jnm/LETTERS TO THE EDITOR

Resolution Limit for Positron-Imaging Devices

Three letters in Vol. 17 of this Journal have discussed the effects of positron range and annihilation-angle spread (i.e. deviations from 180°) on the resolution limit of positron cameras (*1–3*). We believe that the authors of Ref. 2 greatly underestimated the effects of positron range, and overestimated the effects of annihilation spread by a factor of two.

We have measured the relative effects of these factors for a pair of 8-mm-wide rectangular NaI(Tl) crystals separated by 80 cm, (*4*) where the theoretical geometrical resolution has a FWHM of 4 mm and a FW(0.1)M of 7.2 mm.

The measured values for line sources of 1.2-mm-diam are:

Emitter	β^+E_{max} (MeV)	FWHM	FW(0.1)M
^{22}Na	0.54	5.0mm	9.2mm
^{68}Ge–^{68}Ga	1.90	6.0	11.5
^{82}Sr–^{82}Rb	3.15	7.1	16.5
^{82}Sr (in lead sleeve)	3.15	5.2	11.2

From these values we conclude that the range distribution of positrons around ^{68}Ge and ^{82}Sr sources has an apparent spread of 3.5 and 5.0 mm FWHM, which is in fair agreement with the measurements of Cho et al. (*5*) but is in considerable disagreement with the FWHMs of 0.44 and 0.61 mm claimed in Ref. 2.

We estimate theoretically that the annihilation-angle spread of 0.5° FWHM[6] contributed only 1.7 mm to the FWHM. This is in agreement with Ref. 1 but in disagreement with Ref. 2, where this contribution was overestimated by a factor of two.

These considerations are of vital importance to projected uses of positron emitters and new instrumentation. They suggest that it will not be possible to achieve resolutions greater than the square root of (angular spread)^2 + (range spread)^2, which for ^{68}Ga and ^{82}Rb are approximately 4 mm and 5 mm FWHM, respectively.

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2. PHELPS ME, HOFFMAN EJ: Reply No. 1. *J Nucl Med* 17: 757–758, 1976

3. CHO ZH: Reply No. 2. *J Nucl Med* 17: 758, 1976

4. DERENZO SE, BUDINGER TF, CAHOON JL, et al.: High resolution computed tomography of positron emitters. *IEEE Trans Nucl Sci* NS24(1), 544–558, 1977

5. CHO ZH, CHAN JK, ERICKSSON L, et al.: Positron ranges obtained from biomedically important positron-emitting radionuclides. *J Nucl Med* 16: 1174–1176, 1975

6. COLOMBINO P, FISCELLA B, TROSSI L: Study of positronium in water and ice from 22 to −144 °C by annihilation quantum measurements. *Nuovo Cimento* 38: 707–723, 1965

Reply

In our letter (*1*) about the loss of resolution as a result of the deviation of the annihilation radiation from 180° emission, we calculated the width of the line-spread function (LSF) in terms of a projection on the surface of one detector. In an imaging device using coincidence detection of annihilation radiation the effect is distributed between the two detectors and therefore this component of resolution is equal to one-half our calculated value.

By choosing to ignore the FW(0.1)*M* given in our letter (*1*), Derenzo and Budinger (D and B) have misinterpreted our statements on the resolution loss due to the positron range. The resolution values quoted were calculated theoretically assuming a very narrow (0.01-mm) line source. The resulting LSFs are definitely non-Gaussian in shape: they are very narrow at the half maximum but have very broad bases at tenth maximum. In order to calculate the increase in line width due to the positron range, the theoretical line shape must be *convolved* with the line shape due to the detection system. In Reference 2, we calculated another width, which is more appropriate for use with a system whose resolution is comparable with the positron range. This is the narrowest width that contains 75% of the area of the LSF. (A Gaussian LSF has about 75% of its area within its FWHM.) Using this measure of resolution, our calculations give widths of 2.6 mm and 5.0 mm, respectively for the ^{68}Ga and ^{82}Rb positron ranges. These values are in fair agreement with those of D and B (3.5 and 5.0 mm, respectively).

The measurements that Derenzo and Budinger have presented here are valid only in reference to their own imaging system, and they have not shown that the true range distributions of positrons about the line sources of ^{68}Ga and ^{82}Rb have widths of 3.5 and 5.0 mm, respectively. To support this statement, we would like to point out several aspects of their measurements that tend to invalidate their conclusions.

1. The intrinsic resolution of their measurement system is too coarse to accurately define a distribution with an FWHM less than 5 mm. To a lesser degree, Cho's (*3*) measurement of positron ranges suffers from this same problem.
2. The intrinsic resolution of their system is known only theoretically, and since this component dominates the line shape, a small error in the calculated width can translate into a large error in any derived values for the widths of other components in the LSF.
3. The factors influencing the deviations of the annihilation radiation from 180° include the physical and chemical state of the medium, the temperature, and to some extent the beta-decay energy of the radionuclide (*4*). Thus there is no reason to assume that the width and shape of this distribution

is identical for all of these measurements, or that it is possible to calculate the line shape from the information in Reference 5, which concerns itself with water and ice only.

4. From our previous work (*6*), we are confident that the range distribution of positrons is not Gaussian in shape, yet D and B imply a Gaussian LSF by adding the various widths in quadrature. It is impossible to derive a value accurately for the width of one component of an LSF if all three major components have uncertain widths and line shapes.

In our previous work (*6*), we were able to experimentally derive the line shape due to our instrumentation, and we eliminated the spread due to the angular deviation of the annihilation quanta by performing the measurement in a noncoincident mode. In addition, we used a system with higher resolution—2.4 mm FWHM, which is still insufficient. The only undetermined factor in our measurements was the effect of the positron range. We calculated this effect theoretically and compared the results with our measurements. There was excellent correlation between calculation and measurement. Thus we are confident that our measurements and calculations are reliable.

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6. Phelps ME, Hoffman EJ, Huang SC, et al.: Effect of position range on spatial resolution. *J Nucl Med* 16: 649–652, 1975

Direct Recording of Rectilinear Thyroid Scan Images on 5 × 7-In. Film

I read with interest the technical note by Reese and Miskin (*1*) and agree that cost is a central issue in most clinical laboratories.

While at the Miami Valley Hospital, Dayton, Ohio, and with the help of Sylvan Eller, M.D., I developed an inexpensive device to allow a scanner* to use 5 × 7-in. film for thyroid scans.

A thin sheet of clear Plexiglas was cut to fit into the scanner's 14 × 17-in. film cassette. Very thin strips of Plexiglas were appropriately spaced and taped onto the 14 × 17-in. sheet as a guide to set in smaller film while in the darkroom. The x-ray film is held in the cassette by the Plexiglas sheet when the slide is pulled. The film is centered by the guides. Light transmitted through the Plexiglas exposes the film.

The probe must be centered carefully for each scan. The Teledeltos output area is the best aid to assure that the probe is correctly centered to record on the x-ray film. The Plexiglas should be checked regularly to clear surface of smudges. Cleaning should also reduce the occurrence of static electricity which can leave marks on the developed film.

We found that lowered cost will result from substituting 5 × 7-in. x-ray film for 14 × 17-in. film when performing thyroid scans on this scanner.

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FOOTNOTE

* Picker Magnascanner 500, Cleveland, Ohio.

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1. Reese I, Mishkin FS: Direct recording of rectilinear scan images on 4 × 5 in. film. *J Nucl Med* 17: 937–938, 1976

Assessment of a Multiformat Imager with a Scintillation Camera

A performance of a multiformat imager associated with a scintillation camera led us to the discovery that the number of points plotted on the imager is not always the same as the number indicated by the camera, especially at high count rates. This is unexpected, since the camera (the Pho/Gamma IV) is confined to the output frequencies manageable by the imager (Microdot). The ratio of plotted points to camera counts has varied from 0.6 to approximately 1.2, depending on the particular fault.

The system is tested by setting the camera's preset counts to a low but statistically significant number, setting the imager's intensity control to produce distinct dots, exposing the film with a large frame size, and counting the dots produced on the film. Although a small discrepancy is not critical, it does indicate a malfunction, and a large discrepancy would degrade picture quality.

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Purity of the Adrenal-Scanning Agents, 19-Iodocholesterol and 6-Iodomethylnorcholesterol

Recently it has been reported in this journal (*1,2*) and elsewhere (*3–5*) that 19-iodocholest-5-en-3β-ol (19-iodocholesterol, **I**), when synthesized by the method of Counsell et al. (*6*), contains the homoallylic isomer 6β-iodomethyl-19-norcholest-5(10)-en-3β-ol (6-iodomethylnorcholesterol, **II**) in amounts ranging from 10 to 60%. Since **II** has been reported to be 5–10 times more active than **I** with respect to its accumulation in the adrenal gland, **II** is of considerable importance as a potential new radiopharmaceutical (*1,2*). The physical characteristics and spectroscopic data of **II** as reported by two different groups (*1,4*) are, however, significantly different. The purpose of this letter, then, is to make investigators wishing to use these agents aware