NALREP

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lonthly Report of the Fermi National Accelerator Laboratory

April 1976

Fermi National Accelerator Laboratory

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THE COVER: The eight-acre main-ring prairie plot, seeded last spring, was burned this month to reduce weed competition this year. The burn, carried out by R. Dorner and the Fermilab Fire Department, is supposed to destroy shallow-rooted weeds from Europe and Asia but not to affect the deep-rooted, perennial prairie grasses and flowers that have been burned over for centuries. (Photograph by A. R. Donaldson)

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MODEST COLLIDING-BEAMS MEETING

Reported by Rolland Johnson and Peter Limon

Introduction

A meeting was held in January to discuss modest colliding-beams schemes at Fermilab. The goal of these schemes[1-3] is to increase the energy available to create new states of matter on a more rapid time scale than that offered by POPAE and to give experience with the technology and physics that might lead to economies in the design of a larger facility. This paper is a report of that meeting.

Energy and Luminosity

The relevant parameters for colliding beams are energy and luminosity. The great advantage intersecting storage-ring experiments have over experiments with stationary targets using beams from synchrotrons is in the energy available to create new states of matter. The customary variable is $\sqrt{s}$, which corresponds to the most massive state that energy conservation will allow to be produced. The CERN ISR (Intersecting Storage Ring) has two rings of approximately 30 GeV each; this gives a $\sqrt{s}$ of 60 GeV. In principle, two new particles each of rest energy 30 GeV could be produced. By comparison, the 400-GeV Fermilab beam on a stationary hydrogen target gives $\sqrt{s} \approx 28$ GeV, enough to make two 14-GeV particles. In order to have $\sqrt{s} = 60$ GeV, a synchrotron would have to have an energy of 1800 GeV!

One pays for this large center-of-mass energy by having a lower luminosity in colliding-beam experiments than in fixed-target experiments.

The rate of a particular reaction is given by the luminosity multiplied by the cross section of that interaction.

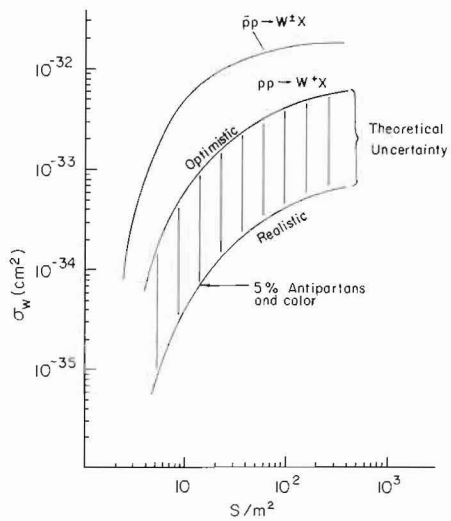
The ISR has a luminosity L of approximately 10^{31} sec^{-1} cm^{-2}. A typical interaction cross section is 10^{-30} cm^2 (1 μb). Thus, the event rate would be $10^{-30} \times 10^{31} = 10$ events/sec. For a Fermilab beam of 10^{13} particles/sec the corresponding luminosity using a liquid-hydrogen target one foot long is 10^{37} sec^{-1} cm^{-2}, or a million times better than the ISR.

Given a sufficient $\sqrt{s}$ to produce a new particle, the next question is whether the luminosity is sufficiently high to allow the particle to be produced often enough to be detected in a reasonable running time. To discuss this question and to evaluate the schemes for colliding beams at Fermilab, it is necessary to choose a desired new particle and its expected mass and production cross section. The standard for these discussions has become the charged intermediate vector boson, the particle responsible for the weak force (nuclear beta decay, neutrino interactions, strange-particle decay, etc.). This boson, the W, is expected to have a mass between 37 and 100 GeV. This expectation follows from gauge theories that seem to explain simultaneously the electromagnetic and weak forces; the actual mass calculation then follows from the relative strengths of the weak and electromagnetic forces.

The expected cross section for producing the W is much more controversial than its mass. Calculations for W production cross sections are usually based on a Drell-Yan model. In this model, the proton is considered to be made up of quarks with a small mixture of antiquarks. The W boson is

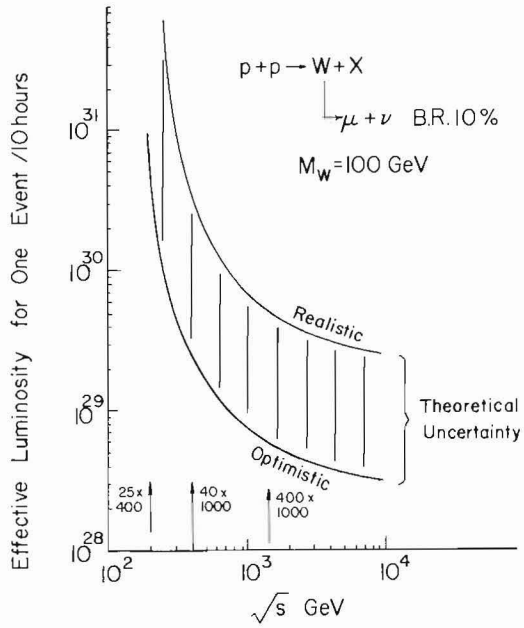
produced by the annihilation of a quark in the proton with an antiquark in the other proton. One problem with this calculation is that the number and momentum distributions of the antiquarks in the proton are not well known, except that experiments show that the number is very small, and the momentum distribution is significant predominantly at low values. It is possible that neutrino experiments at Fermilab will eventually determine the antiquark component of protons, but at present these parameters are very uncertain, making it difficult to calculate the necessary energy and luminosity for W boson production.

The graph at the right gives the cross section for producing a W boson as a function of the scaling variable s/m^2 for $p + p \rightarrow W^+ +$ anything. These curves are calculated using the Drell-Yan model. As mentioned above, the uncertainty of a factor of 10 or so arises from the uncertainty of the antiquark distribution. The cross section for $p + p \rightarrow W^{\pm} +$ anything is also shown on this graph.



Charged W boson production cross section.

The graph on the next page shows the luminosity needed to see one event every 10 hours for $p + p \rightarrow W^+ +$ anything, with the W^+ decaying to $\mu^+ + \nu$ with a 10% branching ratio. This figure also shows $\sqrt{s}$ for some of the schemes presented at the meeting.



Required luminosity as a function of energy.

Other Experiments

Although the emphasis at the meeting was on new and grand discoveries, there are many other experiments that profit from high center-of-mass energy, even at modest luminosity. Total cross sections, inclusive studies, multiplicity distributions, and low $p_\perp$ experiments immediately come to mind. The low-t elastic cross section in the Coulomb-interference region is particularly interesting, because the ratio of the real to the imaginary part of the scattering amplitude is sensitive to the rate at which the total cross section grows.

The fact that the beams are at unequal energies in most schemes can be used to great advantage in some experiments. For example, the particles

that come from an interaction in the direction of the low-energy beam are spread out over a large solid angle, making multiplicity counting much easier.

We turn now to discussion of particular colliding-beam schemes presented at the meeting.

Energy Saver/Doubler on Main Ring

The possibility of making interactions between protons in the Energy Saver/Doubler (ES/D) with protons in the Main Ring (MR) was discussed. Since the ES/D design is still flexible, any bright idea for eventual use of the ES/D as a colliding beam might be well included at this time.

These ES/D on MR schemes involve injecting protons from the Booster into the MR in the "wrong" direction. For example, these wrong-way protons could be accelerated to 400 GeV and injected into the ES/D. Several cycles of the MR could be used to build up the current in the ES/D. This stacking process could store 10 A of circulating beam in a few minutes. The ES/D internal vacuum is expected to limit the beam lifetime; expectations are that the stored beam would last some tens of hours before a refill would be necessary. The MR could then operate in its normal fashion, delivering beam to experimental areas. The MR beam (5×10^{13} protons corresponds to 0.4 A) could then be made to collide parasitically with the beam stored in the ES/D.

The ES/D on MR schemes all depend on the placement of the magnets in the MR tunnel. The farther away from each other the two rings are, the more difficult it will be to bring the beam from one ring to the other, make it cross and then get it back into place again within the 52 m of a long straight

section. One idea was to put the ES/D magnets on top of or below the MR magnets on alternate sixths of the MR. The transition regions at which the beam in the ES/D would cross and interact with the MR would then be at the present long straight sections.

Not all the six long straight sections in the MR are available to be used for colliding-beam experiments. Injection and extraction from the MR take up A0 and the rf accelerating system takes up F0. The present MR to ES/D transfer takes place at B0, although for many colliding-beam schemes, the transfer process would be compatible with an interaction region. The C0 straight section, where the present internal-target area is, might make a reasonable experimental area for colliding beams with minor modifications. The MR abort system is in D0; the abort may prove compatible with an intersecting experimental area. The E0 straight section is completely free. One can envision as many as four interaction regions.

Given that the center-of-mass energy $(4E_1E_2)^{\frac{1}{2}}$ can be formed from ES/D beams from 100 to 1000 GeV and MR beams from 8 to 500 GeV, depending on the placement of the ES/D magnets, the next question is luminosity. The luminosity depends on the currents of the beams, I_1 and I_2 in amps, the area of overlap a in mm^2, and the length of the intersecting region ℓ in meters.

$$L = (0.26 \times 10^{32}) \frac{I_1 I_2}{a} \ell B \text{ cm}^{-2} \text{sec}^{-1}.$$

Here B is a bunching factor that is 1 for an unbunched beam and ≈10 for an rf-bunched beam. Each of the terms in the expression can be changed to

increase the luminosity. The currents can be increased by stacking. The length of the overlap can be increased by decreasing the crossing angle between the two beams. The maximum luminosity is achieved by colliding the beams head-on. In the head-on scheme, the beams do not have to alternate above and below, but can be brought to the interaction region and removed from the interaction region on the same side.

As a direct result of this meeting, it has been decided that the Energy Saver/Doubler will be installed under the main-ring magnets, not on the ceiling of the tunnel, to make it more compatible with colliding the two beams.

The most ambitious scheme has 400-GeV MR beam colliding with the 1000-GeV ES/D beam. In this scheme $\sqrt{s}$ is approximately 1260 GeV. The corresponding luminosity, depending on the tricks and assumptions, would be between 10^{30} and 10^{31} $cm^{-2}sec^{-1}$. With such a scheme, one would have great assurance that the W would be found, if it exists. More modest-colliding beam schemes with lesser energies and luminosities are less certain to find W's.

Conventional Magnet Storage Ring

One proposal was presented for the construction of a small 25-GeV storage ring to intersect the MR at E0[4]. This scheme is discussed in a companion paper by J. K. Walker on page 11.

The 25-GeV ring interacting with the MR at 400 GeV would give $\sqrt{s}$ = 200 GeV and L = 10^{31} $cm^{-2}sec^{-1}$. When the ES/D becomes operational at 1000 GeV, the corresponding $\sqrt{s}$ becomes 300 GeV. Replacing the conventional magnets in the small ring with superconducting magnets would allow

the 25-GeV energy to go to 50 GeV. The corresponding $\sqrt{s}$ would be 400 GeV and L would be $10^{32} cm^{-2} sec^{-1}$.

Antiproton-Proton Clashing Beams

One way to avoid the problems of the small antiquark component in the proton is to store and accelerate antiprotons. The antiquark component of the antiproton is the same as the quark component of the proton, making the cross sections higher for the annihilation process and making the calculations more definite. It is, however, difficult to store a large number of antiprotons because they must be made from a secondary target.

A scheme that used a small accumulator ring to collect antiprotons was discussed. A racetrack-shaped field with 3 m radius curved sections would be used to collect 2-GeV antiprotons produced by a 40-GeV MR beam. The betatron oscillations of these captured $\bar{p}$'s would be large. To "cool" or damp the oscillations, an electron beam of 1 MeV and several amperes would be made to travel with the $\bar{p}$ in the straight sections of the racetrack. The antiprotons and electrons that travel together at the same velocity down the straight sections come to thermal equilibrium after a time of the order of 25 min, thereby reducing the size of the transverse oscillations of the $\bar{p}$. There are possible alternatives to cooling with electrons. CERN has done some experiments at the ISR using "stochastic cooling" of a beam, where fluctuations in the beam centroid are detected and used to kick the beam back to its proper orbit with fast feedback. The filling and cooling cycle could be repeated many times (at 4×10^7 $\bar{p}$ stored/cycle) until approximately 10^{10} $\bar{p}$ were stored. The $\bar{p}$ could then be injected back into the MR in the wrong

direction where they would be accelerated to 200 GeV or so, along with the "right-way" protons, and stored.

At this point, one would have $\bar{p}p$ collisions at $\sqrt{s}$ = 400 GeV and a luminosity 10 $cm^{-2}sec^{-1}$. Since the antiquark fractions and momentum distributions are known for the antiprotons, the Drell-Yan calculation is more reliable than for the pp case. If this mechanism were to produce the W, the larger number of antiquarks might make $p\bar{p}$ one to two orders of magnitude more effective than pp.

Conclusion

The schemes presented above have widely varying degrees of certainty and of cost. But they show that the field of colliding-beam physics can become available at Fermilab with a modest effort. This effort could produce significant physics results, although they could not be expected to take the place of POPAE, which would make available larger energy and luminosity.

The ideas discussed at this meeting were presented (in order of appearance) by R. R. Wilson, D. Cline, C. Rubbia, J. Walker, L. Teng, T. Collins, P. McIntyre, A. Tollestrup, and G. Fox. Additional information was provided by R. Carrigan and the 1973 Fermilab Summer Study. More detailed notes on the meeting are available in the Library.

References

[1] R. A. Carrigan, Jr., Can an Energy Doubler Be Used to Implement a Simple Storage Ring System at NAL?, Fermilab FN-233, July, 1971.

[2] 1973 NAL Summer Study, Vol. 2.

[3] Some Preliminary Concepts About the Proposed Energy Doubler Device for the 200/500 GeV Proton Accelerator at the United States National Accelerator Laboratory, Batavia, Illinois, Fermilab TM-421, May, 1973.

[4] Fermilab Proposal P-478.

W-SEARCH EXPERIMENT

Reported by James Walker

The most direct way of testing the underlying theory of weak interactions is to search for the intermediate vector bosons $W^{\pm}$ and Z^0. We have proposed performing this search by constructing a small, high-current (of the order of 1 A) storage ring that would allow us to study collisions between 25-GeV protons and the normal accelerating proton beam in the Main Ring of the Fermilab 400-GeV synchrotron. This operation would cause no disruption of the standard Fermilab experimental program involving experiments with internal targets and external beams. In the first phase of the experiment, a peak available energy of $\sqrt{s}$ of 200 GeV in the center-of-mass system would be achieved with a luminosity of $10^{31}\ \mathrm{cm}^{-2}\mathrm{sec}^{-1}$.

The proposed detector, with close to 4π solid angle, would permit identification and momentum analysis of muons of both charges from the reactions

$$p + p \rightarrow W^{\pm} + \text{Anything}$$
$$\hookrightarrow \mu^{\pm} + \text{Anything}$$
$$p + p \rightarrow Z^0 + \text{Anything}$$
$$\hookrightarrow \mu^{+} + \mu^{-}.$$

In addition, the detector could provide a rough measurement of the energy and momentum of the hadronic cascades by the calorimetric technique.

Two characteristics of the events would be used to identify the production of W mesons, observation of a peak in the cross section for muon production

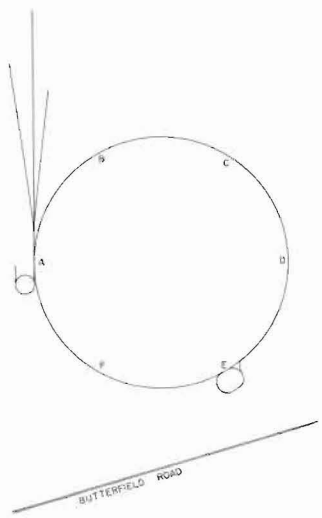
at $p_\perp \simeq M_W/2$, and observation of a large imbalance of transverse momentum corresponding to a missing neutrino. Backgrounds from the continuum of $\mu^+\mu^-$ pairs and known sources of single muons should be small.

The neutral intermediate boson Z^0 probably has a smaller cross section than its charged counterpart. Its production would be signaled by the observation of a resonant peak in the $\mu^+\mu^-$ mass spectrum.

Our schedule calls for achieving proton-proton collisions at 200 GeV in the center-of-mass system two years after approval. A second phase of the experiment would involve raising the c. m. system energy to 400 GeV and increasing the luminosity up to 10^{32} $cm^{-2}sec^{-1}$.

Characteristics of the Small Storage Ring

1. Choice of Location. We have chosen to locate the small ring at straight section E of the Main Ring, as shown below. For easy visualization of its

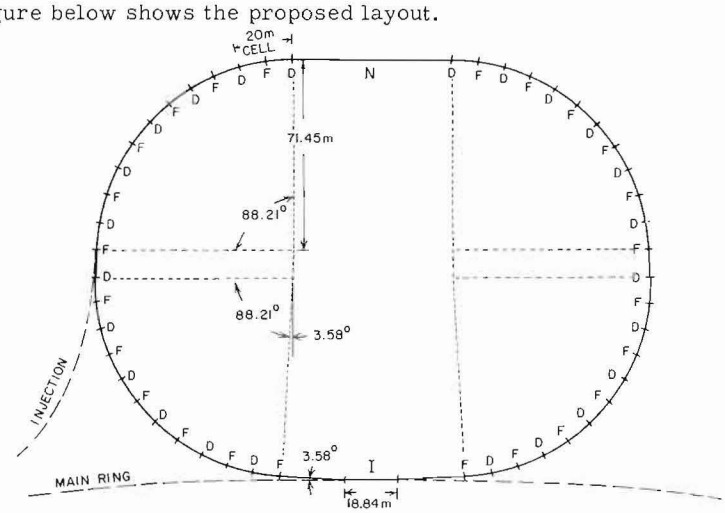


Proposed location of the small storage ring.

size, we mention that it is approximately the size of the Booster. Straight-section E has been chosen as the location because of its proximity to Butterfield Road, so that it will probably not be utilized either in connection with POPAE or future secondary beams. Because of the compact nature of the small ring, this location would provide ample space for construction and isolation from the public highway.

2. Ring Geometry and Lattice. The ring would be roughly in the shape of a racetrack with two semicircular curved sections of approximately 75 m radius joined by two straight sections each approximately 60 m in length. One of the long straight sections would run parallel and next to the MR long straight section in which the two beams would be brought together to collide.

The figure below shows the proposed layout.



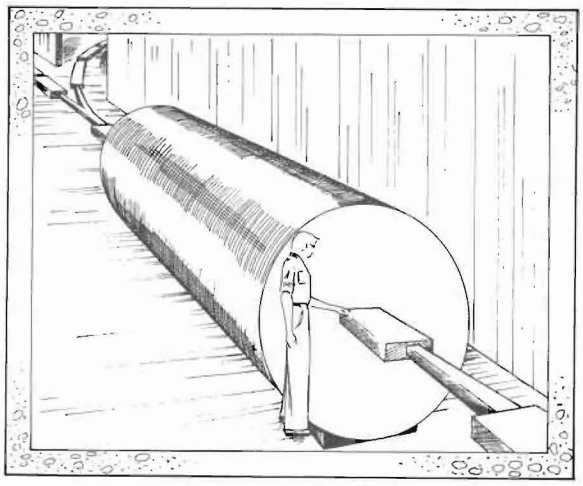
Layout of the small storage ring.

3. Mode of Operation. During stacking, only approximately 1/10 of the main-ring beam for each of 10 pulses would be extracted at 25 GeV and injected

into the storage ring. The remaining 9/10 of the beam in each pulse could be accelerated to 400 GeV for other experiments. Thus there would be no noticeable interference and the storage ring could be recharged rather frequently, say, every 10 minutes. During these 10 minutes with a beam stored in the storage ring, the operation of the Main Ring would be totally normal. Colliding-beam experiments could be performed from 50 GeV × 25 GeV up to 400 GeV × 25 GeV during the ramp and flat-top of each main-ring pulse. Depending on the main-ring cycle time, the duty factor could be as high as 50%. At the end of 60 minutes, the degraded stored beam would be dumped and a new beam stacked from parts of the following 10 main-ring pulses.

Detector Concept

The proposed muon detector is a cylinder stacked from drift-chamber and magnetized-iron sandwiches, as shown in the artist's conception below. The cylinder is approximately 18 m long and 3 m in diameter. Each iron



Artist's concept of proposed muon detector.

plate is 10 cm thick and toroidally magnetized. A gap of about 5 cm is provided between adjacent plates for the introduction of detectors. Muon momenta are measured to about ±10% accuracy.

Hadron cascades would be detected using scintillation-counter hodoscopes located between the iron plates. It is estimated that imbalance in transverse momentum for an individual event could be checked to about 2 or 3 GeV/c.

The trigger would be the production of a muon with transverse momentum greater than 1 GeV/c, possibly in association with a large imbalance in hadron transverse momentum. A Monte Carlo simulation of events in the given geometry is presently being performed and this will help in establishing the optimum trigger.

An event rate of approximately 100 per week has been estimated for the production of 60-GeV intermediate vector bosons.

Cost

The total cost of tunnel construction, equipment for the ring, and detector development has been estimated as $4,000,000. In addition, there are costs for provision of utilities, salaries, and rigging services that have not yet been evaluated.

Conclusion

It seems likely that if the intermediate boson exists, this experiment has a good chance of finding it. The effort and cost are comparable to other large experiments at Fermilab. It remains to be seen whether nature will provide us with the W or perhaps surprises beyond our present imagination.

Patiently awaiting the arrival of goslings, this female Canadian goose basks in the warmth of the April sun. (Photograph by A. R. Donaldson)

NOTES AND ANNOUNCEMENTS

SUMMER HOUSING. . .

The Housing Office is now making plans 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 receipts of reservations for on-site housing.

In order to assure an equitable distribution, Fermilab housing assignments will be determined this year by a new priority and lot system established by the Laboratory after discussion with the Users Executive Committee. The housing assignments were made early in April based on the expected running schedule for the summer, and responses were mailed out on April 22.

The new priority system allocates four houses or apartments to the theoretical program and the remaining houses, apartments, and dormitory rooms to experimenters on running experiments and experiments setting up for the summer and fall. The priority in this group is 1) Soviets and 2) 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. Ten of the 68 dorm 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. Double occupancy will not be employed in dorm rooms unless it is requested.

The starting dates for summer occupancy will be staggered over the week of May 30 through June 5. 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.

APPOINTMENTS. . .

Marvin Warner has been appointed head of Architectural Services effective April 5. Marv Warner was deputy head of the DUSAF group that designed all the buildings and conventional facilities of Fermilab and supervised their construction.

PHOTOGRAPHS SOLICITED. . .

The editors of NALREP are seeking unusual, timely, or seasonal photographs taken by Laboratory personnel to use in future issues of NALREP. Submissions will be handled through the Publications Office, third floor, Central Laboratory. For more information contact R. Donaldson, Ext. 3278.

SITUATION REPORT - APRIL 1976

PAGE 1 FERMI NATIONAL ACCELERATOR LABORATORY J. R. SANFORD

4 APRIL 1976

EXPERIMENTAL PROGRAM SITUATION REPORT

THE EXPERIMENTAL PROGRAM SITUATION AT FERMILAB IS SUMMARIZED BELOW. THE EXPERIMENTS ARE LISTED SEPARATED BY EXPERIMENTAL AREA UNDER CATEGORIES THAT BEST DESCRIBE THEIR CIRCUMSTANCE AS OF APRIL 1,1976. FOR EXPERIMENTS WHICH HAVE BEEN COMPLETED OR HAVE RECEIVED BEAM THERE IS INDICATION OF THE AMOUNT OF RUNNING TIME OR EXPOSURE. THE EXPERIMENTAL AREA NAMES ARE ABBREVIATED AS FOLLOWS: INTERNAL TARGET AREA (ITA), MESON AREA (MA), NEUTRINO AREA (NA), PROTON AREA (PA).

TOTAL NUMBER OF APPROVED EXPERIMENTS - 241

AREA-BEAM		SPOKESPERSON	EXTENT OF RUN TO DATE	DATE COMPLETED
A. EXPERIMENTS THAT HAVE COMPLETED DATA TAKING (145):				
MA -M1	ELASTIC SCATTERING #7	MEYER	2,350 HOURS	28 JAN 75
	PION DISSOCIATION #86A	LUBATTI	800 HOURS	22 MAR 76
	FORM FACTOR #216	STORK	900 HOURS	1 OCT 75
	DETECTOR DEVELOPMENT #229	YUAN	300 HOURS	16 NOV 74
	DETECTOR DEVELOPMENT #261	WANG	600 HOURS	20 NOV 74
	MUON SEARCH #335	FACKLER	300 HOURS	6 JUN 75
	PARTICLE SEARCH #416	LUBATTI	400 HOURS	1 JUL 75
-M2	NEUTRAL MESPRON #8	PINDURIN	2,450 HOURS	22 MAR 76
	MULTIGAMMA #22	COLLINS	350 HOURS	26 JUN 74
	MISSING MASS #51A	VON GOELER	800 HOURS	23 OCT 74
	QUARK #75	YAMANOUCHI	1,050 HOURS	8 SEP 73
	BEAM DUMP #108	ABSCHALOM	350 HOURS	2 JUN 75
	PION CHARGE EXCHANGE #111	TOLLESTRUP	1,800 HOURS	19 SEP 74
	INCLUSIVE PHOTON #268	MELLEMA	1,850 HOURS	11 FEB 76
	PARTICLE SEARCH #365	GARELICK	200 HOURS	5 FEB 75
-M3	NEUTRON CROSS SECTION #4	LONGO	1,450 HOURS	20 MAR 74
	NEUTRON BACKWARD SCATTERING #12	BEAY	1,300 HOURS	2 DEC 74
	NEUTRON DISSOCIATION #27A	ROSEN	850 HOURS	24 APR 74
	MULTIGAMMA #230	LONGO	50 HOURS	24 APR 74
	NEUTRON DISSOCIATION #305	GOBBI	1,400 HOURS	14 APR 75
-M4	QUARK #72	LEIPUNER	500 HOURS	11 JUN 73
	K ZERO REGENERATION #82	TELEGDI	3,500 HOURS	5 JUL 75
	PARTICLE SEARCH #330	GUSTAFSON	150 HOURS	7 JUL 75
-M6	ELASTIC SCATTERING #69A	MARX	2,800 HOURS	3 MAR 76
	ELASTIC SCATTERING #96	RITSON	2,550 HOURS	17 FEB 75
	MULTIPLICITIES #178	BUSZA	800 HOURS	14 AUG 75
-OTHER	EMULSION/PROTONS @ 200 #90	WOLTER	4 STACKS	20 SEP 72
	EMULSION/PROTONS @ 200 #103	KING	1 STACK	20 SEP 72
	EMULSION/PROTONS @ 200 #105	MALHOTRA	1 STACK	20 SEP 72
	EMULSION/PROTONS @ 200 #114	JAIN	1 STACK	20 SEP 72
	EMULSION/PROTONS @ 200 #116	HEBERT	5 STACKS	20 SEP 72
	EMULSION/PROTONS @ 200 #117A	KUSUMOTO	11 STACKS	20 SEP 72
	EMULSION/PROTONS @ 200 #156	NIU	13 STACKS	20 SEP 72
	EMULSION/PROTONS @ 200 #171	LORD	6 STACKS	20 SEP 72
	EMULSION/PROTONS @ 200 #183	TRETJAKOVA	3 STACKS	20 SEP 72
	EMULSION/PROTONS @ 200 #189	RITSON	2 PLATES	20 SEP 72
	SUPER-HEAVY ELEMENTS #147	DEBEAUVAIS	4 EXPOSURES	11 JUN 75
	DI-MUON #337	EARTLY	5 HOURS	7 FEB 75
	SUPER-HEAVY ELEMENTS #371	JURIC	2 STACKS	20 DEC 75
	FRAGMENTATION PARTICLES #426	FUKUI	16 STACKS	20 MAR 76
NA -NEUTRINO	NEUTRINO #1A	CLINE	2,850 HOURS	30 JUN 75
	15-FOOT NEUTRINO/H2GNE #28A	FRY	97K PIX	11 JUN 75
	NEUTRINO #21A	BARISH	2,450 HOURS	2 NOV 75
	15-FOOT FNI TEST #155	PETERSON	14K PIX	30 NOV 74
	15-FOOT ANTI-NEUTRINO/H2GNE#180	ERMOLOV	76K PIX	2 JUN 75
	NEUTRINO #254	KALBFLEISCH	550 HOURS	15 OCT 75
	NEUTRINO #262	BARISH	400 HOURS	20 MAR 74
	NEUTRINO #320	SCIULLI	500 HOURS	1 OCT 74
	NEUTRINO #370	CLINE	400 HOURS	19 MAR 75
-MUON/HADRON	MUON #26	HANO	900 HOURS	16 APR 74
	MUON #98	ANDERSON	1,800 HOURS	17 FEB 75
	DI-MUON #331	PILCHER	1,400 HOURS	22 MAR 76
	PARTICLE SEARCH #382	HAND	200 HOURS	19 DEC 75
-15-FT	15-FOOT ENGINEERING RUN #234	HUSON	57K PIX	5 NOV 74
	15-FOOT P - P @ 400 #34L	KO	34K PIX	21 DEC 75
	15-FOOT P - P @ 300 #343	ENGELMANN	27K PIX	13 JAN 76
-30-IN	30-INCH HYBRID #28	SMITH	479K PIX	22 APR 74
	30-INCH P-P @ 300 #37A	MALAMUD	51K PIX	1 JUN 73
	30-INCH PI+ C P - P @ 100 #121A	LANDER	104K PIX	23 JAN 74
	30-INCH PI- - P @ 100 #125	MORRISON	53K PIX	28 AUG 73
	30-INCH PI- - P @ 200 #137	HUSON	48K PIX	10 MAR 73
	30-INCH P-P @ 400 #138	VANDER VELDE	52K PIX	26 AUG 75
	30-INCH P-P @ 200 #141A	FIELDS	67K PIX	27 NOV 72
	30-INCH PI- - P @ 300 #143A	KALBFLEISCH	51K PIX	10 APR 74
	30-INCH HYBRID #154	PLESS	105K PIX	13 MAR 74
	30-INCH P - PGNE @ 300 #161	MAPP	51K PIX	25 JUN 74
	30-INCH PI- - PGNE @ 200 #163A	WALKER	52K PIX	18 JUN 74
	30-INCH P - D @ 400 #196	ENGELMANN	109K PIX	20 OCT 75
	30-INCH P - D @ 300 #209	DAO	108K PIX	7 OCT 75
	30-INCH PI+ C P - P @ 200 #217	LANDER	85K PIX	15 MAY 74
	30-INCH PI- - D @ 200 #218	YAGER	72K PIX	18 SEP 74
	30-INCH PI+ C P - P @ 60 #228	FERBEL	37K PIX	15 APR 74
	30-INCH P-P @ 100 #252	FERBEL	33K PIX	6 DEC 72
	30-INCH P - D @ 200 #280	FIELDS	103K PIX	11 OCT 75
	30-INCH HYBRID #281	SMITH	301K PIX	28 SEP 75
	30-INCH PI+ C P - D @ 200 #295	YEKUTIELI	156K PIX	2 NOV 75
	30-INCH PBAR - P @ 100 #311	NEALE	98K PIX	27 JAN 75
-OTHER	MONOPOLE #3	EBERHARD	4 TARGETS EXPOSED	4 SEP 74
	PROTON-PROTON INELASTIC #14A	FRANZINI	140 HOURS	21 JUN 73
	MONOPOLE #76	CARRIGAN	5 TARGETS EXPOSED	1 DEC 74
	LONG-LIVED PARTICLES #115	STEVENSON	6 HOURS	23 NOV 74
	SUPER-HEAVY ELEMENTS #142	STOUGHTON	1 TARGET	4 JUN 75
	MASSIVE PARTICLE SEARCH #199	FRANKEL	2 TARGETS EXPOSED	27 AUG 73
	BEAM DUMP #211	GOEBEL	2 HOURS	14 NOV 73
	LONG-LIVED PARTICLES #239	FRATI	350 HOURS	3 FEB 74
	QUARK #276	VAN GINNEKIN	3 TARGETS EXPOSED	2 NOV 75
	DETECTOR DEVELOPMENT #34	HUGGETT	50 HOURS	26 JUN 74
	QUARK #297	LEIPUNER	50 HOURS	10 JUL 74
	DETECTOR DEVELOPMENT #327	ALLISON	50 HOURS	7 FEB 75
	PLASTIC DETECTORS #275	ENGE	6 STACKS	20 OCT 73
	EMULSION/PROTONS @ 300 #181	CARR	3 STACKS	20 OCT 73
	EMULSION/PROTONS @ 300 #195	LIM	3 STACKS	10 JUN 75
	EMULSION/PROTONS @ 300 #232	KING	2 STACKS	20 OCT 73
	EMULSION/PROTONS @ 300 #233	HEBERT	8 STACKS	20 OCT 73
	EMULSION/PROTONS @ 300 #237	LORD	5 STACKS	10 JUN 75
	EMULSION/PROTONS @ 300 #242	NIU	2 STACKS	20 OCT 73
	EMULSION/PROTONS @ 300 #244	JAIN	1 STACK	20 OCT 73
	EMULSION/PROTONS @ 300 #250	KUSUMOTO	1 STACK	20 OCT 73
	EMULSION/PROTONS @ 300 #329	TRETJAKOVA	2 STACKS	10 JUN 75
	EMULSION/PROTONS @ 300 #374	DAVIS	1 STACK	10 JUN 75
	EMULSION/PROTONS @ 300 #419	GIACOMELLI	1 STACK	10 JUN 75
	EMULSION/PROTONS @ 300 #421	OZHELEPOV	1 STACK	24 JUN 75

PAGE 2 EXPERIMENTAL PROGRAM SITUATION REPORT (CONT'D)

AREA-BEAM		SPOKESPERSON	EXTENT OF RUN TO DATE	DATE COMPLETED
	EMULSION/PROTONS @ 200 #271	GOTTFRIED	10 STACKS	10 JUN 75
	EMULSION/MUONS @ 150 #255	JAIN	1 STACK	16 OCT 73
	EMULSION/MUONS @ 150 #205A	KUSUMOTO	2 STACKS	16 OCT 73
	EMULSION/PI- @ 200 #264	YOUNG	2 STACKS	7 OCT 74
	EMULSION/PI- @ 200 #328	TRETJAKOVA	5 STACKS	7 OCT 74
	EMULSION/PI- @ 200 #339	WOLTER	4 STACKS	9 JUN 75
	EMULSION/PI- @ 200 #367	JAIN	1 STACK	9 JUN 75
	EMULSION/PI- @ 200 #387	WILKES	4 STACKS	9 JUN 75
	EMULSION/PROTONS @ 400 #238	LORD	9 STACKS	9 DEC 75
	EMULSION/PROTONS @ 400 #243	NIU	7 STACKS	9 DEC 75
	EMULSION/PROTONS @ 400 #245	JAIN	1 STACK	9 DEC 75
	EMULSION/PROTONS @ 400 #249	WOLTER	3 STACKS	9 DEC 75
	EMULSION/PROTONS @ 400 #251	KUSUMOTO	3 STACKS	9 DEC 75
	EMULSION/PROTONS @ 400 #265	YOUNG	3 STACKS	9 DEC 75
	EMULSION/PROTONS @ 400 #279	KING	3 STACKS	9 DEC 75
	EMULSION/PROTONS @ 400 #292	GOTTFRIED	12 STACKS	9 DEC 75
	EMULSION/PROTONS @ 400 #336	OGATA	2 STACKS	9 DEC 75
	EMULSION/PROTONS @ 400 #346	EKSPONG	1 STACK	9 DEC 75
	EMULSION/PROTONS @ 400 #385	PRAKASH	1 STACK	9 DEC 75
	EMULSION/PROTONS @ 400 #423	SUGIMOTO	4 STACKS	9 DEC 75
	EMULSION/PROTONS @ 400 #428	HEBERT	14 STACKS	9 DEC 75
	EMULSION/PROTONS @ 400 #434	DAKE	3 STACKS	9 DEC 75
	EMULSION/PROTONS @ 400 #461	LORD	6 STACKS	9 DEC 75
	EMULSION/PROTONS @ 400 #462	GIACOMELLI	1 STACK	9 DEC 75
	EMULSION/PROTONS @ 400 #463	TRETJAKOVA	2 STACKS	9 DEC 75
PA -PE	PHOTOPRODUCTION #87A	LEE	2,500 HOURS	21 DEC 75
	PARTICLE SEARCH #100A	PIROUE	1,150 HOURS	4 APR 74
	DI-MUON #358	LEE	400 HOURS	1 OCT 75
-PC	MUON SEARCH #48	ADAIR	500 HOURS	1 DEC 75
	LEPTON #70	LEDERMAN	2,800 HOURS	1 DEC 74
	PARTICLE SEARCH #187	LEDERMAN	200 HOURS	6 NOV 73
	DI-MUON #436	ADAIR	200 HOURS	29 OCT 75
ITA-C-O	PROTON-PROTON SCATTERING #36A	COOL	700 HOURS	24 JUN 73
	PHOTON SEARCH #63A	WALKER	2,600 HOURS	13 MAR 75
	PROTON-PROTON MISSING MASS #67A	SANNES	600 HOURS	9 AUG 73
	PHOTON SEARCH #120	CLINE	1,200 HOURS	29 MAY 73
	PARTICLE SEARCH #184	WANDERER	800 HOURS	29 MAY 74
	PROTON-DEUTERON SCATTERING #186	MELISSINOS	450 HOURS	19 AUG 74
	PROTON-NUCLEON INCLUSIVE #188	SANNES	1,050 HOURS	9 MAY 73
	PROTON-PROTON INELASTIC #221	FRANZINI	950 HOURS	5 SEP 74
	PROTON-NUCLEON INELASTIC #317	COOL	1,400 HOURS	1 NOV 75
	PARTICLE SEARCH #363	OLSEN	650 HOURS	9 APR 75
	PARTICLE PRODUCTION #418	SANNES	900 HOURS	22 OCT 75

B. EXPERIMENTS THAT ARE IN PROGRESS (28):

			EXTENT OF RUN TO DATE	DATE OF RECENT RUN
MA -M1	TOTAL CROSS SECTION #104	KYCIA	1,400 HOURS	1 JAN 75
	INCLUSIVE SCATTERING #324	WEISBERG	400 HOURS	1 APR 76
-M2	PARTICLE SEARCH #357	MEYER	1,050 HOURS	1 APR 76
-M3	NEUTRON ELASTIC SCATTERING #248	LONGO	1,150 HOURS	1 APR 76
	PARTICLE SEARCH #397	ROSEN	600 HOURS	1 APR 76
	PARTICLE SEARCH #366	ABOLINS	1,550 HOURS	1 APR 76
-M4	K ZERO REGENERATION #425	TELEGDI	1,050 HOURS	1 APR 76
-M6	HADRON JETS #260	MCLEOD	1,450 HOURS	1 APR 76
	INCLUSIVE SCATTERING #118A	FRIEDMAN	600 HOURS	1 APR 76
-OTHER	NUCLEAR CHEMISTRY #81A	KAUFMAN	132 BOMBARDMENTS	1 APR 76
NA -NEUTRINO	15-FOOT NEUTRINO/H2 #45A	ROE	162K PIX	1 APR 76
	15-FOOT ANTI-NEUTRINO/H2 #31A	DERRICK	64K PIX	1 APR 76
	PARTICLE SEARCH #247	RUBHOP	100 HOURS	1 APR 76
-15-FT	15-FOOT PI- - P @ 100 #83A	KITAGAKI	11K PIX	1 APR 75
	15-FOOT PI- - PGNE @ 200 #89	PRETTER	4K PIX	1 JUL 75
	15-FOOT PI- - P @ 360 #384	HUSON	20K PIX	1 APR 76
-30-IN	30-INCH P - O @ 100 #194	MURPHY	41K PIX	1 OCT 74
	30-INCH HYBRID #299	PLESS	158K PIX	1 APR 75
-OTHER	SUPER-HEAVY ELEMENTS #285	LEDERMAN	3 TARGETS EXPOSED	1 JUL 75
	TACHYON MONOPOLE #202	BARTLETT	COSMIC RAY RUNNING	1 APR 76
PA -PE	PHOTON TOTAL CROSS SECTION #25A	CALDWELL	400 HOURS	1 OCT 75
	PARTICLE SEARCH #300	CRONIN	650 HOURS	1 APR 76
	PARTICLE SEARCH #325	CRONIN	200 HOURS	1 APR 76
-PC	DI-LEPTON #288	LEDERMAN	2,300 HOURS	1 APR 76
-PW	PHOTON SEARCH #95A	COX	850 HOURS	1 OCT 75
	PARTICLE PRODUCTION #284	WALKER	550 HOURS	1 APR 76
	PROTON-PROTON ELASTIC #177A	OREAR	750 HOURS	1 APR 76
ITA-C-O	PROTON-PROTON INELASTIC #321	LEE-FRANZINI	700 HOURS	1 APR 76

C. EXPERIMENTS THAT ARE IN TEST STAGE (6):

MA -M1	HADRON JETS #236A	HOCKETT	750 HOURS	1 APR 76
	POLARIZED SCATTERING #61	CHAMBERLAIN	300 HOURS	1 APR 76
NA -MUON/HADRON	MUON #319	CHEN		1 APR 75
PA -PC	MUON SEARCH #435	ADAIR		1 APR 76
ITA-C-O	PROTON-NUCLEON SCATTERING #198A	OLSEN	500 HOURS	1 APR 76
	PROTON-PROTON POLARIZATION #313	NEAL	500 HOURS	1 APR 76

D. EXPERIMENTS BEING INSTALLED (11):

			EXTENT OF APPROVAL
MA -M1	FORM FACTOR #456	STORK	500 HOURS
-M2	INCLUSIVE NEUTRAL MESON #350	KENNEY	400 HOURS
	PARTICLE PRODUCTION #415	PONOROM	100 HOURS
-M6	MULTIPARTICLE #110A	MCLEOD	600 HOURS
	HADRON DISSOCIATION #396	GOULIANOS	600 HOURS
NA -NEUTRINO	NEUTRINO #310	CLINE	1,000 HOURS
-MUON/HADRON	MUON #398	WILSON	800 HOURS
-15-FT	PARTICLE SEARCH #379	WOJCICKI	200 HOURS
PA -PE	NUCLEAR FRAGMENTS #466	KAUFMAN	500 HOURS
ITA-C-O	PROTON-NUCLEON SCATTERING #391	MALAMUD	300 HOURS
	NUCLEAR FRAGMENTS #442	TURKOT	400 HOURS

AREA-BEAM		SPOKESPERSON	EXTENT OF APPROVAL
E. EXPERIMENTS TO BE SET UP WITHIN A YEAR (23):			
PA -M2	PARTICLE SEARCH #472	STANFIELD	600 HOURS
	LAMBDA MAGNETIC MOMENT #440	RUNGE	160 HOURS
	PARTICLE SEARCH #411	GARELICK	250 HOURS
	PARTICLE SEARCH #413	GARELICK	150 HOURS
	PARTICLE SEARCH #439	GARELICK	400 HOURS
-M3	NEUTRON-NUCLEUS INELASTIC #438	JONES	700 HOURS
-M4	TEST K ZERO REGENERATION #226	TELEGDI	500 HOURS
-M6	BACKWARD SCATTERING #290	BAKER	900 HOURS
NA -NEUTRINO	15-FOOT NEUTRINO/H2 & NE #53A	BALTAY	100K PIX
	15-FOOT ANTI-NEUTRINO/H2&NE#172	BINGHAM	50K PIX
	NEUTRINO #253	MO	1,000 HOURS
-MUON/HADRON	MUON #203A	KERTH	500 HOURS
	MUON #391	KERTH	250 HOURS
-30-IN	30-INCH PI- - D @ 360 #338	MORIYASU	50K PIX
	30-INCH PBAR - P @ 50 #344	GUTAY	100K PIX
	30-INCH PBAR - D @ 100 #345	EKSPONG	100K PIX
	30-INCH PI+ & P - P @ 300 #277	BARNES	300K PIX
-OTHER	EMULSION/NEW PARTICLES #386	LORD	EMULSION EXPOSURE
PA -PE	EMULSION/ELECTRONS @ HI E #340	DAKE	EMULSION EXPOSURE
	EMULSION/ELECTRONS @ >100 #399	GOLDEN	5 STACKS
	PARTICLE SEARCH #400	PEOPLES	400 HOURS
	PHOTOPRODUCTION #1528	HEUSCH	350 HOURS
ITA-C-0	PROTON-HELIUM SCATTERING #289	MALAMUD	700 HOURS

F. OTHER APPROVED EXPERIMENTS (28):

PA -M1	PARTICLE SEARCH #354	BAKER	200 HOURS
	HADRON DISSOCIATION #272	FERBEL	600 HOURS
-M2	HADRON JETS #395	SELOVE	450 HOURS
	LAMBDA POLARIZATION #441	PONDROM	150 HOURS
	INCLUSIVE NEUTRON #404	JONES	500 HOURS
	MUON SEARCH #453	FRISCH	600 HOURS
	CHARGED HYPERON #97	LACH	400 HOURS
-M6	ASSOCIATED PRODUCTION #99	DIEBOLD	500 HOURS
	FORM FACTOR #446	ANKENBRANDT	500 HOURS
NA -NEUTRINO	15-FOOT NEUTRINO/D2 #151A	SNOW	100K PIX
	15-FOOT NEUTRINO/O2 #227	ENGELMANN	100K PIX
	15-FOOT ANTI-NEUTRINO/O2 #390	GARFINKEL	300K PIX
	NEUTRINO #356	BARISH	1,000 HOURS
	15-FOOT NEUTRINO/H2 & NE #380	BALTAY	200K PIX
	15-FOOT ANTI-NEUTRINO/H2&NE#388	STEVENSON	200K PIX
-MUON/HADRON	DI-MUON #444	SMITH	400 HOURS
	PARTICLE SEARCH #369	KIRK	600 HOURS
-15-FT	15-FOOT P - P & NE @ 400 #291	MANN	25K PIX
-30-IN	30-INCH P - P @ 500 #207	ENGELMANN	50K PIX
	30-INCH PBAR - P @ 200 #392	NEALE	100K PIX
	30-INCH PI- - P @ 150 #393	PLESS	300K PIX
	30-INCH PI- - HI Z @ 300 #304	WALKER	200K PIX
-OTHER	DETECTOR DEVELOPMENT #206	PETERSON	200 HOURS
PA -PE	PHOTOPRODUCTION #401	GORMLEY	300 HOURS
	PHI PHOTOPRODUCTION #263	CHEN	600 HOURS
-PW	PION INCLUSIVE #258	PIRQUE	800 HOURS
	C-TEST #302	CESTER-REGGE	400 HOURS
	MULTIGAMMA #192	GUIRAGOSSIAN	400 HOURS

G. PENDING PROPOSALS (42):

			EXTENT OF REQUEST
PA -M1	DETECTOR DEVELOPMENT #427	YUAN	50 HOURS
	PSI PRODUCTION #452	LUBATTI	400 HOURS
-M2	LAMBDA BETA DECAY #361	MARCH	300 HOURS
	PARTICLE SEARCH #468	STEINBERG	1,200 HOURS
	PARTICLE SEARCH #477	WEINSTEIN	500 HOURS
-M3	K* PRODUCTION #449	ABOLINS	600 HOURS
	NEUTRON-DEUTERON ELASTIC #479	ROBERTS	300 HOURS
-M4	INCLUSIVE K-SHORT #383	KOBRAK	500 HOURS
-M6	INELASTIC SCATTERING #165	RITSON	475 HOURS
	HADRON DISSOCIATION #312	EDELSTEIN	1,000 HOURS
	INCLUSIVE SCATTERING #451	BARTON	600 HOURS
	PARTICLE SEARCH #469	CUTTS	150 HOURS
NA -NEUTRINO	NEUTRINO #355	BARISH	1,400 HOURS
	15-FOOT NEUTRINO/H2 & NE #389	TENNER	100K PIX
	15-FOOT NEUTRINO/H2 & NE #455	PETERSON	200K PIX
	15-FOOT NEUTRINO/H2 & NE #459	FRY	1,000K PIX
	15-FOOT NEUTRINO/H2 & NE #460	HUSON	200K PIX
	15-FOOT ANTI-NEUTRINO/H2&NE#476	KERNAN	200K PIX
-MUON/HADRON	PION DISSOCIATION #318	ASCOLI	400 HOURS
	MUON #348	WILSON	400 HOURS
	EMULSION/MUONS @ 50-100 #373	JAIN	EMULSION EXPOSURE
	EMULSION/MUONS @ 200 #424	WADA	EMULSION EXPOSURE
	DI-MUON #443	PILCHER	400 HOURS
	MUON #448	WILSON	300 HOURS
	TEST PARTICLE SEARCH #457	BRANDENBURG	100 HOURS
	TEST MUON IRRADIATION #467	FREEDMAN	TARGET EXPOSURE
-15-FT	15-FOOT P - P @ > OR = 300 #209	TAKIBAEV	75K PIX
-30-IN	30-INCH K+ - P @ 150 #375	RUBIN	400K PIX
	30-INCH PBAR - P @ 100 #394	WHITMORE	2,000K PIX
PA -PE	PHOTOPRODUCTION #450	CALDWELL	600 HOURS
	PHOTOPRODUCTION #458	LEE	700 HOURS
	MULTI-GAMMA #475	FICENIC	300 HOURS
-PC	CHARGED HYPERON #353	FOKLUND	600 HOURS
	PARTICLE SEARCH #465	BECKER	500 HOURS
-PW	HADRON JETS #246	SELOVE	600 HOURS
	ELASTIC SCATTERING #301	GETTNER	1,000 HOURS
	DI-MUON #326	PIRQUE	400 HOURS
	ELASTIC SCATTERING #347	WALKER	1,200 HOURS
	HADRON-NUCLEON SCATTERING #420	GUIRAGOSSIAN	1,100 HOURS
	ELECTROPRODUCTION #454	GUIRAGOSSIAN	1,500 HOURS
	PARTICLE PRODUCTION #470	TRISCHUK	200 HOURS
ITA-E-0	PARTICLE SEARCH #478	WALKER	1,000 HOURS

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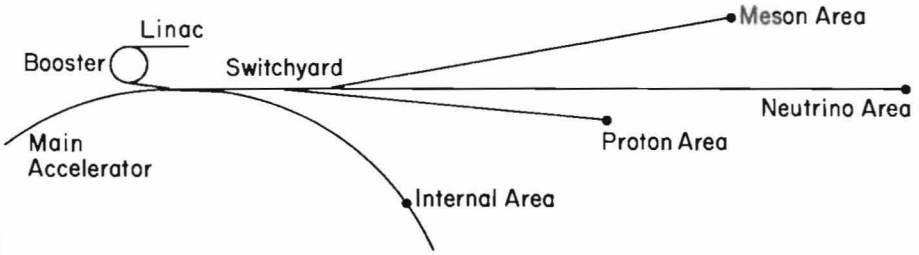

Experiments in the Research Areas

APRIL - JULY 1976

Internal Area	Proton Area	Neutrino Area	Meson Area
P-N SCATTERING #198A	PROTON EAST: PARTICLE SEARCH #325 PHOTON CROSS SECTION #25A	NEUTRINO BEAM: 15-FT. B.C. PARTICLE SEARCH #247	M1 BEAM: POLARIZED SCATTERING #61 HADRON JETS #236A
P-P POLARIZATION #313	PROTON CENTER: DI-LEPTON #288 MUON SEARCH #435	MUON/HADRON BEAM: TESTS FOR - MUON #319 MUON #398	M2 BEAM: PARTICLE SEARCH #357 INCLUSIVE NEUTRAL MESON #350
P-P INELASTIC #321	PROTON WEST: PHOTON SEARCH #95A		M3 BEAM: PARTICLE SEARCH #366
			M4 BEAM: K^0 REGENERATION #425
			M6 BEAM: INCLUSIVE SCATTERING #118A HADRON JETS #260

RESEARCH ACTIVITIES DURING MARCH 1976

Reported by Halsey Allen

Accelerator operation and work on the high-energy physics research program during March was relatively smooth and straightforward. Restoration of the repaired 13.8 kV secondary busduct at the Master Substation and the return to 400-GeV operation in the middle of the first week was probably the most notable occurrence. Prior to this, slow-spilled beam was delivered to the Meson Area at 300 GeV and to the Proton Area at both 200 and 300 GeV for several days, in a continuation of the end of February running. For the subsequent two and one-half weeks, 400-GeV slow spill was delivered to the Proton, Meson, and Neutrino Areas. High intensity fast spill was also made available in the Neutrino Area during the last full week of this period for a special emulsion exposure. The accelerator and experimental areas were shut down on March 22 for a facility maintenance and development period. In the three weeks of facility operation for research, accelerator reliability was nearly 80%, with almost 322 hours of beam time made available in the 403 hours scheduled.

Most of the work carried out during the last 10 days of the month was in the nature of corrective and preventive maintenance. Final preparations were made on the capacitor bank for routine operation in the accelerator main-ring power supply system. Work also began on replacement of the C-2 collimator assembly on the Meson Area target train, along with repairs of related components. These two items constituted the major shutdown projects undertaken.

For the third straight month, the Proton Area research program received the highest priority emphasis. Di-Lepton #288 began a data run looking particularly at high mass region di-muon events in Proton Central; this will augment two-electron events that were studied previously. Particle Search #300/#325 collected high p_T data in the Proton-East beamline using their liquid hydrogen target and later took data on di-muon production using their multi-hole spectrometer and solid targets. Elastic Scattering #177A, running in Proton-West, concluded an eight-week period of data-taking on high momentum transfer events.

Problems continued to plague attempts to operate the 15-ft bubble chamber with the heavy neon/hydrogen mixture. A cracked window seal, a broken vacuum tight weld on a cooling loop, and later a dislodged Scotchlite panel near the bottom of the chamber, along with assorted minor troubles, prevented any chamber operation for neutrino physics research. As a consequence, the Neutrino Area research program was considerably reduced in scope. Operation of the area was restored after 400-GeV beam had been re-established. Di-Muon #331 resumed data taking in the N1 (muon/hadron) beam, first using incident negative pions at 220 GeV/c and later with the beam tuned for positive pions of the same momentum. By the start of the shutdown some two and one-half weeks later the data collection phase of the experiment was completed. 30-In. Hybrid #299 finished up some beam and lead glass counter tests in the N5 line at Lab E during the first week after Neutrino Area startup. In the final week prior to the shutdown, Particle Search #247 began the exposure of their hybrid emulsion in the neutrino beam

behind the 15-ft chamber, using high-intensity fast beam spill on the horn target train.

The Meson Area program included research work by nine different user groups in the five major secondary beamlines plus exposures on the target hall (Meshall). In addition, several groups made use of the M5 test beam for equipment checkout. The three experiments that completed their data collection efforts include Pion Dissociation #86A, looking at events originating in the helium-filled streamer chamber in M1E; Neutral Hyperon #8, collecting Λ-p Scattering data in M2; and Elastic Scattering #69A, studying small-angle elastic scattering in M6W. K^0 Regeneration #425 continued routine high momentum data taking in M4 while Particle Search #366 (M3) and Inclusive Scattering #118A (M6E) moved from tuneup activities into a normal data-taking phase during March. Polarized Scattering #61 and Hadron Jets #236A alternated in use of the M1E beamline for tuneup and equipment checkout activities upon completion of the Pion Dissociation #86A experiment in the second week of the month; some parasitic use of this beam was made by both groups earlier. Five targets were also bombarded in the Meshall primary proton beam for Nuclear Chemistry #81A, using the remotely operated electric train facility. Primary beam intensity on the Meson target continued to be restricted as reported previously.

The experimental research program in the Internal Target Area has remained essentially unchanged from the past several months. Proton-Proton Inelastic #321 continued to collect data at various energies with their 3-mil warm hydrogen gas jet, interspersing the runs with engineering studies of

their apparatus. Work was continued by Proton-Nucleon Scattering #198A and Polarized Scattering #313 on assembly and testing of elements for the spectrometer arm set up in the recoil room at C0, particularly on the superconducting dipole and quadrupole magnets. Final preparations were made and tests were performed on their new warm gas jet early in the month. Installation of the jet target assembly in the main-ring tunnel began immediately after the start of the facility maintenance and development period.

FACILITY UTILIZATION SUMMARY--MARCH 1976

I. Summary of Accelerator Operations

		Hours	
A. Accelerator use for physics research			
Accelerator physics research		31.4	
High energy physics research		321.7	
Research during other use		(27.6)	
	Subtotal		353.1
B. Other activities			
Accelerator setup and tuning to experimental areas		12.7	
Scheduled interruption		289.3	
Unscheduled interruption		88.9	
	Subtotal		390.9
C. Unmanned time			
	Total		744.0

II. Summaries of High Energy Physics Research Use

	# of Expts.	Hours	Results
A. Counter experiments	16	2795.4	
B. Bubble chamber experiments	-	-	
C. Emulsion experiments	-	-	
D. Special target experiments	1	-	5 targets
E. Test experiments	1	118.0	Pb glass counter
F. Engineering studies and tests	1	8.3	
G. Other beam use	-	30.6	
			4 expts. completed

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

A. Beam accelerated in Main Ring		@ 400 GeV	1.160		
		@ 300 GeV	0.159		
					1.319
B. Beam delivered to experimental areas					
Meson Area		@ 400 GeV	0.115		
		@ 300 GeV	0.023		
				0.138	
Neutrino Area	Slow Spill	@ 400 GeV	0.466		
	Fast Spill	@ 400 GeV	0.258		
				0.724	
Proton Area		@ 200 GeV	0.048		
		@ 300 GeV	0.040		
		@ 400 GeV	0.164	0.252	
	Total				1.114

IV. Beam Utilization By Experiment

	Hours	
A. Meson Area		
Neutral Hyperon #8	277.2	Λ-p scattering; complete
Polarized Scattering #61	47.3	Tests
Elastic Scattering #69A	49.3	Nuclear targets; complete
Nuclear Chemistry #81A		5 targets
π Dissociation #86A	252.0	~50K pictures; complete
Inclusive Scattering #118A	233.0	Data
Hadron Jets #236A	17.5	Tests
Particle Search #366	262.6	Data
K^0 Regeneration #425	255.4	High momentum data
B. Neutrino Area		
Particle Search #247	106.8	Data; $\int p \simeq 2\times10^{17}$
30" Hybrid #299 Tests	118.0	Lead glass tests
Di-Muon #331	236.3	Data
C. Proton Area		
p-p Elastic #177A	233.5	Data
Di-Lepton #288	258.3	Data
Particle Search #300/#325	303.6	Data
D. Internal Target Area		
p-N Scattering #198A	79.8	Tests
Polarized Scattering #313	79.8	Tests
p-p Inelastic #321	103.0	Data and tests
Total	2913.4	

MANUSCRIPTS AND NOTES PREPARED DURING MARCH AND APRIL 1976

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

B. C. Barish Experiments #'s 21A, 262, and 320	A Review of Neutrino Physics at Fermilab from the Perspective of the Caltech-Fermilab Experiment (Lectures presented at the Sixth Hawaii Topical Conference in Particle Physics, August, 1975)
T. Nash et al. Experiment #25	Measurement of J/ψ (3100) Photoproduction in Deuterium at 55 GeV (FERMILAB-Pub-76/25-EXP; submitted to Phys. Rev. Lett.)
J. von Krogh et al. Experiment #28A	Observation of $\mu^- e^+ K_S^0$ Events Produced by a Neutrino Beam
L. B. Leipuner et al. Experiment #48	Polarization of Prompt Muons
J. Hudis and S. Katcoff Experiment #81	Interaction of 0.6-300 GeV Protons with U, Bi, Au, and Ag; Mica Track Detector Study (Submitted to Phys. Rev. C)
D. S. Ayres et al. (Fermilab Single Arm Spectrometer Group) Experiment #96	A Comparison of the Shapes of $\pi^+ p$ and pp Diffraction Peaks from 50 to 175 GeV/c (Submitted to Phys. Lett.)
H. L. Anderson et al. Experiment #98	Properties of Inclusive Hadron Spectra in Muon Nucleon Scattering at 150 GeV/c (Submitted to Phys. Rev. Lett.)
J. Erwin et al. Experiment #121A	Extraction of Average Multiplicities in $K^+ p$ and $K^+ \pi^+$ Scattering from Inclusive Λ
C. Bromberg et al. Experiment #'s 138 and 252	Inclusive and Semi-Inclusive Pion Production in pp Collisions at 102 GeV/c and 400 GeV/c (Submitted to Nucl. Phys. B)

Y. Akimov et al. Experiment #186	Analysis of Diffractive pd → Xd and pp → Xp Interactions and Test of the Finite Mass Sum Rule (FERMILAB-Pub-76/36-EXP)
J. Hanlon et al. Experiment #194	The Inclusive Reactions p + n → p + X and π^+ + n → p + X at 100 GeV/c (FERMILAB-Pub-76/28-EXP; submitted to Phys. Rev. Lett.)
T. S. Nigmanov et al. Experiment #'s 216 and 456	Drift Chamber System for K-e Scattering Experiment at Fermilab Accelerator (FERMILAB-76/26-EXP)
H. D. Snyder et al. Experiment #288	Production of ψ (3100) and ψ' (3700) in p-Be Collisions at 400 GeV (FERMILAB-Pub-76/32-EXP; submitted to Phys. Rev. Lett.)
R. Johnson et al. Experiment #335	Direct Production of Muons in the Forward Direction by 300-GeV Protons on Uranium (Presented at the 1976 Vanderbilt Conference, March 1-3, 1976)
G. J. Blanar et al. Experiment #365	Dimuon Production by Pions and Protons in Iron and a Search for the Production in Hydrogen of New Particles which Decay into Muons
H. Kasha et al. Experiment #436	Evidence of Pair Origin of Prompt Muons

Theoretical Physics

R. B. Pearson	A Practical Lower Bound for Scalar Fields on a Lattice (FERMILAB-Pub-75/93-THY; submitted to Phys. Rev. D)
C. Quigg and J. L. Rosner	Hadron Physics with Hyperon Beams (FERMILAB-Pub-76/13-THY; submitted to Phys. Rev.)
A. A. Golestaneh	The η Decay into Three Pions and the On-Mass-Shell Current Algebra (FERMILAB-Pub-76/18-THY; submitted to Phys. Rev. D)
B. W. Lee	My Perspectives on Particle Physics: Summary of Orbis Scientiae, 1976 (FERMILAB-Conf-76/20-THY/EXP; presented at the Orbis Scientiae 1976 Conference, Coral Gables, Florida, January 19-22, 1976)

M. B. Einhorn	Form Factors and Deep Inelastic Scattering in Two-Dimensional Quantum Chromodynamics (FERMILAB-Pub-76/22-THY; submitted to Phys. Rev.)

General

B. Cox and C. T. Murphy	The Design and Performance of a Halo-Free Intense Extracted Proton Beam at Fermilab (FERMILAB-Pub-76/31-EXP; submitted to Nucl. Instr. and Methods)

Physics Notes

L. Voyvodic FN-289	Nuclear Emulsion as Neutrino Track Sensitive Target in the 15-Foot Bubble Chamber

DATES TO REMEMBER

May 7, 1976	Deadline for receipt of new proposals and other written materials to be considered at the Extended Summer Meeting of the Program Advisory Committee.
May 7-8, 1976	Workshop on External Particle Identifiers.
May 14-15, 1976	Annual Meeting of the Fermilab Users Organization.
May 20-21, 1976	Proposal Presentation Meeting.
May 21, 1976	Fermilab Bicentennial Lecture Series: "The Carbon Isotopes and the Rise of American Biochemistry." Dr. Martin Kamen, University of Southern California. No charge; tickets are required and may be obtained in the Guest Office.
June 19-25, 1976	Extended Summer Meeting of the Fermilab Program Advisory Committee (Aspen, Colorado).
June 28-July 9, 1976	Summer Study on the Use of the Energy Saver/ Doubler.