The Beam Line

Stanford Linear Accelerator Center

VOLUME 3 NO. 2 MAY 1, 1972

SPEAR Turns On — Stores Beams

A powerful new device for probing the inner structure of matter has successfully passed its initial test here at SLAC. At 5:25 p.m. on April 22 a beam of positrons (the anti-matter twin of an electron beam) was inserted into the 1/7-mile-circumference, oval-shaped device, SPEAR, and kept circulating for a period of about 20 minutes, making about 1.5 billion turns in that time (equivalent to about 500 trips from the earth to the moon and back). The 1.5-billion-volt positrons, produced by SLAC's two-mile long linear electron accelerator, coasted around the ring in a one-inch high and five-inch wide vacuum chamber guided by over 140 magnets of various kinds.

It is expected that by the time of this printing it will also be possible to store in the SPEAR ring a beam of electrons, also produced by the two-mile accelerator, going in the opposite direction, so that physicists will be able to study the results of electron-positron collisions. Research with SPEAR is planned to begin in December of this year and, initially, beams of up to 2.5 billion electron-volts will be used.

The purpose behind the construction of colliding-beam devices like SPEAR is the attainment of tremendous amounts of usable energy. If a 1.5-billion-volt positron collides head-on with a 1.5-billion-volt electron, the energy available for the production of new particles is 3 billion volts, while the collision of even a 20-billion-volt positron with an electron at rest makes available less than 0.2 billion volts. To attain a 3-billion-volt interaction energy, one would have to bombard a stationary electron with a 9,000-billion-volt positron, which is 450 times the energy that the Stanford Accelerator — the largest of its type in the world — can give to a particle.

When electrons and positrons collide and annihilate, an intermediate state of pure energy — a very tiny but extremely hot fireball — can produce a variety of different states consisting of combinations of elementary particles when it decays. It is through study of these final particle states that physicists hope to obtain new information on the structure of the basic building blocks of matter.

The use of colliding-beam devices was pioneered by Princeton and Stanford physicists at the High-Energy Physics Laboratory at Stanford. Other colliding-beam devices exist or are being built in the USSR, France, Italy, Germany, and at the twelve-nation CERN laboratory in Switzerland. The SLAC project was led by Dr. Burton Richter and Dr. John R. Rees.

On learning of the SPEAR achievement, Dr. Panofsky commented:

"Attainment of a circulated positron beam in SPEAR only six days after turn-on is an enormously impressive achievement. In all earlier storage ring installations a very extended period of time was necessary to get any kind of stored beam established at all. There is one other feature on which I would like to congratulate everyone in the laboratory; that is the achievement of compatible operation of SPEAR turn-on with the ongoing experimental work at SLAC, which continues to "roar on" while SPEAR prepares for experiments of its own. We agreed with the AEC that SPEAR, although it is a larger undertaking than the construction of our other instruments in the target areas, should be treated in a manner similar to our other large pieces of research equipment such as spectrometers, bubble chambers, etc. Therefore many groups, in particular Accelerator Physics, EFD, Mechanical Design and Accelerator Operations have labored hard to modify hardware and procedures on the main accelerator to make it possible to operate the new beam line feeding SPEAR compatible with all the other SLAC beams, in spite of the fact that the new beam line operates at only 1.5 GeV. Moreover, a large number of innovations to the instrumentation and control system were necessary since SPEAR operation poses many problems quite dissimilar from the rest of the program. I should like to thank everyone for having made this truly spectacular achievement possible."

Editor's Note: Since the above story was written, SPEAR has also stored both an electron beam and a positron beam together.

Job Mobility Survey Report

Toward the end of 1971, SLAC's Job Mobility Committee (JMC) conducted a Survey of the SLAC staff to elicit "information, comment, and advice" to aid the Committee in its work of developing programs for stimulating job mobility within SLAC. Two hundred and fifty-three or nearly one-fourth of the staff filled out and returned the questionnaire and many people wrote extensive comments and suggestions.

A JMC Subcommittee has analyzed all the returns and made a complete report to the JMC. Many SLACers have inquired about the results of this survey and now copies of the subcommittee report are publicly available in the Library and in the Personnel Office as "Summary and Analysis of Job Mobility Committee Survey," February 1972.

The report takes its theme from a secretary who commented "No comments, except don't turn your backs. Look at us little people who try so hard and aren't even noticed! Look hard!!" It presents not only numerical results of the survey but categorizes and excerpts the more than 100 extended commentaries and suggestions which were received from SLAC staffers in all kinds of jobs. Recommendations are made based directly and indirectly on recurring suggestions and complaints. An appendix presents all extended commentaries verbatim so that no useful material might be totally lost through bias in the reporting process.

Survey responses showed striking enthusiasm of the respondents for some sort of training or education program for themselves. 154 answered YES to Question 8 (Would you be interested in participating in an appropriate training program...?), even though very few people perceive lack of training or education to be the reason why they are not progressing at an ideal rate. The most chosen reason among those who weren't progressing fast enough was "lack of opportunity" usually explained as due to the deadend nature of the job or the fact that the next step up is occupied by someone who must either retire or die to create an opening.

A very high percentage of respondents (201 or 79%) declared themselves satisfied with the kind of work they were doing but expressed interest in making more money (78) or in expanding their present jobs (76). Of the 154 people who were interested in participating in a training program, 90% were willing to spend considerable amounts of their own time.

A number of people suggested that classes should be made available during non-working hours (i.e. noon and after work) at SLAC so that anyone could attend. Others emphasized their desire to take courses for credit at Stanford University.

Some problems were uncovered in responses to Question 7B (Would you feel free to apply for a job with another group here at SLAC?) and the responses of women employees showed discernible pessimism and uncertainty about opportunities for women to advance at SLAC. (The report develops some background information on relative salary positions of men and women employees at SLAC which suggests the pessimism of women employees may be well founded).

For BEAM LINE readers, we excerpt here the summary and recommendations of this report: (Various groups including the JMC itself and the Personnel Department are studying these recommendations and we hope to present a further report on this subject in the next issue of BEAM LINE).

SUMMARY

From the results of the JMC survey, we conclude:

1. The SLAC staff, a diverse and lively bunch, includes many individuals striving not only for better jobs with better pay, but for greater excellence and variety in their present jobs. The enthusiasm for education and training programs for all levels of non-Ph.. staff is great. More such programs are needed with much more publicity about what is available and how employees may participate. Feedback is needed for employees as such programs are set up.

2. There is a sense of on-the-job stagnation among a significant number of long-term staff. It is more frequently perceived as a lack of opportunity to move into a better job or into a different more interesting job because:

a. Mortality rate is low for supervisors and group leaders.

b. SLAC is a mature organization with static staff, operating on a tight budget in a tight economy.

c. SLAC's policy (or so it is frequently seen by its employees) has been to fill jobs from outside rather than to train someone from inside the project, severely limiting promotion and transfer possibilities for present staff.

3. Women employees emerge as an identifiably dissatisfied group, complaining that they have been omitted from previous training and upgrading programs at SLAC, that opportunities for women at SLAC are limited. Some express keen interest in being able to enter the technical fields. (Satisfaction was greatest among SLAC's small group of women administrators and technicians).

4. There are a troubling number of job-related problems experienced by employees at SLAC and not falling within the score of the Minority Affairs Committee (which doesn't handle complaints from women or any job related complaints not involving discrimination by race). There is at present no mechanism short of formal grievance for handling such job-related problems.—An ombudsman/woman or employee affairs committee/subcommittee may be needed.

5. Lack of communications and/or faulty

Cont. to page 7

Quotes to Remember

Henry David Thoreau
I have a great deal of company in my house, especially in the morning when nobody calls.

Abraham Lincoln
The better part of One's life consists of friendships.

Epictetus
Men are disturbed not by the things that happen, but by their opinion of the things that happen.

Albert Einstein
I am thoroughly convinced that the immortality of the human soul and its relation to God is a reality, but in a way not conceived by man. I also feel that electricity and/or electromagnetic forces are the basic powers of the universe and human life — the soul.

F.G. Kernan
A well-informed man is one whose views are the same as yours.

Booker T. Washington
I shall allow no man to belittle my soul by making me hate him.

Four-Meter Long, One Centimeter Diameter Superconducting Tube

by Fred Martin

Would you believe the suggestion of passing the accelerator's electron beam through a magnetic field without deflecting it? Well — the physicists and technicians of SLAC using the physics of superconductivity have done it!

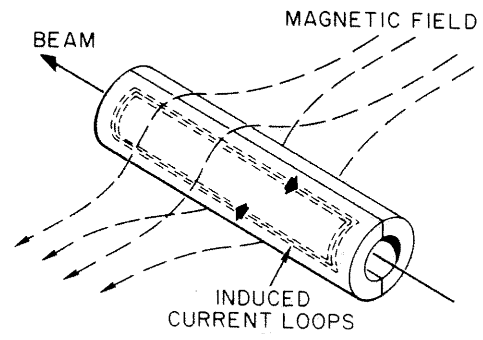
You may recall that many experiments consist of running a beam of particles into a target of liquid hydrogen or other material; on the down beam side of the target is an elaborate apparatus which includes a magnet, counters and frequently spark chambers. These detect and analyze the one or more particles produced and emitted in several directions by the interaction of the beam particles with the nuclei in the target.

One of the principal problems in running an experiment is the separation of the beam particles from the particles scattered by the target. If one attempted to pass the beam through the magnet the detectors would be flooded with unwanted particles. Several techniques exist for dealing with this situation such as using two smaller magnets placed on either side of the beam line and some of the scattered particles pass through the magnets and detectors. A variation on this method is to use a single large magnet set to one side of the beam.

SLAC physicists have now added a new technique for solving this problem. It consists of a long tube made of superconducting material placed at the center of the magnet and passing through the detectors. The magnetic field is excluded from inside the tube by the superconducting material. Through this tube the unscattered beam passes while the scattered particles coming from the target pass through the magnet on the outside of the tube. The great virtue of this system is its ability to collect three or more particles scattered in different directions simultaneously. The earlier systems were restricted to collecting the scattered particles from a small angular region and so their use for reactions producing two or more particles was severely limited.

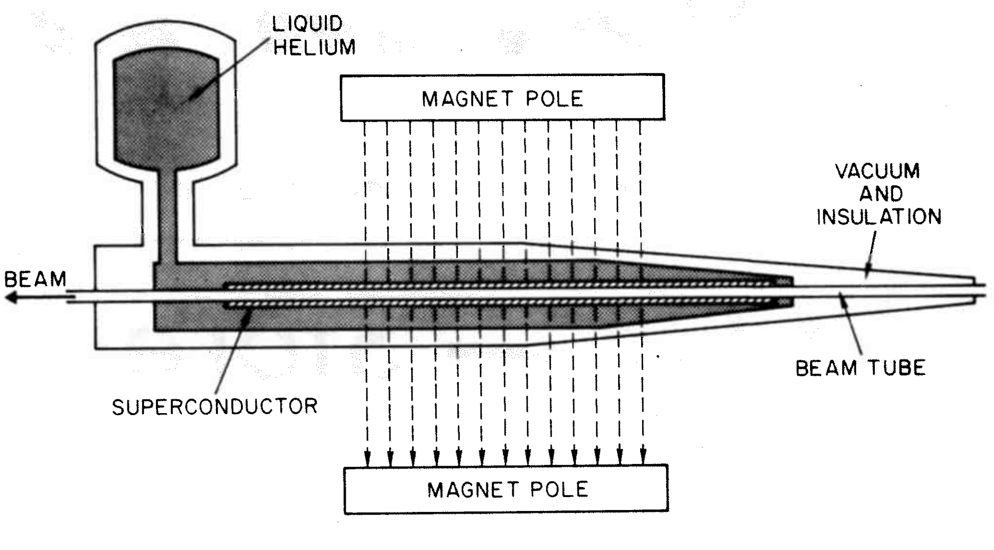
The development and construction of the apparatus was a joint effort of Professor Perl's Experimental Physics Group and Steve St. Lorant's Low Temperature Group. Acie Newton with the physicsts in Group E developed the technique for forming the superconducting tube and Ed Tillman along with other members of the Low Temperature Group designed and constructed the liquid helium dewar and filling apparatus.

The tube is made up of two parts. The inner tube which is also the evacuated beam's pipe is made of stainless steel, copper plated and tinned with soft solder. The outer tube is made from long, .005 in. thick by 2 in. wide ribbons of Nb^3Sn (Niobium-3-Tin) clad with copper and



THE SUPERCONDUCTOR
(Two Half-Cylinders of N_3S_n)

tinned with soft solder. The outer tube was first made in the form of two long semi-cylinders with 30 layers of Nb^3Sn in the middle and stepping down to 5 layers at each end. These two semi-cylinders were then clamped to the stainless steel tube and the entire assembly heated until the solder melted and bonded the many layers into a solid mass. The overall



SIDE VIEW-CROSS SECTION

length of the superconducting layers is 20 feet with a minimum inside diameter of 1/4" and an outside diameter of 1".

This tube was inserted concentrically into a square tube with appropriate spacers to hold the superconducting tube rigidly in place. The square tube also contains the liquid helium. Wrapped in superinsulation, this tube is mounted rigidly inside a third stainless steel tube with a diameter of 3". This outer tube is the vacuum jacket and forms the heat (dewar) shield for the liquid helium. The entire assembly is sufficiently rigid to be suspended on wires and aligned to a precision of + .032" in the magnet and detectors over its entire 30 foot length.

A small reservoir of liquid helium mounted at one end of the assembly feeds the liquid through a long umbilical running the length of the dewar. A low vapor pressure and the hydrostatic head of the helium force it through the feed line and into the helium vessel at the front end and exhausts the warm helium at the back end of the tube.

A 500 liter dewar of helium supplied the liquid to the reservoir by means of a sophisticated servo system which automatically maintained an ample quantity of helium in the reservoir. In practice the only operating requirements were occasional surveillance and the daily replenishment of the 500 liter dewar. Finally, the boiled-off helium was collected in a gas bag and re-cycled by the Low Temperature Group.

As its name implies, a superconductor is a material which exhibits zero electrical resistance. This phenomena occurs when material has been cooled to low temperature, usually somewhere in the region of the boiling point of helium. When a magnetic field is applied to a superconductor a curious effect is observed. The superconductor tries to prevent the magnetic flux from entering it. It does so by creating in its surface circulating "super currents" which produce a magnetic field exactly equal to but opposite in sign to the external field. The superconductor will not, however, exclude an arbitrary large magnetic field. At some point the magnetic field overpowers the "super currents" and the superconductor behaves more or less like any ordinary metal or alloy. Thus we must use many layers of material to exclude the high fields.

The screening currents generated by a magnetic field transverse to a long cylinder taking the form of two long current loops running the length of the cylinder and on opposite sides of the cylinder. Because of the difficulties in manufacturing a complete cylinder of Nb^3Sn from the material available, we took advantage of this symmetry and made two half cylinders. This meant of course that the plane containing the two slits must be precisely perpendicular to the direction of the magnetic field, so that the two long current loops could circulate unimpeded and exclude the external magnetic field from the interior of the beam tube; in the parlance of physicists our tube has become an equipotential surface.

This system has successfully excluded magnetic fields in excess of 15kG and some test samples were tested in higher fields.

As mentioned earlier, high external fields will penetrate the superconductor and a magnetic field appears inside the tube. This internal field persists when the external field is removed and so we have the phenomena of a magnetic field trapped inside the tube by the super currents. These currents have been shown to circulate for two years if the superconductor is kept cold, thus creating a permanent D.C. magnet.

It has been suggested that these "perma-cold" magnets could replace the standard beam magnets used around accelerators.

This reverse application of the superconducting tube, where the super currents generate a strong magnetic field in a localized region, may sound like a rather complex system to replace ordinary magnets, but it is not inconceivable that such a system would find application where space limitations or special geometries are required.

For those who wish to see it, the experiment presently stands in the Group E experimental area, Building 109.

Wanted-- Spires I Users

An improved, expanded version of the SPIRES I on-line information retrieval system is now available on SLAC's IBM 360/91 computer. Anyone who has a WYLBUR account can easily make use of SPIRES I at any time during WYLBUR hours. Instruction sheets are available from L. Addis or R. Gex, SLAC library, x2411. (By the way, throw away your old SPIRES I guides, they don't work any more!)

The current SPIRES I high-energy physics preprint "data base" contains more than 16,000 document entries including all the experimental and theoretical preprints received in the SLAC library since March 1968 and all SLAC documents including technical notes. It is updated weekly with "next week's" preprints and may be searched on-line using combinations of title words, authors, report numbers, dates and citations. The citation search enables a searcher to locate recent preprints which have cited an earlier journal article (for instance your own) and thus locate newer work on the same subject ... Improvements to the file and to the search make SPIRES I more useful than ever. Not only can any searcher invoke the system at any time from his or her own account, but any SPIRES I user can now "save" search results in a personal WYLBUR file for later listing or manipulation, and it is possible to choose a personal format for listing, either on-line or off-line. The preprint data base now contains the journal references for published preprints dated 1970 or later (earlier ones are being worked on too).

A special separate SPIRES I data base was recently created containing information about currently active experimental proposals at the large accelerator laboratories. It is searchable on a variety of topics including beam, reaction and technique, in addition to the standard title, author, and date searches.

Sea Otter Display

Staring today and continuing for at least one month, unique color enlargements of sea otters securing food underwater will be on display in the lobby of the SLAC Auditorium. This display is loaned to SLAC through courtesy of the California Academy of Sciences and the Friends of the Sea Otter.

THE BEAMLINE

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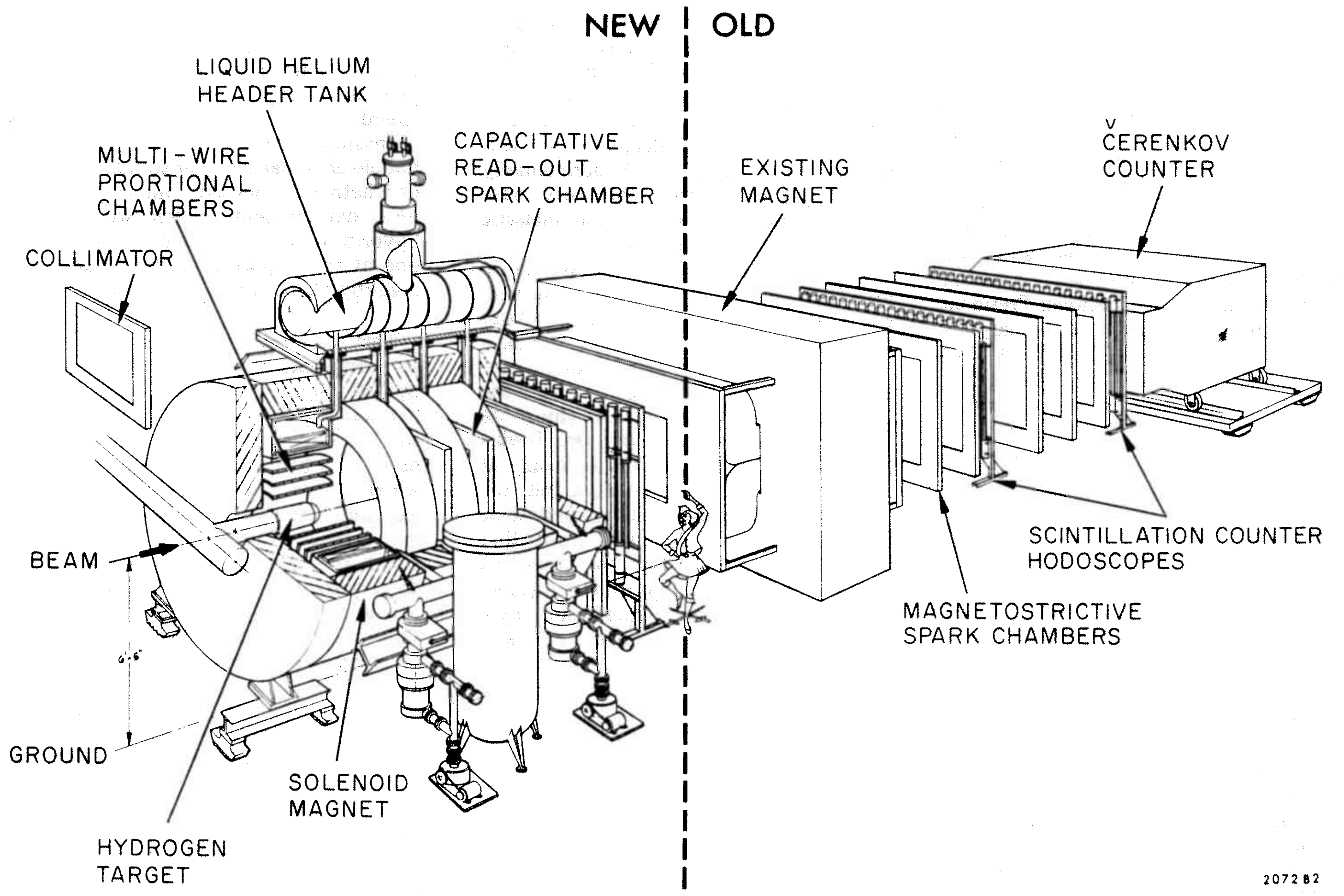
LASS Construction Underway

by Charles Oxley



LASS is a name assigned by Group B's David Leith to his Scottish "sweetheart," the Large Aperture Solenoid Spectrometer. The project is just now beginning the construction stage, and is expected to be physically completed by the end of 1972. After a shakedown of the equipment and associated computer software, it will be ready for physics experiments by SLAC and user's groups in 1974. The new and unique idea of the solenoid incorporated in LASS was the product of a critical study of magnetic-spark spectrometers conducted by Medansky, of John's Hopkins, Luste and Leith, of SLAC. Other large magnet spark chamber arrays along more conventional lines are being built at Brookhaven and Cern.

How do you make a system that is as universally useable as a bubble chamber but operates at much higher rates and whose output is digital?

In a bubble chamber (for example the 82" SLAC instrument) incoming particles interact or decay in the liquid hydrogen and then the products of the process continue through the hydrogen in a strong magnetic field. The ongoing fast particles have enough length to be bent in the magnetic field so that their high moments may be measured. Slower particles, which typically come out at large angles, are easily analysed within the side-ways extent of the liquid hydrogen.

In the LASS system there is a hyrogen target near the entrance to the instrument. Many arrays of wire spark chambers are placed outside the target in and between and beyond two regions of strong magnetic field. The wire spark chambers trace the paths of particles in space, and analysis of data such as curvature and spacial location of the sparks ultimately give the momentum and origin of the particle.

LASS has evolved through several stages of spark chamber-magnet-counter systems. At first there was a hydrogen target in a particle beam followed by an array of spark chambers (among the largest in use anywhere) downstream, then a large iron magnet followed by more spark chamber grids and then a large Cerenkov counter. This system was very productive, but it lost the slower particles coming out sideways. In LASS the target is placed inside a new superconducting magnet, which in turn is placed upstream from the old counter-magnet system, which, in a modified form, will be relocated in a new building.

The illustration shows a perspective view of the LASS system. At the left are the four separate rings of the superconducting magnet. Electric current travels around each of these rings, producing a magnetic field which is generally along the beam axis. The field is two meters in diameter and three meters long overall. The superconducting coils are made from copper in which superconducting niobium filaments are embedded. The coils are operated at liquid helium temperatures. The field produced is 25 kilogauss, and of excellent uniformity throughout the used region. The excellent uniformity and high field are attributable to careful design by John Alcorn. The magnet coil has been separated into four rings to allow easy access for insertion of a flat package of wire spark chambers and counters. The hydrogen target is four centimeters by four centimeters by fifty centimeters long and is placed in the front of the superconducing solenoid. Outside the target, and within the superconducting magnet, many counter cylinders will be placed. These will include multiwire proportional counters and capacitative readout wire spark chambers. These chambers are in the process of design and development.

Referring back to the diagram, downstream, beyond the superconducting rings, are arrays of wire spark chambers, following magnet. First consider a very This entire system is alreay in existence. At the exit end of the magnet are magnetostrictive readout wire spark chambers, and then a large Cerenkov counter for particle identification.

Let us trace two particles from the hydrogen target through the solenoid and following magnet. First consider in very high momentum particle with small sideways momentum originating in the hydrogen target. The magnetic field of the solenoid is nearly on axis and thus along the particle direction. To the extent that this is true the field does not affect it. Such a particle then continues into the array of spark chambers before the second magnet, where its position and direction are initially recorded and into the second magnet where it will be bent because the field is vertical and perpendicular to the particle velocity. After the particle leaves the magnetic field it will be going in a new direction which will be recorded by the wire spark chambers and made available in digital form for analysis.

Just for example, take another slower particle leaving the target at a forty-five degree angle. The component of its motion which is along the solenoid field will be anaffected but it will be bent, if the field is high enough for its momentum, into a circle in the plane perpendicular to the field axis. It will therefore describe a helical or cork-screw motion through the field, leaving a trace in the spark chambers and proportional counters inside the superconducting magnet. It will then leave the magnet probably quite a distance from the beam axis and perhaps recorded on the spark chambers before the second conventional magnet, but because of its low momentum and direction will be lost from the final counter system following the magnet. These are extreme examples.

Using many examples of interesting processes, the placement and size of magnets and counters has been optimized within the available budget.

The electrical data from spark chambers, scintillation counters, and other sources, must be processed and recorded. The present spectrometer system has done this successfully by on-line processing with two small computers and recording the data from these units on high-speed magnetic tapes for later analysis. The LASS system exceeds the capability of the recording system (data rates will go up by two or three times) so it will be supplemented or replaced. It is hoped that a LASS event can be processed in 1/10 second. For the more probable events in strong interactions, it is anticipated that up to one hundred million events could be recorded in a year.

The main task of the computation system is to reconstruct the particle tracks into meaningful physical quantities, such as the four momentum. Although it is possible to preselect types of events and thus reduce considerably the data, the LASS system will generally attempt to loosely trigger events so that selected physical processes may be studied from the same acculculated data — as in the procedure in much bubble chamber work.

Before the major laboratory and user's facility has become operational in 1974 a new large scale computer will probably be obtained by SLAC through general AEC procurement. The uncertainty in the nature of this computer has held back a more definite separation of the functions of small computers and the large central computer. A LASS support group will be formed to facilitate user and laboratory experiments.

The first experiments will be conducted by Group B, together with groups from Johns Hopkins and Caltech, who have contributed to the construction.

CONTRIBUTORS TO LASS

MAGNETS:
John Alcorn, Steve St. Lorant, Henning Petersen, Alan Nuttall, Dan Nevius, Bill Brunk.

OVERALL COORDINATION:
Al Kilert, David Hutchinson.

CHAMBERS:
Al Kilert, Bob Carnegie, Steve Williams, David Hutchinson, Michel Davier.

COMPUTER SOFTWARE:
W. Johnson, D. Buenaers, Mike Gravina, Glen Armstrong, Bob Good.

ELECTRONICS:
Bob Friday, David Hutchinson.

SLAC Blood Bank

In order to make it more convenient for the residents of the Palo Alto and southern county areas to donate blood, the Peninsula Memorial Blood Bank has opened an auxiliary station in the Carpenter's Building at 3065 Middlefield Road, Palo Alto. They will be open to receive donations of blood every Wednesday from 2 to 6 p.m.

Please be sure to state that your donation is for the SLAC Blood Bank. For health and diet prerequisites for giving blood, see Volume 2, No. 5 of the BEAM LINE.

Pollutions Solution?

(Reprinted from American Ecology Newsletter, Vol. 1, No. 1, 1972)

While Detroit and the federal government have been quibbling about converting the internal combustion engine to minimize pollution, a 62-year-old English farmer seems to have come up with a solution.....

Harold Bate, a Devonshire chicken farmer, claims his invention will lower fuel, oil, spark-plug and other miscellaneous car maintenance expenses by a factor of ten, and pollution output by a factor of 100.

His converter works by recycling animal droppings and sewage into methane, an odorless, colorless gas which burns more efficiently then petroleum. As a side-effect, then, it may help solve the organic waste problem.

The converter and other elements in the Bate system were developed by the farmer from odds and ends at hand as he puttered about his 450-year-old chicken farm.

Pief's All Hands

INTRODUCTION

Today, as in past years near this time, I would like to share with you knowledge of SLAC's prospects, financial and scientific, for the coming year. I can give you some idea of our specific plans now that the Federal Budget has been announced. In addition a number of meetings, including those of SLAC's Scientific Policy Committee and two meetings of the Program Advisory Committee intervened between President Nixon's Budget Message of January 24 and today, and these meetings had further implications for our future plans. The Joint Committee on Atomic Energy held very detailed hearings on the country's high energy physics program on February 29, 1972; I had the opportunity of testifying at that time. This talk is thus based on our own experiences at SLAC on the Federal Budget, and on the subsequent meetings.

Let me first turn to a survey of what SLAC, with your help, has accomplished during the last year.

To begin with, let me cite some very impressive numbers: The SLAC beam was on for 3,171 hours. This is 83% of that which was scheduled — an excellent record for reliability of performance, considering the over-all complexity of the SLAC accelerator, the traget area facilities, and the experimental equipment. What is even more impressive is the fact that we ran on the average three experiments simultaneously, so that the effective experimental use was well above 9,000 hours. As you know, the SLAC beam is time-shared among several experimenters, each of whom can program their intensity, energy and other beam variables according to the requirements of his own experiment.

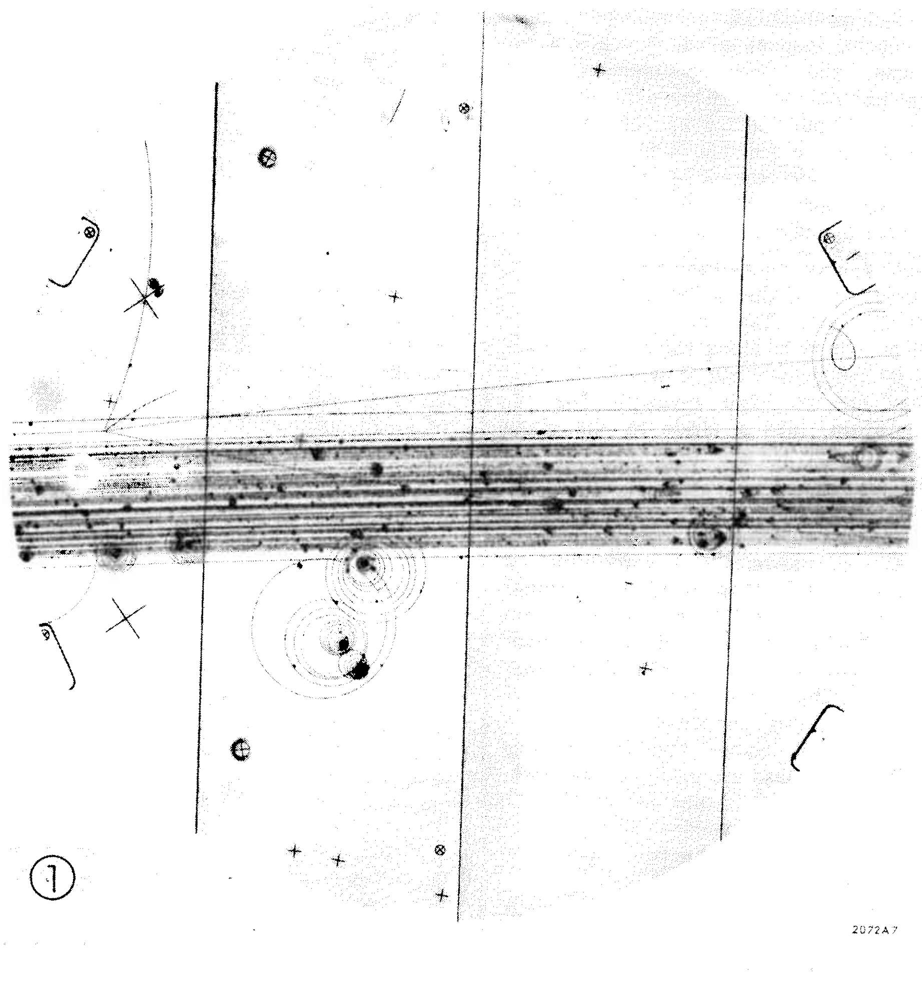
We turned out 4½ million bubble chamber pictures of which most went to outside users. Our bubble chamber production has been so prolific that several other AEC-supported laboratories have agreed to close down some of their less efficient chambers and to concentrate production at SLAC (and to a lesser extent at Brookhaven) in order to fulfill the needs of the various research people across the country who are involved in bubble chamber picture analysis. The April and May cycle was particularly productive; it was a single, continued operation during which 2 million bubble chamber pictures were produced in 6½ weeks and where 32 experiments were given running time.

However impressive such numerical statistics might be it should be recognized that what we are interested in are physical results: The future of SLAC depends even more on really exciting and important discoveries than it does on a sustained output of reliable measurements. I am happy to say that last year was a very good one from the point of view of physics research output also; again let me give you some highlights.

During the "All Hands" lectures of last year Professor Drell told you about some of the exciting experiments on inelastic electron scattering. In these experiments SLAC's electron beam is aimed at liquid hydrogen targets in End Station A; the spectrometers located there measure the distribution in energy and angle of electrons which have undergone reactions in the hyrogen target. The experiments revealed that there is an unexpected excess of particles scattered at the larger angles; from this we were able to conclude that it is very unlikely that the proton and the neutron — the fundamental constituents of the atomic nucleus — are smooth, uniform structures; rather it appears that a model, to use Drell's phrase, which makes the proton look like "raspberry jam full of seeds" is much more satisfactory in describing the data. During the last year we have elaborated greatly on these spectacular findings — both theoretically and experimentally. Theoretically our understanding of these remarkable experiments has been deepened but it is by no means complete. Experimentally several groups in the laboratory have studied other details of these inelastic electron scattering experiments.

Let me remind you how simple in principle the past inelastic electron scattering experiments have been. After the incident electron beam has struck a hydrogen target many things can happen. However, the experiments by the MIT/SLAC collaboration, on which the conclusions outlined by Dr. Drell's lectures were based, took a look only at the electron which had done all the "damage" to the proton; the experiments did not look at the "damage" itself, that is, at the fragments which the impact of the electron on the proton produced. During the last year experiments have become more elaborate, so we can look in more detail as to what really has happened to the proton. Group A did an experiment in which a second spectrometer looked at some of the products of the reaction, while the first spectrometer looked at the scattered electron. A collaboration between Groups A and B has undertaken a very elaborate experiment in which a beam of mu-mesons generated in End Station B hits hydrogen atoms in the 40" bubble chamber; mu-mesons are particles not found in nature bug which behave very much like electrons although they are heavier. The photograph of an event in the bubble chamber such as the one shown in Figure 1 can tell you in detail what has happened in the collision because everything which is produced can be seen. However, to make this experiment work some major technological advances had to be made. Primarily the bubble chamber had to be made to pulse, that is to expand, at a very high rate. The bubble chamber group has reached a rate of almost 10 cycles per second. This is an enormous achievement since in the past bubble chambers have been designed to expand only once every few seconds. When you run a bubble chamber this fast it is obviously impossible to take photographs on every expansion or else you will end up with so many pictures that all the scanners or physicists in the world could not handle them. Therefore an ingenious method was devised in which a combination of other particle detectors was added to the bubble chamber to search for the particular events of interest and then tell the cameras of the bubble chamber whether to take a picture or whether to "let that one go by." This new development, which we call the "hybrid bubble chamber" technique, is one of the important technical advances made by SLAC during the last year.

One reason why these experiments are so complicated is that the study of inelastic electron scattering is more or less like looking for a needle in a haystack; by this I mean that lots and lots of things happen when electrons hit hydrogen which are not interesting at all; what the experimenter has to do is to pick out of the morass of all events those things which are really interesting. Group E and the cryogenics people have developed an ingenious way to simplify this problem: They devised a method in which a very thin-walled pipe made of superconducting material is suspended in a magnet. A superconductor is a piece of material in which electric currents continue to flow once they are started without needing any external source of power. For superconductivity to work the temperature must be very low; Group E's superconducting pipe consists of a very thin-walled, multi-layered pipe of Niobium immersed in a bath of liquid helium which maintains a temperature of more than 400° F below zero. This pipe screens out the magnetic field inside its bore, while outside the magnetic field is essentially normal. As it turns out, the uninteresting events are usually generated in the forward direction, while the events we are interested in produce particles at larger angles. Therefore the pipe captures most of the "dull" events and leads them away. To day it another way — Group E has devised a means to look for a needle in a haystack by stuffing the haystack into a pipe and having the needle left over. Finally, Group D, in cooperation with people from the University of California at Santa Cruz, has started to work on these studies also, using the large streamer chamber; these experiments will start later this year, but a large amount of preparation has already been made.



I thought that describing this kind of work might be of interest because it illustrates how scientific work at a laboratory of this kind develops. Nobody "planned" this series of experiments several years ago. However, after the work of the MIT/SLAC collaboration produced results which surprised everyone and which upset the views of the physicists about what they thought the inside of the proton looked like, many of the experimenters "rallied around" and devised a variety of methods to examine these new phenomena in further detail. This pursuit has become particularly successful because the arsenal of instruments which had been developed at SLAC was sufficiently flexible so they could be adapted to aid in this broader look. Thus it is the physical results themselves, rather than any central planning, which is the largest force in guiding where SLAC's program is going.

I do not mean to imply that all of SLAC's physical research program was dedicated to following up the "seeds in the raspberry jam" model of the proton. Many other things have also been going on. Several experimental groups, in particular Group F, have made important contributions to the study of the interactions of extremely high energy X-rays with the proton; they have put on more quantitative footing some of the relations between the photon, which is the physicists' description of the bundle of energy which is transmitted in high energy X-rays or in light, and other particles in nature.

Experimental Group B did many things which turned out to be exceedingly important but which at the time when SLAC was started we did not expect to be SLAC's "strong suit." Group B built a wire chamber spectrometer which is a combination of a large magnet surrounded by a number of magnetostrictive wire spark chambers which trace how particles have come through the magnet. By this means Group B was able to elucidate on some of the excited states of the nucleon and mesons. As a result of these successful experiments we have decided to go forward with constructing a very large wire chamber spectrometer incorporating many novel features. This device, called LASS, will take about two years to construct. I am giving this example to indicate that even in fields of physics which do not involve electrons or photons at all, and which are therefore in direct competition with the work of other laboratories, SLAC has done some exceedingly valuable work.

Experimental Group G also did some exciting things: They dug a big vertical shaft in the embankment behind End Station A and installed equipment in this shaft to study the elusive neutrinos, which are particles so penetrating that they can go through the whole diameter of the earth without being significantly affected. These experiments were motivated by speculations that possibly new, undiscovered kinds of neutrinos might be formed in a target struck by SLAC's electron beam. After some initial excitement it now appears that the result of this search was negative: The neutrinos generated in SLAC's target seem to be no different than anyone else's neutrinos! At the same time Group G has done an experiment in which the decay of one of the neutral unstable particles which are being produced in SLAC's targets — the so-called neutral K particle — is being studied to an unheard of degree of accuracy. This experiment was concluded in the last cycle and will give some important results to increase our understanding of some of the basic symmetries existing in nature. Again I am giving you this illustration not to explain in detail what has been happening – there

Talk of March 28

is not enough time for that — but to illustrate the contrasts in SLAC's program. On the one hand we occasionally do some very speculative work to search for things which may or may not exist, but if they do exist would change our whole view of nature. On the other hand we make measurements, usually very precise, which fill in gaps of our knowledge about phenomena which have already been cursorily explored. A laboratory like this must balance these two kinds of activities; the initial exploratory, often speculative, work on the one hand, and the generation of solid data on the other.

Much of this work would not have been possible without the many improvements on the accelerator which feeds all the experiments. During the last year operation of the accelerator has been made more flexible, thereby increasing the number of simultaneous experiments we can run. The control rooms have been changed; the first steps have been taken to pull the two control rooms together so operation can be concentrated in the Main Control Center (which is the new name we have given to what used to be the Data Assembly Building near the switchyard). By the middle of this year we hope to be running the present Central Control Room entirely by a computer which will get its instructions from another computer located in the Main Control Center, which in turn is responsive to the instructions from the operators. Many ingenious innovations have been designed and installed to make these changes possible and which aim at substantially increasing our ability to support the large variety of "customers" who wish to use SLAC.

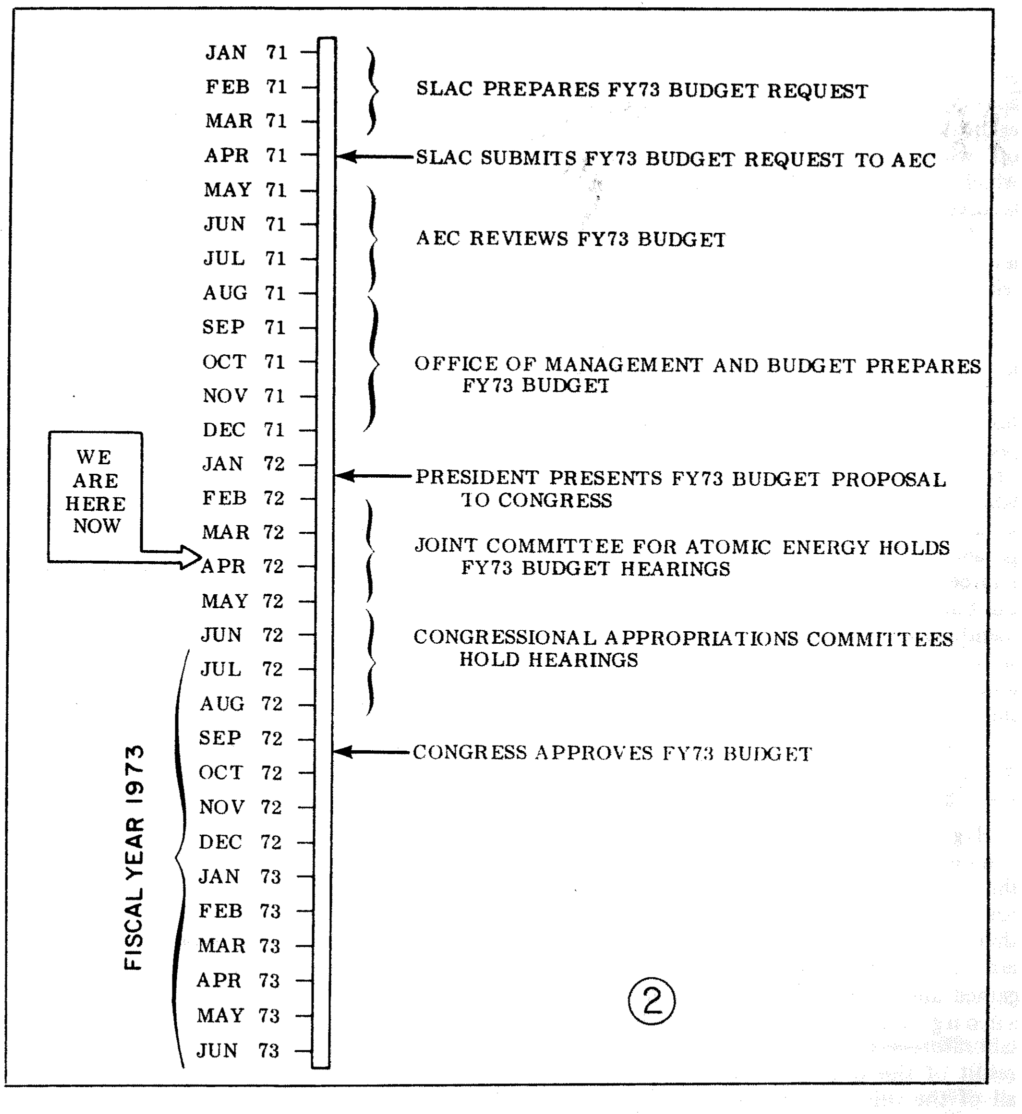
All these achievements of the past year have been accomplished in spite of the fact that SLAC (together with most of the rest of the country's research facilities) has suffered both from inflation and from cutbacks by the Federal Government in research funding. Before taking a look at our future in the high energy physics field, I would like to discuss our budget and some other financial questions.

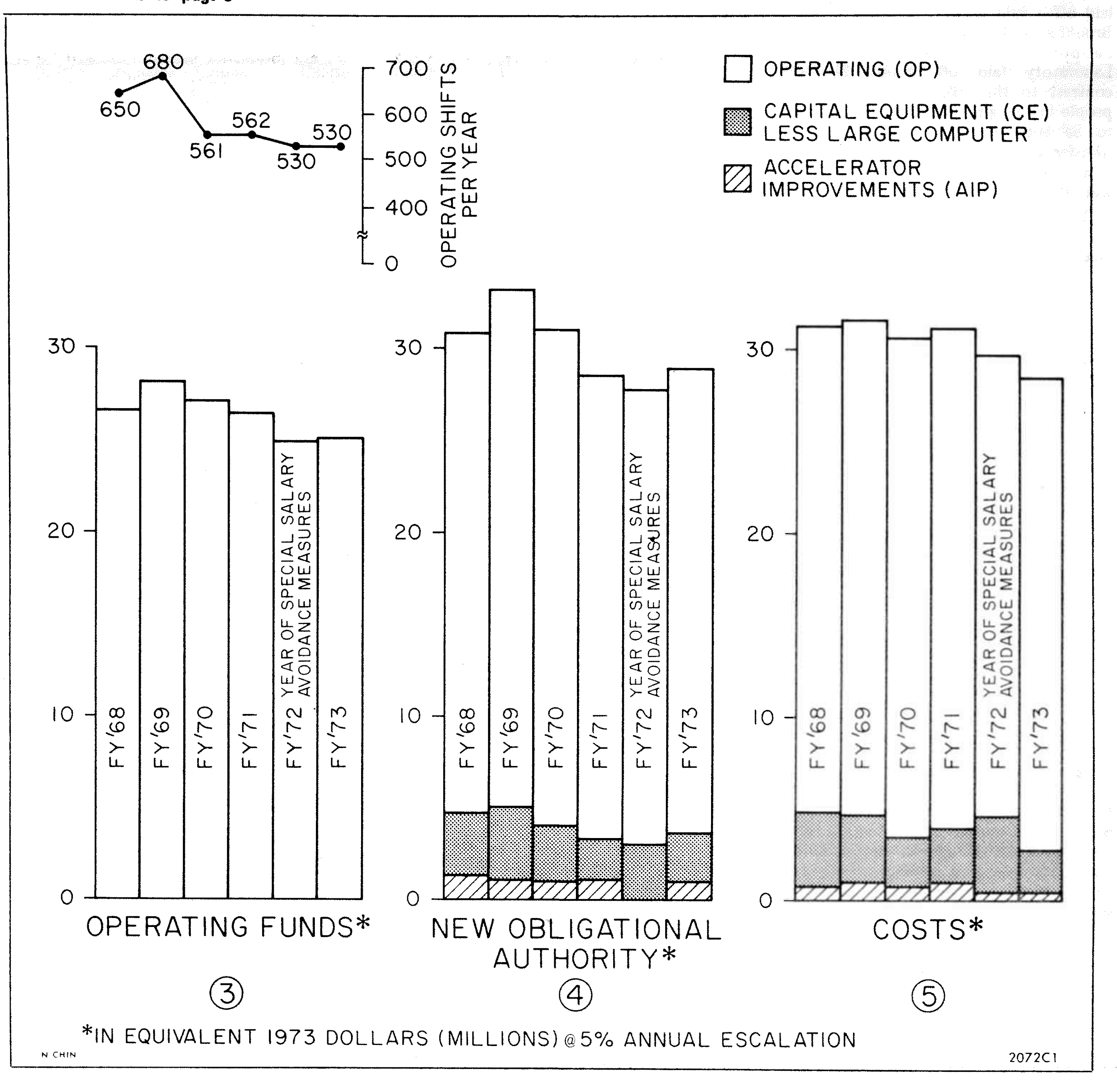
During my talks last year I gave you a forecast of SLAC's prospects for the year to come, and today I want to do the same thing for the year now ahead of us. My forecast for next year is more optimistic than the forecast I made for this year because of the budget proposed for us in President Nixon's message.

The question is often asked why I can never be more definite in telling you precisely what SLAC will be doing in a coming year. There are two reasons for this uncertainty — one is the very nature of our work here, which thrives on the uncertainty brought by new discoveries, and the other is the time cycle of the budget processes of the Atomic Energy Commission within the U.S. Government. The fiscal year of the government starts July 1 of each year; the laboratory submits a budget to the Atomic Energy Commission outlining our needs sometime in April of the preceding year, that is, 15 months before the fiscal year starts. In a fast-moving field like high energy physics many things can happen during those 1¼ years! The Atomic Energy Commission reviews our budget request and then transmits it to the Office of Management and Budget, which is the over-all budget authority within the Administration. This office, the "OMB," produces the over-all Federal Budget which is then announced in the President's Budget Message to the Congress (given this year on January 24, 1972). Even that is not the final budget for SLAC, because the Congress still has to approve it. The Joint Committee on Atomic Energy holds hearings, usually in February and March; and the Appropriations Committee of the House and Senate hold still further hearings throughout the spring and sometimes into the summer. Final Congressional approval is usually not given until the fall of the year — this is several months after the fiscal year has started. The slide (Figure 2) indicates how the budget timetable is made up. All this means that in running the laboratory I do not know exactly how much money we will have for a given year until a substantial fraction of it has already been spent. Nevertheless, from past history we can judge reasonably well what actions the Congress might be expected to take (although of course there can be surprises). Based on this past history, and on the reaction of the Joint Committee on Atomic Energy to SLAC's work, I assume that next year's budget for SLAC as announced in the President's Budget Message will remain essentially intact throughout the Congressional process; however, this is only an assumption, not a certainty.

The SLAC budget as included in the AEC's total program for the next fiscal year is higher than the one for the current year by approximately the amount corresponding to continuing inflation.. The next slides (Figures 3, 4 and 5) show some comparison of the past year's budgets and those of the 1973 fiscal year, which begins July 1st. From these charts you can see that the total effort which we can spend will be roughly the same next year as this year, if this budget is approved. This means that our permanent manpower will not have to decrease much further, at least not by an amount which cannot be taken care of by not filling

Cont. to page 6





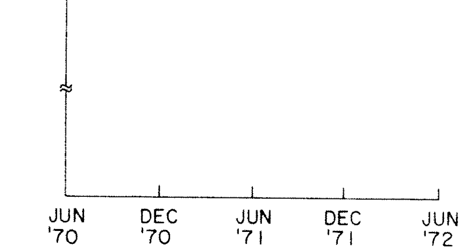
Pief's Talk (Cont'd)......................

some of the vacancies as they naturally occur. However, transfers among job categories will be necessary owing to the changing nature of our program. It will also not be necessary, if the budget is approved without change, to consider again the kind of special program of days off without pay and deferral of raises, which we engaged in last year to keep layoffs at an absolute minimum.

This brings me to the subject of layoffs. The laboratory has been flooded with a large amount of misleading and outright incorrect information on that subject; therefore I would like to explain to you precisely what transpired last year and what we may reasonably anticipate for the coming year in light of the proposed budget. You can see from the previous charts that last year the laboratory's budget was cut sufficiently so that we had to face the unpleasant prospect of either laying off a substantial number of people, or else of distributing the burden of this budget cut among the members of the staff. At the same time we continually have to realize that in the long run the health of the laboratory and the fortunes of its entire staff will depend on our productivity, that is, how much good work in high energy physics we are turning out.

High energy physics is a very competitive business. It speaks well for the record of SLAC -- and I am grateful for all your contributions to this record — that in spite of our relatively recent arrival on the scene our laboratory has gained and maintained its strong position among the high energy physics laboratories in the United States. As a result of the financial crisis of last year, all of the other laboratories of the AEC laid off a substantial number of people. Brookhaven had to lay off about 150 people and the Argonne National Laboratory laid off about 200. In contrast to this, SLAC advised several people in the spring that they might have to be laid off; efforts were made to transfer as many of these as possible, and as a result only a few people had to be laid off at SLAC.

The next slide (Fugure 6) shows that we did, however, reduce our staff. This was done by a scheme which I might call



attrition management. By this I mean that whenever someone left voluntarily for personal reasons, be it family relocation or moving to another job, then we either didn't fill the vacancy at all, or else we tried to find someone else in the laboratory who could be transferred to that spot. Of course, this plan does not always work; sometimes there is no one at the laboratory who fits the new slot, and sometimes it is impossible to leave a particular position unfilled if it is critical to our work. In decreasing our staff by attrition this way, rather than by layoff, we could not, of course, plan very precisely ahead because we could not know in advance where vacancies might occur. It is for this reason that on February 9, 1971 I included the following statement in my talk:

> "The number of people on the SLAC payroll will have to be reduced by approximately 40. It is hoped that most of these will be taken care of by not filling jobs which become vacant by the departure of people who leave on their own accord or by transfer to other jobs at Stanford. Hence we hope that the number of involuntary separations will be very small indeed."

I am happy to say that we were able to deliver on this promise. It speaks well for the cooperation which we have received from employees, supervisors and group leaders that we have been able to decrease our staff as shown in the slide with very few involuntary layoffs. In short, we consider our success in avoiding layoffs to be a result of your willingness to accept the program of last year, together with cooperation from all parties, and we are proud of everyone for having made this possible. Since the proposed budget for next year looks tight, but manageable, I see no need for a repeat performance of last year's efforts, so, together with my explanation, I simply would like to express my thanks to all of you at this time.

What does all this mean about our future experimental activities? It means for the immediate future that work will continue at approximately the same level as last year, but with a number of changes. First, SPEAR — the electron-positron colliding beam ring — will come into operation; tests will start in April. Burt Richter has given you a number of talks as to what SPEAR is all about, and therefore I will not tell you about that again. I just wish to say that SPEAR is going to be one of the unique tools of modern science, and it will increase even further the demand of outside physicists to use our facilities. During the coming year we will have some real problems in that the total number of physicists who want to use SLAC will greatly exceed our ability to give them all they want. This will be true in spite of all the improvements which our electronics, EFD and accelerator people have made in supporting many experiments simultaneously and in changing experimental setups. This is both good and bad; it is good because this increased demand publicizes both SLAC's contribution to an ever-widening community and the need of that community for SLAC. It is bad because the pressure on all of us to perform on a tight schedule and the problem of coordinating a highly diverse set of activities is going to become even more severe. At the same time, if your past work is any indication, I see no real problems about next year being an even more productive year than last.

As far as prospects for experimental activities beyond next year are concerned, the future looks very good. We hope to install a new generation of central computer facilities. We have submitted to the Atomic Energy Commission plans to double SLAC's energy by a device known as a Recirculating Linear Accelerator (RLA). My next slide (Figure 7) shows approximately how we will do this: We will accelerate the electron beam, as usual; then, however, before delivering it to the physicists, we will store it in a loop in which the electrons are stored for 122 revolutions. While the electrons are being stored in this loop the accelerator gets ready for its next pulse, and we then take the stored electrons and re-insert them into the main accelerator and accelerate the beam again. Thus we get twice as much energy from the same machine. These plans involve a substantial

construction project — recirculating involves a great deal of civil engineering and construction, magnet design and fabrication, vacuum systems, cooling systems, instrumentation and control, mircowave and electronic engineering, etc. Although we cannot be sure at this time whether construction of this major step in SLAC's life will be authorized and funded, I feel very encouraged that we will get the green light to proceed with this new venture next year.

In addition to this major leap forward in SLAC's energy we are also going to increase the energy of SPEAR from its initial value, above 2 BeV, to about twice that amount, thus again increasing the power of SLAC's tools.

These two projects — SPEAR and RLA — illustrate our double-pronged approach to our future. SLAC is going to maintain leadership in two directions:

1. The design, construction and exploitation for high-energy physics of electron accelerators.

2. The application of colliding-beam storage rings to high energy research.

With your help I have full confidence that SLAC will retain leadership in both of these fields for the foreseeable future.

The Neutron

(Reprinted courtesy of New Scientists, 17 February, 1972)

When a pion an innocent proton seduces
with neither excuses
abuses
nor scorn
for its shameful condition
without intermission
the proton produces:
a neutron is born.
What love have you known,
O neutron full grown,
as you bombinate into the vacuum alone?
Its spin is a $^{1}2$, and its mass is quite large
—about one A.M.U. — but it hasn't a charge;
though it finds satisfaction
in strong interaction,
it doesn't experience coulombic attraction
But what can you borrow
of love, joy or sorrow,
O neutron, when life has so short a tomorrow?
Within its
twelve minutes
comes disintegration
Which leaves an electron in mute desolation
and also another ingenuous proton
for other unscrupulous pions to dote on
and last, a neutrino:
alas, one can see no
fulfilment for such a leptonic bambino—
no loving, no sinning—
just spinning and spinning—
eight times through the globe without ever beginning...
a cycle mechanic—
no anguish or panic—
for such is the pattern of life inorganic.
O better
the fret a
poor human endures
than the neutron's dichotic
robotic
amours

Gina Berkeley

Survey Report(Cont'd)..

communication is a problem in several areas at SLAC. It takes multiple forms, notably poor communication between middle level management and employees (lack of information, misinformation, fear) and poor communication between groups ("reinvention of the wheel") doing similar work.

It seems clear from JMC Survey results that the Job Mobility Committee should not limit itself to recommending a single program aimed at benefiting a pilot number of minority and women employees but should in addition propose a spectrum of practical programs to provide increased education and training opportunities for all SLAC employees and to effect a stirring of the job pool at SLAC. Greater job mobility within SLAC and the larger University job market is absolutely essential to provide increased job opportunities for any significant number of employees at any level. Each JMC program should be coordinated with or integrated into present programs, should be designed to give the greatest possible motion with the least red tape, and the greatest possible increase in direct management-employee and group-to-group communication in the laboratory.

Many such programs have indeed been suggested directly or indirectly by respondents in the JMC Survey and are presented as recommendations in this report.

RECOMMENDATIONS ON EDUCATION AND TRAINING

1. It should be clearly stated to supervisors at all levels, not just to group leaders, that it is SLAC policy to encourage employees to participate in programs of education and training.
2. As many classes (short and long-term) as possible should be offered at SLAC during noon and after hours so that as many employees as wish may actually participate without having to seek their supervisor's permission. More than one session of a class should be offered if possible. This is particularly important in the case of long-term courses since the pressure of workload may keep an employee from successfully completing courses during working hours, even if he or she has permission to attend. At present, many employees would like to take advantage of educational opportunities which don't directly relate to their present jobs. Employees are also limited in the number of hours they can take off for job related class.
3. The SLAC Personnel Dept. is presently working on plans for more junior college level courses (Foothill Extension) to be given at SLAC. The JMC should act as an advisory committee to Personnel to ensure that the range of courses offered genuinely represents the expressed needs of the SLAC staff.
4. SLAC should continue to exert pressure on Stanford University to open freely its classes with credits to staff.
5. More attention should be given to the needs of women employees when educational and training programs are developed. This means actual participation by women at the planning stages. Women from the technical, administrative, and clerical staffs should be included with particular attention to representation for minority women.
6. SLAC employees who are experts in various fields (from technical typing to vacuum techniques) should be asked to prepare short courses which they could offer from time to time. This type of course has been found in the past to be particularly desirable in that it not only increases employees' knowledge about subjects that apply directly to jobs at SLAC but brings together persons doing similar work from diverse areas of SLAC and puts them in touch with a locally available expert.
7. A quarterly list (created from photoreductions of a paste-up of excerpts from original catalogs and listings) of various useful courses being offered in the area should be compiled by the JMC and published by Public Information. Such a listing would not include recommendations but would rather indicate availability and directions about who to see for further information and counseling if needed. A column in the BEAM LINE should regularly announce the publication of this list, give registration deadlines for local colleges, and information about all SLAC sponsored programs. Publicity is essential for creating an atmosphere in which employees feel encouraged to continue their educations.
8. Form a JMC Subcommittee on Continuing Education and see that these things are done.

RECOMMENDATIONS ON JOB MOBILITY

1. It should be clearly stated to all supervisors at all levels, not just group leaders, that it is SLAC policy to encourage transfer and promotion within SLAC.
2. The JMC should review the actions taken in filling SLAC jobs and should actively cooperate with the Personnel Department is seeking SLAC applicants for all SLAC openings. While it is neither possible nor desirable to fill every single job opening from within, the percentage so filled can be greatly increased if effective search and train policies are pursued.
3. The JMC should be prepared to uncover and work out the various practical details which impede transfer for all but the very determined. (a) transferees should somehow be guaranted a chance to return to their old jobs or to a comparable job if transfer doesn't work out. (b) The step-4 salary barrier should somehow be overcome. (At present, employees who have advanced beyond the step-4 level in their pay range into the merit pay area may be penalized in some transfer situations by having to drop back to step-4). (c) The problem of non-release should be examined. (d) The complaints about the Personnel Dept. handling of "inside" applicants should be examined.
4. All job postings at SLAC should include the names of supervisors and groups, and possibly a list of job classifications from which applicants would be appropriate (inclusive rather than exclusive). The JMC should review all job descriptions for wording which encourages rather than discourages applicants. An experimental "job market" might be tried in which supervisors would personally describe openings and answer questions at a noon-time public meeting. Lists should be maintained by Personnel Dept. of employees who wish to be notified directly of appropriate job opportunities and this service should be amply publicized. Stanford University job openings should be, at least, posted and promptly.
5. At present, supervisors who encourage employees to apply for transfer or promotion may be doubly penalized by not only losing an experienced worker but by being unable to refill the job slot under current head-count restrictions. Some head count bonus system should be considered in which a vacancy due to internal job mobility can automatically be filled if an internal applicant can be found. Perhaps some further reward could be found for the supervisor who encourages transfer for a deserving employee. (Supervisors who take a non-punitive attitude toward transfer for their employees are at least more likely to learn in advance of such events and have time to plan and train for them).
6. Provide recourse for women with job bias problems perhaps by enlarging the scope of the Minorities Affairs Committee (MAC) to include women (MAC has already established its effectiveness and is accepted by SLAC employees), or by including these special job bias problems within the scope of the JMC.
7. All JMC programs should involve women employees in both planning and participation. Minority women should be represented. All JMC Subcommittees should have women members. A technical woman should be added to the advisory committee for the Skills Training program. Technician trainee slots should be available for women and an active program of recruitment for these positions should be carried on at SLAC. Advice and aid should be sought from SLAC's women technicians. Postings for all skills training program and job mobility positions should specifically state that applications from women are encouraged.
8. The JMC should explore the possibility of a "JOB EXCHANGE" which would allow experienced employees (perhaps those who have been in their jobs two or more years) the possibility of trading jobs for a year or more with some other employee doing similar work at a similar salary. The JOB EXCHANGE might be similar in mechanism (though not in purpose) to a dating bureau. Interested parties sign up, Bureau provides a list of suitable matches (or advertises), the individuals work out the details on their own (with permission from supervisors, counselling, if needed, and paperwork by Personnel Dept.). The aim should be to do it all as directly as possible with as little red tape or third party interference as practical.

A pilot program should be proposed and if possible a test case exchange or two carried through.

9. A number of JMC survey respondents mentioned the desirability of maintaining updated personnel resumes in a computer database so that a SLAC-wide search could easily be undertaken when openings occur.

Such a project would be a very large undertaking but probably should be at least considered by the Personnel Department. The SPIRES II (Stanford Public Information Retrieval System) scheduled for operation June 1972 would provide all the necessary information retrieval and file protection facilities for such a personnel data bank so that costs would not include any for basic system development or programming. However, the worth of such a databank would be totally dependent on the information which went into it, "garbage in, garbage out" still being the most important law of information retrieval. Developing non-garbage about the current state of people's job skills is not a trivial problem. Whether the results would be worth the effort is not clear.

SLAC Organization Charts

If you wish to have organization charts, please pick them up in Room 233 A&E Building. There is not a superabundance of these charts, so please plan to share.

Opera-Lovers

The San Francisco Opera Association is offering an outstanding selection of operas on the occasion of its Golden 50th Anniversary. The selection of music together with the number of outstanding artists make this upcoming season truly exceptional by any standards. When have we last had the opportunity to be present at such feasts as the complete Ring des Nibelungen, Lucia de Lammermoor, and Norma; to name just a few! For brochures or more information, write: San Francisco Opera Association, Opera House, San Francisco, 94102 (number 861-4008, ext. 201).

For opera lovers at SLAC who would like to do some ticket-swapping (for instance if you've bought a season ticket but don't wish to see all the operas), or possibly exchange records, please call ext. 2351 and ask for Jerry Renner.

Back-Pack Trip

WANTED: 12 or 14 ardent SLAC back packers or peak freaks to dust off dull winter's sloth and get it together one week-end soon for a good stiff work-out in the mountains. At this time of the year the aroma of spring wildflowers in the Sierra will bowl you over. And the spectacle of the spring run-off will undoubtedly blow your mind completely. We'll take everything we need with us in our packs; food, warm clothing, cooking utensils. So let's do it then. Either the last weekend in May or the first weekend in June. For more detailed information call Patrick Colgan at Ext. 2552.

Pets: A No-No

The BEAM LINE was asked by a trembling caninophobe to check SLAC policy concerning pets at SLAC. We found no explicit policy except that absolutely no pets are allowed in buildings. So in the interest of all, please try to leave your pets at home.

Clouds

by Kimo Welch

Oft perceived as scattered, fluffy fragments,
Moving slowly to man's eye —
Retaining form on your journey
Though your ragged edges scrape bue sky

Invulnerable to man's tiny winged arrows,
Immortal cloud in your reincarnation
As a wisp of smoke lost to a breeze
Or a gigantic darkness covering a nation —

In anger joined by close companions,
Wind and lightening and thunder's sound,
We observe your onrush from above and below
Though future will is yet to be found —

No pattern the same, by no constraints are you bound —
The power of life in you keep,
But seeing this earth in her thirst for your blessing
You often have pity and weep.

To reach out, touch you and shape you with hand,
Your beauty to covet as mine —
But you part and are gone with a noble dignity,
That which one covets, not to find.

Soft cloud with all of your hues,
From the deepest black to the most brilliant white,
Forgive my greed to touch you in your beauty —
'Tis possession enough to see you in your silent flight.

Less Land-More Tunnels

EDITOR'S NOTE: My associate editors questioned the relevance of this story to SLAC. According to Bob Gould, any future large developments at SLAC could well require total undergrounding by tunnel using little brothers of the machines described here.

WASHINGTON, D.C.— With the virtual disappearance of land available for aqueducts, power and utility transmission lines, highways and other transportation modes, the federal government has asked the National Academies of Science and Engineering to serve as a focal point for underground tunnelling technology.

In an attempt to stimulate new technology and disseminate existing information on such things as water cannons, rock melting lasers and automated boring machines, Dr. Edward E. David, Jr., the President's Science Adviser, asked the Academies to establish a National Committee on Tunnelling Research and Technology.

Dr. David said that as surface area becomes scarcer — particularly in populated areas — and as land values increase, tunnelling will become increasingly important. Specialists foresee new applications for tunnels and other underground structures which range from utility and transportation routes such as subways to shopping, parking and industrial sites.

Experts estimate that new techniques developed here and abroad can reduce the cost of tunnelling by as much as 30 percent in the next 8-10 years. These include new ways of lining, supporting and boring tunnels in more-or-less continuous processes.

In addition to the enhanced aesthetic values when utilities and roads are underground the experts point out, there is a good possibility that some forms of air pollution can be better managed there than at present.

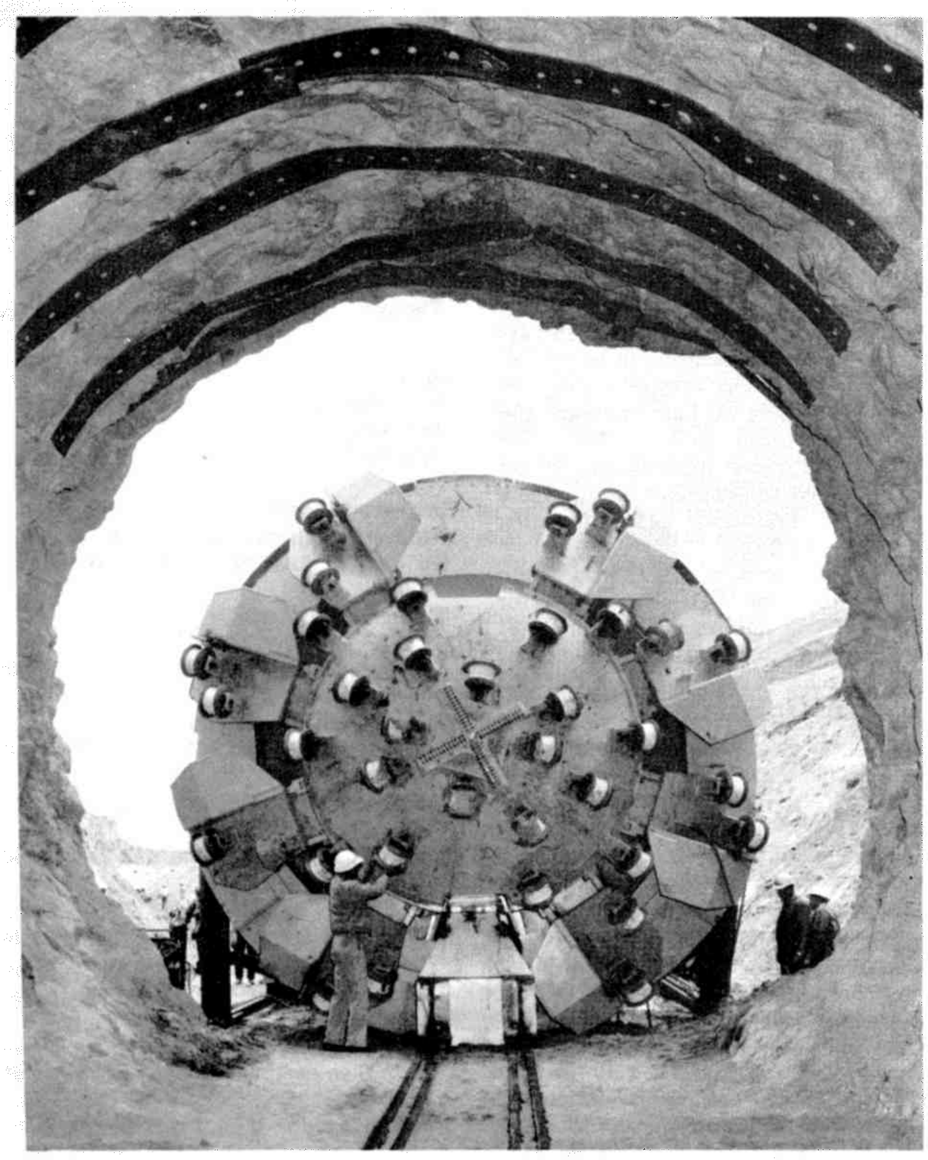
Tunnelling specialists believe that transportation tunnels, for instance, can be vented in such a way that air pollutants can be concentrated and discharged into the atmosphere at preselected points where their environmental impact would be minimal.

The selection of the Academies as a focal point for tunnelling is designed to bring academic, industrial and professional skills to bear on the problems in a multidisciplinary way.

In addition, the Academies have long standing ties with specialists in other nations with whom they will be expected to work closely.

The concentration of expertise stems from recommendations of the Advisory Conference on Tunnelling of the Organization for Economic Cooperation and Development and the Interagency Committee on Excavation Technology of the Office of Science and Technology.

Southern Nevada Water Project — Nevada
Front view from above outlet portal of mole being moved into tunnel. The River Mountains Tunnel being built by the Bureau of Reclamation, will be a four-mile long, ten-foot diameter, concrete-lined tunnel. It will carry Lake Mead water from the east side of the mountains to Las Vegas Valley.



Tunnels — Navajo Indian Irrigation Project, N.M. Tunnel Borer is pictured prior to initial excavation at the outlet portal of a Tunnel on the Navajo Indian Irrigation Project near Farmington, N.M.

Encina Pools

SUMMER SWIMMERS
June 19 — August 31, 1972
10:00-12 Noon Daily (M-F)
5:00 P.M.-7:30 P.M. Daily (M-F)
12:00 Noon-5:00 P.M. Saturday and Sunday
(Pools closed September 1-27 for yearly maintenance)

Above program open to Men, Women and Children — Faculty, Staff, Registered Students, and all Summer Conference Members. All will be charged as follows: $5.00 per person for Summer Recreation Card. $1.50 per person for a weekly swim card. NO INDIVIDUAL SWIM PRIVLEGES. FURNISH OWN TOWELS.

NOTE: Summer Recreation Swim Cards may be purchased at the Department of Athletics after June 5. NO TICKETS WILL BE SOLD AT THE POOL.

MALE SUMMER SWIM PROGRAM
June 18 — August 31
12 Noon-2:00 P.M. Daily (M-F)
Open to Faculty, Staff, Students, Conference Men. NO CHARGE. Sons admitted if accompanied by fathers.

June 18 — July 28
2:00 P.M.-4:00 P.M. Daily (M-F)
Same as 12:00-2:00 P.M. except sons must leave at 2:00 P.M. This period corresponds to Coaching Camp Swim Hours. Males may use pool if they do not interfere with Camp personnel. NO CHARGE.