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PERFORMANCE OF A TIMING DISCRIMINATOR FOR A BGO SCINTILLATION DETECTOR USED IN A POSITRON CT.

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A timing discriminator for a BGO (bismuth germanate)scintillation detector was designed and constructed. Having high gamma ray detection efficiency and photopeak efficiency, BGO scintillators are useful for detectors of positron imaging devices. The timing properties of BGO scintillators for 511 keV annihilation gamma rays, however, are restricted by the slow scintillation decay (300 ns) and the small photoelectron yield at the initial stage of the scintillation (about 0.5 photoelectrons/ns in our detectors). For the time pick-off having good time resolution and count rate performance, the first photoelectron detection method was applied and adequate pulse shaping was accomplished.

Combined with a BGO crystal (12mm×20mm×26mm) optically coupled to a 29mm diameter photomultiplier tube (PM1980), the timing discriminator was used as a detector unit of a positron CT device. The time resolution for 511 keV photon pairs in the two detectors with discrimination level of 350 keV was 5.2 ns and 10.3 ns for FWHM and FWTM, respectively, at low counting rates and 6.8 ns for FWHM at a singles countrate of 100 kcps.

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DETECTOR SYSTEM OF POSITRON ECT FOR BRAIN STUDIES: POSITOLOGICA.

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A positron ECT device for brain studies has been constructed. It consists of 64 12x20x26 mm BGO detectors mounted on a circular gantry which rotates continuously at a speed of 1 rps or less. The detectors are arrayed on the circle of 44 cm in diameter with non-uniform spacing which has been determined by a computer iteration to provide a reasonable uniformity in linear sampling with its interval of 2 mm. Another advantage gained with such a simple gantry motion of rotation is high "detector redundancy" which reduces the effect of changes in detector efficiency on a reconstructed image, because each point of the linear sampling is formed by many pairs of coincident detectors. The device has a field of view of 23 cm in diameter with a single slice the thickness of which is variable from 1 to 2 cm. The resolution in reconstructed images is about 7 mm FWHM in the central region which is mainly set from the width of the crystals used, 12 mm.

Preliminary images with line source phantoms and a volunteer intravenously injected $^{13}NH_3$ were demonstrated.

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DESIGN AND DEVELOPMENT OF ELECTRONICS FOR POSITRON EMISSION CT DEDICATED TO HEAD STUDIES.

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In design of electronics for positron CT, coincidence timing of around 10ns is required in case of bismuth germanate scintillator. To attain speed requirement, ECL(Emitter Coupled Logic) were adopted throughout coincidence and crystal address encoding circuits.

64 crystals are subdivided into 8 groups each of which contains 8 crystals and coincidences are performed among such 8 groups. As such, with fan angle of 60°, total coincidence pairs are reduced to 20 in place of 736 pairs out of 64 crystals with straight forward method. Crystal address pairs in coincidence are encoded in three steps, i.e. crystal address encoding within a group, group address encoding and crystal address multiplexing.

Chance coincidence limits high counting rate performance of the system because of low true-to-gross counting rate ratio. With the incorporation of delayed coincidence, chance coincidence can be subtracted from on-time coincidence data. Another problem at high counting rate is multiple event coincidence, which can be effectively eliminated by means of two-fold multi-event rejector.

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A SELF-ABSORPTION CORRECTING -RAY SOURCE.

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A rotating -ray source for the correction of the self-absorption and of the variation of the detectors' sensitivity in the image reconstruction of a positron annihilation -ray emission CT was explained. A small area -ray source orbitally rotating around the object is identical in effect to a circular -ray source with uniform radioactivity so long as it rotates with constant speed. A good uniformity of the source intensity along the ring is easily obtained by this simple mechanism.

The method expanding this principle to an ECT with continuously rotating detectors was proposed. It can be done by rotating a small source whose length tangential to the circle of rotation is 1/N (N is a positive integer) of the length of the circumference of the rotating orbit. And if the source is turned M times (M is an integer having no common measure with N) in a period that the detectors rotate N times, an effectively uniform ring source is realized. The correction data acquisition is made in the time or its multiples that the detectors turn N times.