PHYSICS AND ASTRONOMY
COLLOQUIUM

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"Instrumentation for improving the spatial resolution and sensitivity of small animal PET"

Abstract

The first dedicated small animal PET scanners were developed in the mid 1990s and there remain several challenges specific to small animal PET that need to be addressed. The spatial resolution in commercial small animal PET scanners is ~ 1 mm, leading to partial volume effects and problems in quantification for structures smaller than 2 mm. In addition the duration of an imaging study using a small animal PET scanner is on the order of 10-30 minutes. This duration is, in part, due to the sensitivity of the scanner. With an improvement in sensitivity, the duration of the scan may be reduced without sacrificing image quality. Additional benefits to improving the sensitivity of the scanner include the improvement of dynamic studies of the tracer distribution in the subject and the potential to reduce the injected amount of radionuclide (decreasing the radiation dose to the subject).

In this work, detector design to improve the spatial resolution and sensitivity of small animal PET is explored. To improve the spatial resolution, detectors with smaller elements were developed, progressing from detectors with individual crystal sizes of 0.7 mm X 0.7 mm X 20 mm to detectors with individual crystal sizes of 0.22 mm X 0.22 mm X 20 mm. All of the characterized detectors have a length of 20 mm along with depth-of-interaction encoding so that the improvements in spatial resolution are matched with an improvement in the sensitivity of the scanner. These detector designs are complemented by Monte Carlo simulations that explore the sensitivity and spatial resolution achieved with such detectors. Novel tapered detector designs are explored as is a single-detector insert to locally improve the spatial resolution and sensitivity of an existing small animal PET scanner.

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