Simultaneous PET/MRI: Evaluation of electromagnetic interactions and *in vivo* imaging in 9.4 T MRI

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Objectives: A small animal MRI-compatible PET tomograph was developed to acquire simultaneous PET/MRI data of the rodents in a Bruker 9.4 T microMRI scanner. The main goal was to minimize the electromagnetic interference effects between the PET and MRI systems and validate our system to study the biological mechanisms in rats and mice using different MRI pulse sequences and PET radiotracers.

Methods: The non-magnetic PET tomograph [1] comprises of 12 detector blocks. Each block consists of a 4 x 8 array of 2.2 x 2.2 x 5 mm^3 LSO crystals glued to a matching non-magnetic APD array (Hamamatsu S8550). A custom-designed MRI coil (ID = 32 mm) operating in a fully quadrature transceiver mode is inserted inside the PET detector (ID = 38 mm). Simultaneous PET/MR imaging studies (including MR spectroscopy and echo planar imaging) of the rat brain were performed. To demonstrate the application of nanoparticles as a PET/MRI biomarker, Fe-52 iron oxide nanoparticles were administered to a Swiss-Webster mouse and MR images were acquired of the mouse torso. The uptake of the nanoparticles in the mouse liver was monitored over time. The PET electronics residing in close proximity of the RF coil were covered with metallic shielding to minimize the effect of electromagnetic interference. The MR image quality and PET performance were evaluated for different shield conditions (aluminum shield, single layer and double layer segmented copper shields). Simultaneous PET/MR images of a resolution phantom were acquired in all orthogonal planes, using this setup.

Results: From the MRS data of the rat brain and the EPI data acquired in the presence of powered PET, no noticeable artifacts were observed. The time course of the uptake of nanoparticles in the liver of the mouse can be clearly seen in the T2*-weighted FLASH gradient echo sequences. From the shielding studies, the continuous aluminum shield suppressed the effect of RF fields on the PET electronics, but resulted in poor signal-to-noise ratio in the MR images of the phantoms. The double layer segmented copper shield has provided a good tradeoff between obtaining good quality MR images and minimizing RF effects on PET.

Conclusions: Simultaneous PET/MR images of a rat brain and a mouse heart demonstrate the feasibility to perform tumor models in small animals with our PET/MRI system. The uptake of nanoparticles in the mouse liver indicates a possibility of performing radiolabeled nanoparticle experiments correlating the dynamic information obtained from PET with the MRI data. Quantitative PET information can now be obtained after employing optimal shielding around the PET detectors.

References:

[1] D. Schlyer *et al.*, *IEEE Nuclear Science Symposium Conference Record,* Volume: 5, pp. 3256-3259, 2007.