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PERFORMANCE OF CERENKOV DETECTOR

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PERFORMANCE OF CERENKOV DETECTOR

J. W. Mather and E. A. Martinelli

March 6, 1952

Berkeley, California

PERFORMANCE OF CERENKOV DETECTOR

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A Cerenkov counter (Fig. 1), similar to Marshall's[1], utilizing lucite at the Cerenkov radiator, was constructed at this laboratory. The 320 Mev bremsstrahlung beam of the Berkeley synchrotron was collimated to 1/8 inch diameter for the purpose of determining the effective aperture and angular dependence of the lucite radiator. As a result, the effective aperture is approximately 3/4 inch at half maximum while the angular acceptance at half maximum is 2.5° (Figs. 2 and 3).

At the 184 inch cyclotron, it was possible to obtain an efficiency figure using the gamma ray decay of the neutral meson produced by 340 Mev protons on carbon. Using the $Al^{27}(p,p3n)Na^{24}$ reaction to monitor the proton flux, and determining the activity of Na^{24} with a β counter, and knowing the production cross section for Na^{24}, it was possible to compare the Cerenkov counting rate with an identical experiment performed previously by Crandall[2] et al using the pair spectrometer. Since the efficiency of the pair spectrometer could be calculated, it was felt that the Cerenkov efficiency based thereon would be a reliable figure for 40-130 Mev gamma rays. The overall efficiency, namely the ratio of observed coincidence counting rate to the number

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1. J. Marshall, Phys. Rev. 81, 275 (1951)

2. W. Crandall (Private communication)

of gamma rays incident on the lucite radiator was as high as 21 percent, using the width at half maximum for the effective aperture. However, the absolute efficiency depends strongly on the high voltage applied to the photomultiplier. Hence it is necessary to select a photomultiplier that can operate at a high voltage with a corresponding low noise component.

Part of the experiment consisted of measuring a transition curve with copper and lead as the materializer for the gamma rays. Using the gamma rays from neutral meson decay, characteristic curves were obtained for the attenuation part of the curve, but the transition from no copper and lead to the peak of the transition curve was at most a factor of 2-3 at a converted depth from 1/8 inch to 1/4 inch copper and 1/16 inch to 3/16 inch lead. Although lucite is not a good converter for gamma rays, the Z^2 effect of pair production for the converter and lucite is offset by the Z dependence of multiple scatterings in both materials. Since the Cerenkov detector has a sharp angular dependence, the multiple scattering tends to cancel the increased pair production. As a result, it is reasonable to expect the transition part of the curve for copper and lead to reach the same maximum value, but displaced with respect to each other.

A fast coincidence circuit, utilizing crystal diodes (based on the principle outlined by Bay[3]) was developed further by Neher[4] and was used throughout with limited pulses. By employing 30 cm. clipping lines at the output of the limiter, a resolving time of 3×10^{-9} sec. was obtained. This gave better limiting action, since Cerenkov photon

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3. Z. Bay, R.S.I. 21, 297 (1951)

4. L. Neher (Private communication)

intensity is appreciably lower than that from a scintillation crystal.

Two selected 1P21 photomultiplier tubes were used in coincidence operating at approximately 1400 volts. No plateau of counting rate versus voltage was obtained, but a definite slower rise was indicated which was not regarded as significant.

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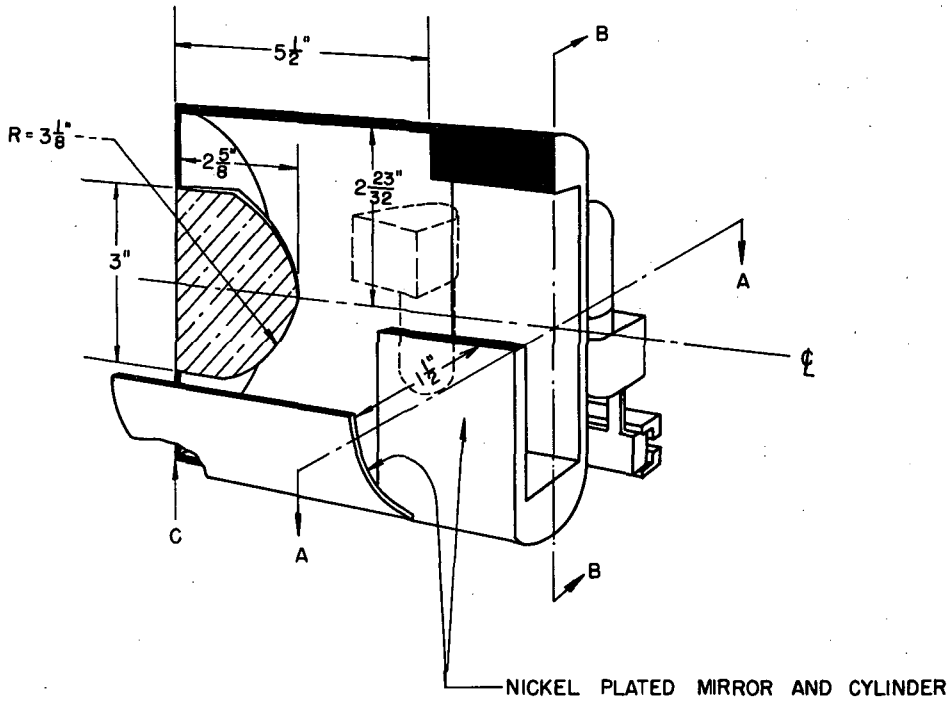

FIG. 1

CROSS SECTION OF ĈERENKOV DETECTOR

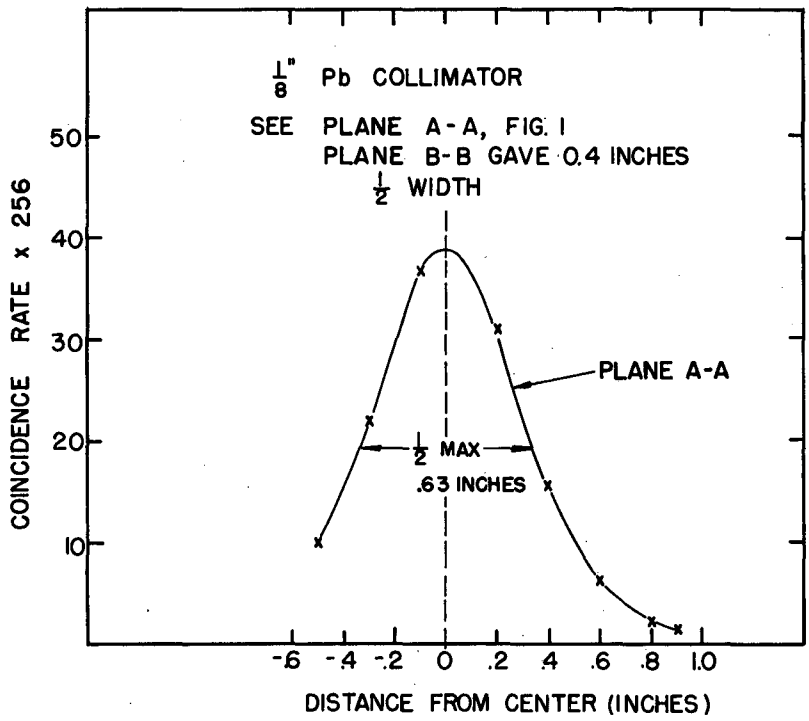

FIG. 2
VARIATION OF RESPONSE ACROSS DIAMETER
OF LUCITE RADIATOR

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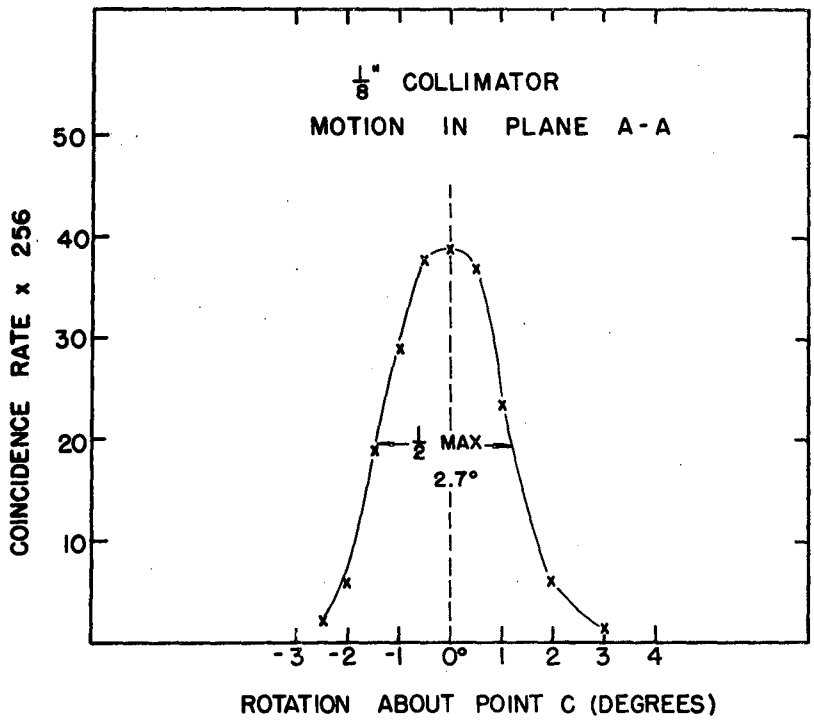

FIG. 3

VARIATION OF RESPONSE UNDER ROTATION OF COUNTER ABOUT POINT C

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