

Development of a combined microPET®-MR system

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I. INTRODUCTION

A number of different approaches for combining MRI with PET have been investigated [1, 2, 3, 4]. Our approach (Figure 1) is based on a novel, 1T actively-shielded superconducting magnet with a 80mm gap to accommodate a multi-ring PET detector array based on a microPET® Focus 120 system (Siemens Molecular Imaging Preclinical Solutions, Knoxville USA). The PET detectors and MR imager view the same region in space, which facilitates simultaneous MRI and PET acquisition. We present an overview of the status of the system.

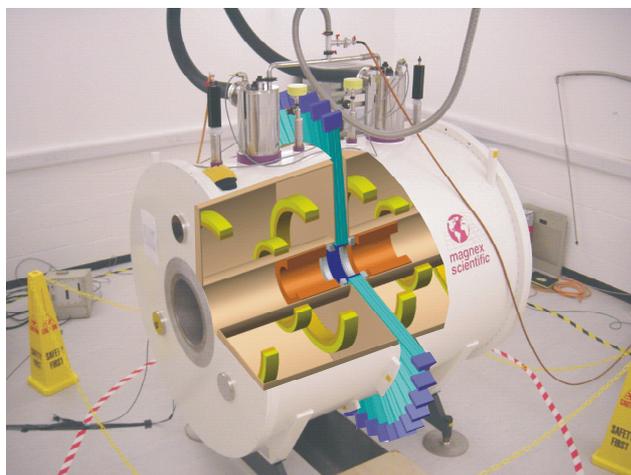


Fig. 1 - Novel magnet with superimposed schematic of PET system.

II. METHODS

When you want to create a figure, you must align it to the center, insert a Frame in the selection figure+legend and select Format-Frame (top or bottom) in order to avoid figures in the middle of the page. Finally remove the Border.

A. MR Performance

A 2D fast spin echo (FSE) sequence (NEX 6 TR/TE 2000/50.5ms) with a slice thickness of 0.8mm and an image matrix of 256 x 192 voxels over a 20.5 x 15.4mm field of view produces in-plane resolution of 80 μ m in 9 minutes.

B. Effect of fibre optic bundle length

To study the effect of increasing the optical fibre length on the PET detector sensitivity, position map, and energy resolution the performance of two 'short' (10 cm optical fibre) and two 'long' (120 cm optical fibre) detectors were compared using a ^{68}Ge point source imaged in singles mode.

C. Performance of PMT in magnetic field

To study the impact of magnetic field on PET sensitivity, position map and energy resolution, a single short detector was operated in singles mode using a ^{68}Ge point source. The PMT end of the detector was located inside a soft iron/permalloy magnetic shield resulting in a nominal 1mT field.

III. RESULTS

A. MR performance

Examples of mouse brain images acquired using conventional MRI gradients and RF coils in conjunction with the novel 1T magnet are shown in Figure 2.

B. Effect of fibre optic bundle length

The mean full width half maximum of the photopeak for the individual crystals increases from $17.2 \pm 0.1\%$ for the short detectors to $27.1 \pm 0.5\%$ for the long detectors. The ratio of the energy resolution values indicates that the long detector measures 40% of the light measured with the short detector. Position maps are shown in Figure 3. The photopeak sensitivity for the long detectors was 2% higher than for the short detectors.

C. Performance of PMT in magnetic field

Direct comparison of the singles count rate with the PMT positioned in a magnetic field of 1mT with the singles count rate at 'low' magnetic field ($\sim 0.05\text{mT}$) shows that the photopeak sensitivity (350-650keV) at the 1mT position is 98% of that at low field. Position maps acquired with the PMT positioned in low magnetic field and in a nominal field of 1mT are shown in Figure 4. The crystal energy spectra acquired with the PMT at the 1mT position shows a mean FWHM of $19.1\pm 0.4\%$ compared with that of $18.7\pm 0.4\%$ at low field.

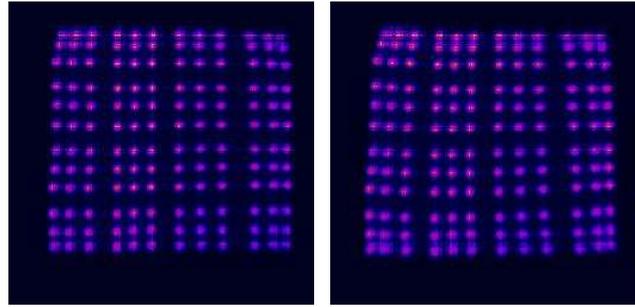


Fig. 4 - Position maps for a PET detector in low ($\sim 0.05\text{mT}$) magnetic field (left) and a nominal 1mT field (right).

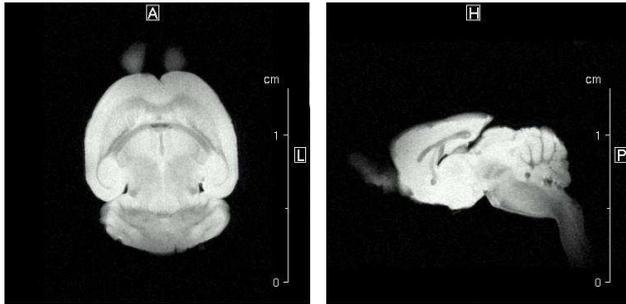


Fig. 2 - Mouse brain images acquired using conventional gradient, shim and radiofrequency (RF) hardware on novel 1T magnet.

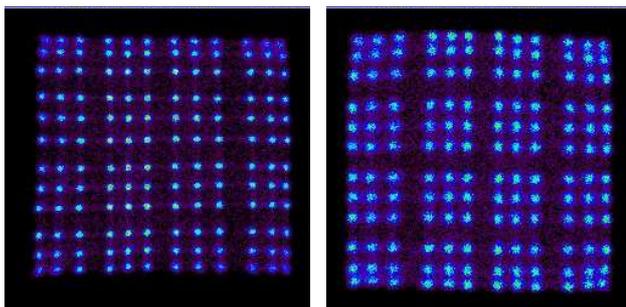


Fig. 3 - Position maps for PET detectors with 10cm (left) and 120cm (right) fibre optic bundles.

IV. CONCLUSION

The light loss from the use of long fibre optic bundles decreases the energy resolution and hence the scatter fraction will increase. However, the spatial resolution and sensitivity are not degraded. Measurements indicate that operating the PMT in 1mT will have minimal effect on image quality.

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