SLAC BEAM LINE

"All composite things decay. Strive diligently."
--Buddha (his last words)

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Professor James D. Bjorken of SLAC was one of five U.S. scientists who received the E.O. Lawrence Award for 1977 at a special DOE awards ceremony in the White House on April 27. The award consists of a citation and $5000. BJ's citation reads "For prescient insights and elegant theoretical contributions to elementary particle physics, including the concept of scaling and the introduction of charm, which have profoundly influenced the course of the science." Others shown in this DOE photo are, left to right, Herb Kinney, Frank Press and John Deutch, all of DOE.

In This Issue

HEAD-ON PHYSICS

[Reprinted from *Scientific American*, March 1978]

Just as a collision between automobiles is most violent when the cars meet head on, so high-energy interactions of elementary particles are observed most efficiently in machines where collisions are arranged between particles moving with equal speed in opposite directions. Three large machines of this kind are operating now, and their success has evidently influenced the design of the next generation of accelerators. Of the high-energy machines now planned or already under construction, at least six will provide collisions between opposed beams of particles.

The principal advantage of head-on interactions is that virtually all the energy invested in accelerating the particles is released in the collision. Protons are now routinely accelerated to an energy of 400 billion electron volts (400 gigavolts, or GeV). When such a particle collides with a proton at rest, however, less than 28 GeV is made available for the creation of new particles. If two protons, each with an energy of 400 GeV, could be made to collide head on, essentially all their energy (800 GeV) would be liberated. To reach the same effective energy by bombarding a fixed target would require an accelerator with an energy of some 350,000 GeV (350 teravolts, or TeV).

Head-on collisions are arranged by storing counterrotating beams of particles in concentric or intersecting rings. After the rings are filled by an auxiliary accelerator the beams circulate stably for hours. A price must be paid for the high effective energy of the colliding-beam devices: the rate of interactions is quite low compared with that of a fixed-target accelerator. The beams usually pass through each other without interacting at all, and in existing machines a collision of interest is observed only once every few seconds. For this reason the number of particles stored and the confinement of the beam to a small cross-sectional area are important in determining the performance of the machine.

Two of the large rings that are operating now store counterrotating beams of electrons and their antiparticles, positrons. One is at the Stanford Linear Accelerator Center (SLAC) in California and the other is on the site of the German Electron Synchrotron (DESY) near Hamburg. It is in these machines that the new family of particles with the property called charm have been observed most clearly. The ring at SLAC has also produced events that suggest the existence of a new lepton, or particle related to the electron. Both rings have a maximum energy of about 4 GeV per beam, and both are soon to be replaced by larger machines.

A new German storage ring, to be called PETRA, will employ the existing ring as part of an injector system. The maximum energy available will be 19 GeV per beam, for a total of 38 GeV. Construction is already well under way (an eighth of the ring has been installed and tested), and the project should be completed in about a year. The new electron-positron storage ring at Stanford, which will be called PEP, is being built at the end of the SLAC two-mile electron accelerator. The new ring will have a circumference of 2.2 kilometers, roughly 10 times the size of the present colliding-beam machine. Current plans call for a maximum energy of 18 GeV per beam, but a proposal has been made to raise the limit to 24 GeV. Collisions will take place at six interaction regions, five of which will be available for physics experiments. A few initial experiments have already been approved, and the particle detectors required for them are being built. PEP itself will be completed in 1979 or 1980, depending on the rate at which money is made available.

Smaller storage rings for electrons and positrons have been operating for some time at the Frascati laboratories near Rome and at the Serpukhov Institute for High-Energy Physics near Moscow. Three more small rings are now under construction. At the Orsay laboratories near Paris a machine with two tangent rings will be installed. At Cornell University an electron synchrotron is being converted to store beams of electrons and positrons with energies of from 1.5 to 10 GeV. A ring called VEPP-4, capable of 7 GeV per beam, is nearing completion at Novosibirsk in the U.S.S.R.

All the foregoing machines store electrons and positrons; the one remaining large ring that is operating now stores beams of protons. This is the facility called the Intersecting Storage Rings (ISR) at the European Organization for Nuclear Research (CERN) near Geneva. It is capable of a maximum energy of 28 GeV per beam.

A much larger machine of the same kind, called ISABELLE, will be built at the Brookhaven National Laboratory on Long Island. ISABELLE will consist of two interlaced rings, each ring capable of supporting a proton beam that can be adjusted continuously over a range of energies from 30 to 400 GeV. Not only these higher energies but also the number of protons stored will represent an improvement over the performance of earlier accelerators. The circulation of the protons in each ring will be equivalent to an electric current of some eight amperes. The beams will be confined to the rings and will be focused by 1,084 superconducting magnets installed in a tunnel 3.7 kilometers in circumference.

At the Fermi National Accelerator Laboratory (Fermilab) near Chicago, which now has only a fixed-target accelerator, two colliding-beam projects are under consideration that might reach energies even higher than those of ISABELLE. A new ring of superconducting magnets (capable of accelerating protons to 1 TeV) is being installed in the same tunnel as the existing proton synchrotron. By storing protons in both the new ring and the old one collision energies of 1.3 TeV might be achieved. Another possibility is to simultaneously store protons and antiprotons in the superconducting ring. In principle an energy of 2 TeV could then be attained, but techniques for creating stable, intense beams of antiprotons are still being investigated.

A proton-antiproton storage ring is also under study at CERN, along with several other proposals. One of these is notable for being the largest of the contemplated storage devices. It would be an electron-positron ring an order of magnitude larger than PEP and PETRA, with a circumference of more than 40 kilometers and a maximum energy of 200 GeV per beam.

It is impossible to say what will be found with the new instruments, but there are two matters left unsettled by studies at lower energy that will surely be given high priority. One is the study of quarks, the elementary particles thought to make up the structure of the proton and many related particles; the new electron-positron rings might settle the question of how many kinds of quark there are. Another is the search for the particles labeled W and Z, which are thought to transmit the "weak" force of nuclear beta decay. The W and Z are perhaps the most highly prized trophies of contemporary physics. With estimated masses of from 50 to 100 GeV they are probably beyond the range of PEP and PETRA, but they should be seen with ISABELLE or with the storage rings being considered at Fermilab and CERN.

SLAC ANNUAL RACE

Back in 1972, long before running and jogging had become a national institution, Ken Moore promoted the first SLAC Annual Race (which, incidentally, he won).

Ken also ran, and ran in, the next six races. Now running has become an "in" thing, and Ken has decided to retire from the management of his traditional event and concentrate his energies on running in it.

At Ken's instigation, a small group of SLAC runners got together recently at noon to discuss the future of the SLAC race. We agreed on the following general ideas:

1. The tradition of the annual SLAC Race has been well-established and should be continued.

2. The Race has been held during the last week in August in the past. This is usually good weather for beer-drinkers but sometimes uncomfortable for runners, so we suggest changing the date to:

Tuesday, November 21
(2 days after Thanksgiving)

3. To encourage participation by people who don't want to run four miles, we suggest adding two events to the program: a 100-yard dash, and a two-mile run. The two-mile run would start at the west end of the accelerator at the same time as the four-mile run started at the east end, and both would use the same finish line. The dash would start from the four-mile starting line after the four-milers were safely out of the way.

4. We suggest awarding beam trees to the following:

First man and woman finishing 4-mile race
First SLAC man and woman finishing 4-mile race
First SLAC man and woman finishing 2-mile race
First SLAC man and woman finishing 100-yd dash

All participants would receive a ribbon and, if we can arrange it, a certificate.

5. Runners from the Stanford community would be encouraged to participate. Their presence increases the interest (and the average speed), and they would be eligible for awards in the 4-mile race.

6. Beer at cost and free to finishers is part of the tradition and should be continued. Reyes Valenzuela has run the beer concession during the past few years, for which he deserves our thanks. He has also decided to "retire," so we need a new bartender.

7. We'll need help from non-participants to act as starters, timers and record-keepers. So if you would like to take part but don't feel like running, please let us know.

However, we want to encourage participation, so we would appreciate any suggestions which would make it easier for shy people to take part. For example, your finishing time will be your own secret, if you wish.

--Herb Weidner et al.

California constantly emits neutrons, which strike other materials and make them radioactive--*Birmingham* [Alabama] *News*.

--Photos by Joe Faust

BLANCHIE KELLEY LEAVES SLAC

The very able secretary of the Accelerator Electronics Group, Blanchie Kelley, has decided to leave SLAC to take a position as Assistant to the Vice President at the American Institute for Research in Palo Alto.

Blanchie would have completed 10 years of service at SLAC on August 19 of this year. She started as a clerk-typist in Purchasing in 1968. Then in February, 1970, she transferred to Pat Kilpatrick's Electronics Shops Group, and shortly thereafter she took over the office duties for the Accelerator Electronics Group as well. The Shops Group was eventually combined with Accelerator Electronics to form the Electronics Department, and in June 1976 Blanchie was promoted to Secretary II in recognition of her increased responsibilities.

Before coming to SLAC, Blanchie had studied for a year at California Western University in San Diego. While here, she continued her studies on a part-time basis at San Jose State. She received her BS in Business Administration in 1976, with special qualifications in the field of human resources, and since that time she has been seeking a suitable position in that field. Now her hard work is finally being rewarded.

Blanchie is a warm-hearted, friendly person who has done a fine job at SLAC. She leaves a void that will be very difficult to fill. We all wish her the best of luck and continued success in her new position.

--Carl Olson

SHIRLEY HAYWARD LEAVES SLAC

A beamimg Shirley Hayward holds up her farewell gift--the traditional "beam tree"--for the admiration of Ken Johnson (left) and Lee Hawkins. The occasion was Shirley's farewell party. After nine years as secretary to the SLAC Medical Facility, Shirley has decided to join the Electric Power Institute in Palo Alto. Shirley and her husband, Sam, were charter members of the SLAC 5 o'clock Health Club. Her fellow joggers and the rest of us will miss her cheerful manner and unfailing good humor.

--Joan Gardner

1974-1977 ANTIPREPRINT CUMULATION

Recently the SLAC Library issued a 4-year cumulation of ANTIPREPRINTS in Particles and Fields. The cumulation was compiled by Rita J. Taylor, and it includes publication information for all published preprints which have been listed in PREPRINTS IN PARTICLES AND FIELDS for the past four years. (See "Preprints, Publications And All That" in the July 1977 issue of the *Beam Line* for a description of the Library's Preprint and Antipreprint listings.) This cumulation covers 9,176 entries arranged alphabetically by first author. Also included are a Report Number list, which identifies first authors of the publications under the Report Numbers assigned by the originating institutions; and an Index To Other Authors, which allows first authors to be identified by looking up any other author of the publication in question.

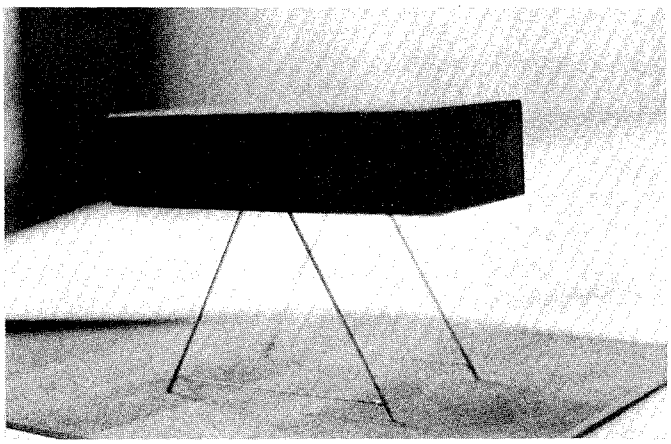
Copies of this ANTIPREPRINT cumulation are available for $15.00 (prepayment preferred) by writing to SLAC Library, Bin 82, ANTIPPF, P.O. Box 4349, Stanford, CA, U.S.A. 94305.

--Bill Kirk

PEP NOTES

Everyone has his or her own vision of the typical experimental detector for PEP. To the experimental physicist, it is a thing of beauty and a joy forever (or at least until upgrading time). To the machine physicist, it is a perturbation on the circulating beams. To the vacuum whiz, it is an unnecessarily thin pipe with too many flanges. To the electrical engineer, a 3-megawatt resistor.

And to the SLAC Earthquake Committee--well, the photograph below says it all:



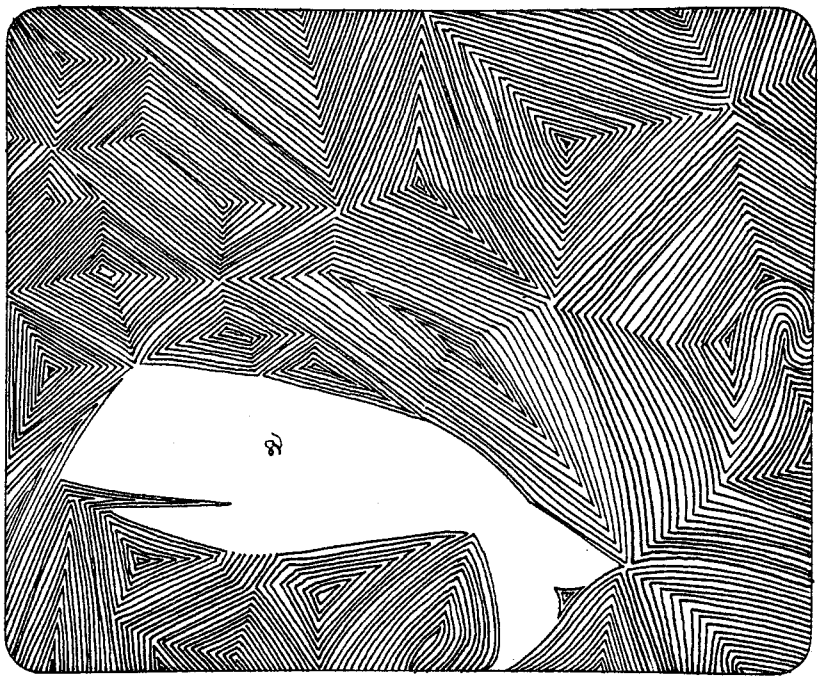
In fact, this lead brick supported on iron toothpicks isn't really the way any PEP detector appears. This model by Al Kilert was made to illustrate how a support system which satisfies many earthquake-safety criteria (such as horizontal accelerations of 3/4 g) could still fail when the oscillating nature of the tremors is accounted for.

Data from the 1971 San Fernando earthquake, for example, show forces which shake with frequencies of about one cycle per second. Any object that has a natural motion of about this same value will be very strongly affected by such forces--much more so than if the forces were applied steadily. This resonance affects hanging light fixtures, for example, so that after several seconds they could be swinging far enough to strike the ceiling.

Regular swinging forces will also make this lead brick rock dramatically back and forth, whereas simple pushes have little effect upon it. There is obviously no equivalent of the Uniform Building Code for such unique devices as the PEP detectors; all the problems must be analyzed individually.

Once a group has designed a detector to do the physics they contemplate, the SLAC Earthquake Committee works with them to discover the potential earthquake hazards that may exist and to devise ways to overcome these hazards. The primary emphasis in this work, naturally, is people-safety, although consideration is also given to minimizing damage to the equipment in the event of an earthquake. The modifications proposed mainly involve the use of tie-downs to floor plates, struts to walls, and the stiffening of support legs in order to avoid the resonance problems.

--Bill Ash



--Chris Schmierer

SOME INTERDISCIPLINARY LAWS

[Note: We are indebted to local Archivist John Ehrman for the following small sample of these collected Laws.]

Airplane Law. When the plane you are on is late, the plane you want to transfer to is on time.

Allison's Precept. The best simple-minded test of expertise in a particular area is the ability to win money in a series of bets on future occurences in that area.

Anthony's Law Of Force. Don't force it, get a larger hammer.

Anthony's Law Of The Workshop. Any tool, when dropped, will roll into the least accessible corner of the workshop.

Corollary To Anthony's Law. On the way to the corner, any dropped tool will first strike your toes.

Army Axiom. Any order that can be misunderstood has been misunderstood.

Axiom Of The Pipe (Trischmann's Paradox). A pipe gives a wise man time to think and a fool something to stick in his mouth.

Baker's Law. Misery no longer loves company. Nowadays it insists on it.

Barber's Laws Of Backpacking

1. The integral of the gravitational potential taken around any loop trail you choose to hike always comes out positive.

2. Any stone in your boot always migrates against the pressure gradient to exactly the point of most pressure.

3. The weight of your pack increases in direct proportion to the amount of food you consume from it. If you run out of food, the pack weight goes on increasing anyway.

5. The difficulty in finding any trail marker is directly proportional to the consequences of failing to find it.

7. The remaining distance to your chosen campsite remains constant as twilight approaches.

8. The net weight of your boots is proportional to the cube of the number of hours you have been on the trail.

Barth's Distinction. There are two types of people: those who divide people into two types, and those who don't.

Bicycle Law. All bicycles weigh 50 pounds:
A 30-pound bicycle needs a 20-pound lock & chain.
A 40-pound bicycle needs a 10-pound lock & chain.
A 50-pound bicycle needs no lock and chain.

Boren's Laws:
1. When in doubt, mumble.
2. When in trouble, delegate.
3. When in charge, ponder.

Brook's Law. Adding manpower to a late software project makes it later.

Brown's Law Of Business Success. Our customer's paperwork is profit. Our own paperwork is loss.

Cahn's Axiom. When all else fails, read the instructions.

Canada Billy Jones' Motto. It is morally wrong to allow suckers to keep their money.

Canada Billy Jones' Supplement. A Smith and Wesson beats four aces.

Cheop's Law. Nothing ever gets built on schedule or within budget.

Churchill's Commentary On Man. Man will occasionally stumble over the truth but most of the time he will pick himself up and continue on.

Clarke's Third Law. Any sufficiently advanced technology is indistinguishable from magic.

Cohen's Law. What really matters is the name you succeed in imposing on the facts--not the facts themselves.

Cole's Law. Thinly sliced cabbage.

Cook's Law. Much work--much food; little work--little food; no work--burial at sea.

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