Spokesman: W. D. Shephard
Department of Physics
University of Notre Dame
Notre Dame, Indiana 46556
219/283-7311

Fermilab Proposal No. 558

PROPOSAL FOR A HIGH-STATISTICS STUDY OF $\pi^{\pm}p$ AND $K^{+}p$ INTERACTIONS AT 100 GeV/c UTILIZING THE FERMILAB 30-INCH HYDROGEN BUBBLE CHAMBER HYBRID SYSTEM WITH EXTENDED DOWNSTREAM PARTICLE IDENTIFICATION

N. N. Biswas, J. M. Bishop, N. M. Cason,
V. P. Kenney, and W. D. Shephard
Department of Physics, University of Notre
Dame, Notre Dame, Indiana 46556

L. R. Fortney, A. T. Goshaw, J. W. Lamsa,
J. S. Loos, W. J. Robertson, and W. D.
Walker, Physics Department, Duke University,
Durham, North Carolina 27706

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I. SUMMARY

1. Physics Objectives: A high-statistics study of 100 GeV/c $\pi^{\pm}p$ and $K^{+}p$ interactions will be performed using the Fermilab 30-inch hydrogen bubble chamber hybrid system with extended downstream particle identification. This proposal is a companion to proposal P-394 for a high statistics study of $\bar{p}p$ and pp interactions and the same exposure will provide data for both experiments. The physics of both exclusive and inclusive interactions will be studied with emphasis on studies of $\pi\pi$ and $K\pi$ interactions and of multiparticle correlations and local conservation of quantum numbers. Detailed comparisons of $\pi^{+}p$ and $\pi^{-}p$ interactions will be made.

2. Request: 2.25×10^6 pictures of $\pi^{\pm}p$ and $K^{+}p$ interactions in the 30-inch hydrogen bubble chamber hybrid system with extended downstream particle identification. 10^6 pictures will be with positive beam and 1.25×10^6 pictures with negative beam. The pictures will be taken in tagged but untriggered mode. Details on use of the downstream particle identifier and photon detector are presented in the body of the proposal.

3. Beam: 100 GeV/c positive beam (60% π^{+}/10% K^{+}/30% p) and 100 GeV/c negative beam (70% π^{-}/30% $\bar{p}$) to the 30-inch chamber with octuple pulsing. The beam particles are to be tagged by beam Cerenkov counters and upstream proportional wire chambers.

4. Equipment: 30-inch hydrogen bubble chamber hybrid system with extended downstream particle identification (see text).

5. Data Analysis: All film and hybrid data tapes will be shared with the P-394 collaboration. The majority of low-multiplicity (2, 4, 6 prong) events will be measured on RIPPLE at Duke. Measurements on high-multiplicity events and remeasurements of low-multiplicity events will be made on film-plane and image-plane digitizers at Notre Dame. Event reconstruction and analysis will be performed using the Notre Dame and Duke computer facilities.

6. User Operation of the 30"-Bubble Chamber: We are prepared to participate, with our P-394 colleagues, in the operation of the 30" bubble chamber during this experiment. Several of our people, particularly Dr. W.D. Walker (Duke), Dr. W.D. Shephard (ND), and Dr. V.P. Kenney (ND) have had extensive prior experience with the hardware aspects of bubble chamber research.

II. INTRODUCTION

Previous lower-statistics experiments with the Fermilab 30-inch bubble chamber and hybrid systems have provided information on a number of interesting topics in strong interactions. Frequently, however, the statistics have been sufficient to indicate the existence of interesting features of the data but insufficient to allow an adequate study of these features. In other cases, the statistics have been inadequate for the study of topics of potentially great interest.

The early bubble chamber studies have clearly shown the persistence at Fermilab energies of effects dependent on the nature of beam and target particles over the complete available range of rapidity. Such effects are most evident when beam and target particles are different. By comparing data for different beam particles the nature of these "leading particle" effects may be studied. Thus we believe that high-statistics studies of π^-, π^+, and K^+ interactions by the same groups (thereby minimizing differences in technique) should prove especially valuable.

Another factor clearly revealed in previous studies has been the importance of having as complete information about all the secondary particles in an event as possible. For example, our understanding of two-particle correlations was greatly advanced over early ISR studies when information about the charges of the secondary particles was obtained in Fermilab experiments. Further advances are expected when $K^\pm$ can be distinguished from $\pi^\pm$ among the secondaries and when better information about neutral secondaries is available. This experiment will yield information on $K^\pm$ production and on neutral particle production over much of the forward hemisphere.

Many of the effects of interest which have been observed in earlier experiments are significant over a range of energies. The energy of the proposed experiment is sufficiently high to allow useful studies of these effects and to provide good acceptance in the planned downstream particle identifiers and photon detectors while being low enough to allow adequate momentum resolution for fast-forward charged tracks in the downstream proportional wire chamber hybrid system.

An especially attractive feature of the combination of this proposal and the companion proposal P-394 is the opportunity to study the interactions of a wide range of incident particles (π^+, K^+, p) and (π^-, $\bar{p}$) in the same exposure. This provides for the most efficient use of the hybrid system, with full use being made of all the observed interactions,while allowing for the intensive study of closely related interactions (e.g. π^+p and π^-p) by smaller groups of institutions.

Our collaboration (Notre Dame, Duke) will be able to make especially effective use of the data on $\pi^\pm p$ interactions since we have direct data from other experiments on $\pi^\pm p$ interactions at a wide range of energies which can be used for studies of the energy dependence of significant features in strong interactions as discussed in more detail in Section III of this proposal.

III. PHYSICS JUSTIFICATION

A large number of interesting features of strong interactions have been discovered in earlier experiments with the Fermilab 30-inch bubble chamber and hybrid systems. In many cases, such as studies of correlations among kinematic variables, the statistics available in the original experiments have been inadequate for detailed studies. Other phenomena of great interest, such as detailed studies of $\pi\pi$ and $K\pi$ interactions, could not be studied in detail with the relatively small samples of events in exclusive channels now available. Other studies of potentially great impact have been hampered by the lack of secondary particle identification. Improved identification of charged secondaries, including $K^{\pm}$ and p, $\overline{p}$ at momenta too great to allow identification by bubble density in the 30-inch chamber, will allow major advances in studies of multiparticle correlations and of central particle production. Significant improvements in π^{o} detection are needed to test hypothesized similarities to charged particle production. Current questions about analogies between particle production in lepton-hadron interactions, electromagnetic interactions, and hadron-hadron interactions will benefit from the availability of high-statistics data on hadron-hadron interactions which can serve as a baseline for the lower-statistics studies of the other types of interactions.

In an experiment which will provide the fullest possible information about interactions of all charge multiplicities, it is difficult to predict exactly what topics will prove to be of greatest importance. At this time we will mention just a few of the many subjects of great current interest which can be studied. In Table I are given estimates of the numbers of $\pi^{-}p$, $\pi^{+}p$ and $K^{+}p$ interactions expected in the proposed exposure. From these numbers it is possible to estimate the number of events of various exclusive reactions which will be available. Subjects of current interest in which significant advances over present knowledge should be possible include the following:

A. $\pi\pi$ (and $K\pi$) Interactions: It will be possible to study $\pi\pi$ interactions over a range of $\pi\pi$ masses up to perhaps 4 - 5 GeV/c^2. Among the important topics to be studied are:

1. $\pi\pi$ total and elastic cross sections as a function of $\pi\pi$ mass;
2. multiplicity of charged secondaries as a function of $\pi\pi$ mass;
3. neutral pion multiplicity as a function of $\pi\pi$ mass;
4. comparison of $I = 2$ and $I = 0, 1$ $\pi\pi$ cross sections;
5. diffractive dissociation of pions by pions.

We will study $\pi\pi$ interactions by isolating primary interactions of the type

$$\pi^{\pm}p \rightarrow \Delta^{++} + X.$$

Our previous studies of Δ^{++} production in 100, 200 and 360 GeV/c π^-p interactions yield an inclusive Δ^{++} cross section of about 1.2 mb for $t_{p\Delta} < 1$ GeV^2 with relatively small backgrounds under the Δ^{++}. The inclusive Δ^{++} cross section is relatively independent of incident pion momentum. Significant Δ^{++} production can be found for charge multiplicities at least up to $n_c = 12$. The Δ^{++} density matrix elements are compatible with Δ^{++} production via one-pion exchange with absorption. Other data suggest comparable Δ^{++} production cross sections for 100 GeV/c interactions of all types. Thus we might expect 5,000 - 10,000 Δ^{++} events in the π^+p and π^-p samples and up to 1000 Δ^{++} events in the K^+p data. This should be sufficient for studies of the topics mentioned above.

The comparison of multiplicities in $\pi\pi(K\pi)$ interactions with those in pp and $\bar{p}p$ will be of special interest in terms of quark models. Qualitatively, each meson quark is expected to carry, on the average, half the energy of the meson while each nucleon quark should carry one third of the nucleon energy. Thus the average available energy and the average secondary particle multiplicity should be greater in meson-meson interactions than in meson-nucleon and nucleon-nucleon interactions at the same total energy.

In addition to providing information on neutral pion multiplicities in $\pi\pi$ interactions, the photon detector will be especially useful in obtaining pure samples of 4-prong 4C events for measuring $\pi\pi$ elastic scattering in the reactions $\pi^- p \rightarrow \pi^- \pi^- \Delta^{++}$ and $\pi^+ p \rightarrow \pi^+ \pi^- \Delta^{++}$. It can be used to veto events where a photon is detected even if an acceptable 4C kinematic fit is obtained. Similarly it can improve the purity of 6 prong 4C samples which can be used to search for specific channels of pion diffractive dissociation such as $\pi^+ p \rightarrow (A^{\pm}\pi^+)\Delta^{++}$.

B. <u>Meson Diffractive Dissociation:</u> The large number of events involving slow protons can be used to study diffractive dissociation of the incident meson. In 100 GeV/c interactions we can expect diffractive systems with masses up to about 4 - 5 GeV/c^2 ($M^2/s = .1$ corresponds to $M = 4.3$ GeV.). Total diffraction dissociation cross sections are expected to be on the order of 1 - 2 mb, so event samples of ~ 10,000 events in $\pi^{\pm}p$ interactions should be obtained. In addition to studying the inclusive characteristics of meson diffractive dissociation such as n_c and n_o as a function of mass, we will be able to study exclusive channels corresponding to dissociation into specific odd numbers of charged pions. Identification of forward $K^{\pm}$ mesons will enable us to study diffractive systems such as $\pi K\bar{K}$. Photon detection will allow a more comprehensive study of diffractive dissociation. For example, we may be able to study such exclusive channels such as $\pi^{\pm}p \rightarrow \pi^{\pm}\pi^{o}\pi^{o}p$, $\pi^{\pm}p \rightarrow \eta^{o}A_2^{\pm}p$, $\pi^{\pm}p \rightarrow \rho^{\pm}\omega^{o}p$, etc. The comparison of the characteristics of meson systems with odd G-parity with those of even G-parity systems arising in $\pi\pi$ interactions should also prove quite interesting.

C. Multiparticle Correlations: Current studies of two-particle correlations have revealed a number of interesting effects. For example, the two-particle correlation functions for $\pi^+\pi^-$ pairs and for $\pi^+\pi^+$, $\pi^-\pi^-$ pairs are found to differ significantly (see e.g. N. N. Biswas et al., Phys. Rev. Letters 35, 1059 (1975)). The correlation between like pions is greatly enhanced when the two pions are required to have momenta similar in both magnitude and direction and appears to be consistent with what is expected from Bose-Einstein statistics (see N. N. Biswas et al., Phys. Rev. Letters 37, 175 (1976)). With current samples of up to ~ 10,000 to ~ 30,000 events of all multiplicities we are comparing the observed inclusive and semi-inclusive charged pion correlations in π^-p interactions with the productions of cluster models at fixed energy and as a function of incident momentum for 18.5, 100, 200 and 360 GeV/c.

While interesting results are being obtained, much more could be done with data from the proposed experiment. Among the areas in which advances could be expected in the study of two-particle correlations are:

1. High-statistics comparison of correlations in π^+p and π^-p interactions;
2. Improved studies of semi-inclusive correlations. Semi-inclusive charged particle correlation data for a range of multiplicities are essential to studies of cluster production. While some results are obtainable with present statistics, the statistics of the proposed experiment would allow extension of the studies to higher multiplicities and would provide improved accuracy at all multiplicities;
3. Improved charged-particle identification will allow comparisons of $K^{\pm}\pi^{\pm}$ correlations with $\pi^{\pm}\pi^{\pm}$ correlations;
4. Correlations between neutral and charged pions in the forward hemisphere will be obtainable with the use of the photon detector;
5. Correlations for various pairs of particles in K^+p interactions can be studied with statistics comparable to those now available for πp and pp interactions.
6. Current studies of meson production in interactions over a range of energies have suggested the importance and possible dominance of meson production via the decay of intermediate states which may possibly be identified with know meson and baryon resonances. If such decays are the major source of final-state pions it should be possible to determine the effects for the observed multi-particle correlation functions when better statistics are available. The explanation of observed correlations as primarily due

to decays of known meson resonances would be of interest. The demonstration that observed correlations cannot be understood solely in terms of such decays would be even more exciting.

7. Studies of second-order interference effects, analogous to the Hanbury Brown-Twiss effect in optics have recently been presented. Interpretation of the observations has been severely hampered by limited statistics. Improved statistics may lead to a possible better understanding of the space and time evolution of particle production.

Three-particle correlation studies will also be of interest. Current studies suggest that observed three-particle correlation functions can be understood in terms of the strong two-particle correlations previously mentioned. The current studies are, however, severely limited by the statistics available. High-statistics data from the proposed experiment will allow a more definitive answer as to the existence of three-particle rapidity correlations.

D. Local Conservation of Quantum Numbers: Current studies of charge exchange along the rapidity axis in high-energy interactions provide evidence for local conservation of charge (see e.g. J. W. Lamsa *et al.*, Phys. Rev. Letters **37**, 73 (1976) and V. A. Sreedhar *et al.*, Phys. Rev. **D14**, 2894 (1976)). This observation has led to considerable speculation about local conservation of other quantum numbers such as strangeness and of variables such as transverse momentum. The improved $K^{\pm}$ identification in this experiment will allow the transfer of strangeness along the rapidity axis to be studied. Current attempts to study transverse momentum transfer are hampered by the lack of data on the neutral particles involved in interactions. Data from the photon detector will allow better tests of local conservation of transverse momentum.

E. Exclusive Interactions: The statistics of the proposed experiment should be sufficient to provide samples on the order of thousands of events for 4C exclusive reactions such as $\pi^{\pm}p \rightarrow p\pi^{+}\pi^{-}\pi^{\pm}$, $\pi^{\pm}p \rightarrow p\,2\pi^{+}2\pi^{-}\pi^{\pm}$, etc. At 100 GeV/c the momentum resolution of the downstream hybrid system will be sufficient to provide reliable kinematic fitting. Contamination of 4C event samples with events involving neutral secondaries can be further reduced where data from the photon detector are available since these data can be used to veto events with associated photons. The resulting samples of exclusive reactions will be used for studies of such topics as double Pomeron exchange, double diffraction dissociation, etc.

The data obtained in this experiment will be sufficient for the study of many topics other than those mentioned above. Many such topics are obvious. As has happened frequently in past track-chamber experiments, other topics, as yet unconsidered, may ultimately be of greatest importance. The key factors for the physics of the experiment, in any case, are the combination of high statistics, improved secondary particle detection and identification, and the capability of comparing strong interactions initiated by several different types of incident particles.

IV. BEAM AND BUBBLE CHAMBER

The availability of beams adequate for the proposed experiment has previously been demonstrated, as discussed in more detail in the companion proposal P-394. A 100 GeV/c positive beam with approximate composition (60% π^+/ 10% K^+/30% p) can be obtained using the currently existing beam line without filtering. Recent $\bar{p}$ experiments (e.g. E-345, 100 GeV/c $\bar{p}d$) in the 30-inch chamber and recent beam tests indicate the feasibility of a 100 GeV/c beam of (30% $\bar{p}$, 70% π^-) which will be quite adequate for both this experiment and P-394.

The current upstream system of proportional wire chambers and beam Cerenkov counters in Enclosures 106 and 108 will be used to tag each incident beam track.

With these arrangements for the beam there will be no need to require triggering the bubble chamber flash on the basis of beam composition in a specific picture. The tagged interactions would be studied by our collaboration or by the P-394 collaboration depending on their nature.

Octuple pulsing of the 30-inch hydrogen bubble chamber is planned. Assuming efficient octuple pulsing and beam operation, the requested 2.25×10^6 pictures could be taken in $\sim 2.25 \times 10^6$ chamber expansions and in ~281 K accelerator cycles.

In view of present plans for participation of the experimenters in operation of the 30-inch bubble chamber it is worth pointing out that our collaboration includes physicists with extensive experience with bubble chamber hardware (e.g. W. D. Walker, Duke University and V. P. Kenney, W. D. Shephard, University of Notre Dame). We plan to participate in the operation of the bubble chamber during the operating periods involving these experiments if the proposed system of chamber operation is continued.

V. DOWNSTREAM PARTICLE DETECTION AND IDENTIFICATION

The downstream proportional wire chamber/drift chamber system in the configuration available at the time the experiment is run will be used for fast-forward particle location and momentum determination. This system, in conjunction with the downstream particle detection and identification systems:

(a) Downstream Particle Identifier (DPI), the Isis/Cerenkov counter system described in detail in P-394.

(b) Downstream Photon Detector (γ detector), the lead-glass hodoscope system described in e.g. V. Kistiakowski *et al.*, paper submitted to Tbilisi Conference, July, 1976.

(c) Neutral Hadron Calorimeter ($\bar{n}$ detector) described in P-394.

The downstream photon detector will be especially useful for exclusive-channel studies where, for example, it can be used to veto spurious 4C kinematic fits of interactions which involve π^0 mesons, and for studies of beam diffraction dissociation where it can provide information on diffractive channels involving fast-forward π^0 mesons. Its use, however, appears to be incompatible with simultaneous use of the Cerenkov counter of the DPI and certainly is incompatible with simultaneous use of the proposed neutral hadron calorimeter for $\bar{n}$ detection.

The complete DPI system will provide the most efficient possible identification of fast-forward charged particles as discussed in P-394.

We propose, therefore, to take at least 2.5×10^5 positive-beam pictures with the photon counter and at least 2.5×10^5 positive-beam pictures with the Cerenkov counter and $\bar{n}$ detector. The configuration for the remaining $\sim 5 \times 10^5$ positive-beam pictures will be determined on the basis of preliminary studies of these event samples. With the negative beam, 2.5×10^5 pictures will be taken with the photon detector and the remainder will be taken with the Cerenkov counter and $\bar{n}$ detector.

The acceptance of the DPI for charged secondaries in the proposed experiment has been determined by studying a 4042 event sample of 100 GeV/c $\pi^- p$ interactions (private communication from J. Whitmore, Michigan State University). In this study all tracks not identified as protons have been assumed to be pions. In Table II is presented the acceptance of the DPI as a function of laboratory momentum of secondary pions. Data for π^- and π^+ are given separately to illustrate the excellent acceptance of the system for "leading" particles, in particular, and for fast-forward particles of both charges. In Table III are shown acceptances as a function of c.m. hemisphere for π^- and π^+. We find that 94.4% of π^- and 85.8% of π^+ in the forward hemisphere enter the ISIS and 68.9% of π^- and 49.9% of π^+ in the forward hemisphere traverse the entire ISIS device. About two-thirds of the backward-hemisphere pions do not leave through the exit aperture of the magnet and thus could not be detected or identified by any device outside the magnet.

The average resolution on ionization obtainable in the ISIS device is expected to be comparable to the ~7.8% FWHM for tracks traversing the full 3 meters and ~11.7% FWHM for tracks not traversing the full 3 meters as estimated in the companion proposal P-394. The momentum resolution on fast forward tracks required for effective use of the information from the DPI is ~7%. Past experience with the downstream system indicates that this should be easily attainable for secondaries of momentum less than 100 GeV/c.

The large atmospheric-pressure Cerenkov counter planned as the second element of the DPI is described in detail in proposal P-394. These details will not be reproduced here. As emphasized in P-394 the Cerenkov is complementary to the ISIS system and the combination will provide an extended range of momenta over which charged-particle identification will be possible and will yield increased probability of unique particle mass identification. Studies of 100 GeV/c $\pi^- p$ interactions indicate that 27.9% of all pions produced (45.8% of forward hemisphere pions and 1.3% of backward hemisphere pions) will traverse the full length of the Cerenkov system and reach the mirrors at the end of the Cerenkov 11.0 m downstream from the bubble chamber.

Details of the rapidity spectra of π^- and π^+ mesons which traverse the DPI for 100 GeV/c $\pi^- p$ interactions are given in Fig. 1. It is clear that the system will provide good particle identification over most of the forward hemisphere.

Acceptance of the downstream photon detector, assumed to be 3/4 m x 3/4 m located 6.0 m downstream of the bubble chamber, has been estimated for π^0 mesons produced in $\pi^{\pm} p$ interactions at 100 GeV/c. We have used charged-pion distributions from 200 GeV/c $\pi^- p$ interactions, scaled to an incident momentum of 100 GeV/c, to estimate the π^0 momentum spectrum. For purposes of these calculations the π^o spectrum has been assumed to be the same as the π^+ spectrum in $\pi^- p$ interactions. A Monte Carlo program was used to simulate the decay of the π^o mesons into photons. In Fig. 2 is shown the estimated acceptance of the photon detector as a function of x and p_T and of y and p_T of the produced π^o. In the calculations, π^o's were assumed to be detected if both of the decay photons would enter the lead-glass hodoscope. As can be seen from Fig. 2, the photon detector should provide information on π^o production over much of the forward hemisphere. The resulting data on π^o production are expected to be of value in, e.g. studies of pion diffraction dissociation involving π^o and perhaps η^o or ω^o mesons.

As mentioned earlier, the photon detector will be used in only a portion of the proposed exposure. It may be possible in the remaining portion of the exposure, to obtain some information about the production of forward gamma rays from the electromagnetic showers detected in the neutral hadron calorimeter described in P-394.

VI. ANALYSIS OF EXPERIMENTAL DATA

Physicists at Notre Dame and Duke have had extensive past experience with measurement and analysis in previous experiments involving the Fermilab 30-inch bubble chamber. Notre Dame and Duke, together with Toronto and McGill, have analyzed 200 GeV/c $\pi^- p$ events from Fermilab experiment # 2B. Duke has studied 200 GeV/c $\pi^- Ne$ interactions in Fermilab experiment # 163A and is approved for a study of 300 GeV/c π^- - high Z interactions in the 30-inch chamber in Fermilab experiment # 304. Notre Dame is currently collaborating with Iowa State, Maryland, and Michigan State in the analysis of 360 GeV/c $\pi^- p$

interactions from Fermilab experiment # 281. Thus we have demonstrated our capability for measuring and analyzing significant numbers of events of all multiplicities in the 30-inch bubble chamber.

The measuring systems of Duke and Notre Dame complement one another, with the large numbers of low-multiplicity events being measurable on the Duke RIPPLE system while the high-multiplicity events can be efficiently measured at Notre Dame using conventional film-plane and image plane devices of high precision with experienced operators and with on-line computer sequencing and checking. Tested techniques are available for partial remeasurements on high-multiplicity events to achieve a high success rate with complex interactions.

No significant difficulties are expected in adapting present programs and/or developing new programs to handle the additional information available from the downstream particle detection and identification system. Our previous experience will enable us to contribute to the development of efficient systems for handling the new data.

Table I

Estimates of Numbers of Interactions

Beam	100 GeV/c Negative		100 GeV/c Positive			
Pictures	1,250,000		1,000,000			
Primary Particle	π^-		π^+		K^+	
Events/μb [a)]	7.89		5.4		0.9	
	σ (mb) [b)]	Events	σ (mb) [c)]	Events	σ (mb) [d)]	Events
Total Inelastic	20.92	165,050	20.05	108,280	16.22	14,600
Inelastic 2 prong	1.95	15,390	2.38	12,850	2.33	2,100
Inelastic 4 prong	4.79	37,790	4.65	25,110	3.50	3,150
Inelastic 6 prong	5.17	40,790	4.82	26,030	3.11	2,800
Inelastic 8 prong	4.30	33,930	3.63	19,600	3.79	3,410
Inelastic 10 prong	2.50	19,730	2.64	14,260	1.83	1,650
Inelastic 12 prong	1.41	11,120	1.25	6,750	1.00	900
Inelastic 14 prong	0.60	4,730	0.49	2,650	0.48	430
Inelastic 16 prong	0.133	1,050	0.13	700	--	--
Inelastic 18 prong	0.045	350	0.04	220	0.18	160
Inelastic 20 prong	0.014	110	0.02	110	--	--
Inelastic 22 prong	0.008	60	--	--	--	--

a) Assuming a (70% π^-/30% $\bar{p}$) negative beam and a (60% π^+/10% K^+/30% p) positive beam.

b) Based on E. L. Berger et al., Nucl. Phys. B77, 365 (1974).

c) Based on W. M. Morse et al., Purdue Preprint PU-76-440 (1976).

d) Based on V. E. Barnes et al., Phys. Rev. Letters 34, 415 (1975).

Table II

Acceptance of the DPI as a Function of Laboratory Momentum for 100 GeV/c $\pi^- p$ Interactions

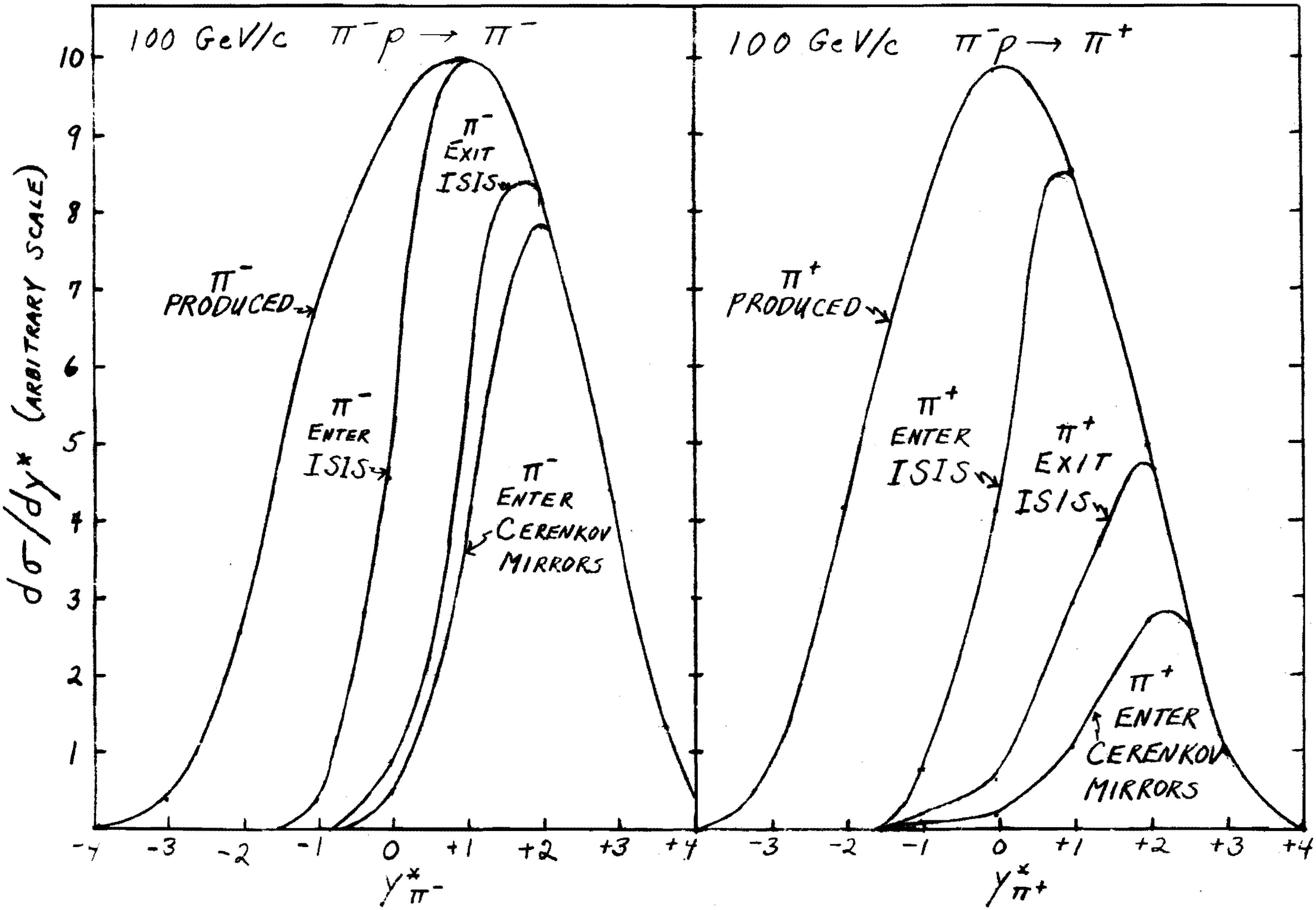
Laboratory Momentum (GeV/c)	No. of Pions Produced		π's Escaping Magnet				π's Escaping Magnet and Thru $1 \times 1 \times 3\,m^3$ ISIS			
	π^-	π^+	No. π^-	% of π^- Produced	No. π^+	% of π^+ Produced	No. π^-	% of π^- Produced	No. π^+	% of π^+ Produced
0 - 5	6352	7227	3529	55.6	3818	52.8	352	5.5	245	3.4
5 - 10	2029	1696	2027	99.9	1689	99.6	1297	63.9	731	43.1
10 - 15	1139	848	1139	100.0	847	99.9	1093	96.0	727	85.7
15 - 20	633	483	633	100.0	483	100.0	632	99.8	466	96.5
20 - 30	791	448	791	100.0	448	100.0	789	99.7	446	99.6
30 - 40	427	176	427	100.0	176	100.0	427	100.0	175	99.4
40 - 50	278	85	278	100.0	85	100.0	278	100.0	85	100.0
50 - 60	183	43	183	100.0	43	100.0	182	99.5	43	100.0
60 - 70	169	25	169	100.0	25	100.0	169	100.0	25	100.0
70 - 100	812	60	812	100.0	60	100.0	812	100.0	60	100.0
Total	12813	11091	9988	78.0	7674	69.2	6031	47.1	3003	27.1

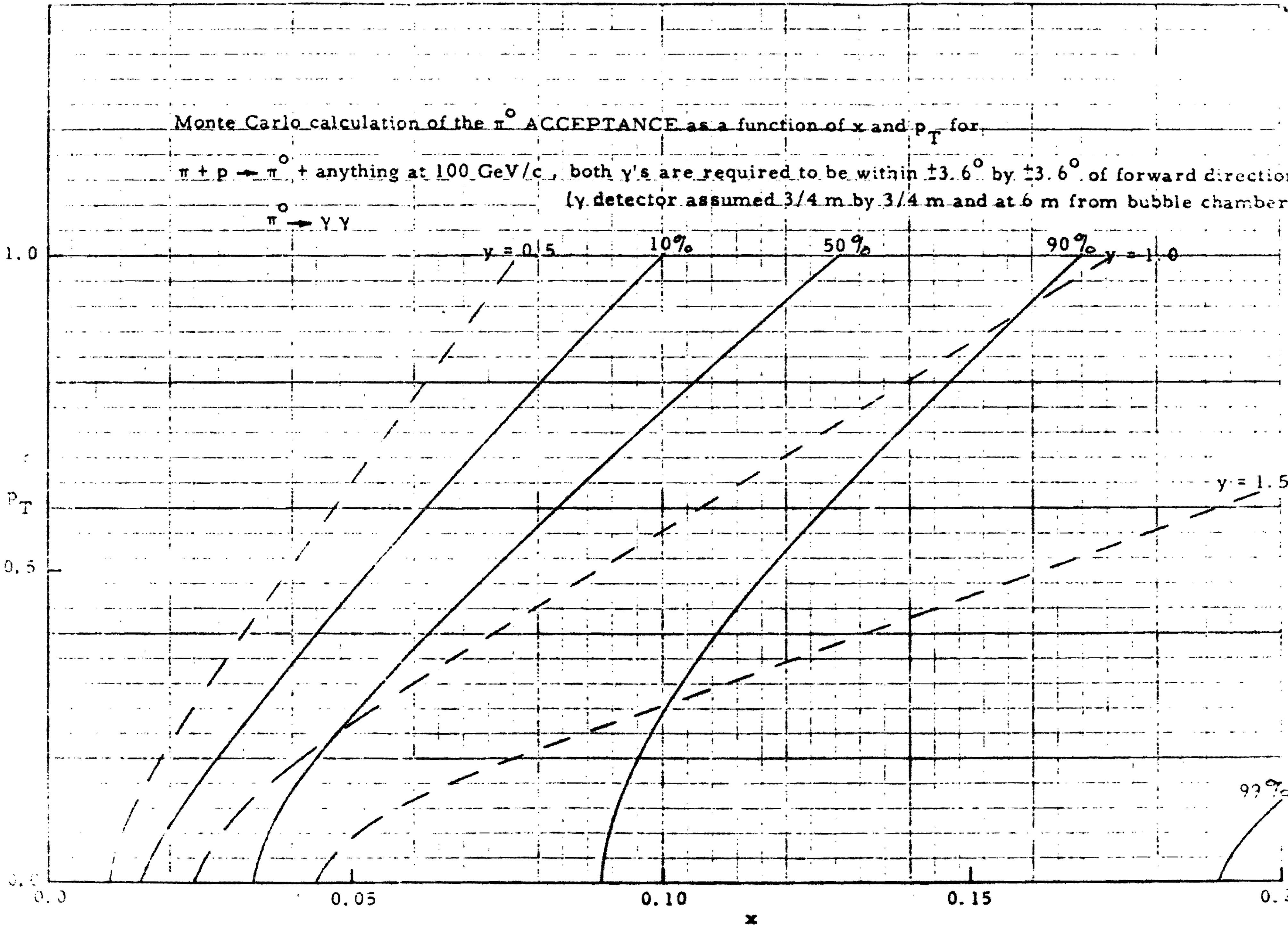
Table III

Overall Acceptance of DPI for 100 GeV/c $\pi^- p \rightarrow \pi^\pm$

					C.M. Hemisphere							
					Backward				Forward			
	No. π^-	% π^-	No. π^+	% π^+	No. π^-	% π^-	No. π^+	% π^+	No. π^-	% π^-	No. π^+	% π^+
Total Produced	12813	100.0	11091	100.0	4267	100.0	5376	100.0	8546	100.0	5715	100.0
Leave Magnet	9988	78.0	7674	69.2	1454	34.1	1960	36.5	8531	99.8	5715	100.0
Enter 1 m x 1 m ISIS at 2.1 m	8851	69.1	5638	50.8	782	18.3	733	13.6	8069	94.4	4905	85.8
Exit 1 m x 1 m ISIS at 5.3 m	6031	47.1	3003	27.1	139	3.3	154	2.9	5892	68.9	2849	49.9

FIG. 1


100 GeV/c $\pi^- p \to \pi^-$
100 GeV/c $\pi^- p \to \pi^+$
$d\sigma/dy^*$ (ARBITRARY SCALE)
π^- PRODUCED
π^- ENTER ISIS
π^- EXIT ISIS
π^- ENTER CERENKOV MIRRORS
π^+ PRODUCED
π^+ ENTER ISIS
π^+ EXIT ISIS
π^+ ENTER CERENKOV MIRRORS
$y^*_{\pi^-}$
$y^*_{\pi^+}$
10
9
8
7
6
5
4
3
2
1
-4
-3
-2
-1
0
+1
+2
+3
+4


Monte Carlo calculation of the π° ACCEPTANCE as a function of x and p_T for
π + p → π° + anything at 100 GeV/c , both γ's are required to be within ±3.6° by ±3.6° of forward direction
(γ detector assumed 3/4 m by 3/4 m and at 6 m from bubble chamber)
π° → γ γ
y = 0.5
10%
50%
90%
y = 1.0
y = 1.5
1.0
0.5
p_T
0.0
0.05
0.10
0.15
0.2
x