Business Case for 3T MRI Scanner

Executive Summary

This retrospective business case is to acquire a new 3 Tesla (3T) magnetic resonance imaging (MRI) scanner for £1.1m, £0.6m is funded by National Institute of Health and Research (NIHR) and the remainder is match funded from the University. **The £0.6m NIHR funding has been confirmed, and the University match funding has been approved at Capital Planning Sub-Committee (CPSC) on 31 January 2012.**

The University currently has one 3T scanner located at Hope Hospital, and two 1.5T scanners at Wolfson MIC (WMIC) and Wellcome Trust CRF (WTCRF). The two 1.5T scanners are not running at full capacity, whereas the 3T scanner at Hope is running at full capacity (operated 6 days a week) and there is unmet additional demand.

The proposal is to replace the existing 1.5T scanner at WTCRF with the new 3T scanner. There will be a need for some enabling works, a one-off cost of around £0.2m.

No new incremental annual maintenance costs will be incurred as they will remain at the existing rate of £76k. Similarly, the existing technicians (Radiographers) will operate the new scanner and there will be no need for additional staffing requirements, unless demand for scanning increases significantly beyond projection. In that case there would be a clear business reason to employ another radiographer.

The loss of the 1.5T scanner at WTRCF will result in increased usage of the 1.5T scanner at WMIC. Some minor enabling works at WMIC may be required to cope with the increased patient volume.

The new 3T scanner will allow the University to further exploit the 3T scanning market and will increase the levels of success in attaining new research grants. If we are to maintain our current position amongst our research peers (let alone improve our standing) then we need to be active in development of the resources available.

The research activity in the area will be monitored and reviewed on an on-going basis. After two years, a review of the income generated will be performed. If the results are strong, then a potential upgrade will be considered, this is likely to cost approximately £0.4m.

Background & Assessment of Need

Biomedical imaging, particularly human imaging in clinical research has been a strategic priority for the University since well before the merger. Investment from the University, MRC and industry has resulted in the establishment of the Wolfson Molecular Imaging Centre (WMIC) with world leading facilities for radiochemistry and positron emission tomography (PET), and the provision of three research-dedicated MRI scanners at Hope Hospital, the Wellcome Trust Clinical Research Facility (WTCRF) and WMIC. We have an enviable mix of leading methodological development and numerous high impact areas of application - a mix that is not matched by any other UK centre. Our activities span basic and clinical research in neuroscience, oncology, musculoskeletal medicine, cardiovascular medicine, pulmonary medicine, and fetal and maternal health. This is underpinned by expertise in MR physics, mathematics and computer science, all of which enhance the competitiveness of MR-related biomedical science and have a substantial impact in their own right. These activities are funded from a healthy mix of research council, charity and industrial sources, backed up by a highly enabling approach to internal pump priming and support for MRI within studentships.

This reach has been achieved through giving our researchers access to state-of-the-art equipment and through continued development and refinement of new techniques. This has given researchers the opportunity to use the latest techniques, essential if high quality publications and competitive grants are to be generated. We are now in the position that this technical pre-eminence is under threat because of the age of our scanners at Hope (3T, 8 years) and WTCRF (1.5T, 10 years). It is important for our work that we have access to the latest developments and good support from the manufacturer. As manufacturers only support us because of the benefits it brings them in terms of new sales, we only retain that support if we run a state-of-the-art platform. If we get a new high specification 3T scanner at WTCRF that can carry out the most demanding work, we will retain good manufacturer support and have access to the latest techniques. The 3T at Hope could then be maintained for another 5 years. The WMIC scanner is 4 years old so upgrade/replacement is a long way off (5-7 years).

The future of scanning is being defined by a greater need for 3T scanning facilities. 61% of the scanning income generated by the 3 scanners relates to work on the 3T. 3T represents the field strength of choice in a range of application areas, most importantly neuroscience, musculoskeletal and cardiovascular research. There is a clear need to acquire a new state-of-the-art 3T MR Scanner in order to remain in the vanguard of such a high profile and potentially lucrative sector. The current 3T scanner in Hope Hospital is operating at optimum capacity and is being fully utilised. This will restrict our ability to carry out scanning in a timely manner on recently awarded grants (e.g. Wellcome Trust, Montaldi and MRC, Lambon-Ralph) and may result in Manchester researchers choosing to use alternative centres for their scanning research.

As a result of the amount of scanning by funded studies we cannot undertake as much as development work on the 3T scanner as there is demand for. In contrast the two 1.5T scanners work at about 50% capacity. By replacing the 1.5T at WTCRF with a 3T we will meet all the demand for 3T scanning, free up development time and also be able to shift some current 1.5T scanning to 3T. The remaining 1.5T demand can then be met by the WMIC scanner, which will operate more efficiently.

Benefits

Values

This project lies at the heart of the core values of the University:

- Scholarship and research excellence in medical and biological science, and physics, mathematical and computer sciences and other contributing disciplines;
- Outstanding education to inspire and empower the next generation of medical researchers;
- Effective organisation to enable collaborating disciplines to work together synergistically and for the benefit of society;
- Effective communication of our work to influence society;
- An environment where all members of the University are able to take of advantage of state-of-the-art facilities.

Reputational benefits

It will maintain our reputation nationally as a leading imaging centre. The 3T scanner at Hope was the first installation by Philips of their then latest model and at that time we were one of only a very few universities with two research-dedicated MRI scanners. It is highly likely that we will be the only single site University with two research-dedicated 3T scanners if the new 3T purchase is approved. We are also almost unique in having research imaging activity across all clinical specialities. Probably only Imperial College do the range of cancer, cardiac, neuro and body imaging research that we do.

Synergy & efficiency benefits

The location of the new scanner will be the space utilised by the existing 1.5T scanner in the WTCRF. Many neuroscience imaging studies involve neuropsychology testing that, due to specific equipment and testing booths, needs to be done on campus. This entails organisation of separate visits for volunteers if the appropriate scanning facilities (3T) are at a distance, as they are now. Pharmacological scanning studies often involve long periods of waiting for drug absorption and recovery during which there is little opportunity to carry out other work. An on-site facility would increase productivity in this respect. In addition, cumbersome testing equipment often has to be transported to Salford for use during scanning. Time spent travelling to and from Salford is costly in terms of productivity. Many volunteers for studies involving MRI are University staff and students and it is noted that recruitment and attendance is reduced when scanning is in Salford. Patients often have difficulties finding the scanner to the extent that researchers need to man the hospital entrance and guide them to the scanning suite. A scanner on campus would be much more practical and a much better experience for many of our volunteers and researchers involving less transport.

Financial Summary

The proposal is to purchase the scanner from Philips Healthcare; the quote is £1.1m. This will be offset by £0.1m trade-in for the 1.5T scanner that is being replaced.

	£m
Purchase price of 3T scanner	1.1
Enabling works	0.2
NIHR funding	(0.6)
Sale of 1.5T scanner	(0.1)
Net cost to University	0.6

The cost of the enabling works has been estimated internally by Estates, and the £0.6m funding from NIHR has been confirmed. Net cost to the University is £0.6m.

Income and expenditure

There is no change to annual running costs because this is a replacement of an existing scanner. Annual maintenance costs will remain at £76k per annum and no additional technician support is required. The only additional annual charge will be the net depreciation at £0.1m per annum over 5 years.

It is assumed that income levels will increase by around 20% per annum across all sites. This is consistent with the increase of 3T income between 2009/10 and 2010/11. 3T income in 2010/11 was £0.4m.

Assuming income does increase at levels of around 20% each year, the additional income will cover the net additional depreciation cost. The financial risk is that the additional demand does not take place and the £0.6m cost of the scanner is not recovered through additional work. Given that the existing 3T scanner is at full capacity and there is unmet demand, this is unlikely.

Risk Analysis

Risk	Likelihood (High/Low/Medium)	Mitigating Factors
Additional Research Grant income is not achieved	Medium	Even maintaining current levels of funded activity will lead to increased scanning as we are currently capacity-limited for 3T scanning
Increase in successful grant applications is not fulfilled	Medium	In last six months the University has successfully been awarded grants that demand substantial 3T scanner capabilities (Montaldi Welcome Trust Programme & Lambon–Ralph MRC Grant)
Additional 3T work may not materialise as anticipated	Low	There is current unmet need for development time

APPENDICES

Appendix 1:Pros & Cons

Case Outline	Pros	Cons
Purchase New 3T scanner	• Imaging facilities would have investment to build upon and cater for unmet demands • This would reduce the reliance on one 3T scanner that is being fully utilised • Easier to accommodate new imaging studies that require 3T scanning • Centre would have state-of-the-art technology • Increased income awards from Research Councils • High level of positive publicity for University • High level of goodwill from external stakeholders within region and UK as a whole • Opportunities to showcase research at WTCRF and elsewhere in University • WTCRF maintains its ability to offer state-of-the-art scanning • The 1.5T scanner at WTCRF is sold. All 1.5T scanning work is picked up by the 1.5T scanner at WMIC • One third of the cost base is removed and the portfolio is run more efficiently	• The investment is expensive • There is no sure-fire guarantee that the new scanner will generate significant additional income or allow the University to be successful in research grant applications • Disruption during installation of new scanner

Appendix 2: Current MRI research in Manchester University

Neuro MRI

Neuroimaging methods, particularly functional MRI (fMRI), facilitate the convergence between neuroscience, social science and clinical science. Understanding the cognitive, emotional and social aspects of the healthy human mind subsequently enables the understanding of neuropsychological and neurological conditions. Probing the metabolic, physiological and structural consequences of disease allows better understanding of progression, aids diagnosis, and allows objective monitoring of response to therapy. The higher field strength of 3 Tesla (3T) enhances signal quality in a number of neuroimaging techniques including fMRI, diffusion imaging, high-resolution structural imaging, arterial spin labelling and spectroscopy. Of all the body areas studied using MRI it is generally agreed that the brain gains most from higher field strength scanners.

The University of Manchester has an excellent reputation in neuroimaging research, with active PIs including Allan, Anderson, Burns, Deakin, Elliot, Hamdy, Herholz, Jones, Lambon Ralph, Mayes, Montaldi, Parker, Parkes, Talbot, Tyrell, Williams, Zahn. At the international Human Brain Mapping conference in 2010, Manchester had 28 presentations, nearly 1% of the entire conference. Although significant aspects of clinical neuroscience in Manchester are based in Salford (the location of the current 3T scanner), the majority of researchers who contribute to this high level of activity are based on the central University campus. A more accessible 3T facility on campus would therefore help to further establish Manchester as a leading centre for neuroimaging.

Cardiovascular MRI

Unlike many areas of MRI application, cardiac MRI has not been historically strong in Manchester. This situation has recently begun to change, with a number of cardiac imaging projects underway and in preparation. Matthias Schmitt (Cardiology, South Manchester) has taken on the role of cardiac imaging lead for the Biomedical Imaging Institute and at the same time has helped bootstrap Manchester's MRI research activity in this area. Current projects include cardiac perfusion work under an NIHR Clinical Fellowship (Chris Miller, Supervisors Schmitt, Parker, Naish), and measurements of cardiac toxicity associated with cancer therapies (Jackson, Radford, Schmitt). In addition to such research activity, Central Manchester Trust purchases scan time on the WTCRF 1.5T scanner for clinical purposes.

Until quite recently, cardiac imaging at 1.5T was generally judged to be superior to 3T due to general difficulties in thoracic imaging at higher field strength. However, mainly due to immense investment by the major scanner manufacturers this situation has recently changed, with 3T now being the field strength of choice for cardiac MRI research. Simon Ray, MAHSC Clinical Academic Section Lead for Cardiovascular has stated, "So much of clinical cardiology research is dependent on advanced imaging that MAHSC will not be able to compete in this field without the further development of a dedicated cardiac MR facility (including 3T) co-located with high volume clinical cardiology and backed up by the physics expertise of the BII." While a 3T located in WTCRF would not be quite the cardiac-devoted facility that we wish for in time in Manchester, it would provide an excellent resource for cardiovascular imaging research that goes well beyond the capabilities of our current hardware.

Fetal and pediatric MRI

Until very recently it was the case that fetal research MRI could be performed at 1.5T but that 3T was generally considered to be 'too high' a field strength for the foetus to safely tolerate. This point of view was based on the principle that maximum caution is needed when studying the foetus but was not based on any evidence that 3T was any more likely to cause harm to the foetus than 1.5T (which is considered very safe). In recent years this attitude has changed, with a number of centres around Europe now performing fetal research MRI at 3T, including recently Edinburgh. Concerns that had existed around tissue heating or loud noise during scanning procedures at 3T have been met by the development of low power, quiet scanning procedures and no evidence has been forthcoming of any likely health risk. The change of general opinion and the lack of any ethical impediment to scanning at 3T now opens up new opportunities for research at 3T, which will be to the benefit of the Fetal and Maternal Health group based on the central campus, who have recently been active in developing novel MR imaging for understanding placental function in intrauterine growth restriction (Sibley, Johnstone, Parker, Naish).

Pediatric imaging is an area of great potential in Manchester. Recent studies have been performed on neonatal brain development (Victor, Parkes, Parker) but we have an excellent opportunity to do far more. The provision of a research-dedicated 3T scanner close to St Mary's provides clear research potential that could translate into significant new activity.

Musculoskeletal MRI

Manchester has a long history of imaging research in musculoskeletal conditions, including the study of joints in osteo and rheumatoid arthritis, SLE, studies of perfusion, reinnervation and fat composition (Bruce, Cootes, Felson, Williams, Waterton, Taylor). Many of the patients recruited for these studies are recruited from within the Central Trust, and the WTCRF provides human performance facilities that are of great use in studying these patients. 3T is generally accepted as being of importance for joint imaging as it allows greater spatial resolution in studies of cartilage. The provision of 3T within WTCRF would therefore provide the appropriate co-localisation of patients, researchers and facilities to maximise research activity in this area. The recent announcement of GSK and AstraZeneca's partnership with the University to create the Manchester Collaborative Centre for Inflammation Research will further increase this activity as rheumatoid arthritis research is expected to undergo a substantial boost.

Cancer MRI

Manchester researchers have played a leading role in the development of MRI methods for cancer research. In particular, much of the development of dynamic contrast-enhanced MRI (DCE-MRI) has occurred in Manchester (Jackson, Parker, Waterton), as has its application in the study of antiangiogenic and antivascular therapies (Jayson, Clarke, O'Connor). Manchester is also developing a reputation for the use of MRI to measure tumour oxygenation and hypoxia (Jackson, Naish, O'Connor, Parker, Waterton, West) and in the measurement of cell packing and proliferation indices (Jackson, Naish, Parker, Waterton).

Since its installation in early 2009, most cancer MRI has taken place on the 1.5T scanner in the WMIC building on the Christie/Paterson campus. Some brain tumour scanning takes place on the Salford 3T, partly for the convenience of patients and local clinical researchers but also because 3T is beneficial for brain imaging. Of all the areas of imaging activity, cancer imaging is probably the area currently

best served by Manchester's research MRI and will be least affected by the proposed installation of 3T in WTCRF on the central campus.

Lung MRI

Lung MRI is an important area of emerging activity in Manchester, with interest in the development and application of novel MRI methods in COPD and asthma (Naish, Niven, Parker, Singh, Vestbo). This work focuses on ventilation/perfusion (V/Q) mapping, microvascular function measurement using dynamic contrast-enhanced (DCE-MRI), and the measurement of lung compliance, and currently takes place on the WTCRF 1.5T scanner as it is best suited to lower field strengths. It is therefore likely that this activity will move without significant impact to the WMIC 1.5T scanner if the proposed 3T machine is installed in WTCRF.

New MRI methods

MRI is an invaluable tool in many areas of biomedical research and is at its most powerful when these applications are coupled with leading innovations in MRI technology and methods. Access to both the best equipment and novel data acquisition and processing methods provides unique research opportunities, which are an essential component in maintaining a leading research position. MRI research is also a fruitful research activity in its own right in Manchester.

Manchester has an excellent reputation for MRI methods research and for methodological imaging research in general. Advanced MRI-relevant methods such as active shape and appearance models (Cootes, Taylor), tractography (Parker), and dynamic contrast-enhanced MRI (Parker, Jackson) have either been invented in Manchester or have been heavily influenced by Manchester innovations. New opportunities abound, with strong methodological expertise not only generating new biomedical research capabilities, but also continuing to generate strong research outputs and grant income in its own right (examples including the 5-year UoM-AstraZeneca Strategic Alliance in Biomedical Imaging (Parker, Taylor, Williams, Jackson, Waterton)). Methodological innovation spans all areas of MRI application: Jackson, McKie, Parkes, Parker, Williams contribute to neuro MRI; Naish and Parker contribute to cardiac MRI; Naish and Parker contribute to fetal MRI; Cootes, Taylor, Waterton and Williams contribute to musculoskeletal MRI; Jackson, Naish, Parker, Waterton contribute to cancer MRI; Naish and Parker contribute to lung MRI. As is implied from this list, MRI methods development often leads to new generic capabilities that are of benefit to a wide range of disease areas.

Most of Manchester's MRI methods expertise is based on the central campus in the Stopford Building. The Imaging Science group (School of Cancer & Enabling Sciences) has faced challenges in recruiting good new staff due to the distance of this core group from the current 3T machine in Salford. The remote location of the current 3T is an everyday obstacle to researchers, who have to travel a number of miles across the city to make use of their main 'tool of their trade'. A new 3T in WTCRF would enhance the output of the group and facilitate the recruitment of high quality new PhD students, researchers and academic staff.