NAL PROPOSAL No. 236

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A PROPOSAL TO EXPLORE THE LARGE-P_t DOMAIN: INCLUSIVE CROSS SECTIONS AND POSSIBLE JET STRUCTURE

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ABSTRACT

A detailed study of large-P_t phenomena is proposed using a magnetic spectrometer and hadron calorimeter. The single particle inclusive cross sections as a function of S and particle type will be measured. A search for hadron jets will be carried out and a measurement of their properties made. The structure of the recoil particles in a large-P_t event will also be explored.

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A great deal of interest and speculation has been centered around the discovery at the ISR[1,2] that, in high energy collisions, the single particle inclusive cross section does not fall off nearly so rapidly with increasing P_t for P_t above $\sim$1.5 GeV/c as it does below this point. Instead of the exponential form of fall off, Ae^{-6P_t}, extrapolated from measurements of small P_t, the cross section appears consistent with a fall off of the form[3] $AP_t^{-9.5}$ and at P_t = 4 GeV/c it is several orders of magnitude above the extrapolated Ae^{-6P_t} rate. See Figure 1. Some success has been obtained in relating large-P_t inclusive cross sections to elastic scattering using parton models[4] but the picture is far from clear. Recent results[5] from ISR favor the S dependence predicted by the parton interchange model[6]. Also, some very new ISR data exhibit very sharply correlated, jet-like structures[7] associated with large P_t. The inclusive cross section at large P_t has been interpreted from many different points of view[6,8,9,10,11,12] and involves such exciting possibilities as parton-parton interactions, production of high mass gluons, and possibly other new fundamental processes. Current theoretical treatments of these phenomena can be found in references 13, 14, and 15.

To help sort out this jungle of theories a detailed mapping of the large-P_t phenomena is clearly called for. Its energy dependence, incoming and outgoing particle dependence, Feynman X dependence and behavior near the kinematic limit need to be established along with such things as multiplicity dependence (to what extent are large P_t-values correlated with high multiplicity?) and the existence and nature of large-P_t jets[7]. The data are so recent and so limited that no clear-cut theoretical framework has been established and some or all of the competing prevalent ideas and predictions may prove inconsistent with more detailed results.

Clearly, an experiment at NAL can help shed a great deal of light on this problem because of NAL's high luminosity, expanded S range, and the facility for studying these distributions with various beam particles.

We have planned an experiment to achieve the following physics goals:

1) We plan to make a high statistics measurement of the single particle inclusive cross sections above P_t 2 GeV/c and out to the kinematic limit ($P_t = \frac{1}{2}\sqrt{S}$). We will obtain the S and X_F dependence and the incoming and outgoing particle dependence of the P_t distribution up to the highest energy available in this beam. Accurate comparisons of negative and positive outgoing particle cross sections will be made. The cross sections for baryons and mesons will also be determined and compared.

2) We will search for hadron jets associated with the large-P_t phenomenon. We will measure the momentum of the individual charged particles in the jet so a full study of how the particles are correlated can be made.

3) We will observe the recoil structure opposite the large-P_t particle (or jet). We will measure the energy and angular distribution of single particles or jets in the recoil structure. We will also be sensitive to recoiling neutrons and π°'s.

To analyze the large-P_t events we will use a large aperture magnetic spectrometer equipped with Cerenkov counters for particle identification. To study the recoil structure we will in addition employ a hadron calorimeter. Figure 3 shows a schematic of the apparatus. We propose to use a branch of the high intensity, 3.5 mr, M1 beam in the NAL meson lab. We would use much of the same equipment employed in our experiment 23A. The techniques involved

are a natural extension of that experiment. Figure 4 shows our acceptance in X_F and P_t for a 200 GeV/c beam momentum. The shaded region shows the domain where we will obtain data during the running of experiment 23A. 23A is designed to obtain data in the small-P_t region ($\lesssim$1 GeV/c); however, data will naturally be accepted in the shaded large-P_t region on the graph. As can be seen, we will already have taken data which extends and compliments the data to be taken in this experiment.*

We will use the three threshold Cerenkov counters and the single BM109 magnet used in 23A with the gap expanded to 12 inches. To obtain sufficient data at high P_t where rates are expected to be very low, a high beam intensity is needed. Also, the interaction point needs to be determined with high precision to eliminate background from multiple interactions and walls. This necessitates the use of proportional wire chambers in the beam and downstream of the target. These we plan to have ready for experiment 23A. In addition we will use MWPC's after the magnet for the momentum measurements. A system of about 4000 wires total will supply the needed coverage. A simple calorimeter with lead glass π° discrimination[16] will supply the recoil information.

Each incoming or outgoing baryon, kaon or pion will be uniquely identified by Cerenkov counters in the beam and in the spectrometer. Measuring the cross section for different incident particles will be very interesting;

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* It should also be noted that 23A will also obtain events over much of the region of this experiment in addition to the area given but without specific particle identification and at a much lower rate.

for instance it is possible that effects due to different constituent quarks might appear. With the proposed set up these cross sections will be measured simultaneously. The trigger system used in 23A can be simply adapted to restrict triggers to those events with $P_t \geq 2$ GeV/c in an unbiased way so we won't be swamped with low P_t triggers. With a nominal setting of $P_t \geq 2$ GeV/c, the actual acceptance falls to zero at 1.2 GeV/c. The trigger will accept both positive and negative secondaries so these cross sections will be measured simultaneously. Despite the rapid variation of these cross sections with P_t, this technique should permit accurate comparisons.

Since we have opened the aperture of the BM109 magnet to 12" we will be able to explore in great detail the jet-like hadron structure recently observed at the ISR[7]. When a large-P_t particle from such a jet of multiplicity two passes through the spectrometer, 60% of the time the second particle from the same jet will also pass through the spectrometer. This acceptance falls to 35% for a jet with twice this average opening angle. The typical opening angle one might expect for such jets is .3 GeV/c/P_t which is close to the ISR result. Consequently, independently of the ISR data we expect our acceptance to be reasonable.

We will use the proportional chambers immediately downstream of the hydrogen target to measure the trajectories of all charged secondaries produced in the large-P_t events. The information on wide angle (>.06) secondaries on the recoil side will be supplemented with coarse (∿20%) energy measurements provided by two adjacent hadron calorimeters. Each calorimeter will have a transverse cross section of 9" x 10". For a 200 GeV/c beam momentum, the two calorimeters will subtend center-of-mass angles from 70° to 135°. In the center-of-mass system the calorimeter acceptance is

opposite the spectrometer acceptance. The calorimeter-spectrometer tandem should therefore provide a highly efficient showcase for jet-jet events. The jet-jet correlation is obscured if the proportional chambers indicate that several charged particles entered a calorimeter at significantly different locations. We have calculated the background from ordinary hadron-hadron interactions and find (for the proposed configuration) that there will be a confusing background track in the calorimeters about 12% of the time. The information obtained by the calorimeters will also become less if the members of the same jet disperse significantly before entering the calorimeters. Still in this case the calorimeters provide a valuable check of the experiment since they must verify the large-P_t character of the event.

To make an estimate of our event rate we have scaled (see Figure 2) the ISR results[1,2] to NAL energies and used the X_F dependence of P_t found at P_t = 1.5 GeV/c by Panvini et al[17]. Using the 15 inch LH target of 23A and assuming a beam intensity of about 5×10^6 particles per pulse we will obtain on the order of 1.6×10^6 events per 100 hours with P_t above 2 GeV/c. See Table I.

TABLE I.

P_t Momentum Range	Events/100 hours
2-3 BeV/c	$1.6\ 10^6$
3-5 BeV/c	$6.3\ 10^4$
>5 BeV/c	$1.1\ 10^3$

We expect to divide the running time among three beam momenta up to the highest practical beam momentum. The data will cover the four charge combinations ++, +-, -+ and -- at the three momenta for the three types of beam particles. We expect to reverse the BM109 magnet once for each beam setting so we require a total of twelve settings to collect the data.

We expect to be able to answer the following type of questions:

1) What is the detailed nature of the large-P_t inclusive cross section - its X_F and S dependence? Its incoming and outgoing particle dependence? Does indeed the cross section scale with $P_t/\sqrt{S}$?

2) Do large-P_t jets exist at NAL energies? What is their structure, particle composition, X_F and S dependence?

3) What is the recoil structure accompanying large-P_t events (or jets)? Is there a single large-P_t particle (charged particle, π° or neutron), many particles or jets?

4) What is the angular correlation between recoil large P_t (or jet) and the large P_t (or jet) observed in the spectrometer?

We will be ready to run this experiment any time subsequent to our running of NAL 23A and with essentially no extra NAL support beyond that needed for 23A. Very little testing time is anticipated ($\sim$50 hours) because of the similarity of this equipment to that in our previous experiment. We request 500 hours of data taking which is expected to provide $\sim 8\ 10^6$ large-P_t events and yield decisive information on this new exciting region of hadron interactions.

REFERENCES

1. CCR Collaboration, Proceedings of the XVI International Conference on High Energy Physics, Chicago - Batavia, 3, 317 (72).

2. M. Banner, et al, Proceedings of the XVI International Conference on High Energy Physics, Chicago - Batavia, 1, 223 (72); British-Scandinavian results from M. Jacob, CERN Preprint, Th.1639 - CERN (73).

3. F. Halzen, Univ. of Wisconsin Preprint, COO-371 (73).

4. M. Moshe and D. Horn, Nucl. Phys. 48B, 557 (72).

5. R. Cool, Private Communication; J. Gunion, Private Communication.

6. R. Blankenbecler, J.S. Brodsky, J.F. Gunion, Phys. Lett. 39B, 649; Phys. Rev. D6, 2652 (72); Phys. Lett. 42B, 461 (73).

7. R. Cool, Private Communication. Rockefeller-Columbia ISR collaboration see both an increase in multiplicity with large P_t and also a strikingly sharp correlation in rapidity for charged tracks accompanying a large P_t π° event. These are interpreted as a jet with a Δy FWHM of $\sim$.3.

8. Minh Doung-van and P. Carruthers, Cornell Preprint, CLNS-225.

9. Sunao Sakai, Tokyo Univ. Preprint, TUETP-73-6; M.S. Chanowitz and S.D. Drell, PRL 30, 807 (73).

10. C. Boldrighini and L. Lusanna, Preprint, UW #003195.

11. S.M. Berman, J.D. Bjorken and J.B. Kogut, Phys. Rev. D4, 3388 (71).

12. D. Bebel and U.M. Wambach, CERN Preprint, TH.1638-CERN (73).

13. J.D. Bjorken, SLAC Preprint (1973); Can We Measure Parton Parton Cross Sections?

14. E.L. Berger and D. Branson, Phys. Lett. 45B , 57 (73).

15. S.D. Ellis and M.B. Kishinger, NAL Preprint NAL-PUB-73/40-THY (1973).

16. B.J. Blumenfeld, et al, Nucl. Inst. & Meth. 97, 427-431 (1971).

17. R.S. Panvini, et al, Phys. Lett. 38B, 55 (72); M.G. Albrow, et al, Phys. Lett. 42B, 279 (72); A. Bertin, et al, Phys. Lett. 42B, 493 (72).

Figure Captions

1. This graph shows the ISR results at large P_t for π^o's and charged pions and is taken from the Chicago-Batavia Conference, Volume #3, p. 317.

2. This graph shows the S dependence of the cross section observed for large P_t. This is taken from M. Jacob, CERN preprint TH.1639-CERN. This dependence is consistent with the π^o data (R. Cool, private communication).

3. Diagram showing the large P_t and X_F acceptance for this experiment with a 200 GeV/c beam. Shaded area shows the region naturally covered by experiment 23A.

4. Sketch of experimental layout showing magnet, Cerenkov counters, hodoscopes and wire chamber positions.

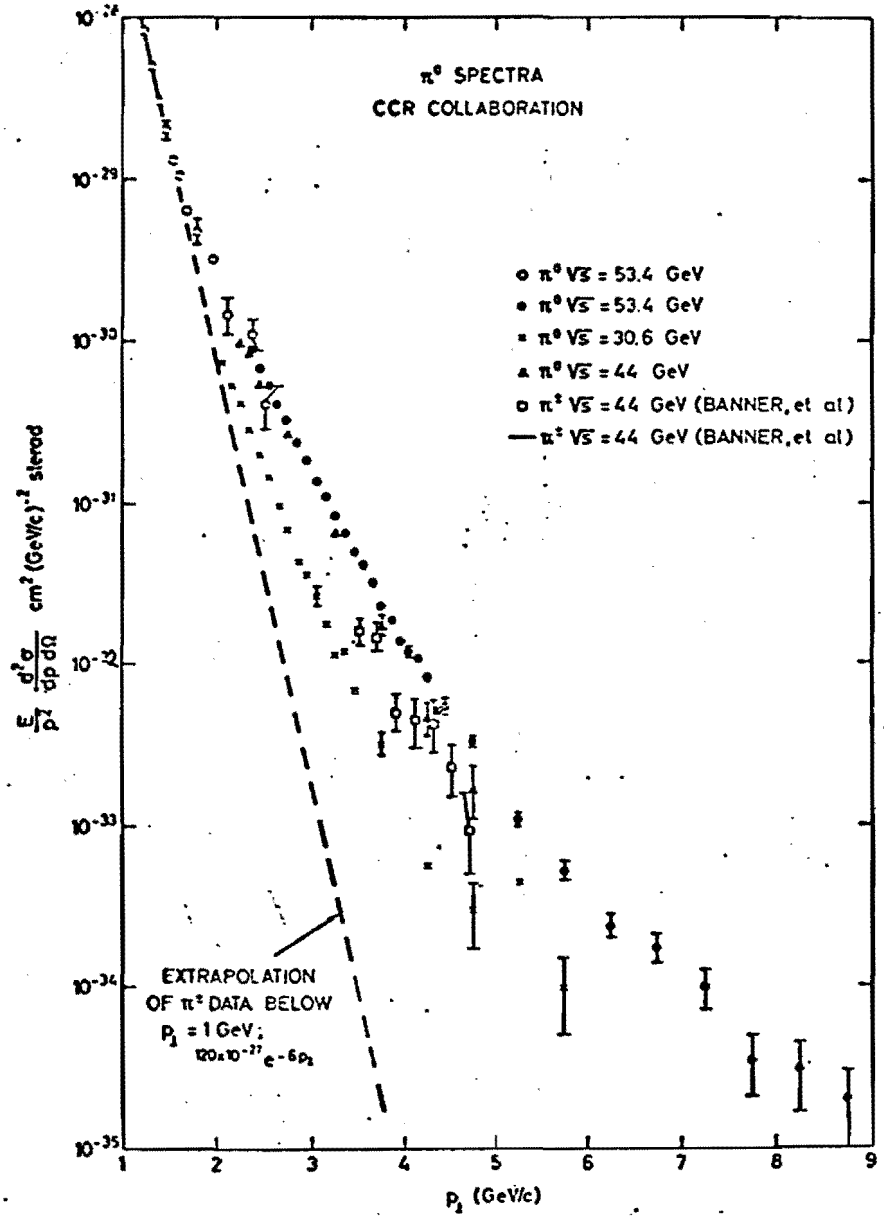
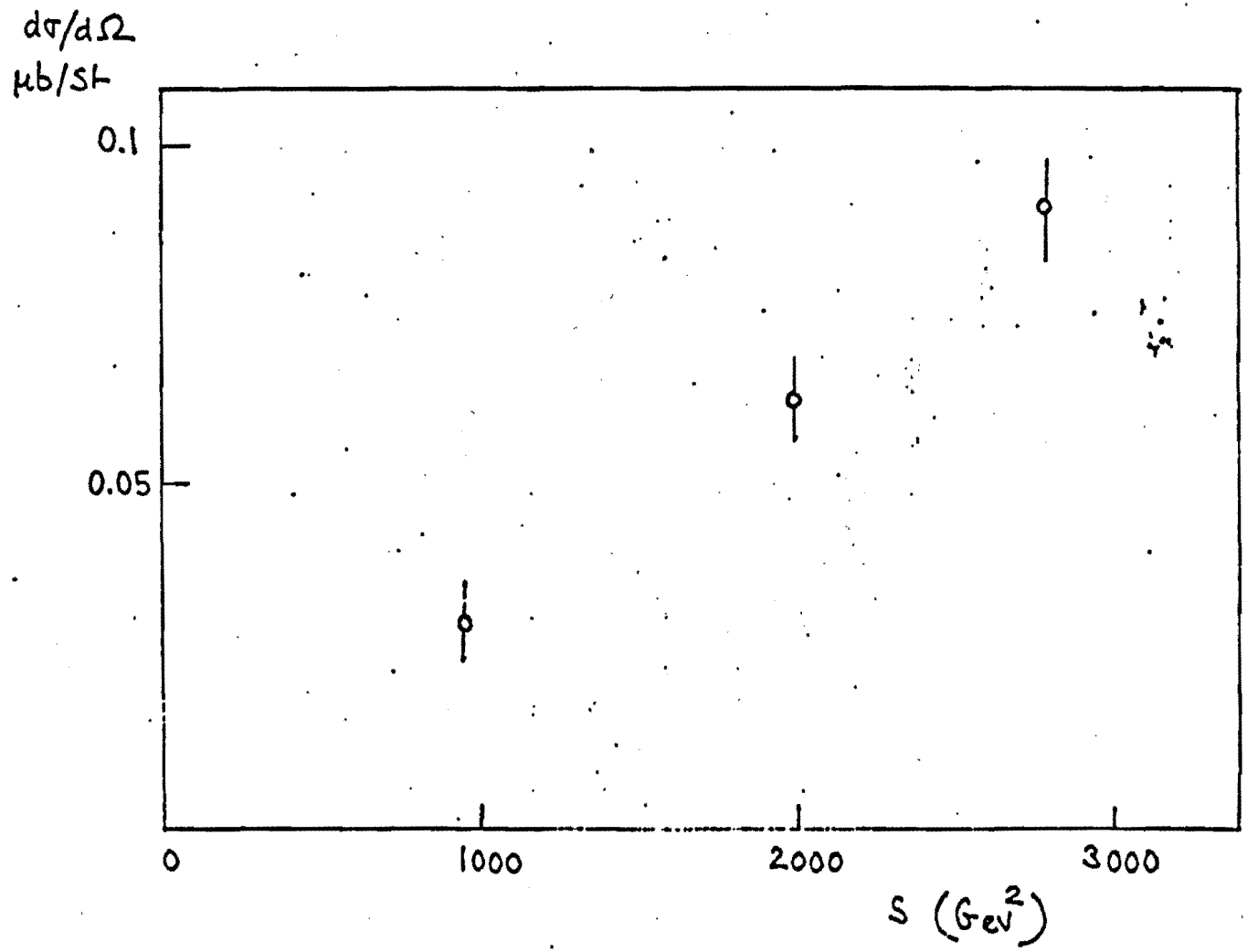

π⁰ SPECTRA
CCR COLLABORATION
π⁰ √s = 53.4 GeV
π⁰ √s = 53.4 GeV
π⁰ √s = 30.6 GeV
π⁰ √s = 44 GeV
π⁺ √s = 44 GeV (BANNER, et al)
π⁺ √s = 44 GeV (BANNER, et al)
EXTRAPOLATION
OF π⁺ DATA BELOW
P⊥ = 1 GeV;
120×10⁻²⁷ e⁻⁶P⊥
E/p² d²σ/dp dΩ cm² (GeV/c)⁻² sterad
P⊥ (GeV/c)

Fig. 1

Saclay. Strasbourg



$pp \to \pi^{\pm} + \ldots$

Average

$3.2 < p_T < 5.2$ Gev/c

$x = 0$

Fig. 2

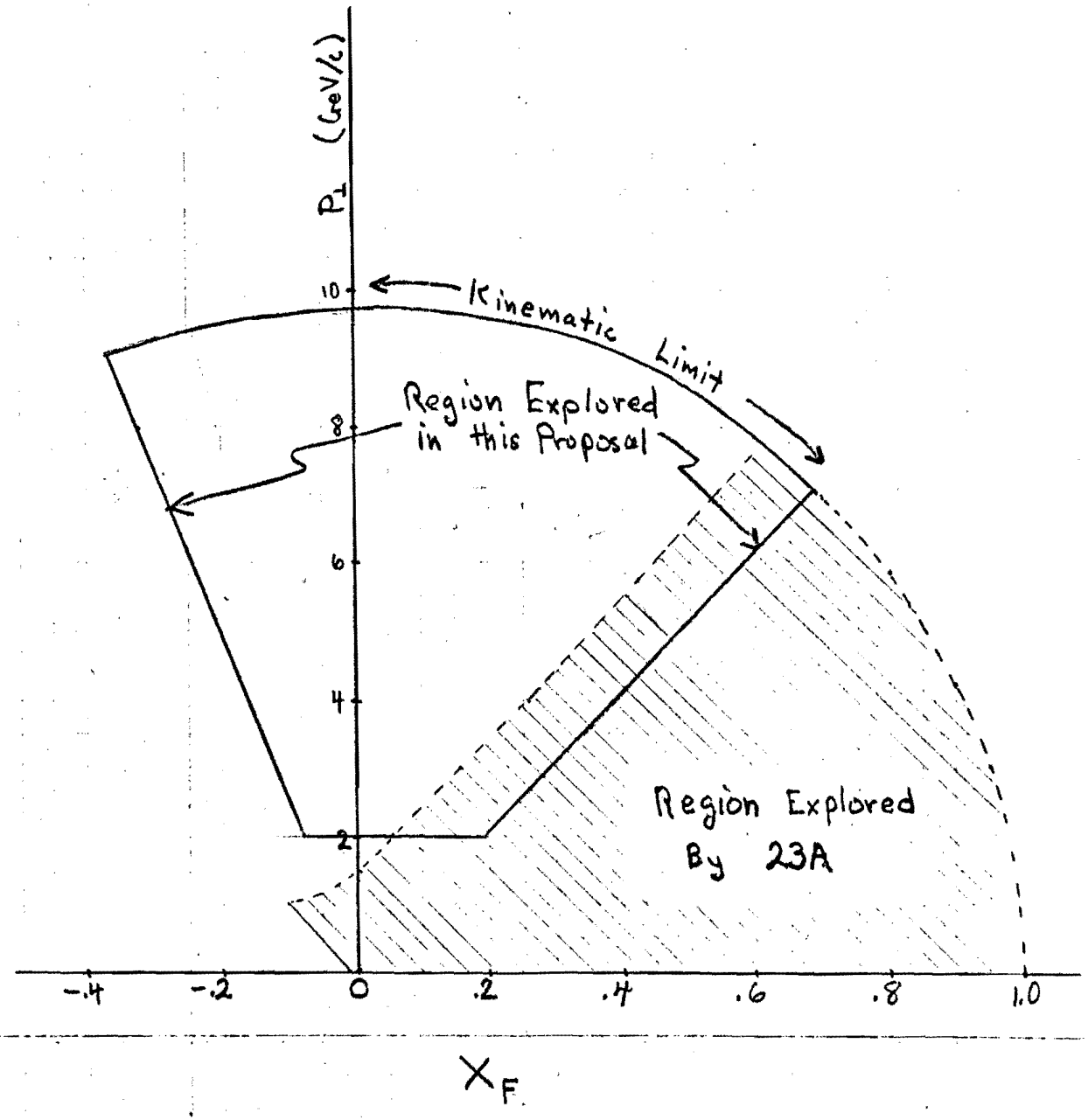
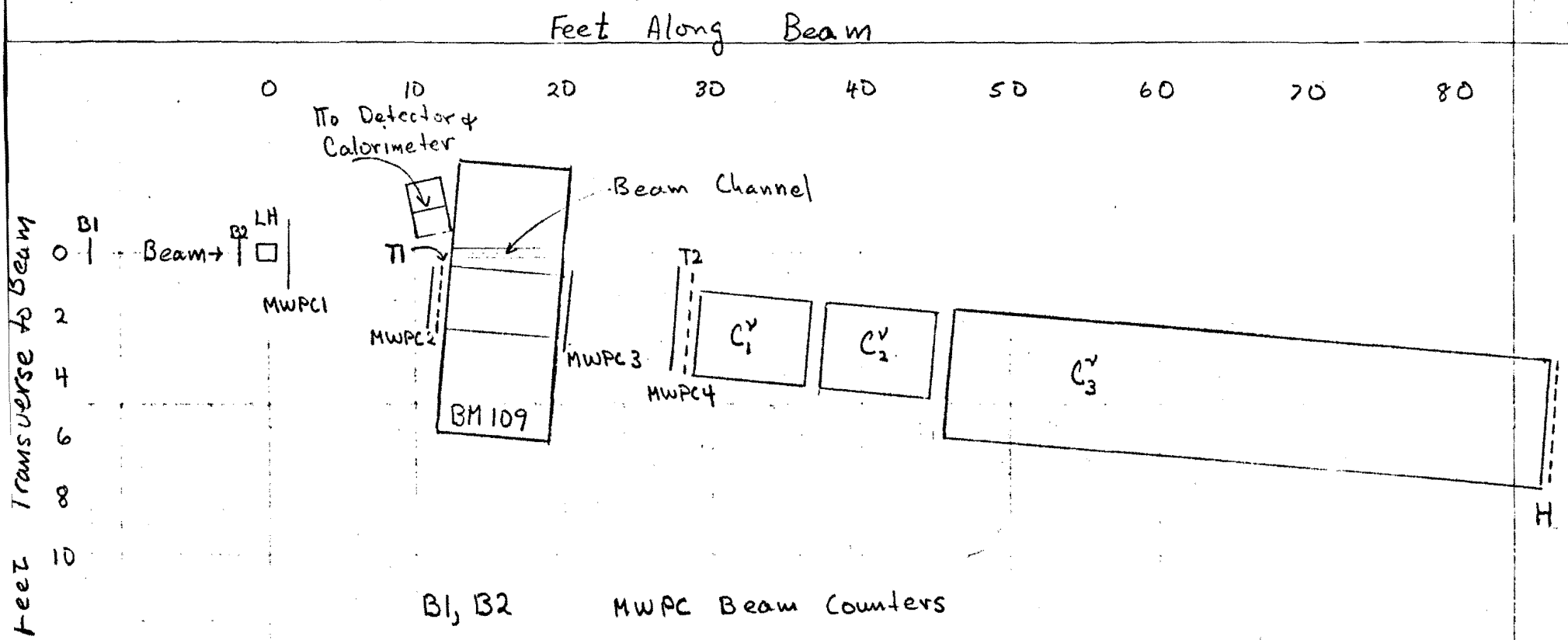

$P_\perp$ (GeV/c)
10
8
6
4
2
Kinematic Limit
Region Explored in this Proposal
Region Explored By 23A
-.4
-.2
0
.2
.4
.6
.8
1.0
X_F

Fig. 3



B1, B2	MWPC Beam Counters
LH	Liquid Hydrogen Target
MWPC1-4	Proportional Chambers
T1, T2	Trigger Counters
H	Hodoscope

Fig. 4

ADDENDUM TO PROPOSAL #236 - A

A PROPOSAL TO EXPLORE THE LARGE-P_t DOMAIN: INCLUSIVE CROSS SECTIONS AND POSSIBLE JET STRUCTURE

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National Accelerator Laboratory

October 10, 1973

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ABSTRACT

A detailed study of large-P_t phenomena is proposed using a magnetic spectrometer and hadron calorimeter. The single particle inclusive cross sections as a function of S and particle type will be measured. A search for hadron jets will be carried out and a measurement of their properties made. The structure of the recoil particles in a large P_t event will also be explored.

The following is an update on the experimental details encompassed in our NAL proposal #236.

We find after detailed Monte Carlo studies on rates for spurious triggers that we can open the magnet to 16 inches. We still plan to trigger on particles within the old aperture but the extra magnet size will allow even better detection of accompanying charged particles. Fig. 1 shows the effects of our detection efficiency for this aperture on a two particle jet of twice the size seen by the CCR group.* The relative efficiency has fallen by only ½ at the two standard deviation point.

In Fig. 2 we show more details of our calorimeter. A 10 radiation length gamma detector is followed by an iron calorimeter, the scintillation counters are segmented, tentatively, at 10 cm in width. Half of the scintillators sample horizontal bands and half verticle to give an overall energy location of ±5 cm. In front of the gamma detector section we will place two sets of proportional chambers separated by 1 cm of lead. This will enable us to locate the π^0 directions almost as well as the charged particle directions. We plan to control "noise" from back scatter by judicious use of Al sheets and plastic scintillator.

We have added another small (9" x 6") MWPC about seven feet from the target which will substantially aid in pattern recognition and momentum measurement. We also found from Monte Carlo studies that our trigger could be substantially improved by adding another plane of trigger counters just after the magnet. See Fig. 3 for an updated version of our set up. Total number of counters involved is 65 . This arrangement would give us a spurious trigger cross section about 10μb from multi track events. More

*We approximate the distribution by a gaussian of 17^0 standard deviation. This is about twice the angular separation of the charged track and π^0 in the jet structure seen by the CCR gruop.

than 90% of these spurious triggers can be removed by simple and fast on line pattern recognition. Using the recently reported scaling form for the CCR data our trigger system would accept a 1μb cross section above 2 GeV/c P_t. The trigger would reach nearly full efficiency at 3 GeV/c P_t and would sample with falling efficiency down to below 1.5 GeV/c. This will cover the possibility that large P_t jets involving several low P_t particles are many times more frequent than are one or two large P_t particles.

Because of some uncertainty in the duty cycle at NAL at the time this experiment might run we are prepared to take very high data rates. At a KHz data rate, use of a double buffered PC read out system would produce <1% dead time. We are considering using a simple modification to the board designed at Cornell by A. Browman ($2.50/wire) to obtain the necessary double buffering. We don't expect this to affect the cost significantly. We have tested our PDP 11/45 and CAMAC system to read 100 data words (our expected number per event) at a KHz rate and simultaneously write them out on disk and find no interference in the data rate. We find we would still have nearly 1000 machine cycles for filtering the spurious triggers before writing on the disk but we could use the time between machine bursts to filter if necessary.

We calculate writing a modest 100 data tapes for off line analysis.

We have checked the probability that a normal event would produce a track through the Cerenkov counters by Monte Carlo means. This indicates that 12% of the time there might be a confusing second track in the Cerenkov counters but since we plan to measure pulse height it is likely that we can sort out a fair fraction of these double track events. The

very important ratio of π:K:P we will measure very well. The ability to distinguish particle types will also enable us to sort out resonance production such as N* and ρ.

We have checked the correction that must be made because of finite momentum resolution and the sharply falling cross section for large-P_t which for fixed angle goes as the momentum. For 100 GeV/c lab momentum for which we estimate our accuracy to be $\sim$10%, the correction would be a modest 16% to a cross section that fell as $^1/P_t^8$. We therefore believe that even with a magnet producing ½ GeV/c bend (e.g. the 16" expanded BM109) the momentum measurement will not produce a significant final error in the cross section. However since the correction goes as the square of the error much worse resolution could certainly present problems.

Our overall amplifier needs for the proportional chambers in order to obtain the necessary momentum resolution and π^0 detection totals 7600 wires.

We estimate that by utilizing much of the equipment planned for 23A we can be ready to run in about 7 months.

These details are presented to emphasize that we can indeed do what we claimed in Proposal #236. Our energy resolution, acceptance ([redacted] one sterradian in center of mass), particle identification and data handling ability will enable us to make a detailed study of the large-P_t phenomena.

Concluding Remarks

Only a magnetic spectrometer can give a single-particle spectrum which includes identification of charged-particle type. All recent parton models predict that at high P_t there will be important effects of particle type, both incoming and outgoing. In fact, the evidence from the ISR is that the behavior of K's and p's relative to π's at high P_t is one of the most

striking features. The role played by kaons and baryons in high-P_t jet structure is almost certain to be very interesting and should not be missed.

FIGURE CAPTIONS

1. Relative detection efficiency for two particle jets as a function of asimuthal angle (distribution shown has twice the width of jet structure observed by CCR group).

2. Schematic of our proposed calorimeter.

3. Schematic of layout showing additional features of the calorimeter, trigger hodoscopes and MWPC's.

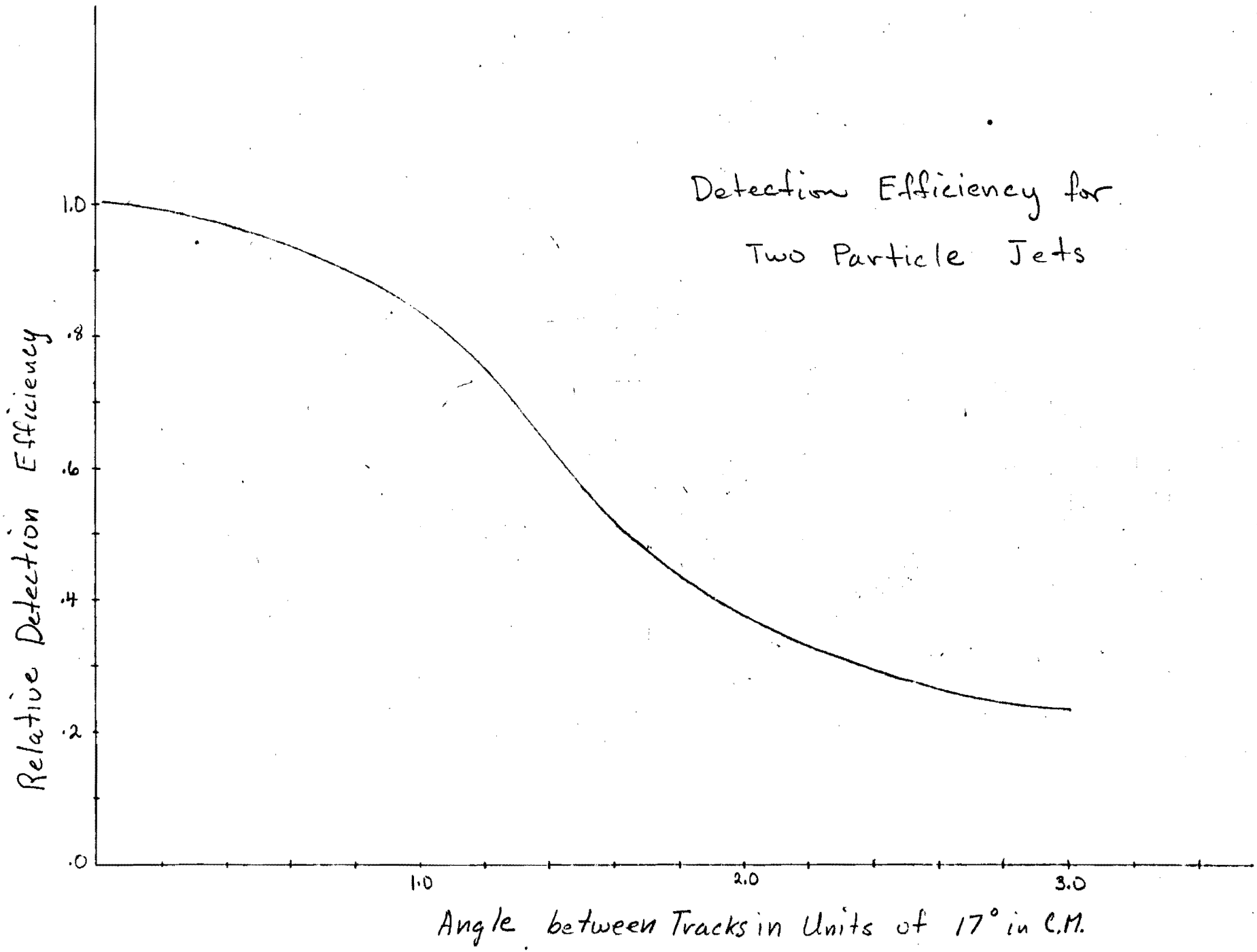
4. Triggering efficiencies for particles bending toward and away from the beam as a function of P_t. The complete cut off is near 1.5 GeV/c and full efficiency is reached at about 3 GeV/c.

5. Distribution of single particle events accepted by the trigger assuming the data has the form presented by the CCR group of

$$\frac{E d\sigma}{d^3P} = \frac{1.5\ 10^{-26}}{P_t^{8.24}}\ e^{-26.1\ P_t/\sqrt{s}}\ cm^2.$$

6. Integrated single particle cross-section accepted by trigger.

7. Peyrou Plot showing acceptance of spectrometer and calorimeter.


Detection Efficiency for
Two Particle Jets
Relative Detection Efficiency
1.0
.8
.6
.4
.2
.0
1.0
2.0
3.0
Angle between Tracks in Units of 17° in C.M.

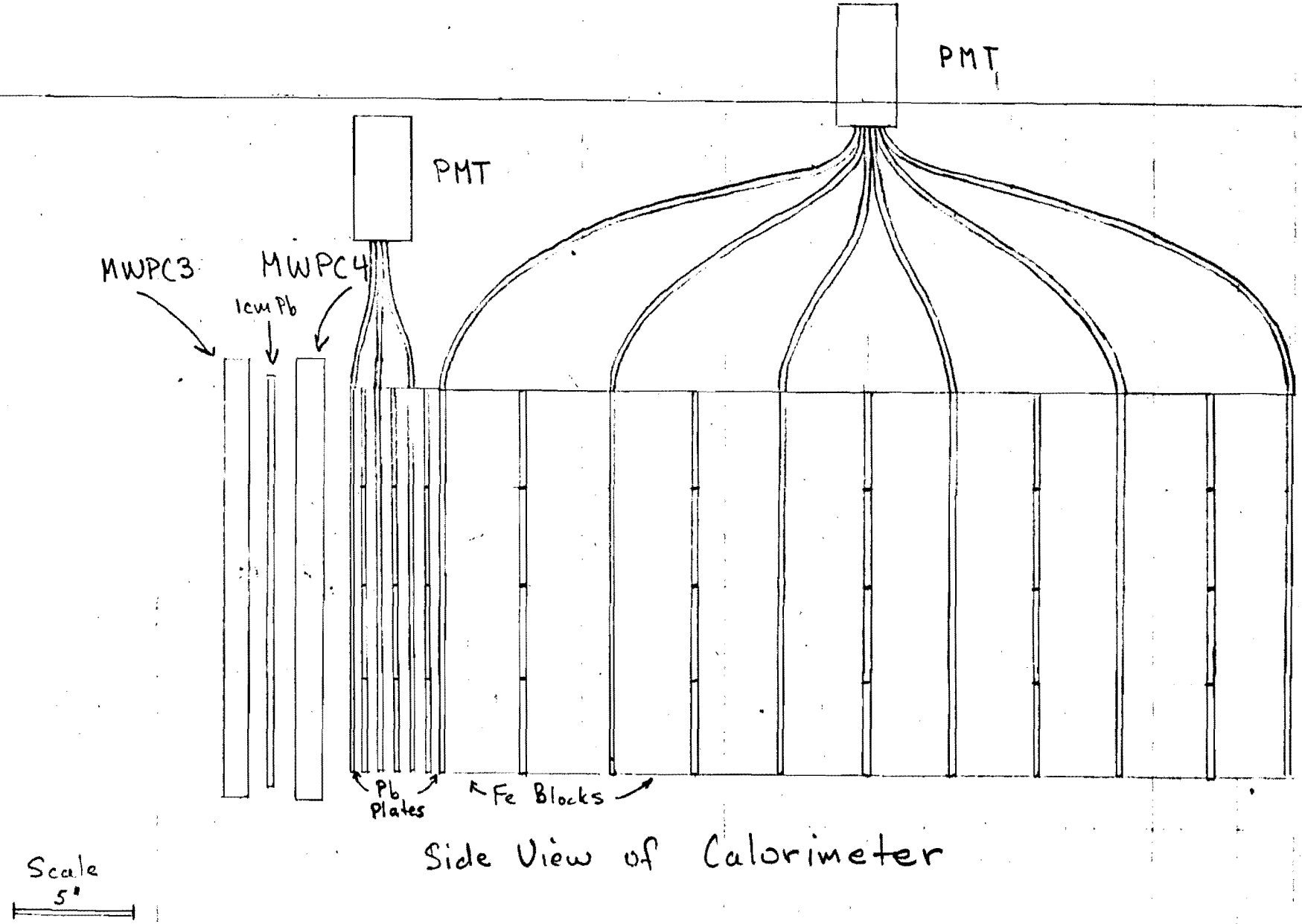
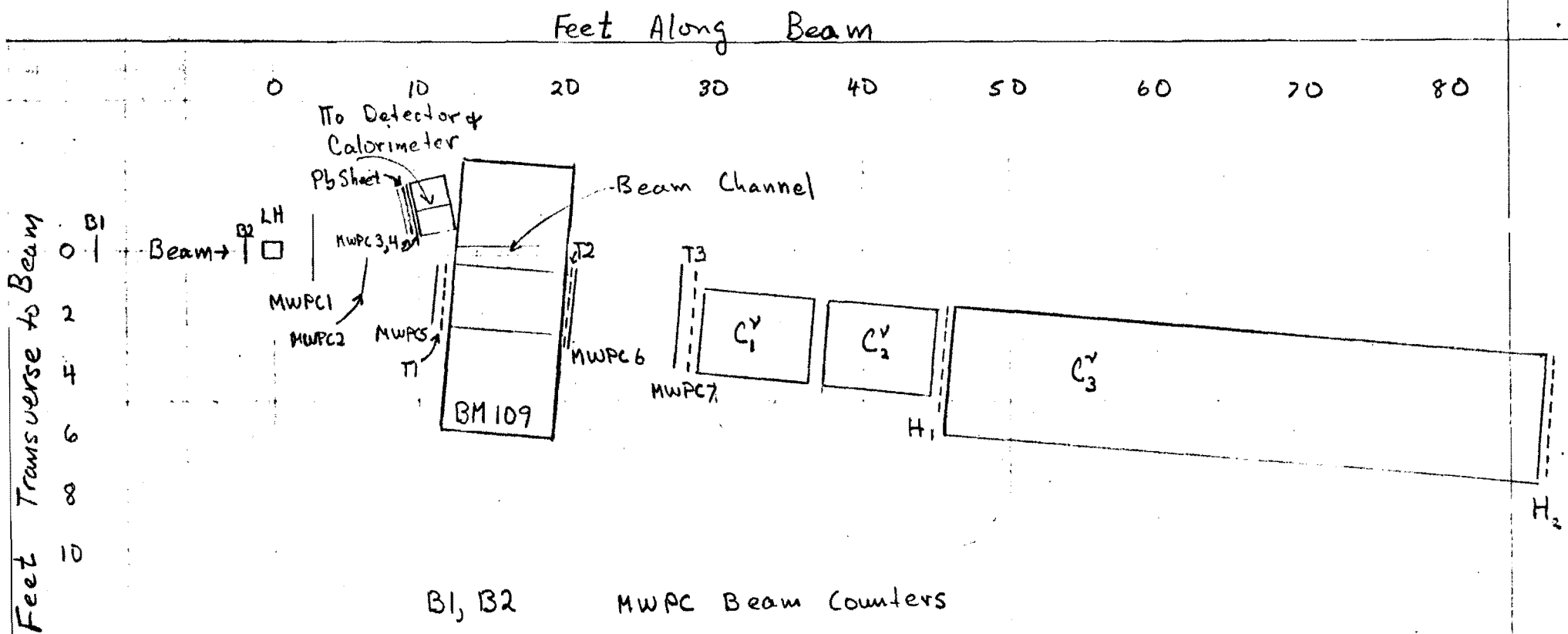

PMT
PMT
MWPC3
MWPC4
1cm Pb
Pb Plates
Fe Blocks
Side View of Calorimeter
Scale
5"

Fig. 2



B1, B2	MWPC Beam Counters
LH	Liquid Hydrogen Target
MWPC1-7	Proportional Chambers Sets Using X, U & V Planes
T1, T2, T3	Trigger Counters
H_1, H_2	Hodoscopes

Fig. 3

TRIGGER EFFICIENCY

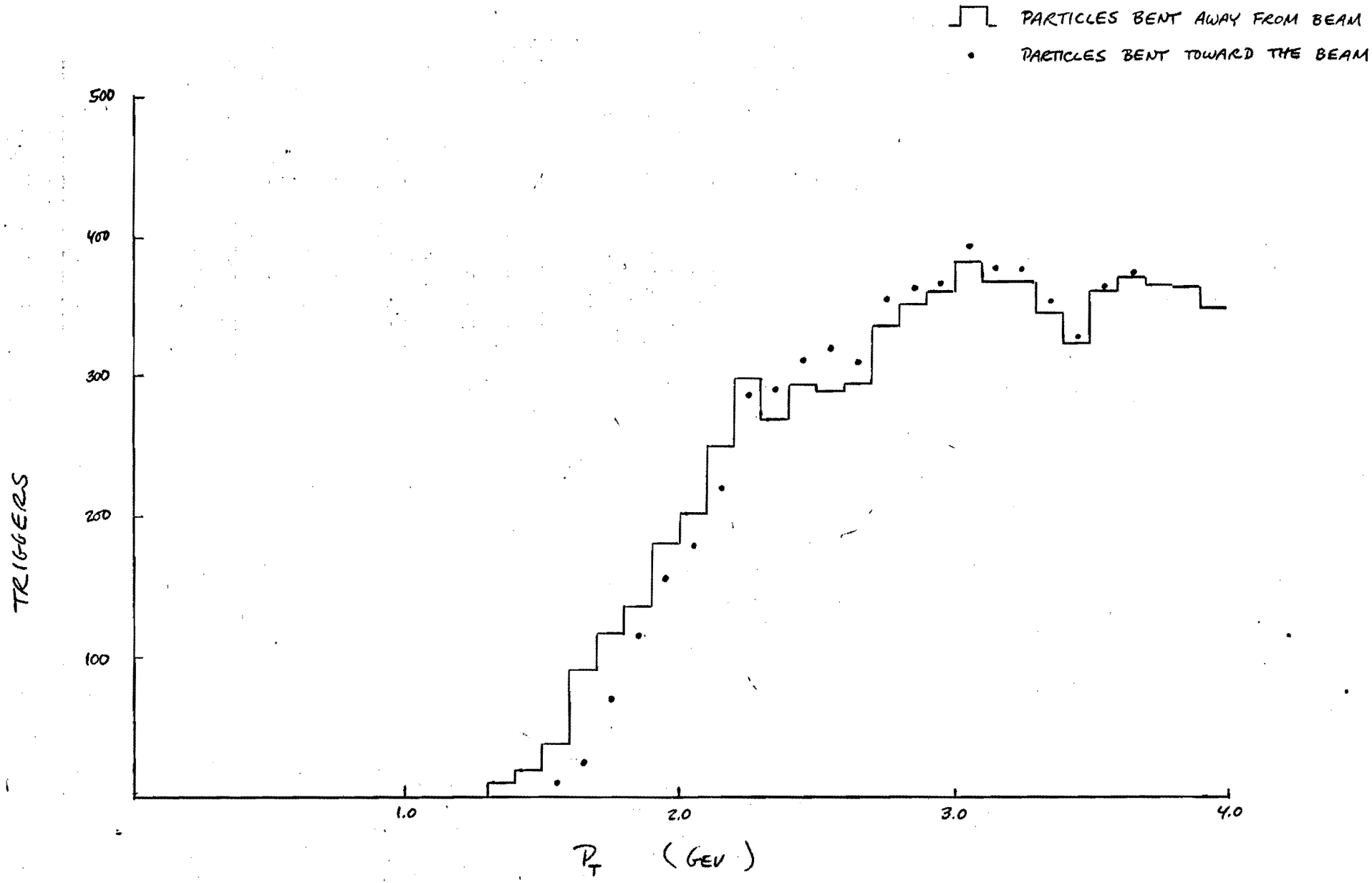


Fig. 4

DISTRIBUTION OF TRIGGERS FOR CCR CROSS SECTION

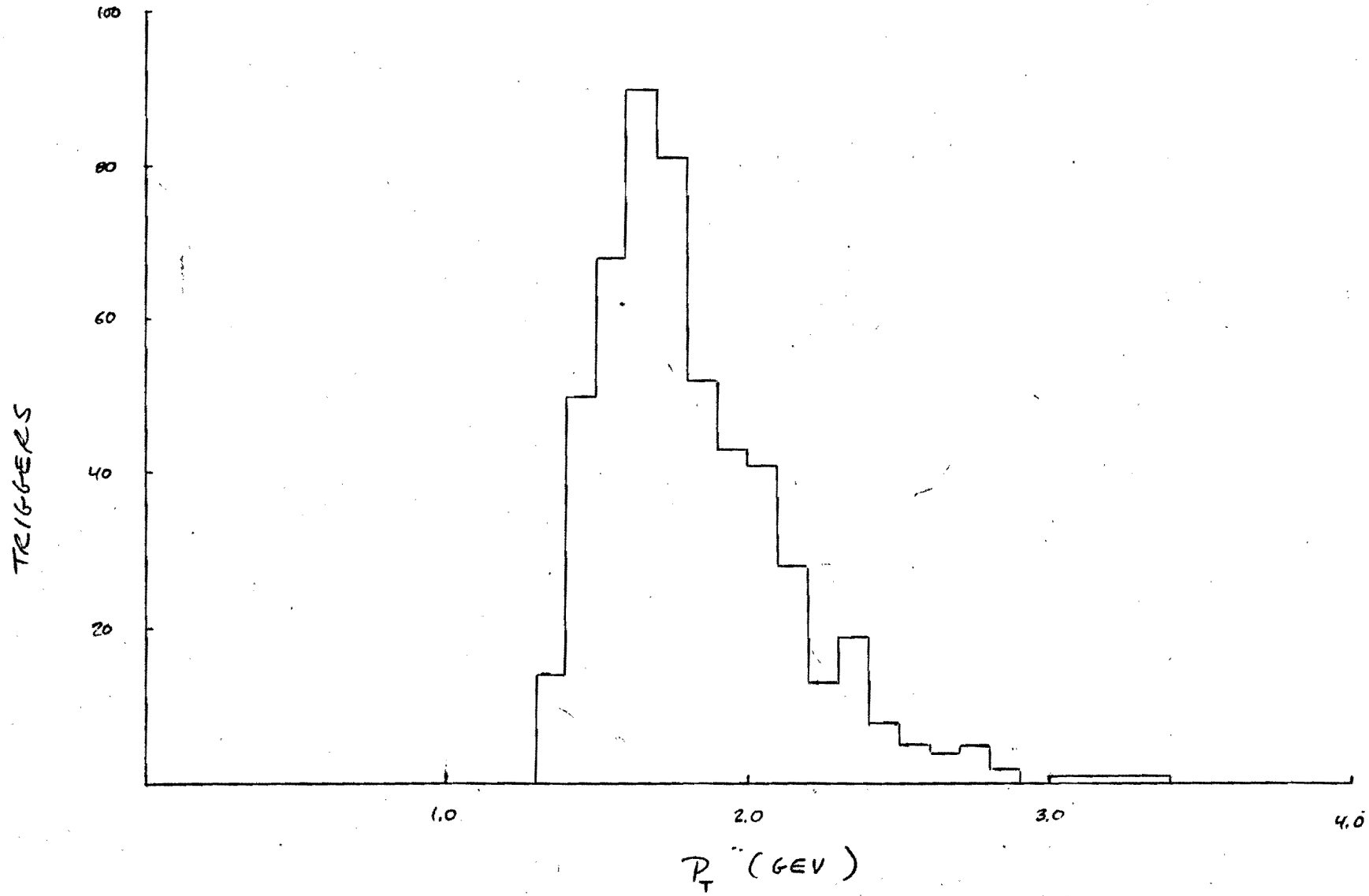


Fig. 5

INTEGRATED YIELD OF TRIGGERS FOR CCR CROSS SECTIONS

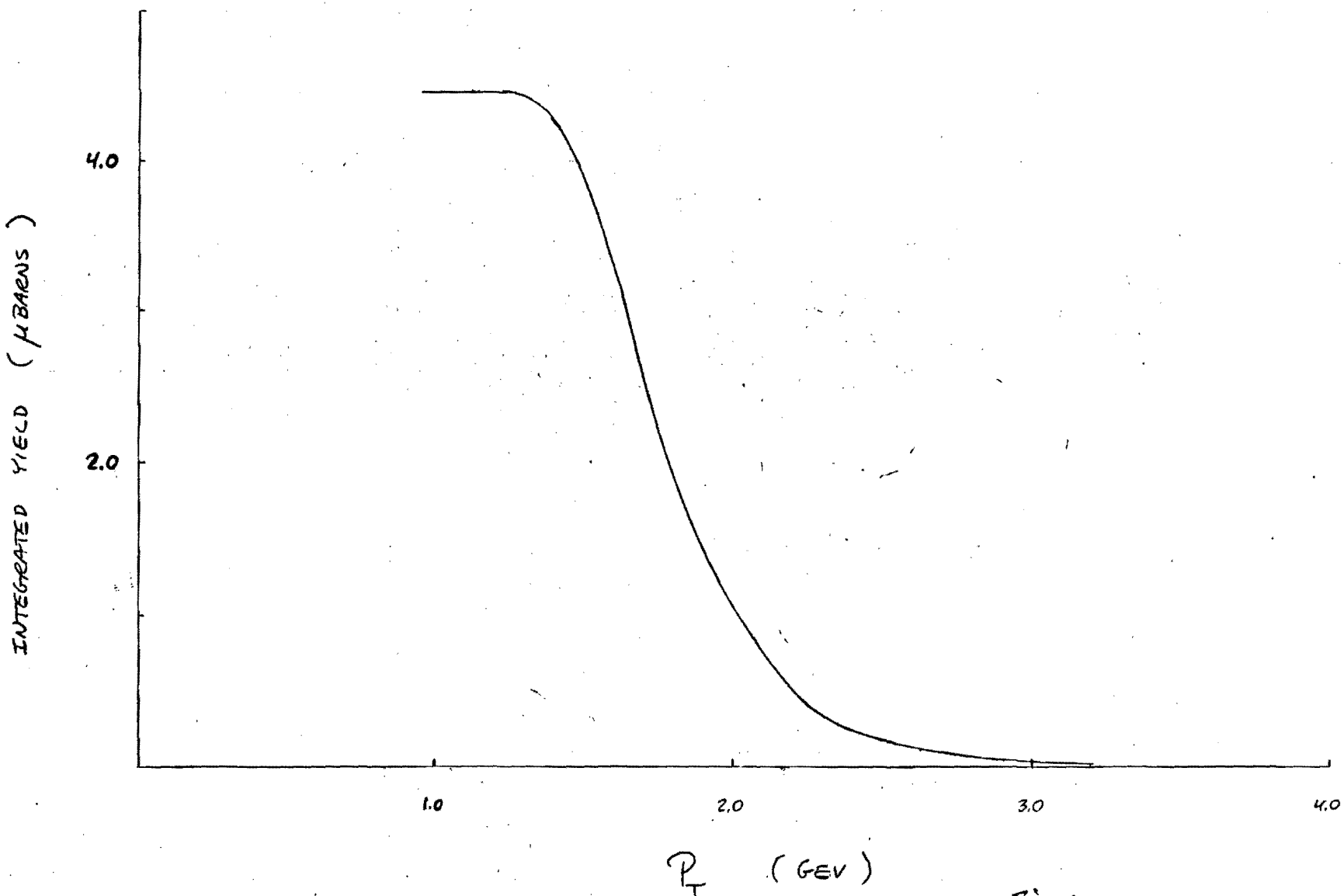


Fig 6

Peyrou Plot for 200 GeV, showing magnet limits proposed for 236.

$\gamma_{cm} = 10.3$ $\tan\frac{\theta^*}{2} = \gamma_{cm}\,\theta$ $\frac{d\theta^*}{d\theta} \approx 10$, horiz. and vert. both.

$P_{Lab} \approx P_t / \theta$

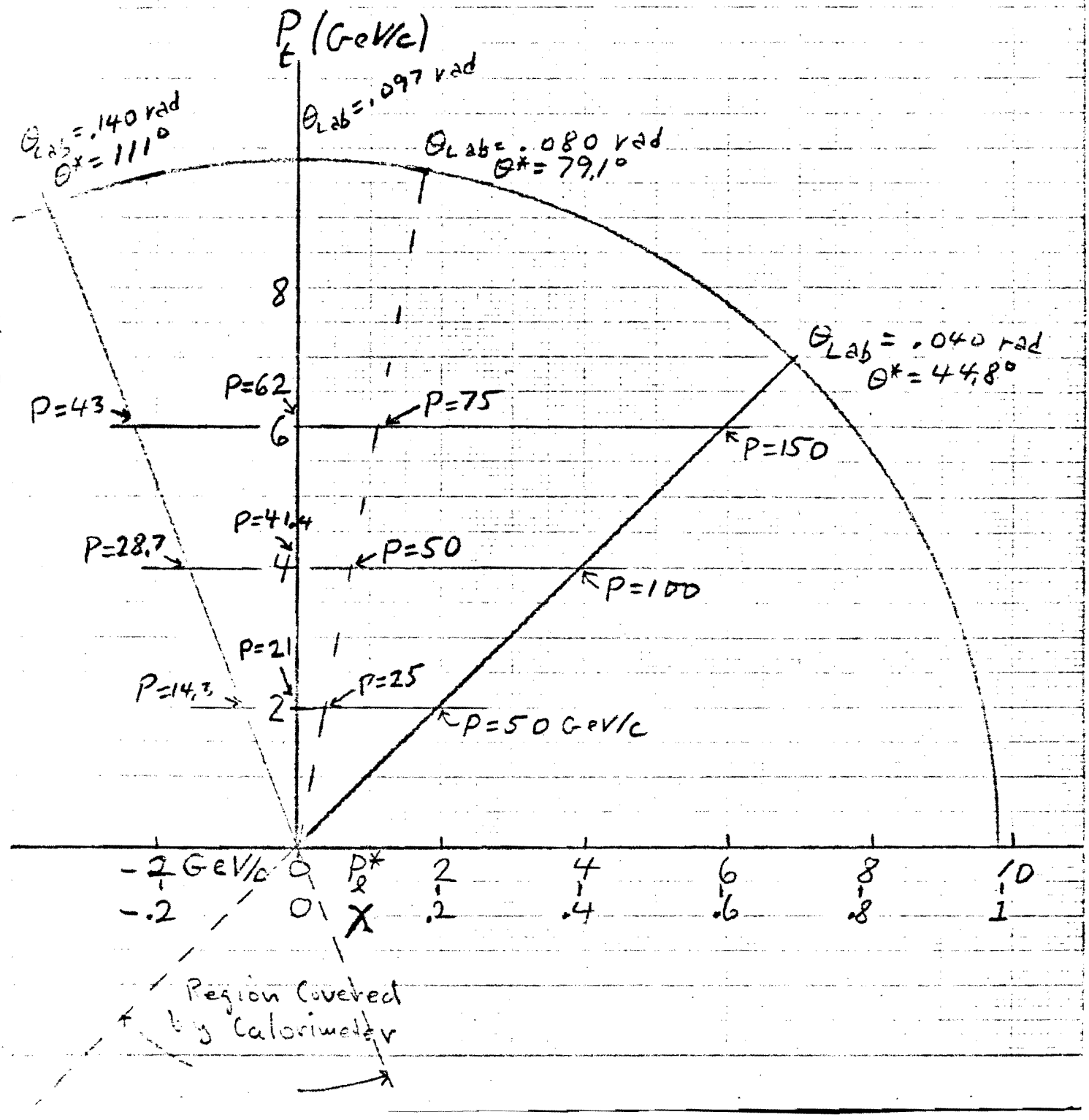


Fig. 7

Master file

ADDENDUM II TO PROPOSAL #236A

A PROPOSAL TO EXPLORE THE LARGE-P_t DOMAIN: INCLUSIVE CROSS SECTIONS AND POSSIBLE JET STRUCTURE

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November 1, 1973

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Addendum II
Proposal #236

Subsequent to the large-P_t workshop we have continued to study details of our NAL proposal #236. We present here some recent results which support our position that we have an excellent technique for exploring the large-P_t phenomena.

1. Calorimeter Design

We have added to our calorimeter and π° detector design slightly to increase the range of uniform azimuthal acceptance. This does not involve a great many more counters, the total now being 32. The center of mass azimuthal acceptance of the calorimeter is shown in Fig. 1 and a cross section of the calorimeter at 10 feet from the target in Fig. 2. We plan to use 32 one-inch iron plates in this calorimeter, thus improving the resolution over the previous design.

2. Calorimeter Trigger

We calculated the background introduced from ordinary small-P_t events to determine the feasibility of triggering on large-P_t jets in the calorimeter. Figs. 3 and 4 show the expected energy distribution deposited in the calorimeter from a random association of small-P_t particles (P_t <1.8 GeV/c) produced in 200 GeV/c πP interactions. These calculations indicate that we could set a calorimeter trigger threshold somewhere between 30 to 35 GeV and not greatly increase our background trigger rate. This corresponds to a P_t threshold of 3 to 6 GeV/c depending on the average polar angle.

3. Cerenkov Counters

For the Cerenkov angles involved in large-P_t studies it is easy to segment each of the three Cerenkov counters used in our proposal into two separate units. This will enable us to sort out species in multiparticle

jets in a substantially larger fraction of cases. Even with three Cerenkov counters in tandem it will be necessary to have two pressure settings to obtain complete separation of π's, K's and P's over nearly all the interesting momentum range for P_t >2 GeV/c. When the pressure change is made we would also move the counters slightly to cover the full Θ aperture of the magnet. Approximate thresholds for each counter are given in the following table:

K Thresholds (GeV/c)

Setting I		Setting II	
C_1	20	C_1	41
C_2	38	C_2	79
C_3	72	C_3	150

These settings would also allow separation of π's from K's and P's down to 6 GeV/c and P's from K's and π's up to the maximum allowed momentum. Fig. 1 shows the solid angle subtended by the counters for Setting II.

4. Beam Energy

We would like to emphasize that the M1 beam line which we propose to use will be upgraded this winter to 285 GeV/c. In addition to the obvious advantage of larger s, this energy will be very useful in obtaining overlap with ISR work. This is also considerably higher than the 180 GeV/c ceiling currently on M6.

5. Summary

To recapitulate our overall view we would like to emphasize the following points:

We propose to study large-P_t phenomena using a straight-forward,

well understood hodoscope triggering scheme which will be sensitive to any jet containing at least one particle (π, K or P) with transverse momentum greater than 1.5 GeV/c. In addition, we will trigger on a threshold energy in the calorimeter. This gives us a trigger for π°'s and neutrons as well as multiparticle jets.

We will study multiparticle final states in detail with a magnetic spectrometer covering one steradian in the center of mass and will simultaneously measure particle species over a good fraction of the region. This is very important for resonance identification as well as for a thorough investigation of the role that mesons and baryons play in large-P_t phenomena. The magnet is a conventional BM109 that already exists and needs only to be modified in the same way as one now used in the proton lab.

We have designed the proportional-chamber and data-acquisition system to take high data rates with little dead time. This provision is wise for any large-P_t experiment because it will be very difficult to calculate all sources of background. Also the question of the rates is compounded by the uncertainty in the future duty cycle.

Because of the limited number of particles passing through the spectrometer, we plan to begin pattern recognition in the section of the spectrometer down stream from the magnet. The six MWPC's and two hodoscopes, along with the incoming beam position, should be sufficient to sort out trajectories here. One would then work back to the target to eliminate many coordinates from the MWPC's immediately following the target. This would greatly simplify the overall pattern recognition.

We will measure charged particle angular distributions over nearly the entire C.M. solid angle. In addition, we will study neutrals such as π° and neutrons over a region covering 1.6 steradians in the center of mass. We

will also explore the azimuthal pattern of the events out to ±50° from coplanarity.

FIGURE CAPTIONS

1. This shows the C.M. acceptance of the calorimeter and magnetic spectrometer. The acceptance of the Cerenkov Counters in their high momentum position is also shown.

2. This depicts the cross section of the calorimeter at 10 feet from the target along with the limiting aperture of the magnet.

3. This gives the distribution of the total energy deposited in the calorimeter from multiple hits from ordinary interactions ($P < 1.8$ GeV/c).

4. This is the integrated cross-section for multiple hits from ordinary interactions as a function of threshold energy in the calorimeter. We have folded in our expected energy resolution.

Figure 1

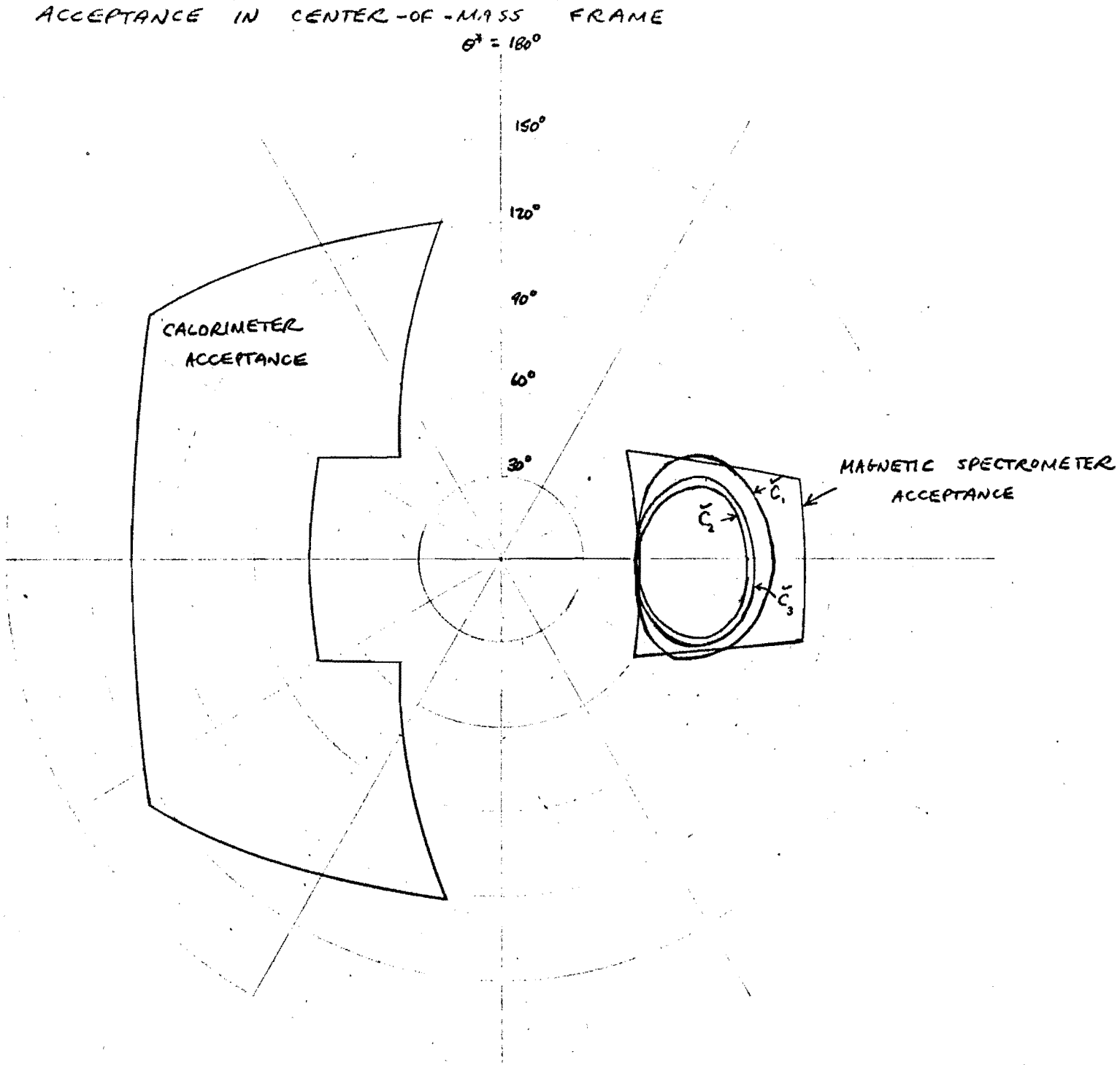
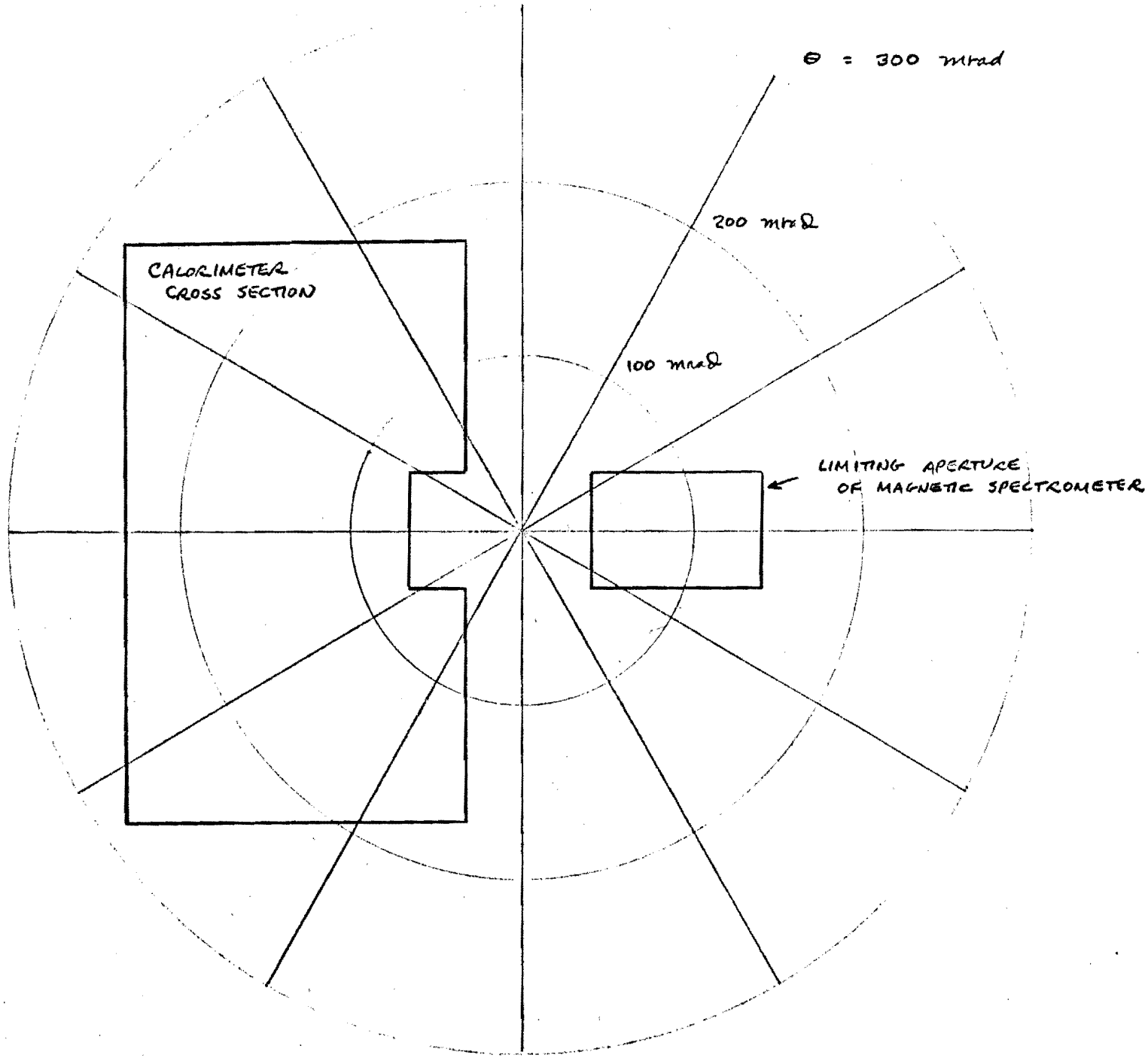
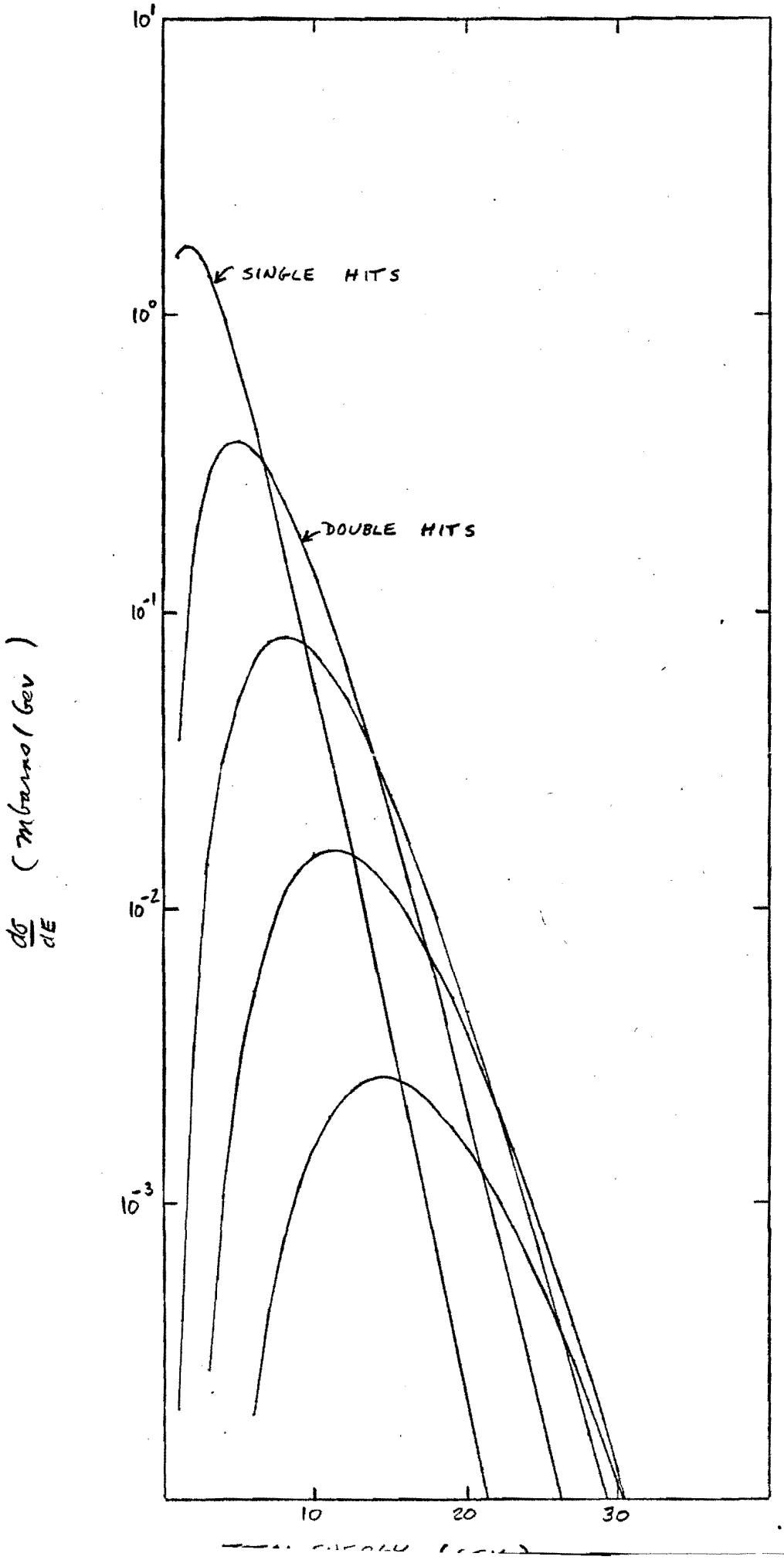

ACCEPTANCE IN CENTER-OF-MASS FRAME
θ* = 180°
150°
120°
90°
60°
30°
CALORIMETER ACCEPTANCE
MAGNETIC SPECTROMETER ACCEPTANCE
Č1
Č2
Č3

Figure 2


θ = 300 mrad
200 mrad
100 mrad
CALORIMETER
CROSS SECTION
LIMITING APERTURE
OF MAGNETIC SPECTROMETER

DISTRIBUTION OF TOTAL ENERGY DEPOSITED IN THE CALORIMETER BY ORDINARY REACTIONS (FOR DIFFERENT HIT MULTIPLICITIES)

Figure 3



TRIGGER RATE IN CALORIMETER FROM ORDINARY REACTIONS

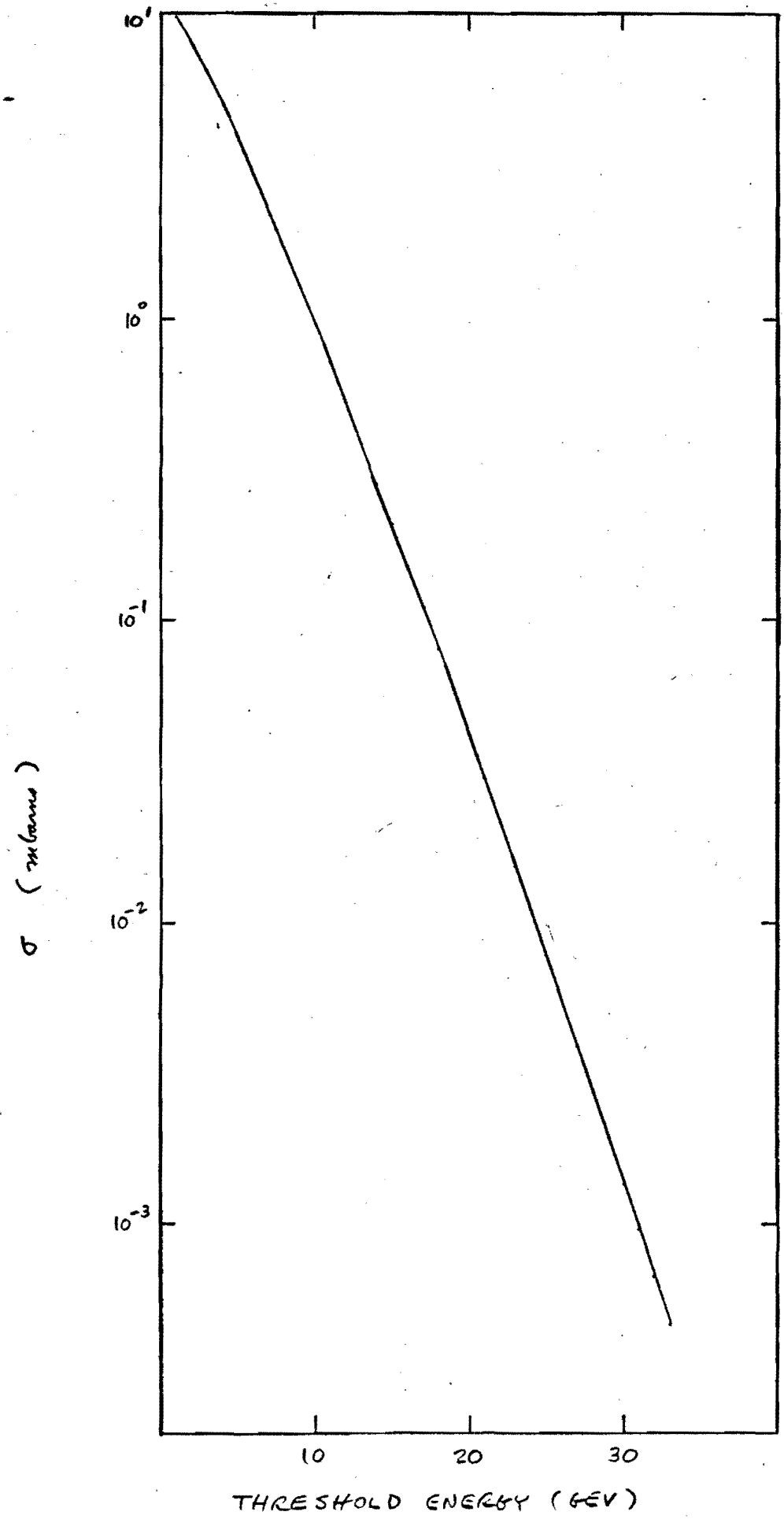



Figure 4