Title

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I. INTRODUCTION

The experiment performed is very similar in most of its essential details to that described in the attached paper (Experimental Study of K^+_{e4} Decay, Phys. Rev. 139, 6B, B1600, 1965). This paper will only describe the differences between our current work and the previous work. In order to make these as clear as possible, the organization of the paper will be the same. We present figures 5 - 9 with our new data and also the sum of old and new data. The data we present here is preliminary and is based on about one-half of the film.

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* - Now at University of Pennsylvania, Philadelphia, Pennsylvania.

II. PROCEDURE

A. Beam and Chamber

A total of 530,000 pictures containing 13×10^6 stopping K^+ was taken at the CERN P.S. in the CERN Heavy Liquid Bubble Chamber. The chamber was filled with C_2F_5Cl which has a density of 1.18 gm/cc and a radiation length of 25 cm under working conditions. The film was divided equally between the three institutions.

B. Scanning

The scanning criteria were the same as before. For normalization purposes τ were scanned for every 50 frames on all rolls of film.

The scanning criteria produced ~1500 events which were measured after being examined by physicists.

C. Selection Criteria for K_{e4} (e^+)

1. Collinear τ Decay

The selection criteria were the same as before with the exception of the dip criterion on the π^-. This was changed from 60° to 70° in view of the larger stereo angle of the cameras. No criteria was applied at the scanning stage to the projected length of the π^-.

D. Losses

1. Scanning Efficiency for K_{e4} Decays

The scanning efficiency for the first scan was 75 ± 10%. This was determined by rescanning about one-eighth of the film.

2. Scanning Efficiency for τ Decays

Every fiftieth frame in the film was scanned for τ's. The overall scanning efficiency for τ's was calculated to be 96 ± 1%.

3. Real K_{e4} Events Rejected by the Selection Criteria

The real K_{e4} events rejected by the selection criteria were calculated as before except that because of the large dimensions of the chamber the tracks were much less likely to escape. This made corrections (e) and (f) negligible. The correction to the invariant mass plot and angular plots due to our rejection of all events with a π^- range less than 4 mm was obtained from our 1000 Monte Carlo generated events.

E. Selection Criteria for K_{e4} (e^-) Candidates

The criteria are the same as before, however since the chance of either pion leaving the chamber is less than 2%, this essentially does not change the detection efficiency, however the rejection of events where one π^+ is very steep and short and decays without the μ^+ being visible as being τ' with a Dalitz pair reduced the detection efficiency for K_{e4} (e^-) to about 90% of that for K_{e4} (e^+). No K_{e4} (e^-) passed all the selection criteria.

III. RESULTS

A. K_{e4} Branching Ratios

Since this data is preliminary and is based on an incomplete scan of the film, we are not quoting a rate. However, our rate appears to be compatible with the previous measurement.

B. $\Delta Q = \Delta S$ Rule

No events of the type $K^+ \rightarrow \pi^+ + \pi^+ + e^- + \nu$ have been found. Since the normalization of the experiment has not been accurately determined, an accurate upper limit to X cannot be quoted. We have scanned approximately twice as many stopping K^+ as in the previous experiment but due to the fact that only one-eighth of the film has been rescanned, our overall scanning efficiency is somewhat lower. Thus, it would appear that the upper limits of X in this section of the previous paper have been lowered by about a factor of two, i.e. $X < 0.13$.

C. $K_{\mu 4}$ (μ^-) Branching Ratio

This decay mode was not searched for in this experiment.

D. Analysis of Correlations

The analysis was performed in the same way as before.

1. π-π Invariant-Mass Distribution

Figures 5a and b show the distributions of the invariant-mass of the two pions, (R), for (a) our 139 new events and (b) 139 new events plus the 69 events from the previous paper. The shaded events in Fig. 5 represent the correction due to the modified cut on the π^- range as determined from our Monte Carlo events.

In the π-π invariant-mass plots, the fitted curves are the same as shown in Fig. 5 of the previous paper.

The χ^2's for the new data shown in Fig. 5a are: 1) 5.0, 2) 2.4, 3) 44, 4) 25.2 and 5) 15.9 for four degrees of freedom. The corresponding numbers for Fig. 5b (sum of previous and new data) are: 1) 0.8, 2) 2.3, 3) 153, 4) 23.3, and 5) 6.6. From this it can be seen that 1, 2 and possibly 5 have a good chance of fitting, which 3 and 4 do not.

2. Angular Correlations

Figures 6a, b and 7a, b show the distributions of $\cos\Theta$ and Φ. The curves shown are the best fit to the forms $1 + a\cos\Theta$ (from -1 to +.8) and $1 + b\sin\Phi$ with $a = .87 \pm .19$ and $b = .15 \pm .13$ for the new data, and $a = .86 \pm .15$ and $b = .19 \pm .11$ for the combined data. The events cut out by the low energy cut on the π^- are in the region

$.8 \leq \cos\Theta \leq 1$. They do not appear to bias the Φ distribution.

$\delta_0 - \delta_1$ from new data = 21 ± 18^o *

$\delta_0 - \delta_1$ from old + new data = 27 ± 18^o

η from new data = $1.16 \pm .28$

η from old + new data = $1.2 \pm .25$

a_o from new data = 0.9 ± 1.0

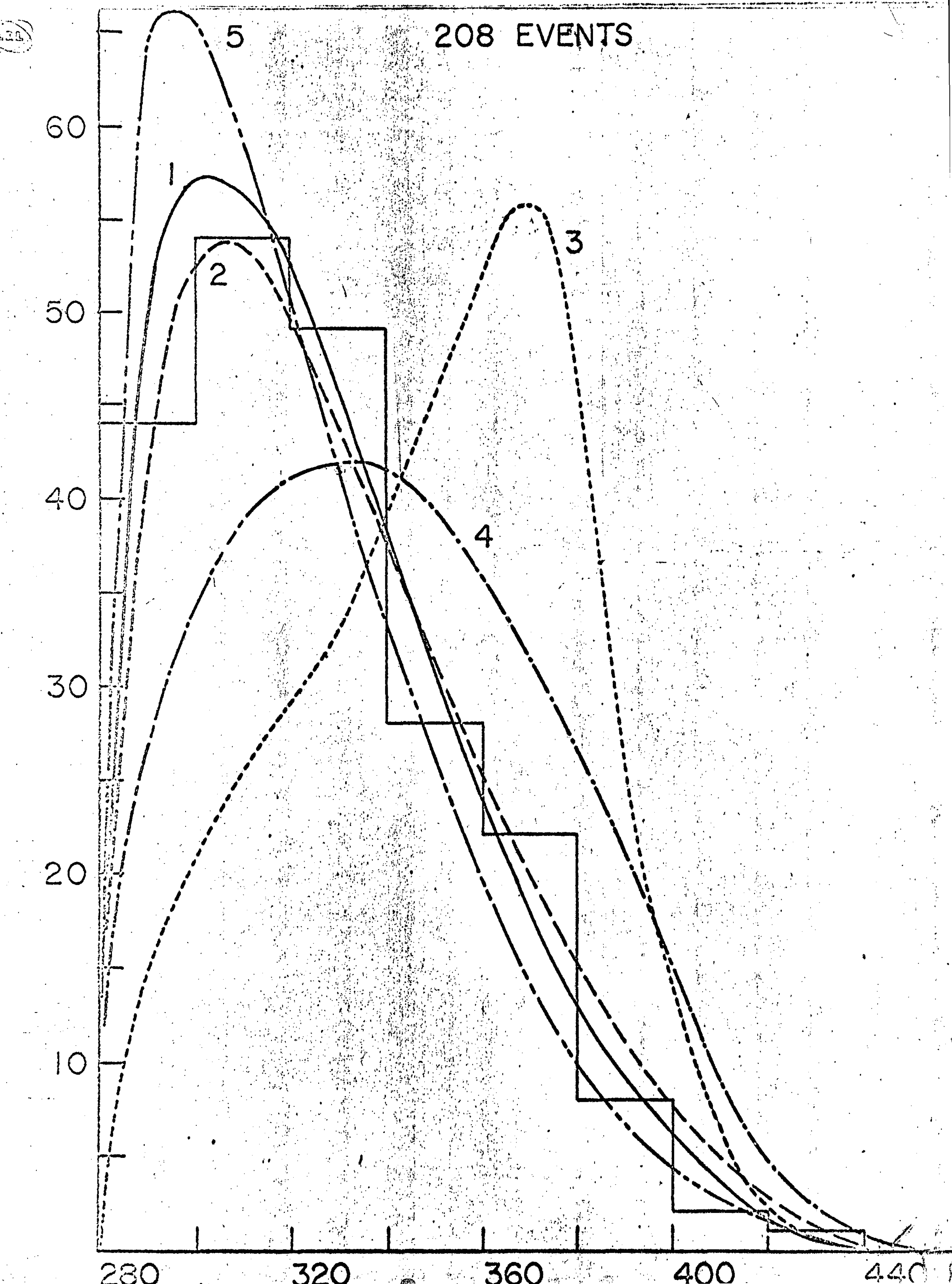
a_o from old + new data = 1.2 ± 1.0

The presence of a correlation in Φ of the form $1 + c \cos\Phi$ would indicate interference between axial vector and vector currents. We find $c = .12 \pm .13$ for the new data, and $c = .106 \pm .11$ for the combined data.

Figures 8a, b and 9a, b show the dilepton invariant-mass plot and the angle between the two pions in the laboratory system.

* These figures were obtained using the angular correlations only.

Revised figures from a maximum likelihood program, fitting the invariant mass plot as well as the angular correlations simultaneously, will be given at the Conference.



208 EVENTS
1
2
3
4
5
60
50
40
30
20
10
280
320
360
400
440

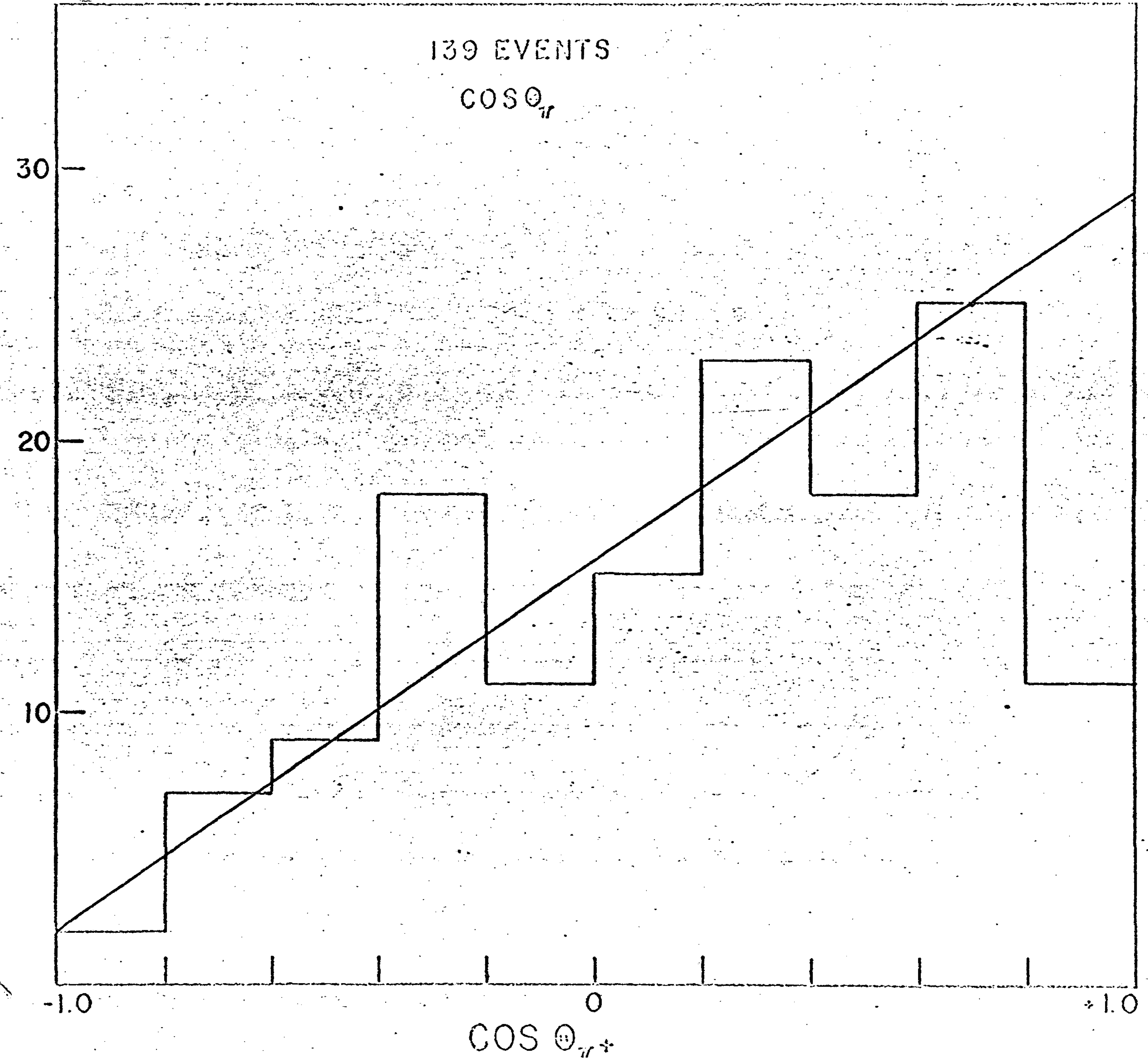
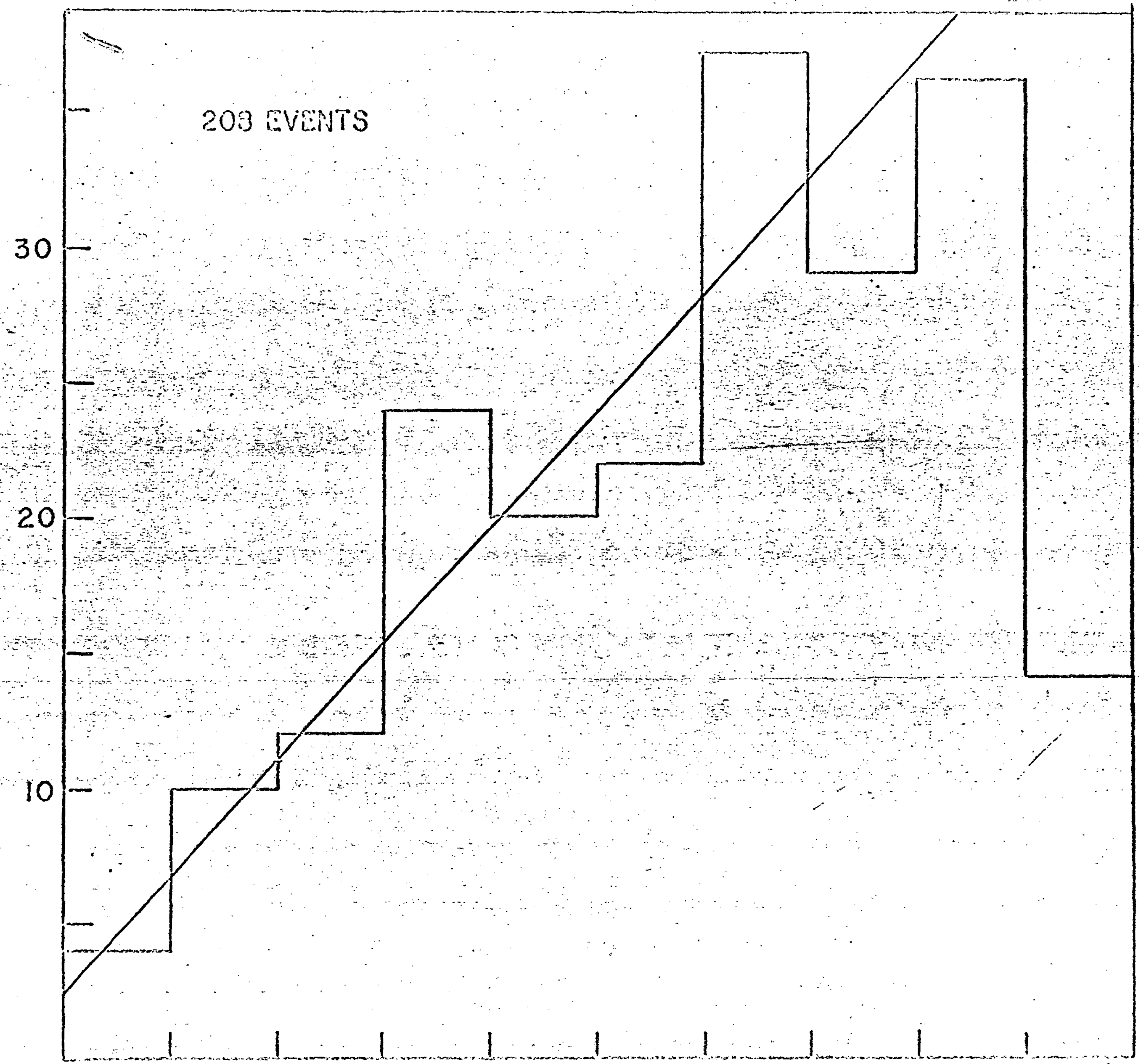
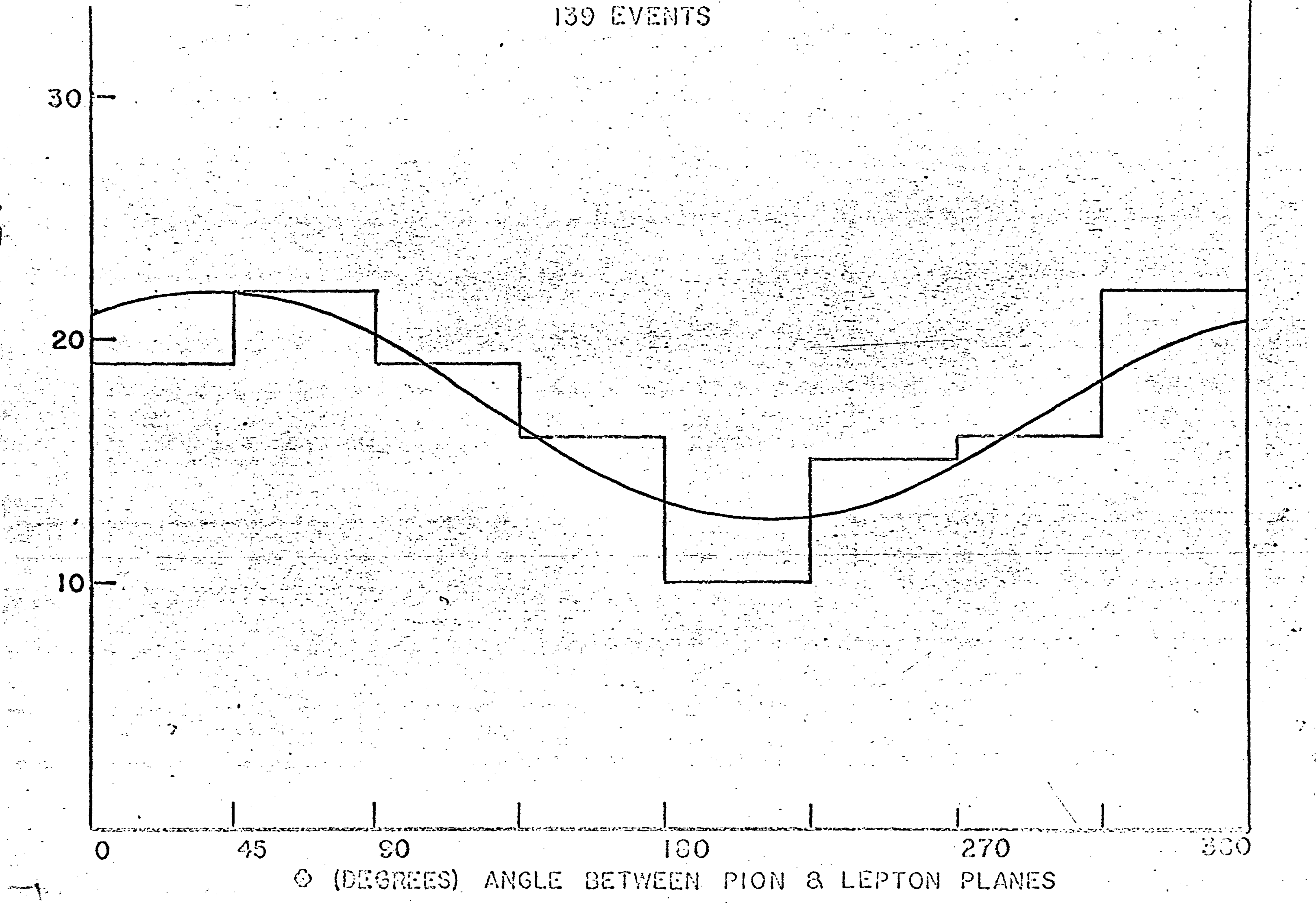


FIG. 6a

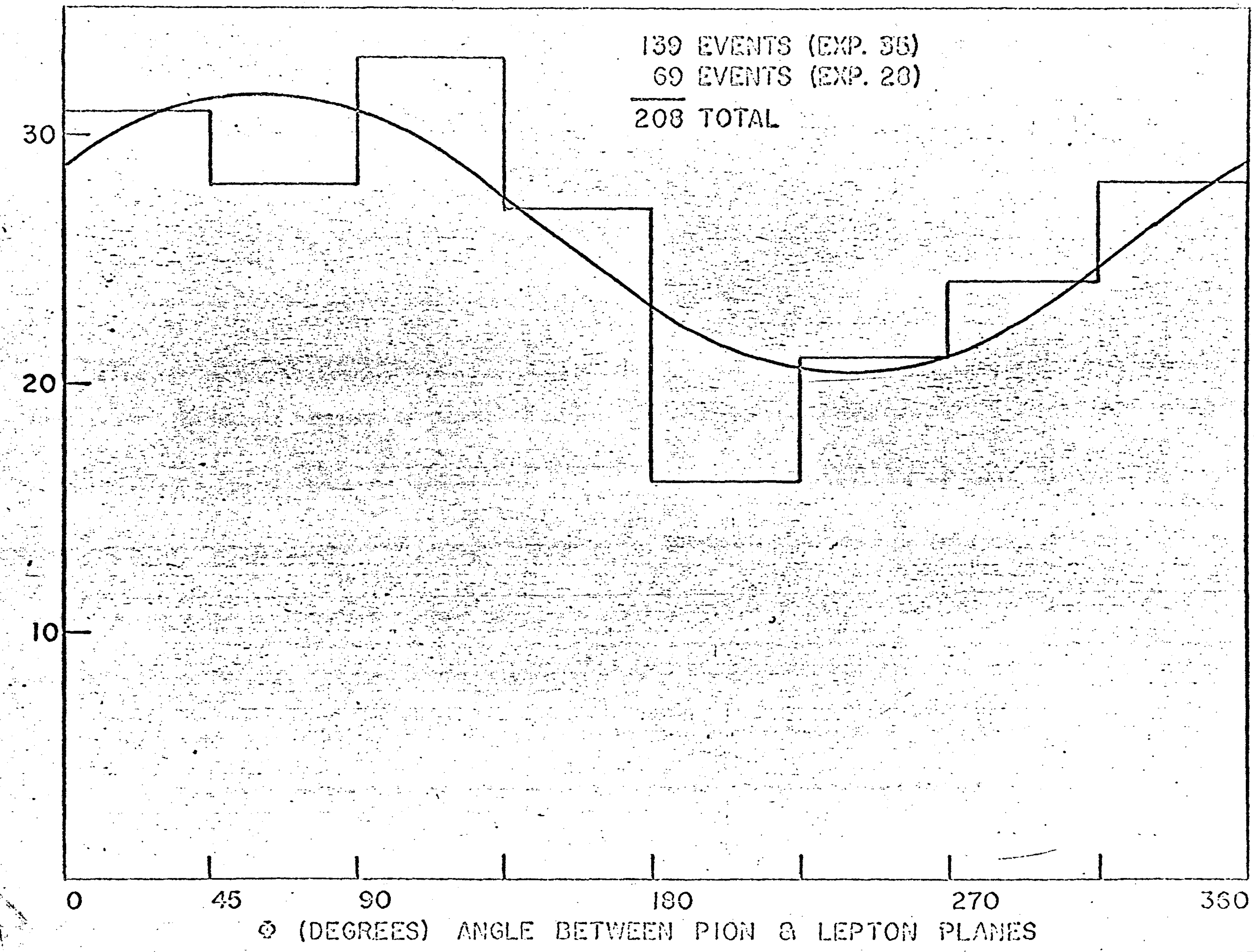


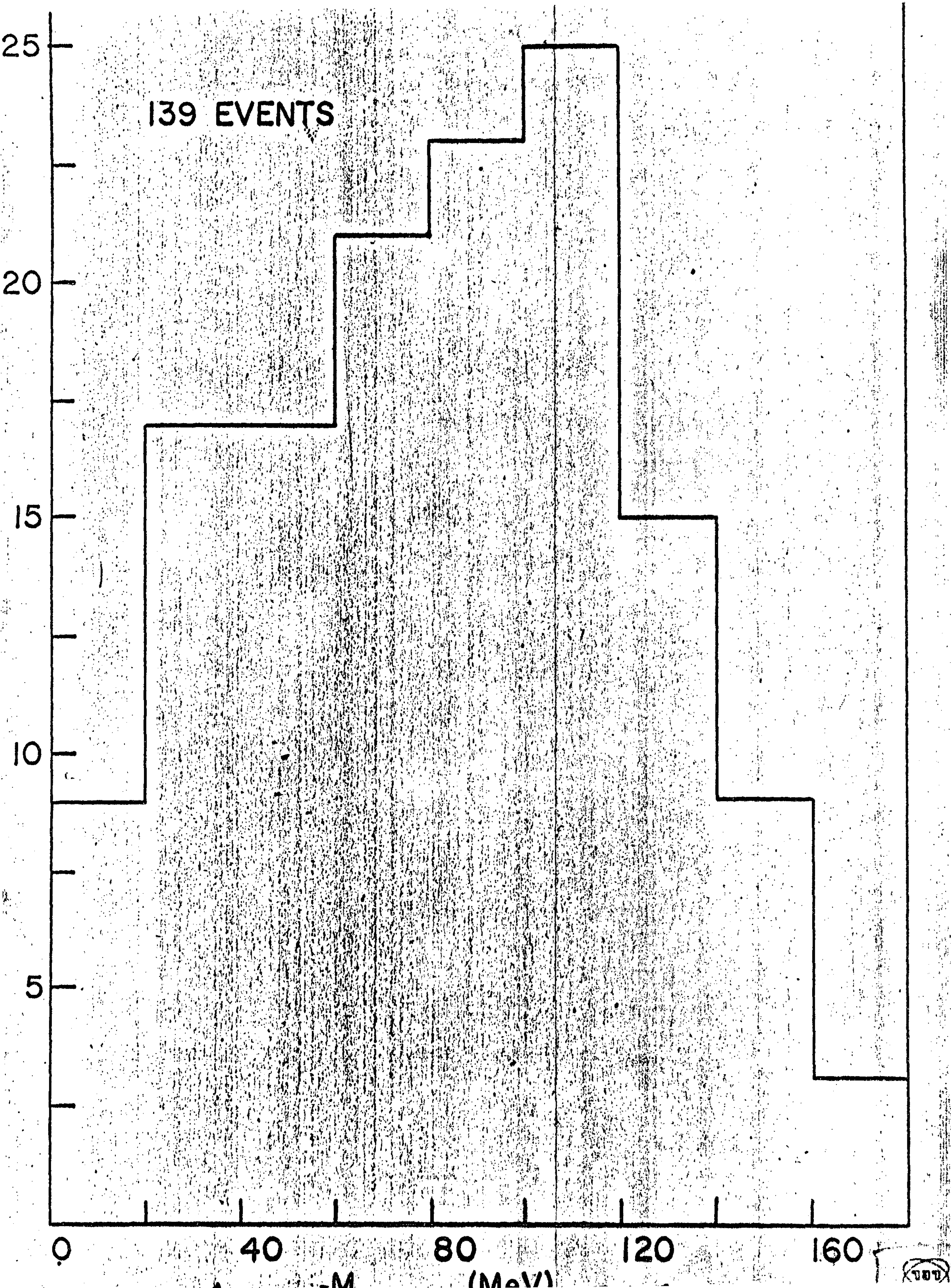
203 EVENTS
30
20
10



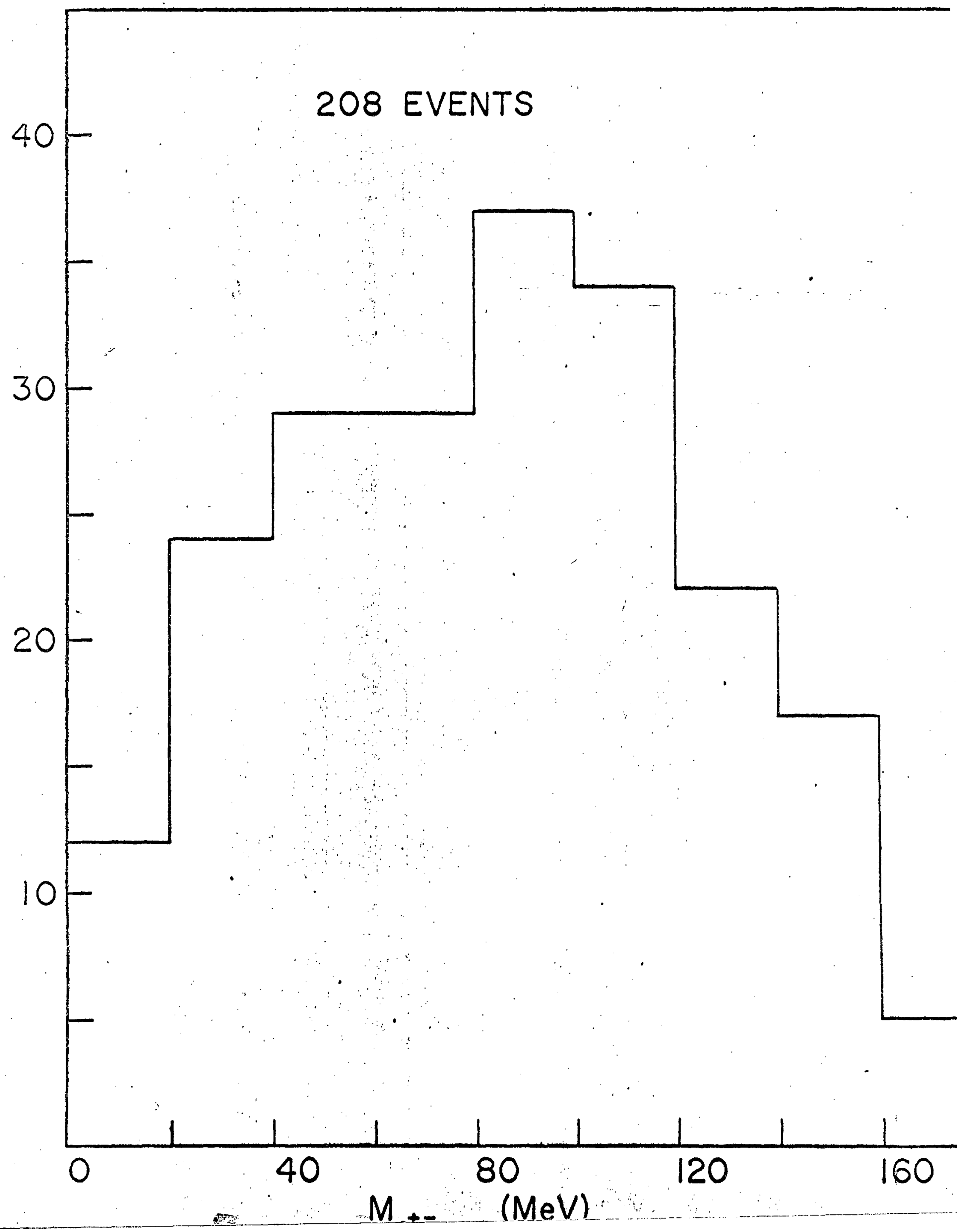
139 EVENTS
30
20
10
0
45
90
180
270
360
Θ (DEGREES) ANGLE BETWEEN PION & LEPTON PLANES

FIG 7a


139 EVENTS (EXP. 35)
69 EVENTS (EXP. 28)
208 TOTAL
30
20
10
0
45
90
180
270
360
Φ (DEGREES) ANGLE BETWEEN PION & LEPTON PLANES



25
20
15
10
5
139 EVENTS
0
40
80
120
160
(MeV)



208 EVENTS
40
30
20
10
0
40
80
120
160
M +- (MeV)