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THE DETECTION OF ARTIFICIALLY PRODUCED PHOTOMESONS WITH COUNTERS

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March 8, 1950

Berkeley, California

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Until recently, artificially produced mesons were detected only in photographic plates. Alvarez was the first to detect at least the positive mesons with counters.[1] This technique, which depends on the decay electron for the identification of the meson, was first introduced by Rasetti[2] in the study of cosmic ray mesons. It has been extensively used in cosmic ray research, and has now, with some modifications, been applied to the photomesons produced by the synchrotron.

When a positive π-meson comes to rest, it disintegrates very quickly into a μ-meson, and this in turn into an electron with the well-known 2.1×10^{-6} sec. mean life. The range of the μ-meson is only $\sim .2$g, so that when this process takes place in a scintillation crystal with linear dimensions of the order of several centimeters, a large fraction of the decay electrons will also appear in the crystal. The $\pi \rightarrow \mu$ decay is too rapid to be resolved in the electronics of the experiment; instead, the characteristic half life of the $\mu \rightarrow e$ decay is used to identify the meson. 2/3

The apparatus is sketched in Fig. 1. A meson is counted if it produces pulses simultaneously in crystals I and II, but not in crystal III, and if its decay electron falls into one of several successive

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[1] L. W. Alvarez, A. Longacre, V. G. Ogren, R. E. Thomas, Bull. Am. Phys. Soc., Vol. 24, No. 7.

[2] F. Rasetti, Phys. Rev. 60, 198 (1941).

delay channels of about 2 x 10^{-6} sec. time width. There will, of course, be accidental delayed coincidences, but these can be calculated from the known single counting rates, gate width, and duty cycle, and can therefore be subtracted. Usually this background is approximately 10 - 20 percent of the counting rate in the first channel.

After the background subtraction, the counting rates in the several delay channels should reproduce the exponential μ - e decay. The lifetime data so far obtained are plotted in Fig. 2.

The stability of the detecting system depends on the sensitivity of the meson counting rate to the pulse height of the three scintillation pulses. One of these plateau curves is shown in Fig. 3.

With the usual synchrotron beam intensity of about 10^4 ergs/sec, and the geometry of Fig. 1, the meson counting rate is about 15 counts/min. This makes it possible to do experiments more quickly than with photographic emulsions. On the other hand, so far only positive mesons can be counted in this manner, and absolute cross sections measurements have a large error, since the detection efficiency is not known with precision.

We should like to express our thanks to Professor E. McMillan for his support of this research, and to the operating crew of the synchrotron, especially to Mr. W. Gibbins, for its expert help.

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Figure Captions

Fig. 1 Arrangement of target, absorbers, and meson detection scintillation counter telescope.

Fig. 2 Relative counting rates in the delayed channels. Two sets of data are shown because three channels were used at first, later four.

Fig. 3 Counting rate in crystal II (points without statistical error) and meson counting rate (with mean statistical error indicated) as a function of the minimum voltage required of the first pulse in crystal II.

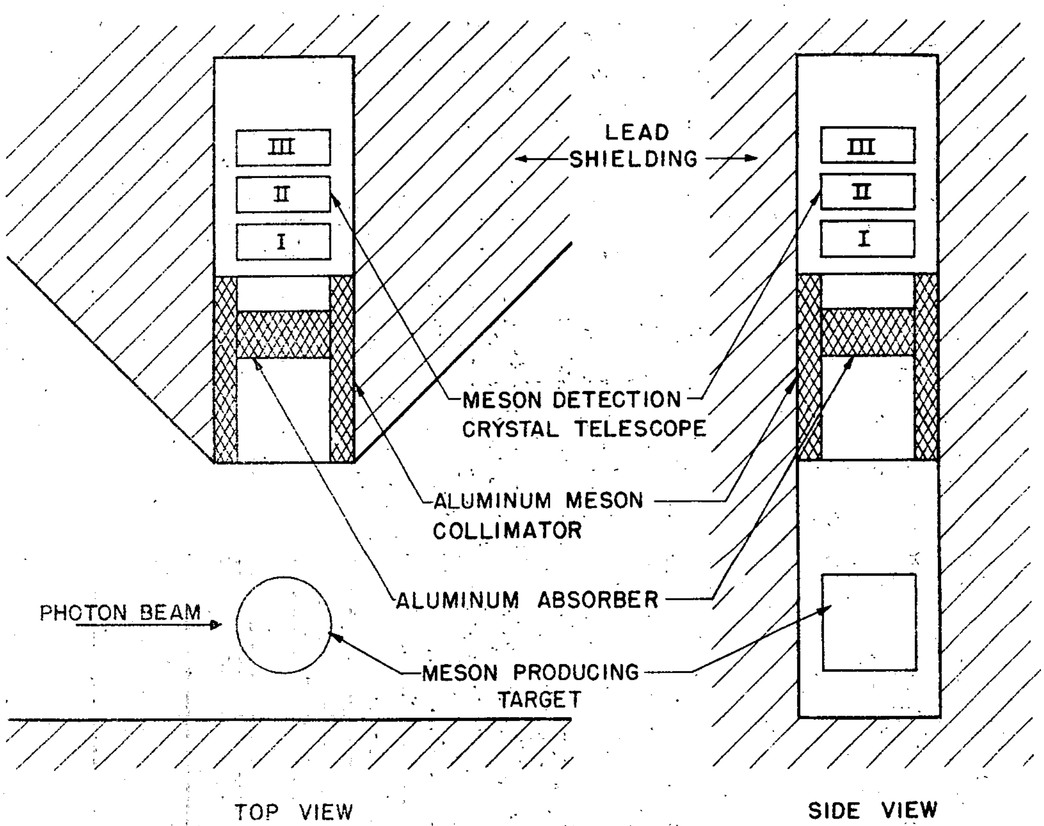
LEAD SHIELDING
III
II
I
MESON DETECTION CRYSTAL TELESCOPE
ALUMINUM MESON COLLIMATOR
ALUMINUM ABSORBER
PHOTON BEAM
MESON PRODUCING TARGET
TOP VIEW
SIDE VIEW

FIG. I

Mu 67

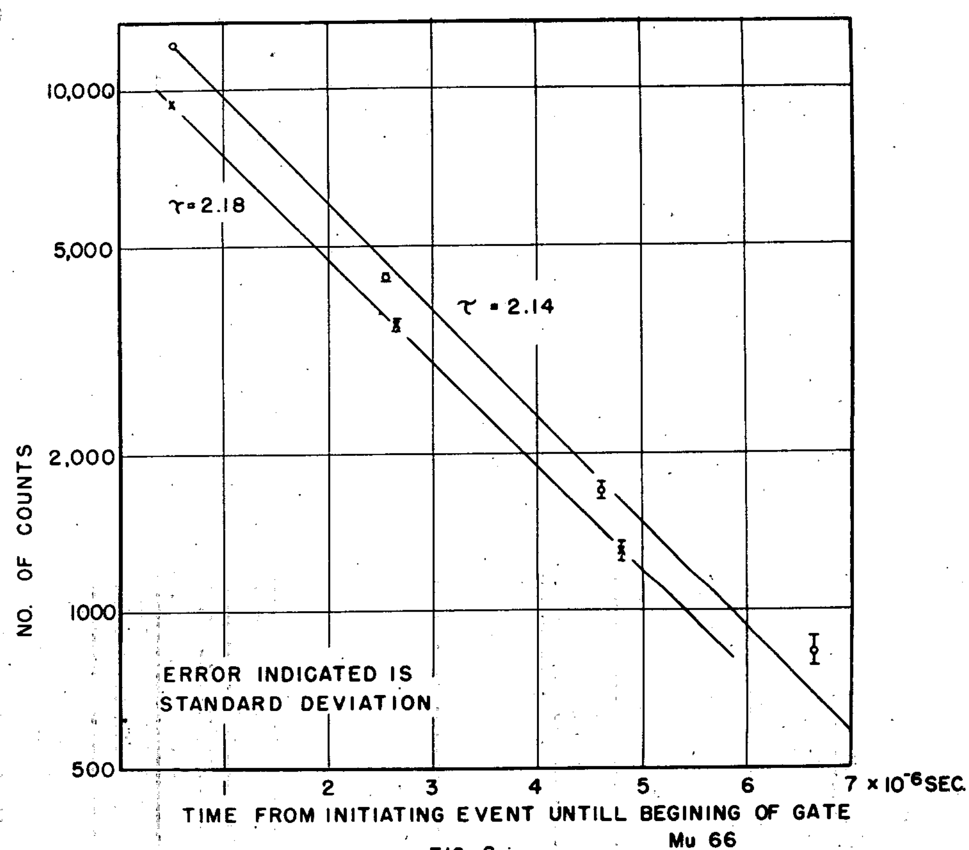
10,000
5,000
2,000
1000
500
NO. OF COUNTS
τ=2.18
τ = 2.14
ERROR INDICATED IS
STANDARD DEVIATION
1
2
3
4
5
6
7 x 10⁻⁶ SEC.
TIME FROM INITIATING EVENT UNTILL BEGINING OF GATE
Mu 66

FIG. 2

14531-1

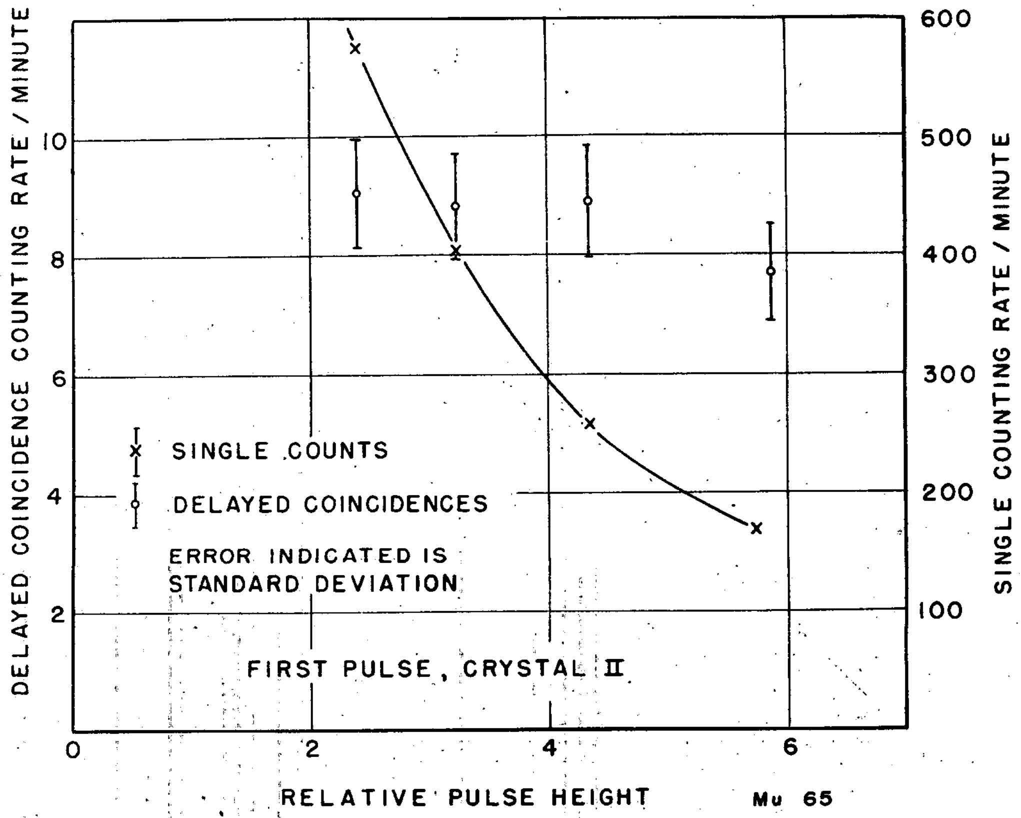
DELAYED COINCIDENCE COUNTING RATE / MINUTE
SINGLE COUNTING RATE / MINUTE
10
8
6
4
2
600
500
400
300
200
100
0
2
4
6
SINGLE COUNTS
DELAYED COINCIDENCES
ERROR INDICATED IS
STANDARD DEVIATION
FIRST PULSE, CRYSTAL II
RELATIVE PULSE HEIGHT
Mu 65

FIG. 3

14497