

ModPET: A Novel Small-Animal PET System

Positron Emission Tomography (PET) and PET/CT systems have become the gold standard for imaging in many applications. Effectively translating this technology to small-animal imaging is vital to allow researchers a common way to image animals and compare these results to their human counterparts. Current small-animal PET scanners are very costly and complicated to purchase and operate, thereby limiting the amount of related research that is done. Here at the Center for Gamma-Ray Imaging, we are developing a novel small-animal PET scanner that utilizes common modular detectors with monolithic NaI crystals coupled to common PMTs.

The proposed scanner would use either two or four modular detectors spaced apart only by the desired field of view (FOV) (Figure 1). This design allows for higher sensitivity and reduced resolution loss due to the non-collinearity associated with positron annihilation. Certain technical challenges need to be overcome to allow for this system to be practical. One of the most critical of these challenges is the resolution loss due to parallax error associated with gamma rays entering the camera at high-incident angles. In commercial systems, this problem is reduced by using more than one layer of scintillation crystals with varying timing responses in each layer. This method only allows for a few relative pixels in depth while largely increasing the complexity of the acquisition electronics required. Our system will combat this problem by utilizing one of the strengths of our design, namely access to the raw PMT signals. Access to these signals allows us to perform 3-D position estimation using maximum likelihood methods. This technique will significantly diminish the resolution loss due to parallax error without any changes to our acquisition electronics.

A prototype system has been completed, and work is now being done to calibrate the camera for the three-dimensional position estimation. This work includes creating an effective collimator at the high energies associated with PET and scanning it across each camera face (Figure 2). This 2-D detector response is then used to determine the detector response in depth as well, thereby allowing us to overcome problems due to parallax error. By utilizing the advantages of this design and overcoming its challenges, development of a simplified and powerful small-animal PET scanner is possible.

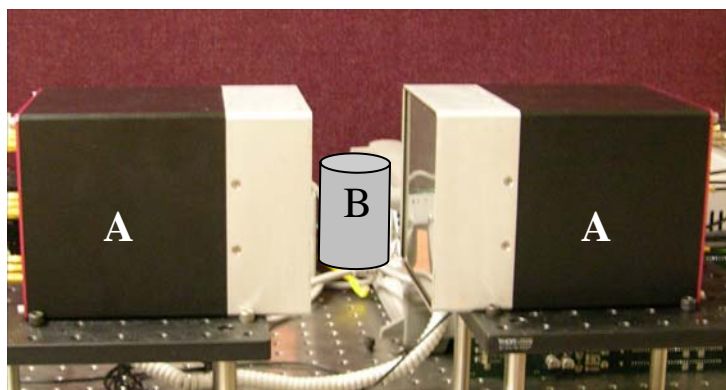


Figure 1. Photograph of our prototype small-animal PET imaging device with two scintillation detectors (A) with the FOV shown in gray (B).

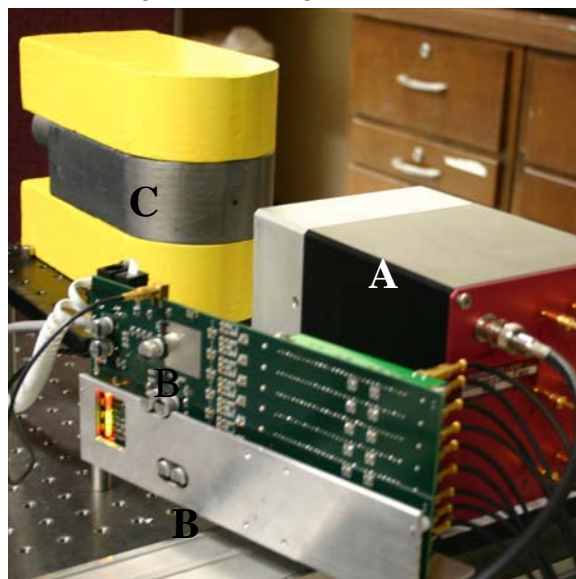


Figure 2. Photograph of the scintillation detectors (A) to be scanned on a 2-D translation stage (B) and the lead collimator (C) with 1/8" bore down the center.

1. D. W. Wilson, L. R. Furenlid, H. H. Barrett, and Y-C. Chen, A new PET system for small-animal imaging, Nuclear Science Symposium Conference Record, 2004 IEEE, Vol. 6, Issue 16-22, 3389-3392, October 2004.
2. S. K. Moore, D. W. Wilson, W. C. J. Hunter, L. R. Furenlid, and H. H. Barrett, Novel small-animal PET imaging, Poster presentation at NIBIB Training Grantees Workshop, Washington, DC, June 16, 2006.