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Simultaneous PET/MRI with Clinical and Preclinical Systems

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In our experiences with simultaneous PET/MRI (Siemens Biograph mMR), we have seen several inherent advantages beyond improved anatomical information. In the heart, for example, new insight can be gained when fusing cine, gadolinium-enhanced, and relaxation time mapping MRI with PET tracers sensitive to glycolysis (¹⁸F-FDG), perfusion (¹³N-ammonia), or sympathetic innervation (¹¹C-HED). Simultaneous PET/MRI with combined contrast infusions of both MRI and PET tracers may help improve pharmacokinetic modeling in tissue. Simultaneity can also be used to retrospectively correct PET data for motion and partial volume effects based on information derived from the MRI. Efforts at Lawson to improve the quantitative accuracy of clinical PET/MRI have also included improvements to MR-based attenuation corrections, multi-site phantom measurements, and implementation of novel, PET-compatible, 32-channel RF coils designed specifically for the Siemens Biograph mMR.

For PET images, the Biograph mMR performs better than most clinical PET systems, with a spatial resolution of 4.3 mm in the centre of its field-of-view and a peak sensitivity of 1.5%. In contrast, small animal PET systems can achieve <1 mm resolution with >5% peak sensitivity. The entire brain of an adult mouse is ˜ 400 µL in volume. In order to develop novel PET tracers and perform imaging studies with small animal models that are comparable to our clinical 3T PET/MRI, a truly simultaneous, preclinical PET/MRI system capable of sub-millimeter spatial resolution is required. We have been working with industry and academic partners, led by Dr. Andrew Goertzen at the University of Manitoba, to develop a high-resolution PET insert designed to operate in a preclinical MRI. This technology has been licensed by a Canadian company (Cubresa, Winnipeg) who will deliver the first commercially available, preclinical PET/MRI insert to Lawson in the first half of 2016. Although it will initially be installed in our clinical 3T PET/MRI, this system is small enough (113 mm outer diameter) to operate simultaneously in most high-field preclinical MRI systems. The design and initial results from this system will be presented.

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