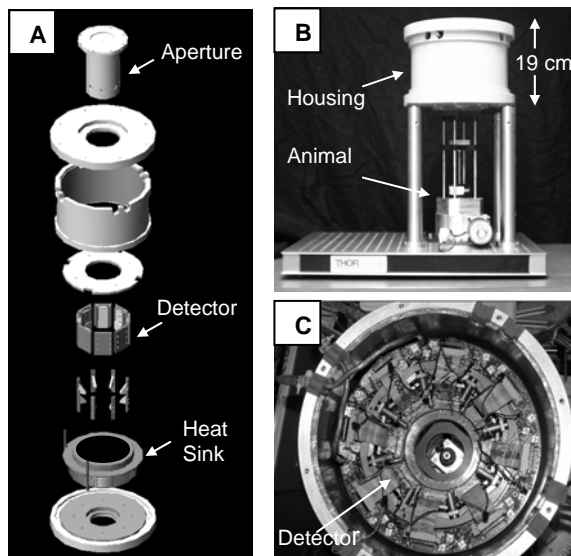


## SemiSPECT: A Novel Small-Animal SPECT System Incorporating Eight Pixellated CZT Detectors

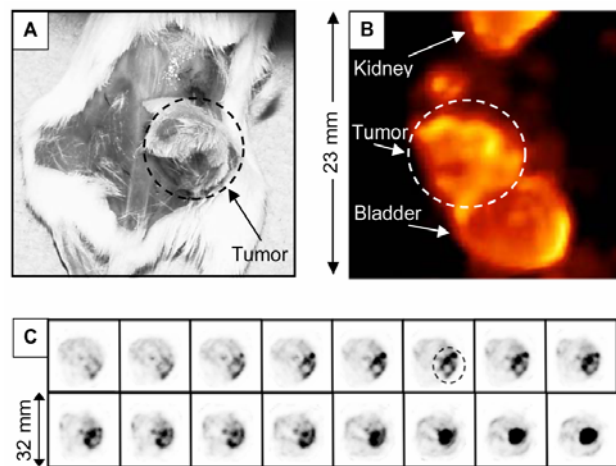
One promising technology for improving intrinsic resolution in SPECT is detector arrays based on wide-bandgap semiconductors. Our group at the Center for Gamma-Ray Imaging has developed  $64 \times 64$  cadmium zinc telluride (CZT) arrays with  $380\text{-}\mu\text{m}$  square pixels. As a step towards realizing the full potential of high-resolution CZT detectors, we have recently completed a tabletop SPECT system using eight of our  $64 \times 64$  arrays.

Each detector consists of a CZT crystal and a customized application-specific integrated circuit (ASIC). The CZT crystal is a  $2.7\text{-cm} \times 2.7\text{-cm} \times \sim 0.2\text{-cm}$  slab with a continuous top electrode and a bottom electrode patterned into a pixel array by photolithography. The ASIC is attached to the bottom of the CZT crystal by indium-bump bonding. A bias voltage of  $-180\text{ V}$  is applied to the continuous electrode. The eight detectors are arranged in an octagonal lead-shielded ring. An aperture cylinder with a  $64.7\text{-mm}$  diameter provides a cylindrical field of view of  $32.0\text{-mm}$  diameter  $\times$   $32.0\text{-mm}$  height with  $0.8\text{X}$  magnification at the center. An object is imaged onto each detector through a pinhole, and each detector is operated independently with list-mode acquisition. The imaging subject can be rotated about a vertical axis to obtain additional angular projections.

The performance of SemiSPECT has been characterized using  $^{99\text{m}}\text{Tc}$  tracers. When a  $0.5\text{-mm}$ -diameter pinhole is used, the spatial resolution on each axis is about  $1.4\text{ mm}$  as estimated by the Fourier crosstalk matrix, which provides an algorithm-independent average resolution over the field of view. The energy resolution achieved by summing neighboring pixel signals in a  $3 \times 3$  window is about  $10\%$  full-width-at-half-maximum of the photopeak. The overall system sensitivity is  $\sim 0.5 \times 10^{-4}$  with an energy window set to  $\pm 10\%$  from the photopeak.



CAD design (A) of mechanical components and photographs of (B) outside and (C) inside views of SemiSPECT.



Photograph (A) of a SCID mouse bearing a  $300\text{ mm}^3$  human-breast-tumor xenograft s.c., (B) volume-rendered SemiSPECT images, and (C) consecutive  $0.5\text{-mm}$  thick transaxial slices.  $^{99\text{m}}\text{Tc}$ -glucarate (GLA) was used as the tumor imaging agent.

SemiSPECT has garnered considerable attention in the molecular imaging community since it was introduced at conferences and published in *Medical Physics*. [1]. Among the honors are presentation on the cover of *Medical Physics* and a feature article in the *Academy of Molecular Imaging Newsletter*.

1. "SemiSPECT: a small-animal SPECT imager based on eight CZT detector arrays," H. Kim, L. R. Furenlid, M. J. Crawford, D. W. Wilson, H. B. Barber, T. E. Peterson, W. C. J. Hunter, Z. Liu, J. M. Woolfenden, and H.H. Barrett, *Med. Phys.*, 33(2), pp. 465-474, 2006.