SLAC BEAM LINE

Understanding atomic physics is child's play compared to understanding child's play. — from "A Random Walk in Science," compiled by R.L. Weber.

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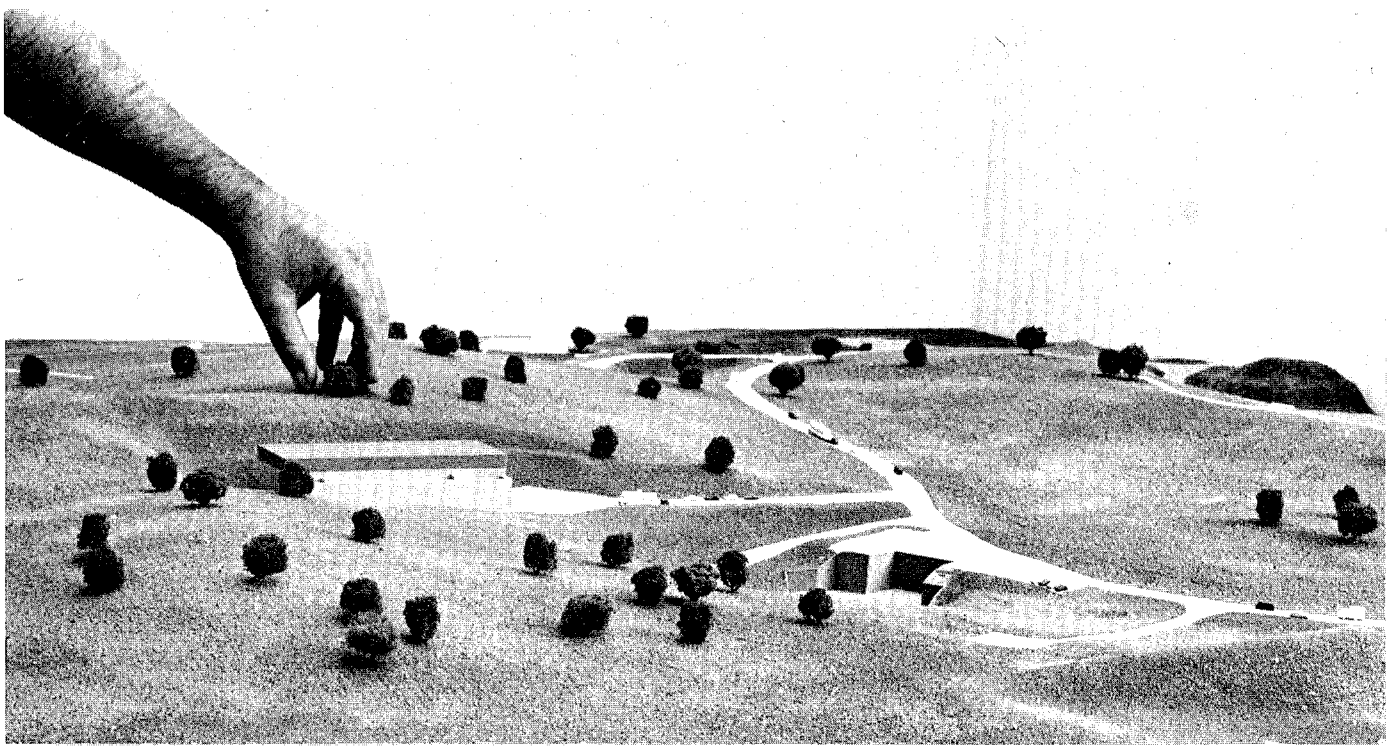
THE SLC IS APPROVED...STORY ON PAGE 2



SPRUCING UP THE SLC SITE

Actually these are oak trees which the hand of Glenn Hughes is planting on a scale model of the SLC site. The model, which will be complete from buildings to bay trees in about one month, shows the experimental hall for the SLC tucked into a slight depression in the hills at the east end of the site. The concrete walls at the center are part of Interaction Region 2 at PEP which had not yet been completed in the model.

An outside company built the model to a scale of about five hundred to one using accurate topographic maps prepared from stereo views of aerial photographs. A router in one arm of a pantograph cut into a block of polyurethane foam while the other arm traced the contours on the map. Fine sanding of the edges finished the shape and the rest was careful planting or placing of grass, trees, roads, and buildings. (Photo by Joe Faust)

THE SLC HAS BEEN APPROVED

The following is the public statement prepared by SLAC announcing the approval of the SLC.

A new kind of machine for studying subatomic physics has been approved for construction at the Stanford Linear Accelerator Center (SLAC). The new machine, called the SLC for SLAC Linear Collider, was included in an appropriations bill that was recently signed into law by President Reagan. The 112-million-dollar facility, which will be built within the present site, is scheduled for completion at the end of 1986.

The appropriation follows a complete and favorable series of reviews by the government and the scientific community over the past two years. SLAC Director W.K.H. Panofsky noted, "The SLC is the only new major construction project in science authorized this year. I am extremely happy that the project can now go ahead full speed."

In this new machine two powerful beams from the center's two-mile-long electron accelerator will be bent around and focused into a microscopic spot. One of the beams will contain electrons, while the other will be composed of positrons, the anti-matter twins of the electrons. When these opposite charges collide, the original particles are annihilated in a burst of energy from which new combinations of subatomic particles appear.

Electron-positron colliding beam machines have been one of the most successful techniques of particle physics in the past decade. Although the SLC will produce these collisions with the highest energy in the world, this machine is equally significant for its new way of making the beams collide.

The traditional method for producing these collisions has been with storage rings, in which magnets keep the two beams circulating in a racetrack pattern, passing through one another millions of times each minute. The linear collider fires its beams into one-shot collisions a thousand times less frequently, but makes up for this by squeezing the beams through a collision spot thousands of times smaller than possible in the storage ring.

The storage rings have been the most economical path to colliding beams at the lower energies. At higher energies, however, the storage rings must be made dramatically larger to compensate for the energy lost by the beams when they are bent into a circular path. A practical storage ring of the same energy as the SLC would be more than fifteen miles around and would cost over 500 million dollars. The much less expensive SLC, by contrast, fits comfortably on the present site.

At the higher energies being thought about for the next generation of electron-positron machines, the linear collider technique will almost certainly be required. It is the study of this growth of accelerators with energy that led Burton Richter, Technical Director of SLAC, to the ideas of the linear collider and to the SLC project.

The experimental program of the SLC will include the most exciting topics of high-energy physics. In the collisions at this energy, the weak force will overshadow the electromagnetic force that has been dominant at lower energies. The recently discovered carrier of the weak force, the Z^0, will be directly produced in these collisions. Thousands of these will be recorded each day, allowing a detailed study of this new particle.

Much of the project involves modifications to the existing linear accelerator to increase its energy by about 60%. New computer controls will steer the beam precisely. Two small damping rings, which shrink the beam size before acceleration, will be placed underground at the beginning of the linac. The biggest apparent new pieces will be the two underground arcs of magnets that will guide the positron and electron beams to the final collision point at the far end of the site. A substantial part of the construction work will be done by local industry and by subcontracts without large permanent increases in the laboratory staff.

The impact of the new construction on the neighborhood and environment has been carefully considered. Over the past two years several meetings were held with neighbors from nearby communities and with representatives of environmental organizations. The initial planning on the location of the new experimental hall was modified, to a large part in response to these concerns.

During the wait for final approval, research and planning has gone ahead. The modifications that would improve the normal operation of the linac have begun, and one of the damping rings has been completed. The project is ready to begin in earnest. According to SLC project director, John Rees, "We have a large construction bid package ready to start at the beginning of October. The project staff is enthusiastic and we're ready to go."

SLC CONVENTIONAL FACILITIES

At this writing the Energy and Water Development appropriation bill of the Federal Budget for fiscal year 1984 has just become law. In that part of the budget which will support the activities of the Department of Energy for the year is an item of great interest to SLAC: the appropriation for the initial construction work for the SLAC Linear Collider.

As most people here know, the engineering for SLC is well on its way. The electron damping ring is installed and operating. The positron ring is being assembled in the Light Assembly Building, the upgrading of the accelerator I&C is progressing, prototypes of the arc magnets are being tested. Tudor Engineering Company of San Francisco is preparing detailed drawings and specifications for the conventional facilities (the tunnels, the utilities, the buildings and the experimental area).

The first part of the conventional facilities work will go out for bid in July and a contract will be let in October. The excavation of the south arc of the collider will begin immediately. One part of this contract will be the excavation of about 120,000 cubic meters of earth for the experimental hall. Most of this earth will be used in shielding fills or shaped into stockpiles contoured to blend into the landscape. One notable stockpile has been named 'Mt. Rose.' It will rise 20 feet above the present ground level opposite the Sharon Park residential area. This work is scheduled for completion in the fall of 1983. When this sight barrier is completed, the excavation of the north arc will begin behind it.

The linac junction on both the north and the south side is scheduled for summer 1984. Equipment installation will begin in the south arc in the spring of 1984 and finish in the north arc in December 1985.

The contracts for the experimental hall, the building and the utilities will be sent out for bid in the spring of 1984 and the hall will be ready for occupancy in October of 1985.

The beam housing tunnels will be roughly 50 feet below the ground, following the generally hilly contour of the surface. The grade in the tunnels will vary up to about 8 percent which is rather steep. As presently conceived, the beam housing is a 10 foot high by 10 foot wide horseshoe with a concrete floor and shotcrete walls. Access to the beam housings will be via three sloping tunnels to the surface - one adjacent to PEP IR-4 , one near PEP IR-12 , and one adjacent to End Station B. Since these access tunnels are inside the arcs, the aisle in the beam housings must be on the inner side also.

Because the electron bunch from the damping ring travels down the accelerator behind the positron bunch, the north arc in which the electrons travel is 17.6 meters shorter than the south arc to permit the positrons to arrive in the interaction region at the same time as the

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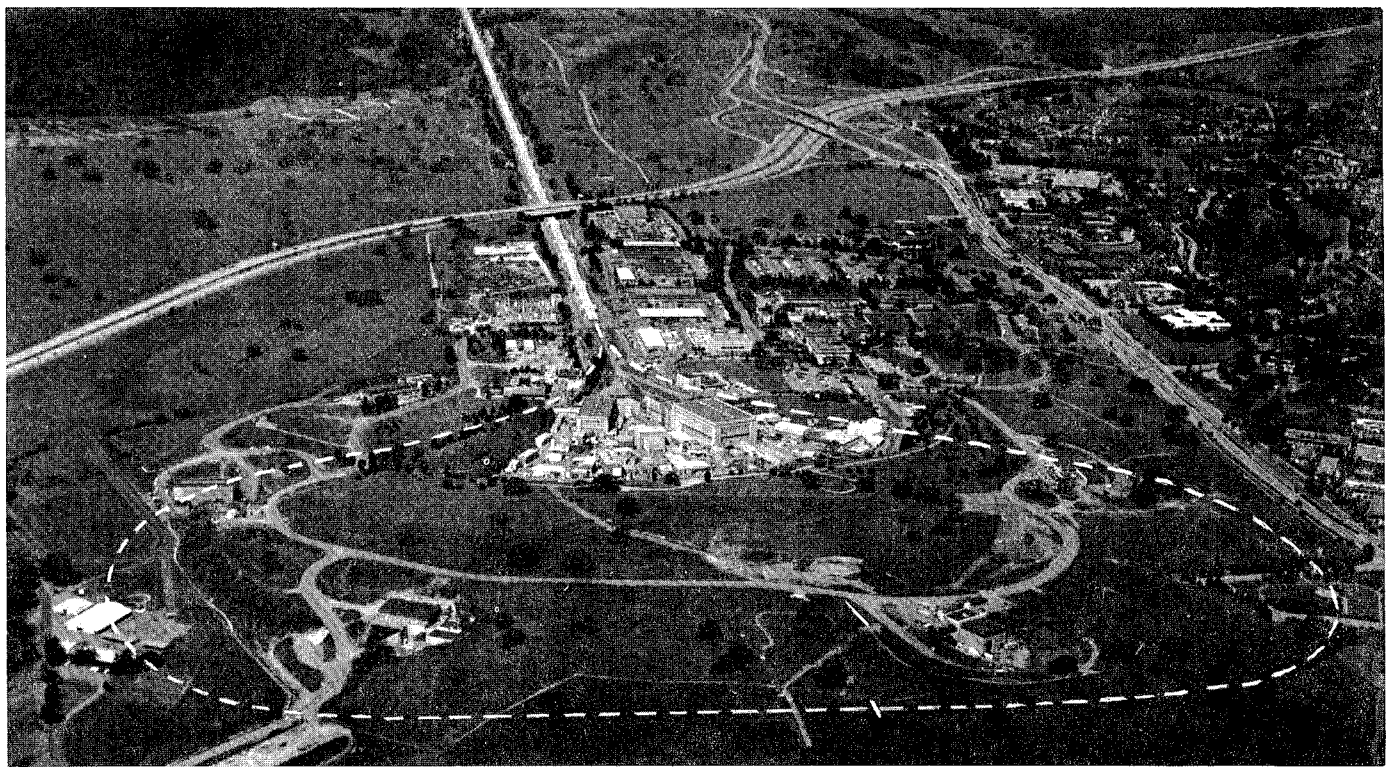
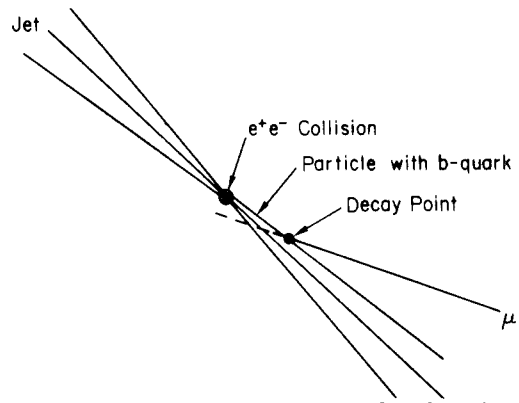


BEAUTY IS FLEETING — MEASURING THE B-QUARK LIFETIME

The MAC detector at PEP has reported the first measurement of the lifetime of particles containing the b-quark. This quark, sometimes called beauty, decays to lesser quarks in a millionth of a millionth of a second.

The experiment is based on events in which an electron and positron collide and produce two streams of particles. These groups of particles, called jets, leave the collision point in opposite directions, as shown in the sketch below.



The particles in these jets are made of various combinations of the five kinds of quarks, including the heavy b-quark. When a b-quark inside one of the particles decays to a lighter quark, the particle containing the new quark continues on while a muon, which is also produced in the decay, is thrown out of the mainstream of the jet. Following back the path of this muon shows that it was produced a small fraction of a millimeter away from the center of the detector. This offset depends on the distance traveled by the heavy particle before it decayed and is directly related to the lifetime of the original particle.

The MAC detector measures the tracks of the charged particles and a computer recreates a picture which is similar to the sketch shown above. This part of the experiment runs smoothly, but then the first tough question comes. How do you know that these decays come from a b-quark and not one of the other quarks? Fortunately, the b-quark is relatively heavy, so its decay muon is thrown out at a large angle to the direction of the original quark. A clean sample of b-quark decays can thus be made by selecting events with energetic muons at large angles. Electrons are an equivalent signal of a b-decay and such events can be selected in the same way.

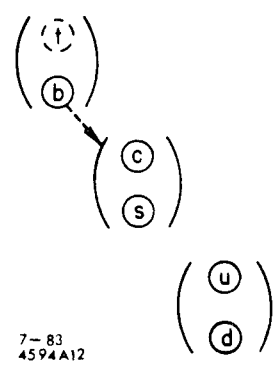
The second problem is that the decay distance is very small, a few hundredths of an inch. Even small measurement errors prevent a clear separation of the reconstructed track from the collision point for an individual event. An average of hundreds of such measurements, however, gives a statistically clear value.

The result is shown below in the form used in the scientific papers. The first number is the average value of the measurements, while the second and third are estimates of the errors in determining the average.

$$\tau_b = (1.8 \pm 0.6 \pm 0.4) \times 10^{-12} second$$

Quark Lifetimes

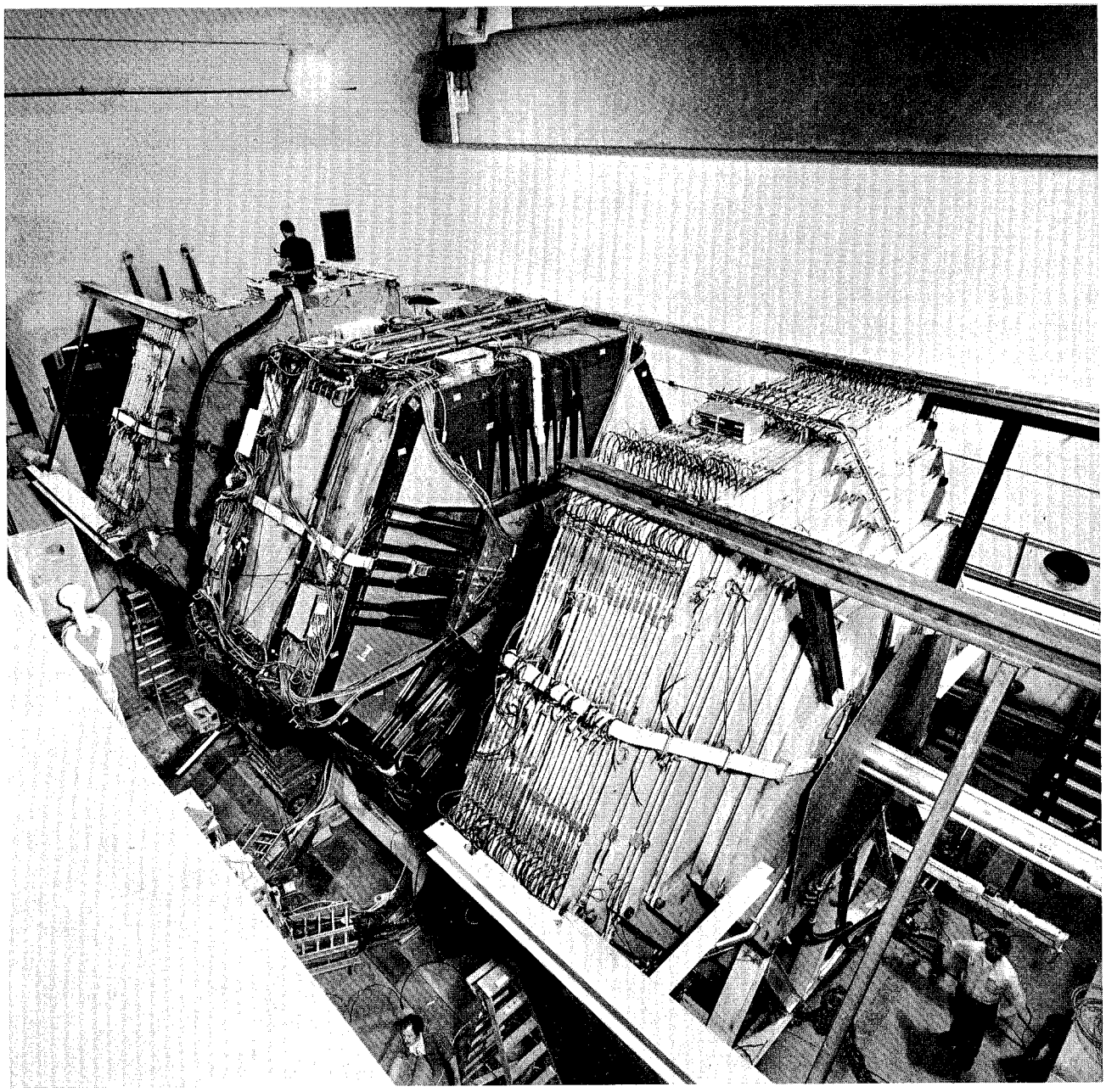
The present theoretical picture of high-energy physics is called the 'standard model.' Included in this model are six kinds of quark organized into three separate families or generations as shown below. The quarks near the top of the sketch are heavier than those below. The heaviest quark, the t or top, is included in the theory but has not yet been found.



The u- and d-quarks make up common heavy particles including the proton and neutron. The quarks of the other two generations appear in particles which eventually decay into those composed of the first generation quarks.

The mechanism which allows quarks of one generation to decay into those of another is called mixing. The amount of this mixing is determined by the lifetime for the decay of a quark from one generation to another.

The theory does not by itself predict the amount of mixing, but there are relationships among the mixing values, the quark masses, and other experiments. The b-quark lifetime can be related, in particular, to the mass of the t-quark.



The MAC Detector at PEP

The photograph was taken about three years ago as the MAC detector was being installed at PEP. The detector consists of a central section and two endcaps, which are separated here. Particles first pass through a drift chamber in the central region in which the tracks of charged particles are accurately measured.

A shower chamber outside the magnetic coil surrounding the drift chamber measures the energy of electrons and photons. The sandwiches of steel plates and thin chambers on the outside measure the energy of the remaining charged and neutral particles. This technique of calorimetry is responsible for the acronym of MAC, MAgnetic Calorimeter. The huge rafts of muon chambers which double the size of the detector were installed shortly after this picture was taken.

The experiment used all of the features of the MAC detector. The external muon spectrometer and segmented hadron calorimeter provided the muon signal. The central shower chamber detected electrons. The central drift chamber, which lies close to the interaction point, provided the precise track measurements.

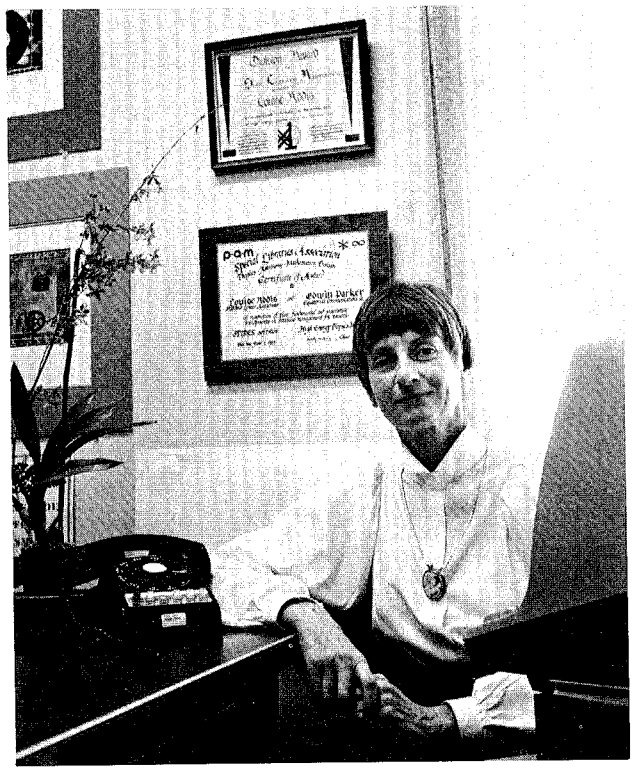
LOUISE ADDIS HONORED

Louise Addis has won the Division Award of the Physics-Astronomy-Mathematics Division of the Special Libraries Association. The 1983 award was given jointly to Louise and to former professor Edwin Parker of Stanford for the development of the Spires High-Energy Physics Data Base. This is the first year that an online computer database rather than a printed book was the basis of the award.

This award is one of the most important ways of recognizing excellence in scientific bibliography. The winners have demonstrated a high level of accomplishment in organizing scientific information and making it available to researchers. In 1979, for example, the award was made to the Particle Data Group at LBL for their publication "Reviews of Particle Properties."

The work behind this award began in the late 60's. The SLAC library was then fighting a slowly losing battle against the mountainous mass of information piling up and spreading about. Help came in the form of a computer system named Spires (Stanford Public Information REtrieval System) which was developed on campus in 1968 under the leadership of Professor Parker of the Stanford Department of Communication. After her first introduction to the Spires system, Louise realized how important such a computerized information retrieval system could be for SLAC.

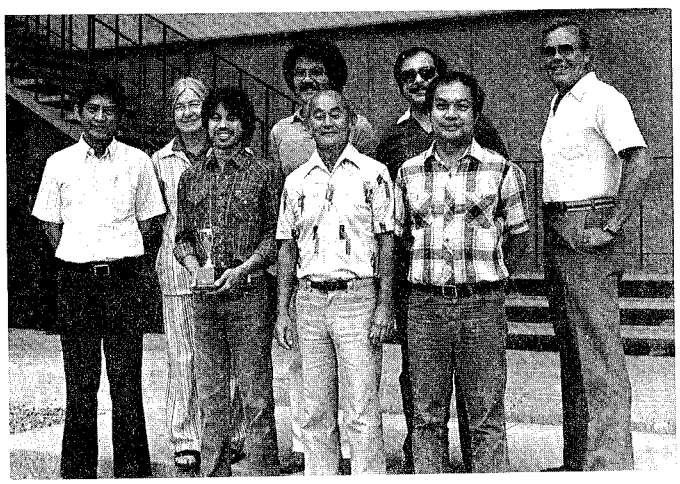
Louise set herself the goal of becoming a Spires expert and studied very hard to master the Spires software and, equally important, to understand the SLAC computer software and how it interrelated with Spires. And master it she did. Then she took on the formidable task of teaching Spires to her fellow librarians so that the first database could be built. Her well-stocked store of patience was almost exhausted when her colleagues began to catch on to Spires and the database began to grow rapidly.



The SLAC Library's Louise Addis is shown above in a rare offline moment. Her Division Award from the Special Libraries Association is in the frame at left.

The High Energy Physics file is now an online data base of more than 100,000 records and is a primary source of high energy physics bibliographic information that is used by physicists everywhere.

–RCG

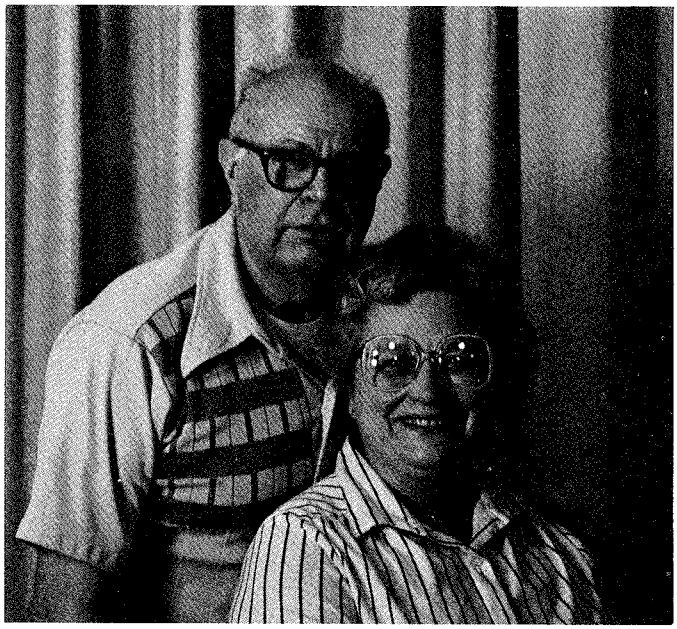


THICKER THAN WATER

The trophy for the highest relative number of donors at the June Bloodmobile at SLAC goes to the Drafting Group. The award was well earned as most of the participants are regular donors. Pictured at left are Romy Castro, Janet Crew, Gene Lete, Vic Itani, Harold Ito, Phil Caroselli, Gerry Vismanos, and Bob Laughead. The closest runner-up was LTR, the Low Temperature Materials Research Group.

The trophy is being engraved to honor the Drafting Group and they are eagerly awaiting all contenders for the next Bloodmobile contest. Won't you join in their generous effort?

–Nina Adelman



ROSS HAGEL RETIRES

After nearly twenty years at SLAC , Ross Hagel is retiring to spend more time at home working at his hobbies. Ross is a skilled woodworker and I'm sure he will keep the chips flying. Ross began here in the Klystron Department. When the research program got under way he transferred to Accelerator Operations, which has been his working home ever since.

One of Ross's most notable contributions to SLAC operations is our effective system of trouble reporting. It enables the operators to report problems to the engineering and maintenance groups and to monitor the effect of repairs. Parts of this system have been copied by other labs. Ross also helped set up a meeting in MCC of the operators, engineers and maintenance personnel to discuss the problems of the previous 24 hours. These meetings, which are frequently lively, have taken place every weekday that the accelerator has been in operation for more than a decade. The meetings have welded together a working organization of people in quite diverse departments at SLAC .

Ross and Jane Hagel call Peoria, Illinois their hometown. His early interest in radio and audio systems led him to start his own company in Peoria to sell and service audio equipment. He also worked as an engineer at a local radio station. He went to a college for a couple of years before joining the Navy at the beginning of World War II. Ross taught radio and radar classes at Treasure Island and then went on to teach instructors for Navy schools. Commissioned as a Lieutenant, he went to sea in both the Pacific and the Atlantic, surviving some harrowing experiences. After the war, Ross and Jane again set up in the Radio TV and Appliance business in the Peoria area.

But before long, having seen the bright lights of San Francisco during the war, they decided on a change of scenery. Lockheed extended job offers to both of them so they moved west. Ross later came to SLAC , but Jane stayed on at Lockheed.

Ross has many friends all around SLAC . He is able to work with just about anyone. We will all miss Ross, especially on Thursday. For years he and Jane have been providing pie and cookies for the operators on three shifts on that day. We wish Ross and Jane a fond farewell and best wishes in their new ventures.

–Vern Price

- SLC, continued from page 3

electrons. As a result, the SLC IR is offset to the north of the axis of the accelerator.

Of the almost 1.8 miles of beam housings, all but 650 feet will be mined tunnels. The rest will be existing structures, and in the vicinity of PEP IR-6 where the ground conditions are not suitable for mining, it will be a cut-and-cover structure.

One permanent road will be required. It will run from the PEP loop road near IR-2 to the SLC experimental hall. Since present plans call for moving assembled detectors over this road, it will be designed for heavy loads.

The experimental hall will be a vault about 180 feet long, 55 feet wide and its floor will be 50 feet below the surface. The assembly building over the vault will be constructed of steel. It will be about 235 feet long, 100 feet wide and 46 feet high. It will contain 2 counting houses for the experiments in the vault and will provide space for the utilities for the arcs and the experiments. It will have a 50 ton overhead crane.

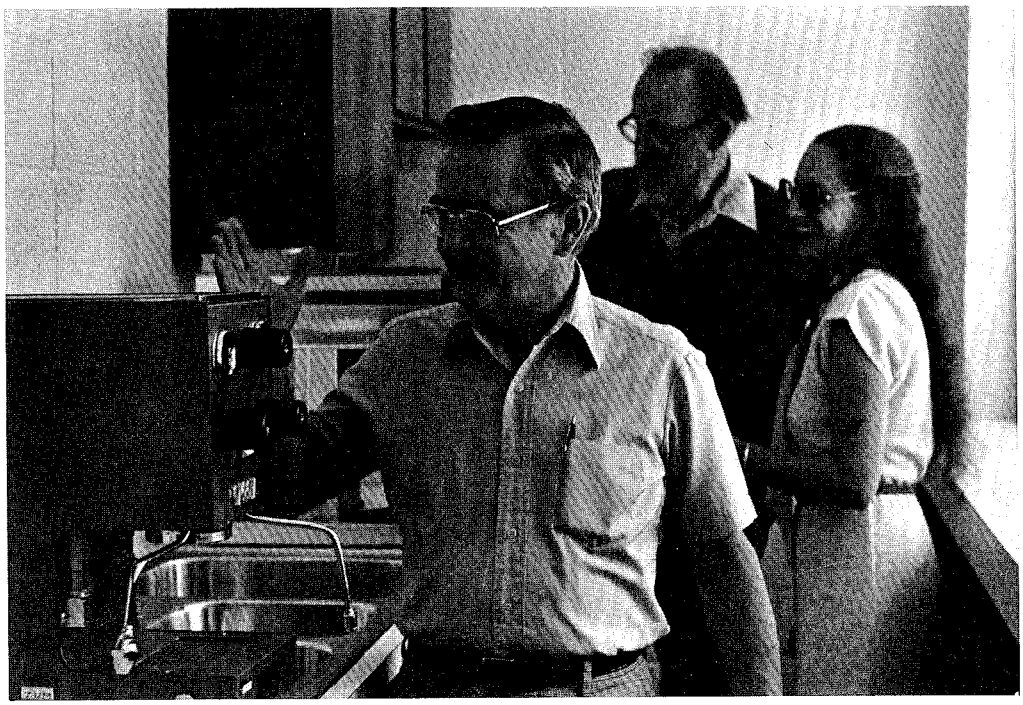
The experimental hall is designed with two assembly areas, one on each side of the interaction region. An experiment can be assembled in an assembly area, checked out and moved into the interaction region ready to take data.

Obviously there will be a great deal of construction activity at SLAC during the next two years, but the end result will be not only a new machine for high energy physics, but a whole new concept for machines of still higher energies to explore the mysteries of nature.

–Bob Bell

NOTICE

The City of Menlo Park is now accepting applications for the Tenant-Landlord Mediation Board. Residency in the City of Menlo Park is required. Applications will be accepted until July 28, 1983. For more information, call (415)858-3372.



Don Getz, Bob Gex, and Nina Adelman of the SLAC Culture Committee check out the equipment. (Photo by Tom Nakashima)

THE SLAC COFFEE BAR

The new SLAC Coffee Bar located in the auditorium corner of the cafeteria patio began serving on Monday, July 11th. Coffee and espresso are available from 12:30pm to 4:30pm. every workday.

The need for a central coffee place at SLAC has been expressed for many years by those who have experienced the importance of the Coffee House in the culture of CERN , the European high-energy physics lab. The CERN Coffee House is available for collegial discussion, meeting visitors and taking a break, over coffee and refreshments (croissants, sandwiches, etc.), anytime of the day or night.

Although initially the SLAC Coffee Bar will be limited in menu, hours, and space, its operation is flexible and adjustment to the needs of SLAC people will be carefully monitored by the SLAC Culture Committee.

SLAC CULTURE COMMITTEE

It's time that SLAC was introduced to its culture committee, the group most responsible for bringing the coffee bar to SLAC . This committee was formed in 1981 and was asked to investigate ways ways that the atmosphere at SLAC could be improved in respect to non-high-energy-physics activities. The committee membership is:

Don Getz, Chairman	Nina Adelman, Secretary
Dick Fuendeling	Joan Gardner
Bob Gex	Hilda Korner
Greg Loew	Bernie Lighthouse, ex-officio
Ruth Nelson, ex-officio	

Another project of the Culture Committee is showers. A shower facility has been approved and is awaiting final budget authorization.

WANT ADS

FOR SALE: 12' X 12' Tent, Great Western Eureka - like new, used only twice. $150. Call J. Faust, x2429.

FOR SALE: Dodge '73 B200 van, 60K miles, walk-in top, bed, stove; good shape; $3000/BO. G. Owens, (415) 856-9533.

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