THE NEUTRINO AREA IN 1975 AND 1976

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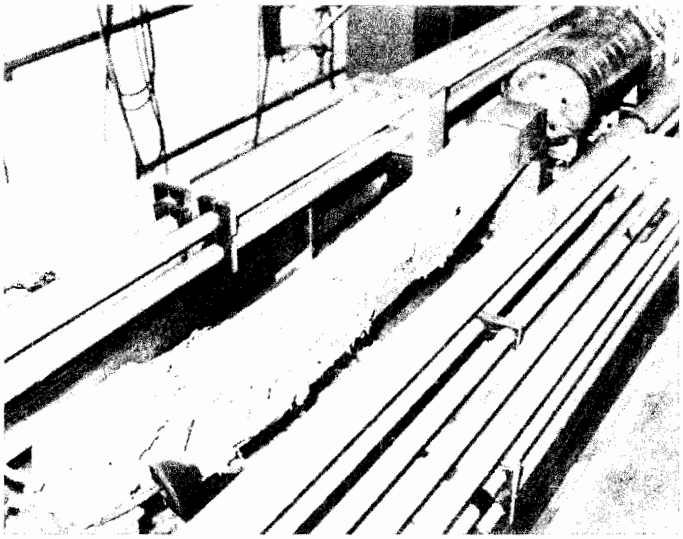
In the last few years, the Neutrino Area, like every other part of Fermilab, has been heavily used for physics experiments and, at the same time, modified, improved, and extended in capacity. The purpose of this article is to chronicle the modifications and improvements in 1975 and most of 1976, during my tenure as head of the Neutrino Department. The work reported here is that of many colleagues in the Department, who have made it possible for others to carry out significant physics experiments in both weak and strong interactions.

The last NALREP report on the Neutrino Area was by Russ Huson in April 1975. Since that report, the work in the area has affected the Target Hall, the beam lines and experimental areas, and the bubble chambers. We shall discuss these areas below.

Target Trains

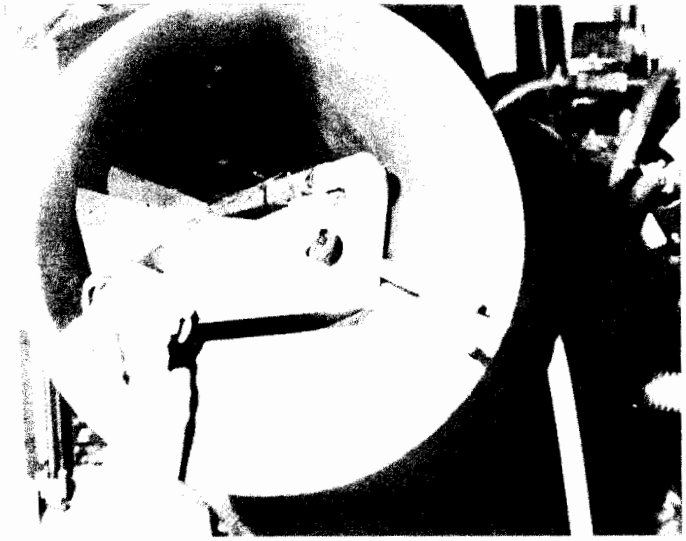
The target trains have had quite different histories in this time. On the one hand, the tried and true quadrupole-triplet train has survived almost intact. It has been upgraded by the addition of more magnets to higher momentum and greater reliability. The figure on page 2 shows a collimator in the triplet train that nobly did its job of protecting the downstream magnet. On the other hand, the old dichromatic train was retired honorably when Experiment #21 left the Wonder Building. A new dichromatic train is now being built; its design was a collaborative effort between the Cal Tech group, the Neutrino Department, and Don Edwards who participates in the experiment



A used collimator on the quadrupole-triplet train. The collimator was made of 2-in. slabs of steel. The shreds are the remains of its cover.

as a Fermilab collaborator. It will reach higher momentum, give higher intensity and more precise neutrino beam properties and have greater reliability.

The conventional two-horn system has been in service for much of this period, with some reliability improvements. Two horn failures were attributed to the higher intensity proton beam. There is also a continuing attempt to operate with a central plug to achieve a more pure antineutrino beam. This plug is shown in the figure at the top of page 3. Construction is proceeding on a separate narrow-band horn train, designed in collaboration with Charles Baltay of Columbia. We are also purchasing new pulse transformers to give a one-millisecond spill time with any of the focusing horn systems. A switching magnet has been added to the horn train to target the bypass proton



Aluminum finger plug in the two-horn system, used to enhance the anti-neutrino flux. The plug has been moved from its mount by beam-induced stresses and heating.

beam onto a new hadron target station a short distance from the end of the neutrino decay pipe.

The entire Target Hall milieu has been enlivened by the acquisition of a surplus mine locomotive, which has been made narrower and modified to operate in Neutrino Hall, but has not yet been christened. The Target Service Building has now been completed. It provides storage space for a number of long trains and for component testing before trains are installed.

Muon Laboratory

The muon beam has been upgraded to 300 GeV/c. Conventional magnets have been used in this improvement. There was work on a superconducting beam line to the Muon Lab, developing magnets and refrigeration. This work

has now moved over to the Proton Area. The conventional muon beam line operates almost exclusively in a ramped mode, both to save energy and to reduce the background for neutrino experiments.

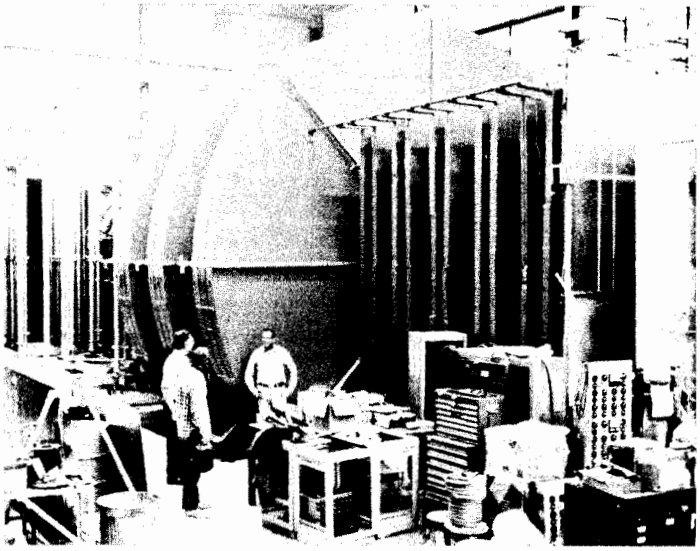
The first generation of muon experiments (for example, E-98) was completed in the Muon Laboratory and the second generation (for example, E-203) is moving in. In addition, the first hadron experiment in the Muon Lab, E-331, has shown that there is a rich future for hadron experiments here, using beams from the new target station at the end of the decay pipe. In addition, Hand and Read carried out some emulsion exposures using tagged muons.

New Construction

Experiment #356, the successor to E-21, has moved to the newly completed Lab E. The Wonder Building has become unsuitable for neutrino experiments because of the enhanced muon background associated with 400-GeV operation. It is planned to install toroidal muon spoilers at the end of the neutrino decay pipe, which should make the Wonder Building suitable for medium-sized neutrino experiments like E-253 (Virginia Polytechnic Institute, University of Maryland, and Oxford University) which is now being installed.

Lab E itself is just upstream of the bubble chamber. It makes use of the N5 hadron beam for high-energy hadron experiments, such as E-379, the Stanford, Cal Tech, Northwestern collaboration. For neutrino experiments, new large (12-ft diameter) magnetic toroids, a Laboratory facility, are now installed and operating. Experiments #356 and #482, the Cal Tech, Northwestern, Fermilab collaboration, are now taking data.

An addition has been completed for Lab C, housing 24-ft toroids for E-310, the Harvard, Fermilab, Pennsylvania, Wisconsin collaboration that is a descendant of E-1A. These toroids are shown in the photograph below. The photograph on the next page shows the detectors of E-310; they are also now taking data.

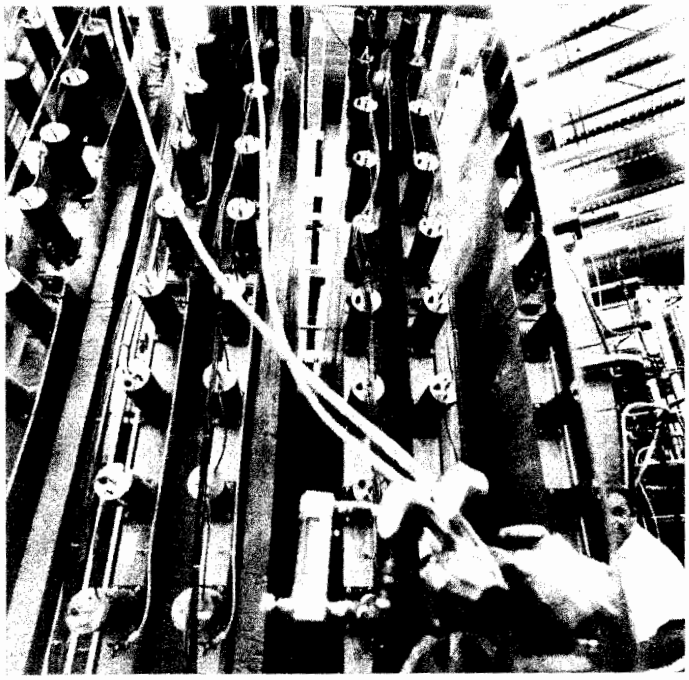


Toroid magnets of E-310.

The unique new N1 cooling system is operating very well. Water is pumped from Swan Lake, used for cooling in heat exchangers at N1, and returned to Swan Lake via the Babbling Brook that wanders along just west of Road A.

Bubble Chambers

The 15-ft chamber has done everything called for in the design except operate with deuterium. This deuterium operation is ready to go whenever deuterium is available.



Detectors of E-310. The iron-plate calorimeters have spark chambers and counters interspersed.

The chamber had operated before 1975 with hydrogen. It has now operated with both light-neon (21% Ne) and heavy-neon (63% Ne) mixtures. For this operation, we have changed from the fiberglass to a metal piston. For hydrogen, eddy currents in the metal had given excessive heat input to the chamber. With neon, the piston stroke is shorter and there is therefore less heat input. There is more confidence in the integrity of the metal system.

Fermilab had a stock of neon. We accumulated more and borrowed some from Argonne and Brookhaven Laboratories. There is now 24,000

liters for the 63%-Ne fill. This is the entire U. S. stock of bubble-chamber neon and is meant to be shared among Argonne, Brookhaven, and Fermilab. The bubble-chamber group has modified a surplus oxygen tanker trailer for use as a neon tanker and the neon has been trucked back and forth between here and the other laboratories. We are also still accumulating neon.

The design of the 15-ft chamber included two sets of cameras, with three cameras in each set. Both sets are now operating, with one set looking into the main body for neutrinos and the other set looking upstream into the nosepiece for hadron identification. We have operated with two expansions per accelerator cycle, one expansion for neutrinos, and one for hadrons. Thus two groups are doing different kinds of physics simultaneously in the same chamber.

The EMI (external muon identifier) has operated without substantial changes. An upgrading is now being carried out with the Berkeley group, to provide increased angular coverage, more planes, and more data capacity.

A tagging system upstream of the chamber has also been completed and operated by Marvin Johnson.

The 30-in. chamber continues to operate steadily. It now has a capability for 8 expansions per flattop. The original hybrid experiment with downstream wide-gap chambers has now been completed. The 30-in. chamber has also been used for the world's only pictures with an enriched high-momentum antiproton beam.

Conclusion

It can be seen from the litany above that the Neutrino Area has played host to many Fermilab experiments, even while improvement and upgrading of its capabilities have been going on.

Studies have been made for even more upgrading. The 1976 Aspen Summer Study was concerned with bringing the Neutrino Area to 1000 GeV. It is a pleasure to acknowledge the dedicated work of many Neutrino Area people who have made a major contribution to Fermilab.

NOTES AND ANNOUNCEMENTS

APPOINTMENTS. . .

As is customary at year's end, there have been a number of rotations of appointments.

Timothy Toohig has become Head of the Meson Laboratory, succeeding Charles Brown, who will become Associate Head.

Peter Koehler has become Head of the Physics Department, succeeding Frank Nezrick. Ed Bleser has been appointed Assistant Head.

Richard Carrigan has become Assistant Head of the Research Division.

Halsey Allen has left Fermilab to join the Tokamak Fusion Test Reactor project at Princeton. James MacLachlan has been named Acting Head of the Operation Section. Halsey Allen's other responsibilities in Plant Support have been put into Technical Services.

MORE ON THE MULTIPARTICLE SPECTROMETER WORKSHOP. . .

Plans are progressing for the Multiparticle Spectrometer Workshop to be held at Fermilab on March 4-5. A tentative agenda has been developed which includes talks on each of the principal features of the multiparticle spectrometer, a critical review of the spectrometer, a discussion of experimental results obtained to date, and a review of related CERN facilities. There will also be provision for contributed talks on ideas for future experiments that would utilize the multiparticle spectrometer.

A mailing is planned for mid-February which will contain an updated version of the agenda as well as descriptive material on the multiparticle

spectrometer. This mailing will be sent to those who indicate by mail or phone that they plan to attend the workshop or who are otherwise interested in receiving the material. Responses should be directed to E. Malamud at Fermilab.

1977 HOLIDAYS. . .

The following Laboratory-wide holidays will be observed this year:

New Year's Day 1977	Friday, December 31, 1976
Memorial Day	Monday, May 30
Independence Day	Monday, July 4
Labor Day	Monday, September 5
Thanksgiving	Thursday, November 24, and Friday, November 25
Christmas	Friday, December 23, and Monday, December 26
New Year's Day 1978	Monday, January 2, 1978

CONFERENCE PROCEEDINGS AVAILABLE. . .

The Proceedings of the 1976 DUMAND Summer Workshop held in Honolulu in September are available from the Physics Department. The Proceedings are about 635 pages and deal with the use of the ocean as a neutrino and muon detector for the purposes of studying extragalactic gravitational stellar collapse, ultra-high energy (above 10 TeV) neutrino and muon interactions, and the abundance of naturally occurring high-energy neutrinos, including both those locally produced and those incident from outside the earth's atmosphere. Prices are postpaid, and payment must be included with order: U. S., $15.50; foreign surface mail, $17.50; Europe by air, $21.00; USSR and Far East by air, $24.00.