SLAC BEAM LINE

Volume 5, Number 3 *September 1974*

ENERGY CONSERVATION AT SLAC

Since last November, considerable progress has been made in reducing SLAC's heating requirements. Turning down thermostats and shutting off systems has been an inconvenience, but it has paid off.

When SLAC's energy conservation program began last August, the lights were turned off at night to reduce the electrical load. A couple of months later the janitors were shifted to days so that the lights could be turned off earlier. Since then, many fixtures have been disconnected to reduce lighting loads. In the A&E Building, for example, one-third of the fluorescent lamps have been removed.

In prior years SLAC has used about 55 million cubic feet of natural gas per year to heat the buildings outside the radiation fence. In addition, about 2 million kilowatt-hours of waste heat from the lights was used in the same buildings. If there had been no energy-conservation program, the present costs for these two heat sources would $70,500. But our program of turning off equipment and lowering thermostat settings has reduced the natural gas requirement to about 44 million cubic feet per year, and it has also eliminated the need to use the waste heat from the lights at night. This has resulted in a net savings to SLAC of $26,500 in heating costs.

There are other plans in the works to make our systems operate more efficiently. The controls on all the multizone systems which serve the A&E, Central Lab, Electronics and Fabrication Buildings will be changed to eliminate unnecessary waste. These changes will reduce both the heating and air-conditioning loads, and although there may be some inconveniences during the switchover, we'll try to hold them to a minimum.

During this past winter at SLAC most thermostats were set at 68°F. In areas where the temperature fell below this value, heaters were permitted. The interior zones of buildings which had no exterior heating load were set at 72°F. In this way the internal heat of those areas (which represents an air conditioning load) could be used to help heat the exterior zones.

The thermostat setting recommended by the Federal government during this past summer was 80° to 82°F. For many of the warmer areas of the country this is a reasonable standard, but for the mild climate and cool nights of the Peninsula it is not. Because of this, we maintained a summer setting of 77°F at SLAC. In the spring and fall, as usual, our thermostats will be maintained at 72°F.

--Gordon Ratliff

Letters To The Editor

Letters to the Editor are welcome. We'll print anything that seems interesting if we have enough space. Anonymous letters are OK but only if the Editor knows who the writer is.

Editor:

The last issue of the *Beam Line* stated that interesting letters would be printed if there was enough sp

BETTY (ROWE) MASTERSON LEAVING SLAC

One of the main stays of SLAC's Purchasing Department, Betty (Rowe) Masterson, will be leaving at the end of September. Betty was recently married to former SLAC employee Don Masterson, and the Mastersons have decided to make their home in Arnold, California, a small town up in the beautiful Mother Lode country. Betty began work at SLAC in November 1962 as a typist in Purchasing, and over the years she has advanced to a senior position in Purchasing's Expediting section. It's expected that Betty's job will be inherited by Cathy Kolb, who has worked closely with Betty for several years.

Plans are afoot to have a going away party for Betty near the end of September--either a special luncheon or perhaps a Cafeteria "breezeway" party. Betty's many friends at SLAC will look forward to this opportunity to express their appreciation for her fine work and to wish her much happiness in the years ahead.

SLAC Beam Line

Production & Distribution

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Herb Weidner, Bin 20, x2521: experimental area & facilities; general news.

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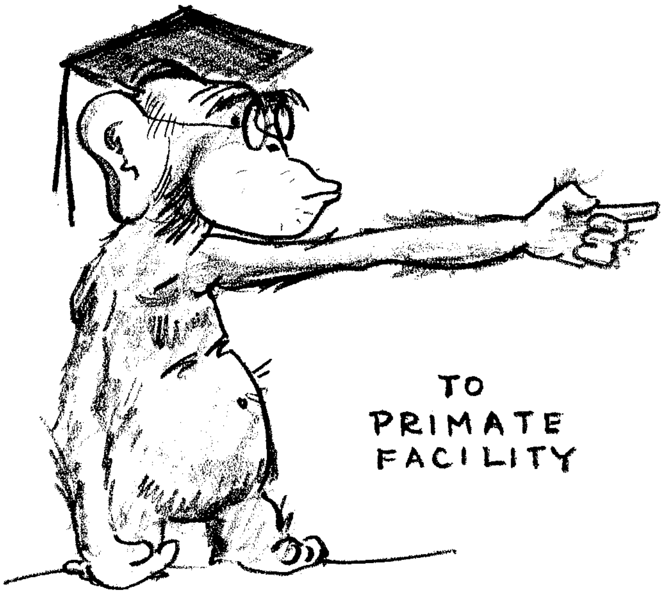
Editor

Bill Kirk, Bin 80, x2605: letters, articles, comments; general news; whatever.



PRIMATE FACILITY WELCOMES VISITORS

Dr. Patrick McGinnis, the Manager of the Stanford Primate Facility which is located right next to SLAC, has repeated his earlier invitation to SLAC people and friends to pay a weekend visit to the Facility. Visitors can be accomodated at the following times:

Saturday or Sunday, 9 or 10 AM, 4 or 5 PM

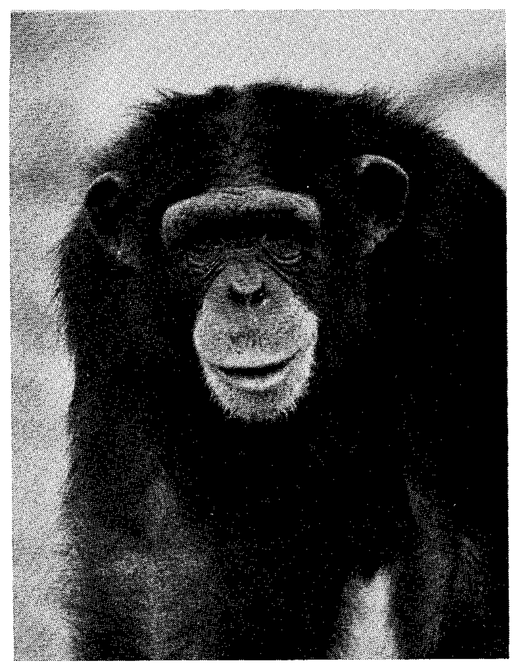
There are a few ground rules that should be observed in connection with such visits. First, appointments must be made in advance, and the names of those who will be in the visiting group should be given at that time. Second, the group should consist of no more than six people. Third, if the group includes children, they have to be reasonably quiet and well-behaved during the visit.

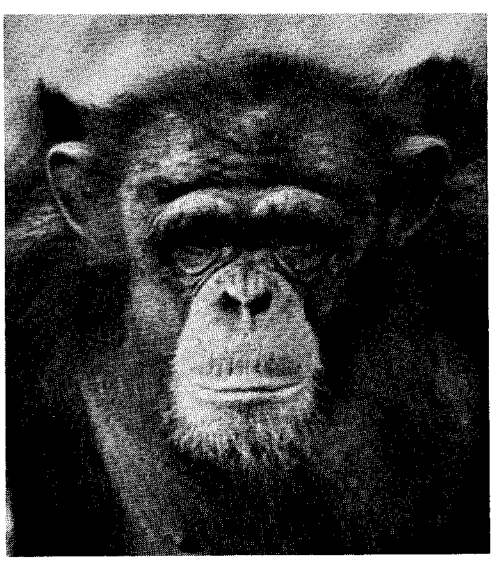
For appointments, call Patrick McGinnis at

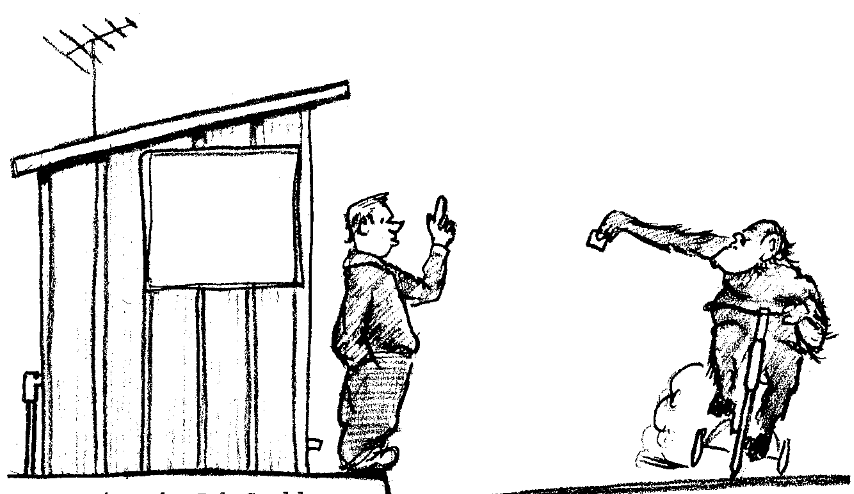
854-1405

. . . Of all the vast array of creatures on earth, none so closely resembles man as the chimpanzee. . . . [The chimp] is a highly intelligent, intensely social creature capable of close and enduring attachments, yet nothing that looks quite like human love, capable of rich communication through gestures, postures, facial expressions, and sounds, yet nothing quite like human language. This is a creature who not only uses tools effectively but also *makes* tools with considerable foresight; a creature gifted in the arts of bluff and intimidation, highly excitable and aggressive, capable of using weapons, yet engaging in no activity comparable to human warfare; a creature who frequently hunts and kills small animals of other species in an organized, cooperative way, and seems to have some zest for the process of hunting, killing, and eating the prey; a creature whose repertoire of acts in aggression, deference, reassurance, and greeting bear uncanny similarities to human acts in similar situations. . . .

--David A. Hamburg, in the "Foreward" to *In The Shadow Of Man*, by Jane van Lawick Goodall







Drawings by Bob Gould

AN INTRODUCTION TO COLLIDING BEAM STORAGE RINGS - PART II

This is the second of a two-part series on storage rings. Part I appeared in last month's Beam Line, *and it covered some Stanford-SLAC history, a brief review of conventional accelerators, and a look at the "Why?" of colliding beam storage rings. In Part II we will discuss some of the early physics results from SPEAR, and also some information about the proposed PEP storage-ring facility and the prospects for its eventual authorization.*

Some Physics Background

Before we get into the early physics results from SPEAR, it will be helpful to have a context in which the significance of these results can be appreciated. We begin with a discussion of *simplicity*, one of the basic threads that winds through the fabric of high-energy physics research.

The idea of simplicity

About 45 years ago, a noted physicist, Paul Ehrenfest, described his subject in these words: "Physics is simple, but subtle." The general conviction that nature, once properly understood, will turn out to be simple is one that most physicists share, but there is less common agreement about the particular form that an eventual simplicity might take. For our purposes, perhaps the easiest way to think about simplicity is to equate it with "fewness": just a few kinds of basic matter (the elementary particles), and just a few ways in which the particles can interact with each other (the force of electricity and magnetism, and certain others). So with the understanding that "fewness" is only one of the possible ways to approach simplicity, and perhaps not the best way, let's use this idea to explore some basic questions.

With this approach a fundamental issue is to determine just how many kinds of particles are truly *elementary*. If the answer to this question seems to be a small number, like 2 or 3 or 6, that's fine, and we can keep moving on with all engines full ahead in the hope that, sooner or later, we may be able to figure out all of the infinite varieties of matter from such a simple starting point. But if the answer seems to be 70, or 256, or 2048, then we've got trouble, and the fascinating attempt to figure it all out begins to appear hopelessly complicated and perhaps futile.

So what *is* the answer? Well, the answer has seemed different at different times, and it has usually been given with at least a little hedging. A hundred years ago, for example, the answer appeared to be the 92 natural elements, from hydrogen to uranium--except that the similarities and sequences that were evident in the Periodic Table of the Elements seemed to point toward some sort of simpler, smaller building blocks. And about forty years ago the answer appeared to be just the 3 atomic constituents of electron, proton and neutron--except that antiparticles were suspected and one of them (the positron) had in fact been discovered, and from the study of certain radioactive decay processes it seemed there must also be "a little neutral one" (the neutrino). Then twenty years ago the answer appeared to have grown to about 14, and there were signs that a rapid population explosion was taking place--except that as early as 1952 it seemed clear that some of the newly discovered particles could not be "elementary" in the same sense the older ones were.

Quarks . . .

During the past twenty years literally hundreds of different particle "states" have been discovered, and this profusion has brought with it the need for some ordering scheme--some "Periodic Table of the Particles" --that might help point the way toward a simpler underlying regularity. Several such ordering schemes have in fact been devised, the most striking of which is a theory that shows how nearly all of the observed particles could be built up from only three truly fundamental building blocks. These sub-particles go by the name of *quarks*, and if they actually exist (eager searching has not yet found them), they must be pretty peculiar beasts. The separate box on the next page gives some information about quarks, but for our main purpose we can simply note that the basic idea of quarks has been so remarkably successful in explaining a vast amount of experimental data that it must express a good deal of truth. And the theories based on quarks (*quark models*, the first one called *The Eightfold Way*) have done much to reaffirm our basic convictions about the "fewness" and simplicity of nature.

. . . and Partons

Perhaps SLAC's most important contribution to physics has come from the studies of nucleon (proton and neutron) structure that were carried out in the inelastic electron scattering experiments in End Station A. The results of this work could be explained by visualizing the proton as not just a uniform blob but rather as an object whose electric and magnetic properties were clustered together in several very small regions within the larger whole. Stated in a different way, the proton appeared to be made up of a few smaller things that were given the name *partons*; and that way of describing it certainly sounded a lot like the quark-model description, in which the proton consists of three quarks. Thus from the scattering experiments it seemed quite possible that partons and quarks were either the same or else very closely related things. At the very least it seemed certain that we were hot on the trail of the new, truly elemtary building blocks of nature, whatever name they were called. But then along came SPEAR.

The SPEAR Physics Results

The electron-positron annihilation process we discussed last month can test elementary-particle theories in a way that is quite different from the scattering or other experiments at a conventional accelerator. This difference comes partly from the fact that the collision process is different (target stationary or not), partly from other factors that we'll just skip over here in order to concentrate on the research results. The first large-scale experiment at SPEAR was a collaboration between physicists from SLAC and from the Lawrence Berkeley Laboratory (LBL). Its aim was to carry out a general survey of the process by which strongly interacting particles (hadrons) are produced in high-energy electron-positron collisions. We've mentioned before that e^-e^+ collisions form a particularly simple starting point for particle-production studies. Theoretical physicists generally felt that they had a good understanding of the annihilation process, and as a result there were a number of predictions that had been made about how hadron production at SPEAR ought to work. We'll describe one such prediction here, and several others a bit later.

A specific prediction based on the quark model was that the cross section, or probability, for hadron production at SPEAR ought to be just 2/3 as large as the cross section for producing pairs of mu-mesons (muons). But even before the SPEAR study began there were signs that the predicted cross section ratio seemed a bit doubtful.

Early Warning Signals

While the SPEAR experimenters were getting ready, some interesting evidence had been coming in from the storage ring at Frascati, Italy, and especially from the ring that had been built by modifying the Cambridge Electron Accelerator (CEA) at Harvard. Although the value that CEA had obtained for the hadron/muon ratio was much larger than the predicted 2/3, their result was based on fewer than 100 individual events; and since this result was so surprising, most physicists decided to sit tight and wait for more data to be accumulated.

The hadron/muon ratio prediction of 2/3 was based on a simple quark model. But there were, and are, more complicated theories which require more than just the three basic quarks. In some models the quarks have "color" (red, white and blue), or they have "charm," or they can even have both color and charm. (We're not kidding; for theoretical physicists it helps to be a little nutty.) And with these more complicated quark models the predicted value of the hadron/muon ratio is no longer 2/3 but is rather 2, or 10/3, or 4, or 6. However, these several theories do have one common feature: although they disagree about the *value* of the hadron/muon ratio, they agree that the ratio will remain *constant* when the colliding-beam energy is changed.

The Puzzled Theorists

The SPEAR experimenters thus began their research with a strong incentive to clear up the open questions about hadron production. With SPEAR's high luminosity

QUARKS

In this discussion we will try at least to scratch the surface of the subject of quarks. To begin with, many of the properties of the strongly interacting particles, the hadrons, seem understandable, if we think of these particles *as though* they were made up of either 3 quarks (for the proton and the other members of its *baryon* family) or of a quark-antiquark pair (for the pion and the other members of its *meson* family). Whether quarks are "real" or not is an open question. The fact that none has yet been discovered could have three possible explanations: (1) quarks do not exist, in which case the "three-ness" that seems to explain so much is just a mathematical peculiarity rather than a trio of actual objects; (2) quarks do exist but nature conspires in some way to keep them hidden from us; (3) quarks do exist but are so massive that our accelerators and storage rings are not yet powerful enough to pry them loose. Although the search for quarks continues, even the CERN Intersecting Storage Rings, with collision energies equivalent to an 1800 GeV conventional accelerator, have not succeeded in creating them. So the question may well remain open, waiting for a new generation of more powerful machines.

Actual or not, the theoretical ideas based on quarks have proven extremely valuable. The original, and simplest, quark theory postulated a basic set of 3 quarks and 3 complementary antiquarks. As symbols for the quarks we'll use *P, N* and *L*. The antiquarks are symbolized by adding a bar to the top of these three letters: $\bar{P}$, $\bar{N}$ and $\bar{L}$. Since each of the elementary particles has a distinctive set of properties (spin, electric charge, a thing called "strangeness," etc.), each quark has assigned to it a distinctive set of values for these same properties. To simplify, we will list the assigned values for only two properties: electric charge and strangeness.

	Quarks			Antiquarks		
Name	P	N	L	$\bar{L}$	$\bar{N}$	$\bar{P}$
Charge	$+\frac{2}{3}$	$-\frac{1}{3}$	$-\frac{1}{3}$	$+\frac{1}{3}$	$+\frac{1}{3}$	$-\frac{1}{3}$
Strangeness	0	0	-1	$+1$	0	0

Since the electric charge of all the known particles is in even units (*+1, 0, -1, etc.*), let's see how the fractional quark charges can be combined. A proton, for example, with charge *+1*, is supposed to consist of the quarks *PPN*, and if we take the sum of *+2/3* and *+2/3* and *-1/3* we get *+1*, so it works. Similarly, a neutron is *PNN*, an antiproton is $\bar{P}\bar{P}\bar{N}$, and so on. In the case of the mesons, the positive pion (π^+), for example, is $P\bar{N}$.

Since we have been looking only at the combinations of electric charge here, it should be evident that adding in the values for the other properties will produce hundreds of different combinatorial possibilities. And it is a remarkable fact that the various combinations of these 6 basic building blocks, each having half a dozen distinctive properties, and grouped together in sets of 2 or 3 quarks, correspond very closely to the hundreds of different particle states that are actually observed in nature.

The hallmark of a successful physical theory is not only that it explains what has already been observed in nature but also that it predicts what has not yet been seen. Perhaps the quark model's most striking achievement occurred in the early 1960's, when it predicted the existence of a new particle, the omega-minus, composed of the quarks *LLL*, which was supposed to have a strangeness value of *-3* (strange indeed). And lo and behold! There it was, captured in a bubble chamber photo from Brookhaven National Laboratory.

they were able to collect more than enough data to provide conclusive tests of the main theoretical predictions that had been made. To see how these tests turned out, we'll list a series of four questions, and for each question we'll give both the predicted answer and the answer that was found in the SPEAR experiment:

1. How does the cross section for hadron production change when the e^-e^+ collision energy is increased?

   Predicted: *Decreases rapidly*
   Observed: *Stays constant*

2. What is the ratio of hadron production to muon-pair production?

   Predicted: *2/3, 2, 10/3, 4, 6*
   Observed: *No fixed value*

3. How does the hadron/muon ratio change when the collision energy is increased?

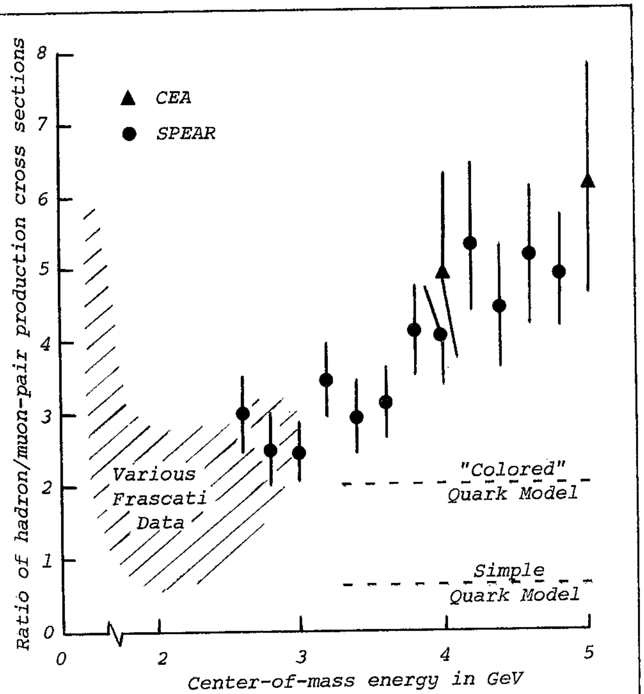
   Predicted: *Stays constant*
   Observed: *Rises steadily*

4. Does the distribution of energy among the created hadrons follow the same pattern (called *scaling*) as that of the SLAC inelastic scattering experiments?

   Predicted: *Yes*
   Observed: *In a limited range*

If physics were baseball, the theorists would have got about one loud foul in four at bats. (We're exaggerating a bit. Making fun of wayward theoretical predictions is a popular game in physics. We trust that the discerning reader will realize that such banter is a sort of back-handed way of expressing respect for the formidable intelligence and imagination that theoretical physicists bring to bear on the complexities of particle physics.)

In the next figure we show the data from SPEAR, and from the earlier Frascati and CEA work, that is applicable to the problem of the hadron/muon ratio.



Note: The length of the line through each point is a measure of how much the experimental result may be affected by various errors.

These data are convincing evidence that the simple and colored quark-model predictions are not correct. In addition, the fact that the cross section ratio keeps rising from left to right in the figure (plus other results not shown here) makes even the fancier quark models rather hard to believe.

The Electron as Hadron

Although it might seem that giving the remarkably successful quark model such a rude jolt would be a bit discouraging to physicists, it turns out that things don't quite work that way. The SPEAR results have in fact caused as much enthusiastic interest as any experiment in recent years. To see why, let's begin with the following question: If electron-positron annihilation into hadrons doesn't look like the predictions of the quark model or of any other present theory, then what *does* it look like? Surprisingly, several aspects of the annihilation process (especially the distribution of energy among the created hadrons) bear a marked resemblance to what is observed in high-energy proton-proton collisions. Stated differently, electrons (leptons) seem to be acting like protons (hadrons), and this is very surprising for the following reason.

If we consider the simplest possible distinction we can make among the hundreds of different particles or particle-like states, that distinction is based on the strong or nuclear force that holds the nuclei of atoms together. And on that basis there are only *two* families of particles:

1. The hadrons, which "feel" the strong force, and which include the proton, neutron, pion, and many others.
2. The leptons, which do not feel the strong force, and which include only the electron, muon, two kinds of neutrinos, and their antiparticles.

It had always seemed evident that the distinction between hadrons and leptons was very sharp--they were two fundamentally different things. But if the electrons in the SPEAR experiment are *acting like* protons, then it becomes at least imaginable that in some way they *are like* protons, which means that the sharp distinction we have always made between leptons and hadrons has now become rather blurred. What the SPEAR results have given us, then, is a first glimpse of what may be a deep underlying simplicity--a simplicity that was recently described in these words:

> The process may be an example of some new force that acts directly between leptons and hadrons. Speculation that the electron may have a hadron core . . . has passed the point of idle talk, and is seriously being discussed in scientific journals. Is there really a hadron at the heart of the electron?
>
> *Science*, May 1974

The Proposed PEP Facility

Where PEP Fits In

Earlier in this article we discussed the two most important characteristics of colliding-beam storage rings: center-of-mass (CM) energy, and luminosity. To get an idea of where PEP would fit into the world picture, the table on the next page lists all of the storage rings with CM energy greater than 1 GeV that have been built or are now being built, or that have either been formally proposed or seriously thought about. To simplify the comparison of luminosities the values are given on a relative basis (a value of

Storage Rings	*Location*	*Beams**	*CM Energy (GeV)*	*Relative Luminosity*
Built or being constructed				
ACO-Orsay	France	e^-e^+	1.1	.01
VEPP-2'	USSR	e^-e^+	1.5	1
Adone	Italy	e^-e^+	3.0	.05
DCI-Orsay	France	e^-e^+	3.0	3
SPEAR I	SLAC	e^-e^+	5	0.5
VEPP-3	USSR	e^-e^+	7	?
Doris-DESY	Germany	e^-e^+	7	10
SPEAR II	SLAC	e^-e^+	9	5
VAPP-4	USSR	e^-e^+	12	?
CERN-ISR	Switz.	p p	56	0.7
Proposed or contemplated				
Doris-DESY	Germany	$e^{\pm}p$	7	0.1
PEP I	SLAC	e^-e^+	30	10
EPIC	England	e^-e^+	30	10
SuperAdone	Italy	e^-e^+	30	10
PETRA	Germany	e^-e^+	36	10
VAPP-4	USSR	$p\,\bar{p}$	48	?
PEP II	SLAC	$e^{\pm}p$	110	10
EPIC II	England	$e^{\pm}p$	110	10
ISABELLE	BNL(NY)	p p	400	100
POPAE	NAL(ILL)	p p	2000	100

** e^- = electrons, e^+ = positrons, $e^{\pm}$ = either electrons or positrons, p = protons, $\bar{p}$ = antiprotons.*
Note: Information about the Russian machines (all at Novosibirsk), is difficult to obtain.

1 equals $10^{31}cm^{-2}sec^{-1}$). For the machines not yet in operation, the luminosities shown are simply estimates and are probably somewhat optimistic. When it comes to actually achieving an advertised luminosity, there is many a slip twixt the cup and the lip.

As far as the prospective physics with PEP is concerned, we have space here for only a brief summary statement:

> [PEP] would provide the source of an initial matter/energy state of particular simplicity, uncomplicated by strong interactions, in a new energy range where the validity of the fundamental laws of electricity and magnetism, the properties of the weak interactions, and the forms of matter into which pure electrodynamic energy materializes can be uniquely explored for the first time.
>
> --S. Drell, HEPAP Chairman. from letter transmitting the Report of the HEPAP Subpanel on New Facilities to the AEC, July 30, 1974

The Prospects For Approval

The Report of the HEPAP Subpanel on New Facilities is described in a separate box on this page. This Subpanel's recommendations, endorsed by HEPAP, constitute as strong a vote of scientific approval as any of us at SLAC could have hoped for. The other part of PEP's prospects--the realities of the political and economic situation--is simply a wide-open question. Pessimistic or optimistic: you pays your money and you takes your choice.

Bill Kirk

AEC'S HIGH ENERGY PHYSICS ADVISORY PANEL ENDORSES PEP

The High Energy Physics Advisory Panel (HEPAP) to the Atomic Energy Commission is the AEC's principal source of scientific advice concerning the research program which it supports in this field. Last May a special HEPAP Subpanel on New Facilities was formed, under the Chairmanship of Professor Victor Weisskopf of MIT, and was charged with the following tasks: (a) to consider the future needs for high energy physics facilities in the United States; (b) to determine the next major steps required in this field over the coming decade; (c) specifically to determine what facilities, if any, should be started in Fiscal Year 1976. In carrying out this assignment, the Subpanel assumed the following constraints:

1. *The budget for the high energy physics program will be near a level of roughly $200 million per year, in FY1974 dollars, for operations and equipment. This is about the average of such spending (in FY1974 Dollars) in the U.S. over the past ten years. The constraint of a near-constant level of funding for operations implies a constant manpower level, with experiments at the new highest energy regions supplanting some of the work at older facilities.*

2. *For a science at the frontiers of the unknown, it is important to devote a substantial part of the program effort to the provision of new and innovative facilities. Past experience in high energy physics shows that an average of 20 to 25% of the total funding supporting the field provides a healthy balance between exploitation of existing facilities and developments for the future. The average funding for construction in high energy physics over the past fifteen years (FY1960 through FY1974) has been about $60 million per year (in FY1974 dollars). The Subpanel guidance from the AEC was to consider an average of about $40 million per year over the next ten-year period as a reasonably constrained level for new facility construction for the program.*

The Subpanel's report was reviewed and accepted by HEPAP in July, and was then forwarded to the AEC. The Subpanel's report contains the following specific recommendations:

Mindful of the budgetary constraints and the present state of technology, the Subpanel recommendations, focussing on FY1976, are:

1. *Authorization in FY1976 of the LBL-SLAC proposal for the construction at SLAC of a 15-GeV electron-positron colliding beam facility ("PEP") with a design luminosity of $10^{32}cm^{-2}sec^{-1}$.*

2. *Providing funds in FY1976 of $3-4 million for Brookhaven National Laboratory to complete fabrication of prototypes of superconducting magnets, with the aim of making a request for early construction at BNL of a proton-proton colliding beam facility ("ISABELLE") with a design luminosity of $10^{33}cm^{-2}sec^{-1}$ and a beam energy of at least 200 GeV.*

3. *Funds be provided to support an accelerator development program at FERMILAB directed toward the long-term goal of fixed target and/or colliding beam systems in the region of 1000 GeV and above.*

HEPAP strongly endorses all of the above recommendations.

ETHIOPIAN PHYSICIST FATALLY INJURED EN ROUTE TO SLAC

Dr. Tewodros Fesesse died recently as a result of an automobile accident in which he and his family were involved while they were traveling from Minnesota to Stanford. Dr. Fesesse's wife and child were both seriously injured in the accident, which occurred near Reno, but both now appear to be recovering. After a period of convalescence at the Washoe Medical Center in Nevada, they have recently been transferred to the Fairview Hospital in Minneapolis.

In the past, Dr. Fesesse had been a Visiting Scientist in Experimental Group B at SLAC, and he had taught several courses for the students in the Summer Science Program. Dr. Fesesse had received his Master's Degree in physics from the University of Michigan in 1964, and had then returned to teach for a period of five years at Haile Selassie I University in Ethiopia. Dr. Fesesse had obtained his Ph.D. in physics from the University of Minnesota in 1973, working under the supervision of Professor Ernest Coleman, and had then stayed on at Minnesota as a Research Associate. A native Ethiopian, Dr. Fesesse had planned to return to Haile Selassie I University as a Professor in the fall of 1975, after he had completed his present research at SLAC and at the University of Minnesota.

We extend our deepest sympathy to his family.

SAFETY & HEALTH

SLAC seeks your help in promoting safe and healthful working conditions. Your comments and recommendations will receive immediate attention. All SLAC employees are encouraged to do the following:

1. Comply with applicable safety and health standards.
2. Report promptly to your supervisor any condition you believe to be unsafe or unhealthful.
3. Respond to warning signals which may be sounded in the event of fire, radiation, or other possible emergencies.

If you have complaints regarding safety or health matters, you are requested first to discuss them with your supervisor. Should this action not result in a satisfactory solution, please consult the SLAC Safety Office, Ext. 2221. If for any reason you wish to remain anonymous, you can still register your complaint by making a written report of the conditions or practices which you consider to be detrimental to your safety or health. Both SLAC and the AEC have suitable report forms available which can be obtained from group secretaries, from the Medical Department, or from the Safety Office.

If your oral or written reports to your supervisor or to the Safety Office still do not bring a satisfactory resolution to the problem, you may file a written complaint directly with the AEC:

San Francisco Operations Office
U.S. Atomic Energy Commission
1333 Broadway
Oakland, CA 94612

No disciplinary action will be taken against any employee who brings safety discrepancies to the attention of SLAC management or of the AEC.

Fred Peregoy, Ext. 2221

ERNEST COLEMAN TAKES AEC POST

The Director of SLAC's Summer Science Program, Dr. Ernest Coleman, will begin work this month as the new Head of the Central Laboratory Research group at AEC Headquarters in Washington. In his new position Dr. Coleman will lead the work of a technical staff which has the responsibility for evaluating the research programs of all of the large laboratories that receive AEC support, and for recommending appropriate funding levels for these programs.

In order to pursue this new activity, Dr. Coleman has taken a leave of absence from his positions as Professor of Physics and Astronomy and as Acting Vice President for Academic Administration at the University of Minnesota. With the assistance of Gail Venables, SLAC's Employment Manager, and of Dr. Vicente L. Llamas of New Mexico Highlands University, who will be the new Associate Director of the Summer Science Program, Dr. Coleman hopes to continue to play an active role in the Summer Science Program at SLAC. We hope so too. This program has given many disadvantaged youngsters who have shown an aptitude for science a first-hand opportunity to see what goes on in a scientific laboratory; and Ernest Coleman has been the mainspring in organizing the program, in teaching the students, and in making sure that they gain the most benefit from the experience.

I remember exactly how I heard about it [in 1939]. I was sitting in the barber chair . . . having my hair cut, reading the *Chronicle*. I didn't subscribe to the *Chronicle*, I just happened to be reading it, and in the second section, buried away some place, was an announcement that some German chemists had found that the uranium atom split into pieces when it was bombarded with neutrons--that's all there was to it. So I remember telling the barber to stop cutting my hair and I got right out of that barber chair and ran as fast as I could up to the radiation laboratory to my student Phil Abelson, who is now the editor of *Science*. . . . Phil had been working very hard to try and find out what transuranium elements were produced when neutrons hit uranium, and he was so close to discovering fission that it was almost pitiful. He would have been there, guaranteed, in another few weeks.

Luis Alvarez, Interview, Feb. 14-15, 1967

GETTING THE MOST OUT OF BUBBLE CHAMBERS

(Reprinted from the May 1974 CERN COURIER)

The Stanford Linear Accelerator Centre has led the development of the techniques to operate bubble chambers at a rhythm much faster than was standard a few years ago. Their 22 GeV electron machine emits its particles at the rate of 360 pulses per second and, since bubble chambers like their incoming particles in short bursts, the Stanford machine is ideally suited to the use of rapid cycling bubble chambers. The proton synchrotrons with their longer pulse lengths at intervals of several seconds are not so naturally geared to sending a rapid series of short bursts.

Even a large 82 inch bubble chamber (previously 72 inch at Berkeley) was modified at Stanford to pulse at a rate of 2 to 3 per second. It has now been retired from active service after accumulating 24 million pictures in its six years at SLAC. Two other chambers remain in action--the 40 inch and the 15 inch which are both rapid cycling chambers.

The 40 inch has been modified to take 12 pulses per second and is being used in association with electronic detectors in "hybrid" experimental setups. The electronic detectors record whether an event of interest has taken place and only then is a picture taken in the bubble chamber. Used in this way, comparatively rare events can be studied without the pain of examining millions of photographs (for example, a recent experiment took 540,000 pictures from 14 million chamber expansions).

The chamber has already been modified to fit better in such hybrid set ups and further improvements are now being implemented. Its magnet yoke was cut away at the exit window to enable particles to escape easier to the electronic detectors. A subsequent field map showed little change from the original configuration with near uniform field of 2.6 T [or 26 kilogauss]. Multiwire proportional chambers (of similar design to those used in the Split Field Magnet at the CERN ISR) are being built for installation at the chamber exit window where the fringe field will give some momentum measurement. A Cherenkov will follow immediately downstream to distinguish between pions, kaons and protons over a broad momentum range.

The electronics will pass signals of events to a NOVA 840 computer. Two events can be collected within the 1.5 microsecond beam pulse from the accelerator and the computer can then decide whether to take a photograph in the chamber. To handle large numbers of emerging particles the use of hardware processors to help the computer is being considered.

A new series of hybrid experiments was discussed at the April meeting of the SLAC Program Advisory Committee and it is hoped that the 40 inch chamber will be back in action with its revamped associated detection systems by October of this year.

At 12 pulses per second, the 40 inch is close to its peak pulse repetition rate. The 15 inch chamber however is capable of faster speeds. It has completed its first physics experiment. Operating at 20 cycles per second it gave 43.3 million expansions while only 120,000 pictures were taken. This year it is hoped to increase the rate to 30 or even 40 cycles per second.

Quarks, schmarks, I told you 2/3 was ridiculous.

Some recent results obtained from the electron-positron storage ring, SPEAR, at Stanford University, seem to cast doubt on quark-like models in both their static and dynamic aspects . . . . The results are so unusual that physicists are already suggesting new ways of viewing matter in order to understand them. Not only do the results contradict the quark and parton models, but they look almost as if protons had collided. In other words, leptons seem to be showing the sort of behavior expected from the hadrons. According to Burton Richter at SLAC, the energy density at the point of annihilation is almost as great as in the "big bang" that presumably started the universe, so perhaps it should be no surprise that the physics coming out of this experiment is so different from what has gone before. . . .

Even though there were warnings, the SPEAR result has astounded many high energy physicists, and there is no doubt, in the words of Sidney Drell at SLAC, that "It has the theorists running for cover."

Science, May 1974

Want Ads

The *Beam Line* is scheduled to appear on about the 10th of each month. The deadline for Want Ads is the 1st of each month. Please send Want Ads to Dorothy Ellison, Bin 20, Ext. 2723.

WANTED: Delta wood lathe and Delta band saw. Will pay the going price. I have a good Delta radial arm saw as possible trade, if so desired. Urban Cummings, X2308 or 328-1177.

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