fermilab report

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THE COVER: Benjamin W. Lee (1935-1977) at press conference during the 1977 Annual APS Meeting in Chicago in February, 1977.

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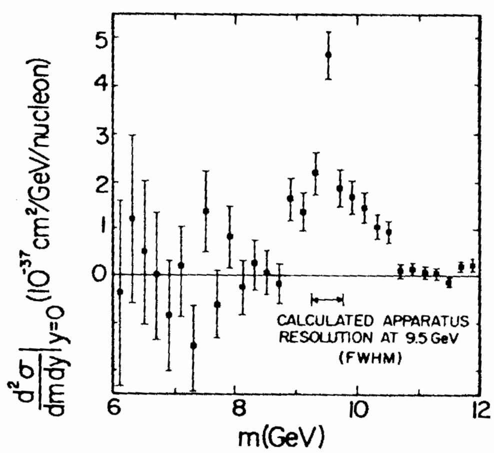
A NEW DIMUON RESONANCE

On June 30, Experiment 288, a collaboration of Columbia, Fermilab, and State University of New York at Stony Brook, announced the observation of a resonance at 9.5 GeV in the mass spectrum of dimuons produced in 400-GeV proton-nucleus collisions. The enhancement is statistically significant, comprising 440 ± 28 excess events, and has been demonstrated to be independent of known experimental effects.

The data can be fitted by a single Gaussian, giving a mass of 9.54 ± 0.04 GeV/c^2. The observed width of 1.2 GeV is greater than the apparatus resolution. An alternative fit with two Gaussians whose widths are fixed at the apparatus resolution gives masses of 9.44 ± 0.03 and 10.17 ± 0.05 GeV/c^2.



Measured dimuon production cross sections as a function of the invariant mass of the muon pair. The smooth exponential continuum fit is subtracted in order to reveal the 9-10 GeV region in more detail.

BENJAMIN W. LEE (1935-1977)

It has been over a month since Ben Lee, Head of the Fermilab Theoretical Physics Department and Professor of Physics at the University of Chicago, was killed in a tragic automobile accident (see last month's issue of Fermilab Report). During this period, his friends and colleagues have all had time to reflect on Lee's interests and accomplishments. His loss is already acutely felt, but we have only just begun to understand how much richer is the world of physics and the Laboratory because of his achievements.

Lee had one of the broadest ranges of interests and research of any physicist of this generation, but he returned again and again to the study of symmetry principles and the weak interactions. He was one of the first physicists to work on SU(6) and related symmetries in the mid-1960's and to propose that these symmetries would find their natural expression through the algebra of currents. In the early 1970's Lee turned to the fundamental problem of the renormalization of theories with spontaneously broken symmetry, such as the σ model, and developed ideas and techniques which were to serve him well in his later work on gauge theories.

In 1971 after it had been shown by functional methods that spontaneously broken gauge theories are renormalizable, Lee developed a proof of this result for Abelian gauge theories by operator methods. For theorists who were unfamiliar with the functional formalism, it was Lee's proof that really settled the matter. In the following year, Lee and J. Zinn-Justin completed the demonstration that renormalization does not spoil the cancellation of unphysical singularities in these theories.

When Lee decided to move from the Institute for Theoretical Physics at Stony Brook to Fermilab in 1973, it was a declaration of his faith in the unity of theory and experiment. After the discovery of neutral weak currents in 1973, Lee along with M. K. Gaillard and J. L. Rosner undertook a systematic survey of the experimental signatures of the charmed mesons and baryons expected in theories with neutral currents. Their report was circulated shortly before the discovery in November, 1974, of the J/ψ particle. It immediately became the guideline for subsequent experimental work.

Robert R. Wilson observed that one of Lee's contributions to the Laboratory was his sensitivity to the needs of young physicists. Lee felt a strong sense of gratitude to older physicists who had influenced his work, and he in turn took every possible opportunity to help other younger physicists. R. R. Wilson, in his eulogy, stated, "One was as likely to find an experimentalist in his office as a theorist, and each day, just after lunch, a felicitous group of young people met around Ben in our lounge for coffee and conversation--conversation that although informal was of the kind most likely to lead to something creative."

At the time of his death, Lee was in the midst of a period of enormous creativity. In the last six months of his life he had explored the problems of CP violation, of lepton nonconservation, and of the high energy limit of weak interactions in gauge theories, and had formulated a theory based on the enlarged gauge group $SU(3)\otimes U(1)$. He was just beginning a program of research on cosmology.

Quoting again from R. R. Wilson's eulogy, "Ben helped set a tone in the Laboratory, a standard of excellence, of excitement, of critical honesty, of mutual respect. . . his joy in physics and his gentle integrity were infectious so that soon others were encouraged by his example to emulate his creative participation."

Truly, Ben Lee will be missed by the large numbers of physicists who learned so much from his work and by those who had the privilege of knowing him and working with him.

ALVIN TOLLESTRUP JOINS FERMILAB

Alvin Tollestrup has joined the Fermilab staff as a physicist in the Energy Doubler/Saver Group. He also will assume responsibility for a new group in the Research Division's Department of Research Services. That group will be responsible for carrying on research and development on electronic detectors and data-acquisition techniques.

For the past two years Tollestrup has been serving as a member of the Energy Doubler/Saver group, having joined the Laboratory in a temporary capacity while on sabbatical leave and leave of absence from California Institute of Technology. During the past two years he has taken a major responsibility for the development of Doubler magnets and has played the key role in transforming the production of those magnets from an art to a science.

The new group which Tollestrup will head in Research Services will combine the Detector Development group led by Muzaffer Atac and the Experimental Systems Support Group of Tom Droege.

CHRIS QUIGG APPOINTED HEAD OF THEORY DEPARTMENT

Chris Quigg has been appointed Head of the Theory Department. Quigg, author of more than 70 scientific papers, was one of the first permanent members of the Fermilab Theory Department. In addition to wide-ranging research interests, he has been deeply involved in the establishment of the Theoretical Physics Department at the Laboratory. He expects to continue the policy of bringing eminent theoretical physicists to Fermilab.

On accepting the new assignment Quigg stated, "When I came to the Laboratory, an important attraction was the opportunity to make a commitment to the institution and to help Ben Lee mold a theoretical physics group of eminence. During the last three years those aspirations have begun to seem easily within our reach. What has been extremely rewarding to me is the development of a cohesion among group members, and a common sense of purpose. Under Ben's leadership, and by his example, Fermilab Theoretical Physics has been a collegial search for nature's secrets. There is every reason to believe that we can complete the task Ben began."

Fermilab chef Bill Ross puts the final touches on his tenth anniversary creation. The 1,000-serving, 200-pound cake commemorates June 15, 1967, the date on which the first employees began work at Oak Brook.

EXTENDED MEETING OF THE PROGRAM ADVISORY COMMITTEE JUNE 1977

E. L. Goldwasser

The annual extended meeting of the Fermilab Program Advisory Committee was held this year during the week of June 18-24. Although it has always seemed that these meetings should become easier as we became more familiar with all the various elements that must be considered in establishing the Fermilab research program, they seem in fact to become more and more difficult each year. This year, the impact of underfunding was felt more sharply than ever before.

Perhaps the story of the recent meeting is best told by some simple statistics. As a result of our discussions with the PAC, we have approved five new experiments, two of them on a parasitic basis. Four experiments that have already seen some operation are being granted extensions in their running time. Final consideration of 14 additional experiments was deferred until a later date. Twenty proposals submitted to the Laboratory, most of them with considerable merit, were rejected. Twelve experiments that had previously been approved for running had that approval withdrawn as a result of our recent deliberations. These statistics are summarized in the table below:

Approvals	Extended Running	Deferred Decisions	Rejections	Approvals Withdrawn
5	4	14	20	12

30-Inch Bubble-Chamber Hybrid-Spectrometer Program

One of the topics that received major attention was that of the 30-in. bubble-chamber program. During the past year, there has been a major change in the planning of bubble-chamber operations at Fermilab. Several years ago, we decided that only one bubble-chamber crew would be supported at the Laboratory. At that time, the 15-ft chamber was in its early breaking-in stage, and it could not be expected to run continuously. Furthermore, during those periods when muon experiments were being done, there were not enough accelerated protons to provide a useful neutrino beam too. There was therefore a substantial amount of time and manpower available to run the 30-in. chamber.

More recently, the 15-ft chamber has come of age. The neutrino bubble-chamber program has proven to be, if anything, of even greater interest than was projected at the time the decision was made to build the chamber. Increasing accelerator intensity promises to support muon and neutrino experiments simultaneously. It is therefore the present Laboratory policy to run the 15-ft chamber all of the time. We recognize that there are times when the chamber will not be able to run, but during those intervals we expect the crew to be fully occupied in the effort of maintaining, repairing, or improving it. Under these conditions, it is clear that no provision remains for the operation of the 30-in. chamber. On the other hand, in 1975 the entire program of the 30-in. bubble chamber was reviewed in the most thorough and critical way possible, and it was recommended that the Laboratory continue its operation. Since that time the Laboratory has not been able to complete the running that was approved as a result of that review.

Several months ago, as this situation was recognized by experimenters as well as by Laboratory staff, discussions were initiated to find a solution under which the chamber could be operated by drawing mostly on resources of the user groups, rather than on the resources of the Laboratory. In spite of the best efforts of all concerned, the implementation of such a mode of operation for the bubble chamber was found to require a substantial contribution from the Laboratory, both in terms of manpower and in terms of financial support. Under the present fiscal squeeze, we found that we could not justify even that reduced level of support unless the 30-in. program were assigned a relatively high physics priority. It was in this context that the matter was re-raised for discussion with the Program Advisory Committee in June.

As a result of those discussions, we have now decided to withdraw the existing approvals of all experiments intended to run with the present hybrid-spectrometer system. Whereas those experiments would, indeed, provide new and useful information, it would not be of a qualitatively new character. That program has been found not to have a sufficiently high physics priority to justify the required support. It is with great reluctance that we have reached this decision, but we see no other alternative, given the present level of funding of the Laboratory.

On the other hand, we have decided that the strongest recommendation stemming from our review of several years ago is still valid. Operation of the 30-in. chamber with a more substantial downstream particle identifier would yield information in a previously unexplored area, the correlations between strange particles, baryons, and antibaryons in the central region. We therefore maintain our resolve to support the construction of a significant downstream particle identifier and to operate the hybrid spectrometer in 1978-1979 for a total of about 2 M pictures.

We intend to assign a high priority to the program described above under one remaining condition. We cannot justify the operation of the 30-in. bubble chamber if such operation constitutes a significant technical interference with the Laboratory's neutrino program. Here we are referring to possible interferences of beam lines, backgrounds, etc. If a study of those problems gives us confidence that no such technical interference is likely to arise, then we intend to support the immediate construction of the downstream particle identifier system, pointing toward the operation of the new hybrid system by the fall of 1978.

Under that schedule, we intend to call a PAC Bubble Chamber Subcommittee meeting during the first part of 1978 to discuss and plan for the 1978-1979 bombardments. Operation beyond the program projected above will depend upon the results obtained and the state of the relevant physics at that time.

Meson Laboratory Pause

Another problem the Laboratory has been considering is that of a possible "pause" in the operation of the Meson Laboratory starting some time in 1978. The pause would offer the possibility of conserving operating funds. At the same time, it would turn off an external experimental area which has had an active program and a very large participation by users. A review of the projection for the spending of operating funds in 1978 had shown that there simply was not enough money to make possible the continued operation of all facilities.

That has become particularly true this year with the advent of operation of the SPS at CERN. Previously, Fermilab experiments have had the luxury of uniqueness. Even if corners were cut in instrumenting the experiments in order to reduce costs, one could have confidence that the results would make a new contribution to physics. Now, whereas we welcome the arrival of our friends and co-investigators in the field of 400-GeV physics, we also must be mindful of the competition. There is no point in doing an experiment at Fermilab, quite similar to one being done at CERN, and doing it less well. The situation is made particularly difficult by reason of the fact that the CERN program is funded at a level more than twice that of Fermilab, and the experiments done at CERN are in general instrumented in a manner that has not been possible at this Laboratory. Thus it has become clear to members of the PAC, as well as to the Laboratory staff, that under the present conditions Fermilab must undertake fewer experiments and do them better.

The deficiency of funds is too large to be compensated by skimping here and there. To make the required savings, it was therefore proposed by the Laboratory that operations in one of the major experimental areas be suspended for a part of FY 78. Both the Proton Laboratory and the Neutrino Laboratory are centers where experiments that are in progress and projected promise to contribute to qualitatively new discoveries that may make important contributions to our knowledge of particles and their interactions. The Meson Laboratory has in a broad sense been a place where important measurements have been made and where more measurements of the same type are projected to be made in the future. These are the kinds of measurements that piece by piece lead to an important new insight about the properties or behavior of elementary particles. Yet it is hard to argue as strongly for the timeliness of experiments of that kind as it is for some of the experiments projected for the Proton and Neutrino Laboratories.

Furthermore, it is an inescapable fact that when CERN-II North Area becomes operational in 1978, its beams should be superior to the present beams in the Meson Laboratory. A number of improvements could be made within the Fermilab equipment budget that would significantly upgrade these beams. The M1 and M6 beam lines could both provide notably higher intensities if the production angles were reduced. There is a plan by which such a reduction might be made. The energy of the M6 beam line could be raised, thus enhancing the interest of the physics that could be explored in the facilities installed in the two branches of that beam.

As a result of our discussions with our Program Advisory Committee, we have decided that, given the present funding situation, the physics program over a period of several years in the Meson Laboratory could probably be enhanced by the proper use of a six-month pause. We believe that during this pause every effort should be made, within the serious financial constraints, to make the desired capital improvements to the Meson Laboratory beams and facilities. Originally, it had been proposed to begin the pause on

April 1, 1978, but it was recognized that to accomplish meaningful improvements would require funds from two fiscal years. It was also recognized that an additional three months would probably be needed to complete the present program. For that reason we now plan to delay the start of the pause until July, 1978, three months before the end of the fiscal year. By deferring some work in the Neutrino and Proton Laboratories until FY 1979, it will still be possible to achieve the necessary savings in FY 1978. The operation of the Meson Laboratory during the period April-July, 1978, will be carried on with a level of support significantly reduced from the present already lean condition.

We recognize that there are dangers to be considered from a pause in the Meson Laboratory operation. The trained personnel must be kept on hand. The equipment located in that area cannot be permitted to be siphoned off to bolster programs in other areas. Experimenters must be encouraged to start planning experiments for the upgraded facilities.

Meson Department staff members need the advice and help of the users to plan for the future. To that end, a workshop on Meson Laboratory beams will be held at Fermilab on September 16, 1977. This first formal meeting will be held to present the general outlines for possible improvements and to initiate a series of regular but informal meetings from which a plan for the Meson Laboratory upgrading will emerge. It is intended to issue a report on the Meson Laboratory improvements by December, 1977.

At that time, proposals for experiments to follow the pause will be invited. These proposals would be heard at the proposal presentation meeting in February, 1978, and subsequently considered at the spring meeting of the PAC in March. Our present plan is to approve a total of three new detectors and to continue with no more than four of the detectors that were operating or under construction before the pause. Two of these detectors will be the Multiparticle Spectrometer and the detector for E515.

Fine-Grain Neutrino Detectors

As a result of our discussions with the PAC, it now appears to us that a single detector will not be capable of addressing simultaneously the major problems in neutrino physics that are now projected to be of interest in the period 1979-1982. We assume that this period will include the initial operation of the Energy Doubler/Saver at an energy of 1 TeV. The major topics we foresee to be of interest for experiments utilizing large electronic detectors during that period are: 1) total cross sections; 2) charged-current interactions; 3) neutral-current interactions; 4) four-fermion interactions; and 5) multilepton events.

We believe that the behavior of total cross sections can be studied using the facility now being assembled in Lab E (E356). Multileptons can be studied by all detectors which make use of downstream toroids. The present layout in Lab C has this capability as well as that in Lab E.

The recent proposals we have received address primarily topics (3) and (4). In considering these proposals, we have concluded that no single one of the proposed detectors is suitable as a system to take care of both (3) and (4). Thus we have decided that it would be wise to encourage further development of promising techniques. Optimization for a specific class of neutrino interactions may yield a greater probability of success than any universal system. We plan to aid the further development of the techniques proposed in P496, P541, and P563. We also remain receptive to additional proposals to compete for the important physics that will be done. It is our present view that a decision next summer will still be timely for the period we are considering.

With regard to the shorter range neutrino program, facilities are heavily committed with the exception of the detector in Lab E, the equipment developed by the Harvard-Pennsylvania-Wisconsin-Fermilab group. That group has an approval for E310 which incorporates one more run using the quadrupole triplet beam for a bombardment of about 2×10^{18} protons. That run should be completed in January 1978. Proposals for running with more or less minor modifications to the existing detector configuration will be considered this fall.

Organization for Colliding-Beams Experiments and Proposals

The Tevatron program described in the May Fermilab Report is based in part on the projection that colliding beams may be achieved by 1980. Accordingly, the problem of implementing experiments with colliding beams was discussed with the Program Advisory Committee.

It is characteristic of the physics of colliding beams that massive detectors are required with large solid-angle coverage. The cost of a single such facility at other laboratories has been shown to be of the order of \$10 M. Fermilab has traditionally encouraged outside groups to take leadership in the design, development, construction, and utilization of detector facilities.

Small experiments and small facilities are the most favorable for such an arrangement. Although a few relatively large facilities have been developed almost entirely through the efforts of user groups, it is not clear that such a system is the only one that should be used for an area of physics in which only large facilities are appropriate and in which several large facilities will almost certainly be needed.

For colliding beams at Fermilab, it is expected that there may be three locations where collisions may be made, at straight section B0, C0, and E0. It has been proposed by the Laboratory that at one of these locations, B0, the Laboratory take responsibility for the project of developing not only the experimental area, but the detector and equipment that will be required. It has further been proposed that the Laboratory undertake responsibility for the formation of a group that will design, develop, and construct the facility and conduct the initial series of experiments in that facility.

Following our discussions with the PAC we have decided that the close interaction between ring design and detector considerations make such an arrangement logical, both from the point of view of convenience and from the point of view of optimization of resources. We have also decided that progress reports on the detector design and construction will be made to the PAC. We intend that running time using this new detector should be assigned in response to the submission of experimental proposals for PAC consideration. Priority in initial use will be given to the designers and builders. Physicists who are interested in participating in colliding-beam experiments, but who are not included within the Fermilab project group, will of course have an opportunity to form independent groups and to submit independent proposals either for second-generation experiments at B0 or for the design, construction, and use of alternate detectors at C0 or E0.

Meetings Planned for 1977-1978

To conclude this article it may be useful to review briefly the schedule of PAC-related meetings currently planned for the next 12 months. This material is tabulated in greater detail in "Dates to Remember" on page 35.

As has been customary in the past, the fall meeting of the PAC will occur in November and will be preceded by a Proposal Presentation Meeting in October. The proponents urging the installation of plates in the 15-ft bubble chamber are expected to present a single proposed design for a multi-purpose plate configuration at this meeting. Those wishing to oppose the installation of plates in the chamber will also be given an opportunity to present their arguments. Final consideration of the matter by the PAC is planned to follow at the November meeting.

The spring meeting of the PAC will occur in March and will be preceded by a Proposal Presentation Meeting in February. As has been noted earlier in this article, the primary focus of these meetings is expected to be the initial round of proposals for experiments to be done in the Meson Laboratory immediately following the "pause." Many of the details involved in the Meson Laboratory upgrading will be determined by the actual choice of experiments decided on at that time.

A Bubble Chamber Subcommittee meeting will be held at some point during the first part of 1978, although the exact date for this meeting has not yet been determined. The main purpose of this meeting will be to give further consideration to the 30-in. bubble-chamber program. The schedule goes on with a Proposal Presentation meeting in May, followed by the extended summer meeting of the full PAC about one month later in June.

RESEARCH ACTIVITIES DURING JUNE 1977

James MacLachlan

The accelerator operating crews who struggled with an unusual variety of accelerator problems in the month of June probably will be surprised to learn that all the ups and downs averaged to a record month for protons delivered at 400 GeV. June also ties the prior record set at 300 GeV two years ago in the last full month of 300-GeV operation. This fact must be viewed in the context that fiscal constraints impose a reduced repetition rate at 400 GeV. As shown in the table on page 22, the average cycle time in June 1975 was 7 seconds, compared to 11 seconds last month. The tabular comparison between June 1977, two prior record months, and a "typical" month for the last year suggests quite a bit about how operation has changed, but the numbers require some interpretation. For instance, although it is true that the Main-Ring intensity is the big reason for matching the 300-GeV monthly proton totals, there is also an effect from increased rate of acceleration, increased Main-Ring feeder capacity, and increased number of hours scheduled for high-energy physics. It would also be wrong to interpret the figures on "HEP efficiency" (actual hours/scheduled hours) to mean that there has been no improvement in reliability. The greater number of hours scheduled for high-energy physics has been possible because accelerator maintenance periods have been cut from every week in 1975 to every third week in 1977.

Accelerator problems during the month included two interruptions caused by effects of thunderstorms on accelerator controls, two occasions of booster magnet power-supply problems, serial failures of gas barriers in the linac, a Main-Ring quad replacement with slow pumpdown, and a preaccelerator

Typical and Record Months for Accelerator Operation

	6/77	"Typical Month" (1976-1977)	6/75	11/76
Protons ($\times 10^{18}$)	2.77	1.80	2.77	2.63
HEP (h)	478	385	451	487
Scheduled HEP (h)	640	550	556	638
HEP efficiency (%)	75	70	81	76
Unscheduled Interruption (h)	183	180	122	169
Energy (GeV)	400	400	300	400
Flattop (sec)	1.25	1.0	1.0	1.5
Average Cycle (sec)	11	11	7	12
Average Intensity (10^{13}p/p)	1.8	1.4	1.1	1.8

ion-source filament failure. Generally, the down time was characterized by the unusually large fraction attributable to the injector; as the above table indicates, the total amount of unscheduled interruption was not particularly out of line with recent experience. Instability of the accelerator's master clock and occasional periods of increased extraction loss reduced the usefulness of some of the beam hours, but by no means prevented an unusually good month of operation.

The top priority in the experimental program was the Neutrino Area for almost the entire month. Neutrino #310 took antineutrino data using a 2-msec spill on the sign-selected bare target up to June 27, when they switched the polarity for neutrino data; they received about 2×10^{18} protons. The 15-ft bubble chamber ran for 15-ft $\bar{\nu}/H_2$ & Ne #180 until a failure of the 9-in. hydraulic valve in the expansion system required a warmup. Two leaks from hydrogen cooling loops into the main vacuum tank were also repaired during the warmup. The chamber provided 87K antineutrino pictures during the month. For two days starting the morning of June 20, the N5 line was tuned to bring 20-GeV negatives into the 15-ft chamber for a test of the practicality of doing calorimetry on electromagnetic showers. The chamber was double-pulsed and about 4500 pictures were taken on the hadron cameras during the antineutrino running. Particle Search #379 ran in Lab E with diffracted protons from the N5 line until June 5 and then switched to negatives at various momenta to get a good pion beam to understand secondaries in the calorimeter. The experiment was completed on June 7. Particle Search #361 started up June 9 in the N1 line, using the production target in the N7 bypass line.

Three experiments ran throughout the month in the Proton Area. Photoproduction #401 began taking data using the broadband photon beam in Proton East after completing system tests and trigger studies during the first week. They lost just over a week of running because of a failure of the 70-ft deuterium cryostat on June 18. Di-Lepton #288 continued to take data on high mass (> 6 GeV) dimuon states in Proton Central. Photon Search #95A, which was just completing electron beam calibration of lead-glass detectors in Proton West at the beginning of the month, spent most of the month in data taking on high mass diphoton states. Both E288 and E95A had similar difficulties with the spill structure at various times, but both also had some extended periods of solid data taking.

In the Meson Area, Hadron Jets #236A (M1E) and Λ Polarization #441 (M2) were just starting up at the beginning of the month. Both experiments had their beam-line problems, E236A with magnet power supplies and E441 with a modified radiation-safety system. Both experiments were taking data by the third week, but E236A accepted a momentum of 340 GeV/c in place of the 400 GeV/c they had planned to use. Inclusive Neutron #404 ran parasitically behind E441 in M2 making use of the copious neutrons in the neutral-hyperon beam. Multiparticle #110A concluded a five-week run in the first half of the month in M6W, accompanied by some low-profile activity of Hadron Dissociation #396 upstream. For the last half of the month, M6 was run in the east branch for Inclusive Scattering #118A using the single-arm spectrometer. This experiment also had some serious beam-line startup problems, including several failures of 3Q120 beam-line quadrupoles and power-supply and control problems associated with the newly installed 4Q120 quads in the single-arm spectrometer. Inclusive K_s^o #383 worked on their equipment on an approximately half-time schedule while awaiting the installation of additional vacuum pipe, which was delayed primarily by the work required to get M6E going.

The internal target continued with p-He Scattering #289 using a cold helium jet and Nuclear Fragments #442 looking at the distribution of recoil fragments of heavy noble gases with semiconductor counter telescopes mounted on the movable arm of the superconducting spectrometer. For the first half of the month, these experiments operated under a complicated agreement for interleaving of pulses so that each could cover its desired energy range. After June 17, E289 was unable to run because a newly installed collimator in the jet did not work. After this was removed, the pulsing valve failed leading to an overdose of helium in C0 and neighboring parts of the main accelerator. While E289 was off, E442 was able to run their jet with a single pulse covering nearly the entire energy range.

FACILITY UTILIZATION SUMMARY -- JUNE 1977

I. Summary of Accelerator Operations

		Hours	
A.	**Accelerator use for physics research**		
	Accelerator physics research	37.6	
	High energy physica research	478.5	
	Research during other use	(16.1)	
	Subtotal		516.1
B.	**Other activities**		
	Accelerator setup and tuning to experimental areas	2.0	
	Program interruption: Scheduled 16.5, Ad hoc 2.6	19.1	
	Unscheduled interruption	182.8	
	Subtotal		203.9
C.	**Unmanned time**	—	
	Total		720.0

II. Summaries of High Energy Physics Research Use

		# of Expts.	Hours	Results
A.	Counter experiments	16	4069.6	1 expt. completed
B.	Bubble-chamber experiments	1	279.9	87,406 15-ft pictures
C.	Emulsion experiments	1	—	1 stack in progress
D.	Special target experiments	—	—	—
E.	Test experiments	—	—	—
F.	Engineering studies and tests	(1)	35.3	4,500 15-ft pictures
G.	Other beam use	(1)	5.4	Test of N1 beam line
		18	4390.2	

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

A.	Beam accelerated in Main Ring			2.77
B.	Beam delivered to experimental areas			
	Meson Area		0.32	
	Neutrino Area			
	Slow Spill	0.09		
	Fast Spill	2.06	2.15	
	Proton Area		0.06	
				2.53

BEAM UTILIZATION BY

	Beam	Run Dates	Hours
MESON AREA			
Multiparticle #110A	M6W	6/1-6/15	216.3
Inclusive Scattering #118A	M6E	6/18-6/30	174.5
Hadron Jets #236A	M1E	6/1-6/30	270.5
Inclusive K_s^o #383	M4	6/1-6/30	140.9
Hadron Jets #395	M2	6/1-6/2	35.0
Hadron Dissociation #396	M6W	6/1-6/15	136.8
Inclusive Neutron #404	M2	6/18-6/30	270.6
Λ Polarization #441	M2	6/1-6/30	344.6
NEUTRINO AREA			
15' $\bar{\nu}/H_2$ & Ne #180	N0	6/1-6/22	279.9
Neutrino #310	N0	6/1-6/30	440.9
Particle Search #369	N1	6/9-6/30	256.1
Particle Search #379	N5	6/1-6/7	107.7
Emulsion/ν #536	N0	6/1-6/30	-
PROTON AREA			
Photon Search #95A	PW	6/1-6/30	399.0
Di-Lepton #288	PC	6/1-6/30	376.2
Photoproduction #401	P1	6/1-6/30	255.4
INTERNAL TARGET AREA			
Proton-Helium Scattering #289	C0	6/1-6/15	203.6
Nuclear Fragments #442	C0	6/1-6/30	441.5
HOURS FOR EXPERIMENTS			4349.5
HOURS FOR TESTS AND BEAM TUNING			40.7
TOTAL HOURS FOR HIGH ENERGY PHYSICS			4390.2

EXPERIMENT -- JUNE 1977

Activities

data: 2 and 3 π exclusive data at -100 GeV/c

tuneup & data: inclusive data for 100 GeV π^-, K^-, $\bar{p}$ on H_2 and D_2

tuneup & data: +340 GeV/c and -280 GeV/c on LH_2 and solid targets with segmented recoil calorimeter and MWPC magnetic spectrometer

tests: chamber and counter tests

data: 200 GeV and 400 GeV on LH_2 target with segmented calorimeters

tests: drift chamber tests

setup & data: inclusive neutron production by 400-GeV protons on hydrogen

setup & data: polarization of Λ produced at various angles by 400-GeV protons on hydrogen

data: 87K $\bar{\nu}$ pictures in the 15-ft bubble chamber filled with 62% Ne-H_2 mix

data: primarily $\bar{\nu}$ data, some ν data taken with iron scintillator target calorimeter

setup & data: μ and 2μ triggers from π's on hydrogen target using the cyclotron spectrometer

data: complete; 400-GeV protons on variable density target calorimeter

data: $\bar{\nu}$ and ν on an emulsion stack in the neutrino beam from the sign-selected bare target

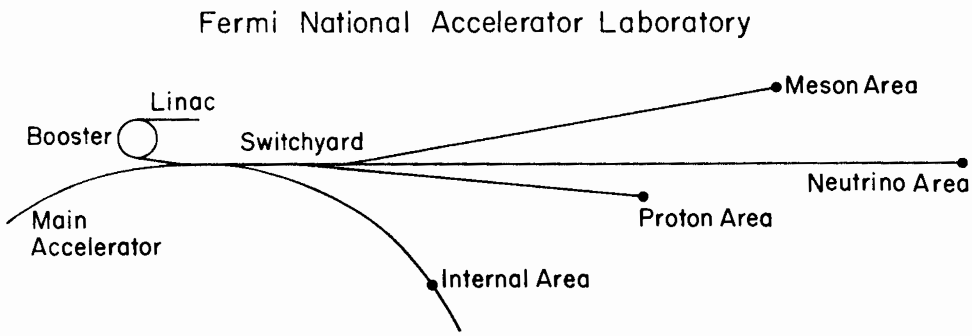
setup & data: lead glass calibration and high mass diphoton data

data: high mass (> 6 GeV) dimuon data from protons on heavy targets with a beryllium hadron filter

tests & data: trigger studies and high mass hadron and muon systems produced by a broadband photon beam

data: proton-helium elastic and inelastic scattering using the internal proton beam on a gas jet target

data: angular and energy distributions of low mass fragments recoiling from a high Z noble gas jet target



Experiments in the Research Areas

JULY - SEPTEMBER 1977

Internal Area	Proton Area	Neutrino Area	Meson Area
SHUTDOWN UNTIL OCTOBER	PROTON EAST: PHOTOPRODUCTION #401 PHOTOPRODUCTION #152B	NEUTRINO BEAM: 15-FT BUBBLE CHAMBER	M1 BEAM: HADRON JETS #236A INCLUSIVE SCATTERING #324
	PROTON CENTER: DI-LEPTON #288	MUON/HADRON BEAM: PARTICLE SEARCH #369	M2 BEAM: HADRON JETS #395 PARTICLE SEARCH #468
	PROTON WEST: PHOTON SEARCH #95A		M4 BEAM: INCLUSIVE K^0_S #383
			M6 BEAM: INCLUSIVE SCATTERING #118A ASSOCIATED PRODUCTION #99

MANUSCRIPTS AND NOTES PREPARED DURING JUNE AND JULY 1977

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

I. P. Auer et al. Experiment #61	Measurement of the π^+p and π^-p Polarization Parameters at 100 GeV/c (Submitted to Phys. Rev. Lett.)
G. Fujioka et al. Experiment #'s 117A, 250, 251	Nuclear Interactions of High Energy Protons in Nuclear Emulsion (Submitted to the 15th International Cosmic Ray Conference, Plovdiv, Bulgaria, August 13-26, 1977)
J. P. Berge et al. Experiment #180	Scaling Variable Distributions for Antineutrino-Nucleon Interactions (FERMILAB-Pub-77/44-EXP; submitted to Phys. Rev. Lett.)
G. R. Farrar et al. Experiment #180	Neutrino and Antineutrino Proton Scattering Data and the Ratio of Down to Up Quarks in the Proton (FERMILAB-Pub-77/45-EXP; submitted to Phys. Lett.)
B. C. Brown et al. Experiment #288	Study of $J/\psi(3100)$ and $\psi'(3700)$ Production in Proton-Nucleus Collisions with Electron and Muon Pairs (FERMILAB-77/54-EXP)
A. M. Jonckheere et al. Experiment #416	Study of Final States in $\pi^-N \rightarrow \mu^+\mu^-$ + Hadrons at 225 GeV (Submitted to Phys. Rev.)
J. Curry and V. W. Steward PRAD-1	Establishment of a Beam Line at the Fermi National Accelerator Laboratory

Theoretical Physics

R. Savit	Vortices and the Low Temperature Structure of the X-Y Model (FERMILAB-Pub-77/26-THY; submitted to Phys. Rev.)
B. W. Lee et al.	Weak Interactions at Very High Energies: the Role of the Higgs Boson Mass (FERMILAB-Pub-77/30-THY; submitted to Phys. Rev.)

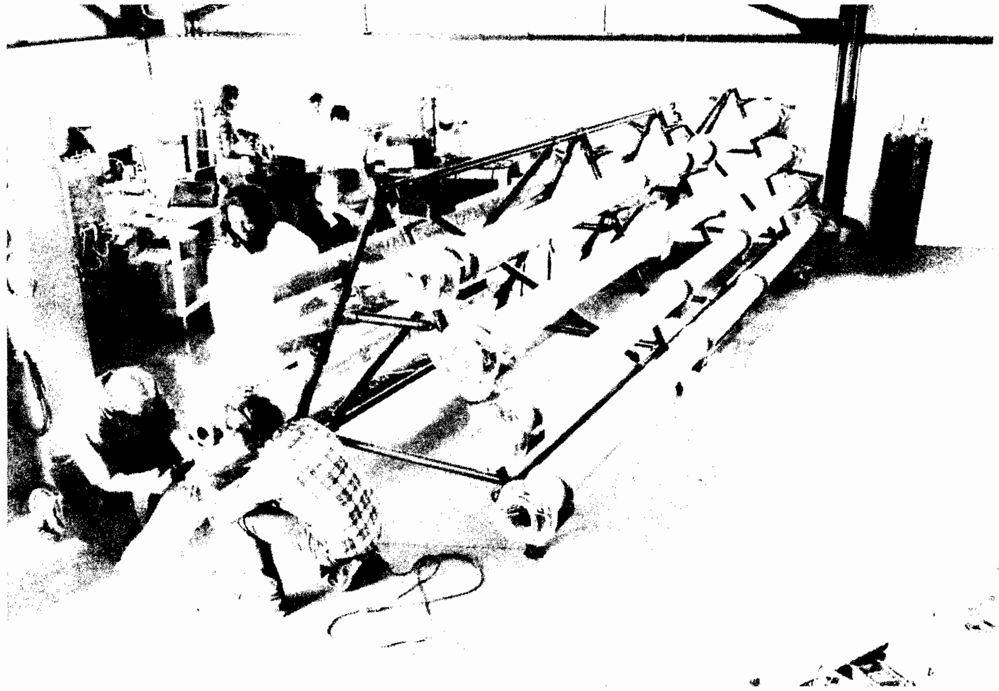
C. Quigg	Dilepton Production in Hadron-Hadron Collisions and the "Factor of Three" from Color (FERMILAB-Conf-77/33-THY; submitted to XII Recontre de Moriond, March 6-18, 1977)
D. W. Duke	Quark Elastic Scattering in Gauge Theories and Large Transverse Momentum Hadron Production (FERMILAB-Pub-77/35-THY; submitted to Phys. Rev. Lett.)
V. A. Matveev and P. Sorba	Is Deuteron a Six Quark System? (FERMILAB-Pub-77/36-THY; submitted to Phys. Rev. Lett.)
R. D. Carlitz et al.	Why the Neutron Isn't All Neutral (FERMILAB-Pub-77/39-THY; submitted to Phys. Lett.)
C. Quigg and J. L. Rosner	Hadronic Decays of η_C (FERMILAB-Pub-77/40-THY; submitted to Phys. Rev.)
B. W. Lee and S. Weinberg	Cosmological Lower Bound on Heavy Neutrino Masses (FERMILAB-Pub-77/41-THY; submitted to Phys. Rev.)
K. O. Mikaelian and R. J. Oakes	Neutral Current Effects in Bethe-Heitler Pair Production (FERMILAB-Pub-77/47-THY; submitted to Phys. Rev. D)
H. J. Lipkin	The Two-Component Pomeron and Hadron Total Cross Sections and Real Parts (FERMILAB-Pub-77/49-THY; submitted to Phys. Lett.)
K. O. Mikaelian	Gravitational Collapse of Spinning Stars: Black Holes versus Neutron Stars (FERMILAB-Pub-77/53-THY; submitted to Phys. Rev. Lett.)

General

R. A. Carrigan, Jr.	Magnetic Monopole Bibliography 1973-1976 (FERMILAB-77/42)

Physics Notes

S. C. Snowdon	Mechanical Stresses in Superconducting Quadrupoles (FN-306)



Magnet production for the Superconducting Ring going on at the Magnet Facility.

The Summer Program for Minority Students is now in progress. At a lecture are (from left to right) Gerry Mansfield, Arthur White, and Evelyn Jenkins.

DATES TO REMEMBER

September 16, 1977	First workshop on upgrading of the Meson Laboratory. (For specific details contact T. Toohig or J. Elias, Meson Department.)
September 23-24, 1977	Muon Workshop.
September 30, 1977	Deadline for receipt of all new proposals and other written materials to be considered at the fall meeting of the Program Advisory Committee.
October 13-14, 1977	Proposal Presentation Meeting.
November 10-11, 1977	Fall meeting of the Fermilab Program Advisory Committee.
January 27, 1978	Deadline for receipt of all new proposals and other written materials to be considered at the spring meeting of the Program Advisory Committee.
February 9-10, 1978	Proposal Presentation Meeting.
March 9-10, 1978	Spring meeting of the Fermilab Program Advisory Committee.
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.