FERMILAB RESEARCH
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EDITOR

J. LACH

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Introduction

This collection of one-page summaries of Fermilab proposals is intended to serve as a way station between the experiment number with its short title and the full proposal. It is not intended to be a review of the Fermilab experimental program. Just as an abstract of a journal article embodies the main points of the article, so these one-page summaries are intended to convey the major points of a proposal. These should include its physics justification, a brief description of the apparatus and the demands that the experiment will make on the Laboratory. Of course these summaries are not intended to take the place of the proposal itself which is the primary document available in the Fermilab library and at SLAC, BNL and CERN. Individual copies should be obtained from the spokesman of the experiment whose name is underlined in these summaries.

Summaries for all experiments and pending proposals are included. These comprise approved, unconsidered and deferred proposals. Rejected, withdrawn and inactive proposals are not included.

It is the experimenters themselves who are best able to write the summary and in most cases that is what was done. For the early proposals and those cases where repeated cajoling could not produce one from the experimenters, the summary was prepared by a Fermilab staff member and then sent to the spokesman for comment. All proposals submitted before the May 7, 1976 deadline for consideration at the extended summer meeting of our Program Advisory Committee are included.

It is not intended that this volume be updated annually but perhaps only reissued when the previous ones becomes hopelessly obsolete.

Joseph Lach
Editor

NAL NEUTRINO PROPOSAL

A. Benvenuti, D. Cheng, D. Cline, W.T. Ford, R. Imlay, T.Y. Ling,
A.K. Mann, F. Messing, J. Pilcher*, D.D. Reeder, C. Rubbia,
R. Stefanski, L. Sulak
        (Harvard-Pennsylvania-Wisconsin Collaboration)

This is a counter experiment in a broad band or mono-chromatic beam to study neutrino interactions with energies of 100 to 300 GeV on free protons and heavy nuclei. The experimental apparatus consists of an 8m long liquid hydrogen target; a target-calorimeter (3mx3mx8m long) is a repetition of a basic module consisting of a lead target plate (~6mm thick), and a liquid scintillator (6mm thick). An interim pure liquid scintillation calorimeter has been installed and is working. The target-calorimeter has optical wide-gap spark chambers interspersed throughout. It is planned to install large drift chamber planes in the near future. If a wide band neutrino beam is used, then the neutrino energy is determined by the calorimeter and muon spectrometer. It is estimated that for the neutrino energy range 30 GeV $<E_\nu<$ 300 GeV, $\Delta E_\nu/E_\nu \leq \pm 0.1$. The muon spectrometer consists of four 18kG iron core torodial magnets 3.6m in diameter and 1.2m long.

The physics objectives of the experiment are:

1) To search for the intermediate boson up to W mass of $\simeq 30$ GeV at 400 GeV operation of the accelerator. Both electronic and hadronic decays of the produced W can be detected in the target-calorimeter or the resultant induced non locality will be detected.

2) To measure the cross section for the diagonal four-fermion interaction $\nu_\mu + Z \rightarrow \mu^+ \mu^- \nu_\mu Z$. A ~10% cross section measurement can be made with 30-60 days of running time.

3) To measure the neutrino deep inelastic scattering cross section $d^2\sigma/dq^2 d\nu$ and σ_{tot} for $\nu_\mu + Z \rightarrow \mu^- + $ (anything) and $\bar\nu$ scattering. Tens of events per day with $q^2 > 200$ (GeV/c)^2 are expected if scaling holds.

4) To measure $d^2\sigma/dq^2 d\nu$ and σ_{tot} (E_ν) for the reaction $\nu_\mu + p \rightarrow \mu^- + $ (anything). It is in this phase of the experiment that the liquid hydrogen target is used. About 370 interactions per day are expected due to neutrinos above 45 GeV.

5) To look for hitherto unsuspected phenomena.

STUDY OF MULTIPARTICLE p-p AND π-p INTERACTIONS
FROM 100 GeV/c TO 300 GeV/c WITH A 30-INCH BUBBLE
CHAMBER-WIDE GAP SPARK CHAMBER HYBRID SYSTEM

ANL, Duke Univ., Iowa State Univ., Univ. of Maryalnd,
Michigan State Univ., Fermilab, Univ. of Notre Dame,
Purdue Univ., Univ., of Toronto, Univ. of Wisconsin

G. A. Smith (Spokesman)

This group has been approved to study pp and πp interactions in an apparatus consisting of the 30" HBC coupled with a wide-gap optical spark chamber detection system downstream of the bubble chamber. In addition to the approved 450,000 pictures, a total of 300,000 pictures have been recently approved (#281)for later running. The detector system is designed to provide accurate bubble chamber data on all charged particles with momenta below ~20 GeV/c, comparably accurate optical spark chamber data on downstream particles above -20 GeV/c (typically 15% FWHM on the momentum of a 200 GeV/c track), and information on neutral particles decaying into gamma rays. The aim of the experiment is to study single and multi-particle distributions from all final states (elastic and inelastic) produced at a variety of energies with a variety of bombarding particles in order to test models of current interest. The cost and construction of the entire system downstream of the bubble chamber has been assumed by the ANL-ISU-Maryland-MSU-NAL members of the collaboration. The cost and construction of a rapid beam deflector and various beam diagnostic equipment, plus the measurement of the bubble chamber magnetic field, has been assumed by the remaining members of the collaboration.

First physics results on (a) two particle correlations and (b) inclusive and semi-inclusive diffraction have been published in two articles in Physics Letters [56B, 395 (1975) and 56B, 400 (1975)].

Summary prepared by

G. A. Smith, January 1976

PROPOSAL FOR A SEARCH FOR MAGNETIC MONOPOLES AT NAL

L. Alvarez, <u>P. Eberhard</u>, H. Oberlack, R. Ross, J.D. Taylor (University of California, Lawrence Berkeley Laboratory)

<u>Objective</u>: To find a magnetic monopole or decrease upper limits for monopole production cross section in a mass range where NAL experiments can do a much better job than previous experiments. To conduct as foolproof a search as possible, e.g. one depending only on those monopole properties that are due to long range "Coulomb" like interactions and avoiding those involving short range interactions that are all questionable.

<u>Technique</u>: Expose a Cobalt coated aluminum target to 10^{18} (or more) protons at the highest energies available. Transport the target to Berkeley after exposure. Grind it and randomize the chips. Run samples separately in the superconducting electromagnetic monopole detector and measure their magnetic charge to a small fraction of a Dirac unit.

<u>Necessary conditions for finding a monopole in this search</u>:

Production: a) Mass < 15 GeV/c^2 (500 GeV incident protons);
                b) Production cross section $\geq 10^{-44}$cm^2 for 10^{18} interacting protons ($\sim 10^{-4}$ of the presently known upper limits at M = 15 GeV/c)^2.

Detection: a) Magnetic charge $>$ a small fraction of the Dirac charge, (1/100 of a Dirac charge is realizable). No upper limit. b) Induction of a signal in a coil (distances of several centimeters). c) Binding of monopoles to the sample. If they are bound to aluminum nuclei the north and south poles must end up trapped at distances of more than 2 mils from one another. Either a small opening angle at production or multiple scattering according to theoretical predictions is sufficient. If they are not bound to aluminum nuclei the monopoles should be trapped in the ferromagnetic cobalt coat. Interaction distances involved in that case are over 1000 Å.

<u>Justification</u>: This is the only monopole search planned at NAL covering such a large range of magnetic charge and, after production, it depends only on the long range interactions of the monopole. Moreover, once we find a monopole, the sample is ready for immediate remeasurement since the monopole remains bound to the same piece of matter all the time.

<u>Status</u>: Irradiation of about 3 x 10^{18} protons have been obtained. Search has been made. No monopole was found. Results have been published Phys. Rev. D11, 3099(1975). Experiment is over.

                                    Summary reviewed by
                                    P. Eberhard, January 1976

NEUTRON TOTAL CROSS SECTIONS UP TO 300 GeV

D. Burke, R. Gustafson, O. Haas, L. W. Jones, M. Longo,
J. Pluta, J. Stone, J. Chanowski (Univ. of Michigan);
B. Cork (LBL)

In this experiment measurements will be made of total
cross sections for neutrons on hydrogen and heavier nuclei in
the energy range 40 to 300 GeV to an accuracy of < 2%. This
will be done using a small-angle neutron beam and a standard
transmission technique. The neutron detector is a total
absorption spectrometer with an expected energy resolution
$\approx \pm 5\%$. The apparatus is set up in the neutral beam enclosures
upstream of the detector building of the Meson Area.

Summary reviewed by
M.J. Longo, February 1974

A PROPOSAL TO MEASURE $\pi^{\pm}$p AND p-p
DIFFERENTIAL ELASTIC SCATTERING CROSS SECTIONS
FROM 50 to 170 GeV/c

C. Akerlof, R. Kotthaus, R. Loveless, D. Meyer (University of
Michigan); I. Ambats, T. Meyer, C. Ward (ANL); D. Eartly,
D. Jovanovic, R. Lundy, S. Pruss (NAL); D. Rust (Indiana)

It is proposed to measure the differential cross sections
for $\pi^{\pm}$p $K^{\pm}$p and p p elastic scattering in the range of $0.1 < |-t| <$
2 to 5 $(GeV/c)^2$ from 50 to 280 GeV/c. The apparatus consists
of a liquid hydrogen target, a double arm spectrometer, wire
spark chambers, an on-line computer, 3 Cerenkov counters in
the incident beam, and 3 Cerenkov counters in the forward arm
of the spectrometer. The highest attainable momentum and t
value will differ from particle to particle depending on the
ratio of particles in the beam and the ability of the Cerenkov
counters to separate efficiently. The angular and momentum
measurements of the scattered particles will be used to
provide a three constraint fit for every event: coplanarity,
opening angle, and transverse momentum balance. The angular
and momentum resolution in the forward arm spectrometer are
0.06 mrad and 0.5% respectively at 200 GeV/c, and 3 mrad
and 1.7% respectively at 2 GeV/c in the recoil arm spectrometer.
The apparatus is designed to include sufficient rejection
against inelastic processes to allow measurements down to
cross sections at least as low as 100 nanobars/$(GeV/c)^2$.

The experiment will explore structure in the high
momentum transfer region especially the $-t = 1.4$ GeV/c^2 p-p
dip bracketed by the CERN PS and ISR data and the dip in πp
at larger t. The slope parameter will be measured to an
accuracy of 0.5%. Some inelastic data will automatically be
collected.

Summary reviewed by
D. Meyer, February 1975

EXPERIMENTS IN A NEUTRAL HYPERON BEAM

E. Behr, G. Bunce, R. Handler, R. March, P. Martin, G. Ott,
L. Pondrom, M. Sheaff,   W. Wilke (Univ. of Wisconsin);
A. Bersbach, T. Devlin, B. Edelman, R. Edwards, C. Muehleisen,
S. Yamin (Rutgers);   O. Overseth, P. Skubic (Univ.
of Michigan);

This experiment is proposed to make the following measurements in a 200 GeV neutral hyperon beam:

1. Survey of a neutral hyperon beam, to measure production of Λ^O, $\bar{\Lambda}^O$, Ξ^O, $\bar{\Xi}^O$, K_1^O, K_2^O, at 0, 5, and 10 mrad, by 300 GeV/c protons on a copper target. The basic instrument consists of a spectrometer which looks at charged decay particles and is capable of a 1% mass resolution.

2. Measurement of ΛN total and diffraction elastic scattering cross sections in hydrogen and deuterium in the region 100 to 250 GeV. A slight modification of the spectrometer used in 1. will be used for $\frac{d\sigma}{dt}$, and a transmission method will be used for the total cross section measurement. It may also be possible to make a measurement of the $\bar{\Lambda}^O p$ and $\bar{\Lambda}^O d$ total cross section.

3. Search for the $\Delta S=2$ decay $\Xi^O \rightarrow p\pi^-$, reducing the branching ratio limit from $\sim 10^{-3}$ to $\sim 10^{-7}$. At 10^9 protons/pulse 72 hours are required.

Summary reviewed by
L. Pondrom, February 1975

A STUDY OF NEUTRON-PROTON CHARGE-EXCHANGE
SCATTERING IN THE MOMENTUM RANGE 50 - 300 GeV/c

N. W. Reay, K. Reibel, T. A. Romanowski, N. R. Stanton (Ohio
State Univ.); M. A. Abolins, M. T. Lin, G. A. Smith (Michigan
State Univ.); K. W. Edwards (Carleton Univ.)

It is proposed to measure the neutron-proton charge-
exchange cross section for incident neutron momenta between
50 and 300 GeV/c, and four momentum transfers squared .002
$(GeV/c)^2 < |u| < 1.0 (GeV/c)^2$.

The np charge-exchange cross section from .5 to 19 GeV/c
is characterized by a sharp peak at u = 0, with a width
$\delta|u| \simeq .02 (GeV/c)^2 = M_\pi^2$, rising from a slowly falling back-
ground slope 4 - 6 $(GeV/c)^{-2}$. Because of its width, the
forward peak would seem to relate to pion exchange. However,
the amplitude for pure pion exchange is constrained to vanish
at u = 0. Many models, both Regge and non-Regge, have been
developed which are based on conspiracy or interference between
the pion exchange amplitude and various poles or cuts. These
models differ in their predictions about the dependence on
incident momentum of the forward peak and the background slope.

The experiment is performed in an intense beam ($\sim 10^7$/pulse)
of neutrons having a continuous energy spectrum which peaks
near the end point of 300 GeV. Data are taken simultaneously
over a wide band (50-300 GeV) of the spectrum; this helps to
minimize systematic errors in the energy dependence of the
cross-section and to maximize the useful beam flux. Charge-
exchange events are accumulated at the rate of approximately
0.15 per pulse. The direction and momentum of the fast forward
outgoing proton are measured by a magnetic spectrometer and
the velocity and direction of the recoil neutron are measured
by a bank of neutron scintillators. Events are processed by
an on-line computer.

Summary reviewed by
N.W. Reay, February 1974

PROPOSAL TO STUDY INELASTIC HIGH ENERGY PROTON-PROTON COLLISIONS IN THE DIFFRACTIVE REGION

P. Franzini, S. Zubarik (Columbia), J. Lee-Franzini, J. Cole, P. Cowell (Stony Brook)

Summary:

Reactions of the type $p + p \rightarrow X + p$ would be studied in the region where the recoil proton has momentum below 300 MeV/c, where the mass of X is between 1 and 10 GeV and the t range is from -0.1 to -0.001. Several incident momenta would be used in 100 GeV steps up to the highest attainable.

Carbon and polyethylene targets would be used in the first instance in the extracted beam. They would be mounted in a vacuum box which would also contain a series of 40 solid state counters to detect the recoil protons. The forward going particle would not be detected. A beam intensity of 10^{11} protons per pulse is needed. The detectors would measure the angle of the recoil proton to an accuracy of 10 milliradians; they would measure its energy to an accuracy of 50 KeV. These yield mass resolutions of 80, 25 and 20 MeV at masses of 2, 4 and 6 GeV respectively. The momentum range of the recoil covered by the detectors would be 30 to about 300 MeV/c yielding a t range from -0.0009 to -0.073 $(GeV/c)^2$.

Event rates per hodoscope bin of 10 to 1000 per 10^{13} incident protons are expected. The fraction of the beam lost in the target is about 10^{-7}. 10^4 events are desired at each energy and 10^5 to 10^6 at one energy. The former would require a few hours, the latter a few hundred. Total time requested is approximately 200 hours.

(JKW)

NEUTRINO PHYSICS AT VERY HIGH ENERGIES

F. Sciulli, B. Barish, D. Buchholz, T. Humphrey, F.S. Merritt,
H. Suter (Caltech); G. Krafczyk, G. Fisk (NAL)

This experiment is a counter experiment in a monochromatic neutrino beam to study neutrino interactions on free protons and heavy nuclei. The neutrino beam momentum is variable from 80 GeV/c to 300 GeV/c with a momentum resolution of about ±6%. The experimental apparatus consists of a target-calorimeter and a muon spectrometer. The target-calorimeter ($1m^2$ x 15m long) is a sandwich of one interaction length plates of iron or lead, liquid scintillator detector and wire spark-chambers. A hydrogen target can also be used. The muon spectrometer consists of a 20 kG iron core magnet (3m diameter x 2m long) between spark chambers.

Neutrino interactions in the targets produce "showers" (hadronic and electromagnetic) and muons. A rough determination of the shower energy by the calorimeter gives through the beam tune the neutrino energy. The muon direction and momentum are determined by the calorimeter wire chambers and muon spectrometer respectively.

The physics capabilities of the experiment are:

1. To detect the coherent production of intermediate vector bosons via $\nu + Z \rightarrow W^+ + \mu^- + Z'$ if the W mass is 15 GeV/c^2 or less. The muonic decay mode of the W is observed as a dimuon event with no hadronic cascade where the μ^+ has a large transverse momentum and the μ^- has a low energy. The electron decay mode of the W is observed as a single muon event accompanied by a relatively short range cascade. The hadronic decay mode of the W is identified as a low energy peak in $d\sigma/dE_\mu$ for the event class $\nu + Z \rightarrow \mu^- + $ hadrons.

2. To study the inelastic lepton scattering cross sections $d^2\sigma/dq^2 d\nu$ for $\nu + N \rightarrow \mu^- + $ (anything) in the region $0 < q^2 < 600$ Gev^2 and $0 < \nu < 300$ GeV. A comparison with electron scattering data, and a test of the scaling hypothesis will be made. The inelastic cross sections for neutrino and anti-neutrino interactions will be measured over approximately the same energy range.

3. To measure the neutrino and antineutrino total cross sections on heavy nuclei from 80 GeV to 300 GeV neutrino energy. The departure from a linear rise of the total cross section with neutrino energy would signify a departure from the simple Fermi theory for scattering from a point particle. Such a saturation of the total cross section could be caused by the existence of a W boson, higher order weak interaction effects, a nucleon form factor or other phenomena.

Summary reviewed by
B. Barish, February 1974

A SEARCH FOR MULTIGAMMA EVENTS
FROM MAGNETIC MONOPOLE PAIRS

G. B. Collins, J. R. Ficenec and W. P. Trower (Virginia Polytechnic Institute); J. Fischer and Seige Iwata (BNL)

The purpose of this experiment is to rediscover the multiphoton events found by Schein, Haskin and Glasser in cosmic rays. If they can be produced at NAL, the next step would be to investigate the nature of their origin. Ruderman and Zwanziger suggested that the photons originate from the production and annihilation of bound magnetic monopole pairs.

In all, five such cosmic ray produced events have been reported. All show multiplicities of 10 to 16, total energies in the 10^{11} eV range, angular divergences of 10^{-3} to 10^{-4} radians, and no charged particles accompanying the photons (photons are observed when they produce electron pairs in the photographic emulsion). These features have guided the design of our experiment. No charged particles means the photon jets must have been produced in a peripheral interaction and at small angles to the incident particle. Also the 10^{11} eV in the jet must approximate the incident energy. We note a similarity here with conventional electron pair production and with muon pair production as observed at BNL by Christenson, et al. and attributed to virtual photons.

Our apparatus accordingly was designed to measure the multiplicity and angular distributions of simultaneous photons produced at small angles ($\sim 10^{-3}$ r.) This has been accomplished by recording the position and number of unresolved electromagnetic showers produced by the photons in a $\frac{1}{2}$ radiation length converter placed in front of three 15" x 15" proportional chambers. A veto counter array was placed in front of the converter to anti out any charged particles such as muons. A large number of neutrons accompany the photons and the interactions they produce in the converter have been avoided by recording only high multiplicity events with good time resolution (0.1 μ sec). We also included in the logic a threshold gas Cerenkov counter sensitive to high multiplicities of electrons and a lead glass counter with threshold set at 100 GeV electromagnetic energy. The detecting apparatus was located in beam M-2 over 100' from a 0.1 collision length Be target (10^6 incident protons of 300 GeV) to allow photons with 10^{-3} rad angular spread to disperse.

We are presently analyzing some 10^5 events satisfying our trigger conditions. Several interesting anomalies are observed in our data; however further analysis is required to determine whether they are instrumental or not.

Summary prepared by
G. B. Collins, Jan, 1975

TOTAL PHOTOABSORPTION CROSS SECTION AND A SEARCH FOR THE
PHOTOPRODUCED MONOPOLE AND OTHER UNUSUAL PARTICLES

D. Caldwell, J. Cumalat, A. Eisner, A. Lu, R. Morrison, F. Murphy,
S. Yellin (Univ. of California at Santa Barbara); T. Nash (NAL);
P. Davis, R. Egloff, G. Luste, J. Martin, J. Prentice (Univ. of
Toronto)

The photon total cross section for hadronic final states
produced from H and D is to be measured at photon energies from
14 to about 300 GeV in 5% energy bins. Both the statistical
accuracy and the systematic uncertainty are expected to be < ± 1%.
The A-dependence of the photoabsorption cross section is to be
determined using C, Cu, and Pb targets at 60 and 170 GeV. In
addition, there would be a simultaneous search for the Dirac
monopole as a sudden increase in the total cross section at the
monopole-pair production threshold, or by its manifestation as a
multi-gamma shower. Also obtained simultaneously is information
on forward events which have π^O's or γ's, such as $\omega^O \to \pi^O + \gamma$.

The electron beam for this experiment has been tested and
gives intensities within 30% of expectations. The photon beam
provides tagged γ energies in the range of 60% to 95% of the in-
cident electron energy and has been used to observe ψ photopro-
duction.

The photo-nuclear interaction will be identified by 1) the
absence of high-energy photons or $e^+ - e^-$ particles emerging
from the target at small angles, and 2) the appearance of hadrons
or their decay products coming from the target at larger angles.
In order to separate better $e^+ - e^-$ pairs from forward pion events
and to detect multi-gamma showers, the shower veto counter is a
hodoscope of lead-glass counters. Combined with proportional
wire counter information, this makes possible the vetoing off-
line of electron pairs, using angle-energy correlations. The
wide-angle hadron detectors also have position and energy deter-
mining capabilities.

The first measurements were made in the summer of 1975 with
just the rear portion of the apparatus (lead-glass hodoscope and
proportional wire counters) moved upstream to provide a larger
solid-angle detector of γ's and charged particles. With the
tagged photon beam we studied the photoproduction of the ψ(3105)
from D.

Summary revised by
D. Caldwell, January, 1976

HIGH MOMENTUM TRANSFER INELASTIC MUON SCATTERING
AND TEST OF SCALE INVARIANCE AT NAL

C. Chang, K. W. Chen, D. Fox*, P. Kunz[+] (Michigan State Univ.);
L. Hand, S. Herb, S. Loken, A. Russell Y. Watanabe (Cornell);
M. Strovink (LBL); W. Vernon (U.C., San Diego)

The primary objective of the experiment is to test scale
invariance using muon scattering from a high Z target. Muon
energy losses up to 180 GeV and momentum transfers up to 100
$(GeV/c)^2$ will be studied using a special technique of "scaling
the apparatus". This physical scaling of the apparatus maps
all experimentally obtained distributions into universal
distributions, independent of the incident energy unless the
scaling of muon interactions breaks down. It also drastically
reduces the effect of systematic errors in the comparison of
different energies.

The physics objective of this experiment is to look for
evidence that a smaller structure exists within the neutron
or proton.

If the nucleon consists of real, physical subparticles
(partons) possessing strong interactions, these particles
will be dressed by these interactions and possess a size
related to the interaction size, when expressed as a mass$_2$
(in a parton form factor) to 100 ± 50 GeV^2. In this experiment,
if partons behave as mathematical point particles, the limit
on m^2 can be pushed back to ~2000 GeV^2.

Data obtained in August and October, 1973 have been
analyzed. This sample contains 100,000 triggers, at 150 GeV
from which were obtained about 40,000 scattering events. Also
a small amount of data obtained at 56 GeV. The 150 GeV
data were compared with Monte-Carlo prediction using SLAC
scaling structure function. Data when compared with prediction
show a depletion in Q^2 distribution, amounting to about 40%
at $Q^2 = 40$ GeV^2/c^2. More data are being analyzed at this time.

The objectives remain to complete the experiment in two
phases:

Phase (a) : 3×10^{10} muons incident (500 hrs at 10^5
              μ/pulse)

Phase (b) : 3×10^{11} muons incident (500 hrs at 10^6
              μ/pulse)

Summary prepared by
K. W. Chen, February 1974

*Deceased
+Now at SLAC

PROPOSAL TO STUDY THE COHERENT DISSOCIATION OF NEUTRONS

J. Biel, T. Ferbel, P. Slattery, D. Underwood (Rochester);
E. Bleser (NAL); M. Block, B. Gobbi, L. Kenah, J. Rosen,
R. Ruchti (Northwestern); D. Freytag (Massachusetts)

At NAL energies, neutrons can be coherently excited by nuclei with appreciable cross section. By coherent it is meant that the target nucleus recoils as a single entity without nuclear excitation. This neutron excitation can occur either by γ absorption in the nuclear Coulomb field (Coulomb dissociation) or by Pomeranchukon exchange in the nucleus (diffractive dissociation). Both channels can result in the formation of $\pi^- p$ V's. It is proposed to study such V's using a spectrometer consisting of wire spark chambers, counters and an analyzing magnet.

The two coherent processes can be identified and distinguished by their characteristic variation with neutron energy, momentum transfer, angular correlation, effective mass and A dependence. The former process (Coulomb) is dominated by $\Delta^0(1236)$ production while the latter is dominated by $N^*(1470)$ production. Coulomb dissociation is expected to be an order of magnitude more copious in high Z materials.

The objectives of the experiment are:

1. High statistical accuracy, comprehensive study of Coulomb and diffractive dissociation. Variations in momentum transfer, angular correlations and invariant mass (up to ~3 GeV) will be investigated as a function of target material and neutron energy (50-300 GeV) using complex nuclear targets and hydrogen.

2. Observe Coulomb and diffractive dissociation of the anti-neutron.

3. Using transmission targets, measure neutron total cross sections as a function of energy.

<div style="text-align:right">
Summary revised by
J. Rosen, February 1974
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SEARCH FOR HEAVY LEPTONS AND HADRONS AND HARD PENETRATING RADIATION IN
THE NEUTRINO BEAM, STUDY OF DIFFRACTION SCATTERING OF NEUTRINOS;
STUDY OF DEEP INELASTIC ν_μ SCATTERING IN A Ne BUBBLE CHAMBER AT
FERMILAB, AND TEST OF THE $\Delta S = \Delta Q$ RULE AT HIGH MOMENTUM TRANSFER
USING INCLUSIVE REACTIONS

A. Benvenuti, U. Camerini, W. Fry, J. Mapp, R. March, J. Michael (Univ. of
Wisconsin); H. Wachsmuth (CERN)

An experiment has been proposed for the Fermilab 15-foot bubble chamber
with a neon (or neon-hydrogen) filling. The specific approval is for 50K
pictures for each of two proton targeting methods which are described below
with the major physics interests.

I. Targeting of protons at the beginning of the muon shield (with no
    focusing)

    Search for λ by looking for ν_λ interactions. λ = heavy lepton
    (M = 3 GeV assumed). These could be produced directly ($\lambda\bar\lambda$) in
    hadron collisions or by protoproduction. They would be identified
    by:

$$\nu_\lambda + n \to \lambda^- + \text{anything}$$

$$\nu_\lambda + p \to \lambda^+ + \text{anything}$$

$$\text{and } \lambda \pm \to \pi^\pm \nu_\lambda$$

    λ will be identified by studying the characteristics of the decay.
    A comparison will be made with ν_μ interactions. This experiment
    is similar to Mann and Schwarz experiment at SLAC.

II. Conventional targeting of the proton beam with broad band focusing of
    the secondary hadrons.

    a) Measure of charge radius of ν_μ through muonless events; i.e.

$$\nu_\mu + p \to \nu_\mu + p$$
$$\to \nu_\mu + \text{anything}$$

        e.g. $\dfrac{d\sigma(\nu p \to \nu p \pi)}{d\sigma(e p \to e p \pi)} = \dfrac{q^4}{30} \langle r^2 \rangle^2$

        where $\langle r^2 \rangle$ is ν_μ charge radius.

    b) Diffraction dissociation of ν_μ
        e.g. $\nu_\mu + Z \to Z + \mu^+ \mu^- \nu_\mu$

    c) Deep inelastic scattering. Measure E_ν, ν, q^2. It is possible
        to measure E_ν by using a short fiducial volume and measuring
        all particles belonging to the interaction (π^0's etc.). Neon
        has advantage of π^0 detection and enhancing diffraction
        dissociation.

III. Search for Charm

PROPOSAL TO INVESTIGATE ANTINEUTRINO INTERACTIONS
IN HYDROGEN AT NAL

Y. Cho, <u>M. Derrick</u>, T. Fields, L. Hyman, B. Musgrave,
P. Schreiner, H. Yuta (ANL); A. Engler, G. Keyes,
R. W. Kraemer (Carnegie-Mellon Univ.)

It is proposed to study high energy $\bar{\nu}_\mu$ interactions on
hydrogen in the NAL 15-foot bubble chamber. The anti-neutrinos
are produced from a horn-focused hadron beam produced with
protons of energy $\gtrsim 200$ GeV/c. The availability of a muon
identifier system would be helpful. An exposure of 10^{19}
interacting protons, or 1,000 K pictures ($\sim$80K events) are
requested.

Physics motivation resides in the following:

1. Specific channels such as

    a. Elastic scattering $\bar{\nu}_\mu + p \rightarrow \mu^+ + n$. Can probably only use
        events where n scatters ($\sim$5000 events). The neutron
        scatters will also measure the baryon polarization and
        so constrain the form factors.

    b. Hyperon production - tests Cabibbo and other theories.

    c. Isobar production $\bar{\nu}_\mu + p \rightarrow \mu^+ + N^{*O} \rightarrow p\pi^-$.

    d. Other fittable final states such as $\bar{\nu} + p \rightarrow \mu^+ + p + \pi^- + \pi^+ + \pi^-$,
        etc.

2. Search for $\Delta S=2$ transitions and other reactions forbidden
    by the usual conservation laws
    $$\bar{\nu} + p \rightarrow \mu^+ + \Xi^O$$
    $$\rightarrow \mu^+ + \Sigma^+ + K^-.$$
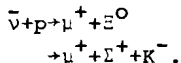
3. Characteristics of deep inelastic scattering

    a. σ Total vs. $E_{\bar{\nu}}$.

    b. x and y distribution of inelastic events.

    c. Contribution of specific channels to the different
        kinematic regions.

Summary reviewed by
M. Derrick, February 1975

TEST AND CALIBRATE A LARGE NaI (Tl) TANC DETECTOR AND
TO MEASURE NEUTRAL HADRON TOTAL CROSS SECTIONS

B. Beron, B. Chambers, J. F. Crawford, L. Doster, R. Ford,
R. Hofstadter, E. B. Hughes, P. Lecoultre, L. O'Neill,
R. Parks, R. F. Schilling, J. Vanderlans (Stanford Univ.)

They propose to test and calibrate a NaI(Tl) Total
Absorption Nuclear Cascade (TANC) detector. This could
later be used as a neutral particle detector with both
high detection efficiency and good energy resolution. In
order to determine the energy resolution of the detector
they need a beam with a small ($\sim.1$ to $.2\%$ $\Delta p/p$) momentum
bite. They desire to run protons at several energies up
to the maximum attainable and to run pions if possible.
An intensity of 10^2 particles/second would probably be
adequate. On the other hand, they should be able to make
use of an instantaneous rate of $\sim 5 \times 10^5$/second.

Their time request is for "several days, not necessarily
in one continuous run". Their space requirements are for ~ 10
feet along the beam line and space nearby for a moderate
amount of electronics which they will bring with them. They
further propose to measure total cross sections for neutrons
and K_L^0 using this detector. The details of this second
phase will, of course, depend on the results of Phase I.

Summary reviewed by
R. Hofstadter, February 1974

NUCLEAR-ELECTROMAGNETIC CASCADE DEVELOPMENT STUDY

R. W. Huggett, D. L. Cheshire, W. V. Jones, P. N. Kirk
(Louisiana State Univ.); K. Pinkau, W.K.H. Schmidt,
M. Simon (Max Planck Institute)

The results of this experiment will be used to interpret
data from ionization spectrometers used in cosmic ray balloon
experiments and in NAL experiments. The results will also be
used in the design of an ionization spectrometer to be carried
on one of the first Space Shuttle missions. The objectives of
this experiment are:

1. Investigate both the longitudinal and lateral development
   of nuclear electromagnetic cascades in tungsten and CsI.

2. Test the use of plastic scintillator wedges for deter-
   mining the lateral position of cascades in tungsten.

3. Determine the fraction of the primary energy going into
   a) neutral pions, and b) disintegration of the target
   nucleus.

4. Measure the inelastic cross section.

   The experiment was completed in June of 1974. Data was
taken with protons at 100, 200, and 300 GeV and with pions
at 200 GeV. The total beam time used was 50 hours.

Summary revised by
R. W. Huggett, January 1976

A PROPOSAL TO STUDY SMALL ANGLE p-p SCATTERING
AT VERY HIGH ENERGIES

I. H. Chiang, A. Melissinos (Rochester); R. Carrigan, E. Malamud,
R. Yamada (NAL); R. Cool, D. Goulianos, S. Olsen (Rockefeller);
Plus USSR Participants

Summary:

The experiment uses a thin foil and a hydrogen jet target to measure small angle p-p elastic and inelastic scattering. By detecting the slow recoil proton studies of the energy dependence of the slope of the p-p diffraction peak will be made. Measurement in the Coulomb interference region will give the real part of the nuclear scattering amplitude. Inelastic scattering will produce nucleon isobars.

The target would be placed in the internal circulating beam of the accelerator and measurements would be made during the acceleration cycle from 7 GeV to the top energy available. Solid state detectors (10) and a sodium iodide crystal would be placed 2.5 meters from the target near 90° to the beam line to detect the recoil protons. This system would measure the slope of the diffraction peak from $t = -.001$ to $-.25$ $(GeV/c)^2$ to an accuracy of $\pm 1\%$. The ratio of the real to imaginary part of the scattering amplitude would be measured in sign and magnitude to an accuracy of 0.01 to 0.02. In inelastic scattering, the missing mass distribution of the recoils will detect isobars.

Event rates of 25 per pulse are expected from a beam of 10^{12} protons. Estimated running time is about 20 days. Increasing efforts are being made to measure reliably the s-dependence of the extrapolated to $t = 0$ differential cross section.

MULTIBODY FINAL STATES IN pp COLLISIONS UP TO 500 GeV/c

E. Malamud, D. Gordon, J. Lach, (NAL) P. Schlein, W. Slater,
(University of California at Los Angeles)

Summary:

        This proposal requests 100,000 pictures at the high-
est available proton energy with three or more tracks/picture.
The number of tracks/picture will be determined by scanning
early film. If a higher flux can be used they may request
some of their pictures be taken at another energy. In addition
to scanning all the film quickly in a search for new particles,
they will study the statistical properties of inelastic pp
collisions by measuring the relatively slow particles produced
in the backward hemisphere in the c.m. The data from this
proposal could be used in the design of the multiparticle de-
tector system of proposal 110, which some of the proposers of
this experiment are working on.

(FRH)
Received: June 15, 1970

Summary Revised: May 30, 1972
                        #37 is for 15' bubble chamber
                        #37A is for 30" bubble chamber

 8/26/71 37A approved pp 50K highest.

Proposal to Study Neutrino Interactions with Protons
Using the 15-foot Bubble Chamber at NAL

J. P. Berge, D. Bogert, F. A. DiBianca, R. Hanft, C. Kochowski,
F. A. Nezrick, Y. Ryabov, W. G. Scott, W. Smart (Fermilab);
R. J. Cence, F. A. Harris, S.I. Parker, M. W. Peters, V. Z.
Peterson, V. J. Stenger (U of Hawaii); A. Barbaro-Galtieri,
G. R. Lynch, J. P. Marriner, F. T. Solmitz, M. L. Stevenson,
(LBL); J. W. Chapman, C. T. Coffin, R. N. Diamond, H. T.French,
W. C. Louis, B. P. Roe, A. A. Seidl, D. Sinclair, J. C.
Vander Velde (U. of Michigan).

This experiment uses the 15' bubble chamber filled with
hydrogen exposed to a broad-band horn focused neutrino beam
produced by 300 GeV protons. An EMI would be used if it
existed. 300,000 pictures have been approved which should
yield about 15,000 events for 5 x 10^{12} protons per pulse on
the horn target. A large physics program can be accomplished
without serious muon ambiguities even without the EMI infor-
mation. A detailed neutrino flux calibration procedure is
proposed which depends on measuring the π and K yields from
the neutrino target as well as the muon distribution in the
shield. This group has constructed the muon monitoring system
in the shield and is involved in measuring the neutrino target
meson yields using the muon beam line in the neutrino area.

This proposal is a detailed study of the individual
channels produced in neutrino-proton interactions. The
physics objectives of this experiment are:

1. New particle search--charm, quarks, monopoles, etc.

2. W-boson search via hadron and electron decay.

3. Four-fermion interactions.

4. Single pion production.

5. Vector meson production.

6. Multiple pion production.

7. Associated production and $\Delta S \neq 0$ reactions.

8. $\Delta S/\Delta Q$ and $\Delta S=2$ and T invariance tests.

9. Locality tests, V-A interference tests and Regge pole
    dominance tests.

10. ν_e interactions with protons.

11. Neutral current search.

12. Inclusive reaction information from all channels.

Summary review by B. P. Roe
January 1976

A MEASUREMENT OF THE INTENSITY AND POLARIZATION OF MUONS
PRODUCED DIRECTLY BY THE INTERACTION OF PROTONS WITH NUCLEI

R. Adair, H. Kasha, R. Kellogg (Yale Univ.); R. C. Larsen,
L. Leipuner, L. Smith, H. Williams (BNL); R. Stefanski (NAL)

Objectives:

To measure the flux and polarization of prompt muons
produced directly by the interactions of 300 GeV and 400 GeV
protons with matter. The measurements will be made as a
function of muon energy and transverse momentum. Such measure-
ments will serve to:

a) Study the production of vector mesons in hadron-hadron
   collisions at high energy and large transverse momentum
   where the neutral vector mesons will be identified through
   their decays into muon pairs where the muons will have no
   net helicity.

b) Search for the production of unusual particles such as the
   W (intermediate vector boson) and heavy leptons by examining
   the flux of prompt muons which have a net natural helicity
   (opposite to the helicity of muons from meson decays). The
   experiment will be sensitive to the production of such
   particles if they are produced with total cross sections
   of the order of 10^{-36} cm^2.

Experimental Technique:

The proton beam will interact with a variable density
copper beam-stop located at the end of the decay-pipe in the
Proton Area. Directly downstream from the target a dipole
magnet will select the sign of the muons and direct the beam
to the detectors. A few hundred feet downstream from the
target, hodoscopes will measure the transverse momenta of the
muons. The muon detector is an aluminum-scintillator sandwich
located at the end of the muon shield. The muon stops in the
detector and decays. Measurement of the decay asymmetry of the
muons establishes the polarization of the muon beam.

Summary prepared by
R. Adair, February 1974

MASS SPECTRUM AND DECAY MODES FOR BOSONS
WITH MASSES UP TO 15 GeV

G. Blanar, C. Boyer, D. Earles, W. Faissler, D. Garelick,
B. Gottschalk, M. Jordan, E. Pothier, D. Potter, M. Ronan,
M. Tautz, E. von Goeler, J. Wang, R. Weinstein
(Northeastern University)

A "missing mass" spectrometer experiment is proposed to study the spectrum of hadrons produced in reactions π(K or p) + N $\to$ N + X where X has mass M_x up to ~15 GeV.

This experiment makes use of a missing mass spectrometer to explore, at momentum transfer ~$.2 < -t < .4$ GeV^2, mass spectra of hadrons up to M_x ~15 GeV. At a beam momentum of 200 GeV the resolution in mass squared is ΔM_x^2 ~2 GeV^2. It is almost independent of M_x and roughly scales with s. This phase is an ideal and sensitive (cross sections down to a few microbarns) probe for new heavy particles. It is worth noting that in the past all the well established heavy bosons, for instance, have shown up clearly in missing mass spectra. At the same time measurement of the missing mass "background" over the large range of s and M_x^2 allows testing of current ideas about inclusive reactions. For example, in the triple Regge picture separation of the various contributions to the cross section becomes possible. 300 hours of beam time are necessary to map the complete range of s, M_x^2 accessible.

Summary reviewed by
E. von Goeler, February 1974

SEARCH FOR THE INTERMEDIATE BOSON, LEPTON PAIR PRODUCTION, AND
A STUDY OF DEEPLY INELASTIC REACTIONS UTILIZING HIGH ENERGY
NEUTRINO INTERACTIONS IN LIQUID NEON

C. Baltay, M. Kalelkar, J. Schmidt (Columbia); R. Palmer and
N. Samios (BNL)

This experiment uses the 15' bubble chamber with (1) a
hydrogen filling and a double plate for 100,000 pictures and
(2) a neon filling and single plate for 900,000 pictures. A
broad-band neutrino beam operating at the highest machine
energy is required. Muons are distinguished from hadrons in
this experiment by inserting in the chamber a stainless steel
plate (~30 tons) in which ~99% of the hadrons will interact.
Since both sides of the plate are visible in the photograph,
muon identification can be made on the scanning tables. It is
proposed to measure the neutrino spectrum from (1) the π and
K yields from the target and muon distribution in the shield
and (2) from the distribution of events in the bubble chamber
for reaction with known cross sections. It is expected to
obtain a 5% absolute flux normalization.

The physics objectives of this experiment are:

I. The neon experiment:

    1) Lepton pair production in a Coulomb field.
    2) W-boson decay modes.
    3) Deep inelastic scattering to determine W_1, W_2 and W_3.
    4) Total cross section measurement to 300 GeV.
    5) Search for weak neutral currents.
    6) Search for new particle production (charm?)

II. The hydrogen experiment:

    1) N* events to determine the neutrino spectrum
    2) Total cross section measurement.
    3) Study the details of the hadronic component.

Summary reviewed by
C. Baltay, January 1976

A PROPOSAL TO MEASURE POLARIZATION IN pp, π^-p AND π^+p ELASTIC SCATTERING AT 50, 100, AND 150 GeV/c

ANL, Harvard, LBL, Los Alamos, NAL, New Mexico State Univ., Wyoming, Yale   O. Chamberlain (Spokesman)

It is proposed to measure the polarization parameter in pp, π^-p and π^+p elastic scattering at incident momenta of 50, 100, and 150 GeV/c over the range of $0.15 \leq |-t| \leq 1.5$ (GeV/c)^2. The apparatus consists of a polarized proton target, a double arm spectrometer which determines the angles and momenta of both outgoing particles, and on-line computer. Good angular and momentum resolution as well as high counting rate capability are achieved by the use of proportional wire chambers in both arms. The fractional momentum resolution $\Delta p/p$ is estimated to be $\pm 0.7\%$ in the forward arm spectrometer and $\pm 3.5\%$ at large $|t|$ to $\pm 6\%$ at small $|t|$ for the recoil arm spectrometer. The apparatus is designed to make full use of the expected high beam intensities at NAL. There are no detectors used in the incident beam. A beam intensity of up to 10^8 particles per pulse is expected to be utilized. Two Cerenkov counters in the forward arm identify the detected particles as a π, K, or proton. The recoil arm identifies the detected particle as a proton by time of flight.

The anticipated error in the polarization parameter P is $0.005 \leq \Delta P \leq 0.01$ over the range $0.15 \leq -t \leq 0.8$ (GeV/c)^2.

This experiment will measure a fundamental parameter, which is essential in understanding the elastic scattering of elementary particles in a new energy region. The high sensitivity of polarization phenomena to interference effects makes such measurements important in imposing constraints on theoretical models.

SURVEY OF PARTICLE PRODUCTION IN PROTON
COLLISIONS AT NAL

D. C. Carey, M. Goldberg, J. R. Johnson, D. J. Ritchie,
A. Roberts, J. Sauer, R. Shafer, D. Theriot, J. K. Walker
(NAL); F. E. Taylor (Northern Illinois University)

The purpose of this work is to measure the single photon inclusive cross section for the reaction p+p→γ+anything at incident proton energies from 50 to 400 GeV. The laboratory angles are from approximately 10 to 275 mrad. The experiment is in progress in the Internal Target Area using both gas jet and rotating foil targets. The basic equipment for examining the directly produced photons includes a scintillation counter for vetoing charged particles, a lead-glass total-absorption counter, and veto counters behind lead absorber for rejecting energetic muons.

Summary reviewed by
J. K. Walker, January 1976

$K^O P$ AND $\bar{K}^O P$ INTERACTIONS FROM ~20-60 GeV/c IN
A LARGE LIQUID HYDROGEN BUBBLE CHAMBER

H. A. Gordon, M. Habibi, K. W. Lai, P.V.C. Hough (BNL);
J. R. Albright, V. Hagopian, J. E. Lannuti (Florida State Univ);
M. S. Webster (Vanderbilt Univ.)

This proposal for the 15-ft. Hydrogen Bubble Chamber requests 10^6 pictures with tantalum plates at the downstream end of the chamber. The bubble chamber is to be exposed to a neutral beam created in a target ~75m from the chamber. The proponents request 10^5 π^-/pulse on this target.

The purposes of the experiment are:

1. K_L $p \rightarrow K_S^O$ p to investigate the difference in the elastic cross sections $K^+n \rightarrow K^+n$ and $K^-n \rightarrow K^-n$.

2. Particle and antiparticle cross-section comparison.

3. Test of one-pion-exchange in high energy by $K_{LP}^O \rightarrow K^*\Delta$.

4. Search for high-mass ρ-like and ϕ-like mesons via double Regge exchange.

5. Test of (K*, K**) exchange degeneracy from the process $\bar{K}^O \rightarrow \pi^+\Lambda$ and a measurement of the Λ polarization.

6. Search for new particles.

SEARCH FOR BARYON RESONANCES UP TO 10 GeV MASS PRODUCED
in p + p → p + MM WITH A RESOLUTION OF ±25 MeV.

K. Abe, J. Alspector, K. Cohen, B. Maglich, B. Robinson, F. San-
nes, (Rutgers); G. Cvijanovich, J. Oostens (Upsala College)

It is proposed to investigate the mass spectrum of non-
strange baryonic resonances of isospins 1/2 and 3/2 in the mass
range from 4 to 10 GeV. If the emperical interval rule is valid,
84 resonances are expected in this range. The missing mass
Jacobian peak method is used, namely the kinematic region is em-
ployed where the magnitude of the missing mass is almost solely
dependent on the angle of the recoil proton and relatively in-
dependent of its momentum.

In this experiment, for which no magnets are required, only
the recoil proton is measured. Its angle and momentum are
measured with hodoscopes, by time-of-flight, and with range and
pulse height analysis, $\left(\frac{dE}{dx}\right)$. The resultant missing mass resolu-
tion is ±25 MeV or better. The Jacobian peak method applies to
only one set of kinematical conditions, so that the momentum
transfer (t value) cannot be varied or chosen freely.

The experiment is being performed in the internal proton
beam using the hydrogen jet target.

A peak with a signal to background ratio of 1/100 could be
detected with five standard deviations in one day of running.

ELASTIC SCATTERING OF THE LONG-LIVED HADRONS

L. Fajardo, A.J. Slaughter, R. Majka, J. Marx, P. Nemethy,
J. Sandweiss, A. Schiz (Yale); M. Atac, P. Gollon, J. Lach,
J. MacLachlan, A. Roberts, S. Ecklund, C. Ankenbrandt,
R. Brown, G. Shen (Fermilab)

The objective of this experiment is to measure the elastic and quasi-elastic scattering of the charged long-lived hadrons on hydrogen and selected heavy nuclei in the angular region from 0.2 to 24 milliradians. In the case of pions of both signs and protons it is planned to gather more than 10^5 events at several energies from 50 GeV to 200 GeV to give measurements of the real part of the forward scattering amplitude to $\pm.01$ by observation of the Coulomb interference. Measurements with K's and anti-protons will give a somewhat less accurate measurement of the real part. The quasi-elastic scattering in the region of small missing mass is recorded at the same time as the elastic. The mass resolution is of the same order as the widths of the known peaks, and the measurements should allow determination of the cross sections for the production of the prominent low mass states. The data on nuclei would allow accurate measurements of the elastic scattering cross sections, made possible by the high angular resolution of the setup. It will be seen whether there is indeed a decrease in the cross section due to coherent intermediate states.

These goals require a beam of about 3×10^5 particles per second, with a momentum resolution of 0.05%, a beam spot with a small intensity in the tail, and mass identification.

The detector consists of a high resolution ($\sim 70\mu m$) proportional chamber system to determine the scattering angle and a high resolution proportional chamber magnetic spectrometer to provide a measurement of the elasticity of the events. Data from the high resolution chambers is immediately encoded and used in the trigger to define scattered particles. The system is capable of accepting over 800 triggers per machine pulse.

Summary prepared by
J. Marx, January 1976

STUDY OF LEPTON PAIRS FROM PROTON-NUCLEAR INTERACTIONS:
SEARCH FOR INTERMEDIATE BOSONS AND LEE-WICK STRUCTURE

J. Appel, M. Bourquin, J.M. Gaillard, I. Gaines, D. Hom,
L. Lederman, H. Paar, J.P. Repellin, D. Snyder, J. Weiss,
J. Yoh (Columbia); B. Brown, T. Yamanouchi (NAL)

The experiment will be performed in stages (see #288).
The first stage will be a single-arm study of $e^{\pm}$ at large p_m.
This is a study of the momentum continuum and of the angular
distribution of single electrons arising from the reaction

$$p+p \rightarrow e^{+}+e^{-} + \text{anything.}$$

Superimposed on the continuum there could be resonance-like
bumps due to the two-body decays of massive objects, like the
intermediate boson

$$X^{\pm} \rightarrow e^{\pm} + \nu$$

or heavy charged vector bosons, neutral weak boson or Lee-Wick
structure:

$$X^{o} \rightarrow e^{+} + e^{-}.$$

This experiment is sensitive to objects in the mass range
2.5-28 GeV.

The equipment consists of a magnetic spectrometer with
counter hodoscopes ($\Delta p/p \sim 4\%$), of an electron detector made of
interleaved dE/dx scintillation and lead glass counters followed
by total absorption lead glass counters with good energy
resolution ($\sim 2\%$), by a hadron calorimeter and a muon detector.

They also look for the direct production of muons through
a movable 30" tungsten plug.

During these runs they will accumulate information on π^{o}
and charged particle spectra.

Summary reviewed by
L. Lederman, January 1976

EXPERIMENTAL PROPOSAL TO NAL QUARK SEARCH

R. K. Adair and H. Kosha (Yale University), R. C. Larsen,
L. B. Leipuner and L. S. Smith (Brookhaven National Laboratory).

Summary:

   This quark search is intended to be sensitive not only to
particles of charge 1/3e and 2/3e but also to particles of charge
4/3e, 5/3e and greater. The quarks are determined by their charge
by measuring their ionization energy loss in a series of eight
scintillation counters. The pulse heights from the eight
counters are examined separately to minimize the effects of
statistical fluctuations and of the Landau tail, which creates
a bias toward large pulse heights. The search would be carried
out in both positively and negatively charged beams at momenta
determined by the primary proton beam.

   With a primary energy of 500 GeV, quarks could be pro-
duced as heavy as 15 GeV/c^2. There would be a good chance of
detecting quarks if their production cross section is as great
as 10^{-39} cm^2. Total running time of 100 hours is estimated.

(JKW)

A PROPOSAL TO SEARCH FOR FRACTIONALLY CHARGED QUARKS

J. Sculli (New York University); T. Nash, T. Yamanouchi (NAL)

This is a counter experiment to search for fractionally charged quarks using one of the secondary beam channels in the Meson Area. By tuning the elements of the beam line to a momentum (for singly charged particles) higher than the primary proton beam momentum, no particle with charge $|Q|>1$ can pass through the entire length of the beam channel, unless it is scattered several times by collimator walls, magnet poles, or other elements in the beam channel. On the other hand, quarks with charge $|Q|=2/3$ and momentum $\sim 2/3 \, p_o$ or charge $|Q|=1/3$ and momentum $\sim 1/3 \, p_o$, where p_o is the tuned momentum value of the beam channel, would pass through.

An array of scintillation counters followed by an ionization calorimeter will measure the ionization loss and total energy of those particles transmitted by the channel. Further rejection against relativistic particle backgrounds will be attained by a threshold Cerenkov counter.

Kinematically this experiment is sensitive for quarks with mass up to 9 GeV/c^2. One event per hour in this experiment, assuming 2×10^{12} interacting protons/pulse, $\Delta p/p = 1\%$, and $\Delta\Omega = .5\mu$ster, corresponds to

$$\frac{d^2\sigma}{dp.d\Omega} \; \approx \; 4 \times 10^{-35} cm^2/ster.GeV/c.$$

Summary sent to T. Yamanouchi
for review, May 1973

SEARCH FOR MAGNETIC MONOPOLES PRODUCED AT FERMILAB.

R. A. Carrigan, Jr., F. A. Nezrick, B. P. Strauss (Fermilab)
                RAC

This experiment searches for monopoles with a rest mass up to
15 GeV/c^2 and is capable of establishing an upper limit on the
production cross section of 10^{-44} cm^2. The experiment detects
monopoles of charge 1/30 to 24 g_D (g_D = e/2α).

Objective:

Search for free monopoles produced in strong and electromag-
netic interactions by using collectors placed in the proton
beam dump and an electronic detection technique similar to one
previously employed in cosmic ray searches.

In the experiment, an attempt is being made to find monopoles
produced in Fermilab beam-stops and targets. The experimental
collection technique is tailored to the kinds of beam-stops
and targets available.

A monopole collector of paramagnetic or ferromagnetic materials
such as aluminum or iron is inserted in the center of the inter-
action region of the beam stop or target. After exposure to
the beam, the collector is placed at the end of an extraction
solenoid. The magnetic field of the extractor overcomes the
magnetic binding of the collector.

The experiment can handle proton exposures from 10^{18} to
5 x 10^{18} protons.

An upper limit has been published for the monopole production
cross section of σ = 6 x 10^{-42} cm^2 based on an exposure of
3.4 x 10^{16} protons at 300 GeV and σ = 5.1 x 10^{-42} cm^2 at 400
GeV.

We still would like a good exposure at 500 GeV to complete the
search at the highest available energy. Note that the same
apparatus has been used recently to search for magnetic mono-
poles in air and sea water. Collectors have been exposed at
the ISR for one year and will be processed shortly.

PRELIMINARY SURVEY OF 200 GeV PROTON INTERACTIONS
WITH COMPLEX NUCLEI

ANL, BNL, Univ. of Chicago, Carnegie-Mellon Univ., Purdue University, Los Alamos Scientific Laboratory, Univ. of Illinois at Chicago Circle, Orsay, Reid College
M. W. Weisfield (Spokesman)

This is a proposal for a broad program of nuclear chemistry submitted by the "Nuclear Chemistry Users Group." Three types of experiments are proposed:

1. Measurement of the absolute cross section for C^{11} production from C^{12} in a proton beam. These and other convenient foil activation studies will be useful to the calibration of beam intensities.

2. Use of mica and lexan track detectors to study multiplicities, ranges, and angular distribution of heavy fragments from proton interaction with high Z nuclei. These studies would determine fission cross sections.

3. A survey, by radioactivity measurements, of cross sections and momentum properties of reaction products for a few selected target elements exposed to high energy proton beams.

Objectives:

1. To do a series of experiments as described above in the Neutrino and Meson Areas.

2. To establish a facility for quick access to targets and another for on line scattering chamber experiments in the high intensity beam obtainable in the Proton Area.

Status:

Some relative cross section experiments have been completed and others are now in progress as are some recoil experiments. Plans for the Proton Area facility are progressing.

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Summary reviewed by
M.W. Weisfield, February 1975

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PROPOSAL TO INVESTIGATE REGENERATION OF NEUTRAL
K-MESONS AT VERY HIGH ENERGIES

S. Aronson, H. Hofer, P. McIntyre, V. Telegdi, J. Roehrig, E. Rosenberg
(Univ. of Chicago); D. Fryberger (SLAC); R. Swanson, H. Kobrak (Univ.
of California, San Diego)

Motivation:

The regeneration amplitude of K_S mesons is, as is well known, proportional to $f(0)-\bar{f}(0)$, where f, $\bar{f}$ are the forward scattering amplitudes for K, $\bar{K}$ on the target used for regeneration. The Pomeranchuk Theorem says that $Im\ f \to Im\ \bar{f}$ as the laboratory energy tends to infinity; thus K_S regeneration should vanish asymptotically if that theorem holds, and this regardless of the target material used. The regeneration phenomenon depends on both the magnitude and the phase of $f - \bar{f}$, and thus supplies more information than the comparison of total cross sections, which depend only on the imaginary parts.

Procedure:

a. "Vacuum Regeneration" Run: As a test of the operation of the spectrometer, they plan a preliminary run with no regenerator. The CP-violating $K_L \to \pi^+\pi^-$ mode will be used to check the acceptance of the 2π decays; the $K_{\ell 3}$ modes, which will be used as monitors in later stages of the experiment, will also be calibrated in this low-background run.

b. $|\rho|^2$ Measurement in Carbon: They will use a moderately thick regenerator (~1 m, or 1.5 collision lengths) and a short decay region (15 m, or $3\Lambda_S$ at 100 GeV/c) and measure the intensity of regenerated $K_S \to \pi^+\pi^-$ decays relative to semi-leptonic K decays at an early proper time downstream of the regenerator.

c. ϕ_r Measurement in Carbon: In order to obtain complete information on regeneration in carbon, they will proceed to more complete determination of the momentum dependence of the phase of ρ.

d. Regeneration in Methane: They will next replace the carbon regeneration with one of CH_4. From this data and the earlier carbon data they can extract the first measure of regeneration from protons.

e. Regeneration in Liquid Hydrogen: The experience gained in the previous steps, plus the value of $\rho_{hydrogen}$ deduced from (b), (c), and (d) will serve to specify the optimum experimental arrangement for this effort. It appears that the statistical power per unit time is greatly enhanced by measuring $|\rho|^2$ and ϕ_r separately as in (b) and (c).

Summary reviewed by
V.L. Telegdi, February 1974

EXPERIMENTAL PROPOSAL FOR FNAL 15-FOOT BUBBLE CHAMBER
ANTIPROTON-PROTON AND KAON-PROTON INTERACTIONS
AT 100 GeV/c

T. Kitagaki, S. Tanaka, H. Yuta, K. Abe, K. Hasegawa, A. Yamaguchi, T. Nozaki, K. Tamai, S. Noguchi, R. Kikuchi, T. Maruyama and Y. Unno (Tohoku University, Japan)

S. S. Pruss and J. Lach (Fermi National Accelerator Laboratory)

This is a proposal for studying $\bar{p}$p and K^-p interactions at 100 GeV/c using 100K pictures from an exposure of the 15-foot hydrogen-filled bubble chamber to a 100 GeV/c unseparated negative beam. A beam kicker magnet is used for obtainning the clean pictures with the maximum beam tracks of 7. About 10K events of $\bar{p}$p and 3.8K events of K^-p interactions are expected within the fiducial volume with using only the mass tagging system. If the enriched beam device is used with the mass tagging system, about 34K events of $\bar{p}$p interactions are expected. Physics interest resides in the following:

1. Measurement of charged multiplicity and π^o multiplicity.

2. Inclusive studies of V^o events such as $\gamma(\pi^o)$, K^o, and Λ^o. Study of distributions of missing mass off proton, and Δ^{++}. Study of vector meson production.

3. Exclusive reactions of diffractive process including elastic scattering and Δ^{++} ($\bar{\Delta}^{++}$) production.

4. Study of K^-p interactions similar to the $\bar{p}$-p physics listed in the above.

PROPOSAL FOR AN EXPOSURE OF THE 15-FOOT DEUTERIUM-FILLED
BUBBLE CHAMBER TO A BEAM OF SEPARATED
π^+ MESONS AT 40 GeV/c AT NAL

Purdue High Energy Physics Group
L. J. Gutay (Spokesman)

It is proposed to study the interaction of 40 GeV/c π^+
in the NAL 15-foot bubble chamber filled with deuterium. A
total of 600,000 pictures with a separated π^+ beam is requested.
The principal aim of the experiment is to study the production
mechanism and properties in the full angular region of
reactions where there are an even number of pions in the
final state. These would be interactions on the bound neutron
of the form

$$\pi^+ N \rightarrow n\pi + p + p_s \text{ (n even)}$$

which are four constraint fits. With this sample of clean
events it is proposed to study the multipion mass spectrum
and production mechanisms.

Summary reviewed by
L. J. Gutay, February 1976

A PROPOSAL TO STUDY INELASTIC DIFFRACTIVE PROCESSES BY OBSERVING
COHERENT PRODUCTION OF MULTI-PION FINAL STATES FROM He NUCLEI

T. Burnett, V. Cook, S. Csorna, L. Dunn, D. Forbush, R. Kenyon,
H.J. Lubatti, A. Jonckheere, K. Moriyasu, B. Robinson,
F. Rohrbach, W. Wallick (Univ. of Washington); D. Fournier,
P. Heusse, P. Rancon, J.J. Veillet (Orsay)

        This group proposes to study the diffractive dissociation
of pions into multi-pion final states for the reaction
$\pi^- + \mathrm{He}^4 \rightarrow \mathrm{He}^4 + X^-$. Measurements of $d\sigma/dtdm^2$, the average
multiplicity of charged particles and the momentum spectrum of
the secondaries which are below 20 GeV will be obtained. The
t-range covered is $.01 < |t| < .09$ $(\mathrm{GeV/c})^2$. It is planned to do
this experiment at two energies, typically 100 and 200 GeV.
A streamer chamber 1 meter long by 50 cm wide filled with helium
serves as the target as well as the detector of the recoiling
helium nucleus. Measuring both momentum and range (or momentum
and dE/dX), it is possible to identify the He^4 in the final
state and therefore assure that there are no contributions from
nuclear break up.

        Because He^4 has J = 0, T = 0, only isospin = 0, C = G = P
can couple. This means essentially that only the P, P', and ω
trajectories can contribute. Including the G parity constraint
at the pion vertex requires that the inclusive cross section be
given by $d\sigma \sim |P+P'|^2 + |\omega|^2$. In the triple Regge limit, there
are a maximum of eight triple Regge couplings including all
cross terms (to be compared with the more than one hundred terms
obtained in pp inclusive when one includes P, P', ω, π, ρ, A
trajectories). This experiment is thus in a good position to
check the predictions of the various diffractive and triple
Regge models.

        More generally, a study will be made of the dependence of
these nearly pure diffractive cross sections as a function of
center-of-mass energy, momentum transfer, produced mass, and
charge multiplicity.

                                        Summary reviewed by
                                        H.J. Lubatti, January 1976

SEARCH FOR HEAVY LEPTONS AND INTERMEDIATE BOSONS
FROM PHOTON-NUCLEON AND PHOTON-NUCLEI COLLISIONS

J. Bronstein, R. Coleman, L. Cornell, G. Gladding, M. Gormley,
R. Messner, T. O'Halloran, J. Sarracino, A. Wattenberg, D. Wheeler
(Univ. Of Illinois); M. Binkley, I. Gaines, R. Orr, J. Peoples,
A.L. Read (Fermilab); B. Knapp, W. Lee, P. Leung, S. Smith,
A. Wijanco (Columbia); J. Knauer, D. Yount (Univ. of Hawaii);
D. Nease (Cornell)

This is a counter (and proportional chamber) experiment using
a high-energy, high-intensity, untagged photon beam. The objec-
tives of this experiment are:

1. To determine the existence or non-extence of particles such
    as the heavy lepton (ℓ) and intermediate vector boson (W), in
    1 - 10 GeV/c^2 mass range. Since the coupling of the photon
    to charged leptons is well-known, one can calculate the
    absolute rate and the angular distribution for the production
    of charged particle pairs of any mass. If the intermediate
    vector boson exists in this mass range, this experiment will
    provide a unique way of determining its anomalous magnetic
    moment from the observed production cross section.

2. To explore the mass range from 1 to 10 GeV/c^2 for the presence
    of $J^P = 1^-$ states. Since the photon is coupled to the $J^P = 1^-$
    family of particles, the use of a high energy photon beam
    provides a natural mechanism for the diffractive production
    of such states. The detector can identify and analyze these
    states through their leptonic decay modes, multihadron decay
    modes or mixed decay modes involving the $\psi(3.1)$.

3. To measure the cross section of vector meson photoproduction.
    The $\rho(765) \to 2\pi$ and $\rho'(1000) \to 4\pi$ states have been observed
    in sufficient number to measure their cross sections. The
    photoproduction cross section of the $\psi(3.1) \to \mu\mu$ has been
    measured in the momentum interval of 60 GeV/c to 220 GeV/c to
    30%, while the photoproduction $\psi(3.7)$ has been observed
    through the decay into $\psi(3.1) + 2\pi$. Additional measurements
    will be made to extend the energy domain and t domain of
    these cross sections.

4. The observation of the $\psi(3.1)$ and $\psi(3.7)$ have raised the
    question of the existence of charmed particles and colored
    particles. A search for the former will be carried out as a
    by-product of Item 3. by looking for diffractive production
    of a charm - anti charm meson pairs. Decays which involve
    $K_S^0 \to \pi^+\pi^-$ and leptonic decays are the most sensitive. The
    latter question will be examined by looking for $\pi^+\pi^-\gamma$ and
    $\pi^+\pi^-\pi^+\pi^-\gamma$ decay modes of $\psi(3.1)$, $\psi(3.7)$ and of course
    entirely new states. Again the search is a by-product of
    Item 3. A sensitivity of branching ratio times cross section
    of 2×10^{-34} cm^2 has been demonstrated for 300 GeV/c protons.
    The sensitivity improves markedly at higher proton energies.

INTERACTIONS OF 150 GeV π^- MESONS IN A LARGE
NAL BUBBLE CHAMBER FILLED WITH H_2-Ne

H. Bingham, W. Fretter (University of California, Berkeley)

It is proposed to study π^- interactions in a mixture of
H_2 and neon (~15% Ne) in the NAL 15-foot bubble chamber. A
π^- beam of the highest possible energy is requested in an
exposure of 250,000 pictures with 3-4 beam tracks per picture.
The major thrust of this experiment is to determine cross
sections for diffractive production of three-pion, five-pion
and possibly seven-pion systems by negative pions on neon
nuclei. They will also study events where neutral pions are
produced, both coherently and in interactions with protons in
the liquid, and will use the γ-veto capabilities of the
chamber to reduce the background in 4C fits on protons such
as $\pi^-p \to \pi^+\pi^-\pi^-p$. They will search for quarks among the beam
particles and for other exotic states produced in nuclear
cascades.

Summary reviewed by
W.B. Fretter, February 1976

CRACOW NUCLEAR EMULSION EXPOSURES

J. Gierula
(Institute of Nuclear Research, Cracow, Poland)

Summary:

This proposal requests a nuclear emulsion exposure with protons and pions.

a. Beam: Protons, 500 GeV

                Pions,   same energy as protons

b. Intensity: $1 - 3 \times 10^5$ particles/cm^2.

c. Emulsion: Ilford G-5, 15 sheets each 600µ thick
                and 7.5 cm x 15 cm. Beam parallel to
                the 15 cm side.

d. Alignment: Better than ±10 millirad.

This group has obtained an exposure of emulsions to 60 GeV/c π^- at Serpukhov. Results presented at Lund Conference. Their primary interest is in jets.

Emulsion Processing: Perhaps ANL

Scanning: Cracow

PROPOSAL FOR EXAMINATION OF WIDE ANGLE GAMMA RAYS ENERGY

MASS SPECTRA AND CHARGED PARTICLE CORRELATIONS AT FERMILAB

M. Binkley, B. Cox, T. Kondo, T. Murphy, T. Toohig (Fermilab); C. Y. Chien, L. Madansky, J. Nagy, A. Pevsner (Johns Hopkins University)

This experiment will initially measure the mass spectrum, dynamics, and both the coplanar and non-coplanar cross sections of two or more photon final states in the reactions

$$pp \to \gamma\gamma + x$$

$$\text{and} \quad pp \to n\gamma + x$$

using the high intensity proton beam available in the P-West section of the Proton Area at energies between 100 and 500 GeV incident on H_2 and different A foils. Concurrently with the multiphoton phase of the experiment we will take data on single photon energy and angular distributions at a wide variety of angles. In the photon experiments we hope to investigate the pseudoscalar mass spectrum of two or more photons (with 5% resolution) to investigate processes such as resonance formation (analogous to the vector ψ production) or parton annihilation cross sections such as have been calculated by Paschos which lead to massive gamma pairs or $\pi^0\gamma$ final states. Correlation cross sections of 10^{-33} cm^2 are readily accessible to the experiment.

In addition, some charge particle-photon work will be done in the two arm spectrometer since momentum analysis and lepton (e, m) identification can be done on the charged particle spectra present in the pp interactions in some kinematic regions. We are also to study the correlations both between charged particles and charged particles and photons.

We are currently performing a final installation of apparatus on the two arm spectrometer under construction in the P-West 50 foot pit. This includes two Pb glass arrays totaling fifty 24 r.l. counters, 65 lucite Cerenkov and scintillator counters in various hodoscopes for charged particle and photon shower identifications, and 20 planes of proportional chambers totaling 4000 wires. Two 6-inch aperture magnets have been installed and the final shielding configuration is finished. We have made four preliminary runs to determine optimal proton beam configurations and modifications that have been made to correct halo problems, and one extensive data and calibration run in September was done October 1975. We will require a minimum of 100 hours of data taking at each energy for the photon work.

Summary Prepared By: B. Cox
                       January 1976

                    FOCUSING SPECTROMETER FACILITY

ANL, Bari, Brown, CERN, Cornell, MIT, NAL, Northeastern,
Stanford   D.M. Ritson (Spokesman)

     This group has constructed a focusing spectrometer at the
end of the 2.5 mrad beam. The solid angle acceptance is
variable from 15 µster at 60 GeV/c to 5 µster at 200 GeV/c.
Momentum resolution is $\pm.1\%$ at present and should improve.
By suitable beam optics techniques, it will be possible to
operate the overall system in either an achromatic or energy
loss mode. Changes in scattering angle are accomplished by
steering some combination of the incident and outgoing particles.
Particle identification is achieved with differential and
threshold Cerenkov counters in both the beam and spectrometer.
Proportional planes located at suitable points enable the
experimenter to decode outgoing particle variables such as
momentum and production angle. The estimate for programmed
data taking is 1000 hours.

     Major Physics Objectives:

1.   Measure elastic scattering for the reactions of protons,
     antiprotons, positive and negative pions, and kaons on
     hydrogen in the region $0 \leq |t| \leq 1.5$ GeV/c^2 and $50 \leq P_{inc}$
     <200 GeV/c to obtain Regge α and α' coefficients, cross-
     overs, and overall behavior to a few percent.

2.   Measure inelastic scattering in the same region for masses
     up to about 4 GeV to cover the resonance and triple-regge
     region to about 5%.

3.   Repeat the measurements with a deuterium target.

ELASTIC SCATTERING OF THE HYPERONS

C. Ankenbrandt, M. Atac, P. Gollon, J. Lach, J. MacLachlan,
A. Roberts, G. Shen (Fermilab); L. Fajardo, R. Majka, J. Marx,
P. Nemethy, J. Sandweiss, A. Schiz, W. Willis (Yale).

This experiment proposes to measure small angle scattering of most of the hyperons. The $|t|$ range is between 0.1 and 0.6 GeV/c². As part of the proposed program, production cross sections in the forward direction of the charged hyperons, Σ^-, Ξ^- and Ω^-, will be measured. Positive hyperons Σ^+, $\bar{\Sigma}^+$, Ξ^+ and $\bar{\Omega}^+$ will be produced along with a substantial proton flux. It is felt that cross section measurements are possible for those produced with appreciable cross sections. As a by product we would also measure their total cross section. Particle detection and identification will be done with two methods. One uses a high resolution gas Cerenkov counter and the second relies on observing the hyperon decay products.

A second goal of this experiment is to search for new short lived exotic particles of lifetime 10^{-11} -10^{-10} sec.

One of the early engineering goals of the experiment will be the study of hyperon production cross sections as a function of hyperon momentum. This will determine at what momenta the experiment can be run most effectively.

An updated description of the detectors and layout is given in Proposal 353 which uses most of the same apparatus.

Two hundred running hours were requested in the original proposal. This should be considered as the time needed for only the first phase.

Summary reviewed by
J. Lach, January 1976

MUON-PROTON INELASTIC SCATTERING EXPERIMENT AT THE
FERMI NATIONAL ACCELERATOR LABORATORY

University of Chicago, Harvard University, University of Illinois,
University of Oxford   **H.L. Anderson** (Spokesman)

This is an experiment to study muon-proton (and muon-deuteron) inelastic scattering in the energy range of 100 to 225 GeV. Initially, the experiment will be performed with muons of energy 150 GeV. Measurements will be made with the momentum transfer squared, q^2, in the range of 0.01 to 30 $(GeV/c)^2$ and the energy loss of the muon, ν, in the range of 10 to 140 GeV. A large aperture magnetic spectrometer, which consists of the Chicago Cyclotron magnet, proportional wire chambers, and wire spark chambers, will detect the scattered muons and charged hadrons produced in the collision.

After the initial run of 400 hours at 150 GeV with hydrogen, they propose to run for 200 hours at 100 GeV and 400 hours at 225 GeV, then repeat these runs with deuterium.

The following information can be obtained:

1. The inelastic form factors $W_1(q^2, \nu)$ and $W_2(q^2, \nu)$ of the proton and the neutron;

2. Cross-sections in the photoproduction limit;

3. The multiplicity and momentum spectra of the forward charged hadrons;

4. Partial information on the multiplicity of neutral pions; and

5. Measurement of some specific channels, e.g. ρ and ϕ production. The cross-section as a function of q^2 and ν, t dependence to recoil proton, and dependence on azimuthal angle will be studied.

Summary reviewed by

Herbert L. Anderson, January 1975

STUDY OF $\pi^+ p \to K^+ \Sigma^+$ AND $\pi^+ p \to K^+ Y*^+$
USING THE FOCUSING SPECTROMETER FACILITY

D. S. Ayres, D. Cohen, R. Diebold, S. L. Kramer, A. B. Wicklund (ANL); A. F. Greene, J. E. Elias (FNAL); R. L. Anderson, D. Gustavson, K. Rich, D. M. Ritson (Stanford University and SLAC); R. Prepost (University of Wisconsin)

It is proposed to use the Fermilab Single Arm Spectrometer facility to detect K^+ mesons produced in association with Σ^+, $Y*(1385)$ and $Y*(1670)$ by $\pi^+ p$ interactions. The study of these reactions is one of the easiest ways to obtain data at Fermilab on nondiffractive processes. The s and t dependence will give valuable information on K^* exchange as well as the importance of cuts at high energies.

These reactions will be studied at five incident momenta from 30 to 200 GeV/c and from t_{min} to about 0.8 GeV^2. The recoil baryon will be identified by the missing mass technique; a resolution at the Σ mass of typically ± 50 MeV is expected. The four Cerenkov counters in the beam plus four more in the spectrometer will be used to achieve the required particle identification.

The line-reversed reactions such as $K^- p \to \pi^- \Sigma^+$ will also be studied at one or two momenta.

Several thousand $K^+ \Sigma^+$ events are expected per momentum, and a total of 500 hours of running time is approved.

A PROPOSAL TO STUDY PARTICLE PRODUCTION AT HIGH TRANSVERSE MOMENTA

J. Cronin, H. Frisch, M. Shocket (Univ. of Chicago); P. Piroué,
J. Boymond, R. Sumner (Princeton Univ.)

This proposal is for an exploratory search of the particle constituents at about 90 degrees in the c.m.s. of proton-proton collisions of 200-500 GeV incident energy (80 mrad in the lab.).

This data would provide information on:

a) Hadron production at high transverse momentum

b) The possible existence of the intermediate boson, heavy photons and heavy leptons by searching for leptons with high transverse momentum. Sensitivity to a 6 GeV massive W-meson is such that lepton yield $\geq 10^{37} \sigma_W$ B/hour (σ_W-production cross section, B-branching ratio).

c) The possible existence of long-lived particles (with or without fractional charge).

d) With small modifications to the apparatus, short-lived particles and also direct photon production.

Required: Beam line capable of analyzing particles up to 200 GeV/c at 80 mrad from a one interaction length target. The beam line which is designed in the proposal has main ring quads and dipoles. The solid angle of acceptance is 16μster and the momentum acceptance is 10%. Two independent measurements of momentum are made in the beam line. Due to the use of a focusing beam line, the counters are small and can be well shielded.

Summary reviewed by
P. A. Piroué, March, 1975

INTRA NUCLEAR CASCADE PRODUCED BY 200 GeV PROTONS

D. T. King, et.al. (University of Tennessee)

Summary:

This proposal requests a nuclear emulsion exposure
with 200 GeV protons.

    a. Beam: Protons, 200 GeV

    b. Intensity $5.0 \times 10^4/cm^2$

    c. Emulsion: Small stack of Ilford K5, 600μ thick

    d. Alignment: Parallel

These data would, through measurements of the angular
distribution of the secondaries, provide information on the
extent to which the incident proton interacted with either a
single nucleon or a group of several nucleons in the nucleus.
Secondly, the angular distributions will be measured as a
function of multiplicity.

Emulsion Processing: U.T.

Scanning: U.T.

MEASUREMENT OF TOTAL CROSS SECTIONS ON HYDROGEN AND DEUTERIUM

R.L. Cool, O.D. Fackler (Rockefeller Univ.); A.S. Carroll,
I-H Chiang, T.F. Kycia, K.K. Li, P.O. Mazur, D.C. Rahm (BNL);
W.F. Baker,   D.P. Eartly, P.F. Koehler,
R. Rubenstein, A. Wehmann (NAL); P.M. Mockett (Univ. of
Washington); K.P. Pretzl (Max Planck Inst., Munich);
G. Giacomelli (Univ. of Padua)

It is proposed to measure total cross sections of $\pi^{\pm}$, $K^{\pm}$,
p and $\bar{p}$ on hydrogen and deuterium between 20 GeV and the maximum
energy available at NAL. The apparatus consists of three
Cerenkov counters (two differential and one threshold), three
targets (one hydrogen, one deuterium and one dummy), a propor-
tional wire chamber telescope in the incident beam, a set of
transmission counters (scintillation counters) and proportional
wire chambers downstream of the target and an on-line computer.
The apparatus is designed to be able to measure the energy
dependence of a given cross section over the full range with
a relative accuracy of about 0.1%. The anticipated error in
the absolute cross sections on hydrogen and deuterium is
0.3%-0.5%. This requires the absolute density of hydrogen and
deuterium to be known to better than 0.1%.

The measurement of the total cross sections will play a
basic role in the understanding of strong interactions in the
new energy range. An absolute accuracy of a few tenths of one
per cent will yield the energy dependence of cross sections,
comparisons of cross sections within SU(3) supermultiplets,
and stringent tests of high energy limiting theorems. The
recent result from the CERN ISR that the p-p total cross section
increases with energy emphasizes the importance of accurate
total cross section measurements at NAL energies for all of the
available strongly interacting hadrons.

Summary reviewed by
R.L. Cool, February 1975

A PROPOSAL TO STUDY SOME CHARACTERISTICS OF PROTON NUCLEON

AND PROTON NUCLEUS COLLISIONS AT 400 GeV USING NUCLEAR EMULSIONS

R. R. Daniel, et.al. (Tata Institute of Fundamental Research)

Summary:

This proposal requests a nuclear emulsion exposure at the highest proton energy (200-500 GeV) possible.

    a. Beam: Protons, 200-500 GeV; diameter of beam ≥5 cm

    b. Intensity: $(1 \, ^{+2}_{-0.5}) \times 10^4$ protons/cm^2

    c. Emulsion: 80 pellicles, 40 of normal G5

                         40 of hypersensitive G5

             Each pellicle is 15 cm x 12 cm x 0.06 cm

             Beam is parallel to 15 cm edge

    d. Alignment: Better than 6 milliradians

These data would:

    a. Determine multiplicity in proton nucleus collisions.

    b. Determine $K^+ + K^-/\pi^+ + \pi^-$ ratio by measurements in the backward hemisphere in the c.m.s.

    c. Determine characteristic transverse momenta of particles by measurements in backward hemisphere.

    d. Search for quarks using hypersensitive emulsion.

    e. Angular distributions of secondaries.

    f. Interaction mean free paths.

Emulsion processing: Tata Institute

Scanning: Tata Institute

A BEAM DUMP EXPERIMENT

M. Awschalom, S. Baker, L. Coulson, P. Gollon, C. Moore
A. VanGinneken (Fermilab)

This is a proposal to perform several related experiments whose over-all purpose is to obtain data relevant to the design of experimental devices and facilities from the point of view of radiation effects.

The investigation includes:

1. Spatial distribution of the density of energy deposition in beam dumps using various detectors.

2. Spatial distribution of radioactivation of various materials such as steel, soil, water, etc. in media such as steel and concrete.

3. Hadron cascade development in beam dumps by foil activation, scintillation counters and other detectors.

4. Undifferentiated total hadron yields at large angles by foil activation and other detectors.

5. Muon production and attenuation characteristics behind beam dumps, using Cerenkov and scintillation counters.

6. Measurements of some absolute cross sections needed for beam intensity monitoring to an accuracy of ±5% or better.

A total beam time of 120 hours of good beam is requested. This is to be split between 200 and 400 GeV operation. About 2 to 3 hours of beam time per week appears optimal. Beam intensities in the range 10^5 to 10^{12} protons per second are requested with the beam size about 3mm diameter or less.

PROPOSAL TO STUDY MULTIPARTICLE PERIPHERAL
PHYSICS AT NAL

C. Bromberg, G. Fox, R. Gomez, J. Pine (Caltech); V. Ashford,
R. Juhala, E. Malamud, S. Mori (NAL); E. Lorenz, P. Schlein,
(UCLA); R. Abrams, H. Goldberg, S. Margulies, D. McLeod,
J. Solomon (Univ. of Illinois, Chicago Circle); A. Dzierba,
(Univ. of Indiana)

A magnetic spectrometer is proposed, to measure forward-going hadronic systems at 50 to 200 GeV/c. The particle detectors are wire chambers, proportional counters, and threshhold Cerenkov counters. While momentum measurements are made only on forwardgoing particles, the remainder of the 4π solid angle around the hydrogen target is covered by charged particle and gamma ray detectors.

Specific reactions will be isolated in order to study the s and t dependences of the cross sections for peripheral processes, search for new resonant states, measure π-π and K-π elastic and inelastic scattering, and study the properties of high multiplicity events. The processes may be divided into two types, differing according to whether there is or is not charge exchange to the recoil nucleon. The non-charge exchange reaction events (e.g. proton recoils) further subdivide into two groups depending upon whether or not they are dominated by diffraction scattering. With the aid of signals from multi-wire proportional chambers and other detectors various triggers will be defined to study a great variety of processes simul-taneously. By computer control, each trigger will be limited to a preset maximum fraction of the "live time."

The initial proposal calls for a physics program for the spectrometer which is initially limited to those processes easiest to measure (e.g., processes where no neutral pions are produced), which nevertheless spans a large range of strong interaction problems. Priority of operation of the facility by the proposing group for 15 to 18 months is requested. After this time, the setup will be available for use by others.

Summary reviewed by
D. McLeod, January 1976

PROPOSAL TO STUDY $\pi^-p \to \pi^0n$ AND $\pi^-p \to \eta n$ AT HIGH ENERGY

A. Barnes, J. Mellema, A. Tollestrup, R. Walker (Caltech);
O. Dahl, R. Johnson, R. Kenney, M. Pripstein (LBL)

The asymptotic behavior of hadronic cross sections is one of the most important questions that NAL may be able to answer. Experiment #111 is at present measuring the π^-p charge exchange cross section up to the highest energies available in the Meson Area.

By using isotopic spin conservation and the optical theorem, an upper limit on the difference between the total π^-p and π^+p cross section can be established.

This cross section is also an excellent test of Regge theory since only the ρ meson is exchanged. In addition, when the results of this experiment are combined with those of the total cross section measurements for π^+p and π^-p, it will be possible to separate the amplitude in the forward direction into its real and imaginary parts and the consistency for the experiment with dispersion relations can be checked.

The experiment utilizes an elegant new detector that is composed of 140 narrow finger counters that locate a shower position to about 1 mm and integrate its total energy loss. This knowledge allows one to uniquely solve for the direction of a neutral particle that decays into γ-rays and to determine its mass squared. Preliminary running has shown peaks for the $\pi^0 \to 2\gamma$, $\eta^0 \to 2\gamma$, $\eta^0 \to 3\pi^0$, $\omega^0 \to \pi^0\gamma$, and a large bump at the mass of the f.

The experiment at present has finished running at 100 GeV. It is planned that the following energies 20, 40, 65, 100, 150, and 250 will be measured. The lower end will tie into existing measurements and should cover a range in t between 0 and 1.5 $(GeV/c)^2$. At the highest energy, due to the rapidly falling cross section, probably only data for t less than 0.6 will be obtained with a beam of 10^6 π^-'s per pulse on the target.

All of the necessary equipment is now assembled and running and no additional extensive construction will be necessary. It is hoped that the energies below 100 GeV will be finished in the current running period (through April, 1974).

Summary prepared by
A. Tollestrup, February 1974

PRIMARY INTERACTIONS, MULTIPLICITY AND CROSS-
SECTION AS t (E_p) FROM 200-500 GeV/c.

P. L. Jain   (SUNY at Buffalo)

Summary:

       A proposal to make an unspecified number of ex-

posures of Ilford G-5 emulsions to protons in the 200-500

GeV range. The object of the experiment is to study second-

ary particle multiplicities and the cross-section as a function

of energy.

       Beam density requirements are 10^4 - 10^5 protons/cm^2.

A SEARCH FOR MASSIVE, LONG-LIVED, FRACTIONALLY
CHARGED PARTICLES PRODUCED BY 300 GeV PROTONS

Cal Tech Neutrino Group, M.L. Stevenson (LBL)

A search has been made for long-lived (25 μsec $< \tau \lesssim$ 1 msec) weakly interacting particles of rest mass greater than 5 GeV/c^2 that come to rest and subsequently decay in the calorimeter portion of the CAL Tech-NAL neutrino detector. The 253 meters of steel, 3 meters of Al, and 178 meters of earth in front of the detector allow only fractionally charged particles of 2/3 e (1/3 e) of momenta between 184 GeV/c and 190 GeV/c (46.1 GeV/c and 47.5 GeV/c) to stop.   No such particles were observed during a six-hour parasitic run, during which time 1.39 x 10^{16} 300 GeV protons struck the target of the "Single Horn" neutrino beam. The "90% confidence level" upper limit to the invariant differential cross section $E \dfrac{d^3\sigma}{dp^3}(0^o)$

times branching ratio into 5 GeV of calorimeter energy is about 5 x 10^{-37} cm^2 (GeV/c)$^{-2}$ (4 x 10^{-38} cm^2 (GeV/c)$^{-2}$) for lifetimes near 100 μsec.

Summary reviewed by M.L. Stevenson
21 February 1975

MEASUREMENT OF TOTAL CROSS SECTIONS, MULTIPLICITY,
ANGULAR DISTRIBUTION AND CASCADE DEVELOPMENT

J. Hebert (University of Ottawa)

Summary:

A proposal to expose stacks of emulsion loaded with B^{10} and LiF to protons of energy 100 GeV, 150 GeV, 200 GeV, and 400 GeV. The purpose of the experiment to study the total cross-section for protons on complex nuclei as a function of energy; the charged multiplicity distribution as a function of energy; the angular distributions in p-nucleus collisions, and to gather statistical information on hadron shower development.

The beam density requirements are 10^6 protons/pulse over a 10 cm x 5 cm area with $\sim$5 min. exposure at each energy.

PHENOMENOLOGICAL STUDY OF PROTON INTERACTIONS AT 200 GeV/c IN

EMULSION

O.Kusumoto, S.Ozaki and M.Teranaka (Osaka City University);
G.Fujioka, H.Fukushima, K.Kobayakawa, M.Miyagaki and Y.Tsuzuki
(Kobe university); H.Okabe and J.Yokota (Science Education Institute
of Osaka Prefecture); M.Ohta (kinki University).

Summary:

The purpose of the experiment is to study the general features
of the proton-nucleon and proton-nucleus interactions at 200 GeV/c
in emulsion.   The cross sections, the contribution of diffractive
interactions, the character of multiplicity distributions and the
behavior of backward produced particles are mainly examined.
The short-lived new particles are also investigated near the
interaction point.

Procedure:

A stack of K5 pellicles of 3"x 6"x 600 μm, 36 sheets, is
exposed to the 200 GeV/c proton beam with a density of $10^4 \sim 10^5$
per cm^2.   Several sandwich stacks each of which is made by three
K5 pellicles of 5 cm x 5 cm x 600 μm and one metal foil (C, Al,
Ni, Ag or W) of $200 \sim 400 \mu$m thick are exposed vertically to the
emulsion plane with a beam density of ~ 5 x 10^4 per cm^2.

HADRON SPECTRA FROM HIGH ENERGY INTERACTIONS

Bari University: C. DeMarzo, L. Guerriero, P. La Vopa, G. Maggi,

F. Posa, G. Selvaggi, P. Spinelli, F. Waldner; Brown University:
D. Cutts, R. Lanou, J. Massimo; Fermilab: A. Brenner, D. Carey, J. Elias,
G. Mikenberg; M.I.T.: W. Aitkenhead, D. Barton, G. Brandenburg,
W. Busza, A. Dilmanian, J. Friedman, P. Garbincius, H. Kendall,
T. Lyons, B. Nelson, L. Rosenson, W. Toy, R. Verdier, C. Young

It is proposed to study inclusive reactions of the type
a + p(or n) → b + anything where a = proton, antiproton, π^+, π^-,
K^+, K^-, and b = any of the above particles and is the detected particle.

The over-all objective is to map out the general behavior
of these reactions over as wide a range of kinematic variables as
possible, concentrating on those reactions which cannot be measured
at the ISR. In particular, incident momenta of 50, 100, and
175 GeV/c would be used and the spectra of particle b would be
measured from the maximum momenta down to about 10 GeV/c in coarse
steps. The range of transverse momenta covered will be determined
primarily by counting rate but generally $\lesssim 1.5$ GeV/c. It is proposed
to use the Fermilab focusing spectrometer. Statistical errors will
range from about 1.5% at small transverse momenta to 10% at large
transverse momenta.

The target will be surrounded with detectors, the purpose of
which is to study the correlation of the inclusive cross sections
with charged particle multiplicities. The set-up will provide this
information simultaneously with the measurements of the inclusive
cross sections.

This experiment will provide a study of the approach to scaling
of a number of different reactions, and will also provide information
about the associated multiplicity as a function of the kinematics
(M^2, t, x) of the leading particle in these reactions. The multiplicity
information can provide a very stringent test of factorization.

A DISC counter, a differential and threshold Cerenkov counter
will be used in the beam and three threshold Cerenkov counters and
a differential Cerenkov counter in the spectrometer. This will permit
the simultaneous measurements of different reactions.

Running time is estimated at 1000 hours with 200 hours of test
time in addition.

Summary revised February, 1976

EARLY π^0 PARTICLE PRODUCTION SURVEY WITH

THE GAS JET TARGET

C. Rubbia, J. Pilcher (Harvard)

D. Cline, R. Imlay (Univ. of Wisconsin)

Summary:

The proposal is to use lead glass counters to study the gamma ray spectrum at several angles produced from the gas jet target. The proposed angular range for detection of gamma rays is from 5 to 20 mrads. The physics objectives are:

a) Obtain the π^0 spectrum to determine the low energy neutrino yield.

b) Study anomalous large transverse momentum gamma rays which might result from W meson production.

c) Study the yield of gamma rays emerging from downstream of the target to obtain the yield of K_S mesons or any heavy particle that lives 10^{-10} secs or longer.

It is estimated that several days of running, with 10^9 interactions in the gas jet per pulse are required.

A PROPOSAL TO SEARCH FOR VERY HEAVY STRANGE PARTICLES
USING A SMALL HYDROGEN BUBBLE CHAMBER

M. Alston-Garnjost (Lawrence Berkeley Lab); J. Friedman (Stanford
Linear Accelerator Center); K. Hayes, W. Ko, R. Smith, R. Sommer,
R. Lander, D. Pellett, P. Yager, J. Erwin, D. Faulkner (Univ. of
California, Davis)

This is a revision to the original proposal after approval
of 50K pictures of π^+p. It is suggested that a large bare
chamber run in the 30" bubble chamber could give important re-
sults, namely the confirmation or refutation of the isotropic
and "black body" nature of meson production.

They have found at energies below 28 GeV that the low
energy pions or kaons are produced quite isotropically in the
center of mass and that a "black body" boson distribution with
a "temperature" of 140 MeV (KT) fit the data quite well. If
this persists at high energy it would violate all scaling
models and so require a non-scaling component.

Summary sent to R. Lander
for review, May 1973

Status: Approved, August 1971

PROPOSAL TO STUDY π⁻p REACTIONS at 60 and 200 GeV/c
IN THE 30-INCH HYDROGEN BUBBLE CHAMBER AT NAL

V. T. Cocconi, T. Coghen, M. Counihan, U. Gensch, J. D. Hansen,
G. T. Jones, V. Karimaki, G. Kellner, W. Kittel, A. Kotanski,
D. Kuhn, D. R. O. Morrison, D. Sotiriou, R. Stroynowski and H.
Wahl (CERN).

This modified proposal requests 50,000 pictures of π⁻ into
the 30" H.B.C. at 100 GeV/c. The aims of the experiment are to
study missing mass spectra, diffraction dissociation and correl-
ations. The energy dependence of these effects will be studied,
in particular by using lower energy πp data already obtained by
this group at 8, 16 and 23 GeV/c. The analysis would be greatly
helped by the use of a Cerenkov counter and hodoscope system
upstream from the chamber.

Summary prepared by
D. R. O. Morrison, May 1973

STUDY OF π⁻+p INTERACTIONS AT HIGH ENERGY

Lawrence Berkeley Laboratory, University of California,
Berkeley, Frmilab, Caltech   F.R. Huson (spokesman)

This is a proposal for the bare 30" to be exposed to
π⁻ at 200 GeV/c. About 10,000 interactions are requested
(50,000 pix). This is an exploratory experiment to search
for new phenomena and study diffraction dissociation.

Summary reviewed by
F. R. Huson, February 1975

STUDY OF MULTIPARTICLE PRODUCTION
IN A 30" BUBBLE CHAMBER

J. Chapman, J. Cooper, N. Green, B.P. Roe, A. Seidl,
D. Sinclair, J. VanderVelde (Univ. of Michigan); J. Biel,
J. Bradick, C. Bromberg, T. Ferble, P. Slattery,
B. Wormington (Univ. of Rochester); J. Sanders (BNL)

The Michigan and Rochester bubble chamber groups are proposing a collaborative investigation of pp interactions at high energy. This proposal is for a general survey using the bare hydrogen bubble chamber. The request is for 50,000 pictures with a proton beam at each of two energies - 100 GeV/c and 400 GeV/c.

The purpose is to extract the energy dependence of the total cross section and of multiparticle and diffractive production processes; to measure such energy dependence, the analysis must be carried out using uniform scanning rules and normalization techniques, consequently, Michigan and Rochester will in effect function as a single group. In addition to looking for unusual events by means of a very rapid scan by physicists, the intent is also to measure all topologies and test current theoretical models of hadronic interactions.

Summary reviewed by
J. VanderVelde, January 1976

STUDY OF pp INTERACTIONS IN THE ANL 30-INCH HYDROGEN BUBBLE CHAMBER AT NAL

G. Charlton, Y. Cho, M. Derrick, R. Engelmann,
T. Fields, L. G. Hyman, B. Musgrave, H. Yuta (ANL);
L. Voyvodic, R. J. Walker (NAL); Z. Ming Ma (Michigan
State Univ.); H. B. Crawley (Iowa State Univ.);
B. Kehoe (Univ. of Maryland)

Summary:

This is a proposal for the first 50,000 pictures of the
30-inch chamber to be taken at NAL. The proponents desire the
highest energy proton beam available when the chamber is opera-
tional. They give two major purposes for their experiment.
First, they are responsible for putting the chamber into working
order at NAL and these pictures would help them check out the
readiness of the reassembled system and insure that the precision
of the chamber has been realized. Second, since they are so
familiar with the characteristics of this chamber they will be
able to rapidly explore the particle physics contained in this
initial experiment. The whole effort of the ANL film analysis facil-
ity will be utilized for the short period of this experiment.
They expect preliminary results within one month and final results
within three months of the run.

(FRH)

8/26/71 Approved 50K pictures pp highest available energy
         at turn-on of 30" and beam.

PROPOSAL FOR A SEARCH FOR SUPERHEAVY ELEMENTS
BY IRRADIATIONS AT NAL

J. Halperin, O.L. Keller, R.J. Silva, R.W. Stoughton (ORNL);
K.L. Wolf (ANL)

This group proposes to use an existing multiple neutron detector consisting of 20 He^3 counters to look for super-heavy elements in samples previously irradiated in a high energy proton beam. They assume that elements in the hypothetical transuranic island of stability above the known periodic table will have a large neutron excess and a large spontaneous fission energy and hence should give rise to high multiplicity ($\sim$10) neutron events; several theoretical studies support this assumption. They will search for elements produced by such mechanisms as those suggested in the Marinov experiment. They are flexible in the sample geometry and location provided the samples can be fit into the 9-inch diameter by 30-inch long sample volume. Exposures of 10^{18} or more protons are desirable. They have previously searched samples exposed at a level of 10^{17} lower-energy ($\sim$25 GeV) protons. The method is non-destructive and hence would allow target-sharing collaboration with others.

Physics Objective: Search for superheavy elements.

Summary reviewed by
R.W. Stoughton, January 1976

PROPOSAL FOR A RAPID SYSTEMATIC STUDY OF ALL INTERACTIONS IN A
π⁻p EXPOSURE OF THE BARE 30" CHAMBER AT 120 GEV/C

P. L. Connolly, G. R. Kalbfleisch, R. C. Strand, V. VanderBurg
(Brookhaven National Laboratory)

This is a proposal for 50,000 pictures of the bare 30-inch hydrogen bubble chamber exposed to a π⁻ beam. The experimenters expect to use a 300 GeV/c π⁻ beam.

Their purpose in doing the experiment is both to test current theories of the strong interaction and to look for new effects at higher momentum.

They expect to have preliminary results within six months of receiving the film and final results in one year.

Summary reviewed
R. Strand, Feb. 1975

PROPOSAL OF AN EXPERIMENT ON THE FISSION OF VERY

HEAVY NUCLEI INDUCED BY 200 PROTONS IN PLASTIC DETECTORS

M. Debeauvais, J. Ralarosy, G. Remy, J. Tripier (Strasbourg)

This group wishes to study binary and ternary fission and fragmentation of heavy elements induced by 200 GeV, 300 GeV and 400 GeV protons. They will use U, Th, Bi, Pb and Au targets evaporated on makrofol detectors and sandwiched between layers of makrofol plastic. After etching the emitted heavy nuclear fragments can be observed in 4 π geometry and measure angular distribution and ranges. It is proposed to irradiate 2 stacks of 10 samples of different heavy elements. This requires an integrate flux of 10^{10} to 10^{11} protons and a defocused beam uniform over a few cm^2. The targets are 20 to 100 micrograms pro cm^2 thick.

Physics objectives : Cross sections measurement of fission with two or more fragments in relation with the deposit energy of the incoming proton.

First Results

The experiment was performed on June 11th 1975 with protons of 300 GeV in the meson area. The makrofol sandwiches are developed and the scanning is beginning. The first result gives a fission cross section for Uranium targets of $\sim$ 850 mb and ternary cross section of about 11,6 mb. The scanning of the other targets are in progress.

Summary prepared by
M. Debeauvais, January 1976

A STUDY OF NEUTRINO INTERACTIONS WITH
NEUTRONS AND PROTONS USING THE 15-FOOT
BUBBLE CHAMBER AT FERMILAB FILLED
WITH DEUTERIUM

C.Y. Chang, R.G. Glasser, D.G. Hill, B. Sechi-Zorn,
G.A. Snow, G.B. Yodh (Univ. of Maryland); R. Burnstein,
C. Fu, D. Petersen and H.A. Rubin (Ill. Inst. of Tech)

This experiment uses the 15' bubble chamber with a
deuterium filling, a broad-band horn-focused neutrino
beam from 200 GeV proton interactions. (The proton energy
could as well be 300 GeV if that energy is more convenient
from the scheduling point of view.) No auxiliary muon or
photon detectors are provided, but the group is amenable to
collaborate with other groups that can provide downstream
detection equipment. The proposal stresses the physics
that can be obtained from the analysis of a 300,000 picture
initial exposure which should yield roughly 25,000 νn and
25,000 νp interactions. The neutrino flux can be determined
directly from the elastic $\nu p \rightarrow \mu^- p$ events seen in the
bubble chamber.

The physics possibilities in this experiment are:

1. New particle search, especially for "charmed" particles.

2. Elastic form factors and flux calibration.

3. ν-n and ν-p inelastic cross section comparison for the
   dominant charged current interaction.

4. Adler Tests of PCAC.

5. Limits on the neutral current event rate for ν-n and
   ν-p interactions.

Summary reviewed by
G.A. Snow, January, 1975

PROPOSAL TO BUILD AN ELECTRON-PHOTON FACILITY AT NAL AND
TO MEASURE PHOTON SCATTERING AT HIGH ENERGIES

D.C. Cheng, D.E. Dorfan, S.M. Flatté, C.A. Heusch, H. Meyer,
A. Seiden, A. Breakstone, A. Grillo, V. Palladino
(University of California, Santa Cruz)

Summary: It is proposed to assist NAL in the setting up and testing of an electron-tagged photon facility; to test and optimize high-energy electron and photon detection devices; and to perform basic measurements on photon scattering.

Beam: An electron beam has been designed by our group and others to provide for energy- and direction-tagged photons of energies up to 250-300 GeV. Hadronic contamination is negligibly small. Available photon fluxes vary rapidly with energy; they are, under reasonable assumptions, above 10^5 photons/pulse at the highest energies considered here. Deficiencies in primary photon flux or energy can be easily absorbed by means of a shift in useful photon energy.

Apparatus: The basic detector consists of shower spectrometers/hodoscopes spanning a large solid angle, plus a $\Delta\phi=2\pi$ recoil detector at large angles in the laboratory. The shower detector is sectioned such that highest precision is gained, at highest rates, in the forward direction. It consists basically of sandwich-type modules with active conver- ters, interleaved hodoscope devices, and summed energy information. It is a state-of-the- art detector for all showering particles, and adequate for hadron detection. The recoil detector serves to catch mainly the slow nucleons recoiling from a diffractively scattered or produced forward particles. No magnets are used.

Objectives: Determination of mostly hadronic features of real photons (to implement virtual photon work in muon beams, etc.).

Basic Measurement: Compton effect, elastic and "inelastic" ($\gamma N \to \gamma$ + hadrons). In 350 beam hours, from 10,000 to 20,000 elastic events and up to 1,000 inelastic events can be fully determined. Elastic slope parameters will be determined to a statistical accuracy of <5% in reasonably spaced intervals (better than present determinations). The inelastic Compton graph with its parton theory implication can be firmly established or disestablished with reasonable assumptions.

Meson Production: As a by-product, radiatively decaying mesons will be detected; there will be clearly distinguished signals for inclusive π^0, ω^0, η^0 production; each of these has special significance for inclusive phenomenology.

Hunting Novelties: Many of the more exotic, and hitherto unseen, particles of the theorist' dream zoo have distinctive radiative (e or γ) decays: the intermediate boson, heavy leptons of various types, heavy photons, magnetic monopoles. Pair production from a clean kinematic initial state may mean a unique path to their detection. In such a case, they will figure in our "backgrounds" free of charge. In particular radiative decays of the Ψ particles may be observed.

TEST OF PROPORTIONAL WIRE CHAMBERS IN HYBRID SYSTEMS

Brown Univ., Univ. of Cinn., Univ. of Illinois, Ill. Inst. of Tech., Indiana Univ., Hohns Hopkins Univ., NAL, ORNL, M.I.T., Rutgers Univ., Stevens Univ., Univ. of Tenn. and Yale Univ.
I.A. Pless (Spokesman)

Phase I: It is proposed to build an electronic beam-defining and tagging system to become a facility with the 30" bubble chamber. The system will identify and tag incoming beam particles. In addition, the direction and momentum of each tagged particle will be measured and recorded.

The system includes Cerenkov counters, proportional planes, and data collection equipment, including interfaces, readouts, magnetic tape units and small computer. It is proposed to install, debug, operate, and document the system (both hardware and software) before turning it over for use as a facility.

Phase II: In this phase, downstream proportional chamber and associated equipment are added, to permit the analysis of complex events.

Phase III: In this phase, it is proposed to take a 500,000 picture exposure. These will be taken at the single momentum of 200 GeV/c with 200,000 pictures taken with incident π^- mesons and 300,000 pictures taken with a mixture of incident π^+ mesons and protons.

Summary prepared by
I. A. Pless, May 1973

DEVELOPMENT OF THE PHASE I EXTERNAL MUON IDENTIFIER (EMI) FOR USE WITH THE NAL 30 m³ BUBBLE CHAMBER

R. J. Cence, F. A. Harris, S. I. Parker, M. W. Peters, V. Z. Peterson, V. J. Stenger (Univ. of Hawaii); A. Barbaro-Galtieri, G. Lynch, J. P. Marriner, M. L. Stevenson (Lawrence Berkeley Laboratory)

The purpose of the muon identifier is to identify which of the final state particles in neutrino-induced reactions is the muon. Processes requiring muon identification include deep inelastic scattering, for both charged current and neutral current processes, dilepton (eμ and μμ) events, and all "unusual" events.

The Phase I EMI proposal includes (1) a passive internal absorber (≈ 3 collision lengths) filling the space between the bubble chamber coils and matching them in effective thickness, and (2) an active external detector module that provides x, y and diagonal coordinates at a single plane for each emerging track. This is located just outside the bubble chamber vacuum tank. This combination of absorber and detector has a measured rejection efficiency for 3 GeV pions of 94 ± 1%, and an acceptance of 96% for muons. At higher momenta the angular acceptance improves but hadron "punch-through" increases.

The present Phase I EMI includes 25 modules of about 1 m² each. Delay-line readout minimizes the cost of the electronics. The initial coil-absorber has been thickened with zinc to interpose 3.5 pion interaction lengths (515 gm/cm²) to the average hadron.

EMI performance is being evaluated using neutrino events from E-45 (hydrogen) and E-28 (neon-hydrogen) neutrino exposures. A paper is in preparation. An EMI "School" was held in October 1975 for 60 interested users.

STUDY OF SECONDARY PARTICLES PRODUCED BY 200 AND

500 GEV PROTONS IN EMULSION CHAMBERS

K.NIU (UNIV. OF NAGOYA)
T.OGATA (I.N.S. UNIV. OF TOKYO)

SUMMARY OF PROPOSAL

The purpose of these exposures are 1. To examine the nuclear interactions produced, in order to validate current methods of inferring primary energies from observations on secondaries. 2. To study the γ ray spectrum and the elasticity of collisions. 3. Search for short-lived particles previously observed by the author in cosmic rays. 4. Investigation of high energy nucleon nucleus interactions.

For these proposes emulsion chambers consisting of emulsion absorber assemblies will be used.

STATUS

COMPLETED: September, 1972
EXPERIMENTAL RESULTS AND PUBLICATIONS.

1)   DETAILED ANALYSIS OF JET SHOWERS OBSERVED BY EMULSION CHAMBERS
      WITH PRODUCING LAYER.

      S.Kuramata et al.

      CONFERENCE PAPERS 13TH INTERNATIONAL COSMIC RAY CONFERENCE
      3, (1973), 2239

      Calibration of the relative scattering method for determination
of momentum of charged particles was done by means of emulsion
chambers exposed to protons with momentum of 205 GeV/c at the Fermi
National Accelerator Laboratory. The method was applied to the
study of super high energy jet showers induced by cosmic rays.

2)   X PARTICLE PRODUCTION IN 205 GEV/C PROTON INTERACTIONS.

      K.Hoshino et al.

      Prog. Theor. Phys. 53, (1975), 1859 and DPNU-3 Feb. 1975

      Among secondary particles of 205 GeV/c proton interaction two
possible candidates of short lived particle were observed. One is
neutral which show clear 2 body decay and the other is charged one.
Estimated life time and mass of those particles are not inconsistent
with the X particles* observed in cosmic ray jet showers.

* K.Niu et al., Prog. Theor. Phys. 46, (1971) 1644

PROPOSAL TO SURVEY HIGH ENERGY PROTON COLLISIONS IN NEON
AND TO SEARCH FOR ANOMALOUS PHOTON BUNDLES AT NAL

A. Benvenuti, U. Camerini, A.R. Erwin, W.F. Fry, M. Robinson,
and M.A. Thompson (Univ. of Wisconsin)

Using the 30" bubble chamber filled with neon-H_2 mixture
they wish to (1) Search for anomalous interactions of high
energy protons producing multiple photon events, (2) Obtain
information on the $\pi°$ production by high energy protons,
(3) Search for nuclear collisions between protons and Ne that
involve large target masses. They request 50,000 pictures of
the Ne bubble chamber at the highest available proton momentum
with (2-5) protons per pulse.

Summary sent to W.F. Fry
for review, May 1973

PROPOSAL FOR A STUDY OF THE INTERACTION OF
HIGH ENERGY $\pi^{\pm}$ WITH NEON

W. D. Walker, L. Fortney, J. Loos, A. T. Goshaw, W. Robertson
(Duke University); G. W. Meisner and R. B. Muir (University
of North Carolina)

They propose to study π^- interactions in the 30" hybrid
(chamber plus wide gap spark chamber) system with hydrogen-
neon in the bubble chamber. They want 50K pictures with $4\pi^-/$
picture and not more than 20 per cent neon. The purpose of
the experiment is:

1) To determine the multiplicity distribution in neon and
   compare this with data obtained in hydrogen.

2) To study the multiplicity of π^0's produced in π^--p inter-
   actions.

3) To look at the inclusive momentum distributions of produced
   pions and compare hydrogen and neon.

4) To search for Quarks.

5) To search for electromagnetic showers.

6) To study diffraction dissociation on neon.

7) To look at the propoerties of stopping tracks -- to see
   whether exotic stable particles are produced.

PROPOSAL TO MEASURE TWO-BODY AND QUASI TWO-BODY
ELASTIC SCATTERING AT LARGE t-VALUES AND IN THE u-CHANNEL

R.L. Anderson, D. Gustavson, K. Rich, D.M. Ritson, A. Weitsch
(SLAC); R. Prepost (Wisconsin); B. Gottschalk (Northeastern)

Objectives: It is proposed to utilize the SASG focusing
spectrometer facility (NAL Proposal No. 96) to study two
types of interactions:

1. Elastic scattering $\pi^{\pm}$, $K^{\pm}$, p, $\bar{p}$ at incident energies of
   50 to 175 GeV to t-values of 5 $(GeV/c)^2$.

2. Quasi-elastic processes both close to the elastic limit
   and over the triple Regge region.

   In addition we would expect to make preliminary runs on
elastic and inelastic u-channel scattering preparatory to
main physics running.

   These runs would complement and supplement the Experiment
96 running and would hopefully give a complete description of
overall and moderate t scattering in the region close to the
kinematic boundaries.

Experimental Technique: The focusing spectrometer will tag
with Cerenkov counters incident beam and outgoing secondary
particles. Its resolution of $\pm$ 0.03% will play a strong role
in kinematic separation of elastic and various quasi-elastic
final states. For the u-channel reactions, where additional
resolution is needed, it is planned to utilize a recoil side
arm with crude magnetic analysis.

   It is planned to spend the bulk of the time on items (1)
and (2) and would expect to make rough preliminary u-channel
measurements with a view to making a subsequent "carryon"
proposal for good u-channel coverage.

   The proposal requests 800 hours of beam.

Summary prepared by
D.M. Ritson, February 1974

PROPOSED EMULSION EXPERIMENT SEARCH FOR

SHORT LIVED PARTICLES AT HIGH ENERGIES

P. Kotzer and J. J. Lord (Univ. of Washington)

Summary:

This emulsion proposal is divided into two parts. The first is concerned with a search for massive new particles with life-times between 10^{-17} and 10^{-12} sec. and also includes an 8% measurement of the π° lifetime. An emulsion stack 7cm.x15cm.x3cm. is to be exposed to 90K protons/cm^2 at the highest available NAL energy. It is planned to examine 5K interactions for evidence of a decay or pair production within 1mm. of a point of interaction. Interest in this search has been stimulated recently by a Japanese cosmic ray emulsion experiment with a suggestion of a new particle.

A second portion of the proposal uses a five pellicle production stack followed by a multi-layered Pb sheet - pellicle sandwich. The objective is to search for new particles decaying to γ-rays. A particle flux of 10K protons/cm^2 is requested.

ANTINEUTRINO INTERACTIONS IN THE 15' H$_2$-NEON BUBBLE CHAMBER

H.H. Bingham, W.B. Fretter, G. Yost (Univ. of Calif., Berkeley);
H.J. Lubatti, K. Moriyasu (Univ. of Washington)

It is proposed to study $\bar{\nu}$ interactions in the 15-foot
bubble chamber filled with ~30% neon, 70% H$_2$. The experi-
menters are approved for 50K pictures using broad band
focusing. They propose to study:

1. Possibly the coherent interactions on neon.

2. Deep inelastic events and compare with the Exp. #28A
    study of ν-neon interactions to obtain W$_3$.

3. Dependence of σ_T on energy and A. Compare with #28A.

4. $\Delta S = \Delta Q$ in single strange particle production.

5. New particles and phenomena, including ψ, ψ etc.,
    sensitivity via e$^\pm$, $\mu^\pm$, γ detection.

These groups have experience with heavy liquids
including neon-hydrogen.

The experimenters hope to work with the LBL-Hawaii group
in using information from the EMI to improve their $\mu^\pm$
sensitivity, and with the Wisconsin group (Exp. #28A) to
compare $\bar{\nu}$ and ν interactions in the same chamber, same liquid
mixture, same EMI configuration.

                    Summary reviewed by
                    H.H. Bingham, February 1975

EARLY MEASUREMENT OF HIGH ENERGY PP LARGE
ANGLE ELASTIC SCATTERING

J. Hartmann, J. Orear, J. Vreislander (Cornell); S. Conetti,
D. Staris, C. Hojvat, D. Ryan, J. Trischuk (McGill); M. Gettner,
W. Faissler, B. Gottschalk, J. Johnson, T. Kephard, D. Potter
(Northeastern); P. Baranov, S. Rusakov (Lebedev Physical Inst.
and Cornell)

Physics Motivation: The proton-proton elastic differential
cross section would be measured at 300 GeV/c in two runs/
$4 < -t < 10$ GeV^2 and $10 < -t < 20$ GeV^2. Results from the ISR at
500 and 1500 GeV/c equivalent suggest the cross section
becomes independent of the energy, whereas it is decreasing
with energy in the 30 GeV/c region. This experiment hopes to
determine at what energy the energy dependence disappears.
Also, IRS results show a very narrow and deep dip at $-t \sim 1.5$
GeV^2. Other dips are expected in the region $|t| > 4$ GeV^2 and
would be measured in this experiment.

Experimental Technique: The experiment fits in the Proton-
West area without modification. Two large aperture spectro-
meters will measure both the forward and recoil protons in
coincidence. Momentum in each arm will be determined using
proportional wire chambers with appropriate bending magnets
(the recoil arm has a large amount of kinematical focusing).
The entire angular distribution from $4 < -t < 10$ GeV^2 is taken
at one time. Intensities $\sim 10^{11}$/pulse will give ~ 100 events
per bin per week for cross sections $\sim 10^{-36}$ cm^2/GeV^2. Phase I
is a test of the forward spectrometer to insure that singles
rates will be under one megacycle instaneous rate. Phase I
was completed in September 1975. Phase II will be the "low"
t run.

Summary reviewed by
J. Orear, January 1976

A STUDY OF THE AVERAGE MULTIPLICITY AND MULTIPLICITY DISTRIBUTION
IN HADRON-NUCLEUS COLLISIONS AT HIGH ENERGIES

W. Busza, C. Young, M.I.T.; C. Halliwell, E.P. Hincks, Carleton
University; J. Elias, F.N.A.L.

Experiment #E178, as originally proposed, has been successfully
completed. The results on the average multiplicity of charged par-
ticles in π-nucleus collisions at 100 and 175 GeV were presented at
the Topical Meeting on High Energy Collisions Involving Nuclei in
Trieste, September, 1974. They will also shortly appear in the
Physical Review Letters.

As a follow-up to these measurements it is planned to study the
following:

a) the rapidity distributions in hadron-nucleus collisions at
   50, 100, and 175 GeV;

b) compare in detail the multiplicities in hadron-nucleus
   collisions for π, K, and p incident hadrons;

c) study correlations in the multiplicities observed in the
   target and projectile fragmentation region for hadron-nucleus
   collisions.

This data is needed to differentiate between various models of
the space-time development of particle production.

For these measurements, the beam will be incident on a nuclear
target which will be surrounded by a 49 element hodoscope array. As
before, particles in the projectile fragmentation region will be de-
tected in a single high resolution Cerenkov counter through the in-
tensity of Cerenkov radiation.

The experiment will be located in the M6W beam line. Threshold
and differential Cerenkov counter will be used to identify the inci-
dent particle.

It is estimated that 100 hours of prime time at $\sim 10^4$ particles/
pulse plus 50 hours of parasitic time will be required to complete
the measurements.

Summary reviewed by Wit Busza
March, 1975

K⁺p Multiparticle Production in the NAL 15'
Bubble Chamber at the Highest Possible Energy

A. R. Erwin, E. H. Harvey, R. Loveless and M. A. Thompson
University of Wisconsin
Madison, Wisconsin 53706

It is proposed to study K⁺p interactions using the NAL 15'
hydrogen-filled bubble chamber. Slight modifications will be made
to the existing hadron beam to obtain an enriched sample of K⁺, and
it is planned to observe the fast K° decays in the large downstream
volume afforded by the 15' chamber. The physics interest involves
a study of quark-quark interactions, particularly with the interac-
tion of a strange quark which is flagged by the production of a
leading K°. Information will also be gathered on inclusive reac-
tions and on particle momentum spectra and correlation functions.
Production of charmed mesons should be at least an order of mag-
nitude greater ($\sim \cos^2\theta_c/\sin^2\theta_c$) for beams which supply a strange
quark in the initial state.

The beam is to be designed and utilized as follows: 300 GeV/c
protons will be incident on an initial target thereby producing π^-
at 200 GeV/c. The π^- will then be incident on a second target
where K⁺'s are produced and collected at about 160 GeV/c. Such a
beam might easily be obtained by switching the π^- in the neutrino
train onto the present hadron target or by striking a second tar-
get at the first focus of N5 in enclosure 103. It is estimated
that 10^{12} protons would yield 2K⁺'s in the 15' chamber with a K⁺/π⁺
ratio of 1:1 when the second method is used. This should be an
ideal flux. Use of the 15' chamber assumes a Cerenkov counter and
a minimum tagging system.

A request for 300K pictures with 4 tracks per picture (one of
which is a K⁺) is expected to yield approximately 3K K⁺ interactions
with a visible K° decay.

Summary reviewed by
A. R. Erwin, January 1976

A STUDY OF ANTINEUTRINO INTERACTIONS IN THE
FERMILAB 15-FT BUBBLE CHAMBER,
FILLED WITH HYDROGEN AND NEON

Fermilab, ITEP-Moscow, IHEP-Serpukhov, Univ. of Michigan,
F.A. Nezrick (Spokesman)

In a collaboration of USSR and USA physicists it is
proposed to study $\bar{\nu}$ interactions in the 15-foot bubble
chamber filled with a neon-hydrogen mixture. The
approval is for 50K pictures at the highest available accel-
erator energy to determine the best neon-hydrogen mixture.
At 350 GeV these would yield approximately 3.75K $\bar{\nu}$ inter-
actions. An external muon identifier would be used if
available. This experiment can examine the following:

1. Total $\bar{\nu}$N cross section and energy dependence.

2. Structure functions of deep inelastic interactions.

3. Study of neutral current interactions; conservation
   law tests.

4. The existence of heavy leptons (mass up to 2-3 GeV)
   and the intermediate boson (mass up to 9-10 GeV) can
   be seen directly and much higher limits on the inter-
   mediate boson mass can be inferred from deep inelastic
   investigations.

5. Limits on multifermion and weak-electromagnetic
   interactions.

6. Questions concerning purely leptonic weak interactions.

Summary reviewed by
F.A. Nezrick, February 1975

THE DIRECT PRODUCTION OF ELECTRON PAIRS IN NUCLEAR EMULSION
BY 100 AND 200 GeV PROTONS

A.S. Cary, T.K. Oskarsson (Harvey Mudd College)

An exposure of emulsions to high energy protons is
requested at NAL. The purpose of this exposure is for a
study of production of electron pairs by protons interacting
with the Coulomb field of nucleus. The data can be used for
a check at high energies of a fourth order process in quantum
electrodynamics. The cross section for pair creation is
expected to be approximately 10^{-25} cm^2 at NAL energies. An
intensity of 10^4-10^6 protons/cm^2 is requested.

Summary sent to A.S. Cary
for review, May 1973

A PROPOSAL OF THE PHOTOEMULSION EXPERIMENT AT THE NATIONAL ACCELERATOR LABORATORY (BATAVIA)

N.A. Dobrotin, G.B. Zhdanov, M.I. Tretyakova (Alma-Ata - Moscow - Leningrad - Tashkent - collaboration)

Summary: A request is made for an exposure of two or three emulsion stacks to a beam of high energy protons at NAL. The interest in this exposure is based on the following:

1) A study of high energy interactions and comparison of predictions from a fireball model.

2) Measuring the energy dependence of the cross section for production of one or more charged particles.

Similar analysis has originated from exposures by this group at CERN and Serpukhov and there is a strong interest to compare the NAL data with the lower energy results.

(AFG)

Proposal Received: May 20, 1972

Summary Prepared: November 7, 1972

Approved: August 25, 1972 (completed)

SEARCH FOR A NEW CLASS OF PENETRATING MASSIVE PARTICLES AT C-0
AND A MEASUREMENT OF DIRECT LEPTON PRODUCTION

A. Benvenuti, D. Cline, J. Curry, W.T. Ford, R. Imlay, A.K. Mann,
J. Pilcher, D. Bintinger, D.D. Reeder, C. Rubbia, L. Sulak,
P. Wanderer (Chicago-Harvard-Pennsylvania-Wisconsin Collaboration)

Physics Motivation:

Results from recently analyzed data from Serpukhov and the
ISR suggest that either direct muon production occurs at high
p transverse ($p_\perp$), or that heavy particles which are stable
or which decay into leptons are copiously produced. The pro-
duction.of new particles can be sensitively observed by the
observation of leptons at large $P_\perp$. Furthermore, an attendant
threshold enhancement might provide an important signature of
heavy particle production that is relatively independent of the
detailed nature of the heavy particle. This is directly
accomplished by means of the magnetic field ramp at NAL which
allows a continuous sweep in energy and therefore a precision
search for threshold effects. In addition, this experiment,
using the internal target, has the unique features that:
(i) it allows a search for short-lived particles because of
the compact nature of the detector ($\leq$ 10 meters), and (ii) it
has the ability to extrapolate easily to zero decay length to
eliminate background, and (iii) it utilizes the well-defined
profile of the internal beam, and (iv) it has the ability to
go to the highest energies of which the accelerator is capable.

Experimental Technique:

The experiment utilizes a plunging, rotating polyethylene
foil target at the Internal Target Area. Secondary particles
are required to pass through a hadron absorber and a Cerenkov
counter is used to search for penetrating particles with masses
above 1.3 GeV. Subsequent momentum analysis is performed with
an air gap magnetic spectrometer with scintillation counters
and proportional chambers placed between. Lead glass Cerenkov
counters at the end of the spectrometer separates muons from
hadrons. The entire apparatus is located below the Main Ring
beam pipe. The results of the experiment were published in
Physical Review Letters: PRL 34, 982 (1975) and PRL 35, 72
(1975).

Summary reviewed by
P. Wanderer, January 1976

A PROPOSAL TO STUDY SMALL-ANGLE PROTON-DEUTERON SCATTERING

Y. Akimov, L. Golovanov, S. Muhkin, G. Takhtamyshev, V. Tsarev
(Dubna); E. Malamud, R. Yamada, P. Zimmerman (NAL); R.S. Cool,
D. Goulianos, H. Sticker (Rockefeller Univ.); D. Gross,
A. Melissinos, D. Nitz, S. Olsen (Univ. of Rochester)

Physics Motivation

Act I.

(1) Measurement of p-d elastic scattering slope parameter.
(2) Excitation of resonances at small momentum transfer.
     (Data taking completed.)

Act II.
     Measurement of the deep diffractive dissociation of
     protons up to masses $M^2 = 100$ (GeV)^2.
       (Data taking in progress.)

Act III.

(1) Measurement of the real part of p-d small angle scattering.
(2) Same for p-p at 500 GeV.
(3) Attempt at large t elastic cross section.
     (Data taking after move of jet, ~August 1974)

Experimental Technique:

     The apparatus for this experiment is nearly identical to
that used for the earlier elastic p-p scattering work. The
gas jet will be operated with deuterium. The recoil particle
detector is extended to accept particles at 45° in order to
reach diffractive states of high mass. The deuterons will
be positively identified by using thin dE/dx detectors in
conjunction with the thicker total energy detectors. In this
fashion the background is greatly reduced and the deuteron
signature verifies the coherent nature of the interaction.
It is expected to measure $d^2\sigma/dtdM^2$ to an accuracy of 0.05 mb/
(GeV)^4 in the range of $0.02 < t < 0.10$ (GeV/C)^2 and $1 < M^2 <$
100 GeV^2. The absolute value of the inelastic cross section
is obtained by comparison with the elastic cross section.

PHASE 0.8-SEARCH FOR LONG-LIVED MASSIVE OBJECTS

L.M. Lederman, J. Appel, D. Saxon, I. Gaines, D. Hom, H. Paar, M. Borquin, D. Snyder (Columbia Univ.); T. Yamanouchi (Fermilab)

During some of the early work for NAL Experiment 70, it has been proposed to utilize some beam time in a search for new high mass particles. These particles, produced by protons with energies from 200 to 400 GeV, could have masses between 5 and 25 GeV/c and lifetimes $\gtrsim 10^{-7}$ sec. It is planned to have the primary proton beam strike a target in the tunnel adjacent to Enclosure E. Secondary particles would be produced and subsequently detected by a counter telescope approximately 1000 meters downstream in Proton Lab-Center. Relying on the r.f. bunching of the beam, it is expected to separate particles of various masses utilizing the differences in arrival time. Assuming 10^9 interactions per pulse, it is expected to detect 10^4 particles per pulse. It is planned simultaneously to use the beam for calibration of counters for later stages of their experimental program.

Summary Reviewed by
L.M. Lederman, January 1976

A PROPOSAL TO MEASURE CROSS SECTIONS FOR pp → pX, nX AS A
FUNCTION OF s AND M_x^2 USING THE INTERNAL TARGET
FACILITY AT NAL

J. Alspector, K. Cohen, G. Cvijanovich, T. Delillo, B. Maglich,
A. Pagnamenta, B. Robinson, F. Sannes and R. Stanek (Rutgers);
J. Carr, J. Keyne and I. Siotis (Imperial College)

Physics Motivation: It is proposed to study the single particle

inclusive reactions pp → px, pp → nX and pd → pX and, in particular,

to investigate the s and s/M^2 dependence of the invariant cross

sections. The data will be useful for a test of the triple Regge

formalism and can be used to determine the relative magnitudes of

triple Regge couplings. This work can also be used for understanding

various diffractive models.

Experimental Technique: The experimental apparatus for the most

part includes an extension of equipment being used for an experi-

ment at the Internal Target Laboratory. The target for the experi-

ment will be the currently available gas jet, running both with

hydrogen and with deuterium. Recoil protons are measured in a

counter telescope using range, pulse height, and time-of-flight.

The counters used for absorbers of recoil protons will also serve

as detectors of recoil neutrons. A check will be possible of the

data from the reaction pp → nX and the time reversed reaction

pn → pX after appropriate screening corrections are made to the

deuterium data. Approximately 200 hours of running is requested

to study reactions from hydrogen at energies up to 300 GeV.

(AFG)

NUCLEAR EMULSION EXPOSURES TO 400 GeV

David M. Ritson (Stanford Univ.)

It is proposed to expose nuclear emulsions to protons
of energies 300-400 GeV. These plates would then be used
by physics students in a laboratory course at Stanford
University.

NAL PROPOSAL FOR STUDY OF PHOTONS AND LEPTONS PRODUCED IN MESON-NUCLEON COLLISIONS IN THE DEEP SCATTERING REGION: SEARCH FOR INTERMEDIATE BOSONS, HEAVY LEPTONS, ANAMALOUS HADRONIC PROCESSES AND STUDY OF MULTI-GAMMA-RAY FINAL STATES

Z.G.T. Guiragossian, R. Hofstadter, R.F. Schilling, M.R.Yearian, (Stanford); E.V. Hungerford III, G.S. Mutchler, G.C. Phillips, (Rice); B. Cox, J. Peoples (NAL); B.W. Mayes (Houston)

The experimenters propose to construct a pion/electron beam facility at NAL and for this phase of their work to construct a spectrometer useful for the following:

1) Study of meson-nucleon collisions in the deep scattering region by observing large angle high energy produced gamma-rays, electrons and muons, singly or in pairs.

2) Search for new particles including intermediate vector bosons, Lee-Wick heavy photons and heavy leptons produced in deep meson-nucleon collisions. The effective mass of lepton pairs will be measured to better than 1% for particles with masses up to 22 GeV produced by 300 GeV pions. The particles would be observable in cases where the product of cross section and branching ratio is better than $10^{-37} - 10^{-38}$ cm^2.

3) Analysis of multi-gamma-ray final states from pion-nucleon collisions with resolution less than 2%.

The 100 - 300 GeV pion beam originates from interactions of protons with energy of 400 - 500 GeV. The beam has the following properties: acceptance of 9.5 µster, $\Delta p/p$ and momentum bite of $\pm$ 2% and a spot size at the target of $\pm$ 2mm. Intensities of $10^8 - 10^9$ pions/pulse are available from 10^{12} protons/pulse. Beam tagging will be done with one threshold and two differential Cerenkov counters. Analysis of events induced by kaons and antiprotons will also be possible at a rate of production of two orders of magnitude lower than by pions.

The spectrometer components are to be arranged in three configurations for each of the three phases of the experiment outlined above. The main and stationary component is an 18kG superconducting magnet with modules of multi-wire proportional chambers (MWPC). Other moveable parts include electron and photon identifiers using NaI (Tl) absorption counters with MWPC's and muon identifier modules. The experiment is approved for 400 hours to study the production of high mass electron pairs and inclusive π° production from π^--p interactions.

Summary reviewed by
Z. G. T. Guiragossian, February 1974

PROTON DEUTERON INTERACTIONS IN THE 30-INCH BUBBLE CHAMBER

S. Dado, A. Engler, G. Keyes, R. Kraemer, G. Yekutieli
(Carnegie-Mellon); J. Lys, <u>C.T. Murphy</u>, M. Binkley (Fermilab);
R. Diamond, A. Seidl, J. VanderVelde (Univ. of Michigan);
R. Engelmann, J. Hanlon, T. Kafka, M. Wahl (SUNY at Stonybrook)

Two exposures are approved for the 30-inch bubble chamber
filled with deuterium and using the upstream and downstream
proportional wire chamber systems. A total of 100,000 pictures
are approved at each of two energies, 100 GeV and 400 GeV. The
analysis of this experiment will be compared with the results
from runs at the same energies in hydrogen in which one of the
collaborators was involved. The analysis will concentrate on
the following topics:

1) Measurement of odd-prong multiplicity cross sections and
    comparison with even-prong results from the hydrogen data.

2) Determination of single-particle distributions. Studies
    can be made of isotopic spin exchange between the beam
    and target for reactions where pions are produced within
    a restricted kinematic region.

3) Study of two-particle correlations for a sample of events
    where the space angles of all secondary tracks are measured.

4) Study of neutron diffraction dissociation and double
    dissociation.

5) Measurement of the elastic and inelastic cross sections
    for particles coherently produced from deuterium.

6) Determination of neutral pion multiplicity and study of
    neutral strange particle production.

Summary revised by
C.T. Murphy, February 1975

PROPOSAL TO MEASURE THE LIFETIME OF THE NEUTRAL PION

Y.K. Lim (Univ. of Singapore); Bernardi (Emmanuel College);
K. Fukui (AFCRL); P.S. Young (Mississippi State)

An experiment is proposed to measure the lifetime of the neutral pion using nuclear emulsions. Using π° production by 200 or 300 GeV protons interacting in the emulsion material, it is planned to study decays into Dalitz pairs. Pion decay lengths are expected to be 20-30 microns in an emulsion with a resolution of ~1 micron. Approximately 100 Dalitz pairs are said to be necessary for a lifetime measurement with a 25% error. Three emulsion stacks are to be exposed with intensities of approximately 10^5 protons per cm^2.

Summary sent to Y.K. Lim
for review, May 1973

PROTON DEUTERON INTERACTIONS IN THE 30-INCH BUBBLE CHAMBER

S. Dado, A. Engler, G. Keyes, R. Kraemer, G. Yekutieli
(Carnegie-Mellon); J. Lys, C.T. Murphy, M. Binkley (Fermilab);
R. Diamond, A. Seidl, J. VanderVelde (Univ. of Michigan);
R. Engelmann, J. Hanlon, T. Kafka, M. Wahl (SUNY at Stonybrook)

Two exposures are approved for the 30-inch bubble chamber filled with deuterium and using the upstream and downstream proportional wire chamber systems. A total of 100,000 pictures are approved at each of two energies, 100 GeV and 400 GeV. The analysis of this experiment will be compared with the results from runs at the same energies in hydrogen in which one of the collaborators was involved. The analysis will concentrate on the following topics:

1) Measurement of odd-prong multiplicity cross sections and comparison with even-prong results from the hydrogen data.

2) Determination of single-particle distributions. Studies can be made of isotopic spin exchange between the beam and target for reactions where pions are produced within a restricted kinematic region.

3) Study of two-particle correlations for a sample of events where the space angles of all secondary tracks are measured.

4) Study of neutron diffraction dissociation and double dissociation.

5) Measurement of the elastic and inelastic cross sections for particles coherently produced from deuterium.

6) Determination of neutral pion multiplicity and study of neutral strange particle production.

Summary revised by
C.T. Murphy, February 1975

A PROPOSAL FOR A MAGNETIC RECOIL SPECTROMETER
FOR THE GAS JET TARGET

D. Nitz, S. Olsen and D. Gross (Rochester); K. Abe, R. Bomberowitz, K. Cohen,
P. Goldhagen, F. Sannes (Rutgers); D. A. Garbutt, R. Rusach, I. Siotis (Imperial
College); and B. Morozov (Dubna).

Motivation:

The proposed experiment is a measurement of the s dependence of p-p elastic scattering in the region of the first diffraction minimum.

The primary questions addressed by this experiment are, for elastic p-p scattering:

1. Does shrinkage persist at high t?
2. How fast does the break seen at $t \simeq 1.2$ $(GeV/c)^2$ at 24 GeV develop into a dip? Does it move as s increases?
3. What is the energy dependence of the height of the secondary maximum observed at $|t| \sim 2.4$?

and for inelastic p-p

1. What is the s and x dependence of the inclusive proton spectrum for $|t| \gtrsim 0.5$ GeV/c^2?
2. How does the production of the N*(1520) and N*(1688) as a function of s and t compare with elastic scattering?

Similar measurements could be made from deuterium.

Technique:

The recoil spectrometer will consist of a superconducting quad doublet and a superconducting dipole interspersed with 12 proportional wire planes. The function of the quads is to focus parallel rays from the target to a point at the first wire plane where the machine vacuum ends. Thus the recoil angle measurement is made using one point, is independent of target size and is unaffected by multiple scattering. The recoil momentum is measured by bending through 25° in the dipole. Pions in the spectrometer will be rejected by time of flight. A Monte Carlo estimate of the mass resolution at 200 GeV and t = 1.5 GeV/c^2 is $\pm$ 137 MeV. The $|t|$ range extends to $|t|$ = 3.0 GeV^2 and the rate of elastic events at $|t|$= 1.5 GeV^2 are $\simeq$ 4/pulse ($d\sigma/dt = 10^{-32}$ cm^2/GeV^2) with 10^{13} circulating protons.

Summary Revised by
S. Olsen, January 1976

PROPOSAL TO SEARCH FOR WEAKLY PRODUCED MASSIVE LONG LIVED PARTICLES AT NAL

S. Frankel, W. Frati, L. Resvanis, and W. Yang, (University of Pennsylvania) and F. Nexrick (NAL)

Summary:

If new particles are produced at > 300 BeV energies it is possible that they might possess new quantum numbers or that they are created by other than strong or electromagnetic interactions and hence are not copiously produced. Having new quantum numbers they might only decay with long half lives. One can search for such particles under "beam-off" conditions.

The key experimental requirement is to be met by a detector which can operate at extremely high radioactivity levels close to a large piece of target or beam dump and detect the decays of multi BeV particles above this high background and in the presence of cosmic rays.

Procedure:

In the first phase of this search a gas Cerenkov counter, possessing six phototubes, viewing independently the Cerenkov light from the same event, will be set at $\gamma > 20$, well above the threshold for the most energetic electrons or γ rays accompanying the radioactivity of the target.

Radioactivity background is suppressed by requiring a six fold coincidence to reduce accidental coincidences due to Cerenkov light in the quartz windows of the Cerenkov counter.

The directional properties of the gas counter, aimed at the target from above, will be used to suppress cosmic ray background.

A thick accelerator target will be removed from the beam line and transported to our apparatus to search for activities in the hour-month range.

Summary reviewed by
S. Frankel, January 1976

Status: Approved, January 1973

SEARCH FOR TACHYON MONOPOLES IN COSMIC RAYS
ABOVE 15-FOOT BUBBLE CHAMBER

D.F. Bartlett, G. Schultz, D. Soo (University of Colorado);
M.G. While, K.E. Wright (Princeton University)

Two of the most speculative hypothetical particles are the magnetic monopole and the tachyon. It is believed that these particles exist as a combined "tachyon monopole" and the experimenters propose using the fringing field above the bubble chamber as a detector. It is assumed that a tachyon monopole will emit Cerenkov radiation when it is accelerated by a longitudinal magnetic field.

This radiation is viewed with 8 photomultiplier tubes placed on the sides of a 14 ft. square by 8 ft. high box. The box is mounted directly below the bubble chamber roof. The bottom of the half of the box can "telescope" into the upper to permit passage of the crane.

Data taken during the winter of 1975 showed several candidate events. But two events also occurred when the magnetic field was off. Detailed calculations showed that extensive air showers (EAS) could occasionally produce sufficient scintillation light in the air filling of the box to simulate a tachyon monopole.

Accordingly, two plastic scintillator counters were installed in the box in May, 1975. The scintillators are large enough to record EAS's but small enough so that a legitamate tachyon monopole would not veto itself. In three weeks of running, we found that every time a large signal was registered by the photo-tubes viewing the box, the EAS counters also registered large pulses. Our inability to find any tachyonic events unaccompanied by an EAS enabled us to fulfill a goal of the experiment; namely, the lowering of the existing limit on tachyon monopoles in cosmic rays by a factor of 100.

We did, however, find several double triggers: two events separated by a few microseconds. One event was accompanied by an EAS; the other apparently was not. Our apparatus was not set-up to record such double events. Modifications made during the summer of 1975 are permitting us to explore these double triggers.

Summary reviewed by
D. F. Bartlett, January 1976

EXPLORATION OF RARE MUON-INDUCED PROCESSES

A.R. Clark, E.S. Groves, L.T. Kerth, S.C. Loken, M. Strovink, W.A. Wenzel
(U.C. Berkeley - LBL); R. Cester, F.C. Shoemaker, P. Surko, M.S. Witherell
(Princeton); R.P. Johnson (Fermilab)

Initial Physics Objectives will be pursued concurrently:

1) Search for heavy neutral muons predicted by gauge theories
    in the mass range 2 - 10 GeV, and other new particles
    decaying into one muon. The sensitivity for analyzed events
    is $1 - 2 \times 10^9$ events/μb.

2) Measurement of deep-inelastic virtual Compton scattering
    and search for other deep-inelastic $\mu^+\mu^-$ pair creation.

3) Measurement of the deep-inelastic muon scattering structure
    function at very high momentum transfers. For example,
    8200 events exceeding $Q^2 = 160$ (GeV/c)^2 will be obtained.

4) Collection of $2 - 3 \times 10^4$ $\psi \rightarrow \mu^+\mu^-$ decays and data at higher
    dimuon masses. The $\psi\mu\mu$ coupling will be measured in the range
    -15 (GeV/c)$^2 < q^2 < 0$ with 7% statistics at $q^2 = -m_\psi^2$.

Experimental Technique

The spectrometer will realize a broader range of muon physics objectives than
those accessible to the first-round muon scattering experiments. It consists
of 18 modules, each containing 5 magnetized iron plates, 5 calorimeter counters,
1 proportional chamber, and 1 drift chamber. Alternate modules contain 1 trigger
hodoscope. The necessary sensitivity to rare processes is provided by high accept-
ance over the full length of the distributed target-spectrometer. Nearly continuous
iron is used to suppress $\pi \rightarrow \mu\nu$ decay background and provide the medium for calori-
metric determination of energy transfer to hadrons. Fast detectors will tolerate
further increases in beam intensity while maintaining acceptance of multiple final-
state muons even within the beam area. The various background trigger rates have
been estimated and found to be manageable.

Requirements for Operation

Existing space in the north portion of the Muon Laboratory is required, with an
illumination of 10^{12} muons at the highest available energy (225 GeV has been assumed).
The experiment is compatible with normal operation of the Muon Scattering Facility
upstream.

Summary prepared by M. Strovink, February 1975

PHENOMENOLOGICAL STUDY OF MUON-NUCLEON COLLISIONS AT 150 GeV/c

IN EMULSION

O.Kusumoto, S.Ozaki and M.Teranaka (Osaka City University);
H.Okabe and J.Yokota (Science Education Institute of Osaka Prefecture);
M.Ohta (Kinki University); K.Shibata (Okayama University); S.Mikamo
(National Laboratory for High Energy Physics).

Summary:

     The phenomenological features of charged hadrons produced by
the muon-nucleon interaction at 150 GeV/c are examined and the
results are compared with those obtained by the proton-nucleon
interaction at 200 GeV/c and, then, any proper feature of particle
production by a virtual photon is probed.   The phenomenological
features of charged hadrons, that is, multiplicity, emission angle,
and so on are examined over the ranges of low-q^2 to the scaling
region and of s value up to 100 GeV^2 or more (q^2 is the squared
4-momentum transfer of the muon and s is the squared mass of the
produced hadron system).   The A dependence (A is the mass number
of the target nucleus) of multiplicity and emission angles of
charged particles are also examined and compared with the results
for the proton-nucleus collisions.

Procedure:

     a)   Stack and Exposure Condition: Ordinary and sandwich stacks
are used. An ordinary stack consists of G5 pellicles of 3"x 6"x 600
μm, 48 sheets, and is exposed with a beam density, 5 x 10^5/cm^2.
A sandwich stack consists of metal foil and emulsion, each of which
is alternatively piled up and is exposed with a density, 5 x 10^5/cm^2.
Al, Fe and W of thickness 200 to 250 μm are used as sandwiched foils.
     b)   Scan and Measurement: Area scanning method is employed.
The charged particle with the highest momentum is assumed as the
outgoing muon. q^2 and s are approximately evaluated by the
momentum measurement of the outgoing muon or by summing up the
energies of the produced hadrons.

Summary prepared by
O. Kusomoto, March 1976

DEVELOPMENT OF A TRANSITION RADIATION DETECTOR FOR
DISCRIMINATING BETWEEN PIONS AND KAONS AT NAL ENERGIES

F. A. Harris, T. Katsura, S. I. Parker, V. Z. Peterson, V. J. Stenger
(Hawaii); R. Ellsworth, G. B. Yodh (Maryland)

The proposal is to develop a practical Transition Radiation (TR)
detector which should complement but may exceed gas-Cerenkov π/K
discrimination at the highest NAL energies. The Hawaii-Maryland-
Oxford collaboration has already obtained good (signal/noise) ratios
from electron-induced TR x-rays, using argon-, krypton-, and xenon-
filled MWPC. Both "sandwich" array (interleaved radiators and detectors)
and "magnetic separation" array (deflected charged particles) have been
tested experimentally at LBL and SLAC.

The proposed NAL setup (in the 30" BC beamline) includes a single
radiator (thin Be and Li foils), magnetic separation with existing
beamline magnets, and a multi-cell xenon-filled MWPC detector ~ 200 feet
downstream. At 400 GeV/c pions are expected to produce a ~ 100 KeV signal
(~ 5.2 photons detected); the kaon signal should be $\sim 6\%$ of the pion signal.

Direct comparison of TR with the gas Cerenkov is proposed.

The reduced multiple-scattering of pions (as compared with electrons)
offer the interesting possibility of observing for the first time "dif-
fraction-grating" coherence in TR.

At present the Lithium-foil radiator has been assembled and a solid-
state detector is under construction. The xenon-gas detector design has
evolved into a drift chamber providing both spatial and pulse-height
information.

Summary reviewed by
V. Z. Peterson, March 1976

PROPOSAL TO STUDY 500 GeV pp COLLISIONS
IN THE 30 INCH BUBBLE CHAMBER AT NAL

R. Engelmann, T. Kafka, J. Lee-Franzini, C. Moore and M. Pratap
(SUNY at Stony Brook)

A 50,000 picture exposure of the 30 inch bubble chamber, filled with hydrogen, to a 500 GeV proton beam is requested. About 5 tracks per picture will yield about 10,000 events. A thin lucite plate is to be inserted in the downstream part of the chamber to assist in track matching.

The measurements of interest are:

1) A 1.7% measurement of σ_{tot} at 500 GeV (from the ISR data one predicts a 5% rise).

2) Multiplicity distribution, its moments and their energy dependence.

3) Single particle inclusive spectra for negative particles (π^-) in the complete backward hemisphere (y) and for all charges in both hemispheres ($\log\tan\frac{0_{LAB}}{2}$).

4) Neutral strange particle production and π^0 production (n_{π^0} vs. n-charged).

5) Two particle correlations.

6) The diffractive process $pp \to p_{slow} + MM^2$ and its energy dependence.

7) Δ^{++} production and its energy dependence.

Summary prepared by
R. Engelmann, May 1973

A PROPOSAL TO STUDY PROTON-PROTON INTERACTIONS
AT THE ENERGY OF 300 GEV OR HIGHER
AT THE NAL BUBBLE CHAMBER

M. A. Markov, J. S. Takibaev
(Academy of Sciences of the Kazakh, U.S.S.R.)

A request has been made for 75,000 pictures of an NAL bubble
chamber exposed to protons with energy of 300 GeV or higher.   The
purpose of this experiment is to study high energy proton-proton
interactions.   It is proposed by a group from the U.S.S.R. which
Has experience studying hadron-hadron interactions both in emul-
sions and in bubble chambers.

Summary reviewed by
M. A. Markov, January 1976

A STUDY OF 300 GeV/c pd INTERACTIONS IN THE
THIRTY-INCH BUBBLE CHAMBER

C. Peck, A.P. Sheng (Caltech); W.E. Anderson, H.B. Crawler,
A. Firestone, W.J. Kernan, D. Parker (Iowa); J.M. Canter,
F.T. Dao, W.A. Mann, J. Schneps (Tufts); R. Cassell, S. Jones,
R.S. Panvini, J.S. Poucher, A. Rogers, S. Stone (Vanderbilt)

Picture-taking for experiment E-209 was completed in October
of 1975. The number of participating institutions and physicists
has increased from that mentioned in the original proposal. The
physics objective has also been altered slightly and expanded to
include a careful study of the double diffraction dissociation
process involving the beam proton and the target neutron. So far
we have worked on the following topics:

1. Charged multiplicity distributions and the effect of double
    scattering in deuterium. Paper completed and published in
    A. Sheng et al., Phys. Rev. D12, 1219(1975).

2. Inclusive distributions in the target fragmentation region
    using reactions p + n → h + x, where h includes the hadrons
    p, π^+, and π^-. Paper presented at the Washington APS meeting
    April 28 - May 1 (1975). Since that meeting we have doubled
    our reaction samples and are presently preparing a paper for
    publication. The paper will also probably include the next
    topic:

3. Excitation states from the neutron target fragmentation.
    Paper also presented at the Washington APS meeting, April
    28 - May 1 (1975).

4. Analysis of the spin structure of diffractively excited states
    and the correlations with the charged multiplicity. Paper
    to be presented at the New York APS meeting, February 2-5
    (1976).

5. Study of double diffraction dissociation process from three-
    to six-pronged events in pd interactions. We are scanning
    for, and measuring the double diffraction candidates in the
    30" bubble chamber; the joining of these bare chamber
    measurements with tracks detected in the downstream hybrid
    spark chambers is presently underway.

We have also considered other possible physics projects
such as a detailed study of double scattering within the deutron
using two-proton events and a search for new heavy resonances
which decay into K^0 or ^{0} plus other charged particles. Detailed
consideration will be given to these new projects as analysis
of our initial five topics nears completion.

Summary prepared by
F.T. Dao and W.A. Mann, January 1976

PROPOSAL FOR RADIATION MEASUREMENTS AROUND A
PROTON BEAM DUMP AT 300 GeV

H.O. Wuster, M. Growley-Milling, <u>K. Goebel</u> (CERN); M. Awschalom (NAL)

A request has been made for use of the primary proton beam to check some Monte Carlo calculations for the 300 GeV CERN project to determine particle flux densities, radiation heating, and absorbed dose. All of these measurements are included in the approved NAL Experiment #108 but it is doubtful that the results from that experiment would be available before these measurements are needed. The spokesman from Experiment #108, M. Awschalom, will participate in this work.

The specific measurements can be broken down as follows:

1. Measurement of energy deposition.
   Measurement of the temperature rise of a cylindrical beam stop; 10^{11} ppp for ~4 hours.

2. Measurement of extranuclear cascade in a beam stop.
   Exposure of a number of steel plates with foils for activation analysis perpendicular to a proton beam with $10^{11} - 10^{12}$ ppp; 24-40 hours of exposure.

3. Measurement of beam losses and extranuclear cascade in a cavity.
   Exposure of a main ring magnet to a proton beam of 10^{12} ppp for ~10 hours.

Summary prepared by
A. F. Greene, June 1973

PROPOSAL TO STUDY HIGH ENERGY
NEGATIVE HYPERON INTERACTIONS WITH
THE NAL 15-FOOT BUBBLE CHAMBER

Cambridge, U. of Michigan (Ann Arbor), Strasbourg

J.G. Rushbrooke (Cambridge)- Spokesperson

It is proposed to transport 10^5 primary protons/pulse to the vicinity of the 15-foot bubble chamber in order to produce a negative hyperon beam suitable for analysis in the chamber. The hyperon beam would rely on the use of high field pulsed quadrupole magnets which have been supplied by the Rutherford Laboratory. The proton beam is incident on a heavy target. Pulsed magnets focus and bend the negative particles of interest through a series of collimators which comprise a total length of 6.5 -13.0 m depending on momentum. The momentum resolution of the hyperon beam is $\sim\pm5\%$ $\delta p/p$. Σ^-/π^- ratios vary from 6/4 to 2/8 at the chosen momenta. Further selection of events can be made by requiring the observation of a secondary Σ^- decay.

The physics motivation is based on systematic studies of hyperon interactions including topological cross sections, multiplicity distributions, inclusive distributions and unanticipated phenomena. The specific request is for 50K pictures of 200 GeV/c hyperons, 75K pictures at 100 GeV/c, and 150K pictures at 50 GeV/c. Within the 100 and 200 GeV/c exposures there are expected $\sim$1000 Ξ^- and $\sim$50 Ω^- decays.

Summary reviewed by
J. G. Rushbrooke, January 1976

STUDY OF 400 GeV π⁻p INTERACTIONS IN THE
BARE 30" BUBBLE CHAMBER

G. Abrams, C. Friedberg, G. Goldhaber, A.D. Johnson, J. Kadyk,
G. Trilling, F. Winkelmann (LBL); H. Bingham, D. Chew,
W. Fretter, W. Graves, L. Stutte, G. Yost (Univ. of Calif.,
Berkeley); D. Bogert, R. Hanft, F.R. Huson, D. Ljung, C. Pascaud,
S. Pruss, W.M. Smart (Fermilab)

It is proposed to obtain a 50K picture exposure of negative pions incident on the 30-inch hydrogen-filled bubble chamber. This work is proposed by the same group which obtained data of π⁻-p interactions at 200 GeV in the 30-inch chamber (Experiment #137). With a primary beam momentum of 400 GeV it is believed that the pion flux at 380 GeV will be sufficient for the exposure. It is expected that about 800 elastic and 6,000 inelastic events will be available for analysis. The primary interests include measurements of total and elastic cross sections, multiplicity distributions, diffractive processes, strange particle production, inclusive distributions, double-Pomeron exchange processes, and characteristics of copiously produced channels.

Summary reviewed by
G. Goldhaber, February 1975

A MEASUREMENT OF THE PION FORM FACTOR
BY DIRECT PION-ELECTRON SCATTERING

D. Drickey, C. May, E. Dally, H.K. Ticho, C. Buchanan, D. Stork,
(UCLA); P. Shepard, (Univ. of Pittsburgh); J. Poirier, C. Rey,
R. Wojslaw (Univ. of Notre Dame); A. Wehmann, T. Toohig, J. Tompkins,
A. Lennox, (Fermilab).

The objective of this experiment is to measure the pion electro-
magnetic form factor in the spacelike region of momentum transfer by
direct observation of pions from a beam scattered from stationary
electrons in a hydrogen target.

A previous experiment conducted at Serpukhov yielded a pion radius
squared of $(0.61 \pm 0.15)F^2$. The initial data for the present experiment
will be taken at 100 GeV, twice the Serpukhov value. The momentum
transfer range will be extended to $0.08 (GeV/c)^2$ and thus the effect of
pion size will be significantly increased and systematic errors
reduced.

The apparatus is being installed in the M1 beam line at the Meson
lab. The trajectory of the incident pion entering a 50 cm long liquid
hydrogen target and the momenta and scattering angles of the recoiling
π-e pairs will be measured with a combination of proportional wire
chambers, spark chambers and bending magnets (2 BM 109's with 8" x 18"
aperature and $\int Bdl = 80$ kg-m). Electrons and hence the q^2 label for each
event will be identified through kinematic analysis of the recoiling
particles made possible by the high angular precision of the apparatus
(± 0.2 Mr). A redundancy check on the electron identification is
supplied by total absorption Pb-glass shower counters and any μ-e
events are rejected in a muon filter.

An approved 100 hours for testing and running is consistent with
the above objectives. We are further encouraged to subsequently run
at the highest beam energy practical in the Meson Area. We anticipate
that 200 GeV running will be practical and hope to thereby extend the
pion form factor measurements to $q^2 = 0.18$ $(GeV/c)^2$.

A measurement of the K meson form factor is experimentally
difficult at 100 GeV. We will attempt to make such a measurement to
a precision of 20%. It becomes considerably easier at 200 GeV and
we hope that the higher energy running proves practical.

D. Stork
January, 1975

A COMPARISON OF 100 AND 200 GeV π^+-p INTERACTIONS

J. Erwin, W. Ko, R. Lander, D. Pellett, P. Yager (Univ. of
Calif., Davis); M. Alston-Garnjost (LBL); J.H. Friedman (SLAC)

An exposure of 50K pictures of tagged 200 GeV positive
pions is proposed for the 30-inch hydrogen-filled bubble
chamber. This would match a similar exposure at 100 GeV
(Experiment #121A).

PION-DEUTERON INTERACTIONS AT 200 GeV/c

J. Erwin, W. Ko, R. Lander, D. Pellett, P. Yager (Univ. of
Calif., Davis); L. Dunn, H.J. Lubatti, K. Moriyasu, W. Podolsky
(Univ. of Washington)

     A proposal is made for 50K pictures of the 30-inch deuterium-
filled bubble chamber exposed to a 200 GeV/c negative pion beam.
Use would be made of a downstream spectrometer system if it
were available. The purpose of the experiment is to utilize the
properties of the deuteron to study reactions which cannot
easily be studied on protons. This may include (1) inclusive
reactions such as $\pi^-+n\rightarrow\pi^\pm+$ anything, (2) diffractive dissociation
of the neutron, (3) diffractive dissociation of pions on deuterons.

                              Summary prepared by
                              A.F. Greene, June 1973

PROTON-PROTON INELASTIC SCATTERING IN THE DIFFRACTION REGION

S. Childress, P. Franzini (Columbia Univ.); J. Lee-Franzini,
R. McCarthy, R. Schamberger (SUNY, Stony Brook)

It is proposed to move the apparatus used for NAL
Experiment #14A to the Internal Target Area. They have taken
data at a location in the Neutrino Target Hall at energies
of 200, 300, and 400 GeV. Their 200 GeV results have been
prepared for publication and indicate that the proton-proton
inelastic cross section exhibits unusual behavior in the
region of low $|t|$. At low M^2 the cross section is small at
small $|t|$ and appears to approach a maximum at $|t| \approx 0.1$ GeV^2.
They propose to extend their measurements to include a careful
study of the s-dependence of the inelastic cross section. The
target will consist of rotating polyethylene foils and carbon
filaments. The basic detectors are solid state and enable
an M^2 resolution of ± 0.5 GeV for $|t| \approx 0.03$ GeV^2. They are
capable of making measurements in the momentum transfer
region $0.02 < |t| < 0.2$ GeV^2.

Summary reviewed by
P. Franzini, February 1974

STUDY OF DIFFRACTION DISSOCIATION (COHERENT AND INCOHERENT) AND
INCLUSIVE PARAMETERS OF THE INTERACTION OF HIGH ENERGY PIONS
AND PROTONS ON NUCLEI HEAVIER THAN HYDROGEN

L. W. Jones, J. VanderVelde and D. E. Lyon, Jr. (University
of Michigan)

This experiment is proposed to study the multiplicities,
momenta, and angular distributions of charged hadrons produced
by protons and pions of 200 GeV on nuclei. The objective is
to make a systematic study of the inclusive parameters of
strong interactions as functions of nuclear size (e.g. atomic
weight). Such studies provide in principle a unique means of
exploring the early evolution of the final state of strong
interactions at very high energies, wherein the nucleus itself
is used as a high-density micro-laboratory. A secondary
motivation is to determine the phenomenological parameters of
nuclear interactions in order to better interpret neutrino
and cosmic ray data wherein direct knowledge of the interaction
energy is unknown.

The experiment would employ a target assembly containing
four small plates of C, Al, Cu, and Pb within the sensitive
volume of the 30-inch bubble chamber. Two sets of 50,000
pictures each are requested in order to have a sample of
4,000 interactions in each element with each beam. Interest
in the results is enhanced if additional runs at divergent
energies could also be obtained.

Summary reviewed by
L. W. Jones, January 1975

COHERENT K_S^0 REGENERATION BY ELECTRONS

J. Roehrig, E.I. Rosenberg, V.L. Telegdi, B. Winstein
(Univ. of Chicago); H. Kobrak, R.A. Swanson (Univ. of
California, San Diego); S.H. Aronson (Univ. of Wisconsin);
H. Hofer (Swiss Fed. Inst. of Technology, Zurich)

It is proposed to extend the use of the E-82 spectrometer in the neutral beam M4 to a determination of the amplitude for regeneration of K_S by electrons. This quantity is directly proportional to the rms neutral kaon charge radius, R^2. NAL is uniquely suited for such a determination since the electron contribution to regeneration is $\epsilon \approx 7\%$ at 100 GeV, and grows as the square root of the kaon momentum. It is proposed to measure this number to a precision $\Delta\epsilon \approx 1.8\%$. For this purpose they need to do some ancillary measurements which are also of interest:

a. Measurement of σ_{tot} (K_L^0-nuclei) in good geometry to a precision $\lesssim 1\%$, by inserting material in the K_L-beam far upstream.

b. Measurement of the K^0-p elastic scattering cross section, by measuring the angular dependence of K_S^0 events, and determining the t=0 point in absolute value from σ_{tot} via the optical theorem.

c. Measurement of K_S^0 diffractively regenerated from a moderately thin regenerator.

d. Measurement of inelastic regeneration. One of the many ways possible is to trigger only on inelastic events.

They require 10^5 regenerated events at 100 GeV/c, which in principle could be taken in 5 days of good running. They estimate a need for 30 days of running time.

PROPOSAL TO INVESTIGATE NEUTRINO INTERACTIONS
IN DEUTERIUM USING THE FERMILAB 15-FT BUBBLE CHAMBER

R. Engelmann, T. Kafka, J. Lee-Franzini, M. Pratap (SUNY
at Stony Brook); J. Canter, W.A. Mann, J. Schneps, G. Wolsky
(Tufts University)

A 300,000 picture exposure of the 15-foot bubble
chamber to a broad band neutrino beam from 350 GeV protons
is requested. The neutrino flux will be determined from
elastic and Δ^{++} production events to about 13%. The μ
can be identified in most of the cases without external
μ identification and the final state hadron energy can be
estimated on a statistical basis. The experimenters are
interested though to collaborate with other groups for the
use of an external μ identifier.

The main physics interest is:

1. Extension of elastic form factor fits to higher q^2 at
   Fermilab energies.

2. Simultaneous investigation of νn and νp inelastic
   reactions in one exposure with one neutrino flux,
   i.e., comparison between $\sigma(\nu n)$ and $\sigma(\nu p)$ and the
   n and p weak structure functions.

3. Search for isotensor currents by measuring the ratio
   $\nu p \rightarrow \mu^- \Delta^{++}/\nu n \rightarrow \mu^- \Delta^+$ in one experiment.

4. Search for and study $\Delta S = -\Delta Q$ transitions, neutral
   currents, new particles.

5. Tests of sum rules.

   Realistic estimates of available neutrino fluxes
suggest that a large number of pictures will be needed in
order to answer the physics questions of interest. The
experimenters therefore feel justified to propose an
exposure similar to one already proposed.

Summary reviewed by
R. Engelmann, February 1974

PROPOSAL TO EXTEND THE ENERGY RANGE OF A STUDY
OF MULTIPARTICLE PRODUCTION IN pp COLLISIONS

J. Chapman, J. Cooper, N. Green, B. Roe, A. Seidl,
J. VanderVelde (University of Michigan); C. Bromberg,
D. Cohen, T. Ferbel, P. Slattery, D. Underwood
(University of Rochester)

The Michigan-Rochester Collaboration, in a pair of
coupled experiments, has obtained a total of about 31,000
exposures of the bare 30-inch ANL/NAL bubble chamber to
100 GeV/c protons (Proposal 252) and 12,000 exposures
of this chamber to 400 GeV/c protons (Proposal 138).
Since their motivation has been largely to study the energy
dependence of various production processes they wish to
substitute the remaining pictures at 100 GeV/c for an
equivalent exposure at 60 GeV/c. This will provide
valuable measurements of the total cross section and of
multiparticle production processes to compare with Serpukhov
and ISR experiments.

They will emphasize the analysis of the diffractive
part of the inelastic cross-section.

Summary reviewed by
T. Ferbel, February 1975

A PROPOSAL FOR TESTING A TRANSITION RADIATION DETECTOR AT NAL

G.F. Dell, Jr., R. Keller, H. Uto, Luke C.L. Yuan (BNL)

It is proposed to use a high energy beam containing hadrons and muons to study transition radiation detectors at NAL energies. Some measurements have already been made using electrons at γ's which simulate NAL energies but uncertainties remain about the bremsstrahlung background and Coulomb scattering of heavier particles. The specific objectives of the experiment are as follows:

1. Measurement of the yield of transition radiation from muons and hadrons using a large number of proportional wire chambers (PWC's) filled with Xe at the highest energy available ($\sim$280 GeV) and comparison with theoretical estimates.
2. Study of the relativistic rise effect also using PWC's.

3. Measurement of the yield of transition radiation from a NaI crystal with a central beam hole.

The specific request from NAL is for a space of 10-15 feet along a beam line in the Meson Area.

Summary reviewed by
Luke C.L. Yuan, January 1975

A SEARCH FOR "SCHEIN EVENTS" AND
EVENTS WITH A HIGH MULTIPLICITY OF γ's

D.L. Burke, H.R. Gustafson, L.W. Jones, and M.J. Longo
(University of Michigan)

Cosmic ray emulsion experiments by Schein, et al. and by other groups have periodically found events which showed a large number of high-energy γ's which are not accompanied by charged particles. Ruderman and Zwanziger suggested that these events could come from the annihilation of a magnetic monopole-antimonopole pair. T.D. Lee pointed out they could arise from other processes such as the annihilation of high-Z lepton pairs.

They propose to use the wide-gap spark chambers which are already set up in the small-angle neutral beam. They will study the forward multigamma production by neutrons and photons in CH_2 and Pb targets. In one beam pulse the target will be exposed to many more particles with energies greater than 100 GeV than the emulsion stack in which the first "Schein event" was discovered.

The trigger selects events where a neutral particle comes to the target, no charged particles come out, and many charged particles are produced in the lead converter. The wide gap spark chambers should be capable of handling the large number of tracks (up to 100) which may be expected. The proposed experiment is strictly exploratory in nature.

The minimum running time requested is 6 periods of one hour each to tune up the chambers and 4 periods of one shift each for data taking.

Summary reviewed by
M.J. Longo, February 1974

400 GeV Protons on Complex Nuclei

D. T. King et al., University of Tennessee

Summary: This proposal requests a nuclear emulsion exposure to 400 GeV protons. The experiment was actually pursued at 300 GeV.

   (i)   Beam: Protons 300 GeV
  (ii) Intensity: $1.5 \times 10^4/cm^2$ and $3 \times 10^4/cm^2$
 (iii) Emulsion: Two small Ilford K5 stacks
  (iv) Alignment: Parallel

These observations provide comparison of nuclear evaporation phenomena with similar data taken at 200 GeV. The proton-nucleus electromagnetic interaction is also examined.

Emulsion processing, scanning: U.T.

Received: July, 1973

Approved: August, 1973

Exposure: October, 1973

300 GeV Proton Interactions in Nuclear Emulsion

J. Hebert, C. J. D. Hebert, H. Areti (Ottawa), M. A. Vincent
(Quebec), G. Baumann, R. Devienne (Nancy), J. Lory, C. Meton,
D. Schune, B. Willot, B. Charquet, Tsai-Chu, M. Morand (Paris),
R Kaiser, J. P. Massue, R. Pfahl, C. Jacquot (Strasbourg),
I. Otterlund, (Lund), A. Van Ginneken (Fermilab), J. Juric,
O. Adamovic (Belgrade), R. Schmitt (Lyon), J. M. Bolta,
J. Pellicier, G. Rey, F. Tejerina (Valencia), F. Fernandez,
J. Medena, A. Dura, V. Gardia (Valencia), E. Villars (Santanber).

This study extends the work of Experiment 116 (200 GeV
protons on emulsion and largely completed) to higher energies.
The emphasis is on establishing the general characteristics
of inelastic p-nucleus interactions: interaction length, average
multiplicity (differentiated by track density), multiplicity
and angular distributions, angular and multiplicity correlations,
coherent production, etc. Where feasible interactions will
be differentiated by target (Ag and Br versus H, C, N and O).

Results are to be compared with results obtained with
emulsion at lower energies, with results obtained with other
target elements (including hydrogen), with empirical scaling
laws as well as with theoretical predictions.

In the course of these measurements special attention
will be given to the possibility of encountering new (or poorly
established) short-lived particles.

ENGINEERING RUN FOR THE 15-FOOT BUBBLE CHAMBER-E-234

D.Bogert, R. Hanft, F.R.Huson, M.Johnson, S.Kahn

S.Pruss and W.Smart

This proposal was approved for 50,000 pictures of one sign and one momentum. Without a beam tagging system, the choice was limited to a π- or proton beam. We have chosen π-, as the high energy π- beam is unique to FERMILAB.

Our data analysis shall commence with the following:

1. Measure all gamma, Vee and kink events to study inclusive neutral distributions and correlations of multiple gamma and Vee events.

2. Measure all 4 prong events on the FERMILAB CRT measuring device SAMM. This will give diffractive cross sections. Also with the high statistics available various Pomeron models can be tested and ππ scattering can be studied.

3. Scanning and measuring of a sample of the film for an inclusive study of charged prongs.

SK:dla
6/12/74

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

V. Cook, G. Hicks, P.M. Mockett, W.P. Oliver, J.E. Rothberg, R.W. Williams,
K.K. Young (Univ. of Washington); P. Limon, P. Mantsch, R. Orr, S. Pruss
(National Accelerator Laboratory)

This experiment plans to achieve the following goals:

i)   High statistics measurements of the single particle inclusive cross
     sections above P_t = 2 GeV/c produced by $\pi^{\pm}$, $K^{\pm}$ and $p^{\pm}$.

ii) Search for hadron jets associated with the large-P_t events. The
     momentum of each charged particle in the jet will be measured so
     that a full correlation study will be possible. In a large fraction
     of cases the outgoing species will also be identified by three
     Cerenkov counters.

iii) Observe the recoil structure opposite the large-P_t particle (or jet)
     with a photon and hadron calorimeter subtending about 2.7 steradians.

iv) Observe the rapidity distribution for all charged particles accom-
     panying the large-P_t event.

     This experiment will run in beam M1-East of the Meson Area following
Experiment #7. It utilizes a large aperture magnetic spectrometer (~1 sr
aperture) followed by three segmented threshold Cerenkov counters. This
is designed to study in detail the charged particle component of large P_t
events. Three hodoscope arrays are employed to select events where at
least one charged particle has a P_t >1.5 GeV/c. Particle species will be
identified over the full kinematic range of the spectrometer. The spect-
rometer will explore the center of mass angular region of 45° to 110°.

     The spectrometer arm will be complemented by a photon and hadron
calorimeter on the recoil side. This will cover an angular range of 60°
to 135° in the center of mass. The calorimeter will be segmented so that
a trigger on large P_t can be employed. It will allow the study of jet-jet
correlations as well as a measurement of the neutral component of large-P_t
events.

     The experiment will utilize a 13,000 wire MWPC system to allow high
data rates with good duty cycle. PWPC's will also give high efficiency
for the large multiplicity events expected in this domain.

     Employing a 12-inch LH$_2$ target and 5×10^6 incident particles per
pulse at 200 GeV/c, the experiment will obtain ~2×10^5 events with $P_t \geq 3$
GeV/c from the spectrometer trigger and ~10^6 from the calorimeter trigger
per 100 hours of data-taking.

     In 500 hours of data taking the experiment is expected to cover three
beam momenta of both sign and all the six types of beam particles. It will
explore how P_t is balanced in large-P_t events and look for the predicted
jet-like structure associated with large-P_t.

EMULSION EXPOSURE TO 300 GeV PROTONS

J. J. Lord (University of Washington)

Proposed Continuation and Extension at 300 GeV.

1. The first phase of our experiment #171 was carried out at
    200 GeV in Sept. 1972. The purpose of the experiment was
    the search for new short-lived particles produced in nuclear
    collisions in emulsion.

2. We would like to extend our search for short-lived particles
    to 300 GeV in case there is a higher threshold energy for
    their production.

3. A side-line found during the 200 GeV experiment was the
    study of intranuclear cascades in proton-tungsten nuclear
    collisions. We would like to extend this to collisions
    with other nuclei from $Z = 5$ to $Z = 90$ in order to compare
    with the Independent Particle Model and the Coherent
    Particle Model theories of J.S. Trefil. A portion of
    this experiment could be carried out at energies of either
    or both 200 GeV and 300 GeV.

4. The experiment can be carried out with 6 separate packets
    of plates each 2" x 6" and 10" long.

5. An exposure of about 75,000 to 200,000 protons per square
    centimeter would be needed.

                    Summary prepared by
                    J. J. Lord, August 1973

EMULSION EXPOSURE TO 400 GeV PROTONS

J. J. Lord (University of Washington)

Proposed Continuation and Extension at 400 GeV

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    200 GeV in Sept. 1972. The purpose of the experiment was
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Summary prepared by
J. J. Lord, August 1973

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PROPOSAL FOR A FURTHER SEARCH FOR
LONG-LIVED PARTICLES AT NAL

S. Frankel, W. Frati, L. Resvanis, W. Yang
(Univ. of Pennsylvania); F. Nezrick (NAL)

The recently completed experiment 199 was sensitive to long-lived particles produced by 300 and 400 BeV protons if their lifetimes were in the range of 1 to 1000 hours. The upper limit on their production and capture cross-section was less than 10^{-36} cm^2.

The authors have just completed taking data which pushed this search down to particles with mean lives in the 10 millisecond to 10 hour region. This was accomplished by looking between spills for ultrarelativistic decay particles, with a gas Cerenkov counter aimed directly at the target, at 90° with respect to the incoming beam. Preliminary analysis shows an upper limit of 10^{-36} cm^2 for production and capture of particles with mean lives between 10 milliseconds and 10 hours.

STUDY OF SECONDARY PARTICLES PRODUCED BY 300 GEV

PROTONS IN EMULSION CHAMBERS.

K.Hoshino, S.Kuramata, K.Niu, K.Niwa, S.Tasaka
and Y.Yanagisawa (Nagoya University)

Y.Maeda (Yokohama National University)

N.Ushida (Aichi Educational University)

SUMMARY OF PROPOSAL

　　The purposes of this exposure are 1. Calibration of relative
scattering method for determination of momentum of charged particles.
2. The distribution of energy given to γ rays and the distribution
of elasticity of collisions. 3. Search for short-lived particles
as found by author in an emulsion chamber exposed to cosmic rays.
　　Two emulsion chamber consisting of nuclear emulsions and thin
lead plates the size of which is 12cm×9.5cm×7cm will be exposed.

STATUS

COMPLETED: October, 1973
EXPERIMENTAL RESULT AND PUBLICATIONS.

1)　APPLICATION OF THE RELATIVE SCATTERING METHOD TO THE ANALYSIS
　　OF SUPER HIGH ENERGY JET SHOWERS.

　　K.Hoshino et al.

　　PROCEEDINGS OF INTERNATIONAL COSMIC RAY SYMPOSIUM ON HIGH
　　ENERGY PHENOMENA. COSMIC RAY LABORATORY, UNIVERSITY OF TOKYO.
　　NOVEMBER 1974, p. 155

Calibrations of the relative scattering method for determination
of momentum of charged particles were carried out exposing emulsion
chambers to protons of 303 GeV/c at the FNAL and to negative
π mesons of 8 GeV/c at the ANL.

　　　　　　　　　Summary reviewed by
　　　　　　　　　K. Niu, February 1976

STUDY OF SECONDARY PARTICLES PRODUCED BY 400 GEV

PROTONS IN EMULSION CHAMBERS.

K.Hoshino, S.Kuramata, K.Niu, K.Niwa, S.Tasaka
and Y.Yanagisawa (Nagoya University)

Y.Maeda (Yokohama National University)

N.Ushida (Aichi Educational University)

SUMMARY OF PROPOSAL

The purposes of this exposure are 1. Search for short-lived
particles as found by author in an emulsion chamber exposed to
cosmic rays. 2. The distribution of energy given to γ rays and
the distribution of elasticity of collisions. 3. Calibration
of relative scattering method for determination of momentum of ·
charged particles.

Several emulsion chambers consisting of nuclear emulsions and
thin low and high Z materials the size of which is 12cm×9.5cm×7cm
will be exposed.

STATUS

COMPLETED: December, 1975

Exposed emulsion chambers are now on the scanning and analysing
stages at each member university.

Summary reviewed by
K. Niu, February 1976

STUDY OF 300 GeV PROTON INTERACTION WITH NUCLEAR EMULSION

Piyare L. Jain (State Univ. of New York at Buffalo)

In 300 GeV proton interacting with nuclear emulsion, we are interested in the study of 1) white stars as was done[1] at 200 GeV, 2) coherent production of particles, 3) characteristics of multiplicity distribution, 4) electron-pair production, 5) study of those events which interact with complex nuclei ($N_L \geq 2$), the multiplicity of their shower tracks as a function of N_h, 6) behavior of backward particles for which momenta and masses are calculated.

We shall expose a small stack of 20-25 pellicles of size 10 x 20 x 600 thick to a proton beam with a flux density ~5 x 10^4 particles/cm^2. We shall collect the data by scanning along the track and by area scanning.

_____

1. Coherent production of particles by 200 GeV/c protons in Nuclear Emulsion, N.C. Lett (1974).

2. Correlation of particles at 200 GeV proton-proton→interaction, N.C. Lett (1974)

3. International Conference on New Results from Experiments on High Energy Particle Collisions, Vanderbilt, Tenn. (1973).

4. Electron pair production by 200 GeV proton in nuclear emulsion ADS meeting, Washington, D.C. Apine 1974.

Summary prepared by
P. L. Jain, March 1976

Study of 400-500 GeV Proton Interaction With

Nuclear Emulsion

by

Piyare L. Jain
Professor of Physics
State University of New York at Buffalo
Buffalo, N.Y.

In 400-500 Ge V proton interacting with nuclear emulsion, we are interested in the study of (i, white stars as was done[1] at 200 GeV, (ii, coherent production of particles, (iii, characteristics of multiplicity distribution, (iv, electron-pair production, (v, study of those events which interact with complex nuclei $(N_k > 2)$, the multiplicity of their shower tracks as a function of N_h, (vi, behavior of backward particles for which momenta and masses are calculated.

We shall expose a small stack of 20-25 pellicles of size 10x20x600 thick to a proton beam with a flux density ~5×10^4 particles/cm^2. We shall collect the data by scanning along the track and by area scanning.

1. Coherent production of particles by 200 GeV/c protons in Nuclear Emulsion, N.C. Lett (1974).

2. Correlation of particles at 200 GeV proton-proton→interaction, N.C. Lett (1974)

3. International Conference on New Results from Experiments on High Energy Particle Collisions, Vanderbilt, Tenn. (1973).

4. Electron pair production by 200 GeV proton in nuclear emulsion APS meeting, Washington, D.C. Apine 1974.

SEARCH FOR DIFFERENCE IN PION/PROTON INTERNAL STRUCTURE

W. Selove, L. Kroger, T. Kondo, W. Kononeko, E.M. O'Neil
(University of Pennsylvania); A.R. Erwin, E. Harvey,
R. Loveless, M. Thompson (University of Wisconsin)

Bjorken et al. suggested that parton-parton collisions
might produce jet pairs at large angles, separable from jets
along the beam direction. If found, these jet pairs could
give direct evidence of parton-parton collisions and of the
internal momentum distribution of partons in hadrons. Because
the pion is made of fewer components (2 quarks) than the proton
(3 quarks) the probability for high-momentum components inside
the pion should be greater than for high-momentum components
inside the proton. This effect would cause the products of a
parton-parton collision from a πp initial state to exhibit a
forward-backward asymmetry in the over πp c.m. system (result-
ing from the 2 quark versus 3 quark collision). This asym-
metry should be quite large in high-p_t events.

They propose to study jet-pairs in πp and pp collisions
with the following objectives:

 i) To look for an asymmetry in the production of forward
    pairs compared to backward pairs;

 ii) To measure the ratio of event rates with jets of given
    p_t compared to single particles of the same p_t.

iii) To study the distribution of multiplicities in jets and
    correlations in these multiplicities for jet pairs.

The detector chosen is a calorimeter hodoscope. A pair
of calorimeters on the two sides of the beam is proposed to
detect typical jets of 3 particles with total energy of 60 GeV
and angular separation of 10-20 mrad. Each calorimeter will
be made of about 20 elements, each with a diameter of a cascade
shower (about 8" to 16"). The calorimeters will be located
about 20 meters from the target and should give $\delta E/E \sim 10\%$
at 50 GeV/c. The angular resolution of the hodoscopes will be
$\delta\theta \sim$ few mrad.

They estimate counting rates of about 30 π's per hour in
each hodoscope with p_t > 6 GeV/c and coincidence rates of about
1 per hour, assuming 10^9 negative pions per burst. The beam
momentum spread could be $\pm 5\%$ and have an angular divergence of
a few mrad. If 10^9 pions per burst cannot be achieved, they
will lower the transverse momentum requirement.

Summary reviewed by
W. Selove, February 1974

A PROPOSED EXPERIMENT TO SEARCH FOR
CHARMED PARTICLES AND HEAVY LEPTONS

Universities of Brussels, Dublin, London, Rome, Strasborg and
the Fermi National Accelerator Laboratory
E.H.S. Burhop (Spokesman)

If charmed particles and/or heavy leptons exist and have
a mass in the range 1 - 3 GeV it appears that their mean life
is likely to lie in the range $3 \times 10^{-12} - 3 \times 10^{-15}$ sec. This
lifetime is outside that which could be directly detected in
bubble chambers and in electronic detectors; it is instead within
the capabilities of the photographic emulsion technique.

It is proposed to search for such short-lived particles
produced in neutrino interactions, with a hybrid emulsion-
spark chamber arrangement. Three scintillation counters
would trigger two optical spark chambers; the neutrino inter-
action in emulsion can be readily located by following back
into the emulsion the tracks of the spark chamber. Such a
system proved to be workable at CERN.

The experimenters aim to have about 1000 neutrino inter-
actions in a 20 litre emulsion stack.

Summary reviewed by
E.H.S. Burhop, January 1976

NEUTRON PROTON DIFFRACTION SCATTERING

C. DeHaven, C. Ayre, T. Roberts, P.V.R. Murthy, R. Gustafson,
L.W. Jones, M. Longo, J. Pluta, J. Stone, J. Chanowski
(University of Michigan)

In this experiment it is planned to measure differential cross sections for np scattering in the diffraction region $[0.1 < t < 3.5 \ (\text{GeV/c})^2]$ in the energy range 50 to 400 GeV. The small-angle neutron beam will be used. The apparatus will be set up in and downstream of the detector building. Forward-going neutrons will be detected in an array of wire spark chambers interspersed with steel plates. [This array has already been used in a similar experiment at Argonne.] The recoil protons coming off near 90° in the lab will be detected in a wire spark chamber spectrometer. The incident neutron energy for each event can be reconstructed (to $\approx$ 5% accuracy) from the measured angle of the scattered neutron and the proton angle and momentum.

The precision of the differential cross section results should permit determination of the slope of the diffraction peak to a few percent, should be sensitive to changes in slope with s and t of the magnitudes expected in pp elastic scattering, and should permit study of the possible development with s of a diffraction minimum and secondary maximum (as seen in the ISR pp data).

Summary reviewed by
M.J. Longo, January 1976

CRACOW EMULSION EXPOSURE TO 400 GeV PROTONS

W. Wolter (Inst. of Nuclear Physics, Krakow, Poland)

There is at present a widespread opinion[1,2,3] that the multiple production in hadron-nucleus collisions at high energies provides a sensitive test for the mechanism of multiple production in hadron-nucleon collision. Our previous investigations performed in nuclear emulsion exposed to 200 GeV protons at NAL[4,5] have shown that photographic emulsion method offers a unique possibility of selecting events according to the actually realized number of collisions inside the nucleus. This is due to the fact that in nuclear emulsion we know what happens with the hit target nucleus through the direct observation of the number of heavily ionizing particles N_h which are the products of spallation or evaporation of the nucleus.

In the proposed experiment we would like to extend our observations of regularities in rapidity distributions as a function of the target nucleus excitation[5], to higher energies. Therefore we ask for the exposure of 5 stacks of ILFORD G-5 stript emulsion to 400 GeV proton beam at NAL. Emulsions will be prepared in plastic containers (about 5 cm x 5cm x 10 cm) with an engraved straight line which will be used for optical adjusting of the stack parallel to the beam ($\pm$10 mrad). The optimum density of proton tracks in the stack is 10^5 to 3×10^5 tracks/cm^2.

Within 6 months after the exposure we expect to analyze about 1000 interactions in our laboratory in Cracow.

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1. A. Dar, J. Vary, Phys. Rev. D6, 2412(1972)
2. P.M. Fishbane, J.S. Trefil, Phys. Rev. Lett. 31, 734(1973)
3. K. Gottfried, Ref. TH. 1735-CERN
4. J. Babecki et al., Phys. Lett. B47, 268(1973)
5. J. Babecki et al., INP Report 854/PH Cracow 1973; to be published in Acta Physica Polonica B, 1974.

Summary prepared by
J. Gierula

PHENOMENOLOGICAL STUDY OF PROTON-NUCLEUS COLLISIONS AT 300 GeV/c

IN EMULSION

O.Kusumoto, S.Ozaki and M.Teranaka (Osaka City University);
G.Fujioka, H.Fukushima, K.Kobayakawa, M.Miyagaki and Y.Tsuzuki
(Kobe University); H.Okabe and J.Yokota (Science Education Institute
of Osaka Prefecture); M.Ohta (Kinki University).

Summary:

    The first purpose of the experiment is to derive the mean
free paths of the coherent productions in emulsion at 300 GeV/c
and to derive the energy dependence of these processes by comparing
with the results so far obtained at lower energies.   The second
purpose is to derive the mass number dependence of the cross
section for the inelastic proton-nucleus collision at this energy.

Procedure:

    A stack of K5 pellicles of 3"x 6"x 600 μm, 24 sheets, is ·
exposed to the proton beam with a density of 2 x 10^4 protons/cm^2.
The coherent events are detected using along-the-track scanning
and generally accepted criteria.

                                        O.Kusumoto

                                        March 1976

PHENOMENOLOGICAL STUDY OF PROTON-NUCLEUS COLLISION

AT 400 GeV/c IN EMULSION

S. Ozaki, S. Higashi, O. Kusumoto and M. Teranaka (Osaka City University);
G. Fujioka, H. Fukushima, K. Kobayakawa, M. Miyagaki and Y. Tsuzuki (Kobe
University); M. Ohta (Kinki University)

Summary:

    Main aim of this experiment is to study the following features of the
proton-nucleus collision in nuclear emulsion at 400 GeV/c.

    1) Mass number dependence of the cross section for the inelastic proton-
nucleus collision.

    2) Energy dependence of the cross section for the coherent production.

    3) Distributions of multiplicity and of emitted angles with fast charged
particles produced.

    4) Search for any short-lived particle.

1) and 3) are studied as a relating problem to the recent result with small
mean multiplicity of fast charged particles produced in the high energy proton-
nucleus collision[1] which may open a new way to study elementary processes.
2) is the study of the coherent production in which the enrgy dependence of
its cross section is the main problem in this analysis.   Any short-lived
particle with a life between 10^{-12} and 10^{-16} sec is searched during the
course of the measurement 3).   This experiment is made as an extension of
the experiments at 200 GeV (#117) and at 300 GeV (#250)[2].

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1.   L. Van Hove, Th. 1746-CERN (1973); K. Gottfried, Th. 1735-CERN (1973)
2.   The results obtained in the experiment #117 on the problems 1) and 2)
mentiond above is submitted to the Physical Review Letters.   The analysis
of the experiment #250 is now going on.

Procedure:

    An ordinary stack which consists of 24 sheets of pellicles of nuclear
emulsion, each having a size of 3" x 6" x 600 micron, is exposed to the 400
GeV/c proton beam with a density around 10^4 protons per cm^2.   The events
induced by the proton-nucleus collision in emulsion are detected by along-
the-track scanning.   It is scheduled that the main part of the analyses will
be finished within a year.

STUDY OF MULTIPARTICLE PRODUCTION
IN A 30" BUBBLE CHAMBER

J. Chapman, M. Green, B. Roe, D. Sinclair, J. VanderVelde,
(Michigan); C. Bromberg, D. Cohen, T. Ferbel, P. Slattery,
D. Underwood (Rochester)

The Michigan and Rochester bubble chamber groups are proposing a collaborative investigation of pp interactions at high energy. This proposal is for a general survey using the bare hydrogen bubble chamber. The request is for 50,000 pictures with a proton beam at each of two energies - 100 GeV/c and 400 GeV/c.

The purpose is to extract the energy dependence of the total cross section and of multiparticle production processes; to measure such energy dependence, the analysis must be carried out using uniform scanning rules and normalization techniques, consequently, Michigan and Rochester will in effect function as a single group. In addition to looking for unusual events by means of a very rapid scan by physicists, the intent is also to measure all topologies and test current theoretical models of hadronic interactions.

NEUTRINO-ELECTRON SCATTERING AT NAL

H.L. Anderson, L.W. Mo, S.C. Wright (Univ. of Chicago);
N.E. Booth (Univ. of Oxford)

It is proposed to measure the cross sections for the reaction $\nu_\mu e^- \to \nu_\mu e^-$ and eventually for the antineutrino counterpart. These reactions and the $\nu_e e^- \to \nu_e e^-$ reaction have not yet been observed experimentally. Their measurements will answer the following questions:

1. The existence of lepton-lepton current interactions.

2. The distinction between various weak interaction theories such as:

> a. The four-fermion local V-A theory;
> b. Gauge theories;
> c. The W-boson theory.

3. The existence of a lepton neutral current.

The ν-e interactions will be detected in a 50-cell calorimeter, 1 m^2 in area. Each cell is made of one multiwire proportional chamber (MWPC) with a 2 cm aluminum plate support and 1.38 cm of steel (1 r.l.). A few steel plates may be replaced with lead-glass.

The anode signals from the MWPC will be used to trigger the system, when the signals from several adjacent chambers show the characteristics of an electron shower.

Assuming a cross section

$$\sigma(E_\nu) = 10^{-41} \, E_\nu \, (GeV) \; cm^2$$

they should obtain 137 events in 1000 hours of running with 10^{13} protons of 350 GeV on the primary target. These events should be adequate for distinguishing among the various theories. They propose to set up the equipment behind Experiment #1A and to run in parallel with other neutrino experiments under any beam conditions.

Summary reviewed by
L.W. Mo, February 1976

PROPOSAL TO SEARCH FOR A SECOND MUON NEUTRINO, λ_μ

G.R. Kalbfleisch, (BNL); E.C. Fowler (Purdue) and NAL-Caltech Group (Exp. #21A)

It is proposed to check experimentally whether the neutrino from kaon decay ($K^+ \rightarrow \mu^+ + \lambda_\mu$) is different from the neutrino from pion decay ($\pi^+ \rightarrow \mu^+ + \nu_\mu$). If $\lambda_\mu \neq \nu_\mu$ then it is probably that the ratio

$$R = \frac{\sigma(\lambda_\mu N)}{\sigma(\nu_\mu N)}$$

of the interaction cross section of the neutrinos with nucleons at the same energy, E, differs from unity. Some indications in this direction may already exist in the Gargamelle bubble chamber neutrino experiment at CERN.

They propose to use the Caltech apparatus of Experiment #21A in the NAL narrow-band neutrino beam. Assuming a value of R close to unity, R may be measured to a ±10% precision at neutrino energies around 50-70 GeV. For this purpose they request 3×10^{17} protons onto the primary target. The running will be done at two different charged particle momenta, in order to have one overlapping energy for both λ_μ and ν_μ. The accuracy in the determination of the number of neutrinos will be assured by monitoring the muon flux in the shielding as well as the protons on target and the pions and kaons decaying in the vacuum pipe.

The experiment could later be extended to 10^{18} protons (~1500 events), in order to reach a precision of ±5%, and to two different neutrino momenta.

Summary reviewed by
G.R. Kalbfleisch, February 1975

INTERACTION OF 150 GeV MUONS WITH EMULSION NUCLEI

Piyare L. Jain (State Univ. of New York at Buffalo)

Recently we have reported the direct-electron-pair production from the Coulomb field of an emulsion nucleus by 200 GeV protons[1] from the Fermi Laboratory and 15.8 GeV/c muons[3] from the Brookhaven National Laboratory, in order to test the predictions of the theories based on quantum electrodynamics at small distances. From most of the present theories[4-7], the predictions for electron production cross section depends on the ratio γ (=E/m) and not on E and m separately or on the type of the incoming particle. Our recent results indicates that the mass of the incoming particle is perhaps playing an important role. In order to check this point we woule like to have two or three more muon beam exposures between 150 GeV at FNAL. These experiments will help us to settle the mass dependence question very clearly.

References

1. P.L. Jain, M. Kazuno, B. Girard, and Z. Ahmad, Phys. Rev. Lett. 32, 797(1974).

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3. P.L. Jain, M. Kazuno, and B. Girard, Phys. Rev. (accepted Feb. 1975).

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Summary prepared by
P.L. Jain, March 1976

A PROPOSAL TO MEASURE PARTICLES PRODUCED AT
HIGH TRANSVERSE MOMENTUM BY PIONS

J.W. Cronin, H.J. Frisch, M.J. Shochet (Univ. of Chicago);
J.P. Boymond, P.A. Piroué, R.L. Sumner (Princeton Univ.)

It is proposed to measure single particle inclusive
spectra at high transverse momenta for negative pions incident
on a heavy nuclear target (and also hydrogen if possible).

$$\pi^- + Z \rightarrow \pi^\pm + \text{anything}$$
$$\rightarrow K^\pm + \text{anything}$$
$$\rightarrow p^\pm + \text{anything}$$
$$\rightarrow \mu^\pm + \text{anything}$$

The main purpose of the experiment is the comparison of
particle production at large transverse momenta in p-nucleus
and π^--nucleus collisions. If quarks or partons play a role
in large p_t phenomena, it would seem that replacing incident
protons by pions should lead to significant differences in
the ratios of secondaries produced. Also direct muon produc-
tion might be enhanced because of the definite anti-quark
content of a pion beam.

They propose to build a high intensity pion beam, using
a quadrupole triplet and one bending magnet. Such an arrange-
ment should allow the production of a 200 GeV/c beam of 10^8
π^- per 10^{13} interacting protons of 400 GeV/c. The momentum
bite of the π^- beam would be $\Delta p/p \simeq \pm 4\%$.

For the detection of the reactions above they will use
the same heavy targets and the same spectrometer presently
employed in Experiment #100A for studying charged particle
production by protons at $\theta = 80$ mrad. The expected rates should
allow observation of particle production up to $p_t \simeq 6$ GeV/c.

A PROPOSAL TO STUDY HIGH P_T PHYSICS
WITH A MULTIPARTICLE SPECTROMETER

G. Fox, R. Gomez, J. Pine, C. Bromberg (Caltech); E. Lorenz, P. Schlein
(UCLA); R. Abrams, H. Goldberg, S. Margulies, D. McLeod, J. Solomon
(University of Illinois, Chicago Circle); A. Dzierba (Univ. of Indiana);
V. Ashford, R. Juhala, E. Malamud, S. Mori (Fermilab)

It is proposed to use the multiparticle spectrometer system, now being constructed for Experiment #110A, to gain a global view of interactions in which one or more particles carry off high values of p_T.

Recent experiments at the CERN-ISR and at NAL have shown that the expotential transverse momentum distribution for single particle spectra apparently becomes a power law distribution at high values of p_T. The interest in these results has been intensified by the interpretation that in high transverse momentum particles are the result of hard parton-parton collisions. While the parton picture is qualitatively appealing, the theory is in no sense detailed and there is also the possibility that the non-parton picture is more correct. It is thus very interesting to look at the large p_T phenomena in a more detailed way, in particular to see what the entire interaction looks like when one of these high p_T particles is emitted.

The multiparticle spectrometer of Experiment #110A will be complemented by three calorimeters for both photons and hadrons. Two will be on either side of the beam line, covering c.m. angles from about 60 to 120 degrees, each subtending about 90 degrees in azimuth. The third calorimeter, for more forward directions, spans the c.m. angular range from about 15 to 50 degrees, with almost complete azimuthal coverage. The p_T for charged particles will be determined with the spectrometer, the calorimeters being used merely to generate a high p_T trigger. For photons and neutrons the calorimeters will provide the p_T determination.

The spectrometer will give 4π acceptance for detection of charged particles, and large solid angle for momentum measurement and particle identification. Several triggers are discussed, but the main emphasis is on the calorimeters, which detect high p_T particles, or groups of particles, over a large part of the c.m. angular range from 0 to 120 degrees.

The apparatus is expected to give detailed information in range $2<p_T<6$ GeV/c. They request 100-150 hours at 200 GeV/c for a first test. To pursue the high p_T study further, they will require 300-500 hours. The running for this experiment may be interleaved with the running for Experiment #110A.

PROPOSAL TO TEST TRANSITION COUNTERS AT NAL

J. Fischer, S. Iwata, V. Radeka, C.L. Wang
(Brookhaven National Laboratory)

A test is proposed of transition radiation counters to differentiate pions from kaons at NAL energies. One proposed arrangement involves radiation foils with a NaI transition radiation detector downstream of a magnet used to deflect away the beam. Another scheme is a counter comprised of an array of wire proportional chambers and radiator foils without such a deflecting magnet.

It is proposed to place this detector in the M6 beam in the Meson Area to be run parasitically with Experiment #69A. Total running time is estimated to be 200 hours.

Summary reviewed by
C.L. Wang, February 1974

NEUTRAL CURRENT INVESTIGATIONS AT NAL

B. C. Barish and F. Sciulli (Caltech)

They propose to run the equipment of experiment 21A in the narrow band neutrino beam for a verification of the recently reported neutral currents. The ratios of neutral-to-charged current contributions is at present:

$$R = \frac{\sigma(\nu_\mu + N \to \nu_\mu + \text{hadrons})}{\sigma(\nu_\mu + N \to \mu^- + \text{hadrons})} = 0.20 \pm 0.03$$

$$\bar{R} = \frac{\sigma(\bar{\nu}_\mu + N \to \bar{\nu}_\mu + \text{hadrons})}{\sigma(\bar{\nu}_\mu + N \to \mu^+ + \text{hadrons})} = 0.45 \pm 0.09$$

The major background in the Gargamelle bubble chamber experiment at CERN was due to neutron interactions, while in the experiment 1A at NAL it consisted of the small efficiency for observing low energy muons.

The proposed experiment does not have any background arising from neutrons and minimizes the misidentifications of muons. This last point comes about because

i)   The neutrinos are of high energy; thus there are no low energy muons, which go at large angles and thus may go undetected. Moreover the background coming from the wide angle component of neutrinos can be measured by increasing its contribution in a separate run.
ii) The experiment is proposed for the antineutrino beam, which has a more favorable situation than the neutrino case because of the larger fraction of energy which goes to the muon and because $\bar{R}$ seems to be larger than R.

iii) The calorimeter of experiment 21A has a good acceptance for muons.

They request a total of 3×10^{17} protons on target at an average intensity of 2×10^{12} protons/pulse with fast spill.

A PROPOSAL TO STUDY PHOTOPRODUCTION OF φ MESONS

U. Becker, J. Burger, M. Chen, J. Leong, S.L. Wu, S.C.C. Ting (MIT); T. Nash, R.F. Stiening (Fermilab); E. Coleman, E. Marshak (Univ. of Minnesota)

It is proposed to measure the differential cross section for φ mesons and search for new narrow resonances produced in the reactions

$$\gamma + p \to \phi + p \to K^+ K^- + p \qquad (1)$$

$$\gamma + p \to \text{narrow resonances} + X$$
$$\to \text{multiple hadrons and/or electromagnetic}$$
$$\text{particles} \qquad (2)$$

and $\gamma + A \to \ell^+ + \ell^- + A$ where $\ell^{\pm}$ represents high mass leptons   (3) in the 20 to 195 GeV range using a tagged photon beam.

Reaction (1) is the best approximation to a pure Pomeron exchange reaction. Interesting features versus energy are:

a. From the observed increase in the K^+p and pp total cross sections one expects that the forward differential cross section for (1) to increase by about 40% in the above energy range.

b. At low energies the slope of the forward peak in reaction (1) is measured to be $b \simeq 4$ (GeV/c)-2, contrary to most other reactions where it is $b \simeq 8$-10 (GeV/c)-2.

c. No structure has been observed in the angular distributions of (1), again contrary to the scattering of other particles.

The equipment for measuring reaction (1) will consist of three sets of chambers for detection of the recoil protons. Two standard magnets (of the BM109 type) with opposite magnetic fields bend the forward-going particles horizontally, refocusing particles with the same production angle at a point 120' downstream of the target. Four proportional chambers and two drift chambers measure the momenta of the forward-going particles. Two multiple tube Cerenkov counters distinguish π, K, p up to 120 GeV and can detect a maximum of 16 final state charged particles. With shower counters in the back one can also detect electromagnetic particles such as e, γ, π^0, η^0, etc.

With 480 hours of running with e^- at 200 GeV and 120 hours with e^- at 160 GeV, we expect to obtain 10^5 events of reaction (1), covering the range 20 $< k <$ 195 GeV and $0 < |t| < 2$ (GeV/c)^2. The background is expected to be negligible.

The same apparatus as proposed to detect $\phi \to K^+K^-$ can also detect narrow resonances and high mass lepton pairs - similar to the J particle recently found at BNL and Spear and the mysterious μe events found at Spear - decaying into hadronic as well as leptonic final states.

We expect ~50 J→ee/day from $5 \cdot 10^5$ effective quanta/burst. The decay of J or higher mass J-like particles into multihadrons (π, K, p detected) is expected to be 1(-3) orders of magnitude bigger.

For a resonance of 3.1 GeV decaying into: 2e   4K   6π   6K
the mass resolution is δm = 110   50   38   7 MeV

The signature of reaction (3) is: a) obvious missing energy and momenta, b) Z^2 dependence of cross section. Better particle identification is another advantage for doing it at NAL rather than at Spear.

Summary reviewed by
M. Chen, February 1976

EXPOSURE OF EMULSIONS TO 200-300 GeV π^- for
NEW DETERMINATION OF MEAN LIFE OF π^0

P.S. Young (Mississippi State University)

Objectives: To determine the π^0 mean life by use of the
200-300 GeV π interactions in nuclear emulsion.

Parameters to be measured: The quantities to be measured are
the path lengths of π^0-decay through the Dalitz Mode. The
precision in the measurement is primarily determined by statis-
tical errors which depend on the number of Dalitz pairs analized.
With 100 pairs we expect to obtain a total accuracy of better
than 25% error.

Advantages of using π^- Beam: The production of π^0 from π^- makes
use of the charge exchange reaction. Consequently we expect
to obtain much longer path lengths than those in the pp colli-
sion as described in Experiment No. 195.

Exposure and Beam Time Requested: Three exposures are requested
hereby for three emulsion stacks, consisting of 10 pellicles
of 7.5 cm x 18 cm x 600 μ each. The desired total intensities
are 5×10^4, 1×10^5, 1×10^6 per cm^2.

Remarks: This experiment is an extension of Experiment No. 195
for which the exposures of emulsion stacks to the 300 GeV
protons were carried out in last October.

Summary prepared by
Poh Shien Young, March 1976

EXPOSURE OF EMULSIONS TO 400 GeV PROTONS FOR
NEW DETERMINATION OF MEAN LIFE OF π^0

P. S. Young (Mississippi State University)

Objectives: To determine the π^0 mean life by use of the 400
GeV proton interactions in nuclear emulsion.

Parameters to be measured: The quantities to be measured are
the path lengths of π^0-decay through the Dalitz Mode. The
precision in the measurement is primarily determined by statis-
tical errors which depend on the number of Dalitz pairs analyzed.
We anticipate to obtain a total accuracy of better than 25%
error with 100 pairs.

Advantages of using 400 GeV Protons: The main difficulty in the
determination of the π^0 mean life lies in the measurability of
the path lengths which were of the order of several microns in
the previous experiments. With the 400 GeV protons beams, we
have reason to expect to observe longer path lengths.

Exposure and Beam Time Requested: Three exposures are requested
hereby for three emulsion stacks, consisting of 10 pellicles
of 7.5 cm x 18 cm x 600 μ each. The desired total intensities
are 5×10^4, 1×10^5, 1×10^6 per cm^2.

Remarks: This experiment is also an extension of Experiment
No. 195 for which the exposures of emulsion stacks to the 300
GeV protons were carried out last October.

Summary prepared by
Poh Shien Young, March 1976

A PROPOSAL TO STUDY MESON PRODUCTION AT LARGE $P_\perp$
WITH A γ-RAY DETECTOR

A. Barnes, K.W. Lai, J. Mellema, A.V. Tollestrup, R. L. Walker
(Caltech); O. Dahl, R. Johnson, R. Kenney, M. Pripstein (LBL)

It is proposed to use the γ-ray detector and the 24" long
liquid hydrogen target now being used for Experiment #111 to
study production of $\pi°$, $\eta°$ and other mesons at large $P_\perp$ from
$\pi^\pm p$ and pp interactions for CM angles from 30° to 110°.

High transverse momentum ($P_\perp$) phenomena have traditionally
been associated with interactions at small distances. For the
case of hadron-nucleon collisions they provide a tool to probe
the structure of the nucleon, in particular to investigate its
possible constituents. However, most of the observations ob-
tained thus far are confined to the proton-nucleon interaction
and very little data exist for meson-nucleon interactions. From
the simple quark model of hadrons, only qq interactions were
thus probed for producing large $P_\perp$ events. Whereas, in the case
of meson-nucleon collisions one probes $\bar{q}$q interactions also.
There is a strong suggestion from the constituent picture of
hadrons that inclusive meson production at high $P_\perp$ could be
qualitatively different and considerably more copious for inci-
dent mesons than for incident baryons.

It is proposed to perform the experiment in two steps.

Phase I is to study pp → γ+ X at 300 GeV/c in the x-region
from 0 to 0.5,using the same setup of Experiment #111 in the M2
beam without any essential change. There is good enough angular
resolution to be able to identify the production of mesons de-
caying into two or more γ-rays, such as $\pi°(2\gamma)$, $\eta°$ (2γ and 6γ),
$\omega°(3\gamma)$, $f°(4\gamma)$, etc. The results of Phase I should help for the
final planning of Phase II. A 100 hour run should be sufficient
for this purpose.

Phase II is to measure large $P_\perp$ photons produced in $\pi^\pm p$
collisions at 100 and 200 GeV/c, also in the M2 beam. Two posi-
tions of the γ-ray detector are anticipated, one around θ_{CM} =
50° (x≈0.5) and the other around θ_{CM} = 90° (x≈0). To
estimate a rate for observing $\pi^\pm p \to^{CM} \pi°$ + X at large $P_\perp$, they
take $E\frac{d^3\sigma}{dp^3}$ to be the same as for pp → $\pi°$ + X and independent
of $x_\parallel$. With 2.5 x 10^{12} protons/pulse on the Meson Area tar-
get, they then obtain a rate of ~ 1200 $\pi°$ events in the range
$3 < P_\perp < 4$ GeV/c (~50$\pi°$ events above 4 GeV/c) for a 200 hour run
in either θ_{CM} position with 200 GeV/c π^- incident. An initial
allocation of 400 hours is requested to study the dependence of
$E\frac{d^3\sigma}{dp^3}$ on incident momentum for pion-induced interactions and to
make a comparison with proton-induced interactions.

Summary prepared by
J. Mellema, February 1974

MULTIPARTICLE PRODUCTION IN NUCLEI BY
PROTONS OF SEVERAL HUNDRED GeV

J. Cohen, E.M. Friedlander, M. Marcu, A.A. Martin, R. Nitu
(Bucharest); A.J. Herz, O. Kofoed-Hansen (CERN); K. Gottfried
(Cornell)   Bucharest-CERN-Cornell Collaboration

It is proposed to study the multiplicity and angular
distribution of particles produced in collisions of protons
with heavy nuclei at 200 and 400 GeV. The targets will be
very thin wires of tungsten (~25 μm) and steel (50 μm) which
will be embedded in nuclear emulsion. The extremely high
spatial resolution of the emulsion makes it relatively easy
to observe and measure the fast particles in the projectile
system, and the geometry of the experiment is such as to allow
the simultaneous observation of the slow particles emitted in
the process. We thus expect to be able to obtain detailed
information on the fate of the projectile system as function
of the atomic number of the target, and on the excitation of
the target nucleus as determined from observation of the
tracks of evaporated particles and knock-ons.

Note: The 400 GeV part of the proposal is No. 292.

Summary prepared by
K. Gottfried

PROPOSAL TO MEASURE COHERENT DISSOCIATION OF π, K AND p

INTO STRANGE PARTICLES AT NAL ENERGIES

P. Koehler (Fermilab); H. Courant, M. Marshak, E. Peterson, K. Ruddick
(Univ. of Minnesota); T. Ferbel, Y. Fukushima, T. Jensen, B. Kern,
F. Lobkowicz, W. Mollet, P. Slattery, E. Thorndike, D. Underwood
(Univ. of Rochester).

Cross sections for the coherent excitation of particles impinging
on nuclei rise with incident bombarding energy. Two processes are held
responsible for these projectile excitations: (1) the interaction of the
projectile with the nuclear Coulomb field, and (2) the hadronic inter-
action between the colliding objects. The first process can be in-
terpreted through an analysis paralleling the Primakoff effect, and
can yield valuable information pertaining to radiative widths of reso-
nances produced through Coulomb dissociation. The second process, usually
referred to as diffractive dissociation or Pomeranchukon exchange, is not
currently understood in any fundamental way. The two separate types of
interactions responsible for coherent dissociation are most readily
distinguished through their differing dependences on nuclear mass, nuclear
charge, scattering energy and momentum transfer. It is intended to examine
both processes in sufficient detail so as to gain a significant advance
in the understanding of the overall dissociation phenomenon.

Specifically, the objective of the experiment is the investigation,
with high statistics, of the dependence of the cross sections on mass,
momentum transfer, target and energy, for the two-body dissociation
reactions:

$$\pi^- \to \pi^- \pi^0, \pi^- \to K^- K_s^0, \ K^- \to K^- \pi^0, \ K^- \to K_s^0 \pi^-, \ K^- \to \Lambda \bar{p}, \ \bar{p} \to \bar{\Lambda} K^- \ .$$

The decay angular distributions and the states of Λ ($\bar{\Lambda}$) polarization
will also be examined. This study will provide important new information
concerning knowledge of radiative widths and of coherent processes, and
will probe the detailed nature of the Pomeranchukon trajectory in the in-
elastic regime. It is proposed to execute this experiment utilizing a
drift-chamber spectrometer system in conjunction with a high-precision
π^0 detector. The experimenters request 900 hours of data taking in the
M-1 beam line to initiate these studies.

Summary reviewed by
T. Ferbel, February 1976

PROPOSAL FOR A NEON EXPOSURE IN THE 30-INCH BUBBLE CHAMBER

G. Alexander, I. Bar-Nir, O. Benari, S. Dagen, J. Grunhaus,
L. G. Hyman, A. Levy, L. Lissauer, Y. Oren, L. Rosenstein
(Tel-Aviv University)

It is proposed to study high energy proton-nucleon inter-
actions (at several energies) in the 30" bubble chamber when
it is filled with neon. The principal objectives of this study
are:

1) It is expected that the study of multiplicity, rapidity
distributions, transverse momentum, correlations etc.
when compared with the same quantities measured in p-p
collisions will yield valuable information on the role
played by cluster formation in hadron-hadron interactions.
There is particular interest in:
   a. The mean number of clusters per interaction as a function
      of energy as well as their distribution.
   b. The mean number of particles per cluster including
      neutrals.
   c. The lifetime of clusters.
   d. Information on the cluster-nucleon cross section.

2) Good γ-ray detection efficiency permits a high statistics
study of the number of π^0's as a function of the multi-
plicity, f_2^{00} and higher moments. One can also study
charged-charged, charged-neutral, neutral-neutral etc.
correlations in a single experiment. It will be possible
to search for η^0 and ω^0 production.

3) It will be possible to study diffractive processes with
the neutral component visible. By comparing $n(\pi^0)$ with
$\dfrac{n(\pi^+) + n(\pi)}{2}$ one verifies that only $\Delta I = 0$ contributes.

4) Finally, the experiment will investigate the process
$pp \rightarrow pp\, e^+e^-$ as well as provide useful calibrations on
total cross section and multiplicity for people working
with cosmic rays.

STUDY OF EVAPORATION AND SPALLATION EFFECTS IN
PLASTIC VISUAL TRACK DETECTORS

R. Beaujean, W. Enge (University Kiel)

Four stacks of plastic visual track detector sheets have been exposed to the 300 GeV proton beam. The stack size was 5 cm x 5 cm x 3 cm, the proton fluence about 10^3 protons/cm^2 and 10^5 protons/cm^2.

The intention of the experiment was to study the angular and energy distribution of secondary particles with charge $Z > 2$ which are evaporation and spallation products originated from nuclear interactions of the protons with carbon and oxygen nuclei of the detector material. Simular processes induced by cosmic ray protons occur in our measurements on the isotopic composition of light cosmic ray nuclei. Since the detector is sensitive only to energy losses above a certain threshold the incoming proton is not detected. But some of the secondaries have the same registration range and therefore the same image as stopping light cosmic ray particles. The accelerator experiment was planned to find corrections on such secondaries in our cosmic ray measurements.

After irradiation part of the sheets were etched in 6n NaOH and scanned for tracks of heavy secondaries. Unfortunately the number of tracks was too small for a worthwhile analysis due to a too low fluence of primary protons.

A SEARCH FOR STABLE INTEGRALLY CHARGED, MASSIVE PARTICLES
(HAN-NAMBU QUARKS)

A. Van Ginneken (Fermilab), H. R. Heydegger (Purdue Univ.
       and Univ. of Chicago), C. M. Stevens (ANL).

     A search for stable (or long lived), integrally charged
(+1 or -1), massive particles is proposed. These could be
the fundamental particles of the type proposed by Han and
Nambu. The detection method exploits the chemical properties
of the atoms these particles would form when they are brought
to rest. Positive particles would form hydrogen-like atoms,
negative particles would attach themselves to ordinary nuclei
and form an atom having one electron less than the original
nucleus. Following chemical separations their identification
and a rough measure of their mass would be obtained by mass
spectroscopy.

     On the basis of mass spectroscopic analysis, isotopic
composition, chemistry and practical considerations suitable
targets for the search of (-1)-charged particles appear to be
$NaCO_3$ and CaO. These are to be placed, securely contained, in
a beamdump. For (+1)-charged particles the target choice is
less critical. However, the mass spectroscopic search would
be more difficult since H, H^2 and H^3, all copiously produced
during the irradiation, are likely to interfere.

     Assuming a sensitivity for the mass spectrometer of
10^5 atoms/sample an upper limit of 10^{-35} cm^2 for the production
cross section of (-1)-charged particles could be established.

     Between July and October of 1975 three vessels each
containing about 1/3 kg CaO were present in the main dump of
the dichromatic train of the Neutrino Lab. The dump received
in excess of 10^{18} protons of 400 GeV. Chemical analysis of
the targets is presently being performed.

π^+ AND K^+ INTERACTIONS AT 300 GeV IN THE 30-INCH HBC

V.E. Barnes, D.D. Carmony, R.S. Christian, J.A. Gaidos,
A.F. Garfinkel, L.J. Laszlo, A.T. Laasanen, F.J. Loeffler,
R.L. McIlwain, D.H. Miller, W. Morse, T.A. Mulera, T.R. Palfrey,
K.L. Rangan, R.B. Willmann (Purdue University)

We plan to study π^+ interactions on protons at an energy near 300 GeV in the NAL 30-inch HBC using a tagged beam enriched by differential absorption of protons. In a 300,000 picture exposure at 270 GeV, for example, we estimate that there would be 26,000 π^+p interactions, 7,300 K^+p interactions, and 96,000 pp interactions. We would measure all meson interactions and 10% of the pp interactions to give a direct comparison in the same system, which in addition to the bubble chamber would include the downstream proportional wire spectrometer plus whatever neutral particle detectors and particle identifiers may be available at the time. A second gas Cherenkov counter ~350 feet long will be used to separate K^+ from π^+, thereby turning an unacceptable K^+ contamination into a useful (and very interesting) data sample.

The physics motivation is a general survey of the interactions of positive mesons at new energies, and includes the following:

1. Multiplicity distribution and its moments.

2. Single particle inclusive distributions, including neutrals, if the spark chamber spectrometer is used.

3. Particle correlations in multiparticle processes, including neutrals.

4. Diffractive dissociation of target and of meson beam: cross sections, mass distribution versus multiplicity, tests of factorization.

5. V^o production, hyperon production.

6. Resonance production, e.g. Δ using slow identifiable proton recoils.

7. Intercomparison of our 100 GeV π^+, K^+ data with the new 300 GeV π^+, K^+ data.

Summary revised by
V. E. Barnes, February 15, 1976

THE INTERACTION $pA \rightarrow pAe^+e^-$ AT 400 GeV

A.S. Cary (Harvey Mudd College); J.E. Butt, D.T. King, C.R. Vane (University of Tennessee)

The proposal requests a nuclear emulsion experiment with 400 GeV protons:

1. Beam: Protons 400 GeV

2. Intensity: $3 \times 10^4/cm^2$

3. Emulsion: Two small stacks of Ilford K5, 600μ thick, mounted on glass

4. Alignment: Parallel

These observations examine the proton-nucleus electro-magnetic interaction cross section in a region where it is supposed to be rising with increasing energy. Previous experiments (NAL #103, #232) suggest that it may actually be declining.

Emulsion processing and scanning: Univ. of Tennessee

Received: January, 1974

Approved: March, 1974

Exposure: December, 1975. Beam intensity ~ right.

Processed: Univ. of Tennessee

Comparison studies continues.

Additional data has been taken on π^- beam: $\pi A \rightarrow \pi Ae^+e^-$ at 200 GeV (#264) in collaboration with P.S. Young.

Summary prepared by
D.T. King, January 1976

PROPOSAL TO STUDY p-D INTERACTIONS AT 205 GeV/c
IN THE 30-INCH BUBBLE CHAMBER

S. Barish, M. Derrick, T. Fields, L. Hyman, R. Miller,
B. Musgrave, J. Phelan, P. Schreiner, R. Singer and R. Smith
(Argonne National Laboratory); N. Fadeev, V. Grishin,
G. Jancso, T. Kanarek, E. Kladnitskaya, A. Kuznetsov,
N. Melnikova, M. Sabau, L. Shcheglova, M. Soloviev and
A. Solomin (Joint Institute for Nuclear Research, Dubna).

This is a proposal for the 30" bubble chamber with the
following requirements:

Bubble chamber ------------------ filled with deuterium
Hybrid system ------------------ will make use of information
from the downstream spark
chambers, but do not consider
the hybrid system essential
for most of their objectives.
Beam -------------------------- 200 GeV/c protons
Tracks per picture ------------- 6
Number of pictures ------------- 100,000
Total No. of events ------------- 70,000
pn events with visible spectator- 11,000

The main emphasis of the proposal is the study of pn
interactions, with an initial classification of events with
seen and unseen spectator proton. The physics objectives
are similar and complimentary to those of the pp exposure
at 200 GeV/c. In particular, they will study (a) charged
particle multiplicity distributions; (b) diffraction
dissociation, including I = 1 exchange; (c) double charge
exchange reactions; (d) inclusive K^{o}, Λ^{o}, $\pi\pm$ production;
(e) coherent events.

They should be able to have the first results 6 months
after receiving the film; the analysis should be completed
in two years.

Summary prepared by
G. Giacomelli, March 1974

STUDY OF HIGH ENERGY PI-MINUS
PROTON INTERACTIONS WITH THE NAL 30-INCH
BUBBLE CHAMBER-WIDE GAP SPARK CHAMBER HYBRID SYSTEM

Iowa State Univ., Univ. of Maryland
Michigan State Univ., Univ. of Notre Dame

G. A. Smith (Spokesman)

This is an experiment of 300,000 pictures of π^- at 360 GeV/c in the 30" NAL bubble chamber with the wide gap spark chamber system of Experiment #2B. The pictures were taken in August, September 1975 and scanning and measuring analysis is currently underway.

Besides the bubble chamber, the downstream experimental apparatus consists of four wide-gap spark chambers. The trigger is provided by five upstream beam deflection counters in conjunction with five downstream ones. The trigger requires that the incoming beam particle does not go through corresponding upstream and downstream beam deflecting counters, thus indicating that there was an elastic or inelastic event with $|t| \gtrsim 0.04$ $(GeV/c)^2$.

The data taken to date in Experiment #2B have demonstrated that the hybrid system is a workable and a valuable instrument. It improves the momentum resolution of the forward going particles by more than a factor of ten over the bare bubble chamber measurement and provides information on $\pi°$'s produced in the entire forward hemisphere.

The experiment will yield high statistics for a more significant study of:

(i)   correlations among charged particles;

(ii)   exclusive channels;

(iii) inelastic diffractive and non-diffractive components;

(iv)   individual topologies

Summary prepared by

G. A. Smith, January 1976

SURVEY OF PARTICLE PRODUCTION IN PROTON COLLISIONS AT NAL

D. Carey, J. Johnson, R. Kammerud, D. Ritchie, J. Sauer,
R. Shafer, D. Theriot, J.K. Walker (NAL)

A 2.4 GeV/c double focusing magnetic spectrometer has
been constructed to study the yields of single particles in
the kinematic range $0 \leq |x| \leq 1$ and $0 \leq p_\perp \leq 2$ GeV/c for proton-proton
collisions up to 500 GeV. This experiment makes use of the
forward-backward hemisphere symmetry in the proton-proton
center of mass system. The reactions that will be studied are:

$$p + p \rightarrow p + \text{anything}$$
$$\bar{p} + \text{anything}$$
$$\pi^{\pm} + \text{anything}$$
$$K^{\pm} + \text{anything}$$
$$\mu^{\pm} + \text{anything}$$
$$e^{\pm} + \text{anything}$$

The s- and t-dependence of these single particle inclusive
distributions will be studied over the ranges indicated.
Approximately 150 hours of beam time are required at each
beam energy that is available. It is hoped that measurements
will be made from 50 to 500 GeV. In addition, 50 hours for
beam tuning and 100 hours for equipment testing are requested.

Summary revised by
J.K. Walker, January 1976

A SEARCH FOR A NEW STATE OF MATTER IN THE
ANALYSIS OF A NAL BEAM DUMP

L.M. Lederman, L. Price (Columbia University); P. Limon
(Fermilab)

This is a proposal designed to test a speculative impli-
cation of a theory due to T. D. Lee and G. C. Wick on the
possible formation of an esoteric object with very high baryon
number (N>400) which is stable and whose constituents are lower
mass baryons. It could be possible that such a state be formed
in a two-stage process initiated by high energy protons in a
uranium beam dump.

$$p + U \rightarrow U^* + p$$
$$U^* + U \rightarrow \text{(esoteric object)} + \text{anything}$$
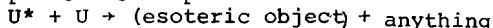
The proposal requests:

1. To make available a high-Z target already bombarded with
    $>10^{17}$ protons;

2. To install a uranium block surrounded by a lower-Z material
    in an NAL beam dump.

3. To calibrate the exposure by a study of the probability
    of emission of heavy fragments from the bombardment of
    high Z nuclei with 300 GeV protons using Lexan and Quartz
   detectors of very heavy ionizing particles.

The esoteric objects would be looked at by means of
successive separations with diffusion processes, centrigues,
and mass spectroscopy.

Summary reviewed by
L. M. Lederman, January 1976

A STUDY OF DI-LEPTON PRODUCTION IN
PROTON COLLISIONS AT NAL

J.A. Appel, M.H. Bourquin, D.C. Hom, L.M. Lederman,
J.P. Repellin, H.D. Snyder, J. Weiss, J.K. Yoh (Columbia);
B.C. Brown, W. Innes, T. Yamanouchi (Fermilab)

It is proposed to study di-lepton production in proton-nuclei collisions:

$$p + nucleon \rightarrow e^+ + e^- + anything$$
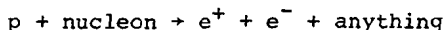
For this purpose the single arm electron spectrometer of Experiment #70 will be transformed into a large solid angle, two-arm spectrometer, each with a hadron calorimeter and a muon filter. The equipment will be complemented with proportional wire chambers (about 5,000 wires).

The physics objectives may be summarized as follows:

1. Search for structure in the di-lepton spectrum.

2. The continuum of the effective di-lepton mass distribution is a measure of the spectrum of virtual photons emitted in the p-nucleon collisions. It may also be used for a test of parity violation due to interference of electromagnetic and weak interactions.

3. Qualitative study of the mass spectrum of hadron pairs ($\pi\pi, \pi p$, etc).

4. Check μe universality, studying $\mu^+\mu^-$ pairs.

5. Extend the study of single lepton production of Experiment #70.

6. Study of the $\pi°\pi°$ pairs via the conversion of the photons.

Summary reviewed by
L. M. Lederman, January 1976

SMALL ANGLE PROTON-HELIUM ELASTIC AND INELASTIC SCATTERING
FROM 8 to 500 GeV

A. Kuznetsov, S. Mukhin, V. Nikitin, Y. Pilipenko (JINR, Dubna);
E. Malamud, R. Yamada (Fermilab); S. Olsen, D. Nitz (Rochester);
E. Jenkins (Arizona)

It is proposed to measure p-He^4 elastic scattering in the
$0.1 < |t| < 0.3$ (GeV/c)^2 range and at energies varying contin-
uously from 8 to 500 GeV. This proposal represents a logical
continuation of work on p-p and p-d scattering.

The physics motivation may be summarized as follows:

1. Study of the energy dependence of p-He diffraction
    scattering, that is, of the slope for $|t| < 0.2$ and
    of the minimum at $|t| \simeq 0.25$ (GeV/c)^2.

2. Computation of the part of the nucleon-nucleon scat-
    tering amplitude at $t = 0$ as well as at $t \neq 0$ using
    Glauber theory. In particular, one is interested in
    knowing if the ratio of the real to the imaginary
    parts of the nucleon-nucleon scattering amplitude,
    ρ $(t \neq 0)$, goes through zero at an energy of 280
    GeV as does ρ $(t = 0)$.

3. Investigation of Glauber theory.

4. The scattering from a $J = 0$ object, such as He^4, at
    $t \neq 0$ may add useful information on spin effects at
    high energies.

5. Investigation of inelastic scattering, in particular,
    of the production of N* (1400).

6. Determination of the isobar-nucleon interaction cross
    section inside the He^4 nucleus.

The experimental technique is similar to that used for p-p
(Experiment #36A) and p-d (Experiment #186) scattering using the
C-0 internal target. The helium gas jet will require a special
molecular sieve or condensed CO_2 or Argon added to the tap
cryosurface to contain the helium. Sandwiches of silicon
(dE/dx, E) solid-state detectors will be used to separate
α-particles from background. The $0.1 < |t| < 0.3$ range
corresponds to $40 < \theta < 70$ mrad from 90°, requiring better
angular resolution than in the p-p and p-d scattering. This
will be achieved by placing the detectors further away; quad-
rupoles may be added.

The experimenters request 200 hours of testing time and
500 hours for data taking, including some running at 400 and
500 GeV/c.

Summary reviewed by
E. Malamud, January 1975

BACKWARD PION-PROTON ELASTIC SCATTERING

W.F. Baker, D.P. Eartly, A. Lennox, R. Rubinstein (Fermilab)
and R. M. Kalbach, A. E. Pifer (Univ. of Arizona)

It is planned to measure the backward scattering of π^+ and π^- mesons on hydrogen at 10, 50 and 80 (or 100) GeV/c in the angular range of $-0.8 < u < 0$ (GeV/c)^2.

They will study the energy and angular dependences of the elastic differential backward cross sections. Both will yield tests of Regge pole models in a relatively simple configuration where only two specific trajectories may be exchanged (Δ_δ in $\pi^- p \to p\pi^-$, Δ_δ and N_α in $\pi^+ p \to p\pi^+$); the presently available high energy data disagree with the predictions.

The beam required should have 5×10^6 pions per burst. Such rates are possible in the Ml and M6 beam. The incoming beam momentum will be defined to an accuracy of about ±0.2% by a scintillation counter hodoscope located at a momentum dispersed focus.

The experimental equipment consists of a liquid hydrogen target 1 m long, of a forward and of a backward spectrometer.

The forward spectrometer uses two NAL 24D72 (BM109) analysis magnets and proportional wire chambers. The total length of the spectrometer will be increased with momentum according to the formula ℓ(feet) = 3 p_0(GeV/c). The spectrometer will allow a momentum resolution $\Delta p/p = \pm 0.2\%$. Forward going pions will be placed in anticoincidence by a gas threshold Cerenkov counter.

The backward spectrometer will use a 72D18 magnet and proportional wire chambers. Its aperture is matched to that of the forward spectrometer and its momentum resolution is expected to be of the order of ±4%.

They will measure a complete angular distribution at one time. The rates anticipated from extrapolation of lower energy data are about 800 events/hour at 10 GeV/c, 50 at 50 GeV/c and 5 at 100 GeV/c. The highest momentum will be lowered or raised according to the rates experimentally found. The background is expected to be small at all energies and angles.

They request 200 hours of testing time and 900 hours of data taking.

PROPOSAL TO STUDY MULTIPARTICLE PRODUCTION
USING A NEON-HYDROGEN EXPOSURE
IN THE 15-FOOT BUBBLE CHAMBER

R. Ammar, R. Davis, C. Eklund, N. Kwak, L. Loos,
R. Stump (University of Kansas); J. Whitmore
(Michigan State University); J. Canter, F. T. Dao,
W. A. Mann, J. Schneps (Tufts University).

It is proposed to take two exposures of the FNAL
15-foot bubble chamber with a light neon-hydrogen fill
($\sim$ 20% mole neon) for a quantitative examination of the
space-time structure of hadronic interactions at high
energy. From a comparison of data for charged and
neutral particle multiplicities, single particle inclusive
spectra and multiparticle correlations, as observed in
hadron-neon interactions, with analogous data from hydrogen
bubble chamber exposures, the nature of multiparticle
production in proton-nucleon collisions can be probed for
small space-time intervals. Furthermore, the hydrogenic
interactions are expected to provide unique information
on neutral particle spectra and correlations by using the
high probability for gamma-ray conversion and neutron
interactions from individual events. The specific request
is for 25,000 pictures with 400 GeV/c protons and 25,000
pictures with a 100 GeV/c Cerenkov-tagged secondary beam
of protons and π^+'s.

Summary prepared by
W. A. Mann, January 1976

MULTIPARTICLE PRODUCTION IN NUCLEI BY
PROTONS OF SEVERAL HUNDRED GeV

J. Cohen, E.M. Friedlander, M. Marcu, A.A. Marin, R. Nitu
(Bucharest); A.J. Herz, O. Kofoed-Hansen (Cornell); K. Gottfried
(Cornell)   Bucharest-CERN-Cornell Collaboration

It is proposed to study the multiplicity and angular
distribution of particles produced in collisions of protons
with heavy nuclei at 200 and 400 GeV. The targets will be
very thin wires of tungsten (~25 μm) and steel (50 μm) which
will be embedded in nuclear emulsion. The extremely high
spatial resolution of the emulsion makes it relatively easy
to observe and measure the fast particles in the projectile
system, and the geometry of the experiment is such as to allow
the simultaneous observation of the slow particles emitted in
the process. We thus expect to be able to obtain detailed
information on the fate of the projectile system as function
of the atomic number of the target, and on the excitation of
the target nucleus as determined from observation of the
tracks of evaporated particles and knock-ons.

Note: The 200 GeV exposure has been designated No. 271.

Summary prepared by
K. Gottfried

A π^+-d 200 GeV/c BUBBLE CHAMBER EXPERIMENT AT FERMILAB

Y. Eisenberg, B. Haber, D. Hochman, U. Karshon, E. Kogan, E.E. Ronat,
A. Shapira, R. Yarri and G. Yekutieli, (Weizmann Institute, Rehovot); and
H. Braun, D. Brick, F. Etienne, A. Fridman, E. Jegham, P. Juillot and
C. Voltolini (Centre de Recherches Nucleaires, Strasbourg)

Purpose: The main purposes of the experiment are:

   a. Comparison of multiplicity distributions in π^+p, π^+n, pp and pn
       collisions.

   b. Study and comparison of single particle spectra of slow charged
       (π^+ and π^-) and neutral (π^0, Λ^0/Σ^0 and K^0) particles in π^+p and
       π^+n collisions. The data will be compared with similar spectra in
       pp and pn collisions.

   c. Study the fragmentation of neutrons into protons and measurement of
       the inclusive spectrum of protons in π^+n and pn collisions for
       $-1 < x < -0.3$. The inclusive reactions $\pi^+n \to (p\pi^-) + x$ and
       $pn \to (p\pi^-) + x$ will also be studied in order to observe the possible
       production of the $N^*(1470)$ isobar.

   d. Study of the coherent reaction $\pi^+d \to$ (fast prongs) + d. In this
       reaction the incident proton is presumably fragmented by diffraction
       dissociation into fast particles with no isospin exchange. Study
       of the multiplicity distribution in this reaction can be used to
       test the various fits of high energy multiplicity distributions,
       based on the two component model.

   e. Study of elastic coherent scattering $\pi^+d \to \pi^+d$, and measurement of
       do/dt for $|t| \geq 0.12$ GeV^2.

Procedure:

   a. Exposure: 150,000 pictures with 200 GeV tagged beam of protons,
       π^+, μ^+ and K^+ in the 30 in. bubble chamber filled with deuterium.
       The experiment will also use the downstream P.W.C. hybrid system.
       With 6 protons per picture 40,000 good π^+ events are expected,
       namely about 500 events/mb.

   b. Scanning: All types of events will be scanned for. The number of
       charged prongs, associated stopping tracks, V^0 decay and e^+e^- pairs
       will be recorded. The identify of the incident particle (p,π^+ or K^+)
       will be found from the data of the upstream tagging system.

   c. Measurements: The momentum of all charged particles (p < 15 GeV/c)
       and associated K^0, Λ^0 and e^+e^- pairs (p < 20 GeV) will be measured.
       Protons and π^+ (p < 1.4 GeV) will be identified by ionization
       measurements. The momentum of energetic charged particles in the
       forward direction will be found from the downstream P.W.C. data.

   d. Coherent d-events: Deutrons having a range $\geq$ cm can be identified
       in the bubble chamber by measurements performed on the slow particle
       alone. This will correspond to coherent d-events with $|t|$ ~0.16 GeV^2.
       By demanding coplanarity, coherent elastic d-events with $|t|$ ~0.12
       GeV^2 could also be identified.

Progress: In September 1974, 53,000 pictures were taken in the 30" bubble
chamber filled with deuterium and exposed to the tagged 200 GeV/c positive
secondary hadron beam of proton, π^+ at K^+.

QUARK SEARCH USING 400-500 GeV PROTONS
(By Measuring Ionization Energy Loss)

L.B. Leipuner, R.C. Larsen, L.W. Smith, H.H. Williams (BNL);
R. Kellogg, H. Kasha, R.K. Adair (Yale)

In June, 1973, data-taking for a quark search was completed in the M4 beam in the Meson Area. The experiment was done with the accelerator operating at 300 GeV, hence yielding a quark mass limit of approximately 12 GeV. More specifically, assuming a general production mechanism, they found that the production cross section for quarks of 1/3 e or 2/3 e was smaller than 10^{-35} cm^2. A search was also made for particles of charge 4/3 e achieving an upper limit on the cross section of 5×10^{-31} cm^2. It is planned to continue the search in the 30-inch hadron beam in the Neutrino Area and to push the mass limit higher (up to ~15 GeV for quarks of charge 1/3 e and 2/3 e).

The basic equipment used in the search includes eight scintillation counters with outputs fed to two sets of discriminators. Their thresholds are set to a specific range of ionization corresponding to fractional charge. The recorded pulse heights further assist in the identification.

Approximately 24 hours of beam time is requested with the accelerator operating at 400 GeV or above. Roughly half the time will be spent looking for 1/3 e and 2/3 e particles and half the time looking for those with charge 4/3 e. Through this run it will be possible to raise the mass limit and place an upper limit on the production cross section of approximately 10^{-35} cm^2.

A PROPOSAL TO STUDY HADRON-NUCLEUS COLLISIONS AT FNAL
ENERGIES USING 30" CHAMBER FILLED WITH PURE NEON

S. N. Ganguli, A. Gurtu, P. K. Malhotra, U. Mehtani, R. Raghavan
and A. Subramanian (Tata Inst. of Fundamental Research)

Summary:

    a. Bubble Chamber: 30" bubble chamber filled with pure
        neon and with 32 KG field.

    b. Beams: (i) Protons at 100 GeV/c
            (ii) Protons at 400 GeV/c
         (iii) Negative pions at 100 GeV/c

    c. Pictures: 10K pictures (35 mm cameras - 3 views)
              for each of the three beams with about
              3 tracks/picture

Objectives:

    a. Hadron-neon absorption cross sections (to study
        multistep regeneration effects).

    b. Multiplicity distributions of charged particles
        and γ-rays.

    c. Effective cross-section of a system of hadrons
        against a nucleon for different multiplicities
        of the system.

    d. Coherent inelastic production cross section.

    e. Rapidity distribution of charged particles and
        γ-rays in the target fragmentation region.

Summary reviewed by
A. Subramanian, January 1976

PRECISION STUDY OF HIGH ENERGY COLLISIONS INDUCED BY INCIDENT 150 GeV/c PIONS AND PROTONS

Brown University, Univ. of Cincinnati, Fermilab, IIT, Indiana University, University of Illinois, Johns Hopkins University, MIT, SUNY Albany, Oak Ridge, Rutgers University, Stevens Inst. of Technology, University of Tennessee, Yale University   Irwin A. Pless (Spokesman)

The experiment will be performed using the Fermilab Proportional Wire Hybrid 30" Bubble Chamber System. They require 400,000 pictures each of π^+, π^- and protons with incident momentum of 150 GeV/c. However, they have preliminary approval for only 600,000 pictures.

The objective of the experiment is the study of the following topics.

1. Charged particle multiplicity moments

2. Production spectra for charged and neutral particles

3. Leading particle and diffraction phenomena

4. Correlating in momentum and rapidity among the produced particles

5. Factorization of production amplitudes with respect to the quantum numbers of the incident particle.

In addition, we expect to make a preliminary study of $K^{\pm}p$ and $\bar{p}p$ interactions.

STUDY OF PARTICLE PRODUCTION AT HIGH TRANSVERSE
MOMENTA USING HYDROGEN AND DEUTERIUM TARGETS

J.W. Cronin and H. Frisch (Univ. of Chicago); P.A. Piroué
(Princeton University)

It is proposed to study the particle constituents of a
beam produced at 80 mrad lab angle (~90° in the p-p c.m.
system) by 200-500 GeV protons striking a liquid hydrogen/
deuterium target. This work is basically an outgrowth of
the investigation carried out in Experiment #100A using
targets of complex nuclei. The objectives of the proposed
investigation with a hydrogen/deuterium target are:

1. To unfold the hadron production cross section for p-p
   and p-n collisions;

2. To make a more precise determination of the s-dependence
   of the cross section than can be done with complex nuclear
   targets due to the effects of Fermi momentum;

3. To establish without ambiguity that no complex nuclear
   effects are affecting the data sample acquired in
   Experiment #100A.

It is planned to complete the experiment in the P-East
line of the Proton Area. The experimenters wish to make
measurements for incident proton energies of 200, 300, 400,
and if possible 500 GeV. The estimated time required is
3 weeks for each energy.

MEASUREMENTS OF HADRON-HADRON ELASTIC SCATTERING
AT LARGE FOUR-MOMENTUM TRANSFER SQUARED

Cornell University, McGill University, FERMILAB, Northeastern
University   Marvin Gettner (Spokesman)

It is proposed to measure the hadron-proton ($\pi^\pm p$, $K^\pm p$, $\bar{p}p$) elastic scattering differential cross sections at large angles to a sensitivity of 10^{-35} cm^2/(GeV/c)^2. As a first step it is planned to measure $\pi^- p$ elastic scattering at 50 and 200 GeV/c in the $2 < |t| < 8$ (GeV/c)^2 range.

The measurement of hadron-hadron scattering at large s and large t provide information on strong interactions at small distances. Present high energy data includes mainly pp elastic scattering. The purpose of this experiment is to obtain data for the scattering of the other hadrons.

The proposed experimental method is the same as the one used for Experiment #177A to measure pp elastic scattering. The equipment consists of a two-arm spectrometer system where the momenta and angles of scattered and recoil particles are measured. The forward spectrometer is made of two septum magnets which will yield a resolution of $\Delta t = \pm 0.5$ (GeV/c)^2. The large angle spectrometer is made of two BM-109 magnets, providing $\Delta p/p \approx \pm 1\%$, $\Delta\theta/\theta \approx \pm 0.5$ mr and $\Delta t \approx \pm 0.1$ (GeV/c)^2.

The beam required is of 10^8 π^- per machine pulse. It is expected to have $\Delta p/p \approx \pm \ldots \%$, $\Delta\theta_{horiz.} = \pm 0.5$ mr, $\Delta\theta_{vert.} = \pm 0.3$ mr and a beam spot of $\pm 0.1"$ horizontal and $\pm 0.2"$ vertical. The incident beam will not be counted.

Because of the relatively large angular acceptance of the apparatus they expect to cover the t-range in two settings, one from 2 to 4 (GeV/c)^2 and the other from 4 to 8 (GeV/c)^2. The expected event rates should be of the order of 1 event per hour at t=4 with Δt=0.1 and 1 event/20 hours at t=8 with Δt=1 (GeV/c)^2. Backgrounds due to scattering from collimators and pole faces, inelastic collisions, randoms, and from neutrons should be small.

They request 200 hours for testing and 800 hours for data-taking for the $\pi^- p$ studies.

TEST OF C AT SMALL DISTANCES

R. Cester-Regge, V. Fitch, M. Witherell (Princeton University); R. Turlay (Saclay)

It is proposed to measure a possible charge asymmetry in the momentum spectra of pions and kaons produced in $\bar{p}p$ inclusive reactions at $\theta_{c.m.}=90°$ initiated by 200 GeV $\bar{p}$:

$$\bar{p}p \to \pi^- + --- \qquad \bar{p}p \to \pi^+ + --- \qquad R_\pi = \pi^+/\pi^-$$

$$\to K^- + --- \qquad \to K^+ + --- \qquad R_K = K^+/K^-$$

Ten years after its discovery, the source of CP violation in K decay is still unknown. One may speculate that CP violation could be a short distance phenomenon; in this view it is interesting to test other discrete symmetries at the shortest distances and at the highest momentum transfers.

The proposed experimental apparatus consists of two symmetric magnetic spectrometers, each viewing a 3 ft. long liquid hydrogen target at 97 mrad in the laboratory, corresponding to 90° in c.m. Each spectrometer has one 18D72 magnets, proportional wire chambers and two differential Cerenkov counters capable of separating π from K's up to 50 GeV/c. The range of transverse momenta which could be covered will be up to 5 GeV/c. Great care will be exercised in reducing asymmetries. In principle the experiment could be done with a single arm spectrometer, but in all previous asymmetry measurements it was found high desirable to have two symmetric spectrometers.

The beam required is a 200 GeV negative beam produced by 400 GeV protons. The intensity should be about $10^7/\pi^-$ and 4×10^5 $\bar{p}$ per 10^{12} protons on target. The incoming $\bar{p}$ will be counted, while π^- and K^- will be anticoincidiced with Cerenkov counters.

In 400 hours of data taking with 1.6×10^5 $\bar{p}$/pulse they hope to achieve a charge asymmetry measurement of $\pm 0.25\%$ at $p_t=2$ GeV/c for the production of pions and twice less accurate for kaons.

The apparatus is capable of yielding as by-products:

(i)   The inclusive spectra at large transverse momenta (up to $p_t=4.5$ GeV/c for $\bar{p}p$ collisions).

(ii) The mass spectrum of high mass objects (up to ~10 GeV) which decay into two particles.

PROPOSAL FOR A STUDY OF THE INTERACTION OF HIGH
ENERGY $\pi^{\pm}$ WITH URANIUM

W. D. Walker, L. Fortney, J. Loos, A. T. Goshaw,
W. Robertson and J. Lamsa
(Duke University)

The proponents request 200K pictures of the 30-inch Bubble
Chamber filled with hydrogen and exposed to a 300 GeV/c π^-
beam. Two thin heavy metal plates (Pb or U) would be placed
in the chamber at the upstream end. Use of the downstream PWC
Hybrid System and the new Pb-Glass gamma-detecting spectrometer
is requested.

The proponents state as their purpose for doing the experi-
ment, the following six items:

1. To determine the multiplicity distribution produced in
    high energy π-Uranium interactions and to compare this
    data with data obtained in hydrogen and neon.

2. To measure the inclusive momentum distributions of pro-
    duced pions and protons and compare these data with the
    distributions found for neon and hydrogen.

3. To measure nuclear coherent πA → MA, M → 3π, 5π, etc.

4. To look at high $P_\perp$ (> 1 GeV) events that are produced
    in the heavy nucleus.

5. To do a feasibility study for looking at π-γ collisions.
    The γ's being the virtual gammas produced by the high
    charge of a heavy nucleus.

6. To measure direct electron pair rates in a dense medium.

The proponents expect ~ 5,000 events in a 1-mm plate of
Uranium per 100K pictures with four beam tracks per picture.
They assume 1 π-γ interaction per every 20 events in the Uranium,
thus an experiment of 200K pictures should provide them with a
data sample of ~ 1000 such events.

Summary prepared by
T. H. Groves, January 1976

PROPOSAL TO STUDY THE COHERENT DISSOCIATION OF NEUTRONS

E. Bleser (FERMILAB); D. Freytag (Univ. of Massachusetts);
B. Gobbi, L. Kenah, R. Lipton, J. Rosen, R. Ruchti, H. Scott,
D. Spelbring (Northwestern Univ.); J. Biel, C. Bromberg,
T. Ferbel, P. Slattery, D. Underwood (Rochester)

The participants in this proposal have recently completed
an experiment (#27A) to study diffraction dissociation from
neutrons. This proposal is for an extension of that work with
modifications to the equipment described below.

Experiment #27A involved a study of the reaction $nZ \to \pi^- pZ$
over the large energy range of the neutron beam (50-300 GeV)
and with various nuclear targets from Be to U. It is required
that the interaction with the nucleus be coherent and the
forward V (from $\pi^- p$) is detected in a spectrometer system which
includes an analysis magnet and wire spark chambers.

The preliminary data from Experiment #27A shows the
difference between the Coulomb dissociation (photon exchange)
and diffraction dissociation (Pomeranchukon exchange) and the
variation with target material (Z). A study of the effective
mass of the $\pi^- p$ system shows $\Delta^\circ(1236)$ production associated
with Coulomb dissociation and $N^*(1470)$ production with diff-
ractive dissociation. This study is presently limited to
energies $\gtrsim 150$ GeV because of background. As part of this new
experiment a neutron and a photon counter will be added to
enable a study of the $n \to \pi^- \pi^- n$ and $n \to p\pi^- \pi^\circ$ diffractive processes
and to eliminate them as background.

The physics interest in the new proposal includes:

1. Further study of the diffraction dissociation process
    including further examination of the s- and t-dependence
    and mass dependence. Some of this will be done with a
    high pressure hydrogen gas target.

2. Study of dissociation of partially polarized neutrons
    involving changes in the M3 beam.

3. Measurement of neutron and anti-neutron total cross
    sections from various targets including hydrogen and
    deuterium.

4. Search for two body decay of narrow mass resonances in
    the high mass region of neutron dissociation.

The experiment would utilize approximately five months of
beam time interspersed with that for other experiments over
the next year and a half.

15-FOOT BUBBLE CHAMBER PROPOSAL FOR 485 GeV/c π^- - p INTERACTIONS
USING A TRACK SENSITIVE TARGET

A. R. Erwin, M. A. Thompson, E. H. Harvey and R. Loveless
(University of Wisconsin)

The proponents request 250K pix of the 15-ft Bubble Chamber filled with a 33% atomic mixture of neon in hydrogen and exposed to a π^- beam of 485 GeV/c. Use of a Track Sensitive Target and an upstream beam tagging system is assumed.

The proponents draw attention to four energy dependent phenomena which they would plan to study:

1. The average charged prong multiplicity as a function of the produced mass M*.

2. The ratio of neutral particle to charged particle multiplicities.

3. The integrated correlation functions, f_2.

4. The properties of events with π^0's produced at extremely large p_T.

In each of these areas, the proponents emphasize the increased analysis power that will come as a result of the π^0 detection that will result in the 4π geometry of the bubble chamber filled with the NeH_2 mixture. In particular, they stress the importance of the correlations involving $2\pi^0$'s. They believe it will also be possible for them to search for resonances which decay predominantly via a π^0 or electromagnetic decay mode.

The proponents believe the film can be analyzed using the SATR automatic measuring device at Wisconsin.

Summary prepared by
T. H. Groves, January 1976

FURTHER STUDY OF HIGH ENERGY NEUTRINO INTERACTIONS AT FERMILAB

A. Benvenuti, D. Cline, A. Entenberg, W.T. Ford, R. Imlay
T.Y. Ling, A.K. Mann, F. Messing, D.D. Reeder, C. Rubbia,
R. Stefanski, L. Sulak, P. Wanderer and H.H. Williams
Harvard-Pennsylvania-Wisconsin-FERMILAB

This experiment has two specific physics goals, to study
the matrix element for the muonless events and to study the
deep inelastic scattering by charged currents at large y (and x)
over the neutrino energy range of 20-300 GeV.

These goals are accomplished by use of the present Exp. #1A
detector augmented with two new components, an energy flow
device that measures the direction of the hadronic cascade that
emerges from the muonless collision and a large angle magnetic
muon spectrometer with large drift chambers. The complex of
target-calorimeter-energy flow device is made of 8 units; each
unit consists of a three-element system of liquid scintillator
calorimeter cell, wide gap spark chambers and a Pb plate array
that serves as a hodoscope and a γ-ray calorimeter simultaneously.
An iron-plate calorimeter is placed at the end of the liquid
scintillator-Pb calorimeter (at the beginning of the muon
spectrometer) in order to completely contain the hadronic
shower.

Other neutrino processes, such as those listed below,
have a unique experimental signature in this detector and
feasibility studies for measuring them will be carried out.

The experimenters plan to make full use of the versatility
of neutrino beams which can be sent to their apparatus; they
specifically mention the possibility of running with neutrino
and antineutrino beams produced by 300 and 400 GeV protons
in the one-horn, two-horn, quadrupole triplet and dichromatic
configurations.

Estimates are given below for the event rate per 10^{17}
protons of 400 GeV using the two-horn system (the second
column is for the same reaction initiated by antineutrinos).

$\nu_\mu N \to \mu^- +$ hadrons	46,000 events	10,000 events
$\nu_\mu N \to \nu_\mu +$ hadrons	4.600	3.100
$\nu_\mu e^- \to \nu_\mu e^-$	1.8	3.5
$\nu_\mu Pb \to \nu_\mu \mu^+ \mu^- Pb$	1.2	-
$\nu_e N \to e^- +$ hadrons	460	23
$\nu_e e^- \to \nu_e e^-$	0.1	-

For the first reaction it should be possible to investigate the
(Q^2, E_H) region, $Q^2 < 200$ $(GeV/c)^2$ and $E_H < 200$ GeV.

Use of a large hydrogen target is also envisioned as a
possible future addition.

PROPOSAL TO STUDY MULTIPARTICLE PRODUCTION IN HIGH
ENERGY ANTIPROTON-PROTON INTERACTIONS WITH THE NAL
30-INCH BUBBLE CHAMBER

R.E. Ansorge, J.R. Carter, J.G. Rushbrooke and B.R. Webber
(Cavendish Laboratory); W.W. Neale, L. Voyvodic, R.J. Walker
and J. Whitmore (Fermilab); Z. Ming Ma, W. Morris, B.Y. Oh,
D.L. Parker and G.A. Smith (Michigan State)

We propose to study multiparticle production in the inter-
actions of 100 GeV/c antiprotons in the 30-inch hydrogen bubble
cahmber. We request 100,000 pictures with a Cerenkov tagged
secondary beam containing roughly equal numbers of $\bar{P}$'s and π^-'s.
We also plan to use the downstream wide gap spark chamber hybrid
system with a few minor modifications to study neutral particle
producton in the forward direction.

HADRONIC INTERACTIONS IN COMPLEX NUCLEI

R.M. Edelstein, D.R. Green, H.J. Halpern, J.S. Russ
                (Carnegie-Mellon University)

It is proposed to study several types of hadronic inter-
actions in complex nuclei using the Multiparticle Spectrometer
Facility (MPS) in M6(West) at FERMILAB. Broadly speaking,
these experiments are for the purpose of learning about the
following:

1. Diffraction dissociation, through the use of the unique
    filter of coherent hadron dissociation.

2. The interaction of high energy hadronic systems in nuclear
    matter, including production, absorption, and cascade.

3. Manifestly incoherent beam dissociation reactions such as
    those with charge exchange.

4. Details of nuclear models for coherent and incoherent
    scattering.

The MPS facility is a magnetic spectrometer with propor-
tional wire chambers, wire spark chambers and Cerenkov counters
for particle detection. It will be used first to perform
approved Experiments #110A and #260. This experiment is
proposed for a time when it is expected that the spectrometer
as well as beam detection equipment will be functioning. Most
revisions of the apparatus are required in the form of Pb-
scintillator sandwich counters 1) downstream of the spectro-
meter for π° detection, and 2) surrounding the target for
π° and nuclear breakup detection.

The running time requested is 200 hours for testing and
800 hours for data taking. A minimum of 6 calendar months is
needed for setting up, testing and running.

                                    Summary prepared by
                                    R.M. Edelstein, June 1974

POLARIZATION IN p-p ELASTIC, INELASTIC AND
INCLUSIVE REACTIONS AT NAL ENERGIES

G.W. Abshire, B.B. Brabson, R.R. Crittenden, A. Dzierba,
S. Gray, R.M. Heinz, J.E. Mott, H.A. Neal, D.R. Rust
(Indiana University)

It is proposed to utilize the expanded Internal Target Area
and the hydrogen jet target and recoil spectrometer facility to
measure the polarization in p-p elastic, quasi-elastic, and
inclusive scattering. The motivation for such a study origi-
nates with the wish to determine the energy dependence of the
fixed-t polarization over an energy range corresponding to
beam energies from 20 to 400 GeV.

In Regge models the recoil proton polarization in p-p
elastic scattering is due to the interference of participating
Regge trajectories and the prediction for the variation of the
fixed-t polarization at large s is particularly simple. A
significant deviation of the fixed-t polarization from a power
law in s would be of substantial interest. It will also be of
interest to determine if the double zero in the polarization t
distribution observed near $|t| = .7$ $(GeV/c)^2$ at all momenta
below 20 GeV/c remains as a systematic feature of the proton-
proton system at very high energies. This feature has been
accounted for in certain optical and parton models.

The new item of equipment for the experiment is a carbon
polarimeter capable of measuring the recoil polarization to an
accuracy of ~1%. The analyzing efficiency for this device will
be greater than .005 at all proton energies covered by the
experiment. The polarimeter consists of a block of carbon
(of variable thickness) preceded and followed by groups of
proportional chambers.

Estimates of running time are for 800 hours to collect
data on p-p elastic scattering at ~6 t-values from .2 to 1.0
$(GeV/c)^2$ and 5 s-values from 63 to 752 $(GeV)^2$. The polari-
zation in N* and inclusive production would require an
additional 200 hours for data-taking to cover t-values below
1 $(GeV/c)^2$. The inclusive studies are expected to lead to a
proposal to pursue such work in detail at a later time.

PROTON DIFFRACTION DISSOCIATION ON
HYDROGEN AND DEUTERIUM

JINR (Dubna), FERMILAB, Rockefeller Univ., Univ. of Rochester
S. Mukhin (Spokesman)

It is proposed to extend the study of inelastic scattering
begun in Exp. #186 and to compare the behavior of the inelastic
cross sections for $pd \rightarrow Xd$ to that for $pp \rightarrow Xp$ over the same mass
and t range. The earlier work of Exp. #186 was done with a
deuterium gas jet and involved a study of coherent scattering
of protons from deuterons. In subsequent analysis the inelas-
tic proton-nucleon cross sections have been unfolded using the
deuteron form factor. Those results show a $1/M_X^2$ dependence of
$d^2\sigma/dtdM_X^2$ as is predicted by the triple-Regge formula with pure
Pomeron only. Also the t-dependence of the cross section for a
specific range of M_X^2 is linear, suggesting a discrepancy with
the earlier results studying inelastic reactions from protons
(Exp. #14A) which showed a turnover in $d\sigma/dt$ for $|t| < 0.1$ $(GeV/c)^2$.

It is planned to continue the study of these inelastic rea-
ctions using hydrogen, where the t-dependence of the deuteron
form factor would not have to be considered, and comparing
these results with coherent deuterium measurements. Some ad-
ditional solid state detectors would be added to the existing
system enabling a t-coverage of $0.01 < |t| < 0.1$ $(GeV/c)^2$ and an
M_X^2 out to 60 GeV^2 at a beam momentum of 300 GeV.

The running time request is for approximately two months of
data-taking with the jet operating at 4-6 shifts per week.

Summary prepared by
A.F. Greene, June 1974

PION DIFFRACTION DISSOCIATION

<u>G. Ascoli</u>, R. Klanner, L.J. Koester Jr., V.E. Kruse, R.D. Sard
(Univ. of Illinois), D. Garelick, M. Glaubman, E. von Goeler,
D. Potter, H. Johnstad (Northeastern Univ.)

The broad aim of this proposal is to study pion diffrac-
tion dissociation at the highest available energies. Diffrac-
tion dissociation is here meant as $\pi^\pm p \rightarrow pX^\pm$ (with $X^\pm$ observed
in detail) at modest values of p_t and of M^2_x. Specific purpo-
ses will be to confirm the diffractive nature of A_2 production
as observed at Serpukhov energies and to test particle produc-
tion models like the triple Regge formula.

They plan to use the Chicago Cyclotron spectrometer in
the present configuration used by Experiment #98, with the
following modifications: (i) use of 30 cm liquid hydrogen
target, (ii) addition of a proton recoil detector consisting
of one proportional wire chamber, three magnetostrictive wire
chambers and two scintillation counter hodoscopes, and (iii)
ignoring the last part of the equipment, after the γ-ray
detector.

The setup will be triggered in different ways: (i)
"<u>bubble chamber mode</u>" in which the spectrometer is triggered
by any inelastic interaction in the hydrogen target. They
expect 750,000 of these events. They will be used to study
single particle spectra, correlations in inclusive distribu-
tions, and general features of the interactions. (ii) <u>Proton
trigger events</u>. In the reactions $\pi^\pm p \rightarrow pX^\pm$ the proton has to
be detected in the proton recoil detector. This limits the
kinematically accepted ranges to $0.05 < |t| < 0.45$ (GeV/c)^2 and
$M_x < 4$ GeV. They propose to take 2.5 million triggers. Par-
ticular care will be reserved to the fully measured reactions
$$\pi^\pm p \rightarrow \pi^\pm \pi^+ \pi^- p \qquad \pi^\pm p \rightarrow \pi^\pm \pi^+ \pi^- \pi^+ \pi^- p$$
The acceptance of the spectrometer, though   not as good as
in a bubble chamber, covers most of the forward hemisphere,
and is better than for previous spectrometers. The presence
of a photon detector will help in separating the type of re-
action. (iii) <u>Coherent production</u> of 3π, 5π systems from
nuclei $(\pi Z \rightarrow (3\pi) Z)$. For this purpose the hydrogen target and
proton recoil detector will be replaced by a heavy Z target
surrounded by anticoincidence counters designed to remove all
events with particles produced at large angles and with $|t| > 0.2$
(GeV/c)^2.

They plan to run with negative pions at momenta of 50, 100
and 150 GeV/c and at one momentum for positive pions. Beams of
$\leq 10^5$ pions per burst are adequate. They estimate a need for
about 300 hours of testing and 1000 hours of data-taking.

FURTHER TEST OF SCALING AT HIGH MOMENTUM
TRANSFERS IN DEEP INELASTIC MUON SCATTERING

C. Chang, K.W. Chen, A. Kotlewski, L. Litt, R. Renninger, and
P. Schewe (Michigan State University)

This proposal is a follow up of Experiment #26. The main
purpose is to test scale invariance in muon-nucleus deep inelas-
tic scattering at the highest q^2. During the past three years
the Exp. #26 group originated, developed, and operated a magnet-
ized iron spectrometer in the Muon Laboratory. The preliminary
results of the experiment indicate a possible deviation from
scaling at large q^2.

It is proposed to increase the q^2 and ν ranges covered by
the experiment by: (i) placing the targets and magnets closer
together, (ii) running at higher muon energy and higher inten-
sities (for this purpose proportional wire chambers will be
placed upstream and downstream of the target where the rates
are higher), (iii) changing the target to 20 feet of heavy z
target which will be segmented with scintillation counters
every 4" to aid in vertex identification. Using a muon beam
of 240 GeV, they expect to be able to cover the range $0<q^2<160$
$(GeV/c)^2$ and $40<\nu<210$ GeV.

Three muon beam energies are contemplated for the test of
scaling: 90, 150 and 240 GeV. The original method of Exp.#26,
to geometrically scale the apparatus, will be used again.
Both μ^+ and μ^- are desired so as to measure the ratio of μ^+ to
μ^- deep inelastic cross sections. It is also planned to use
Be, Fe, Pb and W targets.

The data-taking will require 5×10^{11} muons corresponding
approximately to 1100 hours of running.

Summary prepared by
G. Giacomelli, June 1974

PROPOSAL TO MEASURE NEUTRAL CURRENT CROSS-SECTIONS
AND ASSOCIATED INELASTIC DISTRIBUTIONS IN THE NARROW-BAND BEAM

B.C. Barish, K. Brown, F. Bartlett, D. Buchholz, F. Jacquet,
F. Merritt, F. Sciulli, L. Stutte, H. Suter (Caltech), G. Fisk,
G. Krafczyk (FERMILAB)

They propose to continue the neutral current investigation
begun in Exp. #262 with measurements of the absolute cross
section and of the y-distribution of neutral current events.

In the Weinberg model the y-distribution of neutral cur-
rent events is expected to have the following form

$$\frac{d\sigma^\nu}{dy} \simeq N[r+s(1-y)^2] \qquad \frac{d\sigma^{\bar\nu}}{dy} \simeq N[r(1-y)^2+s]$$

where N depends on the neutral current coupling and on nuclear
structure functions; r and s depend on the Weinberg angle.
Thus both the y-distribution and the overall normalization
are of considerable theoretical importance.

Experimentally it is difficult to measure events with low
hadron energies and thus at low $y=E_h/E_\nu$. In order to minimize
experimental biases it is preferable to use high energy neu-
trinos. The setup of the dicromatic neutrino beam allows a
cha ge of the relative number of π- and K-neutrinos, by steer-
ing the hadron beam relative to the neutrino detector (the
kaon neutrinos are enhanced by a factor of 10 relative to the
pion neutrinos if the angle is changed from 0 mrad to 1.75
mrad).

Using the same equipment of Exp. #21A (and #262) and an
enhanced (monochromatic) kaon neutrino beam of high energy
they estimate they are capable of measuring the absolute angular
distribution down to y=0.06. Based on the rates from Exp. #262
they request 3×10^{18} protons with a fast spill on the neutrino
target to measure the absolute neutral current and inelasticity
distributions for both neutrinos and anti-neutrinos with dif-
ferent neutrino beam conditions. They could start running in
September 1974.

Summary prepared by
G. Giacomelli, June 1974

A HIGH PRECISION EXPERIMENT TO MEASURE THE
INELASTIC p-p CROSS SECTION AND ITS
ASSOCIATED FORWARD MULTIPLICITIES
AT SMALL MOMENTUM TRANSFER

S. Childress, P. Franzini (Columbia Univ.); F. Bletzacker,
J. Lee-Franzini, R. McCarthy, R.D. Schamberger (SUNY, Stony
Brook)

This group has completed an experiment to study inelastic
proton-proton collisions (Exp. #14A) at 200, 300, and 400 GeV
using an external proton beam in the Neutrino Area. Exp. #221,
now in progress, is a further study of these processes using the
internal proton beam at the Internal Target Area. The group
is proposing yet another extension of this work, still at the
Internal Target Area but now using a hydrogen gas jet instead
of relying on carbon-polyethylene subtraction. They also plan
to study the associated forward multiplicity of the inelastic
collisions.

Preliminary results from Exp. #221 show fits to the inelas-
tic cross section, $d^2\sigma/dtdM_x^2$, to require a constant term plus
a $1/M_x^3$ term; the former is energy dependent and the latter is
not. This compares with results from other experiments cover-
ing a similar kinematic range which suggest an energy independent
$1/M_x^2$ behavior consistent with pure Pomeron exchange in a triple-
Regge formula. Results from Exp. #14A also show a non-exponen-
tial t-dependence below $|t|\approx0.1$.

The experiment proposed will cover the regions:
$0.011<|t|<0.234$ $(GeV/c)^2$, $0.75<x<1.0$ and M_x^2 up to 200 GeV^2 at
480 GeV beam momentum. Measured resolution is expected to be:
$\Delta M_x^2=0.5$ GeV^2, $\Delta t/t\approx2\%$, $\Delta s/s\approx2.5\%$. The following changes in equip-
ment are proposed: i) a new low intensity hydrogen jet (10^3-10^4
times smaller than the present jet target), ii) an extended ion
chamber with radiation protection to be provided by the expan-
sion of the Internal Target Area, and iii) a downstream scin-
tillator hodoscope for multiplicity measurements.

The experimenters ask for 3-6 months for testing and 6-9
months for data-taking assuming beam time availability of 30%.

Summary proposed by
A.F. Greene, June 1974

SINGLE-PARTICLE SPECTRA IN HIGH-ENERGY COLLISIONS
OF CHARGED HADRONS

E. Beier, H. Brody, G. Featherston, K. Raychaudhuri, H. Takeda,
R. Thern, R. Van Berg and H. Weisberg (University of
Pennsylvania)

This experiment is proposed to measure the differential
cross section for the inclusive reactions a + b → c + anything,
where a, c = p, $\bar{p}$, $\pi^{\pm}$ and $K^{\pm}$, and b is a target proton.
Threshold Cerenkov counters in the incident beam and in the
scattered particle spectrometer are used for particle identifi-
cation. In each phase incident beam momenta for 40, 80, and
160 GeV/c will be used.

The beam requirements are for maximum available intensity
that the Cerenkov counter can handle (for most of the run), with
a 1 cm x 1 cm spot size and angular divergence better than
± 2.5 mrad. It is proposed to place the equipment in the "front
porch" area of the 3.5 mrad beam (M1).

The spectrometer is now being used at the AGS in Experiment
555 (Single Particle Spectra). It pivots mechanically around
the target and uses proportional chambers. A small C-magnet
(12C24), an on-line computer link, a LH_2 target and certain
beam-line instrumentation are required from Fermilab.

The experiment covers secondary moments $p_{lab} \lesssim 20$ GeV/c
corresponding to the "target fragmentation" and "central"
region of particle production, $-1.0 \leq x \leq 0.1$.

The total estimated time for running is 800 hours.

Summary reviewed by
H. Weisberg, January 1975

Di-Muon #325

STUDY OF DI-MUON PRODUCTION EMPLOYING A
PROTON BEAM STRIKING A COPPER TARGET

J. P. Boymond, P. A. Piroué, R. L. Sumner (Princeton University);
J. W. Cronin, H. J. Frisch, M. J. Shochet (University of Chicago)

As part of the recent interest in direct production of
muons in high energy interactions including their possible
origination from decays of vector mesons, one of the groups
which originally observed these phenomena (in Exp. #100A) is pro-
posing a further examination of these reactions in subsequent
work with the same apparatus. Experiment #300 is intended as an
extension of the particle production work from heavy nuclear
targets but now using hydrogen and deuterium targets. As part
of that running a copper target would be used to look for di-muon
production. A second arm to detect direct muons coincident with
a count in the main spectrometer will be constructed. This arm
will consist of 10 12'-high by 4'-wide liquid scintillation detectors
placed in an array of 4' diameter x 20' deep holes. The detectors
are placed on a line displaced 15' from the west edge of the
Proton-East pit. Muons produced at the target are required to have
$p_\perp \gtrsim 2$ GeV to penetrate the earth between the target and the de-
tectors. In the cm system this detector system (Multi-Hole Spectrom-
eter) will subtend a polar angle of between 45° and 120° and an
azimuthal angle of 33°. A movable absorber placed near the target
will enrich the direct muons arriving at the detector.

Using a parton-antiparton annihilation model it is estimated
that about 2% of the events with a direct muon in the primary
spectrometer with $p_\perp \simeq 3$ GeV/c would have a muon coincidence in
the second arm. Chance coincidences in the muon detector are
estimated to be 3×10^{-3}. The effective mass of the muon pair will
be calculated from the angle and momentum of the muon in the spec-
trometer arm and from the angle of the second muon measured with
the other arm. The mass resolution, $\delta M/M$, is estimated to be about
10%. The mass range covered is $3 < M_{\mu\mu} < 15$ GeV/c^2 with a cross
section sensitivity $\sim 10^{-39}$ cm^2.

Summary revised by
J. W. Cronin, January 1975

A PROPOSAL TO MEASURE MUON PAIRS PRODUCED
AT HIGH TRANSVERSE MOMENTUM BY PIONS

J.W. Cronin, H.J. Frisch, M.J. Shochet (Univ. of Chicago);
J.P. Boymond, P.A. Piroué, R.L. Sumner (Princeton)

It is proposed to measure the direct di-muon
production by 200 GeV pions

$$\pi^- p \to \mu^+ + \mu^- + \text{ anything.}$$

Experiments #70, #100A and #184 have recently
observed direct muon production at large p_t in nucleon-
nuclei collisions. The yields are $\sim 10^{-4}$ of the pion
yield, essentially independent of E_o, p_t and θ_{cm}. These
muons could come from the decays of vector mesons or
from new phenomena. It is thus important to study the
direct production of di-muons, in particular in pion
initiated reactions. The parton model predicts that
di-muon production by pions should be considerably larger
than in nucleon-nucleon collisions, because the pion has
a fast antiquark content, which facilitates the quark-
antiquark annihilation into a high mass virtual photon
which then decays into a muon pair.

They will use the high intensity pion beam and
the focusing spectrometer of their approved Experiment
#258, to which they will add a second arm, made of
scintillation counter hodoscopes placed after some shielding.
The focusing spectrometer will be at an angle of 100 mr,
while the added muon counters will cover the angular
range between 35 and 160 mr in the lab. This experiment
will be intrinsically parasitic on Experiment #258. They
anticipate a counting rate of 8 di-muon events per
shift when the incoming pion momentum is 200 GeV/c and
the focusing spectrometer is set at $p_t = 3$ GeV/c
(invariant mass of 6 GeV).

Summary reviewed by
P. A. Piroué, March 1975

TESTS OF PARTICLE IDENTIFICATION BY
IONIZATION LOSS (ISIS)

W.W.M. Allison, C.B. Brooks, N.N. Bunch, P. Shield (Oxford);
R. Yamamoto (MIT)

The mnemonic ISIS is to describe "identification of
secondaries by ionization sampling." The Oxford group has been
experimenting with a large multi-wire drift chamber to distin-
guish between pions, kaons, and protons with momenta from 5 GeV/c
to about 100 GeV/c. Cerenkov counters can furnish only a limited
number of cells and consequently have difficulty in separating
multiple secondary particles, and transition radiation detectors
are believed to be useful only in the region of several hundred
GeV/c.

The ISIS effort has been directed toward using the
relativistic rise of ionization loss in gases at atmospheric
pressure. This rise is due to the effect of the relativistic
expansion of the transverse electric field of a particle.

One difficulty is Landau fluctuations which tend to mask
the correlation between particle energy and ionization. However,
it is believed that with the selection of a proper gas and by
measuring many samples on each track that this technique could
succeed.

These data will also allow detailed quantitative comparison
with theoretical calculations of loss distributions at different
velocities. Significant differences between available data and
earlier calculations have been understood and better agreement
achieved by Monte Carlo calculation based on the single scattering
collision probability as described by U. Faro. These calculations
give absolute predictions for the results of this experiment.

The experimenters propose to test a prototype ISIS chamber
in the hadron beam of the Neutrino Area at Fermilab. It would
be possible to compare their results with a conventional tagging
Cerenkov counter also in that beam. There is a need for
approximately one shift of data-taking at the positive beam
momenta of 25, 50, 100 and 175 GeV/c, one negative momentum
and some miscellaneous checks.

Summary prepared by
W. Allison, January 1975

Addendum, January 1976: The analysis of the data is complete
and the final results have been written up (Oxford University
preprint 67/75 and 68/75) and are to be published (Nuclear
Instruments and Methods). The results indicate that the Monte
Carlo model calculations are correct and that particles may
be identified using this technique.

THE INTERACTIONS OF π^--MESONS IN
NUCLEAR EMULSION AT 200 GeV/c

M.I. Adamovich, N.A. Dobrotin, M.I. Tretjakova (P.N. Lebedev
Physical Institute of the Academy of Science, USSR)

The principal interest in this experiment is to investigate
the characteristics of π^--nucleon and π^--nucleus coherent and
incoherent interactions at 200 GeV/c. Comparison will be made
with observations previously by this group using lower energy
pions, at 17 and 60 GeV, as well as with 200 GeV proton
exposure.

THE INTERACTIONS OF PROTONS IN
NUCLEAR EMULSION AT 400 GeV/c

M.I. Adamovich, N.A. Dobrotin, M.I. Tretjakova (P.N. Lebedev Physical Institute of the Academy of Science, USSR)

The purpose of this experiment is to continue the study of interactions in nuclear emulsions by high energy protons. An exposure with 400 GeV protons in this experiment will allow systematic studies, and comparison with previous studies at 67 and 200 GeV, on multiplicities and angular distributions of secondary particles for both proton-nucleon and proton-nucleus interactions.

Search for Massive Neutral Particles

C.A. Ayre, H.R. Gustafson, L.W. Jones, M.J. Longo,
P.V. Ramana Murthy, (University of Michigan)

It is proposed to search for new massive neutral particles in the M3 and M4 beams of the Meson Laboratory. The search would be sensitive to neutral particles with mass $\geq$ 2 GeV and with proper lifetimes $\geq 10^{-7}$ sec. The masses of the particles would be determined by measuring their time-of-flight relative to the R.F. and their energy with a total absorption calorimeter.

There are at present many discussions about the possible existence of particles with new quantum numbers, such as charm or color. Most guesses suggest that their masses would be of the order of several GeV and their lifetimes of the order of 10^{-13} sec. However, it is quite possible that new particles exist with a combination of quantum numbers such that much longer lifetimes would be possible. Furthermore no previous experiment could have detected neutral heavy particles with $10^{-8} < \tau < 10^{-3}$ sec.

The apparatus would be principally the Michigan calorimeter, which is presently located at the end of the M3 line for use by Experiment #248. They plan to tune up the calorimeter in the M3 beam and take actual data in the M4 beam, which should allow a more sensitive test because of the reduced neutron background.

They request approximately 2 months for testing in the M3 beam line (with some low intensity runs) and 2-3 weeks of data taking in the M4 line.

Summary prepared by
G. Giacomelli, September 1974

Di-Muon #331

A PROPOSAL FOR A DETAILED STUDY OF DI-MUON PRODUCTION

K. Anderson, D. Bintinger, J. Curry, J. Pilcher, J. Sidles
(University of Chicago); G. Sanders, A.J. Smith, J.J. Thaler
(Princeton University)

It is proposed to measure the detailed character of di-muon production in hadron-nucleon collisions ($hN \rightarrow \mu^+ + \mu^- +$ anything) In particular they will study the di-muon mass distribution down to low masses, the angular distribution and density matrix elements as a function of bombarding energy and beam particle species. The experiment will use the Chicago cyclotron spectrometer in the Muon Laboratory.

Experiment E-70, E-100A, and E-184 have recently observed direct muon production in nucleon-nuclei collisions. The yields are $\sim 10^{-4}$ of the pion yield, the ratio being apparently independent of p_t and θ_{cm}. These directly produced muons could come from the decay of vector mesons or from new fundamental phenomena Since the single prompt muons may be one of a pair, it is important to study the direct production of di-muons.

The experimental equipment consists of a heavy target (later on hydrogen and deuterium targets will be used), a hadron shield, a magnetic spectrometer with large acceptance and muon identifier The magnetic spectrometer and muon identifier are those of the E-98 muon scattering experiment. Additional proportional chambers are used between the target and hadron shield to allow a mass resolution which is unaffected by scattering in the shield. The triggering will be done in two modes:

    (i)   A non-selective trigger to study all muon pairs traversing the spectrometer and

    (ii) A selective mode where low di-muon masses and low p_t pairs are not recorded.

The only background which cannot be easily rejected is that of two muons originating from two pions from the same event. This will be monitored by recording triggers having 2 muons of the same sign, and by studying the μ-pair rate as a function of distance between the production point and the hadron shield. Di-muon mass resolution is expected to be better than $\pm 5\%$ over the range $0.0 < x_{\mu\mu} < 0.7$. The range of production angles to be studied corresponds to $0.2 < x_{\mu\mu} < 1$ and $p_t < 3$ GeV/c. Mass acceptance extends to 10 GeV.

They request a beam with 10^7 π/burst at 50, 100, 200 and 300 GeV. Their sensitivity with such a beam is 1 event/hour at a cross section of 10^{-34} cm^2. They estimate a need for 100 hours o data-taking with heavy targets and 400 hours with hydrogen and deuterium targets. The actual event yield will depend on the production cross section which is unknown at this time. Should the single prompt muons be one of a pair, then several million events would be collected with the requested beam flux.

Initial running will be parasitic with a beam flux of approximately 3×10^5 particles/pulse.

STUDY OF THE INTERACTIONS OF 2C0 GeV/c K⁻ IN THE
FERMILAB 15-FOOT HYDROGEN BUBBLE CHAMBER

Birmingham, Cambridge, Florida State
J. G. Rushbrooke (Spokesperson)

Using 300 GeV/c protons incident on a target high momentum negative secondaries, being mainly Σ^- hyperons, will be focussed onto a second target in Enclosure 100 using a system of high gradient pulsed quadrupole magnets. The K^-/π^- ratio obtained from the second target should be much higher than that obtainable at the first and is expected to be 20% or more at the bubble chamber. The number of pictures requested is 100,000 with approximately one incident K⁻ per picture. The particle tagging system using the upstream P.W.C's and Cerenkov counters would be essential.

In a fiducial volume of length 2 metres slightly more than 10,000 K⁻p interactions would be obtained. As this is to be regarded as a survey experiment all the events would be measured and all aspects of K⁻p interactions at 200 GeV/c studied. Special emphasis would be given to the study of processes involving visible strange particle decays, for which the 15 foot bubble chamber is an excellent detector.

STUDY OF THE INTERACTIONS OF 200 GeV/c K$^+$ IN THE FERMILAB 15-FOOT HYDROGEN BUBBLE CHAMBER

Bonn, Cambridge, CERN, Aachen
J. G. Rushbrooke (Spokesperson)

Using 400 GeV/c incident protons and a polyethylene particle filter in enclosure 100 it should be possible to make a 200 GeV/c particle beam containing at least 20% positive kaons. The number of pictures requested is 100,000 with approximately one incident K$^+$ per picture. The particle tagging using the upstream P.W.C.'s and Cerenkov counters would be essential.

In a fiducial volume of length 2 metres a little over 10,000 K$^+$p interactions would be obtained. As this is to be regarded as a survey experiment all the events would be measured and all aspects of the K$^+$p interactions studied. Special emphasis would however be given to processes involving visibel strange particle decays for which a large bubble chamber is ideal.

Summary updated by
J. G. Rushbrooke, January 1976

A SEARCH FOR DIRECT MUON PRODUCTION
IN THE FORWARD DIRECTION

D. Buchholz (Caltech); R.P. Johnson (Fermilab); R.L. Sumner
(Princeton); O. Fackler (Rockefeller); H. Frisch, M. Shochet
(Chicago)

The experimenters propose to search for direct muon
production in the forward direction from 300 GeV protons
incident on a heavy nuclear target. They would use the first
stage of the Ml beam as a diffracted proton beam and the second
and third stages of Ml as a spectrometer. This would allow
measurements of the direct muon to pion ratio at values of x
between 0.3 and 0.75, at a fixed and small value of p_t
(<0.3 GeV/c).

The recent measurements at a number of laboratories gave a
relatively abundant production of directly produced leptons at
large angles with a ratio of 10^{-4} of the pion rate, the rate
being essentially independent of energy and transverse momentum
(at large p_t). It is possible that these leptons come from the
dileptonic decays of vector mesons, such as the ρ, ω and ϕ.
If the direct lepton/π ratio were equal to 10^{-4} also at low p_t
for a wide range of x, the vector mesons would have to be produced
at least as copiously as pions in strong interactions. The
purpose of this search would be to extend the measurements of
direct muon production over a wide range in x.

The first stage of the Ml beam would be transformed into
a diffracted proton beam with an intensity of 5×10^8 protons/
pulse. The beam would strike a variable density target followed
by a steel muon filter. The second and third stages of the beam
line would be used as a spectrometer with $\Delta\Omega \, \Delta p/p = 5 \times 10^{-8}$
steradians. A simple muon detector would be located at the end
of the spectrometer.

Event rate calculations show approximately 800 direct
muons detected per hour at x = 0.5 and assuming μdirect/$\pi = 10^{-4}$.

Backgrounds are expected to come from muon decays of π's
and K's inside the target and absorber, muons from hadron punch
through, and muon contamination in the beam. The first source
can be measured by varying the target density, the second and
third by using a Cerenkov counter downstream of the target to
measure pions and muons at that location.

It is claimed that the experiment would involve only a minor
perturbation on the Ml beam line and the addition of only a
few items of equipment. The request for running time includes
approximately one week for testing and one week for data-taking.

Summary prepared by
A.F. Greene, September 1974

MULTIPARTICLE PRODUCTION IN NUCLEON-NUCLEUS
COLLISIONS AT 400 GeV

F. Fumuro, R. Ihara, T. Ogata and Y. Yukimasa (Kwansei Gakuin
University)

The object of our experiment is to investigate the mass
number (A) dependence of various quantities such as absorption
cross section, multiplicity, inelasticity, angular distribution
etc. at 400 GeV proton-nucleus interactions.

To investigate the nucleon-nucleus interactions, emulsion
chambers are used. The emulsion chamber consists of nuclear
emulsion and various metals piled up in an alternative way.
The total size of this chamber is 10cm x 10cm x 2.5cm. Four
chambers are prepared for this experiment.

The chambers are exposed to proton beam in the vertical
direction to the emulsion plane.

Intensity need is 10^5 particles/cm^2.

Summary prepared by
J. Lach, May 1976

MEASUREMENT OF DI-MUON EVENTS IN THE MESON AREA

D. Eartly, G. Giacomelli (Fermilab); K. Pretzl (Max-Planck)

The experimenters propose to study the direct dimuon production with the double arm muon-range telescope located in the hall downstream of the target train in the Meson Area. Each telescope consists of six scintillation counters. The telescopes are at present looking at the Meson Area beam dump at an angle of 76 mrad with respect to the incoming proton beam, covering a transverse momentum range of $1.4 < p_t < 2.7$ GeV/c and a dimuon mass range of $2.5 < m_{\mu\mu} < 5.2$ GeV.

For this study they request two periods of running time totaling 1.5 hours, with no Meson Area target. If successful they may wish to move the range telescopes to other angles and would require two extra runs of half an hour each.

Summary prepared by
G. Giacomelli, September 1974

PION - DEUTERON INTERACTIONS AT 400 GeV

J. Erwin, J. Klems, W. Ko, R. Lander, D. Pellett, P. Yager
(Univ. of California, Davis); L. Dunn, H. Lubatti, K. Moriyasu,
W. Podolsky (Univ. of Washington); J. Bartke, A. Eskreys,
P. Malecki, K. Zalewski (Cracow); R. Sosnowski, M. Szczekowski,
A. Wroblewski, A. Zieminski (Warsaw)

It is proposed to take 50,000 pictures of the 30-inch deuterium filled bubble chamber exposed to a 400 GeV negative pion beam. Due to the manner in which the accelerator and the beam are operated, it is likely the actual energy will be at about 375 GeV. Use will be made of the downstream PWC hybrid spectrometer. The purpose of this experiment is to utilize the properties of the deuteron to study reactions which cannot easily be studied on protons. This may include: 1) inclusive reactions such as $\pi^- + n \rightarrow \pi^\pm +$ anything, 2) diffractive dissociation of the neutron, and 3) diffractive dissociation of pions on deuterons.

CRACOW EMULSION EXPOSURE TO 200 GEV PIONS

W. Wladyslaw
Institute of Nuclear Physics, Krakow (Poland)

Summary:

In the last two years we were dealing with the interactions
of 67 GeV, 200 GeV and about 3000 GeV protons with nuclei of
photographic emulsion. The results of the analysis performed
have been summarized in a few publications listed below. These
results contain new informations about some regularities in the
rapidity distributions, as a function of the target nucleus
excitation. It seems for us very interesting to perform similar
analysis with primary pions. It may occur that this analysis
applied to the final states in proton - nucleus and in pion -
nucleus interactions may easily detect differences between them.
Therefore we would like to expose to the 200 GeV pion beam in
NAL two stacks of Ilford G5 stripped stripped pellicles.
Emulsions will be prepared in plastic containers /5cm x 5cm x
10 cm/, with engraved straight linc, which will be used for
optical adjusting of the stack parallel to the beam / ±10 mrad/.
The optimum density of pion tracks should be between 5 x 10^4/
cm^2 and 3 x 10^5/cm^2 at the entrance side of the stack.

References:

J. Babecki et al. Physics Letters B 47 268/1973/
J. Babecki et al. Acta Physica Polonica B 5, 315/1974/
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J. Babecki et al. Physics Letters B 52, 247/1974/

Summary prepared by
W. Wladyslaw, February 1975

STUDY OF THE ELECTRON-PHOTON CASCADE SHOWER IN LEAD ABSORBER

Kobe University, Konan University, Nagoya University, Saitama
University, University of Tokyo, Utsunomiya University,
Wasede University   S. Dake (Spokesman)

The purpose of our experiment is to study the three-dimen-
sional behaviour of electron-photon cascade shower in lead, using
nuclear emulsion plates inserted at various depth in lead
absorber. Measuring the shower electrons on each shower in
nuclear emulsion with a microscope, the following informations
are obtained: (a) lateral and longitudinal development of
shower electrons in lead absorber, (b) fluctuations of shower
development at various depth and (c) effects of the inhomogeneous
media on the shower development. These results are compared with
the three-dimensional cascade theory, the Monte Carlo calculations
and the results obtained with detectors such as ionization
chambers, scintillation probes, X-ray films and thermoluminescent
dosimetry.

We are preparing 30 units of detectors. The geometrical
size of each detector is about 14 cm x 12 cm x 10 cm, and it is
constituted of nuclear emulsion plates and lead plates
(thickness of 0.5 ~5.0mm) which are piled up alternately. The
parallel and mono-energetic electron beams are irradiated
perpendicular or oblique to the front of each shower detector.
In order to suppress the room background, the whole of the
detector must be surrounded by lead bricks of thickness of about
10 cm. Following are the summary of the conditions required
in this experiment.

1. Beam; parallel and mono-energetic electron beams,

2. Energy of the irradiated beam; several points between
    about 50 GeV and the maximum energy,

3. Accuracy of the beam energy; better than ~±3% (absolute)
    and ~±3% (relative),

4. Amounts of irradiation; 5-10 electrons/cm^2 on each
    detector,

5. Running time; about two hours,

6. Shield material; lead bricks (about 0.5 m^3 in total
    volume) enough to shield each detector.

Summary prepared by
S. Dake, February 1976

INTERACTIONS OF π+ MESONS AND PROTONS IN HYDROGEN

W. Ko, J.H. Klems, R.L. Lander, D.E. Pellett, P.M. Yager
(Univ. of California, Davis); R.P. Ely, G. Gidal, W.B. Michael
(Lawrence Berkeley Laboratory)

The exposure of 25,000 pictures at 150 GeV/c will be used
to explore the usefulness of the large geometric volume chamber
for hadron physics. In particular the 15-foot chamber offers
improved momentum resolution for charged particles allowing a
detailed study of correlations. The large volume makes possible
the detection and measurement of the γ-rays from π⁰ decay or
decays of other particles. Thus, direct measurement of the
momentum of neutrals is possible, so there is the possibility
of kinematic constraints when such neutral particles are present.
These conditions make possible the study of the following topics:

- correlation studies.

- neutral particle multiplicities by direct observation.

- inclusive distributions of vector mesons, including
  in particular ρ^0 and ω^0.

- inclusive distributions and correlations of other
  neutral particles (K^0 and Λ^0 and $\bar{\Lambda}^0$).

- heavy resonance mass spectroscopy, since all decay
  products, charged and many neutral, can be measured.

The photographs will be scanned and pre-digitized at
Davis and LBL, and measured at LBL. The track reconstruction
and fitting programs are presently being developed. We will
develop both TVGP and Hydra-Thresh for the 15-foot geometry.

Summary prepared by
W. Ko, May 1975

PROPOSAL TO STUDY NEUTRAL PION PRODUCTION IN
200 GeV/c π⁻p INTERACTIONS IN THE
15-FOOT BUBBLE CHAMBER WITH A TRACK-SENSITIVE TARGET

R. Louttit and J. Sondericker(BNL); N.N. Biswas, N.M. Cason,
V.P. Kenney, W.D. Shephard, J.M. Bishop (Univ. of Notre Dame)

It is proposed to study neutral pion production in 200
GeV/c π⁻p interactions in a track-sensitive liquid hydrogen
target mounted in the 15-foot bubble chamber with neon/
hydrogen filling. The experimenters are interested in
exclusive channels in which no neutral pions are produced,
single-inclusive production of π^0's, two-particle inclusive
production and correlations of $\pi^0\pi^0$ and $\pi^{0\pm}$ pairs, and
cluster-model analyses of events with no missing neutral
pions. They request a preliminary engineering run of ~10,000
pictures and a final data run of 200,000 pictures with an
average of 4 tracks/picture through the target. The track-
sensitive target, with instrumentation and control system,
will be supplied by the experimenters.

Summary prepared by
V. Paul Kenney, January 1976

PROPOSAL TO STUDY NEUTRAL PARTICLE PRODUCTION IN 250 GeV pp INTERACTIONS IN THE FERMILAB 15-FOOT BUBBLE CHAMBER

K. Jaeger (ANL); R. Ammar, R. Davis, L. Loos, R. Stump and N. Kwak (Univ. of Kansas); A. Brody, R. Engelmann, J. Lee-Franzini, J. Hanlon and T. Kafka (SUNY at Stony Brook); J. Canter, F.T. Dao, A. Mann and J. Schneps (Tufts Univ.)

A 25,000 picture exposure is proposed of the hydrogen-filled Fermilab 15-foot bubble chamber to a 250 GeV proton beam.

The main physics objectives are:

1. To study the dependence of neutral particle production (π^0, K^0, Λ) on the charged multiplicity in diffractive and non-diffractive processes.

2. To measure integrated correlations ($f_2^{\pm 0}$ and f_2^{00}) for neutral pions in a "clean" experiment.

To make these measurements reliably requires neutral particle detection in both CM hemispheres and the CM symmetry of the pp system. For example, f_2^{00} will be determined to ± 0.2.

The event analysis of the neutral secondaries together with the measurement of the slow laboratory protons in pp $\rightarrow$ p_{slow} + X for the distinction between diffractive and non-diffractive events will be done in 1/2 year.

Further objectives are:

3. To measure differential neutral-charged correlations.

4. To measure multiplicities, spectra and correlations ("inclusive program") inside the mass M_X in pp $\rightarrow$ p_{slow} + X^-.

Summary prepared by
R. Engelmann, October 1974

PROPOSAL TO SURVEY CENTRAL COLLISIONS IN THE
REACTION p̄ + p → MESONS BETWEEN 30 AND 60 GeV/c
IN THE 30" HYDROGEN BUBBLE CHAMBER AT N.A.L.

V.E. Barnes, D.D. Carmony, R.S. Christian, C.R. Ezell,
J.A. Gaidos, L.J. Gutay, R.L. McIlwain, A.T. Laasanen,
P. Leong, D.H. Miller, T.R. Palfrey, R.B. Willman
(Purdue University); F. Turkot (Fermilab)

This is a detailed survey of antiproton interactions with
particular emphasis on the annihilation process.

Annihilation interactions could give an insight into the
behavior of hadrons at small distances and shed light on the
detailed structure of the nucleon. This physics may well be
closely related to the high $p_\perp$ phenomena and to the recent
results on e^+e^- annihilation both of which have exhibited
unexpected features which may indicate a common underlying
structure. This study of central collisions is ideally
suited to the bubble chamber since the cross section is high
and the interactions are dominated by high multiplicities.
The choice of beam momentum is such that $\sqrt{s}$ ($\sqrt{s}$ = 7.9 GeV)
centers on the energy range of SPEAR; and such that the
annihilation cross section is large enough to be accessible
to bubble chamber study.

The 30" hydrogen bubble chamber would be used in an
enriched antiproton beam at 30 GeV/c. The incident antiprotons
are tagged and the downstream hybrid system is used in analyzing
the interaction products. With 3×10^5 antiprotons traversing
the chamber, 19×10^3 interactions are expected with 2.8×10^3
of these being annihilation events. The expected number of
photographs is 100K.

PROPOSAL TO STUDY MULTIPARTICLE PRODUCTION IN 100 GeV/c
ANTI-PROTON-DEUTERIUM INTERACTIONS WITH THE FERMILAB
30-INCH BUBBLE CHAMBER

Stockholm-Liverpool-Vanderbilt
G. Ekspong (Spokesperson)

The experiment will take 100,000 pictures in the deuterium filled 30-inch bubble chamber and use the downstream PWC system. The beam will be a tagged antiproton beam with 100 GeV/c momentum. The analysis will include the following topics:

1. Determination of $\bar{p}$n cross sections and multiplicities. Comparison of the features of 100 GeV/c pp, $\bar{p}$p and $\bar{p}$n reactions.

2. An s-dependent analysis of the $\bar{p}$n reactions making use of the data at lower energies.

3. Study of the π^{o} production and two-particle correlations.

4. Study of the diffractive systems in $n \to p\pi^-$ and $n \to p\pi^- \pi^+\pi^-$ which could be obtained in fits to $\bar{p}n \to \bar{p}p\pi^-$ and $\bar{p}n \to \bar{p}p\pi^-\pi^+\pi^-$

5. The fragmentation processes in $n \to \bar{p}\pi^-$ and $n \to \bar{p}\Lambda^{o}$ will add to the understanding of the fragmentation of the nucleon. The study of the corresponding fragmentations of the proton $p \to p\pi^-$ has given interesting results.

6. Properties of the multiplicity distributions. There is a marked difference in the s-dependence of for instance the <n>/D ratio for pp and $\bar{p}$p reactions. A study of the s-dependence of the <n>/D ratio for $\bar{p}$n reactions would contribute to the understanding of this feature.

7. The possible existence of a Δ-Δ component in the deuteron wave function. It has been suggested that a way to test such a picture is to study inelastic reactions on the deuteron. It is a great advantage to have access to the data from the $\bar{p}p \to \bar{p}p\pi^+\pi^-$ reaction in order to be able to estimate the kinematical background.

8. The strange particle cross section is rising in pp interactions being $\sigma(\Lambda) = 3.2 \pm 0.4$, $\sigma(K^o) = 9.2 \pm 1.0$ and $\sigma(\bar{\Lambda}) = 0.23 \pm 0.10$ mb at 100 GeV/c. Similar cross sections in $\bar{p}$n will make a fairly detailed study of the production of K^o, Λ^o and charged hyperons possible. Antiproton annihilations to kaons are likely to be the best reactions to search for the production of charmed mesons.

Summary prepared by
G. Ekspong, January 1976

SEARCH FOR HEAVY, SHORTLIVED PARTICLES

G. Ekspong, S. Nilsson, N. Yamdagni (Stockholm Univ., Sweden)

The aim is to search for new, possible charmed particles with lifetimes around 10^{-13} ±1 sec.

Nuclear emulsions will serve as target and detector. The signal will be a secondary interaction (neutral decay, charged decays of several topologies) close to the primary proton-nucleus vertex.

The distances will be measured in microscopes. After background elimination the remaining signals should show a distance distribution which is exponential in the first approximation. From this, the existence of new particles and their lifetime can be investigated.

Beam: 400 GeV protons in the Neutrino Area.

Flux: (2-3 x 10^5 protons/cm^2 over about 10 cm^2

Emulsion stacks: One stack with entrance area exposed equal to 30 cm^2.

Summary prepared by
G. Ekspong, January 1976

PROPOSAL TO MEASURE THE ELASTIC SCATTERING OF
HADRONS AT LARGE MOMENTUM TRANSFER

D. Carey, R. Kammerud, D. Ritchie, J. Sauer, R. Shafer,
D. Theriot, J.K. Walker (Fermilab); J. Johnson (Northeastern);
F.E. Taylor (Northern Illinois University)

It is proposed to study elastic scattering of $\pi^{\pm}$, $K^{\pm}$, p,
and $\bar{p}$ at energies of from 50 to 400 GeV and over a t-range of
from 2 to 15 $(GeV/c)^2$ or to a differential cross section limit
of $10^{-37} cm^2/(GeV/c)^2$. It is emphasized that measurements of
the elastic cross sections over these kinematic ranges are of
fundamental importance, possibly providing information on the
mechanism of rising total cross sections. Tests can also be
made of models which attempt to relate the dynamics of elastic
and inelastic inclusive scattering. It is also mentioned that
the apparatus could be useful for studies of backward scattering
or of inclusive reactions.

The unseparated incident beam would have an intensity of
approximately 10^9 particles/pulse and because of the high
intensity would not have any identifying counters. The beam
is incident on a 16" liquid hydrogen target. The spectrometer
consists of two arms and is designed for large acceptance to
be sensitive to the lowest possible cross sections. The forward
arm contains a sweeping magnet, 6"x3"x72", with 18 kG to protect
the front proportional wire chambers. This is followed by the
main momentum analyzing magnet 6.5"x9.5"x20' with 18 kG.
Proportional wire chambers and scintillation hodoscopes are
distributed throughout the system. Particle identification
is accomplished using the threshold Cerenkov counters; C_1 to
detect pions is 65m long and C_2 to detect pions and kaons is
25m long. The momentum resolution in this arm will be $\lesssim 1\%$
and angular resolution at 100 GeV will be $\pm 0.25mr$.

The recoil arm will have a magnet 24"x15"x60" with 15 kG.
Momentum and angular resoltuion are expected to be $\lesssim 1.5\%$ and
$\pm 2.5mr$ respectively. Triggering is to be done at three levels.
The first involves a scintillation hodoscope coincidence, the
second a hardware matrix of hodoscope information, and the
third a hardware processor of proportional chamber information.

Running time for the first phase of the experiment is
described in the proposal. The elastic cross sections would
be measured at 200 GeV for $2 < |t| < 13$ $(GeV/c)^2$, requiring 600
hours, and at 100 and 400 GeV for $3.5 < |t| < 7$ $(GeV/c)^2$, requiring
200 hours. Also, 200 hours are requested for testing. Further
studies of the s-dependence and measurements to the highest
$|t|$-values will await Phase II of the experiment.

Summary reviewed by
J.K. Walker, January 1976

PROPOSAL TO STUDY SCATTERING OF MUONS FROM PROTONS AND DEUTERONS
AT MOMENTUM TRANSFERS UP TO $q^2 = 150$ (GeV/c)^2

T. Loomis, F.M. Pipkin, A. Sessoms, L. Verhey, R. Wilson (Harvard);
W. Francis, T. Kirk (Univ. of Illinois)

It is proposed to extend the measurements of Experiment #98 on inelastic scattering by protons and deuterons to $q^2 = 150$ (GeV/c)^2. For this they require a higher momentum muon beam and a much longer hydrogen (deuterium) target. Besides allowing higher q^2 values, these changes will also allow considerably higher rates on several interesting hadronic channels at moderate momentum transfers.

They plan to add a 10 meter long (130 liter) liquid hydrogen target in front of their present 1.2m target and have both filled with H_2 or D_2 or one with H_2 and the other with D_2. A set of proportional counters will be placed between the two targets. It is not planned to study the hadrons escaping from the sides of the 10 m target. The trigger will be basically the same trigger used by Exp. #98: an incident beam muon must be found in a scattering hodoscope without having any beam halo particle nor an undeflected muon forward.

They request 0.6×10^{11} muons at each of 150 GeV and 300 GeV energies and each of H_2 and D_2 targets. Assuming a beam of 2×10^6 muons per pulse inside a 4" diameter they estimate a need for total running time of 400 hours. They would favor higher muon energies if the energy of the accelerator has been increased.

Summary prepared by
G. Giacomelli, October 1974

A PROPOSAL TO STUDY π° AND η INCLUSIVE PRODUCTION WITH
INCIDENT π^- IN THE TRIPLE REGGE REGION

Caltech, LBL, BNL
R. Kenney (spokesperson)

It is proposed to measure the inclusive reactions

$$\pi^- p \rightarrow (\pi^\circ, \eta^\circ, \omega, \ldots) X^\circ \quad , \quad X^\circ \rightarrow \text{charged + neutrals}$$
$$\pi^- p \rightarrow (\pi^\circ, \eta^\circ, \omega, \ldots) X^\circ \quad , \quad X^\circ \rightarrow \text{neutrals}$$

in the essentially unexplored kinematic region $0 \lesssim |t| \lesssim 3$ $(\text{GeV/c})^2$ (or $p_t \lesssim 1.7$ GeV/c) and $0.8 \lesssim x \lesssim 1$. This is a further contin- uation of the work begun in Experiment #111 (study of exclusive π^- charge exchange) and Experiment #268 (production of π°, η, etc. at p_t up to about 5 GeV/c).

The purposes of the newly proposed work are: (1) to measure the ρ and A_2 Regge trajectories to larger t-values than can be reached in exclusive π^- charge exchange; (2) to obtain data in the triple Regge region for comparison with theory for reactions involving relatively simple exchanges and where the theory makes unambiguous predictions, and (3) to study the relation between high-p_t and low-p_t phenomena.

The experiment would utilize the M2 beam in the Meson Area with π^- at 100, 150, and 200 GeV/c. The experimental apparatus basicly consists of the photon detector utilized for the other experiments with the addition of a charged particle hodoscope (also used in Exp. #268). Two set ups would be required for this experiment, one with the photon detector system on the beam line and the other with the system displaced to one side. The respective t-regions covered are $1 < |t| < 3$ $(\text{GeV/c})^2$ and $|t| < 2$ $(\text{GeV/c})^2$.

The running time request is for approximately 5 weeks (or about 500 hours) in two periods.

K^O REGENERATION AT THE HIGHEST FERMILAB ENERGIES

S. H. Aronson, R. H. March, L. G. Pondrom (Univ. of Wisconsin);
J. Roehrig, V. L. Telegdi, B. Winstein (Univ. of Chicago);
H. Hofer (Swiss Fed. Inst. of Tech.)

It is proposed to measure K^O regeneration in hydrogen and carbon in a short neutral beam where the K^O_S component is still present. The experiment will determine the magnitude of the regeneration parameter, $|\rho|$, and its phase, ϕ_ρ, from 150 to 300 GeV/c with incident proton energies of 400 GeV.

In K^O regeneration experiments one measures the regeneration parameter ρ and by this determines the K^O-$\bar{K}^O$ total cross section difference. Experiment #82/425 by this group has made measurements up to about 120 GeV/c using the M4 K^O_L beam in the Meson Area. Difficulties occur in obtaining sufficient statistics in regeneration measurements when going to higher energies with a K^O_L beam. This happens when the magnitude of the regeneration parameter, ρ, becomes comparable with η_{+-}, the decay parameter for the CP-violating process $K^O_L \rightarrow \pi^+\pi^-$. One can avoid this difficulty by performing the regeneration measurements in a beam where there is a sizable fraction of K^O_S. Then one can measure the interference of ρ and the original K^O_S component of the beam.

The experiment would utilize a K^O beam from the magnetized beam dump also used for the neutral hyperon experiments. This is located in the M2 beam of the Meson Area, but another similar K^O beam could be constructed in another location such as the Proton Area. The K^O detection spectrometer would consist of wire proportional chambers or drift chambers and an analyzing magnet with a gap of 0.2m x 0.6m. A 7.2m liquid hydrogen regenerator (currently in use in E-425) is required. This regenerator will have to be moved from a location close to the production target to further downstream in order to study the interference as a function of distance. The extremities of the regenerator location are 50m and 200m downstream of the target.

The running time request includes 1,200 hours for testing and 1,800 hours for regeneration measurements from carbon and liquid hydrogen with a 400 GeV primary proton energy. There is also interest in measurements at the highest proton beam energies.

Summary prepared by
S. H. Aronson, January 1976

VERY STRANGE HYPERON DECAYS

C. Ankenbrandt, M. Atac, R. Brown, S. Ecklund, P. Gollon,
A. Lennox, J. Lach, J. MacLachlan, A. Roberts (Fermilab);
J. Johnson, R. Majka, J. Marx, P. Nemethy,
J. Sandweiss (Yale)

It is proposed to pursue a comprehensive program to study decays of the charged hyperons with an emphasis on the properties of the Ω^-. While most of their effort will be devoted to decays of negative hyperons or lambdas coming from Ξ^- decay they hope to spend some effort studying leptonic decays of the Σ^+.

The apparatus consists of the equipment needed for Experiment #97. The addition of superconducting quadrupole magnets to the magnetic channel to enhance the intensity of the hyperon beam is discussed in the proposal and interpreted to be useful also to the goals of Experiment #97. The charged hyperons can be identified using two separate methods: a high resolution gas Cerenkov counter and a spectrometer to observe the decay products. For this new proposal there would be the addition of detectors for electrons and possibly gamma rays.

The running requirements are for a beam of approximately 10^{11} protons/pulse at 300 GeV/c. About 600 hours of beam time will be needed for the data-taking part of the experiment. It is also asked that this study of hyperon decays be carried out immediately following Experiment #97.

SURVEY FOR EXOTIC PARTICLES IN THE M1 BEAM

BNL, Fermilab, Rockefeller Univ.
W.F. Baker (Spokesperson)

As a continuation of their beam survey in the M1 beam line, they propose to perform a survey for exotic particles, that is the production of $\bar{d}$, $\bar{t}$, $\overline{He}^3$, search for $\overline{He}^4$ and heavy mass particles with charges -1 and -2, and search for heavy quasi-stable muons. For these purposes they shall use the equipment of Experiment #104 already set-up in the M1 beam. In particular they will use extensively the two Brookhaven gas Cerenkov counters and will be able to test their ultimate capabilities.

It has been proven at Serpukhov, Fermilab and at the ISR that the efficient production of antinuclei requires that the bombarding proton energy be considerably greater than the threshold value. The Fermilab accelerator offers the possibility of testing models of antiparticle production and establishing the existence of as yet unobserved antinuclei or heavier particles. As far as the heavy muon search, such heavy muons are required by certain gauge theories of weak interactions.

Specifically they plan to do the following searches with 300 or preferably 400 GeV protons:

i) Detection of charge 1 particles with heavy mass. They plan to measure d and $\bar{d}$ production at 60, 80 and 100 GeV/c. The study of $\bar{t}$ production and the search for heavier masses will be done at 80 GeV/c to a sensitivity of approximately 1 in 10^{10} pions. For this purpose two gas Cerenkov counters will be placed in anti-coincidence; one will be placed on the $\bar{t}$ mass and time of flight will be used for heavier masses.

ii) Detection of antihelium nuclei. The study of $\overline{He}^3$ production and the search for $\overline{He}^4$ will be done with the M1 beam set at a momentum of p/e = 40 GeV/c, corresponding to 80 GeV/c for anti-helium nuclei. The search will be carried out to 1 particle in 3×10^{10} pions.

iii) Search for heavy quasi-stable leptons. For this search the first collimator of the M1 beam line will be closed and the muon detector of Experiment #104 will be used. The search will be carried out to 1 particle in 10^{11} pions.

They request 1-3 weeks of stable running at 300 GeV. An additional week at 400 GeV will be requested if the beam spill is adequate.

MEASUREMENT OF TOTAL ν, ν̄ CROSS SECTIONS AT HIGH ENERGIES

B.C. Barish, J.F. Bartlett, A. Bodek, K.W. Brown, D. Buchholz,
F.S. Merritt, F.J. Sciulli, L. Stutte, H. Suter (Caltech);
E. Fisk and G. Krafczyk (Fermilab)

It is proposed to measure the total cross sections for ν and ν̄, with at least one muon in the final state, from 30 to 300 GeV/c with an accuracy of better than ±10%.

The proposed work represents a logical continuation of the research program initiated by the group associated with Exp. #21A. Accurate total cross sections for neutrino and antineutrino interactions have been a prime goal since the construction of the Fermilab accelerator.

The participants have already measured the total cross sections for ν and ν̄ using the dichromatic beam at 40 and 105 GeV. The present limitations are purely systematic and do not allow measurements to better than ±20%. In order to achieve precision of ±10% they need to (i) improve the dichromatic beam, (ii) change to a new larger toroidal magnet in order to have a better efficiency for detecting large angle muons, (iii) perform an accurate and extensive beam survey, and (iv) improve the flux monitors.

They plan to measure the total cross sections at 10 neutrino energies between 30 and 300 GeV. For this program they request 400 hours for beam survey with a low intensity and long spill beam and 1000 hours of data-taking with the dichromatic neutrino and antineutrino beams. This experiment should logically follow that of Proposal #356.

Summary prepared by
G. Giacomelli, October 1974

STUDY OF DEEP INELASTIC DIFFERENTIAL DISTRIBUTIONS
AT HIGH ENERGIES FOR ν, ν̄ BEAMS

B.C. Barish, J.F. Bartlett, A. Bodek, K.W. Brown, D. Buchholz,
F.S. Merritt, F.J. Sciulli, L. Strutte, H. Suter (Caltech);
E. Fisk and G. Krafczyk (Fermilab)

It is proposed to make a systematic study of deep inelastic cross sections using a new dichromatic ν-beam and improved equipment of the Caltech-Fermilab collaboration.

The participants have already measured in Exp. #21A the x-, y-, and q^2-distributions in deep inelastic neutrino-nucleon interactions

$$\nu_\mu + N \to \mu^- + X$$
$$\bar{\nu}_\mu + N \to \mu^+ + X$$

Because of the small acceptance of their toroidal magnet they had a reasonable acceptance only up to y = 0.6 and had a considerable distortion in the x-distributions. The improved setup should allow reasonable acceptances to larger values of y (y~0.8), x and q^2 and should provide a significant step towards a quantitative study of deep inelastic neutrino and antineutrino scattering.

The apparatus will be the same of Exp. #21A but will have a larger toroidal magnet and an improved neutrino beam. These improvements will result in larger acceptances as well as in improved resolution for the muon momentum ($\Delta p_\mu/p_\mu \simeq 0.14$ instead of the present 0.21) and neutrino energy ($\Delta E_\nu/E_\nu \simeq 0.10$ instead of the present 0.30).

They request 1000 hours of running time with the dichromatic ν and ν̄ beams. In this time they should be able to collect approximately 10,000 ν-events and 3,000 ν̄-events.

Summary prepared by
G. Giacomelli, October 1974

A PROPOSAL TO SEARCH FOR CHARMED PARTICLES AND MEASUREMENTS OF
TWO-PARTICLE INCLUSIVE CROSS SECTIONS AT LARGE P_T

D. Jovanovic, R. Lundy (Fermilab);D. Finley, F. Loeffler,
E. Shibata, K. Stanfield (Purdue Univ);R. Loveless, D. Meyer,
R. Thun (Univ. of Michigan)

They propose to search for charmed mesons in the following
reaction

$$\text{hadron + hadron} \rightarrow C + \text{anything}$$
$$\hookrightarrow \pi K$$
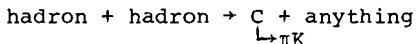
where C is a charmed meson. They will use a two-arm symmetric
spectrometer. The C meson would be identified as a narrow spike
in the πK effective mass spectrum. As a byproduct they will
obtain data on inclusive two-particle production as a function of
the two particle momenta and types.

The possibility of a fourth "charmed" quark, suggested
several years ago to provide a more symmetrical relationship
between the four known leptons and the quarks, has recently
received considerable attention since it allows one to construct
a consistent theory of weak interactions. At present there is
no direct experimental evidence for charmed hadrons. They are
expected to have a mass between 2 and 10 GeV and a lifetime of
the order of 10^{-12} sec. Charmed mesons should have a sizeable
$K\pi$ branching ratio (about 10%-50%); this decay tends to give pions
and kaons at large transverse momentum ($p_t \simeq m_C/2$).

The study of two-particle correlations at large p_t should
give information on the production mechanism (for instance on
cluster production) and on the dependence of the correlation
on the types of particles produced and on their p_t.

The experiment is using the M2 beam, with
intensities of the order of 10^8 particles per burst,
impinging on a heavy target. The two spectrometers will
be identical; they will be aimed at ±100 mrad with respect to the
incident beam direction. They will each employ one 8x24x72"
bending magnet, three gas differential Cerenkov counters and
several planes of drift chambers. This set-up covers the mass
range $2<m_C<10$ GeV, with a mass resolution of approximately
$\Delta M_C \simeq 0.005 M_C$, and an efficiency of the order of 10^{-3} of the C
production cross section.

They estimate a need for about 6 months of running time.

DIMUON PRODUCTION BY NEUTRONS

Columbia Univ., Cornell Univ., Univ. of Hawaii, Univ. of
Illinois (Urbana), Fermilab   W. Lee (Spokesperson)

It is proposed to measure the invariant cross section of
dimuons produced by neutrons in a nuclear target.

Direct lepton production has already been observed in
both photon-nucleon and neutron-nucleon collisions using
the equipment of Experiment #87A. The neutron induced
events indicate the presence of a rho meson and a $\psi(3.1)$ signal.

The experimental equipment consists of the apparatus of
Experiment #87A supplemented with a hadron calorimeter and a
steel shield placed 5' after the target. When it is used, the
total energy of the electromagnetic and hadronic secondaries
accompanying each interaction is measured. In the absence of
the production of neutrinos the total energy of the event is
measured. Data can also be taken without the steel; in this
instance some information can be obtained about the high
energy secondaries which accompany the dilepton. The $0°$
neutral beam can be easily changed from a photon beam to a
hadron beam by appropriate insertion of 6 radiation lengths
of lead and removal of the deuterium filter.

It is proposed to measure dimuon production with neutrons
produced by 300 and 400 GeV protons. In particular data would
be taken:

(a) At 400 GeV with low intensity (2×10^6 neutrons per second)
to study dimuons with $m^2_{\mu\mu} < 10$ GeV^2 and $t_{\mu\mu} < 10$ (GeV/c)^2;

(b) At 400 GeV with high intensity ($\sim 10^7$ n/sec) to study
dimuon production with $m^2_{\mu\mu} < 25$ GeV/c and $t_{\mu\mu} < 20$ (GeV/c)^2;

(c) Running with a 300 GeV front porch to get 300 GeV data
at the same time as the 400 GeV running.

Summary revised by
John Peoples, March 1975

PRECISION MEASUREMENT OF
$\Lambda \to e^- \nu p$ DECAY PARAMETERS

G. Bunce, R. Handler, R. March, L. Pondrom, M. Sheaff
(Wisconsin); K. Heller, O. Overseth (Michigan); T. Devlin,
R. Edwards, P. Yamin (Rutgers)

Recent progress in the gauge theory of weak and electro-
magnetic interactions provides motivation for improving the
data on hyperon beta decays. The Fermilab neutral hyperon
beam is capable of producing a sample of lambda beta decays
significantly larger than what has previously been possible.
Current yield measurements from Experiment #8 in the M-2
beam in the Meson Area predict 3 $\Lambda \to pe^- \nu$ events per 10^8
incident protons. The experiment would be performed with the
apparatus already in place for Experiment #8. A study is being
made of the feasibility of using synchrotron radiation from
bending the outgoing electron in the magnetic field of the
analysis magnet to identify this particle. It is proposed to
add a xenon multi-wire proportional chamber behind the magnet
to measure the electron and its corresponding radiated photons.
It is also planned to study possibilities for producing
polarized Λ's (or $\bar{\Lambda}$'s) from the decay of Ξ^0's (or $\bar{\Xi}^0$'s). The
experimental setup is compatible with that for the Λ-p total
cross section measurements to be made in E-8. Total requested
running time is 300 hours. It is estimated that in about 200
hours approximately 4×10^5 $\Lambda \to pe^- \nu$ decays will be observed with
1,200 polarized Λ's and 400 $\bar{\Lambda}$'s.

INTERACTION OF 200-400 GeV PIONS WITH EMULSION NUCLEI

Piyare L. Jain (State Univ. of New York at Buffalo)

Recently we have studied proton-Nucleon and proton-Nucleus interactions with 200 and 300 GeV proton beams at FNAL. These studies have been confined to the multiplicities and to the angular distributions of the shower particles produced in proton-nucleon and proton-nucleus interactions. Low multiplicity observed in complex nuclei does not depend upon the size or the excitation of the target nuclei and is not expressed by the internuclear cascade models. It has been found that in the target nucleus A, the ratio $R_A = <N_s>_{pA}/<N_{ch}>_{pp}$, where $<N_s>_{pp}$ is the mean p-p charge multiplicity and $<N_s>_{pA}$ is the mean p-nucleus multiplicity in nucleus A is practically constant and increases very slowly with N_h value. The scaling relation in emulsion is given by $R_E = a+bN_h$ where $a = 1$ and $b = 0.06$. We also find that the rapidity distributions for p-nucleon and p-nucleus interactions are the same in the forward direction and are slightly different in the backward direction.

We would like to use pion as a primary particle and compare the results of (200-400) GeV proton beams with the pion (200-400) GeV beams results.

Summary prepared by
P. L. Jain, March 1976

A PROPOSAL TO SEARCH FOR CHARMED PARTICLE
PRODUCTION NEAR THRESHOLD

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A. Colleraine (Florida State); I. Siotis (Imperial College)

Since the discovery of J or Ψ (3105) there has been
speculation as to the classification of this new particle. It
has been suggested that the Ψ (3105) is a charmed vector singlet,
member of the SU(4) symmetry group. From the known properties
of the Ψ there are predictions of charmed vector and pseudoscaler
mesons with masses of approximately 2.2 GeV and of charmed
baryons with masses of 4-5. GeV. It is also expected that
charmed mesons are produced in pairs in strong or electromagnetic
interactions and that they decay into Kπ final states. This
proposed experiment would carefully examine the energy dependence
of the K^-/π^- ratio, looking specifically for abrupt changes or
anomalies possibly generated from reaching the threshold energy
for production of a particle.

The experimental apparatus would consist of a spectrometer
located within the Internal Target Area and utilizing the up-
stream rotating target. The spectrometer would consist of an
18 kG bending magnet with a position variable from 15° to 40°
with respect to the beam line. On either side of the magnet are
scintillation hodoscopes to provide trajectory information and
threshold gas Cerenkov counters. The acceptance is limited by
the aperture of the rear Cerenkov counter and expected momentum
error, Δp, is expected to be about ±0.07 GeV/c at the 15° angle
setting. Using a rotating carbon target they expect in about
one day of running to obtain 1% statistics in each energy bin,
variable from about 20 GeV to the maximum energy of the
accelerator. This must be multiplied by the number of angle
settings. Tuning time is expected to take 2-3 weeks.

Follow-up running could include measurements using the
hydrogen jet target and a coupling of this apparatus to the
spectrometer under construction for Experiment #198 to look
for Kp decays of charmed baryons.

Summary prepared by
A.F. Greene, May 1975

Reviewed by
S. Olsen, January 1976

A PROPOSAL TO SEARCH FOR THE PRODUCTION OF
CHARMED MESONS IN πp INTERACTIONS

Northeastern University
D. Garelick (Spokesperson)

An experiment is proposed which searches for the production of charmed mesons, D, produced in the reactions

$$\pi^- p \rightarrow X^- p \rightarrow D\bar{D}p \qquad (1)$$
$$\pi^- p \rightarrow X^- p \rightarrow D\bar{D}(n\pi)p \qquad (2)$$

Reactions(2) differs from reaction (1) in that n additional pions are produced. For each event the final state proton as well as one or more of the muons from the D or $\bar{D}$ decays will be measured. The experiment looks for D's in the mass range $1.0 \le M_D \le 4.5$ GeV. A total production cross section for reaction (1) plus reaction (2), $\sigma_{1,2}$, of 5 μb for $2M_D \le M_X \le (2M_D + 1$ GeV$)$ and a branching ratio for $D \rightarrow (\mu\bar{\nu}$ hadrons) of 0.1 is expected to give in one day of running a more than 7 standard deviation effect in the observed mass, M_X, spectrum from μp coincidence events.

The experiment uses the existing apparatus of Experiment #51A in addition to a μ detector yet to be installed in the M2 beam line. The experiment can be carried out in a three week running period with 200 hours of beam consisting of 40 hours for testing and 160 hours for data-taking.

Summary prepared by
D. Garelick, December 1974

STUDY OF HEAVY, NARROW MESONS USING
A MASS FOCUSING SPECTROMETER

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It is proposed to search for and study two-body decays of narrow, massive, neutral mesons produced near the forward direction in neutron-Be collisions. The apparatus is a high resolution, mass-focusing spectrometer capable of focusing masses up to ~3 GeV/c^2 with resolution of 15-30 MeV/c^2 FWHM; it consists of a proportional chamber-spark chamber spectrometer constructed around a BM-109 bending magnet. A two-cell 10m long Cerenkov counter allows the identification of decay particles.

The apparatus is sensitive to peripherally or diffractively produced objects and is thus complementary to those that would search in the central region. (For a mass of 2.5 GeV/c^2 we detect with good efficiency particles produced with $P_\perp \lesssim .6$ GeV/c^2 and $.2 \lesssim x \lesssim 1$.) The neutron beam has the advantages that (1) the heavy objects need not be restricted to quantum numbers accessible in e^+e^- collisions; (2) beam intensities an order of magnitude higher than those tolerable with charged beams may pass through the detectors.

Summary prepared by

M. ABOLINS, January 1976

Particle Search #369

A SEARCH FOR CHARMED PARTICLES

Harvard University, University of Illinois, University of Oxford, Max Planck Institute, Munich

T. Kirk (Spokesperson)

The experiment has three basic goals:

i)   a search for charmed particle production in strong interactions
ii) mesonic psi production plus measurements on associated hadrons
iii) pion diffraction dissociation at high energy.

In i), we search for peripheral production of $D\bar{D}$ containing states using a muon from a semileptonic D decay in coincidence with a kinematically restricted recoil proton. The other D is assumed to decay hadronically and have a fully reconstructable mass some fraction of the time. The D will reveal itself as a narrow (50 MeV FWHM) mass peak on a continuum background. We will be sensitive to two and three body decays in which one of the products is identified as a charged or neutral kaon. This trigger is sensitive to peripheral production cross sections of order 0.3 μb.

In ii), we trigger on 2 opposite sign μ's in the final state. From this trigger we will acquire a sample of about 800 psi mesons with their accompanying hadrons. We will use these events to look for $\psi n\pi$ resonances and for evidence of associated charmed particles (Zweig Rule). This experiment is dominated by small x (central) production.

In iii) we gather parasitically a sample of 32,000 pion diffraction dissociation events for study of the A_1, A_2, A_3, A_4 mass region at high energy. This will represent an increase of two orders of magnitude in statistics over present bubble chamber samples and facilitate partial wave analysis of the results. All of the items i), ii), iii) can be obtained simultaneously by using several low rate triggers in logical OR.

We propose to use the CCM spectrometer in the muon laboratory. In addition to the present equipment, we will add a new LH_2 target flask and vacuum chamber and two new recoil proton arms.

We request a beam of π^- at 150 (GeV/c) and 10^6 per burst. We will need 2×10^5 bursts to complete the experiment as proposed.

CONTINUED SEARCH FOR NEW PARTICLE PRODUCTION USING E1A DETECTOR

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During previous running of various types for Experiment #1A there have been observed several hints of possible new particle production. The indications are as follows:

1) A distortion of the y-distribution of antineutrino events at high energy.

2) A possible breakdown of charge symmetry invariance at small x.

3) A distortion of the expected distribution of the mass of the recoiling hadrons.

4) The existence of dimuon events at the level of $\sim 5 \times 10^{-3}$ of the total number of events.

In order to pursue this matter further the experimenters have requested a running period with about 10^{18} protons on target while using the quadrupole triplet train load. A spill time of 1 msec is also requested.

Summary prepared by
A. F. Greene, March 1975

THE INVESTIGATION OF THE PRODUCTION OF HEAVY FRAGMENTS INDUCED BY PARTICLES AT HIGH ENERGIES

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(Institute of Physics, Belgrade)

Solid state track detectors will be exposed to a high energy hadron beam to investigate the production of heavy nuclear fragments. The cross sections for these reactions will be studied as a function of the energy of the incident particle and of the atomic number of the target nucleus. Particular emphasis will be placed on the fission processes for which a dependence is already observed in the range of 10-25 GeV.

A 3x3x1 cm^3 stack of solid state track detectors would be exposed to a beam with a flux of $10^{11}/cm^2$. The detectors permit the study of fragment emission under very favorable conditions: a low level of background tracks, good spatial resolution, precise measurement of track length and reaction angles. The stack will be analyzed by the Institute of Physics, Belgrade.

Summary prepared by
W.F. Baker, February 1975

PROPOSAL TO SEARCH FOR LONG LIVED PARTICLES AT FERMILAB

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This group proposes to use a two armed magnetic spectrometer system to search for two-and three-body decays of long-lived particles. Following their Brookhaven run it would extend the mass range from 5.5 GeV up to 10 GeV.

The questions they will attempt to answer are:

1. Are there long-lived particles which have the quantum numbers 0^+, 2^+, 3^- etc. and which decay into $\bar{p}p$, K^+K^-, etc., but not to e^+e^-?

2. Are there long-lived baryon states π^-p, K^-p, etc.?

3. Are there long-lived strange mesons $K^+\pi^-$, $K^-\pi^+$, etc.?

4. Are there charged J particles, such as $J^+ \to e^+K^+e^-$ or $J^- \to e^-K^-e^+$, which would show up as a threshold cutoff in mass at m_{J^+} when one detects e^+K^+ in coincidence?

5. Are there charmed particles which decay to $Ke\,\nu$, which will also distinguish themselves with a cutoff behavior at the mass m_J when one detects Ke in coincidence?

The two spectrometer arms would look in the region of 90° in the center-of-mass. Each arm would bend vertically to measure momentum, would have two Cerenkov counters to identify pions and kaons, proportional wire chambers, scintillation counter hodoscopes, two banks of lead glass counters, and one bank of lead lucite shower counters. The angular acceptance would be $\Delta\theta^* = \pm6°$ and $\Delta\phi^* = \pm8°$. The mass acceptance would be $\Delta M = 3.0$ BeV, permitting the mass range from 2 to 10 GeV to be covered in three steps. The mass resolution would range from ±4 MeV at $m_J = 2$ GeV to ±7 MeV at $m_J = 8$ GeV

They request 1200 hours of running and 200 hours of beam tuning. This would yield a sensitivity down to 10^{-34} cm^2.

INTERACTION OF 50-100 GeV MUONS WITH EMULSION NUCLEI

Piyare L. Jain (State Univ. of New York at Buffalo)

Recently we have reported the direct-electron-pair production from the Coulomb field of an emulsion nucleus by 200 GeV protons[1] and 150 GeV muons[2] from the Fermi Laboratory and 15.8 GeV/c muons[3] from the Brookhaven National Laboratory, in order to test the predictions of the theories based on quantum electrodynamics at small distances. From most of the present theories[4-7], the predictions for electron production cross section depends on the ratio γ (=E/m) and not on E and m separately or on the type of the incoming particle. Our recent results indicates that mass of the incoming particle is perhaps playing an important role. In order to check this point we would like to have two or three more muon beam exposures between 50-100 GeV at FNAL. These experiments will help us to settle the mass dependence question very clearly.

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Summary prepared by
P.L. Jain, March 1976

A SEARCH FOR CHARMED PARTICLES ORIGINATING FROM
THE INTERACTIONS OF 300 GeV/c PROTONS IN EMULSION NUCLEI

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D.N. Tovee (Univ. College, London); F.R. Stannard (Open Univ.);
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(Universita di Roma); T. Pniewski (Universytet Warszawski)

The exposure of the emulsion stack was made in June 1975
with the object of locating possible examples of the associated
production of charmed particles by high energy proton collisions.
The high spatial resolution of the nuclear emulsion technique,
a few microns, should enable the direct observation of the
decays of such particles with lifetimes as small as 10^{-14}s.
To date no possible examples of pairs of charmed particles decays
have been seen within a 45° forward cone extending some 150 μm
from the primary interaction vertex for a sample of 30,000
proton interactions. This preliminary result implies, provided
that charmed particle lifetimes are in the range 10^{-14} to 10^{-12}s,
an upper limit of ~1 μb for their production by 300 GeV/c proton
interactions. The scanning of the emulsions is continuing.

Summary prepared by
D. H. Davis, March 1976

STUDIES OF K^+-MESON COLLISIONS WITH PROTONS AT AN
INCIDENT MOMENTUM CLOSE TO 150 GeV/c

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M. Nazaretz, H.A. Rubin (IIT); J. Brau, J. Grunhaus, L. Hafen, R.I. Hulsizer,
U. Karshon, V. Kistiakowsky, A. Napier, I.A. Pless, J. Wolfson R.K. Yamamoto
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Univ.); H. Braun, A. Fridman, J.P. Gerber, P. Juillot, G. Maurer, A. Michalon
M.E- Michalon-Menter, C. Voltolini (Strasbourg). D. Bogert, M. Johnson,
H. Kraybill, D. Ljung, T. Ludlam, H. Taft (Yale/Fermilab)

It is proposed to make exposures of approximately 0.5 ev/µb equivalent for K^+
mesons as close as possible to 150 GeV/c in the Fermilab 30-inch bubble chamber
proportional wire hybrid system. These exposures are requested as soon as suitably
enriched beams of K^+ mesons are available to that facility. For beams with K^+/con-
taminant ratio, R, the exposure will require 1/Rx100,000 pictures and will yield
approximately 10,000 K^+p interactions for study.

The purpose of these experiments is to carry out a detailed study, with modest
statistical accuracy, of kaon-proton collisions at energies significantly above
those at which such data currently exists, and to further extend the range of inci-
dent channel quantum numbers over which multiparticle production has been explored
at Fermilab energies. The choice of energy is such as to allow us to make a
reasonable cross particle comparison with existing data at 147 GeV/c. Some of the
specific topics to be studied are topological cross sections, elastic cross
sections, leading particle effects at low-t, resonance production, central emission,
and double diffraction dissociation.

An integral part of this proposal is the development of the K^+ meson beam.
During the summer of 1975 the experimenters made a study of a scheme for producing
an enriched K^+ beam, and have proposed the installation of a polyethylene filter
in the N3 beam line to produce a beam with $15\% < R < 20\%$. It is expected that this
proposal will proceed in two phases. The first phase will be a further feasi-
bility study of the K^+ beam and the second phase, contingent on the success of
the first phase, will be the proposed physics exposure.

STUDIES OF K⁻-MESON COLLISIONS WITH PROTONS AT AN
INCIDENT MOMENTUM CLOSE TO 150 GeV/c

D. G. Fong, M. Heller, A. M. Shapiro, M. Widgoff (Brown Univ.);
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H. A. Rubin (IIT); J. Grunhaus, E. Hafen, R. I. Hulsizer,
U. Karshon, V. Kistiakowsky, A. Napier, I. A. Pless,
P. Trepagnier, J. Wolfson, R. K. Yamamoto (MIT); W. Kittel,
W. Metzger, C. Pols, J. Schotanus, R. Van de Walle (Nijmegen
Univ.); Y. Eisenberg, B. Haber, D. Hochman, G. Mikenberg,
E. E. Ronat, A. Shapira, R. Yaari, G. Yekutieli (Weizmann Inst.);
D. Bogert, M. Johnson, H. Kraybill, D. Ljung, T. Ludlam,
H. Taft (Yale/Fermilab)

It is proposed to make exposures of approximately 0.5
ev/μb equivalent for K⁻ mesons as close as possible to 150 GeV/c
in the Fermilab 30-inch bubble chamber proportional wire hybrid
system. We request these exposures as soon as suitably
enriched beams of K⁻ mesons are available to that facility.
For beams with K⁻/contaminant ratio R, each exposure will
require 1/R x 100,000 pictures for study and will yield approximately
10,000 Kp interactions for study.

The purpose of these experiments is to carry out a
detailed study, with modest statistical accuracy, of kaon-
proton collisions at energies significantly above those at
which such data currently exists, and to further extend the
range of incident channel quantum numbers over which multi-
particle production has been explored at Fermilab energies.
The choice of energy is such as to allow us to make a
reasonable cross particle comparison with existing data at
147 GeV/c. Some of the specific topics to be studied are
topological cross sections, elastic cross sections, leading
particle effects at low-t, resonance production, central
emission, and double diffraction dissociation.

A fundamental part of this proposal is the development
of the K⁻ meson beam. The experimenters are prepared to
explore the particle enrichment schemes being studied for
the hadron beams to the bubble chambers, either alone or in
collaboration with other interested parties. We are also
prepared to study alternate K⁻ beam producing techniques.
It is expected that this proposal will proceed in two phases.
The first phase will be a feasibility study of the K⁻ beam
and the second phase, contingent on the success of the first
phase, will be the proposed physics exposure.

Summary prepared by
T. W. Ludlam/H. A. Rubin, January 1976

A PRECISION STUDY OF LEADING PARTICLE AND DIFFRACTIVE EFFECTS IN π^-p INTERACTIONS AT 300 GeV/c

M. Heller, A. M. Shapiro, M. Widgoff (Brown Univ.); F. Bruyant, Y. Goldschmidt-Clermont, L. Montanet, A. Stergiou (CERN); J. Grunhaus, E. Hafen, R. I. Hulsizer, U. Karshon, V. Kistiakowsky, A. Napier, I. A. Pless, J. Wolfson, R. K. Yamamoto (MIT); G. Alexander, I. Bar-Nir, O. Benary, S. Dagan, A. Levy (Tel-Aviv); Y. Eisenberg, B. Haber, D. Hochman, G. Mikenberg, E. E. Ronat, A. Shapira, R. Yaari, G. Yekutieli (Weizmann Institute); H. Kraybill, D. Ljung, T. Ludlam, H. Taft (Yale).

A 200,000 picture exposure is proposed for the Fermilab 30-inch proportional wire chamber hybrid bubble chamber system, including the Forward Gamma Detector, exposed to a 300 GeV/c π^- beam. It is expected to use the high precision of this system to make a significant contribution to the following topics:

1. Leading particle effects and diffraction phenomena.
2. Charged particle multiplicity moments.
3. Production spectra for charged and neutral particles.
4. Correlations in momentum and rapidity among the produced particles.
5. Total cross section for K^- interactions.
6. Semi-inclusive distributions for interactions with an associated forward π^0.
7. Inclusive cross-sections for ρ^0, forward ρ^+, ρ^-.
8. Charged clusters.
9. Constrained fits to the $p\pi^+\pi^-\pi^-$ final state.

This exposure is expected to yield about 40,000 interactions for our study. The rough breakdown by prong topology (based on a linear extrapolation from previous 30-inch exposures at 147 GeV/c and 205 GeV/c) is:

Type	Number of Events	Events with leading p	Events with leading π^-
Total	40,000	2,400	2,400
2 prong elastic	5,000		
2 prong inelastic	2,000	800	800
4 prong	4,000	1,000	1,000
6 prong	4,000	400	400
8 prong	7,000		
10 prong	7,000		
12 prong	5,000		
14 prong	4,000		
16 prong	1,000		
$\geqq$ 18 prong	1,000		

In addition, it is expected to use the Cerenkov tagging system to detect and measure about 800 K^-p and 300 $\bar{p}$p interactions, assuming beam contaminations of 2% and 0.6%, respectively.

Data taking should require about 2 weeks.

A PROPOSAL TO STUDY LEADING PARTICLE PRODUCTION IN
π⁻p INTERACTIONS AT 75 GeV/c

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V. Kistiakowsky, A. Napier, I. A. Pless, P. Trepagnier,
J. Wolfson, R. K. Yamamoto (MIT); W. Kittel, W. Metzger,
C. Pols, J. Schotamus, R. Van de Walle (Nijmegen Univ.);
A. Levy, D. Lissauer, Y. Oren, I. Bar-Nir, I. Stumer (Tel-Aviv);
D. Bogert, M. Johnson, H. Kraybill, D. Ljung, T. Ludlam,
H. Taft (Yale/Fermilab)

It is proposed to investigate leading particle effects
in the π⁻p interactions at 75 GeV/c. For this purpose a
200,000 frame exposure is requested to be made with the
proportional wire hybrid system (PWHS). The results thus
far obtained by the PWHS consortium in a study of π⁻p
interactions at 147 GeV/c 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⁻, measure-
ments can be made of:

1. $d^3\sigma/dp$ 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.

They will 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 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, or the various
contributions of the Pomeron and Reggeon couplings within
the Triple-Regge Limit Model.

Summary prepared by
R. K. Yamamoto, February 1975

SEARCH FOR SHORT LIVED STATES DECAYING WEAKLY
VIA LEPTONIC MODES

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This search is for high mass, short lived states decaying weakly via leptonic or semi-leptonic modes. A hadron beam interacts in a fine grain calorimeter permitting the detection of missing energy presumably carried off by neutrinos. There is a large solid angle acceptance for muons which are analyzed in a toroidal spectrometer. The experiment would detect charmed hadrons, color states, heavy leptons and W bosons up to a mass of 20 GeV. It would also be sensitive to production phenomena involving single muons and direct neutrinos.

Proportional chambers in the beam line would determine the position of the incident particle and measure its momentum to a precision of 1 or 2%. The calorimeter would be of three parts of increasing size with a total length of 20 absorption lengths. About 70% of the total energy would be deposited in the first section and the most precise measurements would be made here. The density at the front end would be variable to calibrate the number of pion and kaon decays. The second section would be a scaled up version of the first; wide angle components would be identified in it. The last section would be coarse grained and in it would be analyzed the anomalously long hadron showers. The calorimeter resolution should be about ± 4% at 400 GeV. The muon spectrometer consists of two magnetized toroids 11.5 feet in diameter followed by one 5 foot diameter toroid. Wire chambers are placed on both sides of each toroid. Momentum resolution of ± 9% is expected for any two toroids. The overall energy resolution of the system would be ± 20 GeV.

Three types of triggers would be used. The simplest, the energy loss trigger, would require a significant deposition of energy in the calorimeter, indicating the production of muons or neutrinos. The single muon trigger would require at least one muon with some minimum transverse momentum. At lower transverse momenta a di-muon trigger would be used to study multi-muon states. With no low-p_t cutoff, the raw trigger rate would be 30-50 per pulse; with such a cutoff, this rate would be reduced an order of magnitude. An estimate indicates that a background of some tens of events per day is to be expected. A run of 1000 hours is requested in a hadron beam of 10^6 protons/pulse at the highest energy possible. This would yield a sensitivity of $10^{-36} - 10^{-37}$ cm^2.

STUDY OF THE PROPERTIES OF WEAK NEUTRAL CURRENTS IN THE
INTERACTIONS OF A NARROW BAND NEUTRINO BEAM IN LIQUID NEON

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N. P. Samios (BNL)

Since it has already been established that neutral
currents exist, the next step is to study their detailed
properties. For this experiment the main features will
be a) knowledge of the incident neutrino energy and direction,
and b) detection and identification of the individual hadrons
produced through study of their behavior in a liquid neon fill
of the 15-foot bubble chamber. The primary physics questions
to be answered are:

1) What is the primary structure of the neutral currents,
   (V,A) or (S,P)? This should be answered through the
   shape of the y distribution (where y = E outgoing
   hadron/E incident neutrino).

2) What is the total cross section for the neutral current
   events for several values of the incident neutrino
   energy? It will be possible to make more reliable
   cross section measurements when the y-distributions
   are better known.

3) What are the structure functions for inelastic neutral
   current interactions? These can be crudely determined
   from the x- and y-distributions.

4) What is the nature of the specific hadrons produced
   in the neutral current events? These may be
   determined from the behavior of the secondary particles
   in the chamber.

The proponents of this proposal have designed a narrow
band beam to use two pulsed magnetic horns. This would
primarily involve construction of new inner conductors for
the existing horn focusing wide-band train load. A momentum
bite of $\pm$ 5% is expected with an integrated neutrino flux
comparable to those from the train loads mentioned above. In
a 200,000 picture exposure, with a 24 metric ton neon-hydrogen
fill of the 15-foot chamber, with an average of 5 x 10^{12} protons/
pulse on target at 300 GeV, and the existing narrow band train-
load, one would expect about 5,200 charged current and 1,300
neutral current events. A new beam would provide an improved
momentum spread and a larger number of events.

Summary prepared by
A. F. Greene, March 1975

Modified by
C. Baltay, January 1976

MEASUREMENT OF THE REAL PART OF THE p-n and p-p FORWARD
SCATTERING AMPLITUDES; PRODUCTION OF LOW MASS ISOBARS
IN THE VERY SMALL MOMENTUM TRANSFER REGION

University of Arizona, Joint Institute of Nuclear
Research, USSR, Fermi National Accelerator Laboratory,
University of Rochester, Rockefeller University
E. Malamud (Spokesperson)

An internal target experiment is proposed with the following
goals:

1. A measurement of the real part of the p-d forward scattering
    amplitude from 8 GeV to $\geq$ 400 GeV. the p-n real part would
    be extracted from the data using Glauber theory and compared
    with measurements of the p-p real part. The highest energy
    p-n real part measurements to date are 70 GeV.

2. A remeasurement of the real part of the p-p forward scatter-
    ing amplitude from 8 GeV to 400 GeV using the same apparatus
    as the p-d measurements to facilitate the p-p, p-n comparison.
    By using a long ion guide and position sensitive detectors
    the accuracy attainable will be significantly improved over
    previous measurements in Experiment #36A.

3. Measurements of the production of low mass isobars
    $1.0 < M_x < 2.0$ GeV/c^2 in the very small momentum transfer
    region $.005 < |t| < .025$ (GeV/c)^2. The use of a 7.5 meter,
    long ion guide and position sensitive detectors will result
    in a mass resolution of 16 MeV, a significant improvement
    over previous measurements in Experiments #186 and #317.

No additional equipment is required beyond what is already
proposed and partly under construction for Experiment #289 by
the same participants involving proton-helium scattering. The
performance of these proposed measurements with hydrogen and
deuterium is a logical first step in commissioning the apparatus
for Experiment #289. The proposed measurements would require
approximately 300 hours. There is a need for one week of data
up to 400 GeV, and interest in collecting data above 400 GeV.

Summary prepared by
E. Malamud, February 1975

A SEARCH FOR CHARMED HADRONS PRODUCED BY MUON DEEP INELASTIC
SCATTERING IN TAGGED NUCLEAR EMULSIONS

K. Gottfried, L. Hand, S. Herb (Cornell Univ.); L. Read and
L. Voyvodic (Fermilab); L. Litt (Michigan State Univ.);
J. Lord, J. Florian, J. Wilkes (Univ. of Washington)

A relatively simple and efficient method for searching for
charmed hadrons is proposed. The experiment has three basic
ingredients: 1) deep inelastic muon scattering which is
conjectured to be a rather copious source of charmed particles,
2) an emulsion stack to explicitly display the decay vertex,
and 3) very precise triangulation with drift chambers to locate
the event and greatly reduce scanning time. The inelastically
scattered muons would be identified with the muon spectrometer
from Experiment #26; the drift chamber system is similar
to one already in operation at the Cornell synchrotron. The
goal is to obtain 500-1000 emulsion stars known to have been
produced by deep inelastic muon scattering. The experimenters
have reason to believe that 10-20% of these may contain charmed
hadrons, or other new phenomena. An inevitable byproduct of
this experiment would be the first determination of how
multiple production in a heavy target depends on q^2. A second
important byproduct would be a search for "extra" muons in
deep inelastic scattering.

The work needed to complete the exposure includes reacti-
vation of the spectrometer from Experiment #26, a prototype
exposure and the main exposure consisting of about 10^8 incident
muons (~100 pulses).

Summary prepared by
L. Hand, February 1975

A PROPOSAL TO STUDY THE INCLUSIVE PRODUCTION
OF K_S^0 BY K^- ON HYDROGEN

H.G.E. Kobrak, R.E. Pitt, R.A. Swanson
(University of California, San Diego)

It is proposed to measure the inclusive cross section $d^2\sigma/dxdt$ for the reaction $(K^-P) \rightarrow (K_S^0 X)$ with incident kaons of 20 to 150 GeV/c. The experiment is intended to study the triple Regge region of the x, t plane ($0.8<x<1$, $0<-t<3$). In this region results will be compared with the triple Regge theory. This process should involve only ρ and A_2 exchange, which implies a relatively simple situation for analysis. By adding the constraints of SU_3 and factorization, one can make direct comparison with the production of π^0 and η by π^-.

The experiment would be suited for the proposed charged mode of the M4 beam line. The K_S^0 would be detected by the (π^+,π^-) decay in a pair spectrometer such as that used in the K_S^0 regeneration experiment E-82. Downstream from the 30 cm. hydrogen target is a vacuum drift space whose length is adjusted to maximize the detection efficiency and minimize the incident beam interference. Then follows a standard wire chamber spectrometer with two 10 m. legs bracketing the M4B8 analysis magnet. Sweeping magnets before and after the target will remove all charged particles from the detection apparatus.

The experimenters expect to participate in the installation and tuneup of the new charged beam. This time is difficult to estimate because of access problems. Once the beam is ready, they request two separate running periods. 200 hours for setup and initial data taking, followed by a period of data analysis before a final run of 300 hours. Typical event rates would be 2000/hr at 100 GeV/c for $0<-t<1$ and 17 for $2<-t<3$.

Summary prepared by
W.F. Baker, March 1975

PROPOSAL TO STUDY π⁻p INTERACTIONS AT HIGHEST ENERGY IN THE
FERMILAB 15' BUBBLE CHAMBER

D. Bogert, R. Hanft, R. Harris, F.R. Huson, S. Kahn, W. Smart
(Fermilab); J.R. Albright, S. Hagopian, V. Hagopian, P. Hays,
J. Lannutti (Florida State Univ); C.Y. Chang, R. Glasser,
D.G. Hill, M. Kazuno, G. Snow (Univ. of Maryland)

This is a proposal to study hadronic physics with 300,000
pictures in the Fermilab 15-foot bubble chamber filled with
hydrogen and exposed to a π⁻ beam at the highest practicable
energy (≥ 250 GeV). The objectives of the experiment are
(i) to search for charm particles, (ii) to investigate cluster
formation in events containing more than one strange particle,
(iii) to study inclusive production of strange particles,
(iv) to study inclusive processes involving photons, and
(v) to measure parameters of diffraction dissociation.

Negative pions are chosen because they allow the study
of direct meson interactions and secondly because the identifi-
cation of particles in the final state is easier since the
beam does not introduce strangeness or baryon number. The
highest energy is desired so as to allow for the highest mass
of products.

A total of 300,000 pictures are requested in the 15'
hydrogen filled chamber. Assuming 4 beam tracks per picture,
and that the π⁻p cross section at 35 GeV/c is ~24 mb, they
expect a total of ~200,000 primary interactions yielding
an overall rate of 8 events per μb.

The film will be analyzed beginning with a first pass
scan for double V events, using the effective mass of the
two V's as a "trigger" to reduce the amount of measurement
and will produce preliminary physics results on the first
3 subjects mentioned above in about six months from the
conclusion of the run. The second pass scan will concentrate
on finding four-prongs and six-prongs, measuring them on an
automatic device and getting preliminary physics results in
about a year. The full extent of the experiment will take
2-3 years.

Summary prepared by
W.F. Baker, March 1975

STUDY OF 400 GeV/c PROTON-NUCLEUS INTERACTIONS
IN NUCLEAR EMULSION

I.S. Mittra, J.M. Kohli, P.M. Sood, B.K. Agrawal, J. Singh
(Punjab Univ.); B. Bhowmik, S. Singh, P. Sen Gupta (Univ. cf
Delhi); S. Lokanathan, S. Bhalla (Rajasthan Univ.); N.K. Rao,
G.L. Kaul, V.K. Gupta, Gyan Singh, S.K. Sharma, S.K. Badyal,
Balvinder Kour, Y. Prakash (Jammu University)

Studies of proton-nucleus interactions up to 200 GeV/c
indicate that no single model of multiparticle production seem to
explain all the experimentally observed features. Hence, for the
experimental data on the multiplicity of charged particles,
angular distribution of charged secondaries, rapidity distribution
of shower particles, particle correlations and fluctuations etc.
are necessary. The present experiment is aimed towards studying
these problems.

Recently there have been a revival of the interest in that
the fire ball mechanism of high energy interactions. The experi-
mental data will also be used for the study of this problem.

It is assumed that the transverse momentum (p_t) is practically
constant in such interactions. It is proposed that p_t measure-
ments will be made on part of the data.

In the first phase, measurement of the multiplicity of charge
particles, angular distribution of secondaries and rapidity of
shower particles is being studied. At present various models for
production of charged particle secondaries in hadron-nucleus
collisions are in vogue; e.g. Statistical model, Gottfried's
energy flux model, multi-peripheral interactions including KNO
or Feynmann scaling etc. The data will help in checking the
precictions of these models and in understanding the behavior
of such interactions as compared to hadron-hadron interactions.

Recently, a lot of interest has been aroused in the search
of charm particles. It is likely that such particles may be
produced in such interactions which are termed as "Core-Core"
interactions. Such interactions may also be high p_t events.
Efforts are being made to study such events and look for the
existence of 'charm' like particles.

The technique used for these studies is Nuclear Emulsion.

Summary prepared by
Y. Prakash, April 1976

A SEARCH FOR LOW ENERGY NEUTRAL PARTICLES AND
PARTICLE INTERACTIONS INVOLVING SMALL ENERGY
EXCHANGES IN THE NEUTRINO BEAM

Jere J. Lord, Richard J. Wilkes (University of Washington)

A proposal is presented to search for any new type of low energy neutral particles capable of passing through the large neutrino shield and producing nuclear interactions in s stack of nuclear emulsions. The experiment exploits the capability of the nuclear emulsion to detect interactions involving energy exchanges of the order of several MeV which could not be detected with other instruments.

We would like to get a site near the end of the neutrino shield and in line with the beam where a search could be made for new particles of low energy or processes involving small energy exchanges. This experiment obviously is not intended to compete with the large scale neutrino experiments in progress but is aimed at the search for several MeV interactions which could not be detected by conventional means. In addition, the experiment could be carried out with negligible interference with other experiments.

A crude shelter would be needed near the end of the neutrino shelter in order to keep the emulsions out of the weather as well as to provide an area where the emulsions could be coated. Shielding would be required to the extent of providing a box of about 1 ft^3 surrounded by a shield of several feet of iron or concrete. We would try to keep emulsions in the beam for all periods when large beams are striking the target.

Summary prepared by
J. Lord, J. Lach May 1976

PION INTERACTIONS IN EMULSIONS AND HEAVY ELEMENT TARGETS

J. R. Florian, M. Y. Lee, J. J. Lord and R. J. Wilkes
(University of Washington)

Target layers consisting of tungsten, silver, chromium, and silver bromide powders (typical target granule diameter $\leq$ 20μ) were embedded in 600μ thick nuclear emulsion plates, and exposed to a 200 GeV π^- beam at FNAL in June, 1975. The plates are currently being scanned for multiparticle production events. For each event found, the multiplicities n_s (number of minimum-ionizing secondaries) and N_h (number of heavily-ionizing secondaries) are determined, and the angular distribution of minimum-ionizing particles is measured. The experiment is expected to yield valuable information on the A-dependence and, by comparison with the results of earlier proton-beam exposures (E-171, E-237), projectile-dependence of hadron-nucleus multiparticle production processes.

Summary prepared by
R. J. Wilkes, January 1976

PROPOSAL TO STUDY NEUTRAL CURRENT NEUTRINO AND ANTI-NEUTRINO
INTERACTIONS IN THE 15-FOOT BUBBLE CHAMBER USING THE EXTERNAL
MUON IDENTIFIER AND A <u>DICHROMATIC BEAM</u>

University of Hawaii, LBL, Fermilab   M.L. Stevenson (Spokesperson)

It is proposed to use dichromatic neutrino (antineutrino)
beams to study neutral currents (NC), possible breakdown in
scaling of charged currents (CC), evidence for lepton pairs and
their suggestion of charm-particle production, and other phenomena
that require "one-constraint" analysis. Backgrounds and system-
atic errors would be smaller for these events and it is hoped
to use them to reexamine the "zero-constraint" analysis of the
broad band beam events that will have been analyzed in earlier
experiments, thereby, reducing the systematic errors of those
previous analyses. Ne-H$_2$ mixtures (e.g. 1/3 ρ Ne to 2/3 ρ Ne)
in the 15-foot bubble chamber are necessary in order to determine
the hadronic final state four-momentum. An exposure of 200,000
(200,000) neutrino (antineutrino) pictures using a monohorn of
the type that accepts 100 ± 5 GeV mesons between 2 and 8 milli-
radians, produced by 300 GeV protons (10^{13} per pulse) produces
the following number of events:

E$_\nu$ (GeV	ν	($\bar{\nu}$)	Type Current
35	3900	(1500)	CC
35	860	(640)	NC
95	280	(40)	CC
95	60	(20)	NC
Total	5100	(2200)	CC and NC

There is a possible need to run the antineutrinos at a
higher density, $\rho \simeq$ 2/3 ρ Ne, because of event rate and other
reasons. The use of other types of dichromatic beams is also
considered.

When studying neutral currents the Weinberg-Salam gauge
symmetry model can be tested. In the search for scale break-
down the possible existence of a low mass neutral intermediate
boson will be examined. Such a particle would distort the x,y
distribution, where x=Q^2/(2Mχ) and y=(E$_\nu$-E$_\mu$)/E$_\nu$, and reduce the
number of events above Q$^2 \simeq$ M$_W$^{2}. A different form of scale break-
down would be caused by the production of new massive hadrons in
neutral current events. Here, one expects an increase of neutral
current events at high y and low to medium values of x.

The x and y distributions will also be examined for charged
current events. Total cross sections would be more reliably
measured with dichromatic beams. Events in exclusive channels
would be analyzed as 1-C events in the dichromatic beams. Some
40 or 80 dilepton events would be detected, depending on the
Ne-H$_2$ mixture. The external muon identifier would be used in
this study.

Summary reviewed by
M. L. Stevenson, January 1976

PROPOSAL FOR STUDYING NEUTRINO INTERACTIONS IN NEON WITH A NARROW
BAND NEUTRINO BEAM IN THE 15' BUBBLE CHAMBER

University of Amsterdam, Universita di Bologna, CEN-Saclay,
Universita di Torino   A. G. Tenner (Spokesperson)

An experiment is proposed to study neutrino interactions
in the 15' bubble chamber filled with a heavy neon-hydrogen
mixture using a narrow band neutrino beam. The main purpose
of the·experiment is the detailed study of the weak neutral
current interactions and the cross section measurement of
specific reaction channels.

A comparison with cross section measurements at other
energies would enable one to see if the ratio of neutral to
charged current events is constant or depends on energy. Knowing
the incident energy one can make truly inclusive measurements,
particularly of the form: $\nu N \rightarrow \nu$ + hadrons. A study of the y
distribution of each event is sensitive to the nature (V,A) or
(S,P) of the neutral current. Combined x and y distributions
are dependent on the structure functions for neutral current
events. A comparison would be made of inclusive neutral current
events and inclusive charged current events. An additional study
would be made to see if individual inelastic channels scale
separately. Although the statistical accuracy obtainable in
this exposure is admittedly not high, a search would be made
for any new phenomena.

With 2×10^{13} protons per pulse at 300 GeV, 1 event every 10
pictures is expected. A total of 100,000 pictures (or 10,000
neutrino events) is requested.

It is assumed that the chamber fill is from 80% to 90%
neon and that a 30 kG field is available. Possible beams are
the existing narrow band beam of E-21, the proposed dipole-
quadrupole narrow band beam designed by E21 people, and the
proposed two-horn narrow band beam. Any of these would be run
at 90-120 GeV/c if the accelerator is at 300 GeV. The experi-
menters would like to use the external muon identifier.

As a feasibility and rate study the experimenters would
like to have an early run of 5,000 pictures with the existing
narrow band beam and whatever neon-hydrogen bubble chamber
filling is available.

Summary prepared by
W. F. Baker, May 1975

ANTINEUTRINO INTERACTIONS IN THE
DEUTERIUM FILLED 15-FOOT BUBBLE CHAMBER

Purdue University, Carnegie-Mellon University and Argonne
National Laboratory   A.F. Garfinkel (Spokesperson)

It is proposed to study the interactions of antineutrinos
in deuterium. The initial request is for 300,000 pictures out
of a total of one million pictures using the two-horn broad
band system with 10^{13} protons (300 GeV) per pulse. We plan to
use the external muon identifier.

The physics motivation includes the following:

1. Search for charmed mesons.

2. Study of elastic and inelastic hyperon production. Only
   in antineutrino interactions can we study the $\Delta S = 1$ charged
   current in quasi two-body interactions at energies and
   momentum transfers higher than that available in decays.

3. Study of the quasi elastic and pion production reactions.
   These data will be combined with the $\bar{\nu}p$ data of our
   experiment (E-31).

4. Inclusive study of charged current interactions off neutrons
   and protons.

5. We will study the structure of the neutral current
   interaction. We will check the absence of $\Delta S = 1$
   neutral currents.

6. We will also look for di-muon events using the EMI.

7. We are interested in the possibility of inserting a three-
   radiation length metal plate in the bubble chamber to
   serve as a gamma converter and an electron detector.

EXPLORATION OF RARE MUON-INDUCED PROCESSES

A.R. Clark, E.S. Groves, L.T. Kerth, S.C. Loken, M. Strovink.
W.A. Wenzel (U.C. Berkeley - LBL); R. Cester, F.C. Shoemaker,
P. Surko, M.S. Witherell (Princeton); R.P. Johnson (Fermilab)

Initial Physics Objectives will be pursued concurrently:

1. Search for heavy neutral muons predicted by gauge theories in the mass range 2 - 10 GeV, and other new particles decaying into one muon. The sensitivity for analyzed events is $1 - 2 \times 10^9$ events/μb.

2. Measurement of deep-inelastic virtual Compton scattering and search for other deep-inelastic $\mu^+\mu^-$ pair creation.

3. Measurement of the deep-inelastic muon scattering structure function at very high momentum transfer. For example, 8200 events exceeding $Q^2 = 160$ (GeV/c)^2 will be obtained.

4. Collection of $2 - 3 \times 10^4$ $\psi \to \mu^+\mu^-$ decays and data at higher dimuon masses. The $\psi\mu\mu$ coupling will be measured in the range -15 (GeV/c)$^2 < q^2 < 0$ with 7% statistics at $q^2 = -m_\psi^2$.

Experimental Technique

The spectrometer will realize a broader range of muon physics objectives than those accessible to the first-round muon scattering experiments. It consists of 18 modules, each containing 5 magnetized iron plates, 5 calorimeter counters, 1 proportional chamber, and 1 drift chamber. Alternate modules contain 1 trigger hodoscope. The necessary sensitivity to rare processes is provided by high acceptance over the full length of the distributed target-spectrometer. Nearly continuous iron is used to suppress $\pi \to \mu\nu$ decay background and provide the medium for calorimetric determination of energy transfer to hadrons. Fast detectors will tolerate further increases in beam intensity while maintaining acceptance of multiple final-state muons even within the beam area. The various background trigger rates have been estimated and found to be manageable.

Requirements for Operation

Existing space in the north portion of the Muon Laboratory is required, with an illumination of 10^{12} muons at the highest available energy (225 GeV has been assumed). The experiment is compatible with normal operation of the Muon Scattering Facility upstream.

Summary prepared by
M. Strovink, February 1975

Note: The above summary describes the objectives of both Proposals #203A and #391. The specific physics objectives of Proposal #391 are expressed in items 3. and 4. above. (AFG)

PROPOSAL TO STUDY MULTIPARTICLE PRODUCTION AT THE HIGHEST
AVAILABLE MOMENTUM IN ANTIPROTON-PROTON INTERACTIONS USING
THE FERMILAB 30-INCH BUBBLE CHAMBER

R.E. Ansorge, J.R. Carter, W.W. Neale, J.G. Rushbrooke, D.R. Ward
and T.O. White (Cavendish Laboratory); C. Moore, R. Raja,
L. Voyvodic and R.J. Walker (Fermilab); W. Morris, B.Y. Oh,
D.L. Parker, G.Z. Smith and J. Whitmore (Michigan State Univ.)

It is proposed to study multiparticle production at the
highest available momentum in antiproton-proton interactions
in the 30-inch hydrogen bubble chamber using the upstream
tagging and the downstream P.W.C.'s. The antiprotons will be
produced indirectly in Λ^0 decays. Directly produced charged
secondaries will be swept away using a dipole magnet near the
target. Selecting particles at 160 or 200 GeV/c depending on
whether 400 or 500 GeV incident protons are available should
yield adequate fluxes of particles in a beam containing ~20%
$\bar{p}$'s. A total of 100,000 pictures containing about 10,000
useful $\bar{p}$ interactions is requested.

In this experiment all $\bar{p}$ events would be measured and
comparison made with lower energy data (especially from E311-
100 GeV/c $\bar{p}p$). The analysis would include.

1. $\bar{p}p$ topological cross-sections and moments of the
   multiplicity distribution.

2. Inclusive single particle distributions including
   particles, π^c's and resonances.

3. Two particle correlations and cluster analysis.

4. Exclusive processes (for example we expect ~200
   events of the type $\bar{p}p \to \bar{p}p\pi^+\pi^-$).

5. Diffractive processes.

6. Investigation of the $\bar{p}p$ annihilation contribution
   to various processes by comparing with pp data.

Summary revised by
W. W. Neale, January 1976

PROPOSAL TO STUDY THE PROPERTIES OF THE FORWARD-GOING PHOTON
ENERGY IN THE TWO-CHARGED PRONG TOPOLOGY CREATED IN 150 GeV/c
π -p INTERACTIONS

Brown University, Fermilab, IIT, University of Illinois,
Indiana University, Johns Hopkins University, MIT, Oak Ridge,
Rutgers University, Stevens Institute, University of Tennessee,
Yale University, Padova/Rome   Irwin A. Pless (Spokesperson)

It is proposed to study the forward electromagnetic energy
associated with the two-charged prong topology in 150 GeV/c π^-p
interactions. It is believed that there is evidence of a new
phenomenon associated with these photons.

In E154, when beam fragmentation events are examined, an
unexpected distribution is observed in the momentum of the π^- ;
there are accumulations of events at 10, 40 and 110 GeV/c. These
peaks are also reflected in peaks in the energy distributions
of the missing neutrals (beam fragments) which pass through the
gamma ray detector. There are accumulations at 100 and 140 GeV/c.
The questions to be answered are: What is the composition of
the neutral energy? Does the accumulation at 140 GeV/c consist
of a single π^0 or several π^0's? What are the invariant mass
distributions between the neutral π^0 or π^0's and the π^-? Efforts
to explain this phenomenon in terms of known reactions such as
A^- production, have been unsuccessful.

A gamma ray detector would be added behind the last PWC
plane in the FNAL 30" hydrid system. This gamma ray detector
should have an energy resolution $\frac{\Delta E}{E}$ < 1% and a spatial resolution
of less than ± 3mm. A total of 10^6 expansions is requested
in the 30" hybrid system with an incident π^- beam of 150 GeV/c.
The flash will be triggered when an electromagnetic shower
energy greater than 20 GeV/c is detected. It is expected to
take 100,000 pictures of which 9,000 will contain two-prong
events and of which 3,000 will be the events of interest. This
will be an increase of more than an order of magnitude over
present data and in addition will have precise information on
the proton energy and distribution. This precise information
on the photons should allow the experimenters to determine what
the character of the beam diffraction reaction is and whether
or not it represents a new phenomenon.

In addition, we could take these pictures in an untriggered
mode, using a software trigger in the post analysis. This would
then be, in addition, a very high statistics experiment at a
single energy and single particle.

Summary revised by
I. A. Pless, January 1976

PROPOSAL FOR A HIGH STATISTICS STUDY OF ANTIPROTON-PROTON AND
PROTON-PROTON INTERACTIONS AT 100 GeV/c WITH THE FERMILAB 30-INCH
HYDROGEN BUBBLE CHAMBER SPECTROMETER AND EXTERNAL PARTICLE IDENTIFIER

R. E. Ansorge, J. R. Carter, W. W. Neale, J. G. Rushbrooke, D. R. Ward
and T. O. White (Cavendish Laboratory), C. Moore, R. Raja, L. Voyvodic
and R. Walker (Fermilab), B. Y. Oh, M. Pratap, G. A. Smith and
J. Whitmore (Michigan State University), G. Ekspong, S. O. Holmgren, S.
Nilsson and N. Yamdagni (University of Stockholm), plus additional U.S.
and European institutions to be added later.

On the basis of our current analysis of E-311 (100 K pictures of 100 GeV/c p̄p), we
propose to continue our studies of multiparticle production at high energies and request
10^6 pictures of a 100 GeV/c p̄/π⁻ beam and 10^6 pictures of a 100 GeV/c p/π⁺ beam into the
Fermilab 30-inch Bubble Chamber Spectrometer. Such a configuration of beams will result
in significant studies of both π and p(p̄) interactions and thus is an efficient use of
the facility. An important feature of this proposal is the planned use of a downstream
External Particle Identifier (EPI) for p/K/π separation to identify as many produced
particles as possible. The system we propose is the CERN EPI which, with only a few
minor modifications, is well suited for the proposed configuration at Fermilab. This
system is based on detecting the relativistic rise of ionization loss in gases and
successful tests have been made at CERN. The system consists of 128 layers of 32 indi-
vidual proportional cells. Ionization deposited in the detector is sampled by measuring
the pulse height from each cell traversed by the charged particles. Monte Carlo calcu-
lations, substantiated by the tests, indicate that one can obtain 5.5% FWHM ionization
resolution on a track which passes through all 128 layers. The EPI is capable of sepa-
rating π's and K's of ~3 to ~40 GeV/c, π's and p̄'s(p's) from ~3 to ~100 GeV/c and K's
and p̄'s (p's) from ~6 to ~70 GeV/c with efficiencies of >90%, >90% and >80% respectively.

In earlier considerations of an improved hybrid system for the 30-inch bubble cham-
ber, the concept of particle identification was recognized as an important feature of
the system (see Dec. 1975 NALREP). Our studies indicate that the EPI will fulfill the
requirements of particle identification for a broad class of experiments at Fermilab.
With minor adjustments to the plan of Plano et al (12 Sept. 1974), the overall require-
ments of a good hybrid system (precision momentum measurements, γ-ray detection and
particle identification) may be readily met.

On the basis of E-311 events, we find significant differences between p̄p and pp
interactions. It is tempting to ascribe such effects to the baryon annihilation process.
For any future high statistics exposures such as proposed here, it is extremely impor-
tant to have more detailed information on the nature of the produced particles. With
the proposed system we expect to study the following topics: (a) a measurement of the
p̄p annihilation cross section, a study of the multiparticle production in baryon annihi-
lation events, and a high statistics comparison between p̄p and pp interactions. (b) a
study of the Kπ correlations in both p̄p and pp interactions. One of the interesting
features observed at Fermilab is the strong dependence of two particle correlations on
the azimuthal separation for a pair of like pions. It would be interesting to learn
whether this effect is due to the Bose statistics of two identical particles. One may
learn more about such effects by studying $K^{\pm}\pi^{\pm}$ correlations in a similar manner. With
the identification of K_s, $K^{\pm}$, Λ and Λ̄ in a large number of events we expect to study
the process of strangeness exchange in both p̄p and pp interactions. For example,
what is the rapidity gap distribution between the 2 strange particles? How locally is
strangeness conserved? (c) a study of the low cross section processes such as exclu-
sive channels and neutral particle production. (d) with the proposed beams, many of
above topics will also be studied in π±p reactions.

CALORIMETER-ARRAY STUDY OF HIGH P_T EVENTS

Fermilab-Lehigh-Penn-Wisconsin Collaboration
W. Selove (Spokesperson)

An experiment is proposed to study high-p_t events with a calorimeter array of advanced design and of intermediate size relative to E-246. The objectives include detailed study of single- and multiple-particle high-p_t events with an individually segmented detector. Major specific objectives are the measurement of:

1. frequency of high-p_t groups relative to high-p_t single-particle events,

2. total-p_t dependence for such groups,

3. some angular correlation information in a two-arm system.

(These objectives are discussed in more detail in the E-246 Proposal.) The detector will consist of a hadron calorimeter on one side of the beam--27 elements of 0.06 to 0.1 sr each--, and a "π^O" hodoscope of 20 elements on the other side. Emphasis is placed, in the detector, on obtaining the cleanest possible identification of very rare events, to a level of one event in 10^9 to 10^{10} beam tracks. With a beam of 200 GeV/c p/π, 10^6 per pulse, a substantial number of events can be obtained out to at least 5 GeV/c p_t.

Running time requested is 450 hours total, consisting of 150 hours testing and 300 hours data taking. Data taking is planned as 200 hours at 200 GeV/c and 100 hours at 300 GeV/c.

Summary prepared by
W. Selove, May 1975

ELASTIC SCATTERING AND DIFFRACTION DISSOCIATION AT
SMALL MOMENTUM TRANSFER FOR $\pi^\pm$, $K^\pm$, $p^\pm$ AND n

R. Cool, K. Goulianos, S. Segler, H. Sticker (Rockefeller Univ.)

A simple apparatus is proposed for measuring the energies,
angles, and identity of recoil p or d at small $|t|$ from a gas
target. Large solid angle coverage and target length are capable
of extending pp and pd gas jet measurements to $\pi^\pm$, $K^\pm$, $\bar{p}$ and n
using typical Fermilab existing beams. In addition, the recoil
detector will label each diffractively produced state with M_x,
$|t|$ and $\hat{n}$, the normal to the production plane, for study by
downstream apparatus. Since diffractively produced states at
very low $|t|$ carry the same quantum numbers as the incoming
particle, each final state of mass M_x is labeled as to isospin,
parity and strangeness. The variety of quantum numbers provided
by existing beams then allows a sensitive method of searching
for new particles within specified mass ranges with specific
quantum numbers. Apart from the particle search potentiality,
the systematic study of the important diffraction dissociation
production process itself with a variety of incoming particles
is emphasized. In addition to measuring $d^2\sigma/dM_x^2 d|t|$ as a
function of s, $|t|$ and M_x^2 for inelastic processes, $d\sigma/d|t|$ for
elastic scattering will be measured in the range
$0.01 < |t| \stackrel{<}{\sim} 0.12$ $(\text{GeV/c})^2$ thus giving the ratio of the real to
the imaginary amplitudes.

A hydrogen (deuterium) gas target at atmospheric pressure is
located between planes of proportional and drift chambers and
scintillation counters; these measure the recoil proton
(deuteron). With a beam of 5×10^6 particles/pulse, a total inter-
action rate of 86/sec is expected for pp interactions of which
5 would be detected elastic events. Some 4×10^5 elastic events
and $4\times10^4/M_x^2$ diffraction dissociation events per $(\text{GeV})^2$ bin at
M_x^2 are expected in one day, spread over incident π's, K's and
$\bar{p}$'s. The error introduced by Coulomb scattering ranges from
$\Delta M_x = 100$ MeV at $M_x = 1.5$ GeV to $\Delta M_x = 20$ MeV at $M_x = 7.5$ GeV.

Phase I of this experiment would have a simple downstream
detector to record the number and position of charged particles
and γ-rays in a plane perpendicular to the beam ≈10 meters from
the recoil detector. Phase II would add a magnet and Pb glass
(or calorimeter) detectors for momentum (and energy) determin-
ation in the downstream arm.

For Phase I, 1,000 hours are requested in a beam like M1
or M6. The goal is to measure (i) $d^2\sigma/d|t|dM_x^2$ for $50 <s$
< 400 GeV^2, $0.01 \stackrel{<}{\sim} |t| \stackrel{<}{\sim} 0.12$ $(\text{GeV})^2$ and $M_p^2 < M_x^2 < 0.15$ s
for each particle type, (ii) $d\sigma/d|t|$ for elastic scattering
over the same ranges of s and t for each particle type and
(iii) multiplicities and angular distributions for charged
particle and γ-ray secondaries of diffraction dissociation
states together with γ-ray energies. The apparatus can be
ready in early 1976, and its density is so low it can be placed
upstream of other experiments.

PROPOSAL TO SEARCH FOR HIGH MASS PARTICLES PRODUCED
IN ASSOCIATION WITH PROMPT MUONS

E. Bleser (Fermilab); B. Gobbi, L. Kenah, J. Keren, R. Lipton,
D. Miller, J. Rosen, R. Ruchti, D. Spelbring (Northwestern
University); J. Biel, D. Chaney, T. Ferbel, P. Slattery,
D. Underwood (Univ. of Rochester); D. Freytag (SLAC)

It is proposed to investigate the possible existence of
narrow high mass states (e.g. charmed particles) which are
produced in association with prompt muons. Most estimates of
the expected magnitude of prompt muon production, which are
based on electromagnetic processes or postulated intermediate
states involving the known vector mesons, fail to saturate the
observed μ/π ratio of $\sim 10^{-4}$. This suggests that a significant
fraction of these muons could result from weak decays of here-
tofore undiscovered particles which are forbidden to decay
strongly by a new conservation law. Such particles would of
necessity be produced in pairs, and it is proposed to employ
the muon resulting from the leptonic or semi-leptonic decay of
one state to trigger a spectrometer system, and then to examine
the characteristics of the associatively produced particles
using a modified version of the E27A/E305 spectrometer.

The muons are to be identified by their traversal of a
steel and heavimet telescope which will be instrumented with
counters, proportional chambers, and wire spark chambers. The
addition of this second spectrometer arm will permit exploitation
of the proven capabilities of the wide aperture, high resolution,
forward spectrometer to study the multiplicity, transverse
momentum, and invariant mass distributions of events produced
in association with prompt muons. In addition, the ability to
identify forward leptons will enable the experimenters to
investigate $\mu\mu$ and μe correlations in these events.

This proposal is a natural outgrowth of the experience
gained during a previous search for charm-type particles
(revised Experiment 305), and will be a particularly sensitive
probe into this obviously important and still relatively
unexplored physical domain. A total of 1000 hours of beam
time is requested for these studies.

Summary prepared by
J. Rosen, May 1975

A PROPOSAL FOR A FURTHER STUDY OF
MUON NUCLEON INELASTIC SCATTERING AT FERMILAB

Chicago, Harvard, Illinois, Oxford Collaboration
H. L. Anderson (Spokesperson)

A further investigation of inelastic muon-nucleon scattering is proposed employing the muon spectrometer built by the E-98 collaboration. Specifically it is proposed:

1. To extend measurements of inclusive muon inelastic scattering cross-sections to higher incident energies and thereby study the nucleon structure in kinematic regions not hitherto reached. Compared to E-98, the range of q^2 will be extended from 30 GeV^2 to 50 GeV^2, and ν from 130 GeV to 205 GeV. The accuracy will be 5 to 10%, depending on binning. This determination depends on assuming a value of R, the ratio of the scaler to transverse virtual photon cross-sections. Values of R can be obtained from the overlapping (q^2,ν) regions of the proposed 225 GeV runs and the 100 and 150 GeV data of E-98. Values of the total photon-nucleon cross section will be obtained by extrapolation to $q^2=0$. This experiment would yield measurements for photon energies from 175 to 205 GeV, compared to 90 to 130 GeV in E-98.

2. To identify hadrons and thereby measure π/K/p ratios as a function of kinematic variables and charge dependence. Preliminary results from E-98 indicate that the charged hadron ratio h^+/h^- is close to 1 for low x and increases as x approaches 1 and that it increases at q^2 near x=1.

3. To extend the measurements of vector meson production to higher energies. This experiment would yield 2000 ρ mesons and 100 ρ' (1600) mesons in the range ν=175 to 205 GeV; this compares to 50 ρ' and 1000 ρ mesons in E-98.

4. To investigate the target fragmentation region. This new work is made possible by the cylindrical chambers and will allow measurement of charged particle multiplicities and direct correlations in the target fragmentation region.

A few modifications to the E-98 equipment would be made for this experiment. The more significant of these are: a set of four coaxial cylindrical multi-wire proportional chambers around the hydrogen/deuterium target, a thinner target housing, a 10 x 10 element lead-glass hodoscope to measure the forward going electrons and photons and a reduction in the amount of matter in the muon beam by adding helium bags and reducing scintillation counter thickness.

Two periods of running are requested at the highest momentum available, preferably 225 GeV/c. A total of 2×10^{11} muons are required for μp scattering and 2×10^{11}, for μD scattering. Each run could be completed in 400 hours of real beam time at current intensities.

PRODUCTION OF ELECTROMAGNETIC CASCADE SHOWERS
BY SEVERAL HUNDRED GeV ELECTRONS IN EMULSION CHAMBERS

R.L. Golden (Johnson Space Center); R.J. Wilkes, J.J. Lord
(University of Washington); J. Nishimura (University of Tokyo)

It is proposed to expose two different types of emulsion
chambers in order to study the development of electromagnetic
cascade showers. One chamber will be composed of a stack of
pure nuclear emulsions wherein the showers can be studied in
a uniform medium having a radiation length of about 2.9 cm.
Comparison will be made with theory and cosmic ray studies.

Experiments will also be conducted with emulsion chambers
consisting of a combination of lead sheets and nuclear emulsions
of a design similar to those employed in cosmic ray experiments.
Again comparison will be made with theory and the results of
cosmic ray investigations.

It is proposed to expose the stacks to electrons of the
highest practical energy; at least 100 GeV.

Summary prepared by
R. Golden, April 1975

A SEARCH FOR NEW PARTICLES PRODUCED IN ASSOCIATION WITH
THE HADRONIC PRODUCTION OF ψ(3.1) MESONS

M. Binkley, I. Gaines, J.R. Orr, J. Peoples, A.L. Read (Fermilab);
G.E. Gladding, M.F. Gormley, R. Messner, A. Wattenberg (Univ.
of Illinois)

The primary objective of this experiment is a search for
production of new (possibly charmed) particles from interactions
of 400 GeV primary protons with a beryllium target. A suggestion
has been made to explain the large increase in the production
cross section for the ψ(3.1) corresponding to the accelerator
energy increase from BNL-AGS to Fermilab. Consequently, it is
speculated that the favored production of the ψ(3.1) is in asso-
ciation with other new particles containing a charmed quark.

In this Fermilab experiment it is proposed to look at the
following reaction:
$p + Be \rightarrow \psi(3.1) + Y_f (A, \ldots) + X, \psi(3.1) \rightarrow \ell^+\ell^-$.
Here the ψ(3.1) is observed through its decay to a lepton pair
and the remaining particles produced and observed in the reaction
(Y_f) are examined for narrow peaks in an effective mass plot.
These possibly new particles are designated as "A" in the reaction
above. The particle A may also be observed through its leptonic
decay if it has a significant branching ratio.

A secondary physics objective is to measure the yields and to
study the dynamics for production of ρ^0(770), ϕ^0(1020), ψ^0(3100),
ψ^0(3700). Similar measurements from Experiment #358 (involving
the experimenters associated with this proposal) do not enable a
simple interpretation for these production processes because of
complications resulting from use of neutrons which were not
monoenergetic. The proton data will make it possible to obtain
cross sections from the E-358 data.

It is planned to make several changes to the detector and to
the beam to facilitate this experiment. The incident beam is to
be 400 GeV protons, reduced in intensity by collimation from
about 3×10^9 to 1×10^7, transported through the empty deuterium
filter for the wide band photon beam. The detector previously
used for Experiments #87A and #358 will be changed as follows:
1) increasing in the acceptance by a factor of 4 by moving the
target closer, 2) improving the momentum resolution of the
measured secondaries by raising the field in the analysis
magnet to 18 kG, 3) improving the lepton detection efficiency by
adding counters, reducing the length for possible π-decay, and by
improving the muon filter.

The experimenters ask for 50 hours of running to study the
possibilities of bringing a proton beam to their apparatus.
Later running would include 100 hours for testing, 600 hours
for data-taking, followed by 120 hours of data-taking with
additional steel inserted in their apparatus to study carefully
backgrounds from pion decays.

Summary prepared by
A. F. Greene, June 1975

PHOTOPRODUCTION OF HIGH MASS TWO-BODY FINAL STATES

R. Coleman, G. Gladding, M. Goodman, M. Gormley, R. Messner,
A. Wattenberg (Univ. of Illinois); M. Binkley, I. Gaines,
J.R. Orr, J. Peoples, A.L. Read (Fermilab)

It is proposed to extend the photoproduction studies begun in Experiment #87A. The measurements planned for these new studies are:

1) measurement of the energy dependence of $(d\sigma/dt)_{t=t_{min}}$ for $\psi(3.1)$ + nucleon $\rightarrow$ $\psi(3.1)$ + nucleon,

2) measurement of the $\psi'(3.7)$ + nucleon cross section,

3) investigation of the mass spectrum of photoproduced e^+e^-, $\mu^+\mu^-$, K^+K^-, $p\bar{p}$, μe, etc. in the mass interval 3.0 GeV $\leq M_{+-} \leq 7.0$ GeV.

It is emphasized in the proposal that the determination of the $\psi'(3.7)$ + nucleon cross section can probably only be measured at Fermilab energies in such an experiment. Furthermore, a study of the photon-induced two-particle mass spectrum (both resonant and non-resonant) is a natural extension to the earlier measurements of Experiment #87A. The (cross section) x (branching ratio) for a mass 6 GeV object is expected to be about 1 nanobarn.

It is planned to make some additions to the setup for Experiment 87A. These are expected to include:

1) an additional sweeping magnet in the form of a BM-109 to remove e^+e^- pairs with momentum less than 25 GeV just downstream of the experimenters' target,

2) addition of one or 2 Cerenkov counters behind the analyzing magnet for the present E87A apparatus thus to reduce the number of events with secondary pions,

3) improvement of the existing electron/photon identifier.

The main features of these improvements will be a factor of two improvement in the mass resolution (from 145 MeV FWHM to about 82 MeV FWHM), a factor of ten improvement in sensitivity, and acceptance of events with a broader range of incident photon energies.

Event rates are calculated using an extracted proton beam with an intensity of 5×10^{12} per pulse and an energy of 300 GeV. In a 300 hour run the yield of events in the mass region near 5 GeV would be about 1,200 events and near 7 GeV would be 250 events. If the primary proton beam energy is at 400 GeV the number of events in the mass region 3-5 GeV would increase by a factor of 1.5 to 2.

Summary reviewed by
M. Gormley, January 1976

π^+p INTERACTIONS AT 250 GeV/c IN IMPROVED FNAL 30" HYBRID SYSTEM

University of Tennessee, Oak Ridge National Laboratory,
John Hopkins University, Rutgers University, Stevens Institute
of Technology   William M. Bugg (Spokesperson)

It is proposed to utilize the excellent momentum resolution, increased angular acceptance, and neutral particle detection capabilities of the improved FNAL 30" hybrid bubble chamber system to study interaction of 250 GeV/c π^+ mesons in an enriched π^+ beam. The experimenters will examine leading particle effects and diffraction dissociation, long and short range correlations, inclusive single particle and resonance production, strange particle production, and systematics of events with forward π^0 and η^0.

Comparison with Experiment 299 results and a proposed experiment at 75 GeV/c will permit determination of general energy dependence of these effects, particularly leading particle cross section where good resolution near x = 1 is essential to test carefully model dependent predictions of leading particle cross sections.

An exposure of 100,000/F pictures is requested where F is the fractional π^+ content of the beam. With this, it is estimated that 20,000 π^+ events and 40,000 (1-F)/F proton events will be obtained. The experiment would be of sufficient statistical accuracy to permit detailed comparison with other proposed experiments using the improved 30" hybrid system.

Summary prepared by
W.M. Bugg, May 1975

HYBRID BUBBLE CHAMBER STUDY OF p̄p INTERACTIONS AT 75 GeV/c

Rutgers University-Stevens Institute, Johns Hopkins University,
University of Tennessee-Oak Ridge National Laboratory,
Stockholm University   R. Plano (Spokesperson)

    A careful study of antiproton-proton interactions at 75
GeV/c is proposed to be made with the Fermilab 30" hybrid
bubble chamber. An exposure of 300K pictures is requested
to provide 50K interactions of which approximately 7K are
annihilation events. Using the properties of this system
which is very well matched to the often complex topologies
associated with annihilations and to this beam momentum, the
collaborators plan to study all experimentally accessible
features. In particular, single and multi-particle inclusive
distributions for charged and neutrals will be measured,
exclusive fits will be made where possible, new particles
will be searched for, and comparisons made to other energies
and to other beam particles.

π^+p COLLISIONS AT 75 GeV/c IN THE 30-INCH HYBRID CHAMBER

Rutgers University-Stevens Institute, University of Tennessee-
Oak Ridge National Laboratory, Johns Hopkins University
                    T. L. Watts (Spokesperson)

It is proposed to take a more detailed look at π^+p
collisions at an energy intermediate between AGS energies
and current high energies at Fermilab. The experimenters would
initially concentrate on the quasi-elastic diffraction
processes to understand their energy dependence by comparison
to the data at 150 GeV/c (Fermilab experiments E154 and E299).
They expect to examine the following features of leading
particle interactions especially concentrating on their
energy and beam particle dependences:

(a) Leading particle cross-sections

(b) Associated multiplicity

(c) Comparative π^+, π^- and p inclusive distributions.
     Correlation among particles, i.e. invariant masses,
     azimuthal angles, longitudinal and transverse momentum
     distributions. They expect to look for resonances and
     sub-clustering effects.

(d) Exclusive final states determined by 4C fits

(e) π^0 production using conversions in the bubble chamber
     or in a lead glass hodoscope which the experimenters
     plan to help make available.

(f) Strange particle production.

The exposure is for the pure beam equivalent of 100K
pictures in the 30" hydrogen bubble chamber hybrid system
with proportional wire chambers to isolate the fast leading
particles.

HYBRID BUBBLE CHAMBER STUDIES OF
K^+p AND K^-p INTERACTIONS AT 75 GeV/c

Johns Hopkins University, Rutgers University-Stevens Institute,
Stockholm University, University of Tennessee-Oak Ridge National
Laboratory   A. Pevsner (Spokesperson)

An exposure of the Fermilab 30" liquid hydrogen bubble
chamber to K^+ and K^- beams both at 75 GeV/c is proposed.
Each exposure consists   of 100,000 equivalent K pictures,
i.e. 100,000/F pictures each, where F is the enrichment
factor. This would yield 10,000 events for each, K^+ and
K^-.   •

The experimenters plan to use the upstream tagging
system currently in place and a downstream spectrometer
with acceptance considerably increased over that of the
current PWC system. This new downstream system will also
be equipped with a lead glass photon detector with good
spatial and energy resolution.

A comparison will be made of K^+ and K^- results, as
well as results from π^+, π^-, and $\bar{p}$ beams at this energy
which are the subject of separate proposals. In particular
they plan to examine:

1. Particle multiplicities.

2. Leading particle effects and diffraction dissociation.

3. Double leading effects and long range correlations.

4. Strange particle production.

5. Resonance production.

6. Multiparticle production in the central region.

Summary prepared by
A. Pevsner, May 1975

PROPOSAL TO SEARCH FOR PION PRODUCED PARTICLES DECAYING UNDER
PROMPT EMISSIONS OF ONE OR MORE MUONS

D. Garelick, M. Glaubman, E. von Goeler, R. Weinstein,
P. Gauthier, M. Mallary, D. Potter, E. Pothier of Northeastern
University; and P. Mockett, G. Hicks of the University of
Washington, and others

This experiment will search for the production of new
particles which promptly decay emitting one or more muons. The
detectors for this experiment consist of two spectrometers:
A spectrometer which measures slow recoil protons produced at
large angles with respect to the beam and an iron spectrometer
which identifies and measures muons produced in the forward
direction ($\theta_H \sim \theta_V \sim 0.2$ rad.).

Some of the processes that will be investigated are:
(1) the production of pairs of particles such as charmed mesons,
D, produced in reactions $\pi^- + p \to D + \bar{D} + p$ or $\pi^- + p \to D + \bar{D} +$
hadrons $+ p$, where at least one D decays under muon emission.
Another process of this type is heavy lepton production. (2)
the production of particles, W^-, produced singly in reactions
$\pi^- + p \to W^- + p$ or $\pi^- + p \to W^- + p +$ hadrons, where the W^-
decays under muon emission, for example $W^- \to \mu\nu$ or $W^- \to \mu X$.
(3) the production of particles, X, produced in reactions
$\pi^- + p \to X^- + p$ where the X decays under emission of at least
one vector meson, V, which in turn decays into a muon pair.
(4) multimuon production by π^-, K^-, and $\bar{p}$ from an iron target.

The unique features of the experiment are: (1) use of a
missing mass technique to obtain the spectrum of masses $D\bar{D}$, $D\bar{D} +$
hadrons, W^-, W^- + hadrons or X^-. This technique allows a rapid
mass scan for masses up to ~10 GeV, and with good resolution,
$\Delta M^2 \sim \pm 1$ GeV^2. (2) use of a double missing mass technique to
determine the nature of the intermediate state from which the
muon (or muons) originate. (3) Excellent cross section
sensitivity in the nanobarn region. (4) Test data exist which
have determined background levels and have shown the feasibility
of the experiment. (5) Most of the apparatus exists. (6) The
ability to collect interesting data on multimuon production
by π^-, K^-, and $\bar{p}$ on an iron target.

The experiment requires 200 hours in a 200 GeV π^- beam with
a flux of ~10^7 π^-/pulse. In addition, approximately 150 hours
of parasitic time for apparatus testing and calibration are
needed.

Summary prepared by
D. Garelick, April 1976

PROPOSAL TO SEARCH FOR PROTON PRODUCED PARTICLES DECAYING
UNDER PROMPT EMISSION OF ONE OR MORE MUONS

W. Faissler, D. Garelick, M. Glaubman, J. Johnson, M. Mallary,
E. Pothier, D. Potter, M. Ronan, E. von Goeler, R. Weinstein
(Northeastern University)

We propose to measure the reactions

$$p + p \rightarrow X^+ + p \rightarrow \mu + X' + p \qquad (1)$$

$$\text{or } \mu\mu + X'' + p$$

to examine possible structure in the X^+ mass spectrum. In
this experiment a slow proton at large angle and one or more
muons in the forward direction are detected.

Such structure might arise, for example, from a reaction
of the type

$$p + p \rightarrow DB_C p \rightarrow \mu \, X' \, p. \qquad (2)$$

Here B_C might be a charmed baryon, D a charmed meson. Either
particle could decay and give rise to one or more muons in
the detector. The experiment is similar, except for the
incident particle, to Northeastern University proposal 365A,
and should follow that experiment.

The experiment requires 200 hours of beam time with 10^7
protons per pulse at 300 GeV or 400 GeV. The sensitivity of
this experiment to reactions of type (2) is approximately 5 nb.
Test data have already been taken and have shown the feasibility
of the experiment. For further details, see Northeastern
University Proposal 411 and references cited therein.

Summary prepared by
D. Garelick, May 1975

MEASUREMENTS OF π^- Cu $\to$ K_s^o, Λ^o, AND NEUTRON INCLUSIVE CROSS SECTIONS

University of Colorado, University of Michigan, Rutgers University, University of Wisconsin

L. Pondrom (Spokesperson)

It is proposed to measure inclusive strange particle yields from a pion bombardment of a copper target. This work is motivated by the inherent physics interest as well as by a need for particle production data in order to design a K_L^o beam in the Proton-West area. The design work is motivated by interest in Proposal #360 to study inclusive interactions of K_L^o producing hadrons and leptons. The K_L^o beam would be produced by a high energy, high intensity pion beam and thereby contain a reduced number of background neutrons.

This experiment would use the M2 beam of the Meson Area set for π^- at a momentum of 200 GeV/c and at much lower intensity than that planned for P-West. As a detector the experimenters would use the apparatus of Experiment #8, a neutral "V" spectrometer. K^o's would be identified through their decay to $\pi^+\pi^-$, Λ^o through their $p\pi^-$ mode, and neutrons through a technique utilized in a neutron dissociation experiment (E-305). Neutron production can be identified by scattering in a carbon target, producing N*'s which decay to $p\pi^-$.

The running time request for this experiment is 100 hours.

STREAMER CHAMBER SEARCH FOR NEW STATES
WHICH DECAY SEMI-LEPTONICALLY

V. Cook, S. Csorna, A.M. Jonckheere, R.G. Kenyon, H.J. Lubatti,
K. Moriyasu, B. Robinson, P. Tressel (Univ. of Washington);
D. Fournier, P. Heusse, P. Rancon, J.J. Veillet (Orsay);
J. Erwin, R. Kass, J.H. Klems, Winston Ko, R.L. Lander,
D.E. Pellet, P.M. Yager (Univ. of California, Davis)

A test has been made to determine if an enhancement in neutral strange particles (V^0's) observed in a streamer chamber exists when triggered on muons. The beam of 225 GeV negative pions was incident on a 1.3% lucite target.

The reactions being compared were:

$$(1) \quad \pi^- N \rightarrow 2\mu + V^0\text{'s} + \text{anything}$$
$$(2) \quad \pi^- N \rightarrow 1\mu \ (90°\text{cm}) + V^0\text{'s} + \text{anything}$$
$$(3) \quad \pi^- N \rightarrow V^0\text{'s} + \text{anything}$$

In reactions (1) and (2) a muon filter (described below) defines a pair of μ's or 1μ around 90° in the c.m. In reaction (3) the trigger is any interaction (E) (we remove the μ requirement).

The presence of a 3 standard deviation signal is suggestive that we may have seen a real effect. We have tried to find an explanation for this signal which does not assume a new production mechanism or the production of a new particle with a strong semi-leptonic decay mode. A possible known mechanism is $K\mu_2$ decay which would provide a muon and by strangeness conservation would require the presence of an additional strange particle. We have attempted to estimate the contribution from this mechanism. From a simple calculation, we conclude that an upper limit could be approximately 1-2%. A more complicated calculation suggests that this is too large by at least an order of magnitude.

In order to improve the statistical significance of these data, we should like to increase our events by approximately an order of magnitude. We believe that with a 3-week run this should be possible. In a hundred hours of running, this would give us 15,000 triggers which is a factor of 30 more than we obtained in our previous run. To improve our signal/noise, we plan to use instead of pure iron for the muon filter, the magnetized iron used by Experiment 365. The magnetized iron would allow us to harden the muon trigger by rejecting lower momentum muons, many of which come from pions decaying either in flight or in the shield. We would in a hundred hours end up with approximately 5,000 events. Improving our trigger by lowering the rate per interaction should decrease some of the background and hhopefully $\alpha_{2\mu}$ should increase. If this were to be the case, it would be a strong experimental argument that we are observing a new effect. We are encouraged by the results obtained by Perl at SPEAR which suggest that there may be a state of mass approximately 2 GeV which has a 10% leptonic decay mode. Such a state may have a substantial semi-leptonic decay mode which would explain its absence in the $K\pi$ mass spectra studied to date.

Nuclear Size Dependence for Particle Production at
Intermediate Transverse Momentum

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D. Nitz, S. Olsen (Rochester); K. Abe, R. Bomberowitz, K. Cohen,
P. Goldhagen, F. Sannes, D. Saroff, J. Willison (Rutgers)

In a recent experiment Cronin et al. parametrized
the A dependence for particle production from nuclear targets
as $A^{n(p_T)}$. Not only does n vary with p_T but, most unexpectedly,
it takes on values significantly larger than unity. We propose
to study this dependence on the atomic number A of $\pi^{\pm}$, $K^{\pm}$ and $p^{\pm}$
production from carbon and tungsten targets at $\theta_{lab} = 15^{\circ}$ and
$0.25 < p_T < 2.5$ GeV/c. The production from both types of targets
will be measured simultaneously by mounting carbon and tungsten
fibers on the same rotating target at C-O. Data will be col-
lected over the incident energy range of 30 to 400 GeV. Particle
momenta will be determined by magnetic analysis and particle
species will be determined with one differential and two thres-
hold Cerenkov counters.

Summary Revised by
F. Sannes, Jan. 13, 1976

Status: Completed October, 1975

SEARCH FOR SHORT LIVED PARTICLES PRODUCED BY
300 GeV PROTONS IN EMULSIONS

W. Bozzoli, P. Capiluppi, A. Forino, R. Gessaroli, G. Giacomelli,
P. Lugaresi-Serra, A. Quareni and F. Rimondi (Universita di
Bologna); S. Di Caporiacco, A. M. Cartacci and M. G. Dagliana
(Universita di Firenze)

This is a search for short-lived particles with lifetimes in
the range of 10^{-12} - 10^{-14} sec., performed with 300 GeV protons
in emulsion nuclei. As in experiment No. 462, the signal would
be a neutral or charged decay (or possibly two decays) close
to the primary proton-nucleus interaction.

We have exposed one stack of Ilford G5 emulsions, of
80 plates of 10 x 10 x 0.06 cm^3, to 300 GeV protons with a
density of about 3 x 10^5 protons/cm^2, with a total exposure
of 4 x 10^6 incident protons over an area of 5 x 8 cm^2.

The experiment should be sensitive to the production of
new particles if they have a mass of 1 - 10 GeV and if their
production cross section is larger than 1 μb.

Summary prepared by
G. Giacomelli, January 1976

HIGH PRECISION STUDIES OF DEEP SCATTERING PHENOMENA FROM
PROTONS, PIONS, ELECTRONS AND GAMMA-RAYS ON HYDROGEN AND DEUTERIUM

G. Conger, J. Edighoffer, A. Grigorian, Z.G.T. Guiragossian,
R. Hofstadter, M.R. Yearian (Stanford University)

It is proposed to measure with high precision the cross
sections of elastic and inelastic collisions in the deep scattering
region, using the highest energy and intensity beams of protons,
pions, electrons and gamma-rays, on hydrogen and deuterium targets.
Initially, these studies will be carried out in the beam momentum
region of 50-400 GeV/c, and thereafter in the Energy Doubler/Saver
mode, in the region of 400-1000 GeV/c. The cross sections of these
processes will be measured as a function of s, in the range of 95
GeV^2 to 1880 GeV^2, as a function of the invariant momentum transfer
t, in the range of $t_{min} = 0.040$ $(GeV/c)^2$ and $t_{max} = 3.25$ $(GeV/c)^2$,
and as a function of the missing-mass M, in the range of $M = m_\pi$ and
$M = 40$ GeV. Beam intensities and energies to be used are:
50-1000 GeV/ $10^{11}-10^{12}$ p/pulse; 50-800 GeV, 10^9-10^{10} π^-/pulse;
50-700 GeV, 10^9-10^{10} $e^\pm$/pulse; 50-700 GeV 1/2(10^9-10^{10}) γ/pulse.
Moreover, using high precision missing-mass techniques, searches
will be made to discover new states of: heavy baryons (N^{*+} and N^{*0})
produced by protons; heavy mesons (M^{*-}), exotic mesons (M^{*--}), and
charged intermediate vector bosons (W^-) produced by pions; heavy
vector and scalar bosons (W^0, V^{*0}, B^{*0}, ψ^{*0}, η^{*0}_c) produced by real
and virtual photons; excited leptons ($e^{*\pm}$), and heavy leptons (E^0)
produced by electrons.

It is proposed to complete and install the HEPL 168", 2.5
GeV/c, large acceptance, high precision, focussing spectrometer
at Fermilab, at the end of the Proton-West beam line, so that it
can be used initially for the benefit of these studies. The goal
is to complete fabrication of the spectrometer at HEPL in 1978,
and to transport and install the spectrometer at Fermilab in 1979.
Consideration of this proposal is requested presently to permit
the completion of the fabrication project.

EXPOSURE OF AN EMULSION CHAMBER TO A 300 GeV PROTON BEAM

V.P. Dzhelepov (Joint Institute of Nuclear Research)

An emulsion chamber ($20 \times 10 \times 10$ cm^3) was exposed to a 300 GeV proton beam. The requested intensity was $1-1.5 \times 10^5$ protons per cm^3.

Summary prepared by
J. Lach, May 1976

PROPOSAL TO STUDY p̄ INDUCED REACTIONS BY MEANS OF THE 30-IN.
BUBBLE CHAMBER, I.E.:

p̄d INTERACTIONS AT ~50 AND ~80 GeV/c
p̄p INTERACTIONS AT ~80 GeV/c

Centre de Recherches Nucleaires de Strasbourg, Purdue University
(A. Fridman, Spokesperson)

The proponents request three exposures of the 30-in. Bubble
Chamber to an antiproton beam as follows:

1. 150K pix in deuterium at 50 GeV/c

2. 150K pix in hydrogen at 80 GeV/c

3. 150K pix in deuterium at 80 GeV/c

They have acquired substantial p̄ data in bubble chamber experiments
carried out at lower energies. They list among their interests
for this proposed experiment:

1. Measurements of topological cross sections and
    statistical moments.

2. Correlations between the production of neutral and
    charged particles.

3. Search for resonances and study of leading particle
    effects in non-annihilation channels.

4. Study of multiparticle production.

5. Study of diffractive dissociation in the non-annihilation
    channels.

6. Single particle distributions in inclusive and semi-
    inclusive reactions.

7. Strange particle production.

8. Total cross section measurements for the annihilation
    channels.

9. Coherent production processes.

The scanning and measuring will be carried out at both
Purdue and Strasbourg. The latter group has indicated they
will give top priority to this experiment in committing
their analysis resources.

Summary prepared by
T. H. Groves, January 1976

SEARCH FOR NEW PARTICLES IN EMULSION CHAMBER

H. Sugimoto and H. Nanjo (Univ. of Tokyo); Y. Sato (Waseda Univ.);
T. Ogata (Kwansai Gakuin University)

The specially designed emulsion chamber with producing
layers has the very high spacial resolution compared with other
particle detectors. The proposal of our experiment is to
expose the emulsion chamber to the FNAL 400 GeV/c proton beam
to investigate the multiparticle production processes. The
main purpose of our experiment is to search for the new hadronic
particles with mean lives in the range 10^{-11} to 10^{-14} seconds
through their decay mechanisms among the multiparticle processes.
The momenta of the charged particles are measured by multiple
coulomb scattering in lead plates. Leptons are identified also
in lead plates through the electro-magnetic processes.

The main objectives of this experiment are:

1. to search for the new hadronic particles through their
    decay mechanisms and to estimate the cross section of them,

2. to investigate the angular correlation and also the N_γ-N_{ch}
    correlation of the produced particles in multiparticle
    processes,

3. to estimate the scattering constant of lead plates in this
    chamber by measuring the multiple coulomb scattering of the
    incident particles.

Conditions Required in this Experiment

1. Beam; parallel and mono-energetic proton beam.

2. Energy; proton beam about 300 and 400 GeV.

3. Amounts of irradiation; * 10^3 and 10^4 particles/cm^2 on the
    detector.

4. Shield materials; lead blocks enough to shield the detector.

Duration of the Testing and Data-Taking

About two hours in our rough estimation.

Summary prepared by
H. Sugimoto, July 1975

MULTIPLE-PION PRODUCTION BY 200 GeV/c MUONS

Tomonori Wada (Okayama Univ.); Shuichi Katsube, Katsuhiko Saitoh
(Ashikaga Inst. of Technology); Kiyomi Mitsui (Univ. of Tokyo);
Kohei Mizutani (Saitama Univ.)

The main objectives of this experiment are to study the
multiple-pion priduction, especially fire ball-like behavior
at the known muon energy, and to compare with the cosmic ray
data by means of cloud chambers containing lead plates and
with emulsion stack data in the lower energy (5 GeV/c). The
cloud chamber data by cosmic ray muons has been investigated
by means of the One Fire Ball Model (the mesons are emitted
from the excited centers) in the energy range of 10 to 100
GeV, while the emulsion data at 5 GeV/c have indicated dominant
contributions from isobars (the excited baryon of 1238 MeV).
In the cosmic ray data we can not discuss more details of
"the fire ball", such as its mass or temperature, because
that incident muon energies can not be estimated directly.

Two detectors are constituted of nuclear emulsion plates
and 0.25 (0.5) cm lead plates which are piled up in the form
of a stack. The geometrical size of the detector is about
10 cm x 10 cm wide and 16 (12) cm thick including lead target
of 8 cm thick for 300 GeV muons.

Following is the summary of the conditions required in
this experiment:

1. Beam: parallel and mono-energetic muon beam.

2. Energy: 300 GeV

3. Intensity: 10^5 muons/cm^2 on the detector.

4. Accuracy of the beam energy: better than ± 10%.

5. Time for data-taking: February 1976 at the first stage.

Summary prepared by
Tomonori Wade, January 1976

PROPOSAL TO INVESTIGATE REGENERATION OF
NEUTRAL K-MESONS AT VERY HIGH ENERGIES

N. Molzon, J. Roehrig, V. Telegdi, B. Winstein (Univ. of Chicago);
S. Aronson, G. Bock (Univ. of Wisconsin); K. Freudenreich,
A. Gsponer (Swiss Inst. of Technology, Zurich); H. Kobrak,
R. Pitt, R. Swanson (Univ. of California, San Diego)

This is the hydrogen target phase of E-82.

EXTENSIVE ANALYSIS OF LIGHT NUCLEI TRACKS IN PLASTIC DETECTOR

Katsura Fukui(Air Force Geophysic Lab.); R. Beaujean, W. Enge
(University of Kiel, Germany)

Some of the sensitive plastic detectors are capable of
detecting light nuclei particles such as Li, Be and B. Analysis
of these tracks shows clear separation of charge as well as
isotopic components. If we apply these detectors to the study
of cosmic radiation, however, background tracks created by the
interactions of protons and target nuclei in the detector
interfere with the analysis of primary light particles and a
proper solution is needed. Thus, it is important to study the
process of producing secondary particles inside nuclei.

For this purpose plastic blocks consisting of Daicel or
Kodak cellulose nitrate sheets is exposed to the high energy
proton beams. Exposure is made either parallel or perpendicular
to the plastic surface, thus angular distribution of secondary
tracks may be better analysed. Plastic sheets are etched in a
6 n NaOH solution at proper temperature for several hours. They
are scanned under a steromicroscope to find so called Gothic
Window cones which represent secondary tracks originated from
the collisions between relativistic proton and the target nuclei
such as C and O atoms of the plastic detector. By analysing
these tracks, evaporation and spallation process occuring inside
the nuclei will be studied. Thus, the nature of background
tracks may be clarified and the criteria of track identification
may be established. Consequently, this work will open the way
of using plastic as a useful detector for the study of light
particles of both galactic and solar origin.

In order to simulate relativistic cosmic ray, 100-300 GeV
protons are required for the experiment.

No specific devices is needed for this experiment. Only
requirement for the exposure is correct alighment of the plastic
sheets with respect to the direction of the beam.

Summary prepared by
K. Fukui, March 1976

A PROPOSAL FOR TESTING A TRANSITION RADIATION DETECTOR

AND A HIGH ENERGY SHOWER DETECTOR FOR COSMIC RAY EXPERIMENTS

AT FNAL

G.F. Dell, H. Uto, and Luke C.L. Yuan (BNL)

We propose to use a high energy beam containing hadrons and electrons to optimize transition radiation detectors at FNAL energies with particular emphasis on the use of Xe gas, for the use of detectors in the experiments. Measurements of the yield of transition radiation with usual mixture of Argon and methane have already been made earlier at FNAL at lower energies, up to 250 GeV. The specific objectives of the experiment are as follows:

1. Measurement of the yield of transition radiation from electrons and hadrons using a large number of proportional wire chambers (PWC's) filled with Xe, with different number of foils and chambers up to the highest energy available ($\sim$ 400 GeV) and com-pare with theoretical estimates. The standard transition radiator is $\frac{1}{2}$ mil Mylar spaced at 30 mils. We use also the Ethafoam, 1 mil and $\frac{1}{4}$ mil Mylar with different spacing.
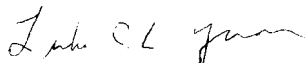
    Study of effects of multiple scattering on transition radiation as a function of the beam energy. The multiple scattering may increase the yield of transition radiation.

    Study of effects of δ-rays on transition radiation detectors.

2. Study on the practical use of the detector for separating particles, e, u, π, K and p using fast chambers, for the accelerator use.

3. Optimization of the transition radiation detector and a high energy shower detector for cosmic ray experiments. The experiments considered are the measurement of the energy spectrum of cosmic ray electrons from a few GeV to 1000 GeV and the energy spectra of high Z relativistic nuclei in cosmic rays.

    The specific request from FNAL is for a space of 10 - 15 feet along a beam line in the Meson Area. The running time required is four weeks.

Summary reviewed by
Luke C.L. Yuan, January 1976

400 GeV PROTON INTERACTIONS IN NUCLEAR EMULSION

J. Hebert, C.J.D. Hebert, H. Areti (Ottawa); M.A. Vincent (Quebec);
G. Baumann, R. Devienne (Nancy); J. Lory, C. Meton, D. Schune,
E. Willot, B. Charquet, Tsai-Chu, M. Morand (Paris); R. Kaiser,
J.P. Massue, R. Pfahl, C. Jacquot (Strasbourg); I. Otterlund
(Lund); A. Van Ginneken (Fermilab); J. Juric, O. Adamovic
(Belgrade); R. Schmitt (Lyon); J.M. Bolta, J. Pellicier, G. Rey,
F. Tejerina (Valencia); F. Fernandez, J. Medena, A. Dura,
V. Gardia (Valencia). E. Villars (Santanber)

This study extends the work of Experiments 116 and 233 (200 and 300 GeV protons on emulsion and largely completed) to higher energies. The emphasis is on establishing the general characteristics of inelastic p-nucleus interactions: interaction length, average multiplicity (differentiated by track density), multiplicity and angular distributions, angular and multiplicity correlations, coherent production, etc. Where feasible interactions will be differentiated by target (Ag and Br versus H, C, N and O).

Results are to be compared with results obtained with emulsion at lower energies, with results obtained with other target elements (including hydrogen), with empirical scaling laws as well as with theoretical predictions.

In the course of these measurements special attention will be given to the possibility of encountering new (or poorly established) short-lived particles.

Summary prepared by
A. Van Ginneken, May 1976

PROPOSAL TO STUDY INTERACTIONS OF 100 GeV/c NEGATIVE
PIONS IN THE 15-FOOT FNAL HYDROGEN BUBBLE CHAMBER

Aachen-Bonn-CERN-Cracow-London-Warsaw Collaboration
Douglas R.O. Morrison - CERN (Spokesman)

A request is made for 50,000 photographs of 100 GeV/c
negative particles in the 15-foot FNAL hydrogen bubble chamber.
One of the main aims of the experiment is to study exclusive
reactions. This would greatly extend our experimental knowledge
of reaction mechanisms, in particular of diffraction dissociation.
Strange particle production would also be expecially studied.

PROPOSAL TO STUDY 50,000 Σ⁻n MULTIPRONG EVENTS AT
~240 GeV/c BY MEANS OF THE 15' BUBBLE CHAMBER

H. Braun, D. Brick, A. Fridman, J-P Gerber, E. Jegham,
P. Juillot, G. Maurer, A. Michalon, C. Voltolini (Centre
de Recherches); P. Antich, R. Attendoli, E. Calligraich,
G. Cecchet, R. Dolfini, G. Fumagalli, G. Liquori, L. Mapelli,
S. Ratti and M. Tomaini (University of Pavia)

In contrast to the large amount of data accumulated in non
strange baryon-baryon interactions, there is only a limited
amount of information available on ΣN interactions. As a $\Sigma^- p$
experiment at 240 GeV/c has already been approved with the 15'
we propose to complete this experiment by studying the $\Sigma^- n$
interactions at the same incident momentum. This will allow us
to make a comparison between $\Sigma^- n$ and $\Sigma^- p$ reactions and to detect
thus the isospin influence on the ΣN interactions. Furthermore,
as previous bubble chamber experiments at Fermilab have shown
that four constraint reactions can be studied, the use of a
neutron target will give us access to four constraint final
states which cannot be obtained from the $\Sigma^- p$ experiment. The
utilization of a deuteron target will of course complicate
somewhat the data analysis. Nevertheless this is a convenient
method to study the pure I=3/2 ΣN isospin state as $\Sigma^+ p$ experi-
ments are more difficult to carry out than $\Sigma^- n$. In a first step
we would like to have a statistics corresponding to 50,000 multi-
prong events, i.e., events having more than two prongs.

The 15' bubble chamber is particularly well adapted for
the proposed experiment. Indeed its large size will increase
the probability to observe the decays of strange particles
which will be produced abundantly because of the S = -1 strange-
ness value of the initial state. Apart of this mean feature
other advantages are connected with the use of the 15' i.e.:

- The possibility of measuring momenta with a good accuracy

- The high probability of observing secondary interactions
  facilitating thus the identification of the outgoing particles.

- The high γ-ray conversion rate allowing to obtain information
  on π^0 and Σ^0 production.

Using a fiducial region of 2.8 m and assuming that one
can have 5 Σ^-/burst we will need about 57,000 pictures.

STUDY OF CASCADE SHOWER ORIGINATED IN JET SHOWERS

S. Dake (Kobe Univ.); Y. Nakanishi, M. Sakata and Y. Yamamoto
(Konan Univ.); K. Mizutani (Saitama Univ.); T. Yuda (Univ. of
Tokyo); I Ohta (Utsunomiya Univ.)

The purpose of our experiment is to observe the longitudinal
development and the lateral structure of the cascade showers
originated in the jet shower in emulsion chamber. The results
can be compared with the pure electro-magnetic cascase shower
initiated by electron, which is our other proposal #340.   If
the difference between the above two kinds of shower is made
clear, we can discriminate them in cosmic ray experiments. And
also, we can distinguish the nuclear events from the Bremsstra-
hlung events in muon experiment with emulsion chamber.

As the proposal #434, the three type emulsion chambers had
been exposed for 400 GeV proton beam on December 8 in Fermilab.
Two chambers of them are the same type which is composed of 16
nuclear emulsion plates (9cm x 12cm x 0.8mm) and 12 lead plates
(9cm x 12cm x 0.5cm) piled up alternatively except first four
emulsion plates. The remaining one is constituted 28 nuclear
emulsion plates and 24 lead plates (9cm x 12cm x 2.5cm).   The
total thickness of lead absorber is 10.5 radiation length for
all chambers. The amounts of irradiation were about 200
protons/cm^2 on each detector.

Now, we are analyzing the emulsion chambers.

Summary prepared by
S. Dake, January 1976

MEASUREMENT OF THE POLARIZATIONS OF PROMPT MUONS
AT $x = 0.14$ at $P_t = 0$ and $P_t = 1.5$ GeV/c

R. Adair, P. Bergey, D. Grannan, H. Kasha, R. Kellogg,
M. Lauterback (Yale), L. Leipuner, R. Larsen, L. Smith (BNL),
and R. Stefanski (Fermilab)

Continuing the work begun in E48 this group proposes to look at the polarization of prompt muons produced at $x = 0.14$ in the forward direction and a transverse momenta near 1.5 GeV/c. These proposed measurements include the kinematic region where the anomalously large production of muons has been observed. If the production process is non-parity conserving there will be a longitudinal polarization of the muons.

The polarimeter is a large block of aluminum and detectors within a low magnetic field. The muons are stopped in the aluminum and the distribution of the decay electrons is measured. In order to accomplish these measurements the polarimeter must be moved, but no additional equipment is required. The experimenters estimate that they will need 250 hours in Proton Center to carry out these measurements.

Summary prepared by
J. R. Sanford, November 1975

DETERMINATION OF THE POSSIBLE DI-MUON CHARACTER OF THE PROMPT MUON FLUX

R.K. Adair, P.D. Bergey, D.M. Grannan, H. Kasha, R.G. Kellogg,
M.J. Lauterbach (Yale Univ.); L.B. Leipuner, R.C. Larsen,
L.W. Smith (Brookhaven); R.J. Stefanski (Fermilab)

We propose to measure the di-muon flux produced by the interaction of 400 GeV protons with copper and compare this flux with the flux of single prompt muons in a manner which will determine whether the prompt muons flux is derived from muon pair production. We will measure the production of muon pairs such that each muon has a laboratory energy greater than 55 GeV and a production angle less than 35 milliradians (or transverse momentum less than 2.0 GeV/c). We demonstrate that we can determine the total cross section for the production of muon pairs, such that each muon has a laboratory energy greater than 55 GeV (or x greater than 0.1375), from our measurements. With the same apparatus, we will measure the total prompt muon flux such that the muon has an energy greater than 55 GeV. Using measurements made previously by us concerning the ratio of the prompt muon flux to the pion flux as a function of x for small p_t, together with measurements of the pion production spectrum made at various laboratories, we can correct for the energy dependence of the cross sections and then compare the total cross section for di-muon production with the total cross section for prompt muon production and then determine whether these cross sections are consistent with the view that they derive from the same source.

We will need about 75 hours of beam time using a set-up and equipment which are minor variations of the equipment used for Experiment 48. We will need one of the portacamps used in Experiment 48 moved about 16'. We will need 6 more duo-quad logic units from PREP. About 35 hours of the requested time will be required for data taking, about 40 for set-up and test time.

Summary prepared by
R. K. Adair, September 1975

INELASTIC CROSS SECTIONS OF NEUTRONS ON NUCLEI

L.W. Jones, C.A. Ayre, H.R. Gustafson, M.J. Longo, T. Roberts
(University of Michigan)

It is proposed to measure inelastic cross sections of neutrons on complex nuclei over the Fermilab energy range. These cross sections on light nuclei are expected to reflect the rise seen in the nucleon-nucleon cross sections whereas little or no rise is seen in the total neutron-nucleus cross section as the onset of the inelastic screening effect largely offsets the rise resulting from the nucleon-nucleon increase. The inelastic cross sections are relevant in determining the interaction mean free paths of protons and neutrons in various elements.

The experiment would be done in the M3 neutral beam in the Meson Area. Target nuclei would include Be, C, Al, Fe, Cu, Cd, W, Pb and U. Determinations would be accurate to at least 1%. The calorimeter detector of E4 would be used along with other equipment from that experiment. A count in a scintillation counter located between the target and the calorimeter would define an inelastic interaction. All energetic reaction products would pass forward into the calorimeter and the measurement of their total energy would give the energy of the incident neutron. An event with no count in the scintillation counter would be due to an elastically scattered neutron or to one that has not interacted. A monitor would be located in the beam upstream followed by an anticoincidence counter before the target.

It is estimated that 1% cross section data can be collected in 5 energy bins in about an hour. 500 hours are requested for the experiment with control of the beam following parasitic set up and testing.

HIGH SENSITIVITY SEARCH FOR NEW STATES
WHICH DECAY INTO MUONS

D. Garelick, P. Gauthier, M. Glaubman, J. Johnson, M. Mallary,
E. Pothier, D. Potter, M. Ronan, E. von Goeler (Northeastern
University)

This experiment will measure the reaction

$$p + Fe \rightarrow muons + anything$$
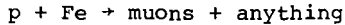
in order to search for new states up to 25 GeV in mass which
decay into two or more muons. A "beam dump" method will be
used with a beam of 400 GeV protons at an intensity of $\sim 10^{10}$
protons per pulse. This method uses a pencil beam, magnetized
Fe and proportional chambers to determine muon angles and
momenta and the effective mass of the muons detected in each
event. In 300 hours of data taking, new states with
$\sigma B \sim 10^{-39}$ cm^2 per nucleon will appear as a 25 event signal.

Summary prepared by
D. Garelick, January 1976

PROPOSAL FOR A NEW MEASUREMENT OF THE
MAGNETIC MOMENT OF THE Λ^0 HYPERON

G. Bunce, R. Handler, R. March, M. Sheaff and L. Pondrom
(Univ. of Wisconsin); K. Heller and O. Overseth (Univ. of
Michigan); T. Devlin and R. Edwards (Rutgers University)

Λ^0 produced at 6 mrad by 400 GeV protons through the
inclusive process p + Be → Λ^0 + anything have a useful average
polarization $\langle \alpha P_\Lambda \rangle = .1$. It is proposed to exploit this polariz-
ation to measure the magnetic moment of the Λ^0 to better than
1%. To do this, the angle of precession of the Λ^0 spin, ω, will
be measured in a 10-foot bending magnet placed in the neutral
beam. A flux of 45,000 Λ^0/hour can be obtained, giving a data
sample of 4 x 10^6 Λ^0 in 100 hours. The error in the precession
angle for $\omega = \pi/4$ is $\delta\omega/\omega = 13/\sqrt{N} = 6 \times 10^{-3}$ for N = 4 x 10^6.
A run of 160 hours is requested.

PROPOSAL TO STUDY Λ^0 POLARIZATION IN THE INCLUSIVE
REACTION p + p → Λ^0 + ANYTHING
WITH A LIQUID HYDROGEN TARGET

G. Bunce, L. Pondrom, R. March, R. Handler and M. Sheaff
(Univ. of Wisconsin); T. Devlin and R. Edwards (Rutgers Univ.);
K. Heller and O. Overseth (Univ. of Michigan)

It is proposed that a 50 cm liquid hydrogen flask be
installed at the hyperon production target to study Λ^0 polar-
ization in pp collisions with 400 GeV protons. Measurements
of $P_\Lambda(X, p_\perp)$ have already been made in p + Be collisions with
sufficient accuracy to establish the effect, but to learn
more about the physical process which causes the polarization
it is necessary to use a proton target and to extend the range
of $p_\perp$ studied. A 150 hour run is requested.

Summary prepared by
L. Pondrom, November 1975

STUDY OF NUCLEAR FRAGMENT EMISSION IN PROTON HEAVY
NUCLEUS COLLISION FROM 10 TO 500 GeV/c

F. Turkot, J. McCrary (Fermilab); J.A. Gaidos, L.J. Gutay,
R.P. Scharenberg, R.B. Willman, T.V. Ragland, P. Leong
(Purdue University)

We propose to measure the double differential cross section
$\frac{d^2\sigma}{d\Omega dE}$ of nuclear fragments ($2 \leq Z \leq 16$), for a given incident proton
momentum, produced by heavy nucleus ($20 \leq Z \leq 80$) collisions in the
10 to 500 GeV/c momentum range. Recent experimental results and
theoretical speculations suggest colletive nuclear motion is
initiated by the passage of a fast proton through a heavy nucleus.
The novel feature of this experiment is the determination of the
energy dependence of the excitation mechanism. Because nuclear
fragments are best studied from thin targets, one needs a very
high beam flux to obtain sufficient event rates. These consider-
ations make the Internal Target Area with a heavy gas jet target
the ideal place to initiate our experimental program. The
detection system will consist of four conventional $\Delta E - E$ semi-
conductor telescopes.

If the measured angular distributions exhibit features
compatible with the nuclear shock wave phenomena or if the
energy dependence of the excitation mechanism for the emission
of nuclear fragments indicates unusual structure, we will propose
to incorporate a time-of-flight capability into the apparatus
and search for abnormally dense nuclear fragments whose existence
could be indicated by anomalous Z/M ratios.

Three to four calendar months of set up and testing time
are requested in the Internal Target Area followed by a three
month period for data taking (400 hours) at ~50% duty cycle.

A PROPOSAL FOR CONTINUED STUDIES OF
HADRON INDUCED μ-PAIRS IN A LARGE ACCEPTANCE SPECTROMETER

K.J. Anderson, G.G. Henry, K.T. McDonald, J.E. Pilcher,
E.I. Rosenberg (Univ. of Chicago); J.G. Branson, G.H. Sanders,
A.J.S. Smith, J.J. Thaler (Princeton)

It is proposed to complete the study of hadron induced μ-pairs as set out in Experiment #331 using the cyclotron spectrometer. For reasons of scheduling and to minimize interference with Experiment #98, the running of Experiment #331 has been restricted to nuclear targets and a positive beam almost an order of magnitude less intense than the spectrometer can handle. The experimenters wish to extend their studies to hydrogen and deuterium targets and to use a higher quality hadron beam into the cyclotron spectrometer.

The physics goals of the experiment remain the same; namely, to study the hadron production of μ-pairs in a large acceptance detector with a minimum of detection biases. They will study the μ-pair production cross section as a function of x_F, p_t and $M_{\mu\mu}$ for incident pions, protons, and kaons. They will also measure the decay angular distribution of the μ-pair state.

Of special interest are the continuum μ-pair characteristics. The experiment claims to be a unique position to study the continuum production by protons, as well as pions of both charges, interacting with free nucleons. These data will provide important constraints to any parton model of the hadrons.

The experiment would use a new one meter long cryogenic target and a beam flux of 10^7 particles per pulse. Such a beam intensity could be obtained during normal neutrino running with the horn system by adding a third split to the primary proton beam and targeting in Enclosure 100. Another possibility is a special neutrino decay pipe triplet recently suggested. It is estimated that this experiment will require about 400 hours of beam time.

Summary prepared by
J.E. Pilcher/A.F. Greene, November 1975

A SPECIAL REQUEST FOR HIGH-PRIORITY RUNNING TO MEASURE HIGH-MASS MUON PAIRS

K.J. Anderson, G.G. Henry, K.T. McDonald, J.E. Pilcher,
E.I. Rosenberg (Univ. of Chicago); J.G. Bronson, G.H. Sanders,
A.J.S. Smith, J.J. Thaler (Princeton)

A request is made for 400 hours or 4 weeks of high priority running in the Neutrino Area to continue work begun in Experiment #331 using the cyclotron spectrometer. During this time use would be made of the quadrupole triplet focusing system to provide positive and negative hadron beams of 225-300 GeV at intensities up to 10^7 particles per pulse. It is asked that this running period occur in Feb.-March, 1976 and that $1\text{-}2 \times 10^{12}$ protons per pulse at 400 GeV be provided.

The new results which would be obtained from this running are:

1. High-sensitivity search for new particles. A sensitivity of about 1 event per 10^{-36} cm^2/nucleon should be possible up to dimuon masses of 15 GeV.

2. Tests of production mechanisms of continuum muons. Using positive and negative beams with an isotopically-symmetric target material, such as carbon, it is possible to test features of various parton models.

3. Detailed study and comparison of continuum and $\psi(J)$ production. Measurement of the density matrix for the $\psi(J)$ and comparison with the continuum should provide information on the mechanism for its production.

4. Other studies will include study of like-sign dimuon events, events with more than two muons, and kaon-induced muon pairs.

Summary prepared by
A.J.S. Smith/A.F. Greene, November 1975

THE DIRECT DETERMINATION OF KAON AND PION FORM FACTORS

Fermi National Accelerator Laboratory, Yale University
C. Ankenbrandt (Spokesperson)

It is proposed to measure the pion and kaon form factors, $F(Q^2)$, at -200, +200 and -150 GeV/c. $F(Q^2) = 1- R^2 Q^2/6...$. Data would be taken simultaneously for both particles.

The experiment would use the equipment of E69 with modifications. The 52 cm LH_2 target is surrounded by veto counters with a small hole in the forward direction. Proportional wire chambers before and after the target measure the angles of the incident particle and both scattered particles to 0.03 mr. A momentum spectrometer further downstream would consist of one of the M6W bending magnets (the second being removed) and proportional wire chambers. The resultant momentum resolution would be 0.22% at 200 GeV/c. Following this is a lead-scintillator sandwich shower counter to measure electrons, and a hadron colorimeter to measure muons, that pass through the spectrometer. The more forward going particle of the two scattering products, meson or electron, will pass through the spectrometer system. In the case of Ke scattering this will always be the kaon. For πe scattering it will be the pion up to $Q^2 \approx 1/2 \, Q_{max}^2$ and, for π⁻e scattering, the electron above that. Since all angles are known as well as the momenta of the incident particle and one of the outgoing particles, a 3C fit will be obtained for each elastic scattering event.

For Ke scattering at 200 GeV/c, for example, the overall range of acceptance is $0.014 \gtrsim Q^2 \leqslant 0.093$ $(GeV/c)^2$. The point-like cross section over this range is 11 μ b; for the region above $Q^2 = 0.05$ $(GeV/c)^2$ it is 0.67 μb. Geometrical acceptance is essentially 100% over the range except at $Q^2 \approx 1/2 \, Q_{max}^2$. Event rates assume a total of 10^6 particles/spill at 8 sec. intervals and an overall safety factor of two. At -200 GeV/c, 3.2×10^4 Ke events would be measured over the full range of Q^2. 2.4×10^5 πe events would also be obtained. The triggering system consists of fast logic and analog circuitry to yield 300 triggers per spill. The experiment would yield R_K to an accuracy of 6% and R_π to 2-3%. A total of 800 hours is requested to run at -200, +200 and -150 GeV/c. New apparatus required would be ready to install in July 1976.

A PROPOSAL TO STUDY $\overline{p}$ - p INTERACTIONS AT 150 GeV/c

Brown Univ., Fermilab, IIT, Univ. of Illinois, MIT, Yale Univ.,
Univ. of Strasbourg, Univ. of Tel-Aviv, Weizmann Inst.
R. Hulsizer (Spokesperson)

We propose an exposure of 0.6 events/μb for antiprotons as close as possible to 150 GeV/c in the FNAL 30-inch Bubble Chamber-Proportional Wire Chamber Hybrid Spectrometer System. We request these exposures as soon as suitably enriched beams of antiprotons are available to the spectrometer system. For a beam with anti-protons consisting of a fraction f of the total beam and eight beam tracks per picture, an exposure of 62,500/f pictures will yield 25,000 events for the study.

An integral part of the proposal is an effort to seek improved methods of obtaining antiproton-enriched beams, and to complete the forward gamma detector now under construction.

The purpose of this study is to gain some insight into the consequences of the difference between the valence quark makeup of protons and antiprotons. This will be accomplished by comparing the interactions proposed here with the p-p interactions being studied at the same energy in E-299. In particular, the availability of the forward gamma detector will enable us to compare the ρ^+, ρ^-, and ρ^0 production in the central region in the two processes. The availability of an external particle identifier would considerably expand the understanding we could gain of the differences between $\overline{p}p$ and other interactions.

Summary revised by
R. Hulsizer, January 1976

PROPOSAL FOR THE
INVESTIGATION OF VIRTUAL PHOTOABSORPTION BY NUCLEAR MATTER

W.A. Loomis, F.M. Pipkin, A.L. Sessoms, R. Wilson (Harvard Univ.);
W. Francis, T.W. Kirk (Univ. of Illinois); T. Quirk,
W.S.C. Williams (Oxford Univ.); H.L. Anderson (Univ. of Chicago)

The behavior of muon-nucleus scattering presents an apparent
paradox which can possibly be resolved by various forms of
Generalized Vector Dominance. The experimental investigation of
the paradox requires that data be taken at very large values of
the scaling parameter

$$\omega = \frac{2 \, M\nu}{q^2}$$

The Muon Scattering Facility is equipped for these studies, and
it is proposed to carry out the investigation.

It long seemed obvious that nuclei should be transparent to
γ rays of any energy, since the total cross section for γ rays
on protons -- 125 μb -- is much less than the "geometric" cross
section of a proton -- 40 mb. Yet measurements made with real
photons with energies greater than a few GeV show that
$\sigma_T(\gamma A)/A \, \sigma_T(\gamma N)$ is much less than 1 indicating opacity. The
opacity is assumed to arise from the existence of the vector
mesons $\rho^0 \, \omega^0 \, \phi^0$, (and now presumably ρ', ψ, ψ' also) which have
the same quantum numbers as the photon, and strong interactions.
At a high enough energy, the mass difference is negligible in
the sense that the photon and a rho meson will stay in phase over
a distance the size of a nucleus, then the photon can appear to
have the strong interactions of the rho meson in spite of the low
total cross section. The critical parameter which separates the
two variables -- transparency and opacity -- is the ratio $k/m_v^2\lambda$
where k is the γ ray energy, λ is the absorption length of the
vector meson in nuclear matter and m_v is the mass of the vector
meson. When this parameter is large compared with unity, nuclei
will show shadowing; when small, transparency. Theory suggests
that the shadowing effect should disappear as ω decreases.

More proportional chambers will be added to the E98 apparatus
including some in the middle of the magnet at some distance from
the target. It is proposed to run the experiment with three
nuclear targets: beryllium, copper and lead. These data will be
combined with the deuterium data of E98. In order to see the
shadowing effect clearly, and in particular to see many rho muons,
the proponents would like to have about 20,000 events on each
target (3% statistics in each of 10 ω bins). A beam of 5 x 10^5
per pulse is requested for 285 hours (or 8 x 10^{10} muons at 150
GeV/c) with the best possible duty cycle. The experiment could
be performed anytime after the completion of E398.

A Proposal to Measure Coulomb
and
Diffractive Production of K*,K̄*

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Michigan State University

H. R. Barton, Jr., N. W. Reay, N. R. Stanton
The Ohio State University

K. W. Edwards
Carleton University

We will measure the production of $K*_{890}$, $\bar{K}*_{890}$ using the K°_{L} component of a hardened M-3 beam incident on a variety of targets from C to U. Using the Primakoff effect this will permit extraction of the radiative width of the K*(890) and possibly K*(1420). These measurements yield important tests of quark and SU_3 models. Measurements will cover the range $0 \lesssim t \lesssim .1$ GeV/c² and $30 \lesssim p \lesssim 140$ GeV/c. The apparatus will be a vee spectrometer with point to parallel focusing using two Cerenkov counters to identify decay products.

We request of Fermilab a BM109 magnet shimmed to 10", absorbing material LiH or (Be) 2.4 m (1.1 m) remotely movable, a Bison PDP 11/45 system, $85,000 of PREP equipment, a 6" I.D. by 5 m vacuum decay pipe. Initial running time requested is 600 hours with 3×10^{12} 400 GeV protons on the meson target.

Maris A. Abolins
March 25, 1976

NEW PARTICLE PHYSICS AT THE TAGGED PHOTON LABORATORY

D. Caldwell, J. Cumalat, A. Eisner, R. Morrison, F. Murphy,
S. Yellin (Univ. of Calif., Santa Barbara); P. Davis, R. Egloff,
G. Luste, J. Prentice (Univ. of Toronto); T. Nash (Fermilab)

It is proposed to continue a study of ψ(J) and ψ' photo-production on deuterium that was begun during the summer of 1975 as a test of the apparatus and tagging system for Experiment #25A. Interest is shown by the experimenters in a continuation of this work to include a running period of 400-800 hours with 3×10^{12} protons/pulse at 400 GeV. With an event rate under these conditions of 1.3 ψ(J) events per hour it is expected to obtain a minimum of 500 ψ(J) events and possibly 20 ψ' events.

The specific goals of this experiment are:

1. Measurement of the photoproduction cross section of ψ(J) on deuterium as a function of energy from about 35 GeV to 130 GeV.

2. Measurement of the elastic part of the ψ(J) cross section as a function of energy and of momentum transfer.

3. Determination of the ψ' photoproduction cross section.

4. Search for new photoproduced high mass states which decay into electrons, photons, and π^0's including heavy leptons possibly.

The experiment would use equipment currently set up in the Tagged Photon Laboratory. The necessary apparatus for these measurements includes a deuterium target surrounded by twelve "barrel stave" recoil detectors, multi-wire proportional chambers used to measure electrons from, for example, the decay $\psi(3.1) \rightarrow e^+e^-$. A lead-glass array for identifying showers from electrons or π^0's and a hadron calorimeter will then follow. Most all of this equipment is required for use in the already approved Experiment #25A where measurements will be made of the photon total cross section into hadrons.

Summary reviewed by
D. Caldwell, January 1976

STUDY OF THE A-DEPENDENCE OF INCLUSIVE PROCESSES AND ASSOCIATED MULTIPLICITY

Bari Univ. (Italy): C. DeMarzo, L. Guerriero, P. LaVopa, G. Maggi,
F. Posa, G. Selvaggi, P. Spinelli, F. Waldner; Brown Univ.: D. Cutts,
R. Dulude, R. Lanou, Jr., J. Massimo; FNAL: A. Brenner, D. Carey, J.
Elias, G. Mikenberg; MIT: W. Aitkenhead, D. Barton, G. Brandenburg,
W. Busza, J. Friedman, P. Garbincius, H. Kendall, B. Nelson, L. Ro-
senson, W. Toy, R. Verdier, C. Young; HEPL (Warsaw, Poland): I.P. Zie-
linski.

It is proposed to study the A-dependence of inclusive reactions over
a wide range of kinematics using the M-6 single arm spectrometer facility
along with a detector for π^0's produced at large p_t. The multiplicity de-
tector of experiment E118A will be used to obtain the associated charged
multiplicity and pseudo-rapidity distribution associated with each event.

The principal objective is to explore these processes over a wide range
of A, x, and p_t. In particular, we will run at 175 GeV/c with π^+, K^+, and p,
incident on H_2, Be, Al, Cu, Sn, and Pb. We will obtain data on the A-
dependence of the inclusive distributions of π^+, K^+, and p^+ produced from
these targets for values of x from 0.1 to 0.95 and from $p_t \approx 0$ to $p_t \approx 1.25$.
Simultaneously data will be obtained for the inclusive π^0 distribution for
$1.0 \lesssim p_t \lesssim 4.0$. Statistical errors will range from about 2% at the smallest
transverse momenta to about 15% at the largest transverse momenta. The
running time needed for this program is estimated to be 500 hours plus 100
hours for setup and testing.

The π^0 detector will consist of an array of lead-glass preceded by a
shower hodoscope of lead-scintillator construction. It will subtend 20 mster.
between 70 and 210 mr. in the lab. The transverse momentum of the π^0 will be
determined to about 10%. Cronin et al. and Lederman et al. have shown that
the A-dependence of the inclusive π^0 cross section increases from $A^{2/3}$ to
$A^{4/3}$ going from $p_t \approx 0$ to $p_t \approx 4$, a result which is totally unexpected from
current models. We will be able to measure the correlation of this pheno-
menon with the associated multiplicity and incident particle type.

This measurement will provide extensive information on leading particle
effects in inclusive production from nuclei. All current models predict a
weak A-dependence for the leading particle. In addition, spectrometer
events with $x \lesssim 0.3$ should show the onset of the strongly A-dependent part
of the rapidity distribution. The position of this feature as a function of
energy is a crucial test for some models. The substantial particle identi-
fication power of the SAS facility will allow simultaneous measurement of
all combinations of π^+, K^+, and p^+ in the beam and in the spectrometer. In
this way, the dependence of the hadron-nucleus cross sections and multipli-
cities on the identity of the incident and produced particle may be compared.

PROPOSAL FOR A STREAMER CHAMBER FACILITY
TO STUDY ψ PRODUCTION

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K. Moriyasu (Univ. of Washington), J. Bartke, A. Eskreys,
P. Malecki, K. Zalewski (Inst. of Nuclear Physics, Krakow)

From Fermilab experiments it is known that the ψ (3.1)
appears to be produced centrally at small x in hadronic reactions,
but almost nothing else is known about the reaction mechanism.
It has been proposed that the ψ mesons are evidence for the
existence of a new quantum number (charm) which should result in
new multiplets of charmed resonances. The failure of the first-
round of searches to find these resonances clearly indicates the
importance of a detailed study of the ψ production mechansim at
Fermilab energies with both pion and proton beams.

It is proposed to study the reaction $\pi^-(p) + p \to \psi$ + anything
using a streamer chamber with a hydrogen target. The streamer
chamber provides the detection efficiency necessary for studying
the charged particles produced in association with a ψ meson.
The trigger will be provided by two muons whose invariant mass
is greater than $\sim$ 1 GeV. In order to perform this experiment it
is proposed to construct a new streamer chamber. This new chamber
and the magnet into which it would be placed would provide a
useful detector for many experiments.

The apparatus consists of a 2 x 1 x 0.6 m^3 streamer chamber
inside a new superconducting magnet of 40 kilogauss meters.
A magnetized iron absorber will be placed downstream of the
streamer chamber. The trigger for the experiment will be muons
from the decay ψ (3.1) $\to \mu^+\mu^-$, with the two muons detected in
hodoscope arrays and identified with fast electronics.

The experiment would utilize a charged hadron beam with
energies greater than 100 GeV and intensities of 10^6 particles
per pulse. A downstream location in the M1 beam in the Meson
Area seems preferable. Estimates of required running time to
obtain 2,000 ψ (3.1) events are one month or about 400 hours.

Summary reviewed by
H.J. Lubatti, January 1976

A PROPOSAL TO CONTINUE DIRECT MUON PRODUCTION
IN THE FORWARD DIRECTION

D. Buchholz (Northwestern), H.J. Frisch, M.J. Shochet (Univ. of Chicago), R.P. Johnson (Fermilab), R.L. Sumner (Princeton), O. Fackler, S.L. Segler (Rockefeller)

The origin of direct lepton production is as yet not understood. The phenomenon was first discovered at large values of $p_\perp$ ($p_\perp > 1.5$ GeV/c), a kinematic region which itself is not well understood. Questions of the s, x, and $p_\perp$ dependence of the direct muon to pion ratio still exist almost two years after the publication of the first Fermilab results. Recently these experimenters have completed the first measurements of the direct muon production at very low $p_\perp$, i.e. $p_\perp \lesssim 0.4$ GeV/c. These measurements were made during a short period of data-taking for Experiment #335 at Fermilab in the M1 beam of the Meson Area.

A brief summary of the results and their significance is presented here:

1. In 300 GeV proton-Uranium collisions the ratio of direct muons to pions is larger at $p_\perp \leq 0.4$ GeV and x = 0.3 than for $p_\perp > 1.5$ GeV at x = 0.

2. The ratio μ^-/π^- is smaller at x = 0.5 than at x = 0.3; i.e., the direct muon production is steeper in x than the pion production.

3. Equal numbers of direct μ^+ and μ^- are created, although far more π^+ are created than π^-. This is consistent, for example, with the direct muons (or their parents) being created in pairs.

These results seem to rule out heavy vector mesons as the source of direct leptons. They are consistent, however, with the many-body semi-leptonic decay of a heavy particle, or with either lighter vector parents or continuum creation of the muons.

It is proposed to improve and extend these measurements in either the M1 or M2 beam operated as a normal charged secondary beam at 200 GeV/c with 5×10^{12} particles/pulse. The target and forward spectrometer would be moved to the Meson detector building. The apparatus will contain an upstream Cerenkov counter to identify beam muons, a variable density target, and a downstream absorber. The downstream spectrometer will have two EPB dipoles with multi-wire proportional chambers on either side. A steel muon identifier is placed at the end of the apparatus.

The request for running time includes 200 hours for tuning and background studies and 400 hours for data-taking.

Summary prepared by
H.J. Frisch/A.F. Greene, October 1975

EXPERIMENT TO MEASURE DEEP INELASTIC ELECTRON SCATTERING ON HYDROGEN AND DEUTERIUM WITH SEPARATION OF νW_2 AND W_1 NUCLEON STRUCTURE FUNCTIONS, AT THE HIGHEST FERMILAB ENERGIES AND Q^2 REGIONS

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R. Hofstadter, T.P. McPharlin, M.R. Yearian (Stanford Univ.
HEPL), B.C. Cox, J. Peoples Jr. (Fermilab)

The physics objective of the experiment is to measure inclusiv‹ deep inelastic electron-nucleon scattering cross sections by e^- and e^+ beam bombardment on 24" long LH_2/LD_2 targets at 150 GeV (5 x 10^8 $e^{\pm}$/pulse), 175 GeV (3.6 x $10^8 e^{\pm}$/pulse) and 250 GeV (1 x $10^8 e^{\pm}$/pulse beam energies. Cross sections will be measured in the range of $Q^2 = 0.16$--160 (GeV/c)^2 and in the range of hadronic mass squared $W^2 = 2$--450 GeV^2. The nucleon structure functions $\nu W_2{}^p, W_1{}^p, \nu W_2 n, W_1{}^n$ will be measured and separated in large (Q^2, W^2) regions, based on values of the polarization parameter ε spanned by the three beam energies. The influence of any two-photon-exchange effects will be identified by measuring the asymmetry in $\sigma(e^+p) - \sigma(e^-p)$ as a function of Q^2. The scaling behavior and variation of the four nucleon structure functions will be determined by direct measurements and separation in unexplored Fermilab kinematical regions. Unresolved differences between the scaling behavior of proton and neutron form factors will be elucidated.

Based on the enhanced synchrotron radiation compensated beam line tuning technique, the Proton-West pion beam will be used to produce at no additional cost a clean electron beam. The experimental apparatus of E-192 at the Proton-West Experimental Hall will be used with addition of an electron arm and a minor repositioning of spectrometer arms I and II, designed to intercept with optimum acceptance scattered electrons in a large (Q^2, W^2) domain, thereby obtaining excellent information on the tracking and identification of these electrons with powerful resolution in the variables Q^2, W^2 and $\omega' = 1 + W^2/Q^2$. The experiment has a built-in self-calibration scheme, whereby all target-associated and beam-associated backgroun‹ occuring in a limited (Q^2, W^2) domain are subtracted by simple experimental calibration runs. There are no event rate, data rate, or background rate limitations in the experiment. Requested total running time, spread over three beam energies is 1500 hr: e^-p 450 hr, e^-d 450 hr, e^+p 300 hr, all experimental calibrations 300 hr.

Since the changeover both in beam and apparatus between E-192 and #454 can be made quickly, the experimenters propose to run this experiment and E-192 in interleaved periods of running time, so that they can perform quick, efficient comparisons of results, probing via respective experiments both space-like and time-like Q^2 regions at the highest and as yet unexplored kinematical domains.

BUBBLE-CHAMBER STUDY OF DIMUON PRODUCTION BY
NEUTRINOS USING THE PHASE-2 EMI AND A DICHROMATIC BEAM

R. J. Cence, F. A. Harris, S. I. Parker, M. W. Peters, V. Z. Peterson,
V. J. Stenger (Hawaii); A. Barbaro-Galtieri, P. H. Eberhard, G. R. Lynch,
J. P. Marriner, and M. L. Stevenson (LBL)

Improved knowledge of dilepton (especially dimuon) production by
neutrinos would become available using the combined advantages of the
15-foot bubble chamber filled with neon-hydrogen (30% atomic fraction),
the new horn dichromatic beam, and the proposed improved EMI. EMI
selection of dimuon events (100 dimuons per 200K pix) does not require
film scanning but the selected bubble-chamber photographs permit detailed
event analysis. Knowledge of neutrino energy should reduce ambiguities.

Other dilepton (e.g., e-μ) events would also be sought and should
occur in yields comparable to μ-μ but will require a complete film scan.

MEASUREMENT OF THE KAON FORM FACTOR

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T. Nigmanov, E. Tsyganov, A. Vodopianov (Dubna); T. Tompkins,
T. Toohig, A. Wehmann (Fermilab); J. Poirier, C. Rey, R. Wojslaw
(Univ. of Notre Dame); P. Shepard (Univ. of Pittsburgh)

The objective of this experiment is to measure the charged
kaon electromagnetic form factor in the spacelike region of
momentum transfer by direct observation of kaons scattered from
a kaon beam by stationary electrons in a liquid hydrogen target.

A determination of the kaon radius is possibly only by such
a direct elastic scattering process. The data will be taken with
a 250 GeV beam in which the beam kaons are selected by differential
Cerenkov counters. Both the kaon and electron will be detected
with nearly 100% efficiency for momentum transfers from 0.03 to
0.13 $(GeV/c)^2$. With 500 hours approved for testing and data
taking, we anticipate 6000 K-e scatters. Systematic errors can
be held to 1% and a precision of 0.04 $(Fermi)^2$ for the determin-
ation of the mean square kaon radius can be obtained.

The apparatus is the narrow-angle, high resolution spectro-
meter in the M1 West beam line used for the pion form factor
experiment E-216. The resolution will be upgraded by the use of
drift chambers. The spark chambers behind the magnets will be
replaced by proportional wire chambers. The trajectory of the
incident kaon entering a 50 cm long liquid hydrogen target and
the scattering angles and momenta of the recoiling K-e pairs will
be measured by a combination of drift chambers and proportional
wire chambers with the aid of two bending magnets (two BM109's
with 8" x 24" aperature and 70 kg-m field integral). Identifi-
cation of K-e scatters and momentum transfer determination will
be carried out through kinematic analysis of the recoiling
particles made possibly by the high angular precision of the
apparatus. A redundancy check on the electron is supplied by
an electron identifier incorporating total absorption Pb-glass
shower counters. Any μ-e events are rejected in a muon filter.

Efforts will be made to achieve a low kaon trigger rate.
If these efforts are successful, pion-electron scattering data
will be taken in order to provide a direct comparison of the
pion and kaon form factors consistent with the primary goal of
the experiment.

Summary prepared by
D. Stork, April 1976

SEARCH FOR μ's, K⁰'s OR CHARACTERISTIC HADRON SIGNATURES
AND MASSES IN COINCIDENCE WITH SINGLE DIRECTLY PRODUCED ELECTRONS

MIT, Brown University, Bori University
G. Brandenberg (Spokesman)

It is requested that consideration be given to tests which
would eventually lead to a formal proposal for the cyclotron
spectrometer in the muon/hadron beam of the Neutrino Area. The
experiment itself would be a search for events containing a
directly produced charged lepton (e or μ) with the expectation
of seeing the topology, character, and energy distribution in
these events. The objective in this is to ensure that the
events contain a rich sample of new particles decaying to
leptons. Included in this sample are also production of pairs
of leptons, such as e^+e^-, $μ^+μ^-$ or $eμ$.

At this time the experimenters are requesting approval of
tests related to the rejection of Dalitz pair electrons, a
large background to the reactions of interest. These tests
can be described as follows:

1. Study of the ability to follow tracks measured only
    within the cyclotron magnet and finding a common
    vertex. This would require moving the presently
    existing 1 m x 1 m proportional chambers to new
    locations inside the magnet.

2. Measurement of the detection efficiency and unambiguous
    spatial measurement of photons in magnetostrictive spark
    chambers. These chambers would have lead sheets
    interleaved between them.

To carry out these tests the experimenters request use of
the cyclotron spectrometer and permission to reconfigure portions
of the apparatus. Actual running will require 100 hours with
a 100 GeV pion beam incident on a solid target.

Summary prepared by
A. F. Greene, November 1975

PHOTOPRODUCTION EXPERIMENT AT FERMILAB

B. Knapp, W. Lee, P. Sokolsky, W. Wisniewski (Columbia Univ.);
G. Gladding, R. Messner, T. O'Halloran, A. Wattenberg (Univ.
of Illinois); M. Binkley, I. Gaines, R. Orr, J. Peoples
(Fermilab)

We propose to continue and extend the study of photo-
production of massive 1⁻ objects and the photoproduction of
pairs of new particles with much improved detector. The main
improvements are: 1) the geometric acceptance of the detectors
is increased from ~±30 mrad to ~±150 mrad thereby making it
possible to momentum analyze charged particles produced at
large angles ($\theta > 60$ mr); 2) momentum resolution of high energy
tracks has been improved leading to improved mass resolution
through the use of drift chambers and a stronger magnetic field;
3) γ ray directions as well as γ ray energies are measured
making it possible to measure the mass states of π^0, η^0, and
γ's; 4) the charged particles are separated into $\pi^\pm/K^\pm/p^\pm$ in
certain momentum ranges by gas Cerenkov counters.

The primary objectives of the proposed experiment are
1) to study the interaction dynamics of the known massive
vector mesons, ψ, ψ', and ψ'', and to search for new massive
vector mesons; and 2) to search for the photoproduction of
heavy lepton pairs. We also plan to improve significantly
our previous search for charmed particle pairs.

We request the use of the broad band photon beam with
the additional steel shielding in EE-4 as requested by E-401.
The proton beam intensity is required to be between 3×10^{12}
and 5×10^{12} protons. We request 300 hours of test time to
debug the detector and 600 hours of time for data taking.

Search for New Phenomena Associated with
High Enegy Neutrinos Using the Quadrupole Triplet Beam

U. Camerini, D. Cline, W. F. Fry, J. von Krogh, R. Loveless,
J. Mapp, R. March, D. D. Reeder(Univ. of Wisconsin);
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It is proposed to take one million pictures of high energy
neutrinos in an approximately 20% mixture of neon and helium
using the Fermilab 15-foot bubble chamber exposed to the quad-
rupole triplet focussed neutrino beam with the external muon
identifier. Experience in Experiment #28A has shown that the
capability of recording and analyzing high multiplicity, multiple
gamma conversions, secondary neutron interactions, and high energy
electrons makes this instrument uniquely useful in searching for
new phenomena in neutrino interactions.

The principle advantage in using the quadrupole triplet beam
is that a greater proportion of the events occur at high energy
(i.e. >35 GeV) allowing a fast and more efficient analysis of the
characteristics at high energy. The results of the counter
neutrino experiment indicate that new phenomena are very likely
to occur at high energy. A 20% neon/hydrogen mixture makes
possible the detection of high energy electrons from the primary
vertex. For a substantially higher density of neon, this
detection efficiency will be much worse due to a confusion of the
primary with secondary vertices from interactions and radiation
losses.

The main emphasis of the analysis of this experiment will be
on the following:

1) Neutrino interactions producing $\mu^- e^+ K^0$ in the final state.
There is a need for more events like those seen in Experiment #28A
in order to understand the nature of the phenomena producing these
particles. There is also indication from the earlier exposure
that this production may be energy dependent. Thus use of the
quadrupole triplet beam will help this study.

2) Study of neutrino interactions with two muons in the final
state. Searches will also be made for strange particles associated
with these events.

3) Search for new phenomena associated with high energy
neutrino interactions. This may include a final state $\mu^- e^+$
with multiple strange particles or $\mu^- e^+ e^-$ events where the $e^- e^+$
are not associated with electromagnetic phenomena. Other
possibilities are neutrino interactions with a final state $e^+ e^-$
or neutral current interactions producing a final state $e^+ K^0$.

The exposure could be made with a horn-focussed neutrino beam.
However, there are advantages to using the quadrupole triplet
system, related particularly to studies of energy dependence and
use of the EMI to identify final state muons. It would be
acceptable to the experimenters to obtain exposures using both
types of focussing systems. Then a comparison could be made of
the advantages of each beam.

PROPOSAL TO STUDY DILEPTON NEUTRINO INTERACTIONS WITH THE
TRIPLET QUADRUPOLE BEAM, THE PHASE I EMI, AND THE 15'
BUBBLE CHAMBER FILLED WITH A H-Ne MIXTURE

R. Harris, F. R. Huson, S. Kahn, T. Murphy, W. Smart   (Fermilab);
R. J. Cence, F. A. Harris, S. I. Parker, M. W. Peters,
V. Z. Peterson, V. J. Stenger   (Univ. of Hawaii);
A. Barbaro-Galtieri, G. Lynch, J. Marriner, M. L. Stevenson   (LBL)

     It is proposed to study dilepton neutrino events in the
15-foot bubble chamber using the quadrupole triplet beam.
The bubble chamber would be filled with at least 80% neon
by volume (a 15-ton fiducial target). The external muon
identifier (EMI) would be rearranged into two planes and
would have additional absorber inserted in it. With the
additional absorber and the heavy neon mixture about 8-10
absorption lengths would be available for muon identification.
A double plane will also enable a time coincidence to be
used in identifying the muon tracks. Thus it should be
possible to reduce hadron punch-through to less than 0.1%.
The neutrino beam would be produced with a 1 msec. spill
in order to reduce backgrounds in the EMI.

     The emphasis of the analysis for this experiment would
be on neutrino interactions with a dimuon or a muon-electron
in the final state. It is estimated that about 2% of the
dilepton production will be from antineutrino interactions.
The experimenters request a total of 200,000 pictures. From
these there should be available 300 dimuon events and an
equal number of muon-electron events.

                              Summary prepared by
                              F.R. Huson/A.F. Greene, March 1976

SEARCH FOR "NEW" PARTICLES
FROM 400 GeV PROTON COLLISIONS IN EMULSIONS

D.C. Peaslee (Australia National Univ.); P.C.M. Yock (Univ. of
Auckland); V.D. Hopper (Melborne Univ.); L.S. Peak (Sydney Univ.);
A.G. Fenton (Univ. of Tasmania); <u>J.J. Lord</u> and Richard J. Wilkes
(Univ. of Washington)

It is proposed to expose stacks of nuclear track emulsions
to protons of 400 GeV. The emulsions will be examined by the
method of area scanning for nuclear interactions. Each inter-
action will be examined for evidence of unstable particles
having lifetimes between 10^{-17} and 10^{-12} second. Direct evidence
for particles of these lifetimes is not possible in bubble
chambers but the high resolution of the nuclear emulsion makes
the proposed experiment feasible.

Summary prepared by
J. J. Lord, November 1975

SEARCH FOR SHORT LIVED PARTICLES PRODUCED BY
400 GeV PROTONS IN EMULSIONS

W. Bozzoli, P. Capiluppi, A. Forino, R. Gessaroli, G. Giacomelli,
P. Lugaresi-Serra, A. Quareni and F. Rimondi (Universita di
Bologan); S. Di Caporiacco, A. M. Cartacci and M. G. Dagliana
(Universita di Firenze)

This is a search for short-lived particles with lifetimes
in the range of 10^{-12} - 10^{-14} sec., performed with 400 GeV
protons in emulsion nuclei. As in experiment No. 419, the
signal would be a neutral or charged decay (of possibly two
decays) close to the primary proton-nucleus interaction.

We have exposed one stack of Ilford G5 emulsions, of 80
plates of 5 x 10 x 0.6 cm^3, to 400 GeV protons with a density
of about 3 x 10^4 protons/cm^2, with a total exposure of 1.2 x 10^6
incident protons over an area of 5 x 8 cm^2.

The experiment should be sensitive to the production of
new particles if they have a mass of 1 - 10 GeV and if their
proeuction cross section is larger than 1 μb.

Summary prepared by
G. Giacomelli, January 1976

THE INTERACTIONS OF PROTONS IN NUCLEAR EMULSION
AT 400 GeV/c (OR 500 GeV/c)

M.I. Adamovich, P.A. Cherenkov, N.A. Dobrotin, M.I. Tretjakova
(Alma-Ata - Leningrad - Moscow - Tashkent Collaboration)

A request is made for an exposure of two or three emulsion
stacks to a beam of 400 GeV/c (or 500 GeV/c) protons at Fermilab.
The interest in this exposure is based on the following:

1. A study of high energy proton-proton and proton-nucleus
    interaction and comparison with predictions from a
    theoretical model.

2. Measuring the energy dependence of the cross sections for
    production of one or more charged particles in proton-
    nucleon and proton-nucleus interactions.

3. A study of distribution of intervals of the rapidity,
    containing K-1 particles (k=1 2...n-1, n-multiplicity)
    for a fixed n.

Similar analysis has originated from exposures by this
group at Serpukhov and Fermilab and there is important to
compare the results with the higher energy data.

Summary prepared by
M. I. Tretjakova, October 1975

A proposal to study diffractive processes in K$^+$p

interactions at 150 GeV/c

F. Grard, V.P. Henri, P. Herquet and R. Windmolders
(Faculté des Sciences, Université de l'Etat, Mons, Belgium)

An experiment is proposed with the FNAL 30" bubble chamber proportionnal wire hybrid system exposed to an enriched K$^+$ beam of 150 GeV/c. The number of pictures requested is $\frac{100.000}{R}$ (R = K$^+$/contaminant ratio) to provide about 10.000 K$^+$p interactions, corresponding to a statistics of 0.5 event/μb.

Besides other points of physics interest (topological cross-sections, elastic scattering, various inclusive analysis...) the main objective will be the study of diffractive processes in inclusive reactions such as

$$K^+p \rightarrow pX \qquad\qquad (1)$$
and $\quad K^+p \rightarrow K^+X \qquad\qquad (2)$

as well as in 4body and 6body exclusive reactions, of which a significant number of 4C fits are expected. Tests of factorization will be possible by comparison with data from different interactions.

Identification of fast outgoing kaons is required for the analysis of reaction (2).

An automatic film measuring device (SWEEPNIK) will be available for this experiment.

The group is ready to collaborate with groups interested in the same experiment. (see proposal n° 375).

PROPOSED CHARM SEARCH WITH MUON TRIGGER

U. Becker, J.D. Burger, M. Chen, R. Forber, F. Heimlich,
D. Luckey, D. Novikoff, W. Toki, M. Weimer (MIT); D. Lowenstein
(Brookhaven)

It is proposed to add a muon detector system to a double
arm spectrometer (E-372) to search for (charm) pair production
with high sensitivity. Should the newly discovered particles
$J(3.1)$ and $\psi(3.7)$, etc. be explained as particles of hidden
charm content, mesons and baryons with quantum number charm = ±1
must exist. They may be produced in pairs:

$$p\,p \;\rightarrow\; D\,\bar{D} \;+\; X$$

$$\qquad\qquad \hookrightarrow K\pi \text{ or } K^-p \text{ if baryon}$$

$$\qquad\qquad\qquad\longrightarrow K\mu\nu \text{ or } \Lambda\mu\nu$$
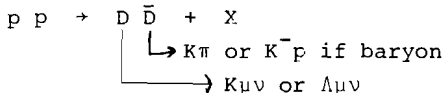
An event selection for $K\pi$ with a μ as fragment from the other
charm partner will be a selective trigger for this reaction.
The rate is strongly energy dependent rising a factor of ~100
from BNL to FNAL energies.

The muon detector is based on one used at BNL. It would
use 20 tons of uranium absorber. It could operate under intense
hadron fluxes, detect muons with CM momentum $\geq$ 700 MeV/c, cover
a large solid angle and absorb kaons and pions near the target
to reduce background muons. A proton beam of 4×10^{10} per pulse
on a 2% collision length target is assumed.

A test set up is proposed for the spring of 1976 in the
proton center beam. (No specific request for hours is made.)

Summary prepared by
W. Baker, May 1976

A PROPOSAL FOR THE STUDY OF HIGH-ENERGY REACTION MECHANISMS BY THE
MEASUREMENT OF THE ANGULAR AND ENERGY DISTRIBUTIONS OF NUCLEI
RECOILING FROM TARGETS BOMBARDED WITH 200-500 GeV PROTONS

S. B. Kaufman, E. P. Steinberg, B. D. Wilkins, D. Henderson
Chemistry Division, Argonne National Laboratory, Argonne, Illinois

and

N. T. Porile, D. Fortney
Chemistry Department, Purdue University, Lafayette, Indiana

and

N. Sugarman, S. K. Chang, A. Turkevich, R. A. Johns, J. LaRosa
Chemistry Department, University of Chicago, Chicago, Illinois

and

L. Winsberg
Physics Department, University of Illinois, Chicago Circle, Chicago, Illinois

The angular distribution and the range distributions at specific angles
will be measured for radionuclides which recoil out of a thin uranium target
under 400-GeV proton bombardment. These data will be analyzed in terms of
the momentum transferred to the target nucleus by the incident proton and
compared with similar measurements made at lower bombarding energies. The
goal is to learn if the forward momentum transfer to the nucleus actually
decreases with increasing bombarding energy, as indicated by integral-recoil
measurements.

The apparatus is an evacuated scatter chamber containing the thin
(ca. 0.1 mg/cm^2) target and aluminum foils to catch recoiling nuclei. The
beam requirements are 2 x 10^{12} protons/pulse in a spot size of 4 mm. A
total of 500 hours, divided into individual runs lasting 24-48 hours, and
separated by 1-2 month intervals to allow for following the sample decay
curves are requested.

Sheldon B. Kaufman
March 19, 1976

Cross section for $^{Z}A(\mu,p,n)^{Z+1}A$ on ^{37}Cl and ^{205}Tl

Melvin S. Freedman, Charles M. Stevens, Argonne National Laboratory, and
Raymond Davis, Jr., John Evans, Brookhaven National Laboratory

In the solar neutrino flux measurements via neutrino capture on ^{37}Cl of
R. Davis, Jr. and that (proposed) on ^{205}Tl by ANL, the reactions of the
title generated by energetic cosmic ray muons are the principal competitive
reactions producing a background of the same isotope (^{37}Ar or ^{205}Pb) as
does the neutrino capture. The goal of experiment P-467 is a refined evaluation
of the background in both neutrino capture experiments.

By a simultaneous irradiation of 1 kilogram targets of Cl and Tl in the muon
spill beam behind experiment 319, the muons first passing through a concrete
proton generator, followed by off-line analysis at ANL and BNL for the product
isotopes, the relative effective cross sections for the (p,n) reactions will
be measured. Calibration of the muon beam by short initial photographic plate
exposure, followed by muon track counting, and on-line beam monitoring by a
pair of scintillator paddles in coincidence, will yield an absolute cross
section for each reaction. The muon energy range of interest is 100-300 GeV,
whatever is chosen for experiment 319.

We require of the order of 10^{11} muons, corresponding to ca. 100 hours of beam
time, as planned for experiment 319. The target mounts, in sealed containers
(C_2Cl_4, liquid, and Tl metal) will be housed, along with the electronics and
detectors (provided), in a weatherproof wooden cubicle (provided) immediately
behind two stacked 3' cubical concrete blocks (request of FNAL) behind the muon
building. The concrete blocks serve as muon → proton converters, simulating
rock in the underground environment of the neutrino-capture experiments.

We request the assistance of the FNAL muon beam monitoring personnel in
initially locating the muon beam at target setup time. We also request a
110 V.A.C., 1 KW extension power line to our irradiation cubicle, about 30' N.
of the muon buildings.

SEARCH FOR PENETRATING MASSIVE NEUTRAL PARTICLES
PRODUCED IN HIGH ENERGY PROTON COLLISIONS

C. Y. Chang, R. W. Ellsworth, E. Sager, P. H. Steinberg
University of Maryland

We propose to search for long lived neutral heavy
leptons produced in high energy proton interactions in a
beam dump. We request the use of the E-8 hyperon beam
magnet as the beam dump. The strong magnetic field is
essential for sweeping out most of the penetrating muons
produced in the hadronic showers. The heavy leptons would
be detected through their decays in a 50 foot downstream
decay region.

We are requesting 1000 hours for data taking and 200
hours for equipment testing. The M-2 beam would be tuned
to 400 GeV protons (i.e. $x = 2P_T/\sqrt{s} \sim 1$) and with an intensity
of 10^9 protons/pulse we expect 10 events/nb/hr.

SEARCH FOR HEAVY LONG-LIVED PARTICLES

C. DeMarzo, L. Guerriero, P. La Vopa, C. Maggi, F. Posa, C. Selvaggi, P. Spinelli, F. Waldner (Bari); D. Cutts, R. Dulude, R. Himmer, R. Lanou, J. Massimo (Brown); R. Meunier (CERN); A. Brenner, D. Carey, J. Elias, C. Mikenberg (FNAL); W. Aitkenhead, D. Barton, G. Brandenburg, W. Busza, J. Butler, J. Fines, J. Friedman, P. Garbincius, H. Kendall, T. Lyons, B. Nelson, L. Rosenson, W. Toy, R. Verdier, C. Young (M.I.T.)

Utilizing the existing apparatus and unique properties of the M6E beam – Single Arm Spectrometer we propose a relatively short experiment which will search for stable and long-lived particles which:

   a) improves sensitivity over previous experiments by two orders of magnitude;

   b) extends the energy range of such searches at FNAL to 400 GeV;

   c) is sensitive to masses over a range from 1 GeV to nearly the kinematic limit without exclusion of fractional or multiply-charged particles;

   d) studies the particles (especially in the 2 GeV "antideuteron" peak) as to their hadronic interaction.

To determine mass we use both Cerenkov counter and standard time-of-flight techniques. Five threshold and three differential Cerenkov counters are presently available and in place; with this number we can have a light particle veto with inefficiencies $\sim 10^{-10}$ and keep 5 counters free for mass measurements of heavy particles. A muon detector has already been added to the Single Arm Spectrometer, so the only equipment required for this experiment not already in place (and tested) is a small number of time-of-flight counters.

We request 50 hours of setup time and 100 hours of running time with standard targeting. Under these conditions we will inspect $\sim 10^{10}$ light particles of both signs. With the usual parametrization of the light particle cross section[†], this total flux corresponds to an upper limit for heavy particle production of $\sim 4 \times 10^{-5}$ µb/GeV/c-ster., per nucleon.

[†]Wang, Phys. Rev. D7 (1973) 2609.

A Measurement of the A-Dependence of Hadron Production

J. Hartmann, J. Orear, J. Vrieslander - Cornell University

S. Conetti, C. Hojvat, D.G. Ryan, D.G. Stairs, J. Trischuk - McGill University

M. Gettner, W. Faissler, J. Johnson, D. Potter, E. Pothier - Northeastern University

Objectives:

The objective of this experiment is to measure the yield of positive hadrons produced by collisions of high energy protons with several nuclear targets distributed throughout the periodic table. The measurements will be made at large Pt (from 2 GeV/c to 6 GeV/c) and extend to the kinematic boundary. In addition to the dependence of the production cross section on atomic number, the yield from hydrogen will be determined as a function of $X_\perp$ and $X_\parallel$.

Present data is limited to regions near small $x_\perp$ or small $x_\parallel$, with very limited overlap. Hadron production at large angles near the quasi-elastic region will be important in distinguishing between hadronic excitation processes and hard (constituent) scattering processes.

Technique:

Foils of 1% interaction length thickness will be exposed to the proton beam in Proton West with intensities up to 4×10^{11} ppp. 200 hours of beam time is required for testing and data taking. The yield of positive particles will be measured with the magnetic spectrometer constructed for E177. The spectrometer consists of a 4 meter septum magnet and two 3 meter EPB magnets. Particle trajectories are measured using multiwire proportional chambers.

PROPOSAL TO INVESTIGATE THE NATURE OF ψ PRODUCTION BY PIONS AND PROTONS

J. Hartmann, J. Orear - Cornell University
S. Conetti, C. Hojvat, D. Ryan, D. Stairs, J. Trischuk - McGill University
W. Faissler, M. Gettner, B. Gottschalk, J. Johnson, D. Potter(Spokesman) -
Northeastern University

SUMMARY

We propose an experiment that investigates the properties of particles produced
in association with the ψ(3.1) and ψ'(3.7). The physics objectives include a search
for heavy parent particles which decay into the ψ and multiparticle resonances pro-
duced along with the ψ. The latter possibility includes both a search for particles
which may be "charmed" (in which case two should be produced along with the ψ) as
well as a search for true associated production, which may occur if the ψ itself has
a new quantum number.

The experiment investigates both pion and proton initiated ψ production processes.
The differences observed in inclusive ψ production by pions and by protons are an
indication that the production mechanisms may depend on the nature of the incident
particle. For example, processes requiring anti-quarks would be more likely to be
initiated by pions than by protons. Therefore, it is necessary that beams of both
particles be used to search for new particles associated with the ψ.

The apparatus is a good resolution, large acceptance spectrometer followed by an
iron muon filter. The spectrometer will be triggered by muon pairs originating from
ψ and ψ' decay and other processes, and will be used to obtain the effective mass dis-
tributions of the charged particles produced in coincidence with the ψ and ψ'. A
large acceptance spectrometer is crucial since both the ψ and decay products of reso-
nances produced along with it must be detected simultaneously. To achieve a large
multiparticle acceptance with a magnet of conventional size, the thin target
(1/2" beryllium) is placed inside a BM109 magnet and the particle trajectories are
measured only after magnetic deflection. The resulting mass resolution for a cen-
trally produced ψ is 140 MeV (FWHM), which is more than sufficient to separate the
ψ from the muon pairs due to pion decay. At 400 GeV, the acceptance for a two body
decay of a particle produced at rest in the C.M.S. is about 35%.

We propose to make the measurement in the M2 line using pion and proton beams
at an intensity of 10^7/pulse. We will require about two hundred hours of set up time
and 1200 hours of data collection time, split evenly between pion and proton beams.
The expected yield of at least 5,000 proton induced ψ events and at least 10,000 pion
induced ψ events is sufficient to investigate phenomena which contribute as little as
a few tenths of a percent to inclusive ψ production.

This experiment is similar in purpose to E-400 but differs in two crucial
respects. First, although both experiments search for new particles produced along
with the ψ, this experiment has a much larger acceptance because the apparatus sub-
tends about five times more solid angle in the lab. Thus, not only does it have a
greater sensitivity to rare processes but it can also detect particles in kinematic
regions inaccessible to E-400. Second, the pion initiated events collected in this
experiment cannot be obtained by E-400. Consequently, the two experiments are in
fact complementary.

SEARCH FOR HEAVY PARTICLES PRODUCED IN
ASSOCIATION WITH PROMPT MUONS

D. Bintinger, D. Jovanovic (Fermilab)
C. Akerlof, P. Alley, D. Koltick, D. Meyer, R. Thun
(Univ. of Michigan); R. Ditzler, D. Finley, O. Johnson,
F. Loeffler, E. Shibata, K. Stanfield (Purdue)

A little over one year ago FNAL approved P-357, the original proposal to search for the hadronic decays of charmed particles. During this year our group has built a powerful double-arm spectrometer which includes 32 drift chambers, 6 Cherenkov counters, and 54 scintillation counters. We had our first and to date only data run in November and December of 1975. We have seen a very clean J/ψ signal in the $\mu^+\mu^-$ decay mode and the run yielded two-body hadron data whose general experimental and statistical quality compares very favorably with the hadron data of the MIT/BNL effort.

Since this investigation concerns processes with extremely small cross sections and large physical backgrounds, we believe it to be imperative to improve the sensitivity of this particle search. Data from hadron interactions, neutrino interactions, and e^+e^- annihilations with prompt leptons in the final state give rather compelling evidence for the production of new particles. Therefore, we propose to search for narrow resonances in two-body hadron mass spectra for events containing a prompt muon.

Muons will be identified with a $15\frac{1}{2}$ foot long hadron absorber built in two parts and covering more than 50% of the c.m. solid angle. An 8 foot long steel absorber with a hole for passage of the beam and channels leading to each spectrometer arm will replace the first two Cherenkov counters in our present apparatus. The second part of the absorber will utilize the iron in the BM-109 magnet yokes. The function of the two displaced Cherenkov counters will be taken over by two similar counters to be positioned behind the BM-109 magnets.

Summary prepared by
K. C. Stanfield, January 1976

SEARCH FOR MONOPOLES ABOVE THE 15-FOOT BUBBLE CHAMBER

D. F. Bartlett and Daniel Soo (University of Colorado), Robert L. Fleischer, Howard R. Hart, Jr. and Antonio Mogro-Campero, (General Electric Research and Development Center), M. G. White (Department of Physics, Princeton University)

Magnetic monopoles having energies less than about 40 TeV will be slowed to their terminal velocity by the earth's atmosphere. They may then be gathered by the fringing magnetic field of the 15-foot bubble chamber. We propose placing detectors in Lexan and nuclear emulsion at convenient locations above and in the bubble chamber. Such a system would be sensitive to monopole masses between 10 GeV and 100 TeV and to monopole charges between 0.7 and 10 $\hbar c/2e$.

The experiment would require the construction of a special light roof and would run for 5 weeks during a time when the bubble chamber is filled with air and not in use for other experiments. This study would lower the existing limit on in-flight detection of monopoles (at the earth's surface) by a factor of twenty.

The simplicity of the detectors, the immediate availability of the experimenters, and the inability of the proposed light roof to shed snow all suggest that the experiment be run during the coming summer. The experimenters propose that such a run be scheduled during one of the long scheduled shutdowns of the 15-foot bubble chamber.

Summary prepared by
D. F. Bartlett, February 1976

A DETAILED STUDY OF "EXTRA MUON" PRODUCTION IN DEEP INELASTIC MUON INTERACTIONS

B. Ball, D. Bauer, C. Chang, K. W. Chen, S. Hansen, L. Litt,
J. Kiley, A. Kotlewski and P. F. Schewe (Michigan State)

We propose here a specific missing energy measurement in direct muon production by high energy muons. First we briefly summarize heretofore unpublished dimuon data collected in a previous muon scattering experiment (E-26). These data support a possible new particle production mechanism. Forty events were found to show extra muons accompanying the scattered muon. These extra muon(s) could conceivably be interpreted as the leptonic or semileptonic decays of some new hadron(s) produced in high momentum-transfer muon interactions. The rate for the extra muon production is greater than 2×10^{-3} of single μ events.

The proposed experiment will be performed using the E-319 apparatus, consisting of a newly constructed fine-grained hadron calorimeter (240" in length and 1-7/8" Fe sandwiched by 1/4" plastic scintillators), an improved muon spectrometer and new beam proportional chambers to be shared with the E-398 group. This new apparatus is particularly well suited to observe the production and weak decays of new hadrons. Among the unique advantages in the detail studies of muo-production of new particles include 1) a precise knowledge of kinematics: incoming muon energy, E_0, scattered muon energy E', Q^2, ν, x, and W, etc., 2) a good measurement of missing energy carried by neutrinos, 3) a large solid angle acceptance for final state muons, 4) an experimental verification of "promptness" of extra muon yields using varying target densities and 5) flexibility in trigger with three sets of new trigger counter hodoscopes.

A run of 10^{11} muons is requested at $E_\mu = 300$ GeV with an intensity of 10^6 muons/pulse. This run can be carried out in the same quadrupole-triplet running period as E-319 following data taking by E-398. We anticipate collecting 2300 dimuon events.

We emphasize here that our improved apparatus resembles that proposed in proposal E-225 (1973), in which the original idea of using a target-calorimeter to study high momentum-transfer interactions was advanced for the first time. The fact that we were able to observe dimuon events with high efficiency using E-26 apparatus demonstrates that our apparatus will be more than adequate to search for the existence and to study the weak decay of new particles.

SEARCH FOR MULTIPHOTON EVENTS PRODUCED IN PHOTON-BERYLLIUM INTERACTIONS

G. B. Collins (VPI & SU), J. R. Ficenec (VPI & SU), J. Fischer (BNL), W. P. Trower (VPI & SU)

The purpose of this experiment is to continue our search for multiphoton events at FNAL. Multiphoton events have been observed by several authors in cosmic ray exposures in the 1950's and have been associated by Ruderman and Zwanziger with bound magnetic monopole pairs. In our initial search, Multigamma #22, we sought to produce anomalous multiphoton events using 300 GeV/c protons on beryllium. In Multigamma #22, after subtracting the neutron background and accounting for the known sources of photons, there remains a residue of 11 multiphoton events whose cross section is most consistent with production by photons and whose characteristics are similar to the reported cosmic ray events. We find that each event has 5-7 converted photons immediately behind a 0.57 rl Pb converter, a projected production angle whose centroid is 0.1-2.4 mr, a production cone angle of 0.5-5.8 mr, and a total electromagnetic energy >100 GeV.

We propose to continue our search for anomalous multiphoton events in the tagged photon beam at FNAL because these events are most probably produced in photon interactions, and the tagged beam has the advantage of known photon intensity, angle and energy free of the troublesome neutron background. Thus the interpretation of the experimental results is less speculative. The experimental arrangement would optimize our search for these narrow, multiphoton showers and would benefit in its design from the experience gained in our previous search. The multiphotons would be produced in a Be target, travel ∿ 40 m. in vacuum, and form showers in a thick Pb converter. The shower cores would be recorded in desensitized multiwire proportional chambers (MWPC's) and their direction would be determined by conventional MWPC's. A lead glass counter array would be used to determine the total energy of the multiphotons. A candidate event would be required to have several shower cores and a total multiphoton energy nearly equal to the incident photon energy.

If we are scheduled to immediately follow E25A, and are able to use some of their existing apparatus (24" vacuum pipe, lead glass array, and information collection system), we would require only two weeks of testing and 100 hours of data-taking to complete the experiment. In order to be effective, each week of testing or data-taking should be preceded by a week with no beam usage. These estimates assume that 3×10^4 electrons/burst at 300 GeV/c are available in the tagged photon laboratory. With a two percent radiator in the tagging system, this intensity gives 400 photons/pulse with energies > 133 GeV. Using our estimated cross section for multiphoton production in γ-Be interactions [(0.2-10.8)mb], > 400 multiphoton events should be recorded, allowing cross sections as a function of energy, multiplicity, and production angle to be measured.

Summary prepared by
J. R. Ficenec, January 1976

PROPOSAL FOR STUDYING ANTI-NEUTRINO INTERACTIONS
IN NEON WITH A NARROW BAND BEAM IN THE
15-FOOT BUBBLE CHAMBER

S. Y. Fung, A. Kernan, R. T. Poe and B. C. Shen (UC Riverside);
W. M. Smart (Fermilab); J. R. Albright, S. Hagopian,
V. Hagopian, J. Lannutti (Florida State)

This proposal is for the study of anti-neutrino inter-
actions with a dichromatic anti-neutrino beam in the 15-ft
bubble chamber filled with neon or a heavy neon-hydrogen
mixture. A total of 200,000 pictures is requested. For
400 GeV protons at intensity 10^{13} protons per pulse we
expect approximately 4000 anti-neutrino interactions, of
which about 1000 are neutral current interactions. The
primary purpose of the proposed experiment is to make a
detailed study of neutral current phenomena.

Summary prepared by

A. Kernan, January 1976

STUDY OF π, K, AND p̄ PRODUCTION OF HIGH MASS
MULTI MUON STATES

W. Faissler, P. Gauthier, J. Johnson, M. Mallary, E. Pothier,
E. von Goeler, R. Weinstein (Northeastern University)

The reactions (π, K, p̄) + Fe → muons + anything will be
observed in order to measure σ and its dependence on X and
$p_\perp$, and to compare to equivalent proton production cross
sections. For example, a dimuon resonance at 7 GeV, with
a production cross section 1000 times smaller than the ψ
would result in a yield of 200 events. A beam dump method
with improved resolution is employed. 400 hours of data
taking and 100 hours of testing with 200 to 250 GeV pions
at an intensity of 10^7 π/pulse is requested.

Summary prepared by
R. Weinstein, January 1976

PROPOSAL TO SEARCH FOR INTERMEDIATE BOSON PRODUCTION
IN PROTON PROTON COLLISIONS AT 200 GeV IN THE CENTER OF MASS

R. Huson, P. Livdahl, R. Steining, L. Teng, F. Turkot, J.K. Walker
(Fermilab)

It is proposed to construct a 25 GeV proton storage device at straight section E of the main ring. This will permit collisions between the stored protons and the normal accelerated beam in the main ring during each acceleration cycle. In Phase I of the experiment CMS energies up to 200 GeV and luminosities up to 10^{31} cm^{-2} sec^{-1} will be achieved. A second phase will raise the energy to 400 GeV in the CMS and increase the luminosity to 10^{32} cm^{-2} sec^{-1}.

Toroidally magnetized iron slabs interspersed with drift chambers and scintillation counters will surround the 18 m long intersection straight. Large transverse momentum muons will be used in the trigger. A study of the single and multiple production of muons will be made. Imbalance in transverse momentum of the hadronic cascades will signify neutrinos in the final state.

A search will be made for a new energy scale signified by $W^{\pm}$, Z^{0}, Higgs bosons, quarks and heavy lepton production. Typically, 100 detected events per week are expected for 60 GeV mass charged intermediate boson (W) production.

The operation of this experiment would be completely parasitic to the normal operation of the research program in the same way as C0.

Summary prepared by
J. K. Walker, February 1976

NEUTRON-DEUTERON ELASTIC SCATTERING

T. Roberts, Cyril A. Ayre, H. Richard Gustafson, Lawrence W. Jones, and Michael J. Longo (University of Michigan)

We propose to measure the neutron-deuteron differential elastic cross-section in the region $0.25 \leq t \leq 1.5$ (GeV/c)^2 for $100 \leq P_{lab} \leq 400$ GeV/c. The equipment requires is identical to that currently in use by E-248, with deuterium replacing hydrogen in the target. Three hundred hours of beam (in the M-3 beam line) are requested. This experiment would not be undertaken until E-248 is completed.

Summary prepared by
T. Roberts, January 1976

PROPOSAL TO SEARCH FOR HEAVY BOSONS, HEAVY LEPTONS,
AND CHARMED PARTICLES AT SSR

Luke W. Mo (University of Chicago); Peter E. Schlein (UCLA);
Andris Skuja (University of Oxford)

   This is a proposal to look for heavy bosons, heavy leptons,
and charmed particles using a small storage ring (SSR; see Fermilab
proposal #478).   The three processes to be investigated are:

(1) $p + p \rightarrow (\gamma^* \text{ or } Z^0) + X$ (heavy bosons)
$$\hookrightarrow \begin{cases} e^+ + e^- \\ \mu^+ + \mu^- \end{cases}$$

(2) $p + p \rightarrow (L^+ + L^-) + X$ (heavy leptons)
$$\hookrightarrow \ell^- + \bar{\nu}_e + \nu_L$$
$$\longrightarrow \ell^+ + \nu_e + \bar{\nu}_L$$

(3) $p + p \rightarrow D + \bar{D} + X$ (charmed particles)
$$\hookrightarrow \mu + \nu_\mu$$
$$\longrightarrow e + \nu_e$$

The signature for the processes are characterized by charged
lepton pairs in the final state.   Hadrons associated with the
heavy particle production will be measured.   It should help to
determine the properties of these new particles.

   The spectrometer proposed here consists of a wheel-shaped
superconducting magnet, sets of drift chambers, scintillation
counter hodoscopes and a lead glass hodoscope.

   Under certain assumptions (parton model, etc.) they expect
the integrated counting rate of $\sim 10^{-2}$ events/GeV/hour for
10 GeV/c^2 and $\sim 10^{-3}$ for 20 GeV/c^2.

   One year of running time on the SSR is requested.

Summary prepared by
T. Yamanouchi, May 1976

INVESTIGATION OF MULTIPLE PRODUCTION BY π^- MESONS
WITH EMULSION CHAMBER

Y. Takahashi, M. Biyajima, T. Matsuda and O. Miyamura
(Osaka University)

This is a study of multiparticle production using π^- of 200 GeV or higher and nuclear emulsions. The emulsion chamber consists of two parts. The top half consists of a stack of emulsion plates and thebottom half contains emulsion, x-ray film and leads plates for gamma conversion. Each emulsion chamber measures 10 x 10 x 15 cm^3 and a total of ten are to be exposed. The desired exposure is about 10^4 π^-/cm^2.

STUDY OF DIMUON EVENTS PRODUCED IN NEUTRINO INTERACTIONS

B.C. Barish, J.F. Bartlett, A. Bodek, K.W. Brown, D. Buchholz,
F.S. Merritt, F.J. Sciulli, L. Strutte, H. Suter (Caltech);
E. Fisk and G. Krafczyk (Fermilab)

This proposal is an outgrowth of E356 and represents that part of the experiment directed to the detection of dimuon events. The experiment will be carried out in Lab E and will be done with a subset of the apparatus being constructed for E356.

With the quad beam focus set to 200 GeV, in a 75 ton fiducial volume (of the full volume of 170 tons), the charged current rate will be about 1 event/minute for $E_\nu > 100$ GeV at 10^{13} ppp and 10 second repetition rate. For a 1% dimuon rate, they feel a realistic goal might be 250 dimuon events/month.

Summary prepared by
J. Lach, May 1976

PROTON-PROTON ELASTIC SCATTERING AT $|t|$ = 374 (GeV/c)^2

Cyril A. Ayre, H. Richard Gustafson, Lawrence W. Jones, Michael J. Longo, Thomas J. Roberts (University of Michigan)

We propose to measure (or put a stringent upper limit on) the differential cross section for p-p elastic scattering at 90° in the CMS with incident protons of 400 GeV. This would push the frontier of high-energy physics out to $t = -374$ (GeV/c)^2, more than an order-of-magnitude increase over the range of previous experiments. This corresponds to a distance scale $\ell \equiv \hbar/p_T$ which is ~0.015 fm.

The experiment is straightforward and modest in scale. The apparatus consists of a liquid hydrogen target and two well-shielded spectrometers placed symmetrically about the incident proton beam. Each spectrometer contains two 20 ft. main ring magnets, proportional chambers (or counter hodoscopes), and a total absorption calorimeter.

We anticipate a sensitivity $(d\sigma/dt)_{min}$ ~10^{-41} cm^2/(GeV/c)^2. This estimate is based on a running time of 600 hrs at 60% overall efficiency with 3×10^{12} protons/pulse.

PROPOSAL TO STUDY ψ PRODUCTION USING THE E-416 APPARATUS

T. Burnett, V. Cook, S. Csorna, D. Holmgren, A. Jonckheere,
H.J. Lubatti, K. Moriyasu (University of Washington); D. Fournier,
P. Heusse, P. Rancon, J.J. Veillet (Orsay)

A number of experiments have been performed at FNAL to study hadronic production of ψ mesons by observing the $\mu^+\mu^-$ decay mode. These experiments have mainly concentrated on the production of the ψ. The momenta of the muons were determined, from which the Feynman x and P_T distributions of the ψ production are obtained. The hadrons which are produced in association with the ψ mesons have been either ignored or not very well studied.

We are proposing to study the reaction π^- + Lucite ($C_5H_8O_2$) → ψ + anything using the apparatus of E-416. The target is placed at the upstream end of a streamer chamber which is in an approximately 8 kg magnetic field. Downstream of the streamer chamber magnet there is a muon spectrometer containing magnetized iron and eight muon telescopes which allows us to trigger on 1, 2 or more muons in the final state. The ψ mesons can be selected by reconstructing the mass of the $\mu^+\mu^-$ pairs from the bend information obtained in the SOD magnet. The apparatus is identical to that used in E-416. The only changes we propose to make to the apparatus of E-416 in this experiment is to: (i) improve the multitrack efficiency of the spark chambers at the downstream end of the muon telescope; (ii) include a small multiwire proportional chamber between the downstream end of the streamer chamber magnet and the upstream end of the muon filter; (iii) close the ± 9 mr gap in the muon telescopes.

We estimate that there should be a factor of 30 increase in the number of ψ's we can obtain in this run. From the seven events in the ψ region obtained in E-416 we then estimate approximately 200 ψ's in this experiment.

From the streamer chamber we will obtain the momentum spectrum of the V^0's observed in the chamber, the rapidity of all of the charged particles, and the multiplicity distributions of charged particles. We would expect to have on the order of 100-200 events from interactions in the target and an equal number in the Fe shield in this experiment. We stress the fact that it requires essentially no new equipment; it simply requires reinstalling equipment with which we have had considerable experience, namely the streamer chamber and the muon telescope.

The low mass (below the ψ) muons are also of considerable interest to resolve the question of Drell-Yan verses other production mechanisms (e.g. Farrar-Frautschi). Having information about the hadrons which are produced in association with these low mass pairs may help in understanding the production mechanism.

A PROPOSAL TO INVESTIGATE EXOTIC REGGEON EXCHANGE IN
THE INCLUSIVE PRODUCTION OF CHARGED HYPERONS

W.E. Cleland, W.E. Cooper, E. Engels, P.F. Shepard, J. Thompson
            (University of Pittsburgh)

We propose to measure the inclusive production of the
charged hyperons Σ^- and Ξ^- in the reaction p + nucleon
(Σ^-, or Ξ^-) + M_x as a function of the variables s, t, and M_x^2.
An analysis of the data using triple Regge theory will measure
the trajectory, $\alpha(t)$, of the exchanged Reggeon for t values
-5 GeV^2 $\leq$ t $\leq$ 0 GeV^2. The exchange is exotic, characterized as
a doubly-charged meson with S = +1 and +2 for Σ^- and Ξ^- prod-
uction, respectively. A measurement of $\alpha(0)$ and $\alpha'(0)$
consistent with triple Regge results for non-exotic exchanges
lends support for the existence of exotics, and will yield
definite experimental predictions of the possible masses and
spins of exotic mesons to be searched for as s-channel
resonances. The polarization of the charged hyperons will also
be measured.

We have designed the experiment around existing laboratory
magnets. We request that the laboratory supply two BM109's,
five EPB magnets, standard fast electronics, and the necessary
shielding for the channel.

We would require approximately 500 hours of beam time to
do the experiment. It would be our intention to take the bulk
of the data at an incident beam energy of 400 GeV using an
intensity of between 10^{10} and 10^{11} protons/pulse. Because of
the triple Regge prediction that the cross sections scale as s,
we would like to do some running at 200 and 300 GeV using a
"front porch" mode of accelerator operation.

                    Summary prepared by
                    P. F. Shepard, J. Lach, May 1976

PROPOSAL TO STUDY THE ATOMIC NUMBER DEPENDENCE OF
THE DIFFERENCE BETWEEN PARTICLE AND ANTI-PARTICLE
TOTAL CROSS-SECTIONS

J.Hoffnagle, W. Molzon, J. Roehrig, V.L. Telegdi, B. Winstein
(University of Chicago); A. Gsponer (ETH Zurich); S. Aronson,
G. Bock (Univ. of Wisconsin)

We propose to perform a high statistics, virtually systematic
free measurement of the A-dependence of the difference in
particle/anti-particle total cross-sections by use of coherent
regeneration in a "double beam" arrangement in the M4 neutral
beam-line. One beam will be used for monitoring, the other
will contain the targets. The roles of the beams will be
interchanged on a pulse-by-pulse basis. By the same technique,
in good geometry, we will obtain precision measurements of the
K_L-Nucleus total cross-sections.

Anomalous behavior in the cross-section difference might
be expected as the contributing channels are becoming rarer
with energy (the cross-sections approach each other with energy):
if the difference goes like A^β β might move from 0.67 to 1.0 as
the momentum increases. We will measure β to an absolute
accuracy of better than ±.01 in several momentum bins between
30 and 150 GeV/c. Data taking will require 1.4×10^{17} protons
incident on the meson target ($\simeq$ 200 hours).

Summary prepared by
B. Winstein, May 1976

A PROPOSAL TO STUDY THE ORIGINS OF "EXTRA" PROMPT MUONS
PRODUCED IN DEEP INELASTIC MUON-NUCLEON SCATTERING

W.A. Loomis, A.L. Sessoms, C. Tao, R. Wilson (Harvard University);
H.L. Anderson, S.C. Wright (Enrico Fermi Inst.); T. Kirk,
W.A. Francis (University of Illinois)

This is an experiment to study "extra" muon production in
muon-nucleon interactions. Using the apparatus proposed for E-398
this group propose to construct an experiment highly sensitive to
multimuon events. If current ideas about quark structure, and
their use in explaining the neutrino dimuon results, are valid one
expects the pair production of charmed particles, and their sub-
sequent semileptonic decay, in the reaction

$$\mu^+ + N \rightarrow \mu^+ \; c \; \bar{c} + \text{hadrons}$$
$$\quad\quad\quad \hookrightarrow \mu^- + \bar{\nu}_\mu + \ldots.$$
$$\quad\quad\quad \hookrightarrow \mu^+ + \nu_\mu + \ldots.$$
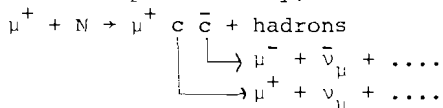
Under certain assumptions the ratio of dimuon (trimuon) to single
muon events is estimated to be $\geq 10^{-3}$ ($\geq 10^{-4}$). Trimuon of the
type $\mu^+ N \rightarrow \mu^+\mu^+\mu^+ X$ are not admitted by any charmed mechanism
and, if seen in reasonable numbers, would discredit charm as the
explanation of multi-muon events.

Given that sufficient numbers of multi-muon events are
recorded it will be possible to look for threshold effect as a
function of $S = 2M\nu + M^2 - Q^2$.

They will also study, via calorimetry, whether events with
multiple muon have anomalous amount of "missing" energy. The
recent results of the Yale-Brookhaven-Fermilab collaboration
indicates that prompt muons produced in proton-nucleon collisions
originate primarily from electromagnetic sources. If it is also
true of "extra" muons produced in muon-nucleon scattering the
dimuon events will be similar to the "normal" muon events, i.e.,
there will be no anomalous "missing energy".

A run about 3.6×10^{11} muons on target at 225 GeV/c is
requested.

PROPOSAL FOR A STUDY OF HEAVY PARTICLE PRODUCTION AND
DYNAMICS NEAR X = 0 AND THE DEPENDENCE ON
INCIDENT QUANTUM NUMBERS

D. Brick, M. Heller, A.M. Shapiro, M. Widgoff (Brown University);
R. Burnstein, C. Fu, H. Rubin (Ill. Inst. of Technology);
E.D. Alyea, Jr. (Indiana University); B. Barnett, C.-Y Chien,
P. Lucas, A. Pevsner, R. Zdanis (Johns Hopkins University);
J. Brau, J. Grunhaus, E.S. Hafen, R.I. Hulsizer, U. Karshon,
V. Kistiakowsky, P. Miller, A. Napier, I.A. Pless, J.P. Silverman,
R.K. Yamamoto (Massachusetts Inst. of Technology); E.O. Cohn
(Oak Ridge National Laboratory); B. Denby, P. Jacques, T.C. Ou,
R.J. Plano, T.L. Watts (Rutgers University); E.B. Brucker,
E. Koller, P. Stamer, S. Taylor (Stevens Inst. of Technology);
C.R. Sun (SUNY, Albany); W.M. Bugg, G. Condo, T. Handler, E. Hart
(University of Tennessee); H. Kraybill, D. Ljung, T. Ludlam,
H.D. Taft (Yale University)

We propose a study of the production of heavy particles
(Λ^0, K^0, K^+, K^-, p, $\bar{p}$) with a tagged positive 300 GeV/c beam
incident on the Fermilab hybrid spectrometer. We propose both
a positive and negative exposure. We wish to achieve a positive
beam composition $p/\pi^+/K^+$ ratio of 6/3/1 and a negative beam
composition of $\bar{p}/\pi^-$ of 1/4. We propose 1.5 x 10^6 positive beam
pictures and 1.0 x 10^6 negative beam pictures. We would use the
downstream particle identifier to be chosen by the 7-8 May 1976
workshop. The major objective of the experiment is to study the
role heavy particles play in multiparticle production processes
at Fermilab energies. This process would be studied as a
function of the projectile particle under identical experimental
conditions. This will be the first time such complete data will
be available. In addition to this new data, the experiment will
yield a major increase in statistics over earlier, more con-
ventional studies. If it required a lower beam momentum to
achieve the desired particle ratio, we would perform the experi-
ment at that lower beam momentum.

Summary prepared by
I. Pless, May 1976

PROPOSAL TO STUDY NEUTRINO INTERACTIONS IN HYDROGEN AND
NUCLEI WITH AN INTERNAL TARGET AND CONVERTER SYSTEM
IN THE 15-FT. BUBBLE CHAMBER

J.P. Berge, F.A. DiBianca, P. Hanft, F.A. Nezrick, G.W. Scott,
W. Smart   (Fermi National Accelerator Laboratory)

We propose a study of broad-band neutrino interactions on
free protons and simultaneously on nuclei with 90% gamma
conversion, 95% electron and muon identification by using an
Internal Target and Converter (ITC) system in the 15-ft.
chamber. We request an exposure of 300,000 pictures with
1.3×10^{13} protons per pulse of energy 400 GeV. Based on
measured yields from E-45 we expect 100,000 neutrino events
in this exposure. The physics program includes studies of
μ^-e^+ and $\mu^-\mu^+$ production; searches for charmed particles, ψ's,
heavy leptons, intermediate vector bosons and other new
particles; comparisons of νp and νn interactions including
precision measurements of $\sigma(n)/\sigma(p)$ for both charged and
neutral currents; charged and neutral current deep inelastic
scattering; detailed studies of exclusive channels including
π^0's, V^0's and kinks in both charged and neutral current
reactions; pure leptonic interactions; and charged and neutral
current reactions; pure leptonic interactions; and charged
and neutral particle multiplicity distributions in both
charged and neutral current reactions.

Summary prepared by
F. A. Nezrick, May 1976

SEARCH FOR SHORT LIVED PARTICLES USING
A HIGH RESOLUTION STREAMER CHAMBER

M. Dine, D. Ljung, T. Ludlam, R. Majka, J. Marx, P. Nemethy,
J. Sandweiss, A. Schiz, J. Slaughter, H. Taft (Yale University);
M. Atac, S. Ecklund (Fermilab)

We propose to search for new short lived particles produced
in hadronic collisions in a manner independent of decay mode,
with ~4π geometry and with a sensitivity such that cross sections
comparable to those for ψ/J production would be successfully
detected.

Using a small triggered high resolution ($\leq$10 μm) high
pressure streamer chamber, currently under construction at Yale,
we will be able to directly observe particles with lifetimes as
short as 2.5×10^{-14} sec. If such particles exist we will
measure their lifetimes, decay multiplicities, semi-leptonic
branching ratios and production cross sections. We will observe
phenomena associated with the production of these particles such
as associated production or pair production, the topological and
kinematical character of the events in which the new particles
are produced, and any new "short time" phenomena associated with
the new particles (such as decays of new heavy mesons into heavy
leptons). If such particles do not exist we will set a signifi-
cant upper limit on σ times the branching ratio for semi-leptonic
decays of ~10 to 50 nb for lifetimes from 2×10^{-14} sec to
5×10^{-13} sec.

We need a 200 GeV/c π^- beam at an intensity of 8×10^5/spill.
The floor space required, exclusive of accelerator and beam line,
is about 2m x 2m. We are asking for 800 hours of beam time
which will result in 7×10^5 pictures, giving 1.6×10^5 inter-
actions in the fiducial volume of the chamber. This will give
a sensitivity to particles produced with cross sections
comparable to ψ/J.

Summary prepared by
R. Majka, May 1976

CLASHING GIGANTIC SYNCHROTRONS

C. M. Ankenbrandt, T. L. Collins, H. E. Fisk, R. P. Johnson, P. Limon,
J. Peoples (Fermilab); A. V. Tollestrup, R. L. Walker (CalTech);
L. M. Lederman (Columbia)

This experiment is a search for intermediate vector bosons, $W^{\pm}$ and W°, and high transverse momentum phenomena produced at very large center of mass energies. These energies are made possible by colliding the beam in the Main Ring with the beam in the 1000 GeV superconducting Energy Saver/Doubler.

A collision scheme and a general purpose detector have been designed to allow the simultaneous detection of:

  i) $p + p \rightarrow W^{\pm}$ + Anything
                    $\longrightarrow$ hadrons
                    $\longrightarrow$ eν

  ii) $p + p \rightarrow W^{\circ}$ + Anything
                    $\longrightarrow$ hadrons
                    $\longrightarrow$ e$^+$e$^-$

  iii) $p + p \rightarrow$ hadrons ($P_t > 5$ GeV/c) + Anything.

The MR operating at 150 GeV and the ES/D operating at 1000 GeV with one beam traveling in the reversed direction are made to intersect at the middle of a long straight section to provide a center of mass energy $\sqrt{s} = 770$ GeV or 1.2 ergs. By powering the quadrupoles at the ends of the straight section appropriately, very low β values are obtained at the intersecting region resulting in a luminosity of 2×10^{30} cm^{-2} sec^{-1} for beams of 2×10^{13} protons in the ES/D and in the MR. Further luminosity improvements are likely.

Because the beams are rf bunched, the interaction region is localized (0.1 x 0.1 x 20 cm^3) and the detector is correspondingly compact. The detector uses drift chambers, electromagnetic shower detectors and hadron calorimeters. It is modular and can be rearranged to be compatible with different beam energies in the MR or Doubler. With the 150 GeV on 1000 GeV scheme the detector has identical arms on either side of the interaction region, each centered about 90° in the C.O.M. (42° in the lab) and each covering ∿.6π steradians in the C.O.M. Because of the small and uncertain W branching ratio to leptons, the detector is sensitive to hadronic as well as leptonic decay modes.

Calculations based on a Drell-Yan model with colored quarks indicate that the experiment described here will be sensitive to W's weighing as much as 200 GeV, and the expected rate for detecting 100 GeV W's is of the order of ten events per day.

Summary prepared by:
R. P. Johnson
May 1976