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Electric Interaction of Hadrons

Draft

PRELIMINARY

Rho Meson Production by Muon Scattering
at 150 GeV. THE CHICAGO-HARVARD-ILLINOIS-OXFORD
COLLABORATION, presented by

- We have identified the mesons produced diffractively in muon scattering at 150 GeV by measuring and identifying both decay pions. A clear peak at the rho mass is observed. We will compare the number of rho mesons with the number predicted by vector meson dominance, both for low q^2 and high q^2 events. The momentum transfer to the hadron system follows $\exp(-Sp_1^2)$. We expect to present correlations between the muon scattering plane and the rho meson decay plane. We have also found an equal number of inelastic rho mesons where the rho meson is accompanied by other pions. However, the background for these events is great enough that it is not possible to discover much detail.

This abstract should immediately follow the abstract Hadron Spectra from Muon Scattering at 150 GeV.

PRELIMINARY

Submitted by _____

This is the short talk I presented at Washington. WRFrancis

PROPOSAL # 98
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(1)

Our spectrometer consists of a very large magnet with detectors of various sorts (mostly in the forward direction) both upstream and downstream of the magnet. The magnet is tuned for muon kinematics - $P_{\text{trans}} \sim 2.2 \text{ GeV}$. We easily see all forward going, high momentum particles. One of the processes for which our spectrometer is ideally suited is the diffractive muo-production of vector mesons.

The incident muons have energy near 150 GeV . We trigger only on the muon scatter. Either a large energy loss (in muon variables, large ν) or/and a large angle scatter (large Q^2) will trigger the apparatus. Since ρ production has a steep Q^2 dependence, the ρ 's I report on today will be high energy ($100 < \nu < 140$) and low Q^2 (80% below $Q^2 = .5 \text{ GeV}^2$)

I report first on what I shall call diffractive or elastic ρ production which for real photons comprises some 10 to 15% of the total absorption cross section.

ENERGY BALANCE PLOT

I present a histogram of the energy balance for events in which two and only two hadrons with opposite charges are found (in addition to the scattered muon). A hadron is defined as a track initially found in chambers downstream of the magnet which not only links thru the magnet to a track upstream of the magnet but also comes from a well defined vertex including the beam and scattered muon. There is a clear peak at the elastic condition. The full width at half-maximum is about 3 GeV . For this report I define elastic, neutral pairs by a cut at $\pm 5 \text{ GeV}$.

Not all these events are really hadron pairs.

OPENING ANGLE PLOT

I remind you that ρ -mesons with energy 100 to 140 GeV have decay opening angles of the order of 8 to 15 mrad in the lab. This is a plot of the opening angle distribution for elastic, neutral pairs. The upper plot with its coarse angular scale displays a clear ρ bump at the expected place, but also a huge peak at small angles. The bottom plot blows up this small angle region to reveal a peak at .3 to .5 mrad . This is a measure of our angular resolution. These events have been identified as electron-positron pairs - presumably muon brems. followed by pair production. I remove these with a cut at 1.25 mrad . This cut is mostly for cosmetic ~~reason~~ since the small

opening angle, in general, prevents these events from invading the mass region near the p .

VERTEX PLOT

Not all of the remaining pairs come from the target. Our hydrogen target, although 1.2 meters in length, presents only 8.4 g/cm^2 of material to the beam. The smaller peak is due to a pair of beam hodoscopes ($\sim 1.3 \text{ g/cm}^2$ of scintillator) located about 8 feet upstream of the target. We will have a small amount of Carbon data. The hydrogen data is isolated by a cut on this vertex position.

MASS DISTRIBUTION

The mass spectrum of the remaining pairs shows a clear and very clean p signal.

Q^2 PLOT

It is quite well known from work at Cornell, DESY, and SLAC that the p electroproduction cross section is fit quite well, at least at low energy, by the p propagator squared. (A known Q^2 dependence of the so-called virtual photon flux factor must also be present). As indicated in this figure this fit to the data continues to work well at high energy.

t -DISTRIBUTION

The scale of the Q^2 dependence of the cross section is set by the p mass squared $\sim .6 \text{ GeV}^2$. In this plot I divide pairs with mass between .6 and .9 GeV into two categories - low Q^2 ($Q^2 < .6 \text{ GeV}^2$) and high Q^2 ($Q^2 > .6 \text{ GeV}^2$). In this graph there are 85 low Q^2 events and 21 high Q^2 p 's. The exponential t -distribution of ~~the~~ diffractive processes is evident. The two parallel lines drawn through the data are not best fits but the e^{-8t} characteristic of photoproduced p 's at low energy. It is well known that the p slope becomes flatter at large Q^2 - however, it is of considerable interest to determine whether Q^2 or w is the relevant variable. We will answer this question when our data set is completely analyzed. For now you will have to judge for yourself

events have $w > \sim 100$.

COS Θ₊ DISTRIBUTION

I include this last plot to show that the observed p's are mainly transverse. The number of longitudinal p's are expected to be suppressed by ϵR_p . ϵ in our kinematic region is only .2 to .4.

I will close with a few comments on inelastic p mesons.

ALL Neutrals & LEADING Neutrals

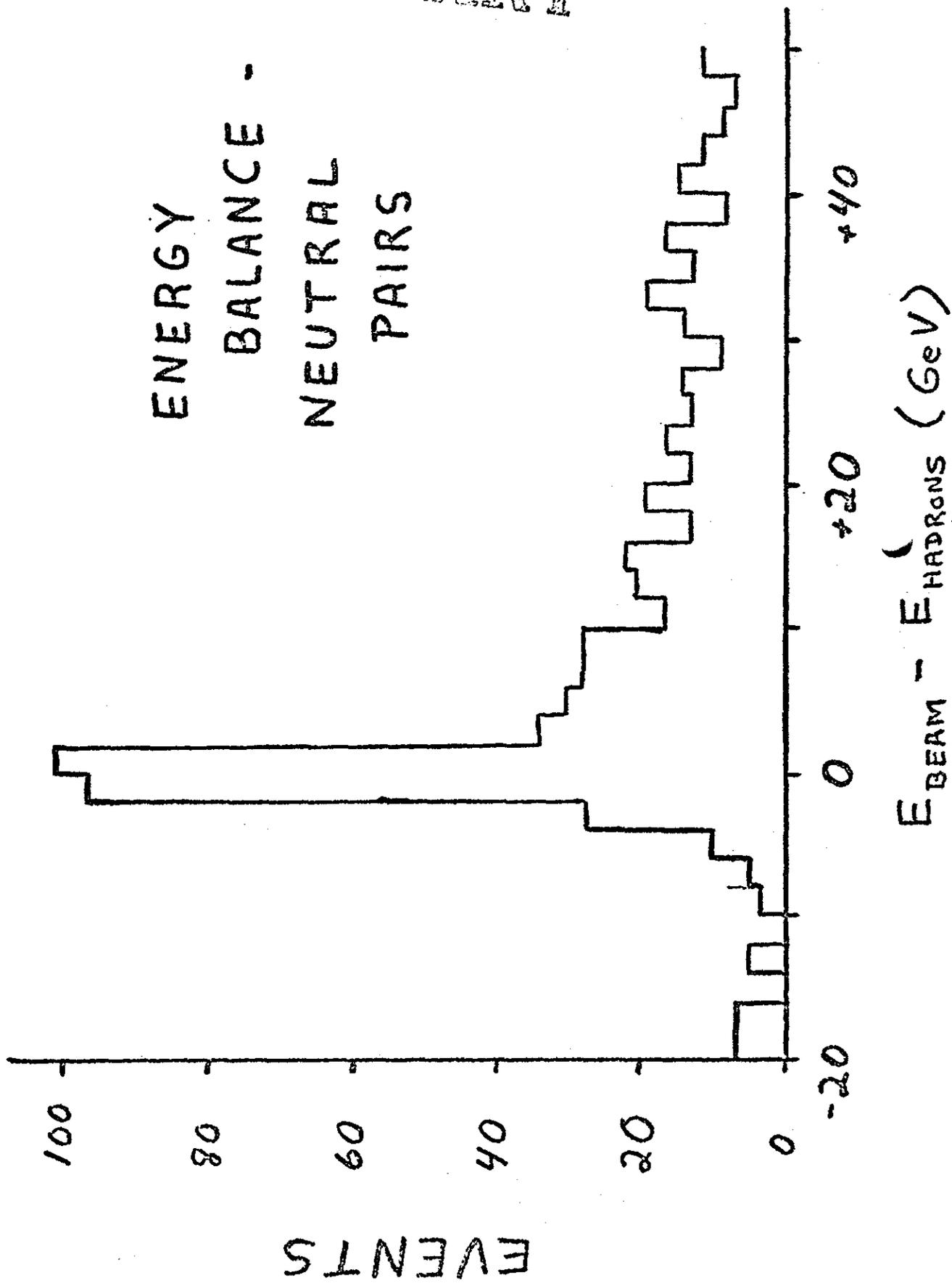
Here the mass of all combinations of neutral pairs is compared to the mass distribution of that neutral pair in each event with the greatest energy. This is a search for leading p's in the photon fragmentation region. The leading neutral pairs do seem to have a hint of structure near the p mass.

CHARGED & NEUTRAL LEADING PAIRS

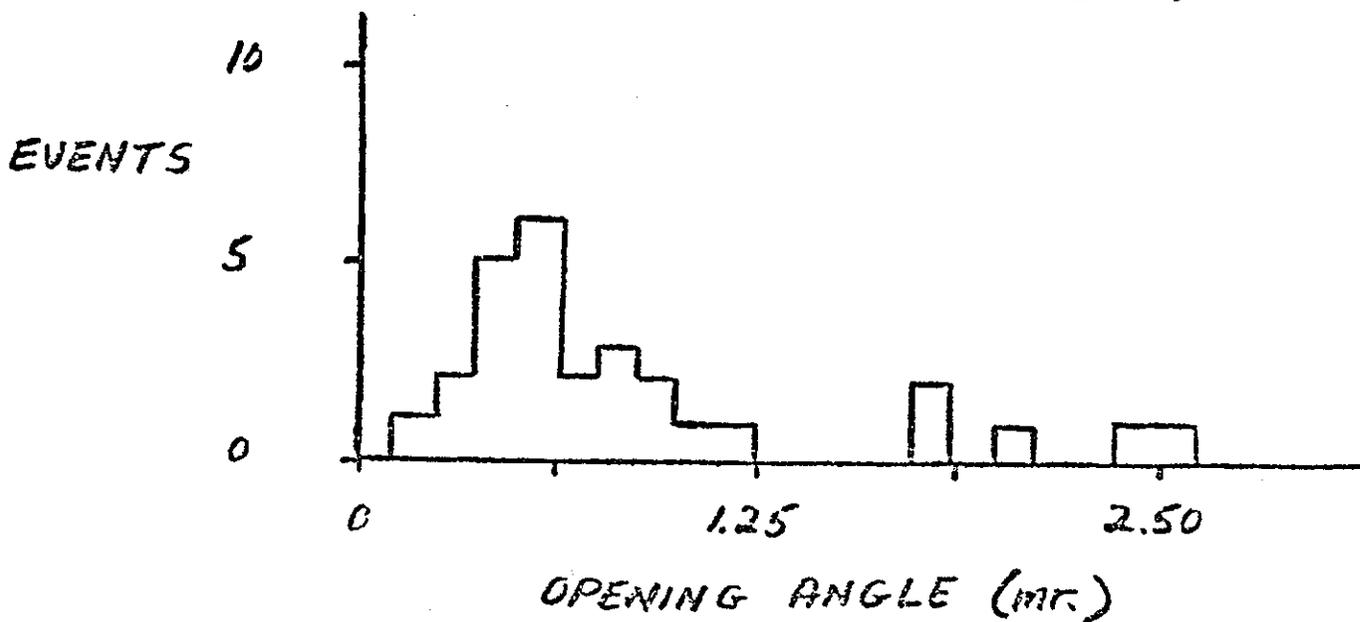
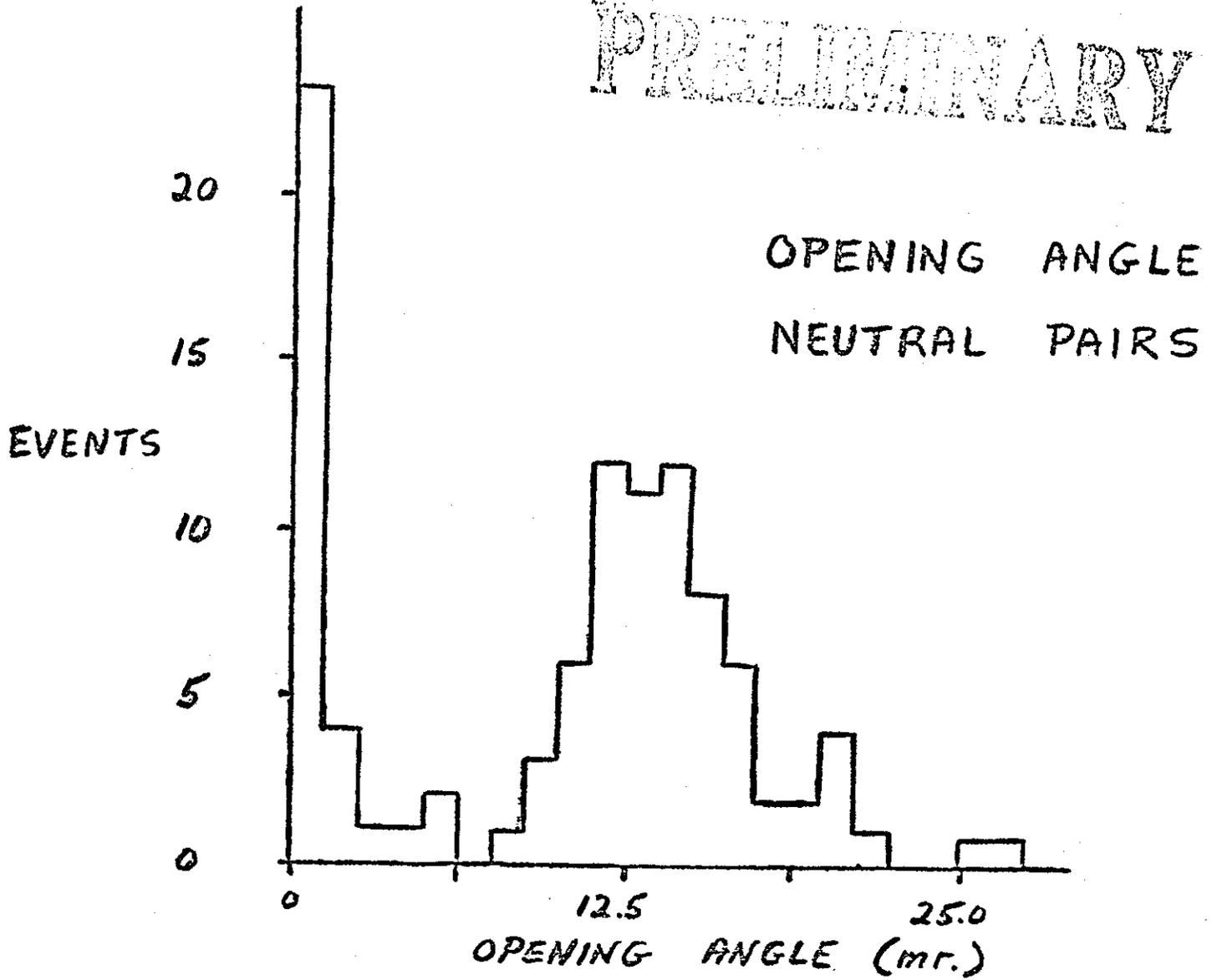
This effect appears more convincing when compared to the mass distribution of leading charged pairs. A few elastic p's do appear in this sample as indicated by the shaded events — but there are few of these since I have restricted Q^2 to be greater than $.5 \text{ GeV}^2$. We intend to investigate the Q^2 and polarization properties of these fragments of the virtual photon. A comparison to the elastic p's will be interesting.

Thank you for your attention.

PRELIMINARY



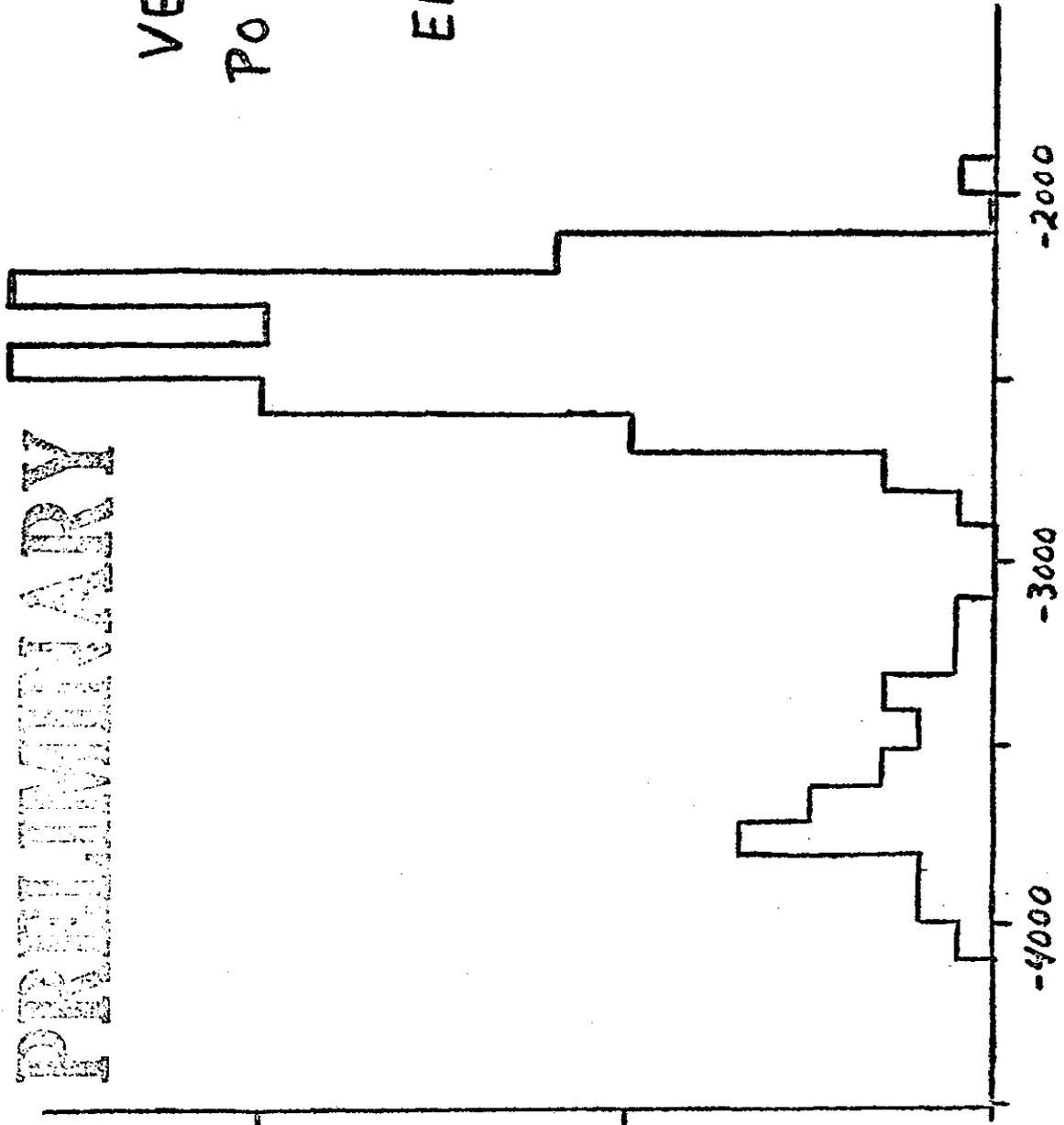
PRELIMINARY



PRELIMINARY

VERTEX
POSITION
ELASTIC ρ 's

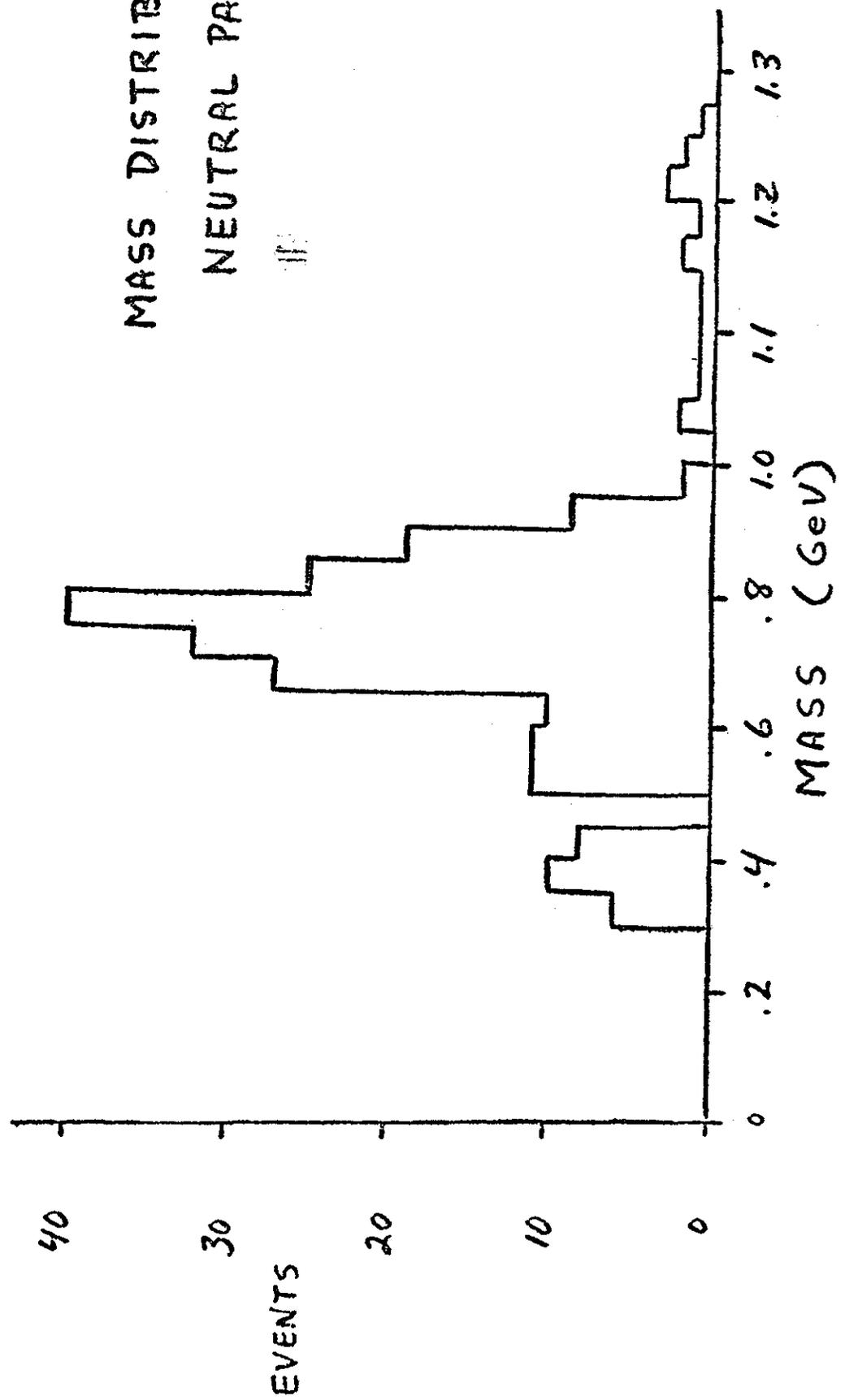
EVENTS
20
10
0



VERTEX POSITION (1/4 cm.)

PRELIMINARY

MASS DISTRIBUTION
NEUTRAL PAIRS



PRELIMINARY

H₂ + D₂ Data
288 events

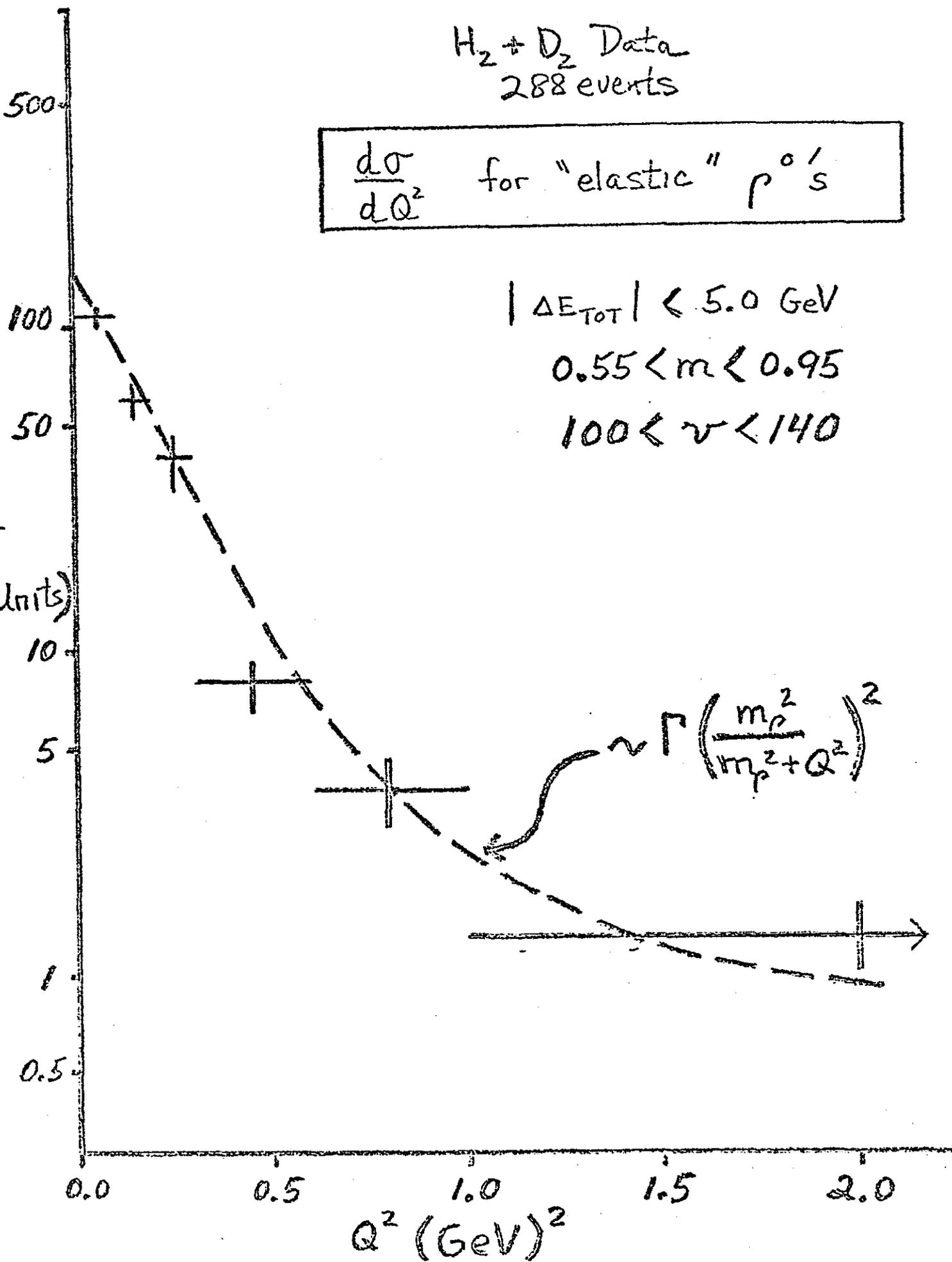
$$\frac{d\sigma}{dQ^2} \text{ for "elastic" } \rho^0 \text{'s}$$

$$|\Delta E_{TOT}| < 5.0 \text{ GeV}$$

$$0.55 < m < 0.95$$

$$100 < \nu < 140$$

$\frac{d\sigma}{dQ^2}$
(Arb. Units)

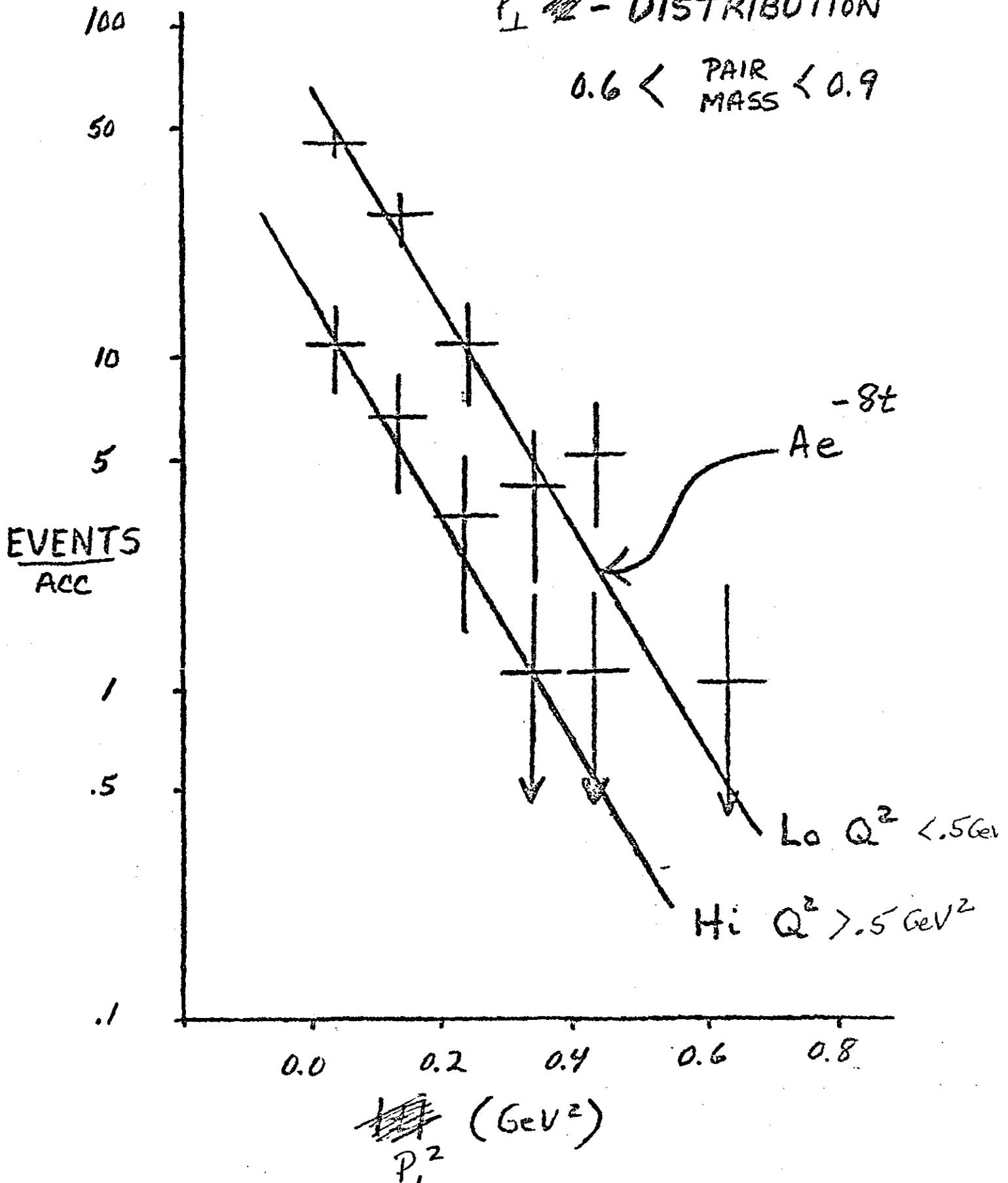


PRELIMINARY

100 "elastic" ρ^0 's
from H₂

P_{\perp}^2 - DISTRIBUTION

$0.6 < \text{PAIR MASS} < 0.9$

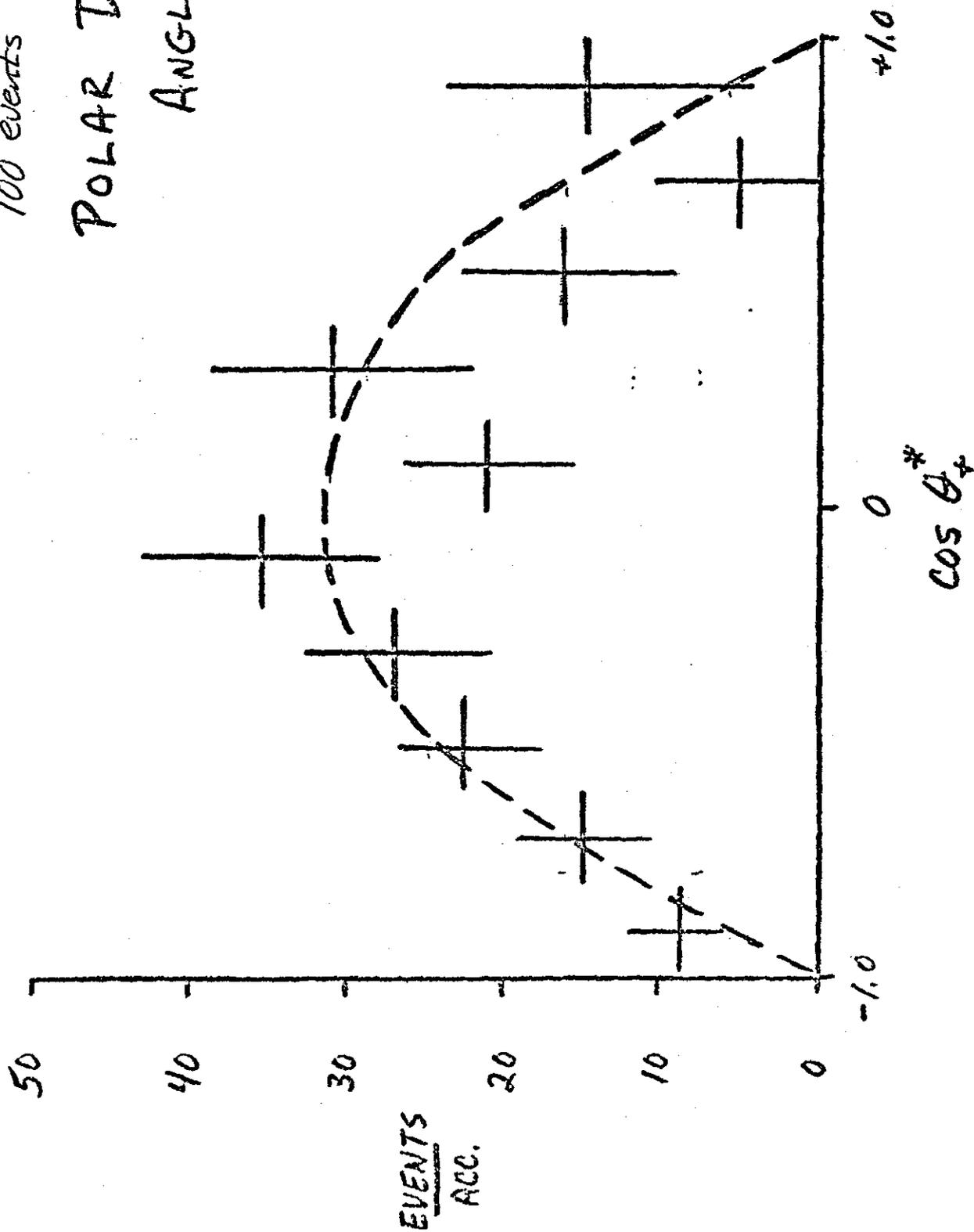


PRELIMINARY

100 events from H_2

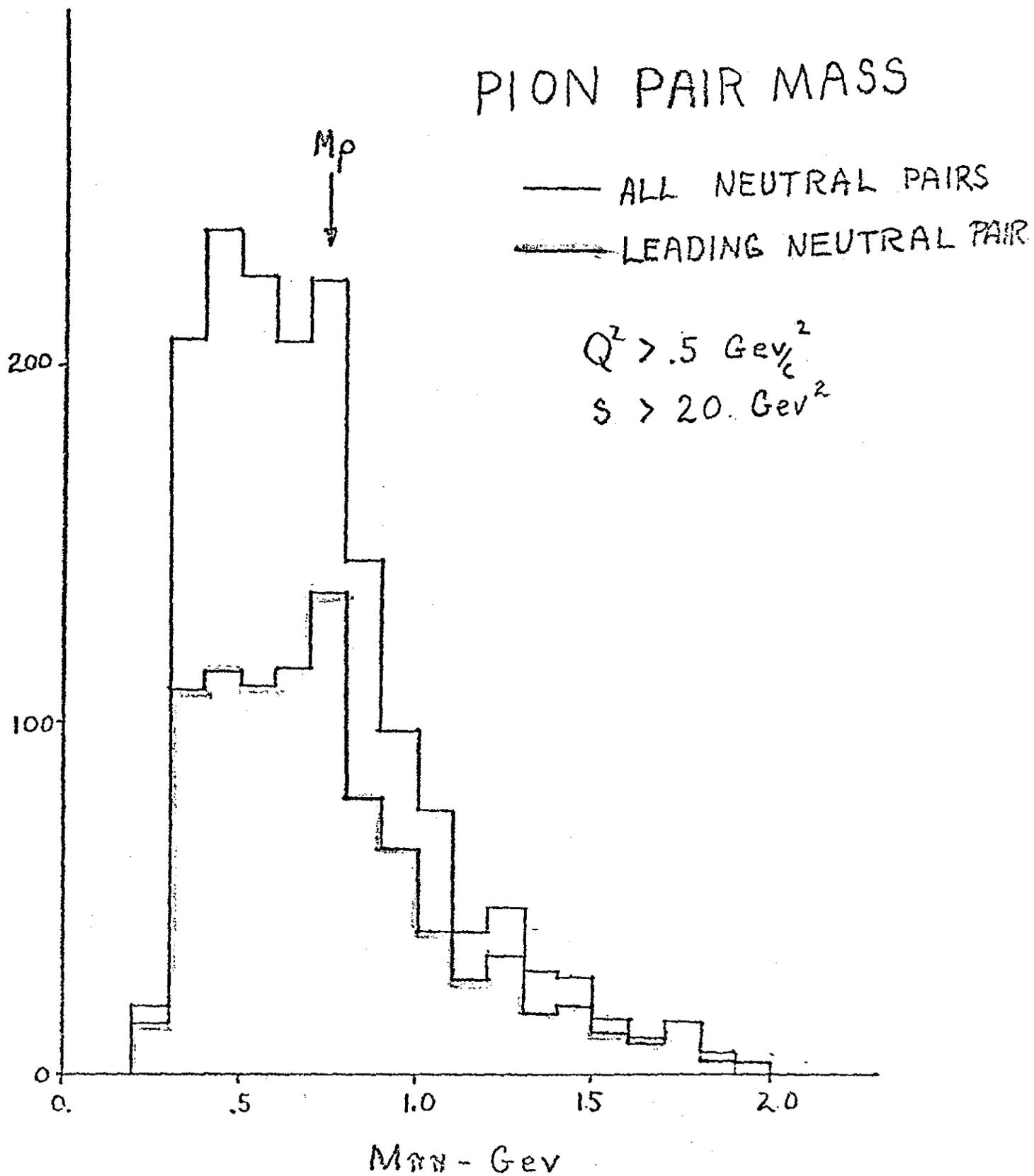
POLAR DECAY

ANGLE



PRELIMINARY

PION PAIR MASS



PRELIMINARY

PION PAIR MASS

- LEADING NEUTRAL PAIRS
- LEADING CHARGED PAIRS
- ELASTIC PAIRS

$$Q^2 > .5 \text{ GeV}^2$$

$$s > 20. \text{ GeV}^2$$

