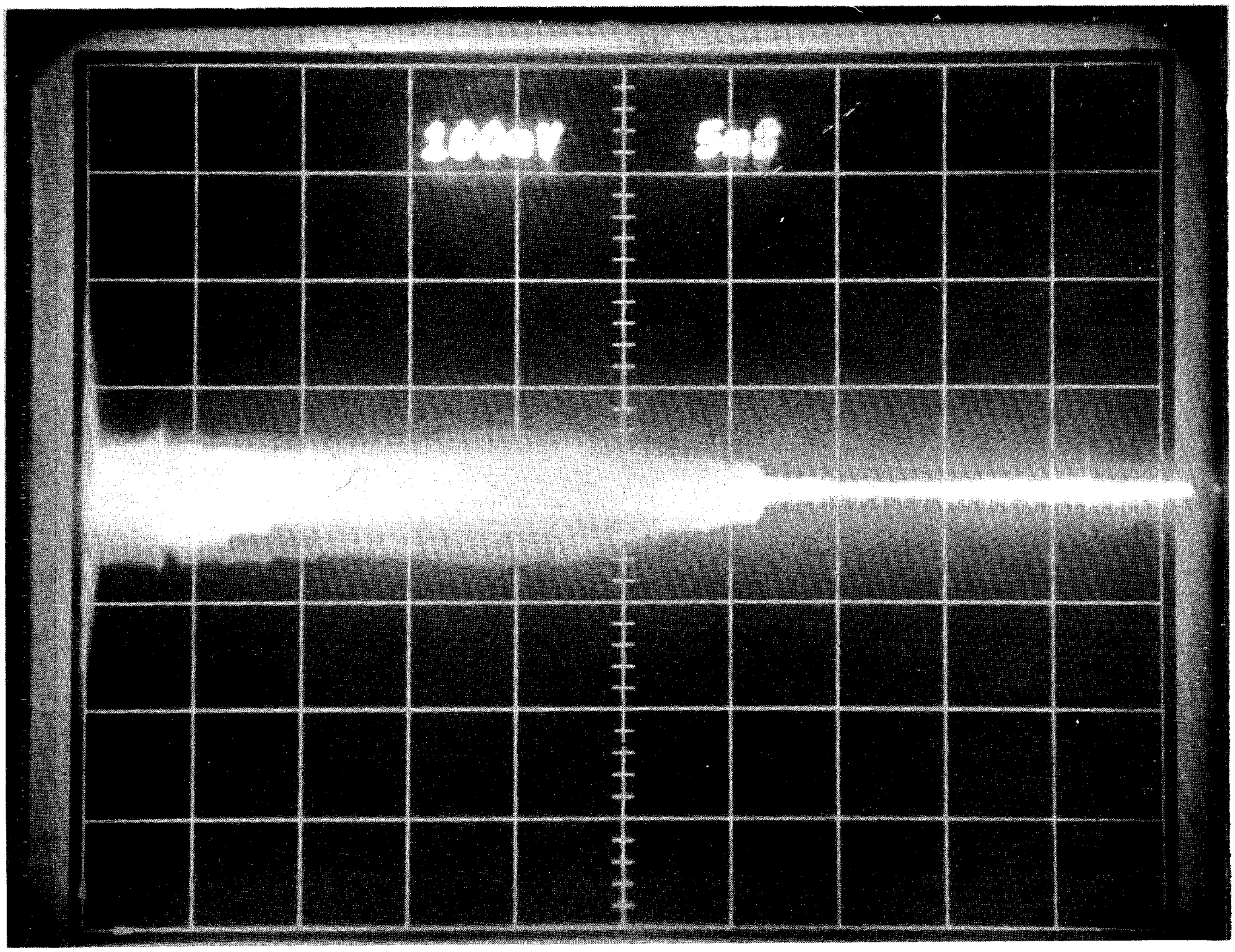
**national accelerator laboratory** FERMILAB-NAL-054

MONTHLY REPORT OF ACTIVITIES

February 28, 1971



ONE BILLION ELECTRON VOLTS

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

| FORTHCOMING MEETINGS AT THE LABORATORY | |
|---|---|
| Fifteen-foot bubble-chamber workshop | Mar. 11-12 |
| Annual NAL Users Meeting | April 30 - May 1 |
| Program Advisory Committee | May 14-15 |

THE COVER: The cover is an oscilloscope trace of accelerated beam in the booster, showing a signal picked up from the beam continuing out to 33 milliseconds, the total acceleration time.

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# MONTHLY REPORT OF ACTIVITIES

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February 28, 1971

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

## Accelerator Operation

Protons were accelerated to 1 BeV in the Booster at 6 a.m. on February 6, a notable milestone for both the RF and Booster Sections. The maximum energy is limited to 1 BeV only because there has not yet been time to put the East Gallery rf systems into operation.

Operation continued through the month. On February 26 the 1-BeV beam was extracted from the Booster and injected into the Main Accelerator by the efforts of the Beam-Transfer Section. In the short time available for Main-Accelerator beam experiments, the beam was detected as far along the main accelerator as Station A-13, approximately 1,300 feet along the accelerator. Preliminary current measurements at Station A-12 detected approximately 1 milliampere of 1-BeV protons, close to the current extracted from the Booster.

## Radio Frequency

The rf system worked well. The only major equipment difficulty encountered was a short in the transformer supplying power to the West Gallery rf systems. This problem was circumvented on February 5 and 6, and the transformer has since been replaced. The rf beam-detection system also worked very well, giving good signals (like that on the cover) from the beginning. Experiments were also carried out on the beam-controlled rf system that will eventually be used.

The main-accelerator rf system is also making progress. A prototype cavity has been operated at 240 kilovolts and 50% duty factor, the design goals.

## Booster

It was, of course, gratifying that the Booster magnets and power supply operated so well. Some electrical-interference problems were uncovered between the magnet power supply and the modulators of the rf system. These problems gave some timing difficulties, which have been circumvented while a more permanent solution is being worked out. In fact, during the initial hours of 1-BeV operation, the Booster magnet power supply was regulated by hand but is now making use of its proper regulation system.

There were also significant gains during February in other Booster activities. Some delay-line modes in the power supply were cured. A method of ganging correction magnets together to produce localized orbit perturbations was put into operation through the computer-control system in a few days. Experiments were carried out with coasting beam to measure the momentum spread. Figure 1 shows a beam signal shortly after injection, while Fig. 2 shows a beam signal after the beam has circulated around the booster and debunched because of the different proton speeds in it. From the rate of debunching, the relative momentum spread is calculated to be $1.4 \times 10^{-3}$. This figure is somewhat lower than that measured by the Linac, but the linac measurement has some transverse emittance contained in it.

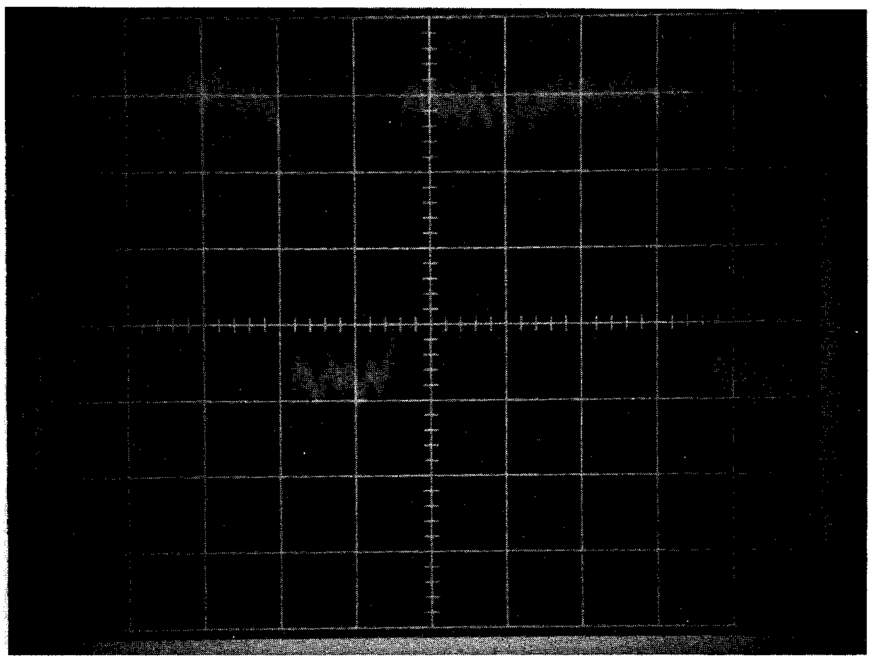

Fig. 1. Coasting beam in the Booster shortly after injection.

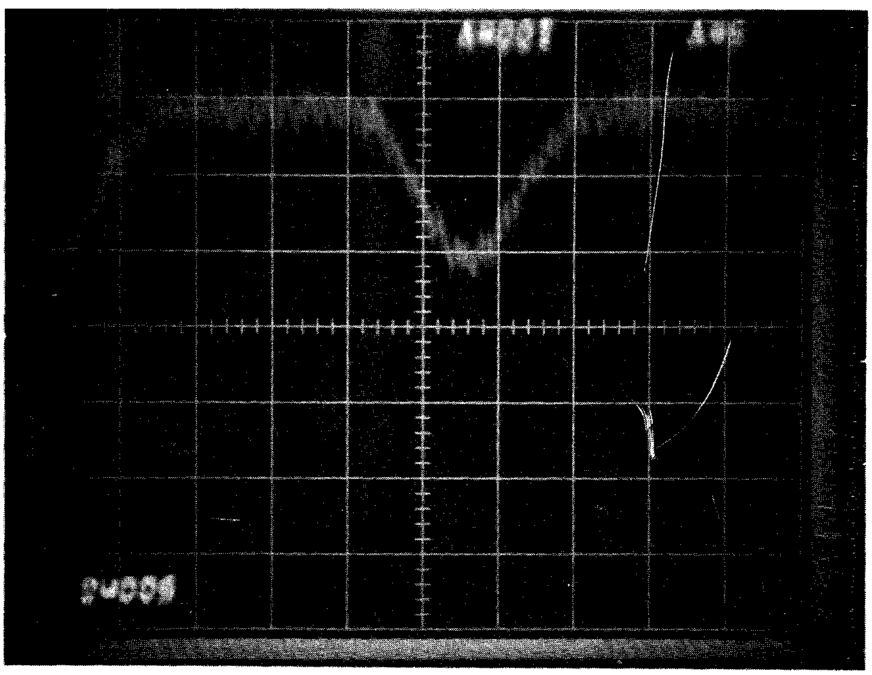

Fig. 2. Coasting beam after some debunching has taken place.

## Main Accelerator

Sector A, the first one-sixth of the main accelerator is operating, as discussed above. It is being powered for the first time by the permanent power lines from the master substation. The power tests have had good results. There is some ripple in the dc injection field because only part of the ring is installed and because the system is operating at field levels corresponding to 1 BeV, rather than the final 8 BeV.

Magnet production rose in February to a record rate of 56 per week. Approximately 530 magnets are now installed.

## Linac

The linac operated as an injector for almost all of February, making reliability tests and training operators. The operation has been so reliable that it has even surprised the people of the Linac Section.

There has been a continuing effort to cure the problems with 200-MeV transverse emittance measurements. A shielded system is now operating utilizing a scintillator and a single wire, rather than the previous three-wire system, which had difficulties with spurious readings from secondary radiation. Figure 3 is an example of vertical emittance at 200 MeV, plotted in several ways. The total phase-space area occupied by the beam is less than the design value of 2.0 milliradian-centimeters.

## Experimental Facilities

The 15-foot bubble chamber construction is cracking along at a good pace. As an example, Figs. 4 and 5 show two states of the vacuum-chamber erection during February.

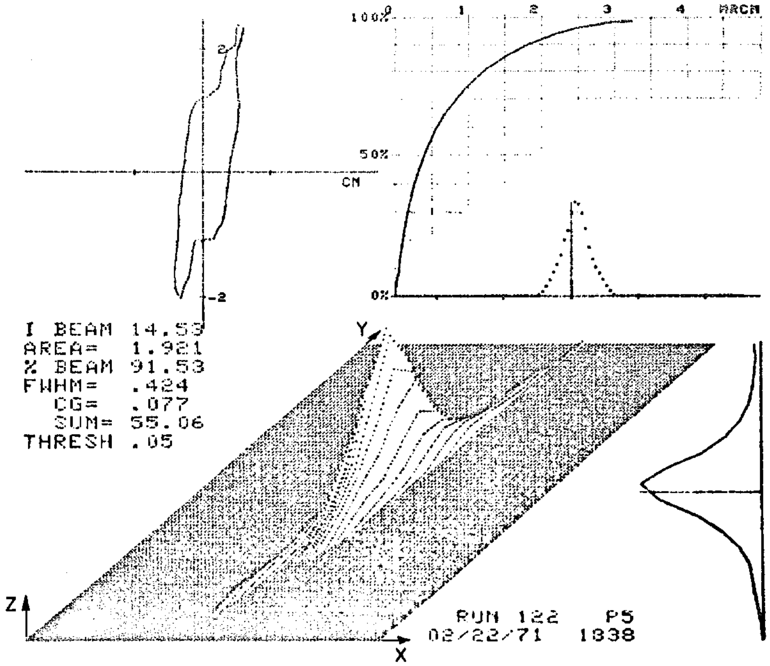


Fig. 3. Computer-produced 200-MeV emittance plot. The three-dimensional isometric plot has vertical displacement on the x axis, angle on the y axis and beam intensity on the z axis. Beam profiles as a function of displacement and angle are at the side and above. A phase plot is at the upper left, while a plot of total intensity included in a given area is at the upper right.

Fig. 4. Field erection of the bubble-chamber vacuum tank. This photo was taken February 24.

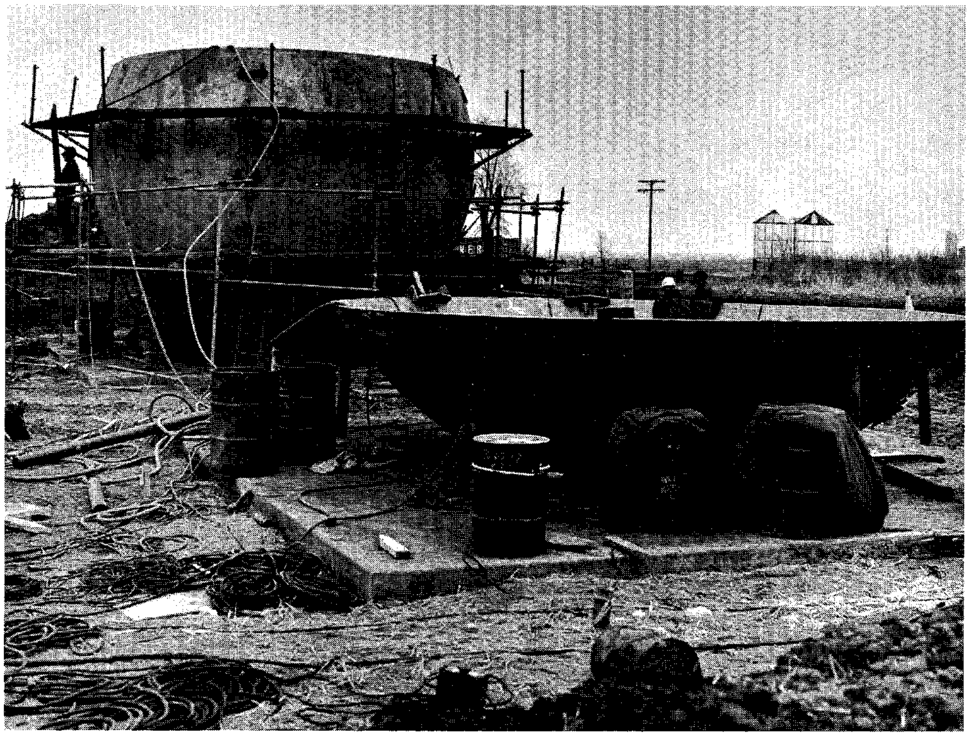

Fig. 5. The bubble-chamber vacuum tank on February 26.

Appointments

Donald Young has been appointed head of a new Operations Section. This section will take over and operate parts of the accelerator as they are completed. This section will eventually be responsible for operation and development of the entire accelerator for research. Philip Livdahl has been appointed to replace Young as head of the Linac Section.

A Controls Group is being formed as part of the Operations Section. Donald Edwards, who has carried out the work on central controls, has been appointed head of this new group.

Roy Billinge has been appointed head of a new Meson Laboratory Section. This section will have responsibility for designing and constructing technical components (magnets, vacuum equipment, beam monitors, and so forth) for the Meson Laboratory. Helen Edwards has been appointed to replace Billinge as head of the Booster Section.

## Construction

Construction progressed in spite of extremely cold weather in the early part of the month and a violent thaw later on. The mud conditions at the end of February are illustrated, with some understatement, in the construction photographs.

a. Main Accelerator. The shielding over the ring is complete except in Sector E. All concrete pads for the electrical substations at the service buildings are finished. The contract is 95% complete.

b. Proton Beam Enclosure. Figure 6 shows the tunnel work in progress. The contract as a whole is 69% complete.

Fig. 6. Proton Beam Enclosure.

c. Central Laboratory. The foundation is finished and concrete is being placed for columns and walls of the ground floor. The work on this first phase is 45% complete and can be seen in Fig. 7.

Fig. 7. The Central Laboratory, looking from near the Linac Building toward the Transfer Gallery.

d. Meson Laboratory. The target-area contract is 23% complete, and the secondary-beam line to the laboratory building is 18% complete. This work is shown in Fig. 8.

e. Neutrino Laboratory. The work until now has been largely excavation, some of which is seen in Fig. 9. The entire contract is 8% complete. Work is also going on at the end of this area on the bubble-chamber area; part of this work is shown in Fig. 10.

Fig. 8. Secondary-beam line tunnels beyond the target area of the Meson Laboratory looking back toward the accelerator. The vertical crane rig beyond is being used for caisson drilling in the target area.

Fig. 9. Excavation for the Neutrino Laboratory, looking along the beam direction. At the extreme left is the work shown in a different view in Fig. 6.

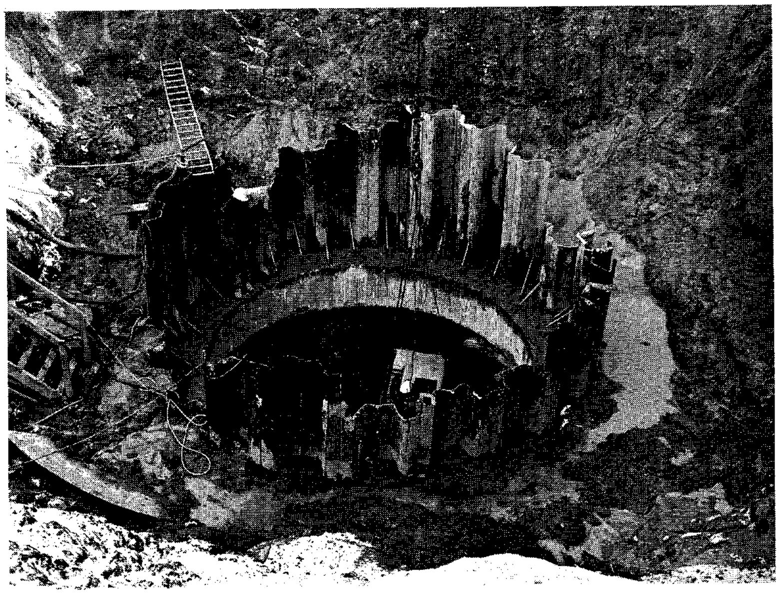

Fig. 10. Bubble-chamber foundation work.

f. Industrial Building. The steel frame of the third Industrial Building has been erected, as can be seen in Fig. 11. Roof and siding installation are in progress.

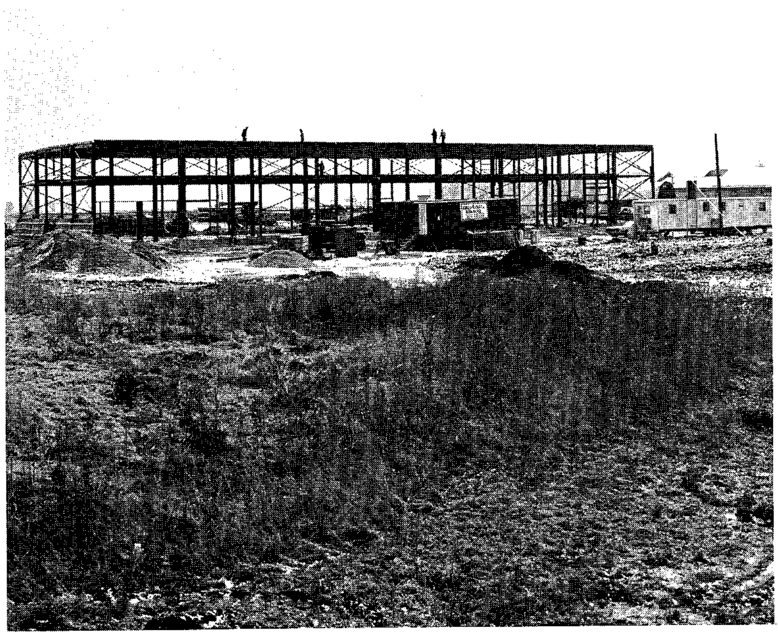

Fig. 11. Progress on the third Industrial Building. The air building, now used as a warehouse, is behind.

## APPENDIX. ADDITIONAL PROPOSALS RECEIVED

104. Measurement of Total Cross Sections on Hydrogen and Deuterium

R. L. Cool, S. Olsen, A. S. Caroll, T. F. Kycia, K. K. Li, D. N. Michael, P. M. Mockett, D. C. Rahm, R. Rubinstein, W. F. Baker, E. J. Bleser, D. P. Eartly, E. Malamud, K. P. Pretzl, S. M. Pruss, J. Schivell, A. A. Wehmann, R. Yamada, and T. Yamanouchi

105. A Proposal to Study Some Characteristics of Proton-Nucleon and Proton-Nucleus Collisions at 400 GeV Using Nuclear Emulsions

R. R. Daniel, S. N. Ganguli, and P. K. Malhotra

106. Proposal For A Study Of Multiparticle Production At NAL Using An Array Of Wide-Gap Triggerable Spark Chambers

B. Cork, G. Smith, R. Sprafka, G. Hicks, S. Meyer, and D. Miller

107. Measurements of Elastic, Quasi-Elastic and Some Inelastic Scatterings of Particles ($\pi^+$, $K^+$, p) and Anti-particles ($\pi^-$, $K^-$, $\bar{p}$) on Protons from ~20 to 60 GeV/c

K-W. Lai, F. Turkot, H. A. Gordon, P. Schubelin, D. Cords, E. Fowler, A. F. Garfinkel, F. J. Loeffler, R. McIlwain, and T. R. Palfrey

108. A Beam Dump Experiment

M. Awschalom, P. Gollon, F. Schamber, D. Theriot, T. Toohig, and A. VanGinneken

109. Unassigned

110. Proposal to Study Multiparticle Peripheral Hadron Physics at NAL

A. Dzierba, R. Gomez, Y. Nagashima, J. Pine, E. Malamud, R. Lundy, D. Bowen, D. Earles, W. Faissler, D. Garelick, M. Gettner, B. Gottschalk, G. Lutz, E. Shibata, E. von Goeler, R. Weinstein, W. Hoogland, P. Schlein, W. Slater, R. Abrams, S. Bernstein, H. Goldberg, S. Margulies, D. McLeod, and J. Solomon

111. Proposal to Study $\pi^- p \rightarrow \pi^o n$ and $\pi^- p \rightarrow \eta n$ at High Energy

R. Gomez, A. V. Tollestrup, R. L. Walker, D. Eartley, O. Dahl, R. Kenney, M. Pripstein, and M. Wahlig

112. Neutron Diffraction Dissociation and Coulomb Dissociation from Various Nuclei

M. J. Longo, H. R. Gustafson, L. W. Jones, and J. vander Velde

113. Proposal to Study the $K^{\pm}$ Charge Exchange Reactions at High Energies

S. L. Meyer, D. H. Miller, and G. Hicks

114. Interaction of 200-500 GeV Proton with Emulsion Nuclei

P. L. Jain