

Evaluation of a Partial Ring Design for the INSERT SPECT/MRI System

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The aim of the INSERT project is to develop a SPECT insert for a commercial MRI system, for performing simultaneous SPECT/MRI brain studies in humans. We have previously investigated various design options for the detector system, based on a complete ring of detectors. We are now considering a partial ring, due to space limitations. We have investigated the degradation in image quality with a partial ring as compared to a full ring, and the possibility of addressing the limitations by utilising MRI data during reconstruction.

Noise-free data were generated by forward-projecting a cylindrical phantom with spherical inserts for a full-ring and a partial ring system, equipped with multi-slit-slat (MSS) and multi-pinhole (MPH) collimators. Poisson noise was added and images were reconstructed using ML-EM and MAP-EM with a smoothing prior and an anatomical prior. Contrast-recovery (CR) was calculated for the spheres in the lower part of the phantom compared to the top ones. Background CoV was also calculated.

With noise-free data, CR was 77-84% for the MSS and 82-88% for the MPH partial-ring system with 400-1600 iterations. For noisy data and MAP-EM with a smoothing prior, CR was 78-80% and 81-82%, and CoV 22-28% and 26-31%, for the MSS and MPH systems, respectively. With the anatomical prior, CR was 85-89% and 87-91%, respectively.

With the partial ring-systems, the transaxial resolution in the lower part of the image is reduced. The degradation is slightly larger with MSS than MPH collimators, but the MSS collimator results in a lower noise-level. Some resolution can be recovered with more iterations, but the improvement is limited when regularisation is included. The anatomical prior offers both qualitative and quantitative improvement in image quality.

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