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A PROPOSAL TO STUDY LEADING PARTICLE PRODUCTION IN $\pi^- p$ INTERACTIONS AT 75 GeV/c

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SUMMARY

We propose an investigation of leading particle effects in $\pi^- p$ interactions at 75 GeV/c. For this purpose we request a 200,000 frame exposure to be made with the Proportional Wire Hybrid System (PWHS). The results thus far obtained by the PWHS Consortium in a study of $\pi^- p$ interactions at 147 GeV/C [1] demonstrate the ability of the system to measure pion momenta at 75 GeV/c with the accuracy to resolve the leading particle peak near $X = 1$. For a given x of the leading particle, either proton or π^-, we can measure:

1. $d^3\sigma/d\vec{p}$ for the other charged particles produced,
2. multiplicity of other charged particles,
3. multiplicity of other charged particles as a function of recoiling invariant mass.
4. invariant masses of subsets of other particles.

We will also investigate to what extent quasi-two body processes occur at this momentum.

In addition to a study of these topics at 75 GeV/c, the proposed experiment, in conjunction with the earlier experiment at 147 GeV/c[1] and another proposed experiment at 300 GeV/c, will contribute to an understanding of the energy dependence of the leading particle production mechanism. In particular, these experiments will provide a test of the assumption that the leading particle peak is independent of energy. The s-dependence of related effects can also be studied in the framework of specific models, such as the double-Pomeron exchange contribution,[2] or the various contributions of the Pomeron and Reggeon couplings within the Triple-Regge Limit Model.[3]

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I. INTRODUCTION

(1) Purpose of the Experiment

To date a wide range of exploratory experiments carried out in the NAL 30-in, bubble chamber have revealed a great number of important characteristics of high energy hadron collisions. These experiments have focused attention on such general properties as:

(i) the predominance of diffractive processes in final states of low multiplicity ($\lesssim$ 8 charged particles)

(ii) the essentially short-range nature of particle-particle correlations in the high multiplicity component, which accounts for the bulk of particle production

(iii) the rapid rise of neutral particle production ($\gamma, K^0, \Lambda, \bar{\Lambda}$) through the NAL energy range.

It is our belief that in order to extend further the present state of our understanding of the production mechanisms underlying these phenomena, the versatility of the bubble chamber should be brought to bear with more accurate experiments.

We propose here an exposure which constitutes a logical second generation experiment for this chamber: an exposure of relatively high statistics utilizing the enhanced analyzing power of the proportional wire hybrid system to study the incident momentum of 75 GeV/c.

(2) The Hybrid System

The full proportional wire hybrid system is now operational at the 30-in. bubble chamber, and its unique features are of central importance for the proposed exposure.

Of primary interest is the enhanced momentum resolution provided by the system for fast secondary tracks leaving the bubble chamber. In test exposures analyzed to date the hybrid system has performed up to its design expectations in this regard, yielding an average value of $\frac{\Delta P}{P}$ which is linear with momentum above ~20 GeV/c and approximately equal to

$\pm$ 3.5% for 75 GeV/c secondaries. This is to be contrasted with the bare bubble chamber measurements, from which useful momentum information cannot be gleaned for $p \gtrsim 50$ GeV/c.

A second feature is the angular accuracy of the system. The upstream system, with a flight path of 200 meters, measures beam track angles with an accuracy which is limited only by multiple scattering in the bubble chamber (~ .05 milliradian), for the downstream portion of the system the angular resolution for high momentum secondaries is of the order of 0.1 milliradian.

This precision in the measurement of angles and momenta has yielded the following results, as observed in a 150 GeV/c test exposure:

(i) A very clean separation of elastic and inelastic 2-pronged events. We estimate a contamination of less than 10% in the inelastic 2-prong sample, as compared with typical estimates of 30-40% in bare chamber experiments.

(ii) A missing mass resolution of a few pion masses for missing masses near zero. This is roughly a factor of 10 improvement over the bare chamber results.

(iii) Transverse momentum measurements accurate to 40 MeV, or about $\frac{1}{4}$ the average pion transverse momentum, for 75 GeV/c secondary tracks.

These capabilities, and the presence of a downstream γ-ray counter (subtending an angle of $\pm 2^0$) will make possible clean samples of constrained fits for events with no missing neutrals, and will allow more detailed examination of multiparticle correlations than can be made with rapidity (or lab angle) measurements using the bubble chamber alone.

Finally, we cite the high duty cycle of the external proportional wire planes. Each sense wire is connected to a 16 bit shift register where cycle time is 100 nanoseconds. Hence, information on each incident particle can be recorded particle by particle, without any need for trigger selection.

The system, like the bubble chamber itself, is essentially a DC devise. External information, such as Čerenkov signals, can also be stored on a particle-by-particle basis, making it possible to tag incident particles as protons, pions, etc.

The efficiency for correctly reconstructing high momentum tracks in the downstream system (excepting those which scatter in the exist window of the bubble chamber) has been found to be essentially 100%. Some 10-12% of the fast tracks (pions) leaving the bubble chamber are lost to the downstream system due to interactions in the intervening material. Since no trigger is required, these are the only significant losses to the downstream system.

(3) Scope of the Experiment

(i) We will measure charged particle multiplicity moments with higher statistical accuracy than has previously been reported and with the improved accuracy afforded by a good measurement of the 2-prong inelastic cross sections.

(ii) We will study particle production spectra as a function of the C.M. momentum with good resolution up to $x = +1$.

(iii) With our 4π geometry, good momentum and angle resolution and relatively high statistical accuracy we will be able to perform detailed studies of leading particle effects and diffractive phenomena. This capability will accrue from our ability to isolate those particles which are truly beam-like ($x \simeq +1$), and to extract clean samples of constrained fits with reasonable statistics for many of the low-multiplicity channels in which diffractive phenomena are apparently the dominant production mechanism.

(iv) An important goal of this experiment will be to carry out programs of analysis which will probe the nature of the high multiplicity component of particle production. This will include measurements of 2 particle correlation functions with improved statistics over data presently available at NAL energies. In addition, with data from the hybrid system, the scope and sensitivity of such programs can be greatly enhanced in the following ways.

(a) We can determine correlations as a function of $P_{\|}$ as well as $P_{\perp}$.

(b) We can examine angular correlations in the CM frame of the collision, for events with and without leading particles.

(c) We can measure multiparticle invariant masses and momentum transfers among groups of particles over the full kinematic range, and can examine the "decay" correlations among groups of pions selected, for example, on their net charge and invariant mass, in the rest frame of the selected system.

(d) It is highly likely that we can provide useful data for new and more differential techniques of analysis as these are developed.

II. LEADING PARTICLE STUDIES AND DIFFRACTION DISSOCIATION PHENOMENA

One striking result from the ISR is the observation of an s independent peak near $x_p = +1$ in the cross section $E \frac{d^3\sigma}{d\vec{p}}$ for $pp \rightarrow px$. This peak is interpreted by essentially everyone as a diffractive phenomenon. (Data from the CERN-Holland-Manchester-Lancaster Collaboration). It is of great interest to study this diffractive peak in 75 GeV/c π^- - p interactions. Our ability to measure single particles with x close to 1 will allow us to make a quantitative study of this process. For a given x of the leading particle, we will be able to answer the following questions:

1. What is $\frac{d^3\sigma}{d\vec{p}}$ for the other particles produced?
2. What is the charged multiplicity of the other particles produced?
3. What is the charged multiplicity of the other particles produced as a function of the recoiling invariant mass?
4. What are the invariant submasses of the other particles produced? Do they contain Δ^{++} or ρ^0 predominantly?

The above questions are relevant for $x > 0.8$. Hence, we are examining in detail the diffraction dissociation of the target proton.

One can also look at a "leading particle" effect when the proton has an $x \sim -1$. ($x_p < -0.9$). In this case, it is the pion which is diffractively dissociating. The ability of the hybrid spectrometer to measure secondary momenta up to higher momenta permits analysis of reactions such as

$$\pi^- p \to \pi^- \pi^+ \pi^- p$$
$$\pi^- p \to \pi^- \pi^+ \pi^- \pi^+ \pi^- p$$

in which the incident pion "fragments" into a fast forward multipion system with small momentum transfer to the target proton. We expect to be able to reduce the π^0 contamination in our fits to $< 10\%$ by balancing transverse momentum. We can also study the proton diffraction dissociation into a ΛK system.

A. $\pi^- p \to \pi^- \pi^+ \pi^- p$

On the basis of the results of the Berkeley - 205 GeV/c π-p exposure [1], we expect about 1000 events of this kind in 200,000 pictures of which about 2/3 will be beam dissociation. With the 200k pictures some definitive physics should be possible. The 3π mass resolution is about 5%. Thus, we expect to see the A_1 - A_2 bump (1.0 - 1.4 GeV) if it continues the slow fall observed between 25 and 40 GeV/c[2], but cannot expect to determine the A_2 cross section unless a partial wave analysis [3] proves possible. The A_3 should also be observable.

We can investigate the decay modes of the 3π system to see whether the $\rho\pi$ channel continues to predominate.

We shall also investigate the t-dependence of the differential cross section for different $M_{3\pi}$ intervals. Comparison with the Serpukhov results at 25 and 40 GeV/c[2] will give the s-dependence over a large range of s. In particular, it will be interesting to see if the M^2/s scaling continues to hold.

B. $\pi^- p \to \pi^- \pi^+ \pi^- \pi^+ \pi^- p$

The treatment of this reaction is much the same as the 3π reaction. We can look at the 5π mass distribution, and also 4π, 3π and 2π mass distributions. Of course, any structure in the sub-mass distributions will tend to be obscured by mis-pairing.

III. SINGLE PARTICLE DISTRIBUTIONS

An important feature of the proposed experiment is the measurement of the single particle differential cross sections for final state pions

$$f(\vec{k}) = E \frac{d^3\sigma}{d^3\vec{k}}$$

as a function of the momentum, $\vec{k}$, over the full kinematic range, with complete information on the charged prong multiplicity for each event. This will allow several important measurements to be made which are not possible either in the bare 30" bubble chamber or with single-arm spectrometers.

The following reactions will be examined in this complete manner:

$\pi^- p \to \pi^\pm$ + anything (1)

$\pi^- + p \to k^0$ + anything (2)

$\pi^- + p \to \Lambda +$ anything (3)

In addition, the following reaction can be examined in the target fragmentation region where the final state protons may be examined by ionization:

$\pi p \to p$ + anything (4)

The measurement of $f(\vec{k})$ for reaction (1) with sufficient precision to resolve the leading particle peak should provide new and extremely valuable information on the character of $\pi^- p$ collisions in this energy regime. Among the results of particular interest from the pion-induced reactions are:

(i) The distributions $f(x) = \int f(x), dP_T^2)$ and the semi-inclusive distributions $f_n(x)$, where x is the Feynman scaling variable and n is the number of charged prongs.

(ii) The cross section for quasi-elastic pion production as a function of the charged prong multiplicity.

(iii) The π^+/π^- ratio as a function of x.

(iv) The average transverse momentum as a function of x and of rapidity.

These measurements will, at the very least, provide more powerful tests of the data fitting capabilities of various models than are presently available. Point ii), along with measurements of the slow proton spectrum, will allow estimates of the diffractive component of the inelastic cross section for $\pi^- p$ collisions in a manner comparable with those which now exist for pp collisions at NAL and ISR energies.

Measurements of the semi-inclusive distributions $f_n(x, p_\perp)$ for $\pi^- p$ collisions may provide sensitive tests of the validity of models based on the assumption of short-range order in the central region. These assumptions imply a very weak dependence of the behavior in the central region on the incident particles. At lower energies ($<$ 30 GeV) the distributions of pions produced near $x = 0$ show rather strong dependence on the incident particle: One such effect is the so-called quark-frame result[4], in which pions produced in $\pi^- p$ collisions fall off more sharply in $f_n(x)$ for $x < 0$ than for $x > 0$ where, in pp collisions, the pion distributions are necessarily symmetric about $x = 0$. Further, in π^- p collisions at 16 GeV/c[5], it is observed that the average transverse momentum behaves quite differently in the central region of rapidity depending on whether or not the observed particle has the same charge as the incident pion.

A well known phenomenon of pion production at low energies is the fact that the differential cross section $f(x, p_T^2)$ does not factorize into the form $g(X)\, h(p_T^2)$: the average transverse momentum is smaller at $x = 0$ than at larger values of x. It has been shown[6] that this so-called "sea gull effect" is only partially accounted for by phase space effects. The distribution $f(y, p_T^2)$, where y is the rapidity, apparently does factorize in the central region for the reactions $\pi^\pm p \to \pi^\pm$ anything and for pions produced in pp collisions at ISR energies.[7]

A study of these effects for reaction (1) at 75 GeV/c should bear sensitively on the scaling properties of the single particle distribution and on the character of particle production in the central region.

Predictions for the energy dependence of the approach to scaling in single particle distributions for reactions of the type

$$a + b \rightarrow c + \text{anything} \qquad (5)$$

depend on the kinematic region in which the produced particle is observed and on the quantum numbers of the incident and observed particles. Thus, Mueller's generalized optical theorem[8] with further assumptions from Regge theory, predicts an $s^{-1/4}$ dependence for reaction (5) near $x = 0$, and an approach to limiting fragmentation (x near ± 1) as $s^{-1/2}$. Additional assumptions regarding finite energy sum rules lead to scaling in the fragmentation regions at very low energies if some (or all) of the combinations a, b, c have exotic quantum numbers.[9] In this experiment data with good statistics from reaction (1), in comparison with the large body of existing data at lower energies, will provide detailed checks for such predictions and will extend considerably the range of energies over which these checks can be made for $\pi^- p$ collisions.

IV. MOMENTUM AND ANGLE CORRELATIONS IN INCLUSIVE REACTIONS

1. The Particle Correlations

Any experiment, such as this one, with 4π geometry for detecting charged particles is capable of measuring very complex correlations among the produced particles in multiparticle final states. At the moment, the types of correlations which can be meaningfully analyzed are still relatively simple. There is considerable interest in two-particle correlations of the type

$$C(y_1, y_2) = \frac{1}{\sigma\,\text{inel.}} \frac{d^2\sigma}{dy_1\,dy_2} - \frac{1}{\sigma\,\text{inel.}^2} \frac{d\sigma}{dy_1} \frac{d\sigma}{dy_2}$$

where y is the rapidity. A good deal of data now exists from NAL and ISR experiments (10), (11) for an empirically normalized variant of this two-particle correlation function in proton-proton collisions:

$$R_{12}(\eta_1 \eta_2) = \frac{\sigma_{\text{inel.}} \frac{d^2\sigma}{d\eta_1\,d\eta_2}}{\frac{d\sigma}{d\eta_1} \frac{d\sigma}{d\eta_2}} - 1$$

where $\eta = -\ln(\tan\frac{\theta}{2})$.

These measurements indicate that collisions from 200 to 1500 GeV/c are characterized by relatively short-range, positive correlations among particle pairs for the bulk of the produced particles. Although the correlation data presently available exhibit considerable structure, much of this structure follows directly from the shapes and magnitudes of the single-particle, semi-inclusive distributions upon which are superimposed the "interesting" dynamical correlations. (12)

A crucial question with regard to the observed short-range correlations is whether or not this behavior indeed results from short-range order in the production mechanism (in which the observed hadrons are produced independently, e.g., along a multiperipheral chain,) or whether the particles are being produced in kinematically related groups or clusters.

Evidence for clustering effects certainly exists [13], [14] although existing 2-particle correlation measurements do not offer definitive conclusions regarding the existance of such effects. Correlation measurements of high precision and good statistical accuracy are needed in order to confront such questions.

This experiment , with the hybrid system, has two advantages over the existing bare bubble chamber data: (1) We can measure the true rapidity, y, as well as η; (2) We can determine the distributions and correlations as a function of p_T as well as p_L. The proposed experiment will provide such measurements for pions incident, and with sufficiently high statistical precision to examine two-particle correlations for the following configurations:

i) y_1 and/or y_2 both inside and outside the central plateau region.

ii) Correlations between like charges (++ and -- correlations), as well as for all charged particles.

iii) Correlations within specific final state charge multiplicities

$$\text{e.g. } f_n(y_1, y_2) = \frac{1}{\sigma_n}\frac{d^2\sigma n}{dy_1\, dy_2} - \frac{n-1}{n}\frac{1}{\sigma_n^2}\frac{d\sigma n}{dy_1}\frac{d\sigma n}{dy_2}$$

The last-mentioned measurements are of particular importance in view of the fact that the semi-inclusive single particle distributions in pp collisions are found to be markedly narrower in the high multiplicity channels than at low multiplicity. [12] This fact, by itself, can account for a positive correlation in the central region when all multiplicities are included in the empirically determined correlation function.

Correlations between the transverse momenta of particle pairs will also be measured for the configurations listed above, and these may provide useful new physics information in this energy range. [15]

2. Many-Particle Correlations

The availability of good momentum information for even the fastest tracks in this experiment will allow not only a detailed study of those low-multiplicity events which constitute the so-called "diffractive" (Sec. II) component of particle production, but will also make possible more differential and more sophisticated techniques of analysis in studying the many-particle events ($\gtrsim 6$ charged prongs) which contribute the bulk of particle production at these energies. These events populate mainly the central region of the rapidity scale, and are characterized by short-range correlations among particle pairs. An important goal of this expriment will be to carry out programs of analysis which will probe the nature of the production mechanism in this component. For example, we would like to distinguish between the predictions of a short-range-order, multiperipheral picture and one in which relatively heavy states are formed which decay to large numbers of particles in the central region.

Such analysis requires the 4π solid angle of a bubble chamber. With the bare 30" bubble chamber the available data for these studies at NAL energies consist of rapidity (or lab angle) measurements with which one can study charged prong correlations or gap distributions. There is ample evidence that such measurements do not provide sufficient sensitivity to push our understanding of multiparticle production mechanisms much further than it stands now with existing bare chamber data. With data from the hybrid system the scope and sensitivity of such programs are greatly enhanced.

1) We can distinguish beamlike (fast) leading-particles from those particles which, although their rapidity may be very large, do not carry a significant fraction of the beam momentum.

2) We can examine angular correlations in the CM frame of the collision, for events with and without leading particles.

3) We can examine the "decay" correlations among groups of particles selected, for example, on their net charge and invariant mass, in the rest frame of the selected system.

4) We can study two -body factorization. The physical idea behind two-body factorization is simply stated by saying that, if two particles come one from the target fragmentation and the other from the projectile fragmentation, then the cross section should factorize. This can be stated as follows:

$$F_{ab}^{cd}(p_\perp^{c}, p_\perp^{d}, X^c, X^d, \phi^{cd} =$$

$$F_{ab}^{c}(P_\perp^{c}, X^c) \cdot F_{ab}^{d}(P_\perp^{d}, X^d)$$

where ϕ^{cd} is the angle between $\vec{p}_\perp^{\,c}$ and $p_\perp^{\,d}$ and $x^c \cdot x^d < 0$. In practice, one must choose x^c close to -1 and x^d close to +1 to ensure that particle c is in the fragmentation region of the target and particle d is in the fragmentation region of the projectile.

5) If the idea of factorization is valid, the mean multiplicity in the target fragmentation region should be independent of the x value of a particle measured in the projectile fragmentation region. This prediction is only poorly and inconclusively measured at the ISR for proton projectiles and obviously not at all for pion projectiles. A study of these correlations, especially at $x \lesssim +1$ will help shed light on the applicability of the currently popular "two component" theories.

6) Neutral Strange Particle Production:

Cross sections for the production of K^0, Λ and $\bar{\Lambda}$ are rising rapidly in the NAL energy range, as is the cross section for $\bar{p}$. Presumably $\bar{P}$ and $\bar{\Lambda}$ result from particle-antiparticle pair production. This need not be the case for the K's and Λ's, which may result from $K\bar{K}$ or $\Lambda\bar{\Lambda}$ pair production internally on a multiperipheral chain, or they may be primarily due to $p \to \Lambda K$ (diffractive processes). In this experiment we will have sufficient statistics to examine a reasonable sample of events in which two (or more) neutral strange particle decays are observed. We can determine the realtive rates for ΛK, $K\bar{K}$, $\Lambda\bar{\Lambda}$ and can examine the correlations between such pairs (effective mass, rapidity difference, etc.).

Fully differential analysis programs, applied to completely specified inelastic channels are feasible for, at best, only a very small fraction of the inelastic cross section at these energies. New techniques for analyzing more global information from the total sample than is given by the two-particle correlation functions are being developed.[16, 17] Such analyses will ultimately demand a knowledge of momentum as well as angle for both fast and slow tracks in the laboratory. This is certainly true of any extension of the longitudinal phase space analyses to partially determined multiparticle final states,[16] and the statistical analysis of Ref. 17 is considerably enhanced in sensitivity if momentum as well as angular information is available over the full kinematic range.

V. TOPOLOGICAL CROSS SECTIONS AND MULTIPLICITY MOMENTS

Measurement of the total charge multiplicity, η_c, of inelastic final states have been of major importance in the development of phenomenological regarding multiparticle production in hadron collisions. The simplest of multiperipheral pictures, in which secondaries are produced uniformly in rapidity with zero-range correlations, predicts a poisson distribution in η_c for produced particles in the asymptotic limit, with $< n_c > \sim \ln s$.[18] Existing measurements of the multiplicities and their moments rule out this simple behavior: the moment

$$f_2 = < n_c \ (n_c - 1) > - < n_c >^2,$$

which is zero for a poisson distribution, is found to be rising with energy, crossing zero for pp collisions with beam momenta ~ 50 GeV/c. Nonetheless, detailed information on the charged prong multiplicities and their moments allows direct confrontation with rather sensitive predictions of specific models.

Diffractive excitation models predict $f_2 \sim \ln s$.

The KNO scaling law,[19]

$$\sigma_n (s) = \frac{\sigma \text{ inel. } (s)}{< n_c >} \quad \psi \left(\frac{n_c}{< n_c >} \right)$$

which is derived from the hypothesis that the semi-inclusive distributions all scale at $x = 0$, has been shown to give a good empirical description of existing data from 50 - 300 GeV/c[20], despite the fact that scaling in the single-particle distributions at $x = 0$ is not observed in this energy range. The KNO law implies $\frac{< n^k >}{< n >^k} = c_k$,

where c_k is independant of energy. A question of current interest is whether KNO scaling is approximate, and will eventually break down, as advocated by proponents of short-range order models.

Two-component models, involving both long- and short-range correlations give specific predictions for, and are constrained by, the charged prong multiplicities.

In this experiment we will obtain the topological cross sections, σ_{n_c} and the multiplicity distributions with good statistics. The electronic information accompanying the bubble chamber pictures should serve to minimize the scanning losses for low-multiplicity events. In particular, the higher moments of the multiplicity distributions are extremely sensitive to the two-prong inelastic cross section, where scanning losses are particularly difficult to overcome under ordinary circumstances.

For the $\pi^- p$ reaction, it is very hard to detect with a bare bubble chamber the 0-prong topological cross-sections; i.e., $\pi^- p \rightarrow$ neutrals. However, because of our special experimental setup, we can easily obtain a reliable measure of this cross section. It has been studied at low momenta where it was found to decrease with energy. In general, it can be shown model independantly that [21]

$$\sigma_0 / \sigma_T = \exp \{ - [< n_{ch} > + \tfrac{1}{2} f^{(2)}_{ch} + 0 \; (f^{(n \geqq 3)}) \}$$

where $f^{(n)}$ are the integrated inclusive correlations. Assuming that the integrated correlation functions are not too large, this can be approximated by

$$\frac{\sigma_0}{\sigma_T} = e^{- < n_{ch} >}$$

For the 75 GeV/c $\pi^- p$ collisions, $< n_{ch} > \cong 7$. Thus, we expect to detect 10-15 zero-prong events.

VI. CROSS SECTIONS

A. Total Cross Section σ_T

We will be able to measure the total cross section to a statistical accuracy of about 0.5-1%. This accuracy makes it possible to establish the energy behaviour of σ_T (π^- - p) with respect to lower and higher energy measurements. For the π^-P interactions we will be able to determine whether σ_T continues to be energy independent as indicated by its values as measured at Serpukhov above 30 GeV/c, ($\sigma_T(\pi^- p)$ ~24.5 mb,) or whether there is a possible convergence of the cross section toward a common Pomeranchuck limit.

B. Elastic Cross Sections

The measurement of the elastic differential cross sections near t = 0, as a function of beam energy, will determine the slope parameter b for $\frac{d\sigma}{dt} = \frac{d\sigma}{dt}\Big|_{t=0} e^{bt}$. Assuming that the elastic and total cross sections stay constant from their values at 30 GeV/c, then we would expect to have about 1000 elastic events with $|t| \geqq 0.05$ $(GeV/c)^2$ which is the region where we expect to be able to resolve the elastic events with very good efficiency.

With these statistics we expect to be able to measure this slope to better than ± 0.30 $(GeV/c)^2$ which represents a 3% measurement. This accuracy will allow a reasonable check on "shrinkage" of the elastic peak and, incidentally, check early counter data.

In addition, we can measure the total elastic cross section, correcting in the normal way, for the loss of events at very small t. The energy dependence of this total elastic cross section is of current interest. Although these checks will not be definitive when compared to counter data, they will be of interest.

VII. COMPARISON TO OTHER BEAM ENERGIES

The availability of the π^- data at 300 GeV/c and 147 GeV/c will allow an energy dependant study of the leading particle cross s ction. This should be of great interest as it is conjectured that the rise in the total cross section may be due to the rise of the diffractive component. We should be able to shed some light on this question and determine which topology is responsible (if there is a single topology) for the rise in the cross section.

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