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A QUAD BGO DETECTOR FOR A POSITRON EMISSION COMPUTED TOMOGRAPH. N.Nohara, E.Tanaka, H. Murayama and K.Ishimatsu. National Institute of Radiological Sciences and Hitachi Medical Corporation. Chiba and Kashiwa.

A quad BGO detector is proposed which can be used as a detector component in a positron emission computed tomograph. The detector configuration allows the closest packing and the use of photomultiplier tubes whose diameter is twice the crystal width, resulting in high light collection efficiency. The detector is composed of four 15x24 x24 mm^3 BGO crystals fastened in line and viewed by two 29 mmØ photomultiplier tubes. The two outer crystals are optically shielded from the two inner crystals which are optically coupled to each other. The response of each crystal was measured by scanning a collimated beam of 511 keV photons. The response to the normally incident beam is nearly rectangular, while the response to the beam at angle is asymmetrical due to shielding effect of the neighbouring crystals. From these responses, coincidence detector resolution of a circular ring detector system using the quad BGO detectors is expected to be 7.5 mmFWHM at the center of the detector ring, and 11 mmFWHM in radial direction and 11.3 mmFWHM in tangential on a half diameter circle of the ring. Cross-talk from one crystal to the next due to Compton scattering is estimated to be less than 5% for a normal incident beam.

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PERFORMANCE OF A TIMING AND POSITIONING CIRCUIT FOR A QUAD BGO DETECTOR USED IN POSITRON CT. H.Muravama.E.Tanaka.N.Nohara and S.Nakase. National Institute of Radiological Sciences and Hamamatsu TV Co.,LTD. Chiba and Hamamatsu.

A timing and positioning circuit for a quad BGO detector which consists of four BGO crystals and two photomultiplier tubes(PMTs) was designed and constructed. The two PMTs were selected so that the difference of the transit times was less than 0.2 ns. With summing up the anode currents of the two PMTs, timing pulses are extracted by a leading-edge discriminator with the first photoelectron detection method and gated by outputs of an energy discriminator set at 350 keV. The energy resolution was about 25 % FWHM at 511 keV. The time resolution of a pair of the detectors for annihilation photon pairs was 3.6 ns and 7.1 ns for FWHM and FWTM, respectively.

Binary positioning pulses are directly extracted by two positioning discriminators and strobed by the timing pulses. Each positioning discriminator consists of a simple analog computer and a comparator; one of the computers is (X-Y) and the other [Max(X, Y)-k(X+Y)], where X and Y are the last dynode signals of the two PMTs, Max(X,Y) the larger of X and Y, and k a constant (k=5/6 in the present case). The circuit had good positioning performance at a counting rate up to 360 kcps at least.

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HIGH COUNTING RATE AND CHANCE COINCIDENCE CHARACTERISTICS AS A FUNCTION OF TIME WINDOW IN POSITRON CT "POSITOLOGICA" FOR HEAD STUDIES. T.Tomitani,H.Murayama,N.Nohara, E.Tanaka and Y.Suda. National Institute of Radiological Sciences. Chiba.

Chance coincidence is a source of spurious events in positron CT. Chance coincidences can be measured separately by delayed coincidence channel and can be subtracted from prompt coincidence data. Subtraction of chance coincidence increases variance. Relative variance of true coincidence rate, Nt, is calculated to be

$$\mathrm{var}\, Nt/\overline{Nt} = (1 + fg^2 t\overline{Nt})/\overline{Nt}$$

where f and g denote coincidence fan fraction, single-to-true ratio, respectively. At chance coincidence rate equal to Nt, relative variance increases by a factor of 2. Due to the lack of any structure in chance coincidence data, smoothing is applicable to it after correction of sampling density and detection efficiency, which will improve statistics. In POSITOLOGICA, coincidence time window can be controlled by a single D.C. voltage remote to fast eletronics simultaneously. Dependencies of chance coincidence rate and detection efficiency on time window were measured. Chance coincidence rate is proportional to time window as predicted. Time window can be set as low as 10nS at a cost of only 10% efficiency loss compared to 20nS window setting. Counting rate performance experiment assured that it works at counting rate of 100kcps.

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IMAGE RECONSTRUCTION SOFTWARE OF POSITOLOGICA: A POSITRON COMPUTED TOMOGRAPH FOR HEAD. M.Endo, Y.Suda, T.A.Iinuma, Y.Tateno, M.Yamamoto, T.Tomitani and E.Tanaka. National Institute of Radiological Sciences. Chiba.

We reported an outline of image reconstruction software of POSITOLOGICA and in particular effects of correction functions on the reconstructed images. In our system correction functions are given by convolution between the Shepp-Logan's correction function and the Gaussian smoothing functions whose widths are continuously variable. The full widths at half maximum of point spread function of reconstructed image is 7.8 mm for the non-smoothing correction function (Shepp-Logan function), while they are 8.3, 10.1 and 12.6 mm for the light, medium and heavy smoothing function respectively. The percent standard deviation of the disk source (20 cm diameter) is 16% for the non-smoothing function when the number of true coincidence is 10 Mc, while they are 7.8 %, 3.3 % and 2.0 % for the light, medium and heavy smoothing function respectively.