national accelerator laboratory

FERMILAB-NAL-073

0090.01

MONTHLY REPORT OF ACTIVITIES

July 31, 1972

CONSTRUCTION OF MAIN-ENTRANCE ROAD

Operated by Universities Research Association Inc. Under Contract with the United States Atomic Energy Commission

THE COVER: Photograph showing July status of main-entrance road construction. View is looking east with Kirk Road in foreground and main ring and highrise in background.

NAL-73
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Abstract: This report summarizes the activities of the National Accelerator Laboratory in July, 1972.

Protons were accelerated to 300 GeV at a little after 9 p.m. on July 16. The local power company, Commonwealth Edison, monitored the operation and seemed satisfied that we were producing no adverse effect on their system at the six-second repetition rate at which the machine was operated.

No significant amount of running for physics at 300 GeV was accomplished during the month, although every indication is that there will be no great difficulty in operating at that level. In particular, the Commonwealth Edison results are most encouraging because the perturbation of their lines can be expected to be the limitation on our ability to operate at energies above 200 GeV.

The annual week-long meeting of the Program Advisory Committee was held at Aspen, Colorado, during the first week of July. A revised list of approved experiments will be included in the August Monthly Report. In general, the PAC recommended cut-backs in the previously approved program rather than expansion of the program.

Accelerator

Some rather interesting experiments involving multiple pulsing have been carried out in the booster, for example:

Beam was accelerated at a 15-Hz rate (6 pulses on a 6-second total cycle) to the booster dump.

The phase-lock system between main ring and booster was tested by phase-locking the accelerated booster beam to a constant frequency and appears to function satisfactorily though a complete test working with accelerated main-ring beam has not been performed.

With "head-to-tail" synchronization, i.e., one pulse immediately following another, three booster pulses were injected into the main ring, captured, and accelerated. Since phase lock was not provided, the capture was statistical.

The main difficulty with accelerating the design number of 15 pulses per second in the booster is due to overheating in the blocking capacitors in the booster rf system. These have been redesigned, and a prototype has been successfully tested. New capacitors have been ordered and are scheduled for fall delivery. Meanwhile, the booster can be run on a one-pulse-per-second average. This means that at 100 GeV, three-second repetition rate, the booster could accelerate three pulses; at 300 GeV, six-second repetition rate, the booster could accelerate six pulses, etc. Only three-pulse injection into the main ring was achieved during July, although as noted above, the booster did accelerate pulses at the six-second pulse rate.

In the main ring, the most important problems which developed during operation at 300 GeV were associated with failures in the magnet excitation power supplies. The reasons for these failures are now understood and corrective action has been taken.

A floating-ground system has been installed in the main-ring magnet system and is operating well. It allows greater freedom in power-supply choice, and stray capacitance in the system is much less important. It is now

possible to make high-potential test of insulation to ground from the main control room.

Considerable progress during the month was made in extraction studies. The second 1/8-mrad pinger is operational and was used in the 300-GeV extraction. The "pingers" are fast pulsed magnets (~20 μsec rise time) that move the beam across the extraction septum. A single pinger was not powerful enough to get the beam out at 300 GeV. The new electrostatic septum is working reliably. A second remotely movable electrostatic septum will be installed during the August shutdown. In addition, the Lambertson extraction magnets will be straightened and made easier to move.

In the beam-line systems, the neutrino line is operating well. Extraction is stable with a given set of accelerator conditions. The proton beam has been bent to the left at the switchyard, thence toward the Meson Laboratory through some 40 magnets and was observed at the point where it is to be bent upward and brought above grade. The distance involved so far is about 2300 feet. Additional trim magnets are being installed to permit entry of the beam into the Meson Lab.

Design of the beam-splitting stations is under way, including a re-examination of the electrostatic-septum parameters. The steel work on the model Lambertson magnet is complete.

There was some slow extraction by scattering off the septum. The beam was observed for 150 msec of the 200 msec flat-top, but the time average beam corresponded to about 1 msec of spill. The reason is that there is large 360-Hz ripple in the extracted beam. New power supplies for the bump magnets are being built to reduce this ripple. The slow extraction efficiency was at best 15%.

A quadrupole and octupole for resonant extraction will be completed in the near future. Power supplies for these magnets are also being built. It is hoped to try some simple resonant extraction tests by the end of August.

Experiments

Proton-proton scattering from an internal thin foil target has been studied whenever operating conditions have permitted. The slope for p-p elastic scattering has been determined in the t-range from 0.01 to 0.07 $(GeV/c)^2$ at eight different energies in the region from 20 GeV to 200 GeV. Meanwhile, work has been progressing on the second phase of the experiment in which scattering will be observed from a pure hydrogen jet. That target was built in the USSR and put into operation at NAL by some of the Russian collaborators in Experiment #36. It is now being installed for operation in the main ring. Russian solid-state detectors and beam monitors were placed in the tunnel at the end of the month. The computer interface and on-line program is almost ready but final debugging is still in progress.

Two other "parasitic" experiments are mounted in the internal target straight section to observe interactions in the hydrogen gas jet target. A photon survey (#120) is intended primarily to study π^0 production. Photons have already been observed in the backward direction from the foil targets up to an energy of 200 GeV.

A second parasitic experiment (#67), using the internal target, involves the use of a missing-mass spectrometer for the observation of proton recoils from inelastic pp interactions. Although data have successfully been recorded, using the foil target, the carbon background from protons with a wide range of Fermi momenta makes interpretation of the data difficult. However when

pure hydrogen running starts, the apparatus is ready and results should be forthcoming rapidly.

In addition to the above three experiments in progress in the internal target laboratory, another set of experiments have been in their early stages in the neutrino target laboratory. For these, protons have been extracted and transported into the neutrino hall (neu-hall). The size of the extracted proton beam image at the target on the Neutrino Laboratory Prototype Target Load was measured in two ways during the 200-GeV running on July 11.

A copper foil was exposed at the target position and then used to expose a polaroid film by contact. The resultant image is shown in Fig. 1, reproduced at 1:1 magnification.

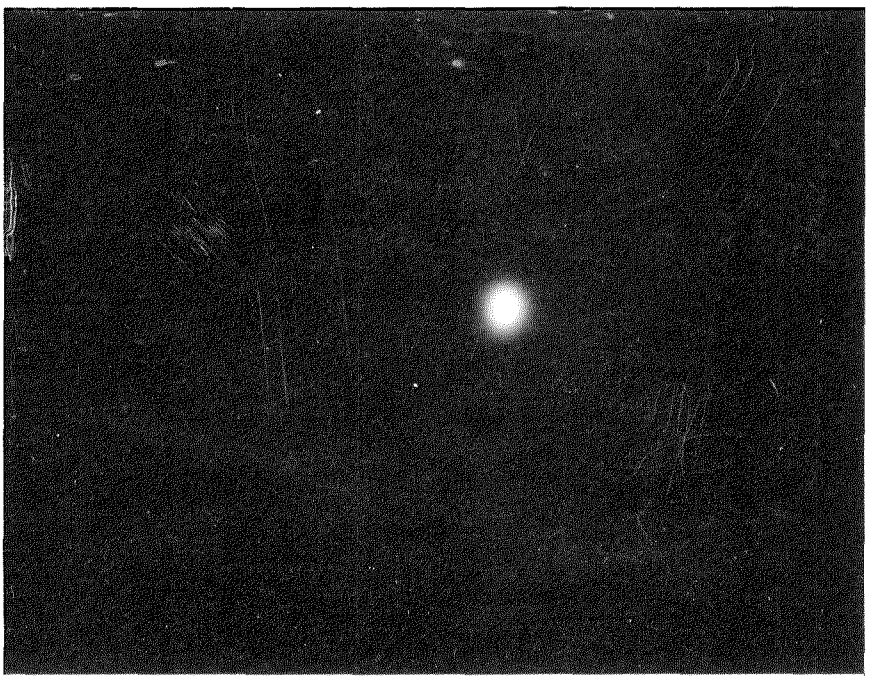

Fig. 1. Extracted proton beam focal spot at neutrino target - 200 GeV.

A glass plate was exposed at the same position and time. The resultant darkening of the plate was measured on a micro densitometer by the Radiation

Physics Group. The full width at half maximum was about 3.3 mm horizontally and about 4 mm vertically.

In one configuration, the beam has been allowed to pass through neu-hall, steered through the hadron beam line and transported to the 30-in. bubble chamber. During the month a 100-GeV proton-proton bombardment was started for experiment #38 (Rochester/Michigan) with about 7000 pictures taken. At the same time, experiment #2-B, using wide-gap spark chambers downstream from the bubble chamber was able to start operation. That group will later have the opportunity to use the bubble-chamber pictures together with their spark-chamber data to improve the resolution for measurement of high energy, small-angle tracks.

The upstream proportional wire chambers which will be used for a particle tagging system were prepared and installed as a first phase feasibility test for experiment #154 in which a large consortium has proposed to analyze strong-interaction events using the 30-in. chamber together with a system of downstream proportional wire chambers, instead of the wide-gap spark chambers installed for experiment #138.

Initial results from the analysis of the previous 200-GeV proton-proton bombardment (experiment #141) together with preliminary analysis of the 100-GeV data indicate excellent technical quality of the chamber photographs. Conventional measurements and the construction of individual 200-GeV tracks have so far shown momentum accuracy of about 20% and a directional accuracy better than 1 mrad.

In addition to the bubble-chamber exposure, some time was devoted to preliminary running for the experiment on inelastic muon scattering (#26) and

for the experiment on neutrino interactions (#21) to be carried out in a dichromatic neutrino beam. For experiment #26 the proton beam was targeted on the neutrino hall train and muons from secondary pion decays were transported successfully to the Muon Laboratory. The beam was tuned for 100-GeV muons, and muons were observed in the experimenters' detection equipment in the Muon Laboratory. A preliminary attempt was made to determine the

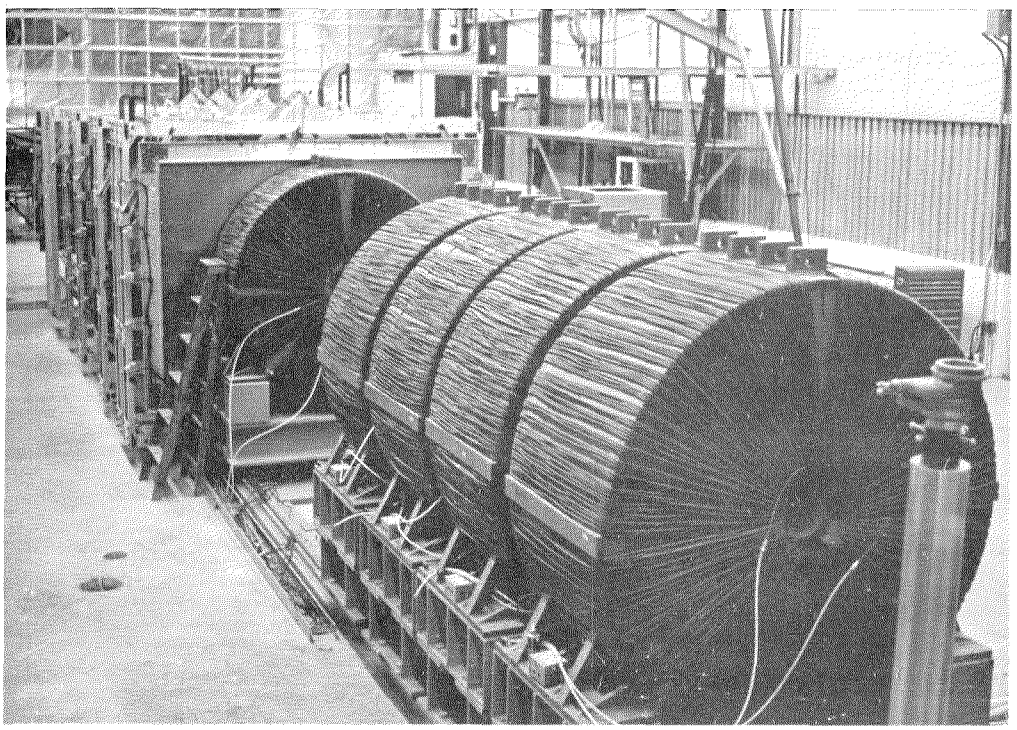

Fig. 2. Muon Experiment #26 apparatus looking downstream. Magnetized iron is in foreground; wire-chamber detectors are in background.

ratio of beam muons to protons incident on the target, but more time will be required to establish that number reliably.

The group performing the neutrino experiment (#21) successfully operated their Cerenkov counter during this month and began to get data on the K/π ratio. More running will be required to improve those data so that the neutrino spectrum can be better determined.

During the running of all of the above experiments, two parasitic experiments were testing operating conditions in the neutrino hall, upstream of the neutrino laboratory's train load and target. One of these experiments (#14) intended to observe large-angle proton recoils from inelastic proton scattering was able to improve their signal-to-background ratio so as to bring them within reach of satisfactory operating conditions. The second experiment, a survey of protons produced between 5° and 185° in the laboratory (first phase of #63) found the backgrounds too great to permit meaningful data taking. That experiment has now been reassigned to the internal target area.

Schedule

A ten-day shutdown is scheduled for early August. The main reason for shutdown is to transfer the booster control system from a Sigma 2 to a Sigma 3 system.

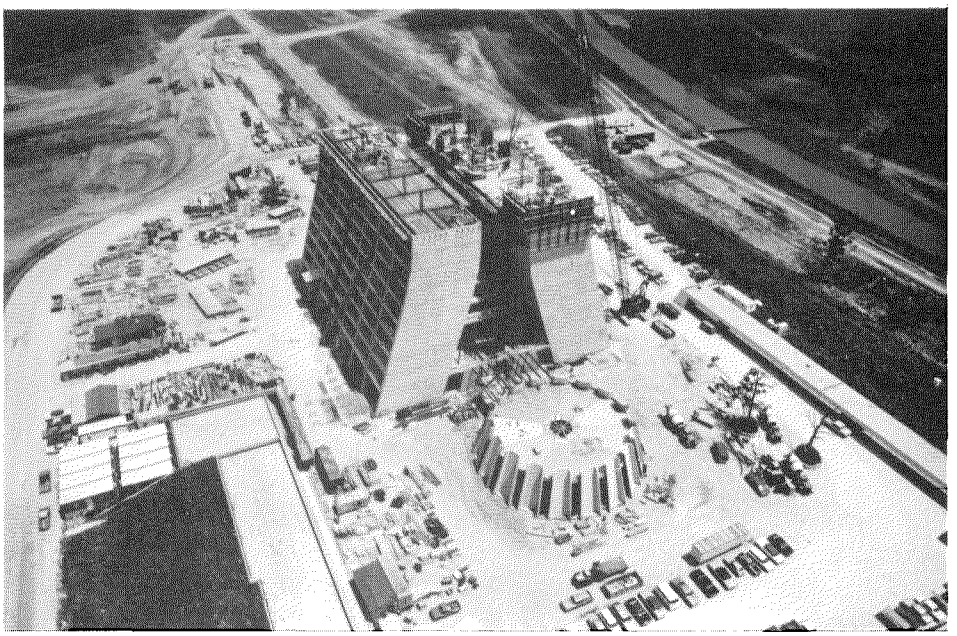

Fig. 3. Recent view of construction of Central Laboratory and Office Building and Auditorium.

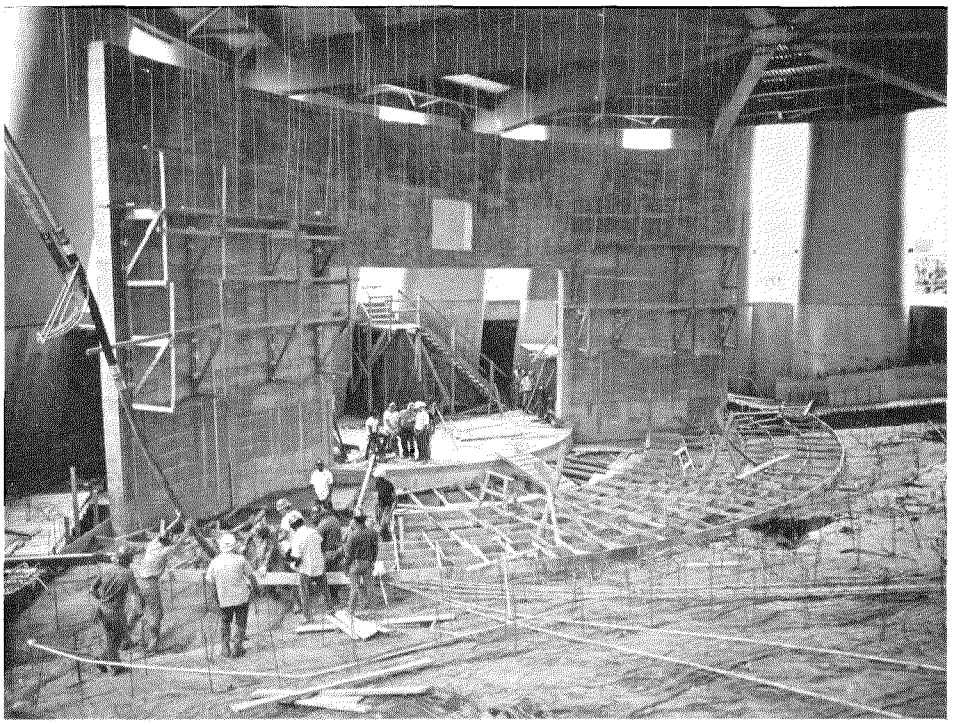

Fig. 4. Interior of Auditorium looking toward stage.

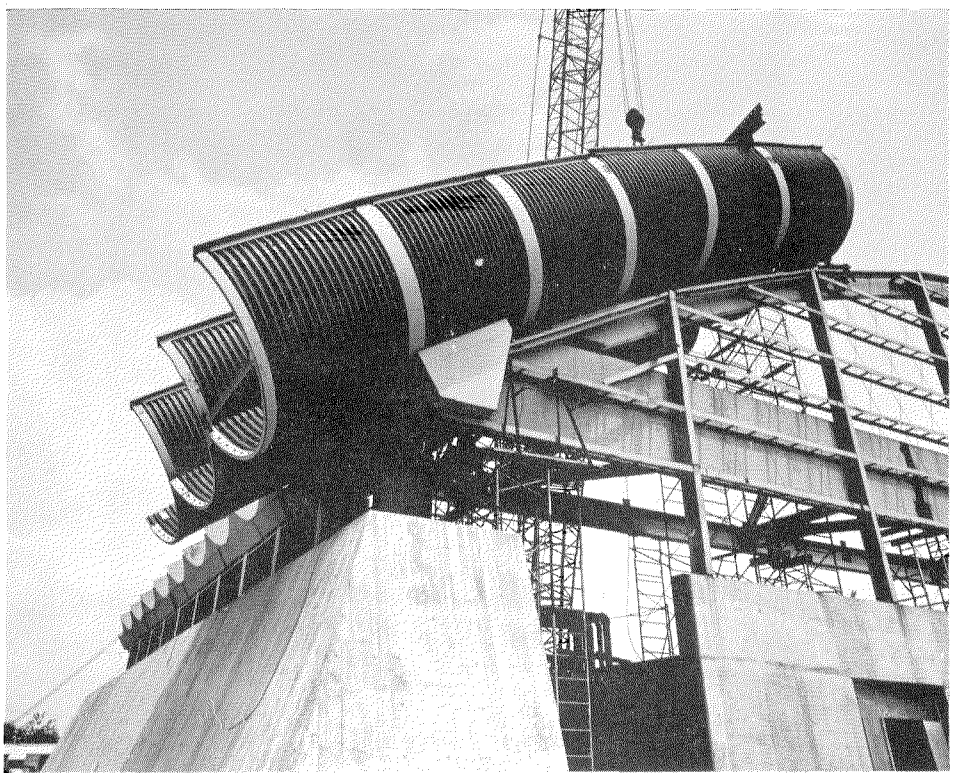

Fig. 5. The Meson Laboratory experimental hall roof being put in place.

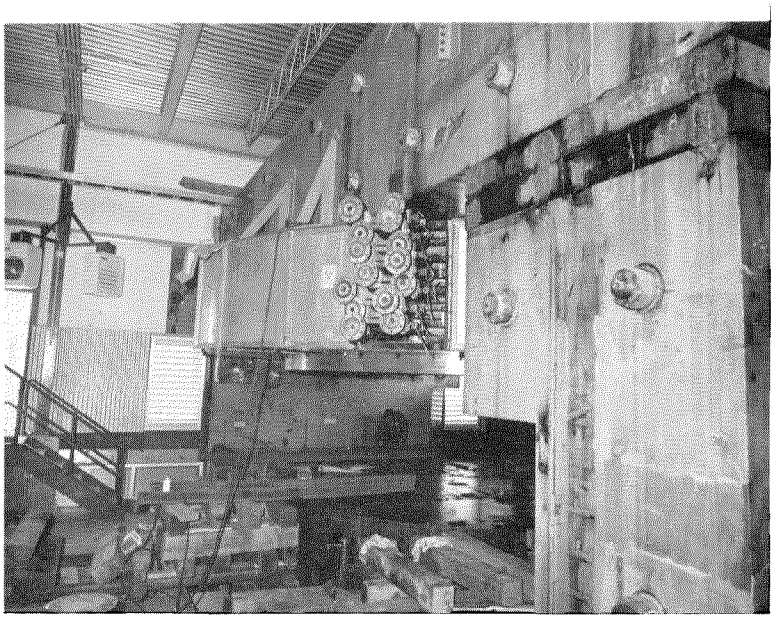

Fig. 6. University of Chicago cyclotron in final stages of reassembly at NAL.

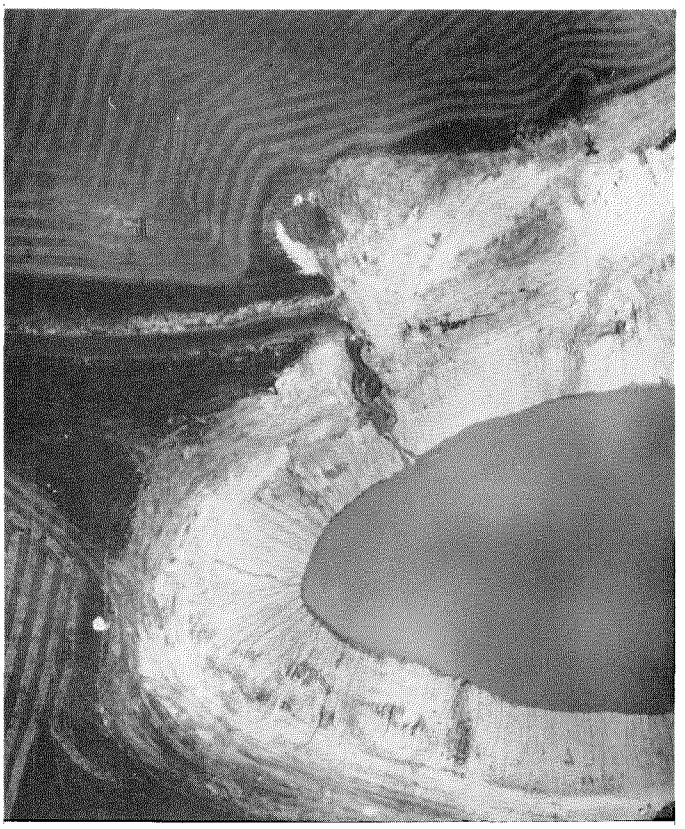

Fig. 7. View of "Casey's Pond," named for K. C. Brooks, who retired June 30 from the Atomic Energy Commission where he held the position of Area Manager, 200 BeV Accelerator Facility. (The background pattern is cut alfalfa hay.)