

SEMISPECT, A NOVEL IMAGER INCORPORATING 8 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 64×64 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 64×64 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 V is applied to the continuous electrode. The eight detectors are arranged in an octagonal lead-shielded ring. An aperture cylinder with 64.7-mm diameter provides a cylindrical field of view of 32.0-mm diameter \times 32.0-mm height with $0.8\times$ 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-mm diameter pinhole is used, the spatial resolution on each axis is about 1.4 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 3×3 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.

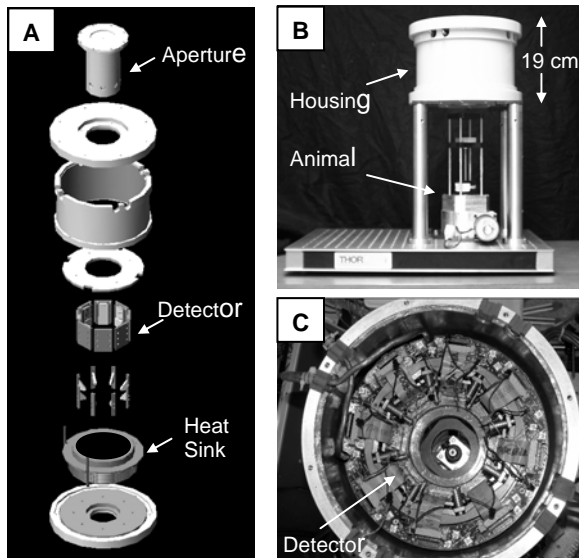


Fig.1. CAD design (A) of mechanical components and photographs of (B) outside and (C) inside views of SemiSPECT

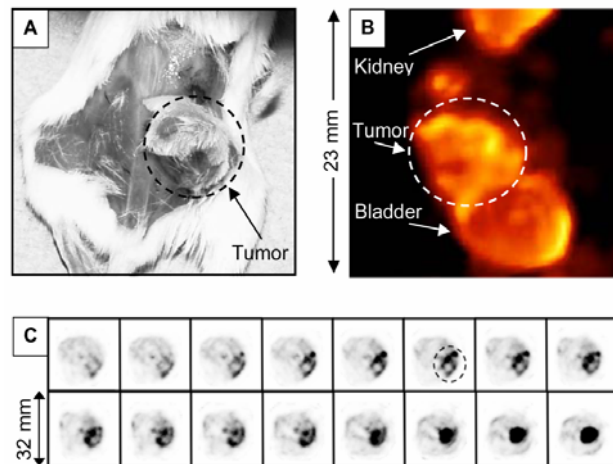


Fig. 2. Photograph (A) of a SCID mouse bearing a 300 mm^3 human-breast-tumor xenograft *s.c.*, (B) volume rendered SemiSPECT images, and (C) consecutive 0.5-mm thick transaxial slices. $^{99\text{m}}\text{Tc}$ -glucarate (GLA) was used as the tumor imaging agent

SemiSPECT has garnered considerable attention in the molecular imaging community since it was introduced at conferences and published¹ in *Medical Physics* in February of this year. 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.*, (2006), 33(2), pp. 465-474.