TECHNICAL PROGRESS REPORT
OF THE
INDIANA UNIVERSITY HIGH ENERGY PHYSICS GROUP*

December 1, 1976 to November 30, 1977

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Since the beginning of our ERDA contract year (Dec. 1, 1976), the Indiana High Energy Physics Group has been actively participating in experimental programs at SLAC, Fermilab, CERN, and the Argonne ZGS. Our SLAC effort (E103) is a search for exotic mesons. Our polarization program at Fermilab's internal target (CO) area involves polarization measurements in $pp \rightarrow pp$ (E313) and $pp \rightarrow pX$ (E522). Our contribution to the Multiparticle Spectrometer at Fermilab is a major ingredient in a series of experiments (E110/260/523/557) studying low- p_t and high- p_t hadron-hadron collisions. At CERN we are working with a Saclay group at the SPS to investigate properties of ψ meson production in experiment W11. Our Argonne ZGS endeavor (E399) will measure various inclusive polarizations, complementing our Fermilab E522 work. We are also participating in design work on a PEP proposal. A discussion of these experiments follows.

*Supported by the Energy Research and Development Administration Contract E(11-1)2009, Task A.

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SLAC E103

The Exotic Meson Search, SLAC experiment E103 (Indiana, Vanderbilt, Purdue, SLAC), is designed to utilize the SLAC Streamer Chamber Facility together with a forward proton spectrometer to search in-depth for backwards-produced doubly-charged exotic mesons. Data were recorded for the six processes:

a) $\pi^- d \rightarrow p(\text{fwd}) + \dots$	160,000 pictures
b) $\pi^- d \rightarrow \pi^+(\text{fwd}) + \dots$	45,000 pictures
c) $\pi^+ d \rightarrow \bar{p}(\text{fwd}) + \dots$	12,000 pictures
d) $\pi^+ d \rightarrow \pi^-(\text{fwd}) + \dots$	18,000 pictures
e) $\pi^- p \rightarrow p(\text{fwd}) + \dots$	8,000 pictures
f) $\pi^- p \rightarrow \pi^+(\text{fwd}) + \dots$	4,000 pictures

at an incident beam energy of 13.1 GeV/c. The primary goal of this experiment is to study in detail the doubly charged system X^{--} in the reaction

$$\pi^- d \rightarrow p(\text{fwd}) + X^{--} + p_{\text{spectator}}$$

The data collection was completed between May 15 and July 15, 1975. Streamer chamber film measurement began immediately at both Indiana (PEPR) and Vanderbilt (hand machines). As of July, 1977, approximately 80% of the film had been measured. We estimate that the remainder of the measuring will be completed by November, 1977.

During the past year several interesting discoveries have been made concerning the nucleon-antinucleon systems. Relatively narrow $\bar{p}p$ resonances have been found at masses of 1935 MeV/c², 2020 MeV/c², and 2200 MeV/c², while a narrow $\bar{p}p\pi^-$ resonance was seen at 2950 MeV/c². Theorists have studied the possibility of mesonic systems which might couple strongly to baryon antibaryon decay states (sometimes called baryonium). A popular conjecture for baryonium is that it is composed of four quarks (two quark, two antiquark states). As such,

it becomes exotic; that is, it falls outside of the simple quark model of quark-antiquark for mesons and three quarks for baryons. The narrowness of the observed baryon antibaryon states is also consistent with certain of these exotic meson models. The crucial test for the existence of such exotic states is the presence or absence of a manifestly exotic system (X^{--}).

During this last year an analysis has been made of each of the six channels listed above. Preliminary results based upon 50% of the measured data include upper limits on the production cross section for manifestly exotic mesons in several pion channels, and in baryon antibaryon channels (February APS meeting at Chicago).

	<u>Upper Limit</u>
$\pi^- d \rightarrow (p_s) p_f X^{--}$	
$\rightarrow (2\pi)^{--}$	80 nb
$\rightarrow (4\pi)^{--}$	70 nb
$\rightarrow (6\pi)^{--}$	70 nb
$\rightarrow p\bar{p}\pi^-\pi^-$	80 nb
$\pi^- d \rightarrow (n_s) p_f X^-$	
$\rightarrow (3\pi)^-$	70 μ b
$\rightarrow (5\pi)^-$	90 μ b
$\rightarrow p\bar{p}\pi^-$	100 μ b

Strong meson resonance production is seen in the backward direction for N^* exchange processes such as:

$$\pi^- d \rightarrow (n_s) p_f \pi^- \left\{ \begin{smallmatrix} \rho^0 \\ \omega \end{smallmatrix} \right\}.$$

Our present analysis is directed toward answering several important questions including:

- 1) Are exotic systems seen when the total data sample is available, the more precise PEPR measurements are used, and the momentum measurement ($\pm 1/2\%$ at 13 GeV/c) from the downstream spectrometer is included in the analysis?
- 2) What are the cross sections for other nonexotic mesons produced by Δ exchange processes, such as

$$\pi^- p \rightarrow p_f A_2^- ?$$

- 3) Do we see $\bar{p}p$ structure produced backwards at masses observed by others (1935, 2020, 2200) and is there structure at or below $\bar{p}p$ threshold?
- 4) What are the inclusive features, multiplicities, topologies of this peculiar corner of phase space where most of the momentum is carried off by the forward baryon?
- 5) What is the result of a one constraint event analysis of the manifestly exotic channel $X^{--} \rightarrow \bar{p}n\pi^-$ including higher precision data?

We expect to report on these and other E103 physics during the next few months.

FERMILAB E313:

One of the principal areas of activity of the Indiana University High Energy Group during the past year has been in connection with its experimental program at the Fermi National Accelerator Laboratory to study spin effects in high energy proton proton collisions. In this experiment the recoil protons

resulting from the interaction of the circulating proton beam with a hydrogen gas jet were detected in a superconducting spectrometer and spin-analyzed in a carbon polarimeter. The experiment is located in the internal target area at Fermilab. The thrust of the experiment is to study the polarization in elastic proton proton scattering at energies from 20 GeV/c to 200 GeV/c for four momentum transfers between $-.3$ and -1.0 GeV/c^2 .

The use of a gas jet in the circulating Fermilab beam has permitted us to obtain effective luminosities for polarization studies that are comparable to or better than those obtainable in an external proton beam utilizing a polarized target. We have fabricated at Indiana University a sophisticated polarimeter which can be used to selectively trigger on scatters in a carbon analyzer within an angular range useful for polarization analysis. Enrichment of double scatters is achieved through the use of a hardwired computer which senses the incoming and outgoing tracks on each side of a carbon analyzer block and determines within approximately 100 nsec whether or not a particular event satisfies certain scattering angle cuts. When the cuts have been satisfied, all pertinent information concerning each event is then transferred to a PDP 15 online computer and is logged onto magnetic tape. The left-right scattering asymmetry from the carbon analyzer is directly related to the polarization of the scattered proton. The proportionality factor between these two quantities is known as the analyzing power and this quantity was determined in an independent experiment conducted in the polarized beam at Argonne National Laboratory. The calibration of the analyzer and the reaction rates permitted a high statistics study to be made of

the behavior of the polarization in the $|t|$ range of .3 to 1.0 (GeV/c)².

The physics goals of this experiment were to determine if appreciable polarizations existed in the diffractive region in high energy proton proton scattering. There was the earlier expectation based on projections of all standard models that spin effects would be negligible at high energies. These projections seemed quite reasonable both from an analytical viewpoint and from an intuitive viewpoint. However, recent information has caused the community to reassess the applicability of the standard models to high energy spin studies. One major surprise discovered at Fermilab that may have some bearing in this area is the extremely large inclusive Λ polarizations observed by a Michigan-Wisconsin group in the process $p + Be \rightarrow \Lambda + \text{anything}$ at 300 GeV/c. Furthermore, there was the hint in the results from a pp elastic scattering experiment at 45 GeV/c performed at Serpukhov that large negative polarization effects might exist near $t = -.8$ (GeV/c)². Our results to date confirm that significant negative polarizations do exist in the elastic pp channel at $|t|$ values beyond .6 (GeV/c)² and less than 1.0 (GeV/c)² over the momentum range between 20 GeV/c and 200 GeV/c. These results are particularly interesting when viewed in the framework of geometrical models. In this context, one observes that the direction of spin of the outgoing proton in the pp elastic process actually reverses sign as one moves from smaller four momentum transfers to larger four momentum transfers. This appears to be an indication of a significant change in character of the pp interaction over this $|t|$ range. It is our understanding that similar effects have been observed in another experiment at Fermilab by Chamberlain et al. and in a CERN

experiment which is currently underway. These observations are likely to have an important impact in our description of the pp system at high energies.

At present, the final analysis of data from our experiment is almost complete. The data are being subjected to numerous tests involving the analysis of incident pions to ensure that the system has no instrumental biases, cross checks of existing low energy polarization measurements, etc. We anticipate that the analysis of these data will be completed within the next two months. Papers have been delivered on preliminary results from this experiment during the Argonne polarization symposium in August of 1976, during the Coral Gables conference in January of 1977, and in two contributed papers at the recent APS meetings in Chicago and Washington. It is our intention to continue the pursuit of these measurements to larger t values and to higher energies in future runs at Fermilab.

FERMILAB E522:

In July, 1977 the proposal to measure proton polarization in inclusive processes was approved for 800 hours of running at the internal target area at Fermi National Accelerator Laboratory. This experiment will use the internal target superconducting spectrometer to select protons from the reaction $p + p \rightarrow p + X$ over a transverse momentum range $.5 \text{ GeV}/c < p_t < 1.5 \text{ GeV}/c$. Forward center of mass momenta will be selected over the range $.6 < x < .95$. The proton polarization will be determined by using the same carbon rescattering polarimeter employed in E313. Since this experiment will measure polarization at a higher momentum and smaller production angle, there are some changes required in the

polarimeter. We plan to add an additional proportional chamber plane to help identify backgrounds, improve the TOF particle identification system, and make some structural modifications to allow measurements at small production angles.

Our preliminary measurements during the E313 running schedule indicated the evidence of $p + C \rightarrow p + X$ inclusive polarization. Running from carbon will be limited to a few low rate points during E522. We intend to concentrate on measurements using the hydrogen "warm jet" installed in the internal target straight section. This will eliminate the possibility of nuclear effects and reveal the p_t and X dependence of the p - p polarization process directly. If the earlier measurements at Fermilab on inclusive Λ polarization (Bunce et al., PRL 36, 1113 (1976)) can be a guide, we expect that proton polarizations will rise with p_t and could be as great as 25% near $p_t \sim 1.5$ GeV/c. Our preliminary data from carbon are consistent with this expectation.

The mechanism for the Λ inclusive polarization and the proton polarization we have observed in our preliminary measurements is unknown. Small inclusive polarizations at lower beam energies were expected to disappear in the Fermilab energy range.

This measurement of the p_t and X dependence of proton inclusive polarization will clarify the dynamics of this new high energy proton-proton spin effect.

FERMILAB E260/E110/P523/E557:

This experimental program is studying low- p_t and high- p_t hadron-hadron collisions using the Fermilab Multiparticle Spectrometer (MPS). Part of the Indiana group (A. Dzierba and W. Kropac*) was involved in the design and construction of the MPS in the M6 beam line at Fermilab. The original collaboration included physicists from Caltech, UCLA, UICC, and Fermilab in addition to Indiana. The MPS collaboration presented technical details of the MPS at a workshop held at Fermilab on March 4-5, 1977. The original MPS collaboration used the MPS to carry out a study of high- p_t hadron physics (E260). The original collaboration, excluding the UCLA group, is currently studying low- p_t , low-multiplicity reactions using the MPS (E110). A. Dzierba is spokesman. R. Crittenden, R. Heinz, J. Krider, and D. Petersen have joined this effort. Indiana is also involved in two other future efforts using the MPS. One experiment is an extension of E110, adding neutral π^0 and η^0 detection to the MPS (P523). The other is an extension of E260 using improved calorimetry and a higher energy M6 beam (E557).

E260: (A. Dzierba and W. Kropac*)

This experiment is in the final analysis stage. Results from data using a beryllium target have been presented in Phys. Rev. Lett. 38, 1447 (1977). A longer, more detailed paper on the beryllium data has been submitted to Nuclear Physics. The hydrogen target data are in the final stage of analysis. The striking

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result of E260 is the comparison of events with single particles of high p_t and jets (groups of particles) with high p_t . The jet and single particle cross-sections have a similar shape from $p_t = 3$ to 5 GeV/c but the jet cross-section is over two orders of magnitude larger. The distributions of charged particle momenta show striking similarities to those observed in lepton-induced processes. Both the beryllium and hydrogen data give strong support to a simple quark-quark scattering model.

E110: (R. Crittenden, A. Dzierba, spokesman, R. Heinz, J. Krider, D. Petersen)

This experiment, a study of low- p_t , low-multiplicity, is currently in progress. This experiment will focus on the production dynamics of known resonances (e.g., A_2, ρ^0) as well as searches for new resonances. We had a four-week test run during February-March of 1977 and a five-week data-taking run during May-June. The second half of our approved data-taking will start December, 1977.

During the test run we completed the target-area apparatus which was not needed for E260 but was necessary for a study of some of the exclusive channels in E110. This instrumentation included 12 shower-counter modules, built at Indiana, used to veto soft- π^0 events. During the test run we collected data from various low-multiplicity triggers using the PWC's in our trigger logic. For example, we triggered on three particles-forward, a topology dominated by the diffractive process: $\pi^- p \rightarrow 3\pi p$. Data from this reaction show the A_1, A_2 , and A_3 peaks in the 3π effective-mass as well as the ρ, f , and g peaks in the $\pi^+\pi^-$ effective-mass. We also ran with several neutral-Vee triggers. An example of this trigger is a one-to-three particle trigger which yields an enriched sample of the reaction.

In this case, about 25% of the triggers yielded a real K^0 with a full width on the K^0 mass of about 15 MeV.

Based on the results of our test run we redesigned our trigger logic allowing for simultaneous triggers. In order to simplify the electronics, the Indiana group designed and built window discriminator units which allowed one to "dial in" the multiplicity requirement for each plane. R. Gomez from Caltech collaborated in the design of these modules.

In our data run we collected data with a negative beam at incident energies of 20, 50, and 100 GeV. We ran with 10 different triggers which included a mix of elastic and interacting-beam for normalization purposes, the well-understood $3\pi p$ diffractive process, several 2π triggers with orthogonal biases, and triggers requiring the presence of neutral-Vee's in the final state. The bulk of our data was taken with the 100 GeV beam which yielded about a million triggers. The expected yield from the 100 GeV data:

(a) $\pi^- p \rightarrow \pi^+ \pi^- n$: 80,000 events with about 8,000 events in the p^0 region. This should allow a study of $\pi\pi$ scattering and a good measure of the t and s dependence, especially when coupled with our 200 GeV E110 run in Fall, 1977.

(b) $K^0 \pi^+ \pi^-$ (20,000) and $K^0 \pi^-$ (40,000) systems:

60,000 events. This will allow a good study of strange resonance spectroscopy. Our test data

have already yielded more than the world's supply of $K^0 \pi^+ \pi^-$ in the Q region.

(c) $K^0 \bar{K}^0$ + neutrals forward:

20,000 triggers (yield of good K^0 events not known yet).

The above numbers are based on actual yields from our reconstruction programs.

Data from the May-June run are being analyzed using computer facilities at Fermilab, Indiana, and LBL. The Indiana group is abstracting track data from event-analysis tapes to allow for a quick initial look at the physics.

During the second-half of the approved E110 running, scheduled to take place starting December, 1977, we will run primarily with a 200 GeV incident beam. This will allow us to study the energy dependence of most of our reactions over a wide range of incident momenta (20-200 GeV/c). We also plan to install a photon-detector in the apparatus to allow us an initial look at the physics of P523 (see below). To this end we have purchased a PDP11/03 computer, using University funds, to be used to monitor the photon-detector. Work is in progress on both software and hardware (interfacing the PDP11/03 to the detector).

P523: (B. Brabson, R. Crittenden, A. Dzierba, spokesman, R. Heinz, J. Krider, and D. Petersen)

The study of low- p_t physics of E110 can be extended by the inclusion of neutral detection capability in the MPS. In P523, a proposal involving physicists from Caltech and Indiana, we propose to install the photon-detector built and used by R. Walker and collaborators for experiments E111 and E350 at Fermilab.

The physics of P523 is naturally divided into two classes. We have first the K^0 triggers ($K^0\pi^+\pi^-\pi^0$, $K^0\bar{K}^0\pi^0$ are the most important) where the main aim is meson spectroscopy in $K\bar{K}^*$, $K^*\pi$, $K\rho$ modes. Secondly, we can study the $\pi^+\pi^-\pi^0$ trigger which is of interest both for spectroscopy and the study of two-body dynamics (e.g., $\pi^-p \rightarrow \omega^0 n$).

Below we briefly summarize the physics goals for the K^0 and $\pi^+\pi^-\pi^0$ triggers. We will use the E110 $\pi^+\pi^-$ and $\bar{K}^0\pi^+\pi^-$ trigger data to ultimately decide how to divide our running time between the two trigger classes.

$\pi^+\pi^-\pi^0$ Trigger:

The two body reaction $\pi^-p \rightarrow \omega^0 n$ is dominated by ρ exchange at high energy. However, current ω^0 production data show no sign of the dip at $t = -.6$ (GeV/c)² seen in the ρ -exchange reaction $\pi^-p \rightarrow \pi^0 n$ and predicted by simple Regge theory. Again ρ exchange in $\pi^-p \rightarrow \pi^0 n$ is dominated by a spin-flip amplitude while the ω^0 spin makes $\pi^-p \rightarrow \omega^0 n$ dominated by nonflip and double-flip amplitudes. Current phenomenology attributes the failure of Regge theory to this difference in spin structure. By studying the similarities and differences between $\pi^-p \rightarrow \pi^0 n$ and $\pi^-p \rightarrow \omega^0 n$, one hopes to gain new insight into the validity of Regge theory.

As our proposal indicates, there are many poorly understood meson resonances that decay into $\pi^+\pi^-\pi^0$. Information on these resonances is now coming out from the Charged Neutral Spectrometer at Argonne. We will extend these measurements up to higher $\pi^+\pi^-\pi^0$ mass with good acceptance.

$\bar{K}^0$ Triggers:

Our basic K^0 triggers are the non-diffractive modes $K^0\bar{K}^0\pi^0$, $K^0\pi^+\pi^-\pi^0$. Compared to E110 the advantages of our new proposal are clearest for the final

state $K^0 \bar{K}^0 \pi^0$. In this mode, we are sensitive to $\bar{K}K^*$ whereas the E110 $K^0 \bar{K}^0$ trigger can only study natural parity ($0^+, 1^-, \dots$) resonances. Generally, unnatural parity resonances are currently much less well-understood precisely because they do not decay into two pseudoscalars.

The $\bar{K}K^*$ decay mode is very attractive for studying resonances with large strange quark content. One expects these $I=0$ resonances in other $SU(3)$ nonets besides the well-known ϕ in the 1^- nonet and its orbital excitation f' in the 2^+ nonet. The most obvious candidate nonets are the 1^+ and orbital excited 2^- nonet.

The advantages of $K^0 \pi^+ \pi^- \pi^0$ over $K^0 \pi^+ \pi^-$ are two-fold. First, we can study $K\pi\pi$ resonances in three charge states ($K^0 \pi^+ \pi^-$, $K^0 \pi^+ \pi^0$, $K^0 \pi^- \pi^0$). Secondly, we are sensitive to resonances whose direct peripheral production is suppressed and are formed as, for instance,

$$\pi^- p \rightarrow K_{\text{fast}}^- M^* x_{\text{slow}} \quad \text{where } M^* \rightarrow \bar{K}^0 K^+ \pi^0 \text{ or } M^* \rightarrow \bar{K}^0 K^+ \pi^0$$

where x_{slow} is the arbitrary slow system allowed by our semi-inclusive trigger.

Charmed mesons are the most obvious case where direct production is suppressed. Another example is pure $s\bar{s}$ resonances (like ϕ) with a π^- beam. (The K^- beam component is, however, a rich source of such resonances.)

Above, we emphasized $K\pi\pi$ ($\bar{K}K\pi$) resonances rather than the well-studied $K\pi$ case. Note that all our channels are non-diffractive and so insensitive to "Deck background" that has hampered $K\pi\pi$ studies in classical diffractive reactions.

Finally, the π^0 detector is very important in allowing sensitive studies of $\bar{K}K\pi$ and $K\pi\pi$ resonances. The alternative of allowing additional charged pions (e.g., $K^0 \pi^+ \pi^-$) with a K^0 trigger has backgrounds which fake K^0 . These come

from interactions of the charged particles in the decay region or from close-together tracks opening up and faking K^0 . For example, in E110 the yield of true K^0 in our neutral Vee + single charged-particle trigger is about 25% whereas when we add another charged particle (as in our $K^0 \pi^+ \pi^-$ trigger) the yield of true K^0 is about 4% of the triggers. The result is that although the geometric acceptance is smaller for π^0 than for charged particles, the triggers with π^0 will have a net higher yield of K^0 since our system will not be saturated with "dirty" triggers.

The status of our proposal is that it was considered at the summer, 1977 meeting of the PAC, and the decision taken at that time was to defer action on the proposal until the summer, 1978 meeting of the PAC. We have learned recently that there may be a possibility of approval for some part of P523 running before the five-month shutdown of the Meson Lab scheduled to begin June, 1978.

E557:

This experiment, an upgraded version of E260, extends the study of "jets" up to 8 GeV/c. This experiment has been approved for some running before the June, 1978 Meson Lab shutdown. The bulk of the approved running will take place beginning January, 1979. The experiment is a joint effort between physicists from Fermilab, UICC, Maryland, Dubna, as well as Indiana. E. Malamud is the scientific spokesman.

The details of which groups are responsible for various parts of the experiment are now being finalized. The Indiana group will take on responsibility for monitoring and calibrating the new, improved calorimetry. Thus, this is a carryover from our P523 work.

CERN SPS WA 11:

This experiment, in collaboration with Saclay, examines states produced in conjunction with the ψ in $150 \text{ GeV}/c \pi^- p$ interactions. During the first four months of 1977, the experimental apparatus was assembled and made operational. With minor modifications the trigger rate was brought to within a factor of two of the design value. Early data show a prominent ψ peak. During Summer, 1977 the equipment will be augmented by a γ /electron detector supplied by a new collaborator, Imperial College. Data-taking will resume in August, 1977 and continue for about one year.

The equipment, located along with two other experiments in beam H3 of the SPS West Area, consists of a target, a large ($\sim 1 \text{ m}^3$) magnet (Goliath) filled with MWPC's, a segmented Cerenkov counter (for K/π separation) and a μ detector. The μ detector is a 3 m long chunk of Fe sandwiched between scintillator hodoscopes. (Details can be found in the experimental proposal which is appended to last year's ERDA proposal.) We have been using Al and C targets and will change to Be then liquid H_2 this fall. The trigger requires 2 μ 's with a large effective mass ($\geq 1 (\text{GeV}/c)^2$). Goliath is used to analyze hadronic byproducts of the production of ψ 's near $x = 0$.

Our main physics motivation is a search for charmed mesons (D) or baryons (C) which should be produced with a ψ . This expectation, following Zweig's Rule, is analogous to the tendency for strange particles to be produced with a ϕ . Beam dump experiments at Fermilab indicate that Zweig's Rule is not operative in ψ production. However, this conclusion requires assumptions about how the $\psi \text{ DD}^{\bar{}}$

(or ψ_{CD}) is produced and the branching ratio of D and C into (μ + anything).

Aside from charmed particle production, our experiment will explore many interesting aspects of ψ production such as how the presence of the ψ affects the K/ π ratio, charged particle multiplicity, and the transverse momentum distribution of associated hadrons.

Our ψ signal in data coming from less than one week of running is shown in the figure. (All chambers have not been used in the mass calculation; we anticipate a final ψ mass resolution of about ± 30 MeV.)

The offline software has been tuned and we are now beginning the complete analysis (μ tracks and hadron tracks) of our data tapes. From this plot we estimate that we already have 400 ψ 's on our data tapes; we plan to collect a total of 7,000 ψ 's.

We are currently installing two MWPC's just downstream of the production target and separated by ~ 1 m to measure the charged particle multiplicity.

These MWPC's are intended to detect V's coming from neutral particles decaying between the MWPC's. Two more chambers will be added in early 1978. Our physics motivation is to trigger on interactions with a K_S^0 in the final state. For example, if the strange-charmed meson (F) is produced, it should often decay into two strange particles and perhaps be produced along with another strange particle. Thus, while we are finishing our work on the ψ trigger we are actively investigating other trigger possibilities.

ARGONNE ZGS E399/P398:

Argonne Experiment E399 measures the asymmetry in $\pi^\pm, K^\pm, p$, and $\bar{p}$ inclusive production by polarized protons. In the experiment we also intend to measure the polarization of inclusively produced protons and certain differential cross-sections.

E399 entered the data-taking phase with the completion of the proportional chamber spectrometer in May, 1977. During the last half of May, pion and proton asymmetry data were taken using a 6 GeV/c polarized beam at all kinematically allowed transverse momenta (out to $p_\perp \sim 1.5$ GeV/c) and $x \geq 0$. Approximately 10^7 triggers were recorded on ~ 100 tapes. Preliminary analysis indicates about one-fourth of these triggers will be in the final data sample. The analysis effort is proceeding well and should be completed for this data set during the present contract year.

We are presently engaged in fabricating the additional hardware required for later phases of the experiment. Drift chambers to provide higher resolution

in the low missing mass region are being tested this August. Proportional chambers for the polarimeter are nearly complete; their readouts are finished and tested. The scatter detector (or polarimeter computer) is under construction. All should be finished and tested before the next run.

We will run again this winter to obtain asymmetry data with 6 GeV/c beam for $x < 0$ using the higher intensity resonance extracted beam at the ZGS. We also plan to take 12 GeV/c asymmetry data over the full kinematic range (out to $p_{\perp} \sim 2$ GeV/c). During that run polarization data from the scattered proton would be taken at a few points.

The general physics thrust of this experiment is the determination of the extent to which initial state spin influences the production and spin structure of the inclusively produced final state particles. It is hoped that information from these studies will be useful in determining the inclusive production mechanism at intermediate energies. The Indiana spectrometer at the ZGS will be one of a few such devices in place to make a sequence of spin studies over the remaining life of the ZGS. The particular emphasis of our program there will be guided by the month-to-month developments in our experiments and in others in such a way that the most promising physics is explored in the limited time available. As examples of other planned measurements, we have proposed to measure the polarization in proton proton elastic scattering in the coulomb interference region (P398). This measurement would give for the first time both the phase and amplitude of the single spin flip amplitude. For this measurement, the E399 proportional chamber spectrometer would be used in conjunction with a proportional chamber beam

telescope and a hardware scattered detector. The running time for this particular measurement would be only a few days.

We also plan to use this same small angle technique and apparatus to measure the coulomb interference differential cross-section for πp elastic scattering near 2 GeV/c. Depending upon the scheduling, we also expect to devote some running to study the polarization in elastic proton proton scattering in greater detail at large $|t|$.

PEP PROPOSAL:

During the past year our group, along with the other members of the "Midwest PEP Collaboration" (University of Michigan, Purdue University, and Argonne National Laboratory), has been actively engaged in proposal preparation for PEP--the future electron-positron colliding beam facility at SLAC.

Work on the first round proposal by our group covered many areas of e^+e^- physics. We designed a two-layer pentane and isobutane threshold Cerenkov counter system to identify hadrons in the jets predicted at PEP energies. A Monte Carlo program utilizing a general N-body phase space calculation was created to evaluate acceptances and ambiguities in jet processes.

Members of our group were also directly involved in the details of the cryogenic design for a large superconducting solenoid. We assisted in magnetic field calculations for this solenoid and in the engineering of the iron flux return. Also, members of our group participated in the proposal presentation at SLAC and in the several workshops associated with the first round proposals for PEP.

Although the first round proposal was not accepted by the Experimental Program Committee at PEP, the Midwestern Collaboration has developed considerable expertise in the many areas of physics associated with e^+e^- detector development. The collaboration has remained unified and is continuing to work on a second round proposal for Fall, 1977. This experiment would be ready for operation at PEP turn-on in the fall, 1979.

The design of a large volume magnetic detector built around the existing 12 foot bubble chamber at Argonne National Laboratory is well underway. A preliminary engineering study of the conversion of the 12-foot has been completed and indicates the feasibility of the project.

The 12-foot, 20 KG superconducting magnet will offer several unique advantages at PEP. The large solenoid radius and high field will result in a momentum resolution eight times more precise than the approved MKII design by Richter et al. In addition, the large field integral will produce a large separation of events in parton jets predicted at PEP energies. The 130 cm of iron flux return that surrounds the 12-foot magnet will provide the best high momentum muon identification at PEP. All of these features, we believe, will be extremely valuable at PEP. The increased mass resolution can be directly related to running time when investigating details of narrow resonances. The magnet exists now and would be available Summer, 1978--well in advance of PEP start-up.

The principal investigators covered by this contract are R. Heinz and H. Neal. R. Heinz has devoted 100% of his time for 11 summer weeks and approximately 40% of his time during the academic year to this research project. H. Neal has devoted approximately 40% of his time for the academic year and approximately 30% during the summer to this research project, having taken on additional university responsibilities as Dean of Research and Graduate Development. It is anticipated that these percentages will apply for the remainder of the contract year. To the best of our knowledge, compliance with the contract requirements has been complete.

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