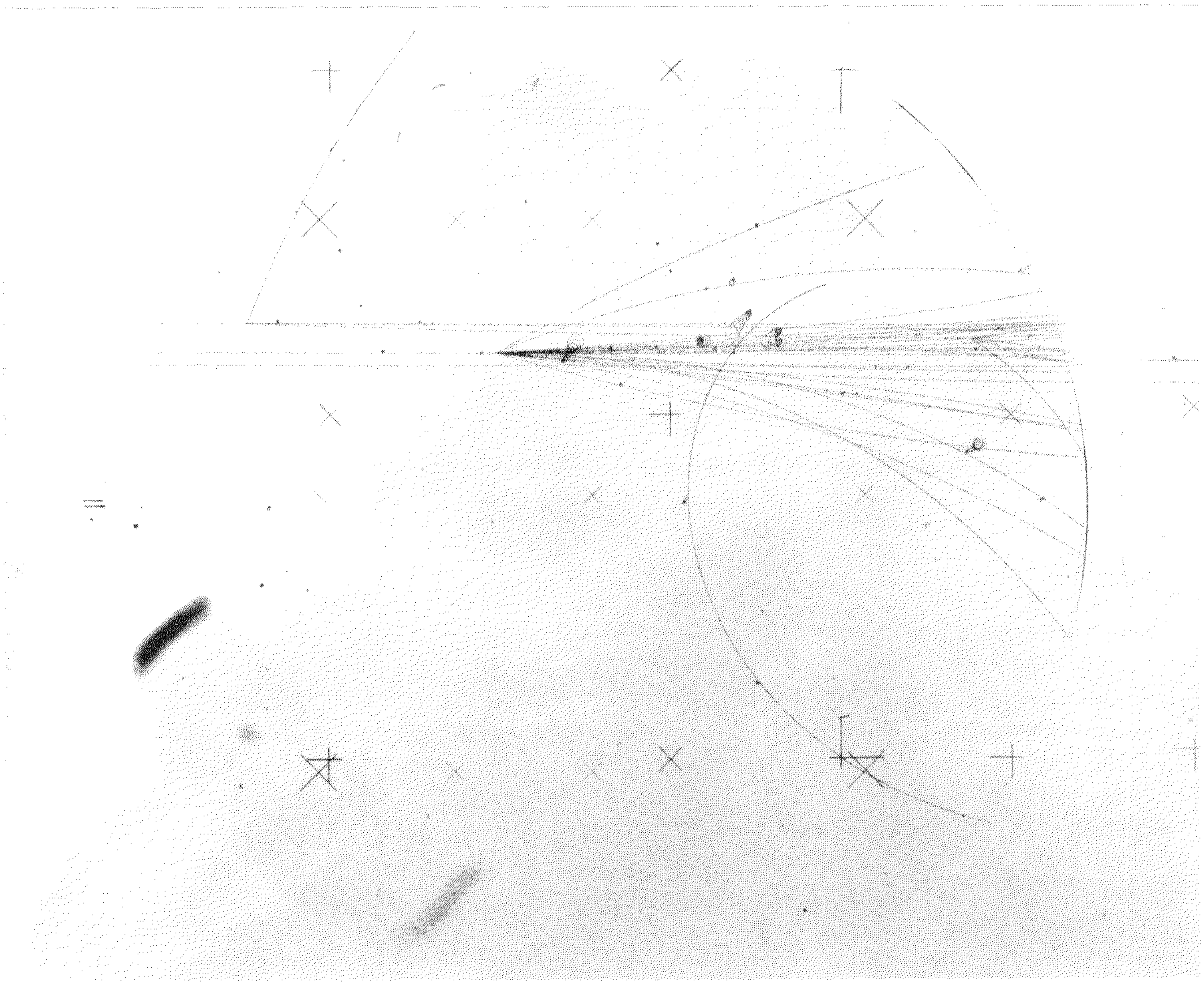
national accelerator laboratory

FERMILAB-NAL-072

0090.01

MONTHLY REPORT OF ACTIVITIES

June 30, 1972



200-GeV INTERACTIONS IN THE BUBBLE CHAMBER

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

THE COVER: See first paragraph of report.

NAL-72
0090.01

MONTHLY REPORT OF ACTIVITIES

June 30, 1972

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

The first photographs of 200-GeV proton interactions in the 30-in. bubble chamber were taken during the month. A "typical" photograph appears on the cover. The following description was provided to us by Malcolm Derrick, of Argonne National Laboratory.

The picture shows one frame taken from 70-mm film exposed at the 30-in. bubble chamber now operating at NAL. Three protons entered the chamber at a momentum of approximately 205 GeV/c; two of which interacted with the liquid hydrogen. The first interaction resulted in a 4-prong event with three high momentum charged particles and one slow, large angle proton identified by the heavy ionization. A 22-prong event occurred in the middle of the chamber with one of the negatively charged particles causing a secondary 4-prong event. Although most of the primary charged tracks from this event are contained within a small cone, examination of the picture under high magnification enables the prong count to be made unambiguously. The mean number of charged particles resulting from 200 GeV pp interactions is 7.6. Detailed studies of the events will enable one to discriminate between the various models of high-energy interactions.

Accelerator

Work has continued on improving beam intensity, extraction efficiency, and general reliability of operation. During the month of June, more than

200,000 pulses were accelerated to 200 GeV. Intensity has been as high as 6×10^{10} protons per pulse. Beam was delivered with some regularity to a number of experiments. For example, some 37,000 pictures at 200 GeV were taken in the 30-in. bubble chamber, and the C-0 internal target had beam about 35% of the time during the month (see below).

Beam loss in the main ring from initial injection to extraction continues to be of the order of 50%. A continuing program of measurements of magnet misalignments (mostly by means of behavior of the beam itself) has been established, and realignment and readjustment of magnets now takes place on a regular basis. It is expected that a considerable fraction of the beam loss will be eliminated by a more precise positioning of the magnets.

At the beginning of June, a new, stronger kicker ("super-pinger") was installed for 200-GeV extraction. It has now operated successfully for more than 200,000 pulses. A second 1/8-mrad pinger will be installed next month. There is still a small air gap in the vacuum line in the Transfer Hall, but when the main-ring internal beam was particularly small in cross section, at least 90% of the internal beam was extracted and transported to the Neutrino Target Hall. The efficiency was generally approximately 60%.

Study of the resonant scattering mode of extraction has shown that extraction on the 1/2-integral resonance may be more favorable from the point of view of control than 1/3-integral extraction. Extraction quadrupole and octupole magnets have been designed and fabrication is under way. The extraction may be further facilitated by a "beta bump," that is, by insertion of pulse quadrupoles to produce a region of large beta at the extraction septum.

We expect to have hardware ready for first resonance-extraction efforts in about two months; however, successful extraction with good duty cycle free of magnet-ripple effects cannot be expected for several months. Meanwhile, it will be possible to produce an external beam with a reasonably long spill (about 0.1 sec) by the rather inefficient method of scattering it out of the machine.

Experiments

Three experiments are presently installed at C -0:

36 Elastic pp Scattering - NAL, Rockefeller University, University of Rochester, and USSR

67 Isobar Search - Rutgers University, Upsala College, and Mississippi State University

120 Photon Search - University of Wisconsin and Harvard University

Experiment # 36 has been running until now with thin-film targets. The hydrogen jet target built in the USSR has now been reassembled and installed in the C -0 straight section. (See Figs. 1-3.) It operates as follows: A narrow jet of cold hydrogen "slush" is shot through the beam in a few pulses, each 0.2-sec long, during the acceleration cycle. In order to maintain a good vacuum in the accelerator, it is necessary to pump the large volume of hydrogen gas involved at high speed. This is accomplished by shooting the jet into a helium-cooled cryo-pump where the hydrogen is frozen. Every half hour or so the whole jet-cryo-pump assembly is raised remotely out of the accelerator and the accumulated hydrogen in the cryo-pump is sublimated away. The idea of using a thin target of relatively high density hydrogen in the circulating beam of an accelerator was proposed by the Soviet group from

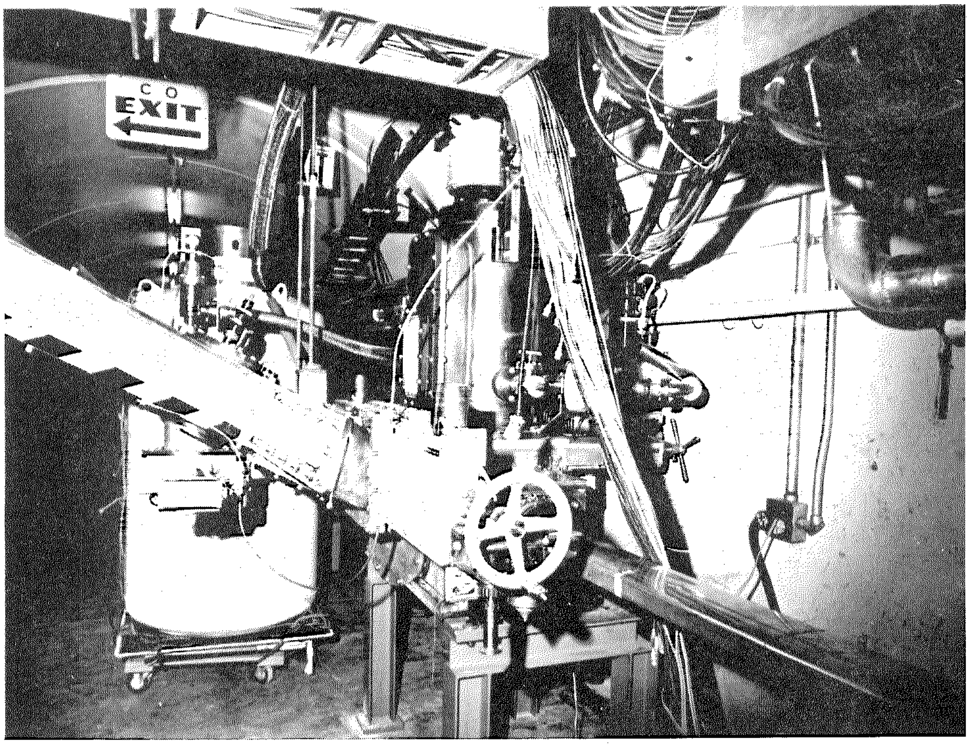


Fig. 1. Hydrogen jet target installed in C -0 straight section of main ring.

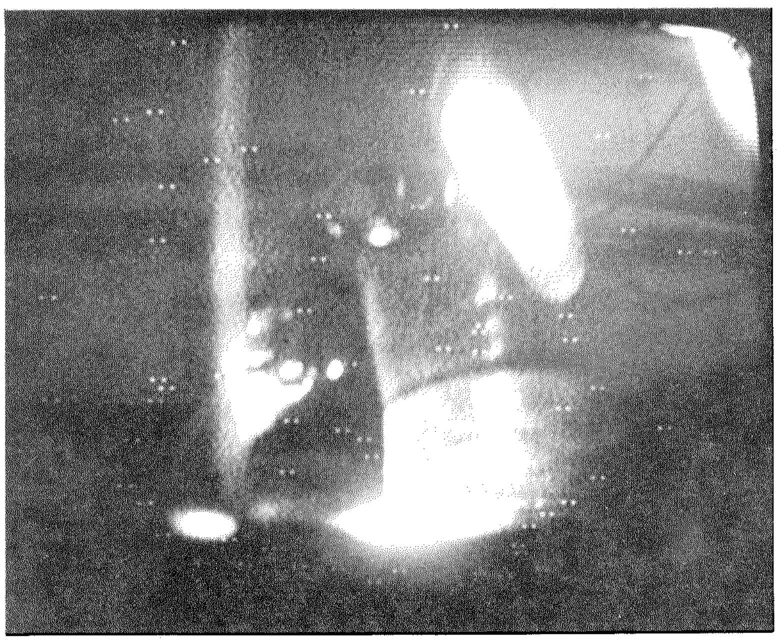


Fig. 2. Photograph of first successful operation of hydrogen jet target at NAL (vertical line at left is the hydrogen).

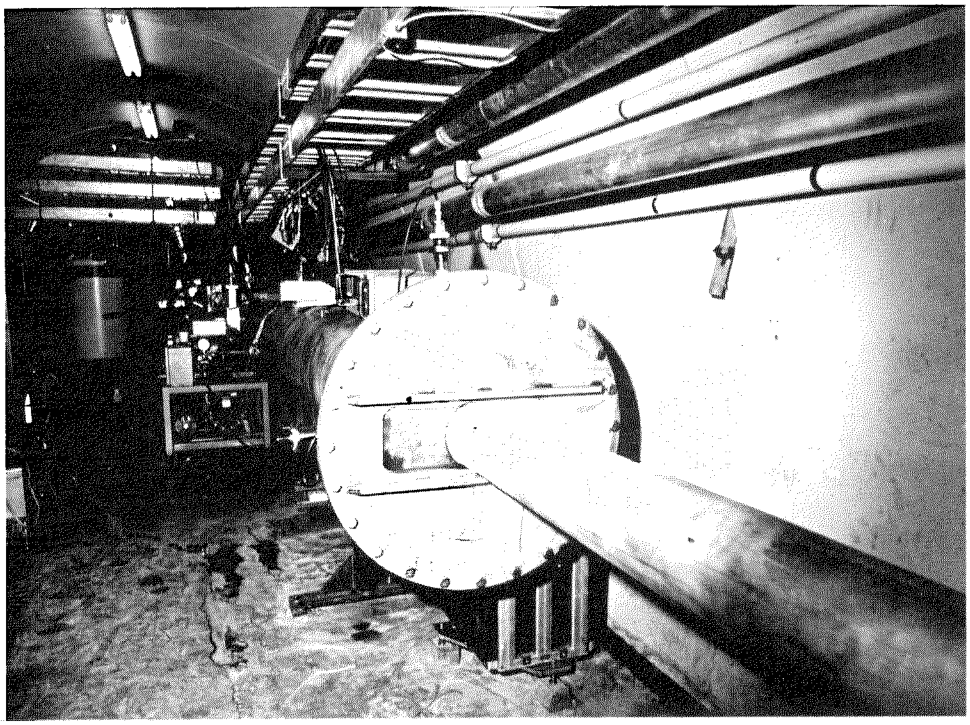


Fig. 3. Downstream end (looking upstream) of enlarged vacuum chamber for experiment # 120.

Dubna who developed the advanced technology required to accomplish this and carried out a small angle p-p experiment at the Serpukhov accelerator using this technique. The Soviet group of seven scientists, accompanied by their wives, arrived in the United States on March 5 and brought with them a gas jet target constructed in the Dubna machine shop to fit in the main-ring tunnel at NAL. NAL supplies the helium liquifier.

The major effort of the group since its formation has been to assemble and test the hydrogen target, including a reconstruction of the C-0 straight section in the Village. The target was run successfully on May 20 and 25, and June 10. The last run was also done with deuterium.

In order to confine as much of the hydrogen as possible to the target region where the efficient cryo-pump can operate, 2-in. × 5-in. tubes were installed upstream and downstream. This increased impedance provides a differential pumping effect and makes it possible to operate the target in the accelerator. The pressure pulse at the target is $\sim 5 \times 10^{-4}$ torr with a time constant of ~0.3 sec. At the ends of the straight section $\Delta p \sim 2 \times 10^{-6}$ and $\tau \sim 1$ sec.

So far, the experiment has data on about 12 million events at 80 GeV (polyethylene and mylar) and 23 million events at 200 GeV (polyethylene).

The experimenters in Experiment #67 and Experiment #120 have measured backgrounds and are confident that by various methods, such as time-of-flight, they can accumulate useful data in the near future.

30-In. Bubble Chamber

Starting from a standby condition, the bubble chamber was cooled down and filled with liquid hydrogen during the first week of June. Beam-tuning pictures started on June 11 and the first photographs of 200-BeV proton-proton interaction were observed on June 15. Examples of such interactions can be seen in the cover photograph.

To prepare for the series of physics experiments with this facility, test pictures were taken with both the 35 mm and the 70 mm camera systems while final beam tuning was in progress. The first physics run (Experiment #141 - Fields) was started on June 21 and accumulated about 37,000 pictures when this phase of scheduled accelerator run was terminated on June 26.

15-Ft Bubble Chamber

Many tests of component systems are now either underway or completed. One set of fisheye optics was successfully cooled to liquid-nitrogen temperature. High pressure gas storage was tested to 3,000 psi (operating pressure is 2,160 psi). The 150-ton superconducting magnet was rigged into place during the last week of June. The helium vessel and the vacuum vessel will soon be put under vacuum. The lower third of the vacuum tank is complete, and it contains the superconducting magnet. (See Figs. 4-7.)

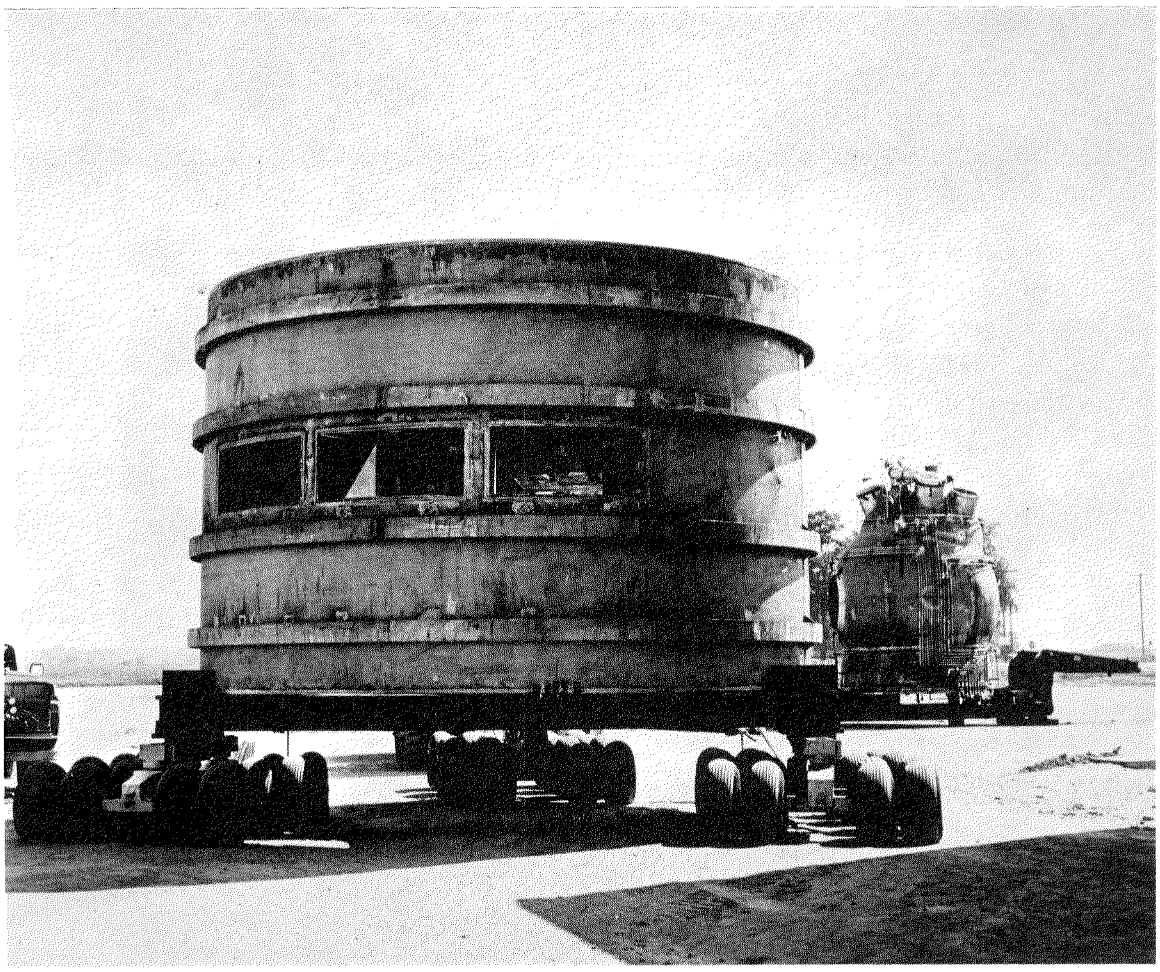


Fig. 4. Superconducting magnet for 15-ft bubble chamber during move from Building A to permanent location (15-ft chamber itself is in background).

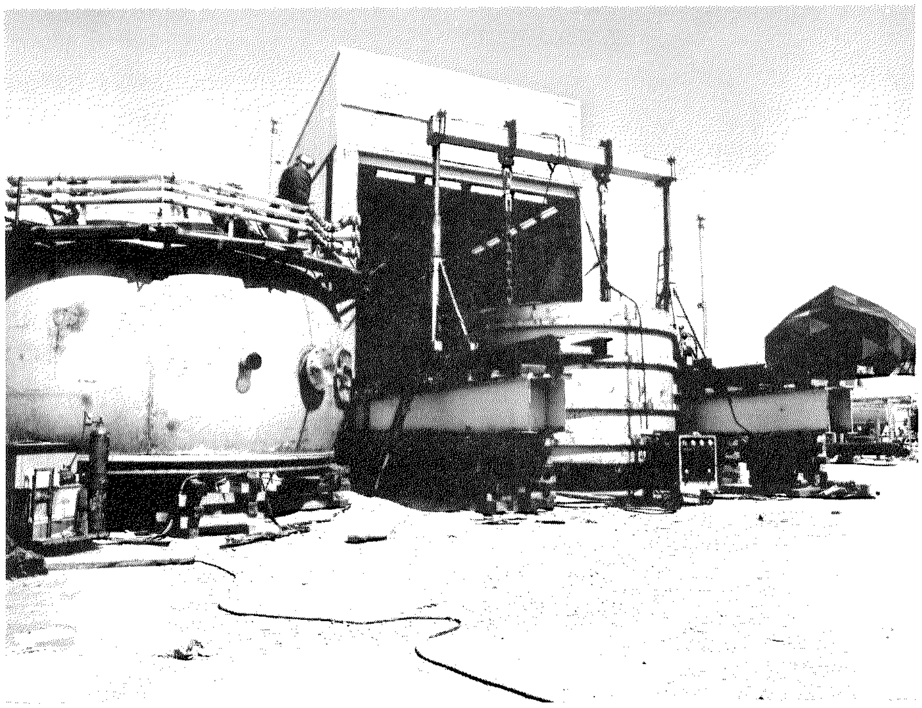


Fig. 5. Superconducting magnet moving into permanent location in the bubble chamber building. Vacuum vessel is at the left of the photograph.

Fig. 6. Superconducting magnet after rigging into permanent location in the bubble chamber building.

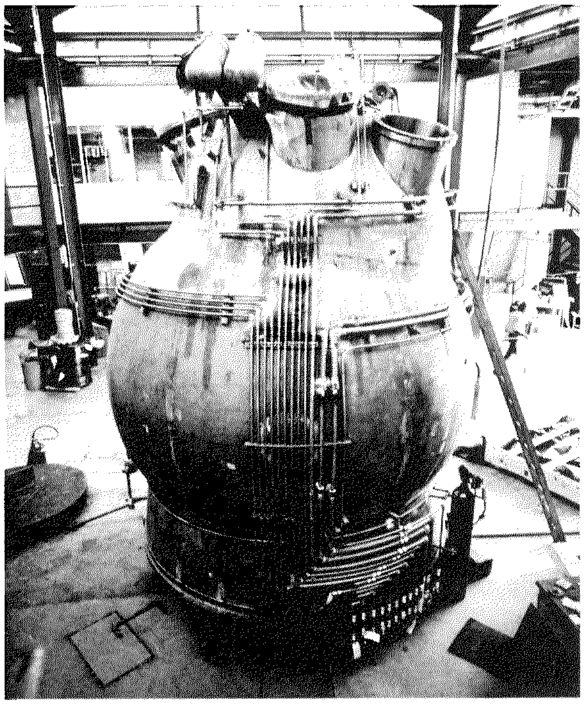


Fig. 7. 15-ft hydrogen bubble chamber in Building A for final assembly.

General

On June 22, a strike of some of the Building Trades in the four-county Chicago area stopped all conventional construction at NAL. Although this has considerable effect on all major construction on the site such as the Meson Lab building, the Proton Lab structures, and the Central Lab and Office Building, no insufferable harm is done there. The major worry is whether or not the Auditorium can be brought to the stage of being used for the XVIth International Conference on High Energy Physics (in September) if the strike is prolonged. The best estimate is that the contractor could recover and catch up reasonably from a one-two week strike, but that anything much longer than that might cause difficulty.