

Nondestructive Testing in the Aerospace Industry

Dr. Ing. Werner Roye

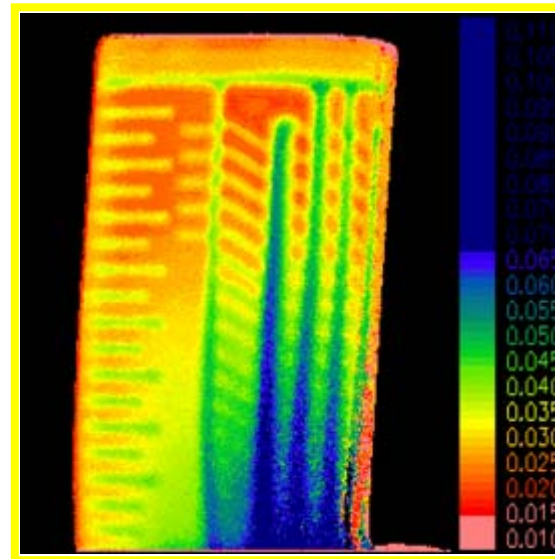
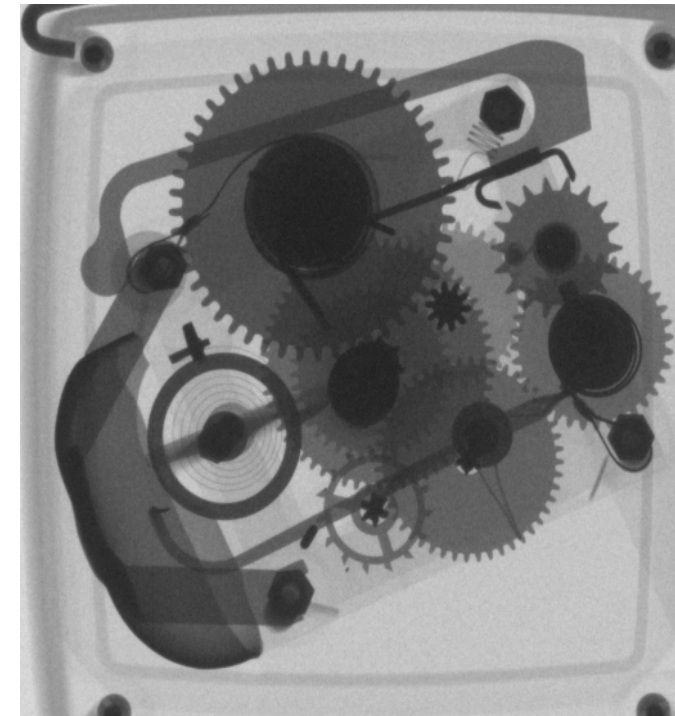
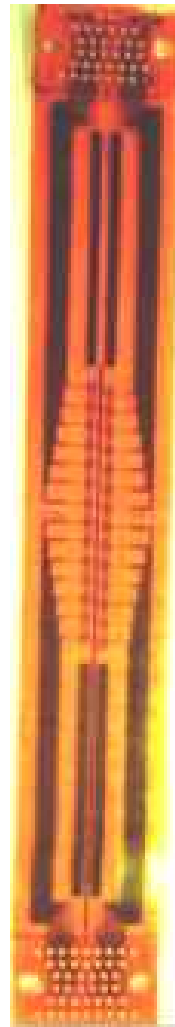
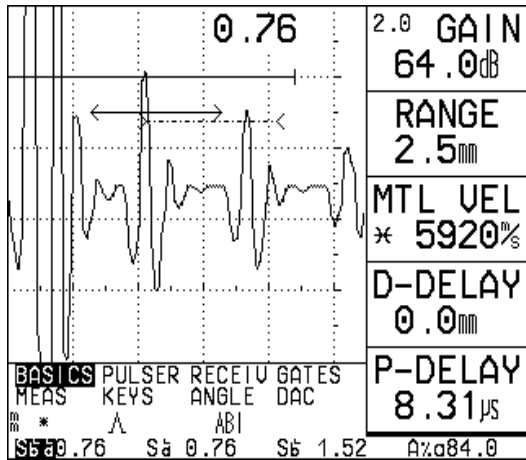
GE
Inspection Technologies
Huerth, Germany

April 2005

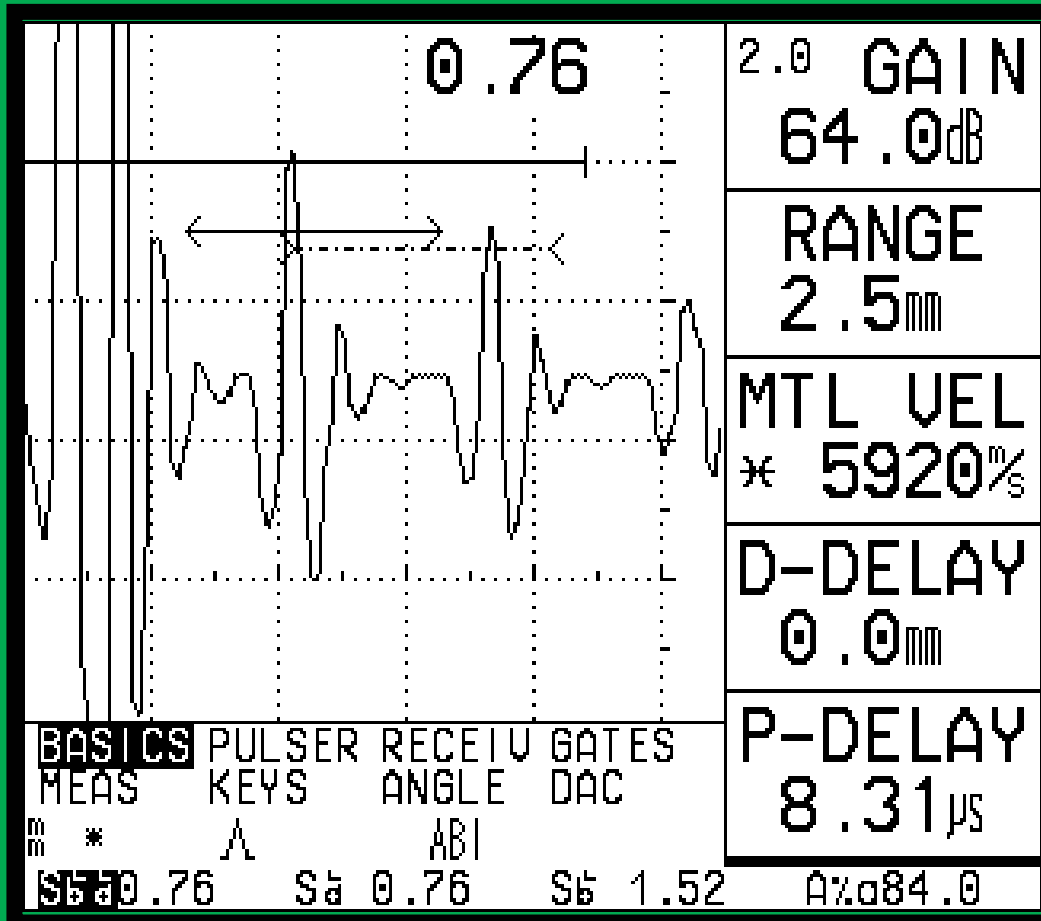


NDT - Methods

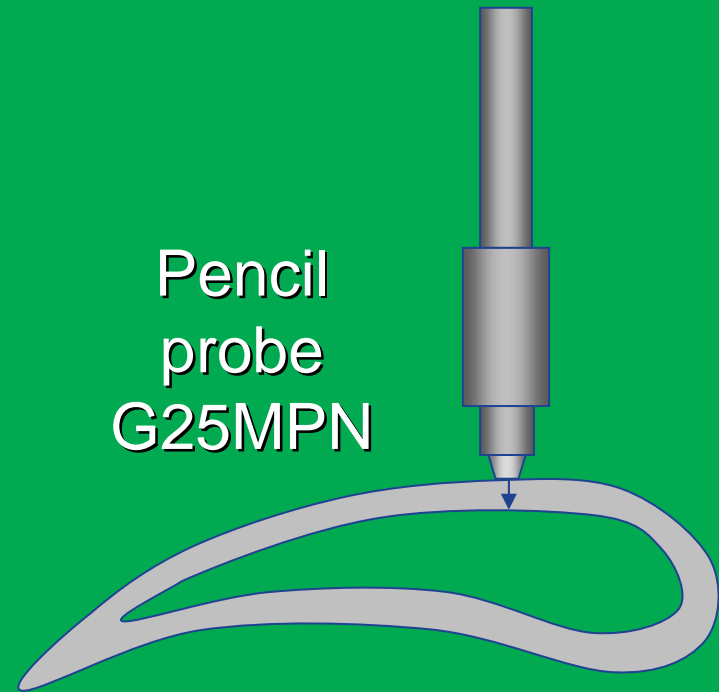
- Ultrasound
- X-Rays
- Eddy Current
- Thermography



Ultrasonic Thickness measurement on Turbine Blades

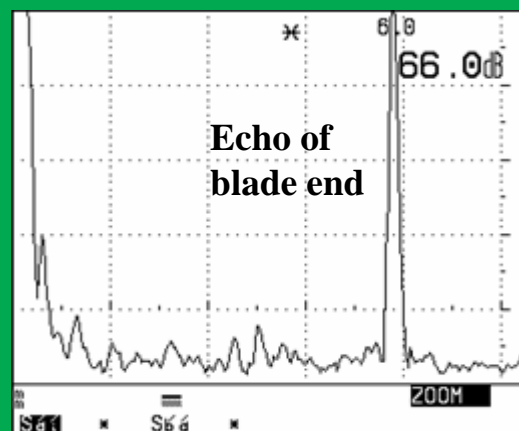
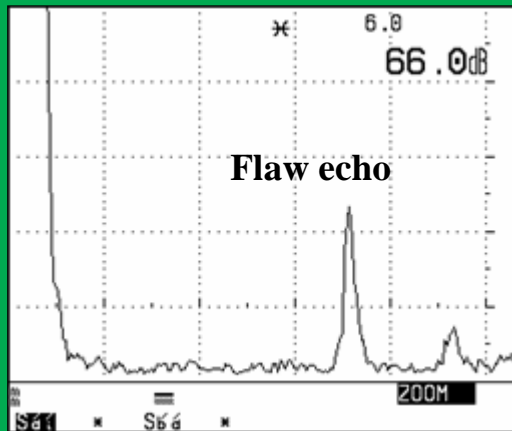
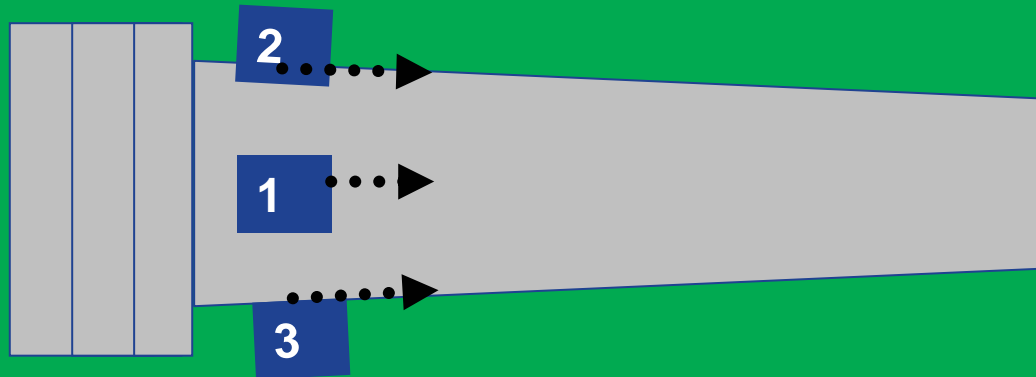


Pencil probe
G25MPN

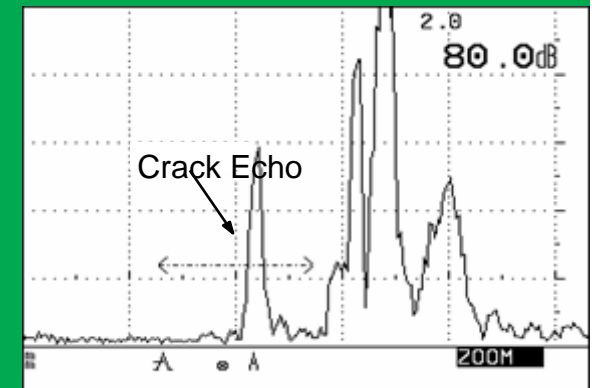
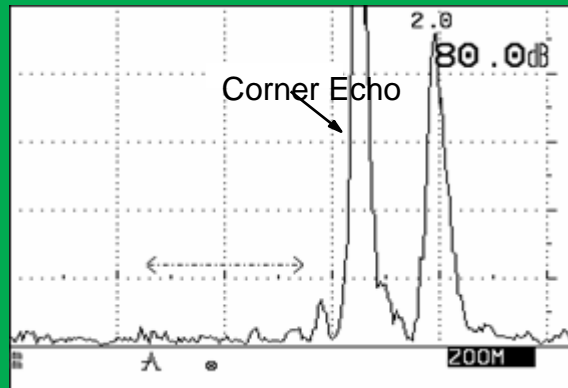
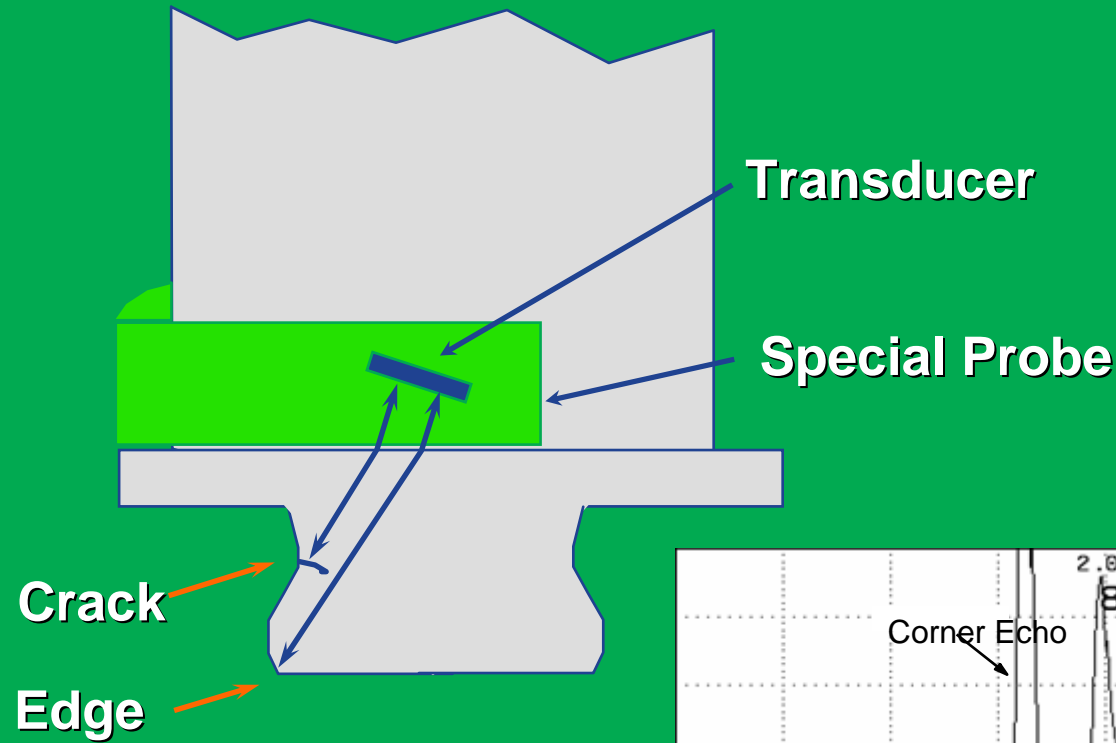


Ultrasound, Crack Detection on Turbine Blades

Probe: MWB90-4



Ultrasound, Crack Detection on Turbine Blade Foot

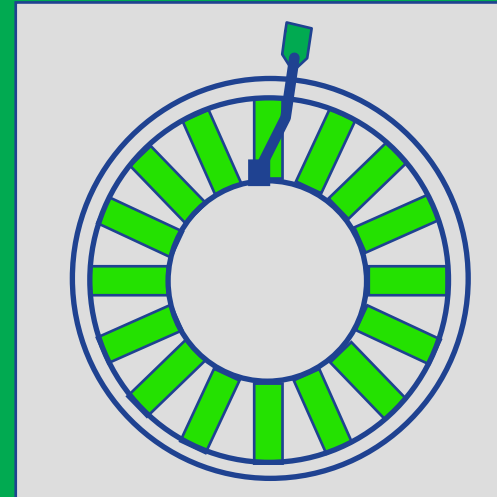


Without Crack

with Crack

Ultrasound, Crack Detection on Turbine Blade Foot

Inspection
„on the wings“



Ultrasound - Immersion System



Customer:
Dassault, Biarritz
Installed: 1981/1995
Electronics upgrade
in 2004

max. part size:
(X;Y;Z) 8x2,5x1m
for inspection of flat
parts

system contains 2
independent
channels permitting
simultaneous
inspection of 2
separate parts

Ultrasound – System with Squirter and Bubbler Technique



Customer:
GKN Aerospace GmbH
Installed: 1987
Electronics & PLC upgrade: 2004
max. part size: (X;Y;Z) 8x2x2m
bridge construction for inspection of flat and curved parts
2-channel system
Squirter- & Bubbler Technique

Ultrasound - System with Squirter Technique

Detail: Squirter Coupling



**Customer:
GKN Aerospace**

**Detail of 2-channel
system squirter
system**

Ultrasound - System with Bubbler Technique

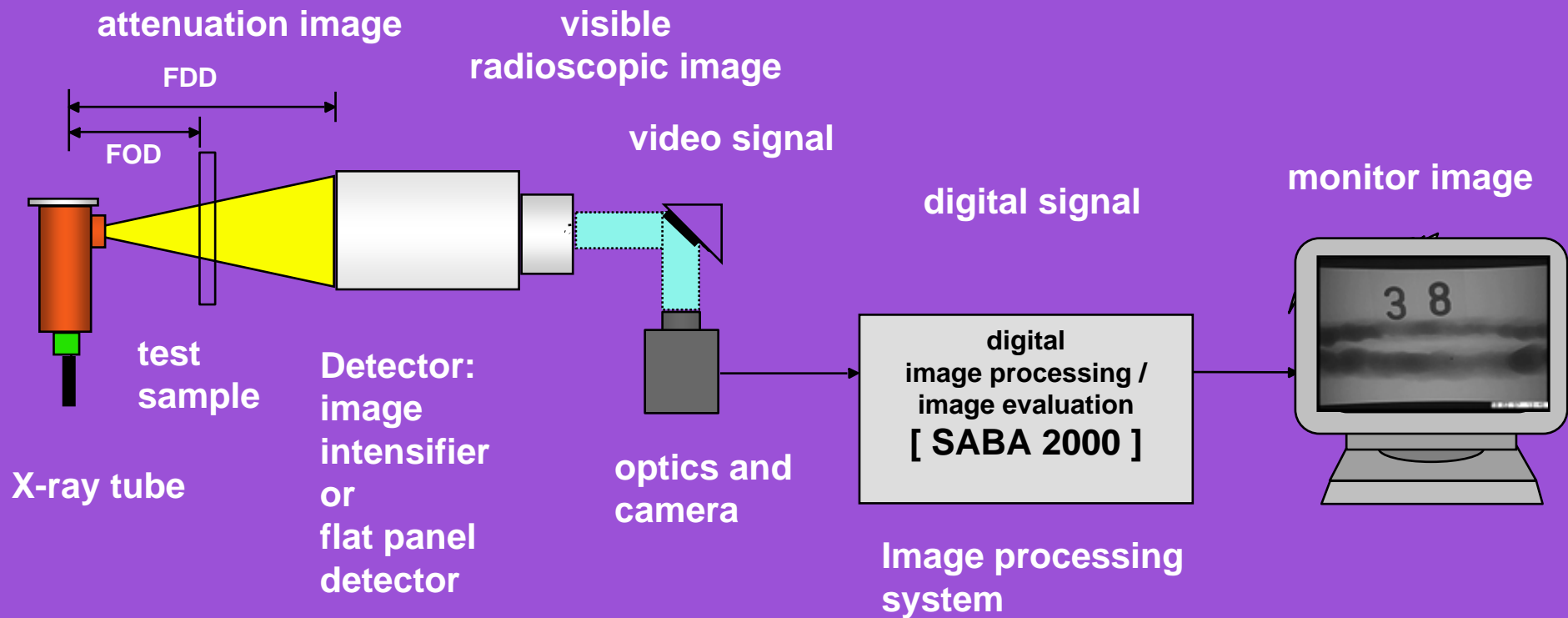
Detail: Adaptive Surface Probe



**Customer: GKN
Aerospace
GmbH**

**Detail of
2-channel
bubbler unit for
pulse/echo Test**

X-Ray – Radioscopy



X-Ray – Turbine Blade Inspection

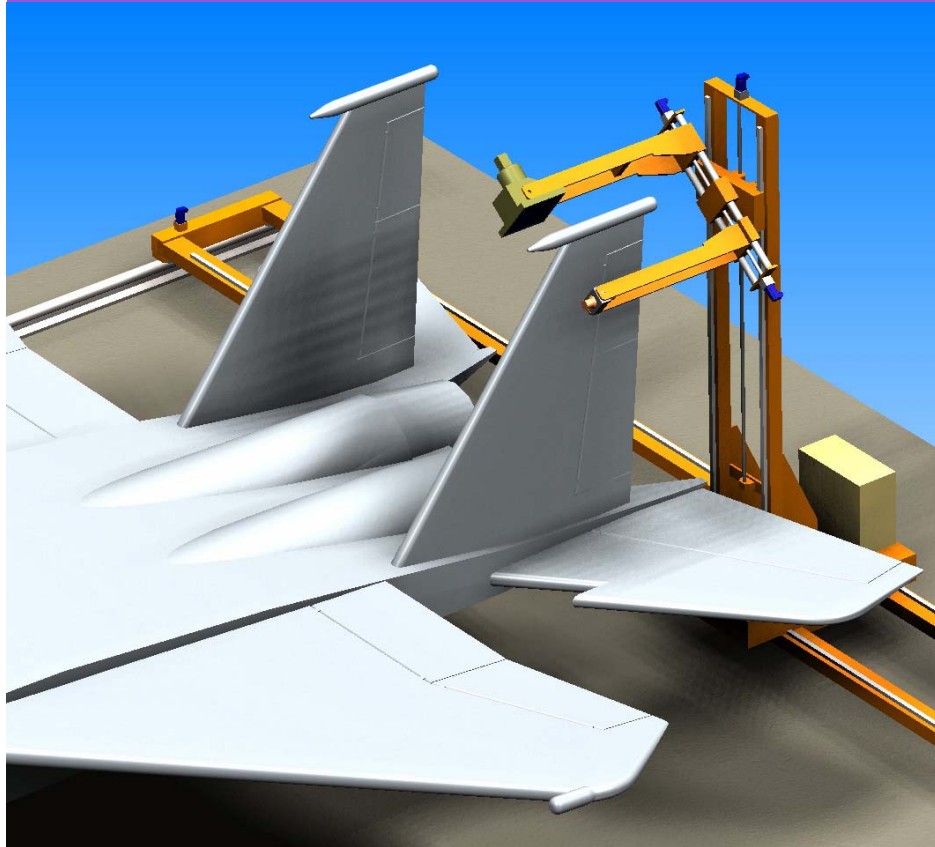
Turbine Blades



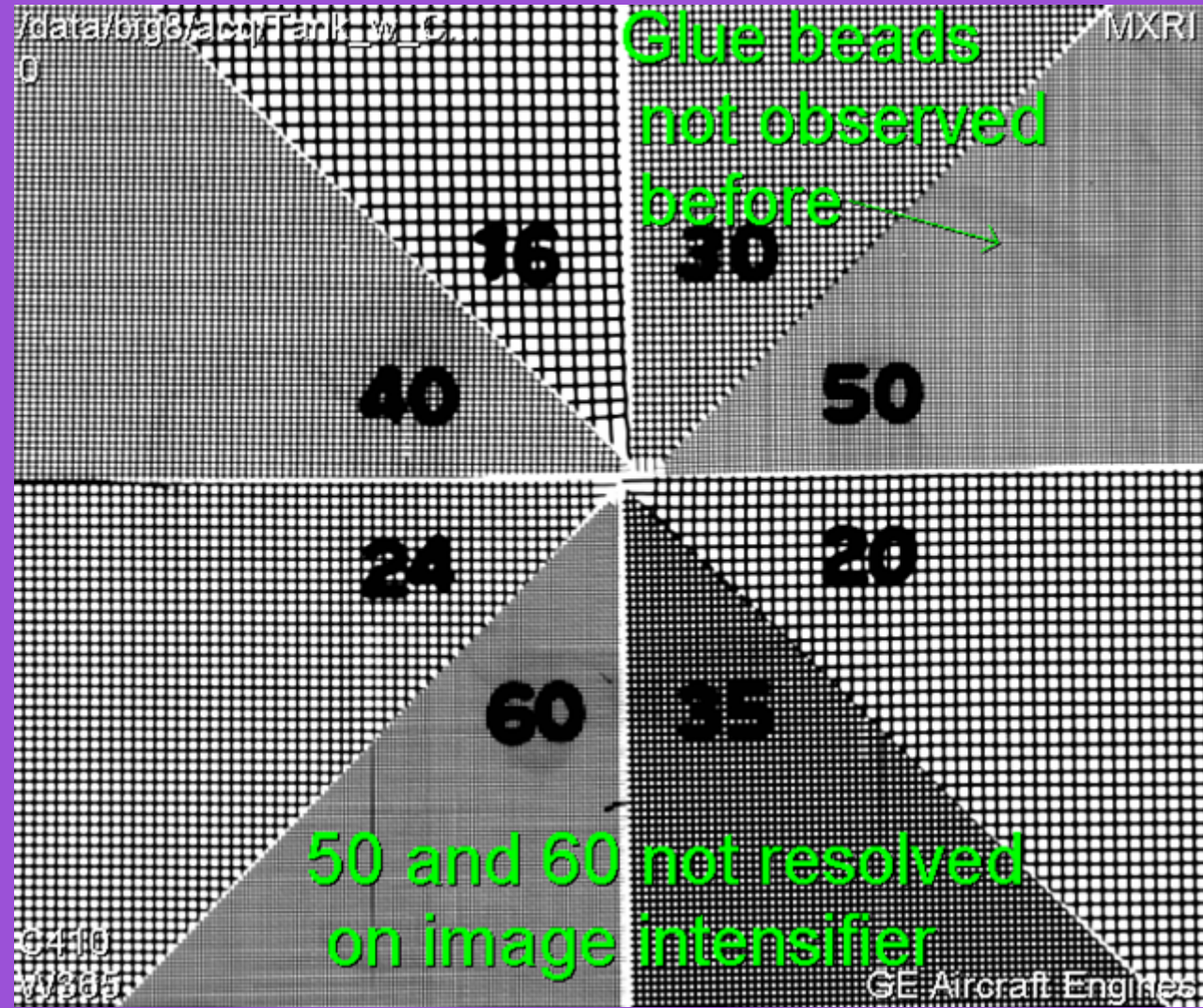
X-Ray system: ISOVOLT 225 HS
Tube: 225 MM2 0.2
Detector: Flat Panel Digilux 2520
System: DP 265



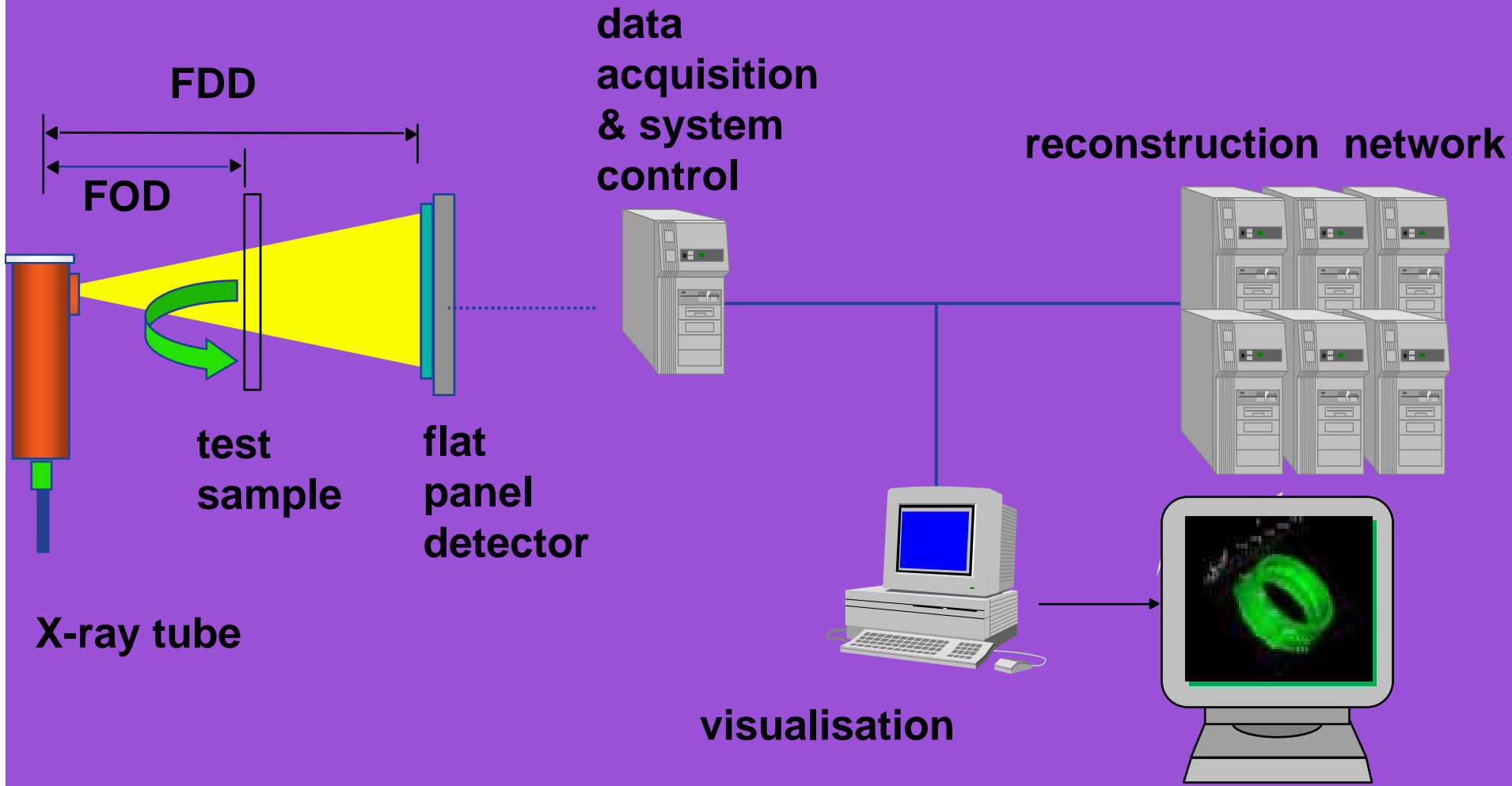
X-Ray – On Wing Honeycomb Inspection



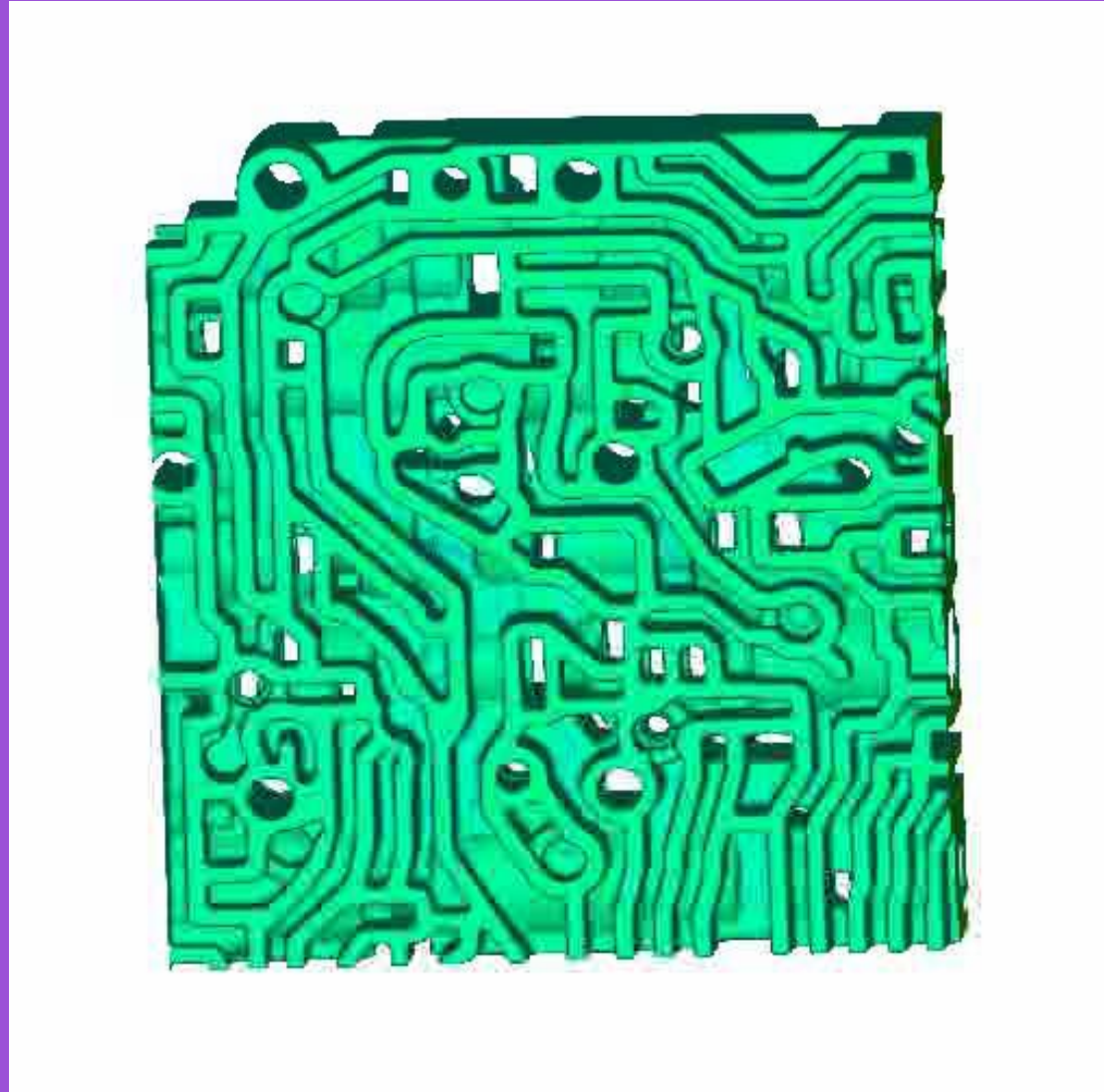
X-Ray – Resolution of Flat Panel Detector



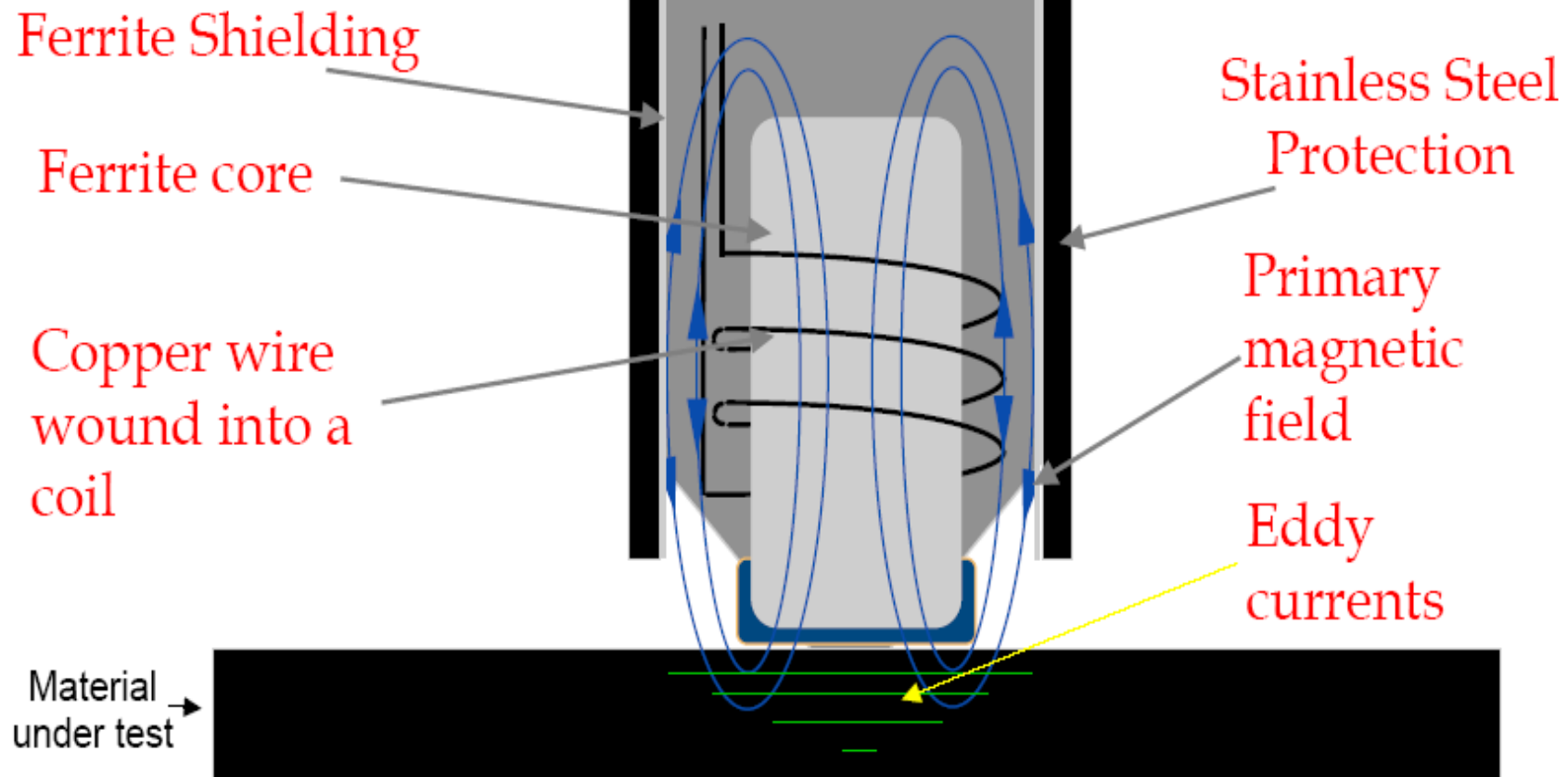
X-Ray – Tomography



X-Ray – Tomography



Eddy Current Absolute Probe Construction



Eddy Current - Instruments



Locator 2s

Phasec 2s



Phasec 2d

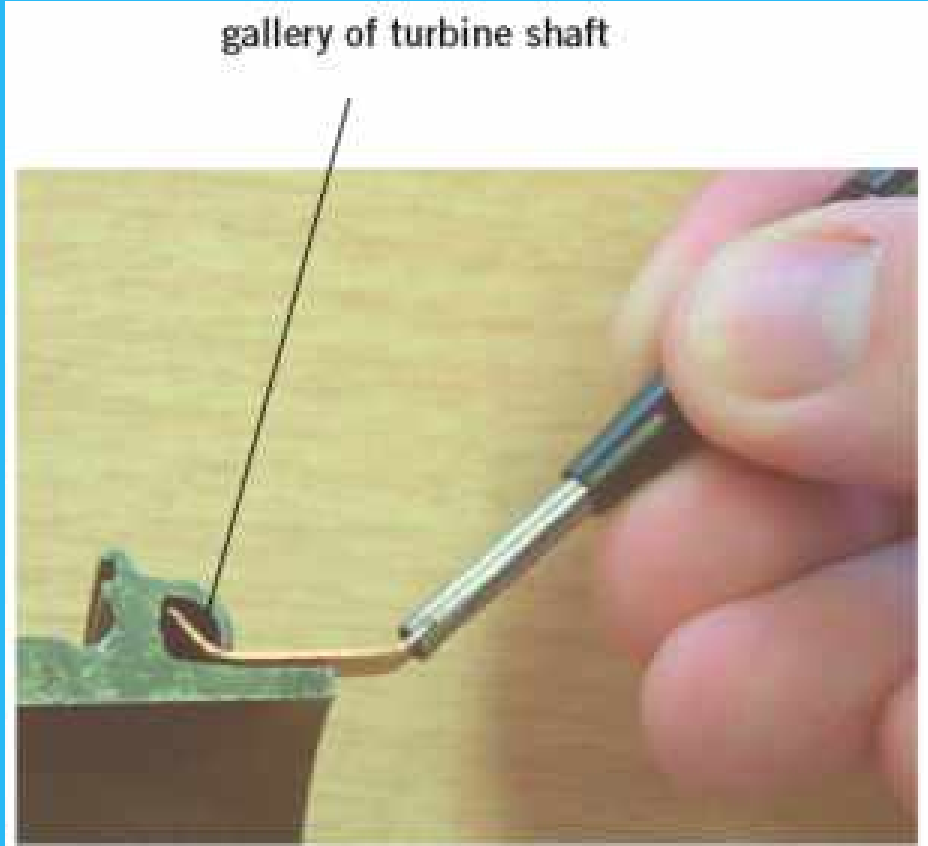
Eddy Current – Probes



Eddy Current – Turbine Shaft Inspection

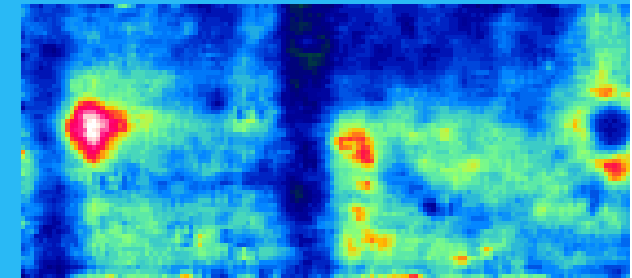
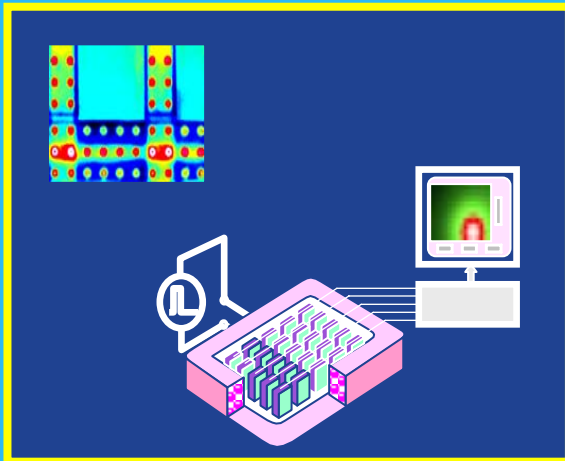


Turbine shaft section

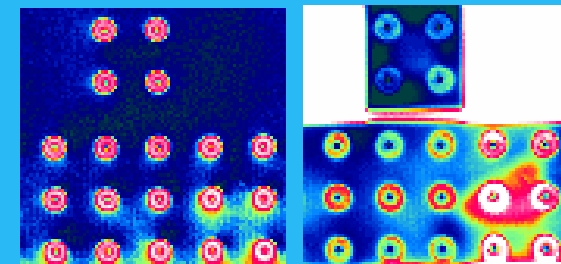
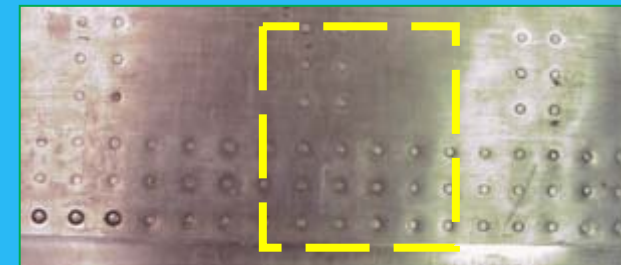


Inspecting the critical area of the gallery

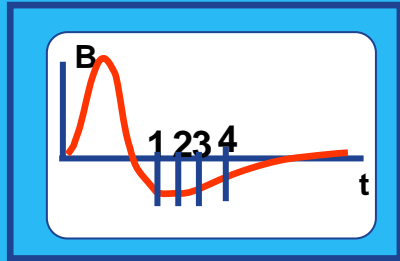
Pulsed Eddy Current for Corrosion & Crack Detection...



- Multi-Layer Corrosion & Crack Detection
- High-Resolution Digital Imaging
- Wide-Area, Single-Pass Inspections
- Enabler for Condition-Based-Maintenance

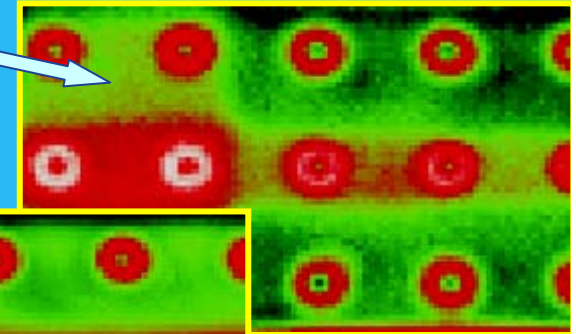


Pulsed Eddy Current for Corrosion & Crack Detection...

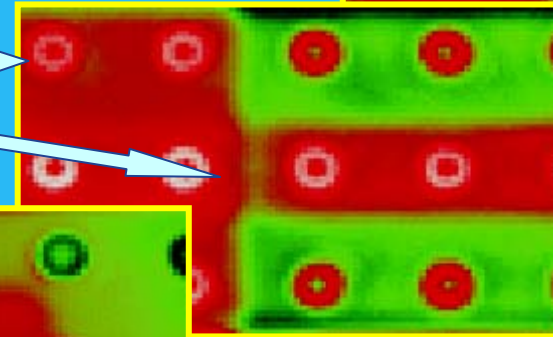


Transient Signal

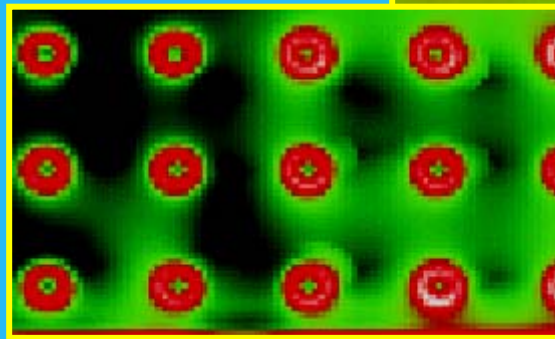
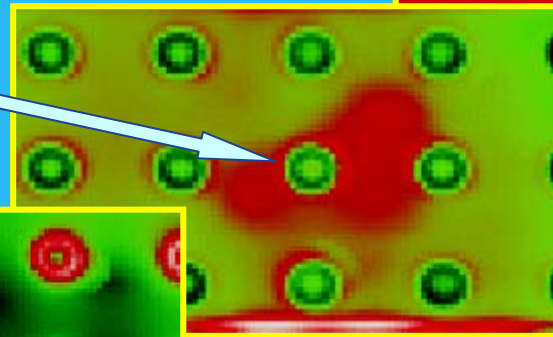
Time gate 4:
4th layer



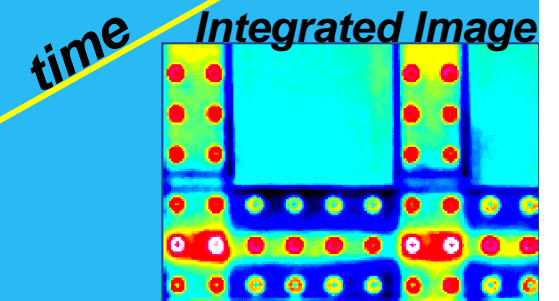
Time gate 3:
3rd layer



Time gate 2:
Corrosion at
the top layer



Time gate 1:
Liftoff and rivet information



GE - Eddy Current Array Probe (ECAP)

25 mm (1") area coverage

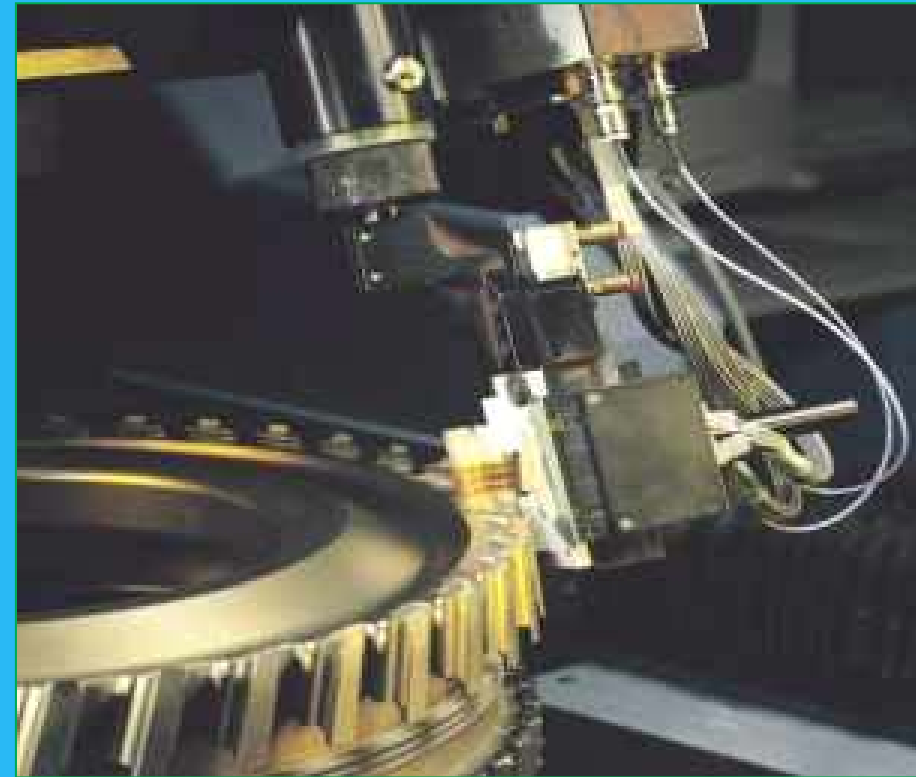
High spatial resolution: 1 mm (0.040") coil size

Low coil-to-coil variations

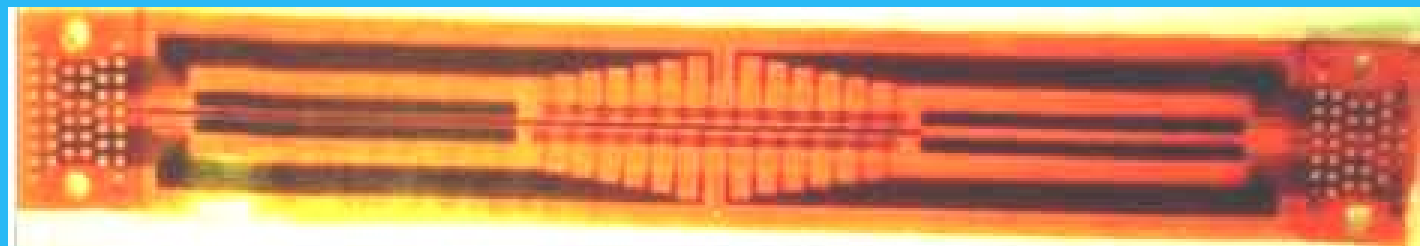
High sensitivity 0.25 x 0.12 mm (0.010" x 0.005") crack detection

Conformable substrate

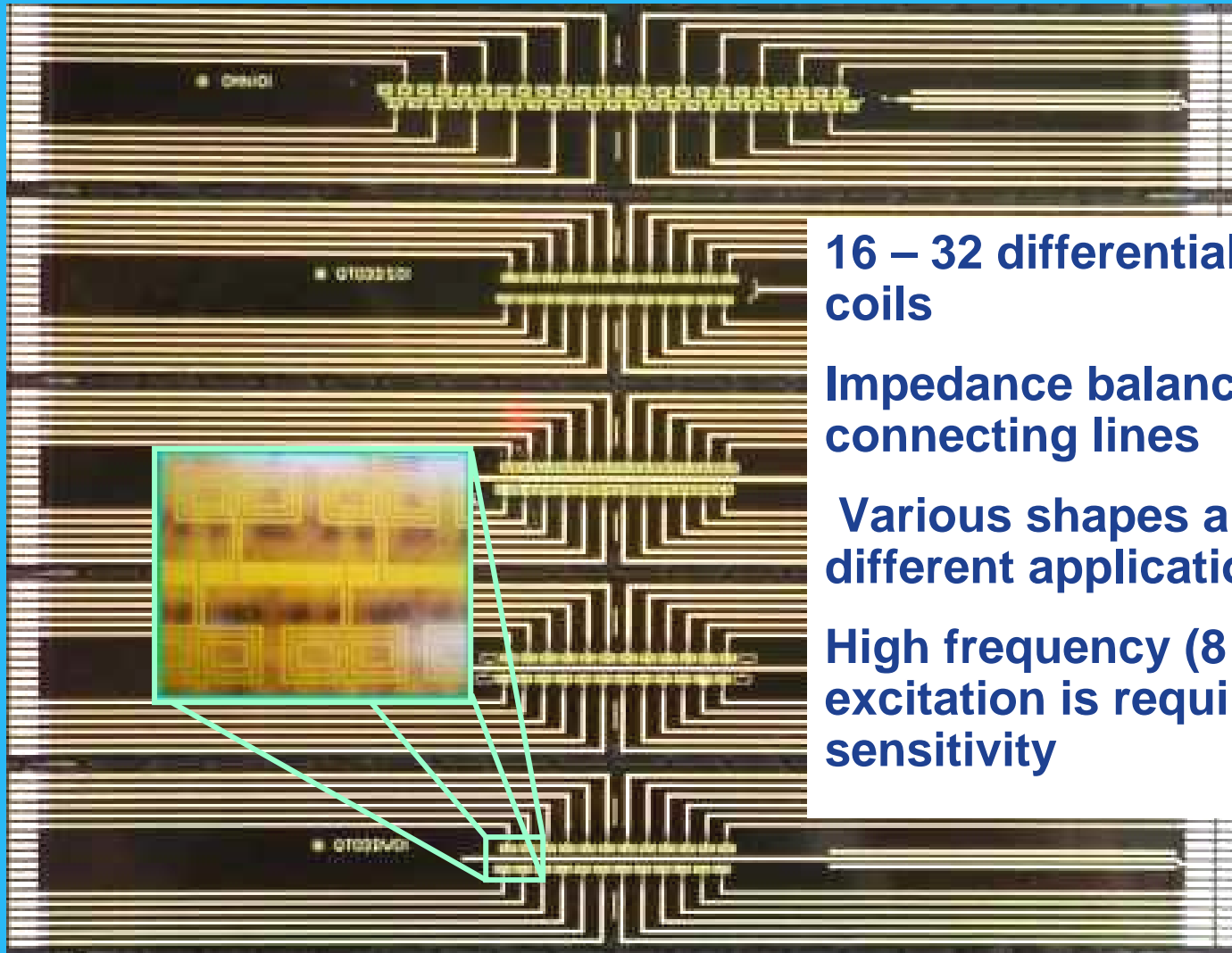
Real-time communication



Dovetail inspection using ECAP



Flexible ECAP: Simple Shape – High Technology



16 – 32 differential spiral sensing coils

Impedance balanced low noise connecting lines

Various shapes and coil sizes for different applications

High frequency (8 – 20 MHz) excitation is required for adequate sensitivity

ECAP Inspection at GE Transportation (AE)



GE EC2000 system for the Inspection of Symmetric or Complex Shaped Objects

**Multi-probe Capability ...
Bolt-hole, Single Element,
Single Coil Imaging and
Flexible Eddy Current
Arrays**

**Automatic Data Systems ...
Acquisition, Analysis,
Storage, Report and
Evaluation**

**Built-in Diagnostics ...
Automated Calibrations
and Inspections**

**Automated Programming
Routines**

**Backed by GE Engineering
and Product Support**

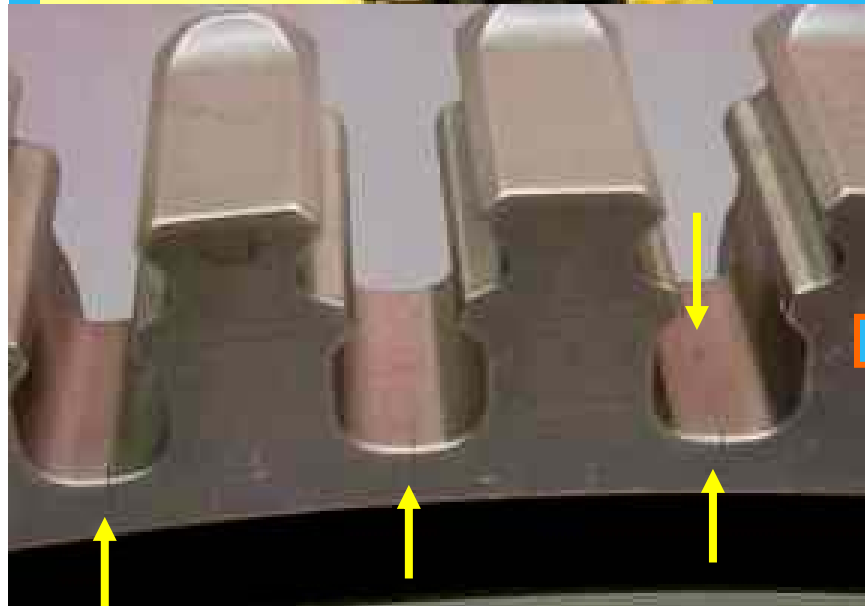


Manual Scan with ECAP

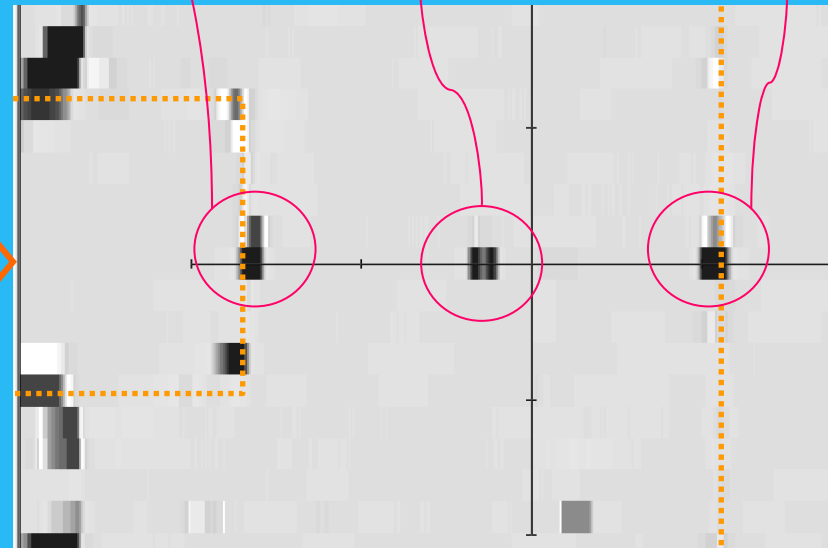


Hand-held system development for field inspection

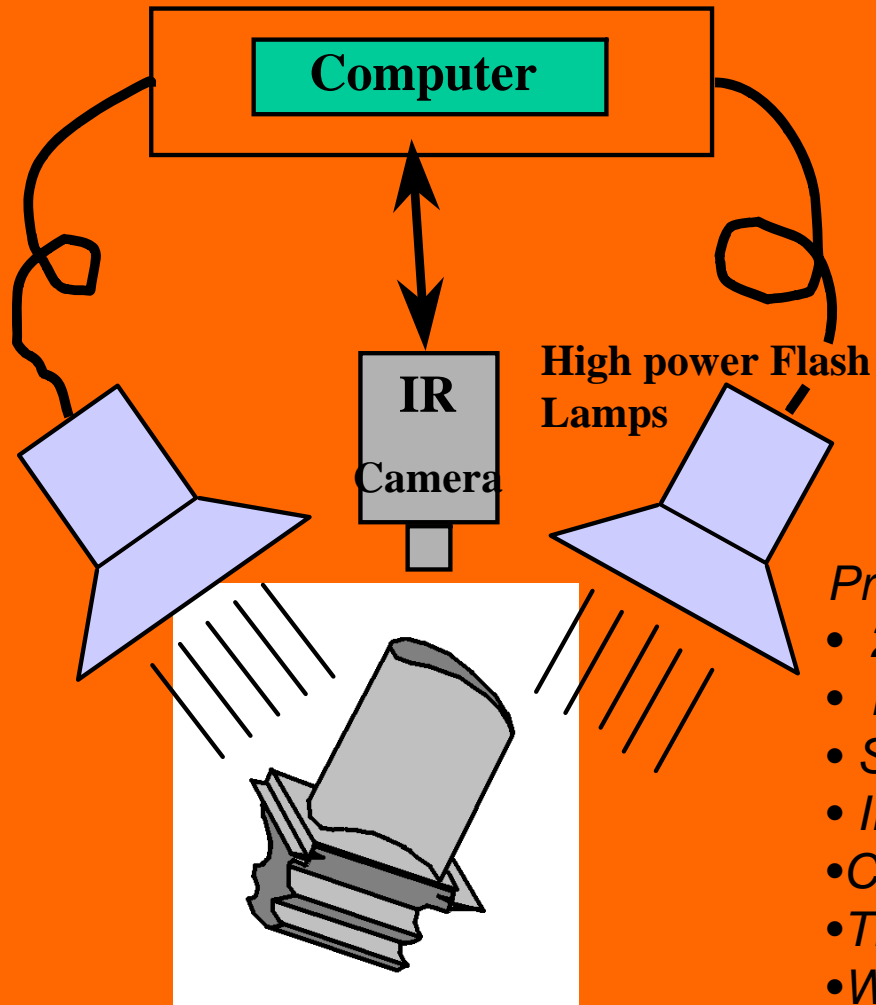
- Larger background noise
- Slot-to-slot variations
- Sensor optimization for corner and slot bottom crack detection



1.25mm
(.050") 0.75mm
(.030") 1.25mm
(.050")



Thermography

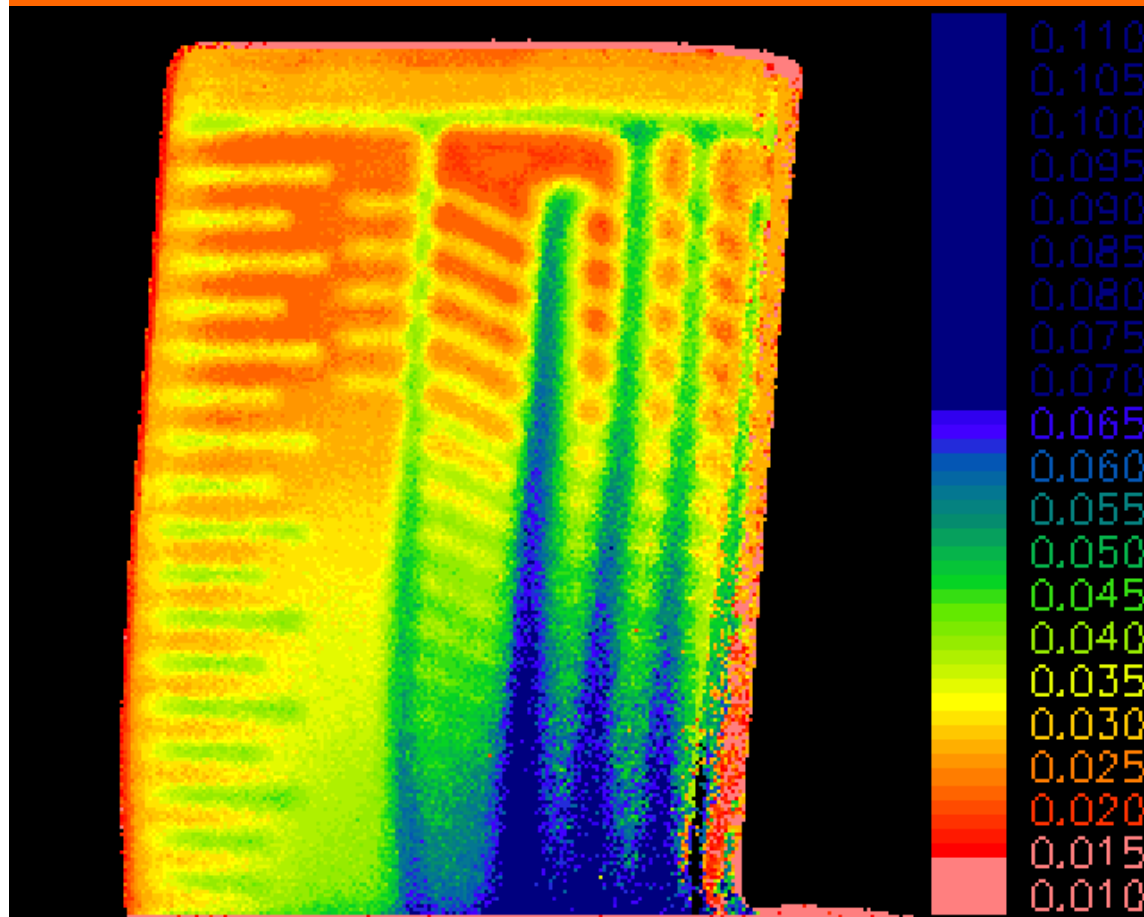


Procedure

- 20 MW, 1ms light flash to surface
- Heat pulse results in metal
- Surface temp evolves in time
- IR camera monitors surface temp
- Computer stores IR image frames
- Time-temp analysis of frame stack
- Wall thickness from “magic point”, inflection point in time of $T-t$ contrast



Thermography – Turbine blade thickness measurement

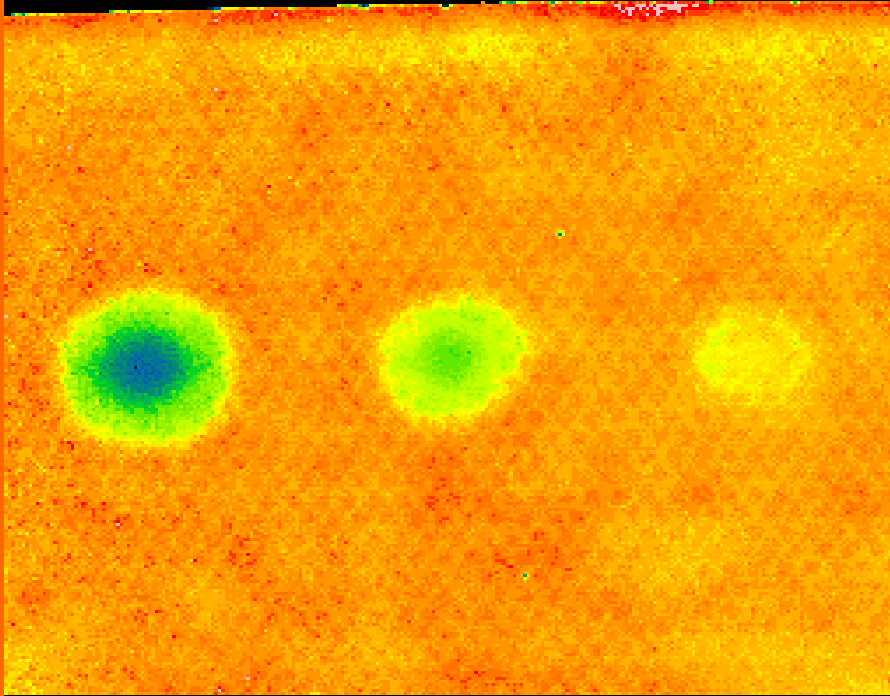


Thickness Image Results

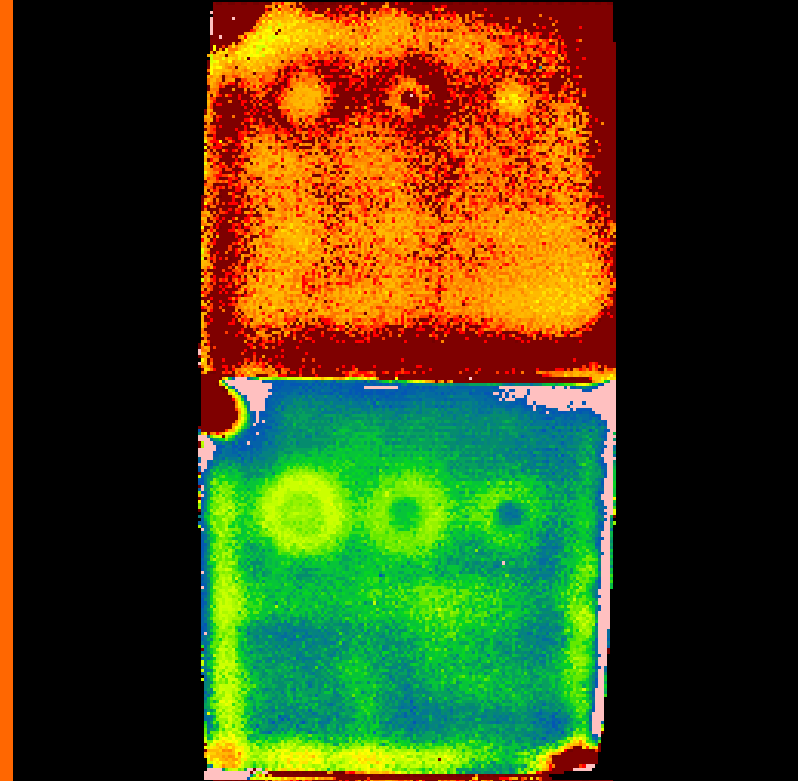
- 3% Typical IR Wall Thickness Accuracy
- Full Thickness map in 30 seconds
- Independent of complex shapes
- Thickness range : 0.012 - 0.300 in. (0.3 – 7.5 mm)

Aluminum honeycomb composite inspection

honeycomb-a5: Time of max contrast



honeycomb031-047c3: Time of max contrast



- Small Area Coverage 6" x 6"***
- .020 In., carbon surface prep***



GE Inspection Technologies

Nondestructive Testing Methods for the Aerospace Industry:

- **Ultrasound**
- **X-Rays**
- **Eddy Current**
- **Thermography**