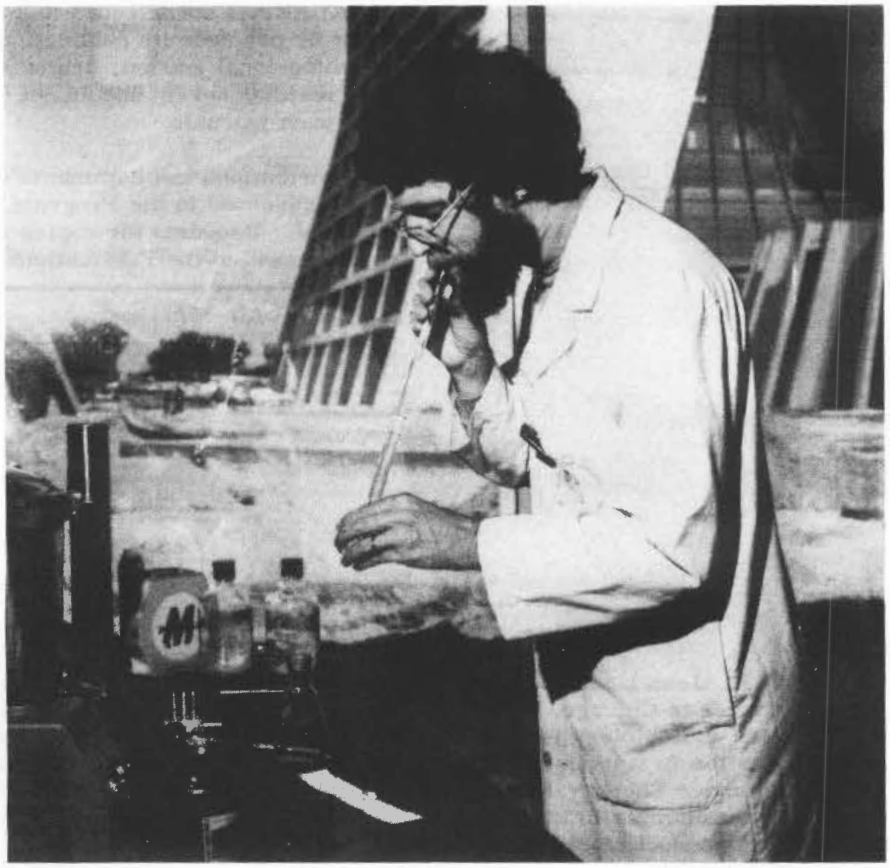
NALREP



Monthly Report of the Fermi National Accelerator Laboratory

November 1975

Fermi National Accelerator Laboratory

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J. R. Sanford, Editor
N. Stiening, Assistant Editor

Contributions and comments should be addressed to the Program Planning Office. Requests for copies should be addressed to the Publications Office.

FERMILAB-75/11 0090.01

THE COVER: John L. Redpath, radiobiologist on the staff of Michael Reese Medical Center in Chicago, conducting neutron experiments on E. coli B/R bacilli in the radiobiology laboratory on the west side of the Cross Gallery. Redpath was the first user of the neutron beam under development for the Fermilab Cancer Therapy Facility. Radiobiologists from Argonne National Laboratory, Columbia University, and the University of Maryland are scheduled to conduct more experiments during December.

Operated by Universities Research Association, Inc., under contract with the United States Energy Research and Development Administration

THE CANCER THERAPY FACILITY

In recent decades, radiation therapy of cancer and the understanding of radiation effects at the molecular and cellular levels have progressed considerably. The qualitative differences in biological effects of radiation with low and high specific ionization are now fairly well understood.

Some types of tumors which have cells effectively insensitive to photons and electrons in tolerable therapeutic doses may be controlled by radiation with high specific ionization. In soft tissues, fast neutrons with energies of a few million electron volts produce such heavily ionizing charged particles. Hence, they could theoretically be effective where photons and electrons fail.

Fast neutrons have been under study for about five years at the Hammersmith Hospital in London, England, where 16-MeV deuterons bombard a beryllium target and produce a beam of neutrons of up to 8 MeV mean energy. The results concerning the local control of head and neck tumors are very encouraging compared with treatment by conventional means.

In 1946, R. R. Wilson suggested using fast protons in cancer therapy. A quarter of a century later, in 1971, Fermilab physicists interested in such possibilities organized a conference on this subject. The organizers had foreseen compatibility between the requirements of high energy physics and medical research in the use of the injector protons.

In the midst of the planning for a proton therapy facility by a group of local radiotherapists and physicists, Dr. David Hussey of the M. D. Anderson Hospital for Tumor Research (Houston) was invited to give a talk about his research program in cancer therapy using fast neutrons. He was very

convincing. By the end of his visit it was generally felt that neutron therapy would be the research choice of most local radiotherapists. Thereafter, the interest in using neutron beams in a medical facility at Fermilab grew.

Early plans for such a facility called for the transport of protons of any energy between 37 and 200 MeV from the linac to the proposed clinic. The planned facility would have been located some 800 feet southwest of the present linac building. The protons would have been used in medical research directly for either therapy or radiography and indirectly for neutron therapy.

This clinic would have had several treatment rooms for exposures to neutrons and protons. It was matched with equally ambitious plans. The estimated cost matched them in magnitude. Inevitably, the realities of practicality led us to suggest a more modestly priced facility located within the existing linac building. This facility is now under development.

Beam Requirements for Medical Research

Fermilab high energy research usually makes use of 400-GeV protons from the main accelerator. To fill the circumference of this accelerator with one turn of protons, the booster accelerator must inject 13 "pulses." This takes nearly one second. The acceleration and extraction of the 400-GeV proton beam plus the return of the accelerator's magnetic fields to injection values takes about 8 seconds. During 8 of these 9 seconds, the linac and booster are on standby conditions. This means the injector systems continue to operate while no protons are needed for the main accelerator. If a deflection mechanism existed ahead of the main accelerator, protons could be diverted for other research purposes. In the present cancer therapy research project, 66-MeV

protons are extracted from midway along the linac to produce a neutron beam. The proton energy was selected as a compromise between neutron flux, neutron energy spectrum, and the cost to build the extraction and transport system.

The final neutron-producing target has not been selected. Neutron beams having satisfactory physical characteristics have been obtained using protons bombarding thick beryllium targets. Beryllium targets are attractive because they may be operated at high temperatures, conduct heat adequately, and have low vapor pressures at high temperatures. However, lithium targets are being considered as well, because they may generate biologically more interesting neutron beams. Before a final selection of target configuration is made, neutron energy spectra, rates of energy loss by recoil particles, and dose per incident proton will be measured at the University of California, Davis.

The biological characterization of these beams has already commenced. Clinically speaking, "good physical characteristics" mean:

-Low entrance doses to avoid skin damage.

-Depth for a dose equal to half of the maximum dose greater than 10 to 12 cm.

-Low gamma-ray contamination.

-Dose rate large enough to permit treatment times shorter than 10 minutes.

-Uniform neutron dose over at the location of the tumor, an area of 30 by 30 cm^2 maximum.

At this time, preliminary values for these parameters have been measured for each of two beryllium target thicknesses.

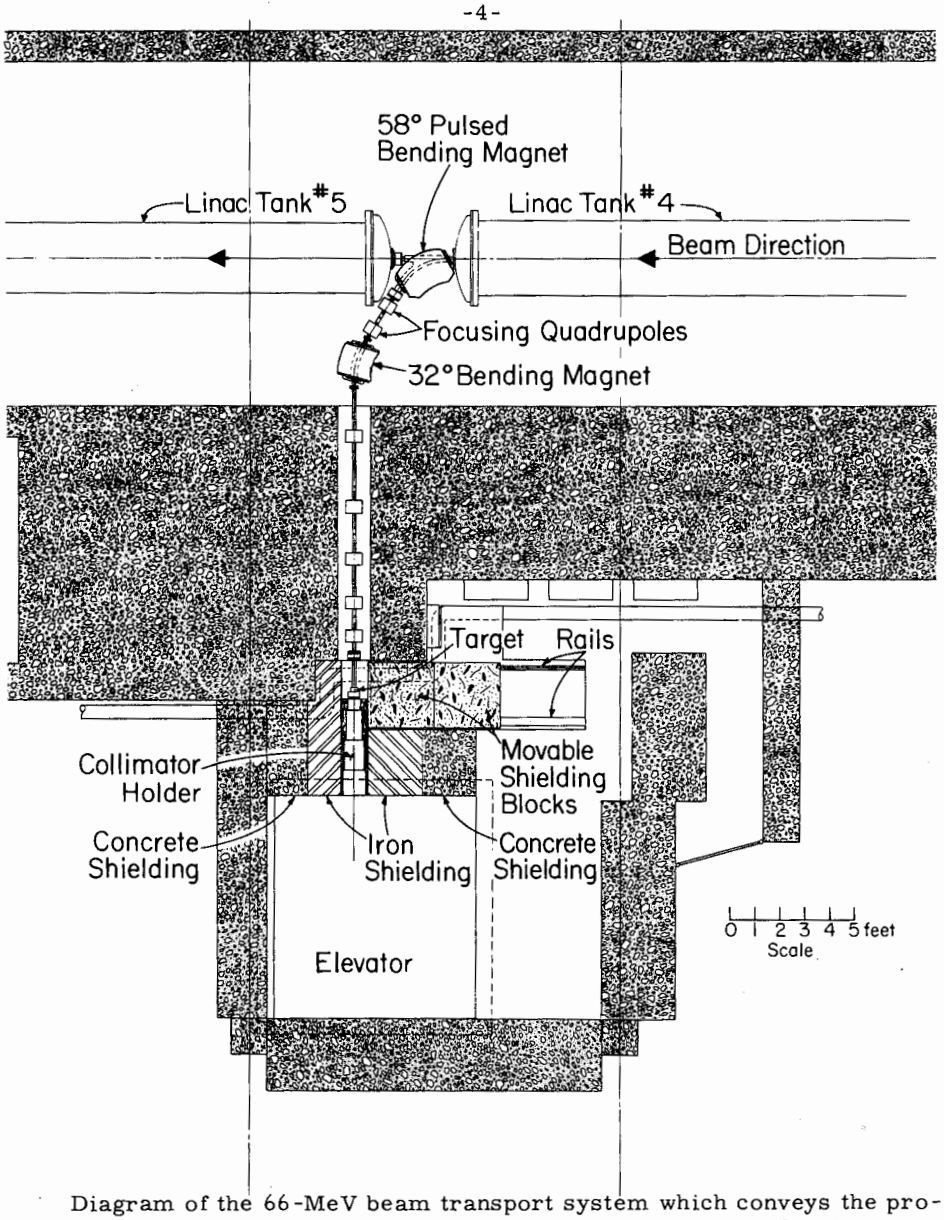


Diagram of the 66-MeV beam transport system which conveys the proton beam from the linac into a shielded enclosure on the lower level of the linac building. The first element in the transport line is a 58°-pulsed bending magnet, between linac tanks #4 and #5. Another bending magnet in the linac enclosure completes the 90° bend to direct the beam onto a beryllium target for the production of neutrons. The neutrons are aimed into a research area positioned on the elevator.

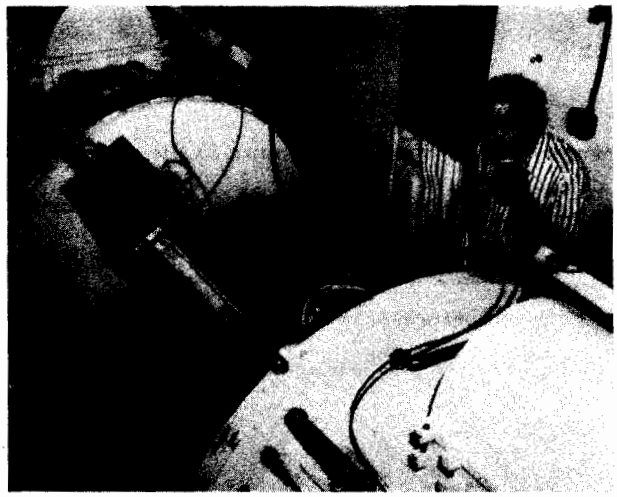
The Beam Line

The protons are extracted from the linac between tanks #4 and #5. The protons are bent by a pulsed magnet, shown in the photograph on page 6, through 58 degrees. After passing through a pair of quadrupole magnets, they are further deflected 32 degrees by a constant-field magnet. The protons then pass perpendicularly through a channel in a 10-foot concrete wall and are kept together with the aid of five additional quadrupoles, as shown in the diagram opposite.

The target is located 19 inches from the wall in the lower gallery of the linac building. The beam line is roughly centered within an area occupied by a hydraulic cargo lift measuring 8 by 9 square feet. Temporary shielding has been installed around and above this cargo lift to allow physical and biological measurements to be performed on the neutron beams. Small areas for radiobiology, reception, examination, and a control room have been planned for medical use on the first floor.

Funding

About $0.75 million of direct operating funds were obtained from the National Cancer Institute (U. S. Department of Health, Education, and Welfare) for an initial three-year period. Private funds are being sought from local foundations for plant modifications and some facility equipment. In addition to these two major sources of funds, two grants totaling slightly over $35,000 to purchase dosimetry equipment, beam time, and travel have been awarded by the American Cancer Society, Illinois Division.



D. Young checking the operation of the 58°-pulsed bending magnet between linac tanks #4 (upper) and #5, prior to the extraction of the first beam last July. Beam direction is left to right.

Status and Long-Term Schedule

The first neutron beam in the medical facility was obtained on July 17, 1975. Measurements of the neutron beam characteristics began this October. The work so far has consisted mainly of measurements to determine dose distributions. These will continue until early 1976, when the facility will be shut down to permit replacement of the temporary shielding with permanent shielding. Then measurements of the beam properties will be resumed.

The biological work has consisted of survival-versus-dose measurements for E. coli B/R bacilli under anoxic and oxic conditions, as well as hamster cell-tissue cultures. Some experiments with mice will also be carried out before the shutdown.

Should authorization and funds be secured, then research involving humans might begin in late spring 1976. It is expected that initially the

patients will come from the Chicago area; however, it is hoped that soon afterward patients will begin to come from throughout the United States.

The Fermilab Cancer Therapy Facility is planned for outpatients only. Other medical support will be provided from the patients' referring institutions, as well as from hospitals in Chicago and in the vicinity of Fermilab.

Most of the accomplishments thus far have been due to the efforts of enthusiastic volunteers, mostly from the Accelerator Division and the Chicago radiotherapy community. Since July 1975, Lionel Cohen of the Michael Reese Medical Center has assumed the position as Head of the Cancer Therapy Facility on a part-time basis. We thank everyone, and express the hope that their cooperation will continue in the future.

Reported by M. Awschalom

NOTES AND ANNOUNCEMENTS

BUBBLE CHAMBER SUBCOMMITTEE TO MEET. . .

A meeting of the Bubble Chamber Subcommittee of the Fermilab Program Advisory Committee will be held at the Laboratory on Thursday and Friday, January 15 and 16, 1975. The Subcommittee will review the large number of proposals currently on hand for hadron exposures in the 30-inch and 15-foot chambers, and will formulate recommendations to be acted on when the full PAC meets next on March 4 and 5, 1976. Questions pertaining to this meeting should be directed to T. Groves in the Directors Office, Ext. 3211.

USERS CENTER COMPLETES FIRST YEAR.

The Users Center, located in the former Village Cafeteria, has been in full operation for more than one year. It now serves as a focus for many recreational and social activities. During this year the Center has been attractively refurbished and developed through the assistance and cooperation of Universities Research Association, Inc. Improvements include a color television set, ping pong, pool, and various other table games. A grand piano is in the Music Room of the Center and an upright piano will be added to the Lounge Area shortly.

Sandwiches and snacks are now served. In the coming months special recreational events are being planned such as a pool tournament and card parties. Social evenings featuring buffet dinners and band music are also planned.

The Users Center Advisory Committee, appointed by the Laboratory, suggests amenities and activities for the Center. Members of the Committee are:

J. Rosen, Chairman	Northwestern University
L. Lederman	Columbia University
P. Limon	Fermilab
S. Mukhin	Dubna, USSR
L. Stutte	California Institute of Technology
C. Sazama	Fermilab (ex officio)

The Center is open Monday through Friday from 5:00 p.m. until midnight. N. Worthley is bartender/manager. A meeting room is also available to private parties and may be reserved by contacting J. Theis, Ext. 3560.

FACILITY UTILIZATION SUMMARY -- OCTOBER 1975

In October the high energy physics research program was basically a continuation of the 400-GeV run which began in July, with primary emphasis on the neutrino program. Accelerator operation was about as reliable as in September, with beam delivered to users for some 429 of the 587 hours scheduled, but the average beam intensity rose markedly and the beam spill quality continued to show improvement. An electrostatic extraction septum of improved design was installed early in the month. After some initial problems were resolved it operated well, and significantly reduced extracted beam losses. Routine splitting of higher intensity, slow-spilled beams to the Proton and Meson Areas were thereby made possible. Further improvements were made in the parallel connections and cooling of the main-ring magnet electrical feeders which resulted in an additional 15% reduction in the cycle time, to less than 8.5 sec when the accelerator is operating at 400 GeV with a 1-sec flat-top. This produced a corresponding 15% increase in the time average beam flux delivered by the accelerator. The net result of these efforts was a record monthly total of nearly 1.9×10^{18} protons accelerated.

During the last week in October the Meson Area was off for maintenance and development, while a concentrated effort was made to supply beam to the Neutrino Area at the highest intensity, consistent with continued running for the Proton Area program. A nominal 1-sec slow-spilled beam was extracted to the external experimental areas throughout the month, with four "pings" per machine cycle sent to the deuterium-filled 30-inch bubble chamber via the bypass beam.

The Neutrino #21 and Neutrino #254 experiments continued to receive first priority attention during October. About 1.4×10^{18} protons were delivered on target for these two groups, nearly half of them during the last week of the month. Antineutrino cross-section data were collected at three energies to complete both experiments. Elsewhere in the Neutrino Area, Experiments #209, #280, and #196 were completed in the 30-inch bubble chamber, with 50,800 pictures, 39,300 pictures, and 109,500 pictures, respectively, and incident proton beams of 300 GeV, 200 GeV, and 400 GeV, respectively. An additional 70,100 pictures were taken for Experiment #295 in a run that continued into November. Particle Search #382 continued parasitic set-up and testing work in the N-1 beam for nearly three weeks using hadrons, and then, for preliminary data, exposed two emulsion stacks to muons during two shifts of priority running. The targets for Quark #276 continued to receive bombardments on the target train from all slow-spilled beam in the N-0 line.

Four Proton Area experiments ran and collected data this month. Photoproduction #87A collected a significant quantity of data using the photon beam in Proton-East following a short tuneup with neutrons. In Proton-Center, Di-Lepton #288 collected data for the first two weeks followed by two weeks of tuneup and data taking by Di-Muon #436. Photon Search #95A was collecting some preliminary data in Proton-West after about two weeks of apparatus tuneup and calibration work.

The Meson Area program involved a total of eight user groups during the three weeks of area operation. Form Factor #216 completed data taking

work for the experiment on October 1. Neutral Hyperon #8, Elastic Scattering #69A, and Neutron Elastic Scattering #248 were in various stages of data collection during this period. Hadron Jets #236A and Hadron Jets #260 were both primarily involved in tuneup, testing, and calibration of their apparatus when beam was used. Particle Search #357 collected some preliminary test data, running behind Neutral Hyperon #8 in a parasitic mode throughout this period. Neutrino #310 tested their calorimeter during a few shifts of running while sharing the beam with Hadron Jets #260.

In preparation for future running using the spectrometer, Particle Production #418 continued to collect test data at the Internal Target Area using a rotating target. At the same time, during day and evening shifts, Proton-Proton Inelastic #321 continued to test their warm hydrogen gas jets using first a 3-mil and later a 1-mil jet nozzle. They also did some calibration of their detectors. Proton-Nucleon Inelastic #317 ran during the last week of October using the cold hydrogen jet, primarily to recheck and recalibrate some modifications and additions to their detector array.

The facility utilization summary for the month of October is as follows:

I. Summary of Accelerator Operations

		Hours	
A. Accelerator use for physics research			
Accelerator physics research		57.8	
High energy physics research		429.2	
Research during other use		(74.0)	
	Subtotal		487.0

B. Other activities

	Hours	
Accelerator setup and tuning to experimental areas	16.5	
Programmed interruption	51.6	
Unscheduled interruption	189.9	
Subtotal		258.0

C. Unmanned time

Total 745.0*

II. Summaries of High Energy Physics Research Use

	# of Expts.	Hours	Results
A. Counter experiments	19	3116.4	
B. Bubble chamber experiments	4	299.6	269,800 pictures
C. Emulsion experiments	-	-	
D. Special target experiments	1	391.4	3 targets
E. Test experiments	-	-	
F. Engineering studies and tests	-	-	
G. Other beam use	-	36.7	beam tuning
	24	3844.1	

III. Number of Protons Accelerated and Delivered ($\times 10^{18}$) @ 400 GeV

A. Beam accelerated in main ring	Total	1.896
B. Beam delivered to experimental areas		
Meson Area		0.231
Neutrino Area		
Main beam (N-0)		1.269
Bypass beam (N-7)		0.011
Proton Area		0.085
	Total	1.596

*Change to Central Standard Time 0200, October 26, 1975.

IV. Beam Utilization by Experiment

	Hours	
A. Meson Area		
Neutral Hyperon #8	295.5	
Elastic Scattering #69A	158.2	
Form Factor #216	18.3	
Hadron Jets #236A	228.2	
n Elastic Scattering #248	206.5	
Hadron Jets #260	26.7	Tests
Neutrino #310	90.5	Tests
Particle Search #357	170.7	Tests
B. Neutrino Area		
Neutrino #21A	316.2	$\int p \simeq 1.2 \times 10^{18}$
30" p-d @ 400 GeV #196	88.5	109,450 pictures
30" p-d @ 300 GeV #209	59.4	50,846 pictures
Neutrino #254	72.8	$\int p \simeq 2.3 \times 10^{17}$
Quark #276	391.4	3 targets (continuation)
30" p-d @ 200 GeV #280	35.0	39,336 pictures
30" π^+-d @ 200 GeV #295	116.7	70,133 pictures
Particle Search #382	139.6	2 emulsion stacks exposed
C. Proton Area		
Photoproduction #87A	296.6	
Photon Search #95A	349.5	
Di-Lepton #288	85.5	
Di-Muon #358	15.0	
Di-Muon #436	177.8	
D. Internal Target Area		
p-p Inelastic #317	130.7	
p-p Inelastic #321	53.5	
Particle Production #418	284.6	
Total	3807.4	

MANUSCRIPTS AND NOTES PREPARED DURING SEPTEMBER AND OCTOBER 1975

Copies of preprints with Fermilab publication numbers can be obtained from the Publications Office or Theoretical Physics Department, 3rd floor east, Central Laboratory. Copies of all articles listed are on the reference shelf in the Fermilab Library.

Experimental Physics

A. Benvenuti et al. Experiment #1A	Characteristics of Dimuons as Evidence for a New Quantum Number
A. Benvenuti et al. Experiment #1A	Dimuons Produced by Antineutrinos
V. P. Kenney et al. Experiment #2B	Leading Particles and Leading Clusters in π^-p Single Particle Inclusive Reactions at 200 GeV/c (Submitted for the Proceedings of the 1975 Palermo Conference on High Energy Physics, June 23-28, 1975)
V. P. Kenney Experiment #2B	Multiparticle Correlations (Rapporteur talk, APS Division of Particles and Fields Meeting, Seattle, August 27-29, 1975)
Notre Dame-Duke-I.P.P. Canada Collaboration (Presented by V. P. Kenney) Experiment #2B	Inclusive Study of Beam Dissociation into "Leading Clusters" at FNAL Energies (Submitted to the APS Division of Particles and Fields Meeting, Seattle, August 27-29, 1975)
N. N. Biswas et al. Experiment #2B	Two-Particle Correlations in Inclusive and Semi-Inclusive π^-p Reactions at 200 GeV/c (Submitted to Phys. Rev. Lett.)
M. J. Longo et al. Experiment #4	Neutron Total Cross Sections
C. W. Akerlof et al. Experiment #7	Elastic Scattering of Hadrons at 50 to 200 GeV (Submitted to Phys. Rev. Lett.)
C. W. Akerlof et al. Experiment #7	Observation of Structure in Elastic pp Scattering at 100 and 200 GeV/c (FERMILAB-Pub-75/69-EXP; submitted to Phys. Lett. B)

S. J. Barish et al. Experiment #31A	Antineutrino-Proton Interactions in the 15-Foot Bubble Chamber (Submitted to the 1975 International Symposium on Lepton and Photon Interactions, Stanford University, August 21-27, 1975)
D. L. Cheshire et al. Experiment #34	Response of a Tungsten-Scintillator Ionization Spectrometer to Hadrons with Primary Energies in the Range 5-300 GeV (Presented at the 14th International Cosmic Ray Conference, Munich, August 1975)
D. L. Cheshire et al. Experiment #34	Measurement of the Interaction Mean Free Path of Hadrons in a Modular Type Ionization Spectrometer (Presented at the 14th International Cosmic Ray Conference, Munich, August 1975)
C. T. Coffin et al. Experiment #45A	Neutrino Interactions on Protons at Fermilab Energies (Presented at the 1975 Meeting of the European Physical Society by B. P. Roe)
L. B. Leipuner et al. Experiment #48	Production of Prompt Muons in the Forward Direction by 300 GeV and 400 GeV Proton Interactions
D. C. Carey et al. Experiment #63	Inclusive π^{o} Production by High Energy Protons (FERMILAB-Pub-75/75-EXP; submitted to Phys. Rev. D)
C. Ankenbrandt et al. Experiment #69	Elastic Scattering of $\pi^{\pm}$, $K^{\pm}$, $p^{\pm}$ at Small Angles: A Preliminary Analysis (FERMILAB-Conf-75/61-EXP; submitted to the APS Division of Particles and Fields Meeting, Seattle, August 27-29, 1975)
S. B. Kaufman et al. Experiment #81	$^{12}C(p, pn)\,^{11}C$ Cross Section at 300 GeV
W. A. Loomis et al. Experiment #98	Inclusive Hadron Production in Inelastic Muon-Proton Scattering at 150 GeV/c (Submitted to Phys. Rev. Lett.)
P. F. M. Koehler Experiment #104	Measurements of Total Cross Sections Between 23 and 280 GeV/c (Submitted to the APS Division of Particles and Fields Meeting, Seattle, August 27-29, 1975)

D. Fong et al. Experiment #154	Evidence for Charged Cluster Emission in 147 GeV/c π^-p Collisions
D. Fong et al. Experiment #154	Inclusive and Semi-Inclusive ρ^0 Production in π^-p Interactions at 147 GeV/c (Submitted to Nucl. Phys. B)
D. Fong et al. Experiment #154	Inelastic 2-Prong Events in 147 GeV/c π p Collisions (Submitted to Nucl. Phys. B)
K. Hoshino et al. Experiment #156	On the X-Particles Observed in the Cosmic Ray Jet Showers
Alma-Ata-Leningrad-Moscow-Tashkent Collaboration Experiment #183	On Some Identical Characteristics in Proton-Nucleon and Proton-Nucleus Interactions at 200 GeV
M. I. Adamovich et al. Experiment #183	Data on 200 GeV Proton-Nucleus Interactions and Generation of Clusters in Multiparticle Production
S. Dado et al. Experiment #194	Multiplicity Distributions in π^+d and pd Collisions at 100 GeV/c (FERMILAB-Pub-75/66-EXP; submitted to Phys. Rev. Lett.)
G. Baroni et al. Experiment #233	Two Particle Rapidity Correlations in Proton-Nucleus Interactions at 300 GeV (Submitted to Phys. Lett. B)
J. R. Florian et al. Experiment #237	Interactions of 300 GeV Protons with Tungsten and Chromium
K. J. Anderson et al. Experiment #331	Mu-Pair Production by 150 GeV/c Hadrons (Invited paper presented at the 1975 International Symposium on Lepton and Photon Interactions at High Energies, Stanford University, August 1975)
A. Benvenuti et al. Experiment #370	Further Observation of Dimuon Production by Neutrinos

Theoretical Physics

T. Appelquist	Gauge Fields and Strong Interactions (FERMILAB-Lecture-75/02-THY)
S. L. Adler et al.	Isospin $\frac{1}{2}$ Nucleon Resonance Production by a V,A Weak Neutral Current (FERMILAB-Pub-75/52-THY; submitted to Phys. Rev. D)

J. Bartels and E. Rabinovici	A Study of Multiparticle Production in Reggeon Field Theory (FERMILAB-Pub-75/55-THY; submitted to Phys. Rev. D)
M. B. Einhorn and B. W. Lee	Contributions of Vector-Meson Dominance to Charmed Meson Production in Inelastic Neutrino and Antineutrino Interactions (FERMILAB-Pub-75/56-THY; submitted to Phys. Rev. D)
C. Itzykson and J. B. Zuber	Quantum Field Theory and the Two-Dimensional Ising Model (FERMILAB-Pub-75/57-THY; submitted to Phys. Rev. B)
H. J. Lipkin and J. P. Schiffer	Possible Evidence for the Existence of Strangeness Analog States (FERMILAB-Pub-75/58-THY; submitted to Phys. Rev. Lett.)
H. J. Lipkin	Spectroscopy After the New Particles (FERMILAB-Conf-75/59-THY; submitted to the International Conference on High Energy Physics, Palermo, Italy, June 23-28, 1975)
J. F. Bolzan et al.	Zweig's Rule Violation, SU(3) Character of the Decay of the New Particles, and Pole Dominance Picture (FERMILAB-Pub-75/62-THY; submitted to Phys. Rev. D)
C. Quigg	An Agenda for Correlations (FERMILAB-Conf-75/63-THY; presented at the VIth International Colloquium on Multiparticle Dynamics, Oxford, July 1975)
C. H. Albright and R. J. Oakes	Vector Meson Mixing, Lepton Pair Decays and Mass Formulas in the SU(4)/Z(2) Sextet Quark Model (FERMILAB-Pub-75/65-THY; submitted to Phys. Rev. Lett.)
H. J. Lipkin	What Are Total Cross Section Data Trying To Tell Us? (FERMILAB-Conf-75/67-THY; submitted to the International Conference on High Energy Physics, Palermo, Italy, June 23-28, 1975)
T. Appelquist	Heavy Quarks and Their Experimental Consequences (FERMILAB-Conf-75/70-THY; invited talk at the Argonne Conference on New Directions in Hadron Spectroscopy held at Argonne National Laboratory, July 9, 1975)

R. Michael Barnett — A Review of Models with More than Four Quarks (FERMILAB-Conf-75/71-THY; invited talk at the 6th Hawaii Topical Conference in Particle Physics, University of Hawaii, Honolulu, August 1975)

B. W. Lee — Review of Gauge Theories (FERMILAB-Conf-75/72-THY; invited talk at the 1975 International Symposium on Lepton and Photon Interactions at High Energies, Stanford University, August 1975)

General

J. Lindberg et al. — Fermilab Target Areas and Target Train Systems (To be presented at the 23rd Conference on Remote Systems Technology Winter Meeting, American Nuclear Society, San Francisco, November 16-21, 1975)

J. Grimson et al. — Design of the Fermilab Neutrino Horn Train System Referenced to Radioactive Maintenance (To be presented at the 23rd Conference on Remote Systems Technology Winter Meeting, American Nuclear Society, San Francisco, November 16-21, 1975)

J. Simon et al. — Design of the Fermilab Remote Target Maintenance System (To be presented at the 23rd Conference on Remote Systems Technology Winter Meeting, American Nuclear Society, San Francisco, November 16-21, 1975)

Physics Notes

S. I. Baker
FN-276 — Beam Intensity Measurements Using Copper Foils

L. C. Teng
FN-277 — High-Efficiency Buncher System for Linac

M. Awschalom et al.
FN-278 — Energy Deposition in Thick Targets by High Energy Protons: Measurement and Calculation

J. Bobbitt
FN-279 — Knowledgeable Modules and Service Controllers

R. Harris
FN-280
Experiment #234 — Searches for Charmed Particles Using Bubble Chambers (Rapporteur talk presented at the APS Division of Particles and Fields Meeting, Seattle, August 27-29, 1975)

D. Bogert et al. FN-281 Experiment #234	Search for Charm in 250 GeV/c π^-p Interactions (Presented at the APS Division of Particles and Fields Meeting, Seattle, August 27-29, 1975)
P. Berge et al. FN-282	15-Foot Bubble Chamber Characteristics (Presented by F. R. Huson at the Fermilab Bubble Chamber Symposium, September 18-19, 1975)
S. Kahn FN-283	Inclusive Neutral Particle Production (Submitted to the APS Division of Particles and Fields Meeting, Seattle, August 27-29, 1975)

DATES TO REMEMBER

December 18-19, 1975	Workshop on the Short-Lived Particle Beam Facility
January 15-16, 1976	Bubble Chamber Subcommittee Meeting
January 23, 1976	Deadline for receipt of new proposals and other written materials to be considered at the March meeting of the Program Advisory Committee
February 5-6, 1976	Proposal Presentation Meeting
March 4-5, 1976	Spring meeting of the Fermilab Program Advisory Committee