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TWO DETECTOR MWPC POSITRON CAMERA WITH HONEYCOMB LEAD CONVERTERS FOR MEDICAL IMAGING: PERFORMANCE AND DEVELOPMENTS

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TWO DETECTOR MWPC POSITRON CAMERA WITH HONEYCOMB LEAD CONVERTERS FOR MEDICAL IMAGING: PERFORMANCE AND DEVELOPMENTS. V. Perez-Mendez, C.B. Lim, D. Ortendahl, R. Hattner, L. Kaufman and D.C. Price (Lawrence Berkeley Laboratory and Radiology Department, University of California, San Francisco, CA).

A Multiwire Proportional Chamber (MWPC) camera for Emission Tomography with positron emitting isotopes has been built (1,2). The coincident 511 KeV gammas are detected by their interaction with lead-on-plastic honeycomb converters coupled to planar MWPC detectors with sensitive area 48 x 48 cm^2 placed 50 cm apart with clear space in between for the patient (Fig. 1). Each detector box has two MWPC: the innermost MWPC are coupled to two converters, while the outer ones have only 1 converter. This configuration leads to an effective sensitivity of 1600 coincidence cts./min./μCi. for a source placed in the center of the median plane between the detectors. With the present electronics and lead-on-plastic honeycomb converters (Fig. 2a) the spatial resolution is 8 mm FWHM and the event rate at which images are taken with the camera is 30,000-40,000 events/min. The camera can be improved both in maximum event rate and spatial resolution by changing the dimensions of the converters. Decreasing the aperture size of the converters for the same thickness of lead wall leads to an increase in detection efficiency and hence improved count rate, as well as a decrease in the FWHM of the spatial resolution (3). We are continuing to investigate the use of surface conducting glass tube arrays with high concentrations of lead oxide (50% or more) and with hole size between 1.5 and 2 mm. Fig. 2b shows the expected detection efficiency of various converters as a function of lead content and wall thickness. Alternative techniques under investigation are the use of etched hole patterns on stacks of thin lead-antimony (4) or tungsten sheets (5). All of these gamma converters can be made with hole sizes 1.5-2.0 mm, compared to the 3.5 mm of the present honeycomb converters.

Other factors which contribute to image degradation are multiple scattering of the 511 KeV gammas in the converters; effects of this are seen in the images of point sources which have long tails outside the main peak. Electronic techniques which we have developed (6) are capable of rejecting over 95% of these scatter events. Data acquisition at high rates introduces a background distribution in the images due to accidental coincidence events of two 511 KeV gammas not originating from the same positron annihilation. Duplicate electronics, which is being implemented, can map out this accidentals distribution and will allow us to make a properly normalized pixel by pixel correction.

These modifications, when implemented in a new camera, are expected to yield a sensitivity and event rate a factor of 10 better than the present camera. The spatial resolution is expected to be between 4-6 mm, depending on the amount of scatter within the object.

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REFERENCES

1. Lim C.B., Chu D., Perez-Mendez V., Kaufman L., Hattner R., Price D.C.: Initial results of MWPC Positron Camera. IEEE Trans. Nuc. Sci. NS-22:388-394, 1975.

2. Perez-Mendez V., Kaufman L., Lim C.B., Price D.C., Blumin L., Cavalieri R.: Multiwire Proportional Chambers in Nuclear Medicine: present status and perspectives. J. Nuc. Med. and Biol. 3:29-33, 1976.

3. Chu D., Tam K.C., Perez-Mendez V., Kaplan S.N., Lim C.B., Hattner R., Kaufman L., Price D.C., Swann S.: High efficiency gamma converters and their applications in a MWPC Positron Camera. Proc. IAEA Symposium on Medical Radionuclide Imaging, Los Angeles, CA, Oct. 1976, 171-193.

4. Jeavons A.P., Townsend D.W., Ford N.L., Kull K.: A high resolution Proportional Chamber Positron Camera and its applications. IEEE Trans. Nuc. Sci. NS-25:164-173, 1978.

5. Charpak G. (CERN), private communication.

6. Ortendahl D., Tam K.C., Perez-Mendez V., Lim C.B.: Elimination of image blurring due to double scatter events in γ-imaging detectors. IEEE Trans. Nuc. Sci. NS-25:148-151, 1978.

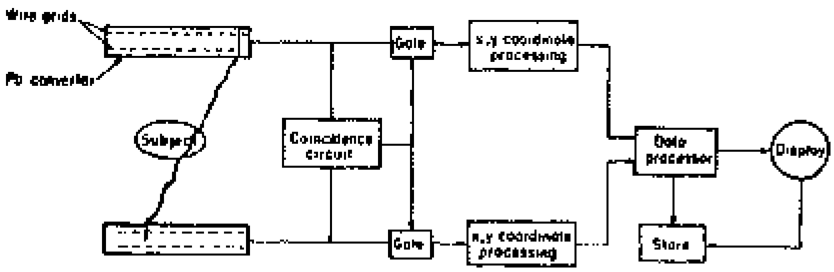
FIGURE CAPTIONS

Fig. 1: (A) Schematic configuration of large area MWPC positron camera. Only coincidence counts between the two detectors are stored into the data processor.

(B) Schematic view of one MWPC with two gamma converters. Electrons produced by gamma interactions in the lead of the converters are drifted into the sensitive region between the wire planes, where they are amplified and their position is recorded.

Fig. 2: (A) Photograph of a section of a honeycomb lead converter. Lead layers 100μ thick are plated onto copper-backed plastic which is etched into 4 separate bands. The electric field created by suitable voltages drifts the electrons into the chamber. The converter is 15 mm high with 3.5 mm holes. The gamma detection efficiency is 3.3%.

(B) Calculated efficiencies for lead glass converters as a function of wall thickness, for an assembly 15 mm high and with 2 mm I.D. tubing.



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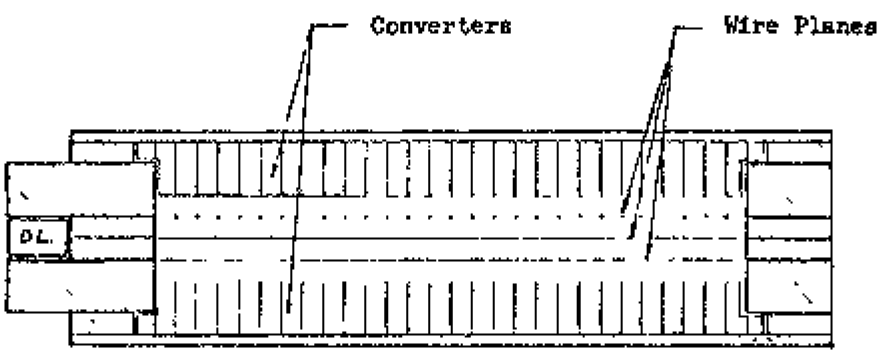
A



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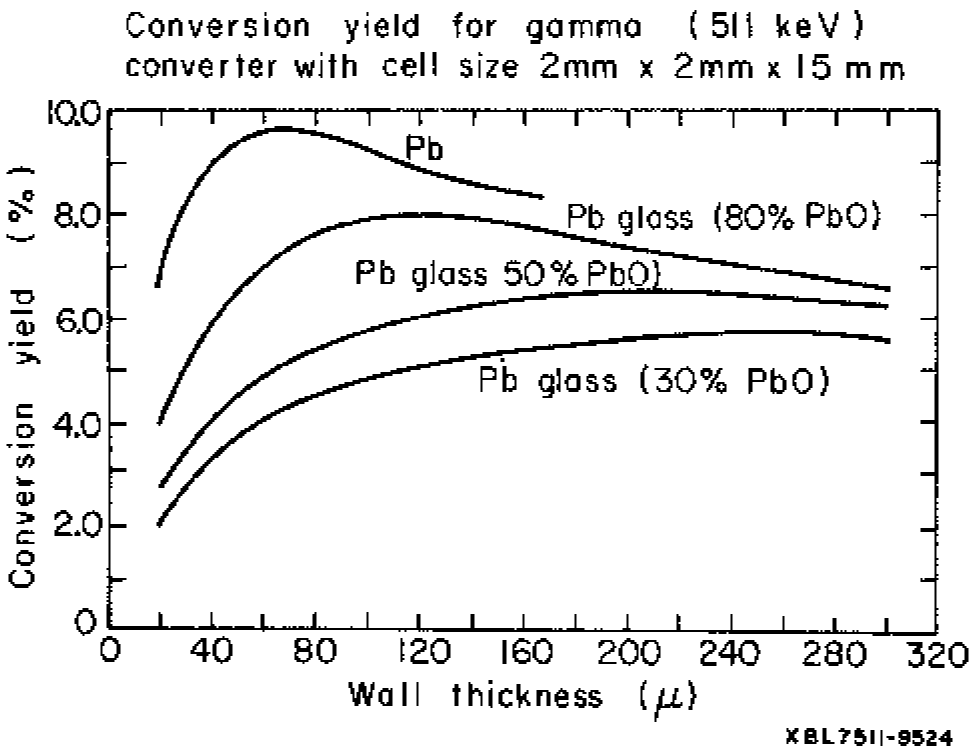
B

FIGURE 1

A



Conversion yield for gamma (511 keV)
converter with cell size 2mm x 2mm x 15 mm
Pb
Pb glass (80% PbO)
Pb glass 50% PbO)
Pb glass (30% PbO)
Conversion yield (%)
10.0
8.0
6.0
4.0
2.0
0
0
40
80
120
160
200
240
280
320
Wall thickness (μ)
XBL7511-9524

B

FIGURE 2