SLAC BEAM LINE

There is no excellent beauty that hath not some strangeness in the proportion.—Francis Bacon

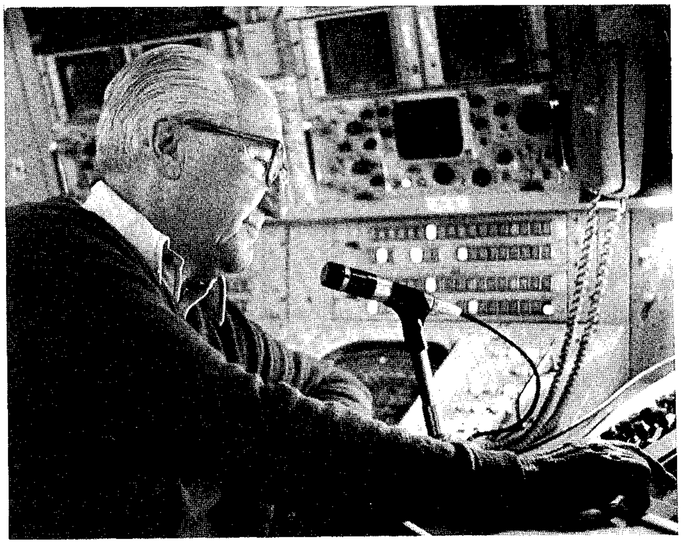
Volume 10, Number 2 *February 1979*

Six of the eight scientists from the People's Republic of China who are presently visiting SLAC are shown in this photo. In the back row, left to right, are Dung Chu-sun, Tung Tai-mao; Ron Rinta, Paul Tsai and Ken Moffeit of SLAC; and Huang Te-chang. In the front row, L to R, are Yang Cheng-chang, Lang Peng-fei; Joe Ballam of SLAC; Chi Chi-sheng; and Bob Watt of SLAC. Two articles in this issue of the *Beam Line* describe the planned cooperation between U.S. and PRC scientists in the design and construction of a new accelerator laboratory near Peking. *(Photo by Joe Faust.)*

In This Issue

HAROLD JOSEPH RETIRES

(Photos by Joe Faust)



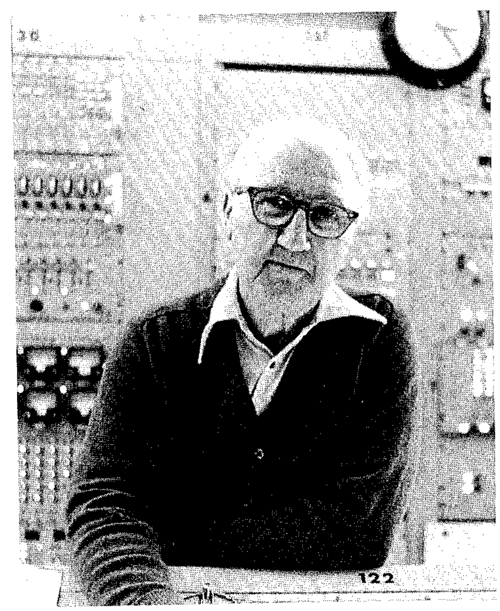
Harold C. Joseph, one of SLAC's six OIC's, (operators-in-charge of the accelerator) retired in early January. With nearly 17 years of experience at SLAC, Harold had become familiar with the wide variety of problems that are faced by the operating groups in delivering beams to the the various experiments. Harold began his career at SLAC in the Klystron Department, but after about a year he transferred to the Test Stand Maintenance Group that was then forming under Jim Sirois. He advanced to Staff Associate in this group, supervising the work of six technicians. In June 1965, the Accelerator Operations Group was formed to begin the testing program of the accelerator. Hal Joseph and several others then joined the new group to apply their talents to checking out the sectors of the accelerator as they were installed. At the end of the testing program, Hal took on the task of engineering OIC working rotating shifts.

Before coming to SLAC, Hal had spent 25 years in the U.S. Air Force, beginning as an enlisted man and rising to the rank of Major. His early experience with amateur radio was put to use during World War II as a radio operator in the Air Corps bomber command. He became the chief of the radio section of a flight squadron, then moved on to become siting officer in locating aircraft control units in North Africa. After the war, he supervised the dismantling of radar equipment in Europe and Japan. After a time spent in teaching electronics courses to military officers, he spent the last seven years of his service as a Division Communications Officer supervising the maintenance and operation of the navigation and communications equipment at a large northern radar base. Coming back from the cold tundra, Hal opted for California as his new home, hoping never to see ice and snow again.

Hal has been able to pursue his hobby of flower-raising that he shares with his wife, Lois. Out of their greenhouse have come many beautiful orchids and roses, and each year they participate in the Rose Society's demonstrations of new varieties they have developed. Recently, Hal has acquired a new microprocessor and has become very interested in the details of assembly language programming. We expect soon to see an article on "Computer-controlled greenhouses" appearing in the hobby microprocessor literature. Perhaps even more beautiful orchids will be the result.

Hal has made an indelible impact upon his co-workers at SLAC. The experimenters are bound to miss his careful and competent hand in controlling beam operations. We wish Hal and Lois the very best in their active retirement!

--Vern Price



NEW PHONE BOOK PAGES

New white and yellow pages to replace the present ones in the SLAC phone book are now available from Mary Ann Blackman at ext. 2200. (The fact that the new pages are dated "July 15, 1979" rather than the correct "January 15, 1979" is a goof which should be ignored.)

THE STATE OF SLAC

W. K. H. PANOFSKY

Note: This is the text of the annual "State of SLAC" talk that was recently presented to the staff by SLAC's Director.

Contents

Today I am continuing what has now become an annual custom: a discussion of the state of SLAC and of the laboratory's prospects in view of the proposed Federal Budget that President Carter has recently submitted to the Congress for Fiscal Year (FY) 1980. In this talk I will describe the funding for SLAC that is proposed in the President's budget submission and the impact that this funding level is expected to have upon the laboratory's operations and staffing. In the latter part of the talk I will also give a brief description of a recent experiment at SLAC, Experiment E-122, that has resulted in an important advance in our understanding of the fundamental forces in nature.

A. A YEAR OF TRANSITION

Fiscal Year 1980 begins on October 1, 1979. By coincidence, that is also the date when the new PEP storage ring facility is expected to begin its first operation. Thus the advent of PEP operations is the single most important new factor expected for FY1980. But there will also be other important changes. For example, once PEP operation has become sufficiently reliable so that about one-half of its running time can be devoted to particle-physics research, we expect to begin sharing the operation of the present SPEAR storage ring on a 50-50 basis with the Stanford Synchrotron Radiation Laboratory (SSRL).

As you know, although closely allied with SLAC, SSRL is actually an independent unit within Stanford University and is supported by the National Science Foundation rather than by the Department of Energy (DOE) which supports SLAC's work. The 50-50 division of SPEAR's operating time will result in a significant increase in SSRL's level of activity. Expansion of the SSRL facilities has been going on for some time in preparation for the greatly increased research opportunities that will become available.

In regard to the non-storage-ring research program at SLAC (the "stationary-target" or "linac" experimental program), it is expected that FY1980 will see a continuation of this program at approximately its present level, or perhaps slightly reduced from the present level.

B. THE PROPOSED SLAC BUDGET FOR FY1980

The operation of PEP in FY1980 will mark a significant increase in both the level of funding at SLAC and in the laboratory's operating responsibilities. As is usually the case, it is unfortunately true that the funding increase will not be quite enough to match the increased responsibilities. Stated differently, the new research opportunities that PEP will make available are being attained at the price of some impact, although not a large one, upon the rest of SLAC's program. I have already noted one part of this story, namely, the fact that the physics output from SPEAR is certain to be reduced when SSRL begins to use 50% of the SPEAR running time. More generally, if we look at the total funding that is earmarked for SLAC in the proposed budget for FY1980, and if we subtract from this total the minimum requirements for PEP, then what is left represents a small decrease (in actual purchasing power) for the remaining SLAC activities other than PEP.

This situation is shown in Figure 1, which indicates on a year-by-year basis the total "recurrent" funding that has been available to SLAC since FY1970. In this figure, the shaded columns ("constant FY1980 dollars") show the funding levels when the cumulative effects of inflation are taken into account over the 11-year period. The term "recurrent" funding means the usual operating funds plus the following "Capital" funds: (a) that part of our Equipment funding which supports the lab's year-by-year experimental program; (b) General Plant Project (GPP) funds which support modifications or additions to the physical plant; and (c) Accelerator Improvement (AI) funds which support improvements to our accelerator or storage rings.

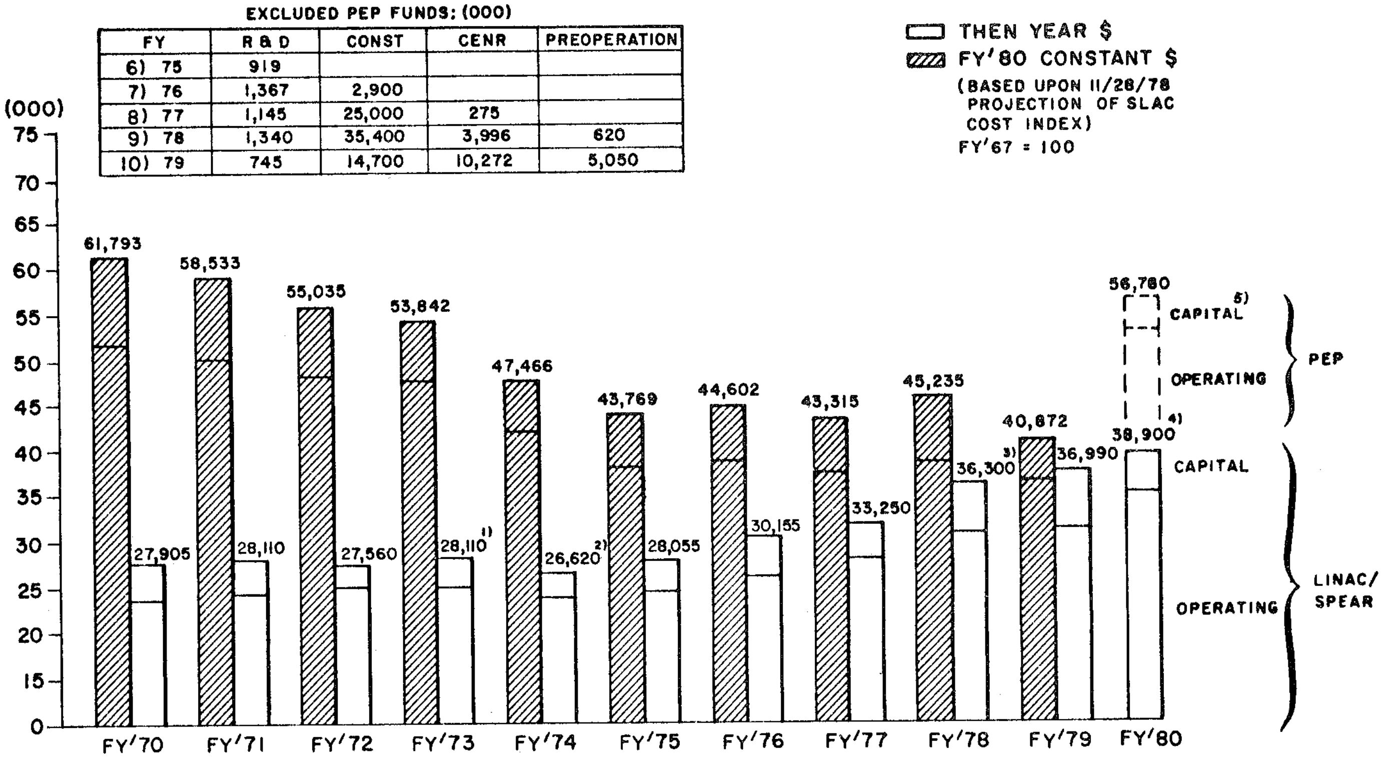
As Figure 1 indicates, in terms of actual purchasing power our recurrent funding declined steadily up until about FY1975, then leveled off during the period through FY1979. Even with the proposed funding increase in FY1980, which must support the new PEP operations in addition to

Figure 1

SLAC NOA BY FISCAL YEAR
RECURRENT FUNDING ONLY

EXCLUDED PEP FUNDS: (000)

FY	R & D	CONST	CENR	PREOPERATION
6) 75	919			
7) 76	1,367	2,900		
8) 77	1,145	25,000	275	
9) 78	1,340	35,400	3,996	620
10) 79	745	14,700	10,272	5,050



1) EXCLUDES $1,160 OF PRIOR YEAR FUNDS APPLIED TO FY'73 CAPITAL EQUIPMENT OBLIGATIONAL AUTHORITY.
2) EXCLUDES $2,900 NOA FOR SLAC COMPUTER BUILDING.
3) EXCLUDES $1,700 FOR CONSTRUCTION OF MASTER SUBSTATION.
4) EXCLUDES $1,000 FOR COMPUTER LEASE.
5) INCLUDES $3,485 PEP EQUIPMENT FUNDS ASSUMED TO FLOW THROUGH SLAC.

SLAC Recurrent Funding, FY'70 – FY'79, Expressed in Both Then-Year and Constant – FY'79 Dollars, and with the Division Between Operating and Capital Funds Shown.

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the ongoing programs at SLAC, the FY1980 funding will not reach the equivalent funding levels that we enjoyed back in FY1970. Nevertheless, there is still much reason to be thankful that our past research achievements have led to the construction of the new PEP facility, which will make it possible to initiate a whole new phase of operation of the laboratory.

You will notice from Figure 1 that our regular linac program has been decreasing gradually over the years, notwithstanding the great research achievements that have come from that aspect of our work, anda highlight of which I will report to you later in this talk. Superficially we can measure the total activity of the linac program by the number of pulses that the accelerator has delivered over a period of years. This is shown in Figure 2, which illustrates the gradual attrition when this index is used. On the other hand, the total number of eight-hour operating shifts we have been able to man has remained roughly constant over the 12-year period shown in the figure and has been determined almost entirely by the shutdowns required for various technical reasons, including PEP construction. It is the number of manned shifts that determines the level of service we can provide for experimentation with the storage ring and the bubble chamber.

During FY1980 this pattern will continue. As Figure 1 indicated, there will be an additional squeeze on linac operation and it will thus again be very difficult to satisfy the demands of experimental users for linac pulses. One circumstance that aggravates this situation is the cost of electrical power. As PEP comes into operation, there will be a natural increase in the use of electric power. Since the total amount of power that is available to SLAC from the less costly public power sources is fixed, the increased power demand occasioned by the operation of PEP must be met from the much more expensive commercial power source. Thus the cost of electric power at SLAC during FY1980

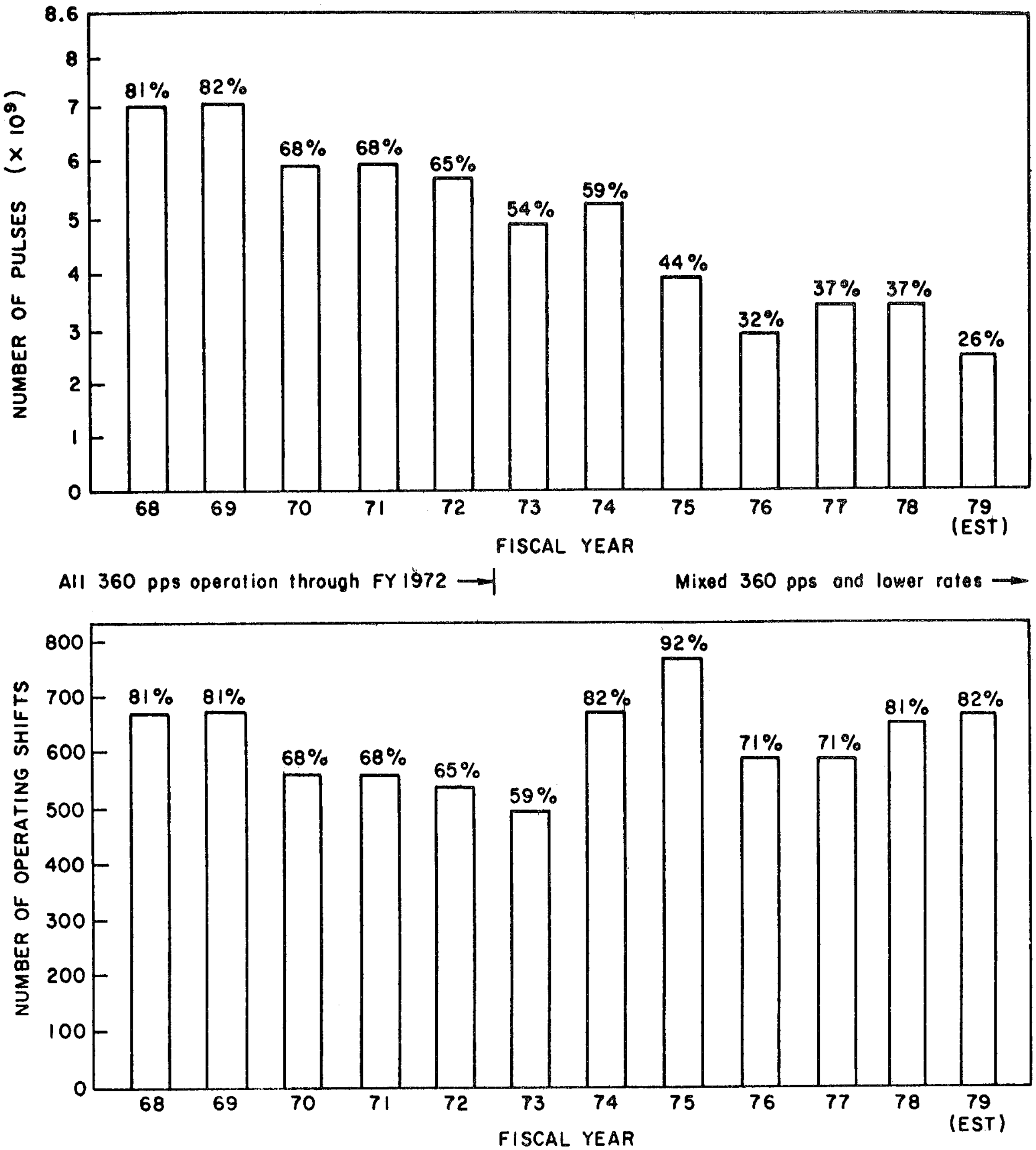

Figure 2

UTILIZATION OF THE SLAC ACCELERATOR
BY PULSES AND OPERATING SHIFTS

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will be several million dollars greater than in any previous year.

For all of these reasons, and for many others that are too detailed to report on here, all phases of SLAC's operations during FY1980 will have to be on an austere basis, even though this year will indeed mark a major expansion in SLAC's operations funding as PEP construction comes to an end.

C. SLAC ORGANIZATION

During its construction period, the PEP project is being managed as a separate entity, solely involved with the construction of this new facility. There are several reasons for the isolation of this project from the rest of SLAC's work. First, PEP construction is a joint responsibility of SLAC and of the Lawrence Berkeley

Laboratory (LBL); the Director of PEP, Professor John Rees, is responsible to the heads of both Laboratories. Also, PEP's construction requires the single-minded attention of a separate organization, with support being drawn as needed from both SLAC and LBL.

With the completion of PEP, however, this will change. The intention is that PEP will become a regular part of the SLAC organization, and toward this end, a new Division of SLAC, the PEP Division, will be created and function much like the present Technical and Research Divisions. The PEP Division will include both PEP and SPEAR within its responsibilities, since much of the technology involved in the two storage ring facilities is the same or very similar (e.g., vacuum and RF systems, beam injection, etc.). It thus makes good sense to have the operating crews of the two facilities under common supervision, to have training programs that qualify operators for both facilities, and so on.

An important aspect of this planned organizational change is that the budgets for PEP and for the rest of SLAC will no longer be separate from each other. Once PEP construction is complete, scientific priority will dictate how SLAC's funding is distributed among the PEP, SPEAR and linac aspects of the experimental program. An indication of this intention is the recent action we have taken to combine the two previous experimental program committees (one for PEP experiments and the other for SPEAR and linac experiments) into a single new body, the Experimental Program Advisory Committee (EPAC), which will have its first meeting next month. EPAC will advise the Director of SLAC on experimental selection, allocation of running time, and possible new research facilities for all three aspects of the future SLAC program. The Director of LBL will also participate on an advisory basis in matters related to the PEP program.

D. SLAC STAFFING LEVELS

I would now like to turn to the implications of the proposed FY1980 funding and the planned organizational changes for future SLAC staffing levels. As far as the period through FY1980 is concerned, the answer seems reasonably clear: there will be a modest increase in the overall SLAC staff as we combine the responsibilities of the now-separate PEP and SLAC organizations into a single unit. One example is the SLAC Experimental Facilities Department (EFD), whose funding will probably increase by about 30% as it takes over the responsibility for the "care and feeding" of the new PEP experimental areas in addition to its continuing work on linac beam lines and target areas. We have already experienced a substantial growth in the SLAC shops during the PEP construction period. The expectation is that the present shop staffing will hold at approximately the present level as the needs of the experimental program replace the work that is now being done on the construction of PEP.

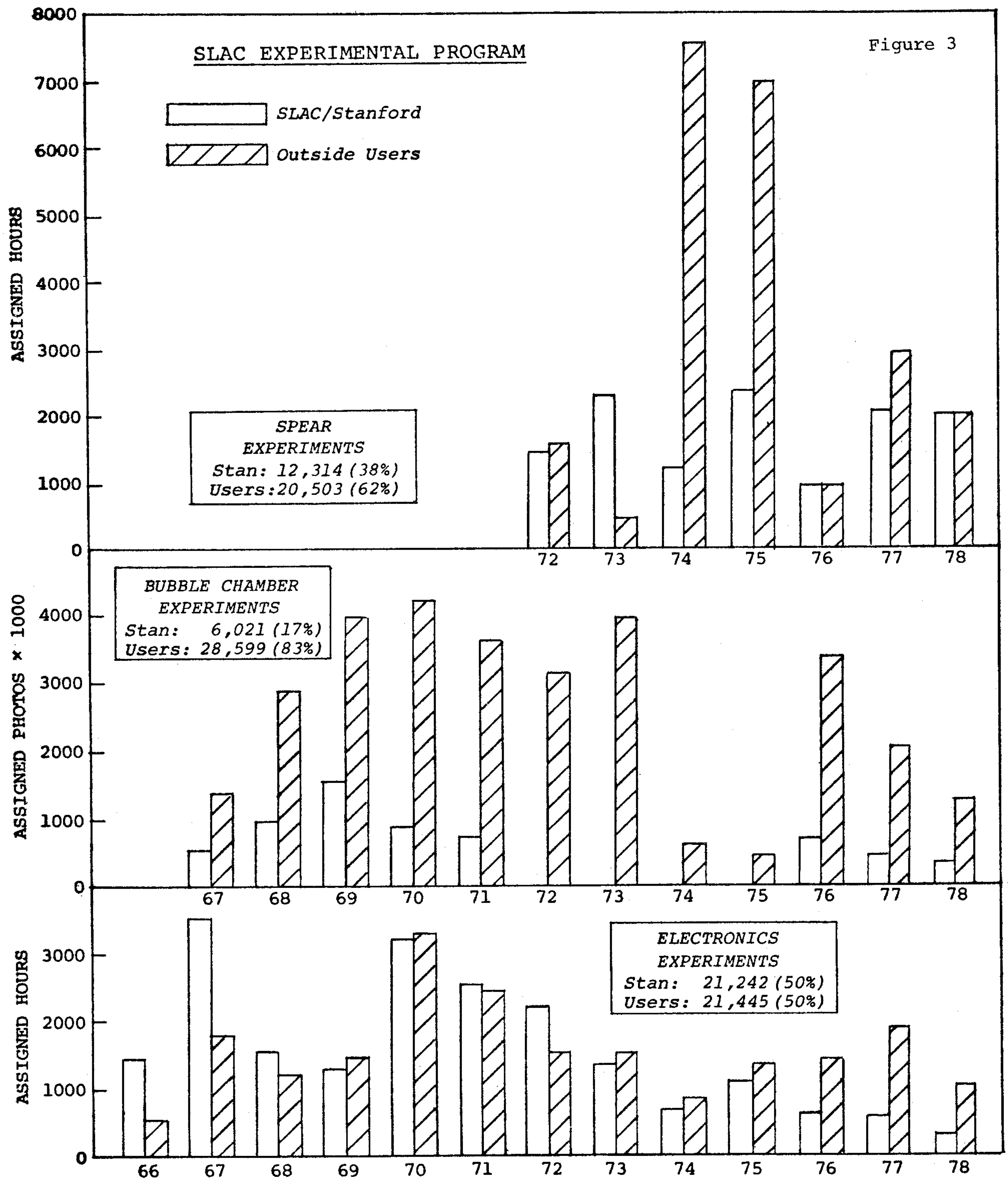
We also expect the total research activity carried out by the lab to remain roughly constant, as measured by the size of the scientific staff and their associated support personnel. This fact implies, of course, that a larger fraction of the total research at SLAC will be done by users from outside institutions than has previously been the case. This development has been foreseen for some time, and it reflects the fact that research opportunities throughout the rest of the United States have gradually been shrinking as major accelerator facilities have been closed down. It is presently planned that the ZGS machine at Argonne National Laboratory will be shut down sometime during the coming year. Thus the entire community of high energy physicists will depend on three major labs, Brookhaven, Fermilab and SLAC, and on the smaller Cornell facility as the only U.S. facilities for particle-physics experimentation. As a matter of general interest, Figure 3 shows how the SLAC experimental program has been divided between Stanford (including SLAC) physics and groups from other institutions since SLAC first began operating in 1966. The trend has been steadily toward greater outside use of our facilities, and we expect this trend to continue in the foreseeable future.

To summarize, we estimate that by FY1980 the total SLAC staff will have increased by about 2 to 4% over the present level. The reason for this relatively small increase is of course related to the fact that the recent "one-shot" funding we have been receiving for construction of PEP and its initial complement of experimental facilities will soon be coming to an end.

One note of caution about the foregoing remarks: Our conclusions have been based upon the funding levels for FY1980 that are contained in the President's recent budget message to the Congress. The proposed funding must still be reviewed by Congressional authorization and appropriation committees, and must also be apportioned (as it is called) by the Office of Management and Budget and the DOE. All this takes a number of months, and there is no guarantee that the proposed funding will not be changed. Although we have some confidence that any changes will be relatively minor, this will not be known for a number of months.

E. LONG-RANGE PLANS

The preceding discussion has been an overview of our expectations for the next fiscal year. The outlook is for a significant expansion of our operating activities as the new PEP oper-



ating program begins. SLAC's general plans for the longer term are shown schematically in Figure 4, which contains only minor changes from the similar Long Range Plans figure that I showed to you last year.

The intent of this plan is that SLAC will continue to maintain a reasonable balance between the linac program (augmented by SLED) and the storage ring programs. The backbone of the linac program will continue to be the Hybrid Bubble Chamber facility, the LASS facility, and the spectrometer facilities in Ens Station A. The ongoing experimental program at SPEAR will have the relatively new Crystal Ball detector in the

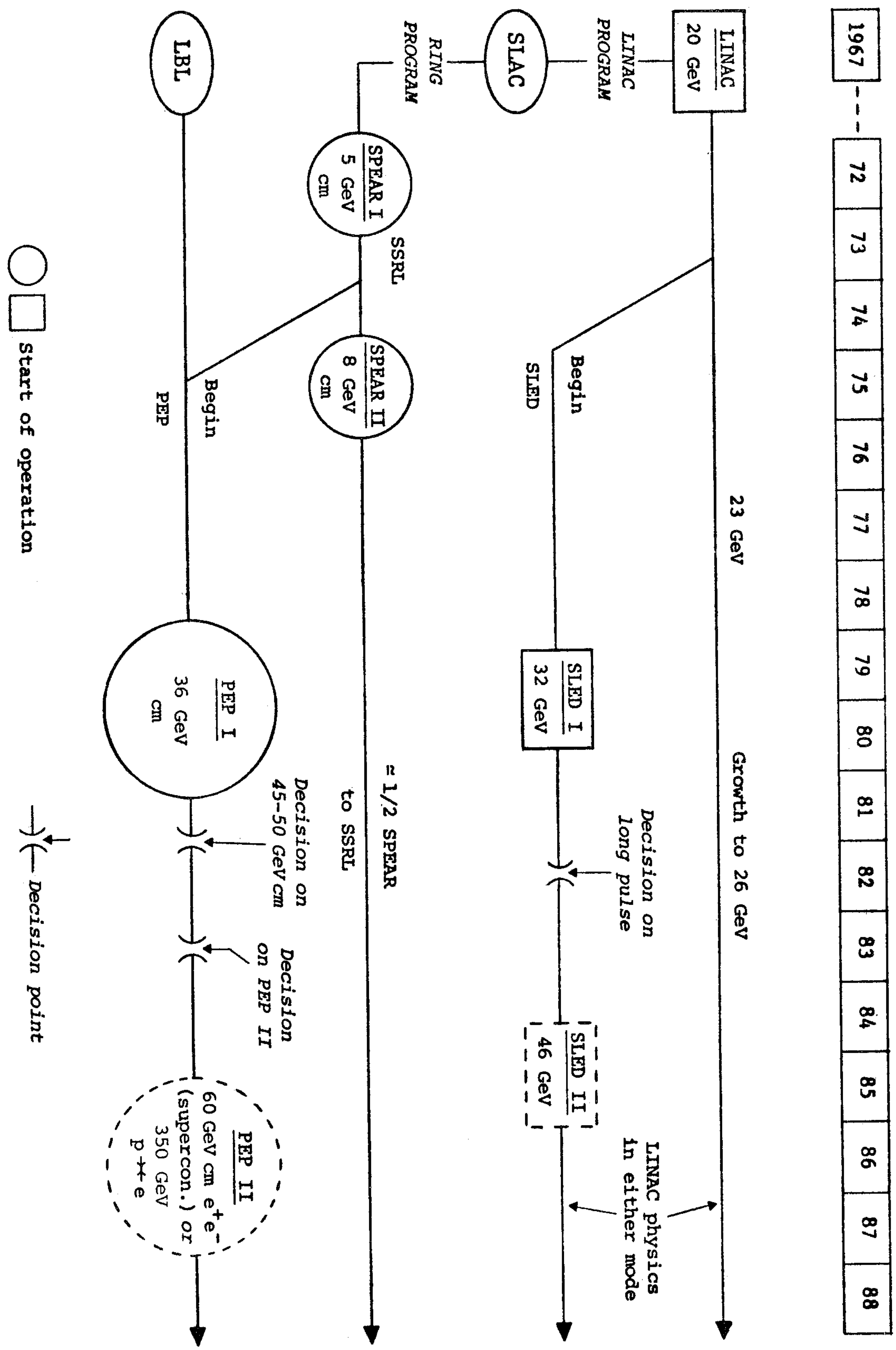


Figure 4--SLAC Long Range Plans

East Pit. This device has now undergone its initial operation, and it appears to be very successful in its planned program of measuring the gamma-ray spectra resulting from electron-positron collisions. In addition, we have now begun the design of a major new detection system for SPEAR, the Mark III, that will eventually replace the Mark II about one year after the latter has moved over to PEP.

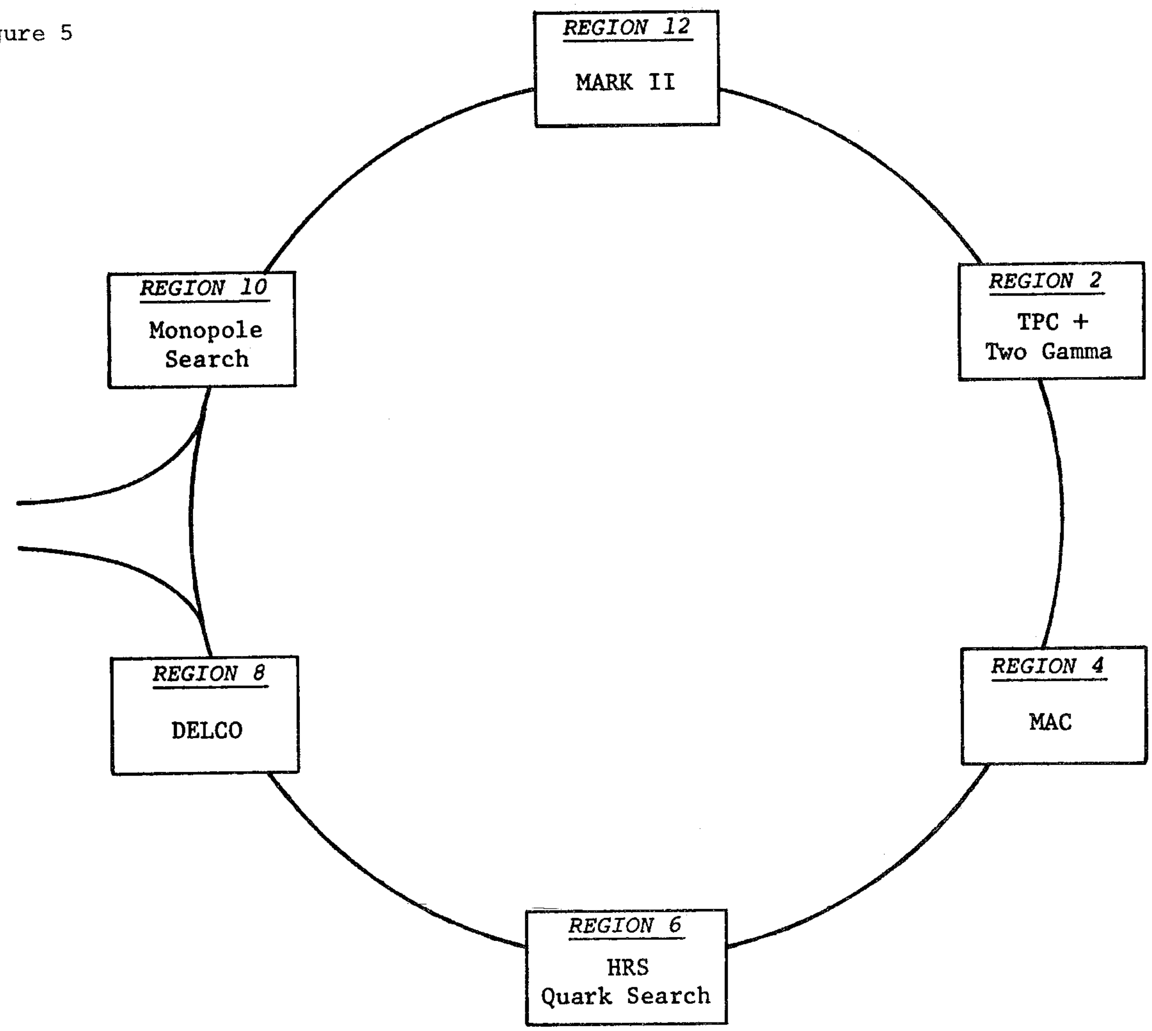
Figure 5 is a schematic drawing of the PEP interaction regions, showing the various major new detectors and smaller facilities that are scheduled for the initial research operation of PEP in early 1980. As an indication of the wealth of new research opportunities that PEP will open up, the facilities listed in this figure represent the work of about 175 physicists from 21 different institutions throughout the United States and several more from abroad.

SLAC is both a national and an international institution. There is no other electron accelerator in the world that even approaches SLAC's performance. This circumstance, combined with the long tradition of worldwide collaboration in particle physics research, has made SLAC a center for frequent visits by foreign scientists and for collaboration in our experimental program by such scientists. Of particular recent interest is the recent decision by China to build a 50 GeV proton accelerator near Peking. This machine will be built by Chinese physicists, engineers and technicians, but substantial U.S. involvement in the project is also envisioned. For this reason, we expect to see during the next few years more frequent visits by Chinese scientists and some additional work to be undertaken at SLAC in relation to the construction of the new Peking laboratory.

F. EXPERIMENT E-122

For most of the remainder of this talk, I would like to give a brief description of what is probably the most spectacular experimental result that has come from SLAC during the past year. I am referring to Experiment E-122, whose spokesman was Charles Prescott of SLAC. The experiment was carried out in End Station A, and

Figure 5



it demonstrated that "parity" is not conserved in the scattering of electrons at high energy. Let me explain what that means.

Polarized Electrons

I have mentioned in previous talks that the particles we accelerate here at SLAC, electrons, have certain intrinsic properties, for example, mass and negative electric charge. They also have a property that physicists call "spin," which can be thought of as the rotation of the particle about an axis--like a spinning top. During recent years, physicists from SLAC and from Yale University have worked on the development of sources of electrons whose spin axes are not oriented randomly with respect to their direction of motion, but rather have a preferred orientation with respect to that motion. A beam of such electrons with a preferred spin orientation is said to be "polarized." Just recently this work has resulted in a very successful polarized electron source called PEGGY II, which is able to produce a beam having an intensity that is just about equal to that from the usual SLAC electron "guns" that feed the accelerator.

In considering a spinning object such as a top or an elementary particle, it is customary to indicate both the speed of rotation and its direction by drawing an arrow along the axis around which the object rotates, as shown in Figure 6:

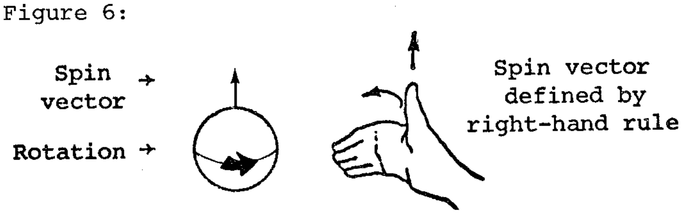


Figure 6

The length of the arrow can be used to show the speed or frequency of rotation, but how does the arrow define the direction of rotation? What is needed is an arbitrary rule of some kind. In the figure, for example, we have adopted the usual "right-hand rule" which relates the arrow to the direction of rotation. If we had instead adopted a "left-hand rule," then the arrow would have come from the opposite end of the spin axis and would have pointed in the opposite direction.

Now in principle the use of either a right-hand rule or a left-hand rule seems to be purely arbitrary, and because of this it seems reasonable to expect that the outcome of any actual experiments would not depend upon the relationship between the orientation of this arrow and the particle's direction of motion. However, the purpose of Experiment E-122 was to test whether this naive expectation was or was not correct when it was applied to the scattering of polarized electrons to atomic nuclei at high energies.

Parity Violation

This was not a new question. For about the past 20 years or so it has been known that certain forms of radioactive decay (beta decay) exhibit a difference between left- and right-handedness. That is, the particles emitted from spinning nuclei come out in a preferred direction that is determined by the orientation of the nuclear spin. Thus it was already known that in such beta-decay processes Nature does make an absolute distinction between left- and right-handedness, and this distinction is described as a violation of the important physical principle known as "parity." However, parity violation had only been observed in the special class of processes in which there is a change in the electric charge of the interacting particles--for example, from plus to neutral, or from neutral to minus. It remained an open question whether parity would be violated in such simple processes as the deflection of electrons in which the electric charge of the particles does not change. The experiment, then, set out to determine whether the probability of electron scattering would depend upon the spin direction or polarization of the incident electron beam.

Design Of The Experiment

The design of the experiment represented a tremendous technological challenge. The most promising theory predicted that under practical conditions the difference in scattering between left- and right-hand polarized electrons would only be about 1 part in 10,000; and in order to make a convincing measurement of this very small effect a number of new features had to be introduced into the experimental technique. First, simple statistical arguments indicated that more than one billion scattering "events" had to be measured in order to reduce the natural fluctuations in the data to an acceptable level. Second, the SLAC accelerator had to be operated with unprecedented stability, both in terms of its energy and the precise position at which the beam was delivered to the target.

These and several other stringent requirements led to the experimental set-up that is shown schematically in Figure 7. Since it would have been impossibly time-consuming (many years) to measure the required number of events individually (the usual technique), the experimenters simply measured the total amount of light that was produced when the scattered beam particles passed through two different counters--a Cerenkov counter and a shower counter--both of which convert into light a portion of the energy that is released by the traversing particles. Special beam monitors were used to feed back information to control the accelerator's energy and the steering of the beam. In addition, the experiment ran for a certain period as the sole

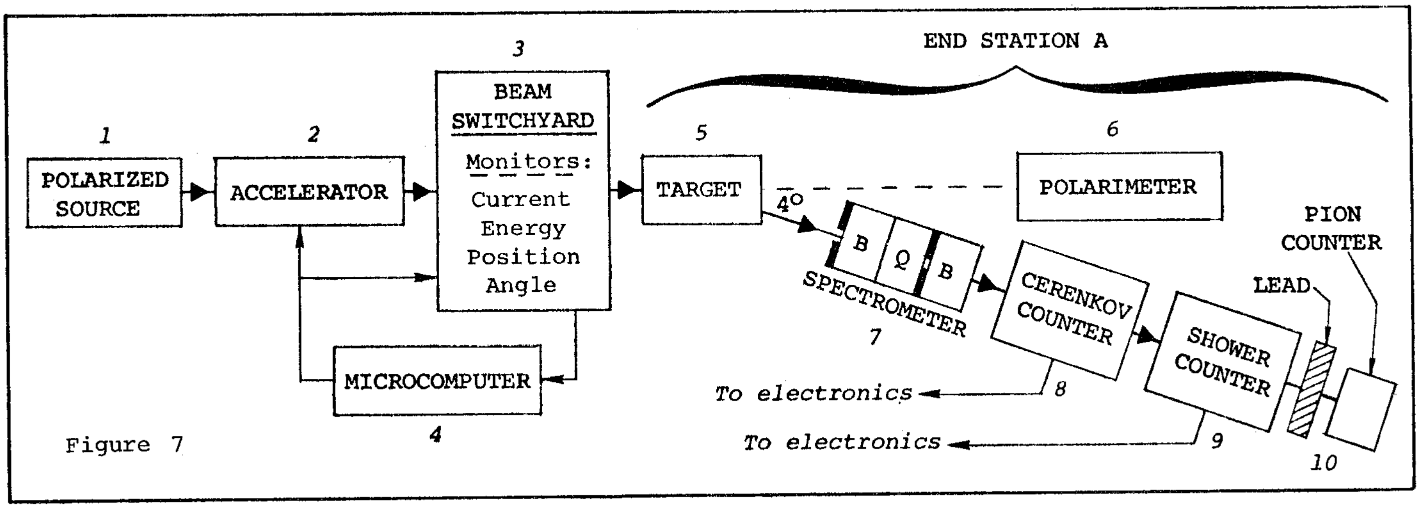


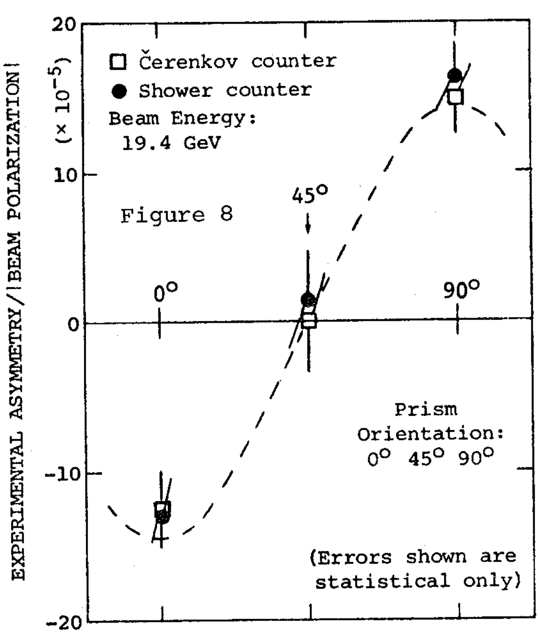
Figure 7

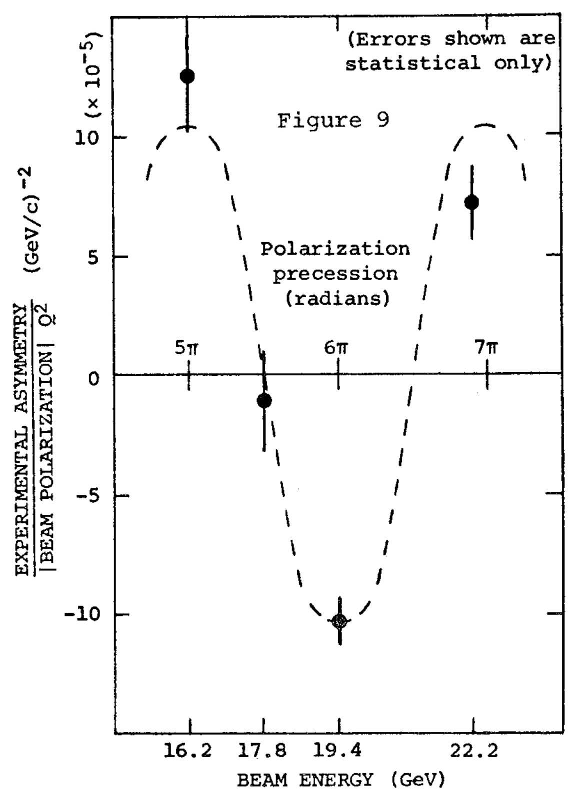
user of the accelerator in order to avoid having any interference effects with other simultaneous experiments.

Results Of The Experiment

All of this innovation and care eventually paid off in a very successful result. The final data from the experiment indicated that the scattering of left-hand polarized electrons did indeed occur with a slightly greater probability than the scattering of right-hand polarized electrons. Moreover, as shown in Figures 8 and 9, the beam polarization could be controlled in several, independent ways, and each method of control yielded results that were fully consistent with expectations. In fact, for an experiment of this remarkable sensitivity, the final data were amazingly clean and very convincing.

What was the significance of this result? First, the experiment indicated that Nature does indeed make an absolute distinction between the left- and right-hand rules that associate a particle's spin direction with its sense of rotation. Second, it showed that the so-called "weak" interactions (which are responsible for the previously known beta-decay processes) are in fact combined in some way with the electromagnetic interactions that, before this time, had been thought to be solely responsible for the scattering of electrons from nuclear particles. Third, and more quantitatively, the results of E-122 are in close agreement with a certain class of "uni-

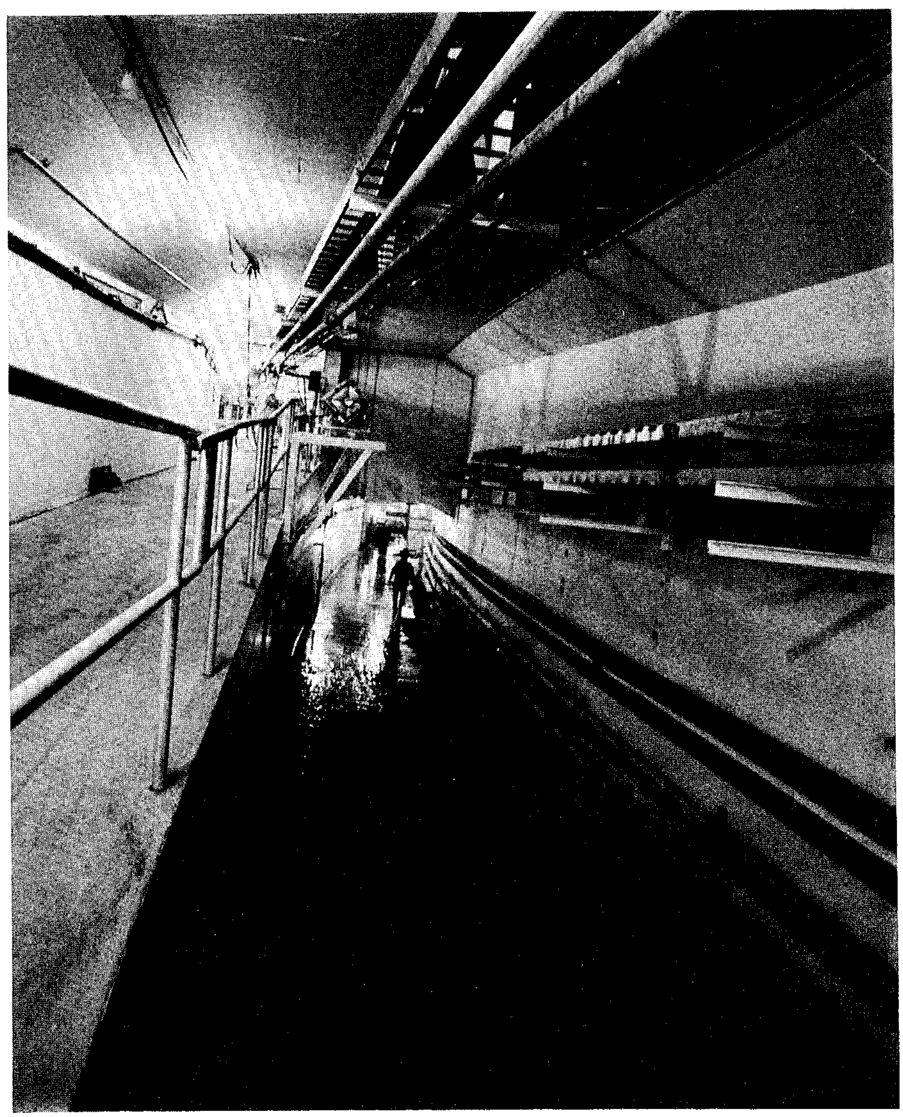




fied" theories which postulate the essential unity of the basic forces in Nature, namely the weak and electromagnetic forces, and perhaps also the "strong" force that binds together the protons and neutrons in atomic nuclei. In short, E-122 represents a very important step toward a unification of the fundamental forces in Nature as simply being different surface manifestations of a single, underlying force.

G. CONCLUSION

I have described Experiment E-122 here for two main reasons. The first is that this experiment was a very important achievement by our laboratory, and it would not have been possible without the contributions of everyone here. The second reason is that the example of E-122 shows once again that it is not possible to predict in so complex an undertaking as we have here at SLAC just what corner of the laboratory will turn up with the next major contribution. In reviewing our achievements in previous years, the major advances have sometimes been instrumental, such as storage ring or accelerator developments, or the building of new particle-detection systems. On other occasions the center of the stage has been held by work in particle theory or in the theory that describes particle motions in accelerators or storage rings. And often, of course, the major contributions have come from particle physics experiments, such as the remarkable series of discoveries that began with the psi/J particles in November 1974. We are fortunate at SLAC to have the opportunity to work at the frontiers of knowledge in a number of different aspects of particle-physics research, and by doing so we increase the chances that genuinely new and important discoveries can be forthcoming in any of these fields. This has proved to be very successful to date, and we intend to continue this broad approach to elementary-particle research for the foreseeable future.



Junction of the South beam-injection tunnel leading down from the upper left to the PEP ring tunnel at the lower right. (Things have dried out a bit since Joe Faust's photo was taken several months ago.)

COOPERATION WITH THE PEOPLE'S REPUBLIC OF CHINA IN HIGH ENERGY PHYSICS

Note: The recent visit to the U. S. of Deputy Prime Minister Teng Hsiao-ping and other officials of the People's Republic of China has resulted in the signing of four agreements between the two countries, one of which deals with cooperation in the field of high energy physics. This article reviews some of the background that led up to the signing of this agreement and describes some of the effects that the agreement will have upon SLAC.

In June 1969, the AEC's High Energy Physics Advisory Panel (HEPAP), then chaired by Professor Victor Weisskopf, issued a report which stated, in part:

> Scientific contacts and collaborations serve the cause of peace and the improvement of relations between nations. There are several reasons why high energy physics is an especially good field for this purpose:
>
> A. The subject is of a fundamental nature, and the field of science from which it grew, nuclear physics, has important technological aspects.
>
> B. The objectives of high energy physics are not immediately and directly connected with applications; therefore, there is less reason for security related restrictions on the exchange of ideas, methods, and data.
>
> C. The field requires expensive instrumentation, and, therefore, there is wide recognition of the desirability of coordinating projects in various parts of the world. In the long range, there may be economic benefits from international collaborative efforts.
>
> D. The senior workers in high energy physics in many countries are in good communication with their respective governments; therefore, international activities in high energy physics constitute a useful channel for the exchange of ideas at a high level.

These reasons remain as valid today as they were in 1969 (and even earlier). Collaboration among high energy physicists has indeed been worldwide, but heretofore it has not been a particularly significant means for opening up communication among national leaders. Physicists from all parts of the world have been frequent visitors to SLAC and to other laboratories, and there are many international conferences. However, past collaborations involving U.S. laboratories have stopped short of active major joint construction projects or of direct U.S. participation in the high energy physics development activities of other nations.

This situation has now changed dramatically with the entry of the People's Republic of China into the high energy physics field. Even before the relations between the PRC and the U.S. were "normalized" through the recent formal recognition of the PRC by the U.S., and even before the outward turning of the PRC had been signalled by the ouster of the "gang of four," many U.S. physicists had participated informally in the planning of a high energy physics program in the PRC. In 1975, a separate Institute of High Energy Physics had been created in the PRC, and this Institute had sponsored visits by American physicists to discuss future PRC plans in this field. Readers of the *Beam Line* may recall an early visit to U.S. laboratories of an Institute group led by Professor Chang Wen-yu.

As a result of these and many other deliberations, it was announced about a year ago that the PRC was planning to build a major accelerator, a 50 GeV proton synchrotron, as a part of a new complex that could eventually be expanded to include a machine with an energy greater than 1000 GeV. (The planned 50 GeV accelerator will be intermediate in size between the Brookhaven 30 GeV machine and the 500 GeV synchrotron at Fermilab.) The PRC is apparently giving very high priority to the goal of building the new accelerator center, which will be located near Peking, and which is to be built on the ambitious time scale of five years.

It soon became clear that for this enterprise to succeed within the estimated five-year construction schedule would require a departure from the traditional PRC doctrine of "self-reliance and hard struggle," and that active direct participation in the project by the more experienced Western laboratories would be beneficial. A number of U.S. scientists returned from visits to the PRC with information about the areas of collaboration that might be profitable, but these informal exchanges were so extensive that a more coordinated discussion of the problems seemed necessary.

To clarify the complex pattern of cooperation, the PRC sent, in January 1979, a delegation to the U.S. led by Lin Tsung-tang, the chief engineer for the new project, who is a well-known civil engineer with extensive experience in large construction projects. During the week of January 15, Mr. Lin's group met at SLAC with representatives from the large U.S. laboratories and from the Department of Energy, then visited each of the laboratories in turn. After these visits, the delegation again met with all the representatives, this time in Washington, to discuss in great detail how the U.S. laboratories could participate in the work, what the administrative arrangements would be, and how the work of the U.S. laboratories work would be coordinated with each other and with the main effort at Peking.

(The delegation headed by Lin Tsung-tang included engineers and accelerator physicists. Of particular interest to SLAC people is the fact that one of the members was Dr. Hsieh Chia-lin, chief designer of the new Peking machine, who took his Ph.D. degree at Stanford under the supervision of Professors Edward Ginzton and Marvin Chodorow at the Microwave Laboratory, and whose thesis was typed by Helen Morrison of SLAC's Research Division.)

As it happens, the final meeting of the Lin delegation with the U.S. laboratory representatives occurred during the same dates as those of Deputy Prime Minister Teng Hsiao-ping's much publicized visit with President Carter in Washington. Considering the considerable detail that had already been worked out between the PRC and U.S. groups, it became apparent that collaboration in high energy physics was already much better understood and studied than any of the other possible science and technology collaborations that were being discussed by the government leaders. In view of the high priority and personal interest that the PRC's leaders had been giving to high energy physics, it was decided that an explicit agreement on this subject would be signed during the Teng visit. This was one of the four agreements that were worked out during the visit (see box below). One of the four was an umbrella agreement covering the principles of collaboration in science and technology, signed by Vice Premier Teng and President Carter. The agreement dealing specifically with collaboration in high energy physics was signed by Vice Premier Fang Yi and Secretary of Energy James Schlesinger. A special discussion between U.S. laboratory directors and Fang Yi was held in Washington on that same day (January 31), and this was followed by a reception given by Vice

Washington, Feb.1—Following is the text of a joint press communique issued by the White House at the close of the visit to Washington of Deputy Prime Minister Teng Hsiao-ping of China.

At the invitation of the President of the United States of America and Mrs. Carter, the Vice Premier of the State Council of the People's Republic of China Teng Hsiao-ping and Madame Cho Lin are on an official visit to the United States, which lasts from Jan. 29 to Feb. 4, 1979.

Vice Premier Teng and President Carter held talks on questions of mutual interest in Washington.

Accompanying Vice Premier Teng in the talks were Vice Premier Fang Yi, Foreign Minister Huang Hua and others.

Accompanying President Carter in the talks were Vice President Walter F. Mondale, Secretary of State Cyrus R. Vance, Assistant to the President for Security Affairs Zbigniew Brzezinski and others.

The talks were cordial, constructive and fruitful. The two sides reviewed the international situation and agreed that in many areas they have common interests and share similar points of view.

They also discussed those areas in which they have differing perspectives.

They reaffirm that they are opposed to efforts by any country or group of countries to establish hegemony or dominion over others, and that they are determined to make a contribution to the maintenance of international peace, security and national independence.

The two sides consider that the differences in their social systems should not constitute an obstacle to their strengthening friendly relations and cooperation.

They are resolved to work toward this end, and they firmly believe that such cooperation is in the interest of their two peoples and also that of peace and stability in the world and the Asia-Pacific region in particular.

Science and Technology

Vice Premier Teng Hsiao-ping on behalf of the Government of the People's Republic of China and President Carter on behalf of the Government of the United States signed an agreement on cooperation in science and technology and a cultural agreement.

Vice Premier Fang Yi and the President's science advisor Frank Press signed and exchanged letters of understanding and cooperation between the two countries in education, agriculture and space.

Vice Premier Fang Yi and Secretary of Energy James Schlesinger signed an accord between the two countries on cooperation in the field of high energy physics.

Foreign Minister Huang Hua and Secretary of State Cyrus Vance signed an agreement on the mutual establishment of consular relations and the opening of consulates general in each other's country.

Each side agreed to facilitate the accreditation of resident journalists by the other side.

The two sides agreed to conclude trade, aviation and shipping agreements. These will be discussed during the visits to the People's Republic of China by Secretary of the Treasury Michael Blumenthal and Secretary of Commerce Juanita Kreps. . . .

(Emphasis added to the above paragraph on high energy physics.)

Premier Teng Hsiao-ping. Thus high energy physics was the only field of science that was specifically singled out in the U.S.-PRC agreements reached during Teng's visit. In short, the prediction that high energy physics should be a leading activity in promoting international communication and cooperation was in this instance fulfilled in a most impressive way.

In parallel with the formal and publicized agreements, a detailed summary was prepared and agreed to by both sides which specifies the activities that will be undertaken by each of the U.S. laboratories in support of creation of the new PRC accelerator center. Since the planned machine is a circular proton accelerator, it is natural that the bulk of the commitments will involve Fermilab and Brookhaven. However, SLAC will also have a major role to play, both in regard to the accelerator itself and in planning and construction of future research apparatus for the facility.

It is still premature to specify the exact nature and scope of the responsibilities that SLAC will assume in connection with the PRC program. However, the present plans include the following:

Two PRC visitors will soon arrive at SLAC to participate in the PEP magnet assembly program in order to become familiar with our methods. We will put together a sample of a control system involving a prototype bending and quadrupole magnet with their associated power supplies, together with magnetic measurement equipment and computation apparatus. This system, called the "sand box" (learn by playing), will provide an early vehicle through which the PRC designers can become familiar with the problems involved in developing computer programs and control functions of the type that they will encounter in their machine.

PRC visitors will also study our methods in developing a technical data library, critical-path scheduling procedures and other administrative matters.

In addition, six PRC visitors have recently arrived at SLAC to study the detailed design of our 40-inch hybrid bubble chamber facility. A chamber of similar design is presently intended as one of the principal research instruments for use at the Peking accelerator.

PRC visitors are already at SLAC to work on the orbit theory of PEP and to collaborate in the quark-search experiment (PEP-14) that is now approved for the first round of experimentation at PEP. There are also plans to have a small number of PRC experimentalists join the regular SLAC experimental groups in their work, and perhaps three others to participate in our work in elementary particle theory. We have also been asked to nominate some 5 to 8 SLAC staff members, mainly in the accelerator and storage ring fields, who will travel to Peking to present lectures and to consult on the design of their machine.

We also expect to receive PRC visitors who will be concerned with topics not covered on previous visits. One group, for example, will study conventional construction methods with special reference to building a laboratory that is located close to an earthquake fault (a problem that SLAC shares with the new Peking laboratory!). A management froup will be concerned with developing a fully integrated high energy physics center that effects a reasonable balance among the interests of machine builders, experimentalists and theorists. We cannot yet judge whether SLAC will take on any further responsibilities as a result of these further visits.

The U.S.-PRC collaboration in high energy physics brings with it a number of important questions, some of which have yet to be fully answered. The preliminary administrative and financial arrangements are simple enough. The PRC is willing to reimburse SLAC for work done here on the same basis that we have previously used in supplying services to other organizations. Specific arrangements for authorizing new work, estimating costs, etc., are straightforward. The general question of most importance is to understand how our participation, together with that of the other U.S. labs, will help the PRC to produce a fully integrated accelerator system, and more broadly to create a productive new world center for research in high energy physics. Because of the relative isolation of the PRC from the mainstream of high energy physics during recent decades, there is at present no well-defined leadership that is responsible for accomplishing all of these goals. Rather, a task force has been put together which draws on the talents of many different organizations within the PRC, and which enjoys a very high priority within the PRC system. Part of the job of this task force will be to devise the plans for this new particle physics center, which will eventually become a permanent laboratory operating under the aegis of the Chinese Academy of Sciences.

All of this is a very ambitious undertaking, since the intention is through this new laboratory to join the front-rank of international high energy physics facilities within a remarkably short time. In fact, there are those who have questioned the wisdom of the decision to pursue a high energy physics program with such vigor and priority. The scientific results of high energy physics research will have very little direct bearing upon the general state of PRC technology, at least for a long time. The creation of a 50 GeV research program some five years from now will indeed make a significant contribution to physics, but at that time this program will not be in the forefront of research in the field. However, there are indeed a number of important reasons for going forward with this project. The 50 GeV machine will form the basis for creating a much larger machine in the future, which would indeed place the PRC on the front line of experimental research. Moreover, the training offered to PRC scientists in both basic and applied science will be invaluable. PRC representatives have recognized that high energy physics is an excellent vehicle for informal and rapid communication and transfer of technological achievements between societies. In fact, the four reasons enumerated by the 1969 HEPAP report, cited at the beginning of this article, appear to be the very reasons why the PRC has chosen to pursue their goals in high energy physics. The American community of high energy physicists hopes that the collaborative efforts described above will be helpful in this purpose and that this PRC enterprise will be wholly successful.

PRC DELEGATION VISITS SLAC

A group of eight scientists from the People's Republic of China visited SLAC during the week of January 15-19 as a part of their overall visit to each of the large high energy physics laboratories in the United States. The purpose of the visit was to explore ways in which the U.S. labs might collaborate with PRC scientists in the design and construction of the 50 GeV Beijing (Peking) proton synchrotron (BPS). The PRC delegation was led by Lin Tsung-tang. The other members of the delegation and participants in the discussions at SLAC are listed at the end of this article.

During the first several days of the meeting at SLAC, each of the U.S. labs presented proposals concerning the specific areas of accelerator design and construction that it would be willing to undertake in connection with the BPS machine. Those areas in which SLAC offered assistance included the following:

Design and construction of non-conventional beam-injection magnets.

A "sand-box" test facility consisting of prototype bending and quadrupole magnets, power supplies, and associated control equipment.

Participation in the program of PEP magnet assembly and testing.

Assistance in establishing a technical data library and reference search capability.

Assistance in establishing project management and scheduling procedures.

The other U.S. labs which offered assistance were Argonne National Laboratory (ANL), Brookhaven National Laboratory (BNL), Lawrence Berkeley Laboratory (LBL), and Fermi National Accelerator Laboratory (FNAL). Plans were developed for PRC visitors to visit all of these labs, including SLAC, in connection with the follow-

(Photos of PRC visit to SLAC by Joe Faust)

ing work:

Two or three PRC scientists to visit each lab for about one year to study accelerator control systems.

Five or six people to visit each lab for about one month to study vacuum systems.

Small groups to visit each lab for about one month to study conventional construction methods (buildings, ultilities, etc.). Particular emphasis will be given to earthquake-resistant design while at SLAC.

During the summer of 1979, a group of administrators will visit the labs to study the problems involved in the overall creation of a large new scientific research center.

Three to five visitors to each lab for one to two years to participate in high energy physics experiments.

The PRC also plans to invite each of the labs to send five to eight U.S. scientists to Peking during the next two years as lecturers and consultants. Separate invitations are also expected to be extended to scientists from U.S. universities.

The first three days of the meeting at SLAC were devoted to working out the plans noted above, with participation by representatives from all of the labs and from the Department of Energy (DOE). The last two days, January 18 & 19, were specifically concerned with SLAC's areas of offered assistance and with tours and discussions of SLAC's facilities.

At the outset of the meeting, the need for translation made the discussions progress rather slowly. Translation was done by four SLAC scientists, Alex Chao, Martin Lee, Paul Tsai, and Tah Yen Yuan, who also acted as scientific secretaries to record the essence of the discussions. However, the initial stiffness of the formal discussions faded rather rapidly, aided by several social events that lightened the burden of the intensive meetings. According to one observer, "There was a lot of good will. There was a good understanding of our desire to help, as well as of the limitations imposed by our own heavy workloads." The construction schedule for the BPS machine is five years. It is expected that there will be a continuing series of meetings between PRC and U.S. representatives as the work progresses.

On a more personal note, one member of the PRC delegation, Hsieh Chia-lin, got his Ph.D. degree from Stanford University many years ago. Helen Morrison of SLAC was responsible for gathering together many of his old friends at a luncheon meeting.

The week ended with a banquet given by the PRC delegation as a gesture of appreciation for the help given by SLAC people during the visit. The evening was marked by the ring of chopsticks on wine glasses calling for toasts and speeches. The call of "Gam bei!" or "Bottoms up!" was raised to toast old and new friendships and hopes for continuing cooperation and scientific exchanges between the two countries.

Many thanks to all the people at SLAC who helped the visit go smoothly, particularly in the face of last-minute changes in the agenda and in scheduled tours of the various SLAC facilities.

--Nina Aidelman

<u>PRC Delegates</u>

Lin Tsung-tang	Jan Zhen-chiang
Lu Hian-lin	Yin Tzi-lie
Hsieh Chia-lin	Li Chang-fa
Chou Bein-long	Chou Chi-kang

<u>U.S. Participants</u>

T. D. Lee, Columbia (Chairman)
L. M. Lederman, FNAL

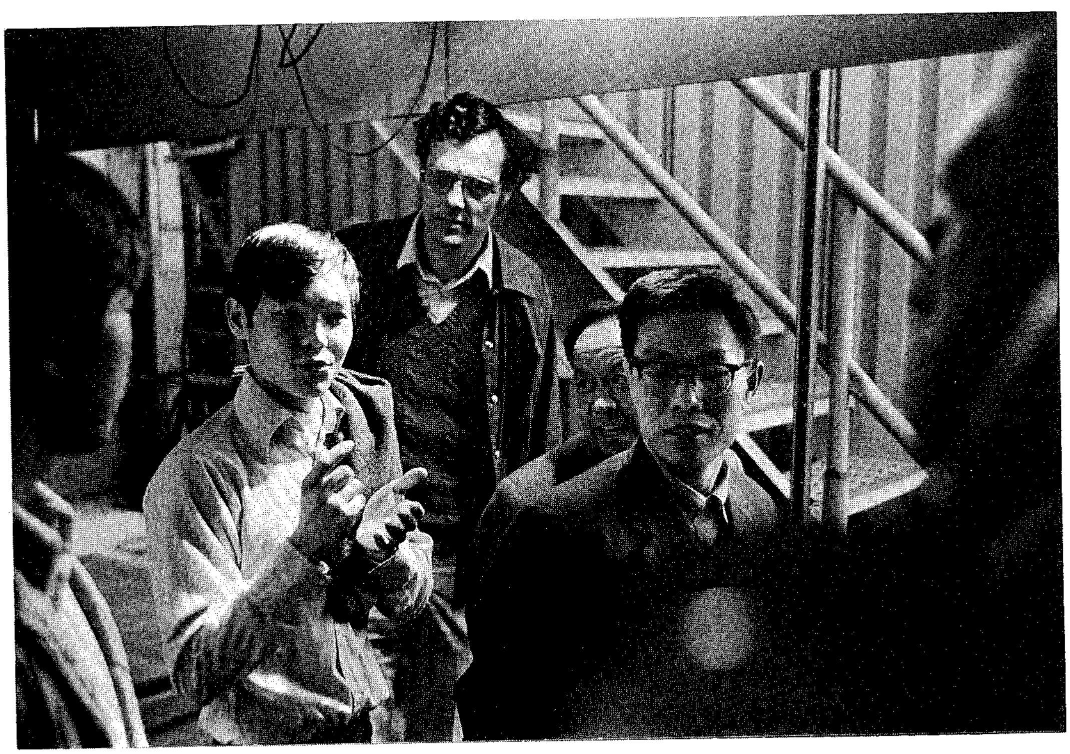
R. R. Wilson, FNAL	E. Lofgren, LBL
R. Huson, FNAL	W. Hartsough, LBL
R. Rau, BNL	J. Ballam, SLAC
L. Yuan, BNL	S. Drell, SLAC
W. Wallenmeyer, DOE	R. Neal, SLAC
J. Kane, DOE	W. Panofsky, SLAC
D. Sutter, DOE	R. Taylor, SLAC

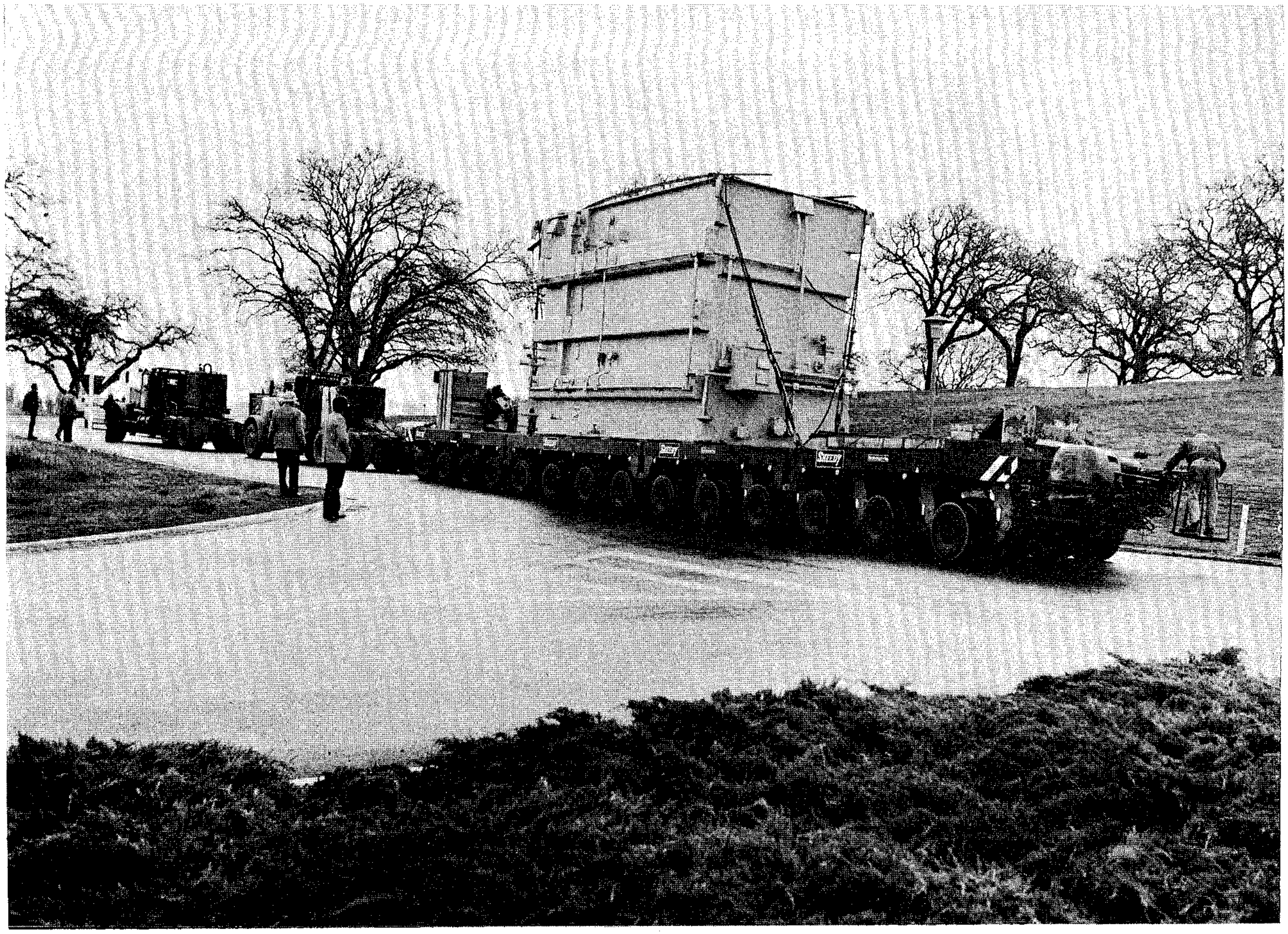
<u>Stanford U.S./China Relations</u>

T. Fingar

<u>SLAC Participants</u>

L. Addis	G. Loew
R. Gex	A. Lisin
S. Livengood	L. Keller
R. Taylor	S. St. Lorant
K. Crook	R. Bell
J. Ashton	N. Dean
G. Warren	J. Pope
R. Mellon	L. Cottrell
J. Brown	R. S. Larsen
J. Wells	M. Berndt
G. Konrad	E. Rickansrud
R. Thor Nelson	A. Keicher
D. Dupen	L. Kral
N. Aidelman	V. Price
H. Morrison	D. Walz
M. B. Jensen	R. Gould
S. Unze	N. Gray
M. Allen	





In early February, SLAC took delivery of a second main power transformer that will be used as a back up for the existing transformer. Joe Faust's photo shows this new transformer arriving on the site. The tranformer weighs about 125 tons and is being carried on a special vehicle that has 112 individual tires mounted four to an axle, with all 28 axles being steerable. The transformer converts the 230 kilovolts of the main power line to 12 kilovolts for primary distribution around the site. It is rated at 83,000 KVA. This means that either the existing or the new tranformers can handle the full site power load individually, should one or the other fail. Using the two transformers in parallel to split the load will reduce the wear and tear on both of them. Since the lead time for a acquiring a transformer of this size is a year or more, provision of the second transformer is an important safeguard against an extended shutdown of the SLAC accelerator and storage rings.

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