fermilab report

Fermi National Accelerator Laboratory Monthly Report

February 1978

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THE COVER: Laura Fermi as she addressed the audience at the dedication ceremony of the Laboratory in May, 1974. (Photo by Fermilab Photo Unit)

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ROBERT WILSON

Robert R. Wilson announced on February 8 that he was submitting his resignation as Director of the Fermi National Accelerator Laboratory. In a letter to Laboratory employees he stated:

> I have been deeply concerned that the future of Fermilab is seriously jeopardized by the low rate of funding, and, as you know, I decided to make a fight for better funding. Among other things, I stated that I would resign unless the rate was substantially increased.
>
> Although the President's budget does indicate an improvement, the funding for FY 1979 cannot honestly be described as substantial, nor in my mind as adequate. I cannot in conscience pretend that I can responsibly continue to direct Fermilab within that budget. Regretfully, I have submitted my resignation to the Trustees of the URA through its president, Norman Ramsey.

On February 17, Norman Ramsey made the following announcement:

> At its meetings on February 16 and 17, the URA Board of Trustees discussed with Dr. Wilson his recently submitted resignation as Director of Fermilab. The Board asked him to reconsider his decision and urged him to withdraw his resignation. When Dr. Wilson concluded that he could not do so at the present inadequate funding level, the Board accepted his resignation with great reluctance but urged him to continue as Director until a new Director can be found who meets the standards of excellence set by him. The Board was most grateful to Dr. Wilson for his willingness to continue and it will conduct the search as expeditiously as possible.

LAURA FERMI
(1907-1977)

Laura Fermi passed away in Chicago on December 26. She was the widow of Enrico Fermi, after whom our Laboratory is named.

In her own right, Ms. Fermi had a distinguished career. She wrote a number of books, "Atoms in the Family," "Atoms for the World," "Illustrious Immigrants: The Intellectual Migration from Europe 1930-1941," "Mussolini," and "The Story of Atomic Energy." She was co-author of "Galileo and the Scientific Revolution." She worked in gun-control and anti-pollution campaigns and in University of Chicago activities.

Laura Fermi was a principal speaker at the dedication ceremony of our Laboratory in May, 1974 and the photograph of her on our cover was taken on that windblown but joyous occasion. In her talk, she emphasized the esthetic potential of the Laboratory and we hope that we have carried out her wishes and made Fermilab a place of esthetic value.

WHAT HAPPENED AT FERMILAB DURING 1977?

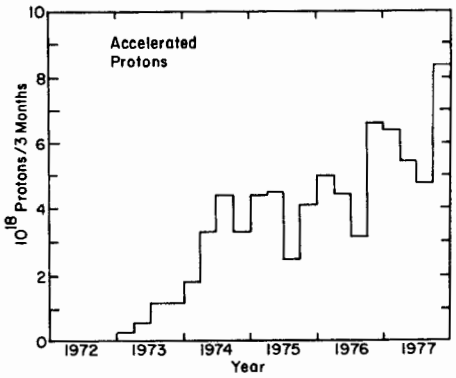
A. F. Greene

The most exciting development at Fermilab during 1977 was the discovery of the T-particle in a dimuon experiment running in the Proton-Center experimental area. Another highlight was the productivity of the 15-foot bubble chamber, in which were taken over 700,000 pictures of neutrino interactions. During the year it was possible to finish data-taking for the experiments that had been in residence since operation of the facilities began. With the removal of these experiments, new activities were initiated. Changes were particularly evident in the M1, M2, and M4 beams in the Meson Area and in Proton-East and Proton-West.

There were two major shutdowns during the calendar year, each about three to four weeks in duration. This pattern of shutdowns is expected to repeat in a similar fashion during 1978. The accelerator was run at 400 GeV, but there were two extended periods of operation at 300 GeV with a 200-GeV front porch. These were arranged at the request of experimenters interested in running with lower-energy proton beams. The beam spill usually included 1.25 sec of slow spill followed by 20 μsec or 2 msec of fast spill for neutrino experiments, depending on the type of focusing system in use. A 20-μsec spill is necessary for effective use of the present pulsed wide-band horn, whereas the longer fast spill is more satisfactory with non-pulsed focusing systems such as the quadrupole triplet or the sign-selected bare-target trains. At times when the neutrino program was not in

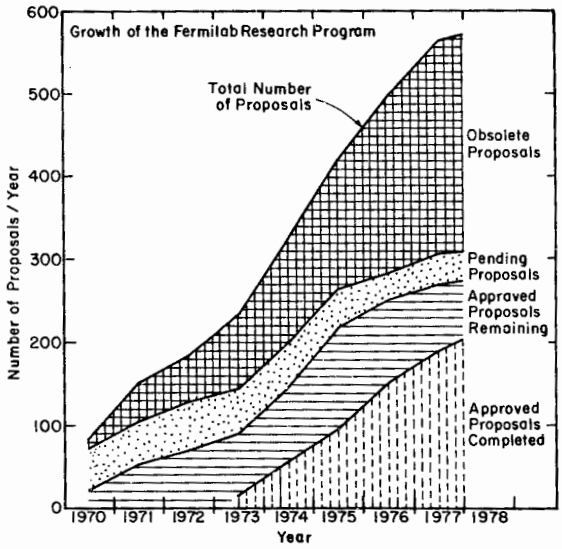
operation, 2 sec of slow spill was available. This chance occurrence provided a bonus to experiments using slow spill which were scheduled at that time.

Overall the accelerator ran well during the year, with a total of 4,800 hours available for high-energy physics research. During the 42-$\frac{1}{2}$ weeks of operation, this meant an average of about 110 hours of beam per week for experiments. Extremes in the quality of operation were noted in January, when the very cold temperatures noticeably affected many facilities adversely, in particular the feeder cables for the accelerator. The most successful month in Fermilab's history was realized in October, when there was a record number of protons accelerated and a record number of hours of beam for experiments. Recently there has been a significant improvement in the number of protons available for experiments, as can be seen in the graph on the right. During the last quarter of the year, the number was larger than in any previous period.



Number of protons accelerated in the Main Ring for each quarter-year since operations began in 1972. A total of 2.5×10^{19} protons were accelerated during 1977.

As shown in the graph on the next page, the rate of completion of experiments is comparable to that in recent years. Underlying this is the feature that the completions have included many significant experiments with large amounts of running time. The number of approved proposals remaining to be run has been reduced below that for previous years.

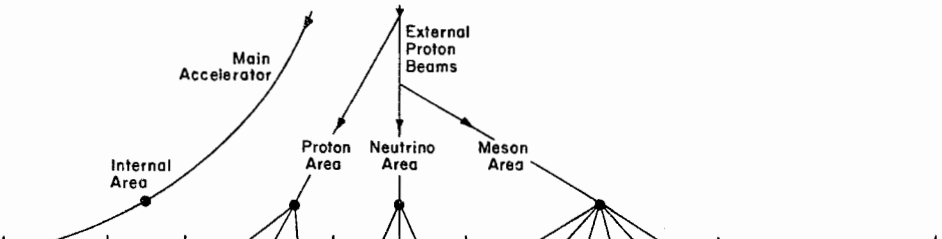


Graphical description of the growth of research at Fermilab. During 1977 a total of 53 proposals were received, 25 were approved, and 29 completed data-taking.

The history of experimental activities at Fermilab during 1977 is given in the figure on page 8. In the table on page 9 are included descriptions of the major activities underway during the year. By using the experiment numbers, it is possible to identify individual activities in the figure and table.

Proton Area

In Proton-Center the apparatus that had previously been used for di-electron and dihadron measurements was converted for study of dimuons. The tuneup of the experiment began in April and by July there was an announcement of the discovery of a new particle, the Υ, with mass 9.4 GeV. Later a second, neighboring particle, the Υ', with mass 10.0 GeV was



Month	C-O	PE	PC	PW	h	ν	μ/h	M1	M2	M3	M4	M5	M6	Comments
Jan., 1977	198A	325	494	177A				61	350		226		396	200/300 GeV
	313				beam tests									
Feb.	198A					15' (Ne) for 180, 53A	beam tests 369	456				test beam	290	400 GeV
Mar.	313,381	87A			379				440				110A	
Apr.	198A		288			310		507	439	438			290	
														facility maintenance & development
May	289,442	87A	288	95A	379	15' (Ne)		507	395		beam tests		110A	400 GeV
June	442					310, 15' (Ne)	369	236A	441, 404			test beam	118A	
July						15' (H_2) for 31A		324	395				99	
Aug.	442	152B							468				290	
														facility maintenance & development
Sept.	289	152B	288	95A	DPI Tests	253, 310, 482, 15' (Ne) for 546	444	61	395		383 Tests		290	200/300 GeV
Oct.								104		540		test beam	396	400 GeV
Nov.	522 552	87A											99	
Dec.	522 552								439					

DESCRIPTION OF MAJOR RESEARCH ACTIVITIES
IN THE EXPERIMENTAL AREAS DURING 1977.
(The individual experiment numbers are shown in parentheses.)

Proton Area

Discovery of the T-states at 9.4 and at 10.0 GeV (288)

High mass hadron pair production from proton interactions (494)

Study of the dimuon continuum produced in proton-nucleon collisions at 200-400 GeV (288, 325)

Continued measurements of p-p elastic scattering with large-t at 200 and 400 GeV (177A)

Continued study of single and diphoton production in proton-nucleon collisions (95A)

Neutrino Area

Study of ν and $\bar{\nu}$ interactions in the 15-ft bubble chamber using a heavy neon/hydrogen mixture (53A, 546) and in electronic detectors (310, 482) with particular interest in multilepton production.

Study of $\bar{\nu}$ interactions in the 15-ft bubble chamber using a heavy neon/hydrogen mixture (180) and using hydrogen (31A)

Search for high-mass, short-lived states produced in 400-GeV proton interactions and decaying into one or more muons and neutrinos (379)

Study of pion dissociation at 215 GeV using a large aperture spectrometer (369)

Production of high-mass muon pairs by pion-nucleon interactions at 225 GeV (444)

Meson Area

Elastic scattering of protons at 300 GeV from a polarized proton target (61)

Continuing measurements to determine the charged kaon form factor (456)

Study of "jet" structure among hadrons produced at large-p_t in hadron collisions (236A, 395)

Measurements of inclusive production of single charged and neutral hadrons produced in hadron collisions (118A, 324, 350)

Continuation of measurements of hadron total cross sections from hydrogen, deuterium and nuclei at the highest available energies (104)

Dimuon production from proton collisions in a magnetized beam dump (439)

Studies of neutral hyperon production and decay: measurement of the Λ^0 magnetic moment (440), Λ^0 production and polarization from p-p interactions (441)

Measurements to yield the charge radius of the neutral kaon (226)

Studies of exclusive production of hadrons: π-p backward scattering (290), associated production (99), ρ^0-production by pions (110A)

Study of diffractive dissociation of charged hadrons from a gas target (396)

Continued study of neutron interactions to include measurements of inelastic cross sections on nuclei (438)

Internal Area

Continued study of p-p and p-d elastic scattering (198A and 552)

Continued measurement of the polarization of recoil protons from p-p elastic and inelastic scattering (313 and 522)

Study of nuclear fragments produced in proton collisions with a target of heavy gas (442)

Measurement of the real part of the p-n and p-p forward scattering amplitudes and study of isobar production (381)

Measurement of proton elastic scattering from gaseous He^4 (289)

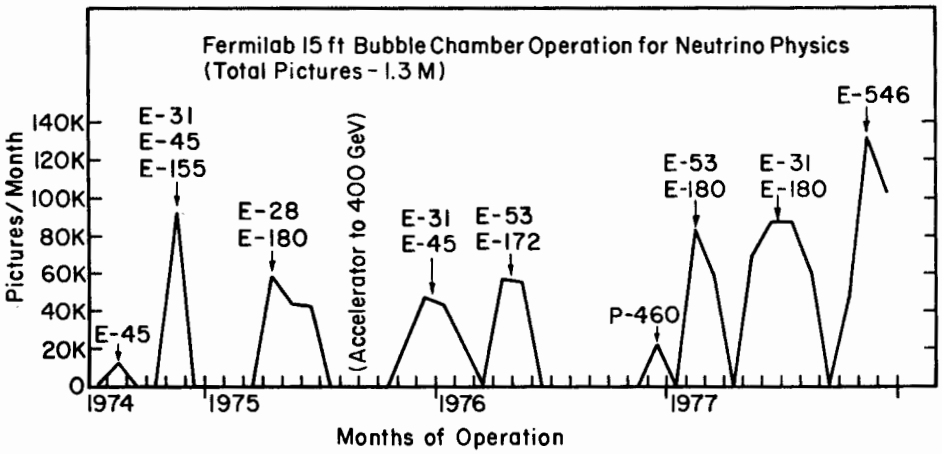
exposed and there was speculation that a third particle might be apparent in the data. During September and October measurements were made of the dimuon continuum produced in proton-nucleon collisions at 200 and 300 GeV using the same apparatus. Accompanying this were studies of production of the Υ at those energies.

During early 1977, measurements of the dimuon continuum were made in Proton-East using a precision spectrometer paired with a simpler spectrometer fashioned from counters installed in holes drilled in adjacent earth. The completion of this dimuon experiment meant the end of a series of experiments by the Chicago-Princeton group that had previously studied high-p_t production of hadrons by protons incident on hydrogen and nuclear targets. Later in the year, Proton-East was used for investigation of photon interactions.

The experimental program originally planned for the Proton-West area was completed during 1977. An experiment studying p-p elastic scattering at large angles was able to make use of 200-GeV beam when that energy was available during accelerator operation with a front porch. The purpose of this work was to study the energy dependence of the elastic-scattering process. The experiment then continued for about three months to collect data at their largest angle with lowest rates. Then later in the year there was a final running period for an experiment which had been studying diphoton production. Since October the Proton-West area has been used for testing or calibrating equipment to be used in other experiments while construction of a new pion beam has continued downstream.

Neutrino Area

As was pointed out previously, the 15-ft bubble chamber was operated very successfully in 1977. This is shown most dramatically in the graph below where there is indication of the historical development of the 15-ft neutrino experimental program. Whereas it was gratifying to see the much-improved performance of the 15-ft chamber, the 30-in. bubble chamber was not able to be run because of insufficient resources to operate both facilities simultaneously.



Graphical description of 15-ft bubble chamber operation for neutrino physics since startup in 1974. The numerals for experiments are given at the time they were run. A total of 717,000 pictures was taken during 1977.

The running during 1977 began with a heavy neon fill for two experiments using incident neutrino and antineutrino beams and the wide-band horn focusing system. During this period, there were two failures of the focusing system. But eventually that system also operated reliably, after it was realized that it was necessary to limit the amount of beam flux per

pulse incident on the horn target. During the summer about 150,000 pictures were taken with a beam consisting primarily of antineutrinos incident on the 15-ft chamber with a hydrogen fill. During this period, the bubble chamber operated almost flawlessly and a new standard of operation was realized--an average of 30,000 pictures per week for several weeks. Later in the fall, the 15-ft chamber was again filled with heavy neon and the External Muon Identifier behind it was supplemented by new chambers and was reconfigured into a double-plane system.

Throughout 1977, electronic detectors to study neutrino interactions were in use in two laboratories. During the fall, a total of over 800 tons of detector was simultaneously employed in the study of neutrino interactions.

While the neutrino experimental program was underway, there were experiments in progress simultaneously using hadron beams in the Muon Lab or in Lab E. A portion of a new neutrino detector in Lab E was used with a fine-grain calorimeter to study proton interactions with outgoing muons and hadrons, and with missing energy. This experiment was motivated by a search for charmed particles produced in hadron interactions. In the spring it benefited from several weeks of running with a long flattop when the neutrino focusing system and bubble chamber were undergoing repairs.

Later during the summer, the muon beam was used with hadrons. An experiment was set up to use the cyclotron spectrometer for studies of pion dissociation. The targeting for that beam was accomplished using a new target station located in the decay pipe for the neutrino beam. During the fall, the same spectrometer was used again but for study of dimuon production by positive and negative pions and by antiprotons. The main goals

of this experiment included a search for new particles decaying into two muons and test of a dimuon production model, which predicts that π^- produce them more readily than do π^+. The experiment relied on beam intensities provided by the quadrupole triplet train. Thus it was possible for a program of neutrino physics using that focusing system to be run in parallel with this experiment.

Meson Area

One of the main goals of 1977 was the completion of experiments in the M1, M2, and M4 beams that had been in residence since the Meson Area was first operated. Consequently, the inside of the Detector Building completely changed in appearance during the year. In the M1 beam, there were activities completed that enabled the removal of experimental apparatus used by five groups. Areas of physics explored in the process of completing these experiments included measurement of elastic scattering from a polarized-proton target, determination of the kaon form factor, study of hadron-jet phenomena, inclusive-scattering studies, and measurements of hadron total cross sections. The last experiment listed had waited for two years for needed improvement of the proton transport to the Meson Area to 400 GeV and for increase of the M1 beam energy. Thus measurements of charged-hadron total cross sections have now been made at the highest available Fermilab energies.

In the neighboring M2 beam, there was completion of running and removal of equipment belonging to two groups. The photon detector previously used for measurement of pion charge exchange ended its service in

M2 with a study of inclusive π^o and η^o production. Further, another hadron-jet experiment was installed, completed, and removed. The neutral-hyperon spectrometer there provided data for four separate experiments. It resides at the end of the M2 beam.

During the year, the shielding for the M2 beam was significantly increased; with this came the ability for an experiment located in a cave inside the Detector Building to use 10^{11} protons per pulse. This increase in intensity is a factor of 100 improvement over previous normal operating levels of the beam. The experiment studied dimuon production using an apparatus with large acceptance.

In M4, there was not only a change of experiments but a significant change in the beam. Early in the year the apparatus originally used for experiments to study K^o regeneration was still in use to study K_S^o-electron scattering or to measure the charge radius of the neutral kaon. The completion of this work then signified the end of an impressive series of neutral-beam experiments. During 1977, the beam was changed to a charged beam. The first experiment to use this new beam has been for study of inclusive production of K_S^o from K^--p interactions. Data-taking for the experiment was commencing as the year ended.

In the M6 charged beam, the Laboratory and the experimenters have been burdened with a large backlog of commitments, which at present seem to extend to the middle of 1978. The apparatus in use there includes the Single Arm Spectrometer and Multiparticle Spectrometer facilities, as well as one experimental setup for study of pion backward scattering and another

for measurements of hadron dissociation. It is hoped that during the first half of 1978 the major commitments to experiments in that beam line will be able to be fulfilled.

Internal Area

The primary research interests in the Internal Target Area have been centered around use of the superconducting spectrometer and associated warm gas-jet target. The operation of the spectrometer has depended on use of two liquefiers that regularly supply liquid helium for the superconducting magnets. A total of four experiments involving two groups have used the apparatus for studies of proton elastic and inelastic scattering. Residing at times in the vacuum chamber for the spectrometer were detectors used to identify nuclear fragments produced in collisions of protons with heavy gasses. This experiment used the spectrometer whenever liquid helium was unavailable.

Other activities in the Internal Area have included completion of two additional experiments involving the US-USSR collaboration, which has been active since the first beam was available in the Main Ring in 1972. The last experiment of this series included study of proton-helium scattering using a gaseous helium target.

A Final Reflection

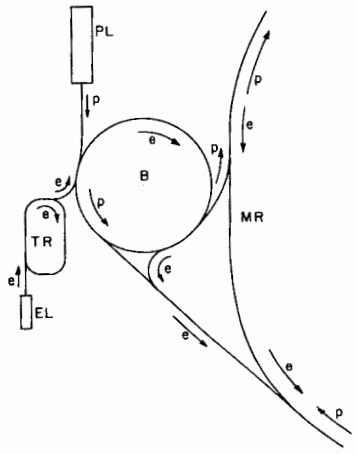
In answer to the frequent question about what has happened recently at Fermilab, there is often initial silence. With that silence come memories of experiences with the experimental program and anticipation of results to come from analysis of data. Verbal description or pages of prose will never appropriately match the significance of what happened.

ELECTRON-PROTON COLLIDING BEAMS

A. G. Ruggiero

In the past, attention in the colliding-beams field has been focused primarily on proton-proton and proton-antiproton scattering experiments. There are major projects for pp and $\bar{p}p$ with the Energy Doubler. A third kind of colliding-beams experiment is also being considered, with less publicity but with no less attention, by a smaller number of physicists. In this scheme, a 12-GeV electron beam circulating in the Main Ring collides with 1000-GeV protons in the Energy Doubler.

A group of a dozen people have been investigating the feasibility of a scheme that was proposed at the 1977 Aspen Summer Study.[1] The scheme is outlined in the accompanying drawing where the 200-MeV proton Linac, the Booster, the test ring for electron cooling and an arc of the Main Ring are shown. An electron linac of output energy 75 MeV and current 400 mA is also shown attached to the electron-cooling ring. The patterns followed by the two beams are shown by arrows.



Layout of electron injection, acceleration, and stacking.

The protons are injected as usual in the Main Ring, accelerated to 100 GeV, extracted and stacked in the Energy Doubler/Saver in ten pulses for a total current of 1.5 A. These pulses are then accelerated to 1000 GeV, where they coast (bunched) for several hours.

In the meantime, the Main Ring becomes available for the electron beam. Electrons are first injected and accelerated to 750 MeV/c in the Electron Ring, then transferred to the Booster, where they are accelerated to 4 GeV. Finally, they are extracted and injected into the Main Ring. Several pulses are required to fill the Main Ring in boxcar fashion. At the completion of this filling, which takes a time depending on the repetition rate of the Cooling Ring, the electrons are accelerated to 12 GeV and made to collide with the proton beam in one of the six long straight-sections.

When the study group was formed, it was decided to work out the scheme minimizing the hardware modifications or additions needed and to use whatever was available from the development of the other two colliding-beams projects. Thus, for instance, the Cooling Ring is a more than adequate choice for an electron injector to the Booster; its final momentum of 750 MeV/c is a little greater than the Booster injection momentum. In addition, the electrons can be transported to the Main Ring via the channel presently being designed and constructed for reverse injection into the Main Ring. No polarity reversal of the Booster of Main Ring is required. The energy of 12 GeV is determined by the power output of the existing Main Ring rf system. The intensity of 400 mA, equivalent to 5×10^{13} electrons, is the maximum that the present vacuum, magnet, and rf systems can tolerate. All the modifications required are software, except for acquiring a 75-MeV linac, radiation shielding and power supply for the electron cooling ring and a low-beta insertion for the Main Ring. These modifications would probably cost less than the experimental setup itself.

The e-p colliding beams project does not require a major capital investment. Indeed, it can be carried out in the wake of the other two (more expensive) colliding-beams projects. It would require primarily the acquisition of a 75-MeV electron linac.

With these constraints, it is still possible to achieve a luminosity over $10^{31}cm^{-2}s^{-1}$, possibly $10^{32}cm^{-2}s^{-1}$. The main limitation encountered so far is the pressure rise induced by synchrotron radiation. One expects a final pressure of 10^{-7} torr. This sets the beam lifetime of about one hour, not because of the gas scattering or quantum fluctuations, but because of bremsstrahlung.

The present phase of studies will end in March with a summary report. Two more phases are then expected to follow, one to investigate experimentally the combined performances of the Booster and Main Ring at 4 GeV and the other to accelerate electrons and investigate the effects of the synchrotron radiation.

Reference

[1] Colliding Beam Physics at Fermilab, 1977 Summer Study, Vol. II, p. 337.

NOTES AND ANNOUNCEMENTS

SUMMER HOUSING. . .

The Housing Office is now making plans and taking reservations for accommodations for the summer. Since there is always an influx of experimenters during the summer months, the office established March 31 as a deadline for receipt of reservations for on-site housing.

In order to assure an equitable distribution, Fermilab housing assignments will be determined again this year by the same priority and lottery system established by the Laboratory last year. The housing assignments will be made early in April based on the expected running schedule for the summer, and responses will be mailed out by April 17.

The priority system allocates four houses or apartments to the theoretical program and the remaining houses, apartments, and dormitory rooms to experimenters on running experiments, experiments in the test stage, and experiments setting up for the summer and fall. After housing has been allocated to foreign experimenters at Fermilab under official exchange agreements, the priority is one house or apartment and one dormitory room per running experiment. If there is still housing available after each experimental group with an experiment running during the summer has received one house or apartment and one dormitory room, there will be a second-round assignment by lot. Five of the eighty-nine dormitory rooms will be set aside for the use of people on running experiments who were not selected in the assignment and will be staying longer than three weeks. These rooms must be reserved at least one month prior to

expected date of occupancy. There will not be double occupancy in dorm rooms unless it is requested.

The starting dates for summer occupancy will be staggered over the week of May 29 through June 4. If for any reason assigned housing is not to be used for some portion of the summer, the Housing Office should be notified so that it can be utilized by another group.

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

USERS ANNUAL MEETING. . .

The Users Annual Meeting has been tentatively scheduled for Friday, May 5, 1978. The length of the meeting (one or two days) will depend on the agenda which has not yet been established. Any conflicts with this meeting date should be brought to the attention of the Users Executive Committee through the Users Office, (312) 840-3136.

FUTURE MEETINGS PERTAINING TO MESON LAB PROPOSALS. . .

It had been previously planned that proposals for "post-pause" Meson Lab experiments would be presented at the February Proposal Presentation Meeting and considered by the Program Advisory Committee at their meeting in March. However, a combination of circumstances forced us to revise these plans. We had hoped that a design report on the Meson Lab improvement plan would be in published form by this time. This expectation proved to be overly optimistic. In addition, the number of proposals received at the

time of the January 27 deadline was unexpectedly large and would have resulted in an unmanageably large number of presentations were we to have included all of them at the February meeting.

As a result of the above we decided to postpone consideration of "post-pause" proposals until the next proposal presentation meeting. That meeting is currently scheduled for May 18-19; however, it is almost certain that more than two days will be required to cover all of the material we expect to be submitted in preparation for the summer PAC meeting in June. More information on the May Proposal Presentation Meeting will appear in future issues of Fermilab Report.

As a prelude to the Proposal Presentation Meeting in May we are planning to hold a one day workshop on the proposed Meson Lab improvement program on Friday, April 14. The purpose of that workshop is to provide interested users with an opportunity to comment on the Meson Lab plans prior to their publication in the design report.

We have already begun to use the proposals that were received at the end of January to aid us in our future planning for the Meson Lab. We have requested that the proponents of those proposals work closely with the Meson Department staff in order to prepare accurate cost estimates of the experiments as well as to define their special requirements with regard to beams, operating conditions and running times.

Users wishing to submit new proposals for "post-pause" Meson Lab experiments should observe the May 5 deadline for the submission of new proposals to be considered at the summer PAC meeting in June. Revisions

and updates for the Meson Lab proposals that were submitted at the time of the January 27, 1978 deadline will be accepted at any time up to the end of the Proposal Presentation Meeting in May.

Questions regarding the April workshop should be addressed to J. Elias in the Meson Department. Questions pertaining to the May Proposal Presentation Meeting should be referred to T. Groves in the Director's Office.

POSITION AVAILABLE AT FERMILAB

The Radiation Physics Group has an opening for a physicist with a background in high energy or nuclear physics. Duties will include liaison work in radiation safety with experimental areas, conducting dosimetry measurements, supervising instrument maintenance and development, doing shielding calculations, and making environmental measurements for penetrating radiation. Candidates should have a strong background in instrumentation, be able to think clearly and communicate well, have sound mature judgment and be interested in being trained in health physics. Applicants must speak and understand English very well. Formal training should include a Ph. D. in experimental physics. Interested persons should contact Larry Coulson, Ext. 3023.

RESEARCH ACTIVITIES DURING JANUARY 1978

James MacLachlan

January was a rather rough month all around. Experimental area crews and Plant Maintenance craftsmen struggled with frozen cooling towers and a snow-filled high-voltage cubicle in some of the bitterest weather Fermilab has experienced. Accelerator operation was plagued by a serious new problem of failure of Main Ring power-supply transformers, which first appeared December 30. There are 64 of these 2.8 MVA, 13.8-kV to 350-V transformers located at service buildings around the Main Ring. During the entire history of operation of the accelerator prior to December, there had been only four failures. In January, there were three more failures, with others occurring February 3 and 7. The failure mode leads to a primary-to-secondary short, which puts very high voltage on the magnet bus and therefore usually leads to magnet failures as well. Needless to say, the problem is being intensively investigated, not only with respect to saving transformers, but also with respect to protecting the magnets when transformer failures do occur. The transformers are being run within their ratings, and the failed transformers have looked very clean inside. It has not escaped notice that the troubles began rather soon after the institution of the day/night variation of the accelerator cycle time.

The accelerator ran for 394 hours of high-energy physics, 63% of the 625 hours scheduled. Operation for the entire month was at 400 GeV with a 1.25-sec flattop and 2-msec fast spill except for a couple of shifts test of 10-msec fast spill. A total of 2.35×10^{18} protons were accelerated. The

cycle time averaged over all January running was 11 sec; in December the average cycle time was 10.4 sec.

The top-priority experiment for nearly the entire month was Muon #203A/391 running downstream of the cyclotron spectrometer in the N1 line. The experiment suffered its share of the winter-weather problems with multiple freeze-ups of the N2 and N3 LCW systems, eliminating several days of beam. But by January 23 the experimenters declared their ability to take data at approximately 2.5×10^{6} μ/pulse; the N1 yield of $\gtrsim 2\times10^{-7}$ μ/p is higher than it has been for previous running. The 15-ft bubble chamber finished up a nearly trouble-free run for 15-ft ν/H_2&Ne #546, which started in late October. About 365K pictures were taken including 17K hadron calibration pictures at energies from 25 to 100 GeV.

Both the Meson and Proton Areas shared in the freeze-up difficulties. The Meson Area was up only about 60% of the time the accelerator was running. The Proton Area was less hard hit and managed to overlap its downtime better with the accelerator so that it made some use of nearly all available beam. Photoproduction #87A in P-East, however, had water problems of a different kind; a broken hose on an analyzing magnet soaked a considerable amount of electronics including a proportional wire chamber. This and later chamber problems kept them off for nearly all of the first half of the month. At the end of the month, one of four coils in this same magnet shorted, but the experiment continued to run with a reduced field.

It was indeed a trying month, but a number of experiments were completed including Di-Muon #444 (N1), Neutrino #482 (N0), 15-ft ν/H_2&Ne

#546 (N0), and Associated Production #99 (M6E). The ratio of total hours for experiments to accelerator hours was 7.6, indicating that at any time the accelerator was running there were approximately 8 experiments making use of the beam. Thus, not only Fermilab people, but a full complement of experimenters were striving to make the best of the adverse weather and the substandard accelerator reliability.

FACILITY UTILIZATION SUMMARY--JANUARY 1978

I. Summary of Accelerator Operations

		Hours	
A.	Accelerator use for physics research		
	Accelerator physics research	44.0	
	High energy physics research	393.9	
	Research during other use	(34.6)	
	Subtotal		437.9
B.	Other activities		
	Accelerator setup and tuning to experimental areas	8.5	
	Program interruption	60.0	
	Unscheduled interruption	237.6	
	Subtotal		306.1
C.	Unmanned time		
	Total		744.0

II. Summaries of High Energy Physics Research Use

		# of Expts.	Hours	Results
A.	Counter experiments	16	2412.6	4 expts. complete
B.	Bubble chamber experiments	1	258.0	94,651 pictures; expt. complete
C.	Emulsion experiments	1	49.4	56 stacks; 10 expts. complete
D.	Special target experiments	1	-	2 targets irradiated
E.	Test experiments	1	239.2	-
F.	Engineering studies and tests	-	-	-
G.	Other beam use	(1)	16.7	N-7 tune
		20	2975.9	

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

A.	Beam accelerated in Main Ring			2.35
B.	Beam delivered to experimental areas			
	Meson Area		0.26	
	Neutrino Area			
	Slow Spill	0.52		
	Fast Spill	1.22		
	Proton Area		0.09	2.09

FERMI NATIONAL ACCELERATOR LABORATORY
MONTHLY OPERATIONS HISTORY
JANUARY 1978

Date	Accelerator	Int. Target Area	Proton Area	Neutrino Area	Meson Area
Sun. 1/1	~ 2.2×10^{13} ppp @400 GeV (1.25 sec flattop)	p-N Scattering 552	Di-Lepton 288 (PC) OFF (PE,PW)	444(N1), 310, 482, 546(N0)	OFF for Repairs
Mon.(H) 1/2	Accel. Studies				Assoc. Prod. 99 (M6E)
Tue. 1/3				Muon 203A/391 (N1) Neutrino 310 (N0) E-546 Hadron Running (N5)	Other Beams OFF
Wed. 1/4	Accel. Studies				
Thu. 1/5	Reprs:MR Magnet & Booster				Assoc. Prod. 99 (M6E)
Fri. 1/6	~2.1×10^{13} ppp @400 GeV (1.25 sec flattop)		Di-Lepton 288 (PC) Photoprod.87A (PE) P-519 Tests(PW)	Muon 203A/391 (N1) Neutrino 310(N0) 15'ν/H_2&Ne #546 (N6) ν356 Calib. (N5)	Multi-μ_o 439 (M2) Incl. K^o_s 383 (M4) Det. Dev. 427(M1W) Part. Sch. 540(M3)
Sat. 1/7					
Sun. 1/8					
Mon. 1/9					
Tue. 1/10	Repairs: MR transformer & 2 magnets				
Wed. 1/11	Accelerator Maintenance & Development				
Thu. 1/12	Accelerator Startup				
Fri. 1/13	~2×10^{13} ppp @400 GeV (1.25 sec flattop)				Assoc. Prod. 99 (M6E) Multi-μ_o 439 (M2) Incl. K^o_s 383 (M4) Had. Dissoc. 272 (M1E)
Sat. 1/14					
Sun. 1/15					
Mon. 1/16	Repairs:MR Xfrmr 3 magnets				
Tue. 1/17					
Wed. 1/18	Accel. Studies				
Thu. 1/19	Accel. Studies				
Fri. 1/20	Repairs:2 magnets MR & Ext. tuning	Proton Polariz. 522			
Sat. 1/21					
Sun. 1/22	~1.7×10^{13} ppp @400 GeV				
Mon. 1/23					
Tue. 1/24	Repairs:MAin Ring				Multi-μ_o 439 (M2) Incl. K^o_s 383 (M4) Multipart. 110A (M6W) Had. Dissoc. 272 (M1E)
Wed. 1/25	Accel. Studies				
Thu. 1/26	Reprs:Exp.Substation				
Fri. 1/27				Neutrino 310 (N0)	
Sat. 1/28	Reprs:Ext.Septum				
Sun. 1/29	~1.5×10^{13} ppp @400 GeV (1.25 sec flattop)			Muon 203A/391 (N1) Neutrino 310(N0) Neutrino 253(N0)	
Mon. 1/30					
Tue. 1/31					

BEAM UTILIZATION BY

	Beam	Hours
MESON AREA		
Nuclear Chemistry #81A	M0	-
Associated Production #99	M6E	239.1
Multiparticle #110A	M6W	56.1
Hadron Dissociation #272	M1E	104.7
Inclusive K_S^0 #383	M4	229.8
Detector Development #427	M1W	41.5
Multimuon #439	M2	219.5
Particle Search #540	M3	79.0
NEUTRINO AREA		
Muon #203A/391	N1	173.3
Neutrino #253	N0	12.8
Neutrino #310	N0	327.4
Neutrino #356	N5	55.4
Di-Muon #444	N1	44.4
Neutrino #482	N0	46.7
15' ν/H_2 & Ne #546	N0	258.0
Emulsion Exposures	N5	49.4
PROTON AREA		
Photoproduction #87A	P1	104.7
Di-Lepton #288	PC	334.3
P#519 Tests	PW	239.2
INTERNAL TARGET AREA		
Proton Polarization #522	C0	132.2
p-N Scattering #552	C0	211.7
Hours for experiments		2959.2
Hours for beam tuning		16.7
TOTAL HOURS FOR HIGH ENERGY PHYSICS		2975.9

EXPERIMENT -- JANUARY 1978

Activities

data: 2 targets irradiated

data: complete; Σ^+ and Y^* with 70 and 140 GeV π^+ using the single arm spectrometer

tuneup: trigger studies and equipment checkout at the multiparticle spectrometer

setup: wire chamber and counter installation and checkout, setup of liquid argon calorimeter

tuneup & data: K_s^o production from a hydrogen target by 125 GeV K^-

data: complete; transition radiation test with Xe-filled PWC

data: high mass dimuon production in a magnetized iron beam dump

data: search for delayed energy release from a target bombarded by neutrons

tuneup & data: deep inelastic scattering with good resolution for multi μ states produced by 225 GeV μ^+ in a distributed target calorimeter

tests: νe scattering in a 40 cell aluminum MWPC calorimeter using a 10-msec spill

data: multi-μ and prescaled single-μ in the Lab C calorimeter and μ spectrometer

tuneup: hadron and muon calibration of the iron-scintillator-spark chamber calorimeter in Lab E

data: complete; mass spectrum of dimuons produced by 225 GeV π's measured with the cyclotron spectrometer

data: complete; single-μ and multi-μ data using the Lab E calorimeter and μ spectrometer

data: complete; 95K additional pictures in the 15' bubble chamber with 47% neon including 17K hadron calibration pictures at 25-100 GeV

data: 56 stacks exposed; experiment #'s: 481(7), 503(4), 506(2), 525(2), 568(3), 573(3), and 574(4) with 300 GeV π^- and 499(5), 547(24), 575(2) with 400-GeV protons

data: high mass hadron states produced by the broadband photon beam

data: high mass dimuon data in a high rate configuration

tests: calorimeter calibration with an electron beam

data: recoil proton polarization in pp inclusive scattering using hydrogen jet and rotating carbon targets

data: pp and pD inclusive scattering at 20-400 GeV using the superconducting recoil spectrometer

PROPOSALS RECEIVED FROM NOVEMBER 1977 THROUGH JANUARY 1978

No.	Title	Spokesperson
573	A Search for Charmed Particles Produced by 300 GeV Negative Pions in Nuclear Emulsion	Y. Yanagisawa
574	A Study of the Mechanism for Multiple Production of Particles at or Above 300 GeV Pion Interactions in Nuclear Emulsion	W. Wolter
575	Proposal to Study 400 GeV Proton Interactions in Nuclear Emulsion	J. Lord
576	500 GeV Proton Interactions in Nuclear Emulsion	J. Hébert
577	Proposal to Measure πp Elastic Scattering at Large Angles	R. Rubinstein
578	A Sensitive Search for Massive Long-Lived Particles	M. Longo
579	Study of Polarization of Inclusively Produced Neutrons	L. Jones
580	A Search for Narrow and Broad Resonances Decaying into $\Lambda\bar{\Lambda}$, $\Lambda\bar{\Lambda}\pi$, $K_S^oK_S^o$ and $K_S^oK_S^o\pi$ from π^-p Interactions at 300 GeV/c using the Fermilab MPS	K. Lai
581	Construction of Polarized Beams and an Enriched Antiproton Beam Facility in the Meson Laboratory and Experiments Using such a Facility	A. Yokosawa
582	Measurement of the Asymmetry in High-$p_\perp$ Events Using a Polarized Beam and Target	A. Yokosawa
583	Proposal to Measure Asymmetries in Mu-Pair Production	J. Rutherfoord
584	Proposal to Search for the Decay of New Long-Lived Neutral Particles with a Mass and Lifetime Exceeding that of the K_L^o	B. Winstein

585	A Proposal to Fermi National Accelerator Laboratory Exclusive KN Charge Exchange	M. Abolins
586	Study of Constituent Scattering in Hadronic Collisions	R. McCarthy
587	Proposal to Study High Momentum Transfer $\Lambda^o, \bar{\Lambda}^o$ and Hadron Jets	P. Schlein
588	Inclusive Power Law Distributions for Non-Leading Particles Produced in Hadron Collisions	J. Elias
589	Di-Muon Production with π^+ and π^-	P. Mockett
590	Hadron Distributions in High P_t Collisions in a Very Large Acceptance Calorimeter	K. Young
591	Broad Search for New Hadronic States via High Resolution Charge and Mass Determination of Nuclear Fragments from P-Nucleus Collisions	L. Gutay
592	Proposal for Experimental Study of the Relationship Between Hadronic and Nuclear Scaling at Very High Energies	S. Frankel
593	A Coordinated Approach to a Beam Dump Experiment at FNAL Using the 15' Bubble Chamber and the E-310 Detector	W. Fry
594	Proposal for a New Neutrino Detector at Fermilab	J. Walker
595	A Study of Charm and Other New Flavors Produced in Pion-Nucleon Collisions	A. Bodek

DATES TO REMEMBER

March 9-10, 1978	Spring meeting of the Fermilab Program Advisory Committee.
March 31, 1978	Requests for summer accommodations should be received in the Housing Office (see page 20).
April 7-8, 1978	Workshop on Channeling at High Energies (for further details contact R. A. Carrigan).
April 14, 1978	Meson Lab Workshop (see page 22).
May 5, 1978	Fermilab Users Organization Annual Meeting. Length of meeting will be determined by final agenda (see page 21).
May 5, 1978	Deadline for receipt of all new proposals and other written materials to be considered at the summer meeting of the Program Advisory Committee.
May 18-19, 1978	Proposal Presentation Meeting.
June 17-23, 1978	Summer meeting of the Fermilab Program Advisory Committee.