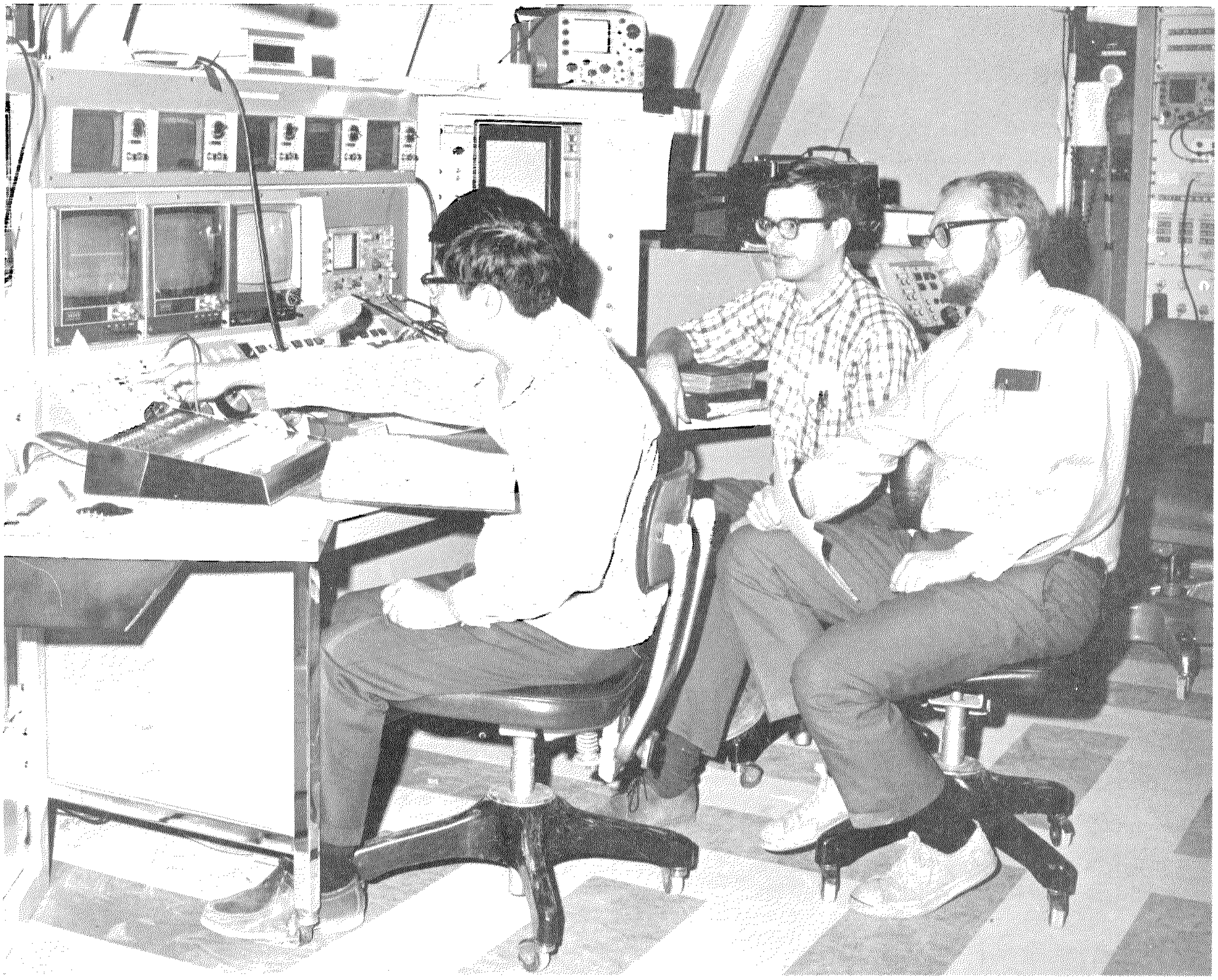
national accelerator laboratory

FERMILAB-NAL-066

0090.01

MONTHLY REPORT OF ACTIVITIES

December 31, 1971



MAIN RING ACCELERATOR STUDIES

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

THE COVER: Ryuji Yamada, Robert Goodwin, and James Walton at the Main-Ring Control Console during accelerator studies in December.

NAL-66
0090.01

MONTHLY REPORT OF ACTIVITIES

December 31, 1971

Abstract: This report summarizes the activities of the National Accelerator Laboratory in December, 1971.

Main Accelerator

Most of December was spent in studying orbit phenomena with the coasting beam in the main accelerator. The results of these studies has been to improve our understanding of the operation of the accelerator and to improve the stability of the coasting beam. Some rf acceleration was obtained early in the month, i.e., from the 7-GeV energy of injection to about 9 GeV, but the momentum acceptance was only about 0.1% at the time and it appeared that the power supplies were not controlled accurately enough to permit a proper tracking of quadrupole with bending magnets to allow for much higher acceleration. Consequently work was directed toward increasing the momentum acceptance of the accelerator, improving the alignment of the magnets, and improving the control of the power supply.

The betatron-oscillation frequencies were varied systematically and measured with beam kickers to map out areas in the "necktie pattern" of good beam. The integral stop bands (regions in which there are integral numbers of betatron oscillations per revolution and in which a magnet error causes the closed-orbit displacement to grow in time) are quite wide. Without correction, the stop bands cover well over half the area of the tune diagram. Correcting magnets can be set to reduce these stopband widths to approximately one-fourth the area of the tune diagram.

Perhaps the most significant improvement was made just before Christmas by exciting the horizontal dipole correction magnets in a twentieth harmonic mode around the ring. A small amount of this excitation could destroy the beam because of the sensitivity, but by the same token, a tiny amount in the proper phase produced a marked improvement in the stability of the accelerator, especially with regard to momentum acceptance which was increased by about a factor of five.

On the other hand, the half-integral stop bands are narrow, in fact, barely detectable. Resonances that couple radial and vertical motion are also observed.

Alignment of the focusing quadrupoles was carried out during the month. This work reduced significantly the settings of the correction magnets needed to get good beam. Levelling of the bending magnets, especially in the radial direction, was begun during the month and is expected to be completed early in January.

The beam size was measured by two independent methods, an ion-profile monitor and adjustable vertical and horizontal slits. The two methods both gave beam sizes of 1.25-cm diameter radially and 1-cm vertically. The ion-profile monitor can be pulsed to measure beam size at any given time during the lifetime of the beam. These measurements give the beam size quoted above throughout the lifetime of the beam.

Over the Christmas and New Year's holidays the main-ring magnet was further purified by systematically raising the "high-potting" voltage from 500 to 1000 V. In order to reach this new level it was necessary to remove from the magnet ring an additional 13 bending magnets and 2 quadrupoles. During the beam studies of December no magnets were lost, so there does appear to be an improvement.

The coasting beam was still observed to decay with a lifetime of the order of several hundred milliseconds. The only thing that appears to affect the decay rate, apart from tuning on or near a stop band, is to allow the pressure in the ring to rise substantially. This qualitative effect will be studied more quantitatively in the future.

It is possible that there are still some small obstacles in the aperture, such as the metal slivers, that cause the decay. Accordingly during the holidays, the spear discussed in previous reports was utilized to search for foreign matter in the vacuum chamber. A few more metal slivers were found.

The injector-system's primary function in December was to provide beam to the main ring. Nevertheless, there was time to put a new beam position detector system into operation in the booster. The measured positions of the circulating beam were then compared with the results of computer simulations in order to determine magnet realignments. Application of this method reduced the radial and vertical closed-orbit displacements by factors of 4 in a few days of effort. The result was to reduce beam losses in the booster and to make its operation more stable. Michael Shea and Robert Kucanda brought the beam-detector system into being and Robert Peters carried out the orbit work, including the computer simulation.

Beam to 30-In. Bubble Chamber

The installation of components in the proton beam transport line from the Transfer Hall to the Neutrino Target Hall is virtually complete. Trial runs of the vacuum, electrical power, control and security systems have been successfully carried out. The alignment of the beam-line has been rechecked under vacuum.

At the end of the month the Neutrino Laboratory sub-system based on Service Building N-2 was ready to become operational. Magnets and power supplies have been tested and run under computer control from the Cross Gallery. The water system is ready to be filled so continuous operation of the magnets for development of the control software and operational experience with the supplies can go on. The instrumentation for the line is completed and ready for installation. Meanwhile, the work of installing and turning on the final sub-system based on Service Building N-3 continues. This system is expected to go operational by the end of January. The first remote beam control units are being delivered to experimenters in the area.

30-In. Bubble Chamber

The 30-in. ANL-MURA hydrogen bubble chamber was moved from the ZGS during this summer and installed in Laboratory D of the Neutrino Laboratory. The first cooldown at NAL was started on November 1 and the track sensitivity shown on November 9 demonstrated chamber readiness for exploratory physics. A new 5.5 megawatt power supply for the chamber magnet has also been installed and is now undergoing final tests.

Arrangements have been made to have the personnel experienced with this bubble chamber at Argonne also continue to operate it at NAL. In addition to this group, led by Lou Voyvodic, the successful move and start-up was especially due to the efforts of John Martin and Vac Sevcik of Argonne, Bill Fowler, Wayne Nestander, and Halsey Allen of NAL, Parke Rohrer of DUSAF. Andy Mravca and Rico Conti of the AEC were of great help.

The initial set of experiments planned with the chamber at NAL is listed in Appendix I. The eight "bare chamber" exploratory exposures will start as soon as proton and pion beams are available. With continuing installation of the downstream wide-gap optical spark-chamber equipment, this form of hybrid operation is expected to start early in the NAL experimental program. Beam-particle tagging and direction definition with proportional chamber planes are also expected to enhance the hybrid capability of this unique bubble-chamber installation.

Fig. 1. While the bubble chamber is being readied for cooldown, components of the downstream wide-gap spark-chamber equipment are beginning to be installed. Lou Voyvodic and Ron Walker are looking over the spark-chamber plans while Dick Brazzale, Gary Hodge, and Del Wilslef are working on the upper platform.

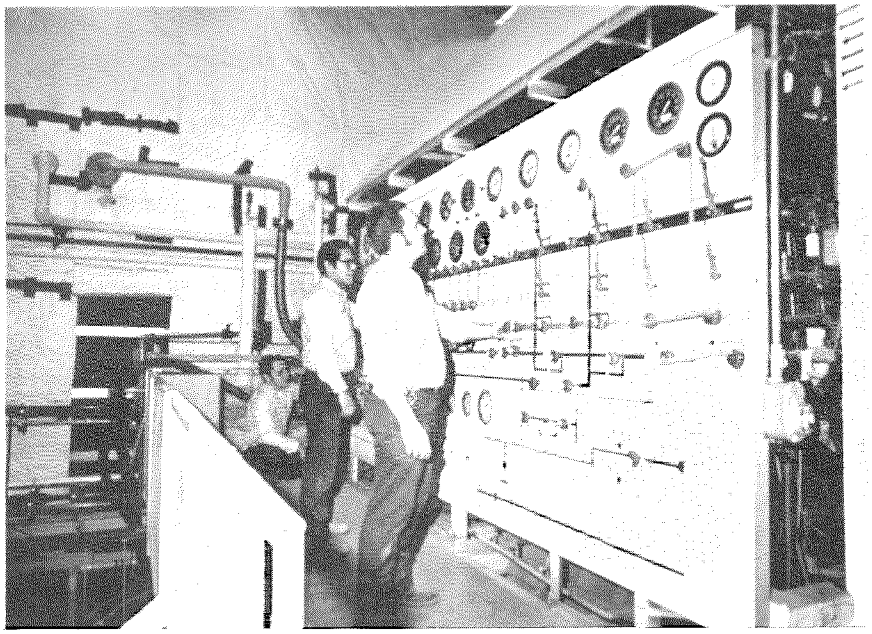


Fig. 2. The main control panel which sits above the 30-in. bubble chamber is given a checkout in its new NAL home by Dick Brazzale, Rich Williams, and Gary Hodge (left to right). On the right is the 500 watt Joule-Thompson refrigerator which provides liquid hydrogen for filling and cooling the bubble chamber.

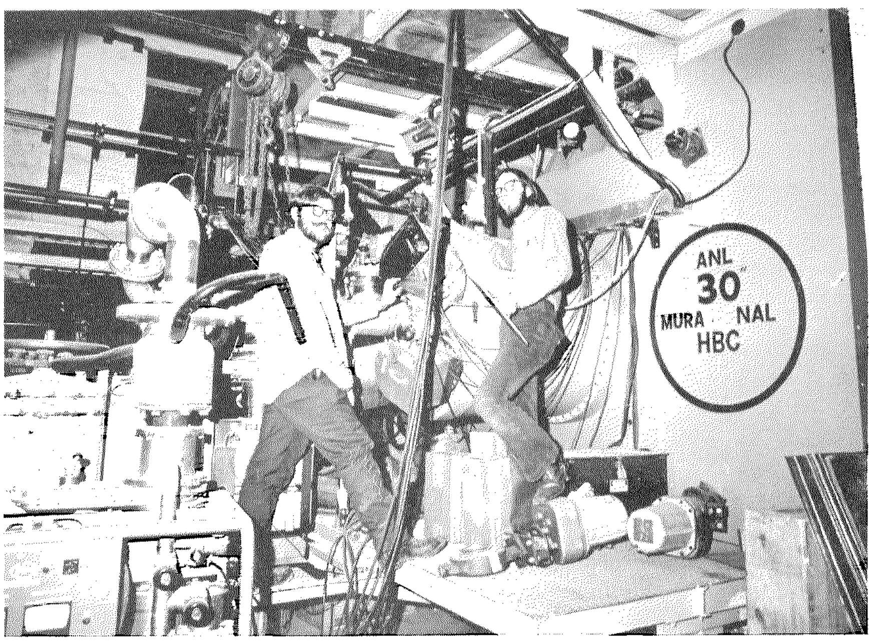


Fig. 3. The illumination end of the bubble chamber. Jim Hoover and Vance Sauter are adjusting one of the four elliptical flash tubes which light up the bubble tracks.

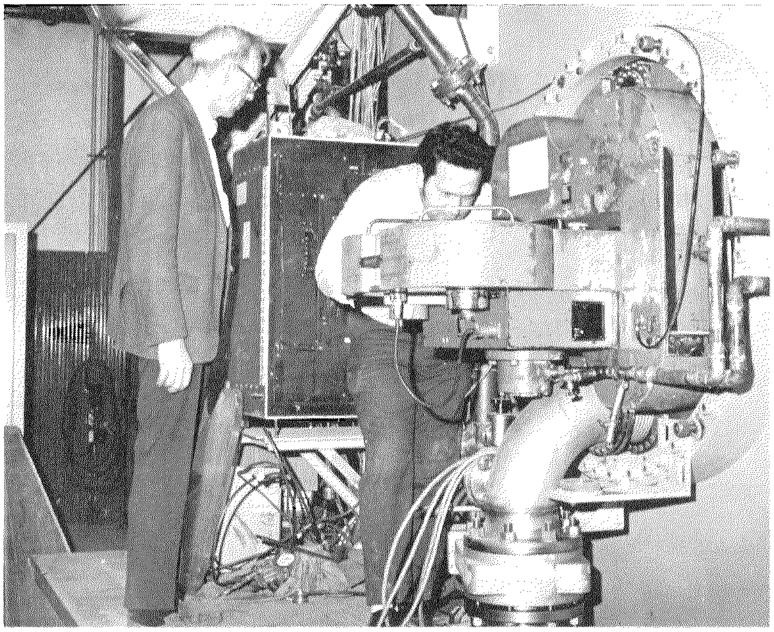


Fig. 4. The camera end of the 30-in. chamber. Vince Shoemaker and Bob Pucci are preparing the 70-mm camera system for new tests of the chamber reconstruction accuracy.

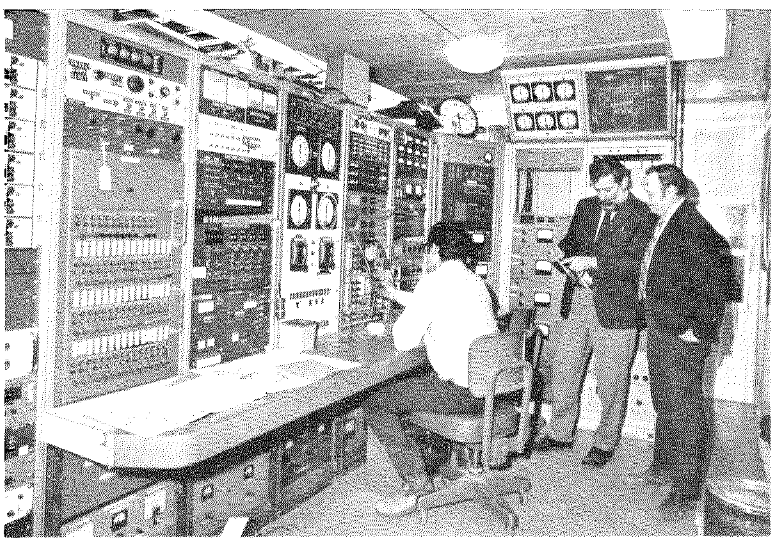


Fig. 5. In the 30-in. chamber control room Lou Voyvodic (center) is checking with Ron Walker the quality of initial pictures taken after the move to NAL. Rich Williams is monitoring the remote displays of chamber expansions.

Appendix I. LIST OF APPROVED 30-IN. HBC EXPERIMENTS.

Experiment Number	Institutions	Scientific Spokesman	Subject
2-I	Michigan State Maryland Iowa State ANL, Duke Notre Dame Toronto, Wisc. Purdue	Smith	Multiparticle Interactions in 30-in. Bubble Chamber and Optical Spark Chamber Hybrid System. 30" b.c. 450K pictures.
37-A	NAL, UCLA	Malamud	30" b.c. - pp, 50K pictures
121-A	UC, Davis	Lander	30" b.c. - π^+p, 50K pictures
125	CERN	Morrison	30" b.c. - π^-p, 50K pictures
137	NAL, LBL, U. of Calif.	Huson	30" b.c. - π^-p, 50K pictures
138-I	Rochester Michigan	Ferbel	30" b.c. - pp, 50K pictures
138-II	Michigan Rochester	VanderVelde	30" b.c. - pp, 50K pictures
141-A	ANL	Voyvodic	30" b.c. - pp, 50K pictures
143	BNL	Kalbfleisch	30" b.c. - π^-p, 50K pictures
154	MIT, Brown, Ill., IIT Johns Hopkins Rutgers, Stevens, Yale, NAL, Indiana U. of Tenn. - Oak Ridge	Pless	Feasibility Study of Proportional Chamber Hybrid Systems with 30-in. b.c.