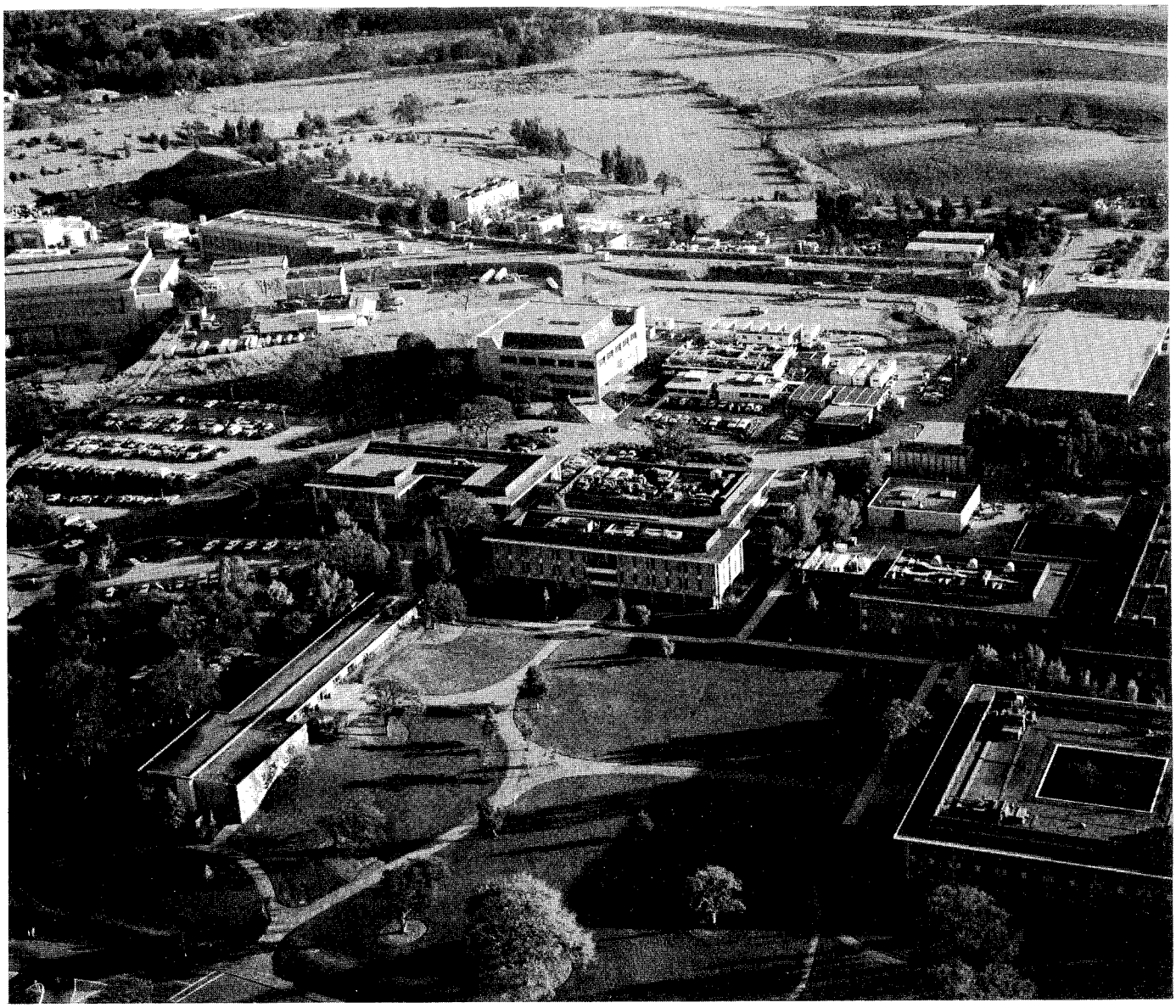
SLAC BEAM LINE

"There are therefore Agents in Nature able to make the Particles of Bodies stick together by very strong Attractions. And it is the Business of experimental Philosophy to find them out."--Isaac Newton, Opticks (1704)

Volume 8, Number 1 *January 1977*



The photograph above is one of a series taken by *Beam Line* photographer Joe Faust during a helicopter flight over SLAC last November. We don't know how Joe manages to take care of the *Beam Line's* photographic needs while also carrying out his full-time duties as an electronics engineer at SLAC. But we do know that in both technical quality and composition Joe's photographs of people, places and things for the *Beam Line* have been consistently superb.--BK

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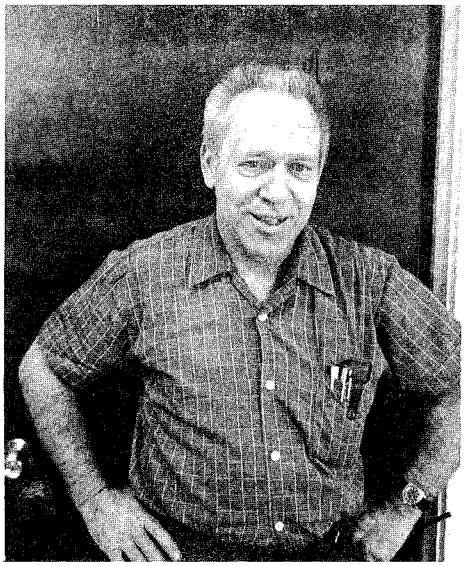


VERN KING, 1919 - 1976

We are saddened to report the passing of Vern L. King, one of our Assistant Operators-in-Charge in Accelerator Operations. He suffered a fatal heart attack on December 3, 1976 at the age of 57.

Vern began work at Stanford in May 1966, first working at the High Energy Physics Laboratory under Don Lee's direction. He transferred to AOG in February 1969.

He had an interesting background, and we will remember many lively discussions with him, particularly during the long hours of the graveyard shift which he preferred to work. Vern was a native son of Jerome, Idaho, where he received his early training. Prior to World War II, he moved to Oakland and completed two years of college at Polytech College of Engineering, after which he joined the Army Air Corps. In the Army, Vern first received training as a radio/radar operator and mechanic, but in 1942 he transferred to flight training. He was trained to fly the big transport gliders (CJ-13E), but most of the time he flew the small L-5 liaison plane. Vern loved to regale us with his war exploits in flying high-ranking military officers at low altitudes through the German fog to pick up intelligence on enemy activities. Those of us in AOG who fly were convinced that Vern easily could land his plane in a ten-foot square on the runway anytime he pleased.

Vern learned to fly helicopters, and after the war he picked up his commercial and flight instructor ratings. For some time he flew his own airplane. He worked for a time as a charter pilot.

Prior to coming to Stanford, Vern worked for several years as a field service instrument engineer at Ampex. He planned and organized two centers for Ampex in Europe. Before going to Ampex, Vern worked for a time as a supervisor of a flight-test telemetry station at Edwards Air Force Base.

Amateur radio was one of Vern's interesting hobbies. His home on Farm Hill Boulevard in Redwood City where his station WB6CAB is located can be recognized some distance away by its tall radio tower with a four-element quad antenna. Vern was a member of the Northern California DX Club, a group that focuses on radio contacts with distant lands. This group listens in for hams in other countries on various bands. Whenever a foreign station turns on, particularly those in sparsely (ham-wise) populated countries, the DX club notifies its members of the station by means of a continuously monitored 2-meter network, and each member can then get on the air and try to "work" the station. In the amateur radio world, there are some 321 different countries in the world even though some, like the "Peter and Paul Rocks" in mid-Atlantic, are only occupied at low tide by an occasional American amateur radio operator who sets up a station for the purpose of adding one more "country" to the "DXers" list. Vern had confirmed 310 countries and was still trying for those elusive last few.

After a hard day on the graveyard shift at SLAC, fighting misbehaving klystrons and trying to please experimenters, Vern often would go home and turn on his own "main control" (his amateur station with all its knobs and meters resembled his work station), and if he heard some exotic ham somewhere in the world, he would excitedly alert his fellow hams. Vern had many personal friends in other countries and made several visits to their homes, particularly those in England and Europe. Some of these hams, most recently from Finland, in turn visited Vern.

In a recent assignment in Accelerator Operations, Vern worked on a new telescope monitoring system. He performed his work with a great deal of interest and did it well. He ground a new six-inch parabolic mirror and seemed to enjoy the work.

In recent years, Vern became interested in real estate and took a number of classes at College of San Mateo to qualify as a real estate broker. He served as AOG's local expert on this subject.

Vern leaves his wife Violet and a son Richard to whom we express our sympathy.

--Vern Price

PEP NOTES

[A column of "PEP Notes" is now scheduled to appear in each monthly issue of the *Beam Line*. Bill Ash will be our regular contributor of PEP information, and we'll also occasionally include other items of topical PEP interest.]

PEP, the positron-electron project of SLAC and Lawrence Berkeley Laboratory, made its first big impact here about one year ago with the announcement of its inclusion in the President's budget message to the Congress (see the February 1976 issue of the *Beam Line*). A lot of work and design had already been done by that time, and by now contracts have been signed, components made, some earth turned, and much more of the design work completed.

Instead of reviewing all that's happened in a nice, orderly way, we're introducing here the first of a series of monthly columns that are intended to report on current PEP activities. (This is a little like joining a conversation that has been going on for a while before you got there--but eventually you catch up.)

Starting At The Top

The drilling rig in the parking lot east of the computer building last month was not a desperate attempt to force rain by threatening to drill for water (although the threat seemed to work). Instead, geologists are studying the soil where the PEP tunnel will be dug.

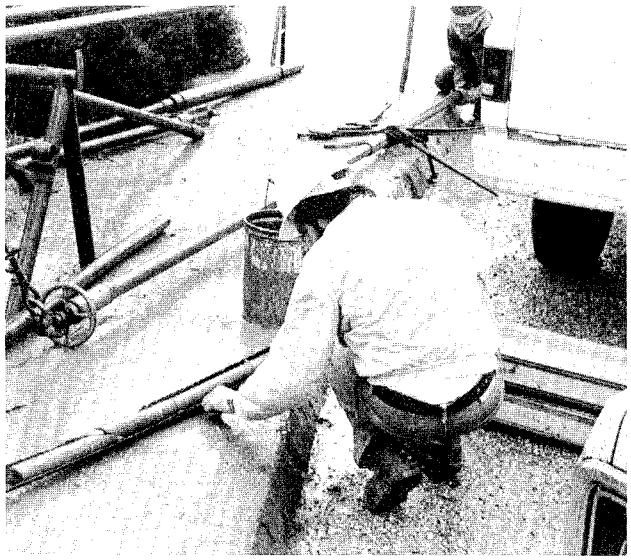
Fred Santana, a civil engineer with Dames and Moore, a consulting firm, explained that about 16 two-inch diameter holes are being drilled around the site of the new ring. The hollow, diamond studded bit cuts out a cylindrical core, and the retrieved samples form a continuous picture of the soil from 20 feet above the prospective tunnel to 10 feet below. At the parking lot site, this means a 70-foot-deep shaft.

From the core itself, you learn what is down there and what condition it's in. With the core removed, more tests are made in the hole itself. Probes are sent down to measure the mechanical strength, the permeability to water, the electrical resistivity, and the smoothness of the wall.

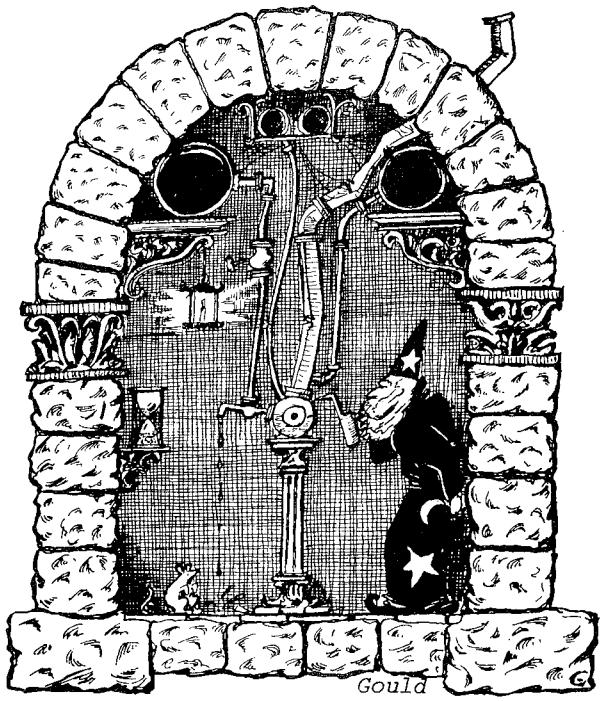
Finally, geophones are sent down two holes and a source of noise down a third to measure the sound-wave velocities in the soil. After this series of holes is finished, about 13 four-foot-diameter holes will be drilled at selected sites. A geologist will be lowered down in a cage into each hole to make direct observations.

This information will be used to decide on methods for digging and shoring the tunnel later this year.

--Bill Ash



Fred Santana, a civil engineer with a geological consulting firm, examines one of the core samples brought up by the drilling rig being used to study the PEP tunnel site.



typical cross-section

ASSU TRAVEL SERVICE CHARTER FLIGHTS

(Tresidder Union, Mon-Fri 9-3, 497-4437)

Chicago	$179	March 17-28
New York	$217	March 17-28
		March 18-29

Also package deals to:

Mazatlan	March 19-26
Puerto Vallarta	March 19-27
Mexico City	March 19-27

FEATURE FILMS BY WOMEN 1920 - 1976

The Committee for Research on Women (CROW) at Stanford University will sponsor a women's film series during Winter Quarter. Films will be screened each Tuesday evening at 7:30 P.M. in Cubberley Auditorium. Admission will be $1.50.

The series will extend from 1923 to 1976, and will include films from Hollywood in the 20's, from surrealist Paris, and from Africa in the 70's.

*Jan. 11 Dulac's "The Smiling Madame Beudet" 1923, Arzner's "The Wild Party" 1929

*Jan. 18 Deren's Shorts including: "Meshes of the Afternoon" 1943

*Jan. 25 Dulac's "The Seashell and the Clergyman" 1926, Varda's "Lion's Love"

*Feb. 1 Menken's "Visual Variations for Noguchi" and "Arabesque for Kenneth Anger", Zetterling's "The Girls"

*Feb. 8 Reiniger's "Aucassin and Nicolette", Duras' "Women of the Ganges" 1969

*Feb. 15 Sontag's "Broder Carl" 1971

*Feb. 22 DeHirch's "Colour of Ritual, Colour of Thought", Muldoror's "Sambizanga"

*March 1 Wieland's "Hand Tinting" and "Water Sark", Rainer's "Film About a Woman Who" 1974.

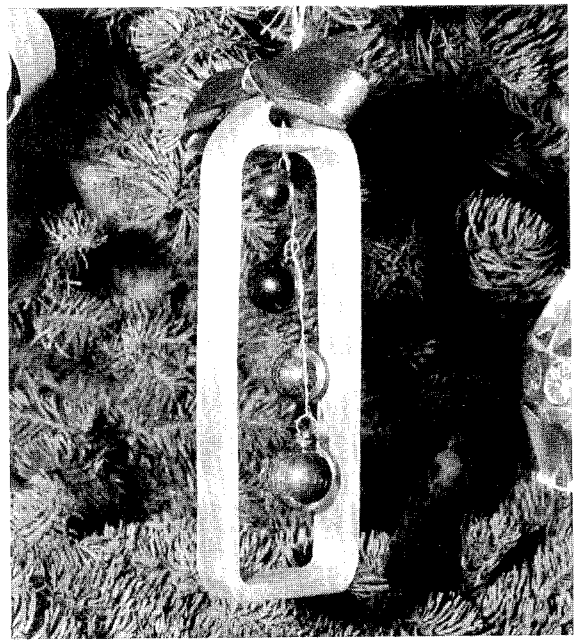
CHRISTMAS PARTY WINNERS

The drawing held during the annual SLAC Christmas party resulted in the following winners:

Turkeys: Roger Miller, Bob Baker, David Farkas, Roque Hilomen, Tom Inman, Abel de la Cerda, J. Lauer and R. Hover.

Beam Trees: Phyllis Jairl, Mary Anne Fisherkeller, Frank Veldhuizen, Guy Scharf, Merrill Card, and several others whose names we unfortunately missed.

The first-place winner in the Christmas tree decorating contest was Michele Bondi, who received a Baskin-Robbins gift certificate worth $4. Her winning "ornament" is shown in the photograph below. The rectangular metal piece is a cross-sectional slice of the vacuum chamber, about 6 inches high, that is used in the SPEAR storage ring. Ramiro Reyna of SLAC helped Michele with the construction of this prize-winner.



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Note to readers at SLAC: Please return any extra copies to B. Kirk (Bin 80) or H. Weidner (Bin 20).

THE STATE OF SLAC

W. K. H. PANOFSKY

Note: This is the text of the annual "State of SLAC" talk that was presented to the SLAC staff by the Director on January 19, 1977. Several illustrations have been added to this written version of the talk.

Contents

A. THE GENERAL OUTLOOK AT SLAC

Today I am continuing a tradition of several years standing by reporting to you again on the "state of SLAC" and on our prospects for the future. As usual, this report follows closely after the official release of the proposed Federal Budget for the coming Fiscal Year. President Ford presented his proposed budget for Fiscal Year 1978 (FY1978) to the Congress on January 17. In this talk I shall discuss the implications of this Budget Message for SLAC, and I hope that you will find this information to be both interesting and reassuring.

1. *The Federal Budget Process*

Before presenting the specific budget information, let me first mention the more-than-usual number of uncertainties that presently exist in the Federal budgeting process. First, Mr. Ford will no longer be in office after January 20, and the new President has the right to modify the proposed budget in any way that he sees fit before the Congress acts upon it. Second, as you probably know, the Federal budget year has recently been changed so that a new Fiscal Year begins on October 1, rather than on the previous date of July 1. Thus the proposed budget we will be talking about today for FY1978 covers a period that does not begin until next October, which means that the Congress will have an additional three-month period (as was intended) in which to review and act upon the proposed budget.

Several changes may occur that affect our sponsoring agency, the Energy Research and Development Administration. Both President Ford and President-elect Carter have expressed their support for incorporating ERDA into a new cabinet-level Department of Energy. Such a reorganization involves many details that would require Congressional approval, and that could also affect the way in which high energy physics is supported by the Federal Government. A reorganization of this kind would also affect the manner in which Congress exercises its oversight of the work supported, and for this and other reasons Congress is presently engaged in revising its committees which deal with energy and the support of science. However, any reorganization moves of these kinds could hardly be enacted before this summer.

2. *National Support Of High Energy Physics*

In spite of these uncertainties, I do not feel very uncomfortable about discussing the proposed new budget with you. This is because I believe that it will "stick" more or less as submitted by President Ford. A tradition has now become well-established that the U.S. program in high energy physics is a kind of "national trust" which will be suuported by one Federal sponsoring agencies, and which must stand on its own merits. Therefore the actual details of how the support of high energy physics will be incorporated into any new govern-

ment structure, or of how the Congress will choose to exercise its oversight of this field, are in my opinion not likely to result in any major changes.

In regard to "standing on its own merits," I believe that these merits are now generally recognized within the government to be large and important, and this recognition is another reason for my confidence about the future of our field. As you all know, the last several years of particle-physics research have produced a creative outburst of tremendously important discoveries, and I am particularly proud that SLAC has played such a major role in these unprecedented achievements.

B. BUDGET IMPLICATIONS

The proposed budget for FY1978 is unusually difficult to analyze in terms of its specific implications for SLAC. The reason for this difficulty is that during FY1978 SLAC will receive support not only in the customary annual categories but also for a number of other programs located at SLAC. These include the following:

(a) The PEP construction program.

(b) A construction project that will double the capacity of our electrical substation.

(c) Development and construction of the initial complement of research equipment for PEP.

(d) A major expansion of the Stanford Synchrotron Radiation Facility (SSRP), funded by the National Science Foundation.

(e) The continuing SLED program for increasing the energy of the SLAC accelerator.

1. *Proposed Budget For FY1978*

Table I shows the total level of support for SLAC, PEP and SSRP that is contained in the President's Budget Message for FY1978. Because of the many special projects listed above, the total proposed funding for work on the SLAC site during FY1978 is extraordinarily large--almost $80 million. Translated into the support of people, the implication is that SLAC's activities during FY1978 will account for something like 4000 jobs, mostly in the local economy. However, as I will discuss later, this projection has very little bearing upon the actual staffing levels for SLAC itself.

We shall now turn to a discussion of some of the specific budget categories in more detail. SLAC's continuing program is funded in four separate budget categories:

Operations	*Operating Funds*
Capital Equipment Accelerator Improvements General Plant Projects	*Capital Funds*

Table I

FY1978 FUNDED ACTIVITY AT THE SLAC SITE
NEW OBLIGATIONAL AUTHORITY
(Dollars In Thousands)

Regular SLAC Program		
Operations	$31,750	
Equipment	2,800	
Accel. Improvement Projects	1,500	
General Plant Projects	900	36,950
PEP Activities		
Construction Project	29,400	
Pre-construction R&D	1,050	
Experimental Equipment	7,000	
Equipment R&D	450	37,900
Other Activities		
Main Site Substation	1,700	
Stan. Synch. Rad. Project:		
New Facilities (NSF)	2,800	
UC-Santa Barbara Effort	50	4,550
TOTAL FUNDED ACTIVITY		$79,400

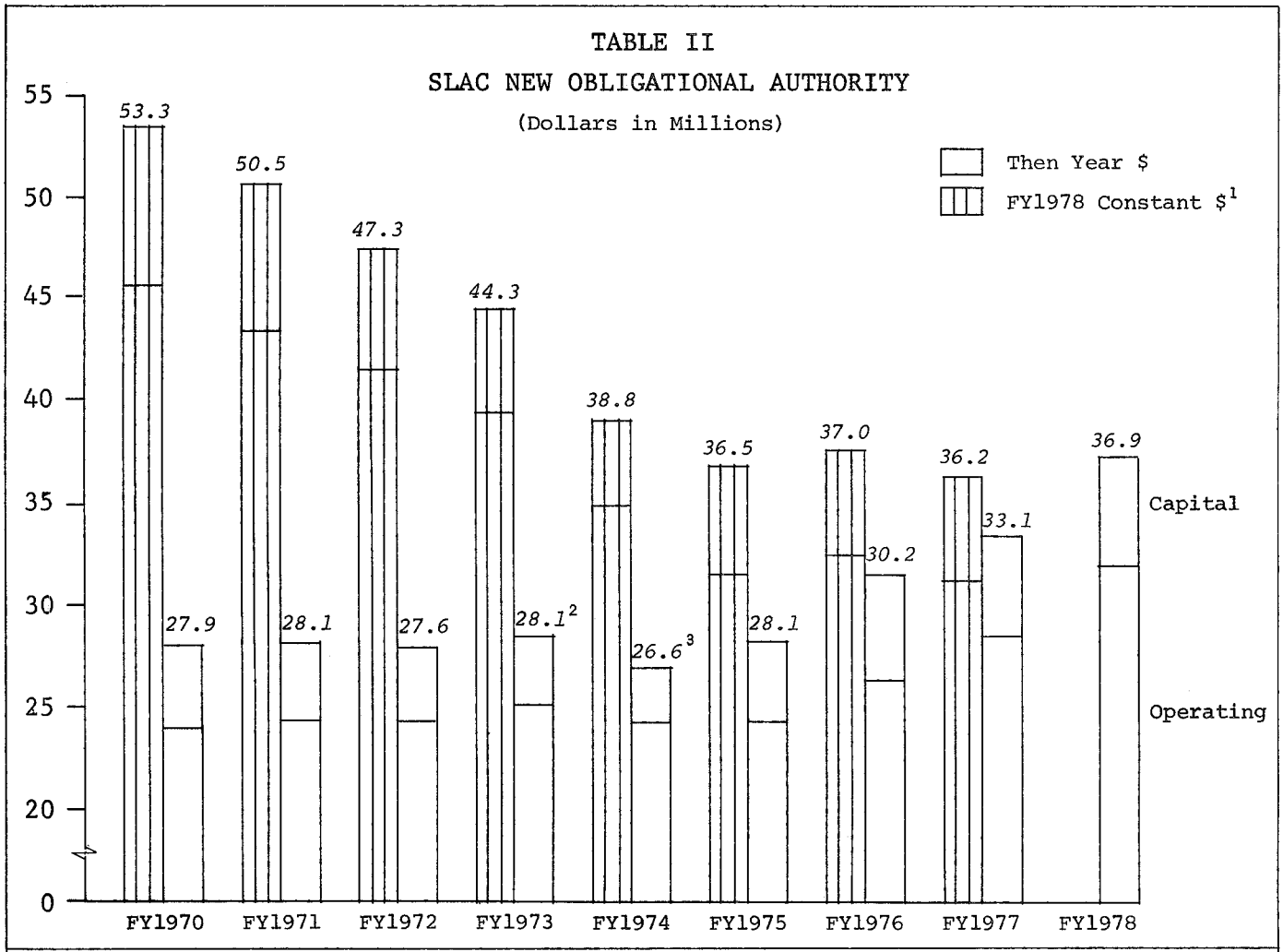
The last three categories are often grouped together as "Capital Funds" because each supports work that makes a long-range addition to the value of a facility. In contrast, Operating Funds support the operation of existing facilities, and also the conduct of research and development work using existing facilities or leading to the construction of new facilities.

Table II shows the proposed Operations and Capital funding for SLAC, excluding PEP, for FY1978 in comparison with earlier years. Table III shows the same information for PEP only, excluding the rest of SLAC.

Note that Tables II and III show the funding levels for earlier years in two different ways: (1) in actual or "then year" dollars, which are the dollars that were actually spent; and (2) in "FY1978 constant dollars," which are used to account for the cumulative effects of inflation during the period. Method (2) makes it possible to see the funding trend over several years in terms of actual purchasing power.

The effects of inflation shown in Tables II & III were calculated through the use of the SLAC Cost Index, which is shown in Table IV. I'm sure that no one needs to be reminded that inflation hits everyone's pocketbook, but not in exactly the same way. Each individual or organization purchases a mixture of goods and services that may be quite different from that of others. The SLAC Cost Index represents the effects of inflation upon the very specific mixture that characterizes SLAC.

I should note here that the use of "FY1978



[1]Based upon 12/30/76 projection of 3/1/78 SLAC Cost Index (FY1967 = 100).
[2]Excludes $1,160,000 of prior year funds applied to FY1973 Capital Equip. Oblig. Authority.
[3]Excludes $2,900,000 NOA for SLAC Computer Building.

constant dollars" in Tables II & III is necessarily based upon a forecast of what cost inflation will be during a year that does not begin until October 1977. This forecast may there-

Table III

PEP FUNDING BY FISCAL YEAR
(Dollars In Thousands)

Fiscal Year	Construction Funds	Total Funds	Total In FY1978 Constant $[1]
1975	-	920	1,195
1976	2,900	4,265	5,240
1977	25,000	26,175	28,650
1978	29,400	37,900	-

[1]Based upon 12/30/76 projection of 3/1/78 SLAC Cost Index.

Table IV: SLAC COST INDEX

Year	SLAC Cost Index	Percent Increase
1978 (Proj.)	217.4-219.2	7.7-11.3[1]
1977 (Proj.)	196.9-201.9	11.3-14.1[2]
1976	176.9	5.9
1975	167.0	12.1
1974	149.0	8.0
1973	138.0	8.9
1972	126.7	4.7
1971	121.0	6.4
1970	113.7	5.2

[1]Based upon 12/30/76 projection of 3/1/78 SLAC Cost Index.
[2]FY1977 projection covers a 15-month period.

fore turn out to be inaccurate. In fact, we have had to revise the FY1977 Cost Index figures that I used during my talk last year on the basis of our actual experience. I am making this remark here in order to point out that you should not be surprised to find small discrepancies between the numbers I forecast each year and the later actual experience.

2. The Cost Of Electric Power

There is one special area in which the impact of inflation upon SLAC is worth looking at in greater detail--the cost of electric power, of which SLAC certainly uses a great deal. For example, during the 12-month period ending on September 30, 1976, SLAC consumed a total of 208 million kilowatt-hours. Up until the present time, our power rates have been unusually low, but because of our large usage the total cost has still been a significant part of our budget. For most consumers, the cost of electric power has been increasing at a higher rate than that of the average inflation factor, and this is of course symptomatic of the growing costs of energy throughout the economy.

This situation has had very little effect upon SLAC in the past because of a combination of unusual circumstances. SLAC gets most of its power through the Federal Bureau of Reclamation, with PG&E being paid a small "wheeling" charge for the use of its transmission lines. Any power that SLAC uses above the "base" level supplied by BuRec has to be purchased at commercial rates from PG&E. As you know, our budgets have been very tight during recent years, and one of the results of this has been a reduced level of SLAC operations and thus lower power consumption. Our energy-conservation efforts around the laboratory have also helped significantly in cutting down on electric power consumption. As a consequence of these factors, the fraction of our power that we have had to purchase at the higher commercial rates during recent years has been quite small and has in fact gradually decreased.

Looking to the future, it seems certain that the favorable power-rate situation I have just described will soon be changed. The Bureau of Reclamation has in fact already begun the process of increasing its rates, but because of procedural delays the higher rates have not yet been put into effect. The present outlook is that the higher BuRec rate will become effective sometime between July 1 and October 1, 1977. This cannot be avoided. As with everyone else, BuRec's operating costs have gone up, and by law the BuRec is required to set its rate structure so that it does not lose money. As a result, we expect that the rate SLAC pays for its electrical power will be almost doubled in FY1978.

This expected large increase in power costs for FY1978 will have a significant effect upon the SLAC Cost Index. We estimate that the jump in the Cost Index between FY1977 and FY1978 will be about 10%, which is a few percentage points greater than what is anticipated for the general cost-of-living increase.

3. Summary

From the foregoing discussion, I can summarize the proposed budget situation for FY1978 in the following way. The apparent increase in SLAC funding over FY1977 is about 12%. However, if the expected 10% jump in the SLAC Cost Index turns out to accurate, the proposed funding levels will represent only a 2% increase in *actual purchasing power*. This is not a very large amount, but it is nevertheless good news because it means that the trend of progressive erosion that has affected our work ever since 1969 has now been definitely reversed.

C. ACCELERATOR & RESEARCH OPERATIONS

Needless to say, there has not yet been time to work out the implications of the proposed FY1978 funding for the SLAC operating program in any detailed way. The expected increase, in real terms, of about 2% will probably support a modest increase in accelerator utilization and perhaps several small program additions. In the following paragraphs I shall discuss in a general way our expectations for accelerator operations and for the experimental research program during the latter part of FY1977 and during FY1978.

1. Scheduled Shutdown Period

The plan for accelerator operations during the coming months is made more complicated by the fact that it must be coordinated with the PEP construction program. We are tentatively planning to shut down the accelerator on July 1, 1977 for a period of about 4 or 4½ months. During this shutdown period there will be two important related activities:

(a) The Mark I magnetic detector at SPEAR will be removed and replaced by a major new experimental device called the Mark II. [The Mark II is described in the June 1976 issue of the *Beam Line*.] As you know, the Mark I was used in making many of the important recent discoveries, and the new Mark II instrument will have even greater experimental capabilities.

(b) With the excellent cooperation of ERDA and of our recently retained Architect-Engineering-Management firm, the PEP construction schedule has been accelerated to allow some of the tunneling work to be accomplished during the planned shutdown period. This work involves the injection-system tunnels at the points where they "break in" to the existing Beam

Switchyard structure at SLAC. This is shown in Figure 1. If everything goes as planned, the earth overburden above the relevant sections of the Switchyard will be removed either before or at about the time of the shutdown. The initial sections of the injection-system branch tunnels will then be constructed and joined with the Switchyard structure. After that the openings in the branch tunnels can be sandbagged in order to block any radiation from the accelerator. Once this "stub-tunnel" work is completed, the subsequent PEP construction activities can proceed without further regard to the accelerator's operating schedule (at least until near the end of construction).

2. *Accelerator Operations*

The July 1 date for the start of the shutdown period represents a very tight schedule for the Mark II installation and PEP construction work just described. However, we consider it quite essential to proceed in this manner because our present funding will not provide for any operation of the accelerator during the last three months of FY1977 (July-August-September). The full shutdown period will extend through next October and very possibly also November, thus also eliminating the first two months of FY1978 for accelerator operations. As a practical matter, the installation of other facilities at SPEAR and other miscellaneous activities will probably require an additional shutdown period of perhaps two months later in FY1978. Thus purely for scheduling reasons it would be difficult to plan on the availability of more than 8 of the 12 months in FY1978 for accelerator running. We hope that the funding will make it possible to achieve a somewhat greater overall utilization of the accelerator during FY1978 than the sparse beam availability of the present fiscal year.

3. *Experimental Program*

Our research plans for FY1978 are largely a continuation of the present program, and for this reason I shall describe these plans in less detail than was presented last year.

SPEAR will be used in a new series of experiments which aim at more detailed exploration of the new phenomena that have been discovered during the past several years. There are recent indications from the SPEAR work that the period of major discoveries may not yet be over. The previous experiments at SPEAR have generally emphasized the detection of electrically charged particles that emerge from the electron-positron annihilation process. The new experimental devices now being developed for use at SPEAR will also make it possible to detect some of the im-

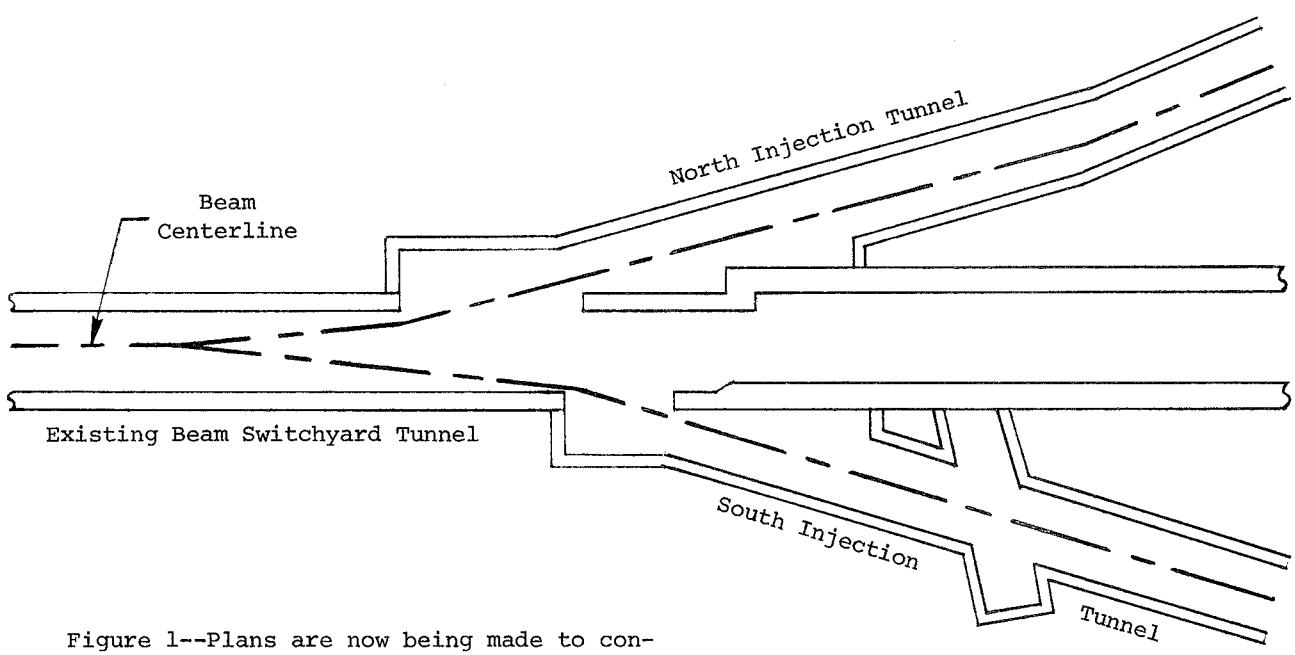


Figure 1--Plans are now being made to construct the initial segments of the two PEP injection tunnels, North and South, during the 4-5 month accelerator shutdown period that is scheduled to begin on July 1, 1977. These tunnels will join onto the existing Beam Switchyard tunnel structure as shown. Once completed, the injection tunnel "stubs" will be blocked off with sandbags that will act as a radiation barrier. This will make it possible to carry out much of the remaining PEP construction work independently of the experimental operations schedule of the accelerator.

portant particles that are electrically neutral.

Experimental work at the major new *LASS* facility began some months ago, and the facility is now in regular operation for experimental research. As you may remember, this facility is a complex, general-purpose detection system that has the capability of generating accurate experimental data at a remarkably fast rate. We have been much encouraged by the many experimental proposals that have been made for the use of LASS by physicists from throughout the country.

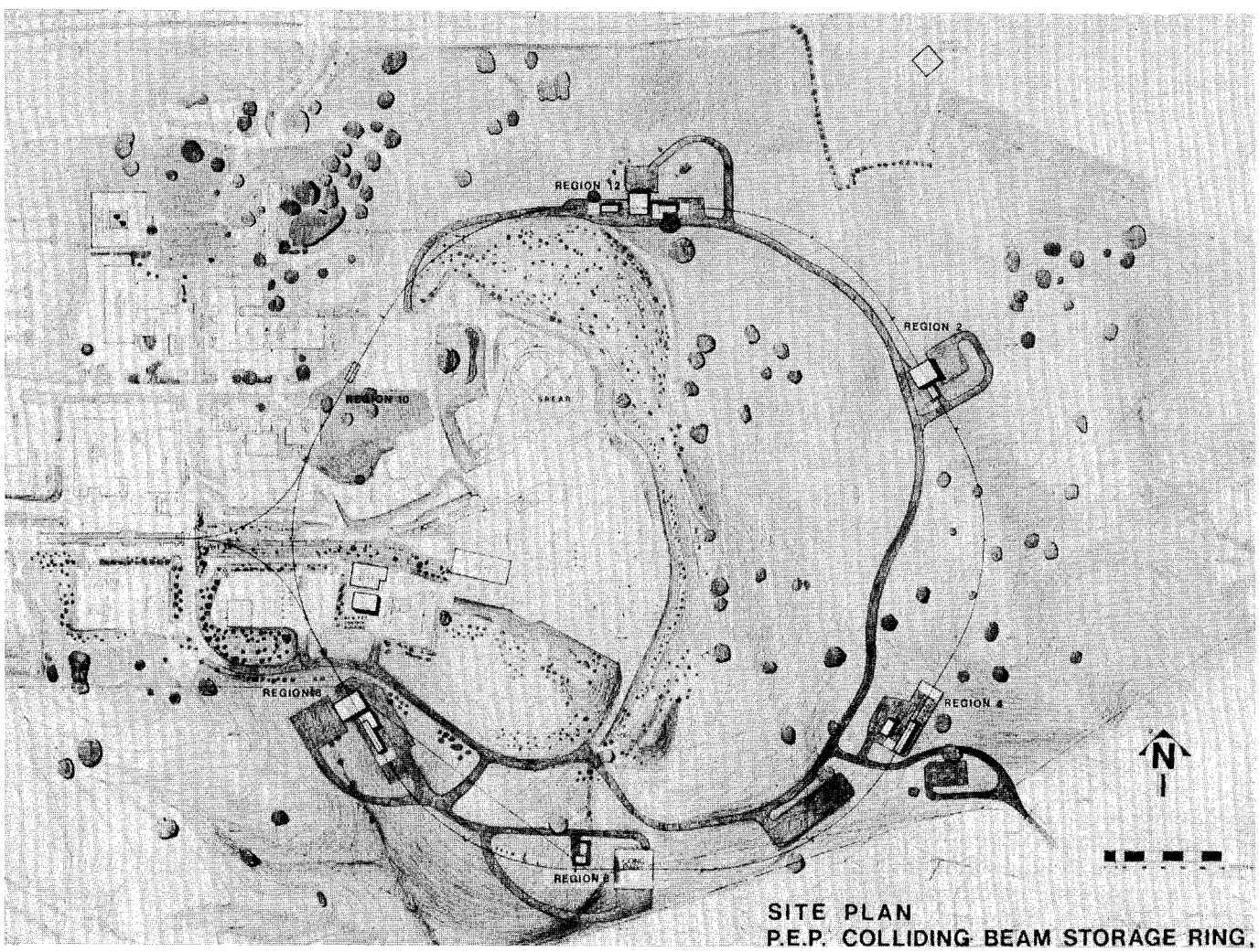
The *hybrid bubble chamber* facility based on the SLAC 40-inch bubble chamber has been used in several recent very productive experiments. Here too we have received many new proposals for the use of this facility in a variety of different experimental configurations. For the past several years SLAC has been the major supplier of bubble chamber photographs to the high energy physics community. The rapid-cycling capabilities of the 40-inch chamber (expansion rates up to 10 or 12 cycles per second), combined with the selective triggering made possible by the hybrid system, have resulted in a facility that is both powerful and flexible.

The large *magnetic spectrometers* in End Station A will continue to see extensive use, in particular in connection with experiments that use polarized electron beams. These instruments have been among the major workhorses of the SLAC program ever since the first operation of the accelerator in 1966. As a matter of interest, a Spectrometer Workshop will be convened at SLAC very shortly to study various alternatives for new experimental instruments that might be well-suited to the electron scattering and photoproduction work in End Station A in the future.

D. THE PEP PROGRAM

1. Conventional Construction

About one-third of the total cost of the PEP construction project ($28 million out of a total of $78 million) is associated with the work that is known as "conventional construction." This includes site preparation, tunneling, the construction of buildings, roads and utility services, and so on. This aspect of the project is carried out by an outside "AECM" organization (Architect-Engineering-Construction



SITE PLAN
P.E.P. COLLIDING BEAM STORAGE RING.

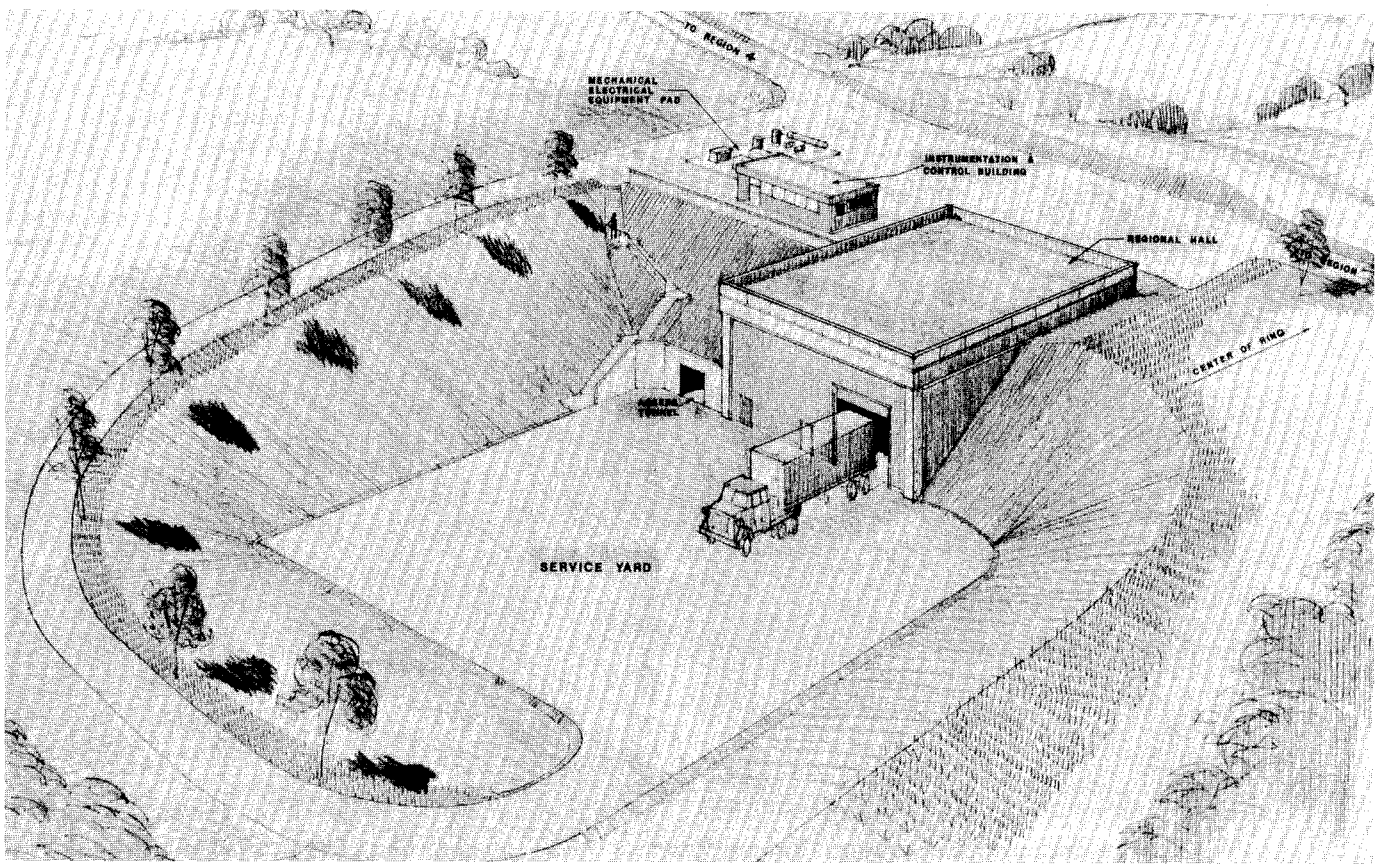
Management) through subcontract. The organization that has been selected for this work is a joint-venture firm consisting of Kaiser Engineers of Oakland, and Parsons, Brinckerhoff, Quade and Douglas (PBQ&D) of San Francisco.

Although we haven't yet seen very much in the way of earth-moving or of heavy construction around the PEP site, the AECM is in fact already hard at work. One construction project that has been started is the new Assembly Building, which is now rising from its pad between the Computer Building and the Beam Switchyard. This building will be used for the assembly and testing of vacuum components for PEP. You may also have noticed a series of test holes being drilled into the ground at various locations around the PEP site. This work will gather the geological data that is needed for proper design of the PEP tunnel and for building foundations. The apparent low level of present activity will change dramatically in the month of June, when heavy earth-moving will begin over the west end of the Beam Switchyard in preparation for the initial "stub-tunnel" construction that I described earlier. This will be followed closely by the first road-building and other site-preparation activities.

2. *Experimental Facility Proposals*

PEP will have an impact on SLAC that extends far beyond the actual construction project. Even though the PEP storage ring is not scheduled to begin operating until 1980, it is already time to begin the process of providing the major experimental research facilities that will be used in the early PEP research program. Last year the high energy physics community was invited to prepare proposals for such facilities, and as of the December 30 deadline we had received in response a total of 9 proposals.

In order to assess these proposals, SLAC and LBL have established a PEP Experimental Program Committee (EPC) which consists of 15 senior physicists from many institutions. The EPC will advise the Directors of SLAC and LBL on the scientific merit of the proposals, and the present schedule calls for decisions to be reached in June of this year. For various reasons it will be possible to accept only 3 of these 9 proposals at this time, and it will be a formidable task to try to select the 3 that will provide the most productive early results from PEP.



The electron and positron beams at PEP will collide at six different points spaced symmetrically around the circumference of the ring. Five of these interaction points will be used for physics experiments, and the sixth for machine studies. This drawing shows an early plan (since modified) for the experimental hall and related structures at Region 2. (The drawings on this and the previous page are from UC-Berkeley/LBL Graphic Arts.)

It is also certain that the selection will involve some agonizing decisions because these proposals represent an enormous effort by some of the most creative and dedicated experimental physicists in the U.S., and many ingenious new ideas have been incorporated in the proposed facilities.

Yet these decisions must be made, and made soon. Assuming that the selection of 3 of the proposals is completed in June, there will then remain a period of about three years during which the successful proponents will have to complete their plans and component designs, procure the materials, build the apparatus, and shake out all the bugs in time for PEP's initial operation for research. Three years is little enough time considering the huge scale and extreme complexity of some of the proposals. When we also consider the fact that a large part of the third year may well be needed for testing and especially for getting the elaborate computer programming into reliable operation, then not much more than two years will be left for the actual physical construction of the complete facilities.

3. *Experimental Facility Funding*

I should point out here that the funding for these experimental facilities is entirely separate from that of the $78 million PEP construction project itself. The PEP funding picture was shown earlier in Table III [page *3*] for FY1975 through FY1978, and Table I [page *2*] indicated that the proposed budget for FY1978 contains a request for $7 million specifically intended for PEP experimental equipment. Although these Tables illustrate the very rapid build up of funding for this initial complement of PEP research facilities, the very tight construction schedules that I've just described may require commitments that exceed the available FY1978 funding. For this reason we hope that additional funding can be obtained from sources other than those now explicitly intended for this purpose in the ERDA budget--in particular from those institutions that will be participating in the building of the equipment.

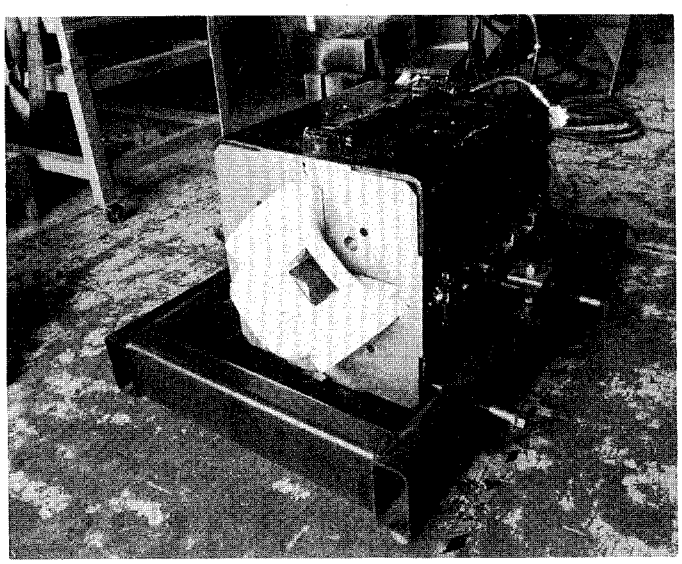
4. *PEP R&D Activities*

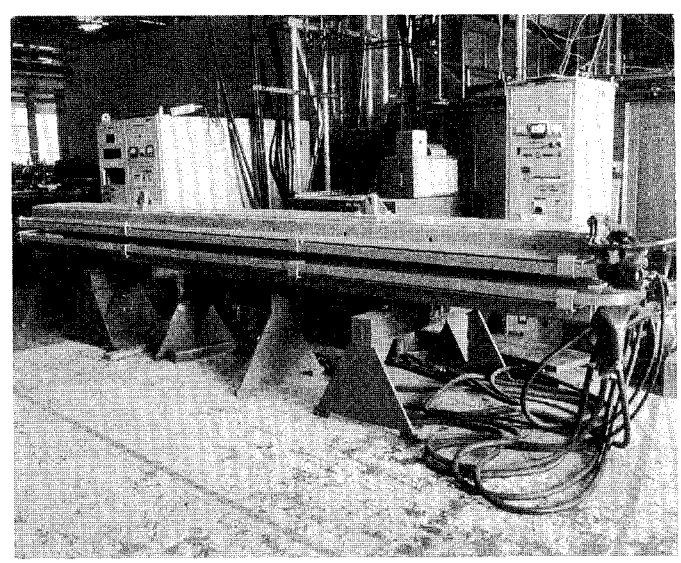
In addition to the separate research facility funding and the direct construction project funding for PEP, there are also operating funds that will be provided to continue the research and development work on the technical components and systems intended for PEP use. This R&D work is related to the fact that PEP is being built on a staggered schedule in which the various technical systems become ready and are installed in sequence at different times. Each of these major systems evolves along the following path:

Pre-construction R&D
Preliminary design
Final Design
Construction

Because of the staggered schedule, there will continue to be some pre-construction R&D work done on certain systems for some time.

Operating funds will also be committed to PEP for the purpose of preparing for the even-





Figures 2 & 3--The complete magnet system for PEP will consist of a total of 669 magnets in the storage ring itself and 96 magnets in the injection system. On the left above is a photo of an engineering model of the standard main-ring dipole or bending magnet, of which 192 will be needed. On the right is an engineering model of one of the three different sizes of standard quadrupole or focusing magnets; 180 of this particular design are required. The ring will also need 204 smaller sextupole magnets. *(Photos by Walter Zawojski.)*

tual operation of the facility. Operating and maintenance crews will have to be trained for the storage-ring complex itself, and we shall also have to train certain groups of people who can support the research operation of the large experimental facilities for the benefit of the physics users in much the same way as is now done by SLAC's Experimental Facilities Department, Bubble Chamber Operations group, and Spectrometer Facilities group. In fact, each of the PEP experimental equipment proposals we have received identifies a plan for accomplishing the transition from equipment building to support of the operating facility for future users. From this example it should be clear that operations-funded activities will continue to be a part of overall PEP program for the foreseeable future.

5. *Current Progress & Future Planning*

Since we have now rather thoroughly gone over the PEP funding picture, let me turn to a report on some of the recent accomplishments related to hardware for PEP and to actual construction of the project. We have made very good progress during the past year in getting ready for a fast start as soon as all the lights had turned green. Some of these achievements are indicated in Figures 2, 3 and 4.

In addition to these technical developments for PEP, we have also reached a number of important decisions concerning the basic design of the storage ring. I'm sure you all realize that a large storage ring is a very complex machine, and most of the major design decisions must be arrived at by choosing the optimum trade-offs among conflicting values. This is a delicate process, and there are always some aspects of

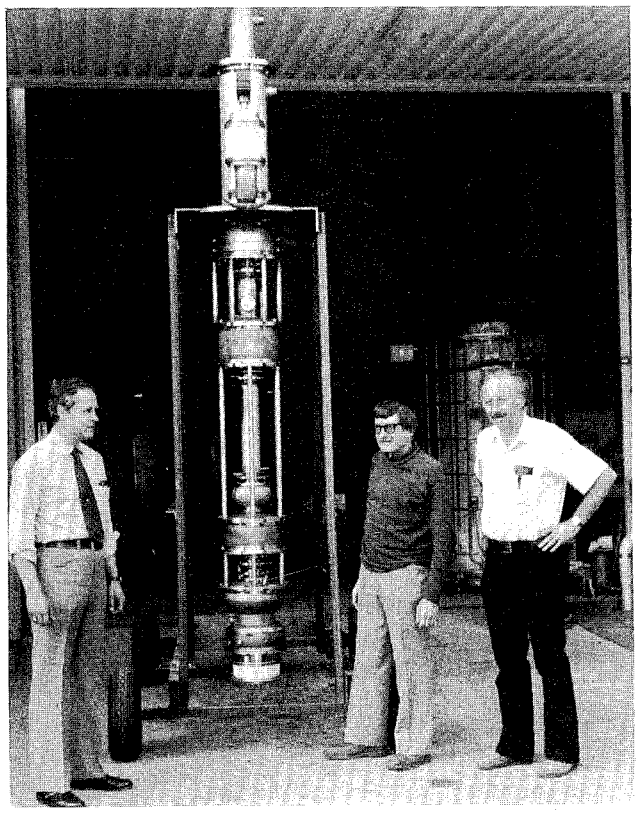
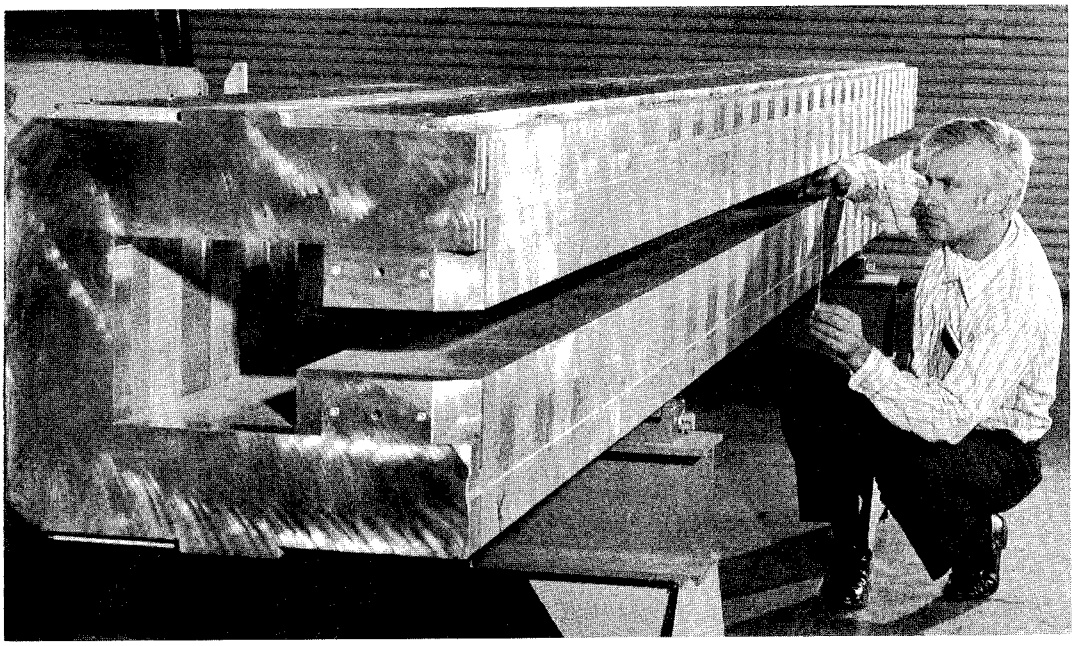
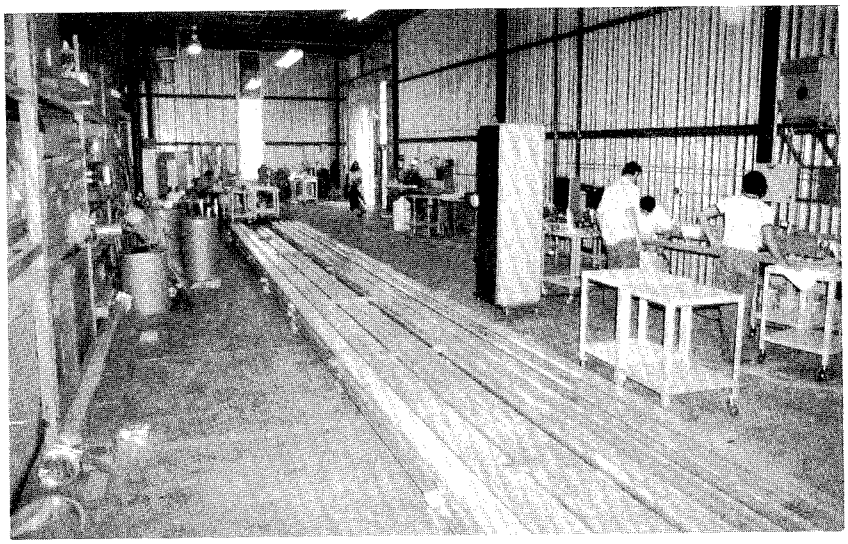


Figure 4--From the left are Gerry Konrad of the Klystron Group; John Rees, Director of the PEP project; and Matt Allen, Leader of the RF Systems group in PEP. The tall tube is an engineering model of the klystron being developed for use at PEP. Twelve such tubes will be used, each capable of delivering a constant 500 kilowatts of radiofrequency power at a frequency of 353 MHz. *(Photo by Dick Muffley.)*



Chief of PEP Mechanical Systems Bob Bell checks a welded stack of steel laminations that forms the frame and magnetic flux path of the C-shaped bending magnets that will be used at PEP.

Photo by Joe Faust



These aluminum extrusions, each about 15 meters long, are used to make the vacuum chamber for PEP. They will be bent to match the curved path followed by the beams. A single extrusion will thread through 2 bending, 2 quadrupole and 2 sextupole magnets to form a modular section of the ring. Flanges at the ends of each extrusion will join adjacent modules together by bellows connections to a common vacuum pump. The extrusion process creates a separate water-cooling passage along the outer rim of the vacuum chamber.

any particular design configuration that tend to give the engineers and physicists involved gray hairs. I am happy to report that the several worrisome aspects of PEP's preliminary design have now been very satisfactorily resolved as a result of some excellent ideas and careful analysis by many members of the PEP group.

Although a great deal of work has thus been done conceptually and on the drawing board, we have not yet had enough experience with actual construction to be able to test the realism of our cost estimates. SLAC has enjoyed an enviable record of completing its construction projects on schedule, within the technical specifications, and within assigned budget; we do not plan to make PEP an exception to this rule. This means that, in these inflationary times, we must retain a substantial reserve of funding for possible future contingencies as we go forward with the job. This conservative approach has the consequence that some ideas concerning possible performance improvements in the machine or possible future facilities will not be acted upon until such time as it becomes clear that the budget can bear their added costs.

I fully realize that the general picture I am painting here has many contrasts. All of the lights are indeed green for proceeding with the PEP project are rapidly as possible. Progress in basic design work has been excellent, and we have been gratified by the cooperation of ERDA and of our AECM in advancing the date at which we can actually begin to move dirt. At the same time we are also under a good deal of pressure to complete and deliver the actual PEP facility, including the initial complement of research equipment, by early 1980--or sooner! And this is true even though a number of the necessary decisions cannot yet be made because the funding is provided only on a year-by-year basis, and also because--as a matter of prudent management--we must hold on to a strong contingency reserve at this early stage of the work.

E. A LOOK TO THE FUTURE

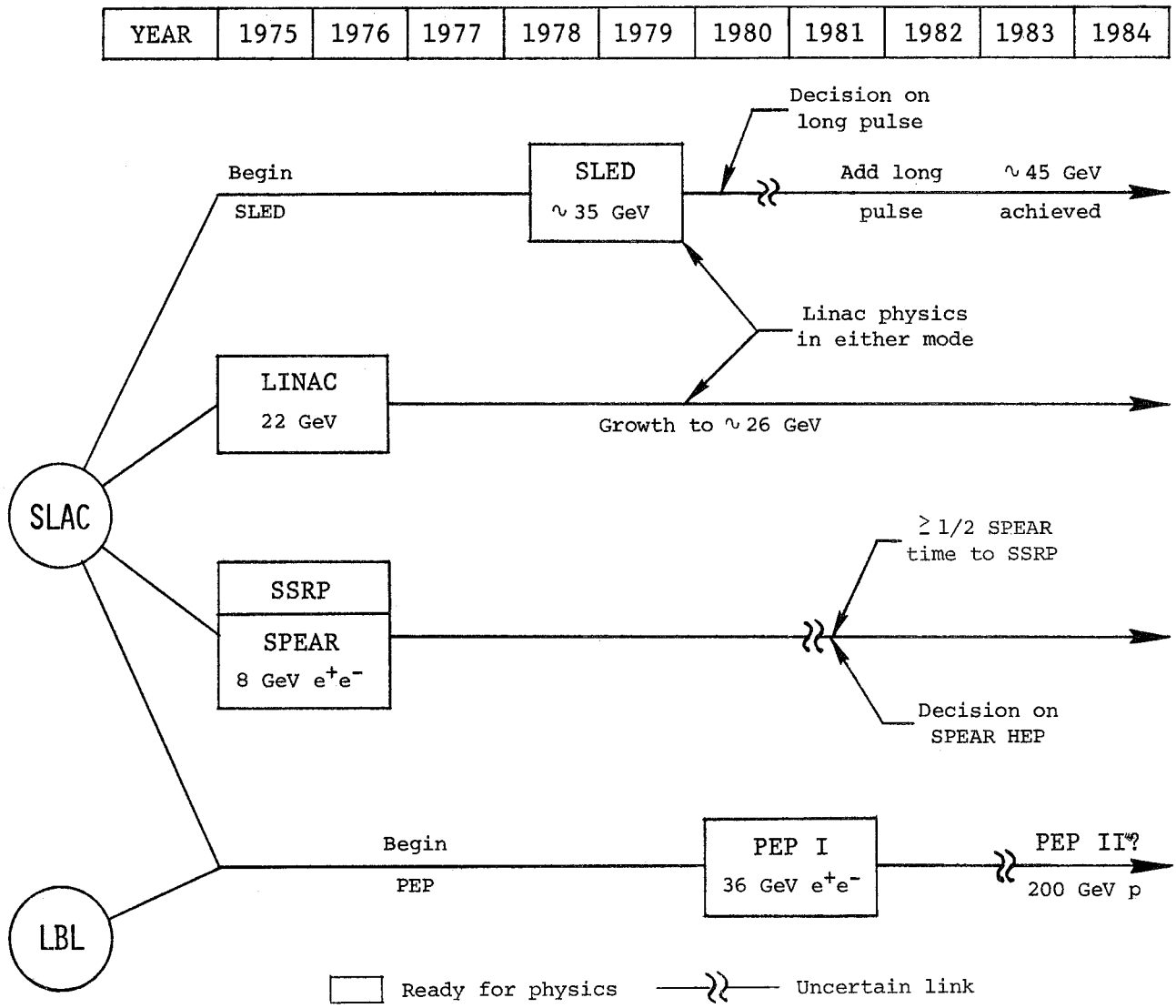
1. *The Prospect For 1980*

These considerations lead me to the principal question that we are now being asked over and over again: How is SLAC going to operate in the year 1980, once PEP is completed? Let me begin to answer this question by showing you, in Figure 5, a chart which indicates the planned directions for SLAC's future growth. This chart has been refined slightly but not basically changed from the similar chart I showed you in last year's talk. As you can see, our intention is to maintain a vigorous program of research in both the "linear" and "circular" sides of the house. The present SLED program will result in a significant increase in the maximum beam energy that can be achieved by the SLAC accelerator, and this will open up a number of new experimental opportunities. The accelerator will continue to serve as the injector for SPEAR, and eventually for PEP.

I should also point out that the Stanford Synchrotron Radiation Project, SSRP, appears to have a very promising future. The President's proposed budget for FY1978 contains $2.8 million that is specifically earmarked for expansion of SSRP facilities, and an additional $2.8 million has been proposed for the following two fiscal years. SSRP presently operates as a "by-product" of SPEAR--that is, the SPEAR operating parameters are determined by the needs of the high energy physics experiments, and these are often not the optimum conditions for the experiments at SSRP. However, there is a tentative agreement that, once PEP nears its full research operation, at least 50% of the running time at SPEAR may be used exclusively for the work at SSRP.

Although it is our intention to continue

Figure 5--PLANNED DIRECTIONS FOR SLAC GROWTH



our program along all four of the lines that were shown in Figure 5, at the present time I am simply not able to predict the mixture of activities or the relative emphases that will occur so far into the future. The activity pattern beyond 1980 will of course depend quite strongly on the funding levels at that time. It will also depend just as strongly on the willingness of individual physicists to make the devoted effort that is needed to plan and prepare for experiments along each of these lines of research. As I noted earlier, more proposals for PEP experiments have been and will be received than can possibly be accomodated. It may be that those physicists whose PEP proposals are not accepted will reappraise their interests and turn to the other areas. However, such reappraisels will not occur until after the decisions on the initial PEP facilities have been made in June of this year.

Let me summarize the prospect for SLAC's experimental program in 1980 and beyond in the following way. Although I cannot predict in detail how the program will be divided among the SLAC accelerator, SLED, SPEAR and PEP, I am fully convinced that the *total* program will surely be at least as large as the present research activities at SLAC.

2. Manpower Planning For FY1978

Obviously most of you will be interested in how the future funding picture for FY1978 relates to you. How much of our support will be directly available to SLAC? What effect will it have on the employment prospects at the Laboratory? And so on. Again, for the reasons discussed earlier, I cannot give precise answers to these questions. However, let me try to make a general estimate of what will happen in FY1978 by making the following assumptions.

(a) Operations. The proposed operating funds for FY1978 represent an increase in actual purchasing power of about 2% over the present year. Let's assume that half of this increase will be used to expand the utilization of the accelerator, while the other half will be used to remedy some of the deficits in maintenance work that have accumulated in recent years.

(b) Special projects. In this case I shall assume that the SSRP expansion program and construction of the new SLAC main power substation will require engineering support from SLAC.

(c) PEP research equipment. Although this situation will not become clear for a number of months, I shall assume here that half of the funding for the initial complement of PEP research equipment will be spent through SLAC.

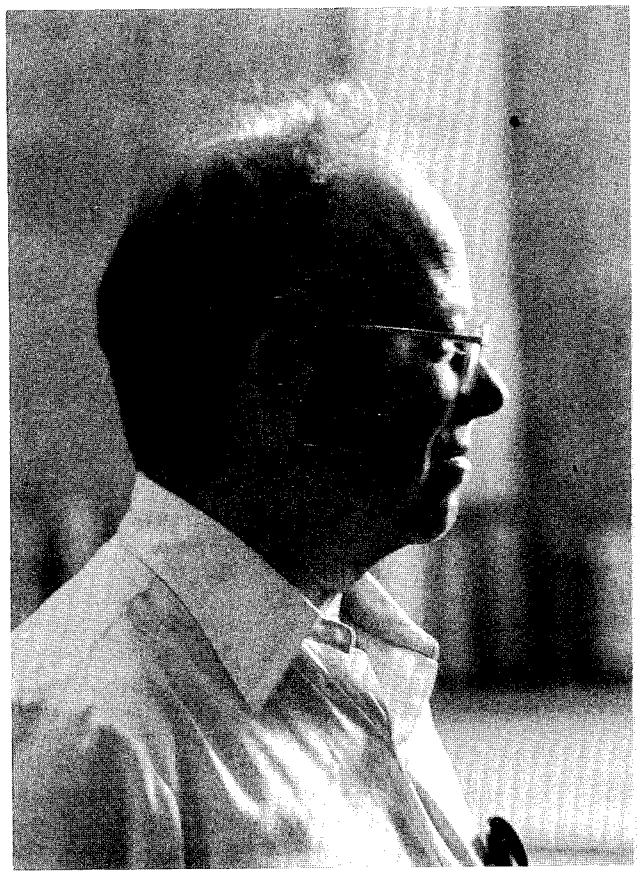
With these assumptions, my best guess is that the SLAC headcount will be increased by about 90 persons during FY1978 relative to the present year. However, let me emphasize again that this projection is very uncertain because it depends upon many decisions that have not yet been made and many factors over which we do not have any control. For example, I cannot now determine what fraction of the PEP research apparatus will be built at SLAC, at other laboratories, or by industry. Nor do I know how the SLAC research program will be divided among experiments done by SLAC groups, by collaborations, or by independent outside user groups. Therefore, although I am willing to project that there will be some increase in the number of job opportunities at SLAC during FY1978, the actual number of such jobs may well turn out to be very different from my "guesstimate" of 90.

I am also not in a position to forecast how any headcount increase would be distributed across the different skills at SLAC. In fact, I cannot even provide any assurance there will not be dislocations that require staff reductions in some areas, even while other areas may be increasing.

F. SUMMARY AND CONCLUSION

In this talk I have been trying to paint as realistic a picture of our future as I know how. The general situation looks exceedingly favorable--in fact, let me say that in this uncertain world of ours it is hard to imagine an area of truly basic scientific research in which the prospects look any better. But we cannot expect to have the future work of our laboratory be exactly predictable. After all, to demand future certainty when the central purpose of our laboratory is to explore the unknown would surely be inconsistent!

Let me close this talk by thanking each of you personally for the hard work that has made our favorable situation possible. Let me also mention that the success of our work has had an impact that has spread out in wider and wider circles in this country and throughout the world. When SLAC first began, our experimental program, though supported nationally, was pursued by only a relatively small fraction of the physics community. However, as a result of the remarkable outburst of discoveries during the last few years, the main interest of particle physicists has now switched over to the study of the interactions of electrons and other related particles that constitute the backbone of SLAC's activities. Thus participation in our work through the very interest generated by its results has now become truly national and even international in scope. The international aspect is emphasized by the fact that the roster of physicists who are responsible for many of the recent results is difficult to read without a pronunciation guide that covers many different languages. One of the things I am most pleased about is the fact that we have strengthened our bonds with scientists from many countries in Western Europe, from Japan, Israel and the Soviet Union, and now also from the People's Republic of China. This enhances the hope that a common interest in a deeper understanding of the basic nature of matter--truly a fundamental aspiration of man--will become one of the factors that will make this a more peaceful world.



--Photo by Joe Faust