NATIONAL NUCLEAR LABORATORY

Overview of the National Nuclear Laboratory University Links

Dr Dominic Rhodes MBE
NNL University Co-ordinator

NNL – Part of HM Government

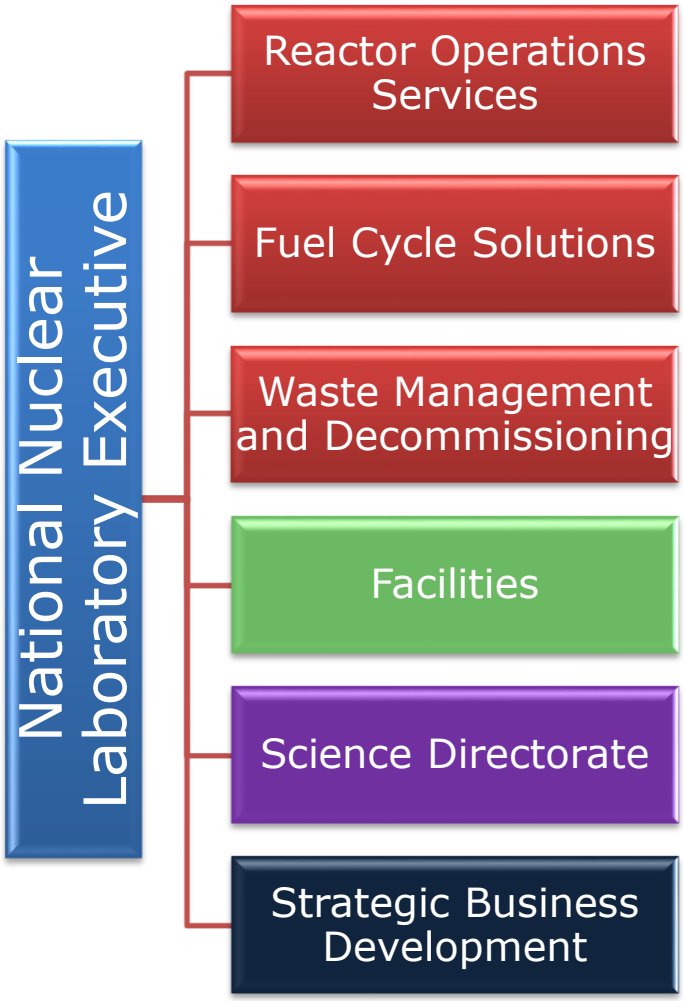
NNL is a Government Owned – Government Operated business

NNL can be the portal for overseas Customers / Governments to access the breath and depth of the UK Nuclear Industry

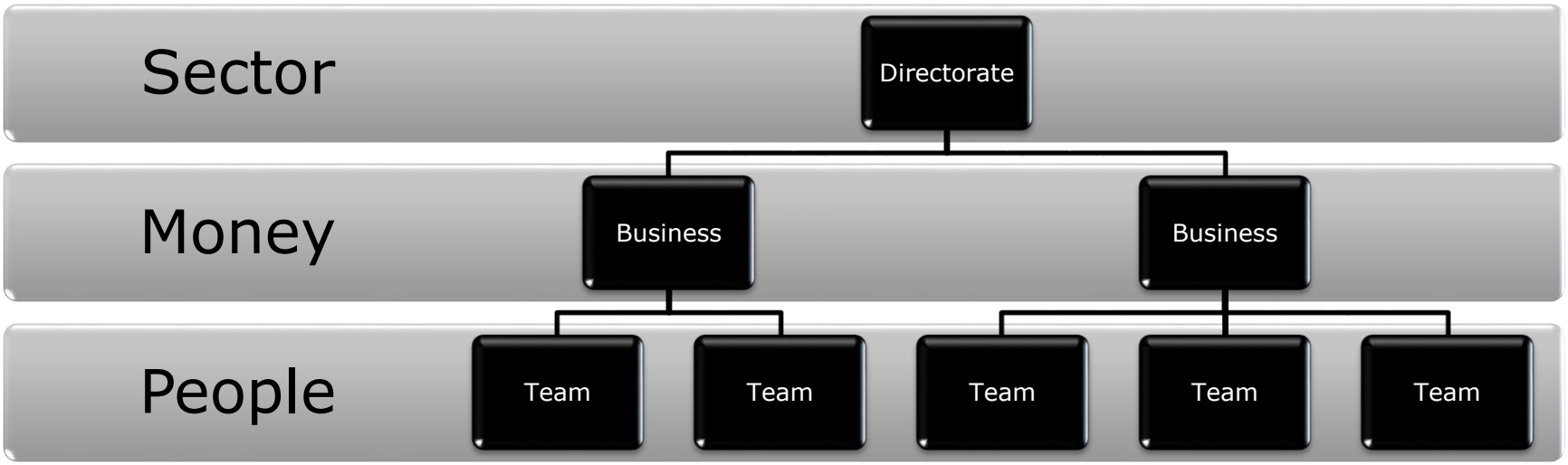
NNL provides independent, impartial advice to UK and overseas Governments

NNL and the UK Nuclear Industry seconds staff to many UK Government Departments and supports UKTI and British Embassies overseas

NNL Structure



Business Structure



Science and Technology

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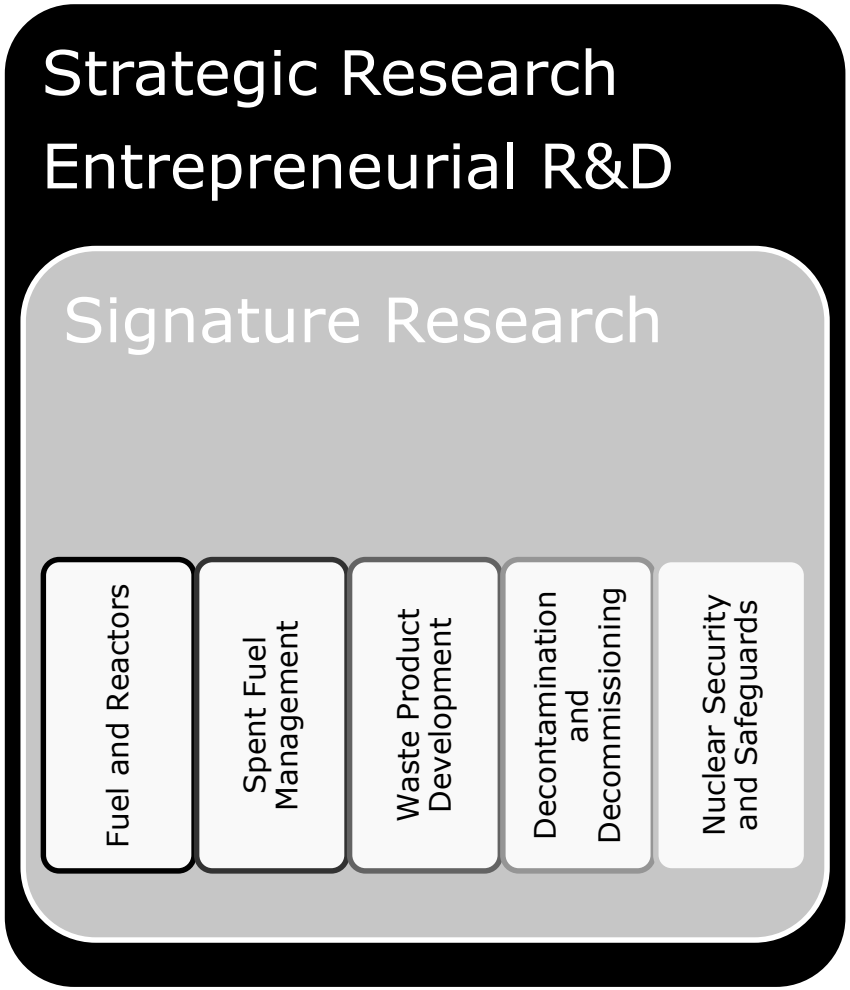

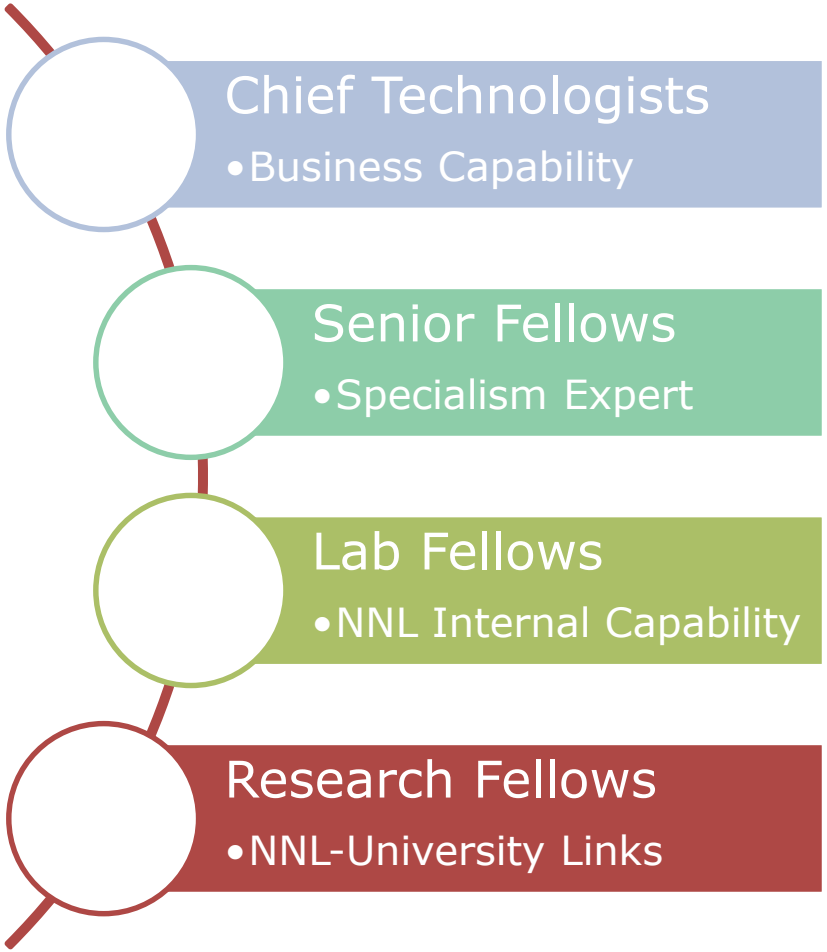

Research Fellows

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- 16x Subject Matter Experts
- Lead on University interactions
- Lead on European research programs
- Student access
- Papers / funding bids

University Interactions

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Strategic Universities

Examples of Universities with strong NNL links + 20 others …

- Over 130 PhDs supervised by NNL staff
- 60 visiting roles at Universities
- Senior Visiting Fellows appointed from key Universities

Subject Matter Expert Training

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- Residential training courses
- Targeted training
- Access to NNL facilities
- NSAN

National Nuclear User Facility
NNUF

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NNUF
National Nuclear User Facility

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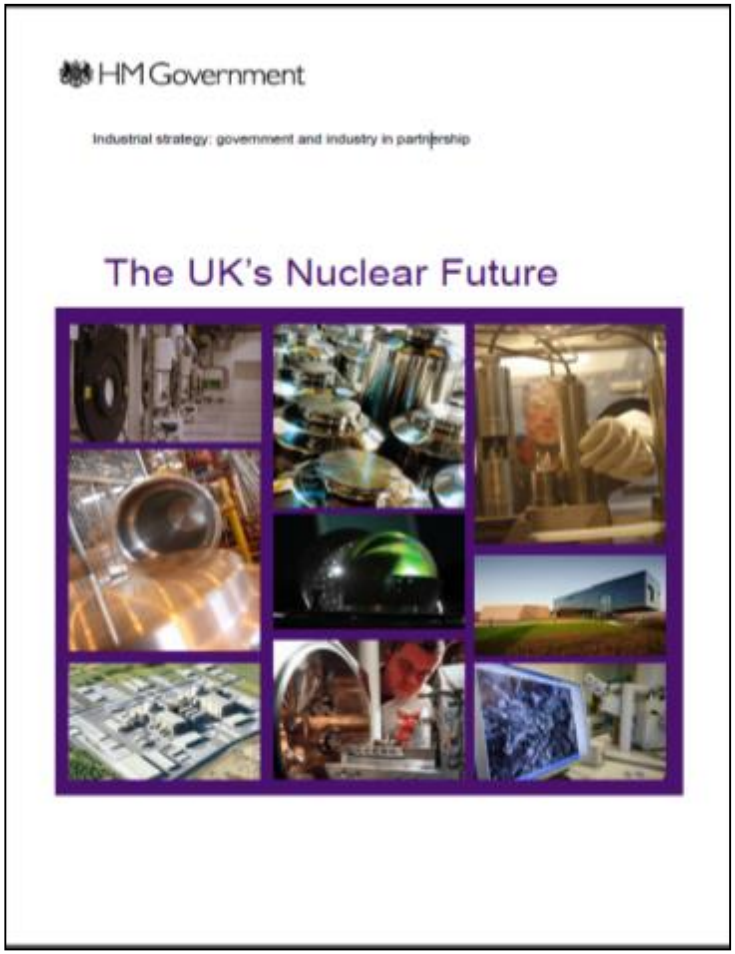
CCFE
CULHAM CENTRE FOR FUSION ENERGY

MANCHESTER 1824
The University of Manchester
Dalton Nuclear Institute

LANCASTER UNIVERSITY

UNIVERSITY OF LIVERPOOL



National Nuclear User Facility NNUF

- In its March 2013 Nuclear Industrial Strategy, Government announced the National Nuclear User Facility (NNUF) initiative
- A multi-site facility to give academia and industry access to experimental equipment for nuclear research on materials with greater radioactivity than can be handled in universities
- £15M over three years from 2012/13, from DECC and BIS via EPSRC. For facilities at the Central Laboratory of NNL, CCFE and the University of Manchester's Dalton Cumbrian Facility
- In late 2013 the ADRIANA nuclear instrumentation project was funded (DECC via EPSRC) - £1M at Lancaster, Liverpool and CCFE
- NNUF Management Committee: members presently from Imperial (R Grimes, chair), CCFE, Lancaster, Leeds, Manchester & DCF, NNL, Oxford. Plus EPSRC (observer)
- December 2014 £60M announced for next 6 years

Focused Ion Beam - 1

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- New FIB (FEI Helios) – allows targeted sampling and analysis of regions such as crack tips
- Used to prepare cross-sectional samples through cladding oxides
- Working to develop internal shielding to control the deposition of sputtered active material within the microscope

Focused Ion Beam - 2

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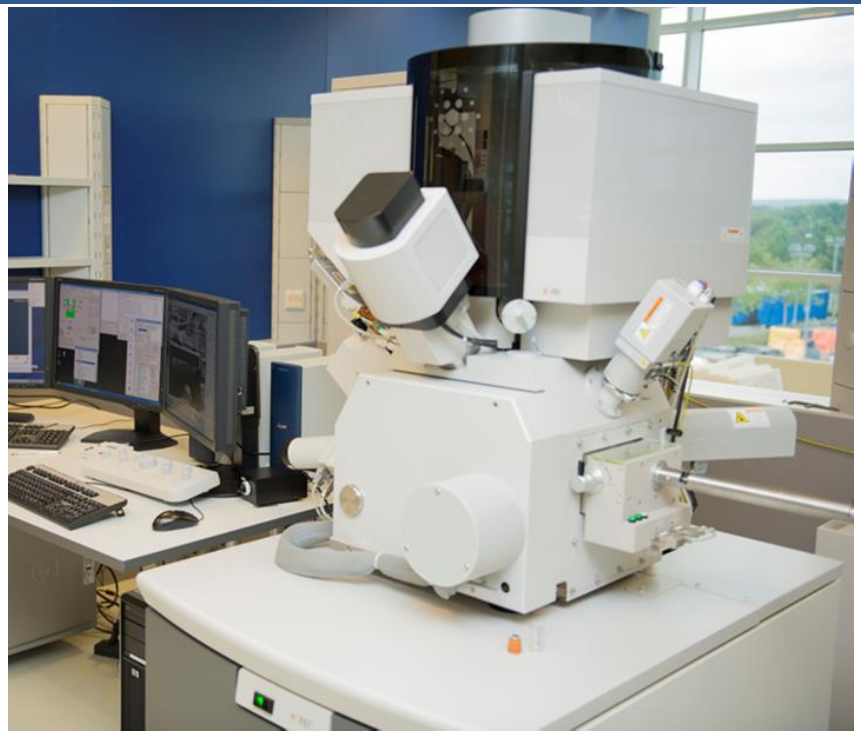
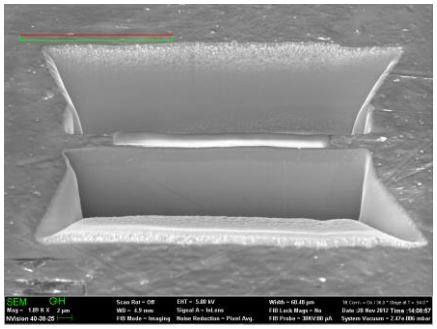
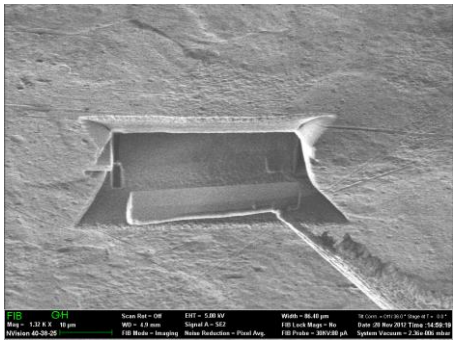
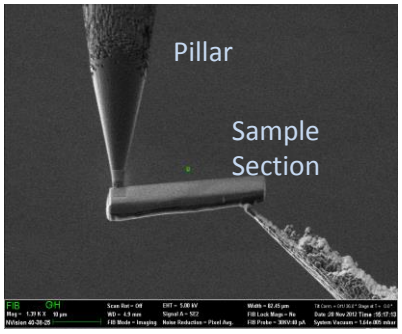
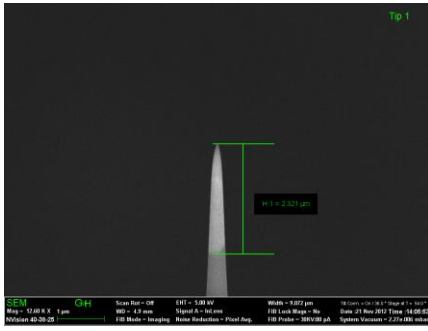
- FEI Helios
  - Airlock and sputtered material shields to mitigate use of active materials
  - EDX & EBSD
  - Trace active samples now
  - Full active commissioning 2015
  - TEM and APT sample prep











Transmission Electron Microscopy

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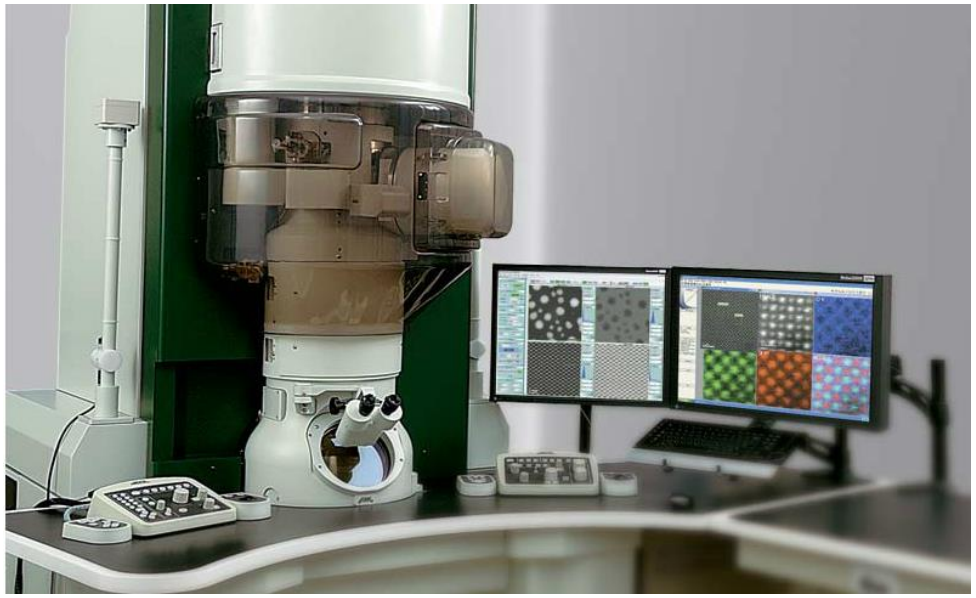
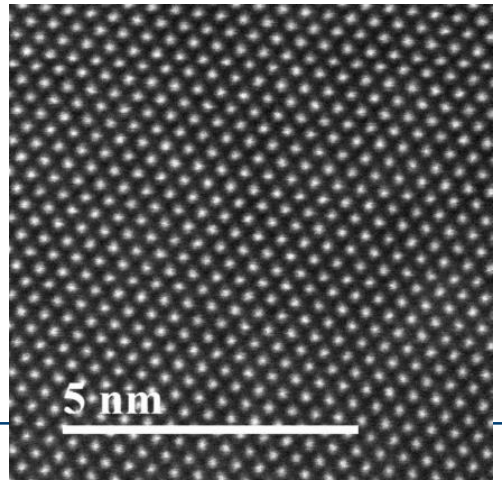
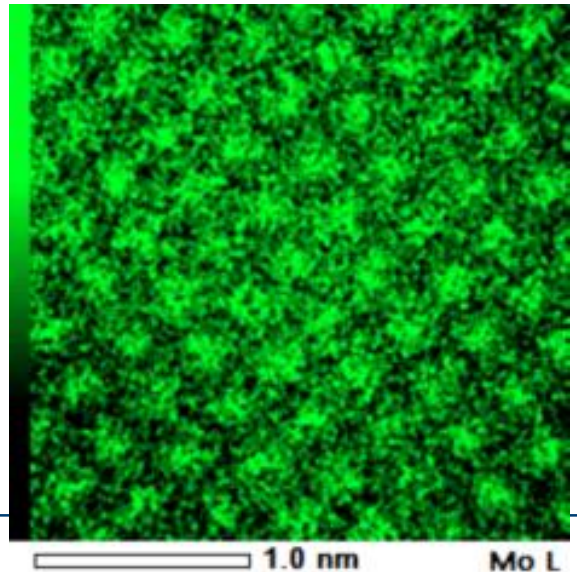
- JEOL 2100 fitted with 80mm^2 Oxford Instruments EDX detector
- Used to characterise phase precipitation in irradiated cladding
- Gatan Quantum EELS upgrade in progress
- Aberration-corrected TEM ordered to enable study of phenomena such as RIS and nano-scale precipitation

FEGTEM

- JEOL ARM200CF
  - Highest resolution analytical S/TEM
  - Atomic resolution composition mapping
  - 80pm probe size
  - 0.98Sr EDX detector
  - Gatan Quantum 965ER
  - Installation due mid 2016







FEG-TEM Analysis Examples

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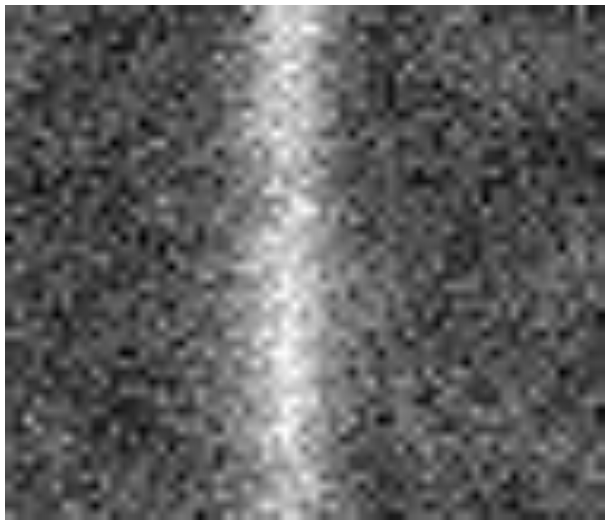
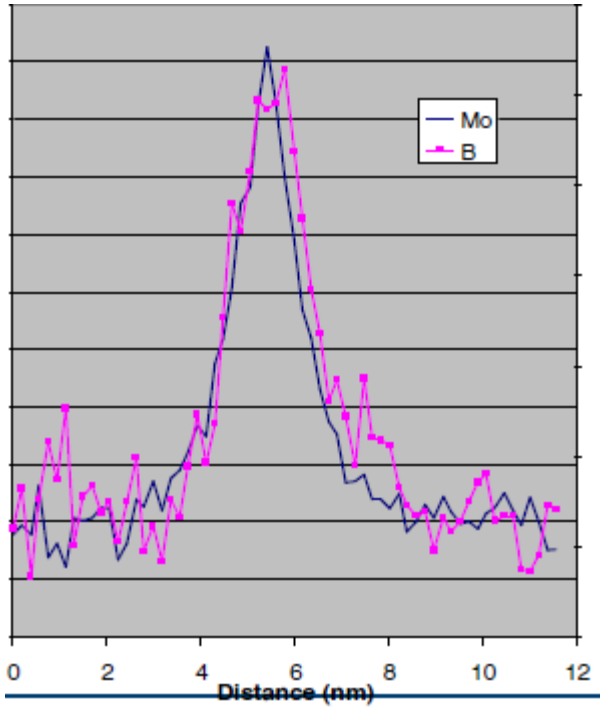
- High speed analysis – 3 to 4 mins. Grain boundary segregation in annealed 316 stainless steel





NNL – XMT

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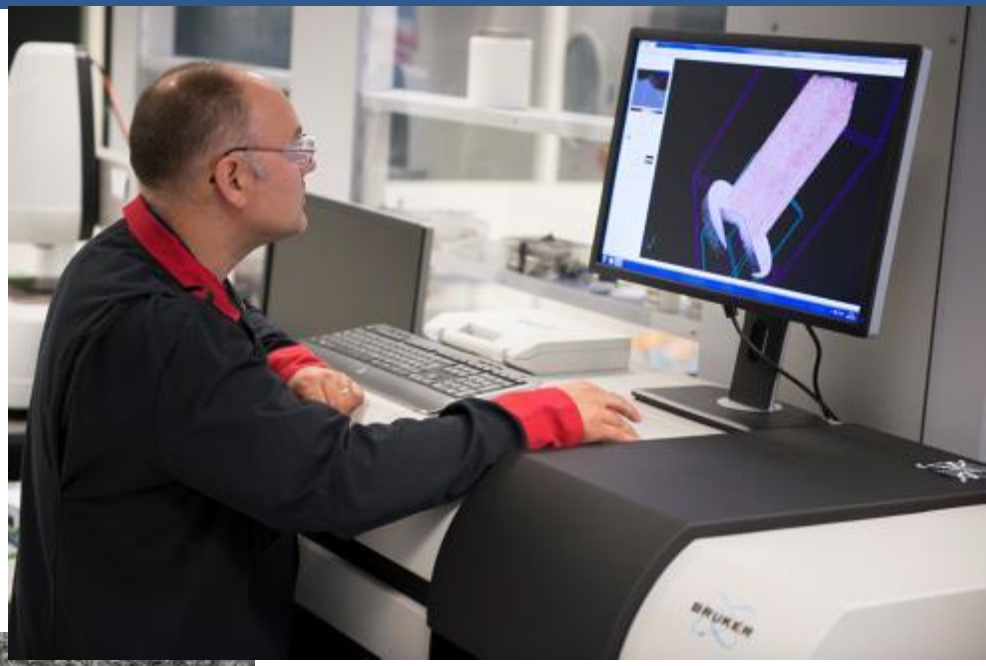
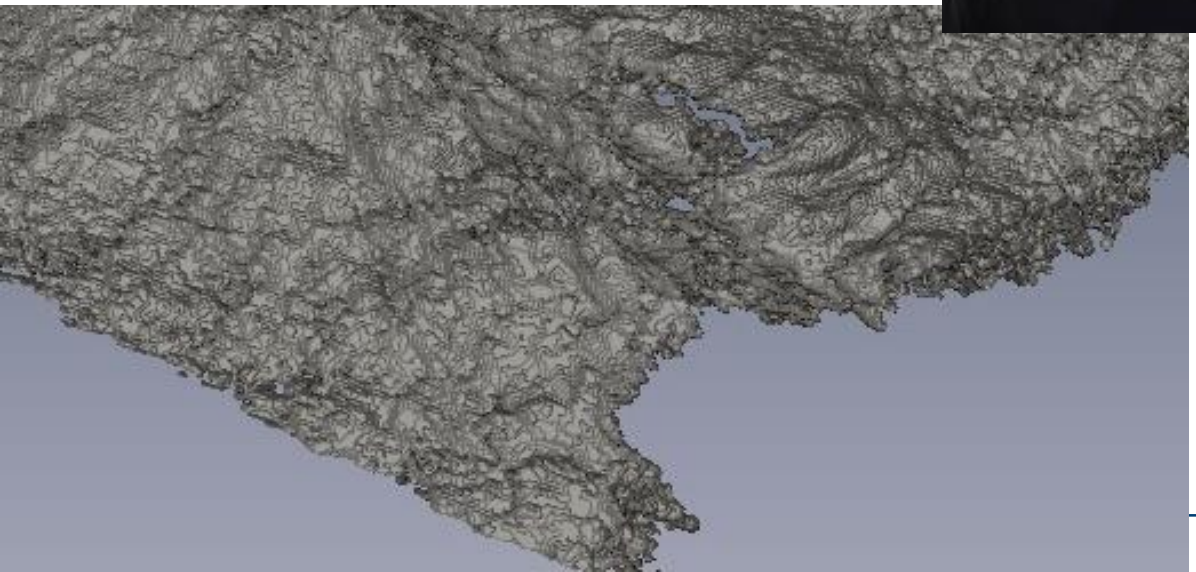
- X-ray Microtomography
  - Bruker Skyscan 1172
  - ~1µm voxel resolution
  - Installed and working in active lab
  - Up to 8000X8000 pixel images for each slice.
  - Resolution limit of ~0.8µm





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- Object sizes up to 27mm (or 50mm using multiple scans).
- Provides detail of internal structure non-destructively including quantitative measurements of porosity
- Provides measurement of relative density
- Initial work on graphite and carbonaceous materials

Access to NNL Facilities

- National Nuclear User Facility (NNUF) website links to NNL website

www.nnuf.ac.uk

• The NNL access to facilities / NNL NNUF contact is:
dominic.rhodes@nnl.co.uk


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