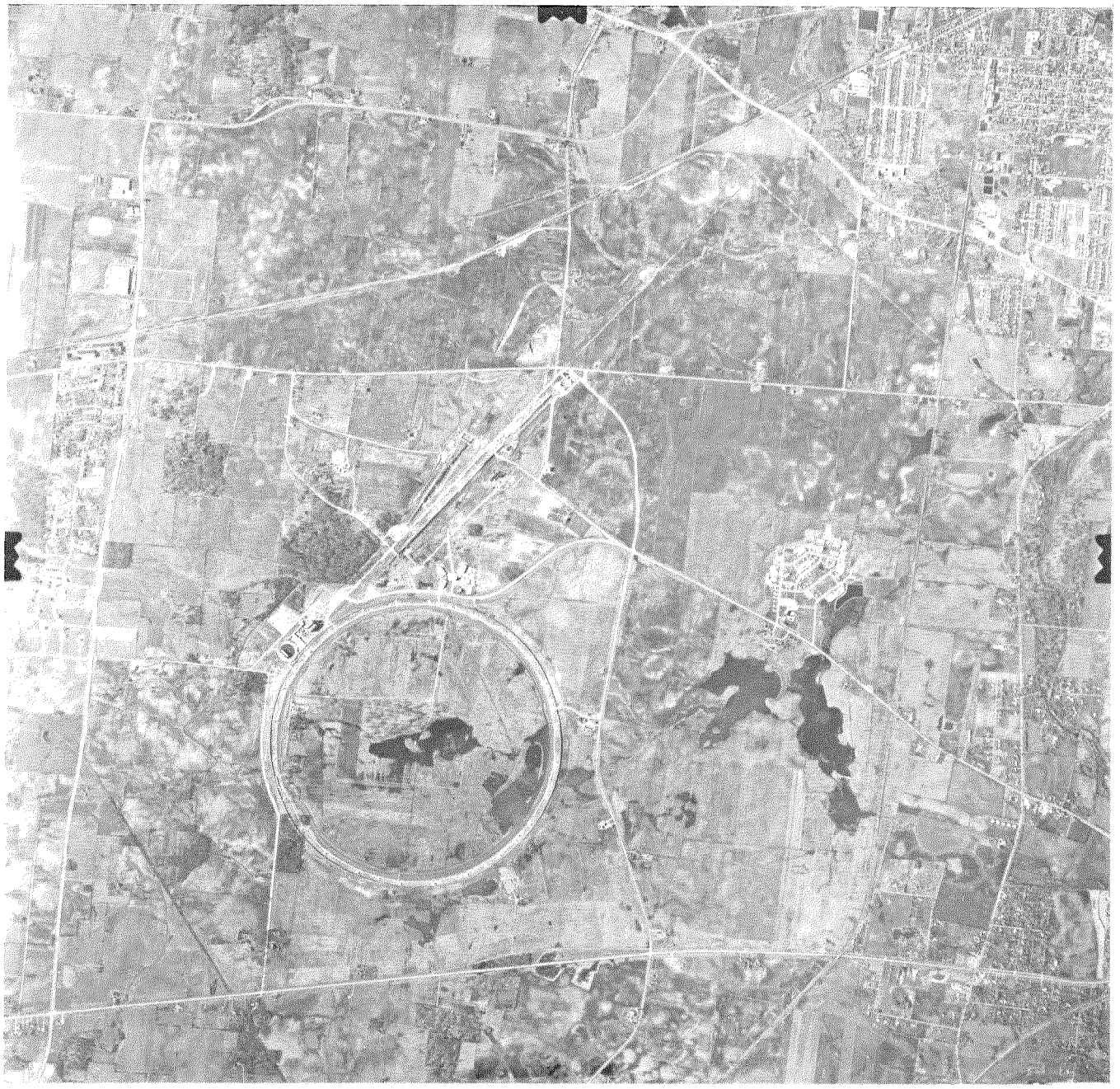
national accelerator laboratory

FERMILAB-NAL-070

0090.01

MONTHLY REPORT OF ACTIVITIES

April 30, 1972



THE SITE FROM THE AIR

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

FORTHCOMING MEETING AT NAL

Program Advisory Committee Photon Subcommittee Meeting and Workshop. . . . . Friday, June 2

THE COVER: A recent aerial photograph of the site from 18,000 feet. West Chicago is at the upper right, Batavia to the left, Warrenville at the lower right. This photo courtesy of the Sidwell Company.

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

Accelerator Section

The most important activity during April was in extraction studies. In these studies, accelerated beam was extracted and transported through the beam line. Approximately one-third of the accelerated beam was detected in the main-ring beam dump and approximately one-tenth was detected in the Neutrino Target Hall across Road A from the Master Substation. The studies were terminated to modify and install equipment on the basis of this experience.

In the near future, we will begin another round of extraction studies, in which the aim will be to increase efficiency and to extract higher-energy beams. These experiments were carried out at 80 GeV. Because of orbit distortions that exist in the main accelerator, extra power is needed to kick the beam past the extraction septum and the present temporary system does not have enough power to extract a 200-GeV beam. Beam was accelerated to 200 GeV during the month, but not extracted.

The work to date has concentrated on fast extraction. Equipment for slow extraction is not yet complete.

Considerable progress has been made in measuring and understanding orbit distortions at both low and high field. Several quadrupoles were realigned vertically; there was a significant reduction in vertical orbit

distortion as a result. The radial distortions, which are the problem in extraction, have not yet been studied in detail. There are apparently problems in the surveying across long straight sections. The positions of magnets at these points will be changed in order to give an orbit more favorable for extraction.

During April nine bending magnets and one quadrupole shorted to ground and were replaced. These are almost all older magnets from early in the production program. None of the recently rebuilt integrally potted magnets have failed. One failure this month appeared to result from wetting of the magnet when an insulator burst. Insulator breakage has been the only problem of note in the water system. After an initial period during which improperly installed check valves were corrected, the system has been running well. The magnets have been ramped to 200 GeV for many hours at a four-second interval without overheating.

Studies of multiple pulsing have been carried out in the booster to prepare for 15-Hz operation. A new low-level rf system has been put in operation, with greater beam stability resulting. Regulation of the booster magnet power supply is still a problem. Reworking of the power amplifiers of the booster rf system has been completed and their reliability is greatly improved. Major changes were made in the injection chopper and septum and the new equipment is working well.

Beam Extraction from the Main Ring

The accelerated beam is extracted from the main ring by moving it into the extraction channel which guides the beam out of the ring into the external proton beam transport system. The extraction channel is installed

and is operational. The first element is an electrostatic wire septum, as shown in Fig. 1, which bends the beam horizontally into a Lambertson septum magnet located 120 feet downstream. This septum magnet is shown in Fig. 2.

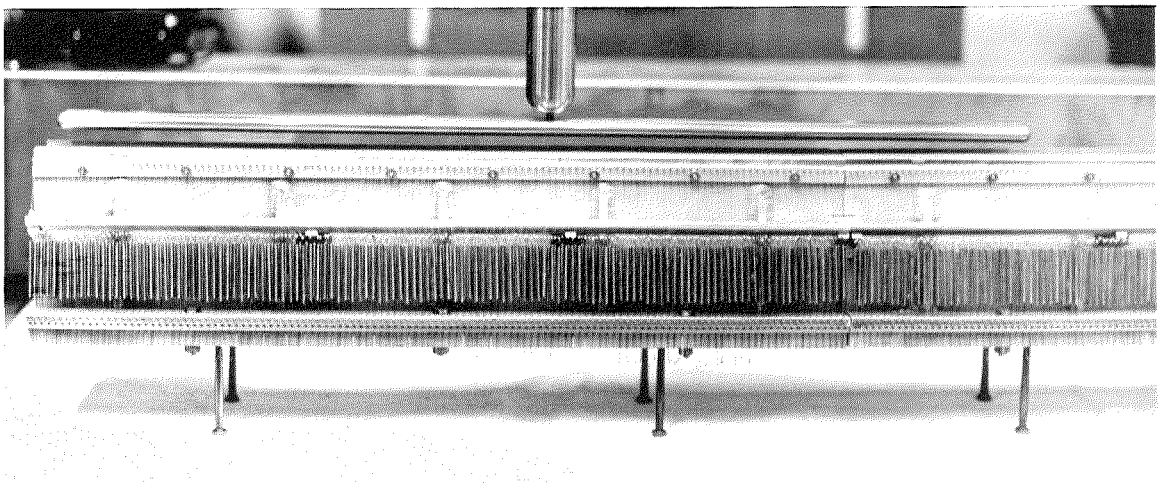

Fig. 1. The electrostatic wire septum has 0.002-in. diameter tungsten wires and operates at a voltage of 50,000 volts across its 1-cm aperture. Two 10-ft units are used to extract a 200-GeV/c beam.

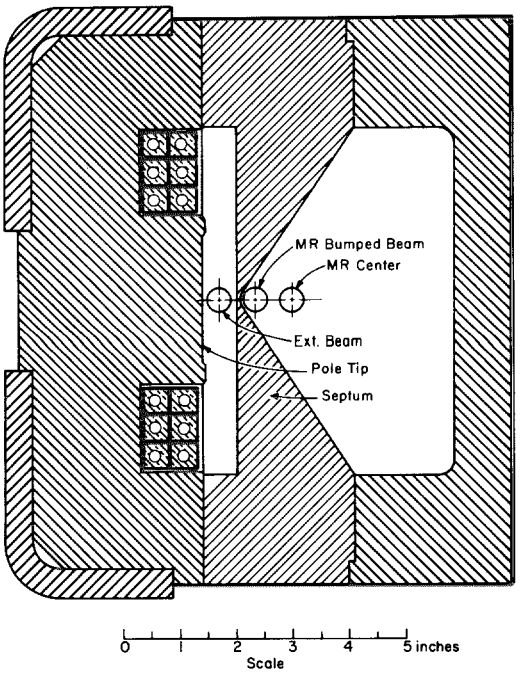

Fig. 2. Cross section of the Lambertson septum magnet which bends the extracted beam down by 3 mrad. Two 10-ft magnets are used at a field of 3 kG for 200-GeV extraction.

This magnet bends the beam down and out of the machine into a vacuum pipe separate from that of the main ring. The extracted beam passes through nine small aperture C and H magnets (see Fig. 3) each 10-ft long which bend it further away from the main ring and level it off. These 11 special bending

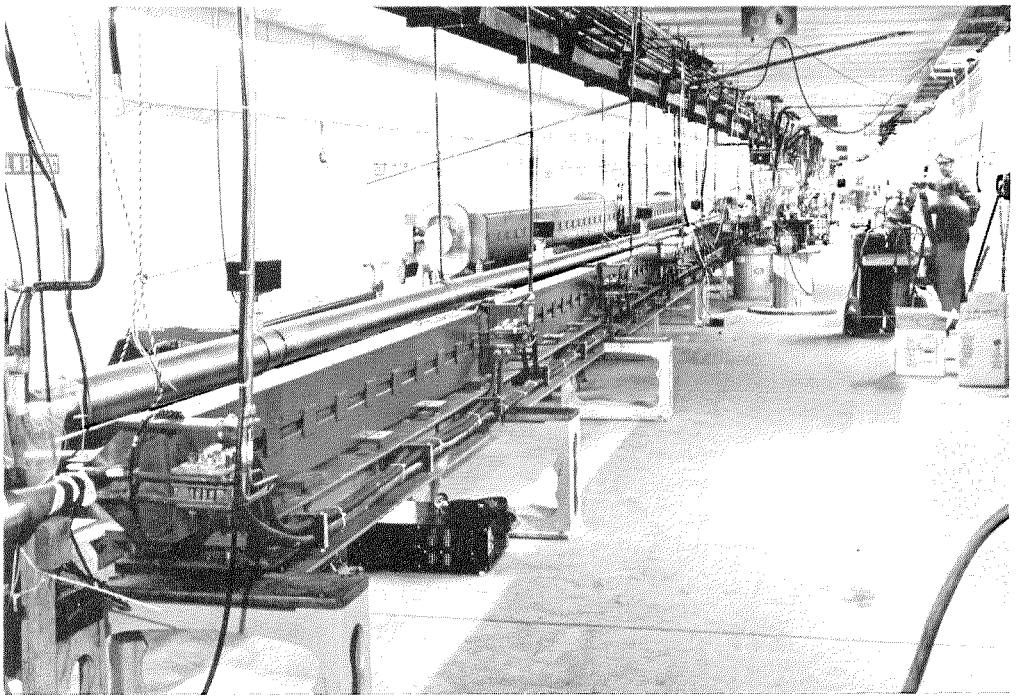

Fig. 3. Looking upstream along the extraction channel with the main-ring vacuum pipe to the left and spare magnets in the background.

elements can be thought of as the extraction channel, the further elements along the beam line being conventional external proton beam magnets.

The crucial part of the extraction process is moving the circulating beam into the extraction channel with a minimum of losses. The first step is to position the beam close to and parallel to the wire septum by putting two orthogonol bumps into the circulating beam orbit, as seen in Fig. 4. A variety of techniques can then be used to move the beam across the septum. For the present, with a single 2-μsec long bunch circulating every 20 μsec in the main

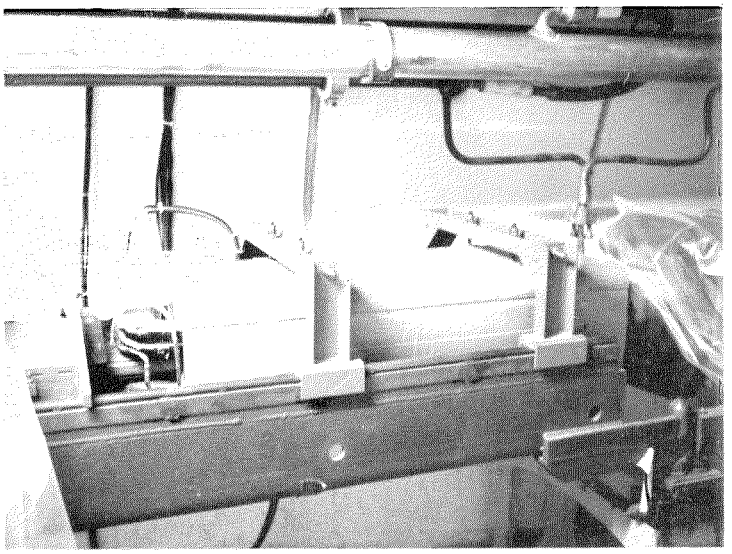

Fig. 4. A ramped bump magnet used to position the main-ring beam next to the wire septum. Two such magnets separated by 360° of phase advance are used to make a bump in the orbit and two such bumps separated by 90° of phase advance are used to control the position and angle of the beam near the wire septum.

ring, it is sufficient to discharge a capacitor into a double-turn air-core magnet. This device (the super pinger) has a 20-μsec rise time and sufficient strength to bend the beam into the aperture of the wire septum--resulting in single-turn extraction with a possibility of 100% efficiency. This fast beam is being used for tuning the extraction channel and beam-transport system. The next step will be a fast resonant extraction (0.1 msec and longer) followed eventually by a slow resonant extraction (0.1 sec and longer). The inefficiency of the resonant extraction process is determined by the width of the septum (0.002 in.) divided by the size of the displacement a particle can undergo in a single turn (projected to be as large as 0.400 in.).

During the past month, two weeks were devoted to 80-GeV fast-extraction studies. On Wednesday, April 19, a well-defined spot of 3×10^9

protons per pulse was observed at the beam dump. At 10 p.m. Friday, April 21, a beam of 1.5×10^9 protons per pulse was seen at the Neutrino Target building.

Construction

Several photographs of the construction are included to show recent progress.

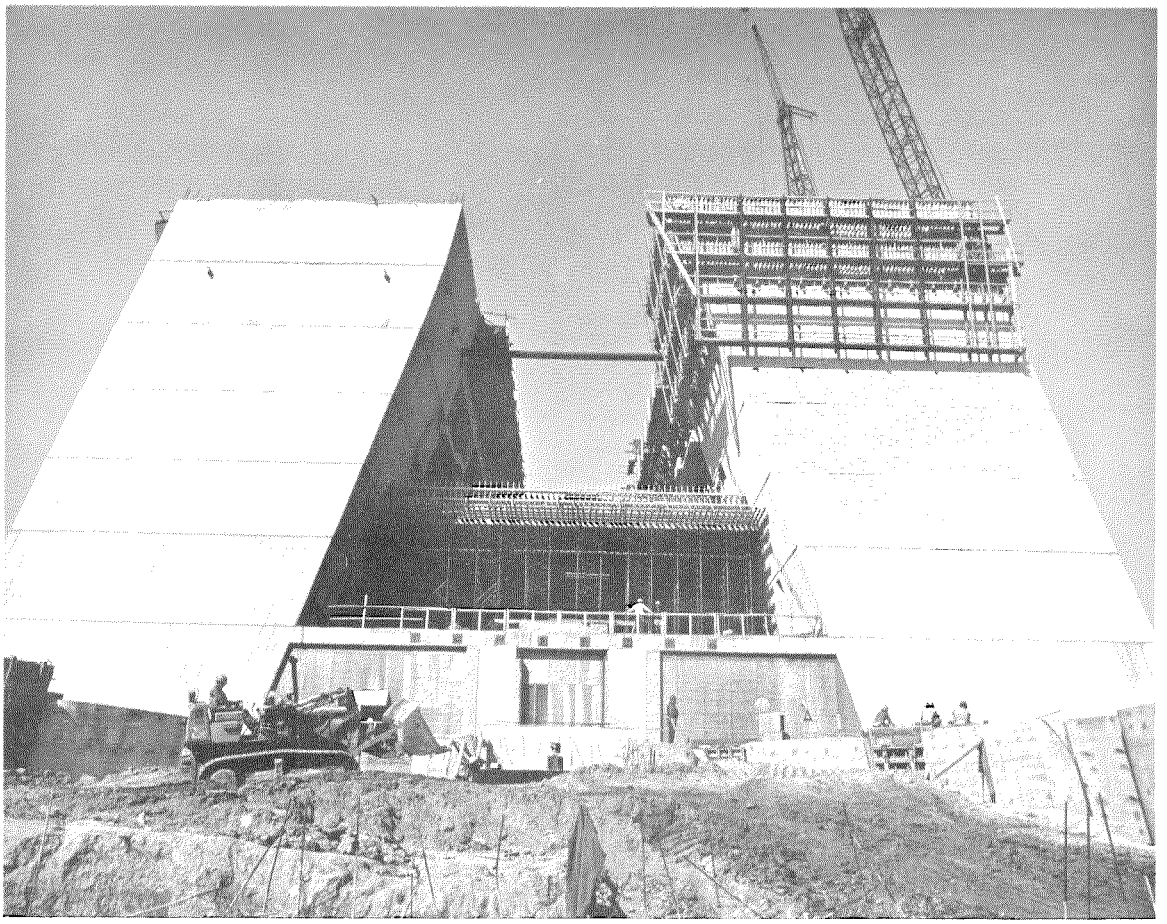

Fig. 5. The Central Laboratory building, viewed from the Auditorium site. Work is now in progress on the seventh floor.

Fig. 6. The interior of the Central Laboratory from the lobby floor. Charles Slaymaker of the AEC is at the left.

Fig. 7. The Auditorium, looking from the Central Laboratory toward the Cross Gallery.

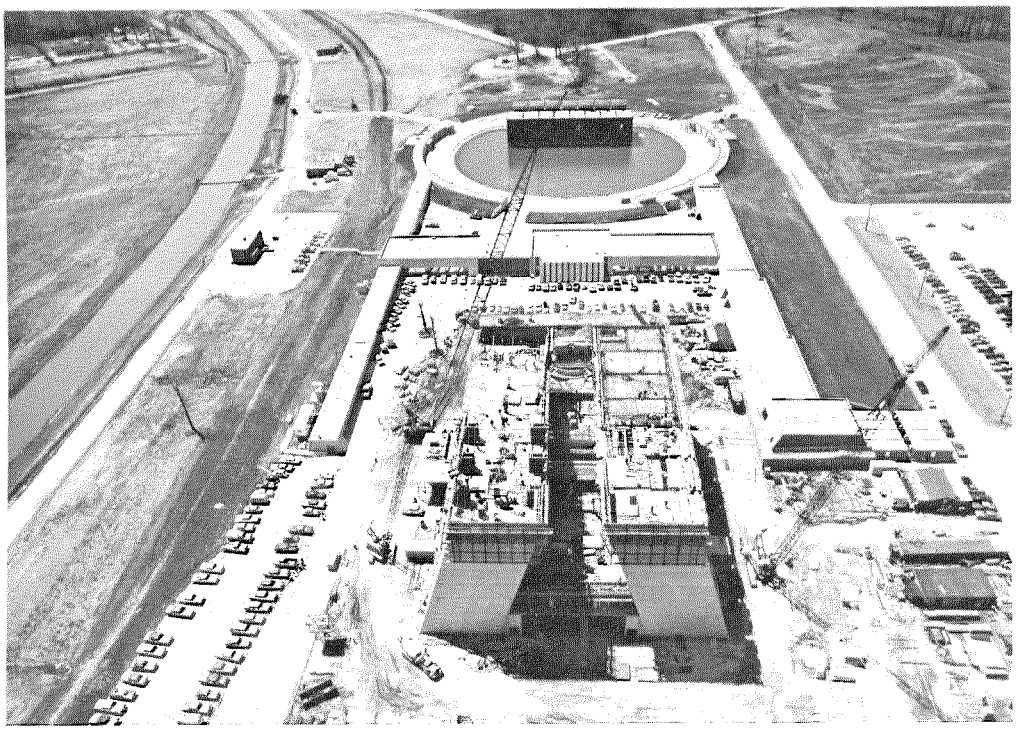

Fig. 8. The Central Laboratory and Cross Gallery area from the air. The Main Ring is at the left.

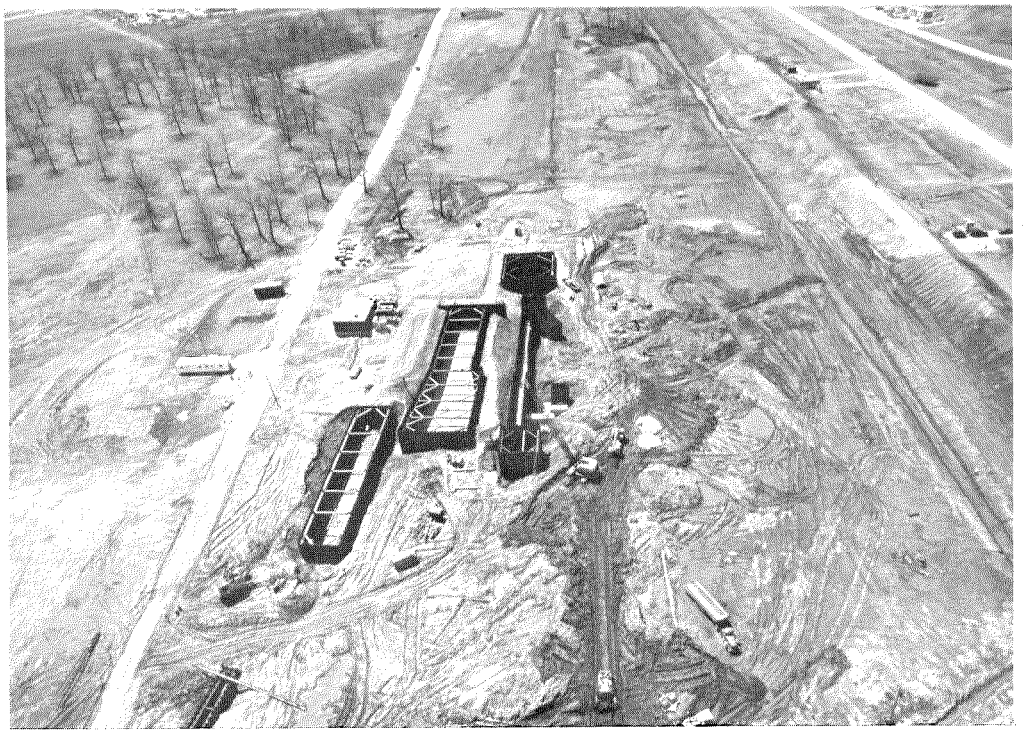

Fig. 9. The Proton Laboratory from the air, looking south. The Neutrino Laboratory is at the right.