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AV-RAY DETECTOR EMPLOYING MULTIPLE SCATTERING SEPARATION OF ELECTRON PAIRS

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A γ-RAY DETECTOR EMPLOYING MULTIPLE SCATTERING SEPARATION OF ELECTRON PAIRS

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Berkeley, California

A γ-RAY DETECTOR EMPLOYING MULTIPLE SCATTERING SEPARATION OF ELECTRON PAIRS

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October 24, 1951

In connection with experiments to detect γ-rays from the decay of neutral pions in the presence of a large flux of neutrons and charged particles, a simple electron pair counter has been developed which depends on multiple scattering instead of deflection by a magnetic field to separate the pairs.

The operation of this counter depends on the fact that the electrons in a pair which have nearly the same initial direction are scattered independently in the converter. If the converter is sufficiently thick the average angle between the emerging electrons is large enough so that they can be detected by adjacent counters in coincidence. Because of the random rature of this process the two electrons of a pair formed on the axis of the system will pass through adjacent counters one half of the time and will pass through a single counter the other half of the time provided the counters are large enough to include all electrons.

The apparatus used is shown in Fig. 1. Each of the adjacent detectors mentioned above consists of a two counter telescope. Telescopes were used instead of single counters to eliminate single particle background. The counters consisted of 3 cm thick x 5 cm wide x 8 cm high tanks of liquid scintillator viewed by 1P21 photomultiplier tubes. The

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phosphors were separated by the two 0.15 cm thick brass walls of the tanks and by 0.2 cm of air between the tanks. The converter which was placed 2.5 cm in front of the tanks was made of 0.6 cm thick lead and was large enough to cover the area of the counters.

Fig. 2. shows the relative efficiency for counting the γ spectrum from neutral π meson decay as a function of converter thickness. The shape of this transition curve agrees with the expected form for detection of high energy photons. The efficiency for detection of the neutral meson decay γ-ray spectrum at 180° to a target bombarded with 340 Mev protons was the same as the efficiency measured at zero degrees. The peaks of these spectra are located at 60 Mev and 120 Mev respectively.[1] The background remaining when the converter was removed depended on the conditions of operation but was usually less than 1/6 of the counting rate obtained with the 0.6 cm converter in place.

Thin converters of several different elements were used. The counting rates obtained with these converters were found to vary with the atomic number Z, the mass number A, the density ρ, and the thickness X approximately as $\frac{Z^2 \rho X}{A}$ as would be expected if the efficiency depended only on the number of pairs formed.

The highest counting rate was obtained when the converter was 2.5 cm in front of the phosphor tanks.

The absolute efficiency of this device for 100 Mev γ-detection was measured by comparing it with a conventional electron pair counter.[2] Since the actual detection area is not well defined the efficiency can best be stated in terms of an effective area in which all γ-rays would be detected. This effective area was found to be 0.2 sq. cm.

The threshold of the detector is determined by the thickness of the phosphor tanks since both electrons of a pair must pass through the first counters of the telescopes and into the second counters in order to cause a coincidence count. For the 3 cm thick tanks used, a 20 Mev γ which is converted at the surface of the lead can just be detected if the energy is equally divided in the pair. The lower limit of the detection energy may be varied by means of adsorbers between the counters of the telescopes.

The principle advantages of this γ-detector are its relative simplicity and its good discrimination against neutron and charged particle detection.

This work was performed under the auspices of the Atomic Energy Commission.

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1 R. Bjorklund, W . Crandall, B. Moyer, and H. York, Phys. Rev. 77, 213 (1950).

2 W. E. Crandall, to be published.

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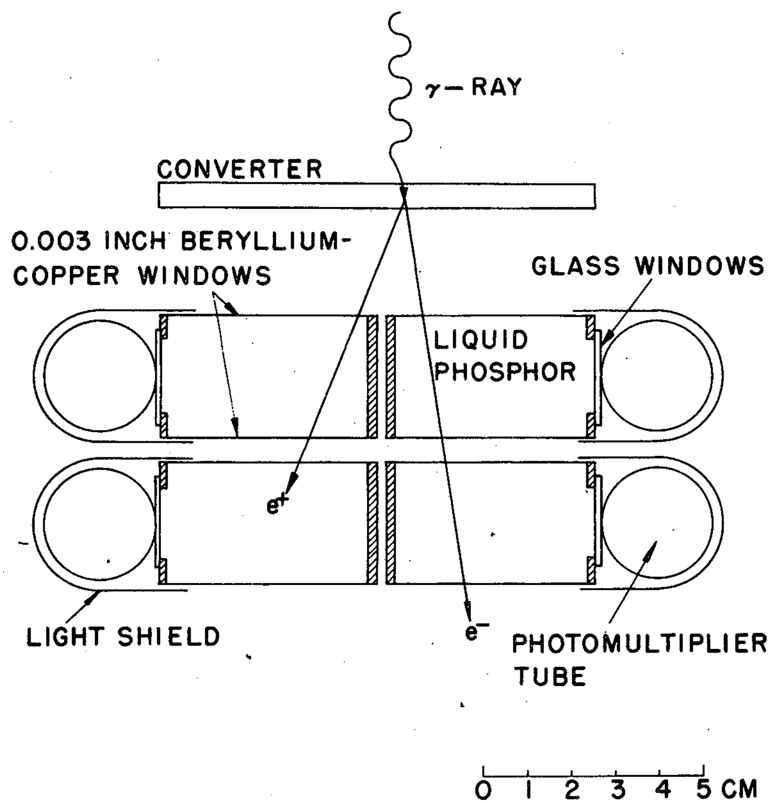

FIG. 1 PLAN VIEW OF DETECTOR

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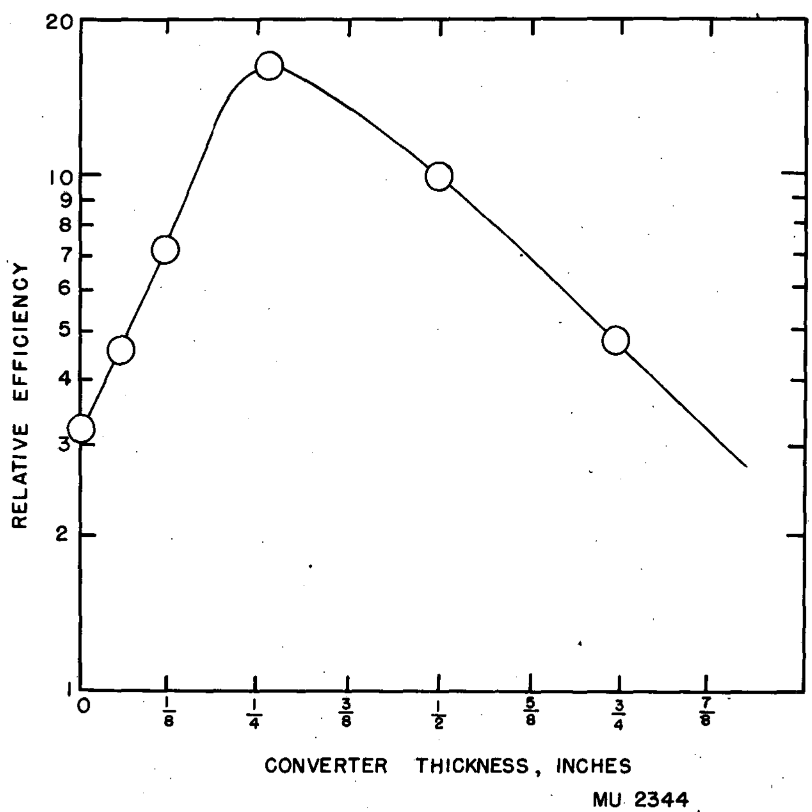

Fig. 2. Relative Efficiency for Detecting 70 Mev γ-Rays as a Function of Converter Thickness.