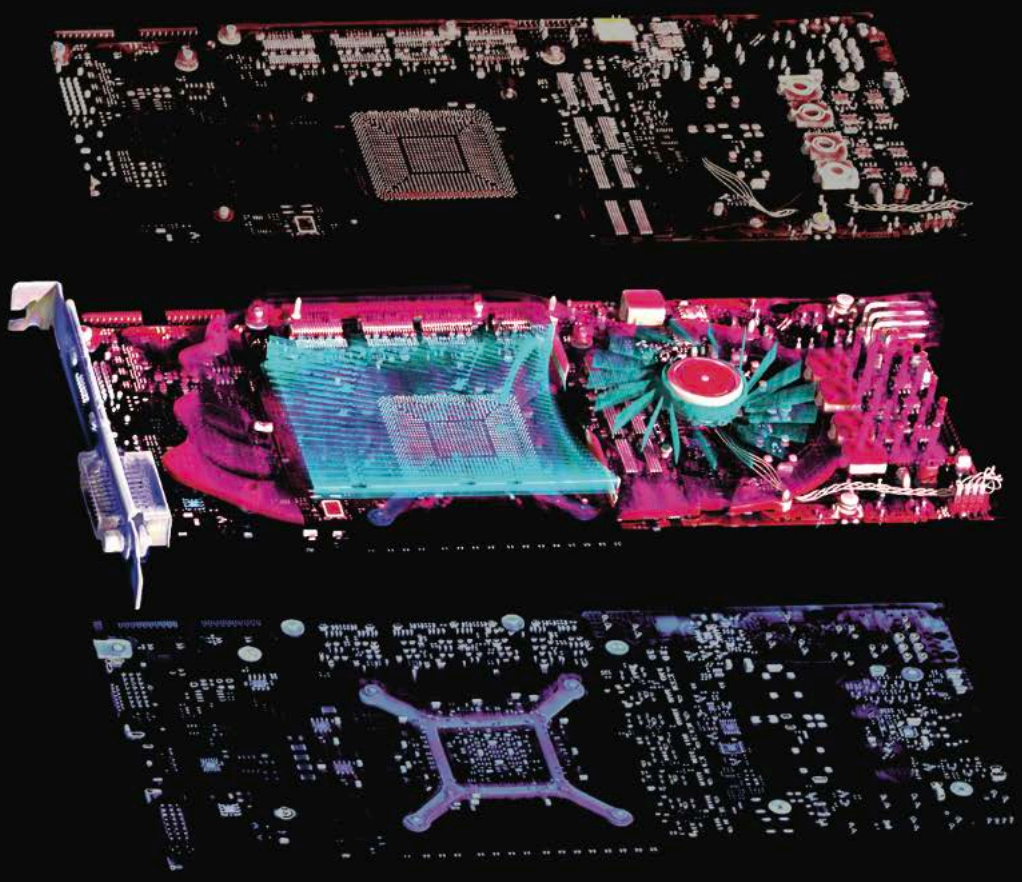
University of Southampton

NXCT National X-ray Computed Tomography

# INSIDE INFORMATION.
## ADVANCED X-RAY COMPUTED TOMOGRAPHY



# µ-VIS X-RAY IMAGING CENTRE

microtomographic Volume Imaging at Southampton

# OPPORTUNITIES IN 3D VOLUME IMAGING AT THE UNIVERSITY OF SOUTHAMPTON

The µ-VIS X-Ray Imaging Centre is University of Southampton's dedicated centre for CT and founding partner of the National Research Facility for lab-based X-ray CT (NXCT). The centre combines state-of-the-art equipment and 25 years of experience, plus the expertise of 40+ academic staff from across the University, offering a unique integrated resource for advanced 3D imaging.

## The benefits offered by CT imaging:

- The ability to comprehensively visualise inaccessible and/or opaque materials and structures in 3D
- High spatial resolution (to submicrometre level if necessary)
- Detailed 3D (volume) parameterisation for characterisation and modelling
- Non-destructive

## Consultancy services

µ-VIS offers a range of services to external institutions (academic and industrial) including:

- feasibility assessments
- experimental design and planning
- 3D volume imaging
- image analysis (visualisation and morphometry)
- metrology
- assembly analysis
- image-based modelling
- correlative imaging
- *in situ / in operando* imaging
- training

## Computational facilities

High-performance workstations for development and optimisation of novel analysis and workflows.

- workstations with up to 1 TiB RAM & 128 threads
- dedicated fast data transfer network
- high speed storage with over 700 TB raw capacity
- leading commercial and open-source software

## CT Imaging equipment

### Large-scale scaning

**2x customised walk-in bays up to 450kVp**

- imaging volumes in excess of 1x1x2 m
- sample weight up to 200 kg & large user labyrinth
- 225 kVp, 300 kVp, 450 kVp X-Ray sources
- ~3 µm up to 300 kV, 50 µm at 450 kVp & 1 mm up to 1500W
- 4 MP & 9 MP Flat Panel detectors + CLDA detector
- helical scanning, laminography, scatter compensation

### Mid-scale and High-throughput scanning

**3x all-purpose CT and radiographic inspection systems up to 225 kVp**

- resolution down to 1.5 µm
- samples to ~300 mm and 50 kg
- 10x & 14x automatic sample exchange racks

### High-resolution scanning

**1x sub-micron resolution X-ray microscopy system**

- 30 -160 kVp, magnification objectives up to 40x
- 0.7 µm true spatial resolution
- phase-enhanced contrast imaging mode

### Biomedical imaging and X-ray Histology (XRH)

**2x in-house designed systems**

- optimised for biomedical imaging & XRH
- resolution down to 1.5 µm
- samples up to ~300 mm and up to 15 kg
- high-throughput and cryo-imaging
- 4 MP & 7.5 MP FP detectors
- photon-counting detector

### Preclinical imaging

**2x small animal *in vivo* imaging systems**

** Systems managed by the Biomedical Imaging Unit*

- correlative X-ray + fluorescence/luminescence imaging
- ~10 µm in vivo spatial resolutions
- integrated physiological monitoring
- gating mode

### Manufacturers

Nikon Metrology UK Ltd | diondo | Zeiss | Dectris
PerkinElmer | Deben | Oxford Cryosystems

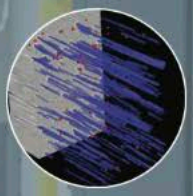
## The µ-VIS Approach:

| Imaging: | + | Data handling: | + | Computer vision: |
|---|---|---|---|---|
| - system flexibility<br>- automation<br>- advanced methods | | - fast, cost-effective HPC (GPGPU)<br>- end-to-end workflow, interoperability | | - training<br>- established resources<br>- advanced algorithm implementation |

# CAPABILITIES & APPLICATIONS

**Uniquely flexible, multi-scale high-energy µCT**

'walk in' custom-built bays equipped with multiple sources and detectors; designed for versatility and large-scale imaging



**High resolution**

sub-µm spatial resolution and phase-enhanced constrast capability

***in situ* testing**

number of *in situ* rigs (incl. load, environment, and flow control) that can be mounted within lab-CT and SR-CT systems

**X-Ray videography**

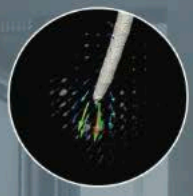
real-time X-Ray imaging for functionality inspection

**Non-conventional CT**

incl. phase-enhanced contrast CT phase-retrieval tomography, laminography and limited angle CT

**Scatter compensation**

single-slice and volume scatter-free imaging modes for stunning image sharpness and contrast of dense structures



**4D-CT**

time-resolved *ex situ* and *in situ* µCT imaging of deformation and/or failure mechanisms within samples

**SRµCT**

25 years of experience at worldwide synchrotron facilities

**Panel-shift radiography**

horizontal and vertical field of view expansion resulting in up to ~ 9,000 x 10,000 pixels (c. 1.6 x 2.0 m) detector size

**Data processing & analysis**

access to high-performance workstations with multiple 3D image analysis software packages

**Applications**

- 3D (volume) visualisation
- Defect analysis
- FE model generation (meshing)
- Densitometry and porosity characterisation
- Actual-nominal comparison
- Petro-physical characterisation
- CT metrology
- Process evolution (time-resolved imaging)
- Digital Volume Correlation (DVC)

**Research areas**

- Engineering materials and structures
- Additive manufacturing
- Biomedical engineering
- Tribology
- Failure analysis
- Manufacturing Engineering
- Civil engineering
- Biomaterials

# GALLERY

1. X-ray projection of tibia implanted with CoCr unicompartmental knee arthroplasty device
2. Sectioned injector tip from a marine diesel engine
3. Visualisation of grain boundaries and cracks through aluminium alloy
4. Cavitation damage on metallic impellor blades
5. Extracted surface mesh (.stl) of an automotive gearbox housing

6a. Overview scan of CFRP composite / metallic wing section structure

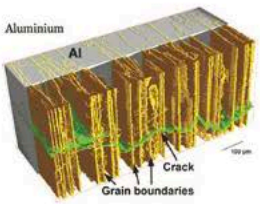
6b. Local region of interest showing ply damage

6c. Sub-micron resolution imaging to resolve individual fibres in the CFRP

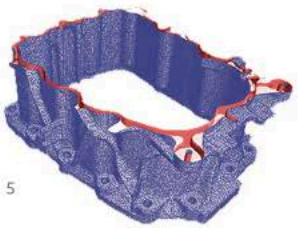
6d. CLARITy: CFRP and metallic airframe slice using CLDA scatter-reduction imaging

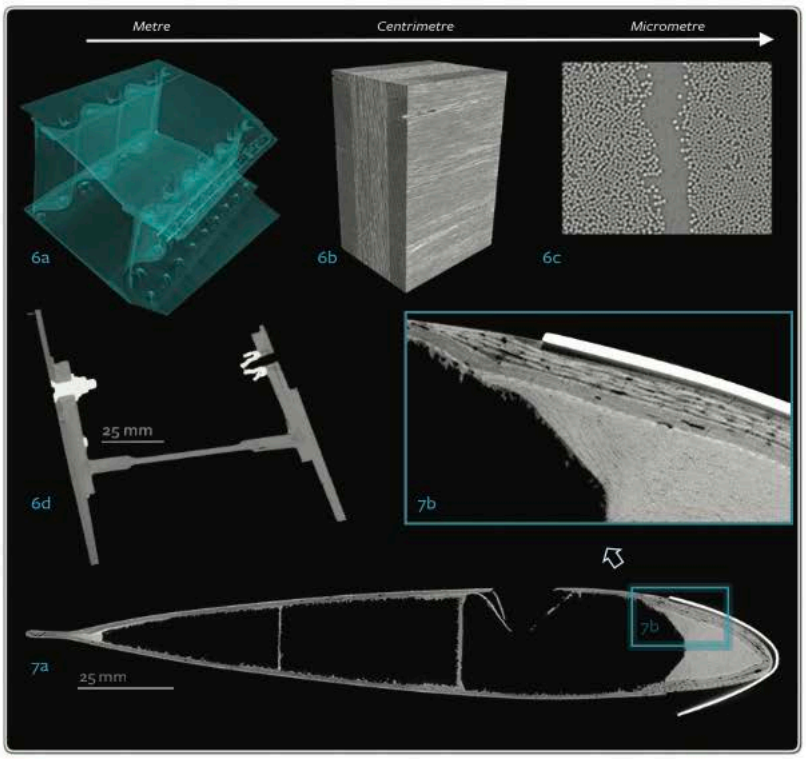
7 a/b. Axial slice of intact composite tail rotor blade (1.25 m tall + 0.20 m wide) scanned at 40 µm resolution across entire cross section using panel shift modality










## VIDEOS

scan and follow the QR codes; from left to right:

1. Multiscale imaging CFRP composite
2. Real-time plant-root growth
3. 3D strain mapping using DVC
4. Time-series of CFRP failure
5. Train ballast imaging & modeling
5. Virtual archeological excavation of a roman coin hoard

VIDEOS

1 2 3 4 5 6

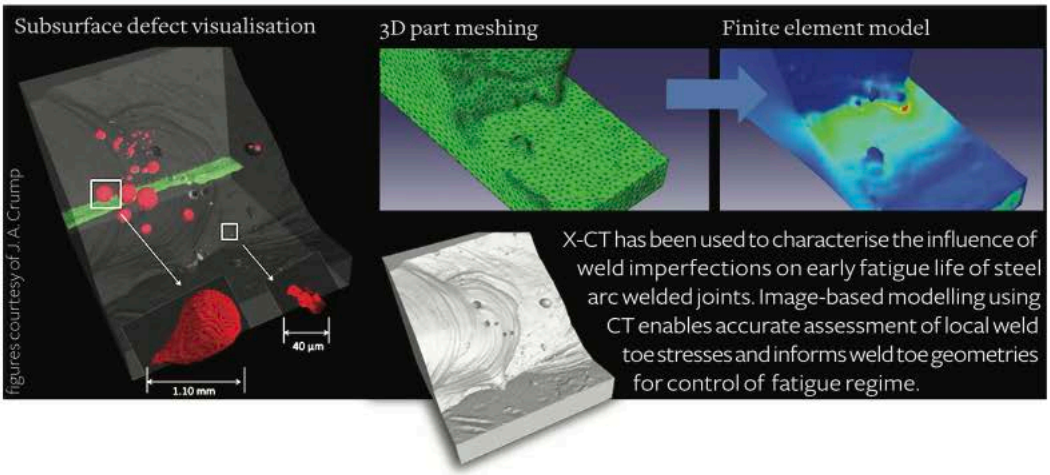
www.youtube.com/@muvis-tomography

To find out more about µ-VIS and how to gain access to our facilities and expertise please email us or visit our website

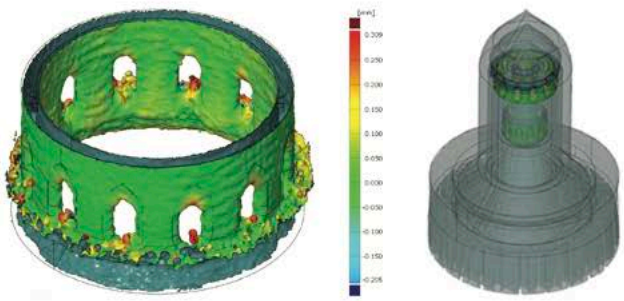
muvis@southampton.ac.uk
www.muvis.org

# CASE STUDIES

## Defect detection in steel weld




## Actual-nominal comparison of additive manufactured component

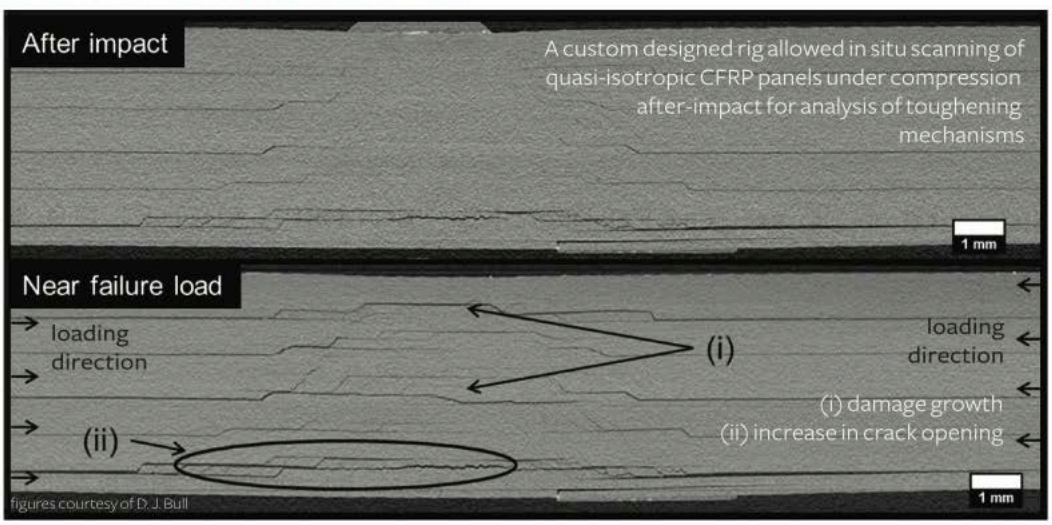


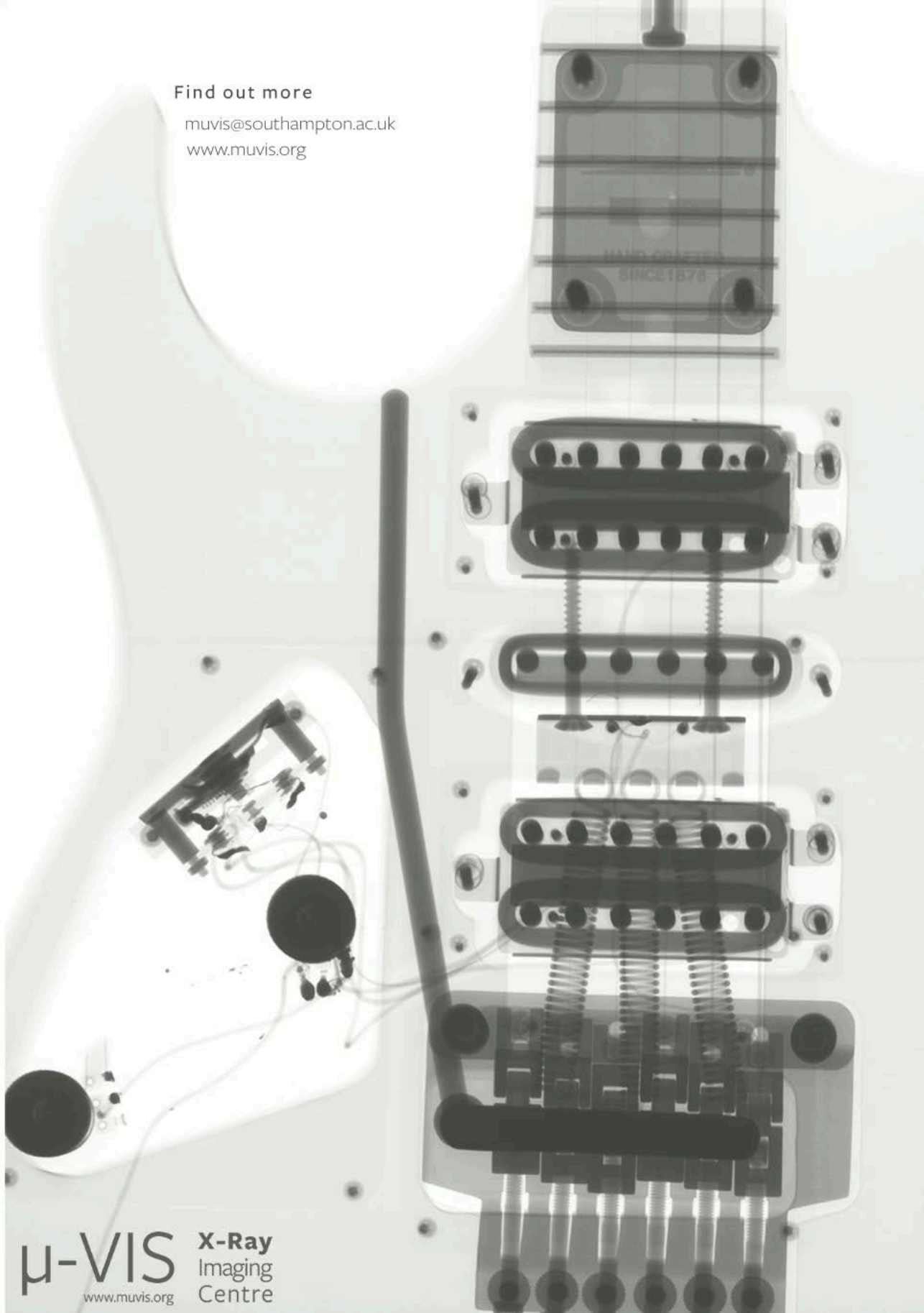
### Resistojet propulsion systems

X-CT enabled non-destructive materials and manufacturing verification of metal additive manufactured resistojet heat exchanger components. Surface mesh generation was used for coordinate measurements, actual-nominal comparison and wall-thickness assessment.

figures courtesy of F. Romei

## Damage visualisation in CFRP





## Find out more

muvis@southampton.ac.uk
www.muvis.org

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