



The  
University  
Of  
Sheffield.

**Advanced Manufacturing Research Centre**



# AMRC Advanced Structural Testing Centre Capability directory



Based in the AMRC Design Prototyping and Testing Centre, the Advanced Structural Testing Centre (ASTC) provides the capacity, capability, and commitment to close the loop on the total engineering process within the AMRC.

Test capabilities range from coupons to prove the material properties of new manufacturing processes, to complete finished components and assemblies.

Certification and product validation are critical to the adoption of new manufacturing methods and technologies. Many of the techniques and products developed at the AMRC will be used for safety-critical components. Because even small changes can significantly affect final performance, it is vital to fully understand the performance of structures and materials.

Without the right certification, it is impossible to introduce innovative methods and technologies into the supply chain for aerospace or other highly regulated industries.

The ASTC can help you prove your technologies and achieve certification. Our capabilities are available to AMRC research groups, member companies, and external companies.

Backed up by the resources and expertise of the AMRC, we are able to physically validate research, analysis, material properties, components, sub assemblies, and full assemblies for both research and commercial projects.

The ASTC is accredited by the United Kingdom Accreditation Service (UKAS). We are currently the only structural test facility within a UK university to hold 'in-house methods' accreditation. This means that we are not restricted to testing to specified international procedures, but can develop new test procedures in collaboration with our customers to prove out components under real-world conditions.

We also have specific accreditation for tensile testing to ASTM E8M, and certification for a wide range of standard tests including pressure testing up to 350Bar.

**For more information, contact:**

Phil Spiers – AMRC head of ASTC  
[p.spiers@amrc.co.uk](mailto:p.spiers@amrc.co.uk)

The AMRC Advanced Structural Testing Centre can bring a wide range of capabilities and expertise to our industrial partners.

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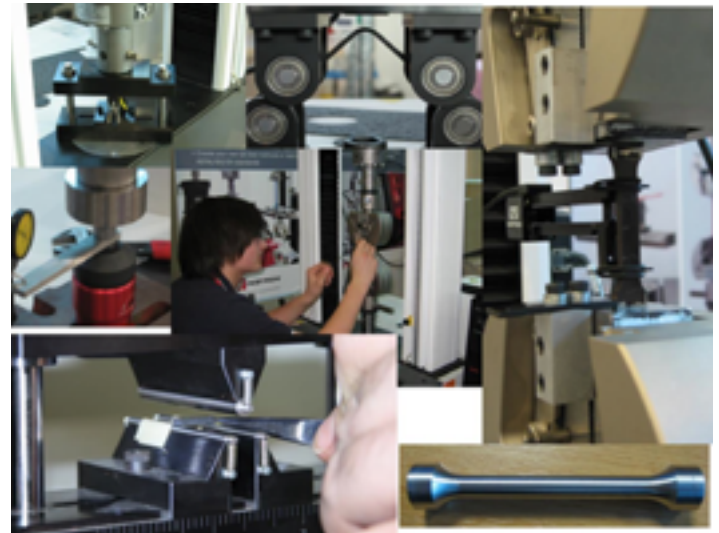
# Uniaxial Test Frames



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## Small 50kN Electric Test Frame



### Specification

- Instron 50kN test frame equipped with Bluehill software
- Load capacity: 50kN and 1kN load cells
- Extensometers with gauge length 6mm to 75mm
- Wedge grips
- Collet grips for tensile specimens
- Bending tests: 3 and 4 point

### Testing

- Tensile test to ASTM E8M
- Tensile test of plastics
- Inter-laminar shear stress
- Crack growth testing
- Flexural testing
- Load vs. deflection testing
- Shear strength testing



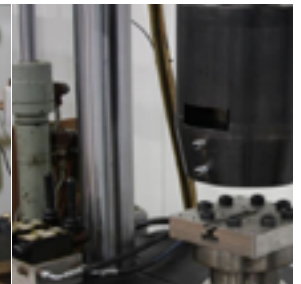
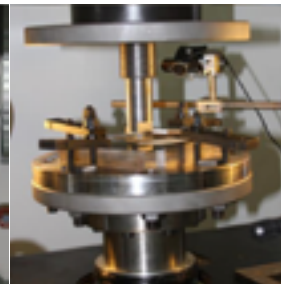
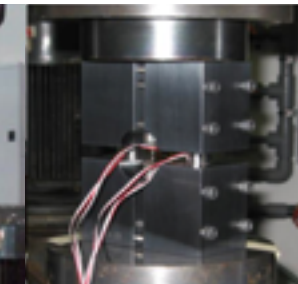
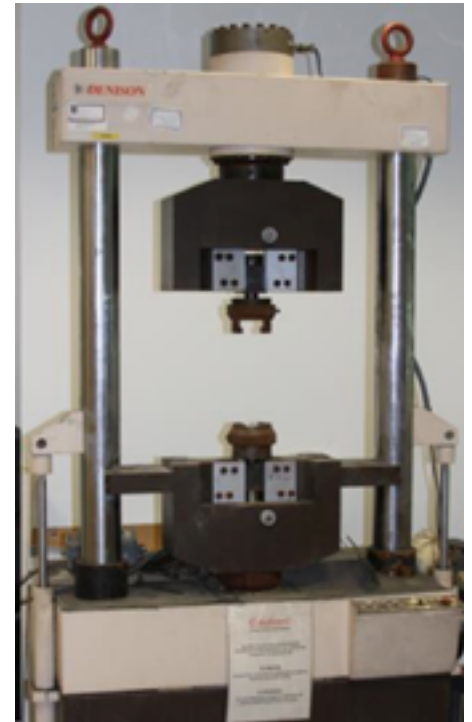
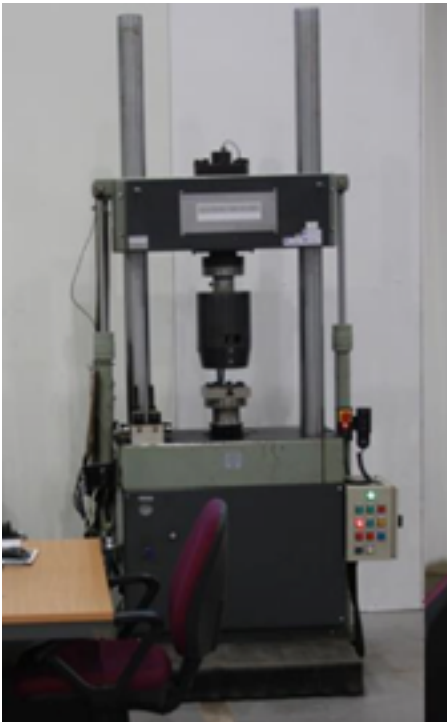
# Uniaxial Servo-hydraulic Machines



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Three machines available: 100kN and 2 x 250kN



## Specification

- Various frames all equipped with Instron 8800 digital controllers and WaveMatrix software
- Load capacity: 100kN, 250kN
- Max stroke length +/- 50mm
- Hydraulic wedge grips
- Bespoke grips and fixturing
- Alignment checks conducted as required

## Testing

- Performance testing of laser cut rapid manufacture structures
- Fatigue testing of tubes to prove NDT crack detection capabilities
- Shear testing of composite interfaces
- Failure investigation testing of nuclear industry manipulator
- Compressive testing of composite specimens
- Push through testing of manufactured composite structures

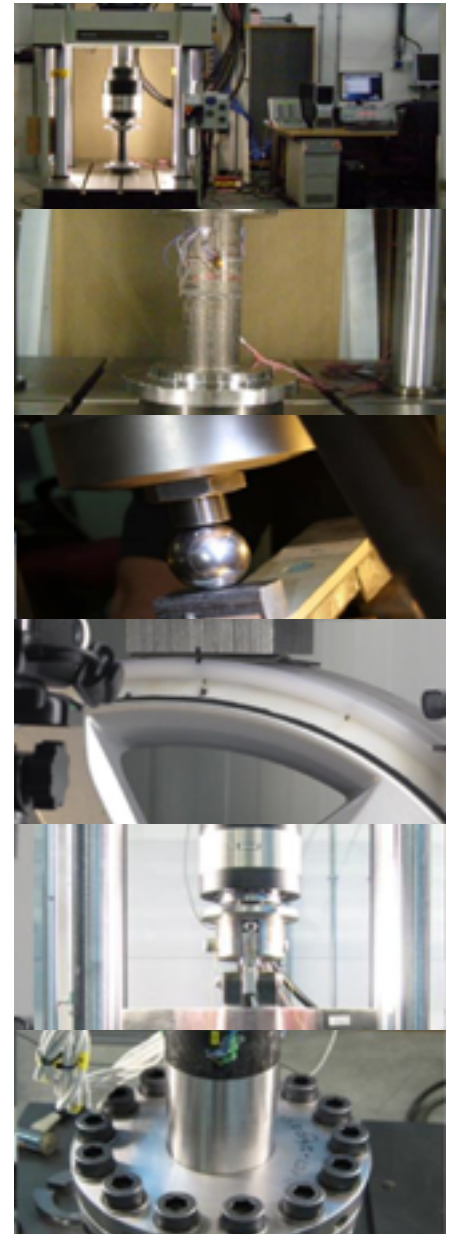
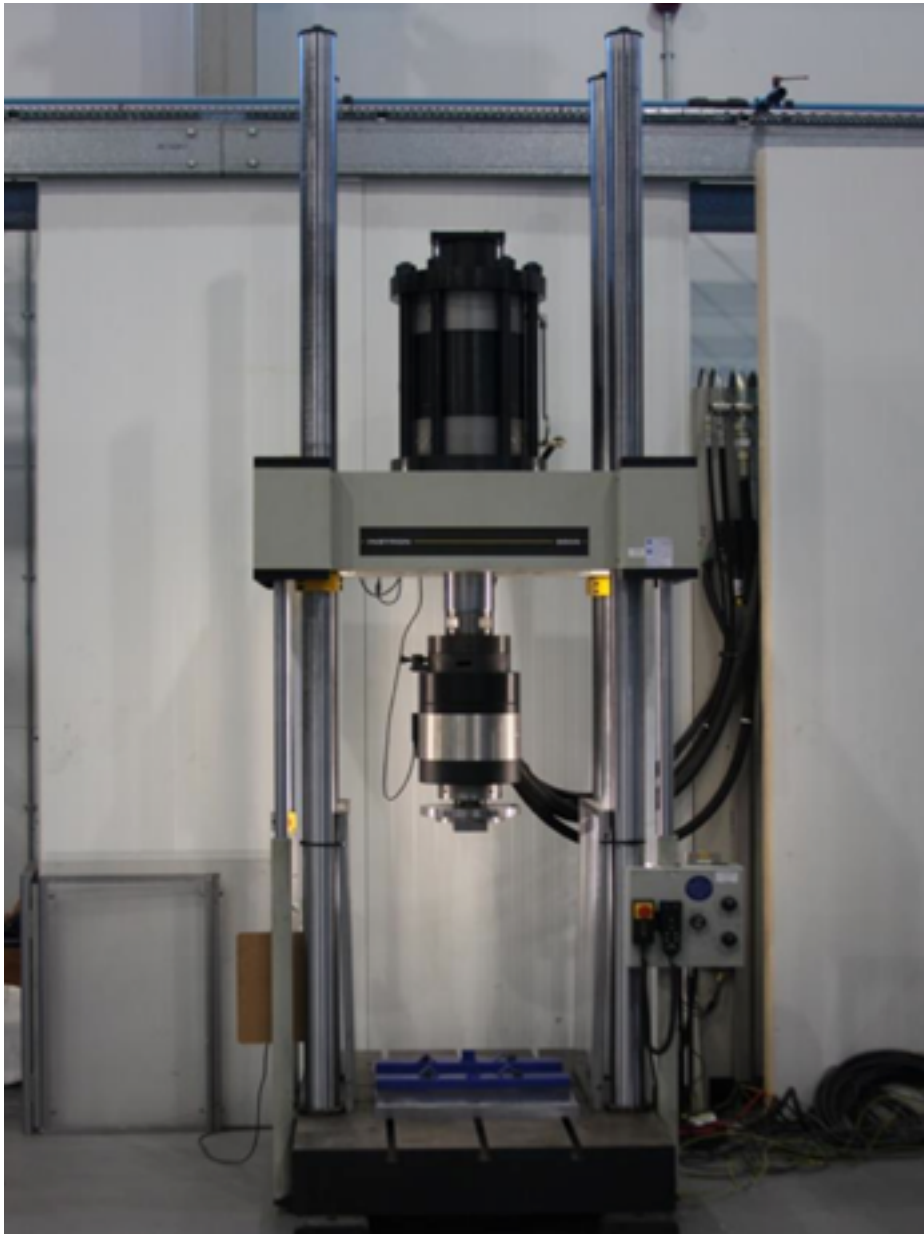
# Uniaxial Servo-hydraulic Machines



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## 4 Post Hydraulic 1000kN Machine



### Specification

- Load capacity: 1000kN load cell calibrated to both 1000kN and over 100kN range (both responding at 0.5% class)
- T-slot bed plate envelope size 1500mm by 750mm
- Bespoke grips and fixturing design & manufacture capability
- Extensometer connection available

### Testing

- Performance testing of composite casing structures
- Fatigue testing of hybrid composite/metallic structures
- Composite flange testing with load applied at various angles
- Luxury yacht chain plate testing
- Run flat tyre static and fatigue testing

# Instron Impact Testers



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## Specification

Available in capacities from 300 to 900 Joules, the MPX is easy to operate making it suitable for high volume testing. The system includes an integrated guard and safety control system that meets the stringent requirements for the European CE mark and for ISO 13849. Fracta™ Software for simple data acquisition and reporting of absorbed energy is included with the system.

## Features and Benefits

- Automatic test start at door closure for efficient testing and adherence to standards for non-ambient specimen testing
- Optional interchangeable hammer weights conveniently adjust the system capacity without removal of the hammer shaft
- Safety enclosure with interlocks protects the operator by preventing the hammer from releasing when doors are open
- Charpy anvil inserts and striker are selectable to meet a wide range of international test standards, including ASTM E23, ISO 148, EN 10045, GOST 9454, AS 1544, JIS Z 2242, and JIS B 7722



# 2MN (200T) Tension Compression Frame



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## SATEC 2000kN capacity tension/compression frame



### Specification

- Digital control via "Partner" software
- Loading plate envelope size 710mm by 750mm
- Max specimen length 2m
- Bespoke grips and fixturing design & manufacture capability
- Platen parallel and flatness within 0.2mm

### Testing

- Composite Panel compression testing
- Integrated Wing structural testing

# Hydraulic Actuators



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A wide selection of actuators for applying loads is available.

# Test Control



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The ASTC has the ability to control tests of up to 8 loading points via MOOG control systems portable test controllers. Tests can be conducted in load or displacement control. 'Real world' data can be transferred into test programmes and accelerated fatigue tests or multi-load strength testing can easily be carried out at the ASTC.



# A 10m x 10m Strong Floor and a Reinforced Wall



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As part of the construction of the AMRC Design, Prototyping and Testing Centre, significant investment has been made to enhance the structural testing capability of the ASTC.

The strong floor enables the creation of bespoke frame rigs to test large size and high-load components or assemblies. The floor is of a design that enables it to be reconfigured to a 20m x 5m test area.





## Four 2MN Actuators



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The actuators enable the Centre to test structures to high loads. Used in conjunction with the strong floor or reaction rigs, there is capability to achieve 800T of tensile/compression loading, as well as bi-axial fatigue up to 200T per axis. When used in conjunction with the FCS digital control system, this creates a flexible and reconfigurable system that can be used for many testing requirements.



# Split Hopkinson Pressure Bar Machine



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A Split Hopkinson Pressure Bar (SHPB) is used to test the high strain rate material properties of materials. The Hopkinson bar is used to impose a dynamic load on a material specimen, akin to loads the material will experience in machining or service. Using the innovative approach that the AMRC Process Technology Group applies to metal cutting, it is of paramount importance that it is understood how the material properties change as a function of the cutting force applied. The SHPB is used for testing the dynamic material properties developed in various metals and composite applications.

# Associated Equipment and Services



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## Data Acquisition (DAQ)

At the heart of any structural test laboratory is the ability to accurately record the test data. Input and outputs from the unit under test must be time linked and recorded in a reliable and calibrated method. The ASTC uses HBM data acquisition equipment to log the required information produced on a test campaign. The DAQ is fully configurable to acquire time based data up to speeds of 19200Hz.

## Strain Gauge Installation

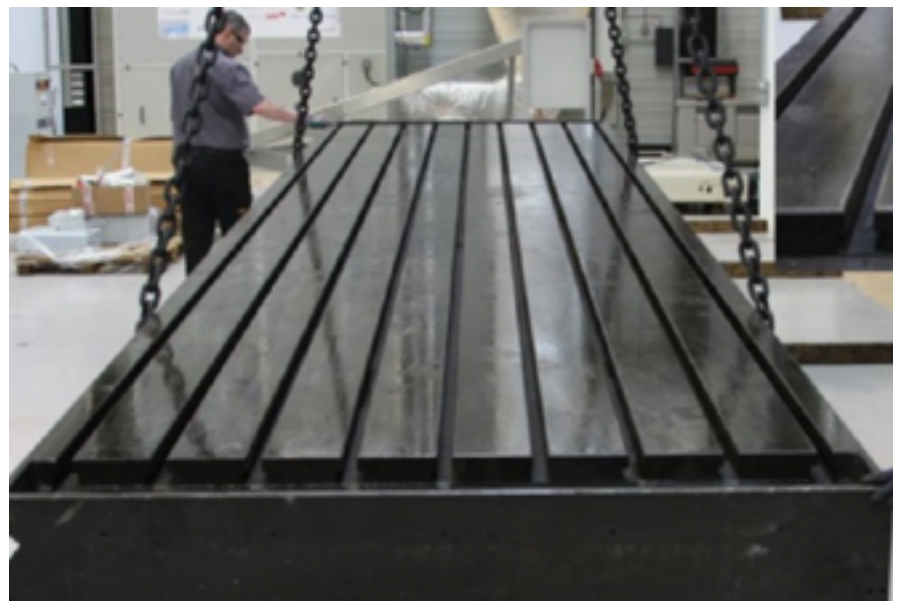
The ASTC is able to source and apply strain gauges to many different materials. The system uses a 4-wire 350 Ohm gauge as standard. However, other systems can be accommodated with prior notice. All gauges are fitted by trained and certified engineers in accordance with BSSM specifications and international standards.

## Video Recording

The importance of recording in detail, the inputs, actions and outputs of a test campaign often conducted on expensive components is understood by the ASTC. Standard HD video is recorded of each critical test together with high quality photographic evidence of test set-up and post-test condition. The ASTC is fortunate to have a former professional photographer on the team to ensure that the quality of images and videos are exceptional.

## Small Strong Floors

Smaller strong floors 2.5m x 3.5m and 2m x 6m



# Major Projects



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## Composite Coupon Inter-laminar Shear Strength

In conjunction with the AMRC Composite Centre, tests are often conducted to examine the inter-laminar shear strength of various fibre/resin manufacturing combinations. The structural test centre was able to support quick turnaround of the testing to deliver the requirements of the research programme.

## Classification of Mechanical Properties of Additive Layer Manufacturing

A series of 405 tests were conducted to evaluate the performance of 11 different materials produced by additive layer manufacturing. The materials were tested for tensile strength, flexural stiffness and impact resistance in three orthogonal directions of part build. Results were presented to the customer to evaluate applicability in an aerospace application.

## Integrated Wing

The nature of the partners and the research at the AMRC has led to significant developments in the ASTC capability to test full scale components. The Integrated Wing project was a Technology Validation Programme and a national collaboration project among 17 UK leading organisations.

The project involved the manufacture of various demonstrator components that were tested under service conditions for static strength and fatigue life durability. As the test partner on the project, ASTC tested components to a maximum load of 130 tonnes and in fatigue for a test duration of 6 weeks. The fatigue spectrum applied was a complex flight-by-flight loading sequence supplied by the project partners from real-world on aircraft data.

## Run Flat Tyre Testing

Runflat Systems Ltd and Performance Engineered Solutions collaborated on a project developing a new vehicle run flat insert system.

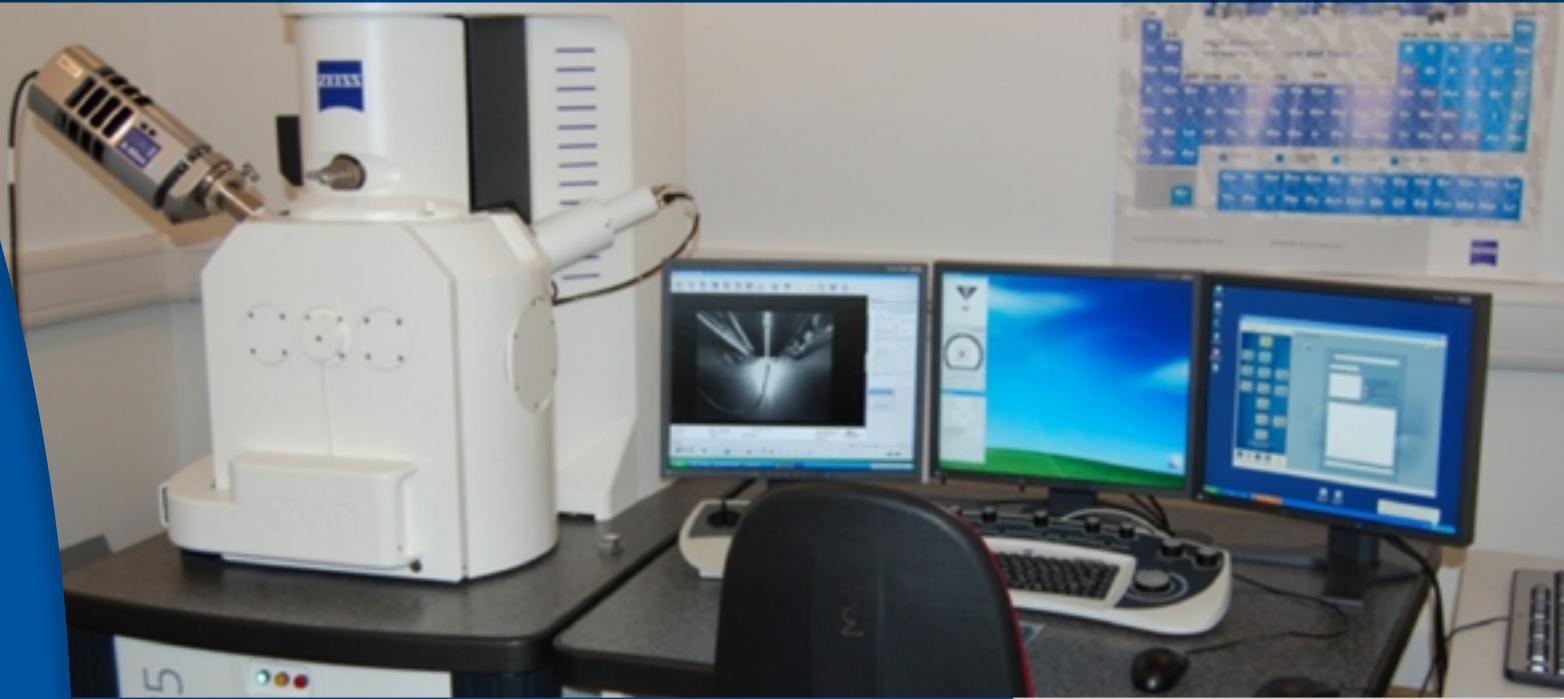
Static load and cyclic fatigue testing was carried out at the ASTC to prove the concept and investigate potential failure modes within the laboratory environment.

## Composite Panel

A partner of the AMRC required a series of tests to evaluate the performance of structural composite panels, in order to validate the analysis models that had been developed. The ASTC compiled a test procedure under their ISO17025 in house methods UKAS accreditation. Rig fixtures were designed and fabricated within the AMRC and the method and equipment were validated by the customer. With the testing of high cost components and the need for control of the process to ensure accurate repeatable results, the ASTC follows internal procedures that ensure the test set up, rig function and applied loads are all validated and are in agreement with the customers before starting the test.

Due to the high value of the unit under test, it is important to gain as much information about the specimen as possible. Whilst the test was being conducted, the ASTC used specialist partners to obtain Digital Image Correlation (DIC) of the panel deflection, high speed video capture of the test failure, as well as shearography and innovative real-time 'lamb wave' analysis of the specimen.





## Microscopy Laboratory



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The AMRC Microscopy Laboratory is a UKAS accredited testing laboratory.

It is involved in the examination of machining process related influences on the surface integrity, in general, in support of the activities of the AMRC or external companies for specific testing programmes. The majority of the materials examined are Ni-based superalloys (e.g. Inconel 718), Ti-6Al-4V / Ti 6246 or various steels.

### Microstructural Evaluation of Cutting Parameters

The residual stress, surface heating and deformation left in materials by the action of cutting tools can have implications on the mechanical properties of the component being machined. The AMRC Microstructural Laboratory has been involved in many studies examining the surface and subsurface conditions of materials when subjected to different machining methods. Sectioning, etching and microstructural inspections are made of the specimens enabling best practice to be set for manufacturing processes.

# Sample Preparation Equipment



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## Sample Sectioning

### Buehler manual abrasive wheel cutter

Straight line sectioning of a wide variety of materials and sample sizes.



## Sample Mounting



### Struers LaboPress-1 hot mounting press with a 30mm diameter sample cylinder.

Samples can be mounted at 150 or 180 degrees and at variable pressure.



### Struers CitoPress-1 semi-automated hot mounting press.

The sample cylinder is changeable to accommodate various sample sizes. At present, it is equipped with a 50mm diameter cylinder. Pressure is automatically adjusted to maintain a predefined value during the heating phase.

# Sample Preparation Equipment



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## Grinding and Polishing



### Struers semi-automated grinding and polishing including multidoser.

There is space for up to six 30mm diameter samples. Pre-programmed grinding and polishing routes for specific material groups ensure that each sample is prepared to a mirror finish with a high degree of repeatability. Parameters include force; time, abrasives and cloths. equipped with a 50mm diameter cylinder. Pressure is automatically adjusted to maintain a predefined value during the heating phase.

# Sample Examination Equipment

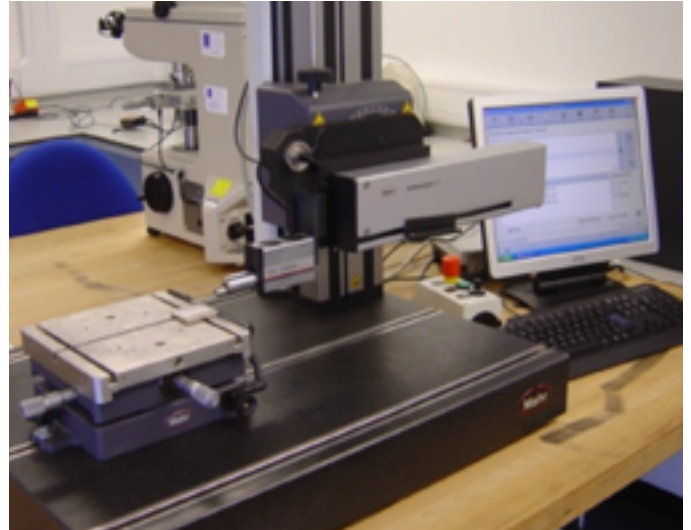


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## Mahr MarSurf XCR20 perthometer PZK drive unit

Accurately assesses surface roughness of a variety of surfaces including holes from 10mm diameter upwards. The measurements are conducted in accordance to BS EN 1134:2010 / BS EN ISO 4287:1998.



## PhaseShift ADE MicroXAM

A White Light Interferometer is used to produce three-dimensional surface texture assessments of sample surfaces.





## Micro-hardness Tester



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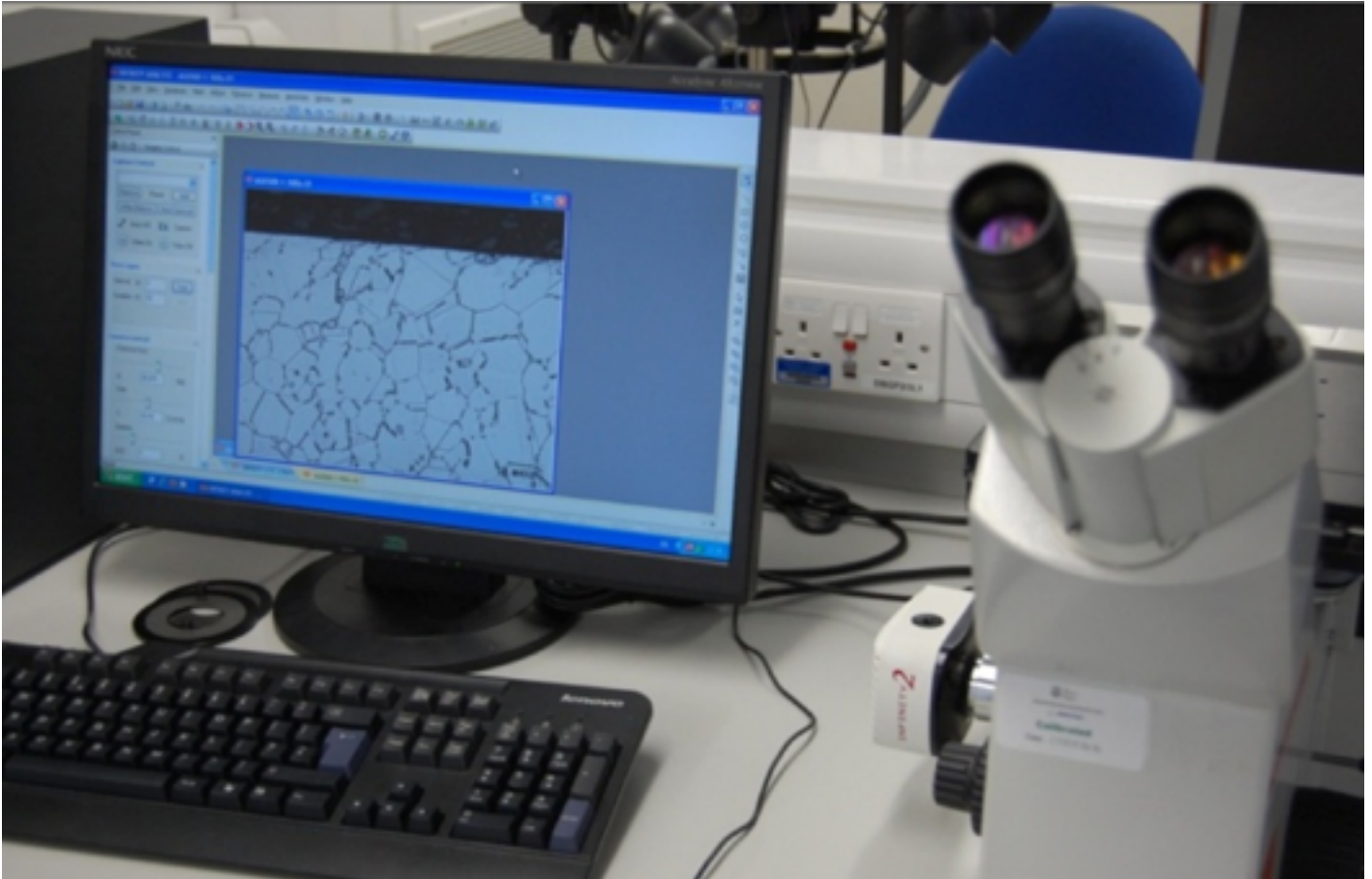
## Mitutoyo HM-122 micro-hardness tester

A manually operated microhardness tester equipped with a Knoop indenter and calibrated for loads of 25g, 50g and 100g. This allows hardness assessment at various depths below the surface of a sample to ASTM E384.

# Optical Microscope



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## Leica DM IRM inverted optical microscope

The microscope is equipped with a magnification of 50x, 100x, 200x, 500x and 1500x. This allows digital imaging and assessment of samples in the macro and micro-scale.

# Scanning Electron Microscope (SEM)



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## Carl Zeiss LS25 scanning electron microscope

It has 420mm (diameter) x 330mm (height) with a vacuum chamber capable of operating at High Vacuum (HV) and Variable Pressures (VP) of up to 3000Pa. The installed sensors include a secondary electron (Everhart-Thornley), backscatter and a VP secondary electron detector.

In addition, the Oxford Instrument X-Max 80mm<sup>2</sup> Energy-Dispersive X-ray Spectrometer (EDX) allows semi-quantitative compositional analysis of materials. This includes examining the compositional changes in welds or identifying the nature of inclusions in machined surfaces.





AMRC with Boeing  
Advanced Manufacturing Park  
Wallis Way  
Catcliffe  
Rotherham  
S60 5TZ

e: [enquiries@amrc.co.uk](mailto:enquiries@amrc.co.uk)  
t: +44 (0)114 222 1747  
w: [amrc.co.uk](http://amrc.co.uk)

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