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Blood Activity Measurement Using 4 Modules High Resolution PET Tomograph

°**Azhar H. Malik[1], Kenji Shimazoe[1], and Hiroyuki Takahashi[1]**

**[1]School of Engineering, The University of Tokyo, Japan**

E-mail: azhar2932@hotmail.com

Abstract: The inherent quantitative potential of PET is seldom used because of problems associated with manual blood sampling which is required as input function for the calculation of rate constants and metabolic rate. We proposed the use of a high resolution LuAG-APD based small animal PET tomograph to in-situ measure the radiotracer concentration in the blood. As a simple case, we discretized the artery into point sources separated by equal distance inside the fore-arm equivalent 6cm diameter cylinder as shown in **Fig. 1.**
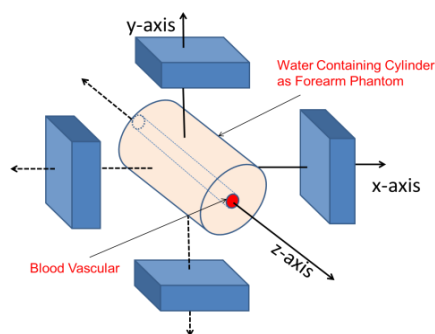
Fig. 1: Proposed high resolution PET system with blood vascular at center of fore-arm equivalent phantom.

The sensitivity at various points is determined using the point sources and the axial and the radial variation in the sensitivity is studied and is shown in **Fig. 2**.
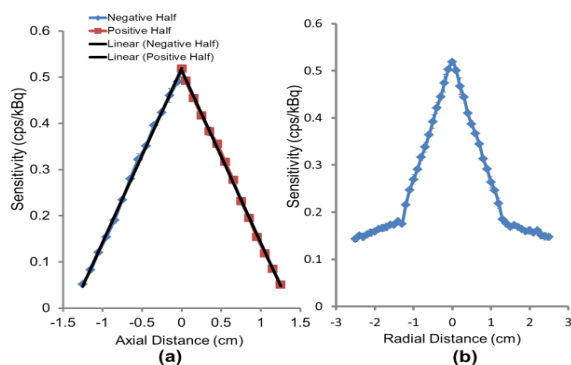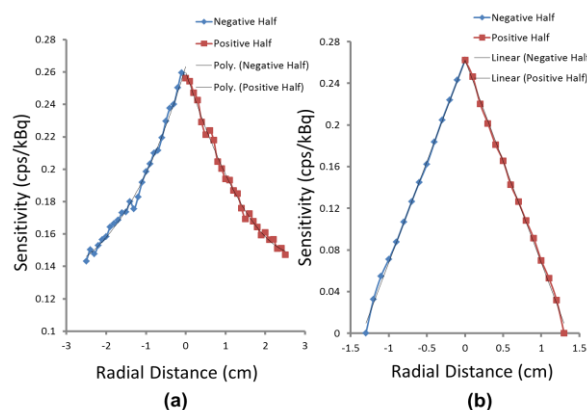

Fig. 2: Sensitivity variation with (a) axial, (b) radial displacement of point source.

The axial variation is off the triangular shape. Whereas, the sensitivity variation is larger in radial direction and is explained in **Fig. 3** for the displacement of point source along x-axis.

Fig. 3: Sensitivity variation of (a) perpendicular (b) parallel pair of detector modules with point source displacement.

The fitted relationships in axial and radial directions are given by,

$$S_a = 0.377 d_{axial} + 0.52, d_{axial} \leq 0$$
$$= -0.373 d_{axial} + 0.52, d_{axial} \geq 0 \qquad (1)$$
$$S_r = 0.001x^3 + 0.016x^2 + 0.277x + 0.525, x \leq 0$$
$$= 0.0006x^3 + 0.011x^2 - 0.268x + 0.521, x \geq 0 \quad (2)$$

The above equations may be helpful while determining the activity, present at ROI, from the measured coincident counts. We calculated the average sensitivity from discretized point sources which came out to be 0.29±0.006cps/kBq whereas, the average sensitivity using cylindrical vascular was found to be 0.26cps/kBq with a difference of 9%. Finally, we determined the measurement time required to obtain 70k coincident counts for image reconstruction which came out to be 53min for 4 and 26min for 8 such modules tomograph. We are trying to reduce the measurement time as low as possible by increasing the rings, crystal thickness, or small ring diameter. We expect that this work will be helpful to avoid the pain to patients, unnecessary exposure to the workers, and lengthy as well as less efficient procedure to the medical center.