SLAC-130
UC-28
(SR)

TWO-MILE ACCELERATOR PROJECT

1 October to 31 December 1970

Quarterly Status Report

STANFORD LINEAR ACCELERATOR CENTER
STANFORD UNIVERSITY
Stanford, California 94305

PREPARED FOR THE U. S. ATOMIC ENERGY COMMISSION
UNDER CONTRACT NO. AT(04-3)-400 AND CONTRACT NO. AT(04-3)-515

March 1971

Printed in the United States of America. Available from National Technical Information Service, U. S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22151.
Price: Printed copy $3.00; Microfiche $0.95.

ABSTRACT

A status report on the Stanford Linear Accelerator Project covering the period October 1, 1970 to December 31, 1970 is presented. Topics included are accelerator and research area operations, accelerator and research area equipment development, and physics research equipment development.

Previous reports in this series of Quarterly Status Reports:

SLAC-1,	1 April - 30 June 1962.
SLAC-8,	1 July - 30 September 1962.
SLAC-10,	1 October - 30 December 1962.
SLAC-16,	1 January - 31 March 1963.
SLAC-18,	1 April - 30 June 1963.
SLAC-23,	1 July - 30 September 1963.
SLAC-27,	1 October - 31 December 1963.
SLAC-30,	1 January - 31 March 1964.
SLAC-32,	1 April - 30 June 1964.
SLAC-34,	1 July - 30 September 1964.
SLAC-42,	1 October - 31 December 1964.
SLAC-45,	1 January - 31 March 1965.
SLAC-48,	1 April - 30 June 1965.
SLAC-53,	1 July - 30 September 1965.
SLAC-59,	1 October - 31 December 1965.
SLAC-65,	1 January - 31 March 1966.
SLAC-69,	1 April - 30 June 1969.
SLAC-71,	1 July - 30 September 1966.
SLAC-73,	1 October - 31 December 1966.
SLAC-80,	1 January - 30 June 1967.
SLAC-85,	1 July - 30 September 1967.
SLAC-87,	1 October - 31 December 1967.
SLAC-89,	1 January - 31 March 1968.
SLAC-90,	1 April - 30 June 1968.
SLAC-93,	1 July - 30 September 1968.
SLAC-98,	1 October - 31 December 1968.
SLAC-105,	1 January - 31 March 1969.
SLAC-110,	1 April - 30 June 1969.
SLAC-112,	1 July - 30 September 1969.
SLAC-116,	1 October - 31 December 1969.
SLAC-120,	1 January - 31 March 1970.
SLAC-126,	1 April - 30 June 1970.
SLAC-128,	1 July - 30 September 1970

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

This is the thirty-fourth Quarterly Status Report of work under AEC Contract AT(04-3)-400 and the twenty-eighth Quarterly Status Report of work under AEC Contract AT(04-3)-515, both held by Stanford University. The period covered by this report is from October 1, 1970 to December 31, 1970. Contract AT(04-3)-400 provides for the construction of the Stanford Linear Accelerator Center (SLAC), a laboratory that has as its chief instrument a two-mile-long electron accelerator. Construction of the Center began in July 1962. The principal beam parameters of the accelerator in its initial operating phase are a maximum beam energy of 20 GeV, and an average beam current of 30 microamperes (at 10% beam loading). The electron beam was first activated in May 1966. In August, 1970, a beam energy of 22.1 GeV was achieved. Beam currents up to 70 milliamperes peak have been obtained.

The terms of Contract AT(04-3)-400 provide for a fully operable accelerator and for sufficient equipment to measure and control the principal parameters of the electron beam; in addition, provision is made for an initial complement of general-use research equipment with which it is possible to perform certain exploratory studies, such as measurement of the intensity and energy distribution of various secondary-particle beams.

Contract AT(04-3)-515, which went into effect January 1, 1964, provided support for the various activities at SLAC that were necessary in order to prepare for the research program which is being carried out with the two-mile accelerator, and also provides for the continuing operation of the Center after completion of construction. Among the principal activities covered in the scope of Contract AT(04-3)-515 are theoretical physics studies, experiments performed by the SLAC staff at other accelerators, research-equipment development programs (such as particle separators, specialized magnets, bubble chambers, etc.), and research into advanced accelerator technology.

I. ACCELERATOR OPERATIONS

A. Operating Hours

Manned Hours	October	November	December	Quarter
Physics Beam Hours[1]				
Machine Physics	17	32	25	74
Particle Physics	490	385	390	1,265
Total Physics Beam Hours	507	417	415	1,339
Nonphysics Hours				
Scheduled Downtime (Maintenance, Startup)	26	30	32	88
Unscheduled Downtime (Equipment Failure, Tuneup, etc.)	45	32	56	133
Total Nonphysics Hours	71	62	88	221
TOTAL MANNED HOURS	578	479	503	1,560

B. Experimental Hours[2]

1. Particle Physics

(3) Beam Line	Sched. Hrs. Electronic Experiments (a)	Electronic Experimental Hrs.		% $\left(\frac{b}{a}\right)$	Actual Bubble Chamber Hours	Test and Checkout Hours		Total Experimental Hours	
		Actual Hours (b)	(4) Charged Hours			Act. Hrs.	Chg. Hrs.	Actual Hours	Charged Hours
A	1,389	1,059	1,372	76.2	---	92	77	1,151	1,449
B_N	---	---	---	---	---	22	22	22	22
B_C	---	---	---	---	266	77	77	343	343
B_S	---	---	---	---	---	295	295	295	295
C	833	694	498	83.4	366	524	433	1,584	1,297
Total	2,222	1,753	1,870	78.9	632	1,010	904	3,395	3,406
2. Machine Physics								77	77
TOTAL EXPERIMENTAL HOURS								3,472	3,483

(1) Number of hours accelerator is run with one or more beams excluding accelerator beam tuneup and other nonphysics beam time.

(2) Number of hours an experiment is run including actual beam hours and beam downtime "normal to the experiment."

(3) Refer to Fig. 1 for beam line location.

(4) Charged hours are represented by the formula $T_c = T_0\left(\frac{R+20}{200}\right)$ where T_c = charged hours, T_0 = total hours beam was available to the experimenter for both checkout and data taking, and R = the average pulse repetition rate. Maximum for $\left(\frac{R+20}{200}\right)$ is 1.5 even if the calculated amount exceeds this value.

C. Overall Experimental Program Status

1. Electronic Experiments

Approved research hours at beginning of quarter	3,379
Hours charged during the quarter	1,870
New hours approved during the quarter	2,007
Approved hours remaining at end of quarter	3,516

2. Bubble Chamber Experiments

	40" BC	82" BC
Approved pictures at beginning of quarter	3,122 K	4,248 K
Pictures taken during the quarter	510 K	1,368 K
New pictures approved during the quarter	(862 K)	273 K
Approved pictures remaining at end of quarter	1,750 K	3,153 K

D. Beam Intensity

	October	November	December	Quarter
Peak	65 mA	40 mA	70 mA	70 mA
Average	5.0 μA	2.5 μA	11.8 μA	6.4 μA

E. Klystron Experience

Total Klystron Hours	137,234	108,189	120,221	365,644
Number of Klystron Failures	7	17	8	32

F. Data Analysis

Spark Chamber Events Measured	12,812	13,640	14,341	40,793
Bubble Chamber Events Measured	15,034	18,882	21,545	55,461

G. Computer Operations

Manned Hours

Computation Hours				
SLAC Facility Group	89	75	90	254
Users Groups	464	477	519	1,460
Total Computation Hours	553	552	609	1,714
Noncomputation Hours				
Scheduled Maintenance	117	89	98	304
Scheduled Modifications	9	12	---	21
Unscheduled Downtime and Reruns	13	17	31	61
Idle Time	2	---	---	2
Utility Failure	---	34	---	34
Total Noncomputation Hours	141	152	129	422
TOTAL MANNED HOURS	694	704	738	2,136

H. Special Operating Features

1. Beam Knockout

The beam knockout was run for 185 hours with two beams and for 704 hours with a single beam for a total of 889 hours during the quarter. It was run at 10 and 40 MHz.

2. Power Supplies

The 3.4 MW power supply was run for 225 hours with the 40" bubble chamber, for 474 hours with the 82" bubble chamber and for 34 hours of magnet testing for a total of 733 hours during the quarter.

The 5.0 MW power supply was run for 266 hours with the 40" bubble chamber and for 568 hours with the analyzer magnet in beam line 11 for a total of 834 hours.

The 5.8 MW power supply was run for 392 hours with the 2 meter spark chamber and for 427 hours with the spectrometer magnets for a total of 819 hours.

The motor generator facility was run for 12 hours with the 40" bubble chamber, for 25 hours of magnet testing and for 2 hours with a dummy load for a total of 39 hours.

II. EXPERIMENTAL ACTIVITY

Figure 1 is a research area plan drawing showing the location of the various experiments. Table I is a list of presently approved high energy physics experiments. The right-hand column of Table I gives the status and activity of each experiment during the period.* Figure 2 is a tentative long-range schedule.

The prime users of the accelerator during the period were:

E-48 — Measurement of the ξ Parameter in the Decay $K_L^o \longrightarrow \pi\mu\nu$

E-49b — Inelastic Scattering from D_2 and Other Nuclei

E-50b — Asymmetry in the Photoproduction of π^o Mesons by Polarized Photons

E-56a — A Search for Short-Lived Sources of Neutrino-Like Particles

E-61 — Forward Angle Electron Scattering

CE-67 — Study of $\pi\bar{N} \longrightarrow N\bar{N}N$ at 15 GeV/c

E-70 — Measurement of the Asymmetry in Compton Scattering on the Proton with Linearly Polarized Photons

E-71 — Vector Meson Electroproduction at High Energy

BC-8 — π^+ Meson Exposure in 82" HBC

BC-10 — Study of $K_L^o p$ Interactions

BC-11 — Study of Resonance Production with 9.3 GeV Polarized Photons

BC-19 — 7.5 GeV γ-d Experiment with Polarized Photons in the 82" Bubble Chamber

BC-33 — Study of $\pi\pi$ Scattering, Extrapolation Procedures and Production in $\pi^- p$ Collisions

BC-37 — Investigation of K_2^o Interactions in Deuterium

BC-40 — Study of πp Interactions with Quasi-Two Body Final States

T-12 — Wire Chamber Spectrometer Checkout

T-15 — Lead Plate Proportional Quantameter Test

---

* E-Approved counter experiments
CE-Checkout of equipment associated with counter experiments
BC-Approved bubble chamber experiments
P-Accelerator physics
R-Research area runs
N-Parasite runs
T-General research equipment tests
D-Special short particle physics runs
Y-Beam switchyard tests
S-Survey (usually Health Physics) runs

T-16 — Solid State Counter Tests

T-17 — Streamer Chamber Tests

T-65 — Experiment to Study Electroproduced Hadrons

D-9 — Study of High Energy Magnetic Bremsstrahlung in Pulsed Megagauss Fields

D-14 — Charpak Chamber Tests

D-16 — Tests of Large Sodium Iodide Total Absorption Counters

D-19 — Measurement of Photofission Cross Sections of U 238 and Th 232

NT-14 — Test of Cerenkov Counter for 8 GeV Spectrometer

Y-6 — Test of Intercepting Beam Profile Intensity Monitor

A. Status of Running Experiments

E-48 - Measurement of the ξ Parameter in the Decay $K_L^0 \rightarrow \pi\mu\nu$ - M. Sakitt

The data-taking phase of E-48 ended with the October cycle. Approximately 2.5 million pictures were taken with minimal trouble. About one in five of these has the decay of neutral K. This then requires 500,000 events to be measured. 80% of these events will be measured at Brookhaven National Laboratory and the other 20% at SLAC. The experiment ran smoothly and the quality of pictures improved throughout the experiment. Overall, the experiment appears to have been highly successful. (L. Schwarcz)

E-49b - Inelastic Electron Scattering from D_2 - J. Friedman/M. Breidenbach

E-49b concluded its experimental run during the October cycle. Sets of data were taken at scattering angles of 18^o, 26^o, and 34^o with incident energies between 4.5 and 18 GeV. The data should allow determination of the neutron and proton inelastic form factors at high four momentum transfers.

All of the apparatus, including the accelerator and beam switchyard, performed exceedingly well this cycle. The 8 GeV/c spectrometer was used down to a scattered electron momentum of 1 GeV/c, and the rebuilt Cerenkov counter, with the total absorption and dE/dX counters, should allow satisfactory pion-electron discrimination even at the low momenta. The 1.6 GeV/c spectrometer was used to monitor the hydrogen and deuterium target density to an accuracy of better than 1%. (M. Breidenbach)

E-50b - Asymmetry in the Photoproduction of π^o Mesons from Hydrogen by Polarized Photons - B. Wiik

During the November cycle we collected data on the asymmetry in π^o photoproduction with polarized photons using the SLAC polarized beam facility. The

process was identified by detecting the photons from π^0 decay in coincidence with the recoil proton. The asymmetry was determined for values of the four-momentum transfer t from -.2 $(GeV/c)^2$ to -1.4 $(GeV/c)^2$ with the polarized spike at 4, 6, and 10 GeV. The run was very successful and completes the data taking part of the experiment. If the asymmetry A is defined as $A = (\sigma_\perp - \sigma_\parallel)/(\sigma_\perp + \sigma_\parallel)$ with $\sigma_\perp(\sigma_\parallel)$ being the cross section for photons polarized normal (parallel) to the reaction plane, then the measured asymmetry is near +1 at large and small t-values with an indication of a dip near t at $\simeq$ -.5 $(GeV/c)^2$. (B. Wiik)

E-56a - A Search for Short-Lived Sources of Neutrino-Like Particles - M. Schwartz

This experiment was designed to search for new sources of highly penetrating neutral radiation. Among the possibilities which were considered in the original proposal and in subsequent discussions were : (a) Short-lived neutrino sources such as heavy leptons and intermediate bosons. (b) Neutral, neutrino-like objects having magnetic moments. (c) Photon-like particles coupled to conserved quantum numbers like strangeness. The experiment is carried out by allowing the full beam to enter the beam dump and looking downstream after about 200 feet of earth shielding. A hole 35 feet deep was excavated behind the hill of the beam dump and 20 tons of spark chamber with trigger counters were placed therein.

During the October cycle we ran for a number of days, mostly parasitically, looking for events which are synchronous with the accelerator and which trigger our counter banks. Part of this data was taken with the beam passing through a two radiation length water target 75 feet upstream of the dump. In this data, particularly at 18 and 19 GeV, a number of events which are quite hard to explain in terms of the expected neutrino background were observed. Calculations indicate that about one neutrino interaction per coulomb with a typical neutrino energy of the order of 1 GeV would be expected. Indeed this appeared to be the rate and in fact, with the water target, three conventional neutrino events, as expected were obtained. The unusual events appear offhand to fall into two categories: (1) High multiplicity stars with a large mesonic component. The multiplicity would indicate that one must have at least four or five GeV neutrinos to make these and even for such neutrinos they would be highly anomalous. The October data contains six such stars. (2) Events

having no visible muon. There are two clear cases of this at 18-19 GeV and one uncertain case at 17 GeV. No unusual events were seen in the running below 15 GeV and no unusual events appeared during the run with the water target. There seems then to be some real indication that the unusual events are not of neutrino origin.

A little over a week's running time was taken at the beginning of the December cycle. During this period four types of data were taken in an effort to clarify the nature of the events which have been found in the prior runs. (1) A short machine pulse (100 nsec) was used to ascertain the times of arrival of the pulses in the trigger counters. The pulses appeared after an additional 100 nsec delay (in addition to that calculated for the direct path through the earth) indicating that the majority of the counter pulses were soft photon skyshine. (2) More water target data. (3) More beam dump data, and (4) using a 3 r.l. tantalum target placed directly in front of beam dump east. While additional events were obtained, there were no obvious trends. The data are presently being scrutinized in detail. (D. Fryberger)

ND-14 - Proportional Wire Chamber Development - E. Bloom; N-61 - Forward Angle Electron Scattering - R. Taylor

In the October cycle, we made the final C-beam checks on the proportional chambers to be used in E-61. Six chambers were checked out and deemed acceptable. ($\sim$99% efficiency into a 30 nsec gate.) Two and three chambers were run simultaneously, read by a PDP 8, and the output tracks stored on magnetic tape for offline analysis. The offline indicated excellent track reconstruction with the chambers, and the final decision was made to use the chambers in E-61.

The proportional chambers were installed in the 20 GeV spectrometer and checkout of the system of instrumentation required for the experiment proceeded during the November cycle.

While the results of these checkouts are encouraging, the work in the November cycle did not go as we had hoped in a number of respects. The computer (SDS 9300) we were given by Spectrometer Facilities Group did not work until the last week or so of the cycle, and, hence, not much was accomplished without online programs for E-61. We did get the wire chambers going and some fast electronics setup done. However, due to lack of sufficient time and the

low beam intensity used by the prime experimenters, we failed to complete our planned checkout. (E. Bloom - R. Taylor)

E-61 - Forward Angle Electron Scattering - R. E. Taylor

In a continuation of the single-arm inelastic electron scattering program, measurements were made in December with the 20 GeV spectrometer at 4^{o}, incident energies from 7 to 20 GeV and with a variety of targets.

There were several experimental changes compared with previous Group A experiments. For the first time, proportional wire chambers (Charpak chambers) were used as the hodoscopes, replacing the scintillation counter hodoscopes. Altogether, five were used, three giving vertical positions and two giving horizontal positions, and they performed very well. In addition, the spectrometer momentum was automatically stepped in small intervals down the spectrum. This was done under computer control, and it significantly increased the fraction of the time that was devoted to data acquisition.

In order to determine the A-dependence of the total cross section for virtual photons, measurements were made at a number of points in the (q^2, ν) plane from targets of beryllium, aluminum, copper and gold. These will be compared with the A-dependence for real photons and with the predictions of the vector meson dominance models of high energy photon interactions.

Another goal of the experiment was to extract the cross section for inelastic electron-neutron scattering by comparing scattering from liquid hydrogen and liquid deuterium targets. We experienced some difficulty with boiling in the hydrogen target, and these measurements will be completed in the March cycle after the targets are reworked. (H. DeStaebler)

E-67 - Study of $\pi N \longrightarrow N\bar{N}N$ at 15 GeV/c - D. Leith/H. Lynch

Data taking in the 15 GeV/c π^- beam was completed in October and November. Approximately 3000 events of the reaction $\pi^- p \longrightarrow p\bar{p}n$ were found in a preliminary survey of the data. These events have a $\bar{p}p$ mass ranging from 1.90 to 2.50 GeV/c^2, and they represent a surprizingly large cross section, being almost as large as that for the reaction $\pi^- p \longrightarrow K^+K^-n$. Detailed data reduction is in progress.

The wire spark chambers performed well, and the large Cerenkov counter was found to have an efficiency of 99.99% for 8 GeV/c pions. Use was made of the SLAC central computer, IBM 360/91, for monitoring the apparatus during this running period. (H. Lynch)

E-70 - Measurements of the Asymmetry in Compton Scattering on the Proton with Linearly Polarized Photons - B. Wiik

The asymmetry in proton Compton scattering with polarized photons was measured for the polarized "spike" at 6 and 12 GeV and for values of the four-momentum transfer t in the range from $-.2$ $(GeV/c)^2$ to $-.6$ $(GeV/c)^2$. This asymmetry is directly related to the s-channel helicity flip amplitude of the photon. In this experiment the process is identified by detecting the scattered photon in coincidence with the recoil proton. Contamination due to π^o decays was experimentally subtracted by moving the photon counter out of the coplanarity plane defined by the incident photon and the recoil proton. A very preliminary analysis of the data seem to indicate some asymmetry at the lower energy and is consistent with no asymmetry at 12 GeV. The experiment will be completed in May 1971. (B. Wiik)

E-71 - Vector Meson Electroproduction at High Energy - C. L. Jordan

This experiment is a study of the reaction ep $\rightarrow$ ep X where the electron is measured in the 20 GeV spectrometer, and the proton is measured in the 1.6 GeV spectrometer. During the December cycle, we checked out the detector system built for this experiment for the 1.6 GeV spectrometer in ESA. The detector worked excellently allowing us to separate the pions and protons with high confidence. Singles counting rates were measured for the settings to be used in the prime experiment in order to calculate incident beam currents needed. Elastic e-p scattering was measured to calibrate the solid angle of the apparatus. The hodoscopes allowed us to correct the timing of two tubes looking at different ends of the trigger counter (~ 50 cm $\times$ 30 cm) such that the difference in the timing information was a distribution about .6 nsec wide at half height. Pulse height information was recorded for each event on tape and will provide a further correction. The new XDS 3900 in ESA was used with good reliability, and the main software for the January cycle was debugged. (C. L. Jordan)

BC-8 - Exposure of the 82-Inch Hydrogen Bubble Chamber to a Beam of π^+ at 7.0, 11.0, and 14.0 GeV/c at SLAC - D. Carmony

The exposure in October of 273,261 pictures of 13.1 GeV/c π^+p was an extension of earlier work, specifically to study the boson resonances seen in the 1.5 - 3 GeV mass region. Further information on spins and parities and on branching ratios is expected. The three strip single strip film format was used. (R. Gearhart)

BC-10 - Investigation of $K_2^o p$ Interactions with the 40-Inch HBC - D. Leith

During the December cycle BC-10 took 350 K pictures of $K_2^o p$ interactions in the 40" HBC. The experiment used the scintillation counter hodoscope surrounding the bubble chamber body to detect the interaction products of $K_2^o p$ events, and to measure the flight time of the initiating K_2^o. Some 200 K pictures were taken running the HBC at 2 pps and logging the counter data on tape. A further 100 K pictures were taken triggering the HBC flash on the occurrence of a $K_2^o p$ interaction with K_2^o momentum less than 2.5 GeV/c. This triggered HBC aspect of the experiment went very well and promises to be a useful new technique of data acquisition with this bubble chamber. Finally, another 50 K pictures were taken with the HBC pulsing at 4 pps and the flash triggered by the counter system. Unfortunately, a large fraction of the film was badly developed and will be of marginal use for the semi-automatic measuring machine. As a result we plan to continue BC-10 during the early portion of the January accelerator cycle. (D. Leith)

BC-11 - Study of Resonance Production with 9.3 GeV Polarized Photons - G. Wolf

In the December cycle 248,000 pictures of 9.5 GeV γ-p were taken in the 82" hydrogen bubble chamber using the Compton scattered laser beam with light from the ruby laser doubled in frequency. This is the first experimental use of the laser following extensive modification. In particular, the yield of blue light was increased by lengthening the cavity and using an ADP crystal inside the cavity, both of which decrease the instantaneous power carried by the laser for a given blue yield. About 100 photons/burst were available so the system runs smoothly at the desirable intensity of $\sim$70/burst.

With this run we require only 150,000 more pictures to reach the approved total of 800,000 pictures. (G. Chadwick)

BC-19 - γ-d Experiment with an Annihilation Beam of 7.5 GeV in SLAC 40" Bubble Chamber and with Polarized Photons in the 82" Bubble Chamber - A. Levy

This experiment was originally proposed for running in the annihilation beam into the 40" bubble chamber. With the approval of the experimental group the experiment was rescheduled into the 82" chamber for an exposure with the laser induced gamma beam. Several attempts have been made to complete this experiment and each time the 82" chamber has failed prior to or early in the

BC-19 run. In this cycle 22,618 pictures were taken before failure of the bubble chamber; earlier they had obtained some 28,000 out of an approved 200,000. The run is now scheduled to be completed in March 1971. (R. Gearhart)

BC-33 - 300,000 Pictures, 4.5 GeV/c π^- in H_2, 82-Inch Bubble Chamber - W. Selove

An exposure of 150,314 pictures was taken in the 82" bubble chamber of a 4.5 π^- beam. The 3-track 35 film format was used. 39,802 pictures were declared unacceptable due to camera induced errors. The typical flux was ~10 tracks/picture, permitting measurement with an HPD system. The film is to be developed at BNL and no preliminary results are yet available. 254,319 pictures were taken during the October accelerator cycle. This completes the planned exposure. (R. Gearhart)

BC-37 - Investigations of K_2 Interactions in Deuterium with the SLAC 40" Bubble Chamber - H. Taft

Of primary interest in this experiment is the study of exchange processes in K^- nucleon interactions in order to determine the magnitudes and phases of the t-channel amplitudes as functions of s and t. For reactions in which only the K and the exchanged particle are involved at one vertex, the exchanged particle has natural parity. For reactions involving K* production, further decomposition into trajectories having natural or unnatural parity is possible.

Other reactions of particular interest are of the form

$$K_2^o + d \longrightarrow K_1^o \text{ (or } K_1^* \text{ or } K_2^*) + d \text{ (or } n + p)$$

The picture taking phase of the experiment was concluded during the November cycle. 132,498 pictures were taken (approval had been granted for 125,000). The 40" bubble chamber was pulsed at the rate of 3/sec after a prolonged shutdown. (R. Gearhart)

BC-40 - Study of πp Interaction with Quasi-Two Body Final States - B. Feld/I. Pless

The experiment is a study of πp interactions leading to quasi-two body final states in order to extract the ω, B, A_1, A_2, π Regge trajectories. Vector meson exchange reactions will be studied to test absorption models, and the region of boson resonances above 1.5 GeV/c^2 will be inspected in the light of quark model predictions. A request for 1,600,000 pictures has been made and approval for 860,000 granted.

The experiment ran in both October and November, 1970 and to date has some 563,000 useful pictures. The film format is the 3-strip, 35 mm. Running in both months was terminated due to bubble chamber vacuum failures.

T-12 - Wire Chamber Spectrometer Checkout - S. Wojcicki

The checkout runs were made in October, November, and December. Four chambers have been run simultaneously to measure chamber efficiency (single track and multiple track), and chamber resolutions. While the chamber efficiency is still somewhat low (>95%) the efficiency does appear to be independent of the number of tracks in the chamber. Analysis of preliminary track reconstruction distribution also indicate a good chamber resolution ($\sim 1/2$ wire spacing). The checkout work will continue in January. (D. Fryberger)

T-15 - Lead Plate Proportional Quantameter Test - D. Yount

Preliminary tests were made on a wire proportional chamber system. The group, including S. Parker of the Moyer/Helmholz group and M. L. Stevenson, Group A, UCLRL, Berkeley, expects to complete the assembly and testing in January 1971. Running time in December was limited to one shift. Preliminary results indicate that the chamber pulse height tracks the pulse height from an adjacent scintillator quite well over a range of 1 to ~ 50 particles, generated by showering single 12 GeV electrons. (R. Gearhart)

T-16 - Test of Counter Controlled Bubble Chamber Photography - J. Murray/ I. Pless

A collaboration of MIT, University of Washington, and SLAC made further tests on a collimated beam into an array of counters placed within the 82" liquid hydrogen bubble chamber. The object is to define five separate channels and to take a bubble chamber photograph only if one of the channels has a single track interacting in the chamber, insuring that every photograph has at least one event.

The test was done parasitically to the data taking phase of E-67 (15 GeV/c π^- — a portion of the beam lines are common).

A total of 22,613 pictures were taken out of a total of 388,171 expansions. The film is presently being analyzed at MIT and the University of Washington. (R. Gearhart)

T-17 - Streamer Chamber Tests - R. Mozley

During November tests were made on a new Blumlein transformer for pulsing the two-meter streamer chamber. It was necessary during part of these tests to have tracks in the chamber and the K^o beam was reactivated for a few hours for this purpose. (R. Mozley)

T-65 - Study of Electroproduced Hadrons - W. Toner

In December, we had two very successful short tests of less than a shift each, of the first part of the beam line for E-65. This part of the beam line is designed to attenuate the primary electron beam for a factor of 10^5 and redefine the beam momentum. The beam was taken into end station B and dumped in a quantameter which was used to measure the intensity.

The tests showed that there were no gross errors of alignment or design, that setting up is straightforward and that beam stability is quite good. Small modifications to the system will be made to improve it further for subsequent cycles. (W. T. Toner)

D-9 - Study of the High Energy Magnetic Bremsstrahlung in Pulsed Megagauss Fields - T. Erber

The data taking phase of the magnetic bremsstrahlung experiment was terminated at the end of the October cycle. The condenser bank was gradually brought up to full energy. Satisfactory emulsion exposures were obtained in a series of coil shots with field intensities ranging up to 1.7 MG and electron beam intensities in the range 10^3 to 2×10^6 e/pulse were carried out. Four electromagnetic (Cnare) implosion experiments were also completed. After two tuneup shots, excellent results were obtained at 1.7 and 2.1 MG. (For these shots the capacitor bank was at only 50% energy.) Preliminary results confirm that the walls of the imploding foil in the Cnare implosion do not impair the bremsstrahlung experiment. A coil shot with a small emulsion stack mounted within the coil was fired, producing a field intensity of ~1 MG. Results indicate that the emulsion was undamaged. (T. Erber)

D-16 - Tests of Large Sodium Iodide Total Absorption Counters - E. B. Hughes

In the October cycle the HEPL group spent six days studying two problems.

1. The response to electrons in the range 4 - 15 GeV of range NaI (Tl) total absorption detector. This detector had recently been reassembled in a mount with improved optical properties and a distinct improvement in the available energy resolution was seen. Resolutions of 0.7% (FWHM) at 15 GeV and 1.3% (FWHM) at 4 GeV were observed, both close to the limits set by fluctuations in shower leakage from the volume of this detector.

2. The frequency with which shower components backscatter from a total absorption detector in such a way as to trigger a large plastic scintillation counter placed close to the entrance face of the detector. This measurement

was needed in design studies for a large gamma ray telescope which is scheduled for launch into space in 1975. (B. Hughes)

D-19 - Measurement of Photofission Cross Sections of Uranium 238 and Thorium 232 - G. Svensson

There are large uncertainties in previously reported photofission cross sections due to the energy dependence and the difficulty in unfolding a typical bremsstrahlung spectrum. It is expected that much improved measurements can be made using the Compton-scattered laser beam. Placement of the foils in front of the final collimator gives an energy-spatial relationship such that differential cross sections can be measured.

A preliminary exposure done parasitically during BC-11 early in December 1970 indicated a photofission cross section of 17 ± 5 millibarn in the energy interval 2 to 10 GeV. Statistics on this sample were too poor to have measured differential cross sections; however, a more complete exposure was performed later in the December cycle and is now being analyzed. (R. Gearhart)

NT-14 - Test of Cerenkov Counter for 8 GeV Spectrometer - D. Sherden

Tests were performed on the 8 GeV spectrometer gas threshold Cerenkov counter, which has recently been modified to operate under positive pressure in order to detect pions above 2 GeV. Pressure curves on pions indicate that the counter will efficiently detect pions down to 1.9 GeV/c when filled with Freon-12 at 3 atmospheres absolute. (Equivalently one can detect electrons at 0.6 atmospheres). The absolute efficiency for detecting electrons at 1 atmosphere was measured to be 0.99 ± 0.01. (D. Sherden)

Y-6 - Test of Intercepting Beam Profile Intensity Monitor - D. Walz

An initial test of an intercepting beam profile intensity monitor was performed. The instrument consists of an array of thin tungsten ribbons and utilizes the shower emission effect.

The use of secondary emission monitors is widespread for beam monitoring purposes. Unfortunately, the efficiency is only about 3% per surface or 6% for a foil. This severely restricts application of such foils to high-intensity beams. In the case of the tested shower emission monitor the signal is due to the difference between intercepted and newly created secondary electrons leaving the tungsten ribbons. Multiplicity in tungsten at SLAC energies is substantial even for thin foils and it is not too difficult to obtain signals which are in magnitude

comparable to the intercepted beam current. The monitor used 10 closely spaced (.005 inch apart) ribbons with a width of .005 inch and a depth (in beam direction) of 2 radiation lengths. The incident beam energy was 10 GeV, the peak current 3 mA and the pulse width about 1.1 μsec. Data were taken at pulse repetition rates of 1 and 10 pps. With the beam centered on one of the ribbons the largest signal observed was approximately 5 times that of the current intercepted by the ribbon. The instrument has a wide range of application and will be further developed to make it fully radiation resistant and to allow for high-intensity beams.

B. New Experiments

During the November 13 - 14, 1970 meeting of the SLAC Program Advisory Committee, experiments E-72, E-73, E-75, and BC-43 were approved. BC-43 had been previously approved for π^+ incident particles; a change to π^- was approved at this meeting. A request for additional time for E-56-A Supp. 1 was approved.

The next scheduled meeting of the SLAC Program Advisory Committee will be held on February 5 and 6, 1971 . The next meeting after that will be in May 1971.

Summaries of Newly Approved Experiments

E-72 - Study of Hadronic Final States in Deeply Inelastic Muon-Nucleon Scattering - C. Heusch

The purpose of this experiment is to study deeply inelastic muon-proton scattering using a liquid hydrogen target in the SLAC streamer chamber. While the SLAC spectrometer experiments have given extremely suggestive results measuring the total virtual-photo-excitation cross section only, this experiment will allow us to study the dependence of dominant hadronic channels on energy loss and momentum transfer, and possibly detect less prominent but significant admixtures to the leading amplitudes. 300 hours of prime running time at 120 pps (or 600 hours at 60 pps) will give us ~3000 events in the deep inelastic (scaling) region; including resonance production, we get ~5000 events with $q^2 \geq 0.5$ (GeV/c)^2, $\nu^2 \geq 2$ GeV, at 12 GeV incoming muon energy. In addition, we will collect about twice this number of events for $q^2 < 0.5$ (GeV/c)^2, large ν.

E-73 - Measurement of the Cross Section of Phi-Photoproduction on Hydrogen with Unpolarized and Polarized Bremsstrahlung - B. Wiik

Data on phi-photoproduction are relatively scarce due to the small cross section and the high mass of the phi, but the presently available data indicates a predominantly diffraction-like behavior. Since the phi-meson has the same quantum numbers as the photon this is not very surprising, and in fact phi-photoproduction can (in the vector meson dominance model) be related to the elastic scattering of transversely polarized phi-mesons on the proton.

As first pointed out by Freund and recently by Barger and Cline ϕp elastic scattering is expected (in contrast to other elastic scattering processes) to proceed only by Pomeranchuk exchange. This follows directly from the quark model with the phi made up of two strange quarks, and it is supported by experimental evidence showing the phi to be remarkably decoupled from nonstrange hadrons. Therefore the phi-photoproduction data should determine the parameters of the Pomeranchuk trajectory $\alpha(t)$ where t is the square of the four momentum transfer. A least squares fit to the earlier data yields $\alpha(t) = (.65 \pm .22) + (.06 \pm .37)t$, but the data are not sufficiently accurate either to reject or confirm the usual Pomeranchuk trajectory. It is at present generally believed that the Pomeranchuk trajectory has an intercept of 1 and a slope of about .4 $(GeV/c)^{-2}$.

This is an experiment to make accurate measurements on the photoproduction of the phi in the energy range from 8 to 16 GeV and for t from -.1 (GeV/c^2) to -1.0 $(GeV/c)^2$. To determine what fraction of the phi's is being diffractively produced the cross section will also be measured with linearly polarized photons at 10 GeV. This will also be a good test on the recent conjecture by Gilman et al., that Pomeranchuk exchange conserves s-channel helicity.

The measurements will be done by detecting the K^+K^- decay mode of the phi in coincidence with recoil proton. Since the mass of the K pair is close to the mass of the phi, the transverse momenta and the corresponding solid angle are rather small. In principle the three momentum of the recoil proton uniquely defines the photon energy k as well as the momentum transfer t for a two-body reaction. However, because of the background caused by the production of lower mass states, the increase in yield due to the onset of phi-production is typically only a few percent of the total yield. Detecting the K^+K^- decay mode in coincidence with the recoil proton will eliminate this background and by using

the gas target the cross section will be determined at smaller t-values than previously possible. The value of t will be determined uniquely by the proton spectrometer. The photon energy k as well as $\Delta k/k$ will be determined by the K detector.

E-75 - Study of the Q Region in $K^+p \rightarrow K^+\pi^+\pi^-p$ for Incident $K^+ > 9$ GeV/c - R. K. Carnegie

This is an experiment to study the reaction $K^+p \rightarrow K^+\pi^+\pi^-p$ in the Q region of $K\pi\pi$ mass for several incident K^+ momenta between 9 and 15 GeV/c. The Q region consists of a large $J^P = 1^+$ enhancement in the I = 1/2 ($K\pi\pi$) system in the region 1000 MeV < M($K\pi\pi$) < 1500 MeV, which decays predominantly through $K^*\pi$ and $K\rho$ final states. Previous experiments have varied considerably in the interpretation of the exact structure in this region. About 40,000 $K^+\pi^+\pi^-$ events will be collected at several K^+ beam momenta with a mass resolution $\sim$6 - 7 MeV. This will permit a much more detailed investigation of the mass spectrum and its possible variation with beam momentum together with the phenomenological determination of the $K^*\pi$, $K\rho$, and other final state amplitudes as a function of ($K\pi\pi$) mass. This experiment will also collect data on a number of other interesting reactions which will enable a search for exotic resonances in K^+K^+ and $K^+\pi^+$ final states, and a study of $K^*\rho$ resonances in the channels $K^+K^+K^-$, π^+K^0, and $p\bar{\Lambda}^0$. The detector for the experiment is a new larger aperture version of the wire chamber spectrometer system used previously to study $\pi^-p \rightarrow \pi^+\pi^-n$, $\pi^-p \rightarrow K^+K^-n$, and $\pi^-p \rightarrow \pi^+\pi^-\pi^-p$ at 15 GeV/c.

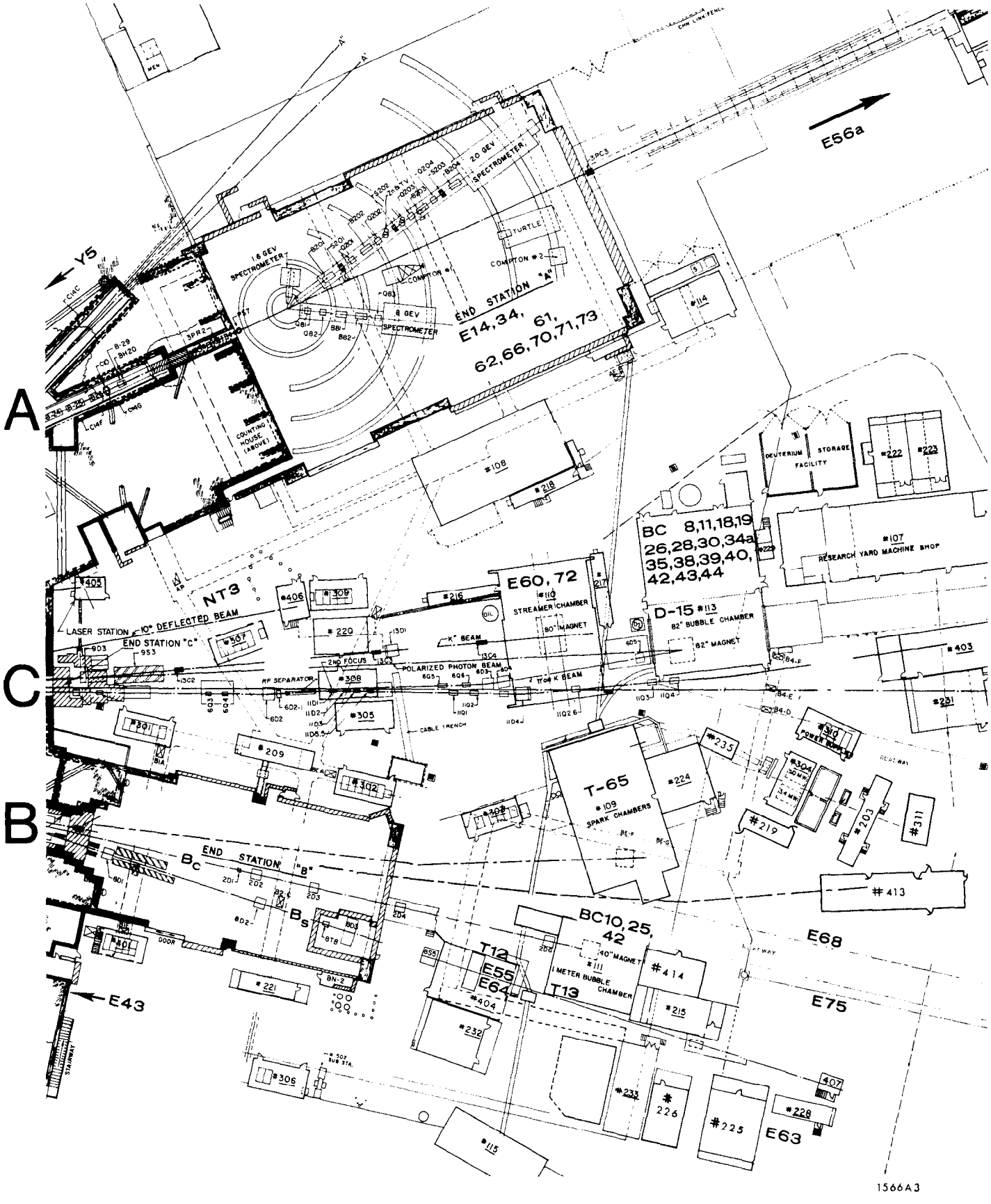

FIG. 1--Experiment locations.

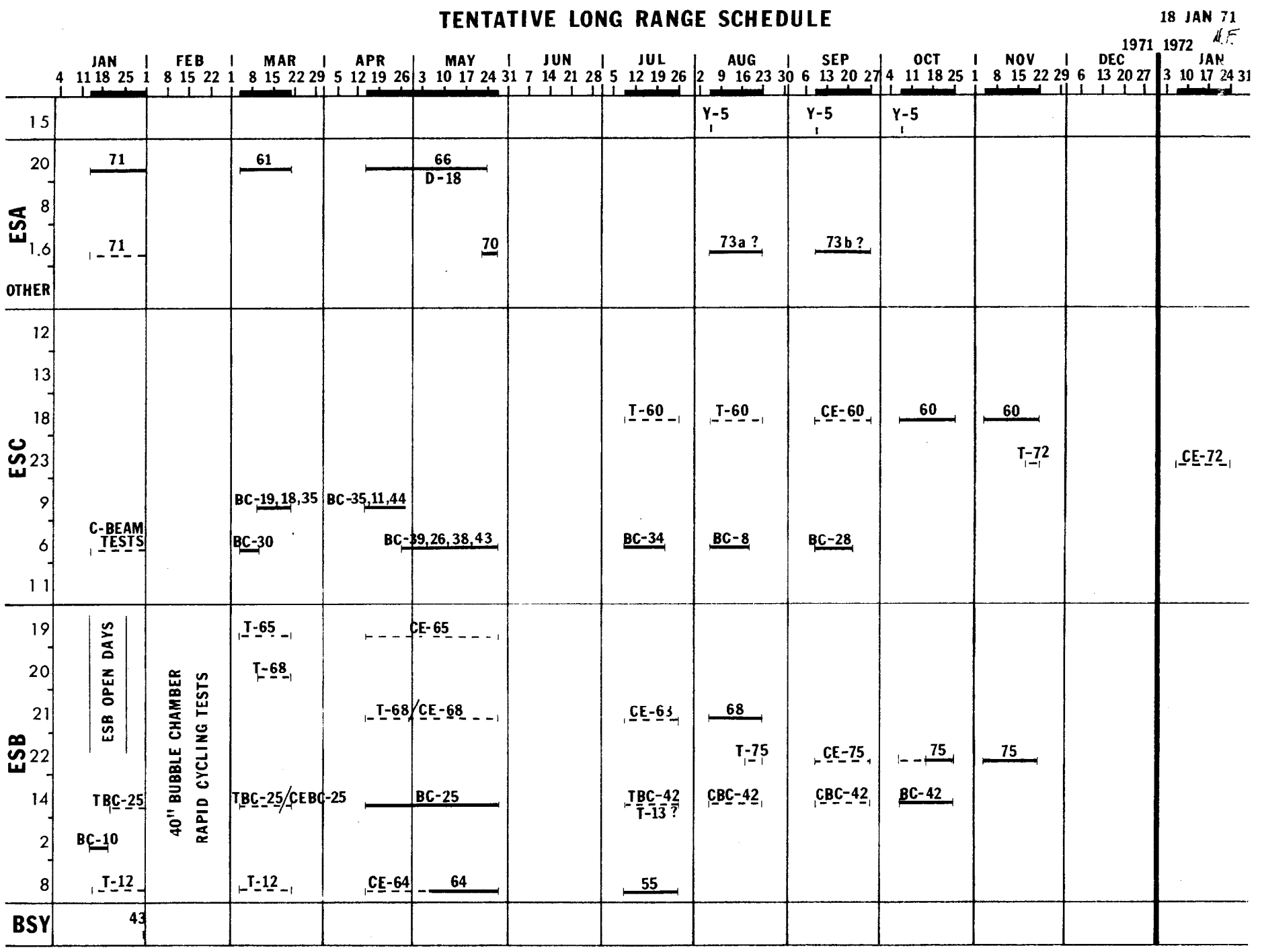

FIG. 2--Tentative long-range schedule.

TABLE I

TABLE OF PROGRAMMED EXPERIMENTS

Number	Title	Authors	Date Approved	Status
E-14	Test of Quantum Electrodynamics by Photoproduction of Asymmetric Muon Pairs	SLAC (Group A) W. Panofsky, D. H. Coward H. DeStaebler, J. Litt, A. Minten, L. W. Mo, R. E. Taylor MIT J. I. Friedman, H. W. Kendall, L. VanSpeybroeck	11/18/66	Inactive
E-34	Electron-Deuteron Quasi-Elastic Scattering	SLAC E. Bloom, D. Coward, H. DeStaebler, J. Drees, J. Litt, R. E. Taylor MIT J. Friedman, G. C. Hartmann, H. W. Kendall CAL TECH B. C. Barish	7/2/68	Inactive
E-43	Velocity of Light Experiment	UCSD G. Masek	12/14/68	Parasiting
E-48	Proposal to Measure the ξ Parameter in the Decay $K_L^o \rightarrow \pi\mu\nu$	BNL D. Hill, R. Palmer, M. Sakitt, N. Samios SLAC D. Fries, F. Liu, R. Mozley, A. Odian, J. Park, W. Swanson, F. Villa	2/8/69	Running/ Complete
E-49b	Inelastic Scattering From D_2 and Other Nuclei: Large Angles	SLAC D. Coward MIT J. Elias, J. I. Friedman, H. W. Kendall, M. Sogard, K. Tsipis, M. Breidenbach, R. Verdier	8/6/69	Running/ Complete
E-50b	Asymmetry in the Photoproduction of π^o Mesons by Polarized Photons	SLAC R. Anderson, D. Gustavson, J. Johnson, I. Overman, D. Ritson, B. Wiik HARVARD UNIV. J. Walker NORTHEASTERN UNIV. R. Weinstein	3/21/70	Running/ Complete

Table of Programmed Experiments (cont'd) - 2

Number	Title	Authors	Date Approved	Status
E-55	Study of Dalitz Plot for the Decay $K_L^o \longrightarrow \pi^+\pi^-\pi^o$	SLAC H. Saal U. C. SANTA CRUZ D. Dorfan UNIV. COLORADO U. Nauenberg	5/23/70	Setup
E-56a	A Search for Short-Lived Sources of Neutrino-Like Particles	SLAC D. Fryberger, A. Rothenberg, M. Schwartz, T. Zipf	10/14/70	Parasiting/ Running
E-60	Hyperon Production in K^-p Interactions	SLAC K. Bunnell, R. Mozley, A. Odian, J. Park, B. Swanson, F. Villa, L. Wang U. C. RIVERSIDE S. Fung, A. Kernan, R. Poe, T. Schalk, B. Shen LRL-BERKELEY M. Alston-Garnjost, R. Bangerter, A. Barbaro-Galtieri, F. Lynch, E. Solmitz	12/12/69	Inactive
E-61	Forward Electron Scattering	SLAC E. Bloom, R. Cottrell H. DeStaebler, C. Jordan, M. Mestayer, H. Piel, R. E. Taylor	2/21/70	Checkout/ Running
E-62	Particle Spectra at High Energies	CAL TECH B. C. Barish, A. Dzierba, W. Ford, R. Gomez, Y. Nagashima, P. Oddone, C. Peck, J. Pine, F. Sciulli, A. V. Tollestrup	3/21/70	Withdrawn by Authors
E-63	Measurement of K_L^o and Neutron Total Cross Sections on Nuclear Targets	STANFORD UNIV. J. Crawford, R. Ford, E. G. Hughes, L. Middleman, L. H. O'Neill, J. Otis	3/21/70*	Inactive
E-64	Study of the Decay $K_L^o \longrightarrow \pi^\pm\mu^\mp\nu$	SLAC D. Fryberger, D. Hitlin, J. Liu, M. Schwartz, S. Wojcicki U. C. SANTA CRUZ D. Dorfan	3/21/70	Setup
E-65	Study of Electroproduced Hadrons	SLAC B. Dieterle, W. Lakin, F. Martin, E. Petraske, M. Perl, J. Tenenbaum, W. Toner	3/21/70	Setup

Table of Programmed Experiments (cont'd) - 3

Number	Title	Authors	Date Approved	Status
E-66	Inelastic Photoproduction of Charged Pi and K Mesons in the Forward Direction	SLAC A. Boyarski, S. Ecklund, B. Richter, R. Siemann	3/21/70	Inactive
E-67	Study of $\pi N \longrightarrow N\bar{N}N$ at 15 GeV/c	SLAC F. Bulos, R. Carnegie, E. Kluge, D. W. G. S. Leith, H. Lynch, B. Ratcliff, S. Williams, H. Williams	3/21/70	Running/ Complete
E-68	Inclusive Pion-Proton Scattering	UNIV. OF WASHINGTON J. E. Rothberg, R. W. Williams K. K. Young, A. Schenck, L. Sompayrac, M. Delay	5/23/70	Parasiting
E-70	Measurement of the Asymmetry in Compton Scattering on the Proton	SLAC R. Anderson, D. Gustavson, J. Johnson, I. Overman, D. Ritson, B. Wiik CORNELL R. Talman NORTHEASTERN UNIV. R. Weinstein HARVARD UNIV. D. Worcester	8/15-70	Running
E-71	Vector Meson Electroproduction at High Energy	SLAC E. Bloom, R. Cottrell H. DeStaebler, C. Jordan, M. Mestayer, G. Miller, H. Piel, R. E. Taylor UCSD C. Prescott	8/15/70	Setup
E-72	Deep Inelastic μ-p Scattering	U. C. SANTA CRUZ D. Dorfan C. Heusche, B. Liberman, C. Prescott, A. Seiden	11/14/70	Inactive
E-73	Phi-Photoproduction	SLAC R. L. Anderson, D. Gustavson, J. Johnson, I. Overman, D. Ritson, B. Wiik UNIV. OF WISCONSIN R. Prepost D. Tompkins HARVARD D. Worcester	11/14/70	Inactive

Table of Programmed Experiments (cont'd) - 4

Number	Title	Authors	Date Approved	Status
E-75	Q Region Study in $K^+p \rightarrow K^+\pi^+\pi^-p$	SLAC R. Carnegie, R. Cashmore, E. Kluge, D. W. G. S. Leith, H. L. Lynch, S. Williams, F. Winkelman, R. Giese, B. Ratcliff, H. H. Williams	11/14/70	Inactive
BC-8	Exposure of the 82-Inch Hydrogen Chamber to a Beam of π^+ Mesons at 7.0, 11.0 and 14.0 GeV/c	PURDUE D. H. Miller	Ext. 3/21/70	Running
BC-10	A Proposal to Investigate K_2^0p Interactions with the 40 Inch HBC	SLAC B. C. Shen, D. W. G. S. Leith, A. D. Brody, W. B. Johnson, R. R. Larsen, G. A. Loew, R. Miller, W. M. Smart	5/11/68	Setup/ Checkout/ Running
BC-11	A Bubble Chamber Experiment with the Polarized Laser Induced Photon Beam (Extended 10/3/69)	SLAC J. Ballam, G. Chadwick Z. Guiragossian, P. Klein, A. Levy, M. Menke, J. Murray, G. Wolf TUFTS UNIV. C. Sinclair U. C. BERKELEY H. Bingham, B. Equer, K. Moffeit UCLRL M. Rabin, W. Podolsky, A. Rosenfeld	5/11/68	Running
BC-18	A 4.25 GeV γ-Deuterium Experiment in the SLAC 40" Bubble Chamber and with Polarized Photons in the 82" Bubble Chamber	WEIZMANN INSTITUTE Y. Eisenberg, B. Haber, U, Karshon, L. Lyons, E. E. Ronat, A. Shapira, G. Yekutieli	9/28/68	Inactive
BC-19	γ-d Experiment with an Annihilation Beam of 7.5 GeV in SLAC 40" Bubble Chamber and with Polarized Photons in the 82 Inch Bubble Chamber	TEL-AVIV UNIV. G. Alexander, I. Bar-Nir, A. Brandstetter, S. Degan, J. Grunhaus, A. Levy, Y. Oren	Ext. 3/21/70	Running
BC-25	Study of Pomeranchon, Meson and Baryon Exchanges by Triggering the SLAC 40" Bubble Chamber on Fast Forward Particles	CAL TECH B. Barish, W. Ford, R. Gomez, C. Peck, J. Pine, F. Sciulli, B. Sherwood, A. Tollestrup, G. Zweig	6/18/69	Setup

Table of Programmed Experiments (cont'd) - 5

Number	Title	Authors	Date Approved	Status
BC-28	A 5 GeV/c π^+p Experiment in the SLAC 82-Inch HBC	WEIZMANN INSTITUTE Y. Eisenberg, B. Haber, U. Karshon, E. Ronat, A. Shapira, G. Yekutieli	8/6/69	Inactive
BC-30	Λp Interactions in the Momentum Interval 1-5 GeV/c	LRL BERKELEY G. Trilling, J. Kadyk, G. Goldhaber, J. Hauptman	12/12/69	Inactive
BC-33a	300,000 Pictures, 4.5 GeV/c π^- in H_2 82 Inch Bubble Chamber	UNIV. OF PENNSYLVANIA S. Barish, J. Bensinger, E. Bogart, P. Jacques, W. Selove	3/21/70	Running/ Complete
BC-34a	K^-d Interactions Around 12 GeV/c	JOHNS-HOPKINS UNIV. C. Chien, B. Cox, D. Denegri, L. Ettlinger, G. Goodman, R. Mercer, A. Pevsner, R. Sekulin, R. Zdanis	8/15/70	Inactive
BC-35	γ-d Interactions at 3.5 and 5.5 GeV with Polarized Photon Beam	U. C. RIVERSIDE S. Fung, A. Kernan, R. Poe, T. Schalk, B. Shen U. C. BERKELEY R. Birge, R. Ely, G. Gidal, D. Grether, G. Kalmus, W. Michael	3/21/70	Inactive
BC-37	An Investigation of K_2^0 Interactions in Deuterium with the SLAC 40 Inch Bubble Chamber	YALE UNIV. V. D. Bogert, T. Ludlam, H. D. Taft	8/15/70	Running/ Complete
BC-38	A Study of π^+d Interactions at 15 GeV/c	FLORIDA STATE UNIV. J. Albright A. Colleraine, S. Hagopian, V. Hagopian, J. Lannutti, G. Yost UNIV. OF PENNSYLVANIA J. Bensinger	8/15/70	Inactive
BC-39	Study of π^+ Interactions in Hydrogen at 15 BeV/c	COLUMBIA C. Baltay, L. Gerschwin, W. Cooper, S. Csorna, M. Habibi, M. Kalelkar STATE UNIV. OF NEW YORK N. Yeh, A. Gaigalas	8/15/70	Inactive

Table of Programmed Experiments (cont'd) - 6

Number	Title	Authors	Date Approved	Status
BC-40	8.0 and 14 GeV/c, π^+ and π^- Exposures in the SLAC 82 Inch HBC	MIT Z. Carmel, F. Dao, B. Feld, R. Hulsizer, V. Kistiakowsky, I. Pless, V. Simac, F. Triantis, T. Watts, J. Wolfson, R. Yamamoto, D. Ballantyne, M. Hodous, A. Nakkasyan, A. Napier, R. Singer, P. Trepagnier	8/15/70	Running
BC-42	Bubble Chamber Study of Deep Inelastic Muon Scattering	SLAC E. Bloom, R. Cottrell, H. DeStaebler, C. Jordan, M. Mestayer, H. Piel, R. Taylor, J. Ballam, G. Chadwick, P. Seyboth, I. Skillicorn, H. Spitzer U.C. SANTA CRUZ C. Prescott	8/15/70	Inactive
BC-43	A Study of π^-d Interactions at 15 GeV/c	UNIV. OF WASHINGTON P. Bastien, L. Kirkpatrick, H. Lubatti U.C. BERKELEY H. Bingham, W. Fretter	8/15/70	Inactive
BC-44	Measurement of the Total Hadronic γp Cross Section at Photon Energies Between 0.5 and 1.2 GeV	DESY G. Knies, P. Soding, G. Wolf	8/15/70	Inactive
NT-3	Fast Cycling Bubble Chamber Development	SLAC H. Barney, R. Blumber, A. Rogers, S. St. Lorant	12/15/68	Inactive
T-12	Wire Chamber Spectrometer Checkout	SLAC S. Wojcicki	6/11/69	Setup/ Checkout
T-13	40 Inch Bubble Chamber Neon Fill Test	SLAC R. Watt	4/24/70	Inactive
NT-14	8 GeV C Counter Test	SLAC D. Sherden	8/25/70	Complete
T-15	Lead Plate Proportional Quanatmeter Test	UNIV. OF HAWAII D. Yount	12/16/70	Running

Table of Programmed Experiments (cont'd) - 7

Number	Title	Authors	Date Approved	Status
T-16	Solid State Counter Tests	MIT I. Pless SLAC J. Murray		Special Test
T-17	Streamer Chamber Tests	SLAC R. Mozley		Special Test, Complete
D-19	Measurement of Photofission Cross Sections of Uranium 238 and Thorium 232	SLAC G. Svensson	12/8/70	Running
Y-5	Profile Monitor Test SPEAR Transport Test	SLAC		Inactive

Running = Experiment is in data collection phase and was a prime user of accelerator time.
Checkout = Experiment is in checkout phase and used accelerator time for checkout purposes.
Setup = Experiment was being setup in the research yard.
Inactive = Experiment was inactive in the research yard.
In Construction = Beam is under construction.
Ready to Run = Experiment ready for future scheduled run.
Parasiting = Used parasite beam time.
Completed = Experiment completed.
Special Test = Special test run performed.

*Approved for checkout only.

III. RESEARCH DIVISION DEVELOPMENTS

A. Physical Electronics

Gallium Arsenide Statistics Program

A sealed off tube (provided by a commercial firm) with a GaAs-GaP emitter and internal 14-stage multiplier was tested. The tube was very noisy and had to be cooled with dry ice before measurements could be made. Typical Furry distributions (exponential) were observed with a Sr^{90} source, but the tube developed a leak before distributions with light as the input could be obtained.

The computer analysis of GaAs statistics data continues with the part-time help of a programmer. Preliminary results show that the mean number of secondaries emitted with the Sr^{90} source in place is about 5. Data on the shape of the distribution cannot yet be obtained. A magnetic analysis system for the Sr^{90} source has been assembled and tested with an electromagnet from Group C, and is ready for use.

A 45^{o} beam deflector and light baffle was designed and constructed for a BTI electron gun, so that the emission characteristics of CsI (Na) evaporated scintillator films could be measured without interference from the light emitted by the gun filament.

A glass scintillator was obtained and will be evaluated together with the scintillator films.

B. SPEAR Activities

1. Main Magnet System

The engineering prototype of the standard quadrupole (6Q20) core was rejected as there were discrepancies between the core and the drawing. The magnet is now en route back for rework. The prototype 6Q40 (Q_3) had had its pole-profile modified, and an end cut was made on the pole. Initial magnetic measurements indicate the magnet is about an order of magnitude better than the tolerances require. Machining is now proceeding on the 10Q50 (Q_2) and, armed with the experience gained on Q_3, we are now certain we can build a magnet meeting the stringent tolerances of Q_2.

All the sextupoles have been cast; half of them (24) have been heat-treated and are presently being machined. The balance are scheduled for heat-treating and delivery to the machine shop within two weeks.

All of the standard girders have been cast including a spare, and work continues on modifying the mold for the nonstandard girders.

In the last month the instrumentation for the magnetic measurements was completed, and experience with prototype magnets has shown that the system as a whole should meet the requirements of the magnetic-measurement schedule. Variations of bending-magnet tracking were confirmed. It was found that $\int Bd\ell$ is a function of core temperature due to variations of permeability with steel temperature. Some evidence of the motion of the magnetic center of the quadrupoles with excitation was discovered at high fields. Absolute gradient-length measurements were found with the new system to check, within tolerances, measurements made on these magnets by the previous integrated harmonic method.

2. Vacuum System

All subcomponents of the distributed pump assemblies have been completed. It is anticipated that the first six production pumps will be completed by January 15. During December, 90% of the temporary structure for the in-house chemical cleaning facility was completed and should be available for the cleaning of chambers by the first week in January. Four prototype bellows assemblies were received in December. Initial QC and leak-detecting appear satisfactory. Accelerated tests will occur in January.

Kicker magnet assembly. The bakeout of the prototype kicker-magnet assembly was completed, and a base pressure and a low 10^{-9} torr pressure were achieved. It appears that this assembly will be satisfactory for the storage ring application.

3. RF System

The model cavity at 10 times the rf frequency has been tested. The R/Q is 65 ohms giving an expected shunt impedance in the full-size cavity of about 0.9 megohm. The design work is well under way for the full-size cavity, and the first batch of drawings has been released to the shops. Low-power hybrid junctions were designed and constructed for purposes of power division and sampling in the rf system. An electronically variable attentuator which will be used in the cavity gap-voltage control system has been completed.

4. Instrumentation and Control

The rented magnetic tape unit for the control computer arrived, but problems in installation have prevented the computer system from becoming operational in

December. The SLAC-designed card reader interface was completed and tested during a period when the portion of the computer required was operational. The card reader system works well now and is being used by XDS to assist checkout of the rest of the system. Final checkout (full diagnostic exercising) of the card reader awaits completion of the computer installation. A simplified design for the card reader interface, taking advantage of the features of the redesigned XDS extended device subcontroller, has been completed. We will replace the present interface with this design when time permits. The new design has about half the number of gates of the present one, and will be much easier to trouble-shoot.

The Synchrotron Light Intensity Monitor (SLIM) prototype has now been tested in the beam switchyard; rise times of 10^{-10} sec have been observed at the end of the cable. Design details for a final version have been worked out, and production prints for a bid package are being prepared.

An optical lab was set up in the screened room in the lab for testing components. The mirror prototype has been tested and proved good. This testing was done with the mirror cold. An Invar mirror has been made and tested with an optical flat. Detailed tests have still to be performed, however.

Construction of the preproduction prototype of the high-level power amplifier for the beam servo system was completed and tests were begun. The driver for this amplifier was slightly redesigned and tested. A final layout which rearranges components mechanically (to allow standard mounting practices) was completed, but we still have to construct this final version and test it.

A scheme for balancing the common mode signals from the pickups for the beam servo has been devised using strip-line attenuators. Fabrication of a prototype will begin shortly.

System design details are now nearly all worked out to provide reference triggers for the position monitor, beam servo, and other beam monitoring instrumentation in the straight sections. Each girder electronics package will provide e^+ and e^- reference triggers (pre-triggers) and two independent triggers selectable from the control room. A note is being written describing the system for approval by the User community.

5. Injection

The majority of the four kicker-magnet detail parts are completed. The four support frames are completed except for the location of mounting pads.

Fabrication has been started on the last two kicker magnet vacuum chambers. Since the location of the magnets has been defined, the detail design of the rest of the kicker section vacuum chambers (and instruments) will proceed. The prototype kicker magnet has been successfully tested under full vacuum conditions (10^{-9} torr range) and at full voltage (12 kV).

Detail parts are in fabrication for the second septum magnet. Detail design of the vacuum chamber and light masking is in progress.

6. Beam Transport System

Installation of both mechanical and electrical items within the BSY housing commenced during the end-of-December linac shutdown. Plans call for installation of the most of the equipment upstream of the slit 15SL1 by the end of the February shutdown.

Trim coils were added to 15Q3 to correct field-gradient errors caused by inaccuracy in coil spacing. Magnetic measurements now show a satisfactory degree of accuracy.

Detail planning for electronic systems continues. All major systems are now defined at the block-diagram level and practical design can proceed. A prototype of a strip line position monitor has been fabricated and given a preliminary beam test.

C. Data Analysis Activities

1. Hardware

NRI System: The last upgraded machine was brought on-line December 7. With all six machines on-line and working through a common interface, time was spent in debugging the system as a whole. There are a half dozen or so small jobs to make the machines really "look alike," which will be done during regular preventive maintenance and should be finished by mid-January.

A low-key effort has started to try to "calibrate" the NRI machines, i.e., to determine their absolute precision by measuring some reference standard. Preliminary results are confusing, in that the machines don't appear very precise (overall rms error $\lesssim$ 10 microns). It is not clear whether this is inherent in the NRI's, or in the method of analysis.

Spiral Reader: The angle-encoding disc modification was completed and debugged, about a month behind schedule.

The console keyboard interface was modified to accommodate a new keyboard assembly, since the old style was discontinued by the manufacturer.

The auto-fiducial interface was enlarged to accept up to four fiducials. There is still a fundamental problem in that the overall auto-fiducial system doesn't produce correct coordinates. The current guess is that this is a hardware problem, and a circuit to average the background signal in the neighborhood of the fiducials will be designed in January to try to correct this.

2. Software

NRI System: Release 4 of BUCAPS was started, and software for the calibration program referred to above was written. Comparisons of answers have been made for computations done both on the 6020 and on the 360/91, to verify that there are no problems with precision or roundoff during the calculation.

Hummingbird 3: A combination of software and hardware changes has increased the overall event-finding efficiency from about 25% to about 50%. The accuracy of the measurements is poor: about 11 microns, to be compared with 7 microns for hand measurements, and it is not clear precisely what is causing this. No good measurements of rate have been made, but fairly obvious software changes should make 30 events/hour feasible.

Miscellaneous: A modest effort is being invested in computerizing the quarterly performance review of the scanners. Much of the work in making this appraisal just consists in adding up numbers, and it is fairly straightforward to perform most of this arithmetic in the 91.

3. Operations

During October 235,000 frames were scanned in 2400 hours; 32,500 events were measured (12,300 on the NRI, 13,000 on the Spiral Reader, 7200 on other conventional machines) in 2800 hours. Both machine problems (including, among others, PDP-9 main frame and 6020 drum difficulties) and system development activities interfered with both NRI and Spiral Reader production. It is hoped that Release 3 of BUCAPS will improve NRI production by reducing the impact of malfunction of the 6020 and its peripherals.

In addition to the figures above, 80,000 events were scanned and measured for the cosmic-ray experiment on Hummingbird II, in 250 hours.

During November 170,000 frames were scanned in about 1600 hours. There were 35,000 events measured in 2500 hours (12,000 events on the NRI system,

12,000 on the Spiral Reader in 300 hours, and 11,000 on the remaining conventional machines). In addition 52,000 frames were scanned and measured on Hummingbird 2 in 180 hours.

252,800 frames were scanned in December in 2100 hours. About 37,000 events were measured as follows:

13,300 in 325 hours on the Spiral Reader

16,000 in 1700 hours on the NRI System

7,700 in 575 hours on Vanguards, SPVB machines.

In addition, 13,500 frames were scanned and measured on Hummingbird II for the cosmic ray experiment; production on this experiment was completed on December 9.

Production was started on Hummingbird II for decoding of binary data boxes on the π-ρ spark chamber experiment (E-40). The output of this process is used as the foundation of the bookkeeping for that experiment. Rates are about 200 frames per hour. By the end of December about a quarter of the 750,000 frames to be done had been processed. Most of the film should be finished by April 1.

IV. EXPERIMENTAL FACILITIES

A. General

Installation of beam line equipment for the new north, central, and south beams in end station B continued. This is part of a major rebuilding of secondary beams in end station B. When the work is complete five secondary beams will emerge from the end station. These are: (1) beam line 8, a neutral K beam which is used in wire chamber experiments. This beam previously existed but has been modified to some extent. Placed back into operation during October, it is now operational. (2) Beam line 2, also a neutral K beam which is used in connection with 40" hydrogen bubble chamber experiments. This beam also previously existed but is significantly modified. It was used for Experiment BC-10 in November. (3) Beam line 14 is a new beam line which will be used to deliver charged secondary particles to the 40-inch hydrogen bubble chamber. Its initial use will be as a π beam in Experiment BC-25. (4) Beam line 20 is a new rf separated, high intensity beam line for general purpose use. This beam line splits into two lines to separate experiments in the research yard. Its initial use will be for experiments with the wire spark chamber facility presently located in beam line 11. (5) Beam line 19 is an attenuated electron beam which will be used in connection with the electroproduction Experiment E-65. It was complete enough to deliver a test beam to a quantameter inside end station B for T-65 in December.

Work continues on the beam transport system for E-68. The building which will house the spark chambers has been erected. It was decided to enlarge this building to house the 15-inch rapid cycling bubble chamber. The location seems suitable for a physics experiment as well as for developmental engineering tests.

The changes in the laser system designed to increase its second harmonic yield have now been tested during an experimental run. This system is used to generate polarized photons in the range from 7 to 10.5 GeV by Compton scattering from the SLAC beam. Previously the second harmonic yield from the laser system was insufficient to obtain the optimum number of photons in the bubble chamber; now this optimum ($\sim$ 70 per burst) can be reached easily. The laser system has been tested at second harmonic yield of 0.5 joules, whereas only about 0.35 joules are required for this optimum photon yield. The system operated for 5×10^5 pulses at this second harmonic yield with none of the serious damage problems previously encountered.

Since the ADP second harmonic generator was temperature sensitive, it was necessary to incorporate a temperature controlled oven (± 0.5° F) to prevent ambient temperature changes from detuning the second harmonic generator. With this addition, the laser system operated several hours at a stretch with no attention from the operator. (J. E. Murray)

B. Spectrometer Facilities

During the first part of November E-50b was set up for prime running with the 1.8 GeV spectrometer and N-61 parasited on the 20 GeV spectrometer. E-50b equipment was arranged this time so that the entire enclosure containing the detectors could be lifted by the crane and placed in either of two carriages, one on the 60-foot rail and one on the 150-foot rail. The control of these carriages was the same as when they were used previously. N-61 employed five new proportional wire counters in the 20 GeV detector shield, making this the first significant trial of this type of detector and the associated electronics.

At the end of November E-61 was set up for prime time running, and NT-14 was put into operation as a parasite using the 8 GeV spectrometer. NT-14 required the installation of the gas Cerenkov counter, this time to be used at positive pressures up to 32 psi above atmospheric.

The counting house rearrangement continued, and by the end of the period was about 80 percent complete. Early in the December run of E-61, one of the 12 kV transformers in one of the 1.59 megawatt power supplies failed. An effort was made to keep going with half of the split 5.8 megawatt supply, but the regulation was not good enough. A replacement transformer was borrowed from Pacific Gas and Electric Co. and was installed within 48 hours.

C. Bubble Chamber Operations

The 82-inch hydrogen bubble chamber operated in October for BC-8, BC-33, and BC-40, taking a total of about 1,100,000 exposures before an internal vacuum leak terminated the run.

It also developed an internal vacuum leak during the November cycle and terminated picture taking prematurely. A total of 388,171 chamber expansions were made for Experiment T-16. Counter gating of the bubble chamber camera, used in this experiment, selected 22, 613 pictures from this number of expansions. Experiment BC-40 was in progress when the vacuum leak developed. BC-40 received 25,380 pictures for 58,667 expansions.

Again in December, it developed an internal vacuum leak, terminating picture taking early. The chamber was expanded 485,614 times on hydrogen, taking 248,084 pictures for BC-11. The chamber was then filled with deuterium and BC-19 was in progress when the leak developed. BC-19 received 22,618 pictures. It was decided in December not to run the 82" chamber again until the March 1971 cycle. January and February will be used to build and install a new structural support system to reduce cyclic stresses in the internal chamber components during chamber expansion.

The assembly of the 40" hydrogen bubble chamber, except for the new refrigeration system, was completed November 8, and cooldown was started using the liquid hydrogen trailers that will be replaced by the refrigeration system. The chamber was filled with hydrogen, and on November 16 testing of an entirely new piston, bellows, expansion system, and heat exchangers was begun. The new bellows and piston system was designed with increased area and rigidity in order to reduce the amount of stroke necessary to produce tracks in the liquid. In addition this design should reduce resonance problems occurring in future 20-pulses-per-second operation of the chamber. These reductions lower the cyclic stresses in the bellows and allow a longer bellows life. The new expansion system and heat exchanger system were designed to cope with the problems anticipated in 20-pulses-per-second chamber operation.

Chamber pulsing with hydrogen began on November 16, and tracks from a test beam were produced. The liquid in the chamber was changed to deuterium for BC-37 and tests to determine the proper operating conditions were made, with the result that the stroke necessary to produce tracks in deuterium was 37 percent less than that of the old system. The chamber was expanded 238,392 times on deuterium, taking 132,498 pictures for BC-37. The chamber was then refilled with hydrogen and 8,065 test pictures were taken for CBC-10. The Scotchlite used in the chamber optical system was attached directly to the stainless steel piston this time and after 305,196 expansions is still usable.

Experimental operation and tests continued during the December cycle. 377,522 pictures with H_2 in the chamber were taken for BC-10 at chamber pulse rates of two and four pulses per second; the chamber operated very well at pulse rates up to 5 pps and a new chamber-to-window seal will be constructed to allow for testing of pulse rates greater than 5 pps.

Initial tests were made on the new refrigeration system and it will be used as the source of chamber refrigeration for the January cycle of operation.

V. ACCELERATOR IMPROVEMENTS

Failure of two more of the pulsed focusing quadrupoles during October resulted in a design review of the entire pulsed focusing system. The decision was made not only to correct the condition which caused failure of the previously installed magnets, but also to change their locations from the drift sections to midway in the sectors with each quadrupole of the pair installed at either end of a section and separated by about 40 feet. Each quadrupole had to be shortened about an inch requiring that new coils be wound. These changes have been incorporated in the magnet design change and fabrication will be resumed in January. The additional cost of modification of the magnets will be more than offset by a reduction in cost of the power supplies which will supply about a fourth of the power required in the original design, and by the comparative ease of installation of quadrupoles between sections instead of on drift sections. Existing power supplies are being modified and, after testing, sixteen additional units will be ordered. Although installation of the first quadrupole has been delayed by these modifications, completion of installation of the system by September 1971 appears feasible because of the more simplified plan for installation.

Work on the off-axis injector continued during the quarter. The pulsed alpha magnet was completed and measured and installed temporarily in the dc vacuum chamber at the end of the December run. Powered by a breadboard power supply, the magnet will be tested in the machine during the January run. Fabrication of the permanent vacuum chamber and power supply continued and installation is planned during the February down period which will complete the conversion from dc to pulsed operation of the off-axis injector.

Work on the link system between the SDS 925 and PDP 9 computers in Main Control Center (MCC, formerly Data Assembly Building) and Central Control Room (CCR) was completed during the quarter and the system has been checked and is operational.

Consolidation of the two control rooms continued during the quarter. The display system and a console mounted type TV monitor were delivered and accepted. The flat screen version of the touch panel checked out satisfactorily but the curved screen version developed some problems. It suffers from low signal strength and cross-talk between adjacent channels. Development work is continuing in an effort to correct these weaknesses while two alternate approaches are being investigated: (1) a crossed wire matrix and, (2) a mechanical linkage.

Work continued on improvements to the profile monitor system in the beam switchyard. Nineteen conversion boxes have been fabricated and eight had been installed by the end of the quarter. Four more are to be installed in early January and the balance as required at a later date. Cabling has been installed and final cross-connects in DAB will be completed during the February shutdown.

Installation of the magnet warning system continued. Work has been completed on about 50 magnets of a total of 70 and the balance of the installation will be completed during January and February. The system provides a flashing red light when magnet power is on and the switchyard is open.

Improvements to the position monitor system continued. High-burnout crystal diodes have replaced the tunnel diodes originally installed thus eliminating the gap in coverage between the thermionic and tunnel diodes. Design of a system of 24 V coaxial switches to replace 110 V switches has been completed and components selected. Procurement will be initiated in January. This will eliminate 110 V current from the main frame and improve operation of the switches.

Expansion of the data system to improve and speed up reporting to and from CCR and the computer of various signals along the machine is continuing.

Design of the pulsed phase closure system was completed. A prototype of a simple movable short type was built and tested and mechanical production units were about 90% complete as the quarter ended. Electronic units are being fabricated and will be completed in early March. System checkout is planned for March or April.

Work continued on the pulse generation system and design of the beam knockout plates was completed. Improved spares for critical sections of the E.G.G. fast pulser were built and a continuing program to upgrade oscilloscope triggering is under way.

VI. KLYSTRON STUDIES

A. Development

1. High Power Klystrons

The development work at SLAC during the quarter consisted mainly of modifications needed to eliminate the pulse breakup observed on high power tubes.

An analysis of the operating failures in the four sectors operated at 265 kV indicated that a high percentage of failures in those sectors was caused by rf breakup, especially for the SLAC tubes operating at the highest efficiency.

A number of tubes were built during the quarter to understand and hopefully eliminate the cause of the breakup. Two possible causes were considered, one being increased interception in the output gap, the other being the possibility of voltage breakdown across the gaps of the penultimate and output cavities.

If interception were the cause of the breakup an increase of the drift tube diameter of the output cavity nose next to the collector should substantially affect the breakup. Tubes built with increased drift tube diameters did not show any substantial improvement in rf breakup characteristics.

If the cause of the breakup is breakdown across the gap because of the high rf fields developed at the noses, an increase in the nose radius should decrease the tendency for rf breakup. No breakup has been observed in tubes in which the radius of the noses of the fourth and fifth cavity was increased from 1/32" to 1/16". Some power output is lost compared to the optimum obtained but typical efficiencies in permanent magnet are still running between 40 and 45 percent.

2. Klystrons for Superconducting Accelerator

The tube described during the previous quarterly status report has been rebuilt and substantially the same results were obtained. Most of the time during this quarter was spent in a complete redesign of the output circuit which should improve the thermal stability. In addition the next tube to be built will have a beam diameter smaller by approximately 15%. The results should be less interception and less thermal detuning even under maximum bunching conditions.

In addition a diode with 1/2" diameter dispenser cathode button has been built and is in life test. The oxide cathode diode (1" diameter) had operated 7850 hours to the first of the year with a current density of approximately 420 mA per square cm. It was beginning to show signs of temperature limitation.

3. High Power Windows

In general the waveguide water cooling initiated during the past six months appears to have reduced the overall SLAC window temperature within safe limits for an average power output of 30 - 35 kW. Only one window out of a dozen tubes tested during the quarter indicated excessive temperature. No explanation of the behavior of this window has yet been discovered.

B. Procurement

Negotiations with three potential vendors were concluded during the quarter. Our recommendations have been submitted to the AEC.

C. Operation and Maintenance

A record number of operating hours (365,800) was accumulated by high power klystrons during the quarter. The number of failures, 31 high power klystrons, also approached a record for the quarter.

1. High Power Klystron Operation

Usage and failures of all klystron vendors are summarized in Table II. One of the tubes that failed during the quarter was the last of the special Eimac contract, and failed after more than 20,000 hours of operation.

The general information of Table I is also shown in graph form in Fig. 3.

Figure 4 gives the tube age distribution of all living klystrons in 500 hour increments.

Figure 5 gives the age distribution of all failed klystrons in 500 hour increments.

From the data in these figures the curves of failure and survival probability have been computed and are plotted in Fig. 6.

After almost one year of operation of four sectors at 265 kV it appears desirable to review the history of failures in those sectors compared to the failures in sectors operating at 245 kV. Table III summarizes the findings. From an analysis of this table it can be seen that the MTBF for 265 kV operation is slightly less than one-half the MTBF of all other stations. Before final

TABLE II

KLYSTRON MTBF

Dates	PER QUARTER				CUMULATIVE			
	Operating Hours	Failures Number	Failures Mean Age	MTBF	Operating Hours	Failures Number	Failures Mean Age	MTBF
To 6/30/66					129,400	19	260	7,200
To 9/30/66	111,000	8	610	14,000	240,400	27	360	9,000
To 12/31/66	154,000	11	1,100	14,000	394,400	38	575	10,300
To 3/31/67	207,000	13	1,490	15,900	601,400	51	810	11,800
To 6/30/67	287,000	9	2,490	32,000	888,400	60	1,060	14,800
To 9/30/67	330,500	25	2,860	13,300	1,218,900	85	1,590	14,500
To 12/31/67	263,000	21	3,520	12,500	1,481,900	106	1,980	14,100
To 3/31/68	309,500	17	4,800	18,200	1,791,400	123	2,360	14,700
To 6/30/68	306,000	15	3,820	20,400	2,097,400	138	2,520	15,200
To 9/30/68	314,200	24	5,500	13,100	2,411,600	162	2,960	14,900
To 12/31/68	349,800	23	8,350	15,200	2,761,400	185	3,630	15,000
To 3/31/69	328,600	20	6,610	16,400	3,090,000	205	3,930	15,100
To 6/30/69	335,000	16	7,280	19,700	3,425,000	221	4,190	15,400
To 9/30/69	179,800	8	11,670	22,500	3,608,100	229	4,450	15,750
To 12/31/69	303,600	10	10,230	30,400	3,911,700	239	4,690	16,300
To 3/31/70	358,700	32	9,950	11,200	4,270,400	271	5,270	15,800
To 6/30/70	257,200	18	11,350	14,300	4,527,600	289	5,650	15,700
To 9/30/70	259,600	13	9,600	20,000	4,787,100	302	5,810	15,800
To 12/31/70	365,800	31	10,800	11,800	5,152,900	333	6,280	15,500

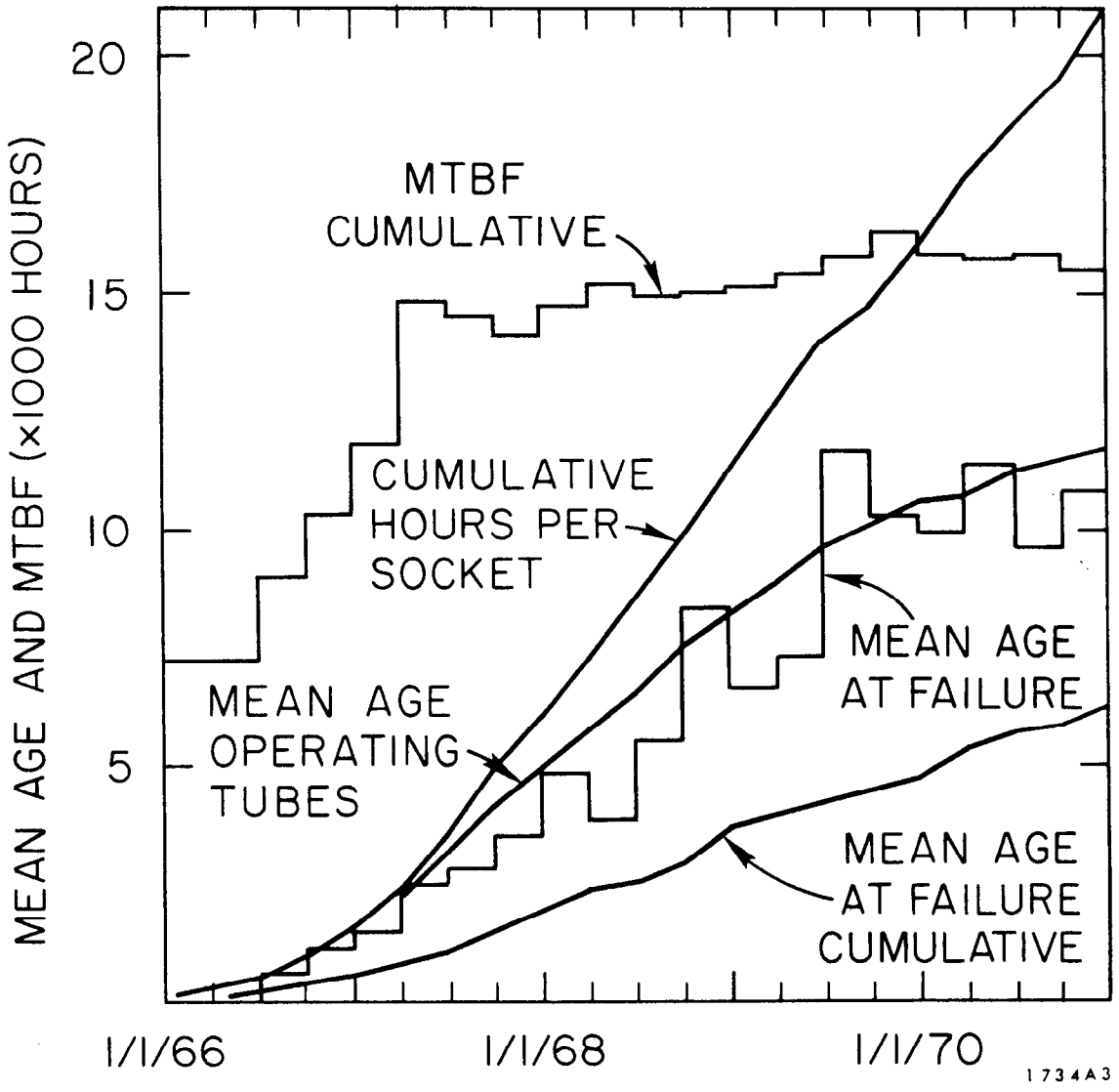

FIG. 3--High power tubes: cumulative MTBF, mean age, mean age at failure, cumulative age at failure, and cumulative hours per socket, Dec. 31, 1970.

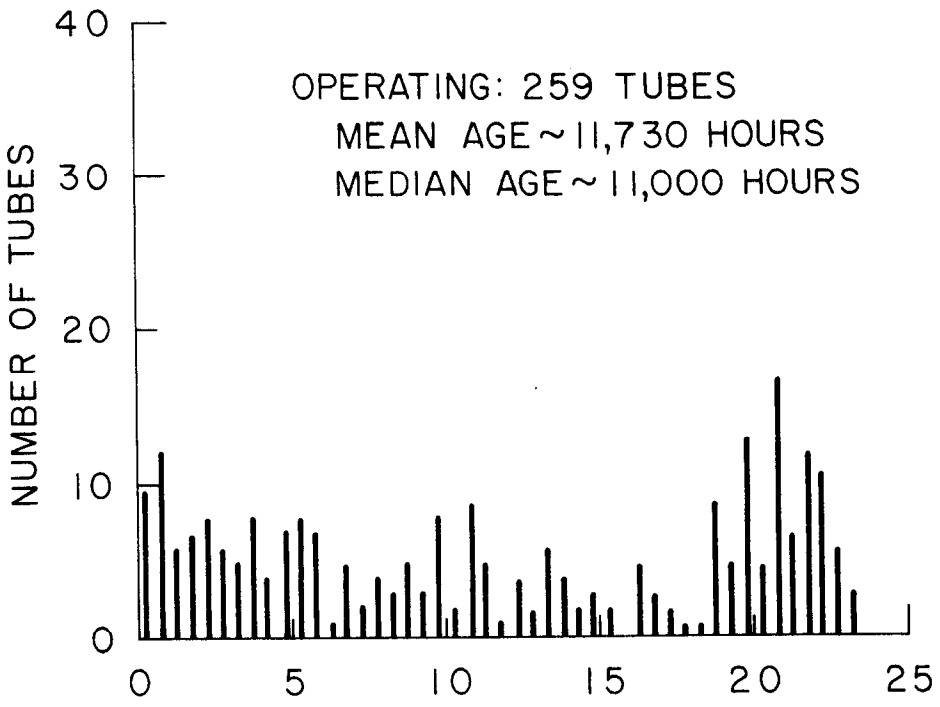

FIG. 4--High power tubes: age distribution of all operating klystrons, Dec. 31, 1970.

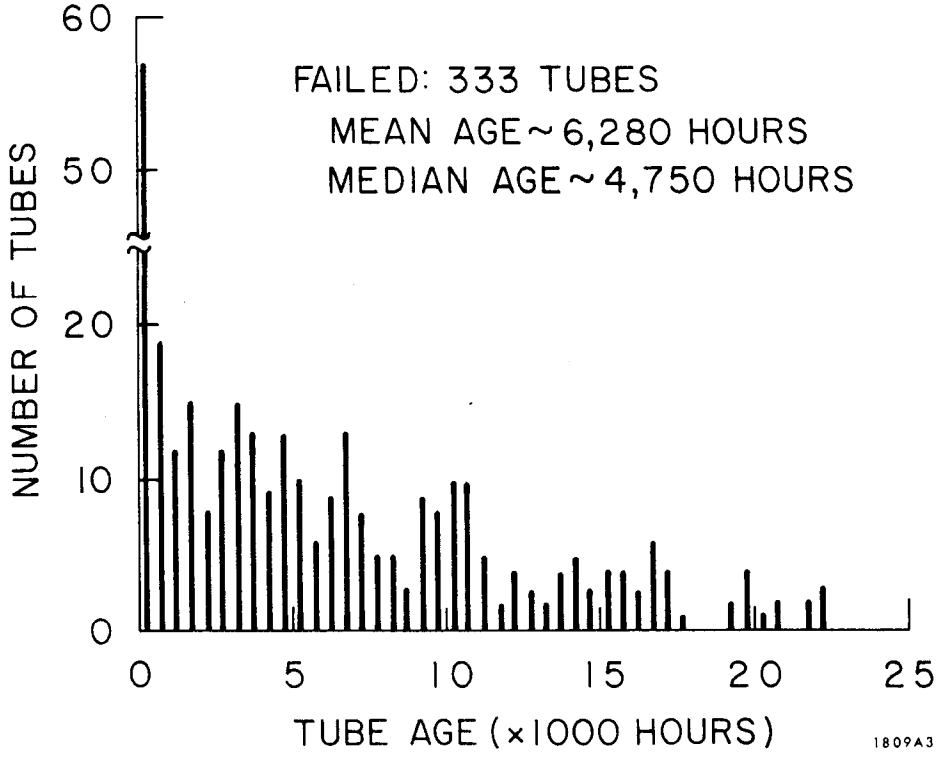

FIG. 5--High power tubes: age distribution of all failed klystrons, Dec. 31, 1970.

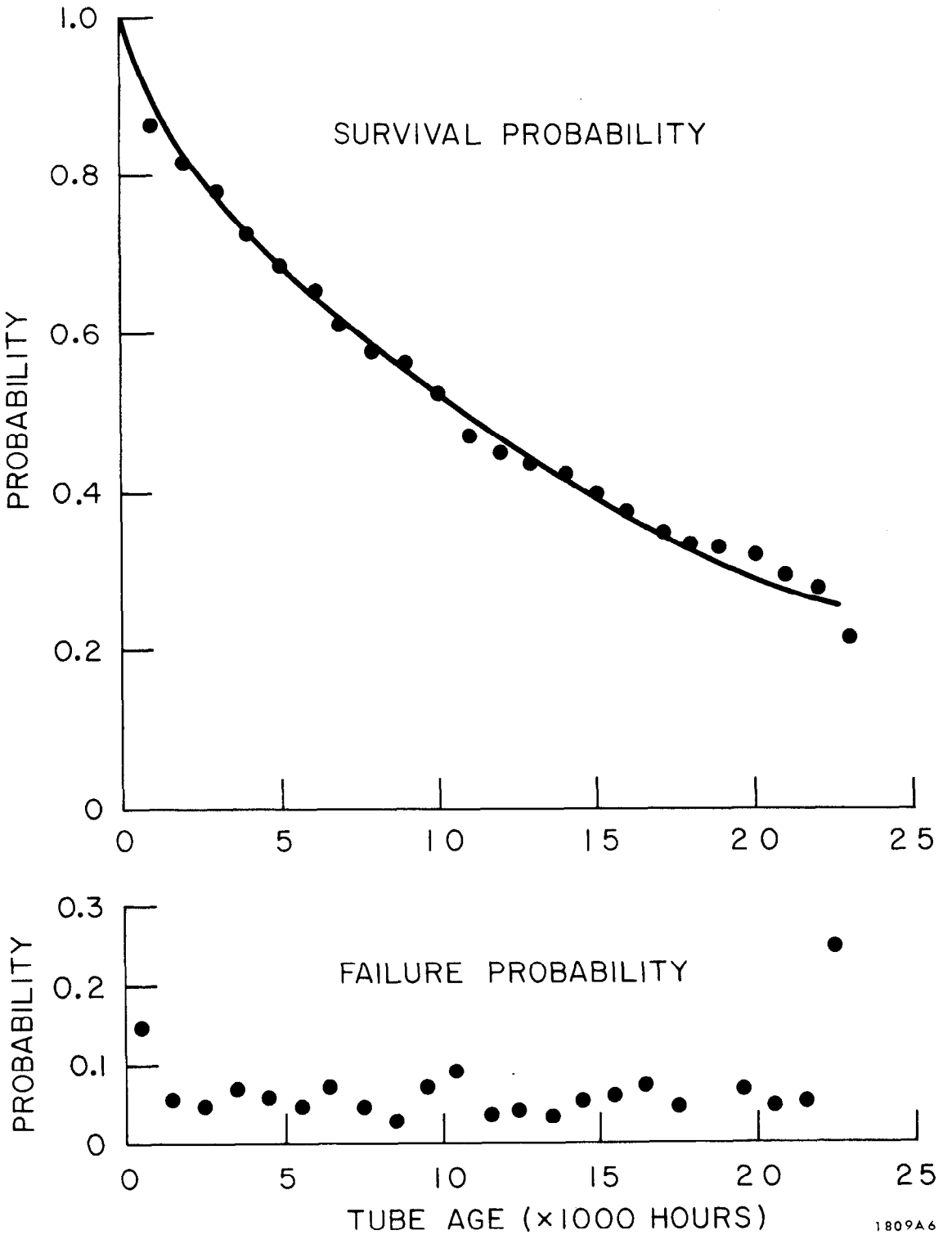

FIG. 6--High power tubes: survival and failure probability, Dec. 31, 1970.

TABLE III

Quarter	Number Stations at 265 kV	Failures		MTBF	
		at 265 kV	at 245 kV	at 265 kV	at 245 kV
1/1 - 3/31/70	32*	6	26	6,600	12,300
4/1 - 6/30/70	32	3	15	11,300	14,900
7/1 - 9/30/70	32	3	10	11,300	22,600
10/1 - 12/31/70	32	11	20	4,350	15,900
	32*	23	71	6,750	15,250

Total operating hours = 1,241,300

* only 16 stations in January 1970

conclusions can be drawn from the above data the following should be considered:

1. Because of availability of tubes the mix of various vendors at 265 kV was not the same as at 245 kV. Specifically there were proportionately more Litton tubes at 265 kV.

2. A large number of 265 kV failures were experienced by SLAC tubes. An analysis of the cause of failure on these tubes indicated rf output breakup and window failures. A redesign of the no. 4 and no. 5 cavities appears to have solved the rf output breakup; additional cooling in the vicinity of the output window appears to have cured the excessive heating experienced by our windows at average powers in excess of 30 kW.

3. During 1967 and 1968 a similar test was run to determine the effect on klystron life of operation at 245 kV. The results which appeared in the quarterly status report are reproduced as Table IV. It can be seen that at that time also the MTBF at 245 kV appeared to be only one-half of that at lower operating levels.

2. High Power Klystron Maintenance

With the increase of the number of failures we experienced an increase in the number of klystron replacements to 69. Suspected pulse transformer tank failures accounted for 30% of all replacements. Table V gives the percentages of failures due to varying causes, computed for individual vendors and for the aggregate of all tubes. The data shown in the table applies to all failures since the beginning of operation. During the past quarter there appears to be little significant change in the ratio of failures between the different causes with the possible exception of RCA where the window failures seem to be less frequent now than they were in the past.

Figure 7 shows the operating experience of all high power klystrons since the beginning of operation.

3. Subbooster Klystrons

There were no failures of subbooster klystrons during the quarter possibly because of the ability to operate at lower peak power than originally requested.

Failure analysis of all SLAC subbooster klystrons built is shown in Fig. 8 with living tube and failed tube age distribution in 1,000 hour increments.

Figure 9 gives the operating experiences for all driver amplifier klystrons. We still have 6 Eimac driver amplifier tubes in use in the gallery with a mean age of approximately 29,500 hours.

TABLE IV

Quarter	Number Stations at 245 kV	Failures at 245 kV	Failures at 235 kV	MTBF at 245 kV	MTBF at 235 kV
7/1 - 9/30/67	32	6	19	7,200	15,200
10/1 - 12/31/67	32	7	14	5,000	16,400
1/1 - 3/31/68	32	2	15	20,500	18,000
4/1 - 6/30/68	32	3	12	13,200	22,200
7/1 - 9/30/68	32	6	18	7,000	15,100
	32	34	78	8,300	17,000

Total operating hours = 1,523,200

TABLE V

	RCA %	LITTON %	SLAC %	ALL %
Windows	63	20	27	37
Vacuum	19	22	18	20
Arcing	8	46	27	28
T.L.	2	4	8	4
Others	8	8	20	11
	100	100	100	100

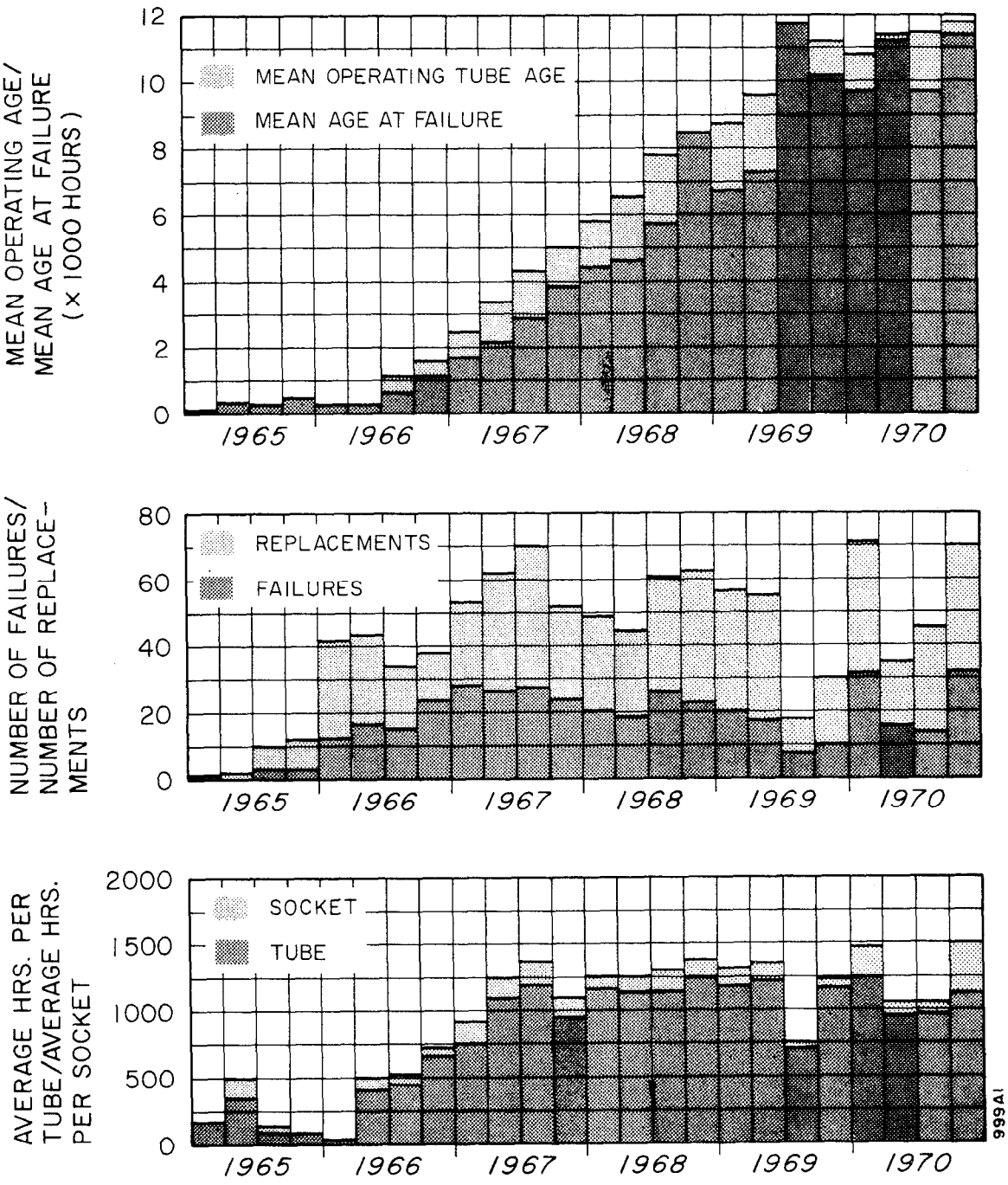

FIG. 7--High power tubes: operating experience through Dec. 31, 1970.

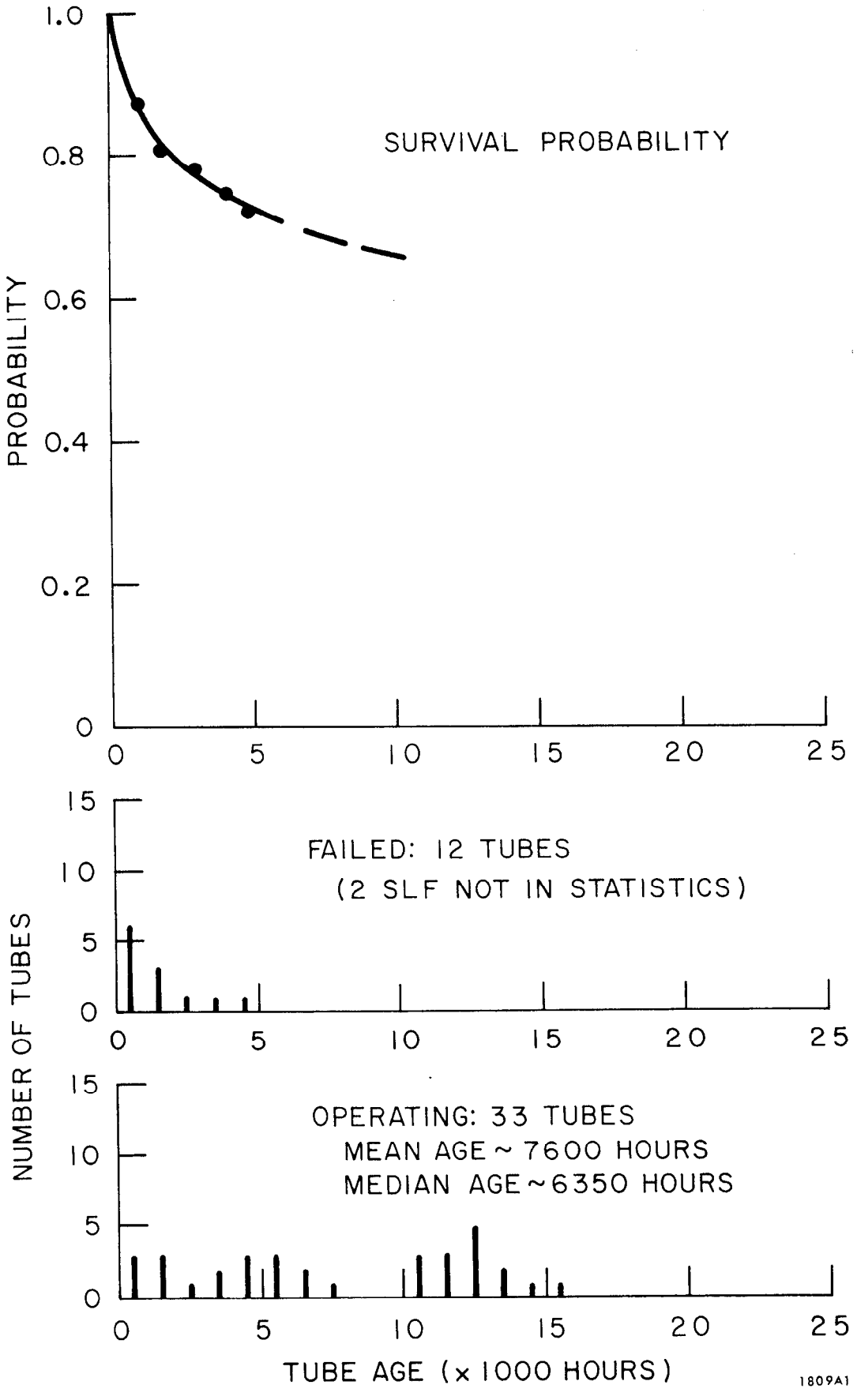

FIG. 8--Driver amplifier tubes: age distribution of operating and failed tubes, and survival probability, Dec. 31, 1970.

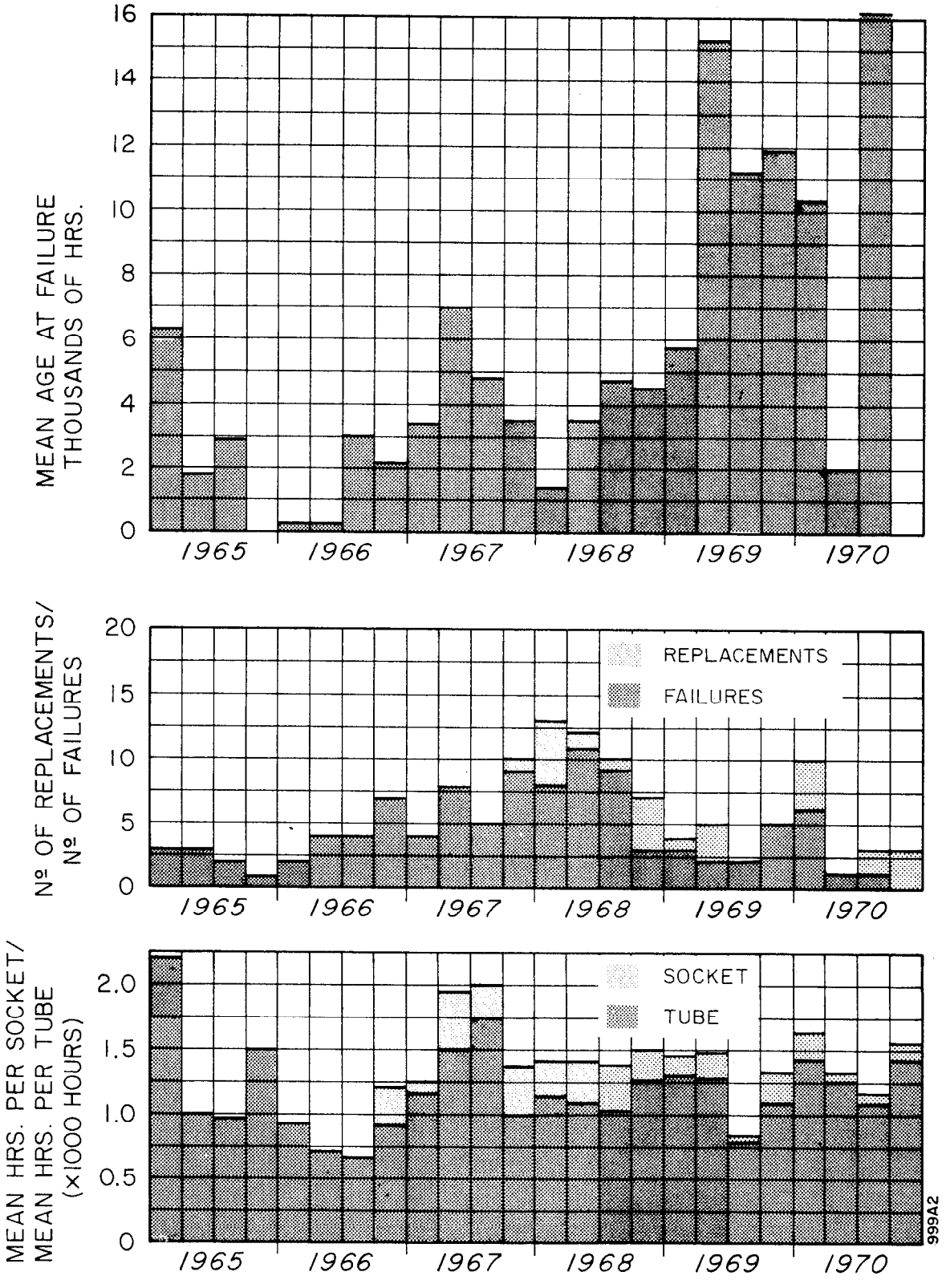

FIG. 9--Driver amplifier tubes: operating experience through Dec. 31, 1970.

VII. ACCELERATOR INSTRUMENTATION AND CONTROL

(July 1 - December 31, 1970)

A. Control Room Consolidation Summary

Consolidation of the two control rooms requires a link, a TV display (data disk), a control input (touch panel) in Main Control Center (MCC, formerly Data Assembly Building) and connection of all remaining accelerator controls and monitoring to the PDP 9 in Central Control Room (CCR).

The link, TV display, and a prototype touch panel are installed and software development to make them operational is under way. The data formats for programs have been determined and detailed programming is now being written. Extensive expansion of CCR data systems is now proceeding.

B. SPEAR Instrumentation Summary

Design has started on the spectrum monitor electronics for beam line 15. Concepts have been developed for control of beam transport power supplies. Magnets will be manually adjusted for a well-steered beam to the slit, and then the computer in MCC will be commanded to read the power supply shunts. Deviation from these values will generate an alarm signal.

C. Touch Panel

Only minor problems were encountered in making the original flat glass touch panel work; however, considerable difficulties have been encountered with a curved glass panel intended to eliminate parallax between the panel and the CRT face. These difficulties arise principally because the mode of propagation of a surface wave on a curved panel is inherently divergent producing poor separation between adjacent channels. A crossed-wire prototype has worked and an improved version is under construction. Other devices are also being investigated.

D. CCR Computer

Pulsed steering and quadrupoles have been installed in some sectors and their analogs have been interfaced to the PDP 9 in CCR via the log Q-DMA (direct memory access) channel. In addition, where dc steering exists, it will also be connected to this channel. The selection of dc steering or six levels of pulsed analogs at any sector can be programmed in the computer. The computer selects the sector level (roughly equivalent to the beam line) through three cable pairs which loop through each sector. These same pairs are used for manual level selection when the computer is disconnected.

Work on the remaining elements of the pulse-to-pulse klystron replacement scheme proceeded during this period. The log Q, X, Y multiplexer in CCR was rewired so that the computer could read the necessary spectrum signal channels early in the interpulse period. Work continues on spectrum signal amplifiers for the system. These amplifiers will have provision for computer control of their gain adjustments.

Design of an interface to allow computer control of patterns and rates was started. This interface will be connected to a PDP 9 data channel so that the rates and patterns can be read into and stored in registers in the interface prior to each beam pulse. The data will be sent in 10 twelve-bit words to the registers.

The solid state area selector, the computer analog selector, and the channel repeater mentioned in the last report are now operational. These units replace the original relay logic which was slow and subject to failure. The area selector allows commands to be sent to the injector and MCC relay trees and then to equipment to be controlled in those areas. Level selection has also been included to further subdivide the control channel commands. The machine protection and personnel protection tone levels have been added to the slow ADC input. Gun modulator A and B height, length and delay controls and analogs have also been connected to the computer via this system.

The nulling time of the slow 12-bit ADC has been reduced by an order of magnitude. The analog signals from each sector had a large 60 cycle component which required heavy filtering at the ADC input. The noise source was located in each even sector and eliminated thus allowing the input filtering to be reduced. The new filter has a 2 kc cutoff which resulted in the decreased nulling time.

Most remote controls along the klystron gallery operate on a relay tree system which requires 48 volt dc signals on 7 wire pairs to actuate a device. The binary coding scheme distinguishes zeroes and ones on the basis of polarity. Since commercially available computer interface line drivers cannot produce the signals necessary for this function, we have developed our own bipolar dc line drivers. These drivers are used in the channel repeater.

The MCC-CCR data link described in the last report has been installed and hardware checked. The clock rate is presently set at 3 kc. It can be increased to 50 kc but we don't anticipate the need of data rates greater than 10 kbaud.

The CCR computer disk operating system (DS) has been operational since September 1970, and has been used for every accelerator cycle since that date.

Every computer function, except for program editing and assembling (software development) is now done within DS. These functions include:

Klystron replacement
Accelerator data logging
Quadrupole setting
Data communications link to SDS-925 in Main Control Building
Periodic VVS reference voltage monitoring
Hardware interface checkout programs, including:
  Computer driven switched sector panel no. 3
  Relay tree and interface checkout
  Fast analog (log Q, X, Y, etc.) reading
  Continuous link (wrap-around) test
  Periodic equipment monitoring
  TIU machine protection system check.

All functions are multiprogrammed in DS, permitting concurrent execution. For example, klystron replacements may occur in the middle of the daily log printout and accelerator status logging continues during execution of hardware checkout programs. An exhaustive link test was performed in which both computers continuously transmitted messages (duplex) for 12 hours, at ~ 3000 bits/sec with no errors.

E. MCC Computer

The Serial Data Device (SDD) work has progressed to include specification for the data format (NRZ with data and clock combined on a single line) and a preliminary design of the transmit receive logic.

Digital to Analog Converter (DAC). Final design of the new DAC mechanical hardware is complete.

Rapid Access Device (RAD) drum memory. Negotiations with XDS resulted in replacement of our unsatisfactory Computer Memories Corp. (CMC) with a newer Bryant RAD. The Bryant RAD has memory capacity of 524,288 (500 K) words. The CMC RAD capacity was 131,072 (131 K) words.

The SDS-925 I/O Bus Wiring (TMCC Fanout) is complete.

Two new SLAC interface cabinets have been installed and equipment is being installed. All SLAC interfaces will be moved from the SDS-925 cabinet to these new cabinets as soon as possible.

The Data disc 6500 TV display system has been installed and interfaced to the SDS-925. The interface (TVI) has been checked out and the hardware system is operational.

Digital Input Device I (DID I) input signal conditioners have been redesigned to provide software-directed checkout of input circuits. Revision of the installed 288 channels is in progress. New channels will include the checkout revisions.

The DID II is a computer data gathering interface for low priority signals capable of handling over 5000 binary inputs and providing an interrupt to the computer only when a particular bit changes. This should improve computer efficiency since programmed scanning of individual words is no longer necessary. The unit is, at present, undergoing final checkout.

F. MCC Improvements

Expansion of the console instrumentation is continuing so that two independent operating positions will be achieved. The final item of major instrumentation is the dual control of the profile monitors. Installation is planned for February 1971.

All of the diodes in the beam positron microwave detectors at positions P1, P2, P10, P12, P30, and P32 have been replaced by MA 4127 units. This change has eliminated a gap in the response between the thermionic and the crystal diode.

Layout of SPEAR controls on the MCC console is continuing. Six proposals including power supply, vacuum, communications, video, and profile monitors have been prepared.

The average current monitor system has been redesigned to increase its stability and a video monitor multiplexer package and low level controls for the beam position microwave monitor have been installed.

Slit SL-30 in the B beam line was recently instrumented. Separate controls and digital readout for the front and rear jaws have been provided. Status lights indicate when the jaws are fully closed and when either jaw is partially or fully open. The full "in position" status is also connected to the B line personnel protection system.

G. CCR Console Improvements

A new "Beam On" panel was completed and installed in CCR. It reports the status of each of the six beam lines defined by the CCR pattern switches. Indicated states are: On, Tune, Reduced Rate, and four Off states, PLIC, No Pattern, No Permissive Pulse, or Priority Yielded by experimenter. Time is charged to each

experimenter according to a logic which includes an acknowledgement by him that the beam is satisfactory. The "Beam On" panel has toggle switches for each beam line so that the CCR operator can control a recorder which indicates the actual running time of each beam subject to that acknowledgement.

Since duplicate beam monitoring instruments must be made for MCC as part of the control room consolidation program, we have simplified the log Q, X, Y controls of the units presently installed in CCR. Previously the CCR operator could continuously adjust the vertical position and brightness of each of the six beam line traces belonging to each beam steering indicator. With the new arrangement he has no separate position adjustment, and only a 3 position (off, dim, bright) toggle switch to control brightness for each trace. The new switches appear to be satisfactory. Operation is quicker and less confusing and the loss of flexibility does not seem to be a problem.

The linear Q maintenance and calibration procedures were improved with the result that the foldover effect on the CCR scopes has been eliminated. It will probably not be necessary to install clipper circuits in the transmitters.

A source of spurious commands in the remote control system has been found and corrected. If the operator pushed two buttons on a switched sector panel, the control system would execute the first one and ignore the second. When the first button was released, the system transmitted the second command immediately. During the transient, a third and unwanted command often resulted. The solution was to delay the issuance of the second command by approximately 250 msec. A relay one shot was designed to accomplish this and has been installed in about one half of the CCR remote control systems.

H. Trigger System

Five pulsed beam loading delay units have now been completed and installed in Sector 5, 10, 15, 20, and 25, to provide for continuous (instead of stepwise) variation of beam loading delay, and separate beam loading delay, controllable from CCR, for as many as six interlaced beams.

A Pattern Distribution Amplifier was installed in Sector 23 for checkout. It is designed to supply patterns to Pulsed Steering Power Supply, Pulsed Quadrupole Power Supply, and Pulsed Beam loading in 5 sectors. After completion of the test, five more amplifiers will be built and installed to cover all 30 sectors. This amplifier is part of a program to provide steering and pulsed quadrupoles

in every sector, and pulsed beam loading delay in as many sectors as may be desirable. Instead of a separate set of drivers in CCR for each of the 30 sectors, there will be only six sets of drivers in CCR (one set for each five sectors). A pattern repeater in the alcove of the central sector of each group of five sectors will then fan out the pattern pulses from CCR to the pulsed steering, quadrupoles, and beam loading delay units in the five sectors in that group. The principal saving will be in length of interconnecting lines. Their total length will be about 50 miles, in contrast to 150 miles that would be required if all drivers were located in CCR.

The injector trigger generator has been modified so that all Sector 0 and Sector 1 klystron modulators go to "standby" mode whenever the permissive pulse is removed or the TIU loop is opened. This prevents undesirable and possibly dangerous acceleration of dark current electrons from the gun when it is not being pulsed.

A pattern generator simulator has been built to provide patterns suitable for testing pulsed steering and pulsed quadrupole power supplies and pulsed beam loading delay units, and to simplify several maintenance problems pertaining to the trigger system and pattern generator subsystem.

The new pattern control system for Sectors 27 and 28 came into operation. The CCR computer can operate this system to switch klystrons between "accelerate" and "standby" in one interpulse period. It will be used in a system to respond to sudden beam energy changes in a like interval.

I. Machine Protection System

A set of ion chambers was installed to detect radiation which can occur when the beam is improperly targeted at BAS II. Measurements showed one dead spot, and an additional ion chamber was installed to correct that condition. It is planned to include a status signal from the new system as an input to the machine protection tone system.

J. Accelerator Beam Guidance System

The I&C portion of the new 6-level pulsed phase closure system in the injector has been installed. The level selection will be done by the control level select system for the Pulsed Steering Power Supply, Pulsed Quadrupole Power Supply, and Pulsed Beam Loading. For this purpose the selection system was extended into the injector. The complete system is expected to go into operation at the beginning of March, '71.

The steering controllers in Sector 2 have been modified for computer control via the Remote Control System. This prototype has been installed for evaluation. When the circuit has been proven, the remaining controllers will be modified. In every case the computer will have priority over the manual steering controls. The new circuitry will allow the computer to do either steering or zeroing.

K. Main Injector

The I&C portion for the Gun Modulator "B" was installed and checked out. In order to save wire pairs and control channels, a novel approach was taken by placing the selection switching into the injector. The same concept was previously used for Gun Modulator "A". The computer can intercept the level selection circuitry and the appropriate remote control channel to read the analog value of the signal and/or control that function. Level selection is roughly equivalent to beam line pattern selection.

L. Positron Source

A successful test was made to show that the positron klystron 11-3B can take over the function of klystron 11-3C, thus freeing a modulator and a klystron for an rf separator in the research area. This test required changes in the instrumentation and controls.

M. Klystrons

The system for moving the klystron fault counters from sector to sector has been improved to permit faster and safer installation and removal. The fault counters were connected to the circuitry using clip leads. The clip leads have been replaced with cables and connectors to eliminate the possibility of shorts.

VIII. PLANT ENGINEERING

Provision of conventional facilities in support of the colliding beam storage ring to be located in SLAC's north target yard is under way. Construction of the underground utilities is complete and a contract for the interaction pits has been awarded. Components of buildings to house the power supplies, control equipment, and interaction pits are on hand and ready for assembly. Design is well along on the necessary site improvements and above-ground utilities and a number of bid invitations for this construction will be issued early in the next quarter. This overall effort is the major item in the current Plant Engineering program and represents a heavy commitment of engineering and drafting time for several more months.

Work continued on a group of eleven individual projects, programmatically approved by the Atomic Energy Commission for FY-71 funding as Fire, Safety, and Adequacy of Operating Conditions items. Construction on one of these, Power Service for Remote Radiation Monitors, is essentially complete. The remaining ten are in various stages of scoping, design, and initial construction. All are scheduled for completion by June, 1971. Of related interest are three F.S.O. projects carried over from FY-70 which were active in the quarter. Construction of two of these was completed: a) Dead-ending of Pole No. 35 in the SLAC 230 kV tap line; and b) Installation of an enclosure fence and special glass replacement of the exterior windows at the Computer Building (No. 214). The third, Extension of the Research Yard Fire Alarm System, is 85% complete.

Field work is in progress on several other capital projects, the principal ones being as follows:

1. Utility Tunnel B-4 Extension — the basic contract work for this 17-foot extension of the research yard utility tunnel system was completed.

2. Film Processing Facility — the project scope is being increased to accommodate the addition of a second processing unit. Beneficial occupancy began in December, 1970.

3. B-Beam Equipment Shelter (Bldg. 413) — this new building is in place and a change order for the addition of two bays has been issued. Construction will be completed in the next quarter.

4. End Station B Utility Extension — mechanical and electrical components are on order and initial construction has started for the utilities needed for new beam line experiments to be conducted in Buildings 403 and 413.

5. Installation of 5 kV contactors — a contract has been awarded and installation of the six contactors in Building 108 is 50% complete.

Preliminary work on various other items, as stated below, is under way:

1. Cooling Tower Cell — this project will increase the capacity of the BSY cooling water tower by adding a cell to the three already in service. Bids will be opened January 21, 1971, for this work.

2. Electrical Utilities — procurement has been initiated for a transformer to replace the unit damaged in service in the BSY substation. A 2 MVA unit substation to be added to the research yard electrical utility system has been obtained and will be installed during the next quarter. Materials are on order for ventilation improvements and the addition of trip indicators and lock-out relays at the variable voltage substations (klystron gallery).

3. Engineering Studies — an engineering study for the conversion of the SLAC two-mile machine to a superconducting accelerator was continued. Cost estimates relative to the use of an off-site building on Sand Hill Road for the computer program were made for SLAC management.

The department's ongoing program of plant utilities operation and minor modification to buildings and site structures was continued. The dispatcher operation was relocated from Building 214 to Building 208, completing the currently scheduled moves for the Temporary Computer Complex. Bids were requested for an addition to the north boundary fence and a relocation of the security fence along klystron gallery Sectors 28, 29, and 30.

The extension of utilities and adaptation of buildings in the research yard for experimental requirements continued to have a high priority.

IX. PUBLICATIONS

Journal Articles

SLAC-PUB-751
PHOTOPRODUCTION OF HIGH MASS DIPION PAIRS AT 15 GeV. F. Bulos, W. Busza, R. Giese, E. E. Kluge, R. R. Larsen, D.W.G.S. Leith, B. Richter, S. H. Williams (SLAC); B. Kehoe (Maryland U.); M. Beniston (IBM, Palo Alto); A. Stetz (UCRL, Berkeley). 10p. Submitted to Phys. Rev. Lett.

SLAC-PUB-787
EXPERIMENTAL DETERMINATION OF THE INELASTIC NEUTRON FORM FACTOR BY THE SCATTERING OF 12 GeV MUONS ON HYDROGEN, CARBON, AND COPPER. W. L. Lakin, T. J. Braunstein, J. Cox, B. D. Dieterle, M. L. Perl, W. T. Toner, T. F. Zipf (SLAC); H. C. Bryant (New Mexico U.). 18p. Submitted to Phys. Rev. Lett.

SLAC-PUB-789
π^-p ELASTIC SCATTERING IN THE CMS ENERGY RANGE 1400-2000 MeV. A. D. Brody, R. J. Cashmore, A. Kernan, D.W.G.S. Leith, B. S. Levi, B. C. Shen (SLAC); J. P. Berge, D. J. Herndon, R. Longacre, L. R. Price, A. H. Rosenfeld, P. Soding (UCRL, Berkeley). Submitted to Phys. Rev.

SLAC-PUB-789 (Suppl. 1)
π^-p ELASTIC SCATTERING IN THE CMS ENERGY RANGE 1400-2000 MeV. TABLES OF CROSS SECTIONS AND LEGENDRE POLYNOMIAL COEFFICIENTS. 37 p. Not to be published.

SLAC-PUB-789 (Suppl. 2)
π^-p ELASTIC SCATTERING IN THE CMS ENERGY RANGE 1400-2000 MeV. A COMPARISON OF THE RESULTS OF ELASTIC SCATTERING PHASE SHIFT ANALYSES. 17p. Not to be published.

SLAC-PUB-794
COULOMB PRODUCTION METHOD FOR STUDYING π-π INTERACTIONS. N. Jurisic (UC, Davis); L. Stodolsky (SLAC). 19p. Submitted to Phys. Rev.

SLAC-PUB-803
PHOTOPRODUCTION OF K^+-HYPERON FROM HYDROGEN AND DEUTERIUM AT 11 GeV. A. M. Boyarski, R. Diebold, S. D. Ecklund, G. E. Fischer, Y. Murata, B. Richter, M. Sands. 14p. Submitted to Phys. Rev. Lett.

SLAC-PUB-807
THE RENORMALIZATION GROUP AND STRONG INTERACTIONS. Kenneth G. Wilson (SLAC and Cornell U. LNS). 92p. Submitted to Phys. Rev.

SLAC-PUB-808
PARTONS AND THEIR APPLICATIONS AT HIGH ENERGIES. Sidney D. Drell, Tung-Mow Yan. 82p. Submitted to Annals Phys.

SLAC-PUB-809
NEW DIGITIZING AND MEMORY SYSTEM FOR WIRE SPARK CHAMBERS. R. G. Friday, D.W.G.S. Leith, K. D. Mauro, B. Richter. 9p. Submitted to Nucl. Instrum. Methods.

SLAC-PUB-810
PHENOMENOLOGICAL PREDICTIONS FOR DEEP INELASTIC ELECTRON SCATTERING. D. M. Ritson (University Coll., London). 9p. Submitted to Phys. Rev. Lett.

SLAC-PUB-812
OPTIMAL EQUATIONS FOR THREE PARTICLE SCATTERING. T. A. Osborn, K. L. Kowalski. 21p. Submitted to Annals Phys.

SLAC-PUB-817
THE QUARK-PARTON MODEL AND THE NEW ELECTRON DEUTERON SCATTERING DATA. C. H. Llewellyn Smith. 10p. Submitted to Phys. Rev.

SLAC-PUB-818
ANALYSIS OF MESON-BARYON SCATTERING PROCESSES RELATED BY SU(3) IN A UNITARIZED VENEZIANO MODEL. J. F. Gunion (SLAC), R. G. Roberts (Rutherford); 26p. Submitted to Nucl. Phys.

SLAC-PUB-819
QUANTUM ELECTRODYNAMICS AT INFINITE MOMENTUM: SCATTERING FROM AN EXTERNAL FIELD. James D. Bjorken, John B. Kogut, Davison E. Soper. 62p. Submitted to Phys. Rev.

SLAC-PUB-820
A POSSIBLE EXPLANATION FOR THE RAPID APPROACH TO "UNIVERSALITY" OF THE INELASTIC ELECTRON SCATTERING STRUCTURE FUNCTIONS. Ashok suri (SLAC and UC, Santa Cruz). 12p. Submitted to Phys. Rev. Lett.

SLAC-PUB-821
ELASTIC HADRONIC PROCESSES, DUALITY AND ABSORPTION. Haim Harari (Weizmann Inst. and SLAC). 19p. Submitted to Annals Phys.

SLAC-PUB-824
QUARK TYPE MODELS AND DEEP INELASTIC e-p SCATTERING. Kwang Je Kim. 11p. Submitted to Phys. Rev.

SLAC-PUB-825
A METHOD FOR MEASURING THE PHOTON-PHOTON TOTAL CROSS SECTION. Leo Stodolsky. 11p. Submitted to Phys. Rev. Lett.

SLAC-PUB-827
π^0 PHOTOPRODUCTION FROM HYDROGEN WITH LINEARLY POLARIZED PHOTONS. R. L. Anderson, D. Gustavson, J. Johnson, I. Overman, D. Ritson, B. H. Wiik (SLAC); R. Talman (Cornell U. LNS); D. Worcester (Harvard U.). 11p. Submitted to Phys. Rev. Lett.

SLAC-PUB-829
CHARGE DISTRIBUTIONS AND MULTIPERIPHERALISM. L. Caneschi (Stanford U. ITP); A. Schwimmer (SLAC). 14p. Submitted to Phys. Lett. B.

SLAC-PUB-830
USE OF HIGH ENERGY ELECTRON LINEAR ACCELERATORS. J. Ballam. In Linear Accelerators, ed. by P. M. Lapostolle, A. L. Septier. North Holland, Amsterdam, 1970, pp. 385-413.

SLAC-PUB-831
ACCELERATING STRUCTURES. G. A. Loew, R. B. Neal. In Linear Accelerators, ed. by P. Lapostolle, A. L. Septier, North Holland, Amsterdam, 1970, pp. 39-113.

SLAC-PUB-832
PARTICLE DYNAMICS. R. H. Helm, R. Miller. In Linear Accelerators, ed. by P. Lapostolle, A. L. Septier. North Holland, Amsterdam, 1970, pp. 115-146.

SLAC-PUB-833
RADIOFREQUENCY PROBLEMS. H. Hogg, J. V. Lebacqz. In Linear Accelerators, ed. by P. Lapostolle, A. L. Septier. North Holland, Amsterdam, 1970, pp. 315-354.

SLAC-PUB-834
BEAM BREAKUP. R. H. Helm, G. A. Loew. In Linear Accelerators, ed. by P. Lapostolle, A. L. Septier. North Holland, Amsterdam, 1970, pp. 173-221.

SLAC-PUB-835
ACCELERATING STRUCTURES TECHNOLOGY. A. L. Eldridge, A. V. Lisin, V. G. Price. In Linear Accelerators, ed. by P. Lapostolle, A. L. Septier. North Holland, Amsterdam, 1970, pp. 265-313.

SLAC-PUB-837
MODELS FOR HADRONIC REACTIONS: DUALITY, ABSORPTION AND QUARKS. Haim Harari (Weizmann Inst. and SLAC). 27p.

SLAC-PUB-839
ISOSPIN STRUCTURE OF THE MULTIPERIPHERAL MODEL AND CHARGE DISTRIBUTIONS. L. Caneschi (Stanford U. ITP); A. Schwimmer (SLAC). 28p. To be submitted to Phys. Rev.

SLAC-PUB-840
SINGULAR CORE INTERACTIONS AND THREE-BODY THEORY. D. D. Brayshaw (SLAC and Columbia U.). 9p. Submitted to Phys. Rev. Lett.

SLAC-PUB-846
SCATTERING AND PAIR PRODUCTION FROM THE DEUTERON AT LARGE MOMENTUM TRANSFERS. J. F. Gunion, R. Blankenbecler. 13p. Submitted to Phys. Rev.

Conference Papers (arranged by date of Conference)

SLAC-PUB-769
LARGE SCALE REFRIGERATION SYSTEMS FOR THE TEMPERATURE RANGE OF 1.0 TO 1.85 K. G. Ratliff, S. J. St. Lorant. 21p. Presented at Cryogenic Engineering Conf., Boulder, Colo., Jun 17-19, 1970.

SLAC-PUB-816
ELECTROMAGNETIC INTERACTIONS. W.K.H. Panofsky. 7p. Submitted to Comments on Nucl. Particle Phys., Supplement Issue on 15th Int. Conf. on High Energy Physics, Kiev, Aug 26 - Sep 4, 1970.

SLAC-PUB-823
K_L^0-p INTERACTIONS FROM 1-8 GeV/c. A. D. Brody, W. B. Johnson, B. Kehoe, D.W.G.S. Leith, J. S. Loos, G. J. Luste, K. Moriyasu, B. C. Shen, W. M. Smart, F. C. Winkelmann, R. J. Yamartino. 60p. Presented at 15th Int. Conf. on High Energy Physics, Kiev, Aug 26 - Sep 4, 1970.

SLAC-PUB-842
RECENT DEVELOPMENTS IN INELASTIC-NUCLEON SCATTERING. Frederick J. Gilman. 29p. Invited talk presented at Symposium on Hadron Spectroscopy, Balatonfured, Hungary, Sep 6-11, 1970.

SLAC-PUB-804
HIGH POWER KLYSTRON DEVELOPMENT AT THE STANFORD LINEAR ACCELERATOR CENTER. R. L. Stringall, J. V. Lebacqz. 7p. Presented at the Eighth International Conf. on Microwave and Optical Generation and Amplification, Amsterdam, Netherlands, Sep 7-11, 1970.

SLAC-PUB-828
A LARGE WIDE-APERTURE CERENKOV HODOSCOPE. A. Kilert, D.W.G.S. Leith, H. H. Williams. 9p. Submitted to Int. Conf. on Instrumentation for High Energy Physics, Sep 8-12, 1970, Dubna, USSR.

SLAC-PUB-800
RECENT AND PLANNED IMPROVEMENTS OF CONVENTIONAL ELECTRON LINACS. G. A. Loew, R. B. Neal. 29p. Presented at Proton Linear Accelerator Conf., NAL, Batavia, Ill., Sep 28 - Oct 2, 1970.

SLAC-PUB-811
ELECTROMAGNETIC AND MECHANICAL PROPERTIES OF NIOBIUM CAVITIES FOR A SUPERCONDUCTING ELECTRON LINEAR ACCELERATOR. W. B. Herrmannsfeldt, R. H. Helm, R. R. Cochran. 13p. Presented at Proton Linear Accelerator Conf., NAL, Batavia, Ill., Sep 28 - Oct 2, 1970.

SLAC-PUB-813
COMPUTATION OF THE PROPERTIES OF TRAVELING-WAVE LINAC STRUCTURES. R. H. Helm. 12p. Presented at Proton Linear Accelerator Conf., NAL, Batavia, Ill., Sep 28 - Oct 2, 1970.

SLAC-PUB-848
RADIATIVE CORRECTIONS TO ELECTRON SCATTERING. Yung-Su Tsai. 66p. Lectures given at NATO Advanced Inst. on Electron Scattering and Nuclear Structure, Cagliari, Italy, Sep 1970.

SLAC-PUB-822
SOME ENGINEERING OBJECTIONS TO USING REINFORCING STEEL AS GROUNDING ELECTRODES. G. Harding, C. A. Harris. 4p. Presented at IGA Group Annual Meeting (G-IGA), Chicago, Ill., Oct 5-7, 1970.

SLAC-PUB-799
INFORMATION PROCESSING WITH TIME-HOLOGRAPHY. Andrew P. Sabersky. 16p. Submitted to Appl. Optics. Presented at meeting of Optical Society of America, Chicago, Ill., Oct 1969.

SLAC-PUB-836
A PROPORTIONAL WIRE CHAMBER ELECTRONICS SYSTEM UTILIZING CAMAC. B. Bertolucci, R. Carman, J. Faust, D. Horelick, J.-L. Pellegrin. 21p. Presented at IEEE Nuclear Science Symposium, New York, Nov 4-6, 1970.

SLAC-PUB-838
CAMAC DATAWAY AND BRANCH HIGHWAY SIGNAL STANDARDS. R. S. Larsen. 15p. Presented at IEEE Nuclear Science Symposium, New York, Nov 4-6, 1970.

SLAC-PUB-843
THEORIES OF HIGHLY INELASTIC ELECTRON SCATTERING. C. H. Llewellyn Smith. 22p. Invited talk presented at American Physical Society Meeting, Austin, Texas, Nov 5-7, 1970.

SLAC-PUB-802
PRESENT STATUS AND FUTURE PLANS AT SLAC. R. B. Neal. 49p. Presented at USSR 2nd National Conf. on Particle Accelerators, Moscow, Nov 11-18, 1970.

SLAC-PUB-844
A COMMAND LANGUAGE META-SYSTEM. James E. George (Stanford U. Computer Science Dept.); Harry J. Saal (SLAC). 3p. Summary of talk to be given at 4th Hawaii Int. Conf. on System Sciences, Honolulu, Hawaii, Jan 12-14, 1971.

Technical Reports

SLAC-123
THEMI MONTE CARLO GENERATION OF ELECTROMAGNETIC EVENTS. Dennis C. Blanchard, William P. Swanson. 13p.

SLAC-124
NEUTRAL PION AND ETA PHOTOPRODUCTION FROM HYDROGEN AT HIGH ENERGIES. James R. Johnson. 95p.

SLAC-125
MEASUREMENT OF THE TWO PHOTON DECAY OF THE K_L^0 MESON. James E. Enstrom. 108p.

SLAC-126
TWO-MILE ACCELERATOR PROJECT; Quarterly Status Report April 1 to June 30 1970. 78p.

Other Publications by SLAC Authors

SCIP TARGETS THERMAL DESIGN. R. A. Bell. Feb 1970. 17p. (CERN MSC-26/82).

THE FORM FACTOR RATIO G_{E_n}/G_{E_p} AT LOW MOMENTUM TRANSFERS. F. A. Bumiller, F. R. Buskirk, J. W. Stewart (Naval Postgrad. School, Monterey); E. B. Dally (SLAC). July 1970. 16p. (HEPL 637) Submitted to Phys. Rev. Lett.

ANGULAR DISTRIBUTION OF THICK TARGET BREMSSTRAHLUNG. R. C. McCall, W. R. Nelson (SLAC); J. M. Wyckoff, J. S. Pruitt (NBS). Proceedings Second Int. Conf. on Accelerator Dosimetry and Experience, SLAC, Nov 5-7, 1969. pp. 684-691. (CONF 691101).

I=2 $\rho\pi$ SYSTEM IN $\pi N \to \rho\pi N$. R. E. Mickens (MIT); H. J. Lubatti (U. of Washington, Seattle); F. C. Winkelmann (SLAC). Sep 1970. 26p. (MIT CTP 149).

VACUUM POLARIZATION CONTRIBUTIONS TO THE SIXTH ORDER ANOMALOUS MAGNETIC MOMENT OF THE MUON AND ELECTRON. Stanley J. Brodsky (Cornell U. LNS and SLAC); Toichiro Kinoshita (Cornell U. LNS). 27p.

PRECISE DETERMINATION OF THE K_L-K_S MASS DIFFERENCE BY THE GAP METHOD. S. H. Aronson, R. D. Ehrlich, H. Hofer, D. A. Jensen, R. A. Swanson, V. L. Telegdi (EFINS and U. of Chicago); H. Goldberg, J. Solomon (U. of Illinois, Chicago); D. Fryberger (SLAC). Phys. Rev. Lett. 25, 1057-1061 (1970).

A STUDY OF THE DECAY $\Lambda(1520) \rightarrow \Sigma(1385)\ \pi$. E. Burkhardt, H. Filthuth, E. Kluge, H. Oberlack (Heidelberg U.); F. Armenteros, M. Ferro-Luzzi, D.W.G.S. Leith, R. Levi-Setti (CERN); R. Barloutaud, P. Granet, J. P. Porte (Saclay). 16p. (D.Ph.II/PHYS 70-58).

MODIFIED SCALING LAW FOR LARGE-ANGLE πN SCATTERING. John M. Cornwall (UCLA); Donald J. Levy (SLAC). 26p.

ELECTROMAGNETIC EXPERIMENTS AT NAL. R. J. Morrison (UCSB); E. Engels, Jr. (U. of Pittsburgh); M. Goitein (LRL); E. A. Paschos (Rockefeller U.); P. Patel (McGill U.); F. M. Pipkin, M. Tannenbaum (Harvard); J. Tenenbaum (SLAC); J. S. Trefil (Illinois U.); D. Yount (U. of Hawaii). 11p. (SS-166).

REGGE-EIKONAL FORMALISM IN THE VAN HOVE MODEL. Ronald Torgerson (OSU and SLAC). 12p. (COO-1545-85).

Other Publications, Based Upon Results of SLAC Research

EVIDENCE FOR A NARROW K^*_N RESONANCE AT 1250 MeV. A. Firestone, G. Goldhaber, D. Lissauer (UCRL Berkeley). Aug 1970. 10p. (UCRL 20091) Submitted to Phys. Rev. Lett.

A MEASUREMENT OF THE FORM FACTORS FOR THE DECAY $K^0_L \rightarrow \pi\mu\nu$. C.-Y. Chien, B. Cox, L. Ettlinger, L. Resvanis, R. A. Zdanis (JHU); E. Dally, P. Innocenti, E. Seppi (SLAC); C. D. Buchanan, D. J. Drickey, F. D. Rudnick, P. F. Shepard, D. H. Stork, H. K. Ticho (UCLA). 12p. (JHU 7016 Rev., UCLA 1054).

A STUDY OF THE DECAY MODE $K^0_L \rightarrow \pi^+\pi^-\pi^0$. C. D. Buchanan, D. J. Drickey, F. D. Rudnick, P. F. Shepard, D. R. Stork, H. K. Ticho (UCLA); C.-Y. Chien, B. Cox, L. Ettlinger, L. Resvanis, R. Z. Zdanis (JHU); E. Dally, E. Seppi, P. Innocenti (SLAC). 13p. (JHU 7018 Rev., UCLA 1052).

PHOTOPRODUCTION OF π^+ MESONS FROM A POLARIZED PROTON TARGET AT 5 and 16 GeV. Charles Conover Morehouse. 107p. Ph.D. thesis. (UCRL 19897).

SEARCH FOR POLARIZATION IN ELASTIC e^-p SCATTERING AT 15 and 18 GeV. Thomas Mabrey Powell. 102p. Ph.D. thesis. (UCRL 20093).

A_2 MASS SPECTRUM IN 7 GeV/c π^+p INTERACTIONS. M. Alston-Garnjost, A. Barbaro-Galtieri, W. F. Buhl, S. E. Derenzo, L. D. Epperson, S. M. Flatte, J. H. Friedman, G. R. Lynch, R. L. Ott, S. D. Protopopescu, M. S. Rabin, F. T. Solmitz (UCRL, Berkeley). 15p. (UCRL-20129) To be published in Phys. Lett. B.

DOUBLE-REGGE POLE ANALYSIS OF $\pi^+p \rightarrow \pi^+f^0p$ AT 13.1 GeV/c. J. A. Gaidos, C. R. Ezell, J. W. Lamsa, R. B. Willman (Purdue U.). 23p. (C00-1428-245). To be published in Nuclear Physics B.

γn PARTIAL CROSS SECTIONS UP TO 12 GeV AND THE ISOVECTOR-ISOSCALAR INTERFERENCE. G. Alexander, I. Bar-Nir, S. Daga, J. Gandsman, J. Grunhaus, A. Levy, Y. Oren (Tel-Aviv U.). 12p. (TAUP-181-70).

$\pi^+p \rightarrow f^0\Delta^{++}$ AT 13.1 GeV/c. J. A. Gaidos, C. R. Ezell, J. W. Lamsa, R. B. Willman (Purdue U.). 11p. (C00-1428-248) To be published in Nuclear Physics B.