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Cover photograph: The scintillation counter and light guides built by a Pisa group as part of a CERN/Dortmund/Edinburgh/Orsay/Pisa/Siegen collaboration studying the decays of neutral kaons at the SPS Super Proton Synchrotron. The distorted light guides at the bottom are in fact reflections in the surrounding aluminized mylar box, and the background striations are the reflections of the corrugated wall of the building (Photo CERN X692.11.84).

The Collider marches on

On Sunday 17 March, packets of 450 GeV antiprotons orbiting in the seven kilometre SPS Super Proton Synchrotron ring at CERN smashed into 450 GeV packets of protons circulating in the other direction. As well as providing a new world record collision energy of 900 GeV, this was the first cheduled physics run for the SPS proton-antiproton Collider operating in its new mode. Its immediate success testifies to the impressive skill of the SPS operating teams and the backup from the other machines, and bodes well for the future when the CERN accelerator complex will also have to supply electrons and positrons for the LEP machine now under construction.

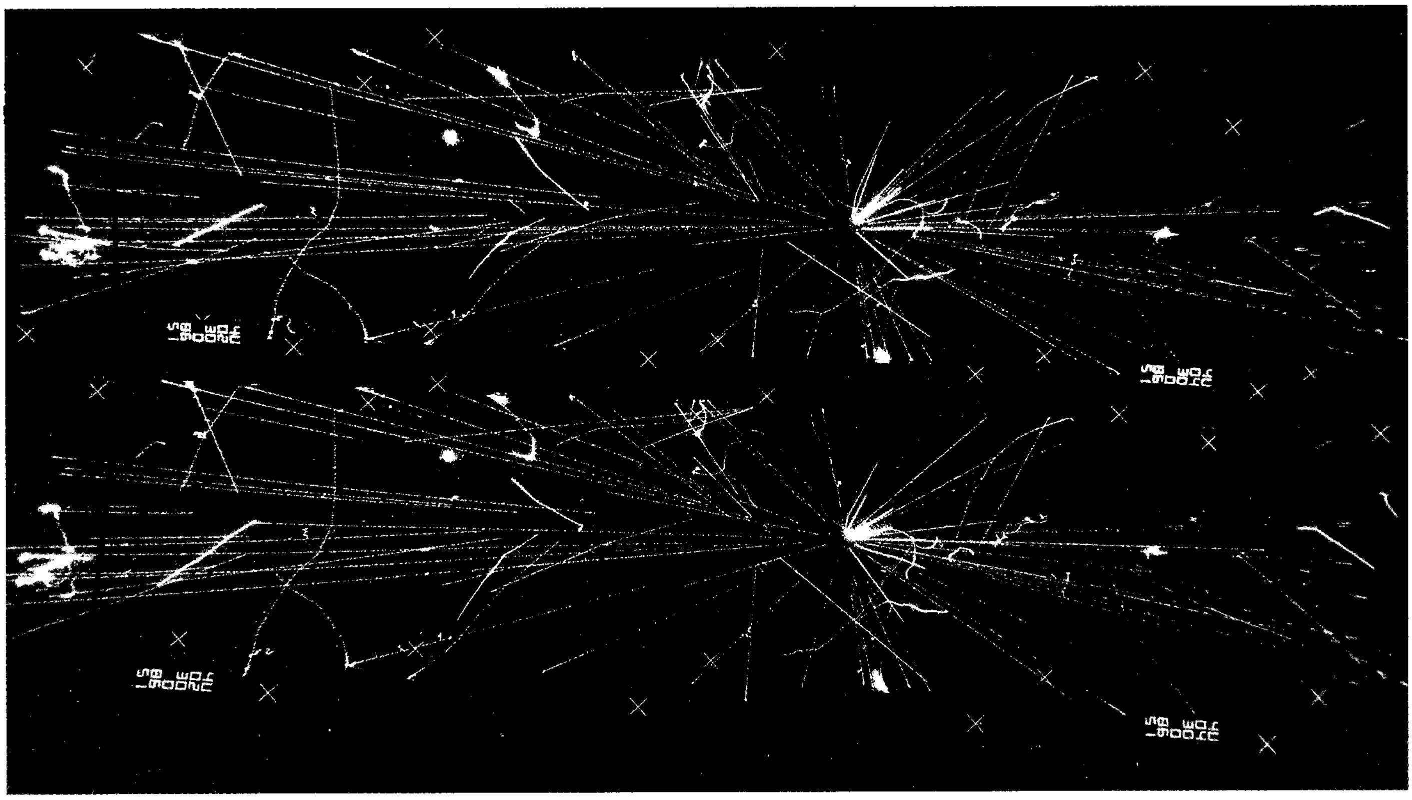
In previous SPS Collider runs, the emphasis was on achieving maximum collision rates (luminosity). The energy of the contra-rotating proton and antiproton bunches was taken from 26 GeV (the energy at which they are received from the PS) initially up to 270 GeV, and in the 1984 run to 315 GeV. This is the maximum energy that particles can now be stored in the SPS because of the ohmic heating in the main magnet coils.

However a different technique, initially suggested by the UA5 (Bonn/Brussels/Cambridge/CERN/Stockholm) streamer chamber experiment at the Collider, sidesteps this limitation by pulsing the stored particles, accelerating them briefly to 450 GeV and then taking them down to 100 GeV.

In the initial 900 GeV Collider run, the stored antiproton bunches hit two circulating proton bunches, enabling both UA5, back in the SPS ring for the first time since the first historic Collider runs in 1981, and UA1 to view the newly accessible energy domain. Luminosity was relatively low, but at 900 GeV and with very clean and stable conditions, this was no great cause for concern.

Physics studies with cosmic rays have suggested that unexplained behaviour is seen at extremely high energies. While this was not confirmed in the initial 540 GeV runs, the newly attained energy might be sufficient for these mysterious phenomena to show up under laboratory conditions.

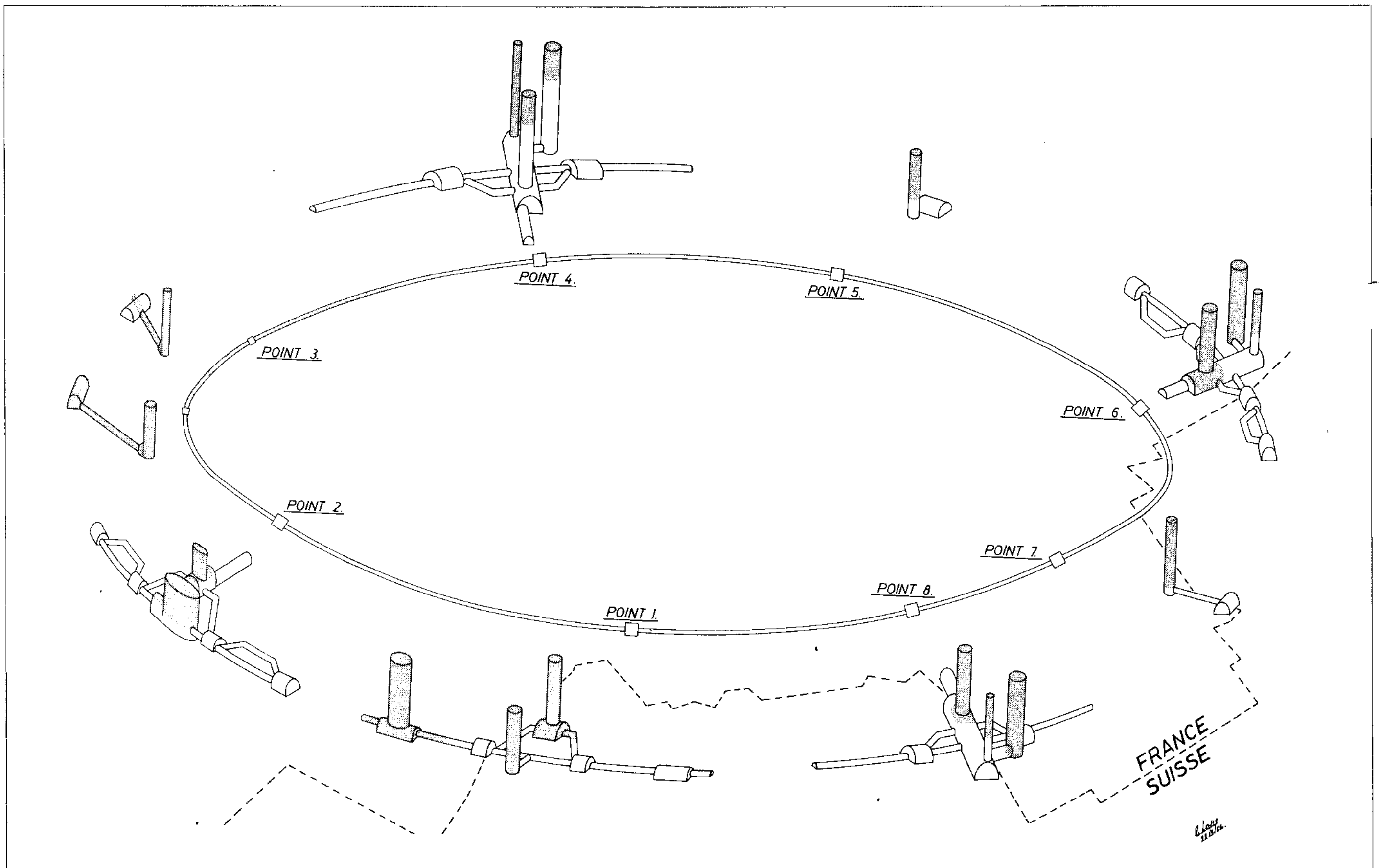
Even if they do not, charting the general characteristics of particle collisions at 900 GeV will be another big advance for physics.



Stereo views of one of the first 900 GeV proton-antiproton collisions as seen in the big 7.5 metre streamer chambers of the UA5 experiment.

LEP progress

A schematic of the necessary excavations for the LEP electron-positron collider at CERN. The shaded volumes indicate the excavations completed as of end-February. The complex configurations of access pits, 'caverns' and tunnels at the eight possible beam collision points around the ring are illustrated adjoining their ring location. Point 1 (the pits nearest to the existing CERN site) is where the first tunnelling machine has started work. The Franco-Swiss frontier is drawn through the illustrations of the pits rather than the ring itself.



Construction progress on the giant electron-positron collider, LEP, was highlighted at the LEP Experiments Committee, which had one of its regular meetings at CERN in March. The meeting brought together many of the physicists involved in the big collaborations which are preparing the first experiments for the advent of high energy colliding electron-positron beams. It began with a day of physics and it was stimulating to see many physics questions identified which LEP can address both in its initial operating phase at 50 GeV per beam and when upgraded to its full design energy of 100 GeV.

Machine construction is proceeding well towards the planned completion of installation by the end of 1988. The present status of the project was described at the meeting by Gunther Plass and the following information is largely drawn from his talk.

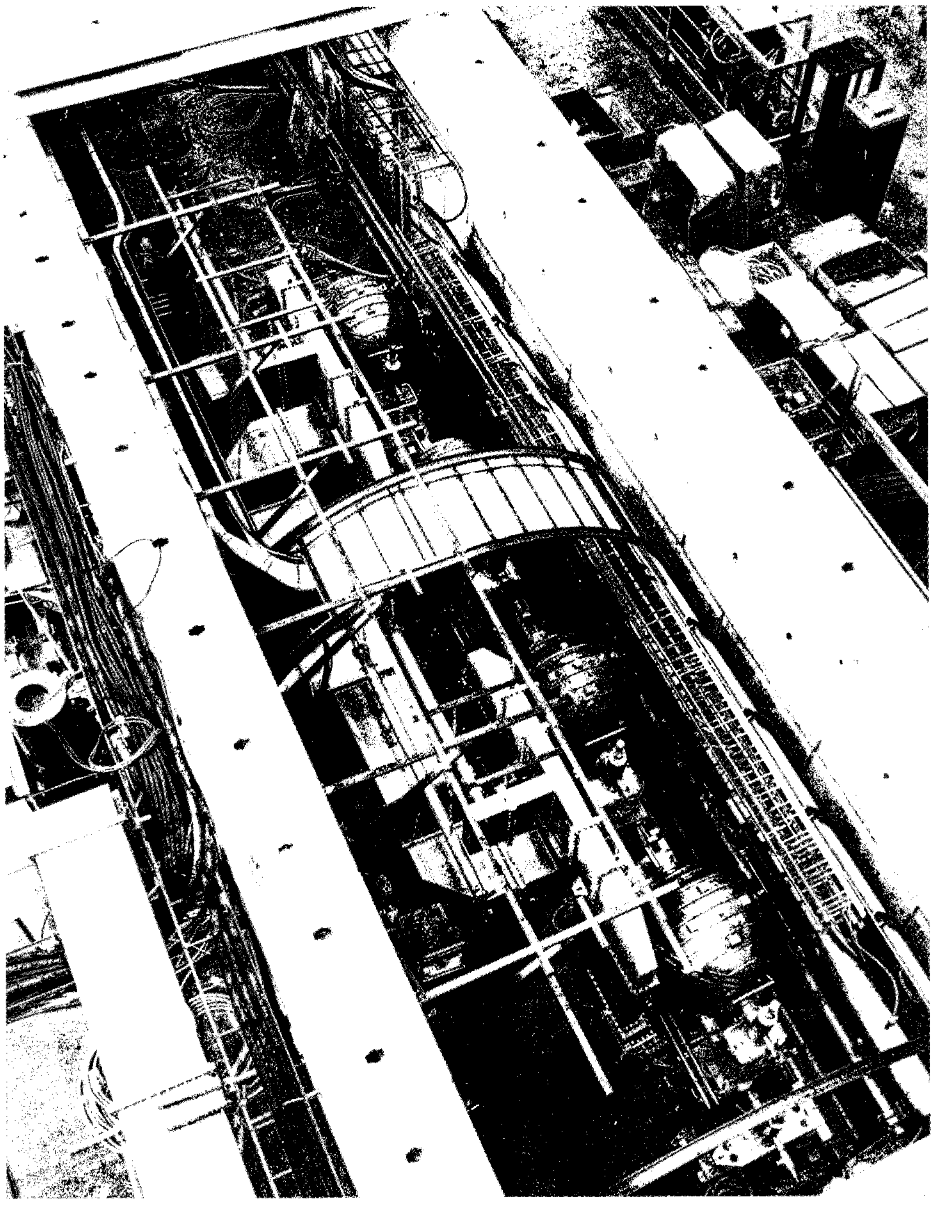
LEP components

The electron source, which has been built and tested at the Orsay Laboratory, will soon be delivered to CERN. Waiting for its arrival are the first 4 m sections of the 200 MeV linac (also assembled at Orsay) which are already installed in the completed linac building. The building to house the Accumulator, which will store electrons and positrons at 600 MeV, is also ready. Production of the Accumulator ring components is now underway. Preparations at the PS and SPS, the last two stages of the LEP injection system taking the beams to 20 GeV, are going well.

Delivery of the Main Ring magnets has started. Altogether some 170 magnet blocks, using the new 'concrete magnet' technique for the low field LEP magnets (see April 1979 issue, page 66), have already been produced — enough to equip the first kilometre of the ring. Prototypes of the various focusing and correcting magnets have been built and tested. A contract has also been placed for the superconducting quadrupoles, which will be used to give the beams an especially hard squeeze before they collide in the experiment detectors. It was interesting to see that this contract attracted

Four radio-frequency accelerating cavities for LEP (together with their 'low-loss' spherical cavities) installed in the West Hall at CERN. It is intended to have sixteen cavities hooked up to two klystrons for tests.

(Photo CERN 63.01.85)



keen competition between several European firms, indicating that superconducting magnet technology is mastered by industry. This bodes well for the HERA electron-proton collider project at DESY and for possible future options at CERN itself.

Radiofrequency cavity production, including the spherical low-loss cavities, is well advanced. Twelve are already on-site and are being assembled in a mock-up of a LEP accelerating section for tests. By the end of April it is intended to have sixteen cavities (corresponding to an eighth of the total LEP system) hooked up to two high power klystrons.

For the phase beyond 50 GeV operation, superconducting r.f. cavities will be necessary so that adequate power can be pumped to the beams with high efficiency, to compensate for the large increased losses due to synchrotron radiation. Happily, progress with superconducting cavity development at CERN has gone extremely well and their use can now be envisaged with confidence (see October 1984 issue, page 331). Accelerating field gradients as high as 13 MeV per metre have been obtained in cavities built under laboratory conditions. For the actual accelerator, the multi-cell sections would be produced in industry and, to be prudent, the present calculations for the 100 GeV upgrade of LEP are using a gradient of about 6 MeV per metre.

An important decision has been taken to include a superconducting r.f.section in LEP from its first operation so the performance of the cavities in the actual storage ring conditions can be monitored. Since the cavity frequency has been set at 352 MHz, as for the conventional cavities, a move to superconductivity for the 100 GeV upgrade would be reasonably straightforward (and more economic) since all the surrounding systems — klystrons, wave-guides, etc. — remain the same. A standard klystron could drive sixteen superconducting cavities during the initial operation of LEP.

All major components of the vacuum system are ordered. A sixth of the necessary getter strip is available and firms are getting to grips with the techniques of aluminium chamber production. Special development is needed for the addition of the lead-cladding which will partly absorb the synchrotron radiation coming from the electron and positron beams. Power, cooling and ventilation systems will be finalized and the corresponding contracts placed in the course of this year.

The civil engineering

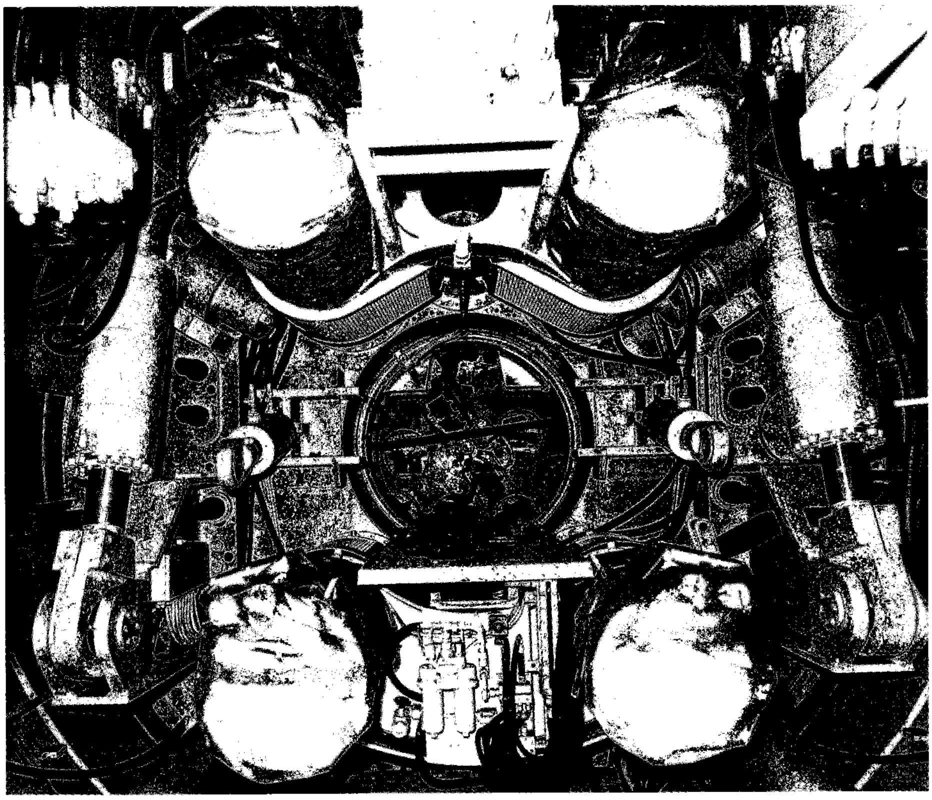
At this stage of the project the most visible signs of progress are in the civil engineering construction of the access pits down to tunnel level, 50 to 150 metres below ground and in the start of boring of the 27 kilometre tunnel itself.

Related to the civil engineering there is interesting news concerning the machine survey. The basic survey grid for LEP was established using a laser interferometer and has achieved reproducibility to an accuracy of 10^{-7} (a millimetre in ten kilometres). Since then it has also been possible to test a new technique — earth survey using satellites. This measures between points marked by an antenna and has confirmed the initial measurements to an accuracy of a few millimetres. A novel feature of the satellite technique is that there is no longer need for 'line of sight' between the two points being measured. The need for survey towers to give 'line of sight' has gone.

Fourteen of the eighteen LEP access pits have been dug and excavation of many of the 'caverns' at the access points is well underway. The work on the pits and caverns represents about half of the total excavation (some 830 000 cubic metres) necessary for LEP. Much attention recently has concentrated on pit PM 18 (82 metres deep and 14 metres across) where the first tunnelling machine was lowered at the end of January. The machine has now been assembled underground and the first 60 metres of tunnel have been bored heading in the direction of the Jura mountains.

The civil engineering is behind the initial schedule for several reasons. However a number of options are open to retrieve the situation. The number of machines to be used for excavation and concreting of the tunnel has been increased (in particular a third tunnelling machine has been added) so that more work can be done in parallel and there is more flexibility to adapt the civil engineering programme to the circumstances as they develop.

Civil engineering was scheduled to take four years from the starting date and present indications are that this will be met with perhaps a couple of months delay. This could then be recovered during the machine installation stage and there is every reason to believe that the attack on those physics questions reviewed at the LEP Experiments Committee can start as foreseen.

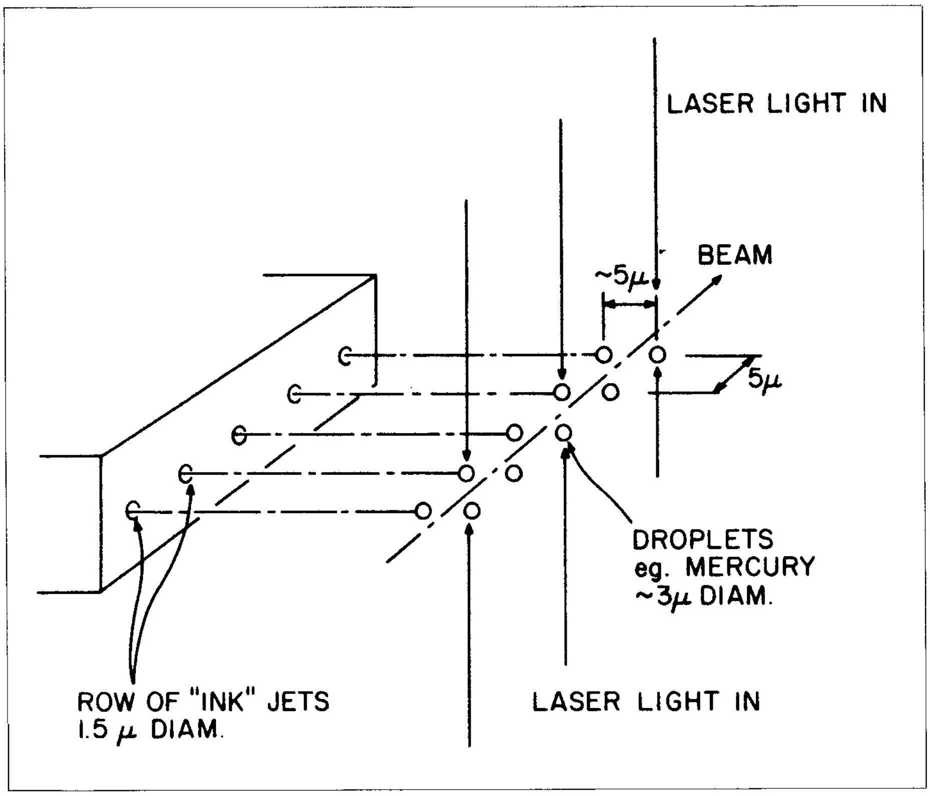


A view inside the first LEP tunnelling machine which has begun work to bore out the LEP ring. The rams on the outside force the cutting head against the rock face.

(Photo CERN 476.01.85)

New accelerator ideas

In the droplet accelerator idea, the beam passes through a miniature open linac structure formed by liquid metal micro-droplets ('ink jets') ionized by exposure to laser light.



In the past, providing higher particle beam energies meant building bigger accelerators. It is now universally accepted that with the current generation of accelerator projects either under construction (such as LEP at CERN) or proposed (such as the Superconducting Super Collider in the US), conventional techniques are reaching their practical limit.

With the growing awareness that progress in particle physics requires new methods to accelerate particles, workshops and study groups are being set up across the world to search for ideas for the machines of tomorrow (see, for example, December 1984 issue, page 436).

The Second Workshop on Laser Acceleration of Particles was held at UCLA (Los Angeles) from 7-17 January, the first having been held almost three years ago, at Los Alamos. This latest workshop was attended by some 120 physicists and engineers experienced in particle accelerator and laser technology, twice the number that attended the Los Alamos meeting.

In the meantime, there has been tremendous progress in the field of laser acceleration methods. This progress is a direct result of the effort by research institutions and the strong support given by funding agencies on initiatives in this area.

Despite its title, the workshop was broadened to include studies of all novel acceleration schemes irrespective of whether lasers are involved.

Substantial progress, both theoretical and experimental, has been made on all three basic types of laser accelerators: so-called near field and far field types and plasma machines. Understanding gained from detailed studies of problems on laser excitation and propagation, and on particle beam containment and stability have pointed to potentially promising schemes.

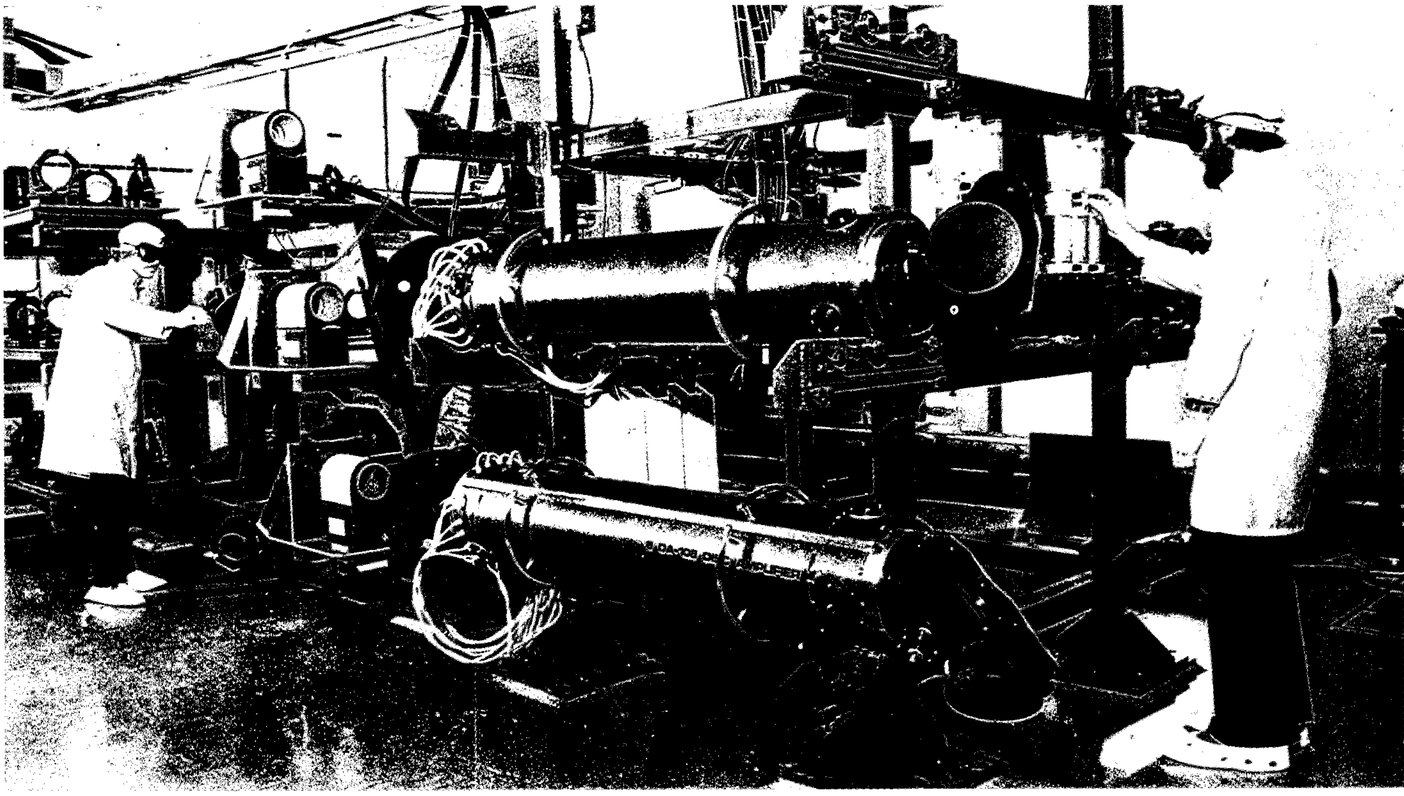
Near field accelerators are miniature open linac structures which support longitudinal accelerating field components (non-plane wave). Here the possibility of forming miniature open linac structures with liquid metal micro-droplets is under close scrutiny. The accelerating gradient in such structures is limited to about 1 GeV/m by droplets turning into plasma.

In far field accelerators the particle motion is wiggled laterally so that the particles are synchronously accelerated by the alternating transverse electric field of a plane laser wave. The main scheme is the inverse free electron laser (IFEL) in which the electron beam is wiggled by a series of alternating static magnetic fields (undulator). Since the first workshop FEL experiments have verified the theory, and the mechanism of IFEL has been observed. The acceleration rate for an IFEL accelerator is limited to less than a few hundred MeV/m and the maximum energy is restricted by synchrotron radiation loss to less than a few hundred GeV. The idea of using a gaseous medium to lower the synchrotron radiation loss was studied theoretically but experimental verification is needed. A proposal to use a wave guide with dielectric walls to keep the laser beam focused was investigated. The concept looks all right on paper, but again, should be confirmed experimentally.

The use of an IFEL to reduce the emittance of an electron beam was discussed. The damping effect is indeed present but rather weak. With presently available technology

The Vulcan laser at the Rutherford Appleton Laboratory, UK, where a beat-wave plasma accelerator experiment is underway.

(Photo RAL)



the damping length is too long to be useful. Further studies are required.

Plasma-laser accelerator concepts have been distilled down to a single scheme, the beat-wave plasma accelerator. Particles are accelerated by the very high electric field in a highly modulated high density plasma wave which is, in turn, resonantly driven by the beat-wave of two interfering laser beams. A great deal of analytical and numerical simulation work has been done since the first workshop. On the experimental side the UCLA experiment using 10.6 and 9.6 micron CO_2 radiation generated and detected the fast beat wave reproducibly over a length of 1.5 mm (limited by the size of the plasma). The electron density modulation in the wave was measured to correspond to fields in the 300 MeV/m to 1 GeV/m range.

A similar experiment is planned at the Rutherford Appleton Laboratory in the UK using 1.06 and 1.05 micron radiations from glass lasers. An unsuccessful experiment at Los Alamos using a single frequency and a long pulse from the HELIOS laser was analysed by two dimensional computer simulation and the outcome of the experiment was found to be predictable. The transverse focusing of the particles by the plasma tends to be excessively strong, making matching between stages rather difficult. This prompted people to look into very long self-focused laser channels, which appear feasible.

For non-laser accelerators, the wakefield or two-beam acceleration schemes are the most promising and have received the most attention. In a two-beam accelerator the electric field (wake field) generated by one low energy high current beam is used to accelerate a low current second beam to high energies. The two beams could travel in separate cavity structures and the field is transmitted from one cavity to the other through couplers, or the two beams could be travelling in the same cavity. In either case the ratio of the electric fields on the two beam trajectories must be very large. This is equivalent to having a large transformer ratio in a voltage step-up transformer. Experiments are being carried out at DESY (single cavity arrangement) and at Berkeley (dual cavity arrangement).

To gain full benefit from high energy colliding beams one must also have sufficiently high luminosity, hence high beam intensity and low emittance, to provide easily detectable event rates. A sizeable part of the workshop's effort was therefore devoted to examining means to fulfil requirements for repetition rate, average beam power and beam emittance.

A central problem is the production and retention of a small electron beam emittance (compactness and potential beam spread). Several methods were investigated and limiting the emittance in a damping ring looks best.

The requisite high average beam power calls for high efficiencies both in the production of laser energy and in the energy transfer from laser to particles. Although capable of extremely high peak electric field, lasers are not yet energy efficient and the construction cost per unit average power is rather high.

Energy efficiency considerations point to two new directions. The laser-to-particle energy transfer efficiency could be improved by going to lower peak accelerating field and hence, longer accelerating structure. This also accentuates the need for staging the accelerating structure and the laser source. Millimetre and centimetre waves could be used instead of optical lasers. The energy efficiency of microwave sources are much higher than that of lasers although the peak field attainable may be lower. The microwaves are induced in cavities by tightly bunched intense electron beams produced from photocathodes irradiated by pulsed laser light.

Nevertheless possibilities of developing high efficiency, high repetition rate, short pulsed lasers continue to be investigated and received much encouragement at the workshop.

The need for high luminosity also points to very low beam emittance and very strong focusing lenses and the possibility of using lasers to provide the required strong focusing is being investigated. It appears possible to obtain a focal length of 5 m for a 50 GeV electron beam.

This second workshop confirmed the promise and likely payoff of a variety of schemes. Faced with the gargantuan proportions of the SSC it is clear that the development of new methods of acceleration are the only hope for the survival of high energy accelerators and particle physics beyond the SSC. The continued support of ongoing efforts need to be supplemented by additional and intensified new activities.

From Lee Teng

Around the Laboratories

DESY Linacs upgraded

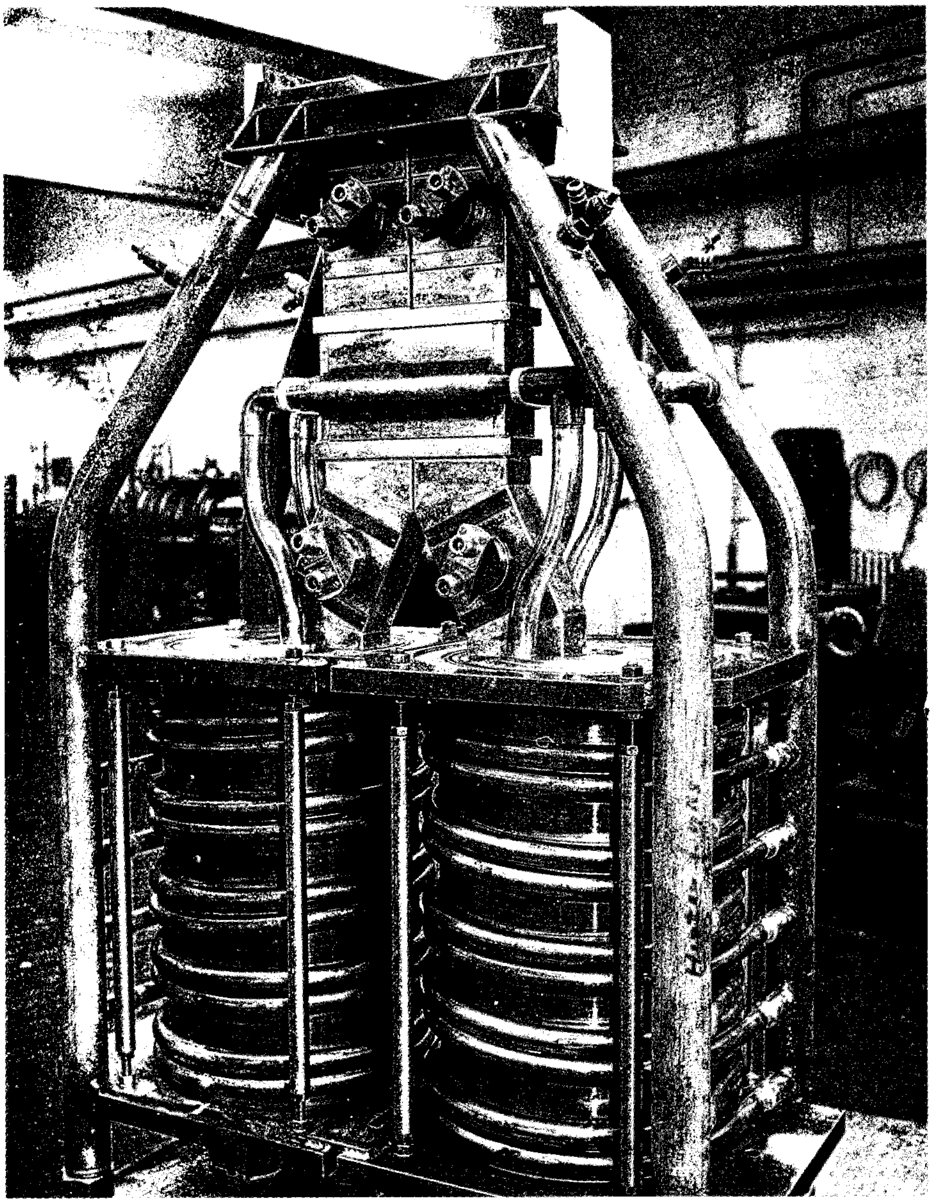
At the German DESY Laboratory in Hamburg a plan was started two and a half years ago to improve the performance of the linear accelerators LINAC-I and LINAC-II used to inject electrons and positrons respectively into the two synchrotrons DESY-I and DESY-II (see May 1984 issue, page 151).

It was then proposed to use the energy storage cavities scheme originally developed at Stanford. This allows higher particle energy to be reached in linear accelerators without increasing power consumption, but at the expense of the length of the particle pulse.

The two DESY linacs have now been modified and storage cavities were added to improve their performance.

The 450 MeV LINAC-II was already upgraded over a year ago. There was no need for an increase of the final particle energy at this linac, but the number of emitted positrons was improved by 60 per cent and at the same time the length of the linac was reduced from 14 to 12 sections. The higher positron rate is essential to reach acceptable injection times for the HERA project, where large positron currents are required if positron-proton collisions are wanted.

The two remaining sections from LINAC-II were moved to LINAC-I, also now fitted with storage cavities, and increase the energy of the electrons provided by this machine from 55 to over 220 MeV. The efficiency of the injection into the synchrotron is much higher at 220 MeV; reaching almost 100 per cent. It was about half this value at 55 MeV. This system is



One of the 13 energy storage cavity-pairs now installed at DESY (11 on LINAC-II and 2 at LINAC-I).

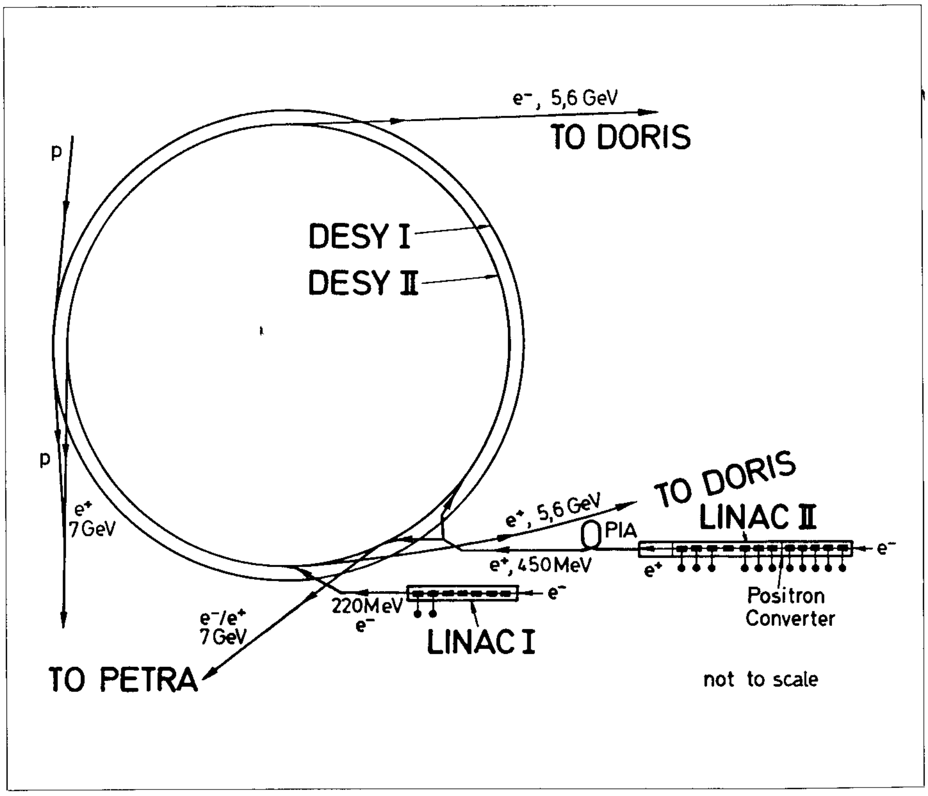
(Photo DESY)

used to inject electrons into the new DESY-II electron-positron synchrotron (not yet complete).

In LINAC-II, the first result of energy storage cavities was an increase of the energy of the electrons hitting the electron-positron converter. Five linac sections are used for this. Positron emission from the converter is proportional to the energy of the incident electrons. Therefore the increase of energy of the electrons provided a 60 per cent higher positron flux. Further acceleration up to 450 MeV (required for intermediate storage in the PIA Positron Intensity Accumulator ring) is then handled by seven linac sections, six of which are provided with storage cavities. (One of the transmitters is used as a drive for the others and could not be attached to a storage cavity.) An additional advantage of the new system is that one of the positron LINAC-II sections is practically redundant and is kept as a standby.

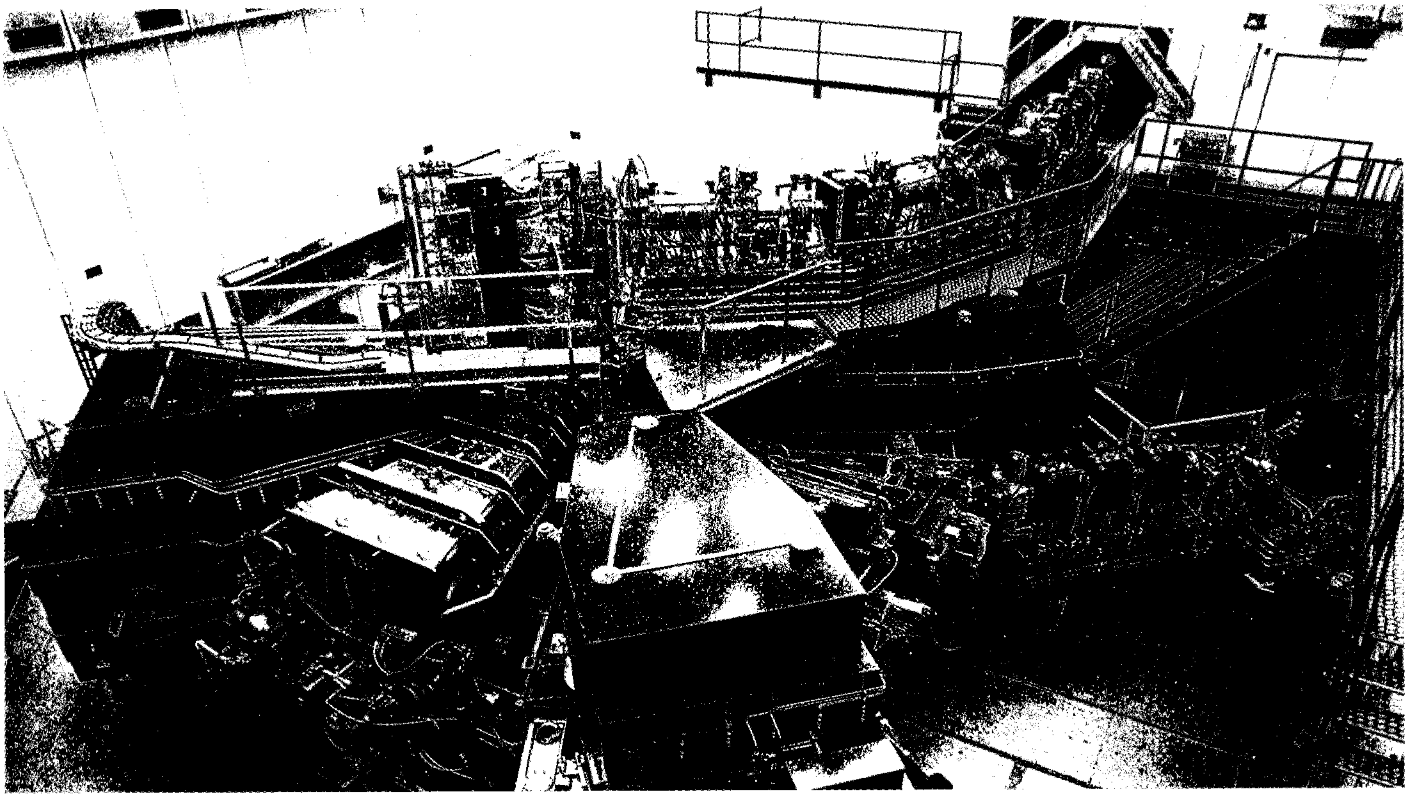
The upgraded LINAC-II has been working for one year without causing any problems. The PIA ring current was increased from 9 to 14 mA. The PIA positrons are adequately bunched for further acceleration in the synchrotron and subsequent injection into the DORIS and PETRA rings and eventually HERA too.

From Arno Febel



The electron and positron injection systems (LINAC-I and LINAC-II) for the DORIS and PETRA rings through DESY-II. At present DESY-I is still being used. Once DESY-II comes into full operation, DESY-I will be rebuilt as DESY-III to inject protons into the big HERA electron-proton collider, now under construction.

General view of the new 72 MeV injector cyclotron at SIN, the Swiss Institute for Nuclear Research.



SIN
lew injector

Until recently, the Swiss Institute for Nuclear Research (SIN) accelerator complex, based on a 590 MeV ring cyclotron, was fed by a 72 MeV injector cyclotron built by Philips. In the past, SIN has always devoted 25 per cent of the injector beam time to low energy research, time lost for 590 MeV work.

Further, as experience with the main ring cyclotron developed, it became clear that its extraction losses were far lower than anticipated (i.e. of the order of 0.01 per cent). Since the activation of some components of the ring at extraction sets a limit on beam intensity, this meant that much higher beam currents could be handled.

For experimental physics, this would for example allow rare decay searches to be pushed to much lower limits. Accordingly it was decided to construct a purpose-built injector cyclotron ('Injector II') with a Cockcroft-Walton pre-injector, capable of much higher beam currents at the same energy of 72 MeV.

This machine is now being commissioned, and promises the following benefits:

an order of magnitude higher intensity than the present injector;
potentially 25 per cent more beam time;
better back-up, with two independent injectors;
some improved technical properties, e.g. better turn separation, and an external ion source.

The higher currents have made it possible to propose a completely new facility — a continuous spallation neutron source, consisting essentially of a heavy metal target exposed to a beam of at least 1.5 mA of 590 MeV protons and surrounded by a moderator. If built, this device could serve other communities, in solid state physics, crystallography, biology and materials research for example.

The more flexible old injector will remain in service, for the time being at least, partly for work with polarized beams and the low energy programme and partly for the 'Optis' eye cancer treatment device, for research into medical isotope production and for other possible biological and therapeutic applications. In addition to its normal work as a high current proton machine, it can accelerate polarized protons and deuterons, and such light ions as helium, carbon and oxygen, all to a range of energies.

First d.c. proton beam from the 860 keV Cockcroft-Walton pre-accelerator was obtained towards

At the recent joint US/CERN School on Particle Accelerators' Topical Course on Nonlinear Dynamics, held in Santa Margherita di Pula, near the southern tip of Sardinia. Left to right; Mel Month, head of the US School on High Energy Particle Accelerator; the Hon. M. Melis, President of Sardinia; Kjell Johnsen, Head of the CERN Accelerator School; G. Piredda, Mayor of Pula; John Jowett of CERN and syllabus organizer; and Prof. R. Habel of Frascati, representing the Italian Physical Society.

the end of 1983. On 22 June last year, the new 72 MeV injector delivered an 0.5 microamp beam, and on 23 August it yielded 23 microamps which were taken to 590 MeV in the ring cyclotron. On 19 November a 590 MeV production run furnished 180 microamps of beam (from 3 mA d.c.), but an unfortunate vacuum leak prevented an attack on SIN's 190 microamp beam record. On 13 December, 500 microamps (from 4 mA d.c.) was obtained at the 72 MeV beam stop, with an extraction efficiency of 99.5 per cent.

After the successful commissioning of Injector II, a great deal of preparation for normal production running has to be done. In order to handle the increased output of Injector II, the main ring r.f. system is being upgraded for beams of the order of a milliamp. The future production schedule will be so organized that 25 per cent of beam time will be used for beam development and modifications. The most important question is the space charge limits of the beam, particularly in view of the planned neutron spallation source. At present, the current is limited by the Cockcroft-Walton preaccelerator, but its beam will be boosted by a factor of three or more during the course of the year.

ACCELERATORS
Nonlinear dynamics in Sardinia

In the last few years, two schools devoted to accelerator physics have been set up, one on either side of the Atlantic. The US School on High Energy Particle Accelerators has organized Summer Schools on the physics of particle accelerators, hosted by the major American Laboratories, each year since 1981. The CERN Accelerator School started in 1983 with a special course on Antiprotons for Colliding Beam Facilities at CERN, followed at Orsay in 1984 with its first course of a regular series on General Accelerator Physics. In addition, it has helped organize special workshops. The response to these courses has demonstrated the great need for training in accelerator physics, a subject which appears on the curriculum of only a very few universities. Meeting this need requires an accelerator school at least on each side of the Atlantic.

However there is also a need to cover certain specialized topics with more general participation. For this purpose the two Schools have combined to create the Joint US/CERN School on Particle Accelerators, which will organize Topical Courses once a year, probably in the winter, in parallel with the separate summer schools. Nonlinear dynamics provided a promising start to this series.

The Italian Physical Society helped organize and support the school, which took place in Santa Margherita di Pula, near the southern tip of Sardinia, from 31 January to 5 February. The Sardinian Government and the local tourist authorities gave generous hospitality and entertainment which provided welcome relief from the long intense hours of the lecture sessions!

As Emilio Picasso (CERN) pointed out in the opening lecture, nonlinear effects are becoming ever more important in determining the ultimate performance and utility of particle accelerators and storage rings. On the other hand, recent explosive progress in the physics and mathematics of nonlinear systems means that there is a great store of exciting and potentially very useful material gradually being assimilated into accelerator physics. Thus about half the lectures covered ideas and techniques from outside accelerator physics.

Accelerator problems have provided a considerable impetus for the modern developments in dynamics. Lecturer Jürgen Moser (Zurich) had guided R. Hagedorn and A. Schoch in their early study of nonlinear resonances in the projected CERN PS back in the 1950s.

Resonances were a key theme, returned to again and again by many of the lecturers. They emerged in the introductory lectures on modern Hamiltonian dynamics given by Ian Percival (Queen Mary College, London). Ron Ruth (SLAC) then described the accelerator physicist's ap-

Jürgen Moser (Zürich) lecturing during the Joint US/CERN Accelerator School Topical Course on Nonlinear Dynamics.

proach which was applied to colliding beams by Alex Chao (SSC). Anton Piwinski (DESY) gave an account of the different sorts of synchro-betatron resonances which can cause problems for large storage rings.

Analytical perturbation techniques used in many nonlinear problems of applied mathematics and engineering were given a thorough exposition by Ali Nayfeh (Virginia Polytechnic). In a complementary set of lectures, Jim Crutchfield (Berkeley) described modern techniques for understanding dynamical systems through numerical experiment on computers and illustrated them in several striking films. He convincingly swept away the old belief that computer experiment does not allow one to go straight to the essence of the problem!

Computers have become indispensable tools in accelerator physics too. In particular, the nonlinear motion of particles in the magnet lattice of a storage ring is a formidable problem in the long-time behaviour of dynamical systems, crucially important in determining the magnet aperture (and thereby the cost) of the large hadron colliders planned for the future of high energy physics. The only tests for stability available in the design of a storage ring are programs which track the orbits of single particles. The tracking algorithms used in such programs were described by Chris Iselin (CERN) while Albin Wrulich (DESY) described their use including the DESY approach of using dedicated processors to speed up execution. The analytical tools available for arranging sextupole magnets to improve stability in storage rings were described by Gilbert Guignard (CERN) while Karl Brown (SLAC) discussed the art of designing single-pass nonlinear optics as in the Stanford Linear Collider.

Much of the recent interest in nonlinear systems has come through the realization that even very simple deterministic classical systems are inherently unpredictable because of the chaotic behaviour which they (nearly always) exhibit. Insight into the origin of such motion was given in the lectures of Jürgen Moser while Robert Mackay (Warwick) described the breakdown of regular motion and the transport effects which arise in the chaotic phase space of a Hamiltonian system.

The limitation of storage ring performance by the collective electromagnetic interactions of colliding beams has long been associated with the transition to chaos in non-linear dynamical systems and there were several speakers on this 'beam-beam effect'. However, some warned against conclusions drawn using the approximation of two intense colliding beams by the perturbation of a 'weak' beam by an opposing fixed 'strong' beam.

Experimental observations were comprehensively surveyed by John Seeman (SLAC) while Jacques Gareyte (CERN) gave an account of the latest impressive results from the proton-antiproton collider at the CERN SPS. Some of the theoretical attempts to understand the beam-beam effect were described by Jonathan Schonfeld (Fermilab) and Jeffrey Tennyson (currently at Novosibirsk). Steve Myers (CERN) reviewed the success story of computer simulation of the beam-beam effect in electron-positron colliders, although simulation for hadron colliders remains an open problem due to the absence of radiation effects.

The difference between electron-positron and hadron colliders provided a nice illustration of the contrast between dissipative and conservative systems in general which was discussed by Robert Helleman (Enschede and La Jolla). John Jowett (CERN) discussed some of the ways in which dissipative nonlinearities could arise in large electron-positron rings. Some of these, like nonlinear quantum diffusion, were detrimental to performance but non-linear wiggler magnets can be used to mould bunches to improve beam stability. George Dome (CERN) described nonlinear longitudinal motion in hadron colliders and the dissipative effects caused by r.f. noise.

The final lecture was given by L. Jackson Laslett (Berkeley), one of the pioneers in the study of nonlinear effects in accelerators, who gave a fascinating insight into his personal approach using meticulous numerical and analytical study.

As Mel Month, Chairman of the US School on High Energy Particle Accelerators pointed out in his closing remarks, 'One of the most difficult aspects of this school was the necessity to affect what has been called the 'transatlantic barrier' for our field... to find support for a significant number of young accelerator physicists to cross the Atlantic is very, very difficult indeed.'

Including the lecturers, the course was attended by 44 North American accelerator physicists together with 73 participants from Europe and the rest of the world. It provided a welcome opportunity for both young and mature accelerator physicists to listen to each other and discuss some of the most pressing and exciting problems in their field.

The proceedings of the school should be published in a few months' time in the Springer-Verlag series 'Lecture Notes in Physics'.

From John Jowett

BETA DECAY Enigma resolved

With the underlying theory of the weak nuclear interaction in such good shape after the discovery of the W and Z particles which carry the force, it would be surprising if the agreement did not extend to the whole of weak interaction theory.

In some of the first physics results to emerge from the new Tevatron ring at Fermilab, an experiment by a Chicago / Elmhurst / Fermilab / Iowa / Iowa State / Leningrad / Yale collaboration (E 715) has tied up one of the last remaining loose ends in the otherwise immaculate theory of weak interactions.

The classic example of the weak interaction is the beta decay of the neutron into a proton and a neutrino. In the same way, the heavier baryons (hyperons) have similar (semi-leptonic) decays. Each hyperon corresponds to a different mixture of quarks and all these semi-leptonic (beta-like) decays are described by an elegant model proposed by Nicola Cabibbo in 1963.

Hyperons are hard to come by in sufficient quantities to test the Cabibbo predictions, but over the years, most of the experimental data has lined up with the model, in particular the studies by the Bristol / Geneva / Heidelberg / Orsay / Rutherford / Strasbourg group which exploited the special hyperon beam in the West Experimental area of the CERN SPS (see December 1983 issue, page 418). This experiment was in complete accord with the Cabibbo picture, with a slight reservation about the sign of the axial vector to vector form factor ratio (a measure of the relative left/right 'handedness' of these decays).

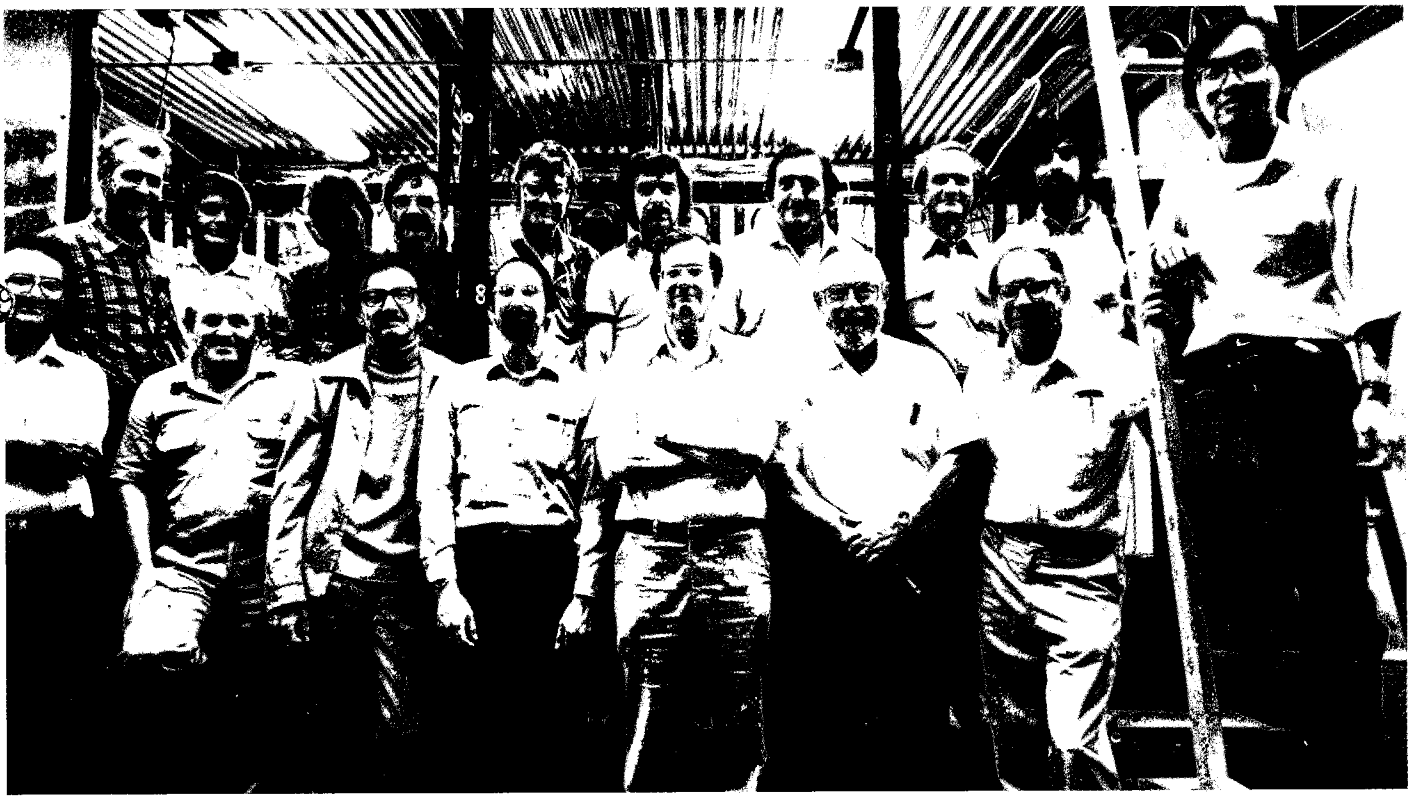
These CERN studies used unpolarized hyperons. Four low energy experiments on polarized (spin oriented) hyperons, the last reporting in 1981, had observed a positive electron asymmetry (more of the produced electrons emerging in the direction of the spin of the sigma rather than the opposite direction) based on a total of 353 events. The magnitude of the axial vector to vector form factor ratio inferred from these measurements was in good agreement with the results of the two highest statistics unpolarized experiments (Brookhaven and the CERN SPS study, together providing 8 000 events) provided the positive value for the form factor ratio was taken.

The problem was that the Cabibbo model definitely predicted that the ratio should be negative in the beta decay of negative sigmas. If these indications could be confirmed, either the Cabibbo model is wrong, or the weak interaction in the decays of negative sigmas is right-handed, in stark contrast to the left-handed behaviour seen everywhere else!

In an unpolarized experiment, all the observables except one depend only on the absolute value of the axial vector to vector form factor ratio. However the shape of the electron energy spectrum is slightly sensitive to the sign of this ratio. By studying this electron spectrum, the CERN SPS experiment concluded that the negative sign predicted by Cabibbo was favoured, in contradiction with the

A delegation from Fermilab experiment E 715, which produced the first physics results from the new superconducting Tevatron ring.

(Photo Fermilab)



previous low energy experiments, but the evidence was not conclu- ive.

Now Experiment E 715 at the Tevatron has reported results on the electron asymmetry parameter in the beta decay of polarized negative sigmas. The group recorded over 80 000 such decays using the charged hyperon beam in the Proton Centre beamline during the Tevatron 400 GeV shakedown run in late 1983 and early 1984, exploiting the pronounced polarization of the hyperons produced at high energy.

In the Fermilab experiment, the major experimental problem was to find the beta decays among the sigma hadronic decays (to a neutron and a negative pion) which are a thousand times more frequent. E 715 used two independent electron identifiers, a four layer lead glass array and a 12 module transition radiation detector (TRD). The TRD, designed and built at Leningrad, provided a trigger rejection of pions (a factor of 35) with 99.5 per cent efficiency for electrons from the beta decay. Off-line the TRD and lead glass systems together gave a pion rejection of 35 000 with 94 per cent electron efficiency.

The sigma polarization could be switched by reversing the targeting angle of the protons which produce the hyperon beam. The ability to flip the polarization is a major improvement over the low energy measurements which relied on a complicated phase shift analysis to calculate the sigma minus polarization.

The results are in perfect agreement with the predictions of the Cabibbo model. The experiment measures the electron asymmetry parameter to be -0.53 ± 0.14, leading to a form factor ratio of -0.29 ± 0.07. The error is dominated by the statistical error in the measurement of the polarization.

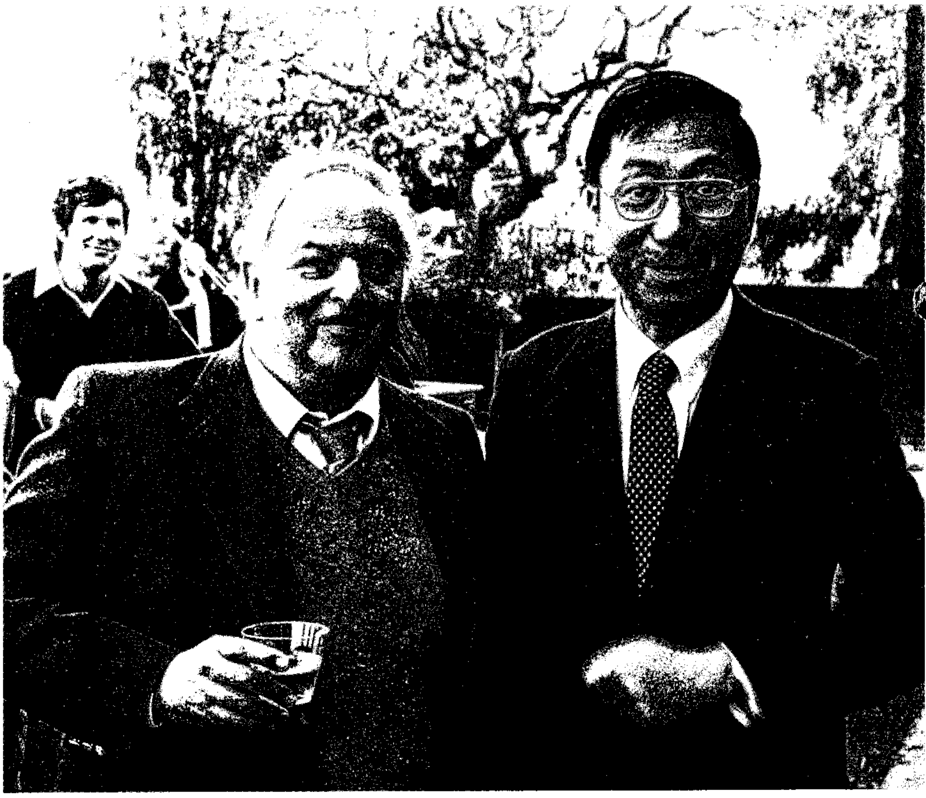
The experiment also has a tracking neutron calorimeter which allows complete reconstruction of the beta decays and a measure of the neutron and neutrino asymmetry parameters as well as repeating techniques of the unpolarized experiments. The experimenters soon hope to have results for these new parameters.

Having removed a major embarrassment in the hyperon sector, E 715 is looking foward to the analysis of the rest of the data, including thousands of other hyperon beta decays.

Ten years after the revolution

by Burton Richter

In his inaugural talk as Director of the Stanford Linear Accelerator Center last November, Burton Richter chose the theme 'Where Are We Going at SLAC?'. The occasion also coincided with the tenth anniversary of the 'November Revolution' — the simultaneous discovery by Sam Ting and his group at Brookhaven and by Richter and the Mark I collaboration working at the SPEAR electron-positron collider at SLAC of a new kind of particle (the J/psi) which did not fit in with the established ideas of the time. Here are some extracts from Richter's inaugural talk.



The recent inauguration of Burton Richter as Director of the Stanford Linear Accelerator Center coincided with the tenth anniversary of the 'November revolution', the simultaneous discovery by the groups of Richter (left) at Stanford and Sam Ting (right) of the J/psi, a new kind of particle which at first didn't fit in...

(Photos Stanford)

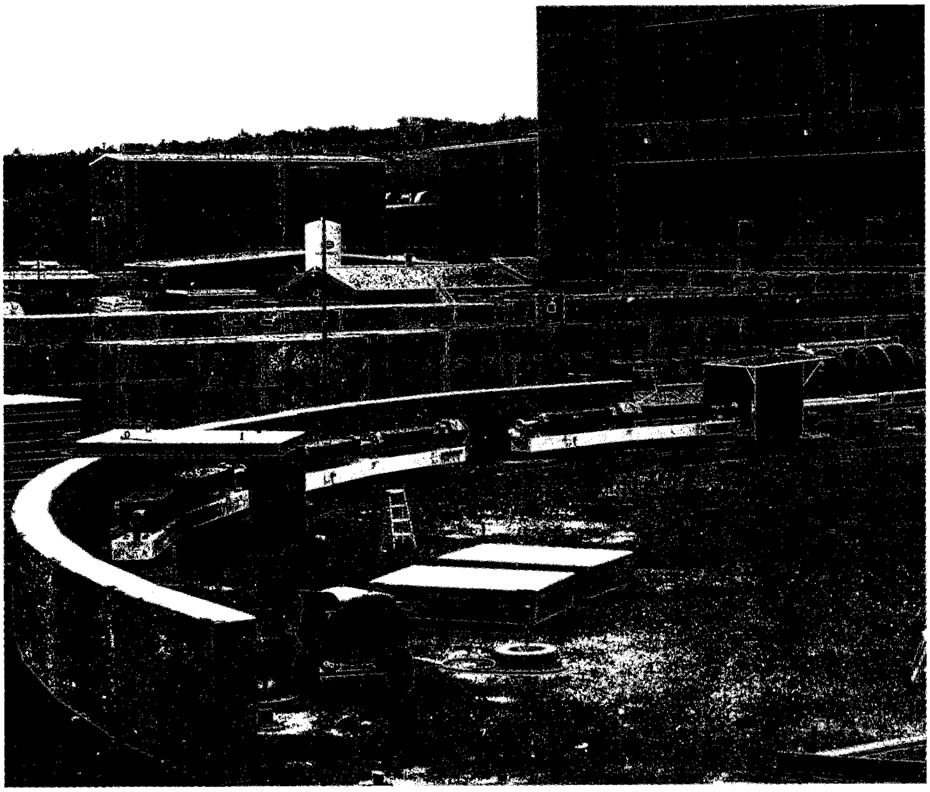
'In high energy physics an interplay of experiment, theory and technology advances our understanding of nature. These three horses pull the chariot of science forward; sometimes one pulls harder than another, but all three are necessary. In deference to our visitors from Washington, I should say that there is a fourth element involved; it is money, and it might be likened to the harness that hitches those three horses to that elegant chariot.

What might be termed the 'standard model' for the advance of science involves an interplay of experiment, theory, and technology. The experimenters, guided by what we know, test the present theories and uncover new facts that sometimes fit and sometimes don't fit into our existing world model. The theorists take the output of the experiments, particularly those things that don't quite fit, and use them to extend the theoretical model to get at a deeper understanding of how our physical universe works. These new models require new experiments, and the accomplishment of those new experiments requires new tools, particularly new accelerators, to give us the ability to probe more deeply into matter. This sounds very evolutionary, and sometimes it is, but sometimes progress in science comes about from revolutionary advances in theory or experiment.

Stanford University and SLAC have played a major role in both the evolutionary and revolutionary advance in high energy physics as long as I have been here, 28 years. It is unusual for a scientist to stay in one place so long, but when I first came to Stanford in 1956 I believed that the electron beams available from the accelerators at Stanford were the best tools with which to gain a better understanding of the structure of matter. I joined a group of scientists who believed as I did, but who back then at least were considered odd by most physicists who thought that experiments at proton accelerators were 'the only way to go'.

When I first arrived at Stanford, the Mark III linac had just recently begun operation. It was a bold step in energy, moving linac technology from the tens of MeV that were the maximum energies of existing machines to over 800 MeV. Mark III was a remarkably large machine — all of 300 feet long! It was a technological tour

Construction begins in 1970 for the SPEAR electron-positron collider at Stanford. This modest machine provided (and continues to provide) a physics harvest out of all proportion to its size and showed the worth of colliding beam machines.



de force in its time, and it was used for many important physics experiments. Robert Hofstadter used its beams to measure the shape of the proton, showing that it was not a point particle and determining its size.

The advances in accelerator technology pioneered at the Stanord High Energy Physics Laboratory (HEPL) were, in the long run, probably just as important as the experiments done with the machine. The first colliding beam storage ring was built there both to pioneer a new technology and to carry out experiments at a new energy inaccessible without the new technology. All major accelerators under construction today are colliders of one type or another, and they all owe much to those early Stanford efforts on colliding beams that showed the way to get much higher energy for a given cost.

While all this was going on, a group of scientists led by 'Pief' anofsky were thinking about the next step in linear accelerators. In 1956 the conceptual design began of a new giant machine, then called 'the Monster' because it was so very large. The first beam from that accelerator, the 10 000-foot-long SLAC linac, was delivered in 1966.

The SLAC linac was a huge extrapolation in technology, taking linacs from the then 300-foot machine at HEPL to 10 000 feet at SLAC. Together with the innovations in linac technology came innovations in experimental apparatus. The first major experiment proved the worth of the entire effort, showing that the proton had a substructure — it was not elementary, but seemed to be made up of still smaller entities very tightly bound inside. As Sidney Drell put it at the time, 'there seemed to be seeds in the grapes.' It changed our view of the subatomic world.

In parallel with many important linac experiments, work began on colliding beams. In 1961 Dave Ritson and I started the design of what would be the SPEAR storage ring. Construction started in 1970, and the turnon was in 1972. Here, too, together with the innovation in accelerators was innovation in experimental apparatus. The Mark I magnetic detector was a powerful tool in its own right, and has been the forerunner of much more sophisticated devices of the same general type at accelerators all over the world. The SPEAR storage ring is still going strong, and we are making major improvements to increase its colliding beam intensity.

In 1970, before the turnon of SPEAR, the first paper on higher energy electron-positron colliding beam systems was written by John Rees. Out of that paper came the machine that is now PEP, which began its experimental programme in 1980 with a new set of experiments of even greater sophistication than what had gone before.

In 1978 work began here on a new kind of colliding beam device — what is now called the SLC (for Stanford Linear Collider). The need for a new technology in colliding beam devices became apparent to some of us when we took a hard look at the greatest of all the storage ring colliders, the LEP project being built at CERN. This machine is 27 kilometres around and will cost more than half a billion dollars. The scaling laws for electron storage rings are well known; size and cost go as the square of

Aerial view of the Stanford Laboratory site showing the two-mile linac in the background. Shown dotted are the arcs for the new Stanford Linear Collider, a novel concept in colliding beam machines in which electron and positron beams from the linac will be led round to collide just once, rather than continuously circulating in a ring. The tunnels for the SLC arcs have been cut, and the project is scheduled for completion in 1986.

the energy. Given this scaling law, to go up a factor of 10 in energy would require a machine of some 2700 kilometres in circumference costing about 50 billion dollars. A new technique was needed to continue at a price that our real masters, the taxpayers, would consider to be reasonable, and the SLC seems to be that technology.

No Laboratory is static. No tool for physics research has an infinite lifetime. The big SLAC linac itself — the reason for building this Laboratory — is no longer being used for frontier high energy physics experiments, but serves as an injector for our present generation of storage rings. However the Laboratory is still doing frontier research, thanks to innovations in accelerators and technology. Work on those innovations proceeds while the 'old' facilities are being exploited.

What now? With the completion of SLC in 1986, our linac will be back as a forefront facility. It is the heart of the linear collider, but it will have undergone considerable improvement. Beginning with 1986, a new era of experiments will start at SLAC that we all expect to contribute important new information to our evolving view of the structure of the physical universe. We can expect something like 10 or 15 years of productive experiments from the SLC. Indeed, the first SLC improvement project is already under design (polarized beams) even though the machine is not yet complete. We have a clear idea of what we will be doing until the second half of the 1990s.

What will we do for an encore? The answer really depends on the imagination and the initiative of the SLAC staff. I can tell you what we're thinking about now, but if someone has a sufficiently bright idea, we may be thinking about, and working on, something quite different a few years from now.

At present we are striving to develop a new technique for colliding beams to allow affordable machines of considerably higher energy to be built. The SLAC linac is not optimized for the acceleration of the kind of beams required for a very high energy linear collider. The linac was aimed at delivering long bursts of particles with as uniform an energy spectrum as possible. Linear colliders deliver very few bursts within a single pulse, and in that mode their optimization is different. The SLC is already teaching us a great deal about beam dynamics in linear colliders, and we will learn much more when the project is in routine operation.

There is a group now working at SLAC called the Big Collider Study Group — composed of theoretical physicists, experimentalists, and accelerator physicists. This group is studying linear collider optimization with a view toward understanding what technical developments are important in making very large machines both practical and affordable.

Two things have come out of their studies already. The first is that much more efficient radiofrequency power sources than our present klystrons strongly impact the design of the large linear collider and can sharply reduce the cost for a given energy. Necessity is indeed the mother of invention, and, in response to this need, an r.f. power source, which uses a laser to produce the electron beam in the tube, has been analysed on paper and looks to be considerably more efficient than our present klystrons. A combined group of people from the Technical Division and the Research Division has done a thorough analysis, including computer simulations, and has started on the construction of a proof-of-principle device which we hope to have ready in about two years. This power source is supposed to have a peak power output of about 100 MW — about twice the power output of the new klystron we are developing for the SLC, — have a pulse length of one microsecond, and be more than 70 per cent efficient. When we achieve it, this will be the most efficient high power pulsed high frequency r.f. source in existence. If it performs as expected we will know that we can reasonably expect to go on to power sources of greater than 90 per cent efficiency.

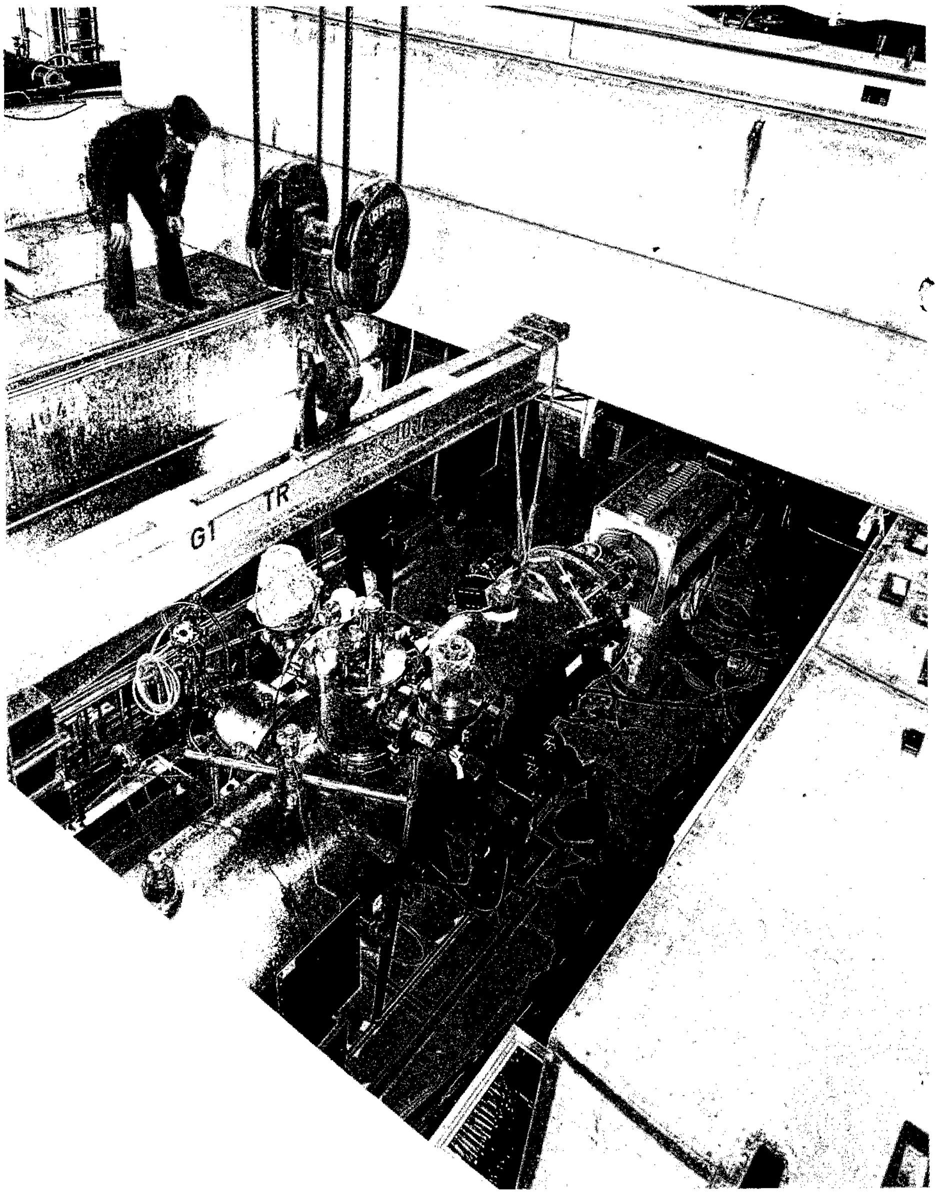
The second thing to come out of the very early stages of the work of the Big Collider Study Group is that much higher accelerating gradients than we use in the SLAC linac look to be desirable to make cost-effective machines. In response to that need, we are trying to find out just how large an accelerating gradient can be obtained in a structure similar to the SLAC accelerating structure. It has already been shown that we can get more than 100 MeV per metre accelerator gradient, or more than six times what is now used in the SLAC linac. Since this has been demonstrated in a section about 1 foot long, I have issued a challenge to the Technical Division: deliver a 1 GeV accelerator less than 30 feet long for less than one million dollars. I expect they will do it!

As to the future of SLAC, I have already told you some of the things that I see in the next 10-15 years, but my real message is perhaps best summarized in the old axiom 'the Lord helps those who help themselves'. Over the entire time I have been at Stanford, we have continued to develop high energy physics here by helping ourselves through the invention of new theories, new accelerators and new techniques of experiments. How far we will go beyond the next 10-15 years depends on all of you.

People and things

In March this nine-cell cavity, working at 1 GHz, by itself managed to store an electron current of 2 mA in the PETRA ring at the German DESY Laboratory. 27 kW of r.f. power could be coupled into the 7 GeV beam.

(Photo DESY)



On people

The Academy of Sciences of Paris has awarded the High Commissioner for Atomic Energy's Prize to Pierre Darriulat of CERN for his role in the UA2 experiment at the CERN proton-antiproton Collider which contributed to the discovery of the W and Z carriers of the weak force and the confirmation of the electroweak theory. The citation also acknowledges the 70-strong UA2 collaboration, particularly the French groups from Orsay and Saclay, as well as CERN as a whole.

At a ceremony at the University of Munich in March, Yoichiro Nambu of the University of Chicago received the prestigious Max Planck Medal from German Physical Society President Joachim Treusch. At the same ceremony, the annual German Physics Prize this year acknowledged contributions to the UA1 experiment at the CERN proton-antiproton Collider which discovered the W and Z carriers of the weak force. Sharing the prize were Karsten Eggert and Ernst Rademacher of Aachen, Traudl Hansl-Kozanecka (now at Stanford), and Hans Falk Hoffmann of CERN.

UK Institute of Physics Awards

Among the awards of the UK Institute for Physics for 1985 are the Glazebrook Medal and Prize to Sir John Gunn of Glasgow, for his contributions to the establishment of large UK facilities for physics research, and the Thomas Young Medal and Prize to John Lawson of the Rutherford Appleton Laboratory for his many contributions in the field of charged particle beams.

SPS Collider workshop

A workshop is being arranged to discuss the potential of the CERN SPS proton-antiproton Collider for the early 90s in view of the then simultaneous operation of the Tevatron at Fermilab, LEP at CERN and HERA at DESY, and to evaluate the need for a new Collider detector. The 'Workshop on Physics in the 90s at the SPS Collider' will be held at Zinal, Valais, Switzerland, from 17-19 June. Study groups on physics topics and detector design have been formed and have started work. Further information from G. Matthiae at CERN, 1211 Geneva 23, Switzerland.

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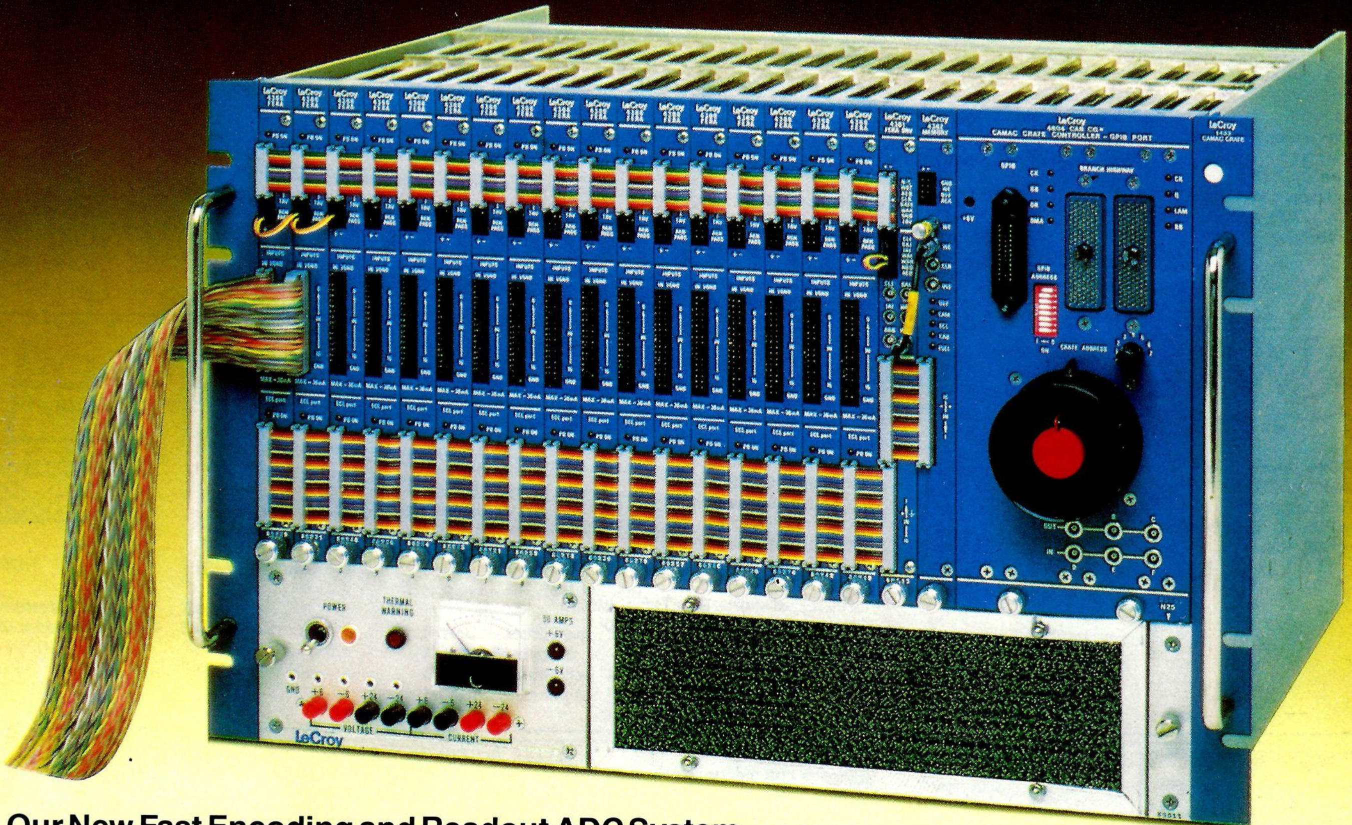

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HEINZINGER
Control & Measuring Instruments
Happinger Straße 71
D-8200 Rosenheim
Telephone: (08031) 62044
Telex: 525777 hemes d

Production line:
Development and manufacture of stabilized DC-power supplies from 3 Watt up to 500 kW for standard and special
For nuclear research in particular-power supplies for:
- linear accellerators
- magnet coils
- Quadrupols
- supra conductors
- electronic lenses
- multipliers
- lasers
- capacitor charging

Laboratory power supplies low and high voltage up to class 10—6
- HV-Digital-system voltmeter
- HV-isolating transformers
- HV-connectors and cables up to 300 kV
- UPS-300 VA—200 V sinus/30 min.

Products exhibited:
Bipolar power supply
HV power supply
laboratory power supplies
HV-cables and connectors
UPS-300 W

INTERATOM

INTERATOM GmbH
Friedrich-Ebert-Straße
5060 Bergisch-Gladbach 1
Telephone: (02204) 84-0
Telex: 8878457 iagld · 8878492 iagld
Telecopierer: (02204) 84-3045

Engineering, Technologies
Material Technology
- Ceramics development
- Ceramic metal joints
- Composite materials
- high temperature metals

Coating technologies and surface analysis
Liquid metal technology
Cryogenics
Fluid and structure dynamics
Reliability analysis
Project management
system engineering

Manufacturing
Components for accelerator systems
- superconducting magnets
- copper cavities
- superconducting cavities
- UHV-components and systems
- UHV-piping systems
- Cryostats
- Wave guides

Special fabrication and joining techniques
- TIG, MIG, Plasma MIG, narrow gap welding
- high temperature brazing
- electron beam welding
- laser cutting and welding
- surface coating (ion plating, CVD, plasma spraying)

knürr®

Knürr-Mechanik
für die Elektronik AG
Schatzbogen 29
D-8000 München 82
Tel.: (089) 42004-0
Telex: 529608-10 knd
Telefax: 089/42004-118

General representative:
Knürr AG
Mechanik für Elektronik
Bruggacher Straße 16
CH-8117 Fällanden/Zürich
Telephone: 01-8250707
Telex: 59706 knuag ch

Production line:
19" steel racks · 19" aluminium racks
19" small racks · 19" cardframes
19" chassis · 19" fanunits
19" heat exchangers · 19" accessories
19" floorstanding console · VME Bus
Multibus II · Dacobas industrial furniture such as:
- 19" lab desks · 19" mobile units
- 19" racks · floorstanding consoles
- desks for office and lab furniture
- Dacobips-Monitor cases · antistatic material
- Tronictool tools for electronics
- Rackpower power supplies AC

Products exhibited
Dacobas industriel furnitures:
- 19" lab desks
- 19" mobile units
- 19" racks
- floorstanding consoles
- desks for office and lab
- Dacobips monitor cases
- antistatic material
- Tronictool tools for electronics
- Rackpower power supplies AC

Lambda Physik

LAMBDA PHYSIK GMBH
Hans-Böckler-Straße 12
D-3400 Göttingen
Telephone: (0551) 69380
Telex: 96633 lambda d
Telefax: (0551) 68691 (GIII)

General representative (CH):
GMP SA
Case Postale 277
Ave. du Temple 19
CH-1010 Lausanne
Tel.: (021) 333328
Telex: 24423 gmp sa ch

Production line:
Excimer Lasers,
Dye Lasers,
Laser Dyes,
For:
- linear and nonlinear spectroscopy
- photochemistry
- isotope separation
- vacuum ultraviolet generation
- medical surgery
- photolithography
- material processing

Products exhibited:
Excimer Laser EMG 103 MSC
Dye Laser FL 2002 E
microcomputer controlled

Germany at CERN

4.6.–7.6.1985

On the initiative and under the auspices of the Federal Ministry for Research and Technology

Matter HYDRAULIK

Matter HYDRAULIK AG
Büelstrasse 89
P.O. Box
CH-8474 Dinhard
Telephone: (052) 381500
Telex: 76510 mhag ch

Production line:

FAG Kugelfischer Georg Schäfer KGaA, Erlangen
FAG Hydraulic tools Lukas
FAG High-pressure industrial hydraulics
HYDRONORMA Medium-pressure industrial hydraulics
FAG Block-technology
FAG Automatic control equipment
FAG Test technology
FAG Hydraulic plants, system-building
FAG Rescue equipment Lukas
Hydraulic bolts pre-tensioning equipment

WEPUKO-Hydraulik GmbH & Co., Metzingen
High pressure-in-line plunger pumps
High pressure pumps for nuclear power stations with pulsation dampener
High pressure piston compressors
High pressure-radial piston pumps
Complete hydraulic equipment and electro hydraulic controls drives for liquid-liquid extraction with adjustable stroke frequency and functions like sine, triangle, saw tooth, trapezium, rectangle.

INTERNORMEN-Filter GmbH, Altlussheim
High pressure duplex filters
High- and medium pressure filters
Suction filters with housing and suction filters without housing
Reservoir-mounted return line filters
Reservoir-mounted duplex return line filters
Single filters for inline · Duplex filters
Single- and duplex filters for coarse filtration
Oil-water-coolerfilter for inline and reservoir mounting
Fill in- and vent filters · Oil bath vent filters
Clogging indicators

Products exhibited:
Pumps · Valves · Filters
Hydraulic bolts pre-tensioning equipment

modutec GmbH

Modutec
Am Osdorfer Born 30
D-2000 Hamburg 53
Telephone: (040) 803012-15
Telex: 2163678

Production line:
Mechanical devices and accessiores for electronic systems
19" cabinets and racks
CAMAC and NIM-crates
FASTBUS-crates and card-frames for EUROCARDS
Modules and cassetts for all systems
Front-panel-cutouts and printing
Airconditioners and blower-systems
Custom-made special mechanical parts, cabinets and racks in steel, aluminium and VA also extrusions
Test-cards and motherboards
Power supplies for CAMAC, NIM and card-frames
Socketstrips

Products exhibited:
19" cabinets and racks
CAMAC and NIM-crates
FASTBUS-creates and card-frames for EUROCARDS
Modules and cassetts for all systems
Airconditioners and blower-systems
Power supplies for CAMAC, NIM and card-frames

RÖHR — TECHNIK IN BLEI

RÖHR RHEINBLEI GMBH
Bruchfeld 52
4150 Krefeld 12 (Linn)
Tel.: (02151) 590233-37
Telex: 853823

General representative (CH):
Jakob Scherrer Söhne AG
Allmendstr. 7
8059 Zürich 2
Tel.: (01) 2027980
Telex: 58700

Production line:
Rolled and extruded products made of lead and lead alloys, especially lead sheet and plate from 0,2 to 200 mm thick, up to 3,20 m wide in coils up to 300 m long.
Special lead sections, lead wire and lead pipes up to a width or outside diameter of 300 mm.
Lead sheets bonded to supporting plates (composite material)
Nuclear engineering:
- Lead bricks according to DIN 25407 and euratom
- Lead containers
- Lead linings and other lead screens
- Precision lead components — stamped, pressed, deep drawn or die-cast
- Lead granules

Products exhibited:
Lead plates with extremely small thickness tolerances (f.e. 4 mm ± 0,03) for Hadron calorimeter barrel and end cap
Extruded lead shieldings
Special lead sections
Lead bricks
Lead containers
Lead safes
Lead shielding for pipework

SCHOTT

SCHOTT GLASWERKE
Optics Division
Hattenbergstrasse 10
D-6500 Mainz
Telephone: (06131) 66-0
Telex: 41879220 smd

Subsidiary Sales Company (CH):
SCHOTT SCHLEIFFER AG
CH-8714 Feldbach ZH
Telephone: 055/411141
Telex: 875628 lsag ch

Production line:
Optical glasses for imaging optics and special applications,
Optical glasses with special properties,
Glass-ceramics of infinitely low thermal expansion,
Glass filters and interference filters for optical control and measuring equipment,
Fiber-optics,
Radiation-shielding glasses and windows.

Products exhibited:
Glasses with Cerencov effect,
Stabilized glasses with Cerencov effect,
Scintillating glasses,
ZERODUR glass-ceramics,
Optical filters,
Fiber-optical components,
Cold-light source KL 1500.

Germany at CERN

4.6.–7.6.1985

On the initiative and under the auspices of the Federal Ministry for Research and Technology

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Spindler & Hoyer GmbH & Co.
Werk für
Feinmechanik und Optik
Königsallee 23
D-3400 Göttingen
Telephone: (05 51) 6935-0
Telex: 96 737

Generalrepresentative (CH):
Wild + Leitz AG
Postfach 145
CH-8032 Zürich
Telephone: 01-556262
Telex: 54517

Production line:
Optical benches/accessories
Collimators, expanders
Light and radiation detectors
Apertures, pinholes etc. · Beam splitters
Optoelectronical components
Laser components and optics
Optical test equipment
Filters · Spatial filters
Interferometers
Lasers
Lenses, all types · Laser eye protective glasses
Mirrors, Laser mirrors · Gratings, Reticules
Holographic systems and devices
Laser systems · Light sources, components
Optical tables · Coatings, all types
Prisms, all types

Products exhibited:
Motor control with measuring tables
Equipment for the production of holograms
Holograms
HeNe laser with frequency stabilization
Optical and mechanical construction systems
Optical elements
Optical elements for laser
Optical table with HeNe laser
Microbench, set of optical and mechanical components
Laser eye protective glasses

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DR. B. STRUCK

Dr. Bernd Struck
Hauptstraße 95
D-2000 Tangstedt
Telephone: (041 09) 9966/67-68
Telex: 2 180 715 tegs

Production line:
CAMAC products
NIM products
FASTBUS products
Physical Trigger Systems
Track processors
VME products
Microprocessor developments Z 80, 8086 based (user specific)
Bloodgasanalyser, gradientoven, animal feeding processors
Oceanographic research - IEEE 488 products relative navigationsystems
Militaric developments

Products exhibited:
FASTBUS products, Sequencer, SI, CIA
Crate, FIORI, BUS-Monitor, Display Unit, KLUGE Cards,
FULLPOWERED CRATE,
CFIFC, CFI-NFI, CFICC,
IEEE 488-products
NIM products
VME products, CFIVC

VACUUMSCHMELZE

VACUUMSCHMELZE GMBH
Grüner Weg 37
D-6450 Hanau/Main
Telephone: (061 81) 362-1

Production line:
Soft Magnetic Alloys
Inductive Components e.g. chokes, transformers
Soft Magnetic Moulded Sintered Parts
Permanent Magnet Alloys
Glass-to-Metal and Ceramic-to-Metal Sealing Alloys
Thermobimetals
Age-hardenable Spring Alloys
Constant Modulus Alloys
Mineral Insulated Electrical Conductors
Resistance Heating Alloys
Controlled Thermal Expansion Alloys
High Field Superconductors
Amorphous Metals
Vacuum Melted Special Steels
Electron Tube Materials

Products exhibited:
Semiproducts and parts of permanent magnet alloys
Amorphous metals
High field superconductors
Inductive components and magnetic shieldings.

Wandel & Goltermann

Electronic Measurement Technology

Mühleweg 5
Postfach 45
D-7412 Eningen u.A.
Telephone: (071 21) 891-1
Telex: 729833 wug d
Fax: (071 21) 88404

Spitalackerstr. 51
Postfach 254
CH-3000 Bern 25
Schweiz
Telephone: 31-426644
Telex: 32-112 wago ch

Production line:
Audio and LF Measuring Technology
Voltage and Level Measuring Technology
Spectrum and Network Analysis
Distortion Measuring Technology
Data Circuit Measuring Technology
Data Network Diagnostics and Data Analysis
PCM Measuring Technology
Analysis and Stabilisation of Supply Networks
Measuring Systems

Products exhibited:
Data Analyzer DA-10
Diagnostics Responder DIR-1
Data Measuring Set DMS-1
Data Network Diagnostics Equipment DNE-2300
A.C. Power Line Harmonic Analyzer NOWA-1
Optical Level Power Meter OLP-1
Bit Error Measuring Set PF-4
PCM Jitter Generator PJG-4
Level Generator PS-15
Spectrum and Network Analyzer SNA-1
Selective Level Meter SPM-15

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UNIVERSITY OF
BRITISH COLUMBIA

Postdoctoral and Research Associate Positions

Intermediate Energy Physics

Postdoctoral and Research Associate positions are available for experimental physics with the University of British Columbia groups at the TRIUMF 500 MeV cyclotron. Candidates should have experience in a relevant field of physics and have completed a Ph.D. in nuclear or particle physics within the past two years. Graduate students expecting to complete their degrees within the next few months are also invited to apply.

These appointments can be renewed annually (subject to the usual budgetary confirmation) up to a maximum period of three years. Salary will depend on experience, with a minimum of $ 23,000 per annum.

Curriculum vitae, list of publications and names of three referees should be forwarded as soon as possible to:

Dr. G. Jones
Department of Physics
University of British Columbia
6224 Agriculture Road
University Campus
Vancouver, B.C. Canada
V6T 2A6

In accordance with Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada. This advertisement is valid for a two year period.

SIN

Low Temperature Physicist (Ph.D.)

The Swiss Institute for Nuclear Research has an opening for a physicist with experience in low temperature instrumentation and physics in the new low temperature muon spin rotation (μSR) facility at SIN. This facility consists of a He_3-He_4 dilution refrigerator with top loading capability and base temperature of 5 mK, and a pair of superconducting Helmholtz coils. The successful candidate will be responsible for the operation, maintenance and development of this instrument. The candidate is also expected to participate in the physics program of the μSR-groups using this facility. Current programs include the study of heavy Fermion systems and investigations of quantum diffusion of μ^+ at very low temperatures.

The appointment will be initially for 3 years with possibility of renewal in mutual agreement. The position is available immediately. Additional information can be obtained from Dr. S. Mango (Telephone 056/99 32 71) or Dr. A. Schenck (056/99 32 63).

Applications, containing curriculum vitae, list of publications and references should be sent as soon as possible to

SIN,
Personnel Division,
CH-5234 Villigen/Switzerland,
Code 591.

STANFORD UNIVERSITY

The Stanford University Physics Department and High Energy Physics Laboratory

are seeking candidates for a faculty position at the level of Professor (Research).

The opening is for a highly qualified physicist with expertise in experimental techniques using large scale, high energy, particle detectors.
The selected person would be expected to play a major part in the ongoing Stanford programs in space-borne detectors studying extra-terrestrial gamma-ray sources and in non-invasive angiography experiments using synchrotron radiation.

Applications with **curriculum vitae** and names of references should be sent to

Professor MASON R. YEARIAN,
Department of Physics,
STANFORD UNIVERSITY
Stanford, California, U.S.A. 94305

within one month of the appearance of this advertisement.

Stanford University welcomes women and minority applicants and is an Affirmative Action/Equal Opportunity employer.

RUTHERFORD APPLETON LABORATORY

HIGH ENERGY PHYSICS RESEARCH ASSOCIATES

There are vacancies for Research Associates to work with experimental groups in high energy physics. Groups from the Rutherford Appleton Laboratory are working on experiments at CERN, DESY, SLAC and FERMILAB.

Candidates should normally be less than 28 years old. Appointments are made for 3 years, with possible extensions of up to 2 years. RAs are based either at the accelerator laboratory where their experiment is conducted, or at RAL depending on the requirements of the experiment. We have in addition home-based programmes on development of detectors, microprocessor systems, etc. Most experiments include UK university personnel with whom particularly close collaborations are maintained.

Please write for an application form quoting VN 303 to

Recruitment Office, R20,
Rutherford Appleton Laboratory,
Chilton, Didcot, Oxfordshire OX11 0QX,
ENGLAND.


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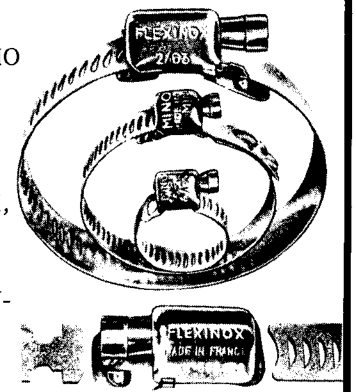

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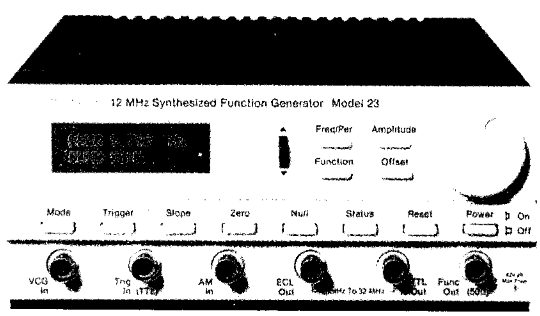
WAVETEK® Function Generators



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Synthesized Function Generator

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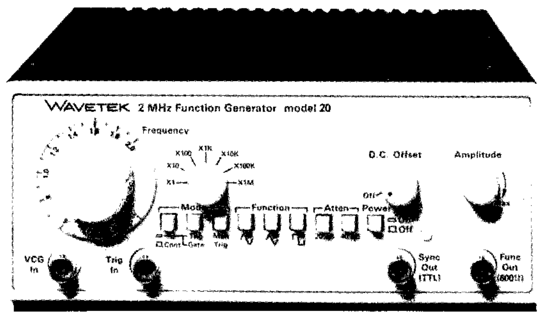

Model 20
Function Generator

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- TTL Pulse Output
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Telephone 021-33 15 35

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All enquiries to:
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CH-1211 Geneva 23 Switzerland
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KfK is looking for them with the XP3462

XP3462
t_r = 3 ns, anode pulse rise time for delta-function light pulse
R_E = 10%, for ^{57}Co and a 3″ x 3″ NaI(Tl) scintillator
s_k = 85 mA / W (11,5 μA/lmF)
G = 10^6 at 1500 V
Pulse linearity within 2% up to 100 mA

The KfK* experiment, in a 6000 ton neutrino blockhouse at the Spallation Neutron Source at RAL, calls for 2240 photomultipliers combining first-rate time response with good energy resolution. To their specification we developed the 3 inch, 8 stage XP3462.

*KfK: Kernforschungszentrum Karlsruhe

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Good news for particle accelerators.

EEV, a world leader in high energy switching thyratrons, has now developed a single cathode multi-gap tube that operates as a bi-directional switch.

Now you can double the power delivered to kicker magnets without substantial rebuilding costs.

This new tube, the CX1671, is a plug-in replacement for the CX1171. Its unique hollow anode design was originally developed by EEV to switch the severe inverse voltages occuring in pulsed gas discharge lasers.

When operating at an anode voltage of 80kV, it has proved capable of switching 2500 amps of reverse current in a 2 microsecond pulse, without any degradation in performance after 10 million pulses.

For further information on this state-of-the-art thyratron, contact EEV today.

EEV Thyratrons

EEV, Waterhouse Lane, Chelmsford, Essex CM1 2QU, England. Tel: 0245 261777. Telex: 99103.
EEV Inc, 7 Westchester Plaza, Elmsford, NY 10523, USA. Tel: 914 592 6050. Telex 6818096.
EEV Canada Ltd, 67 Westmore Drive, Rexdale, Ontario M9V 3Y6. Tel: 416 745 9494. Telex: 06 989 363.

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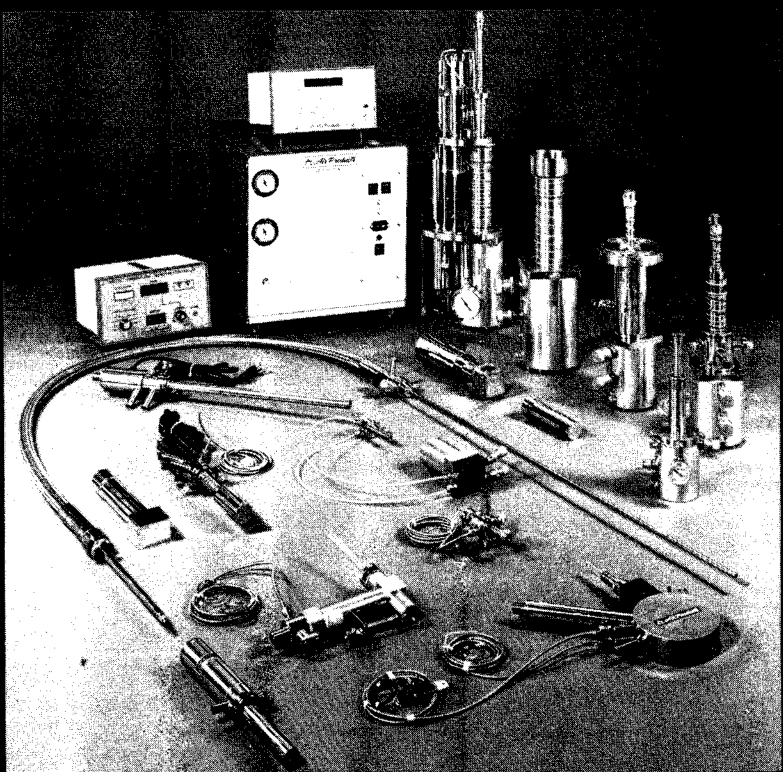
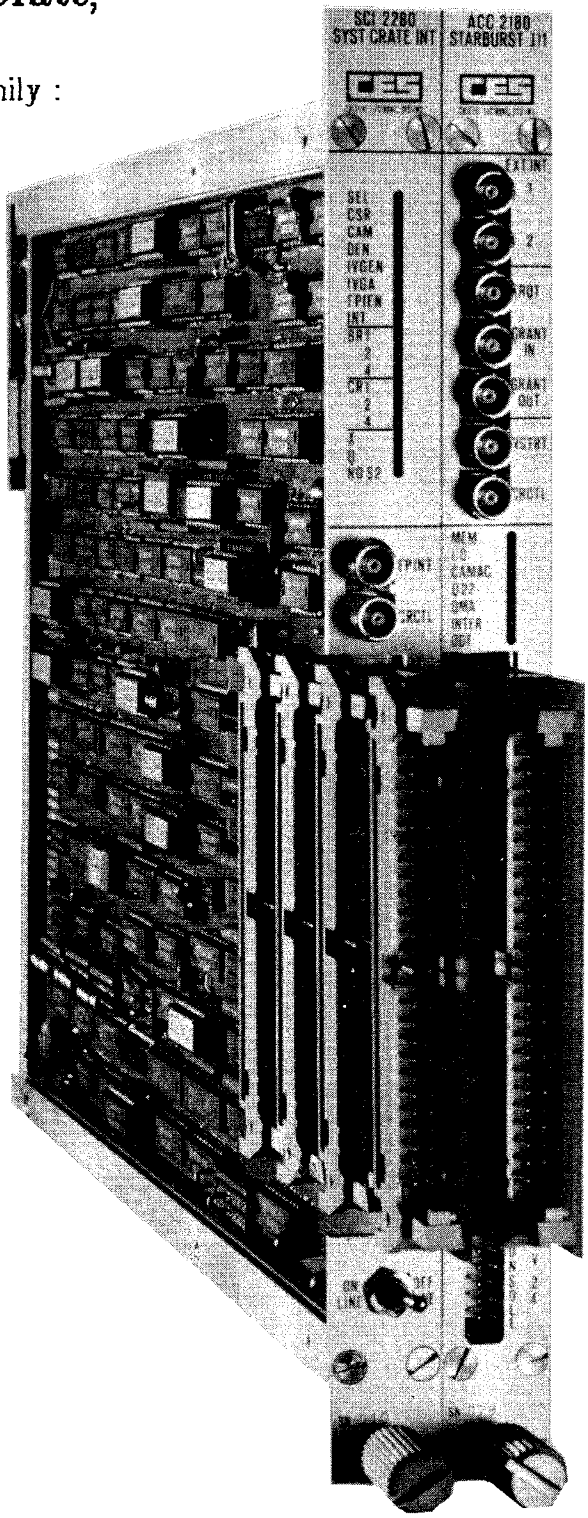


Put a PDP 11/70 in your System Crate,

with the latest member of our STARBURST family :

SCI 2280 System Crate Interface.



In just one slot it provides an interface between the Q–bus and CAMAC which conforms to the System Crate concept of connecting computers to CAMAC, and is directly software–compatible with existing systems.

Join it to an ACC 2180 equipped with a 2134 back–plane and 2135 disk subsystem and you have a powerful and compact stand–alone computer driving your System Crate.

Use it to increase the performance of existing systems by installing it in the crate where a branch–coupler resides, and connecting it to an ACC 2180 acting as a system controller in a 'normal crate'.

For the ultimate power within your System Crate, the ACC 2180 can be equipped with a performance booster which increases both the processing speed and the data–aquisition rate.

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For more information contact us, or your local CES representative:

Creative Electronic Systems SA
70,route du Pont–Butin Case Postale 122 1213 Petit–Lancy 1 Switzerland
Tel:(022) 92 57 45 Telex: 421320 CES–CH

CREATIVE ELECTRONIC SYSTEMS

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North America:	Bytech Eng. Vancouver	Tel:(604)9804131	Japan:	Toyo Corp.	Tel:(03)2790771
France:	INEL	Tel:(3)9563190	North Germany:	PCP	Tel:(040)802046
South Germany:	Silena	Tel:(060)554021	England:	Nuclear Enterprises	Tel:(073)5212121
Italy:	Silena	Tel:(02)7490565			

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Since 1971, when Varian EIMAC introduced the one megawatt X-2159/8974, we have been the world leader in design and manufacture of high power tubes for scientific and communcation applications.

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Power tubes developed and manufactured by Varian EIMAC used in the facilities mentioned include the 8973, 8974, X-2062K/9009 and Y676A/9013. These tube types will be joined by others in development to meet new program requirements.

More information is available from Varian EIMAC. Or the nearest Varian Electron Device Group sales office. Call or write today.

Varian EIMAC
301 Industrial Way
San Carlos, CA 94070
415 • 592-1221

VARIAN AG
Steinhauserstrasse
CH-6300 Zug, Switzerland
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