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Spokesman: L.Hand
Cornell University
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A SEARCH FOR CHARMED HADRONS PRODUCED BY MUON DEEP INELASTIC SCATTERING IN TAGGED NUCLEAR EMULSIONS

K.Gottfried, L.Hand, S.Herb, plus two others
Cornell University

L.Read and L.Voyvodic
Fermilab

L.Litt
Michigan State University

I. INTRODUCTION

We propose a relatively simple and efficient method for searching for charmed hadrons. The experiment has three basic ingredients: 1) deep inelastic muon scattering, which we conjecture to be a rather copious source of charmed particles; 2) an emulsion stack to explicitly display the decay vertex; and 3) very precise triangulation with drift chambers to locate the event and greatly reduce scanning time. The inelastically scattered muons would be identified with the E26 (and E319) muon spectrometer, while the drift chamber system is similar to one already in operation at the Cornell synchrotron. Our goal is to obtain 500-1000 emulsion stars <u>known</u> to have been produced by deep inelastic muon scattering; we have reason to believe that 10-20% of these may contain charmed hadrons, or other new phenomena. An inevitable byproduct of this experiment would be the first determination of how multiple production in a heavy target depends on q^2. A second important byproduct would be a search for "extra" muons in deep inelastic scattering.

II. THE GOALS AND GENERAL FEATURES OF THE EXPERIMENT

a) The Primary Objective

In recent months we have witnessed a remarkable number of important discoveries: the ψ and ψ' states; the observation at SPEAR of a sudden rise of $R \equiv \sigma(e^+e^- \to \text{had})/\sigma(e^+e^- \to \mu^+\mu^-)$ at $\sqrt{s} \simeq 3.1$ GeV*, and further structure[1] in R for $\sqrt{s} > 4$ GeV; $\mu^+\mu^-$ events in the Fermilab neutrino experiment[2]; the appearance of "extra" muons at high $p_\perp$, also seen at Fermilab[3]; and the discovery of a second emulsion event by Niu[4] exhibiting what appears to be short lived ($\sim 10^{-13}$ sec) decays.

A link between these phenomena, and the earlier observation of weak neutral current events, is provided by the hypothesis[5] that hadrons bear a further attribute beyond isotopic spin and strangeness, called charm (C). In this scheme all the presently known hadrons have C = 0, but a new and heavier species having $C \neq 0$ must also exist. From the SPEAR data one infers that the lightest charmed bosons should

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*If R is averaged over $\sqrt{s}$-intervals given by the ψ'-ψ mass difference, $R_{av} \simeq 4.7$ in the ψ,ψ' region, as well as for $\sqrt{s} \gtrsim 4$ GeV. This gives a strong hint that new hadronic degrees of freedom suddenly become excitable when $\sqrt{s}$ rises above ~ 3 GeV.

have a mass of ~2 GeV; the lifetime of such objects is expected to be 10^{-13}-10^{-14} sec.[6]

Clearly it is of the utmost importance to see whether one can directly observe the associated production and weak decay of charmed hadrons. This experiment addresses itself to this objective.

b) Deep Inelastic Scattering as a Source of Charmed Hadrons

Our insistence on explicitly observing the decay vertex settles the choice of target[6]: it must be a nuclear emulsion. What remains is to find a plausibly copious and convenient source for charmed hadrons, and a technique that automatically selects a very small volume within the target for visual scanning.

It is our conjecture that deep inelastic muon scattering provides a promising source of charmed particles. This hypothesis is based on suggestive experimental evidence and on the following intuitive considerations:

i) By selecting only muon scattering events with large q^2 we eliminate the "soft" processes that dominate conventional electromagnetic and hadronic interactions; such processes cannot produce heavy objects with ease.

ii) Photons--real or virtual--can produce objects that are not already present as target constituents; in the present context this is demonstrated by the recent photoproduction of ψ (and probably ψ') at Fermilab.[7]

iii) Virtual photons with q^2 larger than the square of the masses in question therefore combine the advantageous features of points i) and ii).

The suggestive evidence alluded to comes from the deep inelastic muon scattering experiment E26.* This experiment showed[8] that Bjorken scaling was satisfied when the data at 56 and 150 GeV was subjected to the ratio test. On the other hand, a comparison of the absolute yields with those expected from the SLAC data reveals a 25% excess of events with large ν. This appears as a rather sudden rise when plotted as a function of missing mass, and occurs when the muon has lost $\gtrsim \frac{1}{3}$ of the incident energy. In contrast to this, the high energy data of E26 taken by itself shows scaling at about the 10-15% level in all distributions, including the missing mass distribution for $\nu < 100$ GeV.

From this data, and our earlier intuitive observations, we infer that the extra high energy events are due to the opening of fundamentally new channels having a high

* Fig. 1 shows the apparatus layout of E26, Figs. 2 and 3 show a subset of the data of E26.

threshold.* If m_c is the mass of the lightest charmed boson, the threshold occurs at $W_o^2 = (2m_c + m_N)^2$, and $q_o^2 = nm_c^2$, where n is a model dependent quantity of order 1. The resultant threshold $\nu_o = (W_o^2 - q_o^2 - m_N^2)/2m_N$ then ranges from 15 to 30 GeV if $m_c \simeq 2$ GeV, and n ranges from 1 to 4. Given these large values for ν_o, it is reasonable to suppose that SLAC and E26 operate on opposite sides of this threshold, and that would suffice to explain the results of E26 in a qualitative fashion. For if q^2 and ν are well above the threshold, νW_2 would be enhanced above its "low" energy (SLAC) value by a new scaling term, and therefore would be in accordance with the ratio test of E26. In both the post- and pre-charm scaling regions, the transverse cross section σ_T would fall like $1/q^2$, though with different coefficients; in the high energy scaling regime, the ratio of charmed to uncharmed hadrons would be constant. But closer to the q^2-threshold, where the conventional cross section is already dropping rapidly, the cross section for charmed particle production is expected to be more nearly constant. Thus we hope to find a relative enrichment of charmed hadrons by at least the order $(m_c/m_\rho)^2 \simeq 10$ in this

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*In this connection we may mention that Lederman[3] has recently conjectured that the copious hadron yield at large $p_\perp$ seen in pp collisions is also due to the production of charmed particles.

q^2-region.

If we ascribe the entire excess observed by E26 to the production of charmed hadrons, we estimate that 10-20% of the events that we propose to examine would contain charmed final states. Naturally this is a rather optimistic position*, given that we do not understand the electro-production mechanism in the threshold regime; for example, it is possible that νW_2 could show an enhancement due to virtual excitation of charmed pairs before real charm production becomes sizeable. Given enough time one could indulge in a variety of theoretical exercises concerning the electro-production of charmed states. But the real justification of this experiment is not in theoretical arguments, no matter how plausible they may sound. Rather, it is that deep inelastic muon scattering gives access to a unique and promising kinematic region; that in this region there is already evidence for an excess of events; and that by combining the emulsion technique with a

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*Note, however, that the neutrino experiment has observed anomalies in the y-distribution of $\bar{\nu}$-events for $E_{\bar{\nu}} \gtrsim 30$ GeV. This gives further support to our conjecture that 10-20% changes in yield could occur once the charm threshold is crossed.

spectrometer and drift chambers one achieves two goals that appear to be irreconcilable: a large sample of interesting events, and the high spatial resolution necessary to observe decays with the lifetimes expected.

c) Comparison of Muons to Other Possible Sources of Charmed Hadrons

We now turn to the more mundane features of a muon experiment. Since the incident energy is precisely known, and the scattered muon's momentum can be measured precisely in the E26 spectrometer, we can select events in those kinematic regions where we expect an enhanced yield of interesting events. By precise triangulation with drift and spark chambers (see below), the volume of emulsion within which the deep inelastic event occurs can be reduced to <10 mm^3. In this volume there would be of order one other, $q^2 \simeq 0$, muon interaction. It will be clearly distinguished from the sought-after event by having no large angle track that falls within the very narrow angular interval defined by the spectrometer, as well as by rather clear topological characteristics. The time required to visually locate each large q^2 event should therefore be less than one hour.

We comment briefly on other proposed searches for charmed hadrons produced in emulsions.

(i) Conventional hadronic interactions should also produce charmed hadrons. At this time nearly 10^4 stars in emulsions exposed to various Fermilab hadron beams have been analyzed, and no candidate for charmed particle production has been found*. From this it follows that the traditional emulsion technique could only yield a reasonable number of sought-after events if a truly gigantic effort were to mounted. A proposal to examine 10^6 events has therefore been put forward[9]; clearly the time scale needed to scan this amount of emulsion must be measured in years.

(ii) Neutrino-induced events may provide a relatively rich source of charmed particles[10], though the basic cross section is very low. Nevertheless, in an exposure time of some six weeks a 20 litre stack of emulsion could be expected to yield 500 events, a few percent of which could contain new particles. Note that the neutrino and muon experiments are somewhat complementary, for only the latter is expected to show associated production of charmed hadrons.

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* Niu's recent event[4] was not found in a conventional emulsion stack, nor was the vertex actually seen.

In view of the successful[7] photoproduction of ψ, one might contemplate photoproduction of charmed hadrons in emulsions. Unfortunately it appears that such an experiment would face several serious difficulties: (i) the fraction of the photoproduction cross section having charmed final states is estimated at less than 1% from the rise of R seen at SPEAR[1]; (ii) there is no obvious and efficient triggerfor selecting events likely to contain charmed particles: and (iii) the emulsion would contain a very severe background of e^+ and e^- tracks.

On the basis of these considerations we conclude that deep inelastic muon scattering appears to be the most convenient and promising source of charmed hadrons for an emulsion experiment.

d) Secondary Objectives

This experiment also has two secondary objectives: a study of the q^2 -dependence of multiple hadron production , and a search for "extra" muons in deep inelastic scattering. The latter is discussed in some detail in the following Chapter. Here we briefly enlarge on the former.

Because of time dilitation, production processes evolve over ever larger longitudinal distances as the energy is raised. At Fermilab energies, these distances are of order 100 fm for conventional (i.e., typical p_T) hadronic processes. The only

technique presently known that is sensitive to such large distances is multiple production in heavy targets. It has been shown[11] that a study of the inclusive distributions as a function of incident energy and target size can provide valuable information concerning the space-time structure of hadronic processes. A number of experiments on nuclear multiple production have already been carried out at Fermilab: (i) emulsion exposures[11,12]; (ii) the MIT experiment[13] which measures mean multiplicities with a Cerenkov counter; and (iii) the Chicago-Princeton experiment[14] on large p_T production from heavy targets.

These experiments demonstrate that the mean multiplicity is remarkably insensitive to nuclear dimensions, whereas events having a large p_T secondary are markedly sensitive to those dimensions This conforms with the view that the proper-time scales governing the basic dynamics are very sensitive to p_T; for typical p_T the time dilatation suffices to elongate the production region well beyond the nucleus whereas this is no longer true at Fermilab energies when $p_T \gtrsim 1$ Gev/c.

From this viewpoint one would expect that the multiplicity of hadronic secondaries in electroproduction might depend markedly on q^2, for the basic time scales surely decrease with increasing q^2. The sample of 1000 large q^2 events that we propose to accumulate shoul suffice to give a rough determination of the variation of mean multiplicity with q^2, and thereby provide further insight into the space-time structure of multiple production.

III. OTHER POSSIBILITIES, OBSERVATION OF EXTRA MUONS

In the analysis of E26 an attempt is now underway to search for the production of "extra" muons in the deep inelastic scattering. From the high $P_\perp$ lepton experiments one could place a limit of such events at 10^{-4}. This is conservative since not all of our pions in the muon experiment are at high $P_\perp$. If the deep inelastic scattering enriches the data sample to the extent conjectured above then between 0.1% and 1% of our events should contain a muon from the leptonic decay of charmed objects - of course this is only one possible source for extra muons, although purely electromagnetic fiducials are expected to be low for the $P_\perp$'s involved. The number observed is further reduced by

our detection efficiency which is less than perfect for such muons. A signal at about this level (few tenths of percent) has been observed, but it is too early to tell whether these events are really directly produced or not.

If instead of charmed states, heavy leptons were pair produced, then because they are leptons, a lepton must always appear in the final state and the number of anomalous events would have to be much lower than the ballpark figure of 10% estimated for charmed states, possibly as low as 1% of the total. Such a low figure would leave us in this experiment with only a handful of interesting events but they could be identified immediately by segregating events with extra muons at an early stage of the analysis. For this reason some absorber (~24" of lead) will be placed downstream of the drift chambers to provide a hadron filter. Events originating in this absorber will cause triggers but can be removed by using the spectrometer information alone.

Another possibility, although remote, in the excitation of a heavy muon, followed by decay into hadrons + the observed muon. The signature of such an event would be several pions and the observed muon, after a short track which would be observable if the lifetime were as long as 10^{-15} sec.

IV. CALCULATION OF YIELDS

The yield of deep inelastic events can be adjusted by varying the target thickness, the minimum accepted muon scattering angle and the incident energy. Since we have observed scaling, the beam energy may not be critical and could be lowered to increase the yield. Typical yields for a ~620 gm/cm^2 iron target in the "large angle" data

of E26 for reconstructed events through all cuts and $E^1 > \frac{1}{3} E_0$ is ~3.5 x 10^{-6} event/muon at 150 GeV. If we scale the apparatus we get this same yield at 56 GeV with 3/8 of the target material or 233 gm/cm^2. The typical (average) scattering angle is ~30 mrad with a sharp drop in detection efficiency below 22 mrad. The average q^2 (at 150 GeV) is 15 (GeV/c)^2 and the average ν about 53 GeV. The minimum q^2 is 5 (GeV/c)^2. The yield can be $\sim$ doubled by reducing the θ_{min} using 7" round counters instead of the presently used 14" x 14" square counters and 8" radius cut. It can further be increased 15% by taking E^1 down to $.2E_0$. In our "small angle" data taken by moving the target upstream, about 3 times the yield is obtained compared to the large angle data. In fact this would appear to be a more favorable target position since the lower edge of the acceptance in q^2 at 150 GeV is moved down below q^2=4. (The 56 GeV data in principle contains data down to q^2=1.7 or less, but in practice this is a small fraction of the data and more in the province of E98.)

We have assumed a yield of 10^{-5} at 150 GeV for 200 gm/cm^2 of material ("small angle" target position). More detailed calculations and a more sophisticated optimization of target position will be attempted later. There should ideally be a better overlap with the low q^2 (2-4) region if the production model is to be studied. The choice of 150 GeV corresponds to high efficiency for muon beam operation and higher γ for the short lived decay products.

An exposure of 10^8 muons with a yield of 10^{-5} then would give in a total of 1000 deep inelastic events with about 40% in the interacting kinematic region corresponding to large muon energy loss. If we assume a 25% enhancement this gives about 100 "extra" events.

V. METHOD OF EXPOSURE, GEOMETRY OF TARGET

Although the exact details might change, we give here an example of how the experiment could be conducted. A stack of emulsion pellicles 5 cm x 7.5 cm x 6 cm is placed in the beam with the 7.5 cm dimension along the beam. The thickness of each pellicle is 600 μm (0.6mm) so 100 pellicles are in each stack. The volume of emulsion is 225 cm^3 and the thickness is ($\rho \cong 4$ gm/cm^3) 30 gms/cm^2. The muon beam is almost uniform over this area and if we assume 10^6 $muons/cm^2$ is possible with our scanning technique we expose the stack to 3×10^7 muons, or about 100 pulses (if we assume 30% of the beam is covered). If the yield is $\frac{1}{8} \times 10^{-5}$ we expect 30-40 deep inelastic events in the stack. Location of the stack is made precise with respect to the rest of the apparatus by using a jig and dowel pins.

The puchase of 6.7 liters of emulsion (1/3 of that required in the ν experiment proposed[10]) would allow almost 30 such stacks to be constructed and exposed for a yield of 1000 events. Should the density have to be reduced to 5×10^5 $muons/cm^2$ as used by Kusumoto in E205A and proposed by Jain in P255, our yield would correspondingly be reduced to 500 events.

Only a few drift chambers would be needed since track reconstruction is not done using this information, but only an improvement of the spatial resolution is obtained.

VI. USE OF EMULSIONS AS A VERTEX DETECTOR: DISCUSSION

The high spatial resolution of emulsions provides a perfect match to the laboratory lifetimes expected for charmed particles at Fermilab energies. The use of muons as a source of virtual photons to produce charmed states has a number of exceptional advantages as

discussed elsewhere in the proposal. However because muons have low interaction cross sections many muons must pass through the emulsion before yielding an interesting event, defined here to be one with $q^2 >> m_c^2$ and $E^1 \lesssim .4E_0$ (from the E26 results). Not only is the required density of muon tracks in the emulsion extremely high, but there are many $q^2=0$ interactions, mostly for low energy transfers which superficially look like the reactions of interest, with the exception that short lived decays would be extremely rare.

We can identify several types of possible scanning problems:

1. The density of parallel muon beam tracks and electromagnetically generated secondaries might be so high that the "noise level" of extraneous tracks makes the scanning and measuring quite difficult or impossible. A reduction in the beam track density is always possible without an accompanying increase in scanning time since the events are labelled from the spectrometer information. However emulsion cost is a problem. The limit on being able to see into the emulsion to a depth of .5 mm assuming a 0.5μ grain spacing along the track is $N\mu$ muons/cm^2 < $(200\ \sigma_{grain})^{-1}$ or $N_\mu \approx 10^6$ muons/cm^2. We also note that this is twice the exposure density requested by emulsion experiments 205A and 255 which are also exposures of emulsion stacks to muon beams. Proposal 171 (Lord, University of Washington) was an emulsion chamber experiment to search for short lived particles with lifetimes in the 10^{-12} to 10^{-17} second range. Here the density was to be kept below 9×10^4/cm^2 but the stack geometry was much more complicated and the number of interactions (initiated by protons) had to be kept below 11(mm)^3 to allow individual tracks to be followed with sufficient precision.

On a microscopic level, an exposure of 10^6 muons/cm^2 corresponds to one muon/(10 μm)^2 - a level which may be tolerable. Test exposures have already been carried out[15] to determine the actual maximum tolerable level of beam track "noise" - these exposures ranged from 3.10^4 to 5.10^6 particles/cm^2.

If we assume a total cross section of 20 μb/nucleon for muon interactions we will have a density of 48 interactions/cm^3 at an exposure of 10^6 muons/cm^2. This is a volume of 20 (mm)^3 per muon interaction, mostly uninteresting $q^2=0$ interactions.

The triangulation from the drift chambers and spark chambers should define a volume somewhat smaller than this, on the order of 10 (mm)^3, so there will be a <50% chance of finding a second interaction involving muons. Final rejection of events uncorrelated with the spark chamber information rests on the difference in topology between $q^2=0$ and large q^2 events (a jet is expected along the virtual photon direction, which is opposite to the scattered muon track) and precise identification of the scattered muon track using the exceptional angular information available from the spectrometer (~.25 mrad angular resolution). Careful measurements do not need to be made when the event contains interesting topologies, except for the "bread and butter" part of this proposal.

2. Cosmic rays are estimated[10] to contribute 110 stars/cm^3 or about 2-3 times as many interactions as from the beam exposure if the time between preparation and development is 2.5 months. Only a small fraction of these will be confused even at the scanning stage since there will be no incident muon track pointing at the vertex and the

hadrons will be mostly directed downward. Unlike the neutrino experiment proposed, the exposure time for muons will be short and this number ($110/cm^3$) can be reduced by reducing the storage time of the film to a month or less.

3. In the search for neutral V's we would plan to look in a fiducial volume at a radius of about 0.5-1.0 mm from the vertex. In a cylinder of diameter 1 mm and 1 mm in length immediately downstream of the interaction vertex we expect another muon interaction ~4% of the time. This will cause a "loss" of short-lived neutral decays of about that order of magnitude since they will be visible but may not be shown to come from the spectrometer-correlated event.

4. Neutron-induced stars can occur in the emulsion. The neutrons would come from $q^2=0$ interactions and would be mostly very low energy, a few MeV. This alone gives a handle since only neutrons capable of producing $\pi\bar{p}$ stars (>300 new neutrons) can simulate neutral decays. If we assume that each $q^2=0$ interaction (many correspond to photoproduction of the first resonance) produces a single high energy neutron and that the cross section for producing V's is 50 mb (a guess) we get a mean free path in emulsion of 10 cm; i.e., 1% interaction probability within 1 mm of the $q^2=0$ interaction. This means that the volume density of such V's would be less than 30% that of the original $q^2=0$ interactions if the emulsion stack dimensions were $\sim(10\ cm)^3$. A few percent of the time an extraneous V, generally pointing in the wrong direction, would appear within a fiducial volume. Multiple scattering estimates on the tracks would quickly establish that tracks with $P\beta$ less than 1 GeV/c were being observed.

Neutron induced stars, even from high energy neutrons would: a) not be accompanied by another short live decay, and b) would be uniformly distributed in distance from the vertex on this distance scale, unlike the more interesting events. The same remarks can be made about K_S and Λ with mean decay distances of $2.7\gamma\beta$cm and $7.8\gamma\beta$cm respectively. To decay within the fiducial volume of ~1mm^3 around the vertex is extremely improbable unless the energy is quite low. Λ decay, for low energies, could be recognized by the appearance of a heavily ionizing proton track. Production of such low energy K_S or Λ's in 100 GeV interactions is expected to be quite rare and could be estimated from existing bubble chamber data.

Of course the most convincing signature is the observation of the associated production of two short lived objects, each with laboratory lifetimes on the order of 10^{-13} to 10^{-12} cm.

VII TRIANGULATION FROM SPARK AND DRIFT CHAMBERS

Without any new equipment, the E26 apparatus can be used to locate the vertex of an interaction to ±.5 mm in the plane transverse to the beam and ±5 cm along the beam direction. The chief limitation is the multiple scattering in the iron of the first magnet in the spectrometer.

The addition of four drift chambers to the E26 apparatus, plus the approximate vertex information known from the spark chambers, allows considerable improvement on the triangulation. Multiple tracks from the hadrons produced only serve to increase the triangulation accuracy since the drift chambers are 100% efficient for multiple tracks. Halo is eliminated using the existing proportional chamber information with good time resolution. The drift chambers would be two small ones, to

cover the 10x10 cm area of the beam and two larger ones, about 40x40 cm to allow good solid angle for hadron detection. It is possible that K_S and Λ decays not visible in the emulsion can be detected by downstream drift chambers. The chambers would be built according to the design of D.Hartill and would be replicas of existing chambers. The number of wires assuming a 5 cm wire spacing is 20 and we would plan to digitize up to 4 signals per wire (Hartill designed the electronics to do this). With the usual drift velocities, the sensitive time is about 2 microseconds. Drift times can be measured with a least count accuracy equivalent to 80 μm and a safe assumption, based on the experience of others,[16] is to assume a measurement σ of <200μm. If the track angle of the muon is 30 mrad (many hadron tracks will be at larger angles). Then we have a 1σ triangulation volume of .2 mm x .2 mm x 6 mm (along the beam). Multiplying all these numbers by 2 to include 85% of all events, we get a fiducial volume of 2 mm^3, considerably less than the 10 mm^3 assumed earlier in the proposal. We may, of course, wish to use smaller muon scattering angles, so then the safety factor is not quite as good.

The coordinate system in the emulsion will be established by removing the muon absorber in the beam and observing a few pion interactions in a set of test plates. Since the pion interactions should be easy to find by conventional scanning techniques, we can use them to establish the relation between the coordinate systems of the spectrometer and the emulsion scanner.

The total volume scanned by this technique is <10 cm^3 for 1000 events. This is a reduction by about a factor of 1000 from the volume to be scanned by conventional techniques. If the 2mm^3 triangulation

accuracy is achieved, only 10% of the time will another ($q^2=0$) interaction be observed and, to first order, it may not be necessary to make precise angle measurements to isolate the interacting events.

VIII LOGISTICS AND PERSONNEL

There is an obvious need for a scanning capability beyond any possessed by the institutions represented in this proposal. We would hope to receive approval with the understanding that suitable scanning facilities will be located and collaborators with professional experience in this field added to the experiment. We have been discussing a number of concrete possibilities for additional collaborators with emulsion scanning capability. We understand of course that definite arrangements will be needed before a final agreement with the laboratory to undertake this experiment can be made. Thus, at this time we would like to obtain approval contingent on adding this capability. Two more research associates will be added from Cornell.

We would expect that tune-up and reactivation of the muon spectrometer could be done rather soon (~few months) and that an initial prototype exposure, based on the test exposures already made, with about 10% of the event sample could be made even before the more precise triangulation of the drift chambers is available. Such a preliminary study would help us find many of the problems at an early stage and before exposing a substantial and expensive emulsion stack. Initial scanning and development of the triangulation technique could start well before the main exposure.

We expect no interference with the follow-on scaling experiment P319 and in fact early restoration of the operation of the muon spectro-

meter is of positive benefit to this experiment. We see no reason why any interference of any kind need occur if we coordinate the planning of the two experiments.

IX TIME SCALE OF THE EXPERIMENT

A. Time table for the experiment might be:

1. Reactivate the spectrometer on parasite time before July 15, 1975.
2. Expose prototype exposure (again parasiting off the dichromatic ν run at reduced intensity) in latter half of July.
3. September or October 1975 make the main exposure.

This is well before the data taking of P319 is expected to begin.

Supplementary funds will have to be requested to support the emulsion required for this experiment, about $30K is required to cover the emulsion and its development. Part or all of this expense might be borne by the laboratory. Travel funds will also have to be requested for the analysis phase. It is not clear at this time whether the drift chambers and associated electronics can be built with existing funds, but only several thousand dollars are needed.

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FIGURE CAPTIONS

Figure 1. E26 apparatus (from P-319 Proposal)

Figure 2. Data/Monte Carlo in E26 plotted versus ω at fixed Q^2. The Monte Carlo calculation employed the Bodek fit to the SLAC deuterium data. In the SLAC region measurements have been made up to $Q^2 \approx 2 (\mathrm{GeV}/c)^2$ at $\omega \leq 16$. Higher Q^2 corresponds to larger ω.

Figure 3. Yield (again the small angle data) after subtracting the yields from the extrapolated fit. We emphasize that there is SLAC data over part of the ω region where E26 sees an excess and that the Bodek fit represents the actual SLAC data rather well.

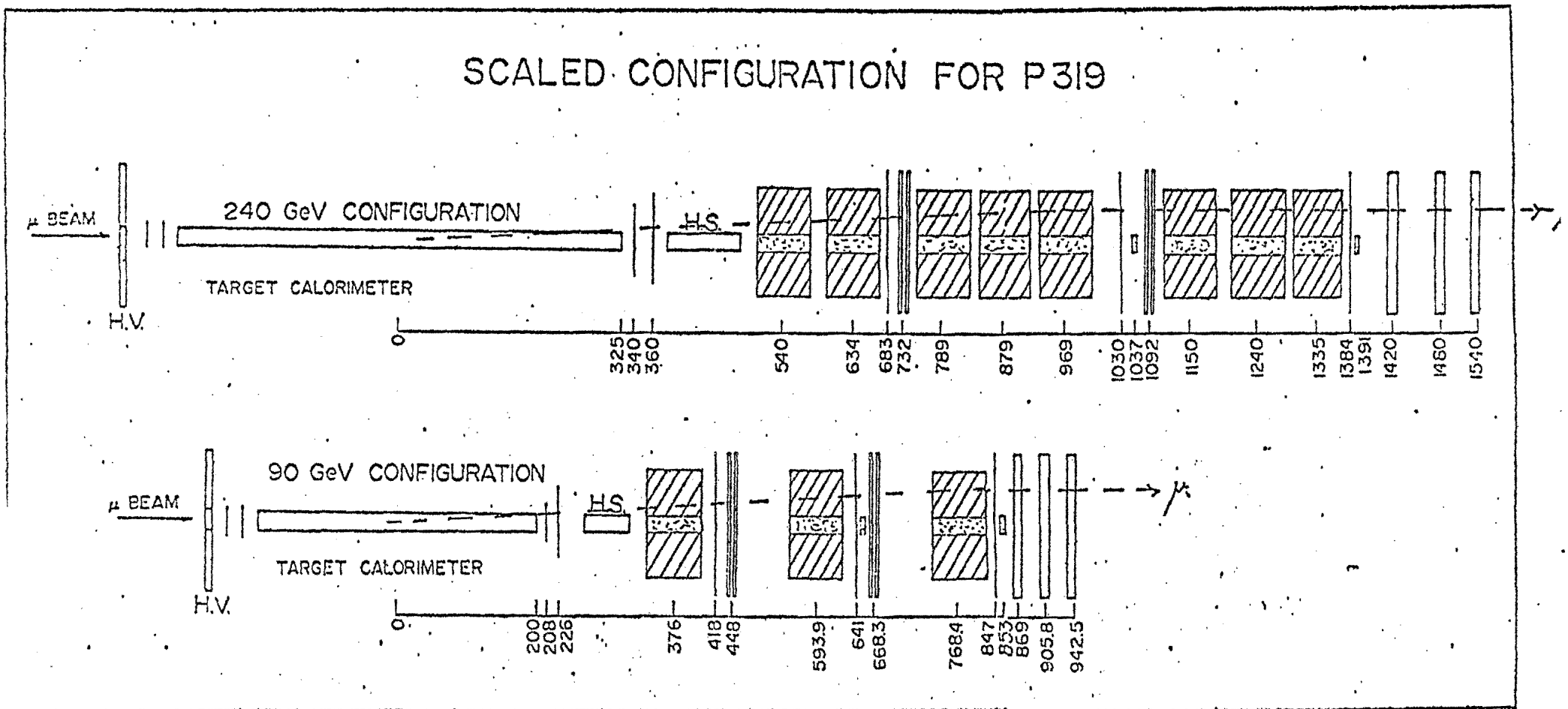
SCALED CONFIGURATION FOR P319
μ BEAM
240 GeV CONFIGURATION
TARGET CALORIMETER
H.V.
H.S.
0
325
340
360
540
634
683
732
789
879
969
1030
1037
1092
1150
1240
1335
1384
1391
1420
1460
1540
μ BEAM
90 GeV CONFIGURATION
TARGET CALORIMETER
H.V.
H.S.
0
200
208
226
376
418
448
593.9
641
668.3
768.4
847
853
869
905.8
942.5

Figure 1

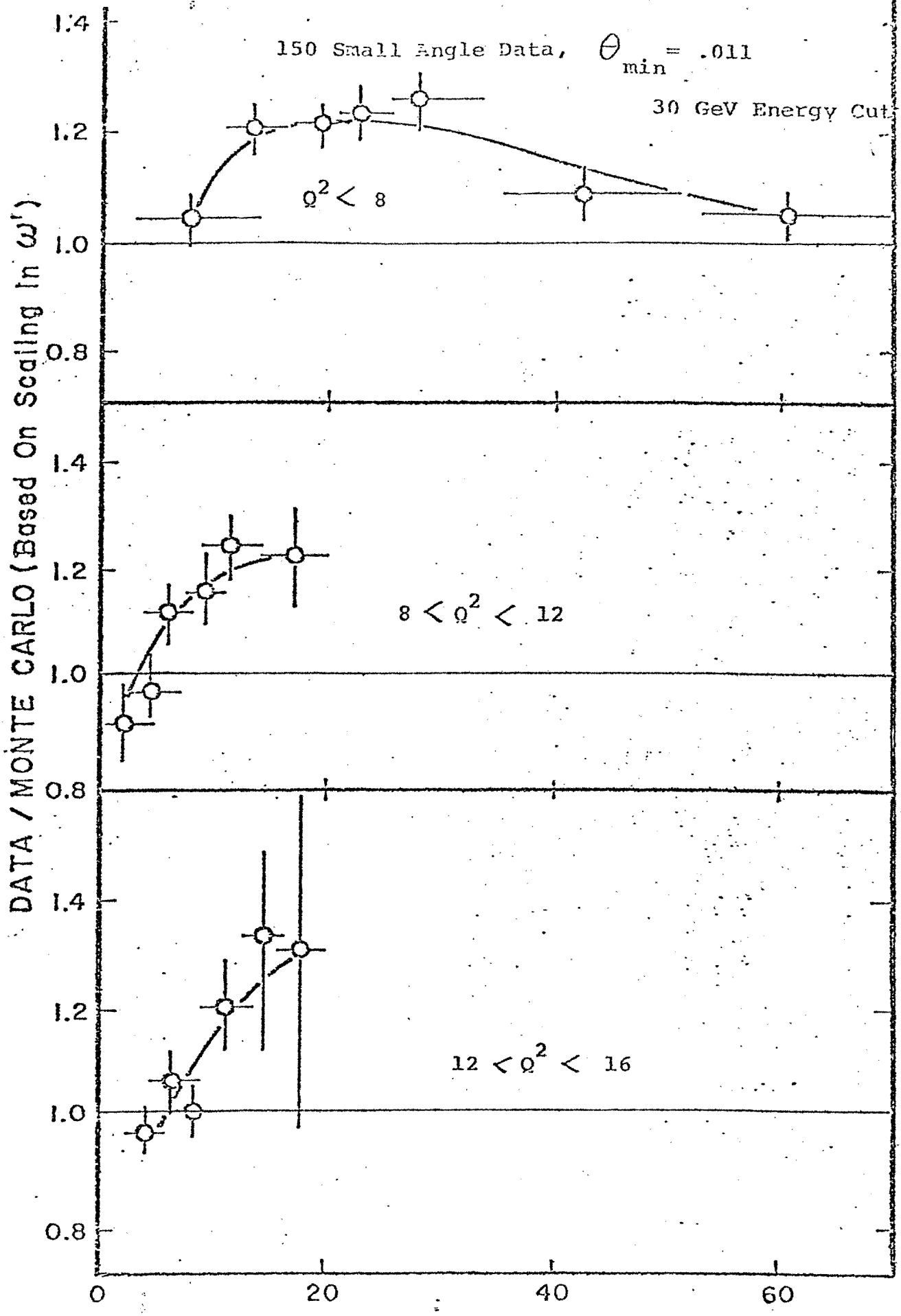

Figure 2 DATA / MONTE CARLO vs ω

The curves shown are not fits. They are drawn to guide the eye

PRELIMINARY!
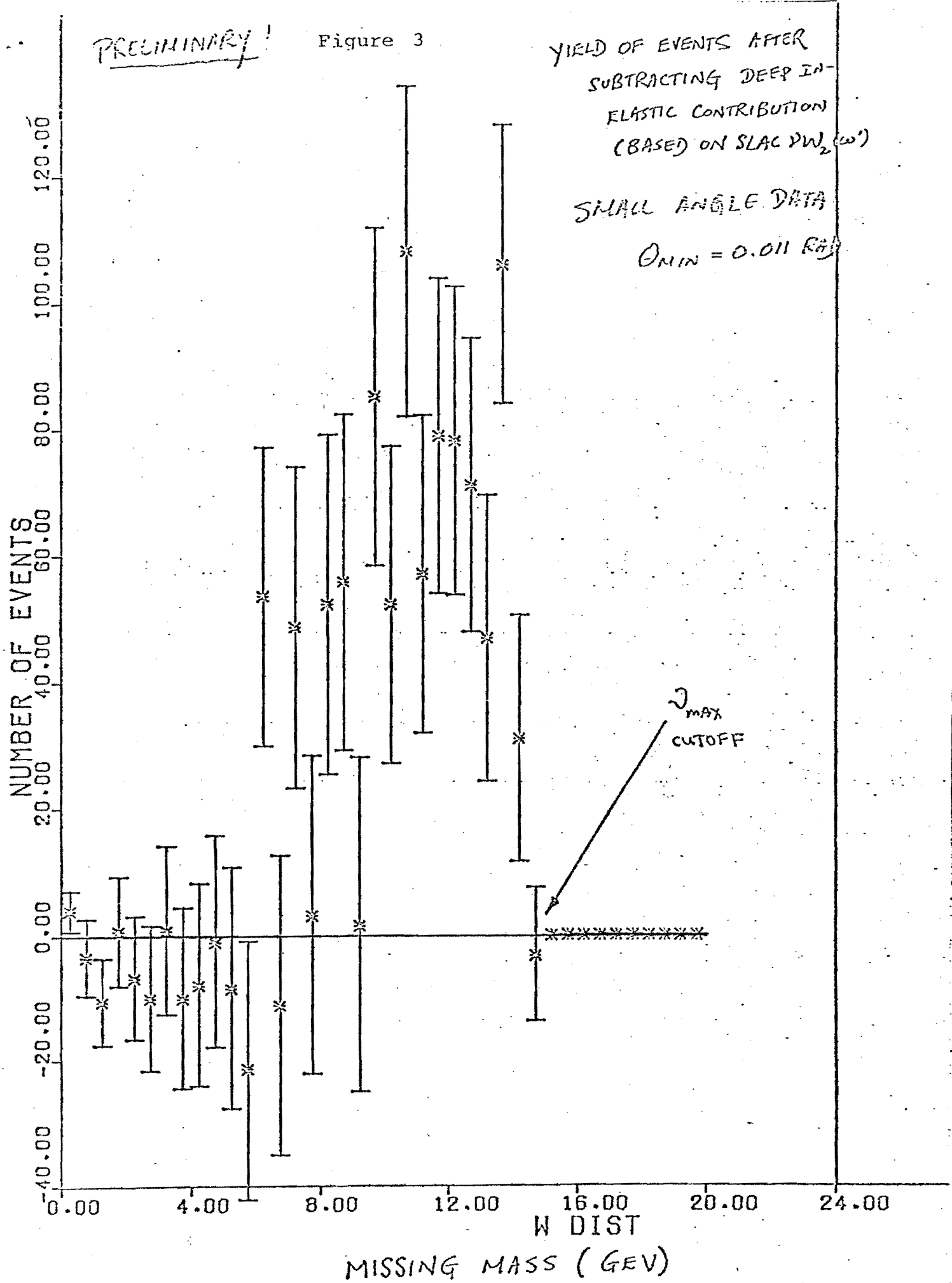
Figure 3