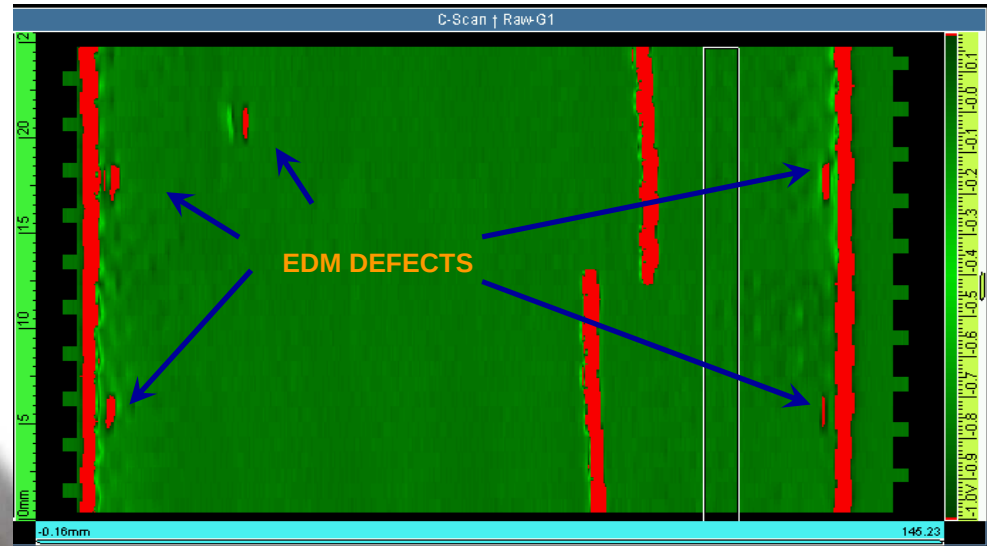
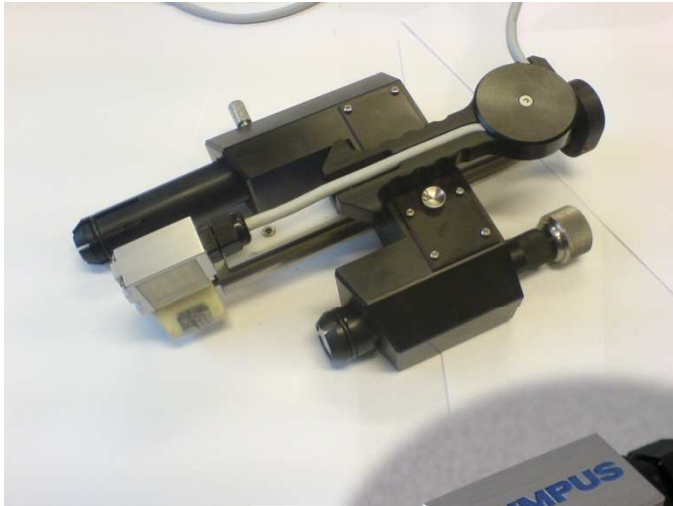
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Boeing 737 Skin crack detection at doubler edge

- ❑ The user can see very well the doubler edge represented by the light to dark green color transition.
- Fastener will show up in light green.
- Defect above the rejection level are in red like shown in this picture



Engine disk dovetail slot Inspection



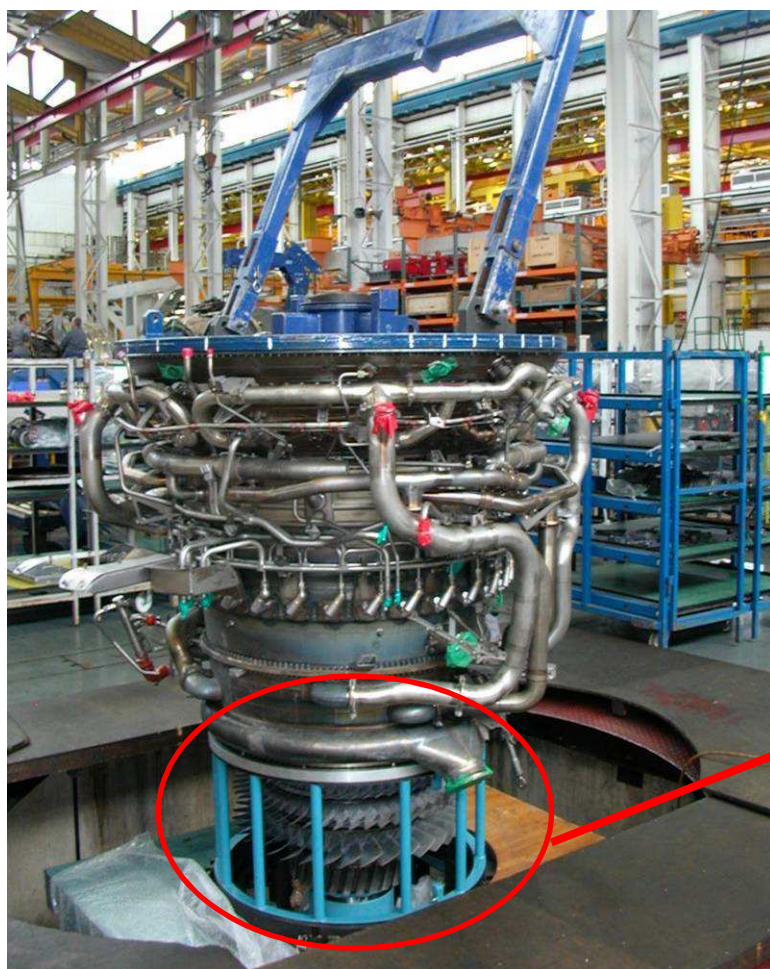
- **ECA probe**
- **32 elements**



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ECA HF Inspection method

Inspection in the maintenance shop



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Screw inspection



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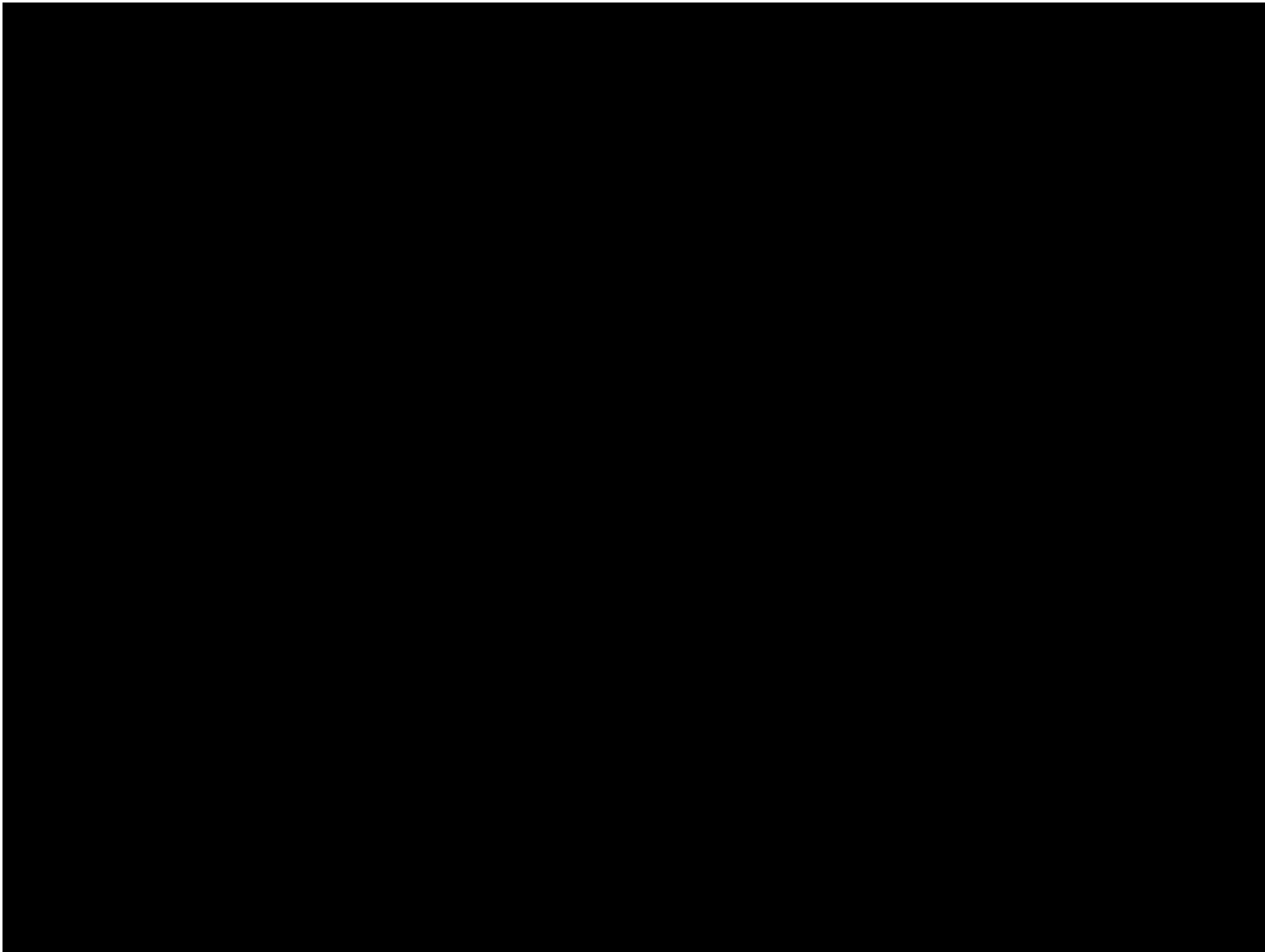
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Weld Inspection

- Pipe
- Windtower
- Rail

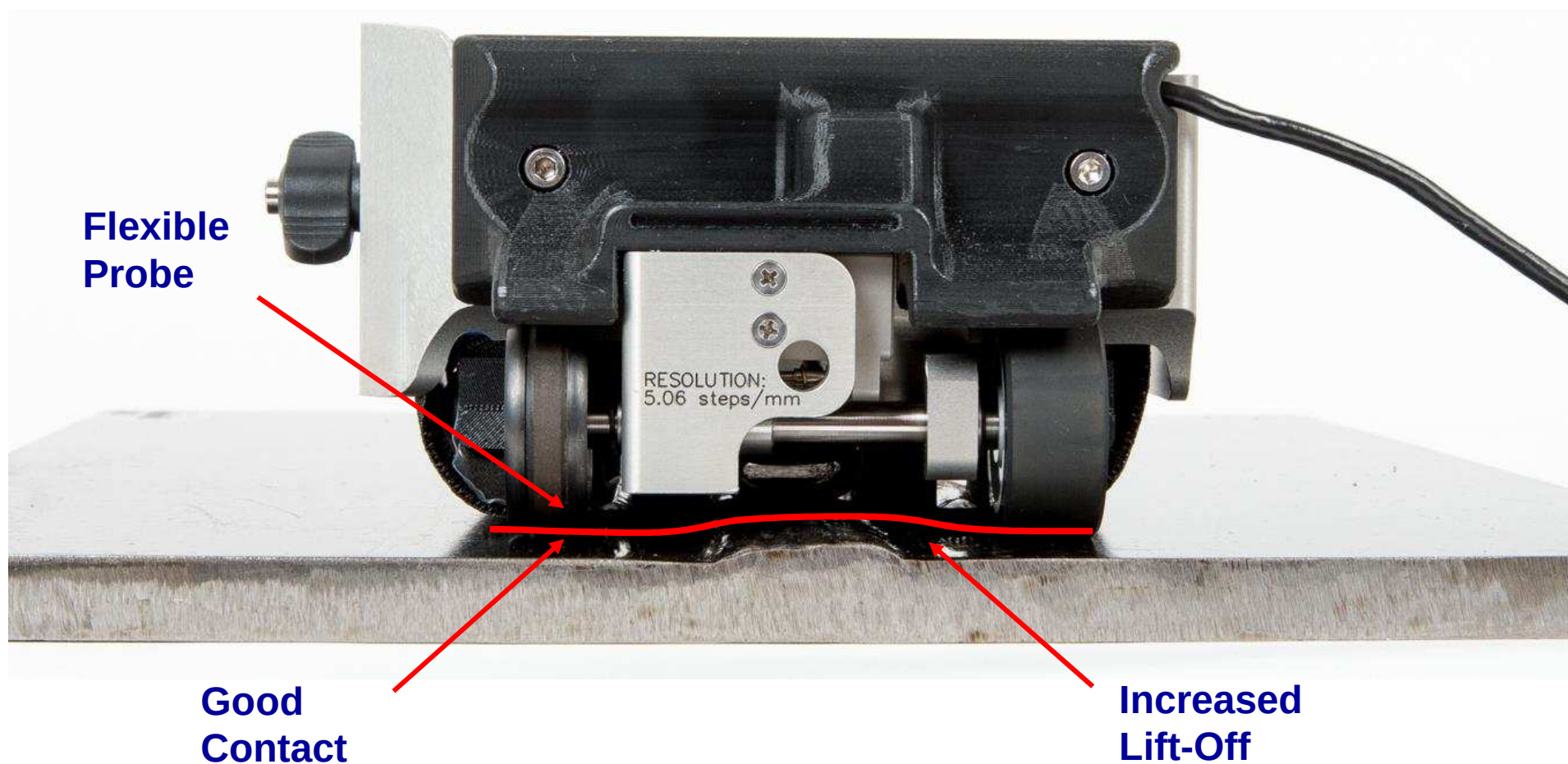


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MagnaFORM on Weld



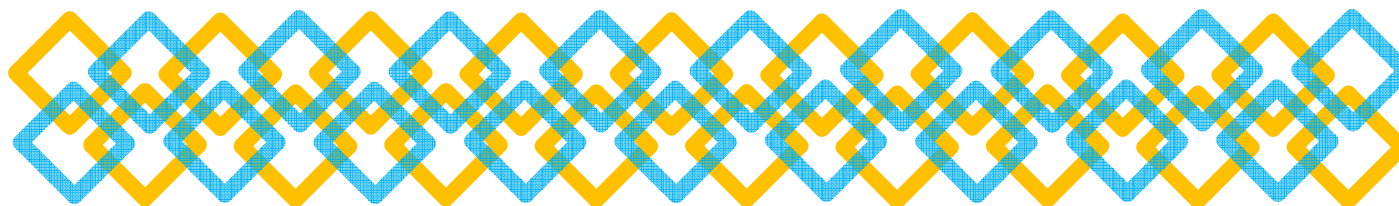
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Flexible Sensor Array



**16 + 16 Sensors
(two types)**

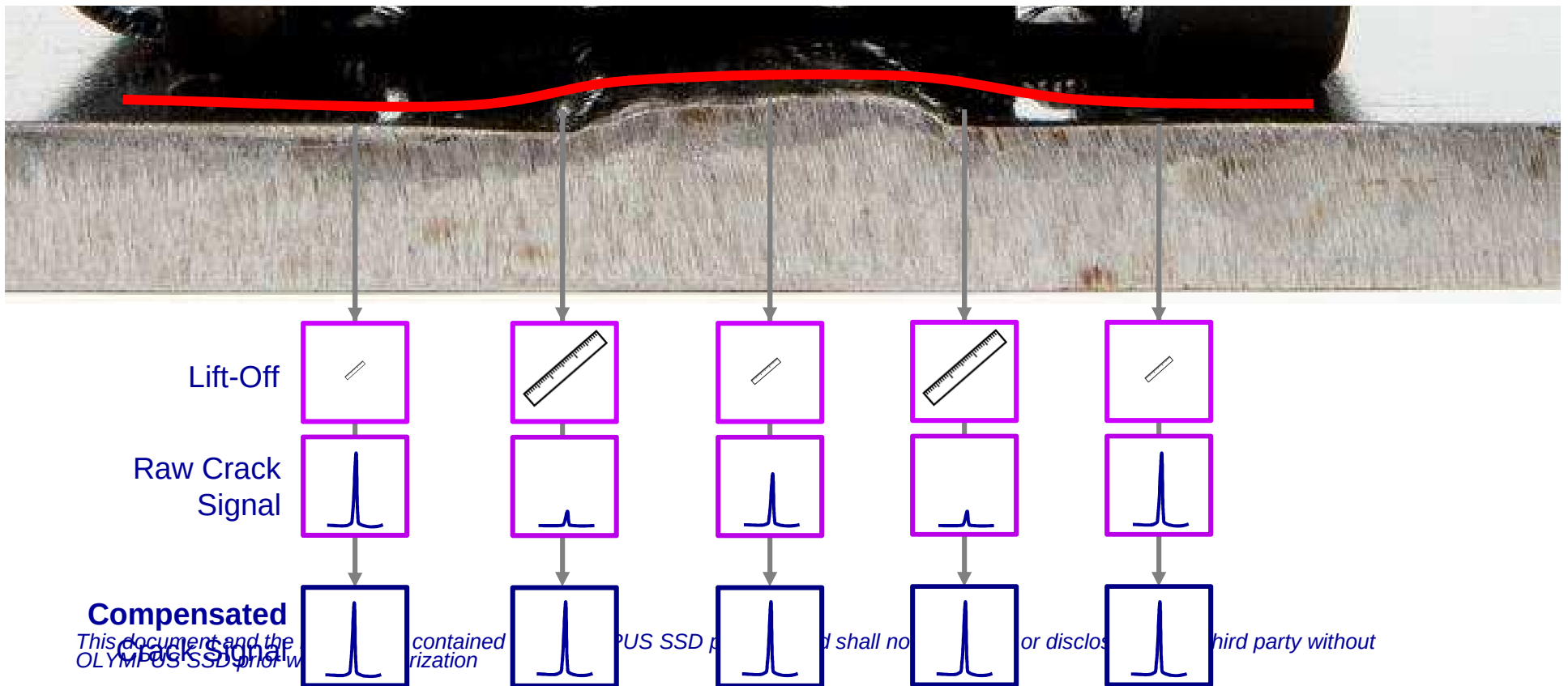
Active Circuitry



**Eddy Current Sensors:
Multi-Layer PCB Etched Coils**

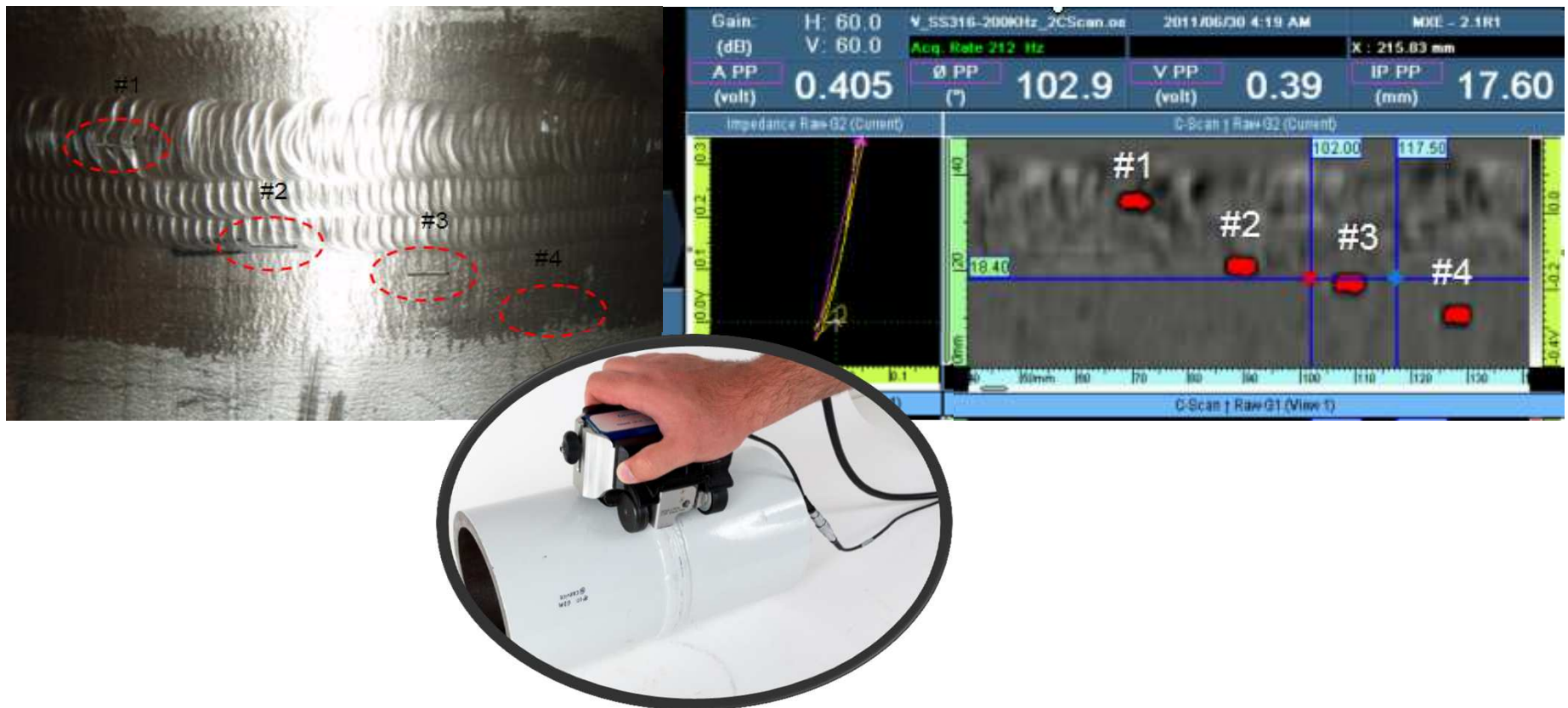
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Weld Close-Up



Notches identification on the C-Scan view

length: 6mm, depth: 1,2mm, width: 0.2mm



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Travel quietly with Olympus SSD

