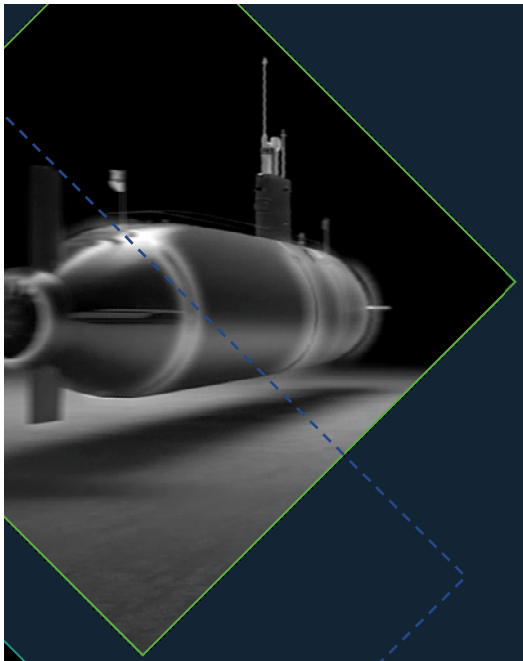

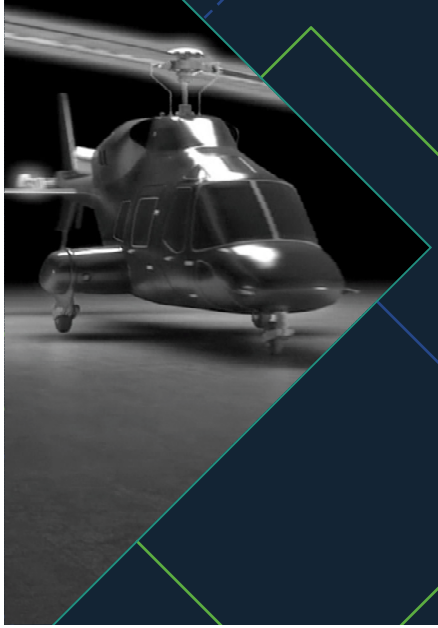

THETA TECHNOLOGIES

GAME CHANGING NDT

# Nonlinear Resonance NDT for rapid pass-fail analysis


**Julian Wright**

**Chief Technology Officer**

**Theta Technologies Limited**

# About Theta

- USP is Non-Linear Acoustic (NLA) NDT
- Based in Exeter, UK
- Only known commercial provider of NLA in the world
- Clients in aerospace, marine and nuclear sectors, European Space Agency

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# About Non-Linear Acoustics

- Reveals flaws invisible to alternative methods
- Sub-surface detection
- Metals and composites
- Uses ultrasound and sound in an unconventional way

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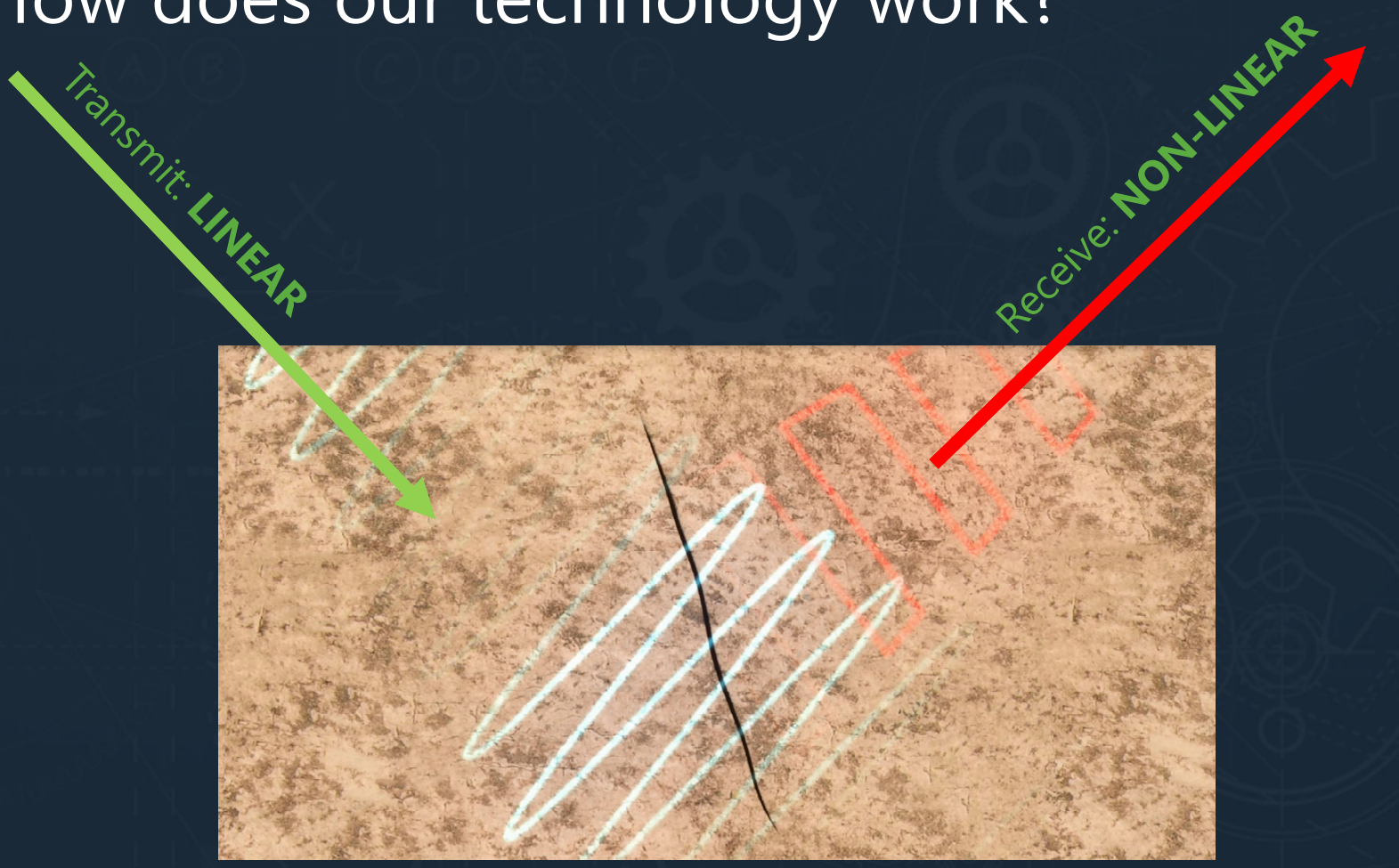
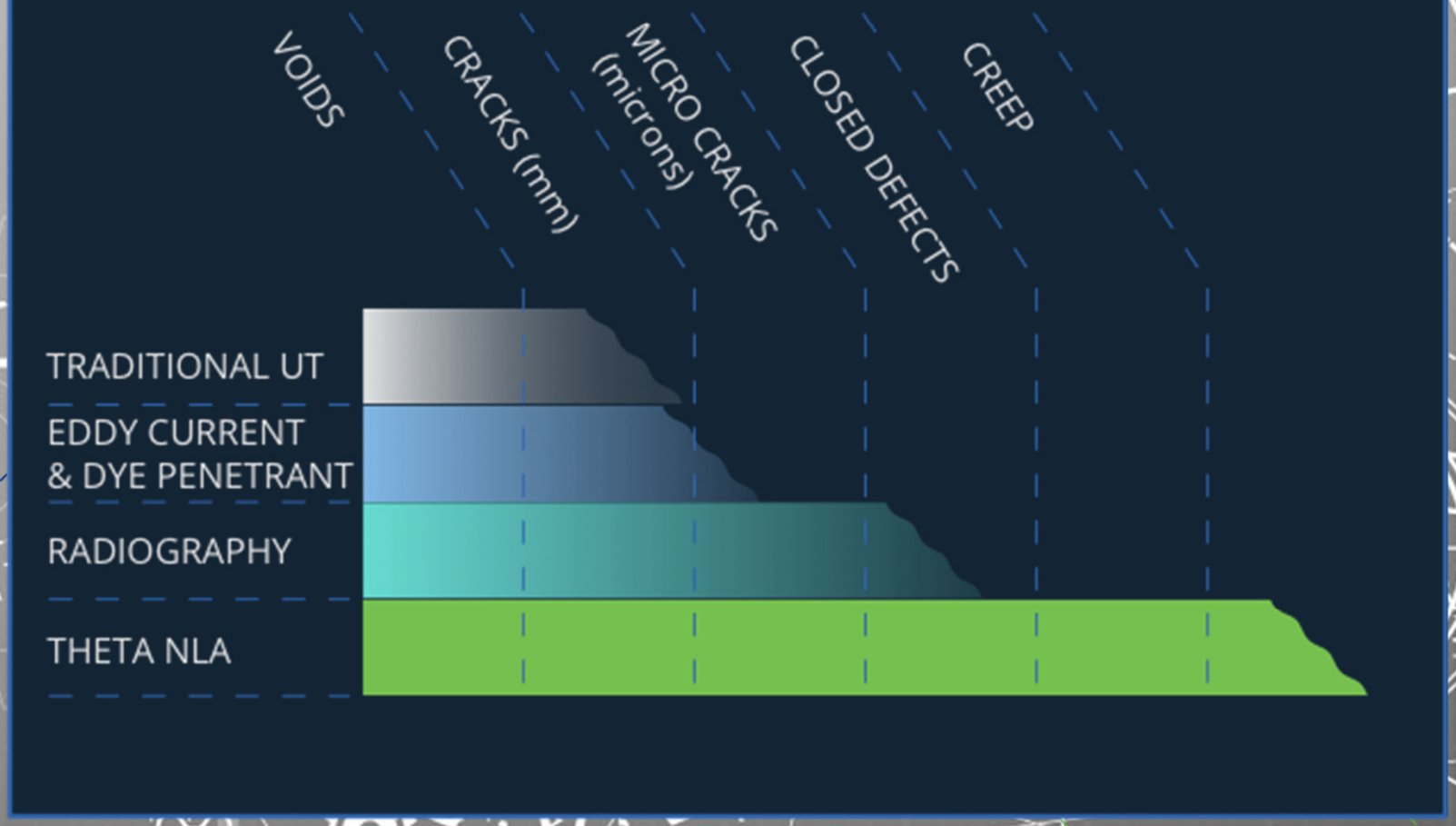
# How does our technology work?



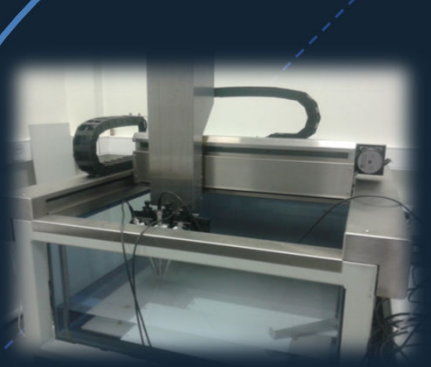

- Crack vibrates asymmetrically, creating non-linearity

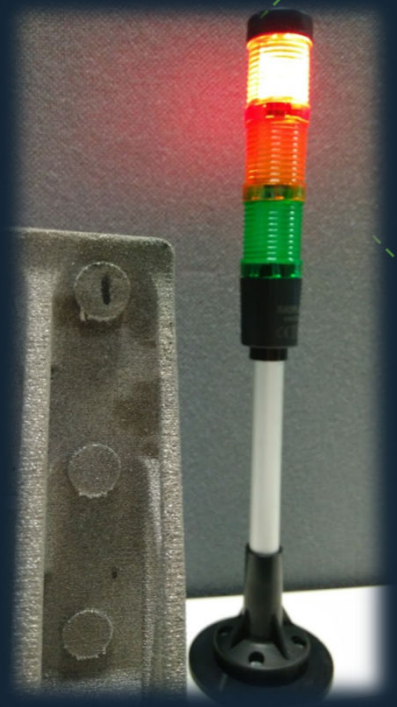
# Capability


VOIDS
CRACKS (mm)
MICRO CRACKS (microns)
CLOSED DEFECTS
CREEP
TRADITIONAL UT
EDDY CURRENT & DYE PENETRANT
RADIOGRAPHY
THETA NLA

# Application

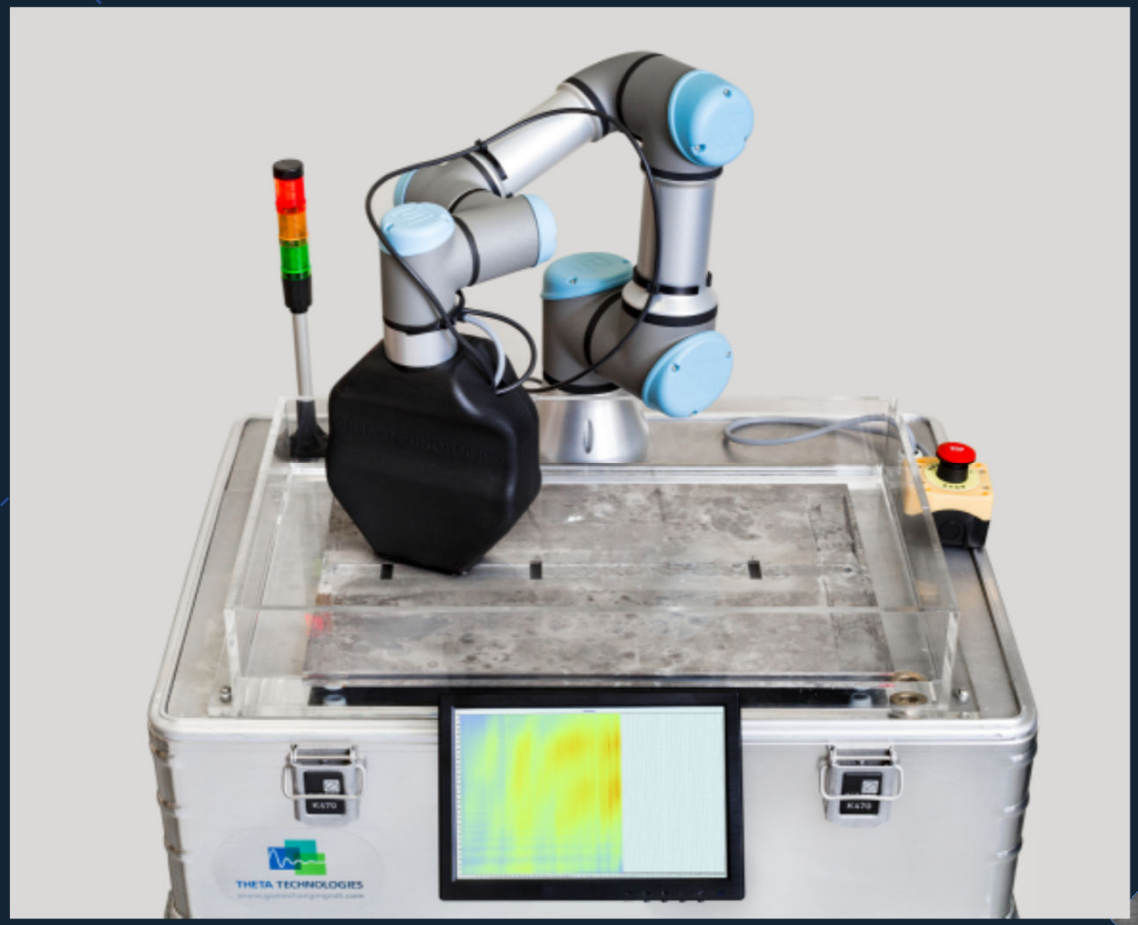
## **Scanning** or **Triaging**

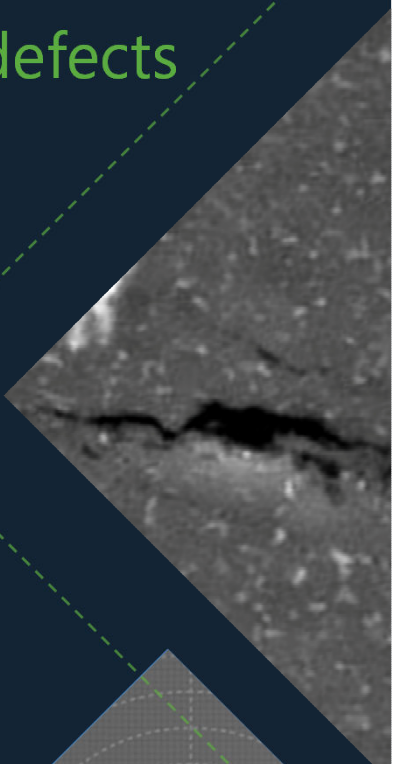




# Applications (Scanning)

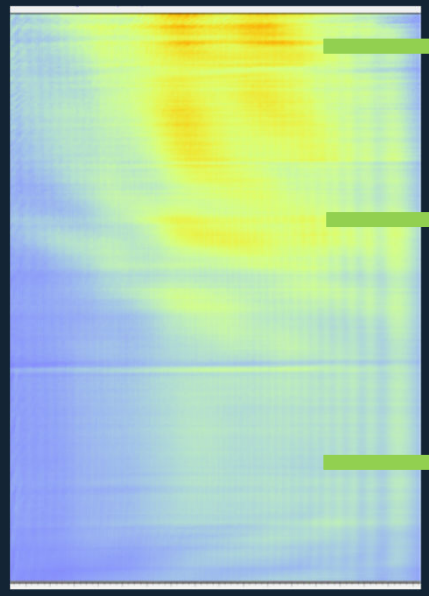
- Robot scanning Friction Stir Weld to find micro-defects

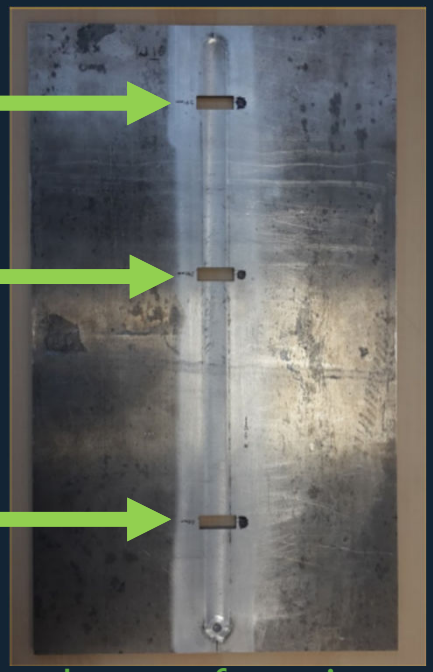


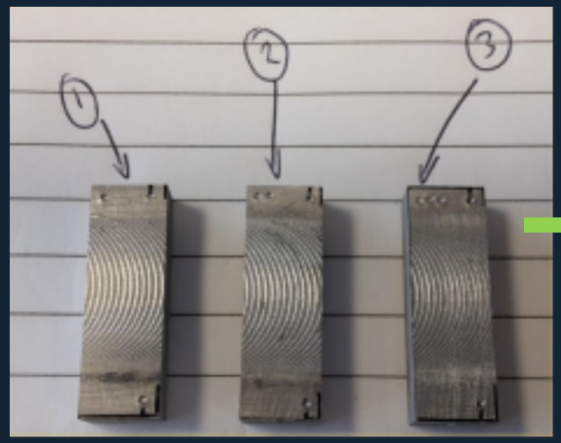
# Applications

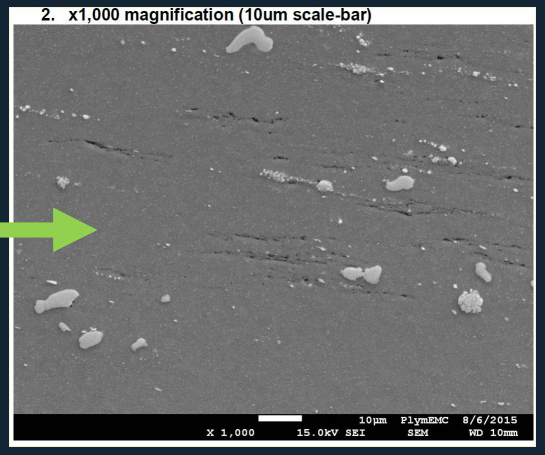
'Heat-map' of non-linearity





Samples cut for microscopy



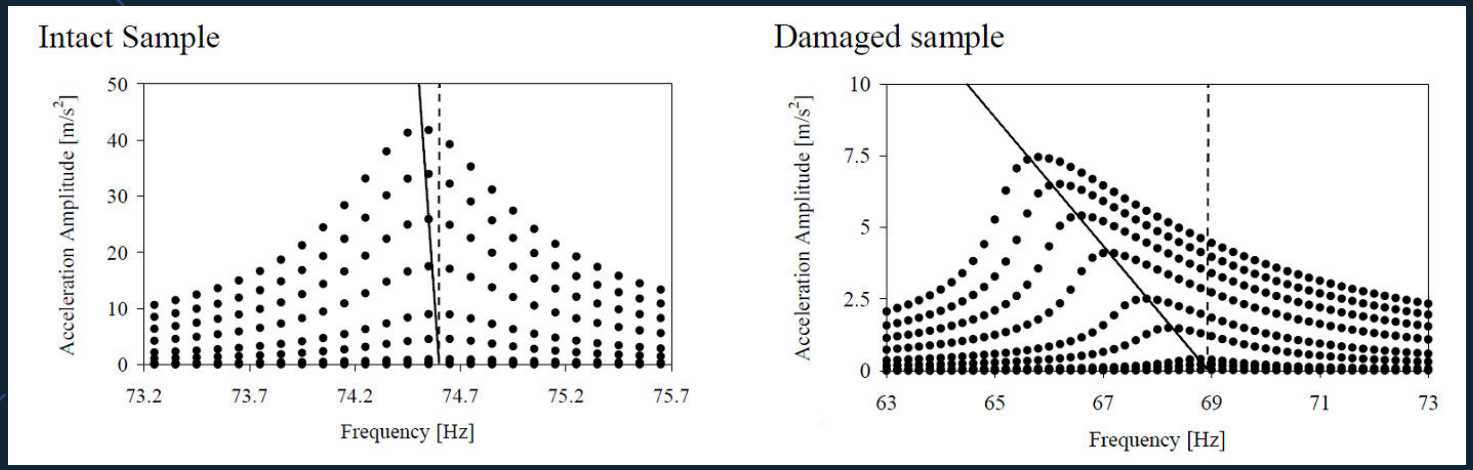




Capability:

1-2um x 100-200um

# Applications (Triage)

- Nonlinear Resonance – rapid pass/fail




In an intact resonant system, the resonance frequency reduces very slightly with increase in excitation amplitude. If the system contains compliant defects (such as a crack), the resonance frequency reduces much more markedly with increasing strain. By comparing the relative shifts in resonance, the integrity of a testpiece may be assessed.

# Applications (Triage)

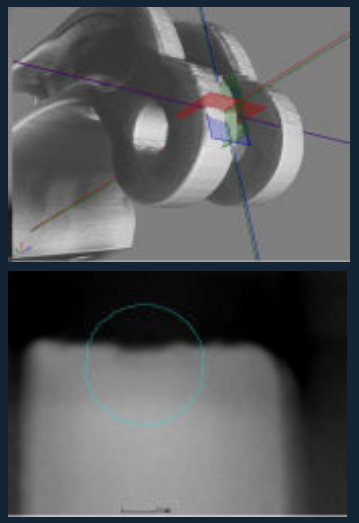
NLR system in RASCAL demonstrator at MTC

# Data for JG59 AM NDT draft standard:

## X-ray CT and Nonlinear Resonance on Nacelle hinges ND1 and ND2

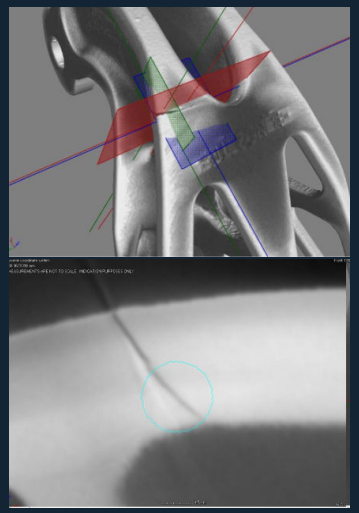
### X-ray CT

X-Ray CT of sample ND1 :
(Voxel size 121 µm):



Planned without defects

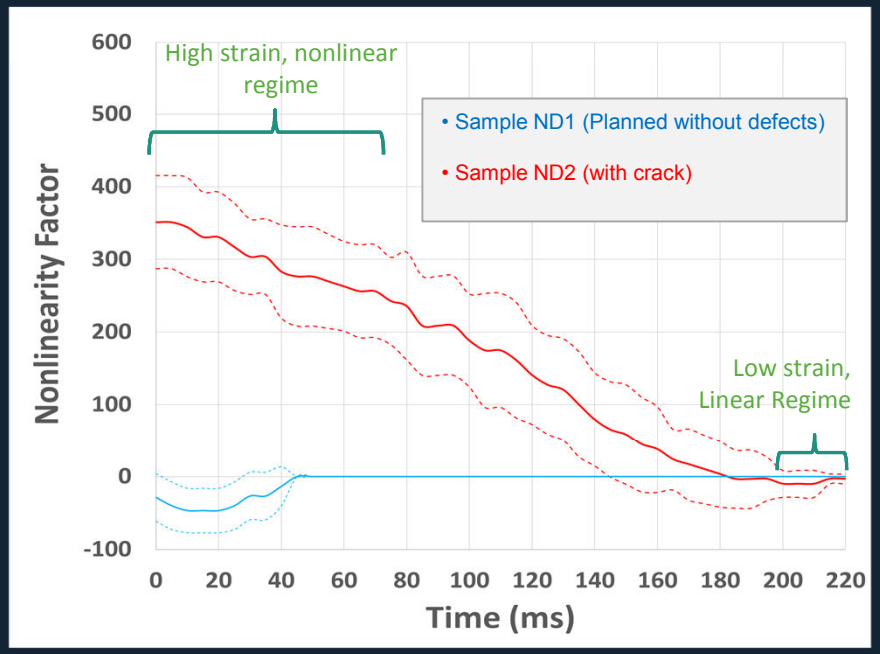
X-ray CT of sample ND2
(Voxel size 121 µm):



Process crack on one of its arms

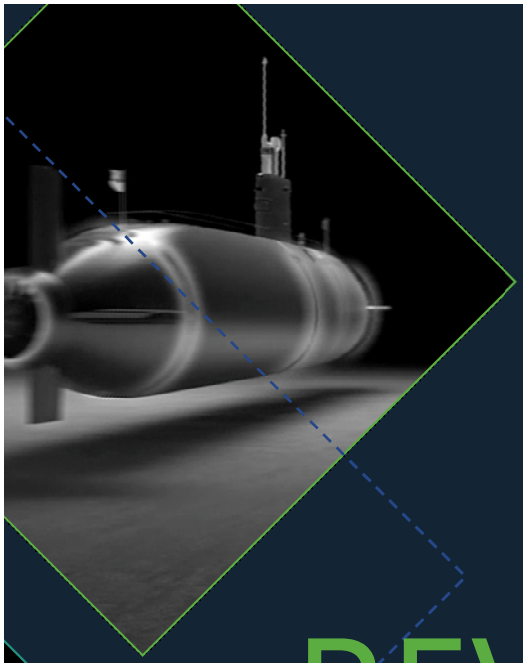
Test time: Several hours per sample

### Nonlinear Resonance




Nonlinear Resonance drift on sample ND1 (planned without defects) compared to sample ND2 (with a process crack) showing clear differentiation.

Test time: <1 minute per shot



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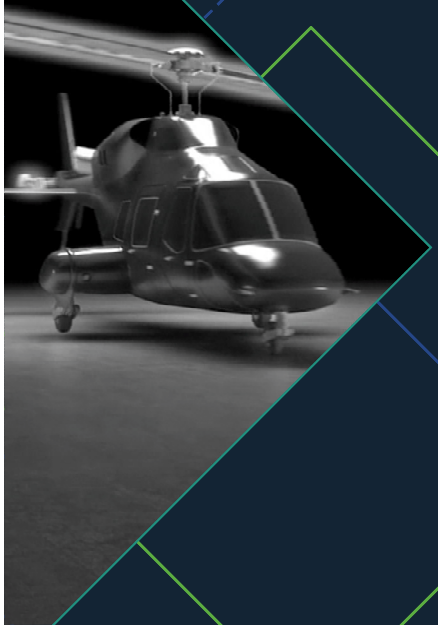
# REVEALING FLAWS

## no other technology can see

julian.wright@thetaNDT.com