fermilab report

Fermi National Accelerator Laboratory Monthly Report

June 1978

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FERMILAB-78/6 **Fermi National Accelerator Laboratory** 0090.01

THE COVER: Ned Goldwasser and Shen Pao-hua (one of the visitors from the People's Republic of China) planting a tree on Arbor Day.

(Photograph by Fermilab Photo Unit)

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GOLDWASSER SUBMITS RESIGNATION

Edwin L. Goldwasser, Deputy Director of Fermilab since its founding, has announced that he has accepted the position of Vice Chancellor for Research and Dean of the Graduate College at the University of Illinois at Urbana. In a letter to the Fermilab staff, Robert R. Wilson said:

> For me, Ned's greatest attributes are his taste in physics, his courage to do what has to be done, nevermind the consequences, his sympathy for the human condition, and his subtle understanding of the complexities of a large laboratory caught between exigent users, regional competition, and inadequate funding, but relishing to the full the important scientific discoveries that have been made, and to which he has contributed directly.
>
> There can be no question but that Ned will contribute crucially to the success of research and the humanities at the University of Illinois, and that he will continue to play an important role in the physics of our nation and of the world. He has been a beloved comrade and we will miss him.

Members of the Institute of High Energy Physics, People's Republic of China, delegation at Fermilab (from left to right): Wang Shu-hung, Mao Chen-lung, Pan Hui-pao, Hsieh Chia-lin, Sui Ching-yi, Lee Teng (Fermilab), Hsiao Yi-hsuan, Shen Pao-hua, Chen Sen-yu, Hsu Chien-ming, and Chung Hui.

(Photograph by Fermilab Photo Unit)

WORKSHOP ON PARTICLE CHANNELING AT HIGH ENERGY

R. A. Carrigan, Jr., Fermilab, and W. Gibson, SUNY at Albany

Channeling of relativistic particles by single crystals represents an interesting conjunction between high-energy and solid-state physics. The interface between these two fields has long been recognized as important in detector systems, but in particle channeling it seems to be even more direct and symbiotic. Exploration of the status and prognosis of particle channeling at high energies was the subject of an informal Workshop at Fermilab on April 7-8, cosponsored by the State University of New York at Albany (SUNYA) and Fermilab. Descriptions of experiments carried out at CERN by an Aarhus (Denmark), Strasbourg, CERN collaboration and at Fermilab by a Dubna, Fermilab, Lehigh, SUNYA, UCLA collaboration comprised the status, while additional contributions from Dubna, SLAC, Livermore, Yerevan, and Moscow representatives added to the prognosis.

Anyone who has gotten this far without knowing what particle channeling is deserves an explanation, albeit brief. Charged particles moving through a crystal at a small angle to a row or plane of atoms experience deflections from each atom that is passed that are correlated and can add up to a gentle steering of the particle trajectory away from the row or plane (if the particle is positive) or toward the row or plane (if the particle is negative). In fact, when this occurs it is convenient and correct to consider the potential exerted by the atomic row or plane as distributed in the form of a rod (for a row) or sheet (for a plane) of charge and to calculate with classical electrostatics the particle motion in the resulting potential. Clearly, if the

transverse energy of the particle exceeds the potential, the particles are not so gently steered away and the whole picture breaks down.

This leads to the idea of a critical transverse energy or, for a given particle energy, a critical angle between the row or plane direction and the particle direction of motion. According to the electrostatic model, this critical angle depends on the inverse square root of the particle momentum-velocity product.

The new experiments demonstrate that the critical angle scales successfully from 10 keV up to the recent 250 GeV measurements at Fermilab (and presumably beyond). Such tests of scaling constitute perhaps the first reason for high-energy channeling studies. To channeling experts, not only the existence, but also the stability of channeled particle trajectories is of central importance. Here is the second--and perhaps from the channeling point of view--the main reason for doing such measurements at very high energies. Destruction of channeling trajectories (appropriately called de-channeling) comes about by multiple scattering of particles from electrons or from thermally displaced nuclei in the crystal. Multiple scattering scales in angle as the inverse of the particle momentum-velocity product; hence, as the energy increases, channeling should become more stable. Dechanneling lengths (at which half of a channeled beam is lost) should increase from tens of microns at a few MeV particle energy to tens of centimeters at 250 GeV/c. The Fermilab measurements verify this expectation.

From the channeling point of view, the increased stability of particle channeling at high energies may make it possible to see effects that would

otherwise be masked by dechanneling. For possible applications, this increased stability may also matter. One such new effect, which has been suggested by high-energy physics experiments, involves cooling of the channeled particle beam such that particles emerge from the crystal with smaller transverse energy than they had when they went in. Since "cooling" is a magic word in high-energy accelerator physics, this is interesting. Any such effect is largely discounted by channeling experts, thus providing the first controversy.

What say the experiments? Both 15-GeV/c measurements at CERN and 100-and 250-GeV/c measurements at Fermilab show the emergent distribution peaked at zero transverse energy for particles incident near a crystal axis and at angles near the critical channeling angle. Cooling? Channelers still say "not necessarily so." This could be the residue of multiple scattering (dechanneling), which can reduce as well as increase transverse energy. More analysis of present experiments or more experiments may be able to say.

If "cooling" is possible, and maybe even if it isn't, perhaps "bending" is. Since channeled particles are obviously steered through the crystal, what would happen if the channels are curved by carefully bending the crystal? Would the particles follow? Again, channeling experts think not, but the benefits could be so great that the next generation of channeling experiments will probably include tests of this possibility. The limiting radius suggested by critical channeling conditions is a phenomenal 2 cm for 100 GeV/c! Nothing is known on this yet, and it probably depends critically on the "cooling" question.

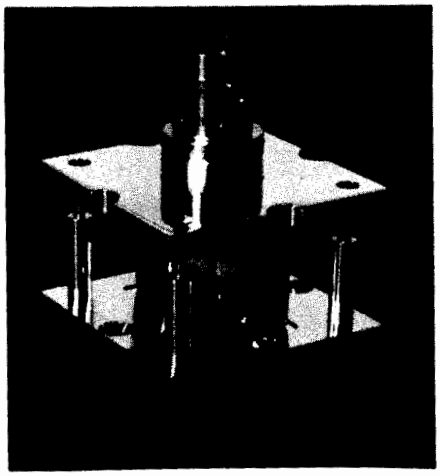
The question of energy loss is more clear but nonetheless interesting. Well-channeled positive particles lose energy in the crystal less rapidly than non-channeled particles because they are confined to the low-density regions. These differences are easy to measure if the crystal is itself a semiconductor detector. Applications for selection (or identification) of particles that are well channeled, and therefore have specific directions of motion are obvious. At energies as high as 250 GeV/c, density effects are expected to be important in the energy-loss process. These should affect non-channeled and channeled particles differently, so quantitative analysis of the ratio of the energy loss of channeled and non-channeled particles may provide a sensitive test of the theory.

One of the most interesting applications of particle channeling (actually of its complementary effect, involving particle emission from crystals called "particle blocking") is the measurement of short nuclear-decay times. Decays as short as one attosecond (10^{-18} sec) have been measured. For relativistic particles it should be possible, in principle, to go even shorter because of Lorentz contraction, perhaps as short as 10^{-20} seconds. A systematic survey of possibilities by the Aarhus group shows the η^{o} lifetime to be a promising candidate for measurement by this technique.

The newest and perhaps the most exciting possibility from high-energy channeling involves synchrotron radiation from channeled particles. Channeled particle trajectories oscillate with a short period. These curved trajectories should radiate from the turnaround point, just as particles in a

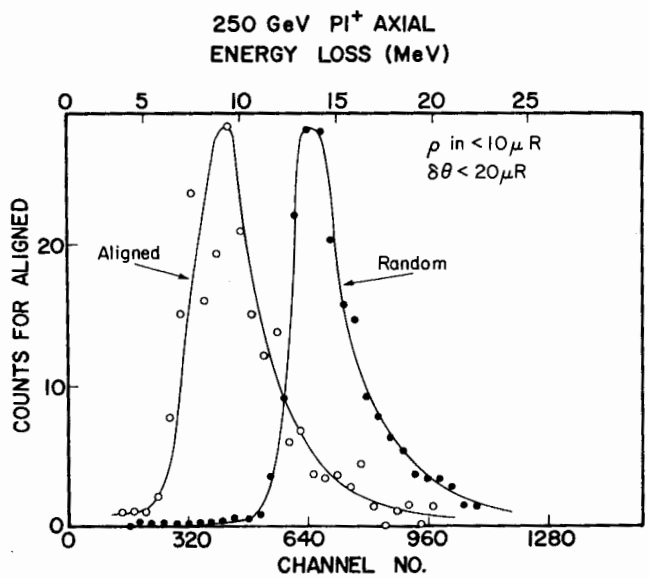
circular trajectory or in a wiggler magnet emit synchrotron radiation, except more so. The bending radius can be very small (of order 2 cm for 100 GeV/c) and for planar channeled particles the radiation should be tightly collimated along the particle direction, perhaps producing coherent interference between successive oscillations. It was generally concluded from the Workshop discussion that the radiation intensity and frequency should scale as $\gamma^{3/2}$. Many possibilities exist, most of them too speculative to discuss here. No measurements have yet been made of channeled-particle synchrotron radiation. Experiments are planned or underway at Livermore, SLAC, Saclay, Dubna, Serpukhov, and probably others. Saclay and Livermore will soon start measurements on positron and electron beams up to about 40 MeV. The SLAC, Dubna, and Serpukhov studies will go to higher energies.

Obviously it isn't yet possible to say with any conviction what high-energy channeling has to offer either for solid-state or for high-energy physics. The effect is, however, well established up to the highest available particle energies. Thus far, only two crystals have been identified as being perfect enough to use for such studies, dislocation-free germanium and silicon, because the extremely small critical angles (about 40 microradians at 250 GeV/c) require nearly perfect crystals. The experimental challenges to continue and extend these studies are formidable. The promise appears to make such efforts worthwhile.



Hyper-pure germanium crystal used for Fermilab channeling studies. The dark block on the lower plate is the crystal. Note the BNC connector for scale.

(Photograph by Fermilab Photo Unit)



Energy loss as measured in an oriented single crystal of germanium at 250 GeV. The positive particles lose much less energy in the crystal when they travel along a crystal axis.

THE TEVATRON HELIUM LIQUEFIER

Henry Barton

A helium-liquefier plant is being built to supply the liquid helium for cooling the superconducting magnet ring of the Energy Doubler-Saver-Tevatron. The new plant is in an orange prefabricated steel-frame building across Road D from the Main Ring near the downstream end of A Sector. The plant will be the largest helium liquefier in the world, with a capacity of more than 4000 ℓ /hr of liquid helium.

The first step in liquefying is to compress the gas to approximately 13 times atmospheric pressure with the two helium compressors. After appropriate filtering, the gas goes into the liquefier.

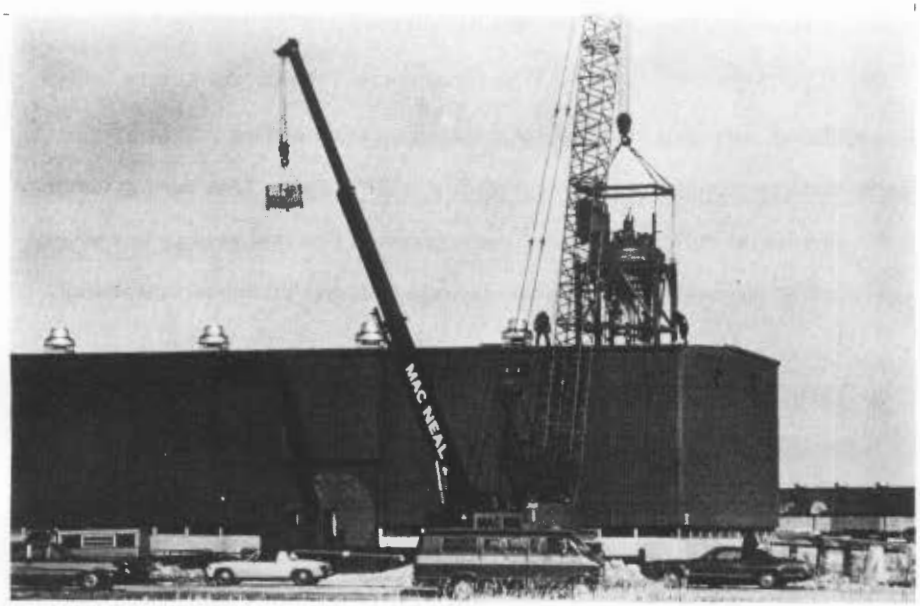
The liquefaction takes place in several steps. First, the gas is cooled to 78 K by liquid nitrogen supplied by the nitrogen reliquefier. It is then cooled further by turbine expanders and flow of cold gas. This cold gas comes from the 85 % of the flow that did not make liquid. The last step is to reduce the pressure of the cold gas as it goes through a Joule-Thompson throttling valve.

A gas-liquid mixture emerges from the liquefier and is separated into liquid (15%) and gas phases (85%) in a vessel located near the liquefier cold box. The liquid portion is used to cool ring magnets and the cold gas is sent back through the liquefier unit so that it can cool the incoming warm stream of high-pressure gas. The devices which do this cooling are counterflow heat exchangers and form the heart of the liquefier. By the time the low-pressure gas emerges from the top of the liquefier, it has been warmed to nearly room

temperature and is sent back to the compressors to be compressed again, in what is, in fact, a closed cycle.

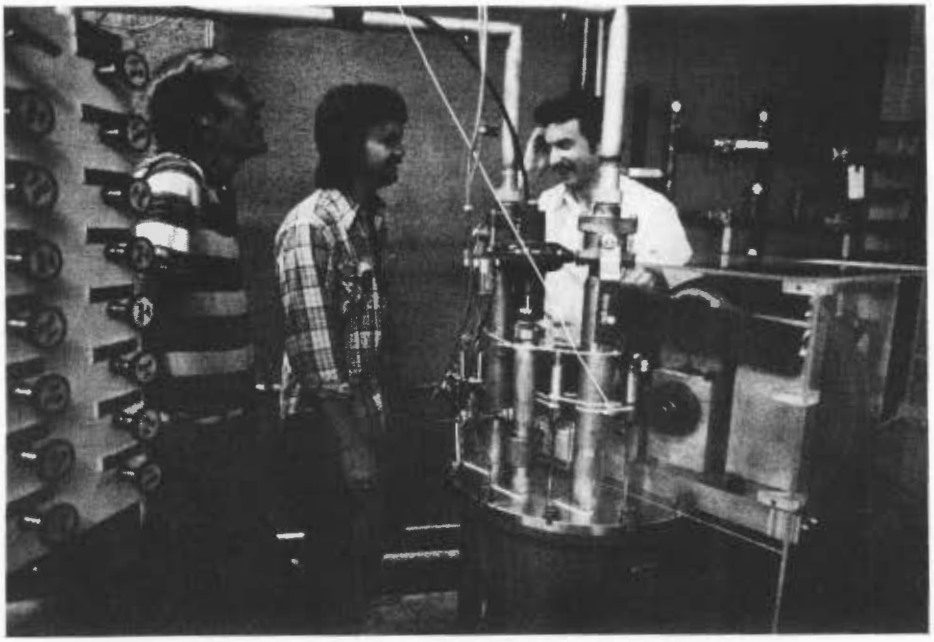
The main liquefier portion of the plant was delivered in April and installed through panels in the roof by two cranes, as is shown in the accompanying photo. The compressors are 4000 hp units acquired as surplus from a liquid-oxygen plant in California and reconditioned and modified for helium service.

At this time, final piping and control assembly and check-out are in progress. The plant is expected to be in operation by this fall.



Installation of the Helium Liquefier.
(Photograph by Fermilab Photo Unit)

The magnet of the old University of Chicago cyclotron is mounted in the Village near Batavia Road as an historical exhibit.
(Photograph by Fermilab Photo Unit)

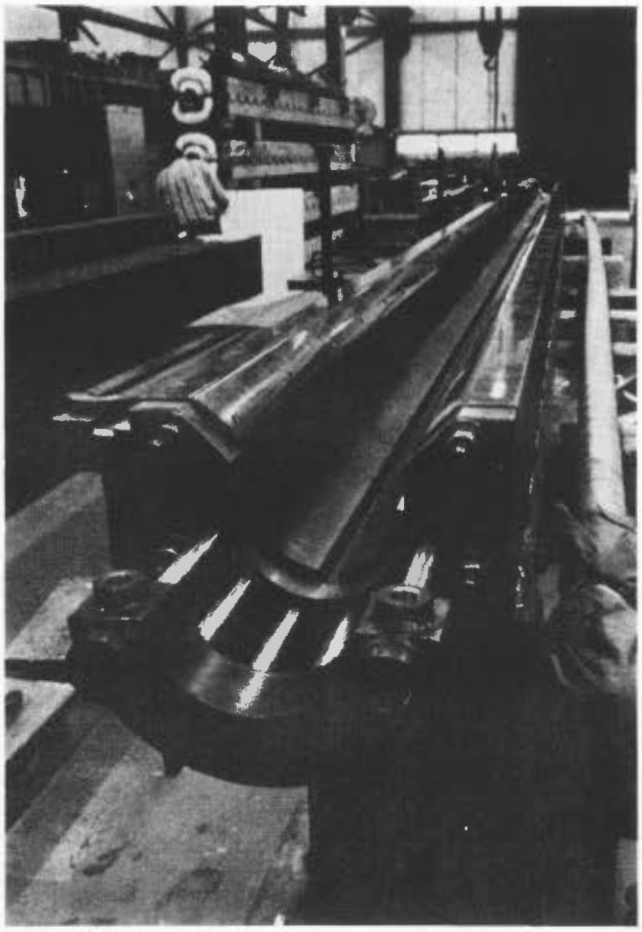


Dick Andrews, Jack McCarthy, and Jeff Appel (left to right) discussing the operation of the gas expansion engine seen in the foreground. The equipment is part of the liquid helium satellite refrigerator system being prepared for use in the Switchyard.

(Photograph by Fermilab Photo Unit)

A view from the 15th floor of the Central Laboratory of the construction work going on at the Switchyard Service Building in connection with installation of superconducting magnets in the Switchyard.

(Photograph by Fermilab Photo Unit)



Laminated tooling built for use in making Energy Doubler/Saver magnets.
(Photograph by Fermilab Photo Unit)

NOTES AND ANNOUNCEMENTS

PHOTON WORKSHOP AT FERMILAB. . .

A four-day Photon Workshop will be held at Fermilab on August 1 through August 4, 1978. The workshop should bring together those people who have an interest in pursuing research in high-energy photon beams. Results from the present Fermilab photon experiments will be reviewed and reports on the programs at other laboratories will be presented.

Opportunities for upgrading old facilities and for building new ones will be discussed with particular emphasis on photon physics at Fermilab after 1 TeV becomes available.

Those who are interested in attending may write or call the workshop secretary, Pat Mascione, Central Laboratory 11th floor, Ext. 4462.

FERMILAB RESEARCH PROGRAM WORKBOOK AVAILABLE. . .

A limited number of copies of the 1978 Fermilab Research Program Workbook are available from the Program Planning Office on a first-come first-served basis. The price of the Workbook is $5.00, which may be enclosed with a request or charged to an active account at the Laboratory. The material in the Workbook has been prepared for the annual review of the Fermilab research program at the summer meeting of the Physics Advisory Committee. The information contained in it may be useful to individuals with a general interest in research at Fermilab or those in need of a reference to the many Fermilab research proposals.

SUMMARY OF OPERATIONS - MAY 1978

Program Planning Office

The approximately two weeks of operation during May brought with it the completion of seven experimental activities. Many of these had begun months earlier and were scheduled to be finished just prior to an interruption for major maintenance and development in the accelerator and experimental areas. The quadrupole triplet focusing train in the Neutrino Area ended its long period of continuous service which began in September 1977. During operation since then the train load was exposed to a total flux in excess of 1×10^{19} protons used for hadron, muon, and neutrino experiments. The successful completion of this running period must be one of the most successful since experimental activities first began at the Laboratory in 1972. The triplet train will now be replaced by a new dichromatic train which will be in use during most of the summer.

Actually, experimental activities at Fermilab have been underway almost continuously from September 1977 until the shutdown which began on May 22. During this period there was a brief standby period at Christmas and an unexpected interruption of about two weeks in February and March during the coal strike. Activities in all experimental areas are expected to resume on June 13.

FERMI NATIONAL ACCELERATOR LABORATORY
MONTHLY OPERATIONS HISTORY
MAY 1978

Date		Accelerator	Internal Target Area	Proton Area	Neutrino Area	Meson Area
Mon.	5/1					
Tue.	5/2	Accelerator Studies				
Wed.	5/3					
Thu.	5/4			87A (PE) 288 (PC) OFF (PW)	203A/391 & 448 (N1) Yield.Meas.(N3)	Part.Sch.469 (M6E) Had.Dissoc. 272 (M1E)
Fri.	5/5	Reprs:MR Gnd.Fault & MR LCW System	OFF			
Sat.	5/6			Photoprod. 401 Tests (PE) Di-Lepton 288 (PC) Nuc.Scal.592(PW)	203A/391 & 448 (N1) ν356 Calib.(N5)	Incl. K^0_s 383 (M4) Multi-Muon 439(M2)
Sun.	5/7	Reprs:Gas bar.&MR LCW				
Mon.	5/8	~1.5x10^{13}ppp @400 GeV			203A/391 (N1) 356 Calib.(N5)	
Tue.	5/9	Accelerator Maintenance & Development				
Wed.	5/10					
Thu.	5/11					
Fri.	5/12				p̄ Target Tests	
Sat.	5/13	~1x10^{13}ppp @400 GeV 1.25 sec flattop	OFF	Photoprod.152B (PE) Nucl.Scal. 592 (PW) OFF reprs.(PC)	Part.Sch.596 & μ203A/391 Calib. (N1) ν356 Calib.(N5)	272 (M1E) 469 (M6E) 439 (M2) 585 (M4)
Sun.	5/14					
Mon.	5/15					same but 451 (M6E)
Tue.	5/16					Incl.Scatt.451(M6E) Multi-μ 439 (M2)
Wed.	5/17			Photoprod. 152B (PE) Nucl.Scal. 592 (PW) Di-Lepton 288 (PC)		Part.Sch.490 (M1W)
Thu.	5/18				596,356 Calib.	K Chg. Ex. 585(M4)
Fri.	5/19	~1.6x10^{13}ppp @400 GeV 1.25 sec flattop			596,Yield Meas. 596, 15' Tests	Part.Sch.490 (M1W)
Sat.	5/20				596, Yield Meas.	Incl.Scatt.451(M6E)
Sun.	5/21				Part.Sch.596 (N1) ν356 Calib.(N5)	K Chg.Ex.585(M4) OFF (M2)
Mon.	5/22	Accelerator Studies; Switchyard Development; Experimental Areas Open				
Tue.	5/23					
Wed.	5/24					
Thu.	5/25	Facility Maintenance & Development (through June 12)				
Fri.	5/26					
Sat.	5/27					
Sun.	5/28					
Mon.	5/29					
Tue.	5/30					
Wed.	5/31					

BEAM UTILIZATION BY

	Beam	Hours
PROTON AREA	PE	20
Photoproduction # 87A	PC	150
Di-Lepton # 288	PW	200
Nuclear Scaling # 592	PE	30
Photoproduction # 401	PE	170
Photoproduction # 152B		
NEUTRINO AREA	N1	200
Muon # 203A/391	N1	40
Muon # 448	N5	180
Neutrino # 356 Calibration	N1	180
Particle Search # 596	N0	-
Nuclear Fragments # 466	N3	40
Yield Measurements	N5	0
15-Ft Plate Tests		
MESON AREA	M6E	110
Particle Search # 469	M1E	120
Hadron Dissociation # 272	M4	60
Inclusive K^o_s # 383	M2	150
Multi-Muon # 439	M4	80
Kaon Charge Exchange # 585	M1W	70
Particle Search # 490	M6E	120
Inclusive Scattering # 451	M0	-
Nuclear Chemistry # 81A		
TOTAL HOURS FOR HIGH ENERGY PHYSICS		1920

XPERIMENTAL ACTIVITY -- MAY 1978

Activities

completed: search for charmed states produced in photon interactions

data: for a high-resolution study of the dimuon spectra produced by 400-GeV protons

tuneup & data: to study connection between scaling phenomena and the determination of structure functions in the inclusive reaction $pA \rightarrow (p, d, t, \pi, K) X$

tests: of the ability to deaden the central region of PWC's and allow higher beam fluxes

tuneup: for study of elastic and inelastic Compton scattering

completed: including a search for heavy neutral leptons produced in muon interactions at 225 GeV

completed: study of muon interactions with nuclear targets at 225 GeV

tuneup: calibration of detectors to be used in the study of deep inelastic ν, $\bar{\nu}$ scattering

completed: use of Cherenkov and time-of-flight techniques to search for heavy long-lived particles

data: 3 targets exposed

data: for measurements of π's and K's produced at various energies and angles by 400-GeV proton interactions with a BeO target

tests: of 15 ft. bubble chamber operation with internal photon converting plates; tests with beam were not done because problems were discovered

completed: use of Cherenkov and time-of-flight techniques to search for heavy long-lived particles

tuneup: for study of inelastic Coulomb excitation and diffractive production of hadrons

completed: study of the reaction $K^- p \rightarrow K^0_s X$ at 75 GeV

completed: study of the high mass dimuon and multimuon spectra produced by 400-GeV proton interactions

tuneup: for study of exclusive KN charge exchange scattering

tuneup: including tests of a new high pressure streamer chamber and of trigger rates in a 300 GeV π^- beam

data: study of the A-dependence of inclusive processes

data: 10 targets exposed

FACILITY UTILIZATION SUMMARY-- MAY 1978

I. Summary of Accelerator Operations

		Hours	
A. Accelerator use for physics research			
Accelerator physics research		53.7	
High energy physics research		289.9	
	Subtotal		343.6
B. Other activities			
Accelerator setup and tuning to exp. areas		1.2	
Program interruption		276.6	
Unscheduled interruption		122.6	
	Subtotal		400.4
C. Unmanned time			
	Total		744.0

II. Summaries of High Energy Physics Research Use

	# of Expts.	Hours	Results
A. Counter experiments	16	1880	7 expts. completed
B. Bubble chamber experiments	-	-	-
C. Emulsion experiments	-	-	-
D. Special target experiments	2	-	13 targets exposed
E. Test experiments	-	-	-
F. Engineering studies and tests	(2)	40	Yield Measurements & 15-ft tests
G. Other beam use	-	-	-
Totals	18	1920	

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

A. Beam accelerated in Main Ring		0.96
B. Beam delivered to experimental areas		0.89
Meson Area		0.21
Neutrino Area		
	Slow Spill	0.53
	Fast Spill	0.10
Proton Area		0.05

MANUSCRIPTS AND NOTES PREPARED FROM APRIL 11, 1978 TO JUNE 7, 1978

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 some articles listed are on the reference shelf in the Fermilab Library.

Experimental Physics

J. Whitmore et al. (Experiment #2B)	Comparison of Inclusive Charged-Pion Production in $\pi^{\pm}p$ Interactions at 100 GeV/c [Phys. Rev. D16, 3137 (1977)]
C. E. DeHaven, Jr. et al. (Experiment #4)	Neutron-Proton Elastic Scattering from 70 to 400 GeV/c
G. Bunce et al. (Experiment #8)	A New Measurement of the Λ Helicity in the Decay $\Xi^0 \rightarrow \Lambda\pi^0$ (Submitted to Phys. Rev. D)
P. Skubic et al. (Experiment #8)	Neutral Strange Particle Production by 300-GeV Protons (Submitted to Phys. Rev. D)
C. Baltay et al. (Experiment #53)	Charmed D Meson Production by Neutrinos (Submitted to Phys. Rev. Lett.)
S. B. Kaufman et al. (Experiment #81)	Recoil Properties of Radionuclides Formed in the Interaction of 1-300 GeV Protons with Gold (Submitted to Phys. Rev. C)
E. F. Anelli et al. (Experiment #'s 96 and 118)	The Multiwire Proportional Chamber System of Fermilab Single Arm Spectrometer (Submitted to Rev. Sci. Instr.)
T. H. Burnett et al.	Inclusive Production of Hadrons in ν_μ Ne and $\bar{\nu}_\mu$ Ne Interactions (Submitted to the 3rd International Conf. on New Results in High Energy Physics, Vanderbilt University, March 1978)
J. E. Elias et al. (Experiment #178)	Projectile Dependence of Multiparticle Production in Hadron-Nucleus Interactions at 100 GeV/c (FERMILAB-Pub-78/36-EXP; submitted to Phys. Rev. Lett.)

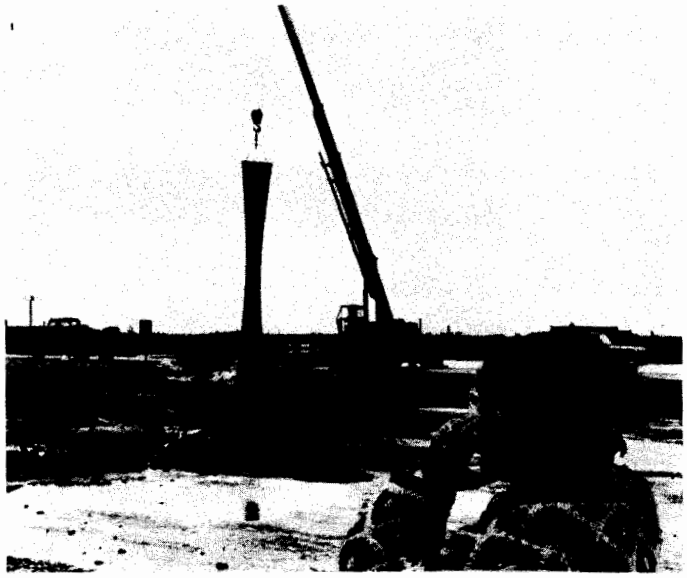
J. P. Berge et al. (Experiment #180)	Inclusive Negative Hadron Production from High Energy $\bar{\nu}$ Nucleus Charged-Current Interactions (FERMILAB-Pub-78/43-EXP; submitted to Phys. Rev. D)
G. R. Kalbfleisch et al. (Experiment #254)	Ratio of Charged Current Cross Sections of Pion and Kaon Neutrinos Near 80 GeV (Presented at the Neutrino '78 Conf., Purdue University, April 28-May 2, 1978)
E. Lehman et al. (Experiment #281)	Tests of the Quark-Parton Model in Soft Hadronic Processes
B. Barish et al. (Experiment #379)	Observation of Prompt Single Muon Production by Hadrons at Fermilab (Submitted to the 3rd International Conf. on New Results in High Energy Physics, Vanderbilt University, March 1978)
E. Jenkins et al. (Experiment #381)	The Real Part of the P-P and P-D Forward Scattering Amplitudes from 50 to 400 GeV (FERMILAB-Pub-78/35-EXP; submitted to Sov. J. Nucl. Phys.)
M. D. Corcoran et al. (Experiment #395)	Comparison of High p_T Events Produced by Pions and Protons (Submitted to Phys. Rev. Lett.)
K. Goulianos (Experiment #396)	Diffractive Hadron Dissociation (Presented at the XIII Rencontre de Moriond Conf., Les Arcs, Savoie, France, March 12-24, 1978)
E. G. Boos et al. (Experiment #463)	Investigation of Inelastic Interactions of 400 GeV Protons with Emulsion Nuclei (Submitted to the XIX International Conf. on High Energy Physics, Tokyo, 1978)
E. G. Boos et al. (Experiment #463)	Diffractive Coherent Production in Interactions of 400 GeV/c Protons on Emulsion Nuclei (Submitted to the XIX International Conf. on High Energy Physics, Tokyo, 1978)
M. M. Chernyavsky et al. (Experiment #463)	A Search for New Particles with Lifetime 10^{-12}-10^{-14} sec in Interactions of Protons with Nucleons and Nuclei in Emulsion at 400 GeV/c (Submitted to the XIX International Conf. on High Energy Physics, Tokyo, 1978)

M. M. Chernyavsky (Experiment #463)	A Possible Event of Charmed Particle Decay Via the (Weak) Neutral Current According to a Scheme $M_c \rightarrow e^+e^- +$ Hadrons (Submitted to the XIX International Conf. on High Energy Physics, Tokyo, 1978)
D. Cutts et al. (Experiment #469)	A Search for Long Lived Heavy Particles (FERMILAB-Pub-78/45-EXP; submitted to Phys. Rev. Lett.)
T. H. Burnett et al. (Experiment #172)	Hadron Production in νNe and $\bar{\nu}$Ne Interactions
R. J. Loveless et al. (Experiment #546)	A Neutrino-Induced Four Lepton Event (Submitted to Phys. Rev. Lett.)
B. Andersson et al. (Reviews of many emulsion expts.)	On the Correlation Between Fast Target Protons and the Number of Hadron-Nucleon Collisions in High-Energy Hadron-Nucleus Reactions

Theoretical Physics

M. W. Roth	The Dynamical Effects of Instantons (FERMILAB-Pub-77/46-THY; submitted to Phys. Rev. D)
M. B. Einhorn and R. Savit	Phase Transitions in the Abelian Higgs Model (FERMILAB-Pub-77/105-THY; submitted to Phys. Rev. Lett.)
C.-H. Lai	Charm Contribution to Neutrino-Induced Production of Opposite Sign Dimuons (FERMILAB-Pub-78/18-THY; submitted to Phys. Rev.)
V. G. Kadyshevsky	Fundamental Length Hypothesis and New Concept of Gauge Vector Field (FERMILAB-Pub-78/22-THY; submitted to Nucl. Phys.)
W. A. Bardeen	Transverse Lattice Theory of Quantum Chromodynamics (FERMILAB-Conf-78/23-THY; lecture presented at the Cargese Summer School, July, 1977)
H. D. I. Abarbanel	The Character of Homogeneous Turbulence (FERMILAB-Pub-78/28-THY; submitted to Phys. of Fluids)
C. H. Albright and J. Smith	How to Extract Heavy Quark and Heavy Lepton Signals in Neutrino-Induced Dilepton Events (FERMILAB-Pub-78/31-THY; submitted to Phys. Lett.)

K. O. Mikaelian	Astrophysical Implications of New Light Higgs Bosons (FERMILAB-Pub-78/32-THY; submitted to Phys. Rev. Lett.)
K. O. Mikaelian	Orthopositronium Decay into Axions (FERMILAB-Pub-78/34-THY; submitted to Phys. Lett. B)
M. B. Einhorn and R. Savit	Flux Loops: More New Heavy Particles in the Weinberg-Salam Model (FERMILAB-Pub-78/44-THY; submitted to Phys. Lett.)



Angela Gonzales, Fermilab artist and designer, watches the erection of "Acqua Alle Funi," a metal sculpture by Robert R. Wilson. The hyperbolic obelisk in the reflecting pond in front of the Central Laboratory stands 32 feet high, including its 4 foot base. The work is fabricated of three stainless steel plates, each 1/4 inch in thickness. Each plate is made up of 23 smaller plates which were edge-welded together.

(Photograph by Fermilab Photo Unit)

DATES TO REMEMBER

June 17-23, 1978	Summer meeting of the Fermilab Physics Advisory Committee.
August 1-4, 1978	Photon Workshop at Fermilab (see page 15).