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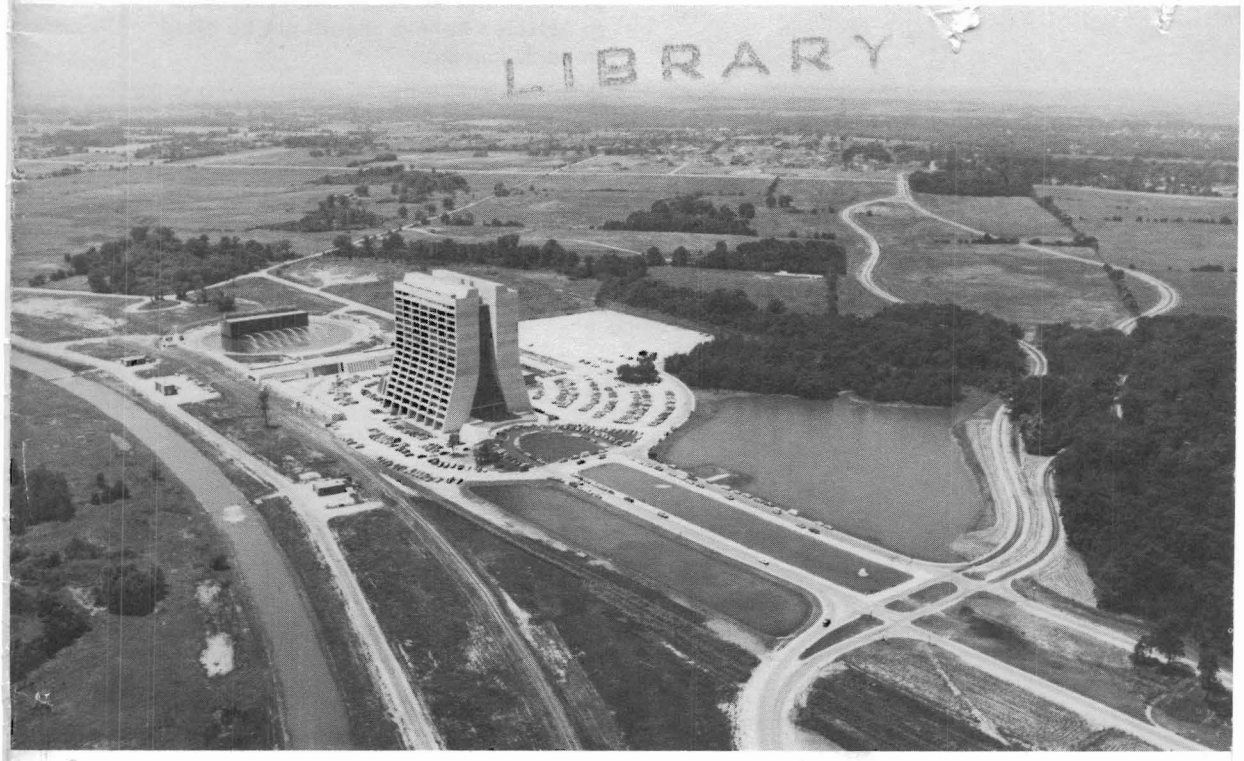

Monthly Report of the Fermi National Accelerator Laboratory

July 1974

Fermi National Accelerator Laboratory

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THE COVER: Aerial view of the Injector and Central Laboratory areas, looking southwest. West boundary of the site is Kirk Road, beyond which the city of Batavia is just visible on the horizon. The two-lane road winding toward the Central Laboratory from Kirk Road is the main entrance to Fermilab.

(Photo by T. Frelo, June 1974)

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THE BEAM-TAGGING SYSTEM FOR THE 30-INCH BUBBLE CHAMBER

With the decision made in late 1970 to relocate the MURA/ANL 30-inch hydrogen bubble chamber at Fermilab, final consideration toward the design and construction of a hadron beam was undertaken by members of the Neutrino Department, in particular, by J. Lach and S. Pruss. It was then decided that an identified (tagged) charged-particle beam be set up rather than an enriched particle beam. The design, construction, and implementation of the equipment needed to tag beam particles, incorporating a Cerenkov signal provided by the Laboratory, was contracted to the Proportional Hybrid System Consortium, which had submitted a proposal (#154) to construct multiwire proportional chambers both upstream and downstream of the 30-inch chamber.

Their proposal was to study high-energy interactions by simultaneously detecting fast-forward particles in the downstream proportional chambers and lower-energy particles in the bubble chamber. The system upstream to the chamber, which can be used independently of the downstream system, was designed to provide accurate angular and positional measurements of the incident beam particles. Thus, by matching the trajectories of the incident beam particles resolved by the tagging proportional chambers with those measured in the bubble chamber, one can identify the nature of the particle along with identification by the corresponding Cerenkov signal. This is known as tagging the trajectory and type of each incident beam particle.

The tagging telescope consists of three chamber stations, each having three detector planes oriented with their wire directions set at 120° relative to each other. The active areas of the planes are 100 cm^2, with 48 wires on

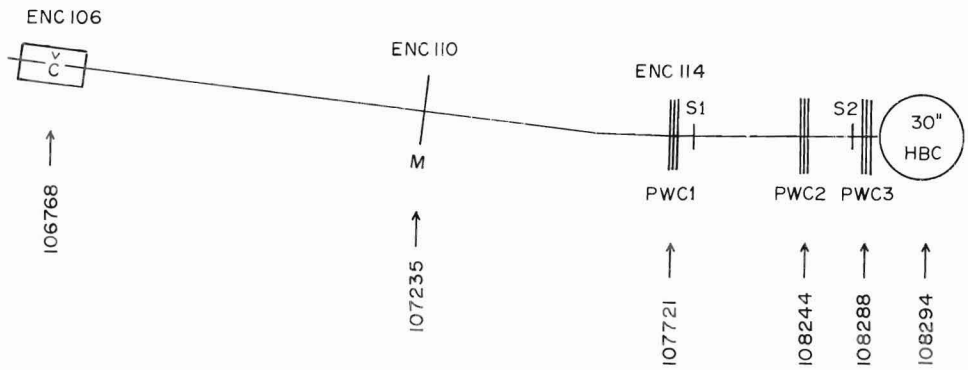

Figure 1. Schematic of the section of the N-3 beam line, including the tagging system for the 30-inch bubble chamber. Beam enclosure 106 (ENC 106) contains the Fermilab Cerenkov counter. The M station, consisting of a single plane for momentum determination, is located in beam enclosure 110 (ENC 110). Proportional wire chambers are located in beam enclosure 114 (PWC1), and 50 feet (PWC2) and 6 feet (PWC3) before the chamber. PWC2 and 3 consist of triple planes. The approximate Z coordinates (in feet) are also shown (Z = 100,000 ft is at the beam extraction point in the Transfer Hall).

an interwire spacing of 1.95 mm. The first of these stations is located in Enclosure 114 along the beam line to the chamber. This station has the sense wires in one of its three planes oriented vertically to allow for a direct readout of the horizontal profile of the beam image. The second and third stations, located approximately 50 feet and 6 feet from the bubble chamber, respectively, both have planes with sense wires oriented horizontally for direct readout of the vertical profile.

A schematic diagram of the tagging system is shown in Figure 1. In order to reject electrical noise, the signal pulse from each sense wire in the system is discriminated and amplified in the immediate locality of the planes, and transmitted as a digital signal. All signals are brought into an area near station 2, through as much as 200 meters of cable, and a coincidence from

scintillators S_1 and S_2 is used to determine a timing gate. The signals from the two Cerenkov channels are treated as if they originated from proportional chamber sense wires and are also added into the local memory. Every sense wire in the system and each pseudo-wire used as a tag signal has its own 16-bit local memory word, which allows storage of time-correlated information for 16 incident beam particles at a rate of approximately 8 MHz. At the end of a bubble-chamber spill, the local memory is read out into a PDP-9 computer located on the mezzanine of Lab A. Data acquired in this manner are sorted for adding to the profile histograms, and are then written out on magnetic tape in Fortran-compatible format for later analysis by the bubble chamber experimenters. Another feature of the tagging system which is useful for beam tuning is its capability to display, in real-time, histograms of the beam profile at the last beam-line component and at the entrance to the bubble chamber.

Momentum tagging is also possible, since station M, which consists of 20 vertical wires, is located at a horizontal focus. At this point, the spatial dispersion of each beam particle is related to its momentum. Thus, by identifying the position of the particle at this location, one can obtain its momentum.

The difference in angle of the particles entering the bubble chamber, as measured by the tagging system and from the bubble-chamber photographs is shown in Figure 2. Figure 2(a) corresponds to angles in the plane perpendicular to the camera optic axes, while Figure 2(b) corresponds to angles in the plane parallel to the optic axes. The smooth curves display the spread

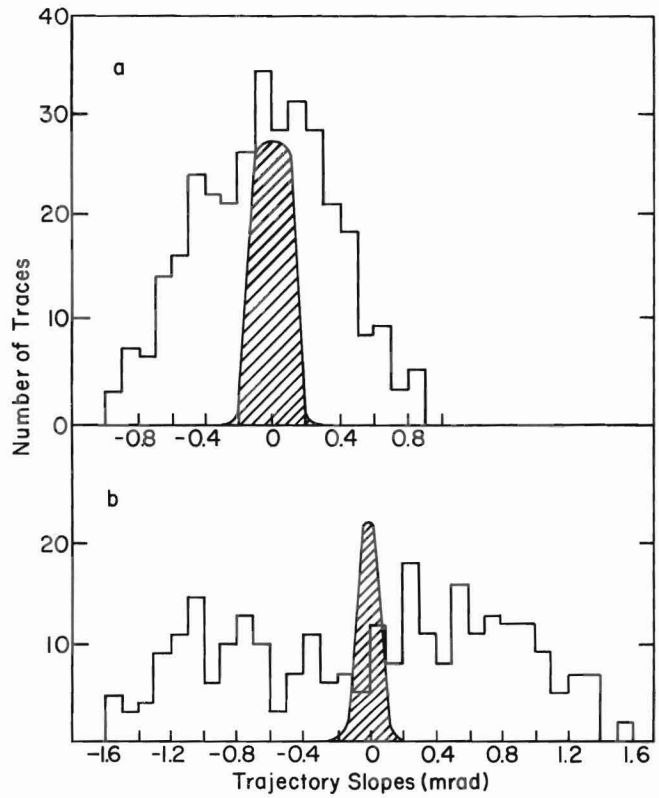

Figure 2. Distribution of track trajectory slopes as measured by both bubble chamber and tagging system (a) in the plane perpendicular to the bubble chamber camera optic axes, and (b) in the plane parallel to the bubble chamber optic axes. The smooth curve represents the distribution of the slope as measured by the tagging system alone.

of a typical measurement due to the tagging system alone; the broader distribution is due to the measurements on the film. The difference in track positions as measured by the tagging system and the bubble chamber in the plane

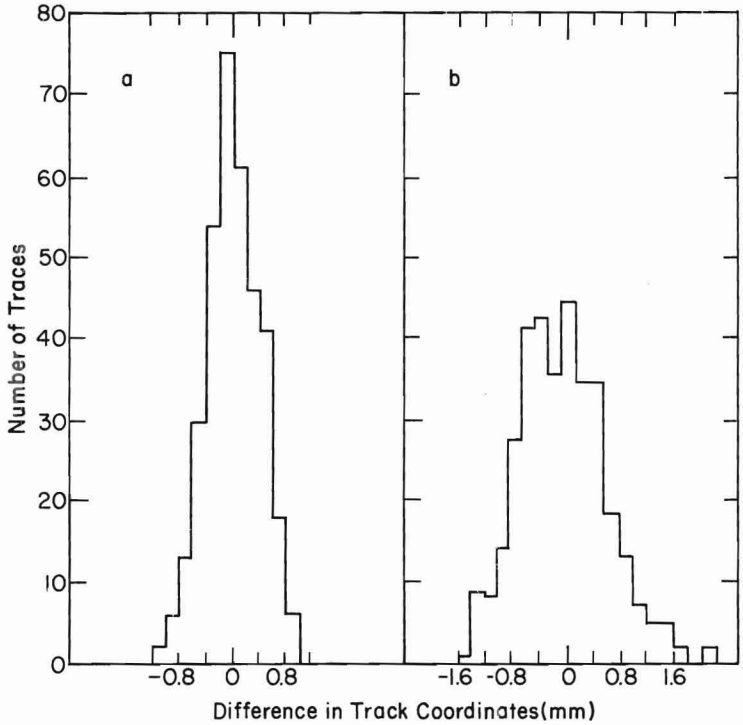

Figure 3. Distribution of the difference in track coordinates as measured by bubble chamber and tagging system (a) in the plane perpendicular to the bubble chamber optic axes and (b) in the plane parallel to the optic axes.

perpendicular to the optic axes is shown in Figure 3(a); that in the plane parallel to the optic axes is shown in Figure 3(b). In both cases, beam position and angle as measured by the tagging system is many times more precise than can be obtained from bubble-chamber photographs alone.

This tagging system has been in operation since the fall of 1972, and tagging for all positively charged pions has been a standard chore for it. More recently, a muon telescope has been added behind the 30-inch bubble chamber building, allowing for track-by-track muon tagging. This is useful for directly determining the muon beam contamination at the bubble chamber.

Reported by R. Yamamoto
Massachusetts Institute of Technology

The Proportional Hybrid System Consortium which built the multiwire proportional chamber system consists of members from the following institutions: Brown University, Fermi National Accelerator Laboratory, Illinois Institute of Technology, University of Illinois, Indiana University, Johns Hopkins University, Massachusetts Institute of Technology, Rutgers University - Stevens Institute, University of Tennessee - Oak Ridge National Laboratory, and Yale University. The Cerenkov counter was designed and implemented by S. Pruss.

DETECTOR DEVELOPMENT AT FERMILAB

The Detector Development group within the Research Services Department is involved with the research and development of particle detectors at Fermilab. The group has developed high resolution proportional chambers, drift chambers, and cryogenic chambers, as well as conducted research on gas mixtures for such chambers.

In the following pages, we briefly discuss some of the most recent accomplishments which have been significant advances in detector technology.

A Portable Beam Diagnostic System for Secondary Beam Lines

We recognized at an early date that a simple system of proportional wire chambers would be exceedingly useful in the initial tuning of some of the beam lines. Hence, a portable data acquisition and display system was built to diagnose the beam characteristics in secondary beams at Fermilab. It provides for beam position and trajectory monitoring on a pulse-by-pulse basis. This is accomplished with two orthogonal pairs of multiwire proportional chambers which are synchronized to provide pulses in coincidence from two locations separated by 30 meters. The beam diagnostic system consists of proportional chambers, readout electronics, and a small PDP-11/20 computer. The chambers used on the diagnostic system are of a standard Fermilab design, as shown in Figure 1. The specifications are as follows:

Wire spacing	1 mm
Number of wires per chamber	48
Active area	10-cm diameter (4.8 cm used)
Gap	3 mm on each side of the signal plane
Wire	0.0005-in. gold-plated tungsten
Chamber gas mixture	80% argon, 20% carbon dioxide
Coincidence gate	40 nsec

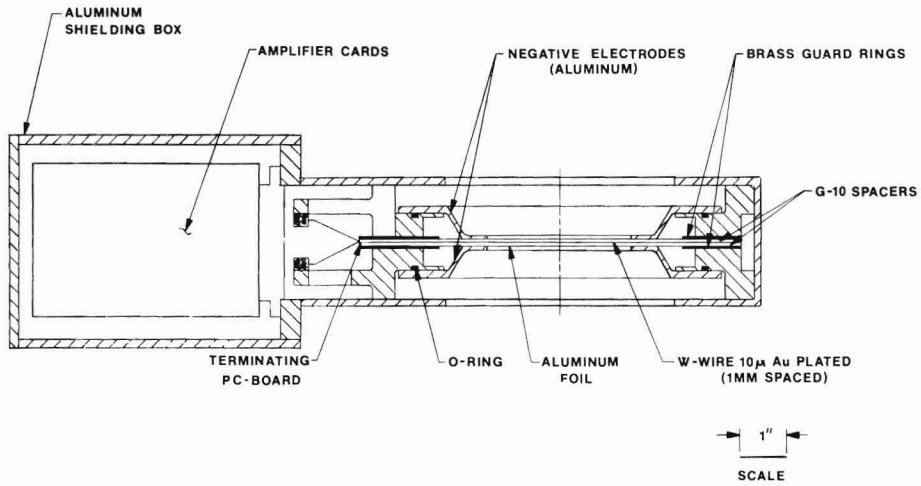

Figure 1. Diagram of the chambers used in the Fermilab beam diagnostic system.

The computer program displays a histogram of events for each chamber, an X-Y scatterplot from each pair of chambers, and records the data on magnetic DEC tape. Histograms of the vertical and horizontal profiles of the M6 high-resolution beam in the Meson Area are shown in Figure 2. Instantaneous beam intensities reached 10^6 particles per second during pulses. The scattergram distributions and phase-space distributions are shown in Figure 3. SCATTR 1 and 2 are cross sections of the beam (X, Y) at the two locations, and SCATTR 3 and 4 are the phase-space distributions in the horizontal and vertical directions. From this information it is possible to determine the approximate position of a focal point in the beam. The entire system is portable and available to users for beam tuning and for determining the parameters for other charged particle beams in the Laboratory.

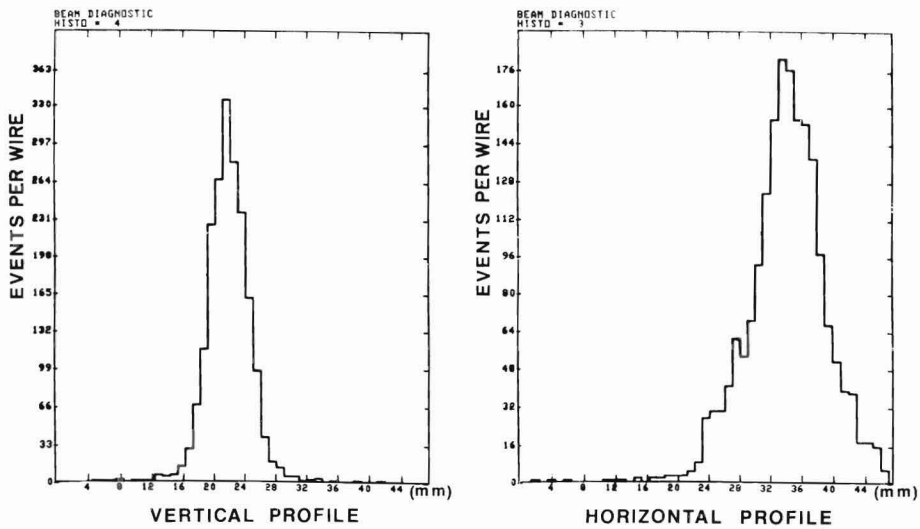

Figure 2. Histograms of the vertical and horizontal profiles of the M6 high-resolution beam in the Meson Area.

A Parallel Foil Drift Chamber and a New Gas Mixture

It has been reported in various papers that positions of charged particle tracks can be determined quite precisely by measuring the drift time of primary electrons produced by a charged particle as it passes through the detector.

The Detector Development Group has designed a new drift chamber with thin parallel foils positioned between alternate signal wires with the plane of each foil perpendicular to the signal wire plane. A prototype chamber was built to demonstrate that increasingly uniform drift velocities and consequently

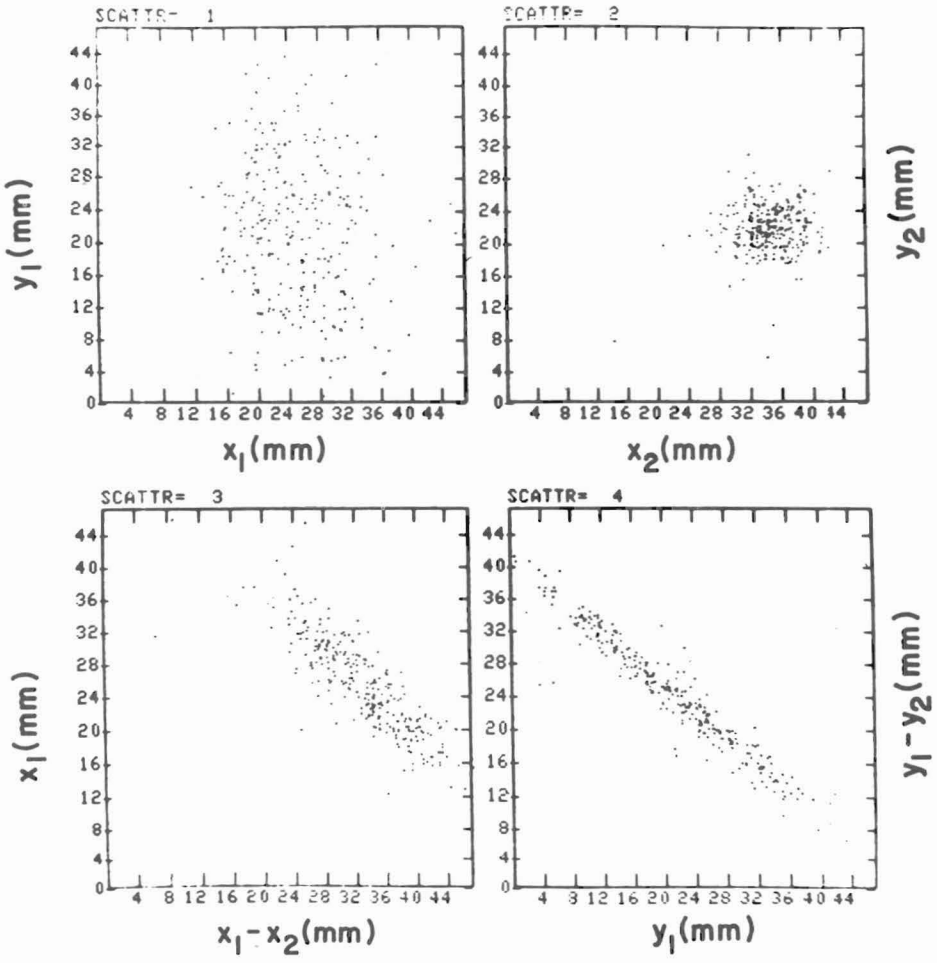

Figure 3. Scattergram distributions and phase-space distributions of the M6 high-resolution beam in the Meson Area.

high-spatial resolutions can be attained. A perspective view of the parallel foil drift chamber with three cells covering an active area 15 × 6 cm^2 is shown in Figure 4. The cells are covered with aluminized kapton sheets to isolate the active area from the rest of the detector enclosure. A voltage of -2600 was applied to the aluminum foils with the signal wires at ground.

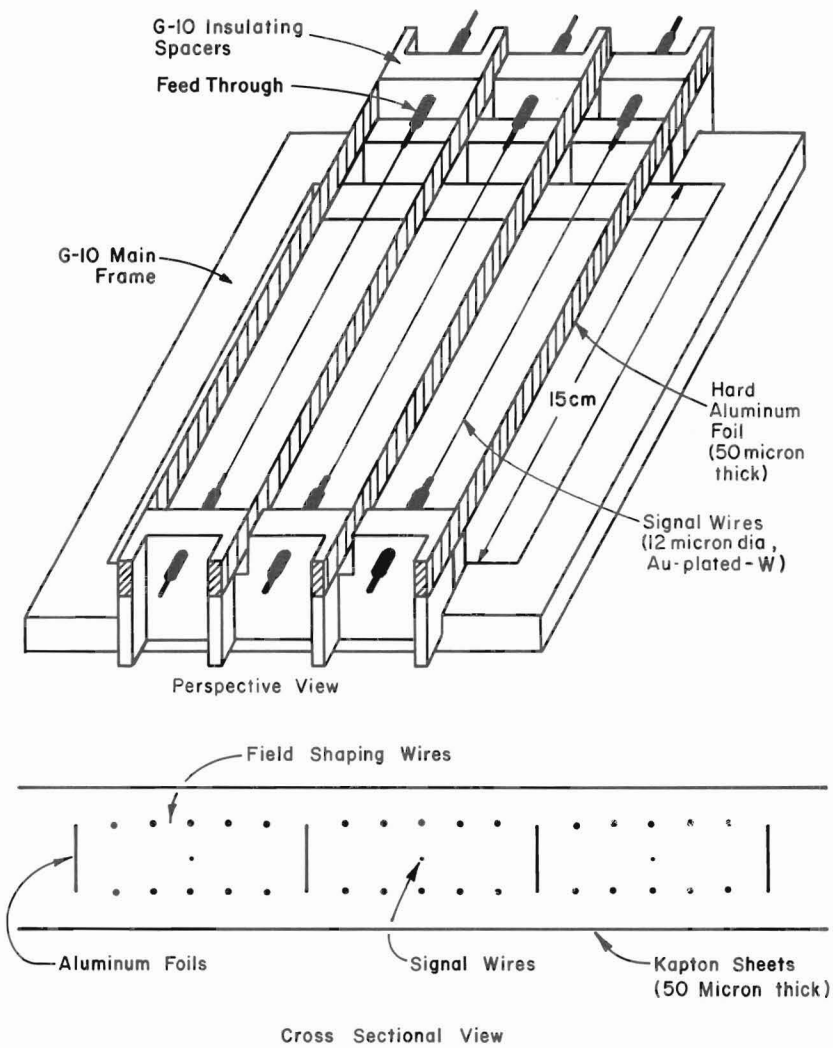

Figure 4. Perspective view of the parallel foil drift chamber.

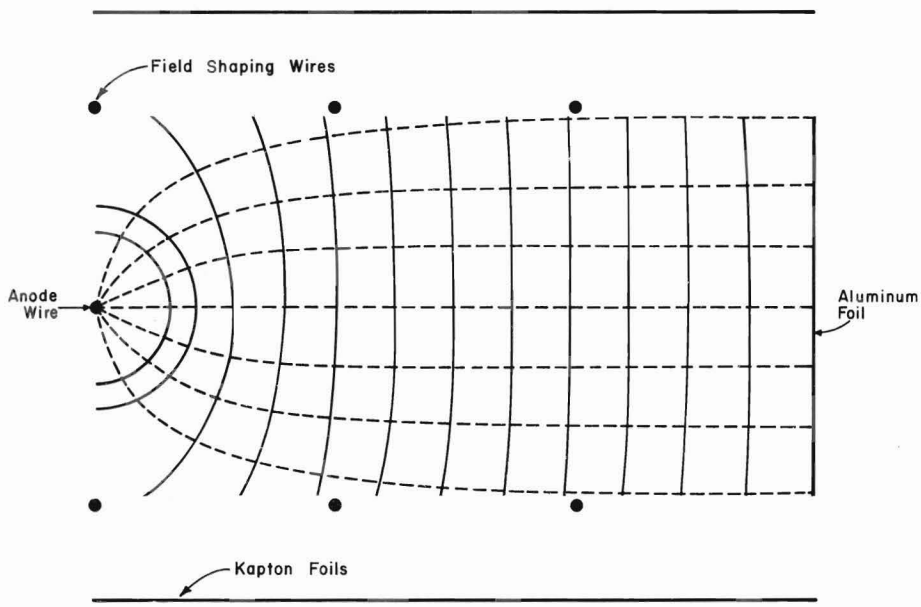

Figure 5. Field shaping wires which produce the equipotential surfaces.

The field-shaping wires indicated in Figure 5 produce the equipotential surfaces which were calculated from the voltage elements of the chamber. The concentric equipotentials reduce ambiquities caused by large-angle trajectories and at the same time eliminate dead regions where electrons can become trapped.

During tests the position of a track can be read directly from the drift-time spectrum. Results show that the electron drift velocities decrease when methane gas is added to argon while acetylene has the opposite effect. Thus, combining the three gases (70% argon, 22% acetylene, 8% methane) produces

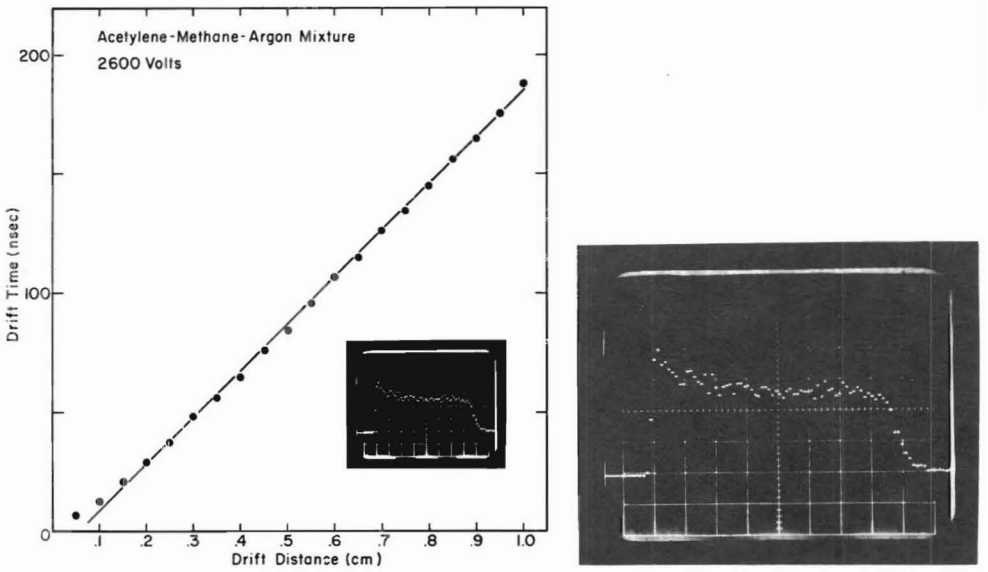

Figure 6. Drift distance to time linearity in the chamber produced by combining argon, acetylene, and methane.

drift-distance-to-time linearity in the chamber as seen in Figure 6. Also shown in the figure is a spectrum taken from the multichannel analyzer indicating the number of events as a function of time. Drift velocity, v_D, can be computed from:

$$\frac{dN}{dt} = \frac{dN}{dx} \, v_D,$$

where dN/dt is the number of events in the time interval dt, and dN/dx is the flux.

In the next generation of parallel foil drift chambers, we plan to replace the foils with resistive foils to determine the position of the particle tracks normal to the electron drift coordinate simultaneously by recording the RC rise time related to the localization of the induced pulses. This will eliminate multitrack ambiguities with two dimensional-dependent coordinate measurements of the track positions.

Reported by M. Atac

SOME COMMENTS ON THE RECENT PAC MEETING

The Program Advisory Committee met in Aspen, Colorado, during the week of June 17 to review research completed and in progress at Fermilab and to consider plans and proposals for future experiments and facilities. Although the lure of the mountains was great, this year's meeting was one of the busiest in the history of the PAC, and sessions continued until late each day.

The steadily improving operation of the accelerator and the beam extraction and transport systems has brought a dramatic increase in the rate of progress on approved experiments. This, coupled with interesting glimpses of new physics, has stimulated a surge in the submission of proposals--about ninety new ones have been received since the 1973 summer meeting. Recommendations were made on nearly sixty proposals. About 25% of them were approved, another 25% were rejected, and the remainder were deferred for consideration pending completion of other experiments or discussions at workshops and meetings scheduled for the coming year.

The Committee considered, in some depth, the progress in and possibilities for neutrino and muon physics experiments at Fermilab. The strong feeling was expressed that unusual and important opportunities exist for new and independent thinking in both these fields. The Committee recognized, however, that there is a potential problem arising from the almost unavoidable inertia resulting from the rather large size of the facilities and equipment required, and from the deep involvement of a rather limited number of physicists. A number of proposals have been submitted for work in these beams, and they will be considered during the coming year.

The Committee strongly supported the establishment of a high intensity, high energy, secondary hadron beam to be located in the Proton West Area. Such a facility might accommodate possible extensions of the types of experiments in progress in the Meson Area.

The Committee also noted that there is a relatively small backlog of experiments proposed for the Meson Area neutral beams, M3 and M4. They suggested that the Laboratory explore the possibility of increasing the effective use of these beams, and recommended, as one possibility, that the Laboratory study the feasibility of changing the present beam line configurations to provide an additional charged beam in the Meson Area.

Perhaps the most striking new area of interest, judging from proposals recently received, is related to the observation of apparent direct muon production at relatively large transverse momenta. A number of experiments have been proposed to explore the possibility that these muons may be produced in pairs. Such proposals will be considered at a Di-Lepton Workshop, scheduled for September 13.

On October 25, a workshop will be held for the presentation and discussion of proposals for second-generation use of the single-arm spectrometer facility in the Meson Area.

On November 4, a PAC Subcommittee will meet to consider proposals for the use of both the 30-inch and 15-foot bubble chambers. We assume that the engineering run involving a hadron bombardment in the 15-foot chamber will be completed by then, and hadron proposals for the 15-foot chamber will then be considered. In addition, by that time the initial results from physics

runs in progress using each of the two hybrid systems associated with the 30-inch chamber will be available. The effectiveness of these systems will be considered, and follow-on experiments which have been proposed for them will be discussed and recommendations formulated. A number of miscellaneous proposals for the use of the 30-inch chamber will also be discussed at the November 4 meeting. It is doubtful, however, that any further decisions will be made concerning deferred or unconsidered proposals for neutrino physics in the 15-foot chamber. The program approved for the Neutrino Area is still imposing, and further PAC action does not appear to be warranted at this time.

The recommendations formulated in the workshops and meetings just described will be presented to the full PAC at a meeting scheduled for November 14. The spring meeting of the full committee has been scheduled for March 20, and the 1975 extended summer meeting has been tentatively scheduled to begin on June 21.

Although this year's summer meeting was very productive, the Committee felt strongly that their deliberations were severely handicapped by the large volume of new material which was submitted in the final weeks before the meeting. As a result, we have decided to establish deadlines for the submission of material to be considered at future meetings of the Program Advisory Committee. Each deadline will precede by about one month the meeting at which the material in question will be discussed. In order to guarantee that a proposal receive full consideration at a given meeting, it must be received prior to the deadline set for that meeting. For the coming year the following deadlines have been set:

Deadline	Material Under Discussion
August 13, 1974	Any material to be considered at the Di-Lepton Workshop on September 13, 1974.
September 25, 1974	Any material to be considered at the Single-Arm Spectrometer Workshop on October 25, 1974.
October 4, 1974	Any material to be considered by the Bubble Chamber Subcommittee at its meeting on November 4, 1974.
October 14, 1974	Any material to be considered by the Program Advisory Committee at its fall meeting on November 14 and 15, 1974.
February 20, 1975	Any material to be considered by the Program Advisory Committee at its spring meeting on March 20 and 21, 1975.
May 21, 1975	Any material to be considered by the Program Advisory Committee at its extended summer meeting, scheduled to begin on June 21, 1975.

It is also our current expectation that at its spring meeting the PAC will consider proposals for second-generation experiments using the multiparticle spectrometer which is being installed and developed in the M6 beam line in the Meson Area. Changes and additions to the proposed meeting schedule will be announced in NALREP.

Reported by E. L. Goldwasser

NOTES AND ANNOUNCEMENTS

WORKSHOP ON DI-LEPTON PRODUCTION SCHEDULED . . .

A one-day workshop will be held on September 13, 1974 to discuss experimental proposals for studying di-lepton production at Fermilab. Representatives of groups having proposals on this topic and any other interested persons are invited to participate in the workshop. In keeping with the new Fermilab policy of establishing deadlines for the submission of written materials prior to PAC or PAC subcommittee meetings (see page 17, this issue), the deadline for the submission of written materials to be considered at this meeting is August 13, 1974.

The purposes of the workshop are to define as clearly as possible the physics objectives of the di-lepton experiments, to delineate what can be done at Fermilab, and to explore how well the experiments proposed meet these objectives. The meeting will begin with a discussion of the theoretical and experimental background leading to interest in studying di-lepton production. Representatives of each group which has submitted a proposal will then be invited to present their ideas (approximately one-half hour each). There will be a panel composed of some PAC members probably augmented by additional persons knowledgeable in this area of interest. The panel members will formulate recommendations for presentation to the Program Advisory Committee at their fall meeting, November 14 and 15.

The proposals that have been submitted to the Laboratory recently are:

Proposal	Institution	Spokesman
Di-Muon #308	University of Chicago Harvard University	J. Pilcher
Di-Muon #322	University of Chicago Harvard University University of Wisconsin	P. Wanderer
Di-Muon #323	University of Chicago Harvard University	J. Pilcher
Di-Muon #325	University of Chicago Princeton University	J. Cronin
Di-Muon #326	University of Chicago Princeton University	P. Piroué

Final arrangements for the workshop will be announced in the August issue of NALREP.

MORE ON-SITE HOUSING COMPLETED. . .

By the end of July, the Laboratory will have doubled the number of on-site housing accommodations available for visiting experimenters and their families. The former AEC Office at 2 Shabbona has been renovated into a 19-room dormitory known as Dorm #2, and the former Personnel and Employment Office at 21 Sauk has been renovated into a 10-room dormitory known as Dorm #3. Both these residences have common lounge areas. In addition, 3 of the farmhouses in Sauk Circle are being renovated to provide 6 more two-bedroom apartments.

There are now 89 housing units on-site. These include 57 dormitory rooms in Aspen East, The Pad, Dorm #2, and Dorm #3; 9 two-bedroom apartments and 1 three-bedroom apartment, and 22 three-bedroom houses. All are fully furnished, and linens are provided.

Visiting experimenters who will be working at Fermilab for nine months or less, and who wish to live on site, should contact the Housing Office, Ext. 3560, for more information. As a general rule, those planning to be at the Laboratory for more than nine months to a year are asked to locate housing off-site. The Housing Office will assist in finding suitable accommodations.

TAXI SERVICE STARTED. . .

Beginning Monday, July 22, taxi service will be available, on a trial basis, for official on-site travel between the hours of 8:00 and 11:00 a.m. and 1:30 and 5:00 p.m. on weekdays. The regular bus service will be in operation during the lunch period.

Pick-up and delivery points will be the main entrances to buildings. Pick-up will usually be made within 10 minutes after the Dispatcher has received the request. However, drivers may only wait for a passenger for 3 minutes--beyond that time, the request should be repeated.

To arrange for service, call the Dispatcher on Ext. 3831.

APPOINTMENTS. . .

James E. Finks, Jr., has been appointed Business Manager of Fermilab, effective immediately. He replaces James R. Campbell, who has accepted the position of Vice President of Queens College, New York. Finks, who joined the Laboratory staff as Assistant Director for Business Administration in July 1973, came to Illinois from Charlottesville, Virginia, where he was with the National Radio Astronomy Observatory. He holds the Bachelor of Electrical Engineering degree from the University of Virginia.

FACILITY UTILIZATION SUMMARY - JUNE 1974

The 300-GeV experimental research program which began on May 25 in the Neutrino, Proton, and Internal Target Areas continued during early June. Activities in the Meson Area were resumed on June 10. Approximately 510 hours of beam were scheduled for high-energy physics research during the month, of which 395 were useful. This is an efficiency of over 77%. The accelerator operated well at 300 GeV. A record peak intensity of 1.2×10^{13} protons per pulse was achieved on June 25; average operation during the period was at the level of 0.7 to 0.8×10^{13} protons per pulse. On June 27, preparations began for a two-week period of 400-GeV operation for experiments in the Proton, Neutrino, and Internal Target Areas. Accelerator tuning was still in progress at the month's end.

It should be noted that over 12,000 people attended a Laboratory Open House the afternoon of June 23. The accelerator was placed in standby with the beam off for an 8-hour period that day, to enable visitors to see the beam tunnels and some experimental areas.

A number of experimental groups took data during June. In Proton Center, Lepton #70 completed their electron and positron data runs at 67 mrad. In Proton East, Photoproduction #87A experienced considerable difficulty with both the 35- and 70-ft sections of their deuterium absorber. They did manage some running with the shorter section, and measured neutron attenuations. They also obtained data on the neutron and photon spectra in their neutral beam.

In the Neutrino Area, Muon #98 received approximately 190 beam hours, of which they used about 160 to take scattering data with liquid deuterium in their target. The beam splitting station was reinstalled and made operational during the first week in June. Splitting of the slow-spilled beam into the by-pass enabled the running of Neutrino #21A calorimeter tests, N-3 and N-5 hadron beam tests, calibration of the Detector Development #34 ionization spectrometer, and some set-up work by Quark Search #297, all in parallel with the operation for Muon #98. In addition, beam "pinged" into the bypass beam was used by Neutrino #1A for calorimeter calibration work and at the 15-foot bubble chamber for test run pictures with hadrons. A short period of fast-spill operation was also set up to take test pictures at the 15-foot chamber, and to check External Muon Identification #155 under neutrino running conditions. At the 30-inch bubble chamber, 52,000 pictures were taken for Experiment #163A, after which 50,600 pictures were taken for Experiment #161.

The Meson Area was in operation for physics research for slightly over two weeks during June. Five experimental groups took data during this period, including Elastic Scattering #7, Monopole #22, Multiplicities #178, Neutron Dissociation #305, and Beam Dump #108. Elastic Scattering #69A made use of available beam for apparatus setup and proportional chamber tests. Two groups, Detector Development #229 and Detector Development #261 used beam downstream of the Elastic Scattering #7 apparatus.

The facility utilization for the month of June is summarized as follows:

I. Summary of Accelerator Operations

		Hours	
A. Accelerator use for physics research			
Accelerator physics research		54	
High energy physics research		395	
Research during other use		(46)	
	Subtotal		449
B. Other activities			
Accelerator setup and tuning to experimental areas		11	
Scheduled interruption		61	
Unscheduled interruption		191	
	Subtotal		263
C. Unmanned time			8*
	Total		720

II. Summaries of High Energy Physics Research Use

	# of Expts.	Hours	Results
A. Counter experiments	14	1884	1884 hours
B. Bubble chamber experiments	3	110	102,583 pictures
C. Emulsion experiments	0	-	-
D. Special target experiments	1	1	1 hour
E. Test experiments	3	345	345 hours
F. Engineering studies and tests	4	84	84 hours
G. Other beam use		126	126 hours
	25	2550	

III. Number of Protons Accelerated and Delivered

		Protons
A. Beam accelerated in main ring	Total	13.10×10^{17}
B. Beam delivered to experimental areas		
Meson Area	1.03×10^{17}	
Neutrino Area		
Main beam	9.45×10^{17}	
Bubble chamber beam (estimated)	0.05×10^{17}	
Proton Area	1.01×10^{17}	
	Total	11.54×10^{17}

*Fermilab Open House

MANUSCRIPTS SUBMITTED FOR PUBLICATION DURING MAY AND JUNE 1974

Experimental Physics

F. T. Dao et al. NAL-Pub-74/37-EXP (Experiment 37)	pp Interactions at 300 GeV/c: Measurement of the Charged Multiplicity, Total and Elastic Cross Sections (Submitted to Physical Review)
F. T. Dao et al. NAL-Pub-74/45-EXP (Experiment 37)	Evidence for a New Scaling Behavior in High Energy Collisions (Submitted to Phys. Rev. Letters)
D. C. Carey et al. NAL-Pub-74/48-EXP (Experiment 63)	Inclusive π^0 Production in pp Collisions at NAL (Submitted to Phys. Rev. Letters)
D. C. Carey et al. NAL-Pub-74/49-THY/EXP (Experiment 63)	A Unified Description of Single-Particle Production in pp Collisions (Submitted to Phys. Rev. Letters)
H. Cheng et al. NAL-Pub-74/52-THY/EXP	Impact Picture Predictions for K^+p Scattering at NAL (Submitted to Phys. Rev. Letters)
B. Aubert et al. (Experiment 1A)	Measurement of Rates for Muonless Deep Inelastic Neutrino and Antineutrino Interactions (Submitted to Phys. Rev. Letters)
J. W. Cronin et al. (Experiment 100)	Observation of Large Transverse Momentum Muons Directly Produced by 300-GeV Protons (Submitted to Phys. Rev. Letters)
J. W. Cronin et al. (Experiment 100)	Search for Massive Penetrating Particles Produced by 300-GeV Protons (Submitted to Phys. Rev. Letters)
P. K. Malhotra et al. (Experiment 105)	Multiplicity in Proton-Nucleus Interactions at 200 GeV/c
P. L. Jain et al. (Experiment 114)	Study of Inclusive Reactions of $\pi^+ + p \rightarrow X +$ Anything ($X = \pi^0, \pi^+$) Near 1 GeV (Submitted to Nuovo Cimento Letters)
E. L. Berger et al. (Experiment 125)	Multiplicity Cross Sections for 100 GeV/c $\pi^- p$ Interactions (Submitted to Nucl. Phys.)

M. I. Tretyakova et al. (Experiment 183)	The Multiplicity in Fragmentation and Pionisation Regions in pp Interactions at 200 GeV/c (Submitted to the XVII International Conference on High Energy Physics, London, July 1-10, 1974)
M. I. Tretyakova et al. (Experiment 183)	Coherent Production of Particles by Protons at 200 GeV/c on Emulsion Nuclei (Submitted to the XVII International Conference on High Energy Physics, London, July 1-10, 1974)
M. I. Tretyakova et al. (Experiment 183)	Distributions of Rapidity Intervals, Jet Ranges, and Maximum Rapidity Gaps in Proton-Proton Interactions at 200 GeV/c (Submitted to the XVII International Conference on High Energy Physics, London, July 1-10, 1974)
M. I. Tretyakova et al. (Experiment 183)	Proton-Nucleus Interactions at 200 GeV/c (Submitted to the XVII International Conference on High Energy Physics, London, July 1-10, 1974)

Theoretical Physics

M. K. Gaillard and B. W. Lee NAL-Pub-74/21-THY	Rare Decay Modes of the K-Mesons in Gauge Theories (Submitted to Physical Review)
H. D. I. Abarbanel NAL-Pub-74/24-THY	Spontaneous Symmetry Breaking in Reggeon Field Theory (Submitted to Phys. Letters B)
H. P. Paar and E. A. Paschos NAL-Pub-74/29-THY	Lepton Pair Production in Hadron-Hadron Collisions (Submitted to Physical Review)
B. W. Lee and W. I. Weisberger NAL-Pub-74/32-THY	Asymptotic Symmetry (Submitted to Physical Review)
H. D. I. Abarbanel and R. L. Sugar NAL-Pub-74/33-THY	Secondary Trajectories in Reggeon Field Theories (Submitted to Physical Review)
M. K. Gaillard and B. W. Lee NAL-Pub-74/34-THY	$\Delta I = 1/2$ Rule for Nonleptonic Decays in Asymptotically Free Field Theories (Submitted to Phys. Rev. Letters)

M. B. Einhorn and R. Savit NAL-Pub-74/35-THY	Rigorous Bounds on Massive Lepton Pair Production and Tests of Parton Models (Submitted to Physical Review)
H. D. I. Abarbanel et al. NAL-Pub-74/36-THY	The Pomeranchuk Singularity in a Class of Reggeon Field Theories Suggested by Direct Channel Unitarity (Submitted to Physical Review)
H. D. I. Abarbanel NAL-Conf-74/40-THY	Theories of Diffraction Phenomena: A Tour for Beginners and Others (Invited lecture prepared for the Vth International Symposium on Many Particle Hadrodynamics, Leipzig, June 4-10, 1974)
R. Savit and M. B. Einhorn NAL-Pub-74/41-THY	Upper Bounds on Massive Lepton Pair Production, $pN \rightarrow \ell^+\ell^-X$, in the Quark-Parton Model (Submitted to Phys. Rev. Letters)
H. D. I. Abarbanel NAL-Pub-74/42-THY	Self-Consistent Pomeranchuk Singularities in Reggeon Field Theories (Submitted to Phys. Rev. Letters)
M. K. Gaillard NAL-Conf-74/43-THY	Notes on Charmed Particle Searches in Neutrino Experiments (Talk presented at the IVth International Conference on Neutrino Physics and Astrophysics, Philadelphia, April 26-28, 1974)
S. A. Jackson NAL-Pub-74/46-THY	Angular Momentum Analysis of a Composite Particle Scattering Problem and Its Cross Channel Analog (Submitted to Annals of Physics)
F. Henyey and R. Savit NAL-Pub-74/47-THY	Final State Interactions in the Parton Model and Massive Lepton Pair Production (Submitted to Phys. Letters)