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STFC key in enabling today's high-resolution MRI scanners

High-resolution Magnetic Resonance Imaging (MRI) scanners have a crucial role in medical diagnosis, providing vital information on the human body that improves success rates of surgery and saves lives. There are more than 32,000 MRI instruments world-wide[1], and the sector grows continuously year-on-year[2]. For example, the number of MRI scans performed by the NHS in England has increased by 170,000 on average a year since 2015, reaching 3.74 million scans in 2019[3]. STFC played a major role in enabling today's high-resolution MRI scanners, which are the result of over 70 years of research. This is a key example of how fundamental research can contribute significantly to socio-economic benefits, but can take a long time to be realised.

Medical benefits

There are significant impacts arising from MRI diagnostics capabilities. For example, MRI increases cancer detection rates and reduces NHS costs with the following estimates highlighting some of the value of this activity[4]:

• MRI is more than twice as effective as X-rays at detecting breast cancer in women classified as 'high genetic risk'. MRI also does not come with the health risks of X-ray exposure.

• MRI has improved the success rate of spinal surgery, saving the UK economy £166 million in lost output, absence management and healthcare costs.

• MRI supported diagnosis and treatment planning has reduced the numbers of limb amputations in primary bone cancer cases, leading to NHS cost savings of £5 million to £10 million each year.

Early developments

MRI scanners use superconducting magnets to capture diagnostic images. Superconducting magnets were first developed at STFC for use in particle accelerators, such as the Large Hadron Collider at CERN. The 'Rutherford Cable', a thin filament developed in collaboration with IMI Titanium Ltd around 1970, has formed the basis of all superconducting magnet technology. Research has continued in this area at STFC in the subsequent decades, playing an important role in understanding superconductivity. The ISIS facility has been at the centre of this research, and was used to provide direct evidence of the strong connection of superconductivity with magnetism. ISIS also determined the crystal structure of the first high-temperature superconducting material. This has opened up applications of global significance such as high performance smart grids, power storage and magnetic levitation devices.

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1. Calculated from OECD 'MRI instruments per million' and 'population' data sets
2. https://www.fortunebusinessinsights.com/industry-reports/magnetic-resonance-imaging-mri-equipment-market-100087
3. https://www.england.nhs.uk/statistics/wp-content/uploads/sites/2/2019/12/Annual-Statistical-Release-2018-19-PDF-1.9MB.pdf, accessed 8/6/20.
4. The economic impact of physics research in the UK: Magnetic Resonance Imaging (MRI) Scanners. Oxford Economics. Nov 2012.

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Industrial partnerships

For the magnets to become superconducting, they need to be kept at very low (cryogenic) temperatures. The superconducting magnet technology, and the associated cryogenic expertise developed at STFC's Harwell Campus in Oxfordshire led to growth in commercial research, development and technology transfer, which still exists today. Key developments of the early technology were transferred to Oxford Instruments, the University of Oxford's first spin-out company. The strong collaboration between STFC and Oxford Instruments has now entered its 50th year. The success of this relationship led to a number of new cryogenic companies starting in the area, creating a national hub of specialist expertise[5]. The application of superconducting magnets to medical imaging played a significant role in the development of the innovative British Cryogenics Cluster in Oxfordshire and the surrounding areas; organisations within the cluster are principally industry partners, and many of them belong to the 105-strong corporate membership of the British Cryogenics Council.

Economic impact

The MRI industry contributed £111 million to UK GDP in 2010[6] and provides a multi-million pound market for UK companies. This supports 2,200 UK jobs in manufacturing and £137 million GVA, as well as savings to the UK economy of over £170 million per year, and this continues to grow. Tesla Engineering Ltd, a West Sussex-based company specialising in MRI components contributed £33M to UK GDP in 2019, up more than 200% in the past decade[7]. The global market for MRI systems was £4.60 billion in 2018 and is projected to reach £5.57 billion by 2023[8].

5. https://stfc.ukri.org/files/cryogenics-impact-report/ p12
6. The economic impact of physics research in the UK: Magnetic Resonance Imaging (MRI) Scanners. Oxford Economics. Nov 2012.
7. Data from financial records at Companies House (accessed 6/6/20), converted to 2019 prices using ONS method for GDP calculation. Presented in 2019 prices.
8. https://www.marketsandmarkets.com/Market-Reports/magnetic-resonance-imaging-market-99.html converted to GBP on 8/6/20 at xe.com/ucc (USD/GBP: 0.78564)