SLAC BEAM LINE

If the Lord Almighty had consulted me before embarking upon
Creation, I should have recommended something simpler.
—*Alphonso X, King of Castile and Leon, 1221-1284*

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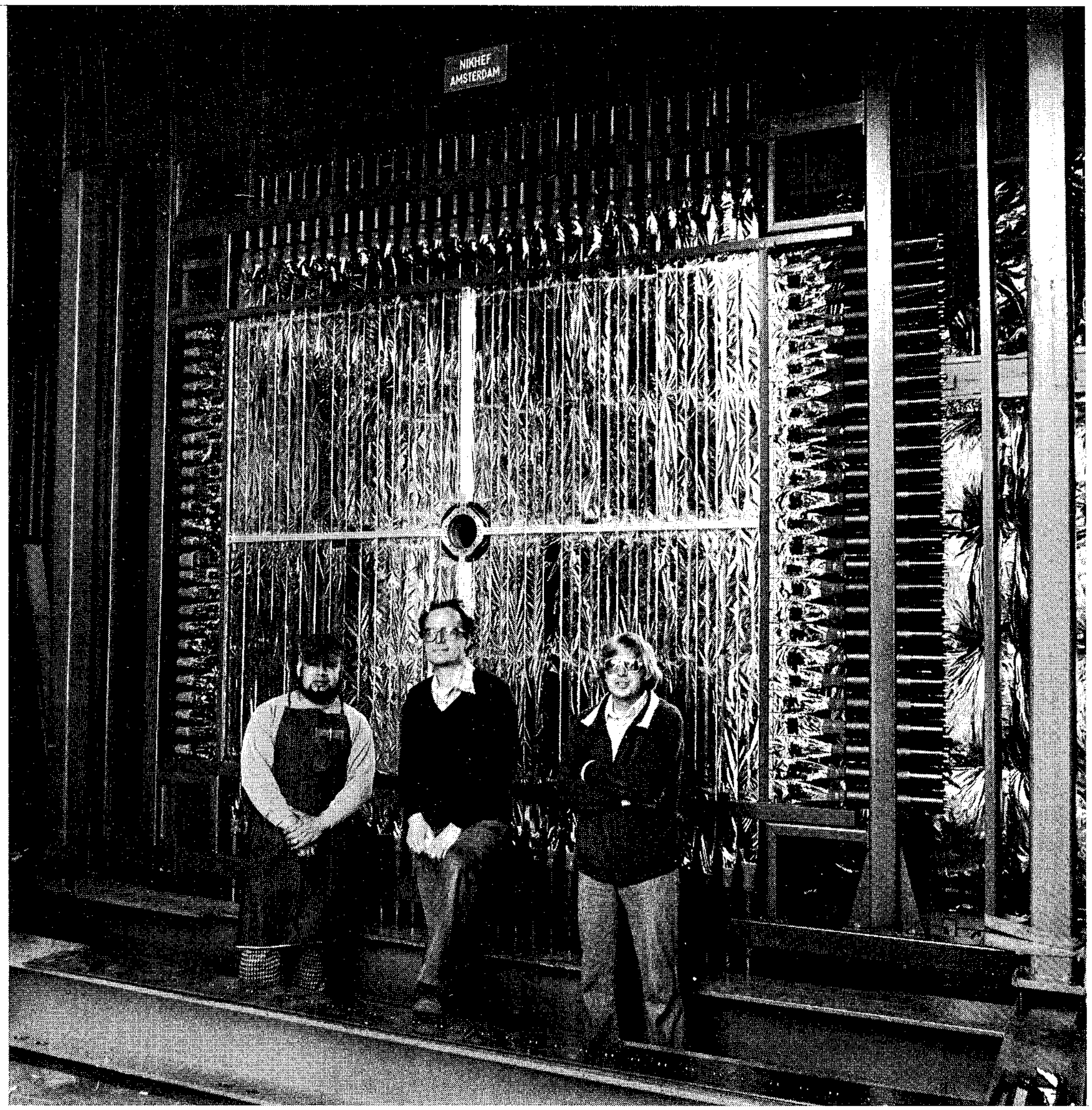


The cover photo this month shows one of the large particle-detection devices that will be used in the PEP-9 (or Two-Gamma) Experiment at PEP. Left to right, the people are Mike Jimenez, Hans Paar and Hank Gurnick. Dr. Paar is from the National Institute for Nuclear and High Energy Physics (NIKHEF) in Amsterdam, The Netherlands. NIKHEF physicists are collaborating with groups from three UC campuses (San Diego, Davis, Santa Barbara) in the PEP-9 work. The photograph is by Joe Faust.

In This Issue

Photo by Joe Faust

LINDA FUKUMA BURTNESS LEAVES SLAC

Illustrator or artist? The entire Illustrations staff at SLAC agree that Linda is a good artist. A self-styled realist working in water colors, oils and dyes, Linda paints mainly people and animals. Her personal artwork demonstrates a combination of skill and style whether the subjects are men, women, fish, cats or frogs.

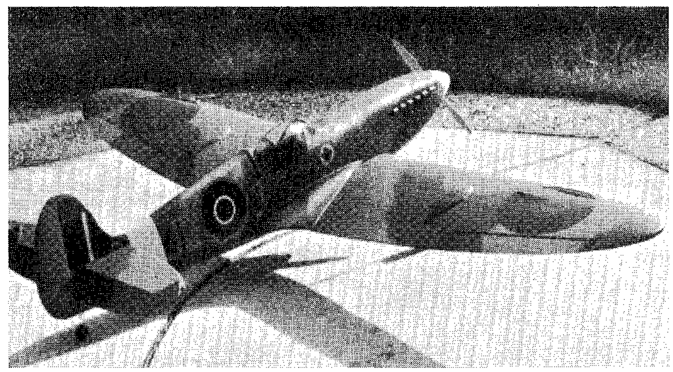
After doing graphic work for GE and working at Any Mountain, doing both artwork and "being out on the floor," Linda came to SLAC in August of 1977, bringing her magnificent sense of humor and creative mind. Serving as "lead" in Technical Illustrations for the Publications Department required these skills. An extremely talented graphic technician, Linda performed her duties with excellence. Her outgoing personality enabled her to get on well with her co-workers and authors alike. She kept things going smoothly with her direct manner and exceptionally even temperament, distributing work evenly and anticipating problems.

Although she remains on call for SLAC, her co-workers were upset to see Linda go. She plans to freelance, do her personal artwork and spend more time with her family. An avid skier, Linda enjoys many vigorous activities including jogging, ballet, backpacking, camping and hiking. A truly remarkable artist, her paintings have to be seen to be believed. The more commercial jobs for places like Any Mountain and The Ultimate Cookie should be helpful to her in starting up her freelance business:

FUKI ILLUSTRATIONS—(408) 446-1854

Speaking for the many people who had a chance to work with her, Linda will be sincerely missed. We all wish her the very best.

—Tiana Hunter
Publications Department



GOOD RC PILOTS ARE ALL THUMBS

Have you ever felt the call of the wild blue yonder? Or felt exhilaration as you watched Pappy Boyington do a victory roll after flaming that last Zero? Or felt that the thrill of flight would have to remain a vicarious experience for a long list of reasons, not the least of which was economic? Take heart! It doesn't have to be that way!

The world of radio-controlled (RC) flight is the next best thing to sitting in that cockpit. Besides the pure joy of totally controlled flight for its own sake, there is a seemingly endless list of activities to challenge the RC enthusiast. Soaring, pylon-racing, RC hang-gliding, aerobatic pattern competition, air-show demonstrations—even parachuting—are just some of the airborne pursuits of RC'ers. We're not limited to flying, either. There are power and sail boats, cars, tanks, and even radio-controlled motorcycles.

The photo on this page shows a beautiful model of a WWII British Spitfire that was built by George Begonia of SLAC.

In recent years, the quality of radio control equipment has improved greatly and costs are lower, thus making it simpler for anyone to enter this exciting hobby.

Several of us here at SLAC would like to form a club for RC enthusiasts. A meeting will be held on

Friday, April 18
Noon

in the Orange Room, in the Central Lab. Topics for discussion will include club name and structure, main interests of those present, a possible site for the club at SLAC, safety, and a question and answer session for newcomers or interested persons. We encourage you to bring finished or partially completed models for display for the benefit of others. All are welcome! For more information, please contact Howard Rogers at ext. 2762.

—Howard Rogers

THE STATE OF SLAC

W. K. H. PANOFSKY

Note: This is the text of the talk given by SLAC's Director to the staff on February 8, 1980.

As has now become an annual custom, I am reporting to you on the state of the laboratory soon after the President has transmitted his annual budget request to the Congress for the next fiscal year (FY1981)—that is, the year beginning on October 1, 1980. As usual, this budget contains a mixture of both good and bad news for SLAC. There are also some other budgetary matters I would like to mention to you that are again a combination of the good and the bad. Nevertheless, I hope you will agree with me that the overall outlook for SLAC is excellent, and we can continue to look forward to a long period of constructive activities and important discoveries in our field of particle-physics research.

1. THE PROPOSED BUDGET FOR FY1981

Figure 1 shows the proposed budget for SLAC that is included in the President's submittal for our sponsoring agency, the Department of Energy. As has been established many years ago, SLAC's funding comes in several different "colors" of money. First there is the annual *operations* funding, which covers support of all our activities with the exception of capital additions to our basic instruments and facilities. These *capital* items are provided for in three different categories: Capital Equipment not related to construction, Accelerator Improvement Projects (AIP), and General Plant Projects (GPP). In addition, the Capital Equipment funds are further segregated into those supporting SLAC needs in general and those specifically earmarked for use at PEP. The latter category provides for equipment needs at PEP, both of outside users and of SLAC experimenters. However, most of the work that is done in providing such equipment is actually carried out at SLAC, irrespective of who initiates the program.

Figure 1
SLAC COMPARATIVE FY1980 AND FY1981 BUDGETS
(Dollars in Thousands)

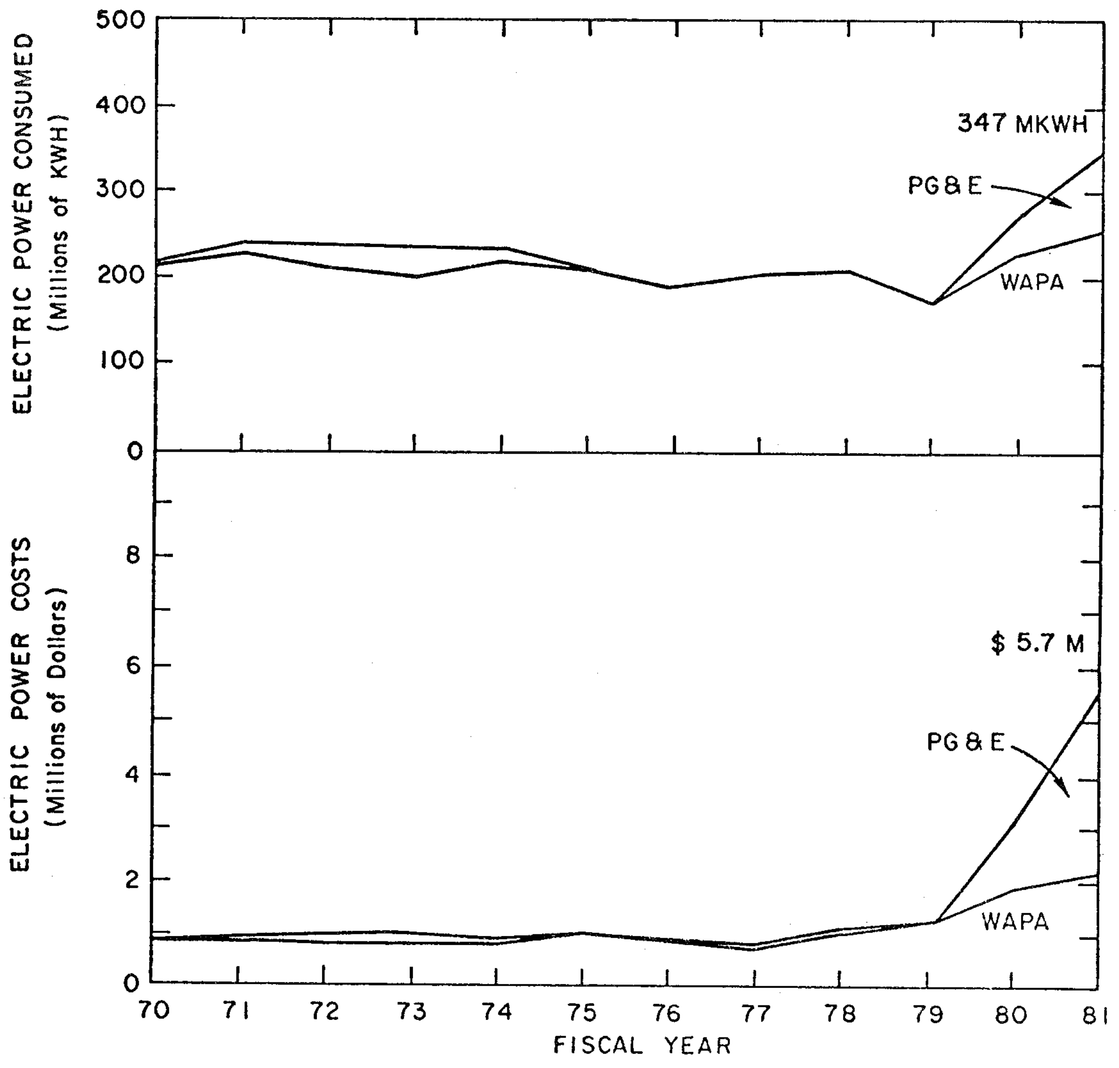
	FY1980 President's Budget	FY1980 DOE Budget	FY1981 President's Budget
OPERATIONS	49,475	48,400	57,750
EQUIPMENT	7,265	6,700	9,600
Gen. purpose	*3,500*	*3,300*	*3,400*
PEP	*3,765*	*3,400*	*6,200*
CONSTRUCTION	2,100	1,950	2,100
AIP	*1,100*	*1,000*	*1,100*
GPP	*1,000*	*950*	*1,000*
TOTAL BUDGET	$58,840	$57,050	$69,450

On the face of it, the total of all of the items in the proposed budget for FY1981—$69.4 million—sounds like a large sum of money, and in fact it is a large sum. In addition to this sum, the Stanford Synchrotron Radiation Laboratory will receive about $2 million through the National Science Foundation which will support about one-half of the cost of operating the SPEAR storage ring, and some of SLAC's outside user groups will receive outside funding to help support their experimental activities at SLAC. On the other hand, about $2 million of the PEP equipment funds will go directly to non-SLAC user groups. Thus in rough numbers total resources approximating some $69-70 million are provided for use at SLAC in the President's budget request to the Congress for FY1981.

However large this figure may seem, it must be looked at with some caution. The first caution is that this is the President's budget as submitted to the Congress, and that body may choose to change it as a result of its annual authorization and appropriation process. In addition, the Department of Energy need not apportion to SLAC the full amount that is actually appropriated by the Congress, but may instead choose to hold some fraction of the funds in reserve in order to cover unanticipated future needs. In fact, as was shown in Figure 1, both the Congress and the Department of Energy, actually did cut this year's budget (FY1980). The total funding that we actually received for our FY1980 program was about $1.8 million lower than I had anticipated when I spoke to you one year ago on the same occasion; and it is still not clear what part, if any, of the funding held back by DOE will be returned to SLAC. Thus I cannot be certain that similar cuts will not be made again in the proposed budget for FY1981.

The second point of caution is that in FY 1981 there will be two bites taken out of our funding that are much larger than we have experienced in previous years. The first of these is the cost of electric power, and the second is the cost of leasing rather than purchasing the next increment to SLAC's computation facilities.

The situation with regard to electric power costs is shown in Figure 2. As you can see, there is a drastic increase in power costs that is much steeper than one might at first have predicted. The reason for this is that our power comes from two different sources: public power supplied through what is now the DOE's Western Area Power Administration (WAPA—formerly the Bureau of Reclamation), and commercial power supplied by PG&E. The total public power that is allocated to SLAC is strictly limited, and in the past most of our operations have not exceeded that limitation. However, with PEP soon to come on line, this will no longer be the case. The reason this will be so costly is that the commercial power rates are roughly 5-6 times larger than the public rates. Because of this, we anticipate that our power costs for FY1981 will about twice as large as those for FY1980—an increase of about $2.7 million. In addition, the lease for the new computer facilities will be $2 million in FY1981.



WAPA ALLOCATION	45/40	45/40	40	40/38	38	38	38	38	38	38	38	38	Megawatts
SLAC PEAK DEMAND	52	51	59	60	54	45	45	46	47	38	58	62	Megawatts
ANNUAL UNIT COST	4.29	4.23	4.37	4.51	4.39	5.00	4.95	4.25	5.72	7.6	11.5	16.5	Mills/KWH

Figure 2—SLAC electric power consumption and costs. The estimates for FY1980-81 assume a WAPA rate of $2/KW demand and 5.11 mills/KWH, and a PG&E rate of 35 mills/KWH in FY1980 and 40 mills/KWH in FY1981.

Thus in comparing our funding for FY1980 and FY1981, we must begin by subtracting roughly $4.7 million from the FY1981 figure for the added power and computer-lease costs. Then we also have to take into account the effects of inflation, which affects this laboratory in much the same way that it affects each of you personally. The comparison between the FY1980 and FY1981 budgets that results when all of these factors are accounted for is shown in Figure 3. As you can see, the net result is that, in terms of actual purchasing power, the President's proposed budget for FY1981 represents a small *decrease* in support relative to our FY1980 budget.

SLAC's long-term funding picture is illustrated in Figure 4, which shows our total resources since FY1967 both corrected and not corrected for the effects of inflation. I would like to make a few observations about the funding pattern shown in this figure.

First, funding for the construction of the new PEP storage ring facility was responsible for the large peak in total funding shown for the period FY1977-1979. This funding peak did not in itself contribute a great deal to the funds available to pay SLAC people or to provide materials and services for general SLAC use; the reason, of course, is that most of these construction funds were used to pay outside contractors. In FY1980, PEP construction funding was no longer provided, but equipment funding is still being obligated for building the first generation of experimental facilities for use at PEP. On a positive note for SLAC, we have found that a larger fraction of the responsibility for PEP equipment has ended up with SLAC's engineers and shops than I had anticipated last year. Thus FY1981 will be the first year in which no major PEP-related construction or equipment projects will be going on, but rather where we will be operating the facilities already built and using them for research.

The funding pattern shown in Figure 4 is one that I find both gratifying and sobering. When the effects of inflation are taken into account, SLAC's total funding is now at a level that is well below what it was in the more liberal years for science in 1967-69, the period directly following the turn-on of the two-mile accelerator. However, although our true funding for this year and next year has decreased from the relatively "prosperous" late 1960's, our responsibilities have dramatically *increased* since that time. Let me explain. Once the two-mile accelerator had begun operating in 1966-67, we started upon a program of research that was ambituous but quite narrow in scope. The emphasis was on the use of research equipment that had been built during the construction period, and it was forecast that our physics program would consist almost entirely of electron-scattering experiments in End Station A and certain other experiments using very high energy X-ray (or gamma-ray) beams for the production of many of the short-lived particles then known to exist in the physical world. Experiments of these kinds are still continuing in one form or another, but *in addition* we now have the vastly expanded scope of research that is represented by the SPEAR and PEP storage rings, and by the LASS and hybrid bubble chamber experimental facilities. At the same time, the total number of outside users for whose support we are

Figure 3

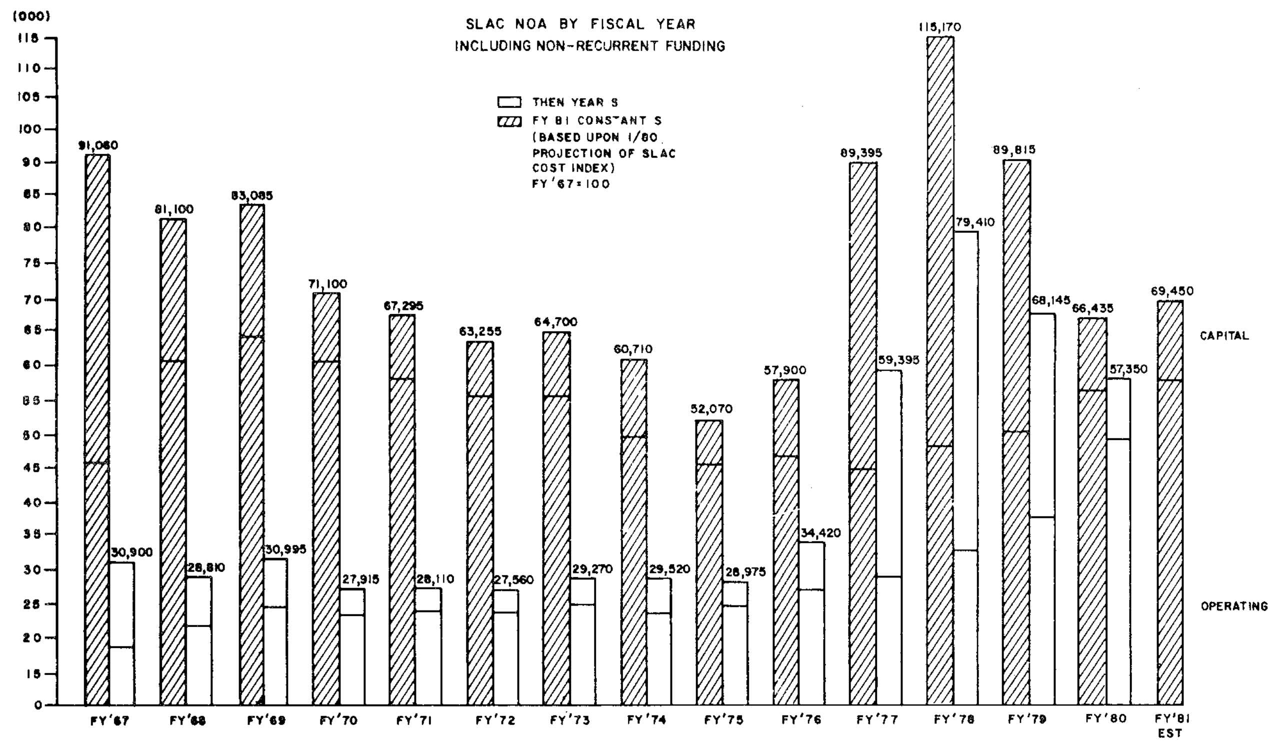
FY1980 SLAC OPERATING BUDGET COMPARED TO

FY1981 PRESIDENT'S BUDGET FOR SLAC OPERATIONS

(Dollars in Thousands)

FY1980 Operating Budget		$48,400
Less: FY1980 Power Bill	(3,025)	
FY1980 Computer Lease	(100)	(3,125)
FY1980 Operating Budget Excluding Power and Computer Lease		45,275
FY1980 Operating Budget Excluding Power and Computer Lease Restated in FY1981 Dollars (inflated at the SLAC Cost Index Excluding Power: 10.9%)		50,200
Add: FY1981 Power Bill		5,700
FY1981 Comptuter Lease		2,000
Total Operating Funds Necessary to Maintain the FY1980 Program Level After Inflation		$57,900
FY1981 President's Budget for SLAC Operations		$57,750

Figure 4



TOTAL SLAC FUNDING, INCLUDING NON-RECURRENT FUNDING EXPRESSED IN BOTH THEN-YEAR AND CONSTANT-FY1981 DOLLARS, AND WITH THE DIVISIONS BETWEEN OPERATING AND CAPITAL FUNDS SHOWN.

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responsible has also increased a great deal. During the present year alone we anticipate that the population of scientific visitors from outside institutions will increase by more than one hundred. Thus if the long-term funding of SLAC is viewed in terms of our actual program, it represents a decrease in actual purchasing power but a significant increase in our responsibilities and research opportunities.

As a result of the current budget pressures, we cannot quite maintain the same level of activity that we had during the time when PEP construction and other capital funds were available. During that time many SLAC activities, in particular our shops, expanded significantly, and that expansion must now be reversed. Some of that peak in manpower was met by contract personnel, that is, workers provided by outside contractors. This is a load that we shared with LBL. We are now forecasting that the work load on our shops will decrease rather sharply during the balance of this year, and that accordingly some manpower decreases in the shops will be required. Most but not all of that reduction will affect contract personnel.

On balance, however, we believe that no significant changes in total staffing requirements, either up or down, will be needed on the average to match the program corresponding to the support level of the FY1981 budget. That is, FY 1981 is approximately a "stay where you are" budget. Naturally, there may well be some dislocations, because there will be some shift in program from construction and fabrication types of activities to operations and research. However, these shifts are expected to be quite minor. In addition, if the President's proposed budget for FY1981 should be cut during the Congressional review process, this may result in decreased staff numbers, since about 70% of our costs are people-related.

2. PEP STATUS

Last year I hoped that at the next anniversary of the State of SLAC talk I would be in a position to tell you that PEP beams have been successfully stored. Unfortunately I cannot do this. The fabrication of technical hardware for PEP has gone very well on schedule, even though there has been a hard struggle with many technical components. However, the work we call "conventional" construction has slipped significantly. We have experienced a domino effect, in which the lateness of our principal tunnel-housing and interaction-region contractor has delayed the starting dates for subsequent contractors, and this in turn has delayed initiation of many phases of the installation of the technical components. We have tried our best to counteract the effects of these slippages by rescheduling activities and concentrating manpower. However, there are limits to the total number of activities that can be carried out simultaneously, and as a result more work remains to be done before beam-storage can be attempted. As it now stands, we hope to complete the work in the PEP housing by the middle of February, then check on the safety systems and begin operating the machine in March. At present we believe this can be accomplished, but obviously there can be further unforeseen problems.

To minimize the risk of such problems, we have already begun to test certain sections of the PEP installation as they become ready for such tests. For example, we have injected a beam from the SLAC linac through the south injection tunnel into a section of the main PEP ring. These tests have been successful and have aided us in "shaking down" some of the instrumentation of the injection lines and main ring, and in learning about the "bugs" in the computer control system. This experience should help us a great deal in achieving a fast final turn-on.

3. THE SINGLE-PASS COLLIDER PROJECT

From the past description you can see a laboratory that is struggling with the final phases of a large construction project and with engineering the transition from construction to research operations. However, as has often been the case, just at the time when we are completing a major new addition to the laboratory, we are already planning further steps for the future. Such advanced planning is needed for two major reasons. The first is that the frontiers of particle-physics research keep moving onward, and SLAC, in accordance with its traditions, would like to participate in advancing those frontiers. The second reason is that the total time cycle involved in planning, making decisions, and carrying out new construction is so long that it is essential to initiate new planning at about the time when the results of past planning are coming to fruition.

SLAC occupies a very special position in the family of high energy physics laboratories. Our accelerator is unique—there is no other electron accelerator in the world of comparable performance. In consequence, much of our research at SLAC could not be done anywhere else. There are also some phases of our work that complement work done elsewhere. For example, the characteristics of PEP and of the German machine called PETRA are almost identical, and some of the experiments done with the SLAC linac are somewhat similar to those that are carried out at the large proton accelerators. Thus as new steps are being considered here at SLAC, we have to design our future program with full understanding of what is going on elsewhere in the world.

The electron-positron work at SLAC through the two phases of the SPEAR storage ring was one of the great innovations in worldwide particle physics research. We hope and expect that PEP will continue that tradition, and there are now plans in Europe for taking another "great leap forward" in the form of a huge new electron-positron storage ring (LEP) that would have a circumference of some 30 kilometers (about 20 miles). Although SLAC can take credit for having pointed the way, this particular path toward higher energy electron-positron collisions is one that we cannot pursue further, for reasons of both cost and space. This is because both the cost and the radius of an electron-positron storage ring go up as the square of the beam energy. There must be a better way, and indeed we are now exploring a different approach to the problem of achieving higher electron-positron collision energies.

Let me explain the storage ring problem in more detail. In "conventional" electron-positron storage rings like PEP the electrons and positrons circulate in opposite directions and collide with one another at a rate of roughly 100,000 times per second. As the beams circulate, they continuously lose energy by emitting synchrotron radiation, and this lost energy has to be continuously replenished through the use of a powerful radiofrequency acceleration system. This is what accounts for the large power consumption of a machine like PEP, and for the sharp increase in costs of larger electron-positron storage rings.

As an alternative, it has often been suggested in the past that one could simply shoot the beams from two linear accelerators at each other and thus obtain beam-beam collisions by that method. One of the problems with this suggestion is that an accelerator like the SLAC linac pulses at best only at a rate of a few hundred pulses per second, rather than 100,000 times per second that would seem to be required to match the performance of a conventional storage ring. However, it is possible that the lower rate of beam collisions can be compensated for by focusing the beams down to an extremely small size at the point where they collide. This would increase the rate of interaction between the two beams by a factor that may be large enough to offset the lower frequency of collisions.

As I said earlier, these ideas are not new, but in the past no one has been able to propose a practical device that would make use of such "single-pass collisions." Recently, however, Burt Richter has revived the idea by pointing out two uniquely favorable circumstances which pertain to SLAC. The first is that the beam from the SLAC linac has such excellent geometric properties that it appears possible to focus it down to a beam size of about one micron (.001 millimeter). Second, he has proposed a scheme that would avoid the expense and complexity of actually having two different linacs to accelerate the two beams. Instead, both electrons and positrons would be accelerated in the same machine, and these two beams would then be split apart and fed into a system of magnets which bring the two beams into collision.

A further circumstance that has made this scheme very attractive for SLAC has been the success of the SLAC Energy Development program (SLED). As you know, the first phase of this program, SLED I, has now been completed and has increased the maximum beam energy of the SLAC linac to above 30 GeV. This increased beam energy will be used in SLAC's research program in its own right, first in experiments with the hybrid bubble chamber facility. The success of SLED I has also made it clear that a further increase in beam energy to about 50 GeV is feasible through the program known as SLED II, which in principle is identical to SLED I except for a longer pulse length being applied to the klystron RF power sources along the machine. Thus the SLAC Single-Pass Collider Project (SPCP), as it is now called, proposes to shoot two 50-GeV electron and positron beams at one another.

The proposed SPCP would thus be an important pioneering project in advancing the energies that can be reached in electron-positron collisions. But the significance of this SPCP proposal goes much beyond an important experiment in technology. As it happens, the energy that could be reached by the SPCP when fed by the SLED II linac is 100 GeV total collision energy. This energy would be large enough, by all reasonable projections, to produce a very special new particle that goes by the fancy name "neutral intermediate vector boson," or "Z-zero" (Z^o) for short. The existence of this particle is predicted by the theory which unifies the weak and electromagnetic interactions, and for which the 1979 Nobel Prize in physics was recently awarded to Glashow, Weinberg and Salam. In fact, if the Z^o particle does not exist, the Swedes may have to revoke the Nobel Prize just awarded!

Since the mass of the Z^o particle is estimated to be around 80-90 GeV, the energy of the SPCP should be adequate to produce it. At the specific energy at which the Z^o is produced, the total number of events generated per second will increase very sharply—not unlike the sharp peak that marked the discovery of the J/psi particle here at SLAC in November 1974. In other words, the SPCP is expected to be a "Z^o factory," a device at which copious production of new particles will occur. This would make possible a wide range of experiments because the patterns of decay of the Z^o will provide vital information for many of the details of the new unification of theoretical ideas that is now in view.

Work at SLAC on this new project already involves a substantial effort. We have already submitted a preliminary proposal for the SPCP to the Department of Energy, and we are aiming for submittal of a complete proposal this Spring. There have been many discussions of this new SLAC initiative with advisory committees and with various government officials, and thus far we have heard "not a discouraging word." As a result, we have some hope that actual construction authorization of this project can be attained for Fiscal Year 1982, about whose budget I expect to speak to you one year from now.

4. SLAC'S FUTURE PROGRAM

Figure 5 incorporates this new SPCP project into a general projection of SLAC's future plans. It remains our policy that SLAC wishes to continue to pursue in parallel work that is based on linac beams striking stationary targets and also work based on electron-positron collisions. Both of these directions continue to be promising, in particular since the SLED improvements have increased the maximum energy of the linac electron beam. Nevertheless, in this time of tight funding it is easier said than done that one wishes tp pursue all approaches that appear promising. Some choices do have to be made. We believe that such choices at SLAC should not be absolute—that is, we should not eliminate the stationary-target work in favor of electron-positron collisions; nor, conversely, should we curtail, let alone eliminate, our more recent work using storage rings, and hopefully the SPCP. Our present policy is to "tilt" our decisions so that in case of competition for funding and to some extent for manpower, we tend to give priority to the electron-positron collision program. This means that the electron-positron work is likely to run closer to its full capability than the stationary-target program. This "tilt" policy is based not only on current scientific priority but also on the fact that SLAC has something of a monopoly on high energy electron beam experiments, and such experiments, if they are done at all, will be done here sooner or later.

In making speeches at the beginning of 1980, it is customary to talk about the closing of the past decade and the start of a new decade. Let me now make some remarks about the past.

5. PROGRESS DURING THE 1970'S

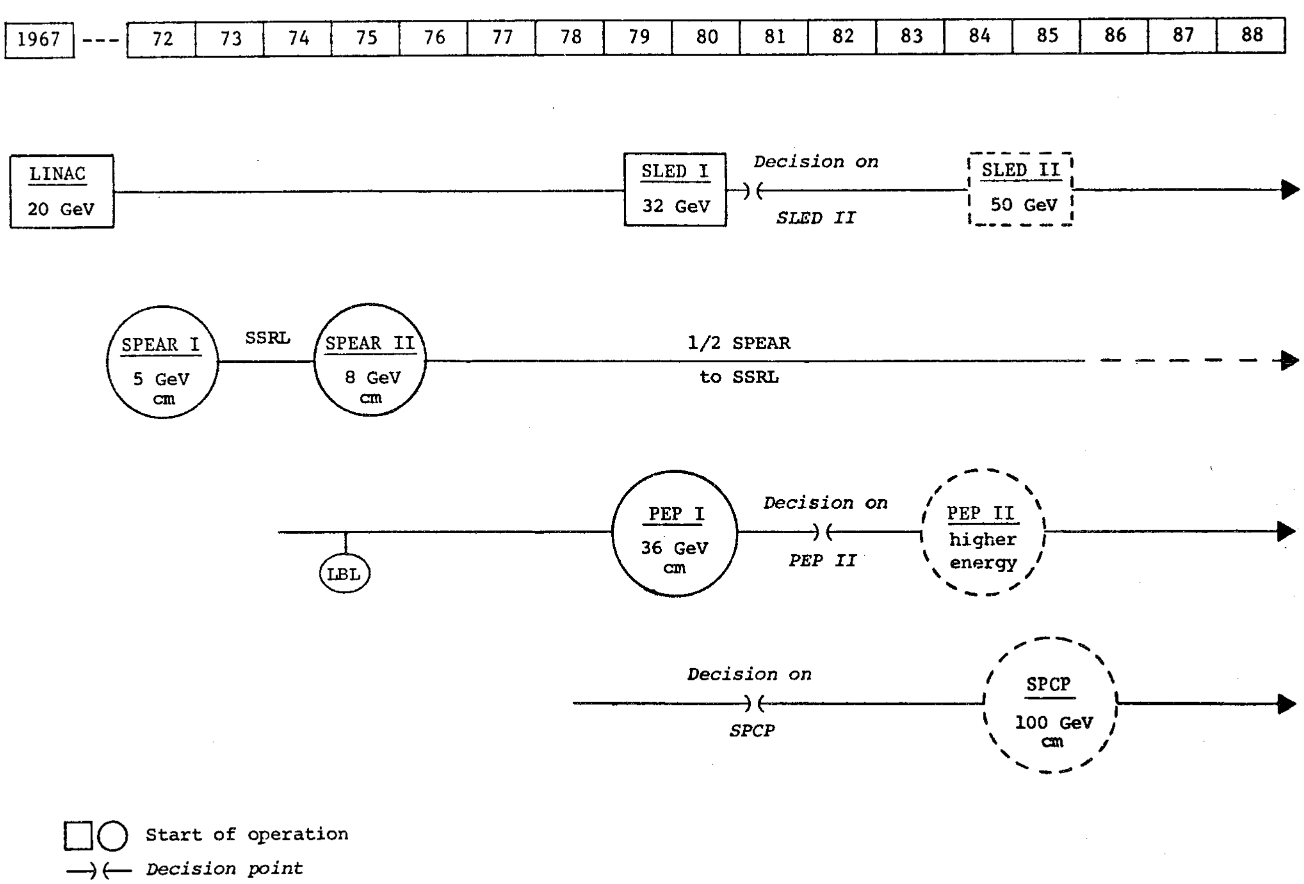
The last decade or so has ushered in what is probably as great a change in our understanding of the basic constituents of matter as any preceding similar period. The period after World War II was characterized by the discoveries of many new kinds of strongly interacting particles, without apparent rhyme or reason. Some order was brought into this proliferation of new particles in 1964, through the proposal by Gell-Mann and Zweig that some of the observed regularities among these particles could be accounted for by postulating the existence of just three different kinds of more fundamental building blocks called *quarks*. The observed variety of the new particles could then be explained by having the three quarks play games by arranging themselves in different regular patterns. For example, neutrons and protons were thought to consist of different combinations of three quarks, while the particles called mesons were thought to be made up of one quark and one anti-quark. This conjecture clearly contained a large element of truth, but it was also clear that it could not be the complete story. First, there arose a need to have each of the quarks come in three different "colors," and second, there were a number of more detailed discrepancies of this simple picture with experimental data that caused some discomfort.

In addition, there remained the question of the other main class of particles called the *leptons*—that is, the electron and muon, each with its own associated kind of neutrino. These are particles that have been around for a long time (the electron was discovered in 1897 and the muon in 1937), and in some respects their properties are rather similar to those of the quarks which seemed to be the constituents of the particles in the nucleus. The main difference, however, was that the leptons did not appear to be affected in any way by the "strong" forces that hold the nucleus together. But were there only two pairs of leptons?

Thus until 1974 we had a picture of three kinds of quarks, each appearing in three so-called colors, and in addition two kinds of charged leptons and their two kinds of associated neutrinos. Then came the wave of discoveries, beginning in late 1974, to which SLAC made such important contributions. It was shown that a fourth kind of quark, the "charmed" quark, was

Figure 5

SLAC LONG-RANGE PLANS



necessary to explain the new phenomena; evidence for this new kind of particle was found in late 1974. Then a third kind of charged lepton, called the tau, was discovered. Perhaps even more important than the discoveries themselves were their fundamental implications. First, the belief that the quark idea was basically correct was greatly strengthened by these discoveries; and second, the growth of both the quark and lepton families indicated that we were dealing with two parallel groupings which, if nature so decrees, might even contain equal numbers, once all the members have been discovered. That particular expectation was brought closer when the existence of a fifth kind of quark was indicated by recent experiments at Fermilab, and particle physicists are now waiting eagerly for the possible discovery of a sixth kind of quark. If that is where it will all end, then indeed we will have two families of basic building blocks, each containing six members.

Figure 6 traces this evolution of the quark and lepton families. Even more important than this "bean counting," however, is the development of the theoretical framework that goes with it. The Nobel Prize in Physics for 1979 was awarded to three theoretical physicists (Glashow, Salam and Weinberg) who developed a formulation that has given unity to these two separate families, and which predicted many regularities in their interactions that have been confirmed by experiment. It is this evolution of theoretical understanding based on experimental findings that brings nearer Einstein's hope, which he pursued throughout his life, that the different particles and forces in nature might be part of a simple, unified structure rather than totally separate entities. This must be viewed by physicists as the main scientific achievement of the last decade.

6. SOME OPEN QUESTIONS

SLAC can be proud of the important contributions it has made to this "great leap forward" in the understanding of nature during the last decade. Not only were the new particle discoveries already cited made at SLAC, but some of the other crucial and of the simply confirmatory work which indicated the basic correctness of our understanding were also done here. For example, the "parity violation" experiment that I described to you last year was a key element in confirming the theoretical framework. However, as is usual when one seems near a breakthrough in understanding, there remain a number of lingering questions. Let me enumerate a few of these open questions:

1. Are there more kinds of leptons and quarks than the 6 + 6 I have described? There are certain arguments that "this it it," but we cannot be sure unless we look—we have been wrong before.

2. Are there free quarks or aren't there? The hunt for free quarks goes on, including experiments at PEP. If free quarks exist, they surely seem to be elusive. If they don't, then our theory to explain why is still somewhat incomplete. However, to the extent that a theory exists, it also predicts some very specific ways in which many reactions should proceed in the next range of energies.

3. An essential element in the new theoretical structure is the postulated existence of certain new kinds of particles which are the mediating agents or messengers that carry the weak interactions. These are the so-called "intermediate vector bosons," and at this time the Single-Pass Collider Project has an excellent chance to be the crucial machine to bring these new objects under investigation.

	LEPTONS		QUARKS		
CHARGE	- 1	0	- 1/3	+ 2/3	DATES & NOTES
	e^-	ν_e	d	u	≤1935 Basic building blocks of all elements
	μ^-	ν_μ	s	c	1937 μ discovered in cosmic rays 1947 Strange particles 1974 ψ/J, charmed particles
	τ^-	ν_τ	b	t(?)	1975-77 τ discovered in e-μ events 1977 Upsilon (Υ) discovered

Figure 6—Three generations of leptons and quarks

4. If there really is to be a grand unification of all the forces and particles in nature, then one of the predictions is that the particle, the proton, which has been believed to be the most stable is itself actually subject to radioactive decay. This may worry some of you, since you know that the proton is one of the building blocks of the nucleus, and the nucleus is the massive core of all matter. However, even if these theoretical ideas are true, the world will not exactly come crashing down—the predicted half-life of the proton is about 10^{31} years, that is, a number of years described by 10 with 30 additional zeros. Note that this predicted half-life of the proton is vastly longer than what we believe to be the age of the universe which, according to current thinking, has existed for "only" about 10 billion (10^{10}) years. Although proton decay is thus not exactly an imminent catastrophe, there are possibilities for carrying out experiments to determine whether the proton is indeed stable or not.

5. Quite apart from the predictions of this new theoretical understanding produced through the work of the last decade, there are many other open questions, some very basic, that we do not understand any better than we did 10 years ago. For example, we do not know whether quarks and leptons themselves have any more fundamental substructure, nor do we know why the plus and minus members of each generation of particles add up exactly to zero. Finally, we are not much closer to an understanding of how the force of gravity fits into this overall picture than Einstein was when he was struggling to develop a general unified theory of natural forces.

This is a very brief summary of the vast amount of information that has contributed to our thinking, based on the experimental results acculated during the last decade, and of what elementary particle physics might reveal during the next decade. You should all be proud to be a part of what is perhaps one of the most profound adventures of our generation.

Photo by Joe Faust

CAROLYN CAROLINA JOINS AAO STAFF

For those of you who have not yet had the pleasure, we would like to introduce Carolyn Carolina, a relatively new face in the SLAC Affirmative Action Office. Carolyn joined the AAO staff as Secretary last August, and since that time she has demonstrated her skill and sensitivity in relating to people at SLAC. Because of her professionalism and efficiency, she has become a valuable asset to the Affirmative Action Office.

Carolyn's responsibilities in the AAO are only a small part of her busy life. When she is not at SLAC she spends time with her husband and two children, as well as participating in various community and social activities. Carolyn holds and A.A. degree in Business Administration from Compton College, and through past job experiences she has developed a specialty in the personnel field.

Carolyn enjoys working with people and is interested in sharing her experiences in the affirmative action area with others. She and other members of the AAO encourage SLAC employees to drop by and get acquainted. Carolyn's smiling face will be there to greet you.

—Margaret Hernandez

AFFIRMATIVE ACTION MATTERS

We would like to remind all SLAC employees that copies of this year's Affirmative Action Plan are available through your supervisors and Group Leaders. The Plan is also available through the Affirmative Action Office (Room 233, A & E Building).

Each employee should make an effort to review the Plan, as it outlines SLAC's program on Affirmative Action and Equal Employment Opportunity. The EEO Policy Statement signed by the Director, W. K. H. Panofsky, is reproduced on this page so you can familiarize yourself with its content.

Employees are encouraged to make comments or suggestions regarding the Plan or our Program. Please direct these and any questions you may have to the Affirmative Action Office, ext. 2967.

As noted in the previous issue of the *Beam Line*, Margaret Hernandez has recently joined SLAC as Assistant Affirmative Action Officer. Margaret is shown here in Joe Faust's photo.

EEO POLICY STATEMENT

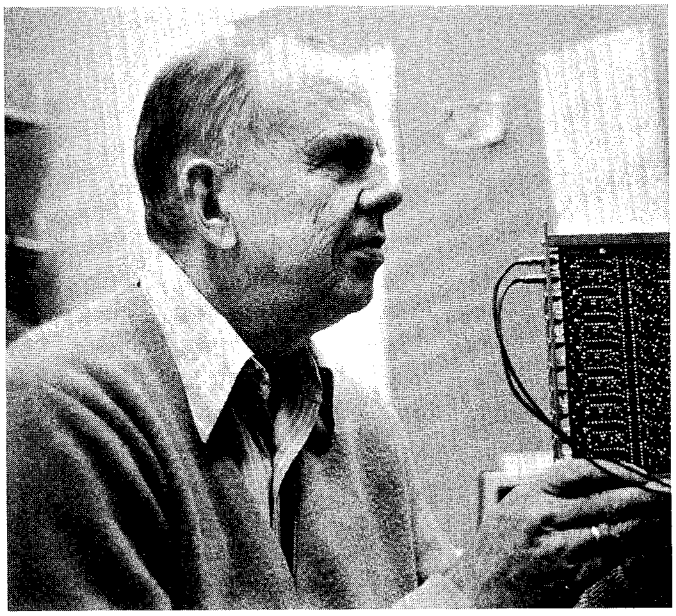
It is the policy of the Stanford Linear Accelerator Center of Stanford University to provide applicants and employees equal employment opportunities. The Laboratory will not engage in discriminatory practices against any persons employed or seeking employment because of race, color, religion, sex, age, or national origin. Additionally, this policy applies to disabled veterans, veterans of the Vietnam era, and to the mentally or physically handicapped. It is the intent of this Laboratory to promote the full realization of equal employment opportunities through a positive, continuing program. The Laboratory will take affirmative action to ensure that our policy of non-discrimination is practiced in all personnel actions including employment, promotion or upgrading, demotion or transfer, recruitment including advertisement, return from layoff, termination, employee relations, rates of pay and other forms of compensation, selection for training including apprenticeship, education and educational assistance, and Laboratory sponsored social and recreational programs. Additionally, this policy will be communicated to all job applicants, recruitment service organizations, SLAC vendors, suppliers, and subcontractors.

It is also the intent of this Laboratory to measure performance in this program against specific goals and to move toward full and equal participation by minorities and women in the opportunities available in the Laboratory, consistent with our standards of quality and excellence. Reviews and analyses necessary to determine the adequacy of our policies and practices will be made periodically to assure that this policy is being applied. Every effort will be made to find, employ, and promote those persons who can contribute to this Laboratory's program. All employees with supervisory responsibilities will be evaluated on the basis of their EEO and Affirmative Action efforts and their performance in implementing this policy.

Overall responsibility for ensuring compliance with the law and coordination of the Laboratory's affirmative action efforts is the responsibility of the Director. SueVon Gee, the Affirmative Action Officer, reports directly to the Director and will be responsible for the day-to-day administration of this policy and the identification of all necessary analyses and reviews required to monitor, audit, report, and appraise our Affirmative Action Program. The Affirmative Action Office is authorized to coordinate the investigation and resolution of all issues concerning employees of this Laboratory that are of EEO nature. All personnel actions require advice by the Affirmative Action Office. The Affirmative Action Office is available to all employees who need assistance in the clarification or resolution of EEO matters.

All employees, supervisory or non-supervisory, must give their full cooperation and assistance to ensure that this policy, which I support fully, is implemented in spirit as well as in principle.

—W. K. H. Panofsky



JIM SPITLER RETIRES

On Tuesday, January 29, 1980, a large group of friends gathered to express to James Wellington (Jim) Spitler their best wishes on the occasion of his retirement after 15 years of service to SLAC. Jim's friends presented him with a number of gifts, including a specimen of the increasingly rare SLAC *Arboretus beamius elusivi* (or Beam Tree to all you newcomers).

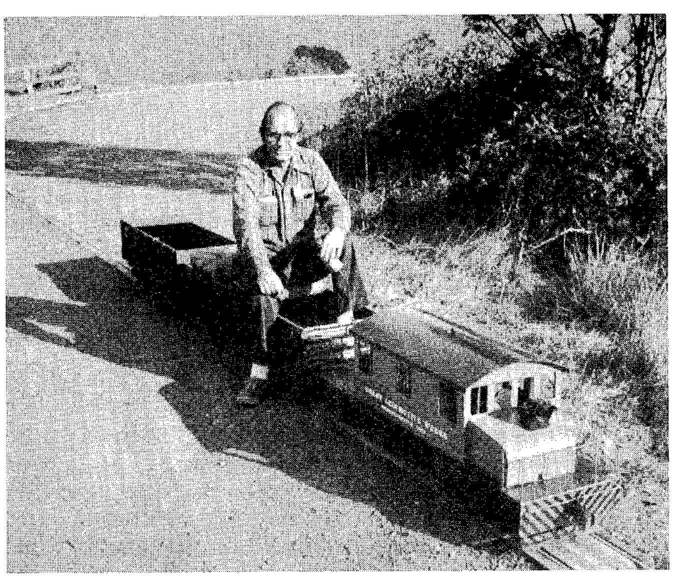
Jim is known to may people at SLAC through his position as the senior member of the HEEP staff under Don Farwell. Jim came to SLAC from Martin-Marietta in Denver in 1965, and immediately began work as an R&D tech in the Light Electronics Group. Later, when HEEP was formed and began to grow, he switched to learning the wiles of high-speed counting electronics equipment. In recent years, Jim expanded his role in HEEP to include CAMAC systems, computer controlled test stands, and most recently LSI-11 microcomputer systems.

Jim made a valuable technical contribution to SLAC. Equally important has been his cheerful approach to his work and to his fellow workers. He was always willing to be challenged and, right up to the point of his retirement, he was learning new skills. At the same time, he also shared his personal interests and always had a bon mot for his many freinds.

Many people at SLAC have talents unrelated to their normal work, and Jim seems to have more than his share. His extracurricular activities include gardening (there is a lottery going on to see who inherits his SLAC garden plot); raising show dogs (Shelties), cockatiels, doves and orchids; ham radio; fishing; and finally, telling stories about fishing in the good old days in the streams of Colorado and the lakes of Northern Ontario. (Jim probably has a few other talents which we've forgotten or which we couldn't get past the *Beam Line* censors.)

We all want to thank Jim for his contributions to SLAC and for his warm friendship, and we wish him every success in his retirement. Come back and see us often, J. W.!

—Ray Larsen



WEST VALLEY LIVE STEAMERS

John Grant and Justin Escalera of SLAC are members of a club, the West Valley Live Steamers, that is presently building a track near the top of the hills west of SLAC. Last summer the group completed a 1200-foot loop that will be one end of a 1400-foot track leading to another turn-around loop. Plans are to lay about 1000 additional feet of track this summer, including a 100-foot tunnel and about 100 feet of bridges.

In the photo above, John is shown with the engine he built about two years ago. This is a model, 1/8 full size, of a Baldwin-Westinghouse electric locomotive that was built during the period from 1910 to 1930 and designed to haul freight on interurban lines. The model is powered by two 12-volt automobile batteries which drive the wheels through four 1/5 HP electric motors. Justin and other members of the group are presently working on their own locomotive construction projects.

John and Justin invite anyone at SLAC who may be interested in trains and/or steam power to join them in this activity.

US/PRC COOPERATION: A ONE YEAR PERSPECTIVE

In January 1979, an Agreement was signed between the United States and the People's Republic of China (PRC) to cooperate in the field of high-energy physics. In June 1979, a secondary agreement was signed in Beijing on specific areas of technological exchange. This has been a multi-level effort. The initial Agreement was between the US and PRC governments. The secondary Agreement was the result of the first meeting of the PRC-US Joint Committee of High Energy Physics.

Of the four Agreements worked out during Vice Premier Teng Hsiao-ping's visit to Washington in January 1979, the accord between the two countries on high energy physics has so far been the most successfully implemented. This accord comes under the umbrella agreement covering collaboration in science and technology signed by Vice-Premier Teng and President Carter on January 31, 1979. (See the February 1979 issue of the *Beam Line* for details.)

Over the past year there have been a number of PRC delegations who have visited SLAC to study such areas as bubble chambers, experimental physics, fast electronics, conventional facilities, earthquake engineering, health physics, magnet power supplies, computer controls and accelerator applications.

The early delegations brought with them a report entitled "Summary of the Preliminary Design of 50 GeV Beijing Proton Synchrotron," in Chinese and English. This report describes the construction plans for a high energy physics experimental center. In March 1978, a decision had been made to build a 50 GeV proton machine with a 200 MeV linac as an injector, to be situated at the southwest of the Ming Tombs area, in the suburbs of Beijing. Advanced surveys and geological testing of the site have been started.

One of the more recent groups to visit SLAC brought with them a second report, "Brief Description of the Engineering Design of the High Energy Physics Experimental Center (HEPEC) in Beijing," a 1979 edition. The topics covered are the 50 GeV proton synchrotron, beam lines, general layout, workshop and warehouse, and conventional facilities. The main design improvement is the addition of a booster synchrotron between the injector linac and the main ring, which will result in "reducing the aperture of the main ring and decreasing the power consumption as well."

In March 1979, the schedule for construction of HEPEC was revised. The first stage of the construction was postponed from 1982 to 1985 in order to permit further study, while still allowing five years for completion of the machine, and ten years for the Center as a whole.

Both of the reports mentioned above are available in SLAC's Scientific Personnel Services Office, ext. 3113. Several copies of the Summary report are on hand; however, only one reference copy of the Brief Description report is available. There have been several other revisions to the original Agreements, as well. During the next few years a number of US accelerator experts and experimental physicists will be invited to the PRC to assist with the BPS effort.

PRC delegations have visited five DOE-sponsored US labs: SLAC, LBL, FNAL, ANL and BNL (usually in that order). A liaison office has been set up at FNAL, which is now the Business Office for the BPS project in the US. The office is staffed by Ji Cheng and Lu Chen, who were initially aided by Sun Jing-yuan, who served as secretary/interpreter. To aid in coordination for the US side, Norman Gelfand of FNAL was named National Coordinator. The purpose of these two offices is to facilitate cooperation —minimize red tape—between the two governments and the many agencies that are involved in (1) approving each visit from the PRC to the US individually; (2) processing the necessary paper work for each individual or group; (3) facilitating communication between individuals in the two countries; and (4) aiding in coordinating travel plans to enable hosts to make proper arrangements and to meet guests as they arrive.

During the visits of PRC delegations to SLAC, many members of the SLAC staff have contributed much time and effort toward the goals of international cooperation. These contributions, both professional and personal, form the essential basis of this collaborative program.

In addition to these visits, there are a number of PRC scholars who are assigned to SLAC for periods for one to two years. The areas of scholarly exchange include theoretical and experimental physics, klystron and magnet studies, and microcomputer applications. A summary of the PRC long-term visitors presently at SLAC follows this article. Many of these visitors are "T. D. Lee scholars." Professor Lee of Columbia University has personally negotiated many of the arrangements between institutions in the US and PRC scholars interested in this program.

During the past year there have been a number of opportunities to arrange social occasions for the PRC visitors. Visiting delegations have been taken on informal tours of San Francisco. the Stanford area, the Santa Cruz mountains, and nearby Universities. Many participating SLACers have also held dinners in local restaurants or in their own homes.

The successes of this program have ranged from meeting the official goals of cooperation to the more personal objectives of meeting people on new terms. The complexities of spending extended periods in a foreign country have given rise to a variety of services provided by SLAC, by the International Center at Stanford, and by members of the Palo Alto community.

Both short- and long-term PRC visitors have had to face many interesting challenges. Beginning with accelerated English courses, only a few friends, a small apartment and a bicycle, the more experienced visitors have become able to translate for their newly arrived associates, have found American families who are willing to share their time and conversation, and those willing and bold enough have even learned to drive automobiles.

—Nina Adelman
Scientific Personnel Services

PRC SCIENTISTS PRESENTLY AT SLAC

Wang Tai-chieh, from the Institute of High Energy Physics (IHEP) in Beijing, arrived at SLAC in February 1979. He is working with Professor A. Litke of Stanford on the Quark Search Experiment at PEP and is currently helping to build counters for use in this work.

Yao Chih-yuan, a research worker in accelerator theory and storage ring design at the University of Science and Technology in Hofei, is working on lattice design and the effect of wiggler magnets in SPEAR. The latter topic has provided the basis of a paper written jointly with Martin Lee of SLAC. *C. Y. Yao* is also working part-time as a research associate at SSRL under Herman Winick.

Wu Erh-sheng, from the Institute of Electronics, has been working with Gerry Konrad of SLAC's Klystron Department since April 1979. Wu is familiar with microwave tube construction, RF circuits and cavities, and has used the computer programs available for calculating the operating parameters of a typical klystron cavity.

Li Bing-an and *Huang Tao*, both of the Theoretical Division of IHEP, joined the SLAC Theory Group at the invitation of Deputy Director Sid Drell last September. *Gao Chong-shou* of Beijing University also joined SLAC Theory last November.

A number of US universities and other institutions have made arrangements to host T. D. Lee Scholars from the PRC. Since many of these host institutions are Users of SLAC's facilities, the PRC visitors often have work assignments at SLAC. Some of these people have now arrived at SLAC to participate in research activities.

Loang Peng-fei, a research associate at IHEP, came to SLAC last September to work in Group BC on the SLAC Hybrid Bubble Chamber Facility. An active experimenter, Loang has also worked with Winston Ko and has spent some time at UC-Davis.

Wang Shu-chin arrived last September to work with Group A on their DELCO collaborative experiment at PEP. She has spent the bulk of her time working on microprocessors, minicomputers and the SLAC Triplex computer system.

Guo Ya-nan and *Mao Zhen-lin*, from the Department of Experimental Physics at IHEP, arrived last October to work with Vernon Hughes of Yale University on SLAC experiment E-130, which is measuring the scattering of polarized electrons from polarized protons.

Gu Yi-fan hails from the same Department as Guo and Mao and arrived here at the same time. Gu is working with Karl Strauch of Harvard University on the analysis of data from the Crystal Ball experiment at SPEAR.

Yan Wu-guang also arrived last October from the same IHEP Department. Yan is working with Stan Wojcicki of Stanford on the DELCO experiment at PEP. Also working on DELCO are *Huang Yin-zhi* and *Gao Shu-chi*. Their host is Barry Barish of CalTech.

Under a separate arrangement, *Teng Tsu-yi*, from the University of Science and Technology in Hofei, have come to work at SSRL with Arthur Bienenstock on the design, construction and testing of an ultrahigh vacuum system at SPEAR. Teng is the most recent arrival, having started work at SSRL in February 1980.

Other PRC visits to SLAC are being planned and implemented. This summary gives a fairly comprehensive view of the scope of the activities that are being carried out as a part of the cooperative agreement between the two countries. The purpose of the summary is to bring SLAC personnel up to date on the actual implementation of this international goal in high energy physics cooperation.

—Scientific Personnel Services

APPRENTICESHIP PROGRAMS

SLAC's Apprenticeship programs presently include training in eight different areas of crafts work. These programs are all approved by the State of California's Division of Apprenticeship Standards. Successful completion of the program entitles the apprentice to a State Certificate which attests to Journeyman status for the person involved.

At present, there are 11 apprentices at SLAC who are training in the following crafts: plumbing, carpentry, electrical maintenance, heating-ventilation and air conditioning mechanics, utility mechanics, instrument repair (2), auto mechanics, and machine shop (3).

—Gerry Renner

> How wretchedly inadequate is the theoretical physicist as he stands before nature—and before his students!
>
> —Albert Einstein
> 12 March 1922

At the meeting of the Stanford University Board of Trustees on February 12, 1980, Burton Richter, Professor in the Stanford Linear Accelerator Center, was appointed Paul Pigott Professor in the Physical Sciences.

RED CROSS BLOODMOBILE

The Red Cross Bloodmobile will return once again to SLAC on FRIDAY, APRIL 11, in the Auditorium Breezeway. Please phone ext. 3113 for an appointment.

This visit by the Red Cross will conclude our original commitment for periodic visits during the past 18 months. Starting next quarter, the Stanford University Blood Bank will be conducting blood drives at SLAC. Watch the *Beam Line* and local bulletin boards for announcements of future dates.

Over the years we have conducted active blood drives for the Peninsula Memorial Blood Bank and, through the current program, for the Red Cross/Stanford University Blood Center. The Red Cross and Stanford have now terminated their relationship. Stanford is soliciting its own needs. Red Cross no longer serves Stanford, and its donations are often used in other communities.

SLAC still has an account with the Peninsula Blood Bank and has a credit balance of approximately 150 units. This reserve can be used for SLAC employees as needed. Thus any donor can give blood to the organization, and at the location, that they feel most comfortable with. It is a personal decision to be made on an individual basis. As noted above, the Stanford University Blood Bank will be conducting blood drives at SLAC in the near future.

Your cooperation in making the transition with minimal confusion will be appreciated. If you have any questions, please call me at ext. 3113.

—Nina Adelman
Blood Drive Coordinator

JAY EVANS RETIRES

"Jay's Cable Factory" lies deep in the recesses of the Main Control Center at SLAC. It was from there that Jay presided over the fabrication and installation of the multitudinous wires and connections that go to make up the accelerator control system. Although the work of the cable factory will go on, Jay's expertise, dedication and infectious enthusiam will be sorely missed.

Jay came to Stanford in 1962, working as an electrician at Hansen Labs until 1968, when he transferred to Crafts Shops at SLAC. In 1974, he moved to the Accelerator Physics Department and took charge of the instrumentation and control installations in MCC and the Beam Switchyard. It was Jay's job to organize the continuous flow of job requests to modify and improve the control system. The busiest time was just before beam turn-on, after a long period of accelerator shut-down. Would the installation be finished in time to meet the turn-on deadline? "Will we make it, Jay?" "Sure, we'll make it." And we always did.

Not that Jay is giving up the pressure cooker entirely. It would be completely out of character for him to sit quietly, puffing a pipe and watching the sunset. First there will be his antique business to revive and make prosper, and there are numerous other irons that have also been warming in the fire for some years. One of these, called the Mexican Stamp Caper, is a work of brilliance, but lest I be accused of giving away classified information, I refer you to Jay for more information.

Happy retirement, Jay. From all your friends, we wish you many fruitful, interesting and rewarding years.

—Ken Crook

SLAC Beam Line (Bin 80)
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Stanford University
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Bill Kirk, Bin 80, x2605 — *Editor*

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Bin Number	1-26	8-4	14-4	24-23	40-110	53-49	62-49	68-10	74-9	82-10	88-29	96-22
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at SLAC	3-7	10-3	20-65	26-21	48-7	56-13	64-17	70-2	78-40	84-8	91-4	98-37
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