national accelerator laboratory

NAL-76
0090.01

MONTHLY REPORT OF ACTIVITIES

September 30, 1972

MESON LABORATORY EXPERIMENTAL AREA CONSTRUCTION

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

THE COVER: Photograph (looking upstream) of Meson Laboratory taken at end of September. Structure to the right is the beam enclosure for the Single Arm Spectrometer (Experiment 96).

NAL-76
0090.01

MONTHLY REPORT OF ACTIVITIES

September 30, 1972

Abstract: This report summarizes the activities of the National Accelerator Laboratory in September, 1972.

The extracted proton beam was transported for the first time to the Meson Laboratory and to the Proton Laboratory during September. Thus all three major experimental areas have now been commissioned.

Meson Laboratory

200-BeV protons were first delivered to the Meson Target Hall on September 6 for several hours. Over the 18th, 19th, and 20th, protons of the same energy were again transported to the Meson Target Hall and were used to expose over forty separate emulsion stacks for nine different experimental groups. The groups are:

Experiment	90	J. Gierula (Cracow, Poland)
	103	D. King (Univ. of Tennessee)
	105	P. Malhotra (Tata Inst., India)
	114	G. Thomas (Ball State Univ.)
	116	J. Massué, R. Kaiser (Strasbourg, France), and A. Van Ginneken (NAL)
	117	S. Ozaki, M. Teranaka (Osaka City Univ., Japan)
	156	K. Niu, T. Ogata (Univ. of Tokyo, Japan)
	171	J. Lord (Univ. of Washington)
	183	V. Nikitin (Dubna, USSR) for Tretyakova (Lebedev, USSR)

Neutrino Laboratory

Tuning of the Neutrino Lab train load continued during the month. The goals were to tune for maximum proton beam onto the target and then to tune the rest of the train for maximum hadron flux into the muon beam line. A secondary emission monitor and an ionization chamber were used to measure the flux of 200-GeV protons entering the train load. These monitors were checked by foil irradiation. About two hundred 100-GeV muons/pulse were observed at the Muon Lab with 3×10^{10} protons/pulse entering the train load.

During the month the proton beam halo was reduced sufficiently to permit the operation of experiment 14. They installed their array of solid state detectors and began to take data. They have now observed about 80,000 proton-proton interactions at 200 GeV.

The Monopole Search 76 target also received about 80 hours of beam during the month.

The Photon Search 95 experimenters installed some scintillation counters in the Neutrino Laboratory and began to study backgrounds.

The following reports, based on 30-in. Chamber pictures taken this summer, appeared as contributions to the XVI International High Energy Physics Conference held here in September:

1. A Measurement of the Charged Particle Multiplicity in pp Collisions at 102 GeV/c. (Experiment 138-I)

2. Neutral Strange Particle Production in 205 GeV pp Interactions. (Experiment 141)

3. The Reaction $pp \rightarrow \gamma$ + Anything at 205 GeV and Its Implications for π^0 Production. (Experiment 141)

4. Two and Four Prong pp Interactions at 205 GeV. (Experiment 141)

5. Angular Distributions and Rapidity Correlations for pp Interactions at 205 GeV. (Experiment 141)

6. Study of π^- Production in 200 GeV pp Interactions with Four and Six Charged Particles in the Final State. (Experiment 141)

7. Charged Particle Multiplicity Distribution from 200 GeV pp Interactions. (Experiment 141)

8. pp Interactions at 303 GeV/c: Multiplicity and Total Cross Section. (Experiment 37A)

Internal Target Laboratory

The hydrogen jet and associated helium recovery system were exercised extensively during the last month, although there were some difficulties with the helium system.

Data obtained with the rotating foil internal target for Proton-proton 36 were presented at the XVI International High Energy Physics Conference. The differential cross section for small angle p-p scattering was measured for 25-200 GeV incident energy in the momentum transfer range $0.080 < -t < 0.015$ $(\mathrm{GeV}/c)^2$. The slope of the diffraction peak increases with energy; the observed dependence is compatible with data existing at both higher and lower energies. The energy dependence of the p-p total cross sections in the range 48-196 GeV was constant within errors (±1.1 mb).

Recent effort in the proton-proton missing mass 67 has been directed towards studying the inclusive reaction

$$p + p\,(n) \rightarrow p + \text{anything}$$

using 7 μ carbon filaments on the rotating target. The relative energy

dependence of the invariant cross section was measured from p_{lab} = 15 - 200 GeV/c during the accelerator ramp.

Data taken in early September were analyzed and presented at the IHEP Conference. Usual assumptions for scaling predict a constant cross section along lines of constant s/M^2, where s is the c.m. - energy - squared and M^2 the missing mass squared. The data suggest a constant cross section for x (longitudinal momentum)/(maximum allowed) ≈ 0.9; and increasing energy-dependent contribution is observed as x decreases from 0.9 to 0.83.

Gamma spectra in Photon 120 have been measured at 175° using the ITL rotating foil target. These allowed a test of the scaling hypothesis for photon production in nucleon-nucleon collisions for p_{lab} = 28-303 GeV/c. Results presented at the IHEP Conference for $P_{\perp} \approx 0$ were in agreement with scaling and the Hagedorn-Ranft statistical model.

Recent measurements with both polyethylene foil and carbon filaments show no significant difference in photon spectra, implying that spectra from hydrogen and carbon are similar.

Proton Laboratory

An important activity in September was the observation of 200-GeV protons in the Proton Laboratory experimental area. Installation of equipment for Lepton 70 I was begun in September.

Accelerator

There were several areas of noteworthy progress in September. Perhaps the most outstanding was the successful initiation of resonant extraction. Beam is now being extracted over the entire length of the flat-top (~250 msec) and used for physics experiments.

Studies show that the originally planned 1/3-integral resonant extraction is rather sensitive to ripples in the main ring quadrupoles. Hence the 1/2-integral resonance is employed which, because of its finite stop-band width, is much less sensitive to tune ripples. On the ring magnet flat top, the RF is first turned off to debunch the beam, the main ring quadrupole current is then adjusted to give a horizontal tune close to 20.5 = 41/2. A resonance-exciting quadrupole installed at F-19 is then ramped to give a 41st harmonic component to excite the resonance. The octapole field normally existing in the main ring quadrupoles supplies the nonlinear component which puts different parts (amplitude) of the beam onto resonance at different times for control of the slow spill. The rapidly growing amplitude of the part of the beam on resonance takes the beam across the electrostatic septum into the extraction channel. The initial extraction efficiency obtained is about 80% despite the rather large ripple in the main ring quadrupoles, which modulates the extracted beam at 720 Hz and 120 Hz. This ripple will be either eliminated or compensated to give a smooth spill. More careful tuning and alignment should increase the extraction efficiency to well over 90%.

During September experiments were successfully done to inject multiple booster pulses into the main ring with phase locking between them. Two pulses were accelerated to full energy on the same ramp. Even under the best tuning conditions, approximately half the beam is still lost at injection.

There was a marked improvement in operation over previous months. There was accelerated beam for over 300 of the 720 hours available and several good runs for physics experiments were made. Stability of the beam improved greatly, probably as a result of improved filters installed in the six

bending-magnet power supplies that turn on first in the ramp. The first active filter was also put in operation and reduced the 720-Hz ripple considerably. At the end of the month 5 mA was being accelerated on almost every pulse, with some pulses as high as 8 mA, higher than ever before.

Ramping to 400 GeV was carried out to study line-voltage fluctuations in collaboration with the power company. During this time, both Commonwealth Edison and NAL made preliminary measurement of voltage fluctuations on the power lines. Further tests will be required to obtain definitive data indicating steps that must be taken before routine operation at 400 GeV will be permitted.

After experiencing difficulty in moving the beam across the full aperture with the correction magnets, a search was started to locate an obstacle in the vacuum chamber in sector B. The search was successful in locating a magnetic stainless-steel sliver approximately 2-in. long and 5 mils in diameter which changed position as the magnetic field varied and was very radioactive. Unfortunately, the beam was not immediately improved even after this was removed. (Fig. 1.)

15-Ft Bubble Chamber

Cooldown of the superconducting magnet was started during the month; by the end of the month the magnet cryostat was about 1/3 full (2,000 liters) of liquid helium and the filling was proceeding smoothly. In addition, the installation of equipment in the expansion system control room is complete, as well as equipment installation in the magnet vacuum control room. The Nitrogen Purge System in the High Bay is complete. The first camera has successfully been operated. Construction of final packaging is to begin momentarily.

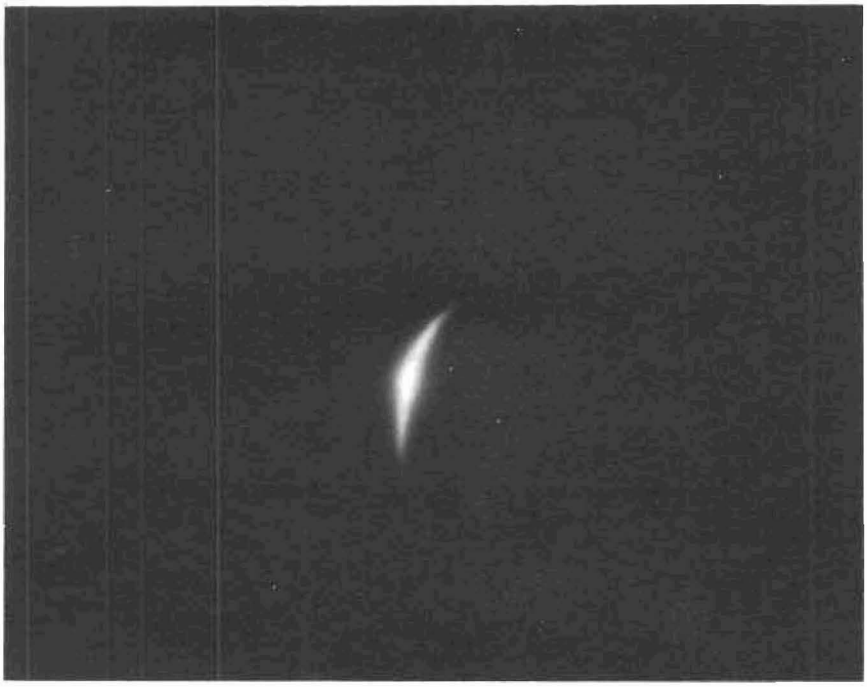

Fig. 1. Autoradiograph of sliver removed from magnet B36-4 on September 7.

15-Ft Bubble Chamber Piston Failure

On September 19 an acceptance test was being performed on the 15-ft Bubble Chamber piston. There are two tests to be performed for acceptance of the piston: (1) 150-psi pressure difference across the head of the piston, and (2) 250 psi on the complete piston. During the first test the piston failed at 65 psi. The failure consisted of the fiberglass on the piston head ripping at the outside diameter for 180° and breaking the bond between the fiberglass and the balsa wood.

It has been determined that over 1/8 of the head of the piston, where a bond should have existed between balsa wood and fiberglass, there was a void of 1/16 to 3/32 in. 65-psi pressure in this void produces 90,000-psi stress in the fiberglass and thus explains the failure.

The reason for the void has two possible explanations. (1) Since this was a blind bond, air could have been trapped between the balsa wood and fiberglass that remained trapped during evacuation and curing, and (2) the vacuum could have failed during curing and thus both allowed air to remain in the bond and did not apply 14.7-psi pressure to hold the balsa wood against the fiberglass. It is believed that both of these things occurred.

The repair of the piston by Brunswick Corporation will consist of replacing some of the balsa wood and relaminating fiberglass over it. This will eliminate a blind bond. The repair should be finished by December 1. Deflections measured during the test confirmed the design as good. Thus there are no changes on the design of the piston.

Fig. 2. Photograph of Central Laboratory construction. The fourteenth of the total of sixteen floors was being poured at the end of September.