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MONTE CARLO CALCULATIONS OF THE DETECTION EFFICIENCY AND THE SPATIAL RESOLUTION OF ARRAYS OF CLOSE PACKED BGO DETECTORS FOR 511 KEV PHOTONS. H.Murayama,E.Tanaka,N. Nohara and T.Tomitani. National Institute of Radiological Sciences. Chiba.

Detection efficiency and response of linear arrays of close packed BGO detectors to 511 keV annihilation photon beams were determined to permit the selection of detector design for positron emission tomographs with high sensitivity. A Monte-Carlo computer procedure was used to determine the dependency of detection efficiency and response on detector width. Evaluations were made with BGO crystals for 24 mm high and 24 mm long, for width from 2 to 20 mm, and for incident angles of annihilation photon beams from 0 to 30 degrees. The computor code traces the Compton and photoelectric interactions of 20,000 annihilation photons uniformly incident on an infinite linear array of BGO detectors for each photon beam of infinitesimally narrow width. The event is accumulated as a successful detection in one detector if an incident photon deposits more than the threshold energy of 350 keV in it. Decrease of detection efficiency for small crystal width is overcome by summing the depositing energy in the adjacent crystals and regarding the smaller of them as a positioning signal under the condition that the summing energy is more than the threshold energy.

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EVALUATION AND FEASIBILITY OF HIGH RESOLUTION POSITRON EMISSION COMPUTED TOMOGRAPHS. N.Nohara,E.Tanaka,T.Tomitani and H.Murayama Division of Physics, National Institute of Radiological Sciences, Chiba.

Performance of positron emission computed tomographs aiming at spatial resolution as high as 3 mm FWHM was evaluated. The slice thickness should be thin in accordance with the transverse resolution. The use of small BGO crystals results in decrease of sensitivity and deterioration of time resolution. Event rates such as singles, unscattered true coincidence, single and double scattered coincidence events were estimated for detector rings from 25 to 100 cm in diameter and for slice thicknesses from 0.5 to 2 cm. Wedged slice collimator was also evaluated, which results in increase of sensitivity. A high resolution positron tomograph with small detector rings may be feasible with application to animal studies. Deterioration of time resolution due to decrease of crystal width was evaluated by estimation of light output from BGO crystal. Light output is given as a function of optical coupling efficiency, which is defined as the ratio of the optically coupled area of photocathode to the total surface area of the crystal.

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DEVELOPMENT OF A REFINED MODEL OF WHOLE-BODY POSITRON EMISSION COMPUTED TOMOGRAPH. K.Ueda,K.Okajima,K.Takami,A.Ohgushi*,S. Inoue*,Y.Takakusa*,K.Ishimatsu*,T.Hayashi** and E.Tanaka***. Central Research Laboratory, Hitachi, Ltd., Kokubunji. *Hitachi Medical Corporation, Kashiwa. **Hamamatsu TV Co., Hamamatsu. ***National Institute of Radiological Sciences, Chiba.

A whole-body positron emission computed tomograph has been developed in our project (presented separately). A more refined demonstration model, which is virtually a commercial model, is under construction. The system has a continuously rotating gantry which includes 4 detector rings, and provides 7 slice images simultaneously. Effective field of view is 450 mmϕ x 120 mm with a 540 mmϕ opening of patient port. Each detector ring consists of 192 BGO crystals, where a pair of 12 x 24 x 24 mm^3 BGO crystals is optically coupled to newly developed dual rectangular photomultiplier tube (PMT). Matching in shape between the crystals and PMT made it possible to design the system with better timing and spatial resolution properties remaining high packing ratio. Collimator system and coincidence circuits design were refined to reduce accidental coincidence rate, and improve sensitivity and axial resolution of cross-layer images. This work was carried out under contract with the Agency of Industrial Science and Technology, Ministry of International Trade and Industry.

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STUDY ON GAMMA-RAY DETECTOR ARRANGEMENT FOR WHOLE-BODY MULTISLICE POSITRON CT. K.Okajima, K.Ueda, K.Takami, A.Ohgushi*, S.Inoue*, Y.Takakusa*, K.Ishimatsu* and E.Tanaka**, Central Research Laboratory Hitachi, Ltd., Kokubunji, Tokyo. * Hitachi Medical Corp., Kasiwa, Chiba. ** National Institute of Radiological Sciences, Chiba.

In positron CT's, many scan methods have been proposed to improve spatial resolution and to reduce statistical noise. These methods include a wobble scan, a rotary scan with an unequally-spaced detector array(1), etc. The rotary scan method is employed in our system for a uniform linear sampling density distribution to reduce statistical noise and the detector arrangement is determined by computer simulation.

The detectors in each ring are divided into 8 groups (24 detectors/ring) and each detector is coincidenced with those belonging to 3 opposite groups. Because of a smaller coincidence fan fraction (f=3/8) than in the Positologica II, accidental coincidence events are reduced, thus improving the counting rate characteristics.

This work was carried out under contract with the Agency of Industrial Science and Thechnology, the Ministry of International Trade and Industry.

(1) M.Yamamoto;Phys.Med.Biol.,Vol.26, No.3,pp489-499(1981).