

## Simultaneous MRI/PET image acquisition from an MRI compatible Positron Emission Tomography system

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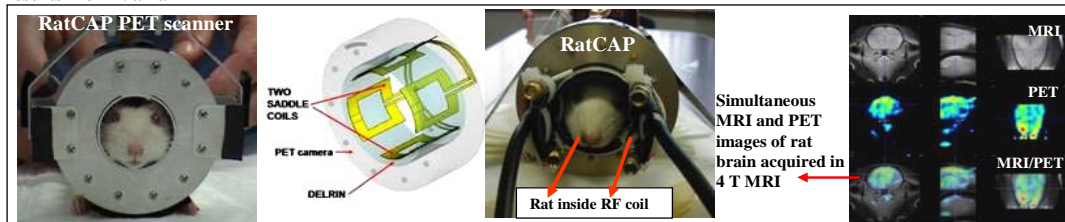
**Objectives:** Acquisition of high-resolution anatomical information with quantitative functional information of the body from two different imaging modalities is of great diagnostic value as compared to stand-alone imaging systems. With the emergence of hybrid imaging systems such as combined X-ray Computed Tomography (CT) and Positron Emission Tomography (PET), accurate anatomical detail from CT is fused with physiological information of the body obtained from PET. However, the PET/CT acquisition is in sequential mode, leading to imperfect co-registration of the images due to the change of position and shape of tissue between scans. Compared to CT, Magnetic resonance imaging (MRI) provides better soft tissue contrast information and does not use ionizing radiation. Also, by integrating a PET detector within the MRI scanner, physiological information co-registered to MR images with excellent soft tissue contrast can be obtained. We have developed three MRI compatible PET scanners based on Rat Conscious Animal PET (RatCAP) [1] for simultaneous acquisition of MRI and PET images of the rat brain at 4 T and 9.4 T, and of the human breast at 1.5 T MRI.

**Methods:** The non-magnetic RatCAP scanner [2] is comprised of 12 block detectors, each of which consists of a 4 x 8 array of 2.2 x 2.2 x 5 mm<sup>3</sup> LSO crystals read out with a matching APD array (Hamamatsu S8550). We developed an application specific integrated circuit (ASIC) with 32-channels performing signal preamplification, shaping, timing and energy discrimination. A 32-to-1 serial priority encoder is embedded to multiplex timing information and channel address of every event through a single digital output [3]. Serialized timing and address information from ASIC is received and processed on a stand alone electronic board called, Time to digital converter and signal processing module (TSPM). The TSPM employs optical data transfer to an external PC to provide electrical isolation [4]. Special shielded (1 mm thick aluminum housing) RF coils with minimal MRI/PET interference were developed [5] and placed inside the RatCAP. We also developed a 24-detector block prototype PET breast scanner, which is now being integrated in the patient table of the Aurora 1.5 T MRI scanner [6], where the breast RF coil is outside the unshielded PET scanner.

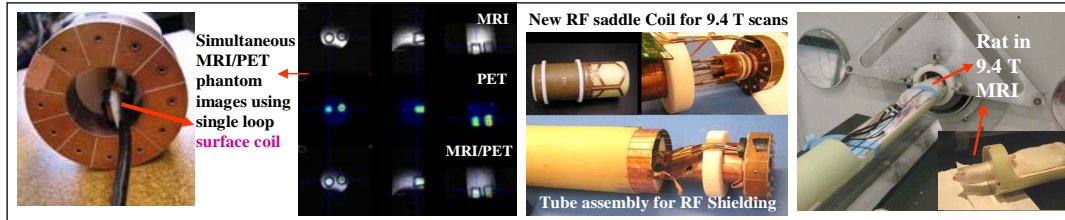
**Results:** Simultaneous MRI/PET images of the rat brain were obtained with different PET radiotracers (<sup>18</sup>F-FDG, <sup>11</sup>C-Cocaine and <sup>11</sup>C-Methamphetamine) at 4 T. To improve RF shielding and minimize eddy currents in 9.4 T, the RatCAP PET detectors were housed in a segmented G10-copper clad casing. Simultaneous MRI/PET images of a rat striatum phantom were acquired in 9.4 T MRI using <sup>18</sup>F-FDG radiotracer. Also, MR images of high-resolution phantoms were acquired in 1.5 T MRI in the presence of a breast prototype PET scanner without any electromagnetic shielding. In all our experiments in various MRI scanners, good quality MR images were acquired in the presence of RatCAP PET electronics and during PET data acquisition. Spurious counts in the PET data stream due to RF pulsing during MRI acquisition are discarded without any significant degradation to the PET image quality.

**Conclusions:** By eliminating ferromagnetic components (nickel and iron) in the RatCAP and minimizing the electromagnetic coupling between the two systems with metallic shielding, we were able to acquire simultaneous MRI/PET images in two MRI scanners (4 T and 9.4 T). Good quality MR images with no significant SNR degradation were acquired without electromagnetic shielding in 1.5 T breast MRI system, using a non-magnetic 24-detector prototype PET breast scanner.

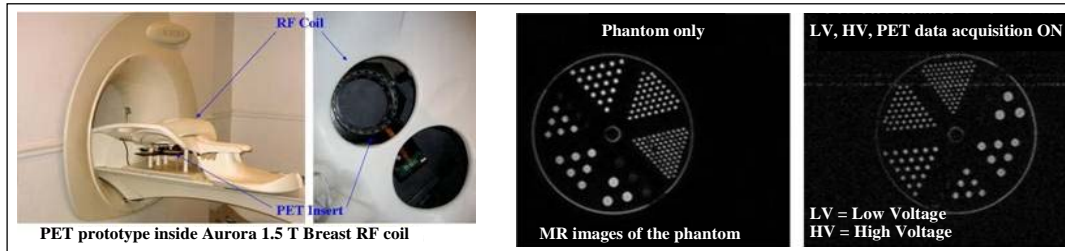
### Results from Varian 4 T MRI



### Results from Bruker 9.4 T MRI



### Results from 1.5 T Breast MRI



### References:

- [1] P. Vaska *et al.*, *IEEE Transactions on Nuclear Science*, Volume: 51, no. 5, pp. 2718-2722, 2004.
- [2] D. Schlyer *et al.*, *IEEE Nuclear Science Symposium Conference Record*, Volume: 5, pp: 3256-3259, 2007.
- [3] J-F. Pratte *et al.*, *IEEE Nuclear Science Symposium Conference Record*, Volume: 1, pp: 19-25, 2007.
- [4] Sachin S Junnarkar *et al.*, *IEEE Nuclear Science Symposium Conference Record*, Volume: 6, pp: 4597-4601, 2007.
- [5] E. Solis *et al.*, *Brazilian Journal of Physics*, Volume: 38, no.2, June 2008.
- [6] [www.auroramri.com](http://www.auroramri.com)

### Acknowledgments:

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