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Progress during FY 1974

W. G. Walker

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PROGRESS DURING FY 1974

Experimental Area Operations

FY 1974 was notable for the major changes in beams available to experimenters and the corresponding new experimental configurations as indicated in Figure #1. There were seven target stations supplying secondary particles, five to electronic spark chamber experiments and two to bubble chambers. During the course of the year, 17 experiments, excluding tests and chemistry, were serviced as indicated in Table 1. Notable items in this effort were:

1. A new "A" line with the "D" branch was constructed.
2. The Medium Energy Separated Beam (MESB) with branches B2 and B4 was commissioned.
3. The Multiparticle Spectrometer (MPS) was commissioned about the middle of the year.
4. The Fast Extracted Beam (FEB) to the 7-ft. bubble chamber was put into operation in November.
5. A new electronic counter facility was added downstream of the 7-ft. bubble chamber.
6. Superconducting magnets were operated in a proton beam for the first time.
7. The EP&S watches were combined with the number of people on each watch being reduced to four from six.

Beam Construction and Experimental Setup

Internal Target at G-10. During the year Beam #2 to the 31 in. bubble chamber was decommissioned in order that beam transport equipment might be used elsewhere. Nuetral Beam #7, inside the ring, was not used during the year and Beam 5-B which had been the short branch of the 3 GeV/c separated beam from the internal target at G-10, was removed in order to make room for Experiment #598.

"A" Target Station. The "A" line with its 0° high energy changed particle beam to the Mark I Double Vee Spectrometer, was removed and a new "A" line constructed to bring a large fraction of the Slow Extracted Beam (SEB) from the A/BC beam splitter to the "A" target of Experiment #598 (MIT/DESY).

"D" Target Station. The "D" target station was constructed late in the year and will receive its protons via the A/D switchyard. Experiment #614 (Stanford/NYU) is located downstream of the "D" target and will alternate running with the "A" station.

"B" Target Station. The two initial Experiments at the "B" target station were successfully completed in FY 1974. In the high momentum, high resolution beam B1, Experiment #555 (Pennsylvania) was replaced by Experiment #635 involving the same experimental group with a greatly modified apparatus. The Princeton/MASS group Experiment #572 in the neutral beam B5 was replaced with Experiment #615 (NYU) which was nearing completion by the end of FY 1974.

The Medium Energy Separated Beam (MESB), a 6 GeV/c kaon and 9 GeV/c antiproton purified beam was commissioned late in the fiscal year. The East Branch B4 is complete to Experiment #546 (Carlton/NRC/McGill/ BNL) which is testing as is the Multiparticle Spectrometer (MPS) in the West Branch B2.

"C" Target Station. The beams from the "C" target station of the SEB remain unchanged with three experiments using the Low Energy Separator Beam (LESB) C2 and C4 and one in the hyperon beam C1. Work commenced on the muon beam in preparation for the next user, Experiment #632 (Rochester).

North Area Beams. Construction of the Fast External Beam (FEB) to the 7-ft. bubble chamber was completed with running of Experiment #427 starting in November. Experiment #605 (Columbia/BNL/ILL./Rockefeller) which was constructed downstream of the 7-ft. bubble chamber ran successfully during the latter part of the year. The radiofrequency separated beam #4 and 80 in. bubble chamber were operated for a series of experiments.

In addition to the above experiments, two test beams, Beam 6B and Beam 7A were available to experimenters for testing and calibration of detectors. Major equipment utilization was as follows:

Item	Inventory	Usage
Magnets	292	75%
Power Supplies	242	77%
DC Separators	12	75%
R.F. Separators	3	5%
Shielding	97^k tons	85%
Experimental Power	75 MVA	70%
HEEP	4500	95%

Major effort of the EP&S Support Groups is briefly described in the following paragraphs.

Experimental Magnet Development Group. Two six foot long superconducting dipole magnets were installed and operated in the proton beam to the 7-ft. bubble chamber. This superconducting system, which operated routinely whenever required either for bubble chamber operation or beam tests, yielded some very significant information concerning superconducting magnets.

1) The magnetic characteristics of the two magnet modules agree with each other and with the theoretical computations.
2) The reproducibility studies indicate that the magnets can be mechanically and magnetically interchangeable.
3) The magnets have the ability to absorb relatively large amounts of beam heating without going normal.
4) The mechanical precision of the two magnet modules compare favorably with that of the best conventional magnets.

A cold bore harmonic search coil was designed and fabricated to make cold bore measurements on the 8^o SC magnet modular. Optimized SC power lead studies were made to observe the effects of heat losses in the system. Also, design and fabrication of a simple model high field pulsed SC magnet was commenced.

During the year this group was also responsible for the operation of the Cryogenic facility where considerable testing was performed on superconducting devices. The facility was also used to purify and liquefy the helium gasses received from the dirty gas recovery systems in the laboratory.

<u>High Energy Electronic Pool (HEEP) Group.</u> During the middle of the year, HEEP moved from Building #426 to Building #922 in order to be closer and provide a better service to the users. The inventory of equipment numbers some 4500 items which are serviced and made available to users on request. In addition the group services experimenters equipment.

FY 1974 can be called the year of CAMAC in HEEP. Several experiments have used the CAMAC equipment with satisfactory results. Failure rates of this equipment appears to be comparable with the NIM equipment.

<u>Cryogenic Target Group.</u> LH_2 target systems, including support structures and positioning devices, were designed for Experiment Nos. 546, 583, 548, 555. Four LH_2 targets were operated on the AGS Floor.

A minimum mass styrofoam vacuum chamber was developed for MPS Experiment #594. The design and fabrication of the system, along with its support structure and positioning table, were tested and readied for installation early in FY 1975.

The LH_2 target for Experiment #598 presented many challenges to the design group. The two overriding design criteria for the target system were, 1) that the liquid in the LH_2 target must be bubble free (no-boiling) 2) that the mass of the target be held to a minimum and that the vessel be thin as possible. In order to satisfy these criteria with seven watts of beam heating, it was necessary to subcool the target liquid and circulate the hydrogen and reject the target heat load into a hydrogen reservoir system. This could have been accomplished by a helium refrigerator, operating at 20^{o} k, as the heat sink. However, with the expense of the refrigerator, transfer lines, and heat exchanger, it was decided to use the reservoir supplied by bulk LH_2 as the heat sink. This system has been successfully tested and is scheduled for installation early in FY 1975.

Work continues on testing various materials for use in liquid hydrogen and deuterium target cup fabrication that will contain the liquid safely with minimum mass. Styrofoam, polyvinyl chloride, phenolic, carbon filament and epoxy were tested. Styrofoam has been selected for use with the MPS target.

A study of automatically controlling liquid hydrogen and deuterium targets has been completed, and design work commenced. It is believed that automation will reduce watch standers for each target and provide safer overall operation.

Beam Instrumentation Group. Efforts were primarily applied to the de-lopment and implementation of computer control and monitoring capabilities related to secondary beam lines at the AGS. This pertains to both hardware and software.

Ninety-two experimental magnet power supply controllers will have been made available for use by the end of FY 74. In the North Area, the FEB to the 7-ft. Bubble Chamber was equipped with this hardware as was beams B1 and B5. Controllers for Beam 4, although available, may not be operational by the end of the fiscal year as this depends on magnet power supply modification progress. Controllers are being provided for magnet power supplies powering the superconducting 8° bending magnet in the FEB. The FEB received equipment originally intended for the MESB at Station B.

Related to this is the fact that a new means of interfacing to magnet power supplies has been adopted and a chassis must now be supplied by a Vendor for use in computer control of the power supply. Two interface units to interface a PDP-11/20 computer to the Datacon 2 serial transmission control system have been constructed and are operational. As of January 1974, one magnet power supply has been operated under computer control.

Datacon 2 single wire monitoring hardware is being designed to monitor the cryogenic equipment operating in the 8° bend of the FEB. Information monitored will be available at the EAO watch station.

A tuning device has been designed which will allow experimenters the ability to hand tune their beamline through the PDP-11/20 computer while it is on-line.

Various pieces of test equipment have been constructed and are in use for testing both computer control hardware and the operations of software.

Programming and software development for the PDP-11/20 has progressed to the point where an initial operating system will be available by the end of the fiscal year. Various software tasks provide for the control, monitoring, and logging functions of magnet power supplies. Beam B1 will be operating on-line under computer control by the end of FY 74. To facilitate further software development, a bulk storage disk has been purchased for use with the PDP-11/20 computer.

Assistance was provided to various experimenters during the year by providing such things as collimator and mass slit controls, shunt monitoring equipment, and scintillation counters. Only the fabrication of scintillation counters will continue on a regular basis during FY 75.

<u>Beam Separator Group.</u> During FY 74, the Beam Separator Group operated and maintained electrostatic DC separators in Beam 5A and LESB C-2/C-4. The RF separated Beam 4 remained in standby mode throughout this period, except for an unseparated test beam run in February 74.

At the beginning of FY 74, the Beam 5A rectangular and cylindrical separator were replaced by a rectangular separator doublet, featuring glass electrodes, ground shields and redesigned cable tips. The voltage on the previous separators was 350 kV and 450 kV respectively on a 4 in. gap. With the new doublet the operating voltage increased to 500 kV at the same gap, representing a voltage increase of 25%. Also, the reliability improved and there was no downtime in FY 74, due to separator problems.

The short separator in LESB C-2/C-4 was operated with 500 to 550 kV on a 4 in. gap. A damaged standoff insulator caused a voltage breakdown which required the removal of the separator for repair.

Construction for MESB B-2/B-4 required approximately 4 1/2 man-years time of Beam Separator personnel. Both separator doublets were installed and operable at full voltage at the end of FY 74.

All beam separator systems were provided with remote metering, status and alarms, this information is transmitted to the experimenters electronics trailer and to the EAO control room. This instrumentation was completed in November and allowed the removal of Beam Separator personnel from around the clock watch duties.

Miscellaneous Items. During the year an EP&S watch was formed to replace the EAO, Target, and Beam Separator watches. This consolidation reduced the number on each watch from six to four people. This reduction was made possible by the automation of the Beam Separators and the combining of group watch functions. Operation of the experimental facilities and service to the experimenters has not deteriorated due to the reduction in watch personnel. Computer control of beam components and automation of targets, which are in progress, should also improve the watch efficiency.

The installation of additional power and water, namely, a six MVA substation and 1000 gpm cooling water was completed and cross connected into the existing EEBA building systems. While these systems were primarily mandated by the MPS, they have in fact, increased the overall flexibility and efficiency of the EEBA area with regard to beams off "B" and "C" target stations.

Fire protection for the electronic trailers has progressed well during the year. Each trailer is now protected with a Halon Extinguishing System inside, and the design for water sprinkling outside has been approved and is in progress.

Distribution: EP&S Division
Department Administration

TABLE #1

Electronic experiments serviced during the past year are tabulated below. Experiments denoted by an asterisk are still in progress.

Internal Target at G10

Beam 5, 1-3 GeV/c electrostatically separated beam

Exp. No.		
607	Yale/BNL	Asymmetry K differential cross section in K^+ backward elastic scattering from a polarized proton target
630	Yale/BNL/CMU	Spin dependent effects in $\pi^- p \rightarrow \pi^+\pi^- n$ in p region

Beam 6, neutral beam

Exp. No.		
620	Rochester/BNL	K* (890) production
*631	Rochester/BNL	K_L radiative decays

Beam 7, neutral beam — No activity

External Targets in SEB

A, Primary proton beam

*598	MIT	$\pi^+\pi^-$, K^+K^-, e^+e^-, $\bar{p}p$ mass spectra in the 1.5 - 5 GeV/c^2 region.

D, Primary proton beam channel

*614	Standord/NYU	Measurement of Lamb Shift in $\pi\mu$ atoms

B Target Station

B1, High energy charged beam

555	Pennsylvania	$\pi^{\pm}K^{\pm}p\ \bar{p}$ -p
*635	Pennsylvania	Cross sections in projectile fragmentation

B2, 4, Medium energy separated beam — 2-6 GeV/c K 2-9 GeV/c $\bar{p}$ Multiparticle spectrometer facility

*594	BNL/CCNY	Production and decay of boson resonances
*546	Carleton/NRC/McGill/BNL	Missing mass measurement of strange meson spectrum in the mass range 1-2 GeV/c^2
628	Syracuse	HD Polarized Proton Target
B5, Neutral beam		
572	Princeton/Mass	Branching ratio for $K_L^o \to \mu^+ \mu^-$
C Target Station		
C1, 6 GeV/c muon beam		No activity
C3, Hyperon beam 23 GeV/c Σ^-, Ξ^-, Ω^-		
*583	Pitt/BNL Mass	Y^{*-} resonances in Σ^- p collisions
C2/C4, Low Energy separated beam .5 - 1.1 GeV/c		
559	Columbia/Yale	X-rays from K^- and $\bar{p}$ stopping in $\bar{p}$ and Σ^- magnetic moment. K^- nuclear interaction. K^- $\bar{p}$ mass
*574	VPI/Wm&Mary/Wyoming/CMU	X-rays K^-, Σ^- and $\bar{p}$ mass. Σ^- and $\bar{p}$ magnetic moments interaction with
*548	Princeton	$\Sigma^{\mp}$ beta decay weak form factor test $\Delta S = \Delta Q$ rule
North Area		
*605	Col/ILL./Roch/BNL	Study of the neutral current in the Leptonic and Semileptonic Processes induced by High Energy Neutrinos

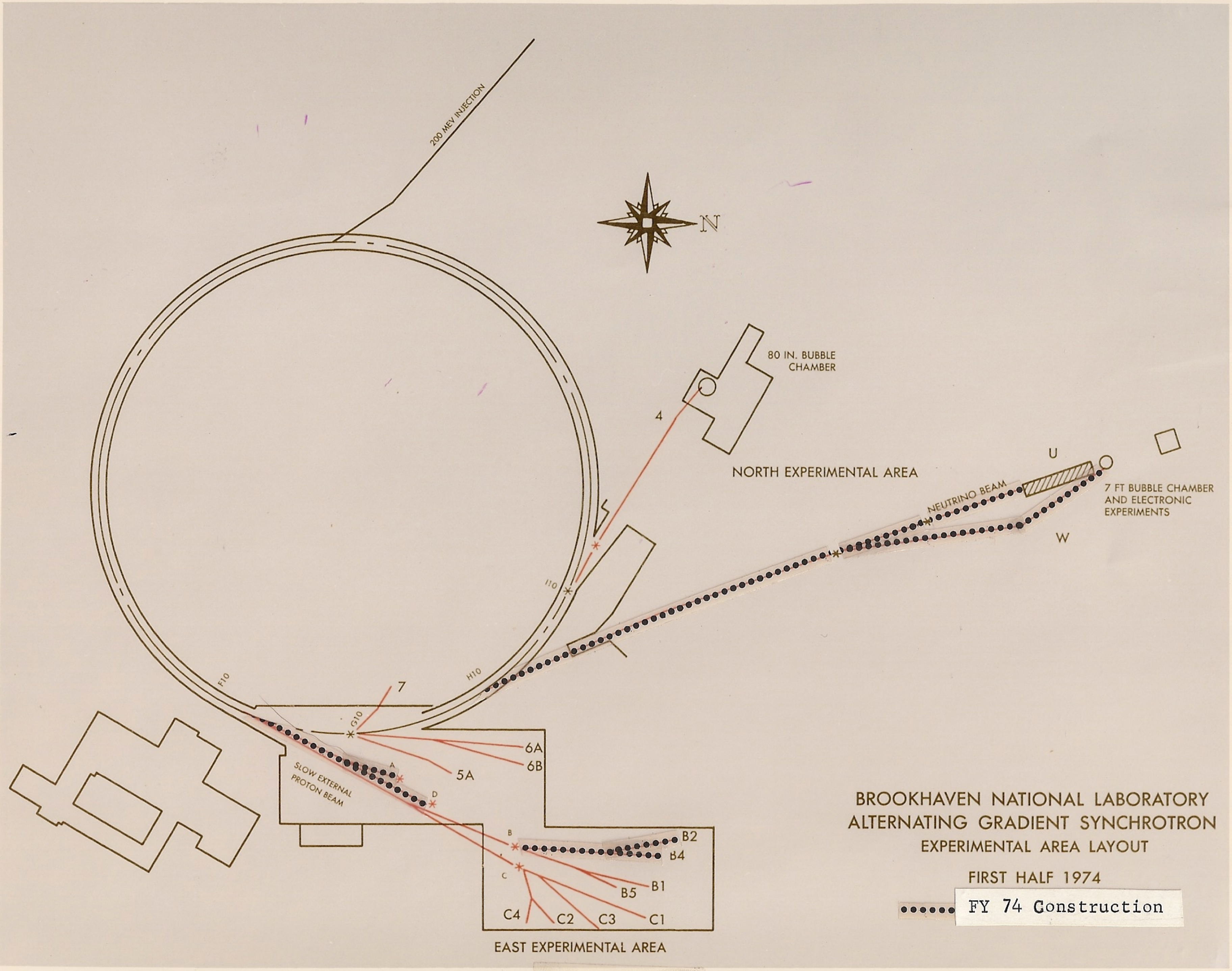
200 MEV INJECTION
N
80 IN. BUBBLE CHAMBER
4
NORTH EXPERIMENTAL AREA
U
NEUTRINO BEAM
7 FT BUBBLE CHAMBER AND ELECTRONIC EXPERIMENTS
W
I10
H10
F10
7
G10
6A
6B
5A
A
D
SLOW EXTERNAL PROTON BEAM
B
B2
B4
C
B1
B5
C4
C2
C3
C1
EAST EXPERIMENTAL AREA
BROOKHAVEN NATIONAL LABORATORY
ALTERNATING GRADIENT SYNCHROTRON
EXPERIMENTAL AREA LAYOUT
FIRST HALF 1974
FY 74 Construction

Figure I.