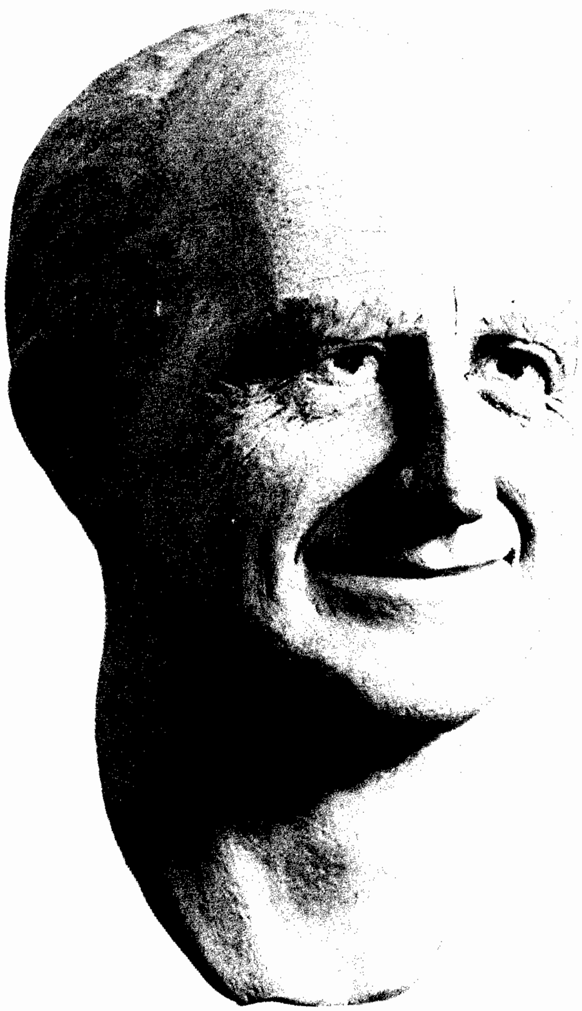
fermilab report

Fermi National Accelerator Laboratory Monthly Report January 1980



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FERMILAB- 80/1 Fermi National Accelerator Laboratory 0090.01

THE COVER: The original sculpture model of a new portrait bust of ENRICO FERMI by sculptor and Fermilab technician, Alan J. Siegel.

"Perhaps a time will come when all scientific and technical progress will be hailed for the advantages that it may bring to man, and never feared on account of its destructive possibilities." E. Fermi, 1952.

(Photograph by Fermilab Photo Unit)

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PROGRESS ON THE SUPERCONDUCTING ACCELERATOR

Over-all Project

Work on the superconducting accelerator has occupied a large part of Fermilab's attention and activity for the last while, and there are significant new steps to be reported since the last discussion in **Fermilab Report** in April 1979. That report came immediately after the completion of a comprehensive design report and was largely concerned with that design. Since that time, there have also been advances in the hardware that should be discussed.

The Design Report was one part of the effort to secure funding. In addition, the Magnet Factory built and measured a series of ten acceptable magnets. Following this milestone, construction funds for the Energy Saver were released in July. The Energy Saver project includes the ring of superconducting magnets and its installation in the Main-Ring tunnel, with enough refrigeration capacity to provide sustained operation at 500 GeV (with, of course, considerable saving in electrical-energy cost).

The later phases of the superconducting accelerator program at Fermilab have been given attention. They have been split into two phases. Tevatron Phase I includes the refrigeration and rf equipment needed for sustained operation at 1 TeV, the beam-cooling ring, and equipment to produce a circulating antiproton beam (the project discussed in **Fermilab Report** in November 1979), and the buildings and utilities for two colliding-beams experimental areas. The colliding-beams detectors themselves are to be separately funded from equipment allocations. The Tevatron Phase I program has been submitted for funding.

Tevatron Phase II includes equipment for extraction and transport of the 1-TeV proton beam to the experimental area and improvements in the experimental areas for fixed-target experiments at 1 TeV. This project is still in the conceptual design stage.

Magnet Production

In October, a problem was detected with magnets produced after June 1979. A new cryostat with several design simplifications giving easier assembly and reduced costs had been incorporated. When these magnets were tested, unacceptably large variations of the vertical magnet axis during cooldown appeared. We have identified the defect as insufficient torsional clamping between the liquid-nitrogen shield and the outer jacket, modified the design, and incorporated the fix in all subsequent cryostats.

Enough magnets plus spares were in the assembly line to meet our next major objective, the installation and testing of a full cryogenic loop (32 dipoles and 8 quadrupoles) in the Main-Ring tunnel. The vertical-axis variation that exists in these magnets will not interfere with the cryogenic objectives of this test. Later, these magnets will be removed from the tunnel for correction of the cryostat defect.

A major success of the Energy Saver program is the establishment and verification of a steady flow of highly specialized parts for the magnets. Very good quality control is necessary to insure that magnets meet all the requirements for accelerator use. The system has now been operating at a steady rate for a long enough period that we are confident that we have demonstrated that only unusual occurrences can cause delays. When production is stepped up in April of 1980, to 10 magnets per week or 2 per day, even more attention will be required if we are to avoid costly interruptions in the production process.

The 21-ft magnets have undergone rigorous testing. The vertical-axis problem was discussed above. The integral field is constant from magnet to magnet within the specified 0.1%. As manufacturing has progressed, the sextupole field component, which had previously had considerable variation, has settled down and now seems well under control. There have been difficulties with large variation, more than the specified $\pm 2.5\times 10^{-4}$ of the dipole field at 1 in., of the normal and skew quadrupole components. It has been demonstrated that these can be changed in a given magnet by reshimming the cryostat coil assembly within the magnet yoke. Efforts are still going on to avoid this reshimming by keeping the quadrupole components small.

The correlation is very good between superconducting-state measurements and room-temperature measurements of the unyoked cryostat assembly with ac techniques, when account is taken of the dipole and sextupole fields added by the yoke. The room-temperature measurements are used to give rapid feedback to the coil production.

The success of these measurements has led to extensions of them in two related directions. A system to measure skew multipole components in dipoles is well along in development. A similar system has been used to measure multipole components in a quadrupole magnet. The agreement with superconducting measurements is very good and the system is expected to be a considerable aid in monitoring quadrupole production.

Efforts to bring on quadrupole and correction-element production have been steadily increased. (About one quad is required for each 4 dipoles.) By the end of the year 18 new quads that match the 21-ft dipoles were produced. Only two of these were installed in their cryostats because of a design change in which the correction elements are now in a separate cryostat. This change was made in recognition of the likelihood that during commissioning of the Energy Saver, necessary changes and additions in the correction-element packages might require ready access to this portion of the ring.

Central Helium Liquefier

A major recent event was the start of the commissioning of the Central Helium Liquefier. This plant will double the world's capacity for liquefying helium when it is brought into full operation early in 1980. Work began on this facility in 1976 and the first important operating milestone was passed when one of the 4000-horsepower helium compressors passed a 150-hour continuous-operation break-in period. In addition, all other equipment necessary for start-up has been completed.

B12 Tests

The systems tests at B12 are particularly important in this beginning part of construction because test results can be obtained rapidly enough to improve the design of magnets and refrigerators. There is no problem at B12 from interference with the 400-GeV program.

The test system at B12 now includes two full lattice cells. There are 19 magnets in the system (one quadrupole is not available and is replaced by a dummy system). The refrigeration system is as similar in design to a planned satellite refrigerator as possible; some minor design changes in the satellite cold box are still being considered and the final choice of engines has not been made, so the B12 refrigeration system has additional value as a test bed.

The system has now been cold and in superconducting operation for a month. The most difficult part of the endeavor was getting the system leak-tight. Approximately a month of leak checking was needed. Decontamination of the system took a week, but then cooldown of the system took only two days. The refrigeration system has operated reliably since it was started on December 3, including periods without local monitoring at Christmas and the New Year.

Thus one major objective of these tests has already been realized. It has been shown that a large cryogenic system can be sealed, cooled down, and kept indefinitely in a superconducting state. A string of Energy Saver superconducting magnets has also been in operation in the M6 beam line in Meson.

Work has begun on other test objectives. The magnet system has been ramped many times to 1000 A and deliberately quenched. Recovery time from quenches was very short, of the order of one minute. During a ramp to 1500 A, a thyristor in the quench bypass circuit failed to fire on a quench. There was no damage to the magnet system, but this incident showed that the system was not fail-safe. A new dc gate generator has been designed and is being installed.

The tests have also shown that the single-phase relief valve on the magnet leaks into the return header after it has been opened and reshut, because the seal is cooled by the escaping helium. This is an annoying heat loss and is being worked on.

When the system is again complete, the quench-protection monitoring and quench circuits will be tested. Then the entire magnet system will undergo life testing during ramping. Measurements of system heat loss and loss distribution will be done.

All the work to date at B12 has been done with manual controls and work is in progress by the controls group to develop a computer control system with feedback and test it. The goal is that the refrigeration system will operate without human intervention.

The work toward a superconducting accelerator at Fermilab is thus moving into high gear. We are working with confidence toward the TeV regime.

MAIN-RING MAGNET FAILURES IN 1979

Rod Gerig

The reliability of the Main-Ring magnets has improved dramatically since the bad old days when more than one magnet a week was lost. The road to this reliability has been one of hard work. The efforts of many people over many years are paying off in far fewer magnet failures. Only 14 Main-Ring magnets failed in the entire year of 1979 and only four of these took any time away from operation.

The glorious table below gives a comparison of 1979 with the two previous years.

	Total Magnet Failures	Failures by Shorting	Failures Requiring Downtime	Downtime From Failures	Percentage of Total Downtime
1977	30	21	14	92 h	5.8
1978	43	40	28	251.8	14.5
1979	14	9	4	42	3.0

Of the nine magnets that developed shorts in 1979 five were dipoles and four were quadrupoles. Four of the five dipoles were ferreted out by routine electrical measurements after the 450-GeV run in March. Three of these four were original, early-production magnets that developed turn-to-turn shorts, a situation familiar in other periods of especially high energy running.

The fourth was a recent magnet embodying our latest improvements (grooved sleeve joints). The autopsy did not find anything conclusive. The other dipole shorted during operation on September 21. It was an original early-production magnet. The cause of its failure could not be determined.

Of the four quadrupoles that failed, two shorted from internal water leaks and two from leaking manifolds.

During 1978, 10 magnet failures could be attributed to overvoltage conditions, but during 1979 none of the failures could be attributed to this reason. The difference is the installation of a new overvoltage-limiting system.

During 1978, there were six failures caused by broken insulators and five caused by ground water coming through the tunnel walls. During 1979 there were no failures from these causes. Tunnel sealing, improvements in humidity control, and great care by those working in the tunnel appear to be the primary reasons for the improvement.

There were 12 failures in 1978 for which no reason could be found. There were only two such failures in 1979. The better overvoltage protection may be responsible for some of the improvement. We have worked hard at maintaining constant magnet temperatures and reducing thermal cycling, particularly when the cycle time is changed.

We have improved greatly in numbers of magnet failures and particularly in downtime caused by them. We need more improvement in water leaks in quadrupoles, beam-induced vacuum leaks and collapsed chambers and we plan to work hard on the these in 1980.

NOTES AND ANNOUNCEMENTS

FERMILAB SUMMER HOUSING...

The Housing Office is now making plans and taking reservations for summer accommodations. Since there is always an influx of experimenters during the summer months, the office has established March 28 as the deadline for receipt of reservations for on-site housing.

This year we will attempt to satisfy the annual summer housing crisis by a procedure of decision making based upon individual needs and optimization of the Laboratory program. We will use a lottery only as a last resort.

All requests should be in by March 28, and responses will be mailed out by April 18. Requests can be for any period in the summer and need not commence on June 1. People currently in Fermilab housing may request extensions into the summer but are reminded that current occupancy does not guarantee placement.

All people using housing for the summer will be asked to state that they will make steady use of the housing for the period they request. If the space will not be used for some portion of the visit, they should notify Housing. In accord with recommendations from the Users Executive Committee, a fee equal to two weeks rent will be charged to an individual or group if **two weeks notice** of cancellation or postponement is **not** given prior to the scheduled arrival.

Five dormitory rooms will be set aside for the use of people actually running for stays of a minimum of three weeks. These rooms must be reserved at least one month prior to expected date of occupancy.

Double occupancy will not be employed for dormitory rooms unless it is requested. The charge for the second person will be $4.00/night.

<u>Allocation Priority</u>

1. Theorists - six houses or apartments and five dorm rooms.

2. Long-term commitments (foreign experiments at Fermilab under official exchange agreements).

3. Running experiments, experiments in test stage, and experiments setting up for summer and fall.

    a. Families -- at least one house or apartment per experiment in this category.

b. Individuals -- at least one dormitory room per experiment in this category.

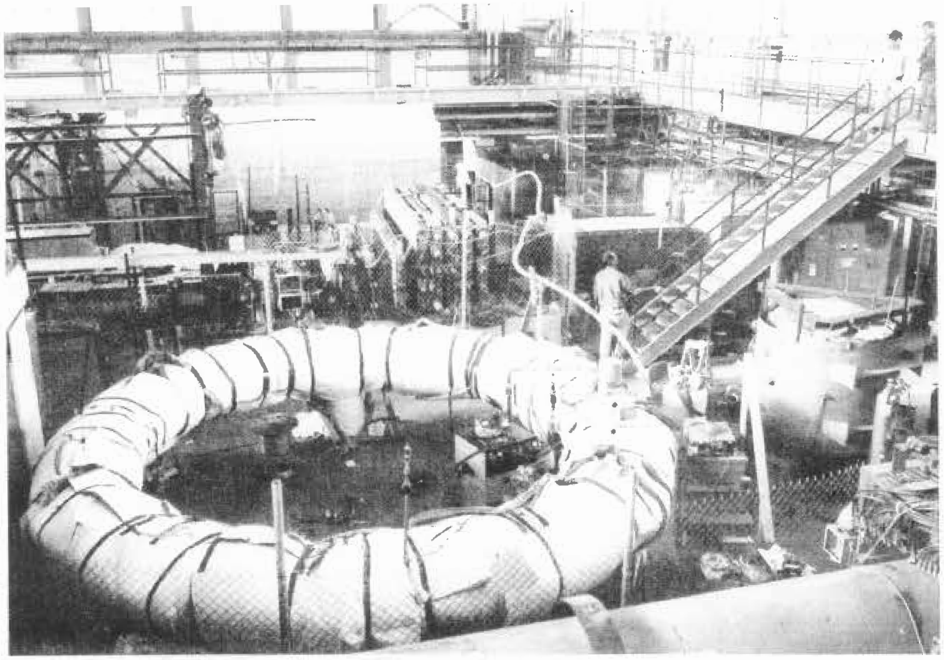
c. Remaining dormitory rooms, houses, and apartments will be assigned until as many requests as possible from persons in this category can be met.

The starting dates for summer occupancy will be staggered over the week of May 29 through June 4.

In the event that on-site housing facilities are filled, the Housing Office will assist in finding off-site accommodations.

APPOINTMENTS...

Norman Gelfand has joined Fermilab and has become a member of the Program Planning Office. He will serve as secretary of the Program Advisory Committee; in this assignment, he will play a constructive role in the liaison between experimenters and the Committee in the course of preparation for proposals. Proposals can be addressed to him. He succeeds **Thomas Groves** as PAC secretary. Groves continues as head of the Program Planning Office.



Superconducting coils for the Chicago cyclotron being built in the Meson Detector Building.
(Photograph by Fermilab Photo Unit)

SUMMARY OF OPERATIONS - DECEMBER 1979

Program Planning Office

The high energy physics research program through the month of December included a three-day period of accelerator operation at 200 GeV to allow Neutrino #616 to do some necessary calibrations. During this period the Proton Area was run parasitically. The failure of a roughing pump in the Switchyard during the 200-GeV running resulted in oil contamination of the Proton splitting septa. The pump was replaced, but the contaminated septa would not hold sufficient voltage to resume operation at 400 GeV. Clean-up and replacement efforts resulted in an alternate configuration of septa that allowed the Proton Area program to resume running at very limited intensities. This condition persisted through the end of the 400-GeV running period on Monday, December 24, when the Laboratory went into a standby mode for the holidays.

Data taking for Hadron Dissociation #272 (M1) was completed early in the month in the Meson Laboratory. A transition between Hadron Dissociation #272 and Particle Search #515 was made during the 200-GeV running period and startup activities for E-515 got underway. Charged Hyperon Magnetic Moment #620 completed Ξ^- data taking on December 16. About three days of equipment changes and tuning were required before Σ^- data taking got underway.

Thanks to extremely steady accelerator operation at 200 GeV, Neutrino #616 completed all of the measurements that had been planned for the dedicated calibration run. The remaining 400-GeV running during the month was utilized for Cherenkov studies and neutrino data taking with the dichromatic train tuned to 250 GeV.

FERMI NATIONAL ACCELERATOR LABORATORY
MONTHLY OPERATIONS HISTORY
DECEMBER 1979

Date		Accelerator	Internal Target Area	Proton Area	Neutrino Area	Meson Area
Sat.	12/1	$\sim 2\times10^{13}$ppp @400 GeV	OFF	326 (PW) 516 (PE)	616 (NO)	272,620,557, Open (M3)
Sun.	12/2	1.0 sec flattop		P-Center Tests		(End 272)
Mon.	12/3	$\sim 2\times10^{12}$ppp @200 GeV				Meson Area OFF
Tue.	12/4	0.5 sec flattop				
Wed.	12/5					
Thu.	12/6	Accelerator Necessary Repairs & Startup @400 GeV				
Fri.	12/7	Repairs: PSEP	OFF	326 (PW) 516 (PE)	616 (NO)	620 (M2) 557 (M6)
Sat.	12/8	Repairs: PSEP Tuning:SWYD;PSEP		P-Center Tests		584 (M3) 515 (M1)
Sun.	12/9			Proton Area OFF due to		
Mon.	12/10			PSEP failure		
Tue.	12/11					
Wed.	12/12	Accelerator Maintenance				
Thu.	12/13					
Fri.	12/14	Reprs:F0 Ion pump;Vert.damper Tuning:PLAMB losses		326 (PW) 516 (PE)	616 (NO)	
Sat.	12/15		OFF	P-Center Tests		
Sun.	12/16					
Mon.	12/17	Necessary Repairs $>2\times10^{13}$ppp				Same as above but, 580 (M6)
Tue.	12/18	@400 GeV				613 Tests
Wed.	12/19	1.0 sec flattop				620 (M2) 557 (M6)
Thu.	12/20	Necessary Repairs $>2\times10^{13}$ppp				584 (M3) 515 (M1)
Fri.	12/21	Linac vacuum				
Sat.	12/22	@400 GeV				
Sun.	12/23	1.0 sec flattop				
Mon.(H)	12/24	Repairs: MR vacuum				
Tue.(H)	12/25	Facility Shutdown				
Wed.	12/26					
Thu.	12/27					
Fri.	12/28					
Sat.	12/29					
Sun.	12/30					
Mon.	12/31					

BEAM UTILIZATION BY

	Beam	Hours
PROTON AREA		
Di-Muon #326	PW	190
Photoproduction #516	PE	220
P-West Beam Tests	PW	15
NEUTRINO AREA		
Neutrino #616	NO	400
MESON AREA		
Hadron Dissociation #272	M1	40
Particle Search #515	M1	280
Hadron Jets #557	M6	170
Particle Search #580	M6	60
Particle Search #584	M3	110
Charged Hyperon Magnetic Moments #620	M2	330
TOTAL HOURS FOR HIGH ENERGY PHYSICS		1815

EXPERIMENTAL ACTIVITY - DECEMBER 1979

Activities
setup and tuneup of experimental apparatus to measure muon pairs produced by pions
setup and tuneup of a large magnetic spectrometer in the Tagged Photon Lab
studies to improve the beam in the P-West High Intensity Area
data and calibrations for the measurement of neutrino structure functions
completed; study of the coherent dissociation of π, K, and p into strange particles
setup and tuneup of experimental apparatus for the study of charmed particles produced in hadronic interactions
tuneup and calibrations; study of hadron jets with the calorimeter triggered multiparticle spectrometer
setup and tuneup of experimental apparatus to search for new resonances with the decay channels $K_S^0 K_S^0$, $K^0 K^0 \pi$, $\Lambda\bar{\Lambda}$, and $\Lambda\bar{\Lambda}\pi$.
setup and tuneup; search for the decay of new long lived neutral particles
data to measure the magnetic moments of Σ^+, Ξ^-, Σ^-, and Ω^- hyperons

FACILITY UTILIZATION SUMMARY - DECEMBER 1979

I. Summary of Accelerator Operations

		Hours	
A. Accelerator use for physics research			
High energy physics research		391.4	
Accelerator physics research		2.6	
	Subtotal		394.0
B. Other Activities			
Program interruption		44.2	
Accelerator setup and tuning to experimental areas		15.5	
	Subtotal		59.7
C. Unscheduled interruption			106.3
D. Unmanned time			184.0
Total			744.0

II. Summaries of High Energy Physics Research Use

	# of Expts.	Hours	Results
A. Counter experiments	9	1800	1 completed
B. Bubble chamber experiments	-	-	
C. Emulsion experiments	-	-	
D. Special target experiments	-	-	
E. Test experiments	-	-	
F. Engineering studies and tests	1	15	P-West beam studies
G. Other Beam Use	-	-	
Totals	10	1815	

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

A. Beam accelerated in Main Ring	2.31
B. Beam delivered to experimental areas	2.12
Proton Area	<0.01
Neutrino Area	
Slow Spill	0.69
Fast Spill	0.92
Meson Area	0.51

If the groundhog sees his shadow on February 2 this year it will hardly matter that Fermilab is in store for six more weeks of winter. This has been one of the mildest winters in a decade, and even the groundhogs have been seen running up and down the berm playing tag with their shadows.

(Photograph courtesy of Robert Poole)

Arthur and Janice Roberts retiring from Fermilab (talking to Lou Voyvodic and Phil Livdahl). They have moved to Hawaii to work on the DUMAND experiment.

(Photograph by Fermilab Photo Unit)

MANUSCRIPTS AND NOTES PREPARED FROM DECEMBER 13, 1979 TO JANUARY 14, 1980

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. P. Berge et al. Experiment #45	Inclusive Production of Non-Strange Resonances in High Energy νp Charged-Current Interactions (Submitted to Phys. Rev. D)
F. Fumuro et al. Experiment #336	*A* Dependence in Proton-Nucleus Interactions at 400 GeV [Nucl. Phys. **B152**, 376 (1979)]

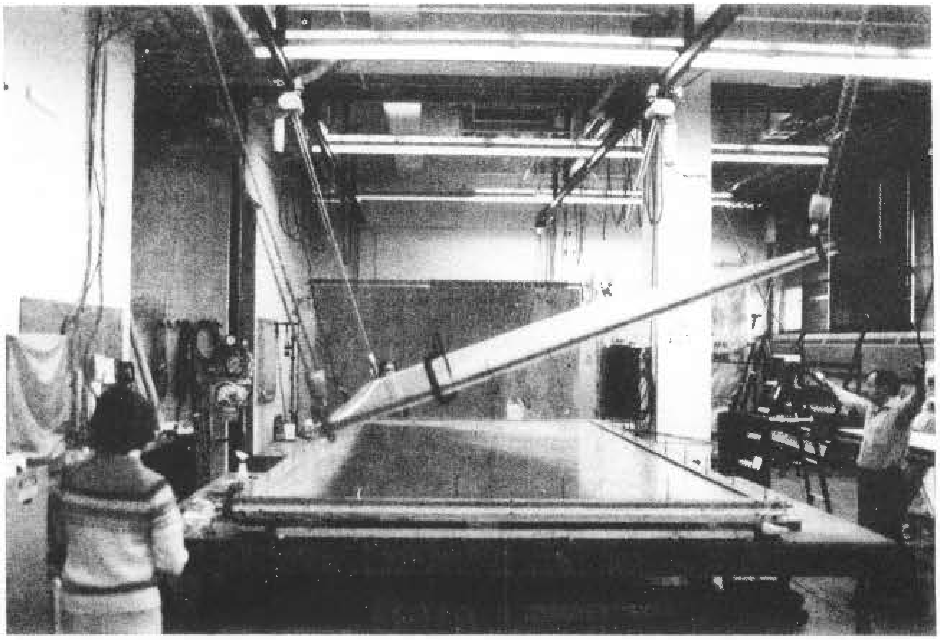
Theoretical Physics

A. Bialas and A. J. Buras	Simple QCD Parametrizations of Parton Distributions Beyond the Leading Order of Asymptotic Freedom (FERMILAB-Pub-79/73-THY; submitted to Phys. Rev.)
J. F. Schonfeld et al.	On the Convergence of Reflectionless Approximations to Confining Potentials [FERMILAB-Pub-79/77-THY; submitted to Ann. Phys. (N.Y.)]
H. J. Lipkin	Do Bound Color Octet States of Liberated Quarks Exist? (FERMILAB-Pub-79/83-THY; submitted to Phys. Rev. D)
H. J. Lipkin	Why Most Flavor Dependence Predictions for Nonleptonic Charm Decays are Wrong (FERMILAB-Pub-79/84-THY; submitted to Phys. Rev. Lett.)
M. K. Gaillard	Weak Interactions and Gauge Theories (FERMILAB-Conf-79/87-THY; submitted to the International Symposium on Lepton and Photon Interactions at High Energies, Fermilab, August 23-29, 1979)

N. Isgur et al.	Isospin-Violating Mixing in Meson Nonets (FERMILAB-Pub-80/13-THY; submitted to Phys. Lett.)

Physics Notes

D. Neuffer	Colliding Muon Beams at 90 GeV (FN-319)



A wire-chamber plane being carefully put in place in the shops on the ground floor of the Central Laboratory.
(Photograph by Fermilab Photo Unit)

DATES TO REMEMBER

February 14-15, 1980	Proposal Presentation Meeting.
March 13-14, 1980	Spring meeting of the Physics Advisory Committee.
March 28, 1980	Deadline for requests for summer housing. Please register as soon as possible. More detailed information will be given in next month's **Fermilab Report.**
April 25, 1980	Deadline for receipt of all new proposals and other written materials to be considered at the summer meeting of the Physics Advisory Committee. This will also be the deadline for receipt of the first set of Tevatron proposals (those dealing with experiments in the Neutrino and Muon areas).
May 15-16, 1980	Proposal Presentation Meeting.
June 21-27, 1980	Summer meeting of the Physics Advisory Committee (Aspen).