Measurement I (Information Processing) and Measurement II (In vivo)

EFFECT OF PULSE SHORTENING ON THE SPATIAL RESOLUTION OF GAMMA CAMERAS

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Effect of pulse shortening on the statistical resolution (the spatial resolution) of a NaI(Tl) detector was investigated experimentally in order to check the applicability of the "variable sampling-time technique"* to gamma cameras.

Assuming the scintillation decay to be exponential, loss of the statistical resolution is given by,

$$Rs=[1+\{e^{-ts/T}/(1-e^{-tc/T})\}]^{1/2} \quad (1)$$

where T is the decay time constant of the scintillation, tc the delay line clipping time and ts the integration period.

Experiments were carried out with a NaI(Tl) crystal ($3.8cm^{\phi} \times 3.8cm$) optically coupled to a photomultiplier tube (HTV R329). The detector current pulses were shortened to 100 nsec pulses by a delay line clipping circuit. Since the scintillation decay is not exponential, the detector pulses were shaped into a single exponential waveform by inserting a RC network. The results obtained are shown in Fig.1.

It was concluded that the effect of pulse shortening is well expressed by the theoretical prediction, but the use of the RC network increases the resolution loss by a factor of about $\sqrt{2}$.

* E.Tanaka,et al.; Jap. J. Nucl. Med. 15(1978) 387

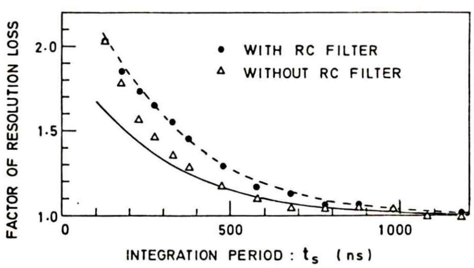

Fig.1. Factor of resolution loss versus integration period

CONTRIBUTION OF STATISTICAL FLUCTUATION OF PULSE AMPLITUDE ON THE SPATIAL AND ENERGY RESOLUTION OF A GAMMA CAMERA

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The energy resolution of a scintillation camera is generally given by the convolution of "statistical resolution" due to the finite number of photoelectrons released from the photo-cathodes and the "system resolution" due to the intrinsic resolution of the scintillator, non-uniformity of the photomultipliers, etc. While the spatial resolution of the camera is proportional to the statistical resolution alone because the position analyzer is so designed to be insensitive to gamma-ray energy. This paper presents a method of determining these two components separately, together with some experimental results obtained with a NaI(Tl) ($2"\phi \times 2"$) scintillation detector.

If detector current pulses are shortened to pulses having a width, t_c, by delay-line clipping, the variance of the integrated charges during $t = t_s (> t_c) \sim \infty$ is given by:

$$V(t_s) = N(1 - e^{-t_c/T})\, e^{-t_s/T} \quad (1)$$

where T is the decay time constant of the scintillation and N the total number of photoelectrons. Eq.(1) does not include the system variance because the signal has zero mean in the integration period. From the experimental data on $V(t_s)$ for various values of t_s and the variance with full integration, we can determine the ratio of the two components of resolutions, together with the absolute value of N. The experimental results are summerized in Table 1. The number of photoelectrons was estimated to be 4.9 electrons per keV of gamma-ray energy.

Table 1.

Source	Overall resolution	Statistical resolution	System resolution
^{241}Am	18.2 %	13.7 %	11.9 %
^{57}Co	13.8 %	9.6 %	9.9 %