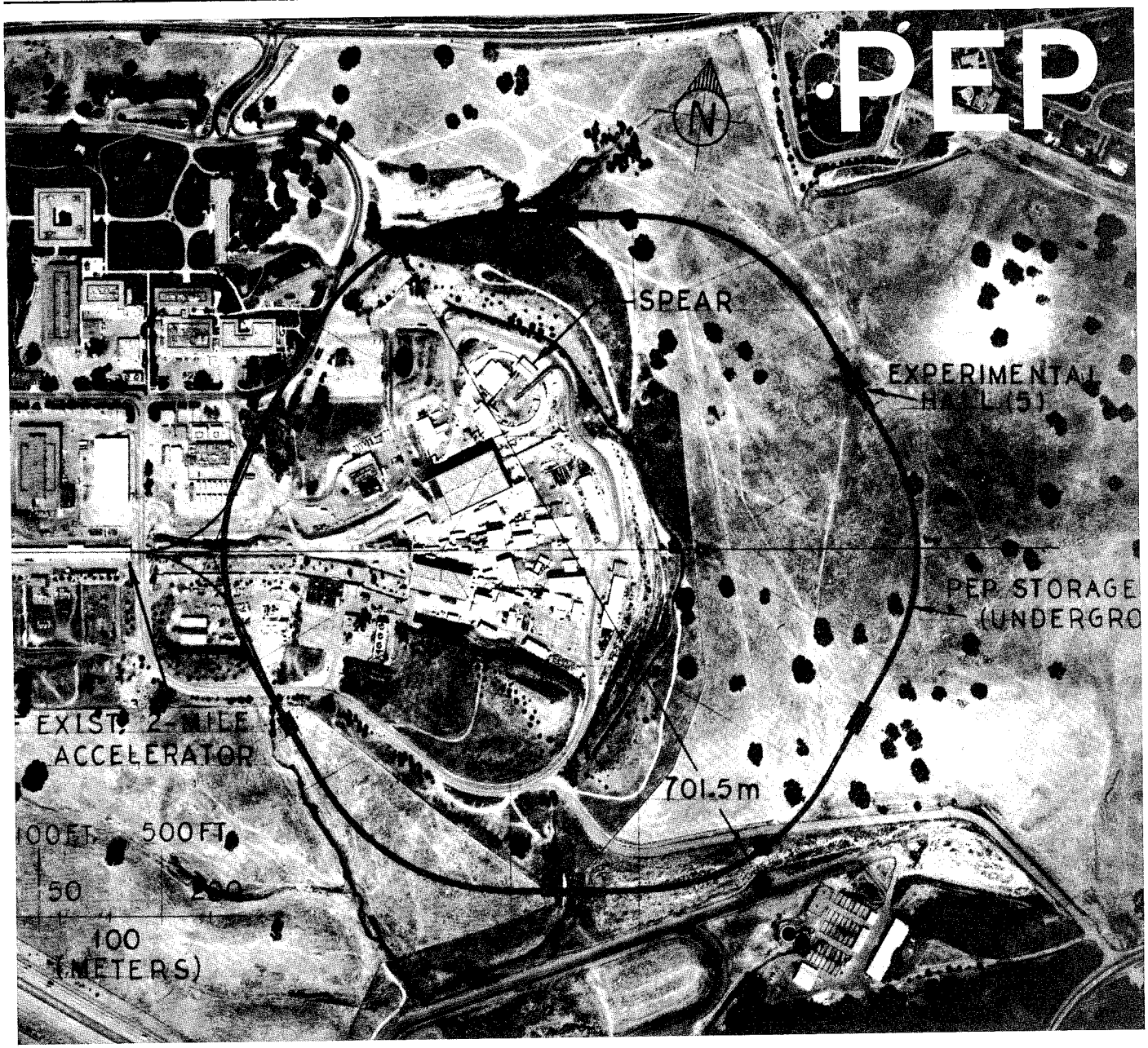
SLAC BEAM LINE

"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 7, Number 2 *February 1976*



CONTENTS

This is the written version of the talk presented by the Director to the SLAC staff on January 22. It describes recent achievements at SLAC, prospective funding levels for the coming fiscal year, and future plans, including the beginning of construction at SLAC of the joint SLAC-LBL storage ring project PEP.

BILL DIVITA FINISHES FOURTH IN NATIONAL AAU 50-MILE RACE

Note: On October 25, 1975, SLAC Storekeeper Bill Divita went to Seattle, Washington, to compete in the National AAU 50-Mile Championship race. He finished fourth in this event, an excellent achievement for which he received a trophy and an AAU championship medal. Many long hours of training go into the preparation for such an event. Bill usually puts in more than 100 miles a week of running, a regimen that continues for months at a time. He is also much concerned with the proper diet, which in his case is wholly vegetarian and is centered around fruit, nuts, bread, rice, vegetables and raw milk. Bill sometimes quotes the famous Olympic champion Emil Zatopek on the subject of long-distance running: "If you want to race, run 100 meters. If you want an experience, run a Marathon." The following paragraphs are a description that Bill himself wrote of his experience in the recent race in Seattle.

--Ken Moore

It was a cold, rainy morning in Seattle on the day of the National AAU 50-mile championships. As the participants arrived one by one in the parking lot, they stayed huddled in their cars, protected from the freezing wetness and unconcerned about loosening up for the event. Eventually, the organizers of the race arrived, set up a tent, and began to register the runners.

When the rain eased up slightly, I ventured out to do some easy running. I had taken my first day off from running in over three months just the day before, and I was curious to see if I still remembered how. It's not really clear to me that there is any need to warm up in preparation for a 50-mile race.

The race course was laid out around the perimeter of Green Lake, and it measured a three-mile loop. So it was 16 times around plus two miles for the full distance. At about 9:15 AM the gun sounded to start the race, and the 20 to 30 entrants took off.

The mind quickly represses unpleasant experiences, but I do remember much of what occurred. The first 20 miles passed by fairly easily and uneventfully, although I wasn't really able to get warmed up until about 15 miles from the start. After 20, the inevitable stiffness began to set in. I passed through the marathon point (26+ miles) in three hours and 14 minutes, and about that time I was beginning to become aware of fatigue. At 30 miles, then at 35, I was still hanging in there, although my times for the 3-mile laps were then a minute or two slower than they had been earlier.

As the race went on, the runners became widely separated. The eventual winner, a man

named Jim Pearson, was far out ahead. (He set a new American record in this event.) I ran most of the first 42 miles with Don Kirby of Arcata, California, before he fell back with leg cramps. He still held on to finish 11 minutes behind me.

At one point in the race Kirby stared at me and said, rather matter-of-factly, "You know, Bill, you look like hell." But not wanting him to know that my outer appearance was an accurate projection of my inner feeling, I just answered by picking up the pace a little.

If there was an advantage to the cold, wet weather, it was the fact that I didn't have to stop for a drink until the later stages of the race. I dreaded those eventual stops, though. The extreme fatigue became most noticeable during the 15-second pauses to drink a cup of water. My rhythm was completely thrown off by the pauses, and afterward I would have to jog a short way before I could regain my natural running form.

One of the highlights of the race for me was the fact that Dave Cuthiell, a former visitor to SLAC from Cornell University and also a very good friend, came down from Edmonton, Canada to offer his encouragement and support. Dave also ran the final 11 miles of the race with me.

As I entered the last two miles of the race the clouds opened up with a heavy downpour, and it became decidedly colder. I became concerned then that I might become the victim of leg cramps. But as the last quarter-mile approached, the sky began to clear for the first time, and the sun beamed down upon the lake. After six hours and 27 minutes of running I finally crossed the finish line. Even though I had finished fourth in this national championship, there was no particular feeling of joy or elation, just fatigue and stiffness and a desire to lie down on the grass and sleep.

--Bill Divita

SCIP'S ULTIMATE

"It's a combination of artistry and technical proficiency."

"It's 60 seconds of near work relying substantially on team spirit."

"For us, now, it's no longer a case of clear and pull, but what goes on in between. That's the real charge, the ultimate. I mean, what's left after that? I guess you could say that for us, at least, falling through 12,000 feet of space at a maximum velocity of 120 miles per hour has got to be the closest thing to freedom that you can experience on this earth."

I was listening in awe to Clarice Garrison (shown in the photo above) and her husband, Skratch, over a pitcher of porter at The Goose. They were discoursing soberly and matter-of-factly, but with enthusiasm, on one of their many hobbies.

Clarice, a 120-pound dynamo, recently joined SCIP as a senior systems analyst to head the Administrative Data Processing Group. She is responsible for all administrative data applications processed on the IBM 360/370 triplex computer system, including the SLAC payroll. You may have gathered by now that she and her husband are avid skydivers. Clarice has made nearly 1100 jumps and has clocked over 13 hours of free-fall. For Skratch the free-fall figure is closer to 20 hours.

"Of course, you aren't free at all," Clarice continued. "You are more bound to terra firma than ever, just as though you had your feet planted squarely on it. But for awhile there you'd never know."

"You can mess up, also," Skratch said. "It's like anything else: surfing, skiing, climbing. Skydiving has its own official regulations and safety standards. Go beyond those rules and standards and you're likely to wind up in a duster!"

"When you're falling through space like that," Clarice continued, "even though you've done it a thousand times and you drill in your sleep, it's difficult to say what really goes on in your mind. All I can say is that I know what I feel. All my adrenaline gets converted into excitement and the most Godawful feeling of exhilaration."

(Continued on next page)

Clarice's skydiving career has been spectacular. It began in college, at North Carolina State University, just trying a few jumps for kicks. Then she met her husband, Skratch. He became her instructor, and still is. Her career includes numerous television commercials: Sunoco, Alcoa, Sheraton Hotels; a skydiving role in "The Star Spangled Girl," standing in for Sandy Dennis; a role in "Mod Squad"; and a free-fall pose for the magazine ad "What I have to do to earn my Canadian Club." She has also appeared in the ABC Tuesday night movie of the week, "The Girl Most Likely To . . ." Then there was the U.S. Industries' fashion ad at Yuma, Arizona, and the Phillipines Aviation Week where she was a guest of the Phillipine CAA. She jumped all over the islands and also in New Zealand.

Since the Garrisons have moved to the Bay Area, Clarice has found a new challenge: the seemingly insuperable task of getting out the SLAC payroll. However, once the paychecks have been delivered, Clarice and Skratch can be found on most weekends hanging around the drop-zone of the Pope Valley Parachute Ranch in their jump suits, waiting for the next "load" to "manifest."

On the way home that evening, I wondered how far it was to Pope Valley. I have since found out.

--Patrick Brendon Colgan

CAMAC MICROPROCESSOR

The unit shown below is a CAMAC microprocessor crate controller designed by the Electronics Instrumentation Group of SLAC's Experimental Facilities Department. This unit has the power, but not the speed, of a small minicomputer. It is designed to carry out relatively slow control and data-logging functions--for example, running motors or valves, measuring temperature and pressure, generating Cathode Ray Tube displays for an operator, and so on.

Dan Porat and Helmut Walz were instrumental in the design of this and related equipment. Paul Arechiga and Fred Rosche were responsible for fabrication and testing.

The microprocessor itself is a single integrated circuit chip, but the complete device also requires a non-destructive program memory (PROM) as well as a fast random-access memory (RAM) for data manipulation or arithmetic operations. It also has a fast direct memory access (DMA) mode for use where high speed data movement is important. The memory bus is expandable up to 64K 8-bit memory words.

The unit shown is fairly complex, since it also contains all the normal features of a CAMAC crate controller, which can access as many as 24 separate functional modules. Just to make things a little more interesting for all concerned, these modules themselves could also contain a microprocessor!

--Ray Larsen

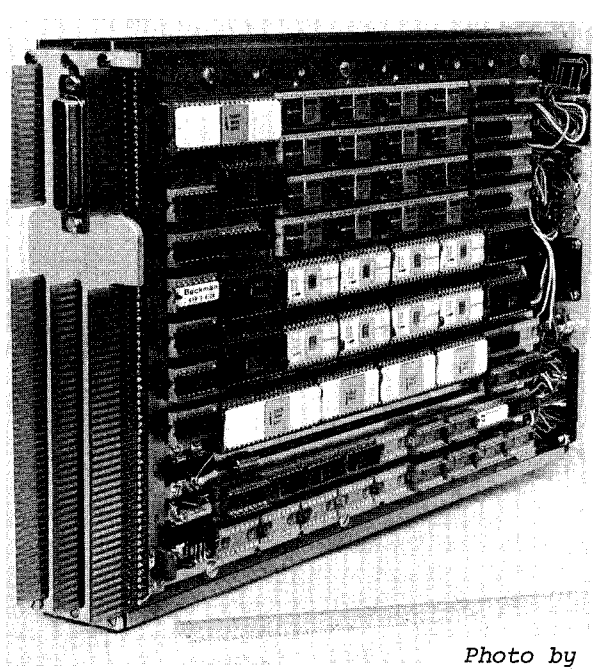
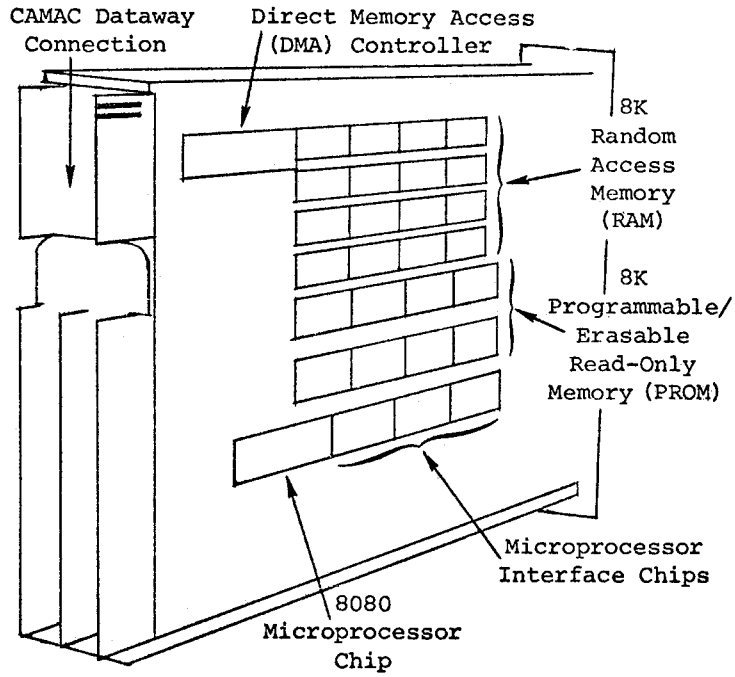


Photo by Dick Muffley



A CHIP OFF THE OLD COMPUTER

There was a time when the idea of giving someone a digital computer as a present would have seemed totally absurd--My how times have changed! This change has been brought about by the vast reduction in both the size and the cost of a new breed of digital computer that is known as a microprocessor, or "computer on a chip." Digital computers have been used for many years by government and industry for data processing, control and scientific calculation. Several years ago, when solid-state circuits had become more compact, one immediate result was the boom in small electronic hand-held and desk calculators. These machines were in fact the first generation of what we now know as microprocessors.

The prices of the simplest hand calculators have just recently broken the $10 barrier. Yet not more than two years ago, machines with similar capabilities were selling for $100 or more. The same pricing trend is evident in the microprocessor market.

Just about a year ago, the world's first computer store opened its doors to the public in West Los Angeles. Now the Bay Area has at least three such retail outlets that sell computers as hobby items. One store that recently opened on the Peninsula sold out its initial stock of small computers in less than two weeks.

People are interested in these machines for all sorts of uses: mathematical computation, writing programs, composing music, building small special purpose systems for business or industry, or just plain enjoying a new toy. (Remember that the price of the toy is proportional to the age of the boy.) There is now a home-brew computer club at SLAC which meets every second Wednesday. Ideas are swapped on programs as well as on hardware--the physical interconnections of the electronics chips that perform these amazing functions.

The prices of "chip sets" and of the computer kits that are offered by several manufacturers are continuing to decrease significantly. Six months ago the Central Processing Unit chips (the heart of a computer) were selling for $200 to $400, while today there are better chips available for prices in the $25 to $50 range. Computer kits or completely wired computers are being sold by several companies for $150 to $600 and up, depending on their complexity. An interesting fact is that the more expensive kits seem to be selling just as fast as the simpler ones. It seems evident that the computer hobby is taking a strong hold on the interest of many different people.

With the large potential market, fierce competition has begun to develop in the microprocessor field. I know of at least a dozen kits, chip sets and complete units that are presently on the market. One of early manufacturers of these units was the Intel Corporation of Santa Clara. This company has been followed by many others, quite a few of which are located along the strip from San Francisco to San Jose that has come to be known as "silicon gulch."

One of the least expensive kits presently available, the Motorola 6800, sells for $150. It is a collection of chips and a printed circuit board on which to mount the parts. The assembled kit will not do a thing until you write and enter a program in its memory. Communication with the unit is via a teletype, or through the use of a built-up keyboard and special adapter that displays the printed characters on your home TV set.

The MITS 680 is a very popular kit that sells for just under $400. With the addition of a teletype, it provides quite a respectable system. The basic unit has 1000 8-bit words of read-only memory, and also has provisions for plugging in preprogrammed read-only memories that contain simple programs to allow the user to write, enter and run his own programs.

Lenny Shustek of SLAC's Computation Group expresses his active interest in this field in the following way: "Microprocessors and feet have much in common. Be good to your feet--remember that they outnumber people two to one. The ratio for microprocessors will probably be ten to one!"

I would like to add to that the following note: "Microprocessors are habit-forming and may therefore by injurious to your health--from lack of sleep." All in all, these small computers seem to be one of the newest and fastest growing hobbies that has come along in quite a while.

--Warren Struven

The "PSIONS" [From an article by Walter Sullivan, *New York Times*, Jan. 1, 1976.]

MASS [GeV]	TYPE	WHERE FIRST DETECTED	COMMENTS
4.45	Vector Meson	Stanford	
4.1	Vector Meson	Stanford	Evidence hints at 2 or 3 particles of almost identical mass
3.7	Vector Meson	Stanford	
3.5	Meson	Hamburg	Stanford suspects another at 3.41
3.1	Vector Meson	Brookhaven & Stanford	The original discovery in 1974
2.8	Meson	Hamburg	Not yet confirmed elsewhere

A HISTORY OF SERA

The SLAC Emergency Relief Association, SERA, is SLAC's home-grown charity; most of its supporters are SLAC employees. Its beneficiaries are the people for whom SLAC employees might "pass the hat." Next June SERA will be eight years old, and a little reminiscing is in order.

SERA was conceived in tragedy. In March, 1967, Chris Schmierer of Drafting--a working mother with four children--was involved in an automobile accident that left her paralyzed and unable to work. As though that were not enough, the other driver (who was at fault) had no insurance. Not only was a large hat needed, but it would also have to be passed again and again. Thus the idea of an enduring charitable organization slouched toward Administration to be born.

To be charitable, philanthropate; to be tax-exempt, incorporate. So after considerable legal shuffling and delay, SERA was incorporated on June 7, 1968. The first Directors were Bill Lusebrink, President; Al Berkman, Vice-President; and Bernie Lighthouse, Secretary. Krys Ciolkosz was appointed Treasurer that year--and every year since!

On August 12, 1968, Win Field, who had done most of the legal work, contributed $5 to SERA, and it was off and running. In September, nine other persons joined, and in October the first payroll deductions were received. At the end of October, the first SERA grant was made: $155 for rent money for a SLACer who had had a little bad luck. The second grant, in November, went to a medical equipment rental for Chris. To date, about 24% of SERA's total grants have been made on Chris' behalf.

The largest single contribution to SERA was made by the SLAC Ski Club at the time it disbanded. This was followed closely by a contribution from a visiting Russian physicist, who turned over to SERA the honorarium he had received. Two benefits also helped SERA, one a songfest, and the other a talk by Alex Tseng in which he described his trip to China. Aside from these unusual sources of funds, SERA's income runs about two-thirds from the payroll deductions of its members and one-third from interest on capital.

Meanwhile, back at the Internal Revenue Service, the battle raged on . . . First the IRS objected that SERA might help only its own *members*. Then, after receiving reassurances about that (only two members have ever received grants, although some grantees have subsequently become members), the IRS balked because the grantees might all be SLAC employees. Three years later, the IRS finally granted exempt status, with the proviso that all concerned must read the the Internal Revenue Bulletin to find out if the exemption were ever withdrawn. What a way to sell subscriptions! After one more year, in October of 1972, the Washington office of the IRS granted

SERA's incumbent Directors, left to right: Secretary Alan Nuttall, Vice-President Glena Stewart, and President Ed Keyser. *(Photo by Glenn Hughes.)*

tax exemption over the objections of the San Francisco office, but with one or two conditions . . .

One of the IRS braches managed to switch two digits in SERA's identification number, so that mighty computer in the sky decided there were two of SERA and thus sent everything in duplicate. The computer grew gradually paranoid at what it felt were our efforts to hide one SERA from it. Not to be outdone, another of the IRA branch offices decided that SERA's plea for tax exemption had failed and thus sent SERA an income tax bill for $51.97. During 1972, SERA found itself corresponding desperately with IRS offices in Washington, Philadelphis, Ogden, San Jose and San Francisco. There was eventually a wild celebration when the offending office not only refunded the $51.97 but also had to contribute an accrued interest of $1.12!

And then came Case #12. It seemed straightforward: both the applicant and her husband had been working at SLAC and following Parkinson's Second Law--expenditures rise to meet income. Then he was laid off, and the bills began to pile up like lint in a Maytag. Their house mortgage would have been foreclosed unless three delinquent payments were made--so SERA put up the funds to pay them. But then suddenly the layoff became a holy war, and SERA found itself being criticized on bulletin boards all over SLAC because it had taken care of only what it had determined to be the emergency, which was just one layer of the lint. But that was minor compared to the criticism from some of the SERA members themselves, who felt that *any* grant made to the owner of a big car and a color TV was too much. This caused 130 (about one-third) of the members to resign in protest. Another one-third were doubtful but accepted the fact that some grants would be controversial. (If you draw the line at a color TV, would a sick set that showed only red

(Continued on next page)

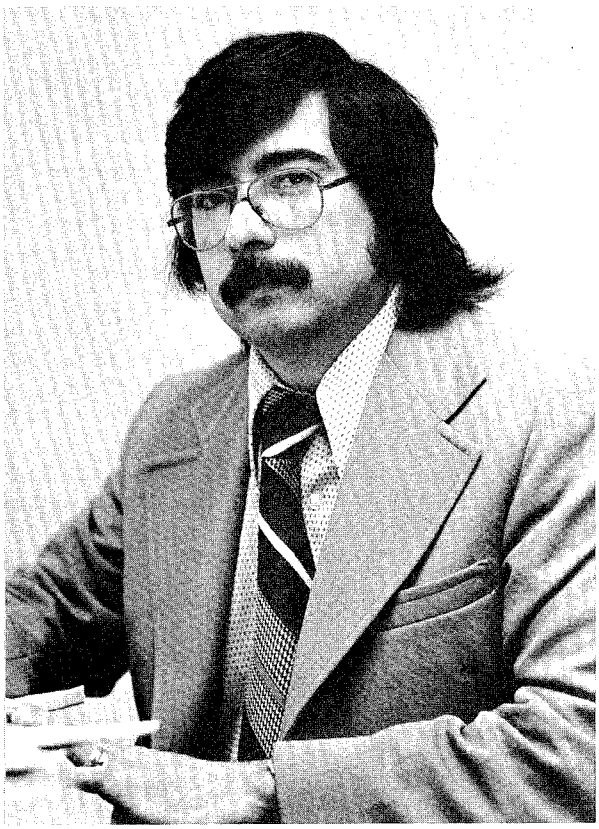
be OK?) The last third of the members doubled their contributions, and maybe they were right; the Case #12 couple are both still SLAC employees, both have learned new skills, and both have been promoted--not a bad ending.

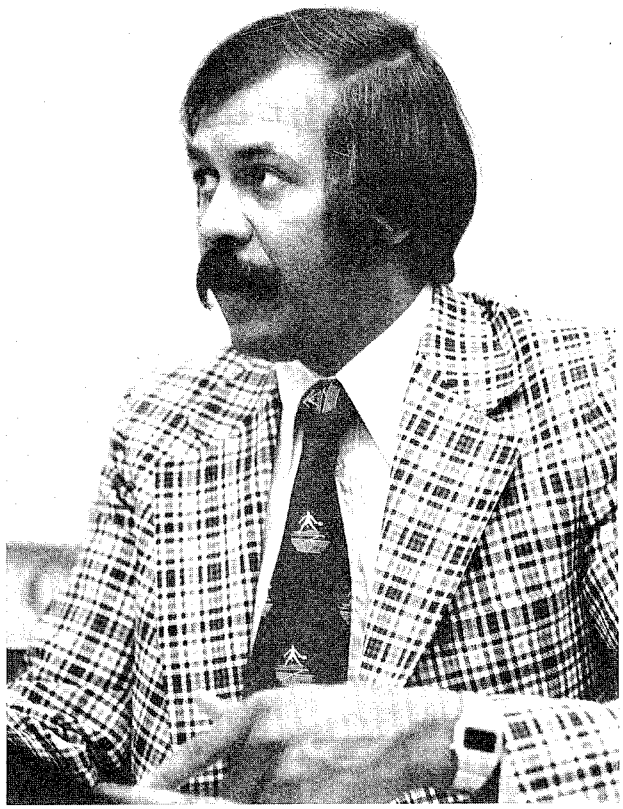
The creation of the SLAC Loan Committee has reduced the SERA case load. Since SERA cannot make loans, any unfortunate who could not convince the Credit Union that his credit was good had to get a grant from SERA instead. But now the Loan Committee takes care of many of these cases.

After five years of operation SERA finally reached its goal of a $15,000 reserve. And then came the move that sent the community into shock: SERA asked its members to please reduce their contributions! Not only has SERA operated with expenses of less than 1%, but when have you ever heard of a charity that turned down a dollar?

There is still a problem, however. SERA is now down to only 170 members. It doesn't need the money that additional members would bring; in fact, if this appeal multiplies the membership (as we hope it will), SERA will probably again ask for a reduction in contributions. But what SERA definitely does need is more SLAC people who are interested and involved. How many more. Well, why not everyone at SLAC? SERA is not a part of SLAC, but it is a part of the community of SLAC people, and the more of you who join the better will SERA operate. And besides, it makes you feel good.

--Charlie Hoard





SLAC'S NEW AFFIRMATIVE ACTION OFFICERS

Armando Venegas, left, is SLAC's new Affirmative Action Officer, and Carl Banks, right, is SLAC's new Associate Affirmative Action Officer. Both joined the SLAC staff in mid-January. The Affirmative Action Office is in Room 231 of the A&E Building, mail bin #10. The AAO phones are ext. 2967 and 2968. *(Photos by Joe Faust.)*

Plant Thief: An asparagus fern, two poinsettia plants, and a macrame plant holder have been stolen from the EFD offices in the A&E Bldg. during the past two months. We hear that the Library in the Central Lab is also missing some plants. Are we harboring a kleptomaniac with a penchant for plants at SLAC?

--EFD Office Staff

The universe is not to be narrowed down to the limits of the understanding, as has been man's practice up till now, but rather the understanding must be stretched and enlarged, to take in the image of the universe as it is discovered.

--Francis Bacon

BOOKMOBILE

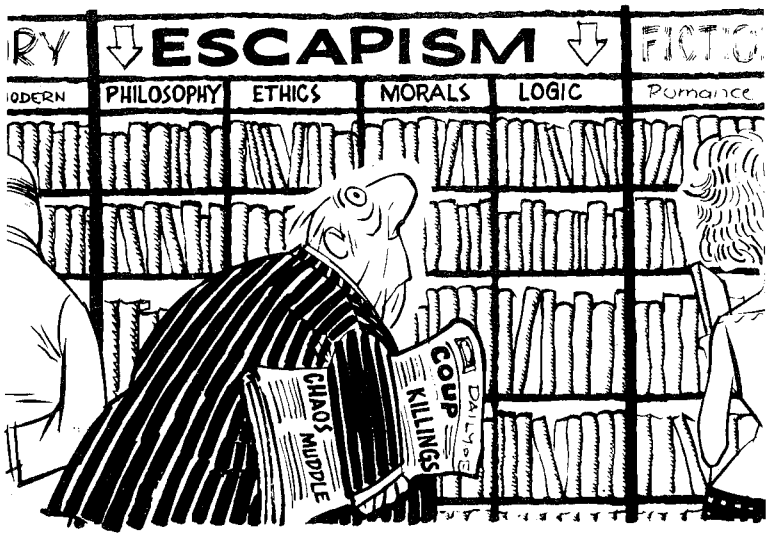
Where? Volley Ball Court
South Test Lab

When? Every second Monday
except Holidays
Noon to 1:00 PM

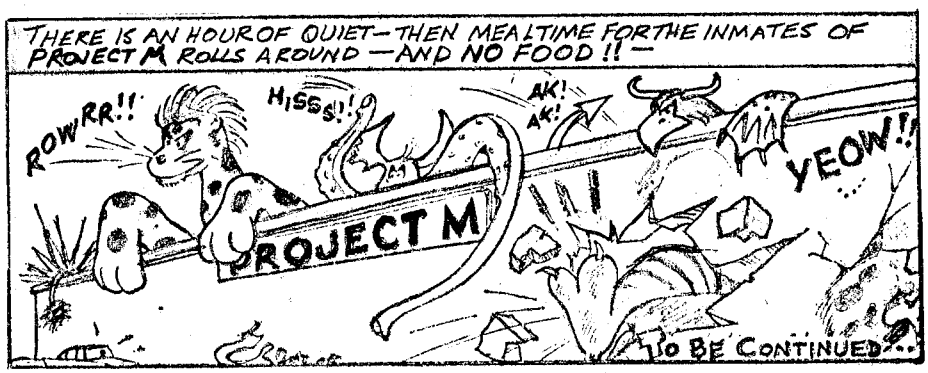
Who? Any SLAC employee
can borrow books

1976
SLAC BOOKMOBILE CALENDAR

Jan 5,19	Jul 5,19
Feb 2	Aug 2,16,30
Mar 1,15,29	Sep 13,27
Apr 12,26	Oct 25
May 10,24	Nov 8,22
Jun 7,21	Dec 6,20



Jensen/The Spectator/London



The project that eventually became SLAC was known for several years as "Project M." Al Capp *(Lil' Abner)* had fun with the name in 1960 by identifying it with an animal cross-breeding experiment. Of the 38 animals who formed the staff of "M" in 1960, it's rather surprising to see how many of them are still around:

PROJECT M STAFF - MAY 1960

Brady, P.	Crabtree, A.M.	Jasberg, J.H.	Mallory, K.B.	Pindar, F.V.L.
Breymayer, K.	Dedrick, K.G.	Jesperson, H.J.	McIntosh, D.	Pope, J.A.
Brown, K.	Eldredge, A.L.	Jones, C.B.	Meloni, J.P.	Post, J.
Bunker, F.W.	Edwards, P.C.	Kirk, W.T.	Moulton, R.G.	Snyder, O.
Cain, L.E.	Fowkes, R.	Kraus, O.	Mozley, R.F.	Sonkin, S.
Christie, T.A.	Ginzton, E.L.	Langston, P.	Neal, R.B.	Taylor, E.P.
Chu, E.L.	Goerz, D.J.	Lebacqz, J.V.	Panofsky, W.K.H.	Turner, T.F.
Copenhagen, K.	Helm, R.	Loew, G.A.		

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Stanford University
P.O.Box 4349, Stanford CA 94305

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Walter Zawojski, Bin 70, x2778 }
Ada Schwartz, Bin 68, x2502 — *Production*
Dorothy Ellison, Bin 20, x2723 — *Articles*
Bill Kirk, Bin 80, x2605 } *Editors*
Herb Weidner, Bin 20, x2521 }

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	0-3	6-13	12-11	23-15	31-10	51-33	60-23	66-25	72-3	80-8	86-12	92-3
	1-15	7-2	14-4	24-12	33-17	52-10	61-21	67-12	73-12	81-57	87-8	94-12
	2-8	8-5	15-4	25-3	34-4	53-43	62-46	68-11	74-8	82-12	88-30	95-41
	3-6	9-3	20-16	26-23	40-79	54-30	63-18	69-13	75-17	83-10	89-18	96-15
	4-5	10-9	21-6	27-3	45-6	55-33	64-15	70-7	78-26	84-18	90-4	97-93
	5-3	11-18	22-15	30-48	50-25	56-13	65-25	71-53	79-86	85-28	91-7	99-3

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 22, 1976. Several illustrations have been added to this written version of the talk.

Contents

Continuing what has now become a tradition at SLAC, I am reporting to you on "the state of SLAC" and on our prospects for the future. As usual, this talk follows closely after the official release of the proposed Federal Budget for the coming Fiscal Year. The President's Budget Message to the Congress was presented yesterday, January 21, and it contained much information that is of great interest to all of us at SLAC. The main budget news was made known to you in the "All Hands" memo dated January 21. As noted in that memo, the most exciting news for us is the fact that the Administration is now actively supporting the construction of the PEP storage-ring project at SLAC. Discussion of the implications of the PEP project will be one of the major themes of this talk.

In the talk I gave last January there was both good news and bad news to report. In this year's talk the news is essentially all good. The only exception to this generally bright picture is connected with the effects of inflation, which continues to erode the purchasing power of your dollars as well as those of the laboratory.

A. BUDGET IMPLICATIONS

1. *The Budget Cycle*

As I reported to you last year, the Federal Budget Year is now being changed from its previous July 1 to June 30 period to a new cycle that runs from October 1 to September 30. This new cycle will begin with the Fiscal Year 1977 (FY 1977), which begins on October 1, 1976. This is the period that is covered in the President's Budget Message to the Congress that was presented yesterday. This budget submission will of course not become final appropriations for SLAC until it has gone through a number of steps in both the Legislative and Executive branches of the government. In fact, the main reason for changing to the new, later, Fiscal Year is precisely to provide more time for the Congress to accomplish its complex task of review, authorization and appropriation. For the present year (that is, for the "extended" Fiscal Year 1976, which started on July 1, 1975 and will end on September 30, 1976) the full budgetary process was not completed until December 20--just in time for Christmas.

Because of these many stages of required review and approval, the remarks I shall make about FY 1977 funding should be taken with some caution. The Congress can, and often has, changed funding levels either up or down. During the present fiscal year we have been fortunate that the Congress actually made an increase in the SLAC budget. This was an addition of $2.9 million which the Congress decided to add to SLAC's funding as a first installment on the PEP construction budget, even though the Executive Branch had not specifically requested such funding for FY 1976. This previous action by the Congress is one of the reasons why I am optimistic that the President's recent decision to press forward vigorously with the PEP project for FY 1977 will be fully supported by the Congress.

On the other side of the coin, however, it is less predictable that the Congress will be willing to accept the exact budget levels that are proposed for SLAC's regular operations and equipment funding in FY 1977.

2. *Operating Funds*

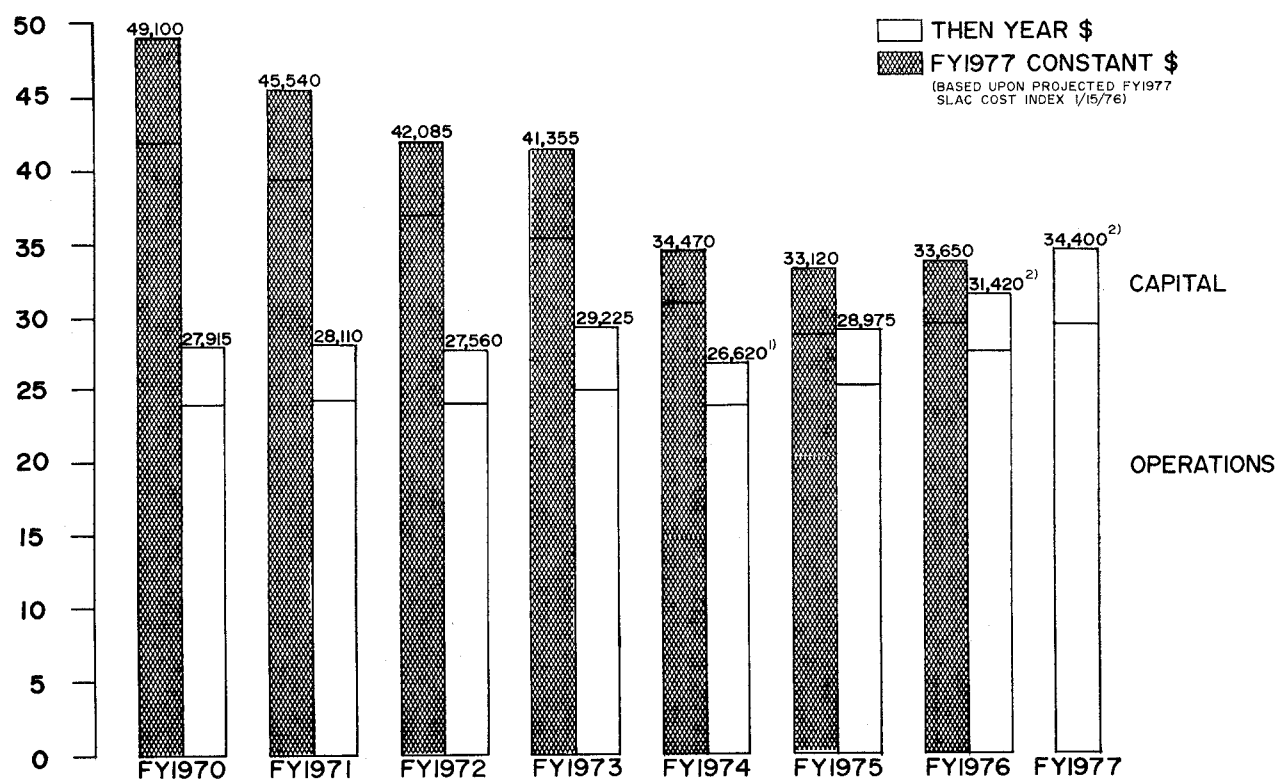
The President's recent budget submission contains a proposed level of operating funds for SLAC in FY 1977 that is larger than the FY 1976 budget, but this increase is almost entirely offset by the effects of inflation. Figure 1 shows how SLAC's operations and recurring capital funding has varied during the last seven years. The information in this figure is given in two different ways: (1) in terms of the actual dollar amounts that were appropriated for each year (called "then-year" dollars); and (2) in terms of constant-purchasing-power dollars with January 1977 used as the base line. The second of these methods of showing this information makes clear the cumulative effects of inflation over the seven-year period. Most of you are probably aware that the level of support for SLAC in terms of actual purchasing power declined steadily from FY 1969 to FY 1975. It is gratifying to note that this downward trend was halted in FY 1976, and that the proposed operating funding for FY 1977 will represent just about the same purchasing power as in FY 1976.

The effects of inflation are felt differently by different individuals and institutions, depending upon how their money is spent. At SLAC we are continually updating what is called the "SLAC Cost Index," which represents the purchasing power of the dollars we spend in various categories--the largest of which, of course, is support of people. Figure 2 illustrates how this Cost Index has changed during the past several years. Preliminary figures for the most recent 12-month period indicate that the effects of inflation have decreased the value of a "SLAC dollar" by about 7%. If this rate of inflation continues during FY 1977, the net effect would be that the proposed operating budget for SLAC in FY 1977 would represent a gain over FY 1976 of only about ½ of 1%.

You may be even more interested in how inflation affects you directly. In the next chart, Figure 3, I show how the average annual wage for all of the members of the SLAC staff has grown during the last few years. The consumer price index for the Bay Area is also shown in the same figure. It may be well to bear in mind certain cautions in examining these curves. First, the consumer price index is a general inflation indicator that does not apply exactly to everyone's family budget. Second, the salary curve is an average over all of SLAC's personnel. In addition, the salary-growth patterns

FIGURE 1

SLAC NOA BY FISCAL YEAR (THOUSANDS OF DOLLARS)

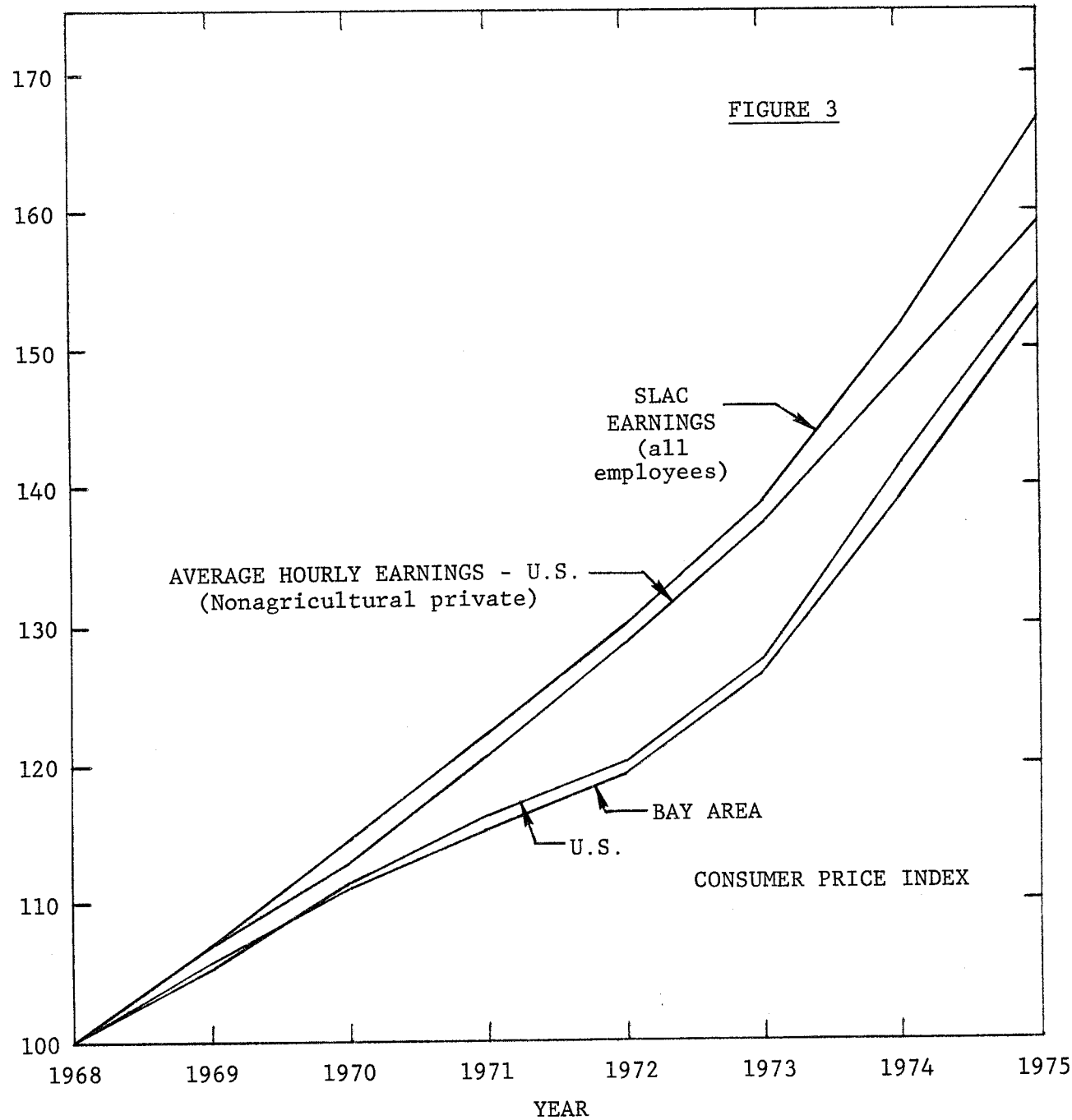


1) EXCLUDES $2,900,000 NOA FOR SLAC COMPUTER BUILDING
2) EXCLUDES PEP NOA AS FOLLOWS: FY1976 $2,900,000; FY1977 $25,000,000

Year	SLAC Cost Index	% Increase
1977 (proj.)	199.2	7.1
1976 (prel.)	186.0	6.7
1975	174.4	13.4
1974	153.8	9.2
1973	140.8	8.0
1972	130.4	6.1
1971	122.9	8.5
1970	113.3	6.1

FIGURE 2

HISTORY OF SLAC COST INDEX CHANGES



shown indicate the combined effects of merit increases, promotions from one classification to another, and general salary increases for whole classifications.

This is not the place for a general discussion of the salary structure at SLAC. Rather, I simply wanted to let you know that we have been making a serious effort to keep up with inflation in providing compensation to all of you who have been responsible for the highly successful operation of our laboratory. I also want to emphasize the fact that it has been necessary, in trying to achieve this pattern of compensation, to devote an ever-increasing fraction of our total funding to the payment of salaries and associated benefits. During this fiscal year, more than 70% of our total operating costs will be directly salary-related; this figure includes direct SLAC payroll costs and the costs of the associated benefits, and also the costs of the Fire Department and of that part of the Stanford Center for Information Processing (SCIP) which supports SLAC's computer operations. It is important to note that *this percentage cannot be increased any further because the remainder has to pay SLAC's increasing utility bill, all of our expenses for supplies and materials, and whatever services we obtain from outside the laboratory*.

To summarize, then, the operations funding for SLAC for FY 1977 is likely to be about the same in actual purchasing power as it is for the present year. You should recognize, however, that in the context of the total national pattern for basic research this is in fact a very good showing. It is somewhat difficult to draw general conclusions about the funding of basic research as proposed in the recent budget submission to the Congress. The national support figures for basic research contained in the President's Budget are hard to analyze because the boundaries between what SLAC is doing--namely, basic research aimed at understanding nature on a deeper and deeper level--and research endeavors that are specifically directed toward more current problems are very difficult to draw. Nevertheless, I can assure you that our field of study, high energy physics, has fared relatively well within the whole picture, and also that SLAC has done reasonably well within the total high energy physics funding. To a very large extent this favorable pattern is a consequence of the recent series of remarkable discoveries in high energy physics--discoveries in which SLAC has played an exceptionally important role.

Partially because of these new discoveries, the pressure upon SLAC to provide services to the total User community of high energy physicists has grown and will continue to grow. Given a funding level that is approximately constant in terms of real purchasing power, the only way in which the requests of the User community for additional support can be satisfied is by somehow managing to "do more with less." SLAC has already had an enviable record of such improvements in efficiency in a number of different areas. For example, the hourly operating costs of such key accelerator components as klystrons, and more recently thyratrons, have been significantly decreased. In addition, accelerator operation with reasonable reliability has been achieved with fewer shift personnel than before; and the bubble chamber operating crew has been able to spread its work to cover the operations of two chambers as well as that of other cryogenic devices such as the Large Aperture Solenoid Spectrometer (LASS).

But there is a limit to how far such stretching and thinning out can be carried. We have had to make do with a skimpy effort in many aspects of equipment maintenance and in other necessary activities. As I mentioned in my talk last year, we are to a certain extent living on borrowed time as far as some of these long-range activities are concerned. A recent and rather striking example concerns the research area "cable plant," the collection of both power and signal cables which feed the the growing number of experimental installations in the research yard. This cable plant has mushroomed in complexity to the point where we have now had to assign extra manpower to the task of organizing and simplifying the maze of wires.

3. *Equipment Funds*

The proposed budget for FY 1977 calls for a total of $3.1 million in Equipment funding for SLAC, which is an increase of about $600 thousand over the present (12-month) fiscal year. This increase is naturally most welcome, but it will still fall a good deal short of the funding that could be very productively used. There are two main reasons for this conclusion. The first is the fact that we have been very hard-pressed for equipment funding in this present year as a result of new experiments that have been proposed for SPEAR and of certain other parts of our work that require elaborate instrumentation. The second reason stems from the fact that some FY 1977 equipment funding will have to be invested in complex research instruments that are intended for eventual use (beginning in 1980) at the PEP storage ring. The long lead times required to design and construct the large and elaborate detection devices that are suited to PEP make FY 1977 initiation mandatory. These two factors place a double squeeze on FY 1977 equipment funding and thus identify it as another very tight equipment year.

4. *Accelerator Improvement Funds*

The FY 1977 budget recently submitted to the Congress calls for Accelerator Improvement Project (AIP) funds for SLAC of $1.0 million. This amount is also an increase over the funding that has been available during the present year, and in fact it represents a substantial fraction of

the total AIP funding that is scheduled for ERDA's high energy physics program. The bulk of SLAC's AIP funds for FY 1977 will be used in the SLED (*SLAC Energy Development*) project that I described to you in last year's talk, and that I shall discuss again briefly later in this talk (Section C.3). In summary, the SLED project will result, sometime in 1978, in an increase in the maximum energy of the SLAC accelerator from the present value of about 22 GeV to approximately 35 GeV. Such an increase will open up very important new experimental opportunities in the areas of high energy, high intensity electron and photon physics in which SLAC has carved out a virtual monopoly position. Because of the excitement associated with SPEAR and with the future possibilities for PEP, we have not been able to pursue the SLED project with the highest priority. However, just because of the monopoly position that SLAC will have in these fields of physics at the higher accelerator energies, there is a very strong incentive to proceed with SLED, even though it cannot be done on a "crash" basis.

During the present year we have essentially completed the design and engineering work that is needed for SLED, and have begun to produce the special radiofrequency components that are required. Some of these components have already been installed on the SLAC accelerator, and the ongoing test program has so far fully verified the expected performance.

During FY 1976 the work on SLED is being supported by a combination of several kinds of Capital funds (Equipment, Accelerator Improvement Project, and General Plant Project) that were diverted from other possible activities. We have been encouraged that the design, fabrication and test work has moved along so well. The anticipated AIP funding for FY 1977 should enable us to continue the present SLED work at about its present rate.

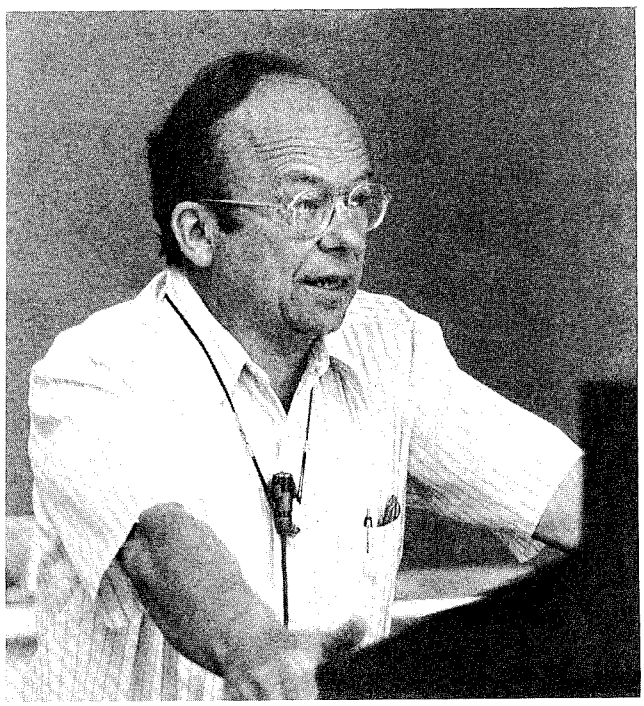
5. *General Plant Project Funds*

As the name implies, General Plant Project (GPP) funds are intended for additions to or improvements of the buildings, grounds, utilities and other facilities that constitute SLAC's physical plant. The recent budget submission for FY 1977 contains a request for SLAC GPP funds in the amount $900 thousand. This figure is again an increase over the present level of GPP funding. Although the prospective SLAC GPP program for FY 1977 has not yet been worked out in detail, it is expected that it will include investments in certain fire-protection and safety systems and in several facility modifications that should prove helpful in the safe and efficient operation of the laboratory.

6. *Construction Funds*

As I noted at the beginning of this talk, the most important piece of good news for SLAC in the President's recent Budget Message to the Congress is the request for construction funding for the joint SLAC-Lawrence Berkeley Laboratory storage-ring project, PEP, to be built at SLAC. The level of construction funding requested for PEP in FY 1977 is $25 million of what is called "new obligational authority." This is very welcome news indeed, particularly in view of the fact that the Executive Branch--faced with all of the strong budget pressures--had not requested that that PEP be funded for FY 1976. (As mentioned earlier, it was the Congress that had taken the initiative in adding the $2.9 million for preliminary PEP work to the FY 1976 budget.) Thus for FY 1977 it appears that both the Congress and the Executive Branch now concur in the view that PEP should move ahead on a rapid and efficient basis.

I shall have some more to say about PEP and its organization later in this talk (Section C.2), but let me reemphasize here that the PEP project now definitely appears to be a reality. With the present construction schedule, PEP should be ready for its initial operation at SLAC sometime in 1980. This new facility at SLAC will open up a completely new range of research opportunities of the highest possible importance. Not only will PEP give us a very healthy prospect for the 1980's, but the facility is also being designed in such a way that it can accommodate possible future growth through the addition of a proton ring to its presently planned "racetrack" for electron and positrons. Thus the beginning of PEP opens up even more new directions of possible fundamental research at SLAC.



SLAC's Director W.K.H. Panofsky is shown during his "state of SLAC" talk to the staff on January 22. *(Photo by Joe Faust.)*

7. *Total Resources*

The total level of funding that is available for SLAC's work in a specific year is represented by a budget category that we call "total resources." This is the total amount of money that can actually be used to pay salaries and benefits and to buy the outside materials and services that we procure. The total resource funding can be divided into two classes:

1. *Operating funds*, which must be spent only during the specific fiscal year for which they are appropriated.

2. *Capital funds*, which include Equipment, Accelerator Improvement, GPP, and Construction projects, and which may be "carried over" from one fiscal year to the next as determined by the requirements of the particular project. Each year's budget contains authority to "obligate" a certain amount of these capital funds, and this obligational authority is generally not equal to the actual costs that are incurred in any given fiscal year.

Because of this difference, it requires some educated guessing about the "carry in" and "carry out" of capital funds to estimate SLAC's total resources for FY 1977 (or any fiscal year).

In Figure 4 I show the results of this guess-and-estimate process for FY 1977, which begins on October 1, 1976. This figure includes an estimate of the effect of the PEP construction work. However, I also want to show you, in Figure 5, the estimated total resources picture as it looks without including PEP construction. At this early stage, I believe that you should focus primarily on Figure 5, which excludes PEP construction, because there are at present very large uncertainties in our projection of what fraction of the PEP construction funds will be spent directly at SLAC. I'll say more about the reasons for these uncertainties a little later (in Section C.2).

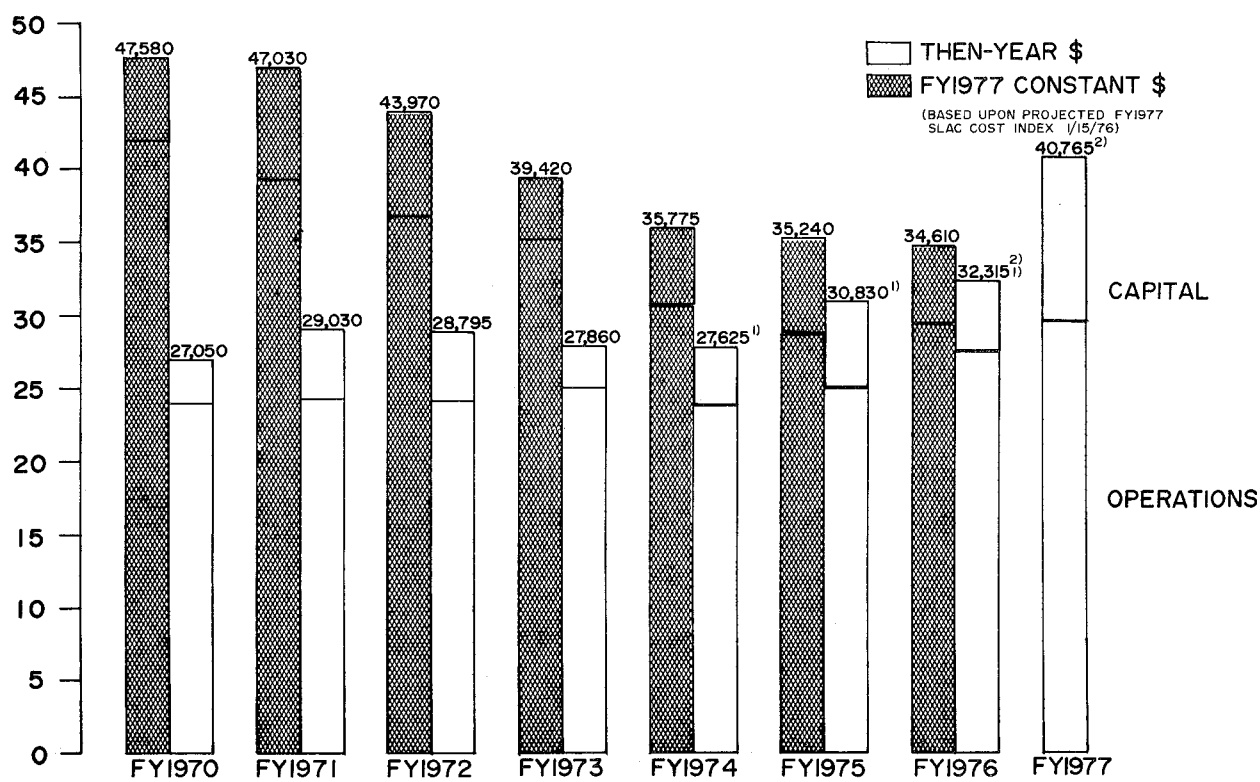
From Figure 5 you can see that, after correcting for inflationary factors, and even leaving out the PEP construction funding, the projected SLAC total resources for FY 1977 are somewhat higher than those available during the present 12-month fiscal year. On the whole, then, this is a rather encouraging picture, and the PEP funding will certainly improve it even further.

8. *Manpower Implications*

I think I can safely assume that you will be

FIGURE 4

SLAC COST BY FISCAL YEAR (THOUSANDS OF DOLLARS)



1) INCLUDES COMPUTER BUILDING COSTS AS FOLLOWS: FY1974 $200,000; FY1975 $2,490,000; FY1976 $210,000
2) INCLUDES PEP CONSTRUCTION COSTS AS FOLLOWS: FY1976 $500,000; FY1977 $6,000,000

interested in what the prospective employment picture at SLAC looks like as a result of the total resource projection for FY 1977. I will try to give a manpower forecast for the year, but before I do so please let me explain why I cannot now be very precise about it. There are several reasons for cautious predictions:

1. The good news that I am sharing with you today is very recent, and there has not yet been time to make a detailed study of the manpower implications.

2. Since the new fiscal year will start three months later than usual, there is more time available for manpower planning.

3. The PEP project is a joint undertaking of SLAC and the Lawrence Berkeley Laboratory (LBL); the construction effort will involve the staffs of both laboratories. We have not yet worked out in detail just how this division of effort between the two labs is to occur. In addition, we do not yet know very accurately what fraction of the work will be "in-house" at either SLAC or LBL and what fraction will be accomplished by sucontracts with outside firms.

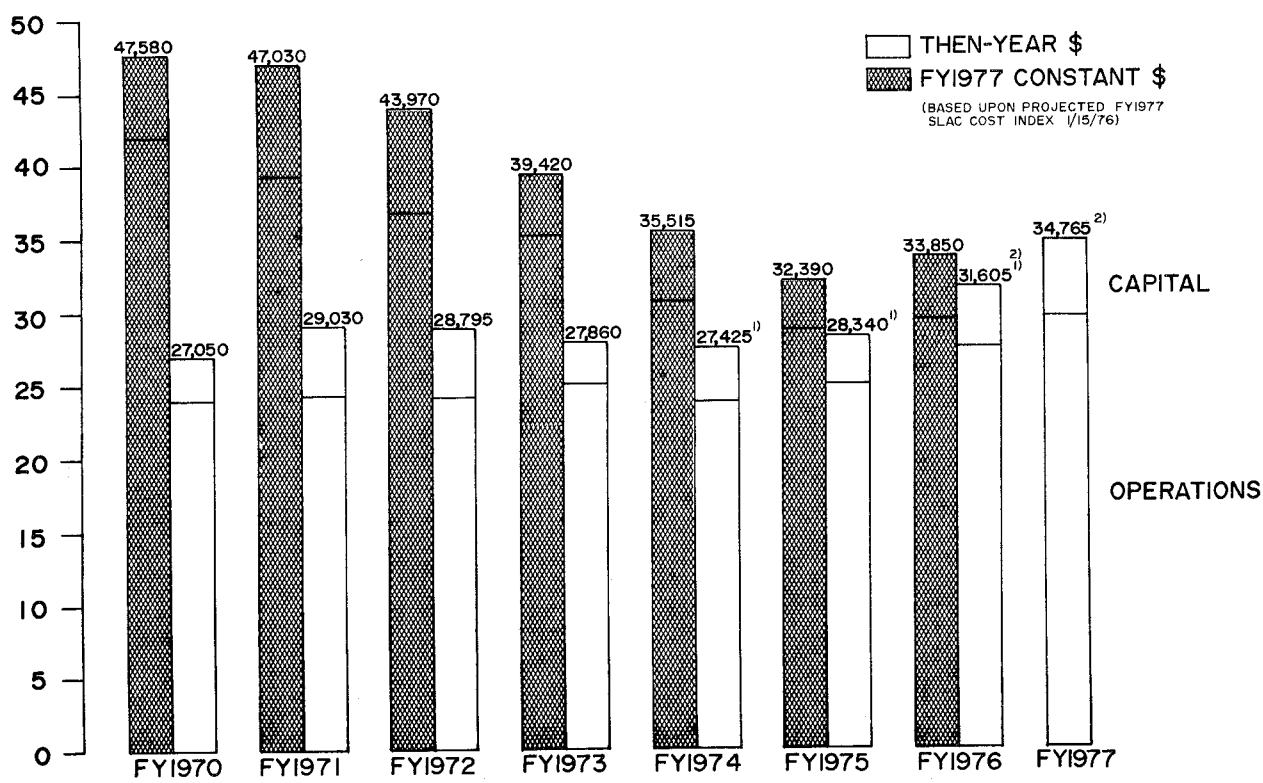
4. I also have to add the usual caution: The funding we have assumed for PEP is that contained in the President's Budget Message to the Congress; future actions by either branch can modify either the amount of funding or the rate at which it becomes available, or both. PEP is a four-year construction project, which means that we are dependent on positive funding actions for several more years by both the Executive and Congressional branches of government.

After all these cautionary remarks, our best present estimate is that we shall have to increase the SLAC staff during the coming year by about 70 to 100 persons--with the bulk of the increase being in the shop categories. As soon as we have had a chance to work up more detailed estimates, we expect to begin a vigorous recruiting effort for these new people.

I think it is important to point out the following fact. Although there will definitely be a significant increase in total SLAC staff during the coming year, I cannot promise that there will not be some required *decreases* in certain selected areas of work. Ours is a dynamic laboratory, and not all of the various technologies that support our work remain equally important over the years. What I can promise, however, is that I will do my very best to try to avoid dislocations.

FIGURE 5

SLAC COST BY FISCAL YEAR (THOUSANDS OF DOLLARS)



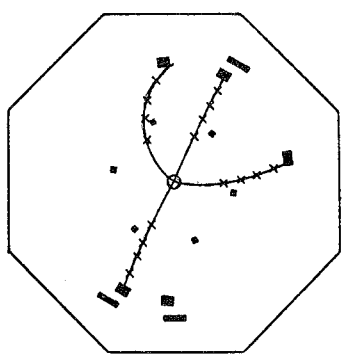
1) EXCLUDES COMPUTER BUILDING COSTS AS FOLLOWS: FY1974 $200,000; FY1975 $2,490,000; FY1976 $210,000
2) EXCLUDES PEP CONSTRUCTION COSTS AS FOLLOWS: FY1976 $500,000; FY1977 $6,000,000

B. ACHIEVEMENTS DURING THE PAST YEAR

I'm afraid that I have spent so much time talking about money that I won't be able to do justice to the full range of very notable achievements at SLAC during the past year. To abbreviate things a little, let me put off until the next section of this talk, "Future Plans," any discussion of the important development work that has occurred on PEP and on SLED (Sections C.2 and C.3). I would also like to apologize in advance to those of you who worked so well on projects or experiments that I shall not have the time to mention in this brief summary. Every member of the SLAC staff deserves the fullest possible recognition for making the past year at SLAC tremendously productive. Here is a small sample of some of the year's highlights:

1. *New Particle Discoveries*

The last year has been almost incredible in terms of unprecedented revelations in the field of high energy physics research. To many of us old fogies who have tried to recollect whether there has been a similar period in the evolution of physics, it is very difficult to find a suitable comparison. Those who are even older than I point out that the period of the late 1920's and early 1930's, in which first quantum mechanics and then nuclear physics became a reality, was a similar time of high excitement. Since



that time, nearly 50 years ago, there have indeed been many important discoveries, but not at nearly the rapid and dramatic rate that we have been witnessing recently. We seem to have uncovered another whole "layer of matter" whose existence was essentially unpredicted, and whose richness and structure has come as a great surprise. Clearly this is not the time to slow down the exploration of this new world. Present speculations about the possible meaning of these new discoveries is now running far ahead of the available facts, and many of the alternative explanations that are now being offered may well fall by the wayside as new experimental data becomes available during the time ahead.

Several months ago the scientific journal *Nature* carried an article that described the main conference that was held in the field of high energy physics research during 1975. The article began in the following way:

> YEAR OF THE ψ
>
> It is appropriate that this year's Lepton-Photon Symposium was held at Stanford, where many of the discoveries that have revitalized high energy physics have been made. Pride of place went to new results from electron-positron annihilation, many of them obtained at the host laboratory . . . .
>
> --*Nature*, October 18, 1975

You have all heard and read about, in the *Beam Line* and elsewhere, the spectacular discoveries of new particles made at Brookhaven National Laboratory by a combined MIT-BNL group, by the joint SLAC-LBL group working at SPEAR (which includes physicists from SLAC Experimental Groups C and E), and by experimenters at the Frascati Laboratory in Italy. These initial discoveries were followed. last summer, by the subsequent findings of more new particles both at SPEAR and at the German storage ring DORIS at the Deutsches Elektronen Synchrotron (DESY) in Hamburg. What has come from the work at these and at many other laboratories around the world is a picture that is still far from complete but that definitely establishes the existence of a whole new family of particles in nature. To explain this new family, and to account for their remarkable properties, it seems to be necessary to add at least one and perhaps several new fundamental constituents to the basic "building blocks" from which the vast majority of previously known particles are thought to be composed. There is a possibility, though not a certainty, that further study of the newly discovered particles may point the way toward a unification of basic ideas concerning the ultimate structure of matter.

In addition to the obvious role that SPEAR and, later, PEP can play in studying such fundamental questions, it is perhaps worth pointing out that most often the opening up of new, higher energy regions by a machine such as PEP has led to discoveries that were largely unforeseen.

It is perhaps less well known at SLAC that the family of new particles is also being studied in experiments other than those at SPEAR. A collaboration of physicists from the Universities of Wisconsin and Pennsylvania and from SLAC's Experimental Group F and Spectrometer Facilities Group (SFG) has successfully studied the direct production of psi particles by very high energy x-rays ("photoproduction") in End Station A. Searches for related phenomena are also being carried out by Experimental Group A of SLAC, and by a collaboration of physicists from SLAC Group D and UC-Santa Cruz in the SLAC streamer chamber.

2. Theoretical Physics

This is an appropriate opportunity for me to make mention of the outstanding work that is being done by SLAC's Theoretical Physics Group. As many of you may know, during the decade or so of our existence SLAC has become a world center not only for experimental but also for theoretical high energy physics research. In addition to our own staff of theorists, physicists from many different nations come to SLAC for varying periods of time to work on the interpretation and clarification of new experimental results, and to continue their post-doctoral education in this field of study. Of particular significance during the past year or so in theoretical work has been the development of models designed to accomodate the recent new particle discoveries, to explain their properties, and to make predictions that can be tested in future experiments. There has also been intense effort in working out a theoretical scheme that may help explain why the postulated basic building blocks of matter--the famous "quarks"--are bound together in such a way that they do not appear separately and are thus not detected in experiments. These kinds of theoretical models act both as interpretations of current experimental results and as invaluable guides for future experimental studies.

3. Polarized Electron Source

Let me begin here by reminding you briefly what "polarized" means in this context. Electrons have a certain property called "spin," which can be thought of as rotation of the electron about an axis (like a spinning top). In normal operation the SLAC accelerator delivers electrons that have their spin axes oriented in a random manner (that is, pointing every which way). If we have a device that can line up a bunch of spinning electron "tops" so that their spin axes are almost all pointing in the same direction, then the electrons are said to be "polarized."

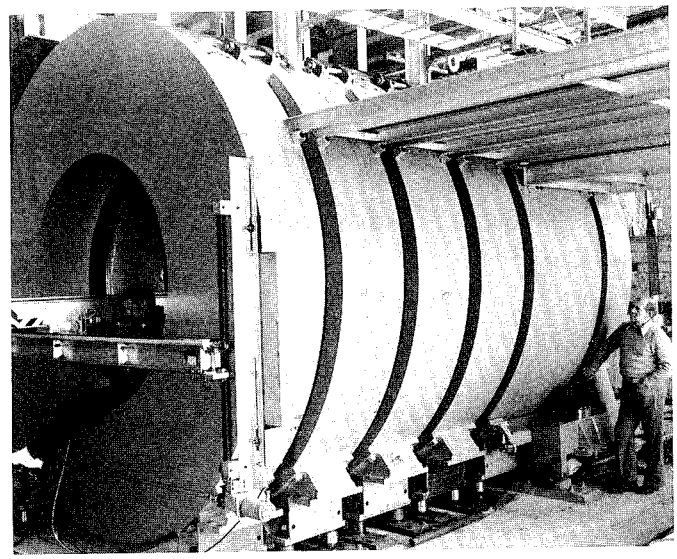
The first polarized electron source at SLAC, PEGGY, was built as a collaborative effort between Yale University and the Accelerator Physics Department and Spectrometer Facilities Group at SLAC. Polarized electrons from PEGGY were injected into the SLAC linac and then accelerated to high energies in an initial scattering experiment last year. More recently, the polarized electron beam has been used in the first part of an En Station A experiment in which the target particles are also polarized. (This target is the product of a collaboration between physicists from Yale and SFG.)

The availability of polarized electron beams adds an important dimension to the physics that can be done at SLAC. A new series of experiments is now starting in which polarized electrons are being scattered and measured with extremely high precision by the End Station A spectrometers. Eventually the PEGGY source will be replaced in such studies with a new source of higher intensity. If the planned experiments are able to detect reliably an asymmetry in the scattering process of 1 part in 100,000, they may be able to establish a fundamental connection between the basic electromagnetic and weak forces in nature.

4. Large Aperture Solenoid Spectrometer (LASS)

This major new research device has been under construction at SLAC for the past several years. As you may recall, LASS consists of two main magnetic elements: a large superconducting solenoidal magnet which encloses the target and serves to analyze particles that emerge at wide angles; and a "downstream" dipole magnet which analyzes the more energetic, small-angle particles. These magnetic elements are supplemented by an extensive array of counters and wire chambers of various kinds that are used to track the particles throughout the large system. The output of the particle detectors placed throughout the system is connected on-line to the main SLAC computer facility, which is programmed to control experimental triggering and data acquisition.

The LASS facility has been undergoing tests and system shakedown during recent months. Most of the system is now fully operational, and the first experimental results have recently been obtained. The large superconducting solenoid has been operated successfully at its rated magnetic field of 24 kilogauss, and the basic magnetic design appears to be very successful. The few residual problems in the system are related to a desired reduction in the rate of liquid helium consumption, and augmentation of the refrigeration capacity to handle the cooling load.



Tom Porter, left, and Henning Petersen are shown with the large superconducting solenoidal magnet that is the main element in the new LASS particle-detection system. The solenoid has been operated at fields up to 24 kilogauss. (Photo by Dick Muffley.)

5. *Bubble Chamber Developments*

During the past year there has been a good deal of work in both the development of SLAC's bubble chamber facilities and in their use for physics experimentation. The 15-inch rapid cycling bubble chamber (RCBC) was operated at rates as high as 36-40 cycles per second, and was used in conjunction with the K^0 spectrometer in a joint Colorado-UC Irvine-SLAC Group G experiment that measured some of the rare decay modes of the elusive neutral K mesons.

Work also continued throughout the year on integrating the 40-inch bubble chamber into the "hybrid bubble chamber facility." As you may recall, SLAC has played a leading role in developing the bubble chamber technique to much higher sensitivities than has been possible in the past. This is achieved through a process of "selective triggering," in which an array of counters and wire chambers is used to detect the particles that emerge from an interaction within the bubble chamber, and this information is fed into a computer. The computer then makes a decision, within about 1/1000 of a second, whether or not the event is interesting enough to be permanently recorded. If "yes," the computer signals for the bubble chamber lights to be flashed on, a photograph of the event is taken, and the film then advances to the next frame.

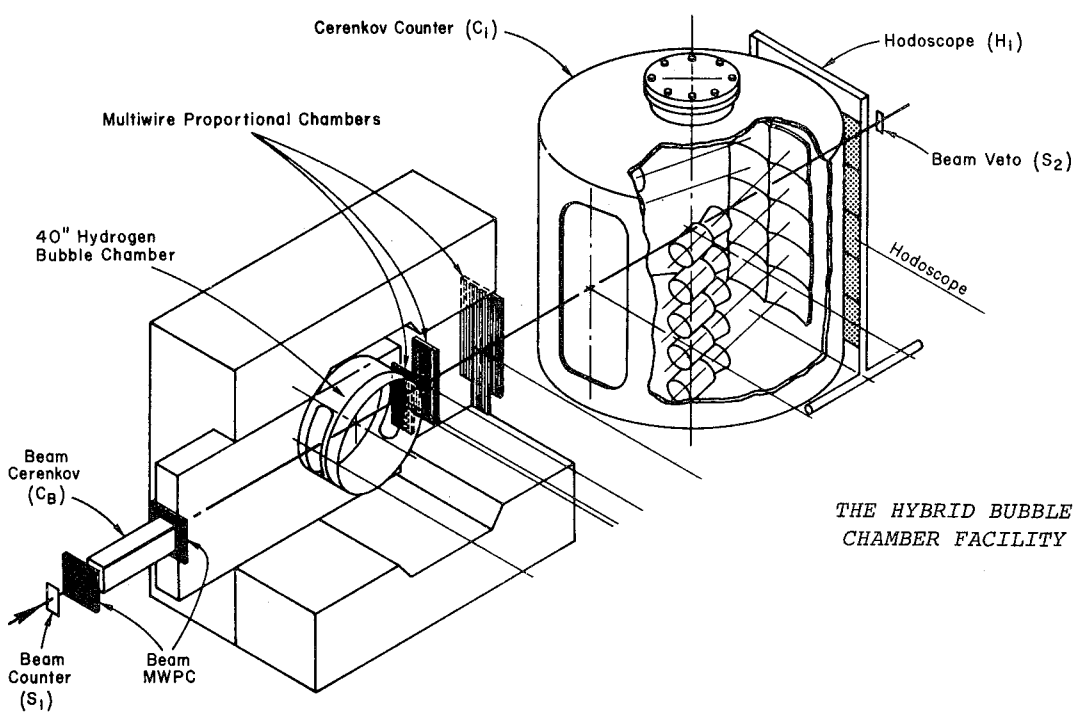
The 40-inch bubble chamber has operated at expansion rates up to 12 cycles per second, and routinely at 10 cps. This high cycling rate combined with the ability to trigger the chamber lights selectively for only those events of particular interest makes the hybrid 40-inch facility a powerful tool for a variety of experiments.

It is probably worth noting that the trend toward more selective triggering has contributed a share during the past year to a rather significant shift away from experimental data that is recorded on photographs to that which is recorded on magnetic tapes. As a result, the total SLAC activity in the scanning and measuring of photographs has been decreasing rather steadily, while at the same time the load on our computation facilities has shown a substantial increase.

6. *Computation Facilities*

SLAC had foreseen the need for enlarged computation capacity a number of years ago, and we have been fortunate to be able to acquire the two new IBM 370/168 computers which are now coupled to the older 360/91 to form the present "triplex" system. The combined power of this system exceeds that of any other installation in the high energy physics community. During the last year a number of improvements have been made in the triplex system, and the fraction of the time that system dedicates to "real time" analysis of experimental data continues to increase. In this mode of operation, the experimenter receives analyses of some of the events that are occurring in his apparatus almost instantly.

As you know, this past year also saw the completion of the new Computer Building at SLAC, which now provides a suitable permanent home for both the equipment and the SCIP personnel who operate the facility for SLAC. The elaborate triplex facility was moved into the new building



THE HYBRID BUBBLE CHAMBER FACILITY

with only a minimal interruption to the users, and the building itself was completed on time and within the estimated cost. I should like to congratulate everyone who was involved in this very successful operation.

7. *Stanford Synchrotron Radiation Project (SSRP)*

I should like here to make brief but special mention of this relatively new research facility located adjacent to the SPEAR storage ring at SLAC. (The *Beam Line* issues of January 1975 and January 1976 contain articles describing SSRP in some detail.) As you probably know, this project is operated by Stanford University through the Hansen Laboratories of Physics on the main campus. SLAC's main contribution to SSRP is the fact that the circulating electron beam in the SPEAR storage ring is the source of the intense beam of synchrotron radiation that the experimenters at SSRP have been putting to such effective use. The SSRP research program covers many different areas of scientific study, some of which are directly applicable to current practical problems (such as the mechanism of nitrogen fixation), while others serve more basic research purposes. Thus our connection with SSRP is indeed an important contribution to applied research which developed through a natural outgrowth of SLAC's technological activities. I have a good deal of confidence that, as time progresses, many other useful applications will evolve from SLAC's technology in a natural way to contribute to such problems as the development of alternate energy sources and others of practical importance.

C. FUTURE PLANS

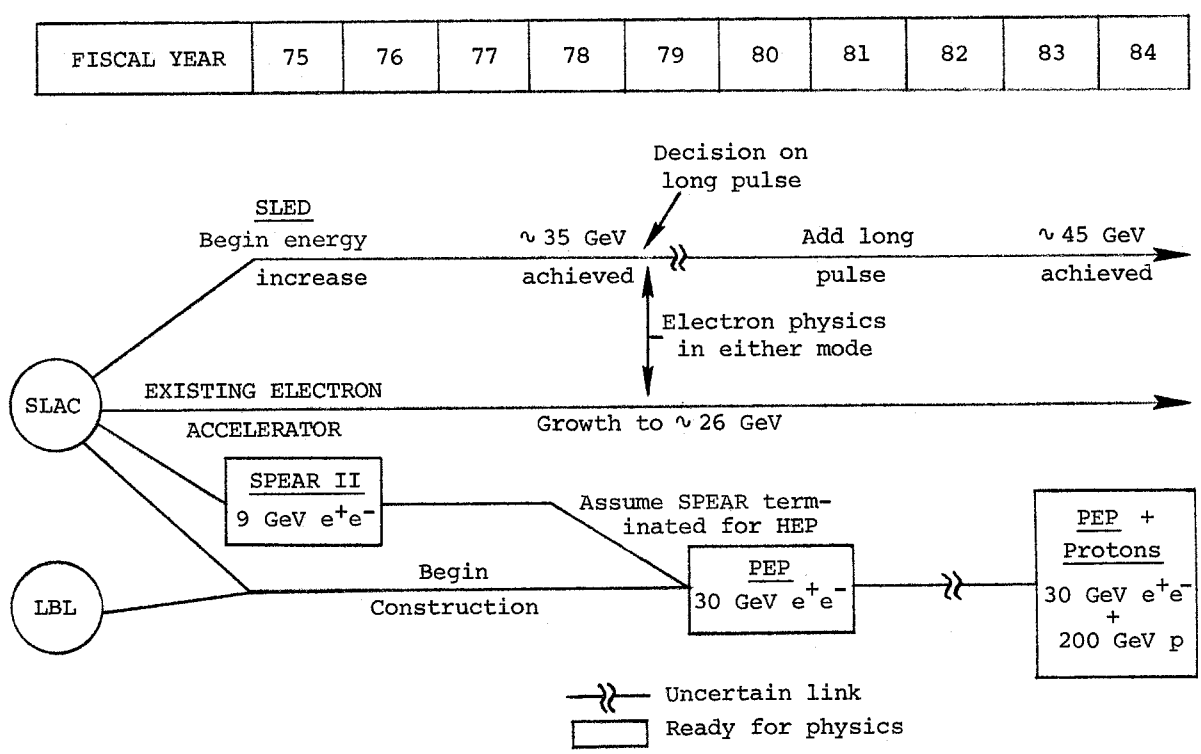
1. *The Long-Range Prospect*

At the beginning of this talk I spoke about SLAC's tentative funding levels for FY 1977 and the implications of these levels for our work in the time ahead. This general funding picture should give us great encouragement about the long-range prospect for the laboratory. In fact, under the conditions as we now see them, we can point ahead to a reasonably predictable (as predictable as anything is these days) and very important program of high energy physics research at SLAC for well beyond the next decade. The main lines of our future planning are shown in Figure 6, in which both the storage ring and accelerator lines of growth are indicated. I would like now to discuss these two main lines, which lead respectively tp PEP and to SLED, in a little more detail.

2. *PEP*

PEP is the *P*ositron-*E*lectron *P*roject, a facility that will make use of colliding beams of electrons and positrons, with each beam having a nominal energy somewhat greater than 15 GeV. PEP is a joint undertaking of SLAC and LBL, to

FIGURE 6
PLANNED DIRECTIONS FOR SLAC GROWTH



be built at SLAC during a construction period of about four years, and at an estimated total cost (allowing for assumed inflation) of about $78 million. This is all I shall say here about PEP as a technical facility. There have been previous descriptions of the project, and there will soon be much more technical information coming out in regard to PEP. I want to use the time here to talk a little bit about how the PEP project will be organized, and how this prospective organization will affect the existing SLAC staff and the present ongoing activities of the laboratory.

Some time ago SLAC and LBL put together a small group of individuals from the two laboratories, under the direction of Professor John Rees of SLAC as Project Director and Dr. Tom Elioff of LBL as Deputy Director, to carry out a program of preconstruction research and development work related to PEP. This group will be the nucleus of the technical management team to continue through the construction period, and for this purpose the PEP group will remain relatively small. We estimate that the total number of individuals drawn from both laboratories (and to a lesser extent recruited from outside) who will be specifically "in the PEP group" will not be large--perhaps 30 to 50. This group will make the basic design decisions for the project, but the actual execution and accomplishment of PEP will be carried out within the existing organizations of the two laboratories.

Thus the construction of PEP will generate an increased work load on many of the existing technical units of SLAC. As an example, there will be a significant increase in work in both the mechanical and electrical shops. The PEP radiofrequency system will require 18 super-high-power klystron amplifiers that are to be fabricated at SLAC. Extensive plant engineering work must be done. Hundreds of magnets must be designed, developed, procured and tested. Large very-high-vacuum systems have to be brought into existence. An elaborate instrumentation and control system must be designed and built, and so on.

None of these tasks requires substantial reorganization of the laboratory to meet the needs. Thus no one at SLAC need ask himself, "What do I have to do so that I can work for PEP?" The answer to this question will evolve naturally as PEP moves from design toward actual realization. It is certainly true that a substantial fraction of the total work will be done by outside industry; this was also the case when SLAC itself was originally built. And it also important to remember that a significant portion of the engineering, design, fabrication and procurement will be carried out by LBL forces. We are presently soliciting, on a competitive basis, the services of an outside architect-engineering firm who will manage the conventional construction part of PEP: the building, tunnels, etc., that will be needed to create an environment for the new facilities. Many of the components for PEP are of such a nature that they are most efficiently produced by outside firms or purchased as "off the shelf" items.

I realize that these general considerations I have just mentioned can do little more than provide you with a sketchy picture of what PEP will mean to us at SLAC. This is necessarily the case at the present time, since so much still remains to be decided. I will make every effort in the coming months to keep you all informed of our major planning directions as these become more definite and well-defined.

. . . With the PEP storage ring we are proposing to extend the energy parameter in electron-positron collisions to 30 GeV of available reaction energy, thus greatly expanding our reach into the annihilation region, by building a storage ring which will contain counter-circulating beams of energies up to 15 GeV each. The available reaction energy will be comparable to that obtainable at the world's highest-energy accelerators, even though the energy of the circulating beams is very much lower. This is true because, when two oppositely directed antiparticles of the same momentum collide, the total energy, i.e., the sum of their energies, is available to the reaction. In contrast, when a beam particle from a conventional accelerator strikes a stationary target particle, most of the energy is necessarily tied up in the continuing forward motion of the reaction products . . . and only a small fraction is available to the reaction. This fact is illustrated in Table 1 below, which shows the available reaction energy for the PEP electron-positron ring and for the three highest-energy machines now operating or under construction, including the world's only proton-proton colliding beam device, the CERN Intersecting Storage Rings (ISR). The most important conclusion to be drawn from the Table is that the PEP facility will provide available reaction energies covering almost the entire range covered by other machines, and covering it through the annihilation process in which the intermediate state is one of pure energy and is inaccessible through the other machines.

Table 1

Machine	Available Reaction Energy
PEP (15 GeV e^+e^- storage ring)	30 GeV
NAL (400 GeV proton accel.)	27.4 GeV
CERN II (400 GeV proton accel.)	27.4 GeV
ISR (28 GeV p-p storage ring)	56 GeV

-- *A Proposal for a Positron-Electron Colliding Beam Storage Ring Project*, April 1974

SLAC'S USERS

As of July, 1975, physicists from 40 different Institutions in the United States and 10 different Institutions in other Nations had participated in one or more high energy physics experiments at SLAC:

FROM THE UNITED STATES

California Institute of Technology
Massachusetts Institute of Technology
Lawrence Radiation Laboratory
University of California, Berkeley
" " " , Irvine
" " " , Los Angeles
" " " , Riverside
" " " , Santa Barbara
" " " , Santa Cruz
" " " , San Diego
Northeastern University
Johns-Hopkins College
University of Wisconsin
University of Washington
University of Pennsylvania
Cornell University
Harvard University
University of Massachusetts, Amherst
Brookhaven National Laboratory
University of Colorado
Tufts University
Yale University
Princeton University
University of Maryland
National Science Foundation
Purdue university
Vanderbilt University
Indiana University
American University
Naval Postgraduate School, Monterey
University of Hawaii
University of Tennessee
University of Illinois
University of Rochester
Duke University
Columbia University
State University of New York, Binghamton
Florida State University
University of North Carolina
Oakridge National Laboratory

FROM OTHER NATIONS

Weizmann Institute, Israel
Imperial College, Great Britain
Tel-Aviv University, Israel
University of Toronto, Canada
Tohuku University, Japan
University of Bonn, Germany
Tech Hochschule, Aachen, Germany
University of Bielefield, Germany
University of Pavia, Italy
CERN, Switzerland

3. *SLED*

Although PEP will certainly be our first priority for the next several years, it remains a strong SLAC policy not to focus exclusively on storage ring physics in its present and future programs. There are several reasons for wishing to maintain the productivity of our more conventional "beam on stationary target" physics research. The first and foremost reason is the potential of the prospective physics itself. Stationary-target experiments continue to make important contributions to strong interaction physics, using specialized secondary beams; to electron-scattering studies and other areas, using the new polarized beams; and to such work as photoproduction of the new particles, using SLAC's unique photon beams.

As noted earlier, SLAC's tentative FY 1977 funding for Accelerator Improvement Projects should enable us to continue the present SLED energy-upgrading program at about its present rate through the coming fiscal year. If a similar effort can be funded during FY 1978, then the Stage 1 goal of the SLED program--a maximum beam energy of about 35 GeV--should be reached in that year.

On a significantly longer time scale (perhaps extending into the early 1980's, it may be possible to extend the SLED program to its full Stage 2 limit, which would yield a maximum beam energy from the SLAC accelerator of about 45 GeV (somewhat higher energy would be possible if 40 megawatt klystrons were to replace the exist- 20 and 30 Mw tubes).

Augmented by the SLED energy-increase program, the SLAC accelerator would remain a unique facility for high energy and high intensity photon beams and also for polarized electron beams of high energy. As such, it would offer attractive research opportunites at SLAC that would act both as a complement and an alternative to the intensive experimental exploitation of the new PEP facility during the decade of the 1980's.

4. *Major New Experimental Devices*

There are at present firm plans for the design and construction of a second large magnetic detector (Mark II) for use at the SPEAR storage ring. In addition, studies are now being made of a possible non-magnetic detector for SPEAR experiments that would be particularly well suited to the detection of neutral particles. This latter device, which is still in the planning stage, would consist essentially of a segmented, spherical array of sodium iodide crystals and associated counters that would be placed around one of the two interaction regions at SPEAR. This device is known as the "Crystal Ball." Additional information on both the Mark II and Crystal Ball projects will be forthcoming as work on them progresses.

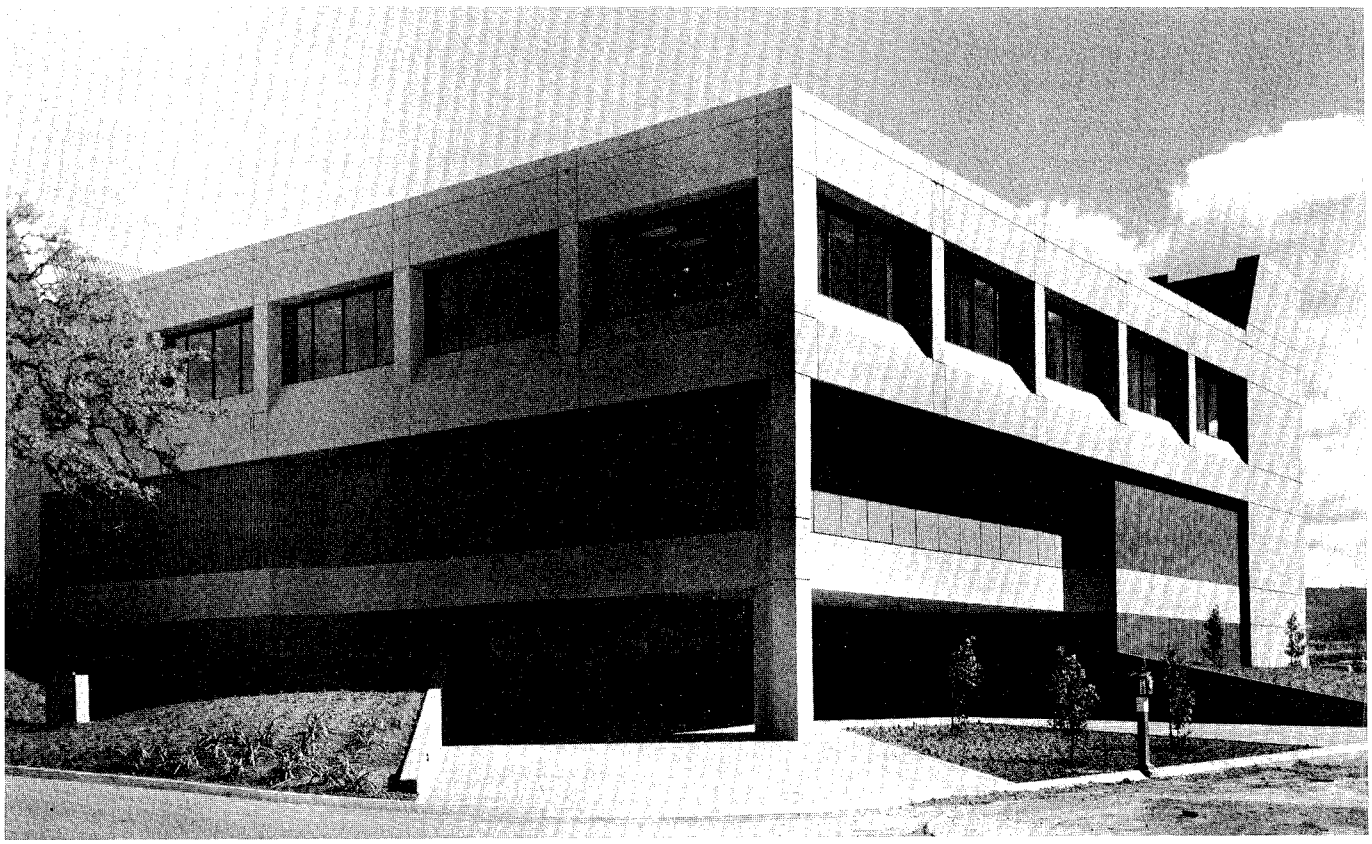
As noted earlier, some of the FY 1977 Equipment funding at SLAC will likely be devoted to early work on a major detection system for eventual use at PEP. Some tentative designs for possible detection systems have already been worked out during the PEP Summer Study programs that have been held for the last three summers.

5. *Other Possible R & D At SLAC*

The plans and prospects for the future that I have discussed so far make it seem quite evident that SLAC will be able to maintain and perhaps to enhance its productivity as a single-function laboratory dedicated solely to high energy physics research. We are, nevertheless, a member of ERDA's family of major laboratories, and I need hardly remind you that ERDA's mission is energy research and development. Both as members of this ERDA family and as private citizens we are naturally concerned with the increasingly visible national problems of assuring adequate energy supplies, with improving the efficiency with which existing supplies are generated and consumed, and with reducing energy demand through rational conservation measures. We shall continue to look for additional opportunites through which SLAC's special skills and facilities can be brought to bear on these pressing energy-related problems. Whenever promising proposals or ideas for work of this kind are suggested from within SLAC (or when SLAC's cooperation is requested by other organizations active in R&D work), I can assure you that they will be investigated thoroughly. As I noted earlier, the SSRP facility at SLAC is an excellent example of SLAC-developed technology finding practical application. We hope and expect that other, analagous, applications will emerge in the future.

John Rees of SLAC, Director of the PEP Project.

This concludes my report to you on the state of SLAC and on our expectations for the future. To me, the outlook has never been better, and I hope that you will agree.



The new Computation Building at SLAC was completed during the past year.