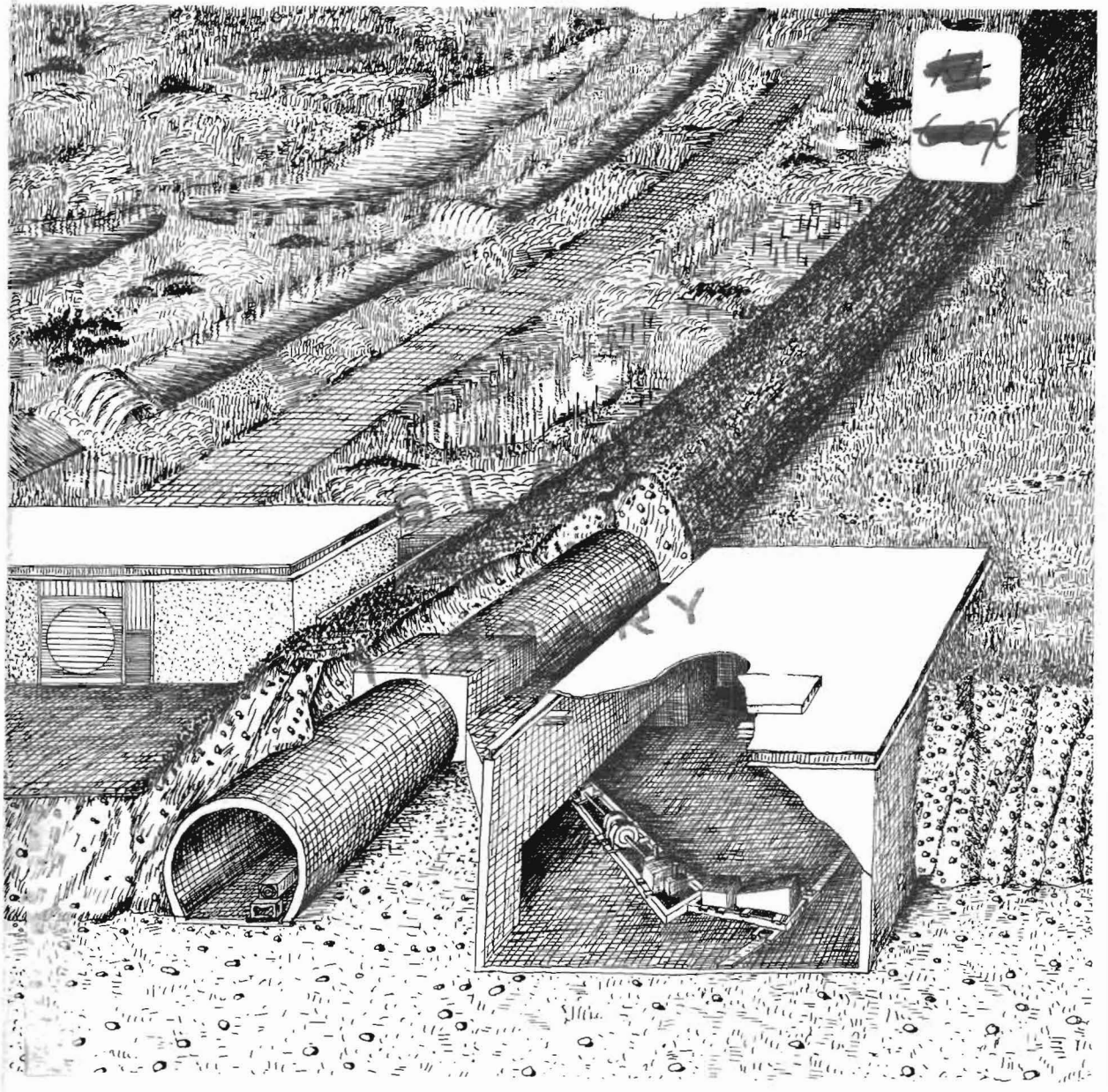
NALREP



Monthly Report of the Fermi National Accelerator Laboratory

June 1975

Fermi National Accelerator Laboratory

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

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FERMILAB-75-6 0090.01

THE COVER: Drawing of the new experimental room adjacent to the main-ring tunnel at the C-Zero straight section. The room, 40 by 50 feet, and 20 feet below ground level, is excavated at the outside rim of the tunnel and connected to it by a 15-foot transition section. A part of the superconducting spectrometer now under construction is shown inside the room. When complete, the ≈40-foot long single-arm spectrometer will be remotely operable from ≈90° to the beam to ≈40° forward angle. The C-Zero service building is to the left of the berm.

(Drawing by A. Gonzales)

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

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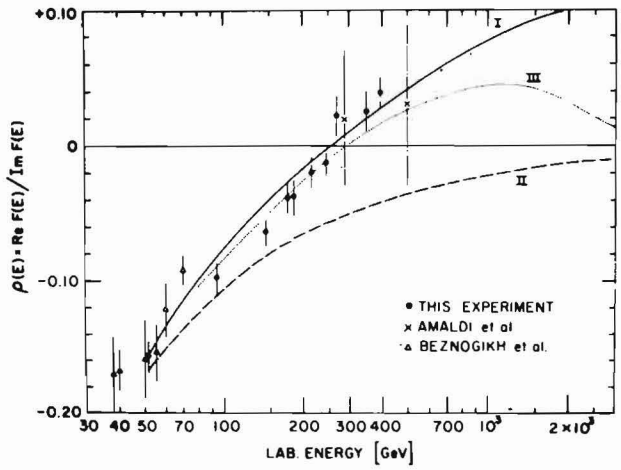
INTERNAL TARGET AREA EXPANDED

With the completion of additional experimental floor area, the Internal Target Area is entering a new era of operation. In the past two and one-half years, experiments have been conducted within the confines of the main-ring tunnel enclosure at C-Zero. This tunnel section, which measures 155 by 12 feet, offers very little "maneuvering space." The problems of doing experiments are compounded by the Accelerator Division requirement that passage be instantly provided for the magnet moving vehicle, thus limiting space for experimental apparatus even further.

Despite these severe limitations, a number of successful experiments have been conducted in the C-Zero straight section, using targets consisting of jets of hydrogen gas or carbon-CH_2 fibers mounted on a rotating disc. Several fundamental experiments have been made by collaborations of United States and Soviet Union scientists: Proton-Proton Scattering # 36, Proton-Deuteron Scattering # 186, and Proton-Nucleon Inelastic # 317 to name a few. As one example of an outstanding contribution, one may cite the measurement of ρ parameter for proton-proton scattering as shown in the curve on page 2:

$$\rho(E) = \mathrm{Re}\, f(E)/\mathrm{Im}\, f(E).$$

The $\rho(E)$ was measured up to 400 GeV, the highest laboratory energy available, with the value crossing zero in the vicinity of 250 GeV. The experimental errors are significantly smaller than the corresponding results from the CERN ISR. Using a rotating fiber target, the Proton-Proton Inelastic # 221 group undertook to measure inelastic inclusive cross sections at small momentum transfer--a domain not accessible at the ISR. The # 317 group is currently doing similar work using the hydrogen jet target.



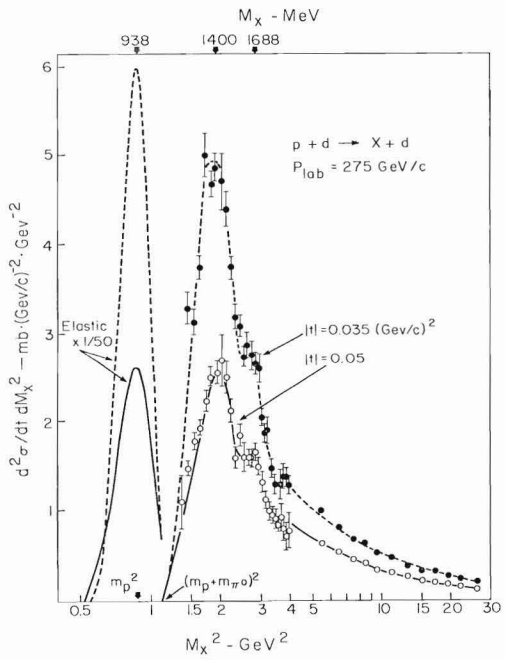
The measured values of the ρ (E) parameter; ratio of the real to imaginary part of the forward scattering amplitude, versus laboratory energy. The circles represent Fermilab Proton-Proton Scattering # 36 values, while crosses are ISR results and triangles represent some earlier values from Serpukhov. The three lines are theoretical model predictions.

Several particle search experiments have been carried out in the C-Zero tunnel section also. The Particle Search # 184 group looked for direct muon production as a function of laboratory energy, and Particle Search # 363 looked for charm particles by measuring the K/π ratio with varying incident momenta. As a further example of timely results, one can mention the inclusive π^0 production spectra measured by the Photon Search # 63 group. The excellent resolution capability of the Internal Target Area is evident in the curves provided by the # 186 group, shown on page 3.

The inaccessibility of the experimental apparatus placed severe demands upon the experimenters' ingenuity in designing reliable apparatus. The difficulties of limited access were overcome, however, and the operation of the Internal Target Area has not caused more than one or two hours of accelerator down time during the past two years.

Missing mass spectrum obtained by measuring the angle and energy of recoiled deuterons in the reactions $p + d \rightarrow X + d$. The largest peak, demagnified by a factor of 50, is the elastic peak; the dashed curve represents the observed production of low-mass resonances (isobars) at the 275-GeV incident energy. Two such curves are drawn, each for a different recoil angle corresponding to the momentum transfers of 0.035 and 0.050 $(GeV/c)^2$, respectively. The curves exhibit a clear minimum at a mass value just before a single pion production sets in: $M_X = M_p + M$.

(Courtesy of #186 group)



The gas jet target operated on demand for almost two years without significant troubles. Late in 1974 the original hydrogen jet target developed small helium leaks, presumably caused by the cycles of cooling and mechanical motion to which it was subjected during its long operating period. Some 2000 to 3000 thermal cycles from room temperature to 4°K have been recorded. Although in no way catastrophic, these leaks were a nuisance to accelerator maintenance personnel, creating a significant helium background during leak testing with helium mass detectors. For this reason, the jet target was removed in late 1974, and a tedious repair begun. The

collaboration between the USSR group from Dubna and the Fermilab experimenters worked well. In fact, besides repairing the old target, a whole new spare jet target has been brought in pieces from the USSR, and with significant improvements completed, is being readied for tests.

Several other avenues of gas target development are now being explored by P. Mantsch and F. Turkot of Fermilab, and by P. Franzini and J. Lee- Franzini of Columbia University and Stony Brook, respectively. Tests are underway to see whether a "warm" jet target can be used for some specific measurements. In such a jet, the liquid helium cryo-pumping method is not employed; instead, the great evacuation ability of diffusion pumps is used to remove the hydrogen gas injected into the vacuum chamber. A massive effort to develop a successful helium gas jet target is in progress at Dubna, as well. When this target passes all of the required safety tests demanded by accelerator operation, it will be installed in the C-Zero straight section. Thus, three jets may be in operation in the main accelerator tunnel by the beginning of 1976. The operation of the jet target has been greatly improved by the addition of new controls and monitoring devices built by the C-Zero crew of technicians.

At the time of this writing, a new room addition has just been finished which will greatly facilitate doing experiments at the Internal Target Area. The addition, a room measuring 40 by 50 feet in area, is connected to the main-ring tunnel by a transition section 15 feet in length. Eventually the room will house a superconducting spectrometer. Besides the main penetration, another hole has been drilled into the tunnel section to accommodate "viewing" of the yet to be installed helium jet.

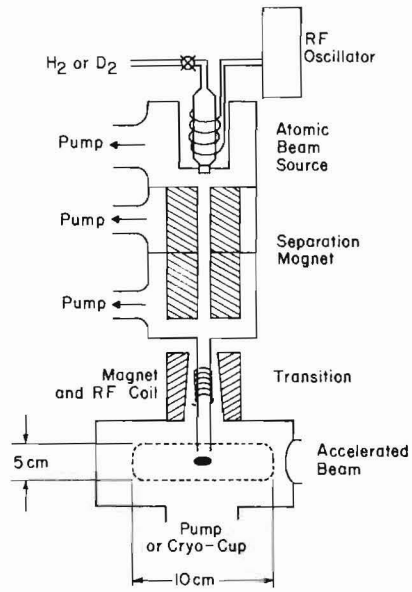
To construct an experimental area adjacent to an operating accelerator required finely planned engineering and arrangements between the Internal Target Group, the Architectural Services Department, and the outside contractors. No delays were experienced, and in a ten-day shutdown in April the remaining 7 feet of transition "hallway" was excavated, concrete poured, and a 7- by 7-foot hole opened into the tunnel wall.

This new recoil room will greatly augment the use of the jet targets for high energy physics research. The benefit is twofold. First, the room can house the spectrometer magnets, thus allowing the measurement of higher momenta for recoil particles than possible using solid state detectors alone. Secondly, by removing the detection apparatus from the main-ring tunnel, the background radiation can be more easily suppressed by adding shielding.

Remote operation of superconducting magnets, with only once-a-week access, together with improved jet cryogenics, will be a very complex undertaking. Just how well and how reliably the whole operation is going to proceed remains to be seen. Once the hurdle of construction and initial operation in the room is overcome and experiments are operating smoothly, one may begin to think of future developments such as a polarized gas jet target.

The increasing accelerator intensity, combined with multiple beam traversals, makes the use of polarized beam targets more than mere speculation. The present state of the art can produce atomic beams of 10^{12} hydrogen atoms/cm^3 with 70 to 95% polarization. A circulating beam of 2×10^{13} protons and 5×10^4 traversals/sec can result in a luminosity of:

$$\underset{\text{target}}{10^{12}} \times \underset{\text{beam}}{2 \times 10^{13}} \times \underset{\text{traversals.}}{5 \times 10^4} = 10^{29}\ \text{cm}^{-2}\ \text{sec}^{-1}$$



Schematic view of a polarized atomic beam target. At the top is a chamber where molecules are dissociated into atoms by an applied radio-frequency field. The atoms of thermal velocity then pass through a sextupole magnet and then through the transition field magnet and the rf spin-flip cavity. The sextupole field and rf field "separate" states of different spin orientation. Finally, highly polarized atoms emerge into a beam chamber and are caught at the bottom by a pumping orifice. The accelerating beam is normal to the diagram and in the center of the beam pipe indicated by the dashed contour.

This is actually an enviable luminosity when compared with the solid polarized targets of the butanol variety in which one achieves 70% polarization. However, solid polarized targets suffer from the contamination of the many non-polarized protons; in fact some 80% of the protons in the target are unpolarized, residing in carbon nuclei. The atomic beam target is free of such background. Therefore, one can contemplate the measuring of reactions in addition to elastic scattering. Since the spin can be flipped with ease a thousand times a second, polarization can be measured in a variety of inclusive processes by direct recoil counting. The cost of such atomic beams is also comparable with that of conventional polarized targets. It is hoped that when polarization

measurements in a variety of proton-proton reactions become important to make, such a target will be available and installed in Fermilab's Internal Target Area.

Reported by D. Jovanovic

HYDROGEN TARGETS

Most high energy physics experimenters at Fermilab require liquid hydrogen or deuterium targets for particle interaction studies or for hadron filtering. The simple nuclear structure of hydrogen permits clearer interpretations of interactions than is possible using denser materials. Deuterium is used as a neutron target in which case the proton-induced reactions must be subtracted. To provide a dense and efficient target the hydrogen or deuterium is used as a liquid. Hydrogen liquifies at 20°K (-423°F) and deuterium liquifies at 23°K (-417°F). With minor adjustments to the equipment, both fluids can be used alternately in Fermilab targets.

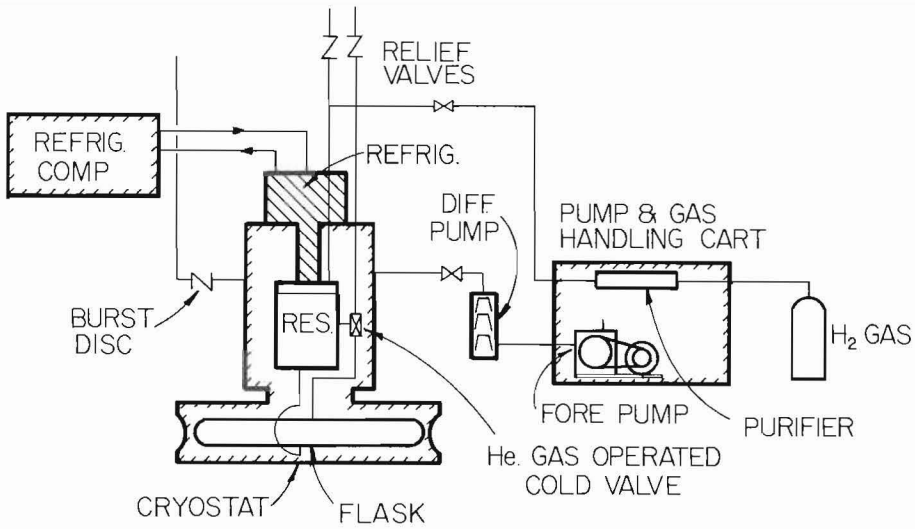
All Fermilab cryogenic targets are refrigerated, since refrigerated targets contain the minimum amount of liquid hydrogen. Only the liquid required to fill the flask is needed, since the refrigerator continuously recondenses the boil-off gas. Transporting liquid hydrogen in the experimental areas is eliminated, and target venting requirements are greatly reduced. Surveillance is minimized because the smaller inventory of hydrogen is more easily controlled. Personnel are necessary only for occasional monitoring and for start-up and shut-down operations.

A typical refrigerated liquid hydrogen target system consists of a Mylar or thin metal cylindrical hydrogen flask, suspended in an evacuated cryostat to insulate the liquid from room temperature. A mechanical refrigerator removes heat incident on the flask from the ambient environment. The target flask and cryostat are usually custom designed to meet the specific experimental requirements. Modularization and standardization of ancillary

equipment reduces the amount of custom work required. Operation is also simplified, since the control console contains the same equipment arrangement and flow diagram for all targets. The diagram on page 11 shows the typical target system piping and components for a single-flask target having less than a 6-liter flask and a refrigerator load of less than 10 W at 20°K. An open cold valve connects the flask to a reservoir when there is liquid in the flask. This valve is closed when the liquid is temporarily moved into the reservoir for taking background data. The hydrogen can remain in the reservoir up to four hours before it must be returned to the flask.

Target systems containing both liquid hydrogen and liquid deuterium are more complicated since they usually have three identical flasks. The two liquid-filled flasks are physically moved aside to collect "target empty" data by substituting an evacuated flask. These systems are several times more expensive, since the refrigeration equipment is duplicated and a specially designed manipulator and readout indicators are necessary.

Targets are designed for experimenters by Research Services Department, Cryogenics Group. The flask, cryostat, and support hardware are specified in the agreement for each experiment. Standardized Fermilab equipment available for assignment include 20°K refrigerators of several types and capacities, a cart-mounted pumping and gas handling unit and a control console containing readouts for pressure, liquid level, and vacuum, in addition to a graphic control panel. Special safety requirements for the target system such as venting, inerting and safety interlocking, are considered very early in the design. Additional equipment, such as hydrogen



Schematic diagram of a typical Fermilab cryogenic target system incorporating a small, single-flask target. The flask contains the liquid hydrogen or deuterium used as a target in an experiment.

gas detectors, inerting system modules, and fire and draft sensors are available to implement these requirements. The completed target system is assembled for testing in Laboratory 3 in the Village. Rigorous testing of each target is performed before the target is prepared for installation in an experimental area. Large target systems, those having a liquid capacity of more than 30 liters, may be tested in an outdoor area adjacent to Lab 3 which has utilities for remote target operation.

Each target installation is reviewed by a subcommittee of the Laboratory Safety Committee to eliminate hazards peculiar to the location of the target system. The experimental area Department Head reviews the findings of

the Cryogenic Safety Subcommittee and authorizes the Cryogenics Group to fill and operate the target. If the target or support equipment is modified, the complete installation is reviewed again.

The Cryogenics Group operates all Fermilab targets and has first-line responsibility for the systems. Upon request, the experimental group is authorized to operate the cold valve for "target empty" runs or for target manipulation when a system is so equipped.

A number of interesting and cryogenically significant target systems have been used at the Laboratory and others are being commissioned or are in the design/fabrication stage.

The total cross section experiment (# 104) used the largest refrigerated target system built to date. With a total liquid inventory of 300 liters, approximately that of the 30-inch bubble chamber, housed in vessels with thin Mylar windows, and located in a poorly ventilated area, this system presented a technical and safety challenge. The target is of the three-flask type; the 50-liter inventory of LD_2 dictated a deuterium recovery system. Installed in a nitrogen gas-filled room, the system met demanding safety criteria. A round-the-clock operator was provided when the target contained liquid. The system operated uneventfully for several months of data taking.

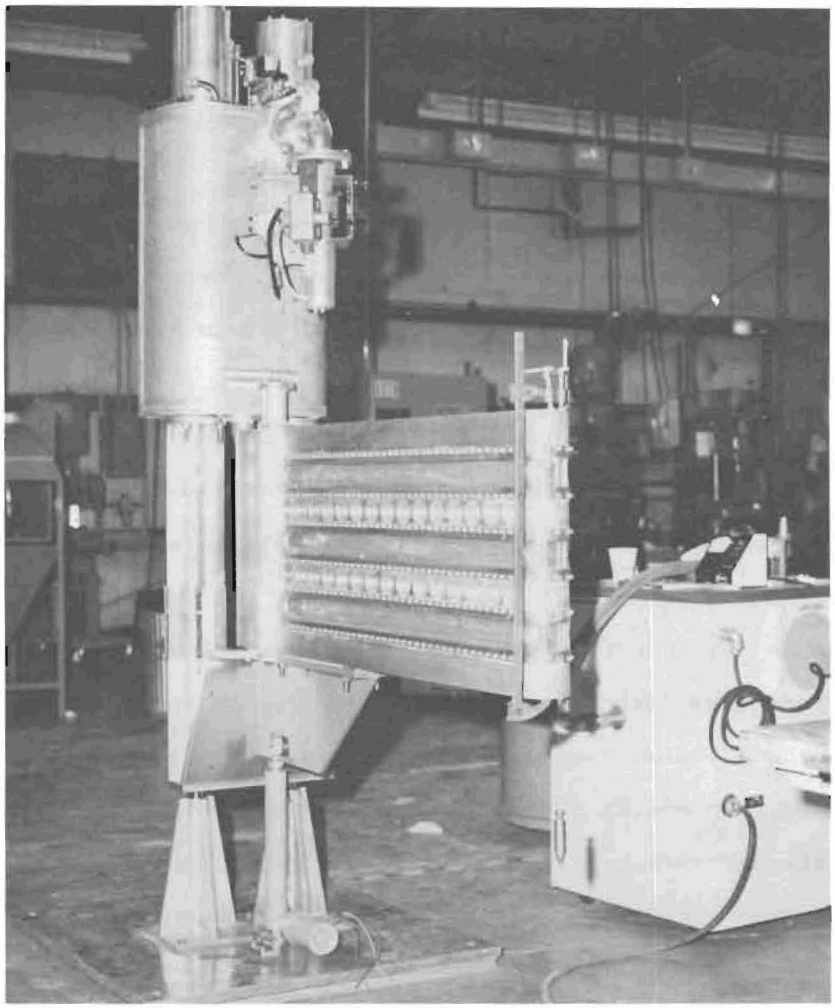
As part of the broad-band photon facility in the Proton Area, a 100-foot-long liquid deuterium vessel is installed between the poles of sweeping magnets. The function of this filter system is to attenuate neutrons and provide the clean photon beam desired for photo-production experiments (# 87). The LD_2 flask is approximately one inch in diameter and the system contains about

32 liters of liquid deuterium. A portion of the deuterium can be emptied into a liquid reservoir to obtain background data or to utilize the unattenuated neutron beam. The filter is installed in the Proton-East underground hall. This location required that special venting be installed. The cryogenic system ran almost continuously for about six months as the experimenters accumulated their data. Several other dual fluid targets have been used and the three-flask target system shown on page 14 for Neutral Hyperon #8 has recently been commissioned.

At this writing, the installation of the small target in Proton-West for Particle Production #284/Photon Search #95 is nearly complete. The flask for this target is unusual in that it is only one centimeter in length and 5 inches in diameter, with flat windows. The life of the flask, limited by radiation damage as it is traversed by the high-energy proton beam, can be prolonged by remotely moving the flask. The target for another Proton Area experiment, Particle Search #300, is under test in Lab 3. The flask is mounted at the end of a 20-foot-long cryostat within one of the Proton-East target box drawers.

There are at present eight liquid hydrogen targets installed in the experimental areas, including five in the Meson Area and three in the Proton Area. Another ten systems are in various stages of design, fabrication, or testing, including two for Proton, seven for Meson, and one for Neutrino.

As part of the improvement program to update equipment to provide greater reliability to the user, an improved computer monitoring system is being designed which will permit continuous monitoring of all target equipment



The three-flask target for Neutral Hyperon # 8 under test in Laboratory 3 prior to its installation in the M2 beam line in the Meson Area. Each flask has a capacity of approximately 1 liter; the upper one is filled with hydrogen, the center one is empty, and the lower one is filled with deuterium. The two refrigerators needed are housed in the container above the target. At the base of the target is the jack mechanism--manipulator--used for vertical positioning.

via telephone link to other parts of Fermilab. Additional circuitry will permit remote restarting of equipment after a power failure and some additional control of target functions. Targets will be continuously monitored from a common point; abnormal parameters will sound an alarm and alert personnel. This system should increase surveillance, while keeping the manpower requirement to a minimum. Down time due to unnoticed operational changes should be eliminated.

The installation and operation of target systems would be impossible without the cooperation and continuing efforts and assistance of engineers and technicians from all the experimental area departments.

Reported by M. Otavka and R. Fast

NOTES AND ANNOUNCEMENTS

REMINDER . . .

All persons visiting Fermilab who will be present on site for more than one day are asked to go first to the Users Office (first floor east, Central Laboratory) to sign the necessary papers related to their stay on site and to receive an identification card. This greatly facilitates the handling of telephone calls and mail.

Anyone working at the Laboratory is required to have in his/her possession a valid identification card to permit access to Fermilab facilities and the stockrooms. Prerequisite to the receipt of a regular I. D. card is the signing of a "Users Patent Agreement" form required by the Laboratory. (This requirement is waived for short-term visitors who are not actually working at the Laboratory and who receive only temporary I. D. cards.)

It is Fermilab policy that all of the services of the Laboratory, including those of the Housing and Travel Offices, and on-site housing accommodations, will be available only to those having valid I. D. cards in their possession. Regular visitors' I. D. cards are valid for two years. Anyone having an out-of-date card should stop at the Users Office and renew it.

APPOINTMENTS . . .

Charles Brown has been appointed Head of the Meson Department effective June 1. Alan Wehmann will serve as Assistant Head of the department.

Robert Daniels has been appointed Head of the Research Services Department.

FOR THE COMING YEAR . . .

Members of the Board of Trustees of Universities Research Association for the coming year include:

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*New trustee, elected January 31, 1975.

The officers of Universities Research Association, Inc., remain the same, namely:

N. F. Ramsey, President
B. F. Bennett, Vice President for Administration
R. K. Buchanan, Jr., Secretary
R. A. Williams, Treasurer/Controller
R. R. Wilson, Director, Fermi National Accelerator Laboratory

USERS EXECUTIVE COMMITTEE . . .

Following the Annual Meeting on May 2, 3, 1975, members of the Fermilab Users Organization voted by mail for new members of the Users Executive Committee and on an amendment to the Users Organization Constitution to open membership to graduate students, scientists, and senior engineers from all URA member institutions. The proposed amendment passed unanimously.

For the coming year, the members of the Users Executive Committee will be:

*W. Busza	Massachusetts Institute of Technology
D. O. Caldwell	University of California, Santa Barbara
L. Hand	Cornell University
G. R. Kalbfleisch	Brookhaven National Laboratory
R. L. Lander	University of California, Davis
*H. J. Lubatti	University of Washington
U. Nauenberg	University of Colorado
J. Peoples	Fermi National Accelerator Laboratory
*J. Pine	California Institute of Technology
*D. D. Reeder	University of Wisconsin
M. L. Stevenson	University of California, Berkeley
*L. Stutte	California Institute of Technology
*M. Widgoff	Brown University

*Elected 1975, for a two-year term.

At its first meeting, scheduled for July 10, 1975, the Committee will elect a chairman.

WORKBOOK AVAILABLE . . .

Copies of the Fermilab Research Program Workbook, a digest of information and decisions concerning proposals submitted to Fermilab as of late May 1975, are available from the Directors' Office at the price of $5.00 each. The booklet was prepared for use by Laboratory staff and members of the Program Advisory Committee at the extended summer meeting this June.

FACILITY UTILIZATION SUMMARY -- MAY 1975

The maintenance and development period that started in April continued through the first week of May. Most of the effort was directed to completing the projects begun last month and in checking systems in preparation for the new running period. Accelerator start-up began on May 7 and continued through the following weekend, while maintenance and development work and new equipment setup continued in the experimental areas. By Monday, extracted beam was available at low intensity for initial testing of the upgraded Meson Area proton beam transport system; that work continued smoothly and quickly during the following two days, while tuning of all accelerator systems continued with 300-GeV beam. Beam was delivered to the Proton Area early Thursday morning, and that evening the tuning of the Neutrino Area began. Accelerator operation was erratic through the following weekend, and that fact plus several turn-on difficulties in the experimental areas produced a slower than hoped for start of the high energy physics research program. However, overall the facility startup following the three-week shutdown proceeded smoothly, and operation for the high energy physics research program during the last two and one-half weeks of May was very good, with an average reliability of 77%.

System reliability and beam intensity improved markedly, and following the usual Wednesday-Thursday accelerator research and maintenance and development period there were five spectacular days of operation for high energy physics research. During that interval, a total of 7.08×10^{17} protons were accelerated, and beam was delivered for over 104 of the 127 hours

scheduled for experimental research. For the Memorial Day holiday period, from 1600 Friday until 0800 the following Tuesday, the comparable figures were 5.37×10^{17} protons and 84 of the 88 hours scheduled, or 95% reliability. Within this time period new intensity records were set in the booster and the main accelerator (2.12×10^{13} protons in the booster per equivalent main-ring pulse, and 1.72×10^{13} protons per pulse in the main accelerator).

In the Neutrino Area, the horn train was removed early in May to check the condition of the beam plugs installed in April for antineutrino running and to make some minor repairs. Both the upstream and downstream plugs were badly distorted and useless as a result of insufficient water cooling. New uncooled plugs, made with titanium rather than aluminum support tubing, were assembled on the train. Following the shutdown, the primary emphasis in the high energy research program was on the antineutrino work with the 15-foot bubble chamber. Meanwhile, the chamber, filled with the neon-hydrogen mixture, remained on standby through the shutdown; it was started during the first weekend of operation by using the hadron beam and taking approximately 4000 pictures for Experiment #89. After that, the two-horn system was set up in the antineutrino mode, and running continued for Experiment #180 until the end of the month. They took some 44,000 more pictures. Simultaneously, Neutrino #1A collected antineutrino data. Some slow spill was directed onto a target in the bypass beam for tuning of the N-1 muon line as a hadron beam by Di-Muon #331, who began serious data taking by the end of May. Neutrino #310 parasitically tested their "gamma catchers" in the Muon Laboratory behind the #331 group, and Tachyon Monopole #202 used the 15-foot chamber magnetic field for cosmic ray running.

In the Meson Area, the major components for Particle Search #357 were installed in the M2 beam line, and other major changes in experimental arrangements were made in the Detector Building, beam tunnels, and beam extension enclosures during the first two weeks in May. This work was completed quickly so that beam could be brought into the Meson Target Hall (Meshall) while the accelerator was being tuned following the shutdown. Five experimental groups collected data through the remainder of the month, including Muon Search #335, Beam Dump #108, Particle Search #366, K^0 Regeneration #82, and Elastic Scattering #69A. In addition, Particle Search #330 took more preliminary data during one shift, and Photon Inclusive #268 performed a series of tests on their experimental apparatus by running parasitically to Beam Dump #108.

In the Proton Area, the Photon Total Cross Section #25A group continued their engineering studies using a 115-GeV electron beam in Proton-East and the converter in the Tagged Photon Laboratory to produce photons for checking the tagging system. In Proton-Central, Di-Lepton #288 continued to install equipment during most days, and used the beam for set-up, debugging, and timing work at other times. Muon Search #48 was also setting up their apparatus downstream and made minimal use of available parasitic beam for testing.

In the Internal Target Area, Proton-Nucleon Inelastic #317 was unable to take data because of a series of difficulties with the gas jet target. These included a mechanically damaged jet, a plugged nozzle in the replacement, position misalignment, and a vacuum leak. However, when the new jet was

tested operationally, the helium consumption was only 5 to 6 liters per hour, less than half that used in the best previous experience. The stacking of a shield wall for the new experimental room was begun, and should be completed soon.

The summary of accelerator and beam utilization for May is as follows:

I. Summary of Accelerator Operations

		Hours	
A. Accelerator use for physics research			
Accelerator physics research		46	
High energy physics research		244	
Research during other use		(12)	
	Subtotal		290
B. Other activities			
Accelerator setup and tuning to experimental areas		162	
Scheduled interruption		218	
Unscheduled interruption		74	
	Subtotal		454
C. Unmanned time			0
	Total		744

II. Summaries of High Energy Physics Research Use

	# of Expts.	Hours	Results
A. Counter experiments	12	1547	
B. Bubble chamber experiments	2	120	47,954 pictures
C. Emulsion experiments	0	-	
D. Special target experiments	0	-	
E. Test experiments	0	-	
F. Engineering studies and tests	4	289	14,145 pictures
G. Other beam use	-	134	
	18	2090	

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

		Protons
A. Beam accelerated in main ring	Total	1.282
B. Beam delivered to experimental areas		
Meson Area		0.341
Neutrino Area		
Main beam		0.731
Bubble chamber beam (estimated)		0.026
Proton Area		0.023
	Total	1.121

IV. Beam Utilization by Experiment

	Hours	
A. Meson Area		
Elastic Scattering #69A	149.4	
K^0 Regeneration #82	188.5	
Beam Dump #108	207.0	
Photon Inclusive #268	53.0	Tests
Particle Search #330	14.5	
Muon Search #335	203.9	
Particle Search #366	222.3	
B. Neutrino Area		
15' π^--p & Ne @ 200 GeV #89	15.4	3997 pictures
15' $\bar{\nu}/H_2$ & Ne #180	104.6	43,957 pictures
Neutrino #1A	145.5	$\int p \simeq 6.02 \times 10^{17}$
Tachyon Monopole Search #202	-	Cosmic ray running
Neutrino #310	108.8	Tests
Di-Muon #331	150.7	Tests
C. Proton Area		
Di-Lepton #288	103.6	
Total	1667.2	

PROPOSALS RECEIVED DURING APRIL AND MAY 1975

Number	Title	Submitted By
388	Proposal to Study Neutral Current Neutrino and Anti-Neutrino Interactions in the 15-Foot Bubble Chamber Using the External Muon Identifier and a Dichromatic Beam	M. Stevenson
389	Proposal for Studying Neutrino Interactions in Neon with a Narrow Band Neutrino Beam in the 15-Foot Bubble Chamber	A. Tenner G. Giacomelli
390	Antineutrino Interactions in the Deuterium Filled 15-Foot Bubble Chamber	A. Garfinkel
391	Exploration of Rare Muon-Induced Processes	M. Strovink
392	Proposal to Study Multiparticle Production at the Highest Available Momentum in Antiproton-Proton Interactions Using the Fermilab 30-Inch Bubble Chamber	W. W. Neale
393	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	I. Pless
394	Proposal for a High Statistics Study of Anti-Proton Interactions at 100 GeV/c with the Fermilab 30-Inch Bubble Chamber	J. Whitmore
395	Calorimeter-Array Study of High P_T Events	W. Selove
396	Elastic Scattering and Diffraction Dissociation at Small Momentum Transfer for $\pi^\pm$, $K^\pm$, $p^\pm$, and n	K. Goulianos
397	Proposal to Search for High Mass Particles Produced in Association with Prompt Muons	J. Rosen
398	A Proposal for a Further Study of Muon Nucleon Inelastic Scattering at Fermilab	H. Anderson
399	Production of Electromagnetic Cascade Showers by Several Hundred GeV Electrons in Emulsion Chambers	R. Golden

Number	Title	Submitted By
400	A Search for New Particles Produced in Association with the Hadronic Production of ψ (3.1) Mesons	J. Peoples
401	Photoproduction of High Mass Two-Body Final States	M. Gormley
402	Photoproduction Experiment at Fermilab	W. Lee
403	Search for $p + Cu \rightarrow \Lambda^0 + \mu^{\pm} + X$ and $p + Cu \rightarrow K_S^0 + \mu^{\pm} + X$ with 300 GeV Protons	L. Pondrom
404	Inclusive Neutron Production by Protons on Protons and Nuclei	L. Jones
405	In Situ Measurement of the Quark-Parton Charge Assignments	P. Mockett
406	Small Angle Hadron-Nucleus Scattering at Fermilab	J. Marx
407	π^+p Interactions at 250 GeV/c in Improved FNAL 30-Inch Hybrid System	W. Bugg
408	Hybrid Bubble Chamber Study of $\bar{p}p$ Interactions at 75 GeV/c	R. Plano
409	π^+p Collisions at 75 GeV/c in the 30-In. Hybrid Chambers	T. Watts
410	Hybrid Bubble Chamber Studies of K^+p and K^-p Interactions at 75 GeV/c	A. Pevsner
411	Proposal to Search for Pion Produced Particles Decaying under Prompt Emission of One or More Muons	D. Garelick
412	Proposal to Observe K^-, π^-, and $\bar{p}$ Produced Dimuon Spectra	R. Weinstein
413	Proposal to Search for Proton Produced Particles Decaying under Prompt Emission of One or More Muons	D. Garelick
414	Proposal to Observe the Proton Produced Dimuon Spectra	R. Weinstein

Number	Title	Submitted By
415	Measurements of $\pi^- Cu \rightarrow K_s^0$, Λ^0, and Neutron Inclusive Cross Sections for Proposal P-360 (Nauenberg) with E-8 Apparatus in the M-2 Beam Line	L. Pondrom

DATES TO REMEMBER

July 1, 1975	Requests for fall housing accommodations, including dormitory rooms and family residences, should be received in the Housing Office.
July 19, 1975	Fermilab Auditorium Arts Series: Choreographers' Showcase. Tickets available in Guest Office.