Development of a combined microPET®/MR system

R. C. Hawkes[1], A. J. Lucas[1,2], R. E. Ansorge[2], S. B. Siegel[3], R. Nutt[3], J. C. Clark[1], T. D. Fryer[1], and T. A. Carpenter[1]

[1]Wolfson Brain Imaging Centre, University of Cambridge, Cambridge, United Kingdom, [2]Department of Physics, University of Cambridge, Cambridge, United Kingdom, [3]Siemens Molecular Imaging, Knoxville, TN, United States

Introduction

A number of approaches have been pursued to combine PET and MR for *in vivo* functional and anatomic imaging for preclinical [1, 2] and clinical [3] applications.

Our approach [4] is to accommodate a commercial microPET® Focus 120 (Siemens Molecular Imaging) preclinical PET detector ring within a 'split' in a MR magnet with minimal modification to the PET detectors. The position sensitive photomultiplier tubes (PSPMTs) – which are sensitive to magnetic fields greater than 10 Gauss - are located in a region of low magnetic field (~300 Gauss) outside the magnet cryostat by extending the length of the optical fibre bundles used in the PET detector modules to ~1 metre. Additional passive magnetic screening reduces the magnetic field at that PMT position to less than 10 Gauss.

This approach delivers a complete PET detector ring of diameter 15 cm and axial field of view 7.8 cm for simultaneous PET/MR, with the unique facility to apply 'gold standard' PET-based attenuation correction for validation of MR-based techniques.

We have previously reported detector module performance, and a 'dual module' PET/MR interaction study. Here we report on assembly and initial tests of the complete PET/MR system.

Methods

A complete PET detector ring as used in the microPET® Focus120 consists of 24 PET detector modules, each containing 4 PET 'block' detectors arranged axially. Figure 1 shows our novel, 1 Tesla superconducting magnet and PET detector modules positioned within the 8 cm magnet 'split'. A black magnetic screening 'box' can be seen covering 4 PMT's; that screen reduces the residual magnetic field of ~ 300 gauss to the operating point of the PMT which is less than 10 gauss. Figure 2 shows the complete crystal array, fibre bundles and brass positioning flange viewed along the magnet bore.

A major consideration has been to maintain the precise positioning of the crystals as used in the commercial PET detector ring.

The detector assembly is held in alignment by brass rods fixed between a pair of brass flanges bolted to the cryostat. Each detector module is designed to support the components and provide adjustment to the final crystal position. The detector module structure provides a light-tight cover for the PET detector outside the magnet bore; the crystal ring within the bore is sealed with a combination of bore tube and sealing between the modules.

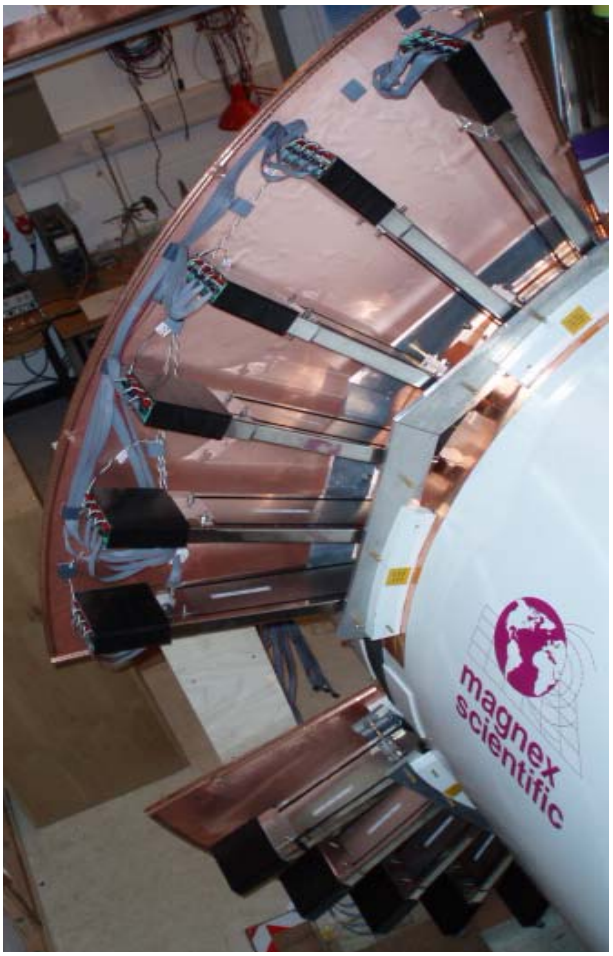
In Figure 3, the ^{68}Ge radioactive source rotation and translation mechanism for transmission scanning as used on the microPET® Focus system is shown mounted on the magnet cryostat. A non-magnetic mechanism has been built to extend the source motion into the central region of the magnet. A full transmission scan can be undertaken at any point in the combined PET/MR examination.

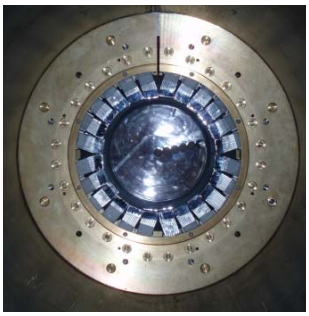
Conclusion

The complete PET ring has been constructed and assembled in the magnet and results will be presented of the initial performance tests.

References

[1] Catana *et al.*, **J. Nucl. Med.** (2006), 47(12):1968-1976
[2] Pichler *et al.*, **J. Nucl. Med.** (2006), 47(4):639-647
[3] Schlemmer *et al.*, **J. Nucl. Med.** (2007), 48(Supplement):45P
[4] Lucas *et al.*, **Technology in Cancer Research and Treatment**, (2006) 5:337-342





Detail of PET/MR system: Figure 1 (above) shows PET detector modules in position, with 6 modules visible in the upper left, and 5 in the lower left quadrant. Figure 2 (left) shows complete ring of LSO scintillator crystals, fibre optics and brass positioning flange in magnet bore.

Attenuation correction: Figure 3 (right) shows the rotation and translation mechanism for conventional PET transmission scans using a ^{68}Ge point source adapted for use on the PET/MR system.