

University of Nottingham

MRI: National Facility for Ultra-High Field MRI

Professor Richard Bowtell Sir Peter Mansfield Imaging Centre University of Nottingham

Magnetic Resonance Imaging (MRI)



Uses strong magnetic fields and radio waves.

Signals from atomic nuclei (mainly hydrogen).

Globally used in ~60 million medical examinations per annum.

Invented in East Midlands.





Sir Peter Mansfield

University of Nottingham, Department of Physics, 1978



Sir Peter Mansfield

Sir Peter Mansfield Imaging Centre



Magnetic Resonance Centre, 1991





Sir Peter Mansfield Magnetic Resonance Centre, 2004

Nobel Prize for Physiology or Medicine, 2003

Sir Peter Mansfield Imaging Centre

19 Academic Staff 40 Postdoctoral Research Fellows 50 PhD Students >100 Members & Associate Members

Strong links to the NIHR Nottingham Biomedical Research Centre and the Versus Arthritis Pain Centre. At the heart of the Beacon of Excellence in Imaging in Precision Medicine.

Lead the **UK7T Network** which brings together seven UK sites with 7T scanners, and the **UK Renal Imaging Network**. Helped form the **Midlands Medical Imaging Network**.



Sir Peter Mansfield Imaging Centre



SPMIC:UP 3T MRI (Philips) 3T Wide-Bore MRI (Philips) 7T MRI (Philips)

Field Camera/Optical Camera 275 Channel Real-time MEG EEG facilities HP Gas Imaging (Kr & Xe) DNP MAS Facility OPM MEG

04/11/21





SPMIC:QMC

1.5T MRI(GE) 3T MRI (GE Premier) Vertical 0.5T MRI (Paramed) Clinical DNP (GE) HP Gas Imaging (Xe) Mock Scanner



National Facility for UHF Scanning



Magnetic Field of MRI Scanners



Earth's field = 0.00005 T

Moser et al ,. Frontiers in Physics, 2017. 5.

Signal to Noise Ratio Increases with Field



x 4 gain for 7 vs 3T

x 9.4 gain for 11.7 vs 3T

Signal to Noise Ratio Increases with Field



Higher Spatial Resolution





7T Scanner







90 cm bore30 tonnes3.3 m long430 km wire78 MJ stored energy





7T MRI



Parkinson's Disease – Nigrosome



Normal Volunteer

PD patient

Blazejewska et al. Neurology 81, 6, 534-540, 2013



7T MRI





Sanchez-Panchuelo et al. Journal of Neuroscience 32, 45, 15815-15822, 2012



UK7T Network





Cambridge Cardiff Glasgow Oxford Nottingham

London (St Thomas') London (Queen Square)



11.7T MRI Scanner





11.7T MRI Scanner

This can provide:

- Assessment of brain function at a mesoscopic level
- Anatomical images with histological detail
- Unique measures of organ metabolism
- A platform for developing new technology and methodology for MRI.



Dumoulin et al, NeuroImage 168 (2018) 345-357



Deuterium metabolic imaging (DMI). De Feyter et al. SCIENCE ADVANCES 4 eaat7314 2018



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AHEAD OF THE FIELD

SUPERCONDUCTING MAGNETS

tesla

MAGNET DIVISION

Tesla designs and manufactures superconducting magnets



Custom-built RF Coils for Ultra-high Field MRI



National Facility for UHF (11.7T) Human Scanning

National facility would provide a platform for world-leading neuroscience-focused and clinical studies attracting talent and investment.

This potential £29m programme is a joint initiative with MRC and EPSRC and has been ranked as a high priority in the UKRI Infrastructure Roadmap.





The UK's research and innovation infrastructure: opportunities to grow our capability





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Nottingham's History in New Scanner Technology

1978 First whole-body (0.1T) MRI scanner

1986 Built 0.5T scanner with first active shielded gradients.

1991 Built UK/world first 3T scanner

2005 UK's first 7T scanner; first 7T Philips scanner installed in Europe

2016 UK7T Network (Lead MRC Partnership Grant)

2018 First wearable MEG scanner (<1nT)





Commercialisation of Wearable MEG Scanner

University of Nottingham spinout company Cerca was formed in partnership with UK company Magnetic Shields Limited in 2020.

Cerca currently has eight orders (£1.5M) for research equipment from five institutions, based in Canada, USA and UK.

Cerca also has a pipeline of £92M of open quotations to leading neurological research centres.





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Thanks for your attention.