Commissioning and Testing of Split Coil MRI System for Combined PET-MR

N. R. Shaw[1], R. E. Ansorge[1], T. A. Carpenter[2]
[1]Cavendish Laboratory, University of Cambridge, Cambridge, United Kingdom, [2]Wolfson Brain Imaging Centre, University of Cambridge, Cambridge, United Kingdom

Introduction

Recent work has highlighted the advantages of combining imaging modalities, particularly the advent of combined PET-CT scanners (1). For many years though, progress has been slow in acquiring simultaneous structural information from MRI and functional information from positron emission tomography (PET). A collaboration between UCLA and UCL have constructed the only working example of combined PET and MRI, in which a small, single-ring PET detector is inserted into the bore of a conventional MR scanner (2). This approach introduces several compromises to the PET system, most notably that only a single 2D slice of activation can be imaged. Our approach has been to insert a state-of-the-art PET scanner into the gap of a specially designed 1T split coil MR magnet. This abstract describes recent progress of the commissioning and testing of the 1T split coil MR imaging system associated with this project, as well as outlining the design of the PET system.

Methods

Using our genetic algorithm based magnet design procedure (3), and in collaboration with Magnex Scientific (4), we have designed and built a 1T actively shielded split coil MR magnet with a room temperature radial gap of 8cm. A state-of-the-art micro PET system with extended light guides may be placed into the split between the two magnet halves as shown in Fig. 1. The homogeneity of the central region has been shown to be better than 1ppm in a 12cm diameter spherical volume after shimming and the fringe field drops rapidly, especially in a radial direction (5 gauss in 2.8m). A Bruker ABX console was used in combination with a custom built active shield gradient set (8cm access, 120mT/m) for initial studies. Samples up to 38mm are imaged using an eight rung birdcage resonator driven through a low-pass hybrid quadrature coupler. Smaller samples are imaged using a 13mm diameter linearly polarised solenoid for both transmission and reception.

Results

T2 weighted multi slice RARE MR images from both coils are shown in figure 2 (Kumquat, 256x256, FOV 5.1cm, SLTH 1.2mm, scan time 14 minutes, 38mm birdcage) and figure 3 (formalin fixed mouse brain, 256x256, FOV 2.56cm, SLTH 1.2mm, scan time 7 minutes, 13mm solenoid). In both cases excellent signal to noise and contrast are exhibited. The high signal intensity regions surrounding the mouse brain in figure 3 are from the preserving fluid, whilst the low signal intensities are from small plastic fixtures.

Discusion

The images demonstrate high-resolution MR imaging on 1T in preparation for combined PET-MR scanning. We will use a an array of surface coils placed over the animal head in vivo, which will further improve the signal to noise ratio. The PET module is currently being designed with 1.20m straight fibre bundles used to bring the light away from the high field region to the photo-multiplier tubes (PMTs). Data from the longer fibres show that position-sensitive detection is not compromised. As seen in figure 4, suitable soft iron shielding (3mm thick) is sufficient to reduce the fringe field to less than 2 gauss, thus enabling standard operation of the PMTs. The use of this combined scanner will make a significant contribution to Molecular Imaging in experimental models of human disease.

References

(1) Beyer et al. 41(8): 1369-1379, *Journal of Nuclear Medicine*, 2000.
(2) Garlick et al. 10(3): 138-142, *NMR in Biomedicine*, 1997.
(3) Shaw et al. 12(1): 733-736, *IEEE Trans. On Appl. Supercon.*, 2002.
(4) Magnex Scientific, Yarnton, UK.

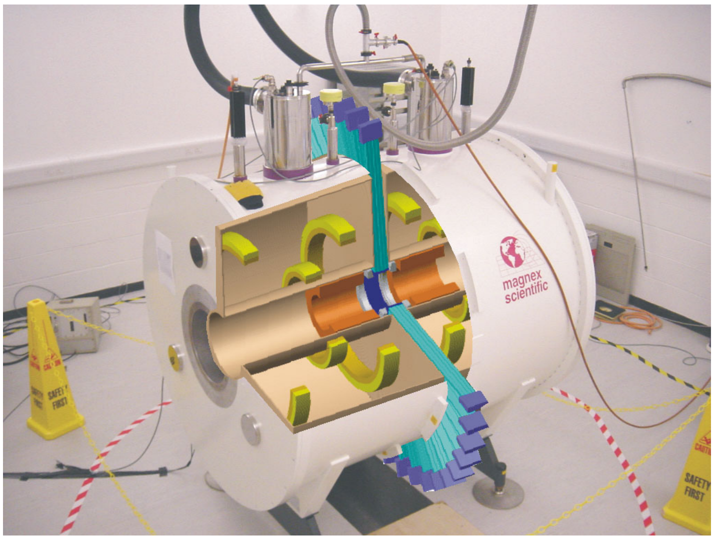

Figure 1

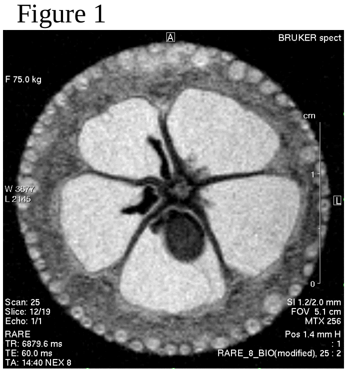

Figure 2

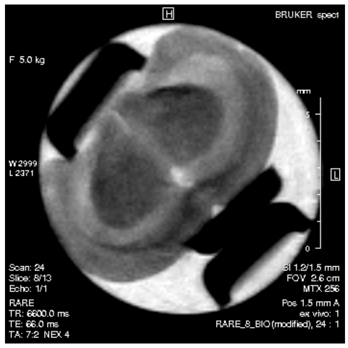

Figure 3

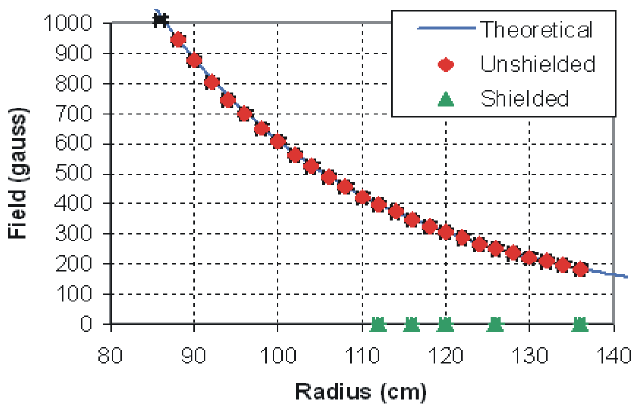

Figure 4