Development of a Simultaneous PET-MRI Breast Imaging System

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Introduction: This abstract reports the development of a simultaneous PET-MRI breast imaging system. This dual modality device combines the ability of PET to provide quantitative biochemical information with the ability of MRI to provide high resolution anatomical information, thereby resulting in a device that will deliver breast scans with high sensitivity and specificity. Such an imaging device can be useful for diagnosis, staging and evaluation of therapeutic response in breast cancer.

Methods: The goal of this project is to develop an MRI compatible breast PET insert that fits inside a dedicated breast MRI RF coil as shown in Fig 1. The proposed breast PET ring will have an inner diameter of ~ 145 mm and an axial extent of ~ 100 mm. We have developed a prototype version of the breast PET system and tested it inside the MRI. The prototype PET system consists of 24 detector blocks, where each detector block consists of a 4 x 8 array of 2.2 x 2.2 x 15 mm^3 LYSO scintillator crystal coupled directly to a non-magnetic APD, read out by an application specific integrated circuit. The PET system shown in Fig. 2 has an inner diameter of ~ 100 mm and an axial length of 18 mm. The system has an overall measured resolution less than 2 mm FWHM throughout its field of view as shown in Fig. 3.
A mini deluxe phantom consisting of 1.2, 1.6, 2.4, 3.2, 4.0 and 4.8 mm rods filled with ^{11}C radiotracer was imaged using the prototype. Rods down to 3.2 mm diameter are clearly distinguishable as shown in Fig. 4.

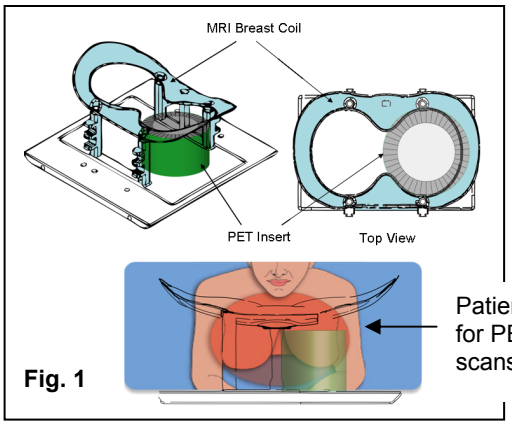


Fig. 1

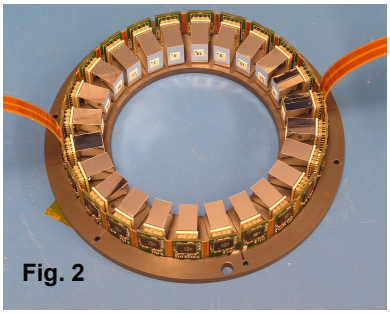


Fig. 2

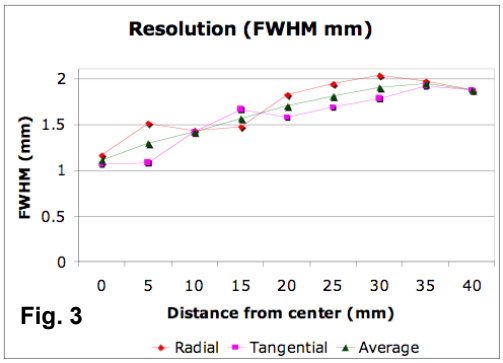


Fig. 3

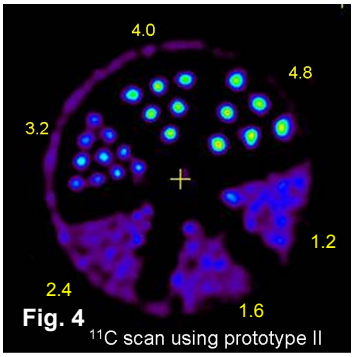


Fig. 4 ^{11}C scan using prototype II

Interference between PET and MRI was evaluated by operating the prototype PET unshielded inside the MRI RF coil (experimental setup shown in Fig. 5). With PET operating in the MRI field of view, artifact free MRI images with good SNR were obtained as shown in Fig. 6 (a,b). On the PET side, an increase in singles count rate was observed during RF pulsing periods of the MRI sequence, which can be gated out post acquisition.

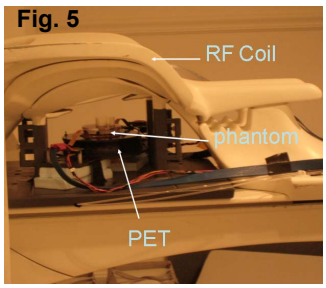
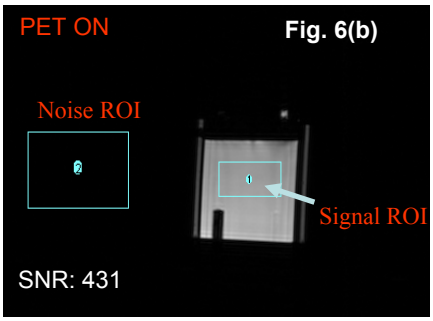


Fig. 5



Conclusion: Good quality MRI images are obtainable with PET operating unshielded inside the MRI field of view. Future goal is to obtain simultaneous PET-MRI images using the prototype system.