

# Nuclear Advanced Manufacturing Research Centre



Supported by the  
Regional Growth Fund

**CATAPULT**  
High Value Manufacturing



EUROPEAN UNION  
Investing in Your Future  
European Regional  
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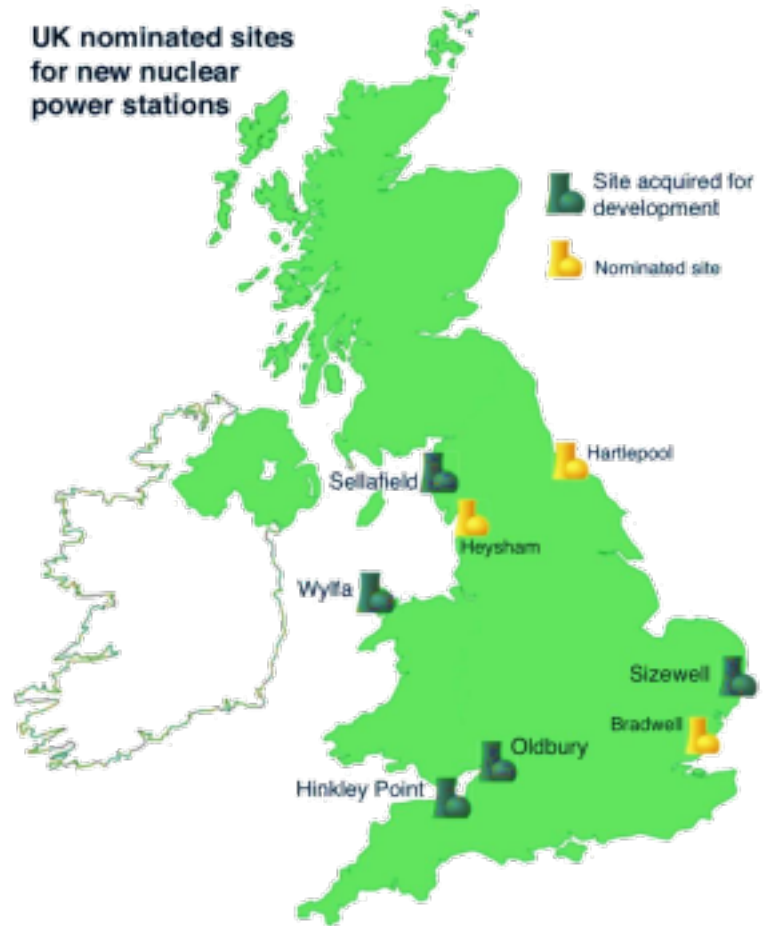
**MANCHESTER**  
1824  
The University of Manchester



The  
University  
Of  
Sheffield.

# UK Nuclear New Build

- Government has authorised 8 sites for new nuclear power stations.
- If all stations go ahead they will provide 16GWe an investment of £40 billion.
- Huge opportunity for UK manufacturing supply chain.



# Nuclear AMRC Work Programmes

## Business Support Programme

- Aimed at getting companies to market, developing their capability and cost-competitiveness and helping them succeed in the long-term

## Manufacturing Process R&D

- Aimed at ensuring that the UK nuclear manufacturing supply chain has the capability to compete on cost, quality and time to delivery in the civil nuclear market

## Training & Skills Development

- Aimed at ensuring that the nuclear manufacturing supply chain has the skills required to compete in the global civil nuclear market (Apprenticeships, CPD, etc. to PhD/Eng.D)

## Quality, Codes & Standards

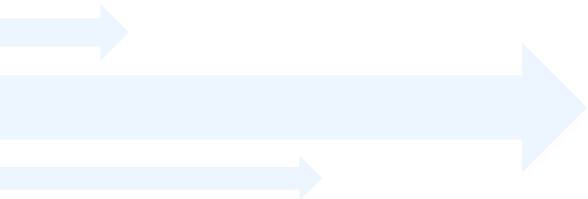
- Aimed at ensuring manufacturers have clarity and knowledge on quality requirements, nuclear codes and standards, and are supported in meeting and exceeding these



**NUCLEAR AMRC**

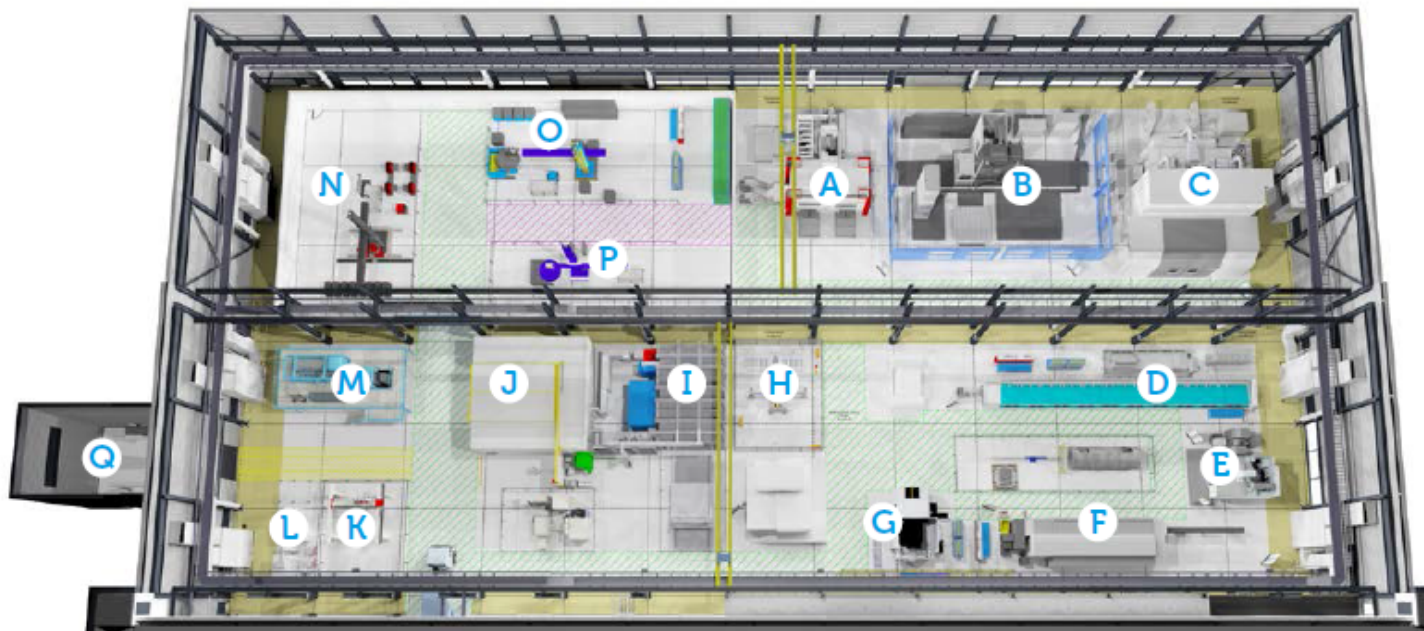
ADVANCED MANUFACTURING RESEARCH CENTRE

Manufacturing Process R&D



# Nuclear AMRC facilities

Infrastructure that may be beneficial to NPL



## Machining

- A Starrag HEC1800 PTM .....
- B Soraluce FX12000 .....
- C Dörries Contumat VTL .....
- D TBT ML700 .....
- E Hermle C60 U-MT .....
- F Mori Seiki NT6600 .....
- G Mazak Orbitec 20 .....
- H Robot machining .....

## Welding & cladding

- I Pro-Beam K2000 .....
- J Diode laser cell .....
- K Pro-Beam K25 .....
- L Additive manufacturing .....
- M Avure HIP .....
- N Lincoln five-wire SAW cell .....
- O ITW/Miller SAW cell .....
- P Polysoude GTAW cell .....

## Metrology & inspection

- Q CMM room .....



# Nuclear AMRC Core Technology Themes

Advanced Machining

Bulk additive Manufacturing

Electron Beam Manufacturing

Hot Isostatic Pressing

Integrated Manufacturing

Large Volume Metrology

Laser Beam Manufacturing

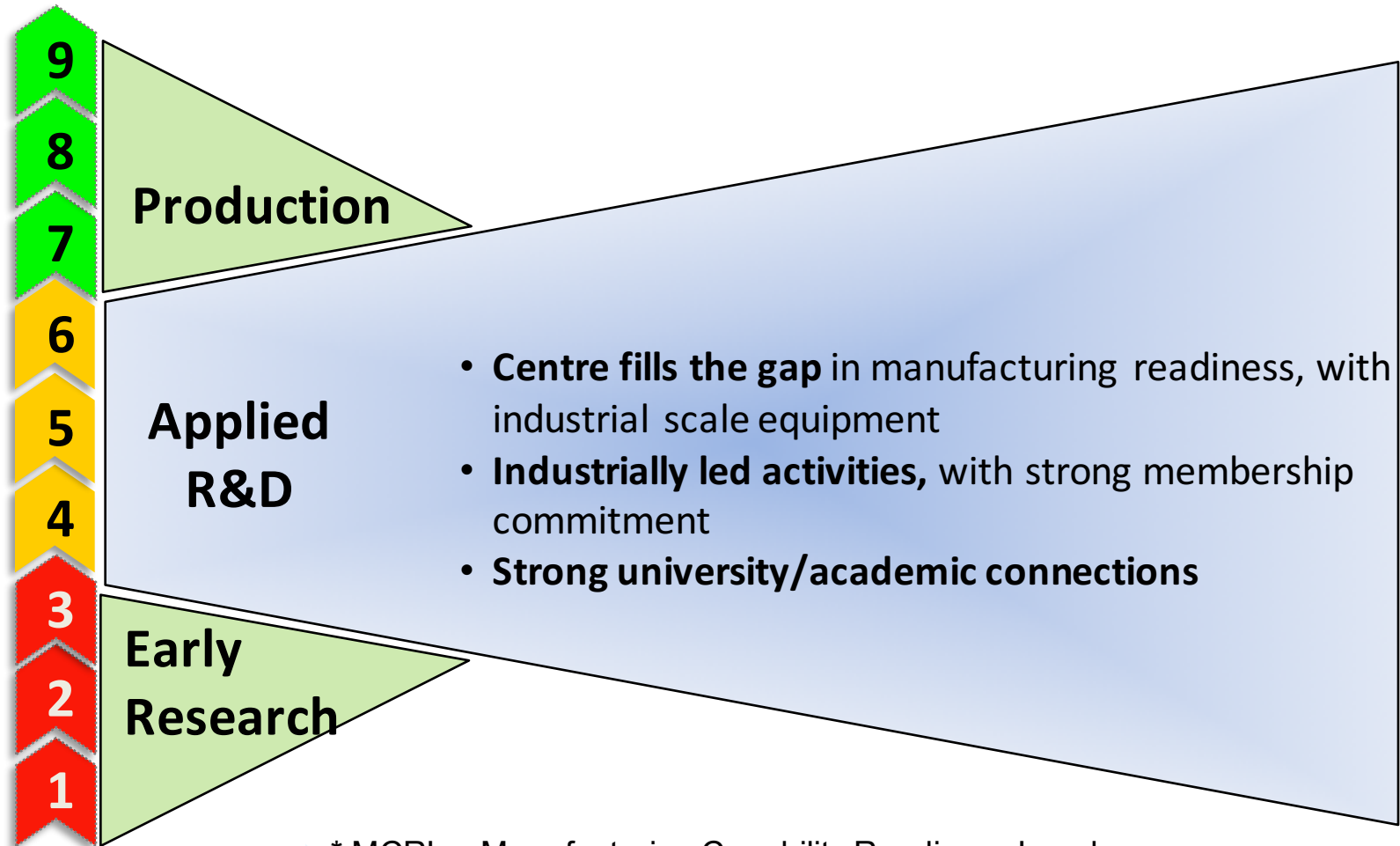
Mechanised Arc Welding

Virtual & Augmented Reality



# Manufacturing Capability Readiness Levels

MCRL\*



\* MCRL – Manufacturing Capability Readiness Level



# Unique, Large Scale Capability

Focused on providing the UK's heavy engineering, high value manufacturing sectors with industrial scale machining R&D capability.

Capability to manufacture parts up to:

- 12m x 5m x 5m
- 50 tonnes in weight
- 6,000m<sup>2</sup> shop floor

R&D facility for:

- Pre-production development
- Machining optimisation
- Cost reduction programmes



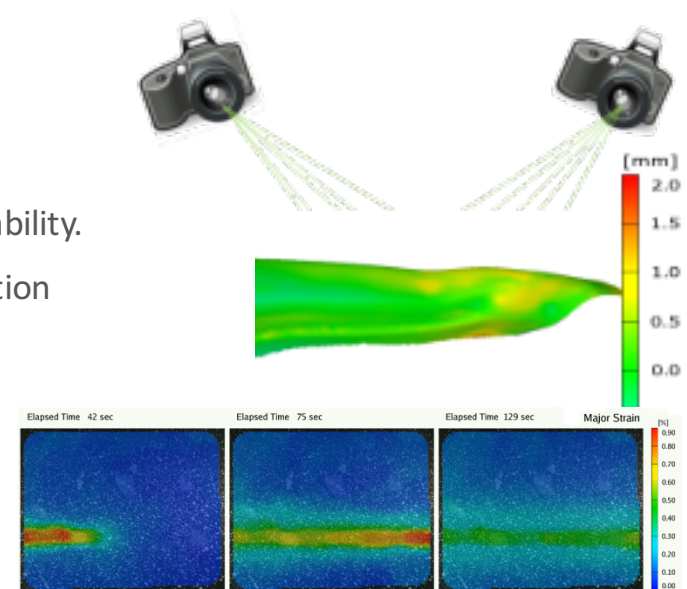
# Automated Photogrammetry for Inspection Applications in Harsh Environments

## Reason:

- Create a step change by using affordable consumer technologies for inspection.
- Provide a distinct competitive advantage for UK manufacturing.
- Establish Nuclear AMRC as a leading centre in the field of Non-contact optical inspection.

## Research required:

- Understanding of volumetric errors.
- Development effective and robust image processing software.
- How to establish the un-certainty of the technology.
- Develop operating procedures and standard to maintain repeatability.
- Automation Development – Potential for robotic or CNC integration
- Residual Stress applications
- Harsh environment: Underwater in machine/chamber.
- Robotic Calibration.



# Inspection of Large High Value Components In Process On a machine Tool Platform

## Reason:

- Create a step change for in-process inspection.
- Provide a distinct competitive advantage for UK manufacturing.
- Establish Nuclear AMRC as a leading centre in the field of CNC machine calibration and in-process inspection.

## Research required:

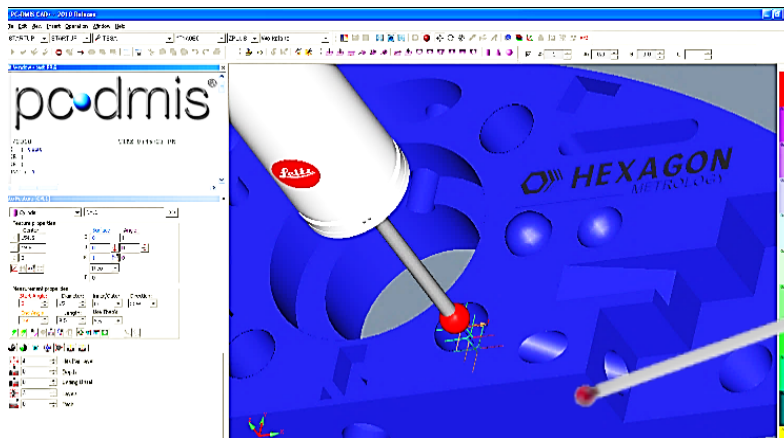
- Understanding of machine tool expansion and dynamic characteristics.
- Efficient and robust processes.
- Thermal monitoring, control and compensation in differing modes of operation.
- In process machine health check.
- Artefact comparison technologies.
- How to establish the un-certainty of a machine.



# Inspection of Large High Value Components In Process on a Machine Tool Platform

## Capability:

- Renishaw RMP60 and RMP600 probes
- Renishaw Sprint
- PC-DMIS Software interfaced



Soraluce FX1200 Working Volume Area of 300 m<sup>3</sup>



# Investigation of Structural Variations in Large Scale Machine Tools

## Reason:

- Determination of machine tool induced compliances in machining of large scale parts.
- Provide a predictive model to estimate the structural variations in large scale machine tools.
- Establish Nuclear AMRC as a leading centre in the large scale part manufacturing.

## Research required:

- Structural analysis and modelling of machine tools.
- Successful application of process models to estimate machining mechanics and dynamics.
- How to develop geometrical models of machine tool components.
- Utilising laser trackers as displacement sensor
- Error compensation

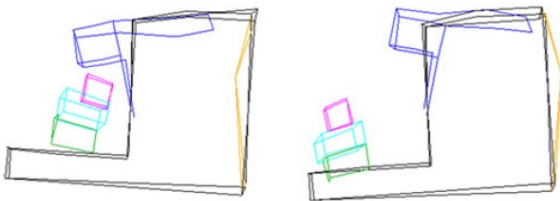
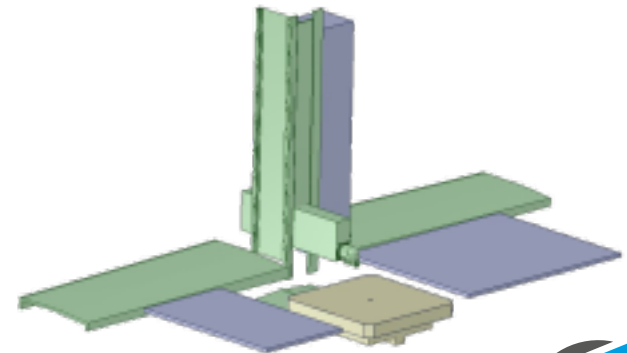
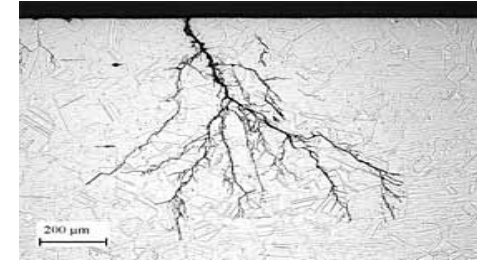


Fig. 3 Critical vibration mode with large relative displacement between tool and workpiece in a key-cutting machine



# Surface integrity

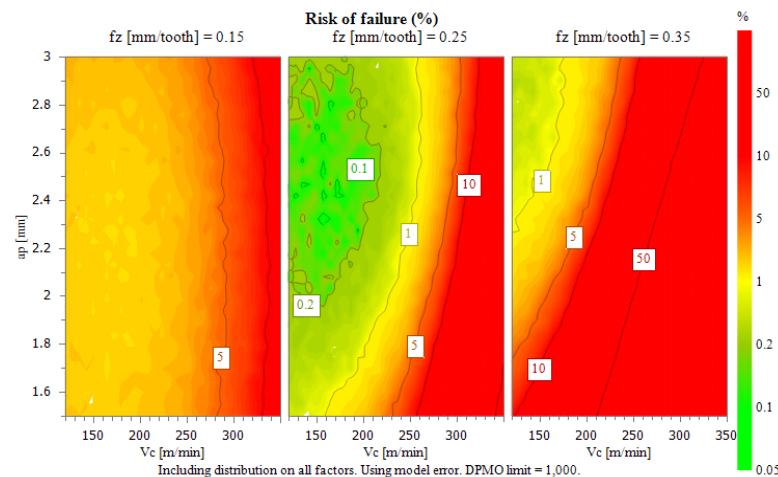
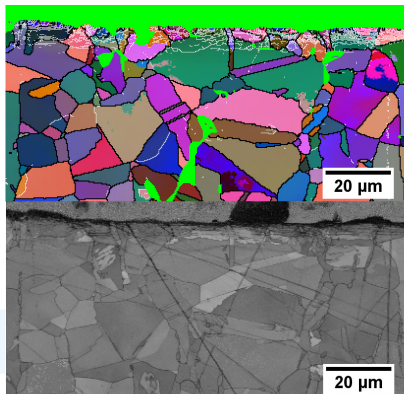


## Reason:

- Nuclear industry has a unique need for components required to have a long operative life while being subjected to an aggressive environment
- Expensive mission critical components need to meet strict inspection parameters or be scrapped

## Research required:

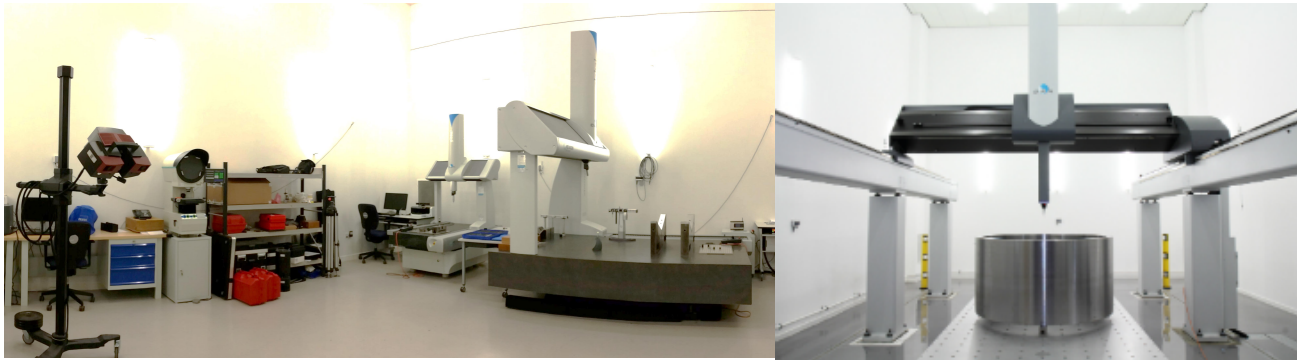
- Understanding the behavior of materials to different machining strategies and parameters
- Effects on surface quality, surface defects and residual stress
- Identification of coolant pressure, tool geometry, machine geometry and their effects on finished component performance
- Development of a machining maps to allow machinists to identify safe parameters resulting in defect-free finished surfaces



## Two temperature controlled facilities Total Floor Area of 80 m<sup>2</sup> typically 20°C ±1°C with humidity monitoring

### Equipment:

- Nuclear AMRC has an extensive range of metrology equipment
- Laser Tracker and Laser Radar
- Co-ordinate measuring machines
- Non-contact scanning structured light, photogrammetry and laser



# The AMRC Group



# High Value Manufacturing Catapult

**AFRC**

ADVANCED FORMING RESEARCH CENTRE  
UNIVERSITY OF STRATHCLYDE

**mtc**

Manufacturing  
Technology Centre



**NATIONAL  
COMPOSITES  
CENTRE**



**cpi**



**NUCLEAR AMRC**  
ADVANCED MANUFACTURING RESEARCH CENTRE

**CATAPULT**  
High Value Manufacturing



Advanced Manufacturing Research Centre



**WMG**  
Innovative Solutions



# Summary

Academic/industry hybrid

Nuclear AMRC's remit is to assist the UK's high value, heavy engineering manufactures.

State-of-the-art, large scale manufacturing and metrology.

The Centre has a national focus for development of the UK nuclear manufacturing supply chain.



# Thank You

