CERN COURIER

International Journal of High Energy Physics

VOLUME 23 8 OCTOBER 1983

Copies are available on request from:
Federal Republic of Germany —
Gerda v. Schlenther
DESY, Notkestr. 85, 2000 Hamburg 52
Italy —
INFN, Casella Postale 56
00044 Frascati
Roma
United Kingdom —
Elizabeth Marsh
Rutherford Appleton Laboratory, Chilton, Didcot
Oxfordshire OX11 0QX
USA/Canada —
Margaret Pearson
Fermilab, P. O. Box 500, Batavia
Illinois 60510
General distribution —
Monika Wilson
CERN, 1211 Geneva 23, Switzerland

CERN COURIER is published ten times yearly in English and French editions. The views expressed in the Journal are not necessarily those of the CERN management.

Printed by: Presses Centrales S.A.
1002 Lausanne, Switzerland

Published by:
European Laboratory for Particle Physics
CERN, 1211 Geneva 23, Switzerland
Tel. (022) 83 61 11, Telex 23 698
(CERN COURIER only Tel. (022) 83 41 03)
USA: Controlled Circulation
Postage paid at Batavia, Illinois

CERN COURIER

International Journal of the High Energy Physics Community

Editors: Brian Southworth, Gordon Fraser, Henri-Luc Felder (French edition) / Advertisements: Micheline Falciola / Advisory Panel: J. Prentki (Chairman), J. Allaby, J. Cronin, K. Hübner, E. Lillestøl

VOLUME 23 N° 8 OCTOBER 1983

Cover photograph: The 31-strong SLAC 'Accelepede' won the prize for the best costume in this year's 7.6 mile 'Bay to Breakers' race in San Francisco.

Fermilab Accelerator Conference

Roy Billinge of CERN giving the opening talk at the Conference to celebrate the remarkable achievements in accelerator physics at CERN which have made colliding high energy proton-antiproton beams possible.

The 12th International Conference on High Energy Accelerators was held at Fermilab from 11-16 August. There was celebration of the great recent achievements in accelerator physics (the bringing into operation of the superconducting ring at Fermilab and the spectacular performance of the antiproton project at CERN), there was delight and relief that, at last, the technology of superconductivity in both magnets and r.f. systems is mastered, and there was excitement at the birth of a great new project for a 20 TeV machine in the USA.

The achievements

With a fine sense of timing, on 15 August during the Conference, work on the Tevatron took the peak energy of the machine to 700 GeV. It was a courageous decision at Fermilab a year ago to hold an 'end of 400 GeV era' party and to put all their machine eggs into the superconducting basket. That courage has paid off and Helen Edwards was able to report that, after ten years of development, superconducting accelerators are mastered. It is an impressive feat to have almost a thousand superconducting magnets in operation together with their extensive 'plumber's nightmare' of a cryogenic system.

Crucial steps along the way have been the development of appropriate cable (usually referred to as Rutherford/Fermilab cable); analysis and implementation of the quench protection and recovery system; the mastery of the huge cryogenics system; the introduction of 'smart bolts' to solve the problem of field tilting due to coil movement; and the installation of a comprehensive beam monitoring system and field correction system allowing refined machine control at all energies. In addition, as is common with all big projects, there has been the task of organizing magnet production, testing and installation on a large scale.

The work of the coming months will be concerned with improving reliability of all the systems (about 50% overall operational availability was achieved in July), pushing to higher peak energy and, particularly, improving beam intensity. Paradoxically the intensity limitation when 700 GeV was achieved came from the conventional ring which has not had much nursing while attention has been focused on the superconducting ring. More will need to be done on the refrigeration system — the heat load is higher than anticipated and the central helium liquefier has to be kept in action as well as the 24 satellite refrigerators when the accelerator is operated.

Resonant extraction was achieved for the first time on 7 August. An enormous amount of work is under way to prepare the experimental areas for higher energy beams (as was reported in our September issue) and experiments are scheduled to restart in the Meson Area in October. Components of the Collider Detector Facility are also coming together and colliding proton-antiproton beams at 1000 GeV no longer seem a dream.

Roy Billinge gave the talk on the antiproton successes at CERN which we have reported regularly in our pages. The exceptionally reliable operation of all elements of the complex system paved the way to the W and Z discoveries. The Antiproton Accumulator (AA) has been in action for over 5000 hours in a year and has provided particles in runs as long as 33 days without losing a single stack. Antiproton accumulation rates have reached 8×10^9 per hour and up to 1.2×10^{11} are collected on a good day. About a third of these make it to the SPS for collider physics at 270 GeV giving luminosities up to 1.6×10^{29}, about a sixth of the design aim.

To yield more physics there is a proposal to increase the collider energy to 310 GeV, which will increase the W and Z production cross-sections, and maybe to install some stochastic cooling in the SPS. It is hoped to improve the antiproton collection rate at the AA and tests with pulsed targets and a lithium lens (on loan from Fermilab) should start soon. The efficiency of antiproton transfer between the machines will also have attention, for example by attempting to know and control better the magnetic fields in the extraction region of the PS. More ambitiously, an additional ring (the Antiproton Collector, AC) is being designed to achieve precooling before injection into the AA (as in the Fermilab collider scheme).

On 13 September, President Mitterrand of France and President Aubert of Switzerland came to CERN for the official LEP groundbreaking ceremony. A full report will feature in our next issue.

CERN clearly has a head start to cream off good physics in this new energy region.

Projects under way or planned

Herwig Schopper reported the start of civil engineering work for the LEP project at CERN and the physics interest is obvious from the fact that, even in Phase I of operation with electrons and positrons colliding at up to 60 GeV per beam, the experiments could see 10 000 Z bosons per day. The higher energy developments (LEP is optimized for 100 GeV) depend up on mastery of superconducting r.f. cavities and it was very encouraging to hear H. Piel and H. Lengeler reporting progress. Their essential new message is that though there are still some problems their sources are all understood. Cavity behaviour no longer defies interpretation and it has been demonstrated that superconducting cavities can be operated in storage ring conditions causing no more headaches than standard copper cavities.

Some major contributions to this achievement have been — the selection of spherical or elliptical cavity shapes to relieve the multipactoring problem; powerful programs to compute higher order modes; and temperature mapping of cavities to reveal trouble spots which can then be fairly easily treated. There are now convincing superconducting cavity results from Argonne, CERN, Cornell, DESY, KEK and Wuppertal.

Herwig Schopper concluded his LEP talk with some indications of later possibilities using the LEP tunnel for protons, referring to a CERN report by Steve Myers and Wolfgang Schnell. The simplest and fastest scheme could use niobium-titanium superconducting magnets to give 5 TeV proton-antiproton collisions (the injectors are, of course, already in action). The most ambitious (and lengthier) variant could have niobium-tin magnets and two proton rings giving high luminosity at energies approaching 10 TeV. Electron-proton collisions of 100 GeV on 5 to 10 TeV are an obvious additional attraction given the existence of LEP.

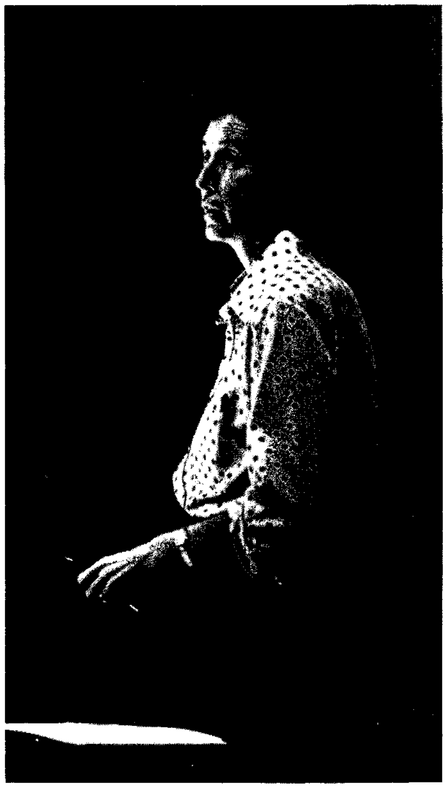
Project approval has now been given for the Stanford Linear Collider with $ 32 million allocated for the first year; total cost is estimated at $ 112 million. Construction time could be as low as three years given an appropriate rate of funding so that, as Burt Richter said, the SLC could start flooding the world with W and Z physics by the end of 1986. Two experiments have been approved — a major refit of the Mark II and a new detector. It is also recognized that the project is an adventure in accelerator physics which could have difficulties mastering technological problems but may pave the way to the only 'fiscally feasible' method of colliding electron-positron beams at energies beyond LEP.

The SLC is 'a pair of beam transfer systems' following the terrain in two large arcs at the end of the linear accelerator. They will receive electrons and positrons at 50 GeV per beam specially formed into intense short bunches. The linac is presently capable of 34 GeV and the upgrade is continuing in conjuction with klystron development to achieve 50 MW tubes of high efficiency. Two damping rings, to reduce bunch emittance prior to acceleration in the linac, are built and under test. By the end of this year it is hoped to have intense electron bunches one third of the way down the linac for positron production.

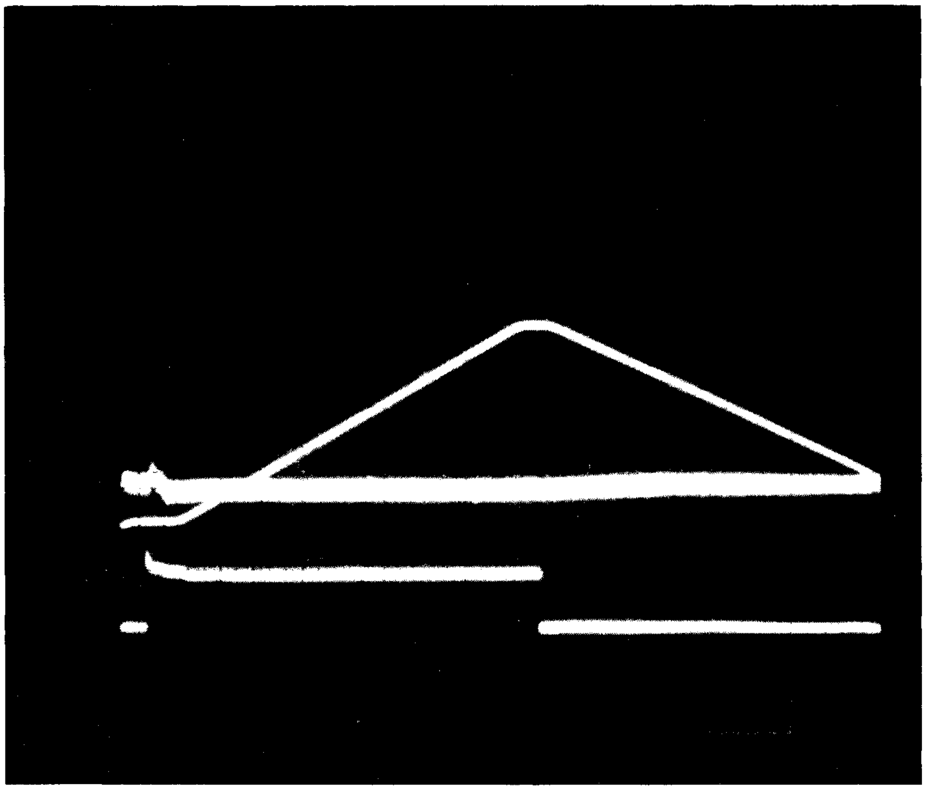
The HERA project at DESY for colliding 820 GeV protons with 30 GeV electrons was reported by Gus Voss. It is hoped to have authorization for construction by the end of this year and to start work on the tunnel at the beginning of 1984. The HERA team are amongst the most relieved at the success at Fermilab since they will use superconducting magnets in their proton ring. Two types are under study, one similar to Fermilab (1 m prototypes have all performed well with fields over 5 T) and one similar to Brookhaven (a first magnet has been ordered from industry to be ready in November). It is intended to build and test a dozen of each type so as to choose at the end of 1984. Other preparations, such as the building of a new 9 GeV electron synchrotron (called DESY II), are planned.

K.P. Myznikov covered construction of the 3 TeV UNK project at Serpukhov. The present 70 GeV proton ring is being upgraded to take the

Helen Edwards reporting on the success of the Energy Doubler project at Fermilab where a superconducting magnet ring was brought into operation for the first time.



Scope trace from the Fermilab control room on 15 August when protons were taken to a new world record energy of 700 GeV in the Energy Doubler superconducting ring.



intensity to 5 x 10^{13}. Superconducting magnets are being developed in collaboration with Saclay and 5 T prototypes have performed well. A magnet factory has been set up. Civil engineering has started with the sinking of two 25 m access shafts and tunnelling of the ring will begin soon. It is hoped to have the conventional 400 GeV ring in action by 1988 and the 3 TeV superconducting ring two years later.

Phase I of the TRISTAN project for 30 GeV electron-positron colliding beams was approved in 1981 and T. Nishikawa reported that construction is on schedule for completion early in 1986. The 6 GeV accumulation ring is complete and the main emphasis is now on main ring (3 km circumference) magnet production. Superconducting r.f. cavity prototypes are being tested to enable peak energy to be moved beyond 30 GeV. Two experiments (VENUS and TOPAZ) have been approved and two others are under discussion.

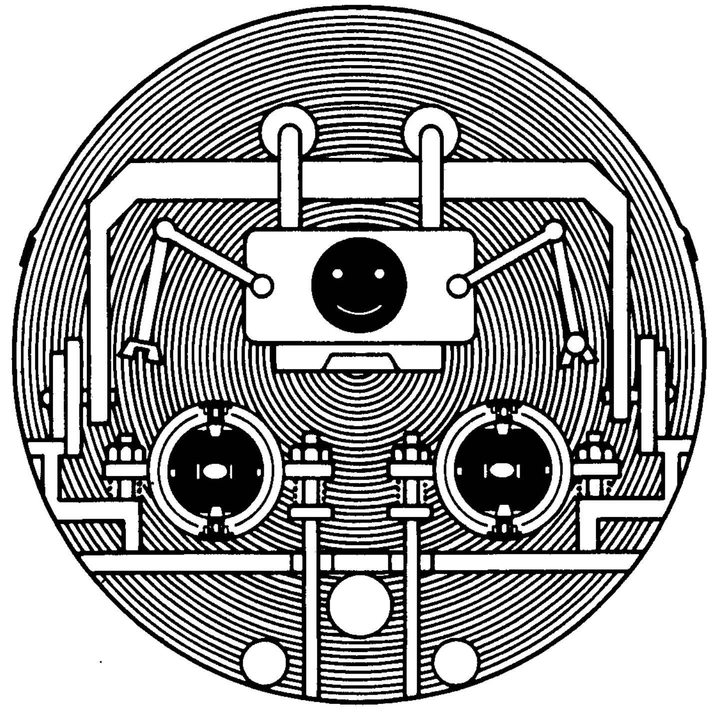
Our colleagues in China have had to step back, for fiscal reasons, from their initial ambitious 50 GeV proton synchrotron project and are now concentrating on a 3 GeV electron-positron ring (BEPC - Beijing Electron Positron Collider) optimized for J/psi physics. It is being built at the Institute of High Energy Physics and is scheduled for completion in 1987.

Since we have moved to lower energy ranges it is worth adding a few words on USA plans for nuclear physics facilities. The Nuclear Physics Advisory Committee has given first priority to an electron machine. The front runner for such a machine is now NEAL — National Electron Accelerator Laboratory — proposed for a site in Virginia by the Southern Universities Research Association and described by B. Norum. It is a 4.2 GeV (2.1 GeV recirculated) electron linac with a pulse stretcher ring, estimated to cost $ 115 million over five years. The next priority is for a heavy ion machine and Mark Barton covered preliminary ideas to use the CBA tunnel at Brookhaven with a missing magnet lattice using CBA superconducting magnets to yield relativistic heavy ions to study quark-gluon plasmas. There are the advantages at Brookhaven of a good tandem injector (which would need to be followed by a booster cyclotron) and of the completed CBA tunnel. Even without the booster, acceleration of ions up to sulphur should be possible. These two priorities somewhat take the emphasis off the LAMPF II project (see October 1982 issue, page 324), described by H. Thiessen. 'Kaon factory' ideas may now concentrate at the TRIUMF Laboratory.

The Future

Thoughts on the accelerators of the next century came from Burt Richter, Bob Jameson, A. Skrinsky (for linear machines), Andy Sessler (new acceleration concepts) and Bob Wilson (hadron colliders). We will concentrate on the last two.

New acceleration concepts were covered in some detail in our report of the Oxford Conference (see December issue, 1982) but it was good to learn that many of the ideas which were little more than ideas a year ago are now beginning to get modest theoretical and experimental attention. An experiment on the wakefield concept (Gus Voss/Tom Weiland) is being prepared at DESY. The two beam ideas of Andy Sessler/Don Prosnitz are being pursued at Berkeley; experiments on a free electron laser are being prepared. The inverse free electron laser is under



One of the many visions of the SCC (Superconducting Super Collider, or 'Desertron'). In the one-metre-diameter tunnel, the two magnet rings are symmetrically placed below, and above (with the smiling face) is a robot able to tour the ring for remote manipulations.

theoretical investigation at Brookhaven (Claudio Pellegrini). The plasma beat-wave concept (most fascinating of all because of its dramatically high accelerating field gradients) is receiving attention, for example, at UCLA, Los Alamos, NRC Ottawa and the Rutherford Laboratory. Proposals for modest significant experiments are beginning to emerge (for example from R. Ruth at CERN).

It was entirely appropriate that Bob Wilson spoke on very large hadron colliders for it was his initiative that stirred the ferment which has led to the 20 TeV machine ideas in the USA (now usually referred to as the SSC — Superconducting Super Collider — or Desertron, in recognition of the vast area which will be necessary for its construction). Following the recommendations of the Woods Hole subpanel of the High Energy Physics Advisory Panel, HEPAP, the SSC becomes number one priority in the USA programme. Bill Wallenmayer announced that the Department of Energy has asked HEPAP to form a subpanel to advise on the content of the research and development programme for the new project. This subpanel has been set up under the Chairmanship of Pief Panofsky and held its first meeting 7-9 September.

The Fermilab auditorium was packed for the technical discussions on the SSC during the Conference, chaired by Boyce McDaniel with introductory remarks by Maury Tigner, who both had leading roles in the 20 TeV Hadron Collider Workshop held in Cornell 28 March-2 April. The base considerations are that both collider technology and superconducting technology are now mature enough to launch a 20 TeV proposal. The research and development phase has to emerge with a project which is not only technically feasible (a task which could be confronted immediately) but which optimizes machine design to give the cheapest version capable of producing the required physics.

The choice of magnet will be, perhaps, the major design decision. Preliminary ideas were presented by Gordon Danby, Russ Huson, Dick Lundy, Bob Palmer and Clive Taylor. There was also a session on magnets at Argonne following the Conference. The balance seems to lie between high field (for example with an 8 T niobium-tin magnet) and 'small' radius (say 12 km) compared to low field (2.5 T superferric magnet) and large radius (say 37 km), with many intermediate options. Magnet development time, operating costs and civil engineering costs should all enter into the equation.

Development time could be important because there is some unease about the health of the USA high energy physics community after a long period without new machines to open new areas of physics; the SSC is likely, even optimistically, to be ten years away. Operating cost obviously dictates the budget of the Laboratory over the full working life of the machine. Civil engineering costs go up with low field and down with high field and it was suggested that magnet plus civil engineering costs are a constant. If that were true there would be a tendency towards the largest possible ring which would allow easy upgrade in subsequent decades. However the suggestion of constant cost has not been clearly demonstrated and, also, tripling the rest of the machine components such as cryogenic plumbing, vacuum system, quench protection systems, cabling etc. in selecting the largest ring is not negligible. A fascinating, high speed study is in front of our American colleagues.

Bob Wilson's talk was more philosophical than technical and he drew on experience in the building of the Fermilab machine to give some pointers for proceeding on the SSC. He maintained that the existence of the Berkeley design for a 200 GeV machine greatly speeded the Fermilab project since it was a constant reference source. The message is to evolve an SSC design rapidly and polish it later. The site selection, which finally settled on Batavia, was a tough process, and the SSC site selection should be confronted early

Our report would not be complete without mention of the excellent organization, under Russ Huson, of the Conference and of the social programme, where events were selected with very good taste and superbly arranged.

— it also obviously influences the final design. (Every State with a handy desert is obviously in the running and, for example, Texas — based on A and M University — are already oiling the selection mechanism. Alternatively there are obvious advantages in expanding an existing Laboratory, such as Fermilab where general infrastructure and a 1 TeV injector already exist.) The cost reductions in the Fermilab design were a positive influence on Washington and Bob Wilson called for an early indication from Congress as to what would be an acceptable 'ball-park' for the machine cost. This also would have a dominant influence on machine design choices.

So work to launch the Desertron is under way. It is designed to penetrate the physics desert that some theoreticians predict but no experimentalist believes. A collision energy of 40 TeV will surely find some oases and maybe even enter Higgsville. The Conference had this anticipation in the air and for accelerator physics, as well as for high energy physics, 1983 must rank amongst the greatest.

(Report by Brian Southworth.)

Brighton Conference

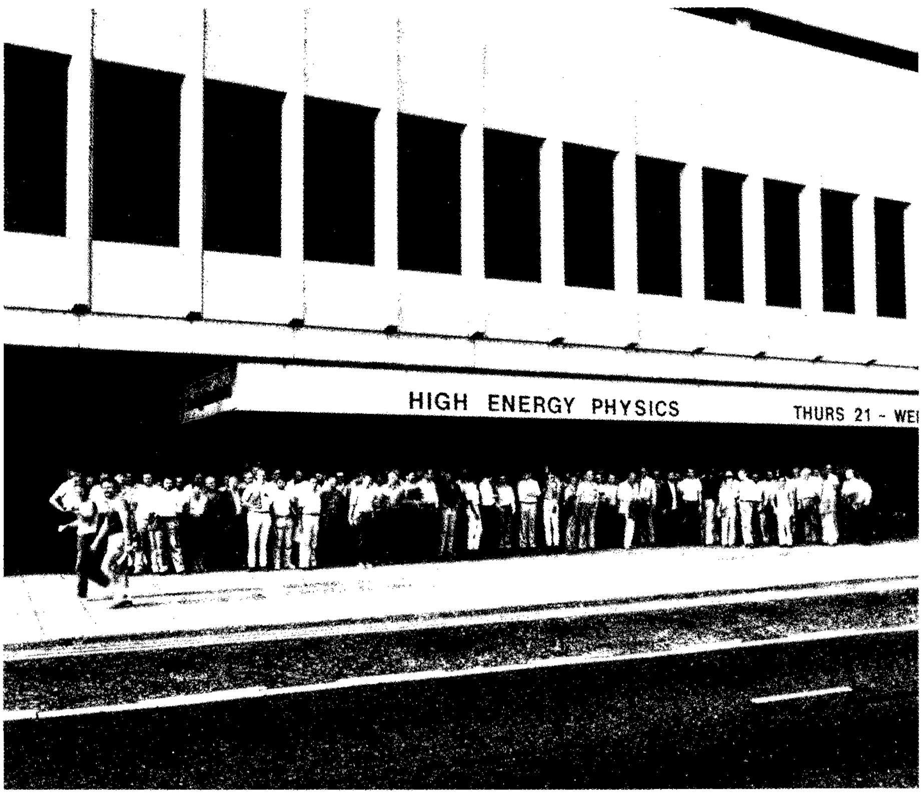
(Further report)

Two years ago, at the 1981 International Conference on High Energy Physics in Lisbon, Carlo Rubbia had arrived with startling news — the first high energy proton-antiproton collisions had been observed in the CERN SPS collider. This year, at the International Europhysics Conference in Brighton (UK), he was able to recount how experiments at the CERN collider had discovered the W and Z^0 bosons which mediate the weak force.

The spectacular progress made during this relatively short time underlines the imagination and foresight of those who proposed the project and pushed it through, and pays tribute to the skill and ingenuity of the machine specialists and physicists who implemented it and brought it to fruition.

Although the W and Z news was not entirely fresh, Brighton was the first major international particle physics conference to hear a full report from the UA1 and UA2 experiments (see pages 306-7). Hidden in a few hours of conventionally dry scientific presentations was the culmination of some twenty-five years of painstaking theoretical and experimental physics which changes our picture of the world around us. The electroweak unification will go down as one of the major scientific achievements of the century. (The November issue of the CERN Courier will review the development of the electroweak theory and the history of the CERN antiproton project.)

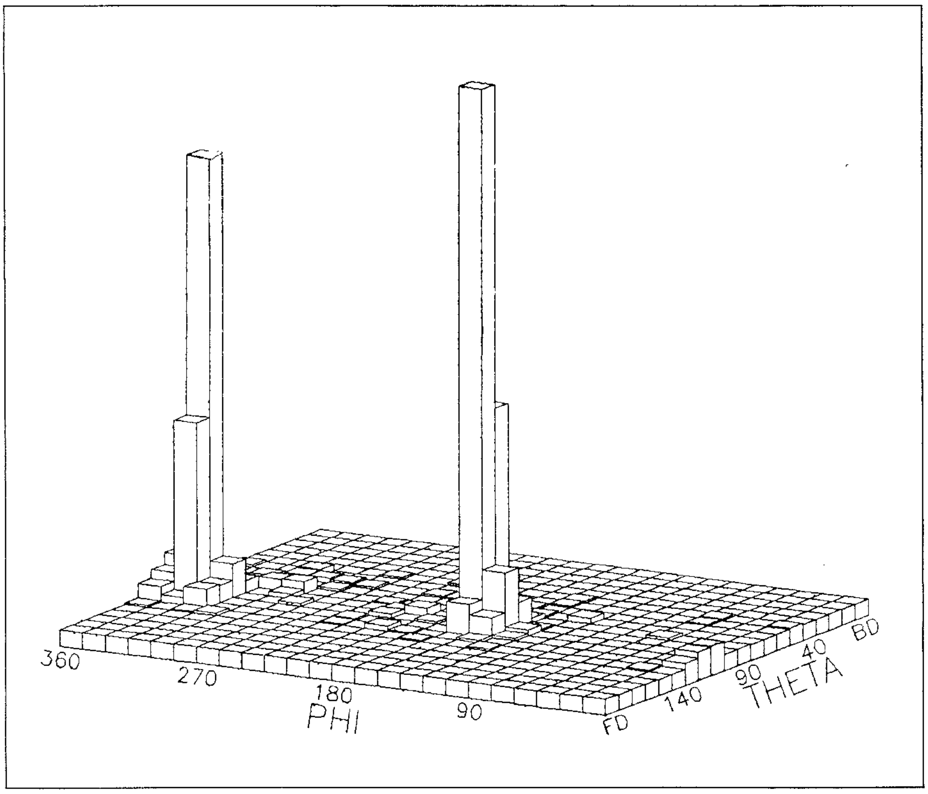
Without belittling the many other important physics results announced, Brighton was very much a showcase for the CERN collider, and the arrangement of the sessions had been carefully stage-managed. The plenary talks were prefaced by reports from the big UA1 and UA2 experiments on how they tracked



Delegates at the Brighton Conference cooperatively posed outside for the camera.

(Photo Rutherford Appleton Laboratory)

As well as the discoveries of the W and Z particles, the jet results from the UA1 and UA2 experiments at the CERN SPS collider provided another Brighton highlight. This 'lego plot' shows two high transverse energy jets as recorded in the UA2 detector, together taking 250 GeV of transverse energy from a 540 GeV proton-antiproton collision.



down their W and Z events, and the concluding experimental speaker was Carlo Rubbia, who summarized the physics findings so far at the collider.

Major physics meetings these days have a lot of ground to cover, and the Brighton plenary talks followed three days of busy parallel sessions, where conflicts of interest were inevitable. Speakers, as well as participants, had to thread their way between halls. Very helpful were the teletext screens which displayed up-to-the-minute status of the various parallel sessions.

Jet physics

Looking back just one year, 'jet' physics had become respectable at the 1982 Paris meeting with the first results from the CERN collider on the production of clusters of hadrons at wide angles to the direction of the incoming beams. New data from wide angle calorimeters at the CERN Intersecting Storage Rings had also played a valuable role in this resurgence of confidence.

Jets have now firmed up even more, reported P. Söding in his Brighton summary talk on quark and gluon fragmentation. R. Sosnowski in his summary of 'hard' hadron collisions emphasized that the observed jets come from the scattering of components hidden deep inside the colliding particles.

There was a lot of jet material presented at Brighton. In total, nearly a day of parallel sessions were needed to cover results from the ISR (M. Albrow), the CERN collider (K. Sumorok from UA1 and J. Schacher from UA2), the PETRA electron-positron ring at DESY (various speakers), the PEP electron-positron ring at SLAC (G. Hanson), and from lepton-hadron interactions (G. Jancso).

There is now more evidence for baryon production in jets. D. Pandoulas indicated that protons and antiprotons prefer to emerge together in the same jet, and there are signs too of hyperon production.

Comparison of jet behaviour in electron-positron and proton-antiproton collisions suggests some kind of universal behaviour. 'There are striking similarities,' declared H. Kowalski in his mini-rapporteur talk. However closer inspection hints at systematic differences between jets coming from gluons and those coming from quarks, remarked Söding. Gluon jets could be fatter and contain different particles, particularly baryons.

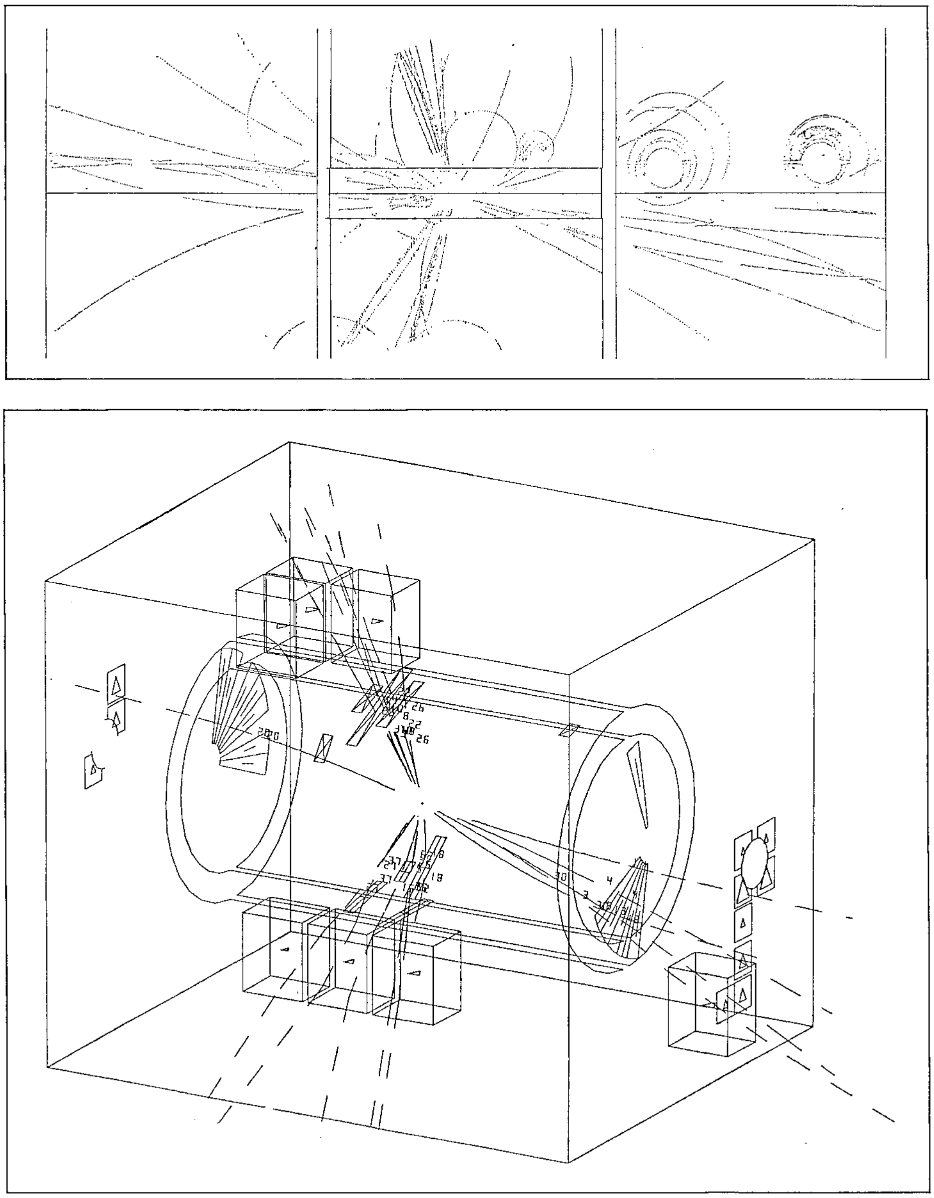
The important role played by gluons in the collider jets gives a handle on the gluon structure function (gluon content of nucleons), and the results tie in with the measurements of the WA1 neutrino experiment at CERN, suitably scaled to take account of the difference in kinematics.

While the CERN collider jet behaviour is dominated by events with two more-or-less back-to-back clusters of hadrons, there are signs of additional jets. The analysis is not yet complete.

When they crash together, the quarks and gluons hidden deep inside nucleons cannot emerge as free particles. Instead, they 'fragment' into clusters of hadrons. Jet analysis is closely bound up with questions of quark/gluon fragmentation into hadrons.

Experiments at PETRA (and PEP) study jet production rates to obtain a value for the underlying quark/gluon coupling constant. The results are very dependent on the way the fragmentation of the quarks and gluons is handled. There is some evidence that the 'string' model of fragmenta-

More jets from the CERN collider. Top, particle tracks as reconstructed in the central detector of the UA1 experiment. Bottom, adding hits in the outer calorimeters and leaving out the lower energy tracks leaves three clear sprays of particles emerging from the proton-antiproton collision.



tion might be good under certain conditions, but there is certainly room for a better description of the fragmentation process.

Several detectors at PETRA and at PEP have managed to infer what happens when different heavy quarks are formed, giving heavy, highly unstable particles. There appears to be a systematic difference between the way charm and beauty quarks fragment. This could be due to the difference in the masses, the beauty quark being much heavier.

Grand unification and proton decay

About ten years ago, Pati and Salam and Georgi and Glashow made the first tentative steps towards 'grand unification' — theories which try to merge the quark/gluon force with the now very successful electroweak unification. Since then, these theories have been refined and extended. At Brighton, S. Ferrara described the grand unification work currently under way.

A general prediction of these grand unified theories is a slightly unstable proton. The simplest possible grand unified theory predicts a proton lifetime of about $10^{29\pm2}$ years, with pion plus electron as the preferred decay mode. Although experiments have been searching for some time, the main effort, using sophisticated large detectors, is now getting under way. The experimental situation was summarized at Brighton by E. Fiorini.

Proton decay had been spotlighted in previous meetings by three events recorded in the underground detector in the Kolar Gold Fields, India. Fiorini reported that this team has seen no more candidate decays in further exposures of its 140 ton detector.

The 150 ton tracking calorimeter under Mont Blanc has one candidate event which could be due to a proton producing a muon and a kaon. This corresponds to a proton lifetime more than 10^{31} years. The absence of other decays gives limits on the respective 'partial' lifetimes.

The other big proton decay search to present results was the gigantic Irvine / Michigan / Brookhaven (IMB) detector, the first to use the Cherenkov technique in a tracking calorimeter. Containing 7000 tons of water, this is well suited to catch rare decays.

L. Sulak presented the IMB data analysed so far, preferring to take a pessimistic view of neutrino background, which could account for the recorded signals. Certainly the electron plus pion decay predicted by the 'minimal' theory is not seen. Fiorini gave limits on partial lifetimes for decays producing kaons.

(Turn to page 308) ▶

'Heavy light'

Chairing the concluding sessions at the Brighton Conference, Abdus Salam, one of the authors of the electroweak theory, paid tribute to the CERN antiproton project which has now confirmed this imaginative unification of the weak and electromagnetic forces.

The UK daily press proclaimed that the Brighton Conference was announcing the discovery of 'heavy light'. The discovery in fact had been announced before, but it was still a good way to describe the elegant picture which now unifies the weak and electromagnetic forces. Just as the photon, the ultimate quantum of light, is the carrier of electromagnetism, so the newly discovered W and Z particles carry the weak force. But while the photon is massless, the W and Z particles are very heavy. At about 80 and 90 times the mass of the proton respectively, they are the heaviest particles discovered so far.

But for the specialists attending the Conference, the momentous discoveries of the big UA 1 and UA2 experiments studying 540 GeV proton-antiproton collisions in the CERN SPS ring were already common knowledge. The finding of the charged W, responsible for the 'charged current' of the weak interaction seen in nuclear beta decay, had been announced back in January, using data from the 1982 CERN collider run.

The detection of the Z^o, the carrier of the electrically neutral component — the 'neutral current' — of the weak force, had been formally announced at CERN on 1 June, ten years after the phenomenon of the neutral current had been discovered in photographs taken in the Gargamelle bubble chamber at CERN.

But the 1983 SPS proton-antiproton collider run did not terminate at CERN until 3 July (see September issue, page 247), and physicists were eager to hear the latest results.

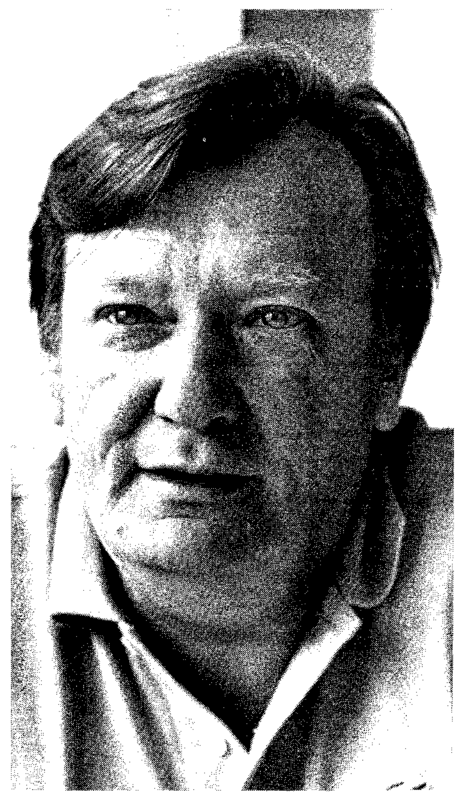
At Brighton, Karsten Eggert took the plenary session platform first to describe how UA 1 tracked down its Z particles. Of 153 inverse nanobarns of accumulated proton-antiproton collisions supplied by the SPS machine in the latest three-month run, UA 1 had intercepted 80 per cent, itself a remarkable achievement in view of the complexity of the detector.

To speed the hunt for the Zs, four 168E microprocessors scanned the on-line data and selected a special sample kept on a dedicated magnetic tape.

The Z is detected at UA 1 by its decay into lepton (electron or muon) pairs. Applying successive selection criteria to the electron pair sample, 225 events boil down to four Z candidates. These events cluster around 95 GeV, with nothing else in sight over an extremely wide effective mass range. The outer muon detector had two initial examples of muon pairs corresponding to Z production. The momentum resolution for muons is not as good as that of electrons, so the Z mass is less reliable.

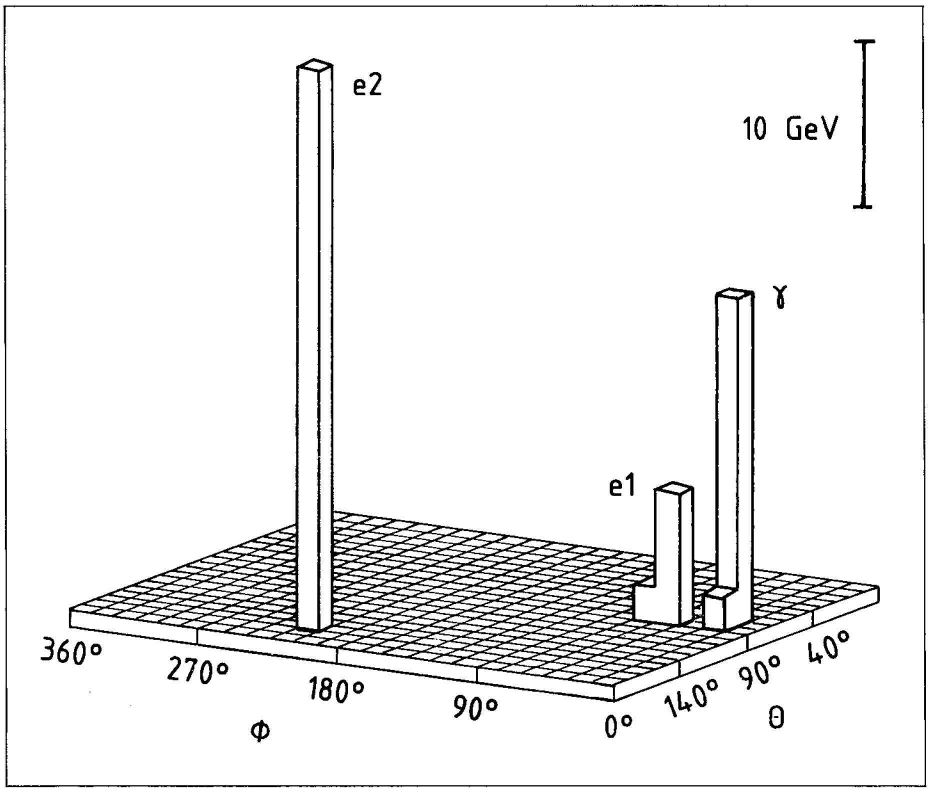
With four electron events being seen compared with two muon events, some Brighton delegates brought up the question of electron-muon universality, but were reassured because of the relative inefficiency of the UA 1 detector in snaring naturally elusive muons.

Jacques Colas then took over to cover the UA 1 W search. The statistics now available represent an eightfold improvement over the evidence from the 1982 run, when the first Ws were found. The W signature is a high transverse energy lone electron produced back to back with missing energy indicative of a neutrino. 52 well-defined such events have been seen in UA 1,



'The CERN collider has apparently fulfilled its potential for "planned" discoveries', said Carlo Rubbia at the Brighton Conference.

The decay of a Z^0 particle into an electron-positron pair (e1, e2), plus a photon taking some 20 GeV of transverse energy, as seen in the UA2 detector. The rate at which Z^0s are expected to produce lepton pairs accompanied by such an energetic photon is very small. However both UA1 and UA2 see signs of energetic photons in the small samples of Z^0 decays collected so far.



and a slightly reduced sample for rapid analysis gives a W mass of 80.9 GeV. UA1 also sees W events producing single muons plus missing energy.

In those cases where the 'electron' has been identified as an electron or a positron, the observed behaviour is still the maximal left-right asymmetry seen in low energy beta decay.

Gilles Sauvage was the UA2 spokesman. Like UA1, this detector has also achieved commendable 80 per cent data-taking efficiencies under difficult conditions. Using the lone lepton plus missing energy signature, 35 W events have been accumulated, giving a W mass of 81 GeV and good evidence for complete left-right asymmetry.

In the hunt for the Z, fate had been unkind to UA2. What now looks to be a Z candidate event was picked up back in the 1982 run, before the W particle had been spotted! This event was in fact reported at the Rome workshop earlier this year, but at that time the Z was still about 100 inverse nanobarns away, and people were reluctant to contemplate it. Z particles seemed to elude the UA2 detector almost until the end of the 1983 run, when several came with a rush, one coming in the last hours! Applying all the desired selection criteria, UA2 has four Z events, three decaying into electron-positron pairs and one which produces a pair and a photon.

Loosening the selection criteria slightly, four more Z candidates turn up, including the one dating back to November 1982. Although they failed the initial selection, these additional candidates are believed to be Zs. For the four preferred events, the Z mass is now 91.9 GeV.

In his concluding talk, Carlo Rubbia brought together the UA1 and UA2 findings and displayed the impressive agreement with the electroweak theory. The CERN SPS collider has made all its 'planned' discoveries, he declared.

For photons, read bosons

The other major particle physics meeting this summer was the International Symposium on Lepton and Photon Interactions, held at Cornell University, Ithaca, New York, from 4-9 August. The physics content of the Brighton and Cornell meetings were very similar, the main difference being that Brighton included parallel sessions. Summing up the Cornell symposium, Chris Llewellyn-Smith warned that although the W and Z bosons had been discovered and had their expected properties, particle physics was far from being a closed book. He warned people not to take Lord Kelvin's famous 'advice' — 'there is nothing new to be discovered in physics now: all that remains is more and more precise measurement!' The standard electroweak theory still does not explain enough, declared Llewellyn-Smith. There are too many parameters for comfort. However with the discovery of the W and Z bosons of the electroweak theory, he advised updating the name of the meeting to the 'International Symposium on Lepton and Boson Interactions.'

Experimental physicists have to turn their hands to many skills. Here, divers check the installation of the underwater detectors in the Irvine/Michigan/Brookhaven search for proton decay. Further results from this experiment are eagerly awaited.

▶ *(From page 305)*

Other proton decay searches using the Cherenkov technique are under way in the US (Harvard / Purdue / Wisconsin collaboration in the Silver King Mine, Utah) and in Japan (Kamioka mine). Data could soon be contributed by the 1000 ton detector in the Fréjus tunnel.

While there is not much new to report yet on the proton decay front, Fiorini conceded that at least there is reasonable agreement among the experiments on the observed level of neutrino background.

To pin down the proton lifetime, more data from existing and new detectors is eagerly awaited. But it appears that the minimal grand unified theory already can be ruled out. While this may be a superficial disappointment, the final form of the theory could turn out to be much richer. Observation of decays with kaons makes some people whisper about supersymmetry.

Another prediction of grand unified theories is the phenomenon of neutron-antineutron oscillations. No evidence has been seen, although the required degree of sensitivity might not yet have been reached.

Grand unified theories also imply the existence of magnetic monopoles — free magnetic charges. P. Musset described the progress to date, but there is an embarrassing gap between theoretical prediction and experiment. At last year's Paris meeting, an idea of proton decay catalysed by magnetic monopoles had been enthusiastically received, but just as for the monopoles themselves, no evidence has yet been seen.

Neutrino physics

Many experiments are also looking for subtle effects in the neutrino sector. At Brighton, I. Lubimov reported on a refinement of the ITEP (Moscow) study of the beta decay of tritium. Several years ago, this gave an indication that the mass of the electron neutrino was not zero. The experiment has been improved, using a pointlike source, magnetic spectrometer and electrostatic scanning. Background has been reduced by a factor of twenty, and the electron neutrino is assigned a mass of at least 20 eV. Cosmologists please take note.

In the past few years there has been a flurry of interest in the possibility of neutrino oscillations — transitions between conventionally distinct neutrino states. This has led to a series of experiments at CERN and Fermilab in which signals from mutually displaced neutrino detectors are compared. Summarizing the measurements, V. Khovansky reported that no firm evidence for neutrino oscillations has been seen, although the limits have been pushed back to allow less room to manoeuvre. More negative results came from the continuing searches for heavy neutrinos and for double beta decay — weak nuclear transformations which emit no neutrinos.

Structure functions, weak decays

At last year's conference in Paris, structure function rapporteur F. Eisele had been able to report increasing agreement between results from different experiments. But the European Muon Collaboration experiment using the CERN high energy muon beam had discovered that the nucleon structures measured in heavy and light targets looked different.

More evidence was soon found in some ancient data unearthed at SLAC (see September issue, page 261). In the Brighton parallel sessions, there was a queue of experiments describing their own hunt for the 'EMC effect', largely without success. Mini-rapporteur K. Rith pointed out the range of different mechanisms which could contribute under various conditions, and warned against trying to combine data from different targets and beams. Whatever the explanation of the EMC effect, it certainly has implications for nuclear physics and for experiments using heavy nuclear targets.

Apart from the EMC effect, the study of structure functions is becoming an increasingly accurate branch of science. Different measurements of quark and gluon distributions appear to converge, and determinations of theory parameters look comfortable.

One of the big new results announced at Brighton was the measurement of the lifetime of the B (beauty) meson by two experiments at the PEP ring at SLAC — MAC (reported by G. Chadwick), and Mark II (reported by G. Hanson). The number is arrived at by looking at the tiny offset between the electron-positron collision point and the direction of emerging lone electrons or muons (see page 312).

The result, still with large errors, comes out at somewhere between 10 and 20 $\times 10^{-13}$ seconds. This contrasts with charm particle lifetimes — between 2 and 8 $\times 10^{-13}$ seconds, depending on particle type.

In a model of three quark-lepton 'families' (a total of six quarks and three types of lepton), this suggests that beauty particle decays are somehow suppressed. Putting in the observed B lifetime gives an indication of the mass of the so far unseen 'top' quark.

In her entertaining talk on weak decays, C. Jarlskog intimated that top mesons might lurk around 40 GeV, but the errors are large, and obviously this prediction is meaningless if there are still heavier quarks and more leptons around.

Many Brighton delegates were convinced that the CERN collider experiments had information up their sleeves on the production of the top flavour. Despite much speculation, UA1 and UA2 spokesmen refused to be drawn. The code-word was 'top secret'.

Elsewhere in the weak decay sector, C. Jarlskog pointed to new results which limit the possible contribution of right-handed charged weak currents (see September issue, page 260). She paid tribute to the CERN hyperon beam experiments which have tidied up a lot of semi-leptonic decays. Measurements of the tau meson lifetime underline the idea of lepton universality (all leptons behave similarly). However a new problem is a sighting of the F meson (carrying charm and strangeness) by the CLEO group at Cornell's CESR ring. The mass is about 50 MeV below where the F conventionally sits.

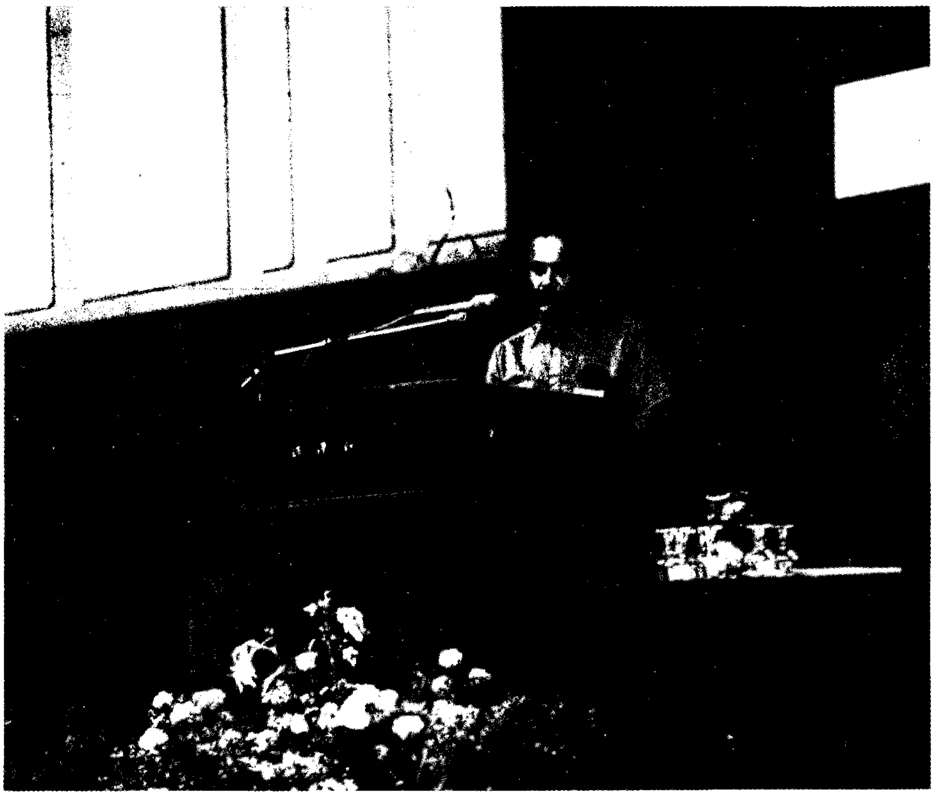
With so much effort going into the measurement of the proton lifetime (more than 10^{31} years), C. Jarlskog thought it a 'pity', that the free neutron, which lives only for about fifteen minutes, has yet to have its lifetime accurately measured.

New particles

The hunt for 'glueballs' — particles containing only gluons and no quarks — is attracting a lot of interest. The Brookhaven experiment which earlier saw a candidate glueball signal now has more evidence from a combination of final state particles which is 'forbidden' by conventional selection rules.

Other candidate glueball states are now seen in a variety of experiments. In an entertaining talk, F. Close described the rich spectroscopy expected from excited states of bound quarks, from glueballs, and from 'hybrid' states containing both quarks and gluons. (Editors of learned journals had forced Close to abandon more lurid labels for these heterogeneous states.) Something is radically wrong, commented Close, when experiments see little sign of all these theoretically possible levels. He advocated continued exploration of the J/psi region, despite the attractions of more glamorous physics.

Underlining this recommendation was the report by K. Einsweiler of a

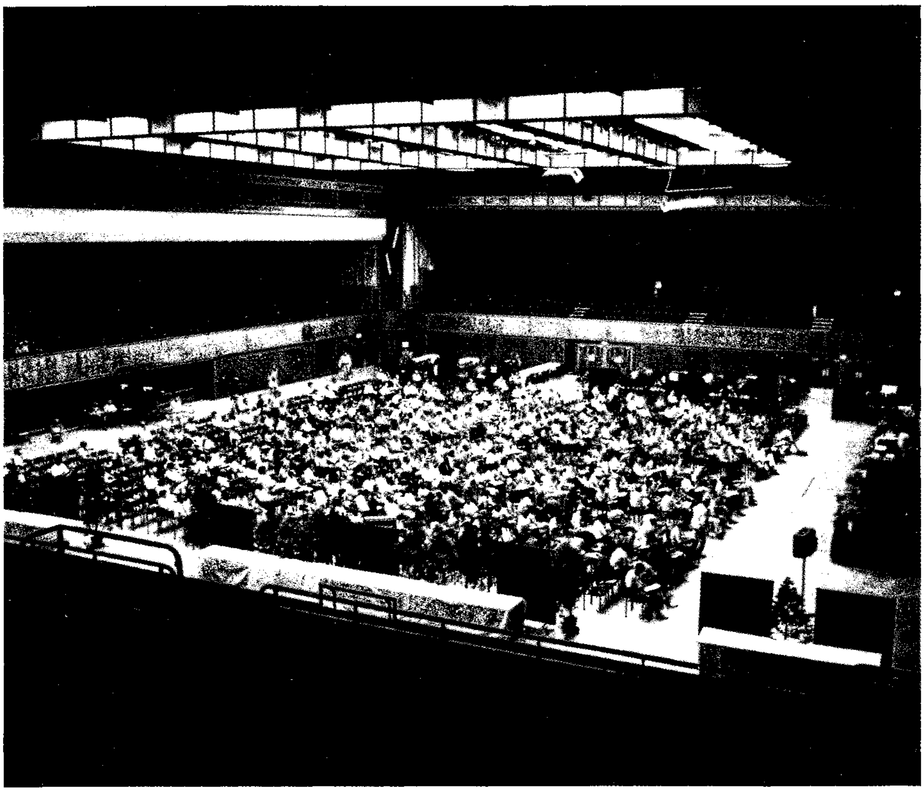


John Charap, chairman of the (highly efficient) Brighton Conference Organizing Committee.

(Photo Rutherford Appleton Laboratory)

A Brighton plenary session

(Photo Rutherford Appleton Laboratory)



new state seen in radiative decays of J/psis by the Mark III detector at the SPEAR ring. An enhancement is seen at 2.2 GeV in a two kaon spectrum. It is not seen in two pion states.

Higher up the energy ladder, upsilon spectroscopy looks very busy, with contributions from CUSB and CLEO at Cornell and from Argus and the Crystal Ball at DESY's DORIS II ring. In his review of hadron spectroscopy, K. Gottfried underlined the interest of the upsilon spectrum for theorists trying to understand interquark forces.

More potential glueball material is a new result from the Axial Field Spectrometer working at the doomed CERN Intersecting Storage Rings. The spectrum of centrally produced pion pairs shows an interesting structure which does not appear to change with collision energy.

Also still on the list of unexplained effects is that seen by the Aachen group in a beam dump experiment at the Swiss SIN machine. This could be due to light, penetrating particles.

G. Matthiae covered 'soft' hadronic interactions. Now that the boundary between what is hard and what is soft is becoming less distinct, this area is of growing interest. Proton-antiproton elastic scattering has now been studied over a wide range of energies and the momentum transfer distribution shows an intriguing behaviour, with secondary maxima which change in shape and position as the collision energy is increased. Already some of the models on the market can be eliminated. It was too early for Matthiae to announce new results from the UA4 study of elastic and total cross-sections at the SPS collider based on data collected this year.

The increase in transverse energy with the number of secondary particles produced in the collider is interesting, and a small effect has been seen at the ISR which could be the onset of this behaviour at lower energies. This could be due to hadronic phase transitions producing quark-gluon plasma ('quagma').

The study of photon-photon collisions (two-photon physics) is now well established and merited half a day of parallel sessions. In his summary, J. Dainton had a wealth of results to present, covering many different final states. The 2.1 GeV enhancement in the four-pion spectrum reported earlier from the TASSO experiment at PETRA is not seen in Mark II at PEP. The photon structure function has now been measured over a very wide kinematic range.

Theory

There was plenty of interest for theorists in the Brighton parallel sessions, but less theory was carried through into the plenary sessions than at the Paris meeting last year. The increasing efforts to apply particle physics ideas to cosmology were confined to the parallels and did not get a general airing at Brighton. In the plenaries, A. Jaffe described the latest attempts to break out of the straitjacket of perturbation theory without using a computer, and T. Walsh dealt with some of the technicalities of quark and gluon calculations.

Both illuminating and entertaining was I. Halliday's coverage of gauge theory on a lattice. This 'admission of defeat' by theorists battling with non-convergent series expansions gives some interesting results but quickly runs out of computer power. The problem is to recover the real world from calculations on an artificial lattice, by letting the lattice spacing approach zero. From the results achieved so far, Halliday believed

Around the Laboratories

that the optimal lattice conditions to allow good calculations are not far away, provided the right computer power can be found!

Another half day parallel session was devoted to innovative instrumentation, later summarized by B. Hyams. Speaking directly after the UA1 and UA2 presentations of the W and Z discoveries, Hyams observed that the impressive achievements of the big collider experiments demonstrate what can be done when state-of-the-art instrumentation is built into an experiment from the start.

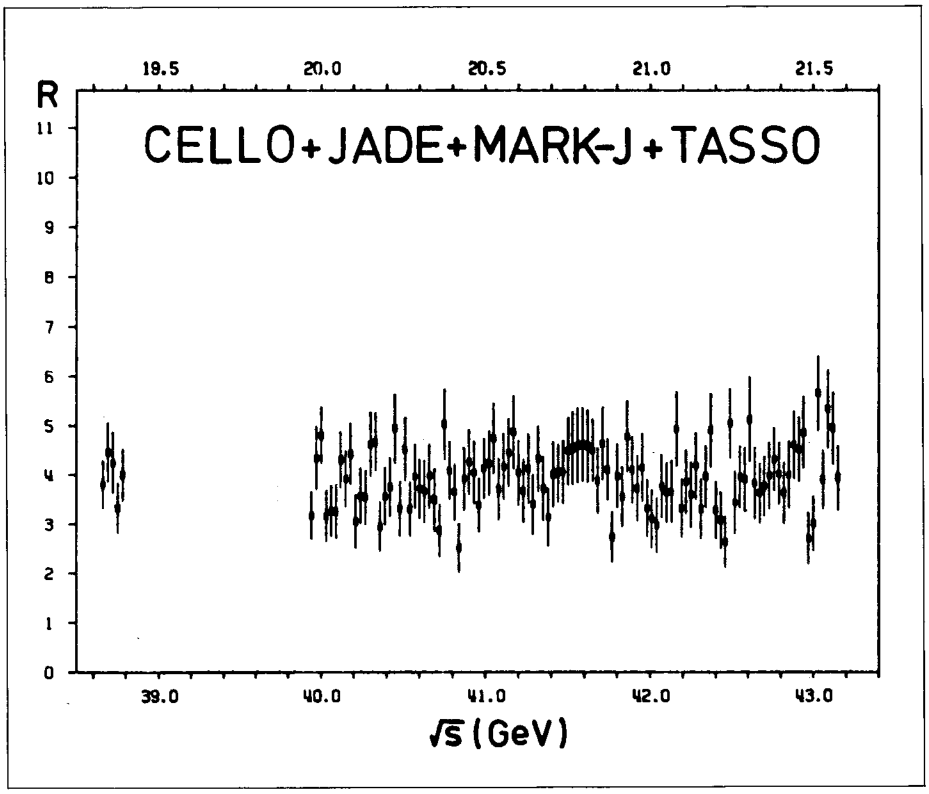
Physics data handling is a growing concern, but Hyams was able to point to a pipelined processor being developed by a Massachusetts / Columbia / Fermilab group which promises some very high data taking rates. With theorists now also looking at computer designs for their lattice gauge theory calculations, more developments could yet occur on the data handling front!

There was no summary talk of the Conference as a whole — thanks to the accomplishments of the CERN SPS collider, there was no need. Carlo Rubbia underlined these achievements — jet physics as well as the W and Z discoveries, and M. Veltman rounded off the meeting with an entertaining talk on vector (photon-like) bosons, past present and future.

The Brighton International Europhysics Conference was sponsored by the European Physical Society and the UK Science and Engineering Research Council.

(Report by Gordon Fraser.)

Topless at PETRA. Results of the scan for the top quark at the new high energies available from the PETRA electron-positron ring at DESY. The R value gives the rate of hadron production relative to muon pairs at collision energies up to 43.19 GeV. After the summer shutdown, the scan continued up to 45 GeV.



DESY
Topless at 43 GeV

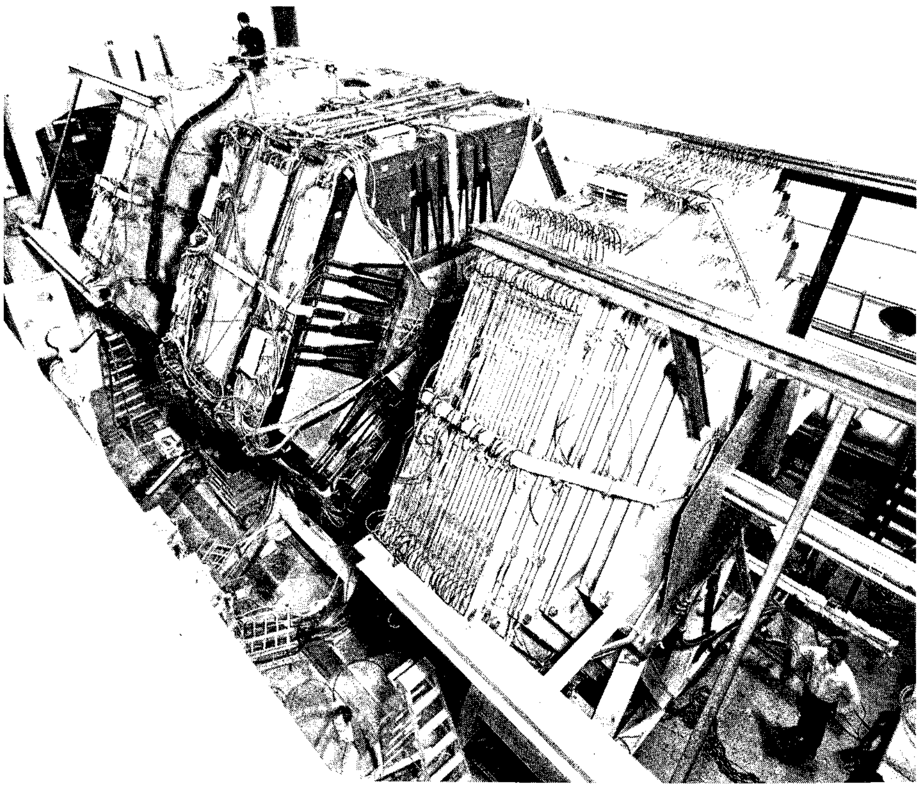
At the end of July the PETRA storage ring reached the highest energy ever achieved in electron-positron collisions — 43.19 GeV. The latest running period was devoted to a scan for the top quark in small steps of 30 MeV, requested by the four collaborations now working at PETRA: CELLO, JADE, MARK-J and TASSO.

In August there was a shutdown for the installation of 20 additional r.f. cavities, the final step in the energy upgrading programme of PETRA. The maximum energy which can be reached with the 112 installed cavities is about 45 GeV, and the scan for the top quark continues.

Nearly 10 per cent of the circumference of the PETRA ring — about all the space available — is occupied by cavities. This seriously limits the beam current of the machine. In the opinion of DESY specialists, further increase of the energy could only be achieved by installing superconducting cavities. Such cavities provide at present about three times higher accelerating field than conventional ones. The stability limit for beam current would then be increased due to the reduced length covered with cavities or, alternatively, a higher energy could be reached. A major step in this direction will be the test of a superconducting 18-cell cavity designed for PETRA which will be installed this winter.

No signs of the top quark were found up to 43.19 GeV at PETRA. However it is still interesting to present the data from which this conclusion was drawn. The most impressive plot is the R-value — the level of hadron production relative to muon pairs. (It is presented in a combined

The MAC detector, seen here being installed at the PEP electron-positron collider at SLAC. At this stage, the central section and endcaps were still separated, and the huge rafts of surrounding muon detectors had yet to be added. Measurements on electron-positron annihilation into jets accompanied by electrons or muons have given a first measurement of the B-meson lifetime.



plot for all PETRA experiments.) The peak expected for a ground-state toponium of small width and for quark charge 2/3 would reach a maximum R-value near to 13, with a width of about 70 MeV due to machine energy resolution. Such a peak seems to be excluded by the present data.

The scan up to 38 GeV was completed at the end of last year's run and the portion of higher energy (just under 40 to 43.19 GeV) was carried out in the 1983 run which finished on 31 July. As is well known, the mean level of R should increase from 11/3 to about 15/3 if a toponium resonance (for quark charge 2/3) was missed at lower energies. There is no sign for such a step.

There are other checks for the absence of the production of a vector meson in the data collected at PETRA. The jet-like distribution of the tracks of the observed multihadronic events should change drastically at such a resonance: part of the events should turn flat or even three-jet-like, due to the three-gluon decay of the produced meson. No such effect was seen. Even if the resonance is broad and therefore not seen in the R-plot, there are enough arguments to show that there is no top resonance up to 43 GeV.

Also other searches for new particles at PETRA had negative results, as was recently reported by Sakue Yamada at the Cornell Lepton/Photon Symposium. There were investigations with different techniques demonstrating an absence of 'technipions' or charged Higgs candidates at least up to 16 GeV. A search for sequential heavy leptons also had a negative result. So far no supersymmetric particles have been seen and there are no signs for an excited lepton.

There was also a negative result in a search for Dirac-type magnetic monopoles, which involved looking for holes in plastic sheets placed inside the PETRA vacuum pipe.

These negative results have important implications for several theories and models. It is the highest energy region ever covered in this kind of systematic search for new particles. The integrated luminosity amounts to about 300 inverse picobarns for the four PETRA groups.

STANFORD B meson lifetime

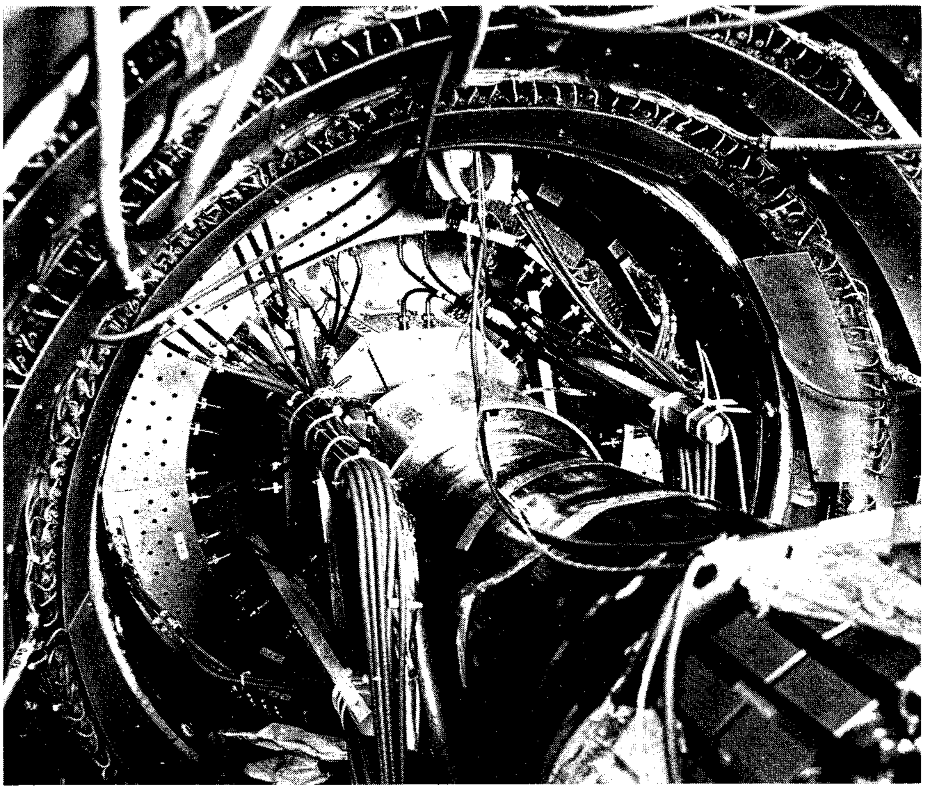
As announced at the Brighton Conference (see September issue, page 249, and this issue, page 309), the MAC and Mark II detectors at the SLAC's PEP electron-positron storage ring have made the first measurements of the lifetime of particles containing the heavy b-quark. The results show that this quark, usually labelled 'beauty', appears to decay into a lighter quark in about a millionth of a millionth of a second.

Using the standard model of six quarks grouped into three families, this lifetime gives a handle on how the three quark families mix. The result gives a lower limit for the mass of the sixth ('top') quark, so far unseen.

The two results use data from events in which an electron-positron annihilation produces two streams of particles, or jets, which leave the collision point in opposite directions. The particles in these jets are made of various combinations of the five known quarks, including the heavy b-quark.

In the measured events, the b-quark inside one of the particles decays into a lighter quark together with a lepton (muon or electron) and an unobserved neutrino. The particle

The 70 cm-diameter secondary vertex chamber of the Mark II detector surrounds the vacuum pipe of the PEP ring at SLAC, inside the concentric layers of the detector's conventional drift chamber. The inner high resolution drift chamber gives a resolution of 100 microns, which pays dividends in the measurement of the B-meson lifetime.



containing the new quark continues on while the lepton is thrown out of the mainstream of the jet.

Following back the path of the lepton shows that it was produced a small fraction of a millimetre away from the collision point. This offset depends on the distance travelled by the heavy particle before it decayed, and hence on the lifetime of the original particle. The particle is most likely a B-meson, containing a b-quark and one of the lighter quarks. Strictly speaking, it is the lifetime of these composites, rather than of the b-quark, which is measured.

The experiments must first separate the decays of b-quark particles from other decays and then measure the very small decay distance. Since the b-quark is relatively heavy, its decay lepton is thrown out at a larger angle than that coming from a lighter quark. As a result, events in which the lepton has large transverse and total momentum provide a clean sample of B-meson decays.

The tracks of the charged particles in the event are measured at several places along their length in a drift chamber. The lepton track can then be followed back toward the interaction point to look for the small offsets. The measurement errors produce offsets which are generally larger than the flight path prior to the decay. Thus there is usually no satisfying separation of the reconstructed track from the collision point for an individual event. A plot of hundreds of such events, however, gives a statistically clear result.

There are some differences between the two experiments. The MAC detector, for example, is designed for lepton detection over a very large solid angle. This produced a large data sample of nearly three hundred events. Mark II, on the other hand, has the benefit of a new secondary vertex chamber for track reconstruction, giving good spatial resolution close to the collision point.

The two experiments extracted their decay events from a wealth of data (about 100 inverse picobarns) collected during this year's high luminosity running at PEP. Including statistical and systematic errors, the lifetimes are $1.8 \pm 0.6 \pm 0.4 \times 10^{-12}$ s from MAC, and $1.20 + 0.45$ $(-0.36) \pm 0.30 \times 10^{-12}$ s from Mark II.

The weak interaction sees mixtures of quarks. This is described by the Kobayashi-Maskawa matrix, whose elements measure the mixing among the three quark generations.

Only four of the nine elements of this matrix are independent numbers. Although these are undetermined by the theory, they may be used with assumed quark masses to predict a variety of experimental numbers. Using known parameters, the mass of the t-quark can be calculated in terms of the B-meson lifetime. If the t-quark is found and its mass determined, then all these ideas can be tested. A discrepancy might be the first evidence for new physics.

SLAC Linear Collider approved

The SLAC Linear Collider, SLC, was included in an approbation bill recently signed by US President Reagan. The new machine is scheduled for completion at the end of 1986. Electron and positron beams, accelerated in the Stanford linac, will be taken in two opposite arcs towards the collision area. This will provide a ready supply of Z^o particles (see page 300).

CERN
LEAR arrives

The CERN antiproton project, already with a fine list of achievements to its credit, now has new muscles to flex. The LEAR Low Energy Antiproton Ring in the South Hall of the PS is now catering for a large array of experiments, providing antiproton beams of an intensity and quality never before achieved. These studies could turn out to be no less fruitful than their high energy counterparts at the SPS.

LEAR is the last major phase of CERN's antiproton project as initially planned. Whereas experiments at the SPS and the ISR involve accelerating the antiprotons supplied by the Antiproton Accumulator, antiprotons for low energy experiments are instead decelerated, first in the PS proton synchrotron and subsequently in LEAR, down to very low momenta.

During the excitement of the latest high energy proton-antiproton run, LEAR quietly supplied low energy proton test beams to the experiments being prepared downstream. Towards the end of July, LEAR received its first scheduled supply of low energy antiprotons. Initial performance was encouraging, and in a few hectic days, the experts readied the machine for action.

The LEAR 'ring' looks in fact more like a square, with four long straight sections and magnets at each corner. Its 78 m perimeter is one-eighth that of the neighbouring PS ring. It exploits ultra slow (stochastic) extraction, a new technique developed at CERN, in which carefully controlled r.f. noise is used to drive particles smoothly towards the extraction resonance in order to avoid spill irregularities due to ripple. Preliminary tests at the PS several years ago promised well, but in initial LEAR operation 308 MeV/c antiprotons were nudged out of the ring at the rate of 300 000 per second for fifteen minutes — just one antiproton in the stored beam left the ring in every three revolutions!

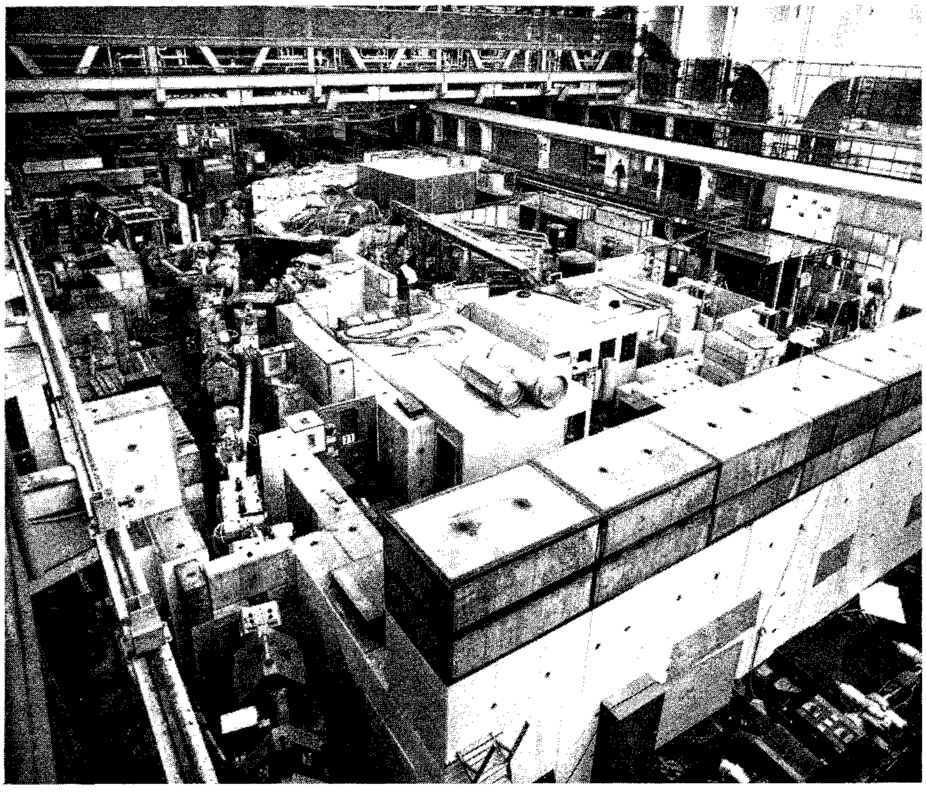
Judged by the number of experiments lined up in its experimental hall, LEAR is already a great success. It has attracted more than 250 physicists, from some 50 institutes in CERN Member States and the USA, Canada, Israel, Poland and the USSR.

In sharp contrast to the nucleon-nucleon case, where the low energy interaction has been charted in detail, nucleon-antinucleon data is relatively thin on the ground. Comparison of nucleon-nucleon and nucleon-antinucleon (and nucleus-nucleon and nucleus-antinucleon) data will provide important new insights into hadronic (and nuclear) forces, while investigation of the annihilation mechanism could considerably extend our knowledge of quark behaviour. Certainly LEAR should help clear up the spectroscopy of low energy nucleon-antinucleon resonances or bound states, where controversy has raged for years.

Each of the initial 49 pulses given to the LEAR experiments contained almost as many low energy antiprotons as the total number given to low energy antiproton physics experiments in the 28 years since the particle was discovered. At this rate, the eagerly awaited physics results should not be far away.

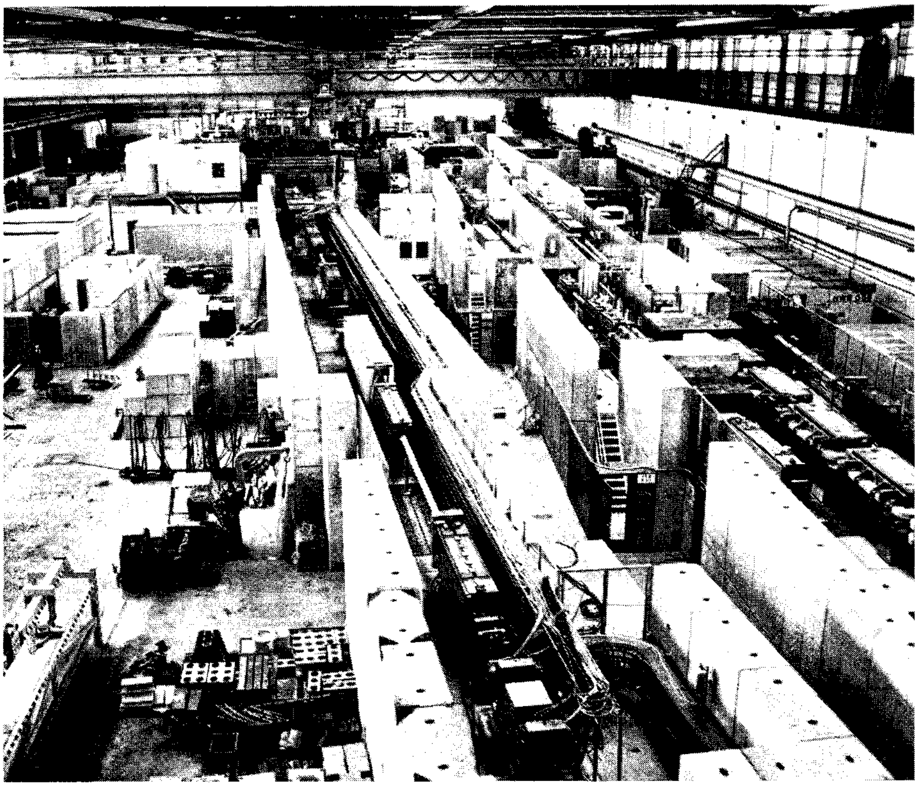
The crowded experimental hall at CERN's LEAR Low Energy Antiproton Ring. Judging by the number of physicists it has attracted — over 250 from 50 institutes — LEAR is a major success. First physics results are eagerly awaited.

(Photo CERN 1.5.83)



The new-look West Experimental Area at CERN now receiving beams at maximum energy (450 GeV) from the SPS proton synchrotron.

(Photo CERN 181.7.83)



Fixed objectives

After the excitement of the proton-antiproton collider run (see September issue, page 247), the SPS Super Proton Synchrotron returned on 14 July to the job it had been built for — delivering high energy beams of protons to fixed targets.

However this time it was doing it with a difference. The particles from the SPS serve two distinct experimental areas, one to the west of the site, and the other to the north. For five years after it came into operation in 1976, the main hall in the West Experimental Area used 40-200 GeV secondary beams derived from protons extracted from an intermediate SPS flat top at 250 GeV. Maximum machine energy (usually 400 GeV) was limited to the better shielded North Experimental Area and the West Area neutrino beam.

While the SPS was operating as a collider, the primary West Area target was placed underground, thus enabling the main West Area to profit from the full energy of the machine. Old beamlines, clad in 50 000 tons of concrete and 5 000 tons of iron shielding, were dismantled, and over 2 km of new beamlines installed, containing over 280 magnets and quadrupoles.

While this was going on, additional r.f. equipment was installed in the SPS itself to boost its normal peak operating energy from 400 to 450 GeV. However initial 1983 fixed target operations concentrated a firm consolidation of 400 GeV running before stepping up to 450 GeV.

One major objective for the revamped West Area is to provide extensive test facilities for the experiments to be built for CERN's big new LEP electron-positron ring. In this way, the components of the complex detectors can be assembled and taken through their paces while the machine itself is still under construction.

Thus the West Area now provides simultaneous beams for physics and for testing apparatus. The incoming proton beam hits a primary target, and is split into two main components, one of which delivers high energy pions and electrons to the large Omega detector, now resited.

The other secondary beam is further divided into three by septum magnets. Two of these branch beams hit secondary targets to provide two tertiary electron/hadron test beams. The third secondary branch beam can either be used for physics (H3 beam), or to provide a third tertiary test beam.

The first recipient of the H3 beam is the big WA 75 experiment (Bari / Brussels / CERN / Dublin / Japan / London / Rome / Turin) looking for signs of beauty particles. The interactions in a thick emulsion target are pinpointed with the help of silicon microstrip detectors sandwiching the emulsion target, plus downstream wire chambers. The experiment is interested in decays producing muons. Other particles are removed by a thick metallic absorber, and the muons are measured in a large superconducting magnet moved in from the North Area. The emulson will be scanned using the newly developed automatic technique (see June issue, page 184).

Another beauty search using sophisticated emulsion techniques, this time concentrating on the charm signature, is being carried out by a CERN / Genoa / Milan / Moscow / Paris / Rome / Santander / Valencia team using the Omega detector.

Other experiments lined up for the big Omega detector cover photoproduction (long a speciality at Omega), the study of direct photons and a search for exotic phenomena ('glueballs').

ARGONNE IPNS reaches 500 million pulses

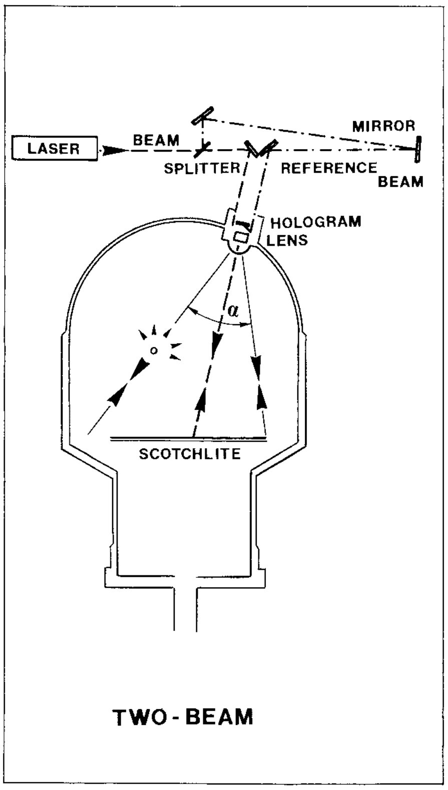
As briefly reported last month (page 268), the Rapid Cycling Synchrotron (RCS) of Argonne's Intense Pulsed Neutron Source (IPNS) reached 500 million pulses in May, delivering a total of 10^{21} protons in only 43 weeks of operation. The RCS accepts 50 MeV negative hydrogen ions from the old ZGS linac, strips and accelerates them to 450-500 MeV, and directs the extracted beam to a uranium target producing spallation neutrons.

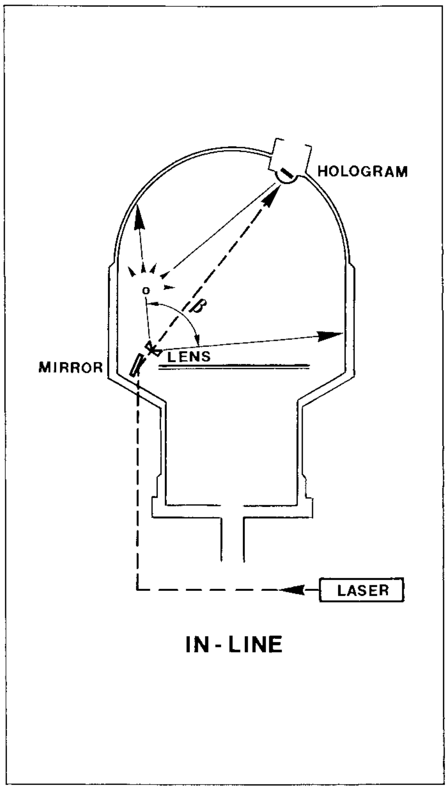
The machine started operation in 1977 as the proton source for the prototype pulsed neutron source ZING-P', then operated from 1981 until the present for the IPNS. It is now delivering up to 2.5 $\times 10^{12}$ protons per pulse (12 microamp average) at 450 MeV in 100 ns-wide pulses at 30 Hz. Acceleration losses are low (12-17 % difference between beam injected and on target) and availability exceeds 90%. The present high current results from continuous improvements in hardware, beam control, and most significantly, installation of a new, high current negative hydrogen ion source.

The IPNS is the world's most intense pulsed spallation neutron source and is used in condensed matter research. 25 % of the accelerator time is devoted to fast-neutron (about 1 MeV) radiation damage studies at the Effects Facility and 75 % to the slow neutron (less than 1 eV) Neutron Scattering Facility. High energy and medical test beams run parasitically.

IPNS has operated as a national user facility since November 1981, with experiment time allocated by a Scientific Program Committee. As the current leader in this new generation of neutron sources for low energy neutron research, it has attracted worldwide attention. To date, 307 proposals have been processed, but only half could be accepted due to budget-imposed limitations on operation (about 26 weeks per year).

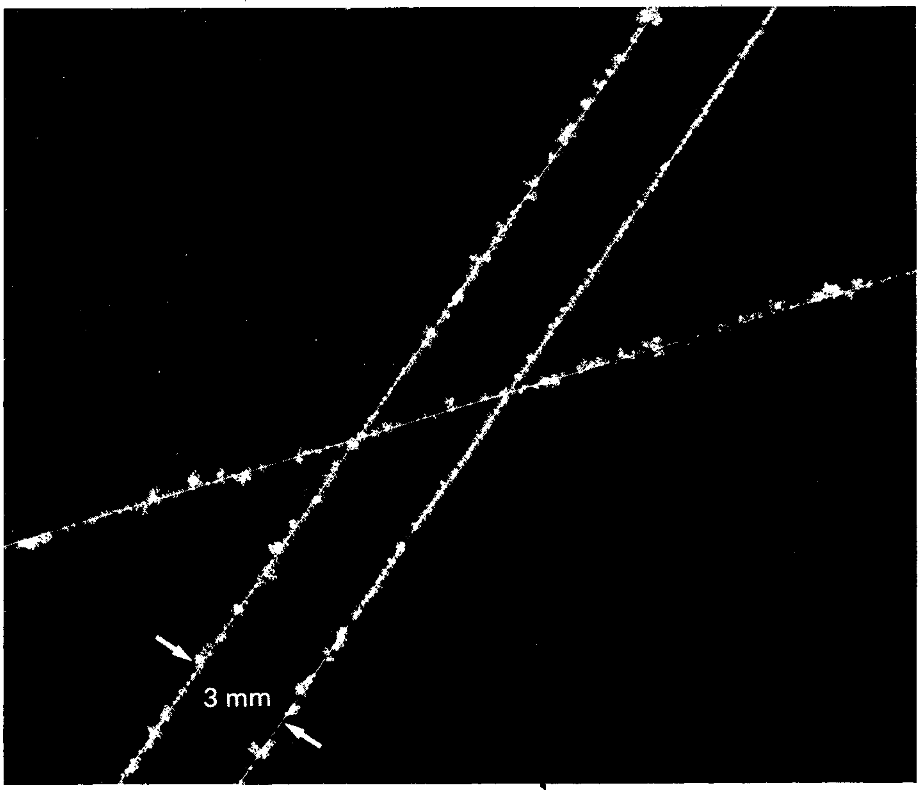
Instrumentation at the thirteen slow neutron beams and five irradiation facilities provides capabilities that significantly extend the range of low energy neutron studies beyond that provided by research reactors (until now the mainstay of this research). Each capitalizes on either the pulsed feature of source operation or the fact that the moderated neutron spectrum is especially rich in 'epithermal' (less than 0.1 eV) neutrons. Future prospects are especially exciting since there is scope within accelerator and neutron source technology for at least two orders of magnitude improvement in intensity. Projects to provide higher intensity are well under way elsewhere; at the Rutherford Laboratory, for example, the SNS is expected to come on line next year, ultimately delivering about thirty times the present IPNS intensity.

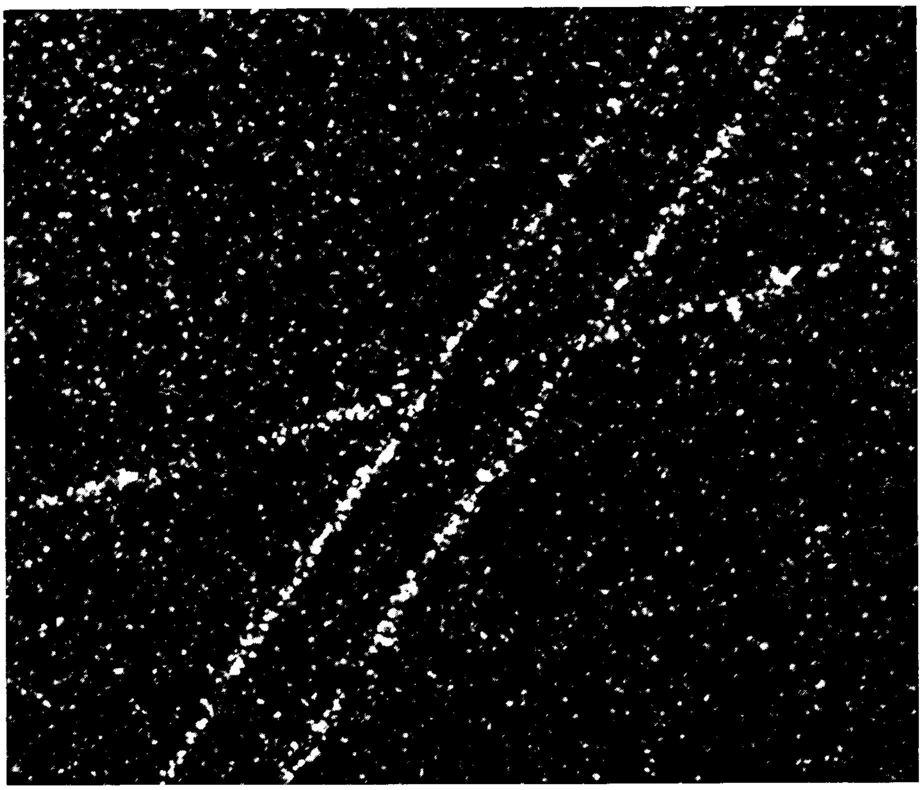




The two techniques for producing holograms in big bubble chambers. Above, in the 'two-beam' method, the laser beam is split into a low power reference beam which passes directly to the photographic emulsion, and a higher intensity component which goes into the bubble chamber and is reflected back. Below, in the 'in-line' method, the laser beam diverges through a specially designed lens. A small fraction of the light goes directly to the chamber's fisheye window to form the reference beam.

In-line holography tests in BEBC used 100-micron glass beads glued to 20-micron wires to simulate particle tracks. Top, the original target, bottom, the hologram.





Big holograms

Short-lived charmed particles and the tau lepton live so briefly that even at very high energies they travel only a few millimetres before decaying. To identify such transient particles and measure their lifetimes requires track detectors with high enough resolution to identify clearly the decay point.

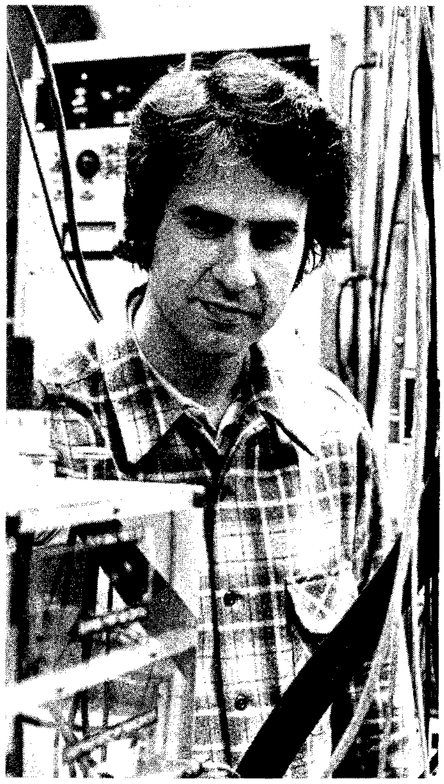
A number of groups have developed small high-resolution bubble chambers for use as vertex detectors in association with larger electronic detectors. These groups have found that holography is quite useful in helping to improve resolution. These small chambers have been successfully used in hadron experiments (see November 1982 issue, page 362), but are too small to catch neutrinos.

Recently some groups have been trying to develop high resolution techniques for the large bubble chambers, BEBC at CERN and the 15 foot chamber at Fermilab. At present the resolution of these chambers is limited to about 500 microns by the conventional optics used to photograph the bubble tracks. Higher resolution with conventional optics means giving up depth of field, thereby reducing the usable volume of the chamber. One possible solution is to use holography in conjunction with conventional optics. Holography holds the promise of a considerable improvement in resolution throughout a large depth of field. This is only achieved at the expense of more complicated recording and measuring, where the playback scheme has an additional third dimension.

The conventional pictures would be scanned and measured in the usual way and selected interesting events examined with the high reso-

Blas Cabrera — in the continuing hunt for magnetic monopoles.

(Photo Stanford)



lution provided by the holographic pictures. With this in mind two groups have been developing two different techniques for recording tracks in large chambers holographically.

A hologram is produced by the interference of coherent light from a 'reference beam' with coherent light scattered by an object. The two schemes for using holography in the large bubble chambers differ essentially in the method used to get the reference beam to the film.

The first method uses a modest intensity laser beam which is split into a low power reference beam, passing directly to the photographic emulsion, and a higher intensity part, which traverses the fisheye window, goes through the liquid, is reflected from the 'Scotchlite' surface back to the same optic port. The returning light wave is disturbed by the bubbles and forms an interference pattern with the reference beam. Applying this technique, cosmic ray tracks were photographed last summer in BEBC by a CERN / Institut Saint-Louis group. More recently, a CERN / Rutherford collaboration has demonstrated that 40 micron wires can be reconstructed from holograms in a realistic model of BEBC. This promises well for high resolution holography.

The other method needs a more powerful laser beam, which enters BEBC through a small window on the bottom of the chamber. This beam diverges through a specially designed lens. A small fraction of the light goes directly to a fisheye window to form the reference beam, while the rest illuminates the bubble chamber tracks. The intensity at larger angles increases to compensate for the decrease of the light scattered by the bubbles under these conditions. The scattered light interferes with the reference beam to form a hologram. This idea was developed at Columbia University and perfected with help from Hawaii, Rutgers-Stevens and CERN.

A 10 Joule Ruby laser with a pulse duration of some 20 ns was installed underneath BEBC in order to test this second scheme. With the chamber still empty, 100-micron glass beads glued onto 20-micron wires, to simulate particle tracks, were photographed with excellent contrast.

This scheme was then tried in a cold-test, parasitically with a physics run, this spring. High contrast holograms were obtained of bubble chamber tracks produced by cosmic rays traversing the neon/hydrogen filled chamber. Due to the random timing of cosmic rays, tracks of various diameters were photographed. Small tracks were seen with bubble diameters of some 120 microns. Potential visibility problems due to local heating or liquid turbulence, or magnetic field were not observed. However at the present laser power level, there was some laser-induced parasitic boiling which obscured the view of the conventional photographs taken several milliseconds after the laser fired. This boiling can be suppressed by a reduction in laser power by lengthening its pulse duration and using a higher sensitivity holographic film. It is intended to install such a system in the 15 foot chamber at Fermilab for Tevatron neutrino exposures.

Magnetic monopole meeting

The attendance of more than a hundred physicists at an 'Interdisciplinary Meeting on Magnetic Monopoles' demonstrated the interest of European physicists in this branch of research. The meeting, held in Orsay, followed the Wingspread Colloquium (see January issue, page 11).

F. R. Klinkhammer of the Leiden Observatory felt that the main question facing theoreticians was not so much the existence of monopoles, but rather how many were left. Contrary to limits from astrophysics (the mass of the universe, the existence of galactic magnetic fields), conventional Big Bang cosmology predicts a monopole abundance. Theoreticians are at present doing a great deal of work on the 'inflationary model': at the phase transition when grand unification symmetry breaks down, the magnetic monopoles are thrown far away from our universe during its formation. If this is correct, it would be impossible to detect a single monopole. (See the article by John Ellis and Dimitri Nanopoulos on Particle Physics and Cosmology, July/August issue, page 217).

The catalysis of proton decay is still not clear. M. Virassoro of Rome concluded that it is hard to imagine a mechanism to eliminate this Rubakof-Callan effect. J. Stone, Michigan, presented the first measurements from the IMB experiment on the lifetime of the proton (see also page 305). The product of the magnetic monopole flux and the magnetic monopole / proton interaction cross-section is lower than 7×10^{-40} per second per steradian (there is a lower limit obtained indirectly in astrophysics by the observation of neutron stars of 5×10^{-49} per second and per steradian). There would then be the choice between a very low flux or the non-decay of the proton! However all these results must be treated with caution for they involve theoretical and experimental work which is still being developed.

It now seems increasingly difficult to believe in B. Cabrera's single event but the experimental physicists are not losing heart. They are preparing new detectors sensitive to slow monopoles (between 10^{-5} and 10^{-3} of the speed of light), and covering ever larger areas. The next stage to be reached is 'Parker's limit' (the galactic magnetic field must not be destroyed by excessive monopole density). The size and cost of such experiments will be comparable to those on the lifetime of the proton.

Large superconducting projects are already planned in the US: 1 m^2 for B. Cabrera's screen target, 3500 cm^2 for the IMB project and 2800 cm^2 for the Chicago-Michigan project. Others are being completed in Britain (Imperial College) and France (CEA). The idea of a 100 m^2 superconducting detector is no longer a pipe-dream, but will the necessary finance be forthcoming?

Great progress has been made in calculating the interaction between monopoles and matter. P. Musset of CERN is convinced that it is now time to set up a major European project for a scintillation detector covering several thousand square metres. It could be installed at the Gran Sasso laboratory in Italy.

S. Drell and co-workers recently calculated the Zeeman energy of the excitation of atoms by the magnetic field of a monopole. The level shift is great enough to produce a signal in a gas detector: the excitation energy of rare gases can easily be transferred to low-ionization-potential molecules. Loh and Ritson, Utah, are building a 800 m^2 gas detector, in which the gas is a helium-methane mixture. G. Charpak, CERN, described a project for a drift chamber containing helium with 2% TEA (a low-ionization-potential molecule). To some extent it is the detector part of a large Cherenkov image counter.

A. de Rujula, CERN, presented preliminary calculations on the magneto-acoustic and thermo-acoustic effects produced by monopoles passing through matter. These effects are very weak, and it is so far hard to imagine a detector which is sensitive enough. It might be necessary to seek inspiration from superconducting gravitational wave detectors.

Under the chairmanship of J. Perez y Jorba, the meeting demonstrated the current interest in magnetic monopole research and could help launch a major European project.

(We thank Pierre Petroff for supplying us with this information.)

Dalai Lama at CERN

On 30 August, CERN turned aside from its usual day-to-day preoccupations when Director-General Herwig Schopper played host to the Dalai Lama of Tibet and his entourage during the holy man's 1983 visit to Europe.

In welcoming his visitor, Professor Schopper stressed the role of particle physics in helping to understand man's place in the cosmos, and how the Dalai Lama's interest would further the interrelation of science, philosophy and religion.

The Dalai Lama visited the UA1 experiment (rolled back into its 'garage' during the present fixed target operations at CERN) and the large installations for the neutrino experiments in the West Area of the SPS machine.

After lunch, there was an intriguing exchange of views with CERN theorists, who described how science has continually modified our view of the world around us. The Dalai Lama said that in the quest for true reasoning, philosophers were obliged to take account of the latest scientific findings. He was particularly interested in the current status of belief in the indivisibility of particles. He was assured that while current theories are based on a series of 'indivisible' quarks and leptons, this has been tested down to about a thousandth of the dimensions of the clearly composite proton. More structure could yet appear when smaller dimensions can be probed.

Theorists also described the modern view of the (non-invariant) vacuum as something necessarily lacking symmetry and which itself mirrors all the laws of physics. In reply, the Dalai Lama stressed the difference between a 'vacuum', such as had been described by the particle theorists, and a more fundamental 'void', which might have

On 30 August, Director-General Herwig Schopper welcomed to CERN His Holiness the 14th Dalai Lama of Tibet.

(Photo CERN 203.8.83)

to be viewed differently.

The exiled Tibetan leader displayed impressive intellect and insight, and was able to provide a serene counterpoint to the conventional scientific dogma with which he was presented. His general comment was 'I am happy and impressed by this amazing work of scientific research by a common effort of people across national boundaries'.

Under the guidance of Carlo Rubbia, the Dalai Lama explored the computer graphics capabilities of the UA1 experiment.

(Photo CERN 264.8.83)

People and things

Felix Bloch, the first Director-General of CERN (1954-55), died on 10 September. A tribute will appear in our next issue.

Bruno Pontecorvo

On people

Viktor Weisskopf, emeritus professor at Massachusetts Institute of Technology, has been awarded the J. Robert Oppenheimer Prize from the Center for Theoretical Studies at the University of Miami. The award was presented by Paul Dirac.

Bruno Pontecorvo celebrated his 70th birthday on 22 August. He started his research career on the properties of neutrons in Enrico Fermi's famous Rome group. In the Joliot-Curie Laboratory in Paris he investigated nuclear isomerism, the most interesting result being the production of beta-stable isomers by X-ray irradiation. Later came the idea of electron-muon universality and he carried out experiments to measure the muon's properties. He then turned his attention to neutrinos, and made major contributions to the development of techniques for detecting these elusive particles. Especially relevant to today's physics are his ideas on neutrino oscillations.

He is presently Academician of the USSR Academy of Sciences, Foreign Member of Academia dei Lincei, Head of Department at Dubna and Professor of Elementary Particle Physics at Moscow.

Theoretician Jon Magne Leinaas from the University of Oslo has been awarded the particle physics prize of computer manufacturer Norsk Data. He has made contributions to the understanding of geometrical and topological aspects of gauge theories. In collaboration with John Bell at CERN he has shown that the acceleration of electrons affects the electrons in a similar way to a strong gravitational field, and leads to a heating of the particles.

At the KEK Laboratory in Japan, work for the new TRISTAN collider has been brought together under the project leader, S. Ozaki. Former TRISTAN coordinator K. Kikuchi has become general research coordinator at KEK.

Philip I. Dee

Earlier this year, Philip I. Dee died at the age of 79, removing another of the links with the great days of nuclear physics at the Cavendish Laboratory, Cambridge, under Rutherford. After experiments with cloud chambers, Dee turned his attention in 1936 to the business of particle acceleration. From 1945 to his retirement in 1972 he held the Chair of Natural Philosophy at Glasgow, where he played a major role in reshaping the Department of Physics.

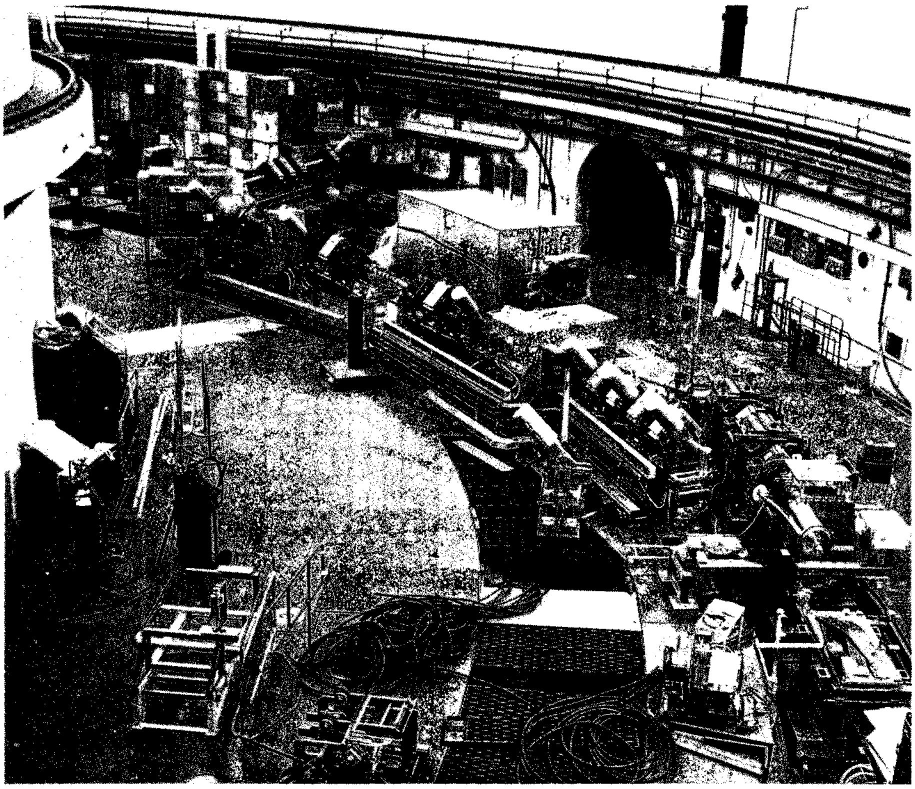
Valerian Shevchenko, Vice-Director for Research of the Institute of Theoretical and Experimental Physics in Moscow, celebrated his sixtieth birthday on 27 June.

Asian physics

The First Asia Pacific Physics Conference, held at the National University of Singapore in June, brought together about 300 specialists from many branches of physics, including the high energy and nuclear sectors. It has been decided to hold the second such meeting in Bangalore, India, in 1986. It is hoped that these conferences will become a permanent feature of the physics calendar. The co-chairmen of the second conference are A. Arima of Tokyo and K.K. Phua and P.P. Ong of the National University of Singapore.

In June, another milestone in the construction of the Spallation Neutron Source (SNS) at the Rutherford Appleton Laboratory was passed when 70 MeV negative hydrogen ions from the injector linac were taken through the beamline from the linac to the ring. Next year should see the start of the SNS experimental programme.

(Photo Rutherford)



First beam for FMIT

The preliminary work at Los Alamos for a Fusion Materials Irradiation Test (FMIT) facility passed an important milestone at the end of May. A beam of deuterons was successfully accelerated through a radiofrequency quadrupole (RFQ) section to reach an energy of 2 MeV.

Work will now concentrate on achieving 100 mA current and a drift tube linac section will be added to push the energy to 5 MeV. The facility is scheduled to be built at Hanford Laboratory using 35 MeV deuterons to produce neutrons of the right energy to study materials for use in fusion reactors.

It is hoped that this work will become an international collaboration. Also in readiness for FMIT, Los Alamos has developed power amplifiers to operate in the 80 MHz range. Successful tests in May reached 600 kW per amplifier.

Keeping track of experiments

The latest edition of 'Current Experiments in Particle Physics' by the Particle Data Group at Berkeley includes the now conventional microfiche, which now contains summaries of 479 approved particle physics experiments. These consist of studies at Brookhaven, CERN, Cornell, DESY, Fermilab, Institute for Nuclear Studies at Tokyo, KEK, LAMPF, Serpukhov, SIN, SLAC and TRIUMF, together with proton decay searches at passive sites. Cornell, LAMPF, SIN, TRIUMF and proton decay experiments appear in the listings for the first time.

Another innovation is the first edition of a supplement, entitled 'Major Detectors in Elementary Particle Physics'. This loose-leaf (one experiment per sheet) compilation covers 40 current experiments or detectors in use at Brookhaven, CERN, Cornell, DESY, Fermilab, Novosibirsk (VEPP) and SLAC, together with the passive proton decay searches. The list is not exhaustive, but provides nevertheless a quick and handy reference for the detectors which provide the bulk of the world's particle physics data.

While stocks last, copies of both the 'Current Experiments' listing and the 'Major Detectors' supplement can be obtained from the Particle Data Group, Lawrence Berkeley Laboratory, Berkeley, California 94720, USA (for requests from America, Australia and the Far East) or CERN Scientific Information Service, 1211 Geneva 23, Switzerland (all other areas).

UA1 pays the price

After being first across the finish line for several years, the UA1 team only managed second place in this year's traditional relay race around the CERN site. But no wonder. The race was run while the SPS collider was operating. Some people were on shift, others were scanning the data for more Ws and Zs, still more had to attend a major committee meeting. Due to the demands of physics, training had been sadly neglected. To cap it all, the same day saw a CERN press conference to announce the discovery of the Z^0. The 3.9 km race was won this year instead by the 'Polar Stars' team led by polarized target specialist Tapio Niinikoski, slicing twenty seconds off their 1982 time.

FRANCE AT CERN

11-14 OCTOBER 1983

The exhibition is organized under the auspices of the Scientific and Technical Mission of the
MINISTÈRE DE L'INDUSTRIE ET DE LA RECHERCHE
101, rue de Grenelle, 75700 PARIS
in cooperation with the
COMITÉ FRANÇAIS DES MANIFESTATIONS ÉCONOMIQUES A L'ÉTRANGER
10, avenue d'Iéna, 75783 PARIS CEDEX 16, Tél.: 505 30 00, Télex: 611 934 F
the
CENTRE FRANÇAIS DU COMMERCE EXTÉRIEUR
10, avenue d'Iéna, 75783 PARIS CEDEX 16, Tél.: 505 30 00, Télex: 611 934 F
and the
POSTE D'EXPANSION ÉCONOMIQUE PRÈS L'AMBASSADE DE FRANCE À BERNE
Sulgeneckstrasse 37, 3007 BERNE, Tél.: 25 33 64, Télex: 32707 COMAT CH

ADRET-ÉLECTRONIQUE
B.P. N° 33
78192 TRAPPES
Tél. 051.29.72/Tx. 697.821

VHF and UHF synthesizers generators; *LF and VLF synthesizers generators; frequency standard; voltage and direct-current standards.*

ALSTHOM-ATLANTIQUE
38, avenue Kléber
75795 PARIS Cédex 16
Tél. 505.20.00/Tx. 611.938

Superconductors, *magnets,* ***vacuum chambers,*** *vacuum chambers and vessels, titanium equipment.*

NEYRTEC
4, avenue du Général de Gaulle
38800 PONT-DE-CLAIX
Tél. (76) 98.81.98/Tx. 320.547

Crushing.

ATELIERS DE LA CHAINETTE
17, avenue Aristide Briand
79200 PARTHENAY
Tél. (49) 64.48.22/Tx. 790.322

Overhead travelling cranes, jib cranes, ***heavy lifting equipment.***

BERTIN-SESO
B.P. 3
78373 PLAISIR Cédex
Tél. 056.25.00/Tx. 696.231

High-precision UV ***optical components;*** *laser optics; positioning assembly for optical fibres.*

CALORSTAT INDUSTRIES
B.P. 41
Zone industrielle de la Gaudrée
91410 DOURDAN
Tél. (6) 459.67.67/Tx. 690.159

Hydroformed ***metal bellows*** *with welded and electrodeposited diaphragms; assemblies comprising metal bellows; vacuum chamber assemblies.*

CHAMBRE DE COMMERCE ET D'INDUSTRIE DE L'AIN
Centre d'Aumard
01210 FERNEY-VOLTAIRE
Tél. (50) 40.66.97

Comprising the following local firms:

BROCHIER ESPACE
01120 MONTLUEL
Tél. (7) 806.23.77/Tx. 310.741

*Samples of ultra-light, reflective **laminated materials for scientific uses** (displayed on panels).*

CERMIP
13, rue de l'Industrie
01150 LAGNIEU
Tél. (74) 35.79.00/Tx. 340.846

*Laser boring and ultrasonic grinding **units for machining micro-holes** (minimum dia. 5µ).*

CIAT
30, rue du Rhône
01350 CULOZ
Tél. (79) 81.11.11, (50) 23.58.19/Tx. 980.437

***Air-conditioning plants** and heat pumps, (displayed panels).*

CONTROL DATA
Chemin de la Planche Brûlée
01210 FERNEY-VOLTAIRE
Tél. (50) 40.85.34/Tx. 385.020

***Electronic sub-assemblies,** computer assisted design (photographs).*

MATRAIR
01560 SAINT-TRIVIER-DE-COURTES
Tél. (74) 30.79.14

***System for handling** welding flux without cracking (displayed on panels).*

NOVOPLASTIC
23, rue de l'Industrie
ARLOD
01205 BELLEGARDE
Tél. (50) 48.24.15/Tx. 385.036

*Rigid **extruded PVC pipes,** medium-voltage cables.*

CHAMBRE DE COMMERCE ET D'INDUSTRIE DE SAINT-ÉTIENNE MONTBRISSON
36, rue de la Résistance
42021 SAINT-ETIENNE Cédex
Tél. (77) 32.74.41/Tx. 330.683

Comprising the following local firms:

CELDUC
Rue Ampère
42290 SORBIERS
Tél. (77) 53 39 55/Tx. 330.872

Reed switches and static relays; power transformers.

COMEFOR
Boulevard Sagnat
42230 ROCHE-LA-MOLIÈRE
Tél. (77) 90.05.55/Tx. 330.828

*Design and manufacture of **tools**, manufacture of high-pressure jacks; one-off or mass-produced mechanical components.*

ETS MAGAND
La Tour-en-Jarez
42580 L'ÉTRAT
Tél. (77) 74.00.95/Tx. 300.006

Precision machinery.
Machining and inspection assemblies; manufacture and development of special machines and prototypes; press tools.

MARTIN BRUNEL
130, rue des Alliés
42100 SAINT-ÉTIENNE
Tél. (77).32.31.08

*Very high-pressure **valves** and fittings from 1000 to 10 000 bars.*

MICRO-P. INDUSTRIE
32, rue d'Arcole
42000 SAINT-ÉTIENNE
Tél. (77) 33.06.01

Microcomputer development systems.
EUROPE format printed-circuit boards, terminals, printers, industrial applications.

SOCOMEL
RN 82 — RATARIEUX
42480 LA FOUILLOUSE
Tél. (77) 74.08.64

***Electrical equipment** (displayed on panels).*
Chargers and dischargers for the French Air Force and Army; special machines for heating strip steel.

TARDY
«Le Canal» B.P. 9
42320 GRAND-CROIX
Tél. (77) 73.24.03/Tx. 330.269

***Mechanical construction** (displayed on panels).*
Presses for injecting plastic material; hydraulic cutting machines.

TECHNIQUES SURFACES
Zone industrielle SUD
42166 ANDRÉZIEUX-BOUTHEON
Tél. (77) 36.56.27/Tx. 900.762

***Mechanical components** (photographs).*
Sight glasses for hydraulic pumps; milling cutters, drills and punching machines; dies for electronics and metallurgy; a few electrical components (electrodes).

TECHMACHINE
Zone industrielle Sud
42166 ANDRÉZIEUX-BOUTHON Cédex
Tel. (77) 36.56.27/Tx. 900.762
(filiale d'HYDROMÉCANIQUE ET FROTTEMENT)

***Design and manufacture of test benches, simulators and special machines**; industrial application of equipment developed by the HEF Centre.*

JAC
Avenue du Pilat
42100 SAINT-ÉTIENNE/TERRENOIRE
Tél. (77) 25.68.44/Tx. 300.043

***Trailers** of all types handling loads of up to 80 tonnes; trolleys.*

CABLERIE DE SAINT-ÉTIENNE ET PHOCÉENNE
B.P. 38
Rue des Janetières
42161 ANDRÉZIEUX-BOUTHON
Tél. (77) 55.10.40/Tx. 900.709

Electric cables.

CEFILAC JOINTS FARGERE
90, rue de la Roche du Geai
42029 SAINT-ÉTIENNE Cédex
Tél. (77) 25.22.77/Tx. 330.697

***Seals, collars, flanges** (displayed on panels).*

CGEE ALSTHOM
13, rue Antonin Raynaud
92309 LEVALLOIS-PERRET Cédex
Tél. 758.13.13/Tx. 620.454

Electrical and electronic equipment, *instrumentation, control and data-processing equipment; radiation-protection equipment.*

COTRAITANCE AQUITAINE
74, avenue Gambetta
33700 MÉRIGNAC
Tél. (56) 45.07.76

Precision engineering: *mechanical welding; sheet-metal work, metalwork; boiler making; aluminium and cast-iron smelting.*

CRISMATEC
18, boucle d'Alsace
La Défense 3-Cédex N° 29
92097 PARIS LA DÉFENSE
Tél. 768.28.66/Tx. 610.500

Monocrystals *(bars, polished sections, plates, epitaxial films).*
Materials for scintillation detectors; magnetic bubble memories.

CRISTEC INDUSTRIES
27, avenue des Barattes
74000 ANNECY
Tél. (50) 66.04.18/Tx. 385.201

Electronic battery testers, *automatic battery chargers, computerized control and drive via external voltages calibrated for computer control of the chargers.*

DATA SUD-SYSTEMES
22, rue de Claret
B.P. 1067
34007 MONTPELLIER Cédex
Tél. (67) 27.32.55/Tx. 490.425

Range of printed-circuit boards *to the VME BUS standard; image processing and acquisition systems; local industrial transmission systems using optical fibres.*

ENERTEC-SCHLUMBERGER
12, place des Etats-Unis
92542 MONTROUGE Cédex
Tél. 657.11.23/Tx. 201.248

Potientiometric recorders, *measuring transductors, digital indicators, thermal printers, static protection relays.*

ERT (Etudes et réalisations techniques)
Le Plan du Bois
06 120 LA GAUDE
Tél. (93) 24.81.24/Tx. 460 000 public
(N° 04200121)

Electronics, electromechanical equipment

GBG (Gauban-Boissonnet-Gourhant)
30, rue Eugène Caron
92400 COURBEVOIE
Tél. 334.30.80/Tx. 610.952

Photographes of various items of equipment designed for the ***nuclear industry.***
Precision mechanics; ***Machining assemblies.***

GOULD INSTRUMENTS
57, rue Saint-Sauveur
91160 BALLAINVILLIERS
Tél. 934.10.67/Tx. 600.824

Electrostatic recorders *of the ES 1000 type; various digital and analog input modules; monitors with V. 1000 screens.*

MICRO-CONTROLE
ZI de Saint-Guenault
B.P. 144
91005 EVRY Cédex
Tél. (6) 077.82.83/Tx. 691.105

Motorized micro-translation systems in vacuum *(traversing, rotation, mirror supports, etc.); tables and optical benches, components.*

MICRO SYSTÈMES ET PROCESSUS INDUSTRIELS
5, rue Audiffred
21350 VITTEAUX
Tél. (80) 49.63.30

8 and 16 bit mini-computers *specially designed for industrial applications: automation, control, data transmission, optimization of manufacturing process.*

Ets NEU
258, avenue Napoléon Bonaparte
92506 RUEIL-MALMAISON
Tél. 732.92.70/Tx. 203.158

Aerodynamics, ***energy management;*** *thermodynamics.*

OSL
Zone industrielle
06510 CARROS
Tél. (93) 29.11.09/Tx. 470.284

Crates and modules, *CUBIC, CAMAC, NIM, CIM.*

PONT-A-MOUSSON
91, avenue de la Libération
54000 NANCY
Tél. (8) 396.81.21/Tx. 850.003

Cast-iron tunnel lining segments for underground works; ductile cast-iron piping for fire-fighting water, ***sewage systems*** *and hot-water distribution systems.*

QUARTZ ET SILICE
18, avenue d'Alsace
Cédex 27-92096 PARIS-LA-DÉFENSE
Tél. 762.46.00/Tx. 611.570

Silica glass ***radiation detectors,*** *silica glass products; optical silica glass.*

RACAL-DANA INSTRUMENTS
18, avenue Dutartre
78150 LE CHESNAY
Tél. (3) 955.88.88/Tx. 697.215

GIGA microwave generators.
Supply modules and CEIS DC/DC converters; CEIS analog data-acquisition systems.

RADIALL
101, rue Philibert Hoffmann
93116 ROSNY-SOUS-BOIS
Tél. 854.80.40/Tx. 220.673

Coaxial connectors; *Industrial banana plugs and sockets; very-high-frequency components; optical-fibre connectors; passive electronic components.*

RADIO TECHNIQUE COMPELEC
130, avenue Ledru Rollin
75540 PARIS Cédex 11
Tél. 355.44.99/Tx. 680.495

Slit cameras; *photomultipliers; cavities; image-intensifying tubes; hybrid circuits; keyboards; ACE-ECL microelectronics.*

SAUNIER DUVAL
250, route de l'Empereur
92508 RUEIL-MALMAISON Cédex
Tél. 732.92.55/Tx. 203.274

Electrification, automation, instrumentation.
Control and electrical switchboards, technical assistance.

SEFELEC
2 ter, rue Gaston Soufflay
94507 CHAMPIGNY-S/MARNE Cédex
Tél. 706.14.80/Tx. 220.429

Programmable instrumentation systems; *automatic cable testers, capacitance meters, inductance meters.*

SEMI-CAN
La Garetière
CIDEX 323 B
38640 CLAIX
Tél. (75) 98.65.81/Tx. 320.245

Aluminium and stainless steel ***components and accessories;*** *standard and special components for vacuum and ultra-high vacuum systems.*

SERAPID FRANCE
ZI, route de Dieppe
76660 LONDINIÈRES
Tél. (35) 93.82.82/Tx. 770.672

Horizontal traversing devices; samples of ***chains and casings.***

SOCEA-BALENCY (SOBEA)
280, avenue Napoléon Bonaparte
B.P. 320
92506 RUEIL-MALMAISON Cédex
Tél. 749.03.30/Tx. 203.978

Public and private building construction; piping, ***civil-engineering works,*** *environmental protection, general contracting.*

TÉLÉMÉCANIQUE
33, avenue de Chatou
92500 RUEIL-MALMAISON
Tél. 732.92.30/Tx. 203.312

Heavy lifting equipment, *lifting equipment; bar code readers; programmed logic (robots).*

THOMSON-CSF
23, rue de Courcelles
B.P. 96.08
75362 PARIS
Tél. 563.12.12/Tx. 203.780

Microelectronics *and particle accelerators.*
Klystrons for particle accelerators (continuous-wave or long-pulse operation).

VERELEC
91, avenue de Villeneuve-St-Georges
94600 CHOISY-LE-ROI
Tél. 890.92.17

Components for vacuum and very high vacuum systems, *alumina machining, glass to metal welding for very high-vacuum systems.*

PHYSICS FROM CAMBRIDGE

Weak Interactions of Leptons and Quarks

E. D. COMMINS
and **P. H. BUCKSBAUM**

A lucid account of weak interaction and its relationship with the other fundamental interactions of nature which examines both early models and the most recent developments. The authors' straightforward style and emphasis on experimental results will be welcomed by all students of the subject.

0 521 23092 6 **Hard covers £37.50/$69.50**
0 521 27370 6 **Paperback £16.50/$27.95**

Rydberg States of Atoms and Molecules

Edited by **R. F. STEBBINGS**
and **F. B. DUNNING**

A stimulating overview of recent work with contributions from A. Dalgarno, R. J. Damburg, V. V. Kolosov, D. Kleppner, M. G. Littman, M. L. Zimmerman, C. Fabre, S. Haroche, P. M. Koch, T. F. Gallagher, A. P. Hickman, R. E. Olson, J. Pascale, F. Gounand, J. Berlande, F. B. Dunning, R. F. Stebbings, R. S. Freund, M. R. Flannery, and J.-F. Delpech.

0 521 24823 X **£40.00 net/$79.50**

The Birth of Particle Physics

Edited by **L. M. BROWN**
and **L. HODDESON**

This collection of papers drawn from the 1980 International Symposium on the History of Particle Physics held at Batavia, Illinois focuses primarily on the development of cosmic-ray physics and quantum theory in the 1930s and 1940s, before the advent of particle accelerators.

0 521 24005 0 **About £40.00 net/About $79.50**
Forthcoming (November)

Proceedings of the Ninth International Conference on General Relativity and Gravitation

Edited by **ERNST SCHMUTZER**

Contributors: H. K. Wheeler, E. Schmutzer, K. Kramer, H. Stephani, I. Robinson, R. A. d'Inverno, J. E. Marsden, J. Ehlers, R. S. Ward, H. J. Seafert, R. Sunyaev, Ya. B. Zel'dovich, R. D. Reasenberg, I. I. Shapiro, G. W. Gibbons, P. van Nieuwenhuizen, S. Ferrara, A. Trautman, D. R. Brill, P. S. Jang, V. B. Braginsky, K. S. Thorne, L. P. Grishchuk, R. W. P. Drever, G. M. Ford, J. Hough, I. M. Kerr, A. J. Munley, J. R. Pugh, N. A. Robertson, H. Ward, H. Melcher, and L. Pyenson.

0 521 24669 5 **£35.00 net/$69.50**

New in paperback

Special Relativity

The Foundation of Macroscopic Physics
W. G. DIXON

Probably the deepest and most careful analysis of the foundations of general relativity yet published, this much-praised volume is a valuable supplement to introductory books on special relativity. The level is that of a second or third year undergraduate course.

0 521 27241 6 **Paperback £9.95 net/$19.95**

An Informal Introduction to Gauge Field Theories

IAN J. R. AITCHISON

Assuming a basic knowledge of quantum field theory and Feynman graphs, Dr Aitchison presents a coherent, self-contained and yet elementary account of the theoretical principles and physical ideas underlying gauge field theories.

0 521 24540 0 **£12.50 net/$22.50**

The Very Early Universe

Edited by **G. W. GIBBONS, S. W. HAWKING** and **S. SIKLOS**

This important collection of papers is drawn from a workshop meeting held in Cambridge in mid-1982. Quantum theoretical ideas are examined and the contributors attempt to derive such initial conditions of our universe as thermal equilibrium, isotrophy, and the baryon to entropy ratio.

0 521 25349 7 **£25.00 net/$49.50**

Quarks, Gluons and Lattices

MICHAEL CREUTZ

An enterprising treatment of the lattice approach to gauge field theory which ranges from the lattice definition of a path integral to Monte Carlo simulation methods. The author assumes a basic background in relativistic quantum mechanics and some knowledge of gauge theories, and his text is designed to serve as the basis for a graduate-level course.

0 521 24405 6 **£17.50 net/$34.50**
Forthcoming (November)

The Quest for Quarks

BRIAN McCUSKER

Professor McCusker's brief, non-technical account of elementary particles is designed both for physics students and the general reader. He examines the basic questions that continue to puzzle scientists: are quarks the fundamental building blocks of nature? what are they like? how many kinds exist? and can they exist in a free state?

0 521 24850 7 **About £7.95 net/About $15.95**
Forthcoming (November)

New in paperback

An Introduction to Gauge Theories and the 'New Physics'

ELLIOT LEADER
and **ENRICO PREDAZZI**

'This book provides essential reading for anyone intending to work in theoretical or experimental particle physics, and is a very useful source of reference to workers already in the field.' *Contemporary Physics*

0 521 29937 3 **Paperback £15.00 net/$27.50**

CAMBRIDGE UNIVERSITY PRESS

National Synchrotron Light Source

Brookhaven National Laboratory

We seek candidates for the following openings:

ACCELERATOR SCIENTIST, with a broad background in experimental particle accelerator physics, and the development of related hardware and diagnostic instrumentation. Responsibilities will be directed to the further development of the high intensity electron storage rings (700 MeV, 2.5 GeV) for the generation of synchrotron radiation. Specifically, the objective will be to study beam intensity and source brightness limiting effects and their cures. The level of the appointment will be determined by the qualifications and experience of the successful candidate. Candidates with a strong record of accomplishments in the field of accelerator science are invited to apply to: Dr. A. van Steenbergen, National Synchrotron Light Source Department, Building 725B.

POSTDOCTORAL RESEARCH ASSOCIATE, to participate in experimental and theoretical work on the generation of XUV coherent radiation by relativistic electron beams, and on the development of Free Electron Lasers. Candidates should submit curriculum vitae and publications list together with the names of three references to: Dr. Claudio Pellegrini, National Synchrotron Light Source Department, Building 725B.

bnl **Brookhaven National Laboratory**
Associated Universities Inc.

ELECTRICAL ENGINEER, preferably with MSEE or equivalent degree, with a broad background in analog circuit engineering, feedback systems and controls, high frequency low-level rf circuitry and BV pulsed systems. Responsibilities will be directed to further development of the high intensity electron storage rings (700 MeV, 2.5 GeV) for the generation of synchrotron radiation, and specifically, involve narrow and broad band electron beam coupled feedback systems for the suppression of beam longitudinal and transverse instabilities. The level of the appointment will be determined by the qualifications and experience of the successful candidate. Candidates with a solid record of accomplishments in network analysis, feedback theory and signal treatment are invited to apply to: Ms. Susan Foster, Personnel, Building 185.

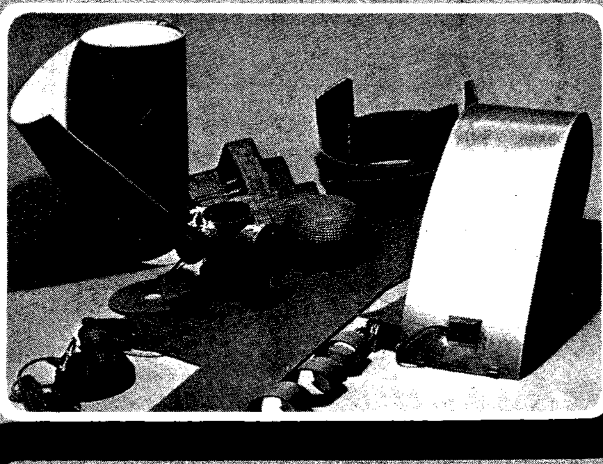
Brookhaven National Laboratory is a multiprogram Laboratory managed by Associated Universities, Inc. under contract with the U.S. Department of Energy. We are located on a 5,000 acre site on eastern Long Island, approximately 60 miles from New York City, in a region known for its excellent recreational opportunities.

Apply to the above named individuals at:
Brookhaven National Laboratory
Associated Universities, Inc.
Upton, New York 11973

An Equal Opportunity Employer m/f

Corps de chauffe au silicone

Nous utilisons le silicone pour fabriquer des rubans chauffants souples, des tissus chauffants et des corps de chauffe profilés. Physiquement stables, ils résistent à presque toutes les influences chimiques. Ils sont très souples, étanches à l'eau et électriquement sûrs. Ils conviennent également pour tous usages jusqu'à 200°C.



Vous trouverez des renseignements sur la gamme de nos produits et leur champ d'utilisation dans notre catalogue d'information « Chauffage industriel » — HW 130/Si

Tous les éléments chauffants : rubans, câbles, tissus, plaques et tuyaux souples. Chauffage de fûts, chauffe-ballons. Dispositifs de réglage, accessoires de montage.

Heraeus WITTMANN

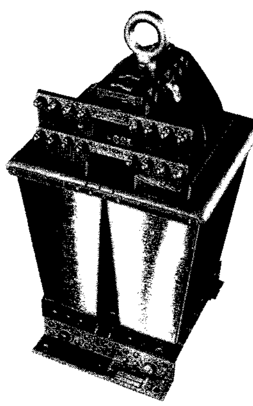
WISAG

Oerlikonerstr. 88, CH-8057 Zürich
Tel. 01/311 40 40

PEARSON

Very High Voltage &
Very High Current

Pulse Transformers



Pearson Electronics specializes in the design of very high voltage (to 1,000,000 volts) and very high current (to 1,000,000 amperes) pulse transformers. Typical applications are for units supplying power to high power microwave tubes, particle accelerator injection systems, pulsed x-ray tubes, high power lasers and plasma physics.

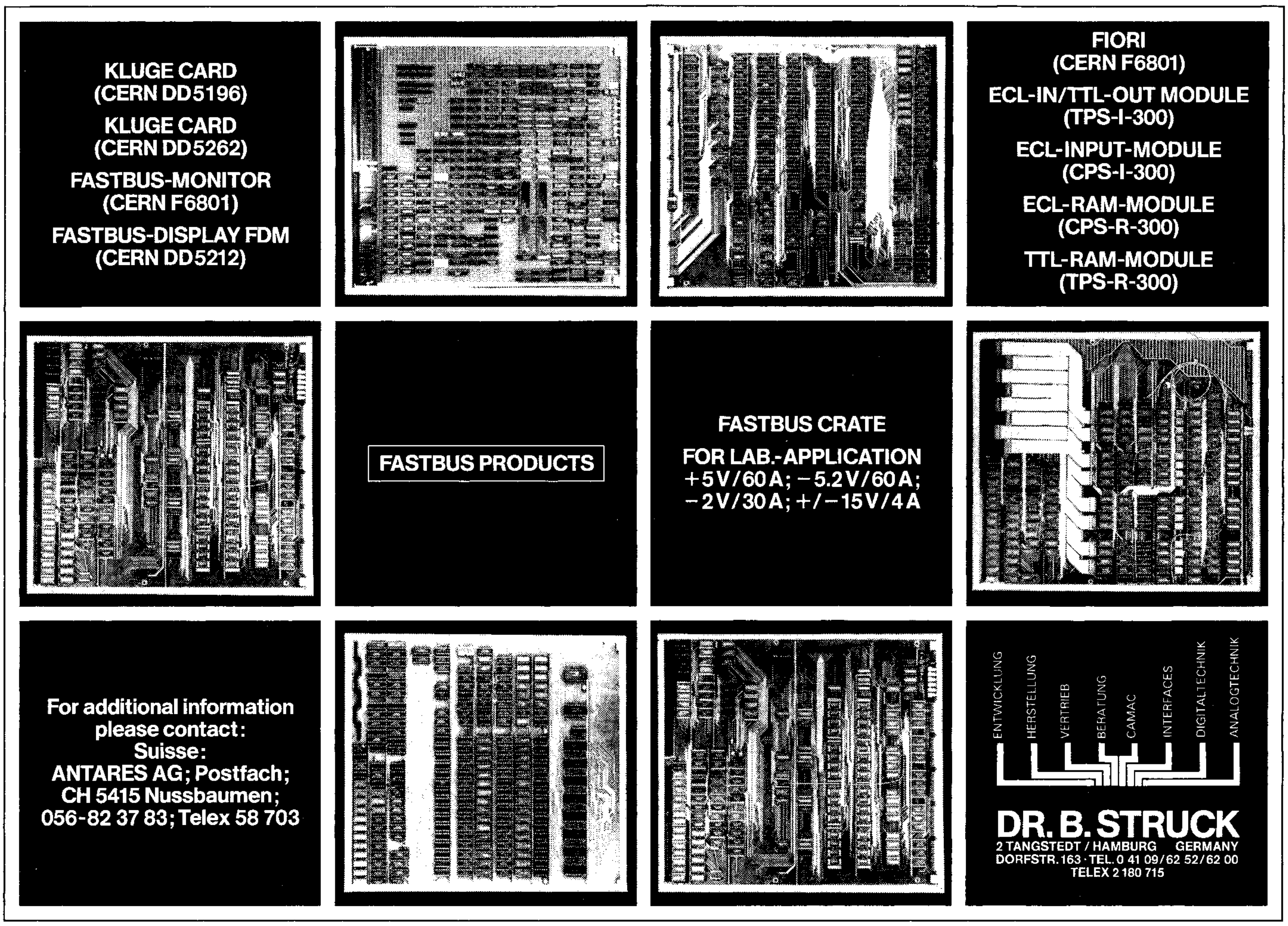
Other Pearson pulse-modulator components include precision current transformers and coaxial capacitive voltage dividers. The current transformers for high voltage use feature double shielding and high voltage stand-off capabilities. Units for use with high currents are rated up to 1,000,000 amperes or more. The voltage dividers are rated up to 500 kV.

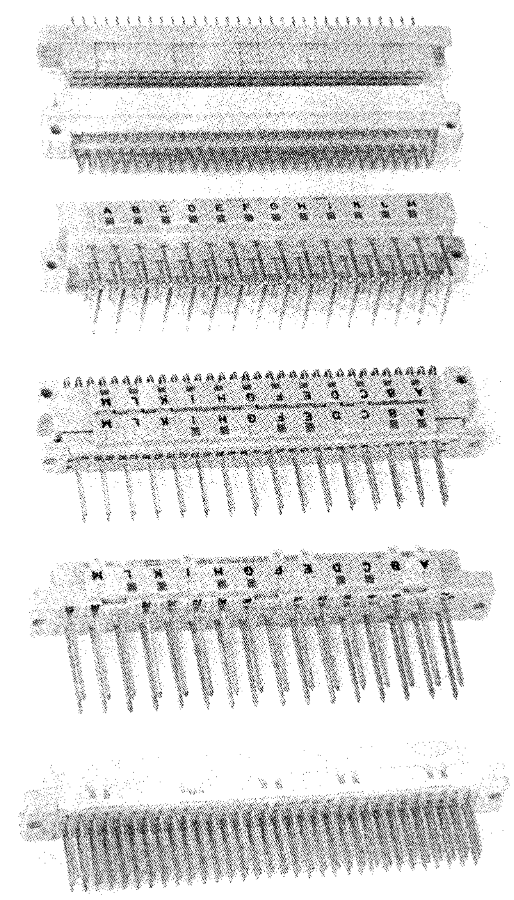
Inquiries regarding specific requirements for these components are welcomed.

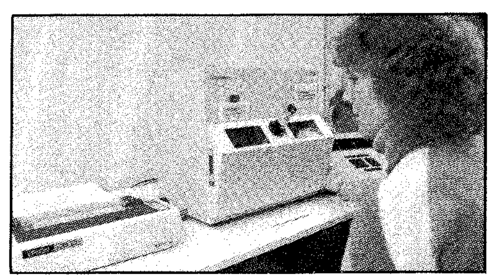
PEARSON ELECTRONICS, INC.

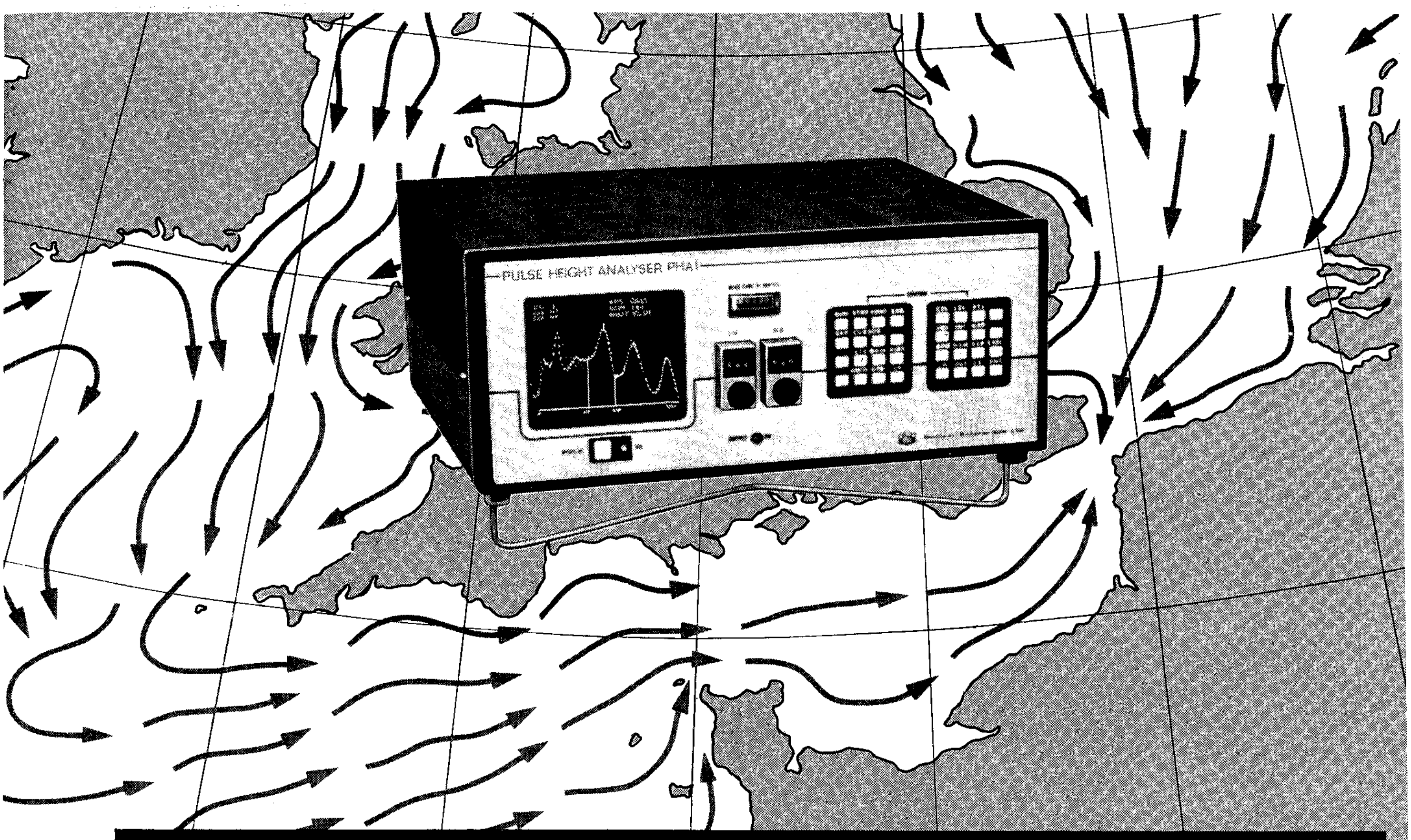
1860 Embarcadero Road, Palo Alto, Calif. 94303, U.S.A.
Telephone (415) 494-6444 Telex 171-412


ateliers
MAITRE
La Forêt du Temple
23360 Lourdoueix St Pierre
Tél.: (54) 30.31.00
Télex: Maitre 750624
Région parisienne:
Tél.: (6) 077.82.83
une société du groupe
micro-controle
Nous bâtissons sur granit


KLUGE CARD
(CERN DD5196)
KLUGE CARD
(CERN DD5262)
FASTBUS-MONITOR
(CERN F6801)
FASTBUS-DISPLAY FDM
(CERN DD5212)
FIORI
(CERN F6801)
ECL-IN/TTL-OUT MODULE
(TPS-I-300)
ECL-INPUT-MODULE
(CPS-I-300)
ECL-RAM-MODULE
(CPS-R-300)
TTL-RAM-MODULE
(TPS-R-300)
FASTBUS PRODUCTS
FASTBUS CRATE
FOR LAB.-APPLICATION
+5V/60A; −5.2V/60A;
−2V/30A; +/−15V/4A
For additional information
please contact:
Suisse:
ANTARES AG; Postfach;
CH 5415 Nussbaumen;
056-82 37 83; Telex 58 703
ENTWICKLUNG
HERSTELLUNG
VERTRIEB
BERATUNG
CAMAC
INTERFACES
DIGITALTECHNIK
ANALOGTECHNIK
DR. B. STRUCK
2 TANGSTEDT / HAMBURG GERMANY
DORFSTR. 163 · TEL. 0 41 09/62 52/62 00
TELEX 2 180 715





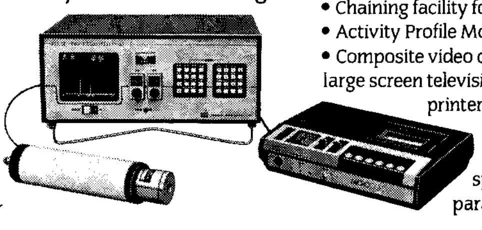


The 1024 Channel Analyser

The PHA1 1K analyser has been specially designed and manufactured by Europe's leading nucleonic specialists — Nuclear Enterprises Limited and Numelec S.A.

Designed for general spectroscopy work, its built-in raster scanned display is exceptionally stable and can drive external large screen monitors.

Scintillation detectors can be directly connected because preamplifier, amplifier and high voltage supply are built-in. An ADC with adjustable conversion gain completes the pulse processing system, and offers excellent linearity backed by auto-incrementing memory.



PHA1 with Scintillation Detector and Digital Recorder

ROI integration, group addition/subtraction and other simple data manipulations, plus stand-alone data logging can all be accomplished.

If you want hard copies of data, we can supply all the peripheral equipment you need. Indeed, the PHA1 can also be connected to a host processor.

For adaptability and easy servicing, the PHA1 is packaged in a Eurocard format.

Compare the specification:

- Incorporates H.V. supply, preamplifier and amplifier for direct connection of scintillation detectors
- Chaining facility for multiple operations
- Activity Profile Mode for Activity/time studies
- Composite video output for driving remote large screen television monitors and video printers
- Simplified operation using keypad entry
- Clear visual indication of spectral data and operating parameters
- Modular hardware system
- Serial interface for spectral data output and input
- Real time, live time and count limit controlled acquisition
- Integration over selected region of interest
- Dead time indication
- Good differential and integral linearity
- 256, 512, 1024 channel groups
- Data manipulation between groups
- Peripheral range includes video printer, serial printer, digital cassette recorder and host microprinter for spectral data analysis
- Small and compact

CC 1083

For comprehensive details, use the coupon and we'll send you a Free copy of our PHA1 brochure.

Name __________

Company __________

Address __________

Nuclear Enterprises
A THORN EMI company

Nuclear Enterprises Limited
Bath Road, Beenham, Berkshire, England RG7 5PR
Telephone: Woolhampton (073 521) 2121 Telex: 848475

Sighthill, Edinburgh, Scotland EH11 4BY Telephone: 031-443 4060 Telex: 72333

THORN EMI

XP2008 and XP2012 contribute in UA1 and UA2 $\bar{p}p$ CERN experiments with

A complete range of modern PMTs for industry and physics							
PMT	cathode		number of stages	stability		pulse linearity (mA)	resolution ^{137}Cs (%)
	∅ (mm)	type		16h/0,3μA (%)	1-0,1μA (%)		
XP2008	32	super A	10	1	1	200	8
XP2012	32	bialkali	10	1	1	200	7,2
XP2202	44	bialkali	10	1	1	200	7,4
XP2212	44	bialkali	12	1	1	250	7,5
XP2030	70	bialkali	10VB	0,5	0,8	40*)	7,2
XP2050	110	bialkali	10VB	1	1	40*)	7,5

*) with a specially tailored bleeder

Stability
Linearity
BBQity
Consistency
Resolution
Economy

Matching the BBQ emission spectrum (BBQity), these PMTs meet the most critical parameter for system resolution: GAIN STABILITY.

We've set the standard for over 20 years

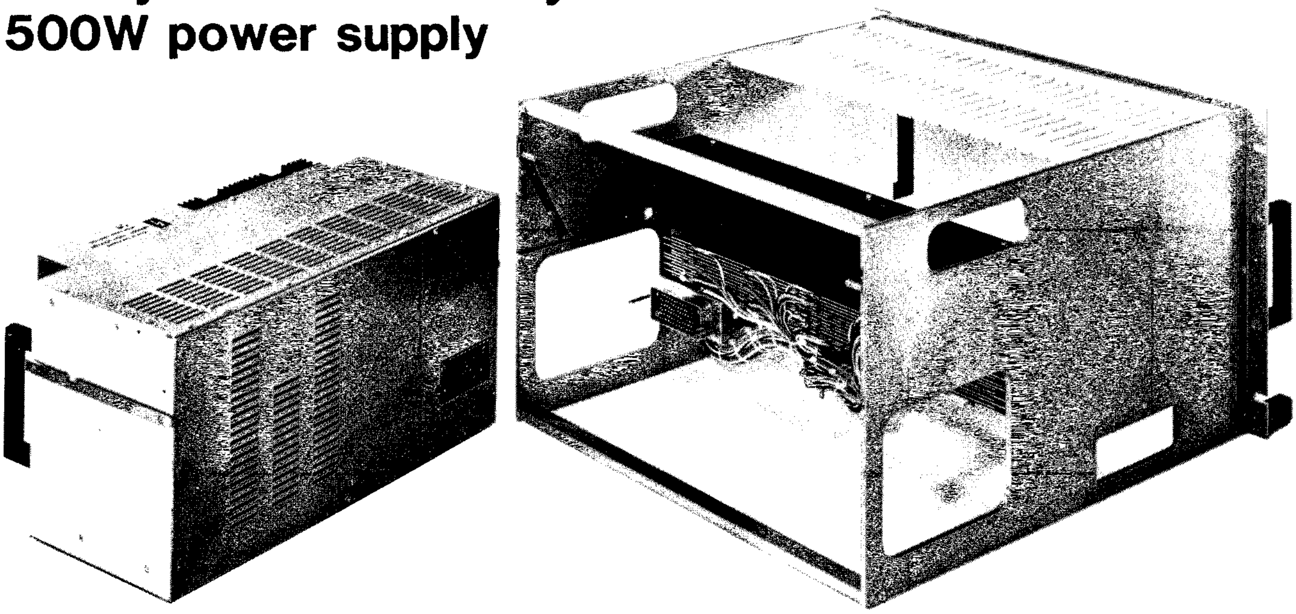
Philips Industries,
Electronic Components
and Materials Division,
Eindhoven, The Netherlands

PHILIPS Electronic Components and Materials

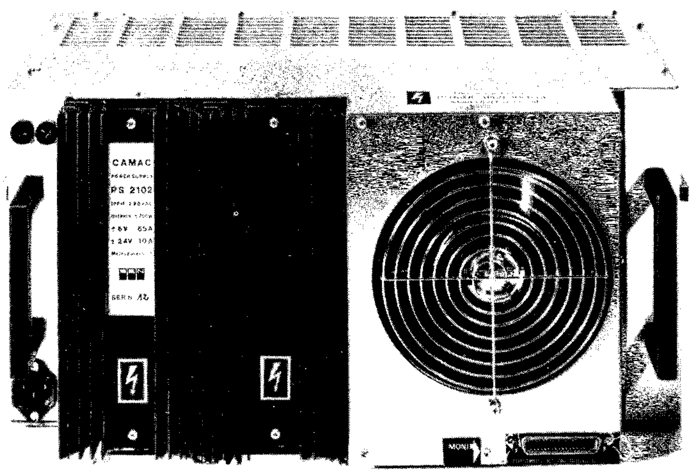
PHILIPS

CAMAC 750 - 1000W
SWITCHING POWER SUPPLY

Now you can remove your 500W power supply



And plug in 750 - 1000W of switching regulated power with reduced heat dissipation



SPECIFICATIONS:

DC Outputs	Power Requirements
+6V (+5.2V) 65A	220 VAC ±10%
-6V (-5.2V) 65A	at 50Hz
+24V 10A	
-24V 10A	

* Adjustable 6V and 24V Outputs
* Stabilized and Meter Monitored
* PARD 50 mVpp
* Hold Time: 10 ms with Power Failure Signal
* All Outputs Protected Against Short-circuit by Means of Trip-off Circuit
* Thermal Switch for Overheating Protection
* Now in Final Stage of CERN Compliance Tests

SEN ELECTRONICS S.A.

SEN ELECTRONIQUE

Avenue Ernest-Pictet 31; Tel. (022) 44 29 40 – Tlx 23 359ch – CH-1211 GENÈVE 13

FASTBUS
for Data Acquisition

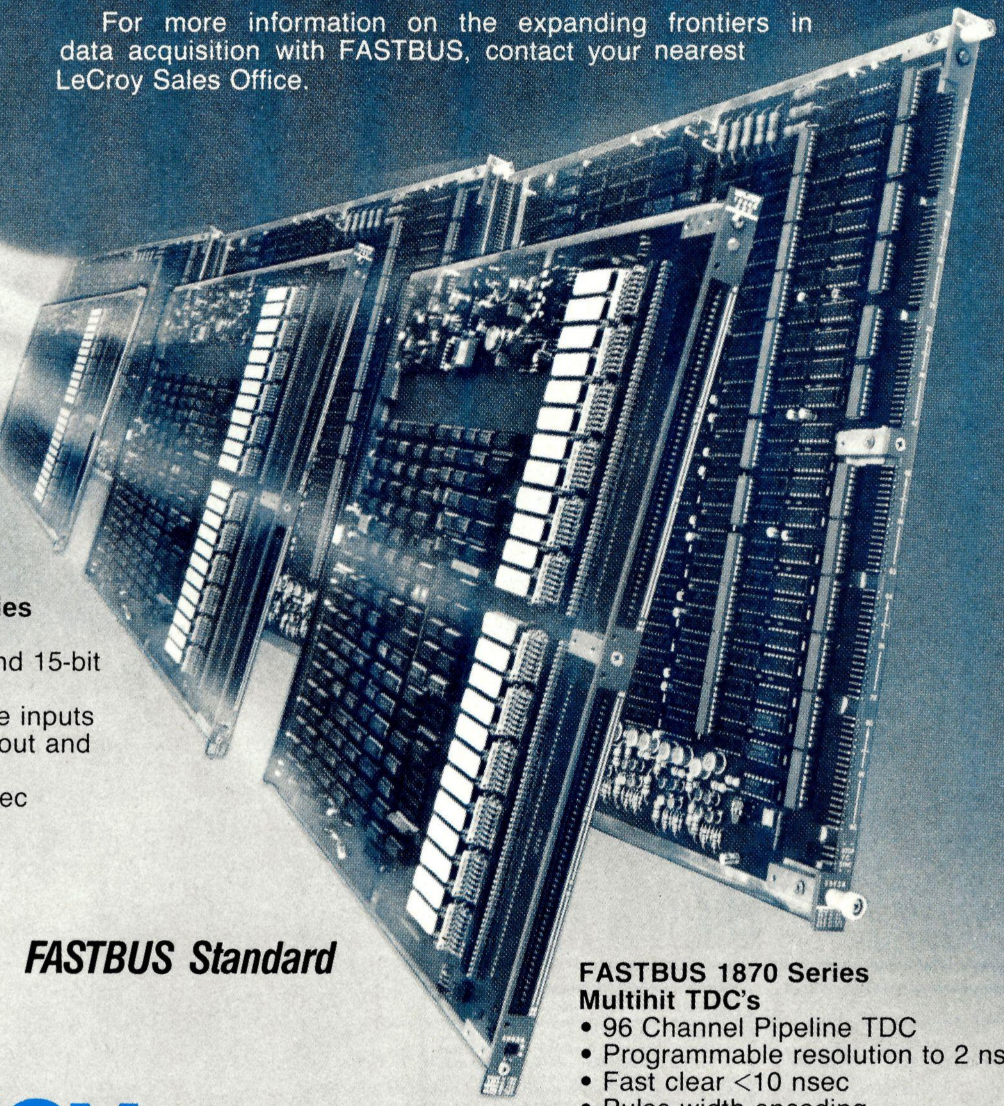
New, sophisticated and available

Data acquisition in FASTBUS using LeCroy's 1800 Series modules and our system integration approach offers new advantages through frontier technology. Sophisticated multiple master architecture permits computer networking, distributed intelligence, multi-tiered decision making, and system monitoring. It uses a 32-bit wide data field providing operations easily 20 times faster than CAMAC.

The 1870 Series 96 Channel TDC's employ high speed SOS shift register IC's and the 1880 Series ADC's use QMUX, a special integrated circuit. These custom components result in easy to understand electronics, excellent linearity, high interchannel isolation, and more.

Our expanding line of FASTBUS modules features unprecedented channel multiplicity, self-test and -calibration, convenient trigger processor connections, and rapid conversion and readout.

For more information on the expanding frontiers in data acquisition with FASTBUS, contact your nearest LeCroy Sales Office.



FASTBUS 1880 Series
Event ADC's
- 96 Channels, 12 and 15-bit operation
- Negative or positive inputs
- Simultaneous readout and conversion
- Fast clear <500 nsec
- Automated testing

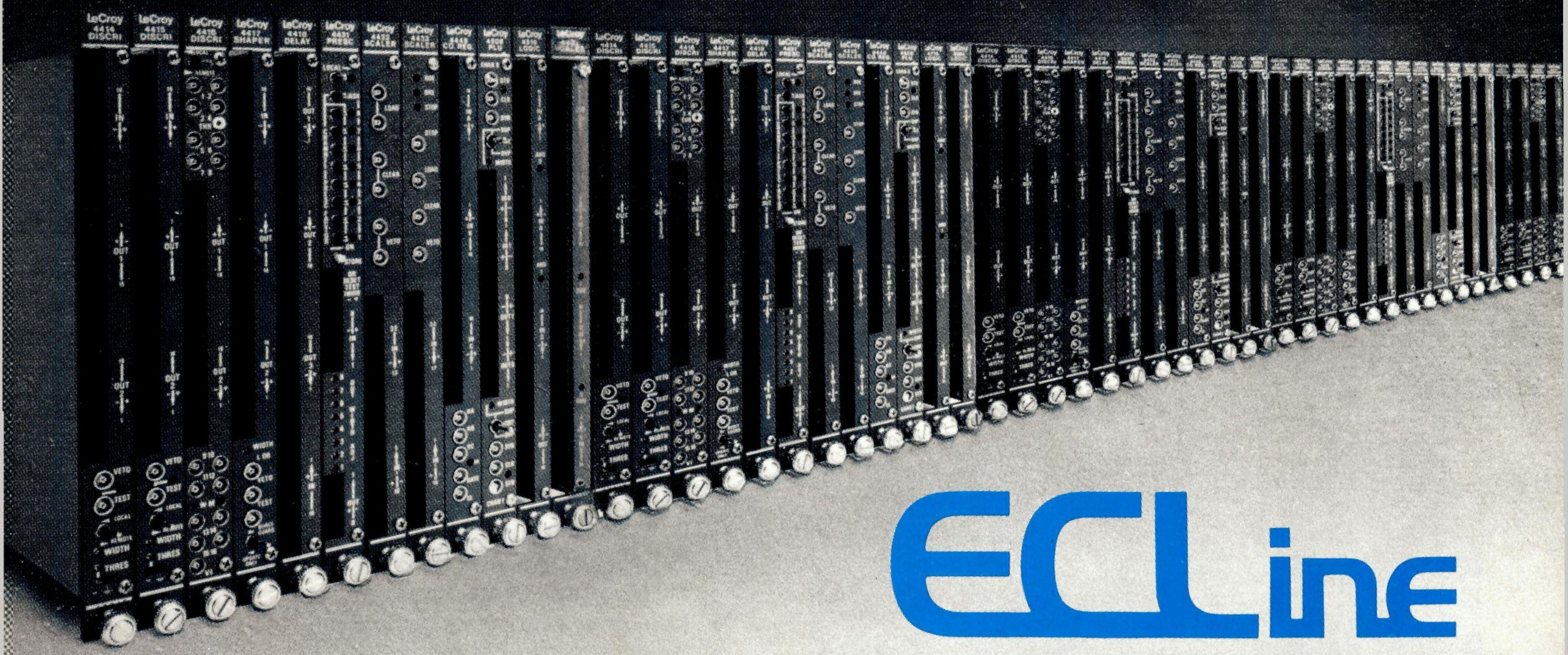
FASTBUS Standard

FASTBUS 1870 Series
Multihit TDC's
- 96 Channel Pipeline TDC
- Programmable resolution to 2 nsec/count
- Fast clear <10 nsec
- Pulse width encoding
- Trigger Processor connection

LeCroy

700 S. Main St., Spring Valley, N.Y. 10977, (914) 425-2000; Livermore, California, (415) 449-5994; Geneva, Switzerland, (022) 82 33 55; Heidelberg, West Germany, (06221) 28192; Les Ulis, France, (6) 907.38.97; Rome, Italy, (396) 320-0646; Botley, Oxford, England, (0865) 72 72 75. Representatives throughout the world.

A Rapidly Growing Line of Fast Pulse Instrumentation



ECLine

The new generation of high energy physics experiments, involving extremely high counting rates and/or large detector arrays, requires a "total system" approach to instrumentation. LeCroy's new CAMAC Series of ultra-fast, high-density programmable instrumentation modules provides the solution to this requirement by allowing the experimenter to achieve full computer control of the data acquisition system within a single instrumentation standard.

Model 2229: Octal ECLine TDC
- 8 Channels
- Resolution to 50 psec/11-bits
- Fast clear to 500 μsec

Model 2365: Octal Logic Matrix
- 16 inputs, 8 outputs, 100 MHz
- Each output represents any AND/OR combination of inputs or complements
- CAMAC programmable and readable
- Battery backup/continuous memory

Model 2372: 64 K Memory Lookup
- 12-in/16-out to 16-in/12-out
- 80 nsec maximum delay time
- Pipeline and dc logic modes
- Battery backup/continuous memory

Model 2374: Data Stack Module
- 2 Ports—simultaneous read/write
- Self-sequencing, sequential read mode
- Trigger Processing

New

Model 4302: Triple Port Fast Memory
- 16 K × 16-bit words
- 100 nsec write time via front panel ECL port

New

Model 4415: 16 Ch Discriminator
- 50 MHz, 30 mV min. threshold
- Channel masking
- Veto and test inputs

Model 4416B: 16 Ch Discriminator
- 150 MHz, 15 mV min. threshold
- Channel masking
- Veto and test inputs

New

Model 4417B: 16 Ch Shaper
- 150 MHz, 30 mV min. threshold
- OR output
- Veto and test inputs

New

Model 4418: 16 Ch Programmable Delay
- 3 Delay ranges: 16, 32, 128 nsec
- 4-bit CAMAC programming
- Fan-out of 3 per channel
- 100 MHz and 30 MHz max.
- Power off memory

Model 4431: 8 Ch Prescaler
- 4-bit, 140 MHz maximum
- CAMAC and manual operation
- OR output
- Test, inhibit, channel masking

Model 4433: 16/32 Ch Latching Scaler
- 32 or 16 bits, 30 MHz
- Sequential or addressed readout
- Auxiliary bus for external memory

New

Model 4434: 32 Ch Latching Scaler
- 24 bits, 20 MHz
- Sequential or addressed readout
- Auxiliary bus for external memory

New

Model 4448: 48 Ch Coincidence Register
- 48 Inputs
- Analog sum outputs
- Fast clear

Model 4504: 4 Ch Flash ADC
- 100 MHz, 4 bits plus overflow
- Front panel fast data outputs
- External strobe or free running

Model 4508: Programmable Logic Unit
- 2 × 8 inputs/8 outputs
- Provides any logic/arithmetic function
- 65 MHz, constant delay
- Input pattern readable

Model 4516: 16 Ch Logic Unit
- 16 × 3 input AND/OR logic
- OR output, veto input
- CAMAC programming, 150 MHz

Model 4532: 32 Ch Majority Logic Unit
- 100 MHz, overlap or latching
- External or internal gate
- Analog and cluster option

Model 4564: 16 to 64-Fold Logic Unit
- 64 Inputs/16 outputs
- 4 × 16, 2 × 32, 1 × 64 OR outputs
- Several AND combinations
- 140 MHz, constant delay

Model 4616: ECL/NIM/ECL Converter
- 16 Channel NIM module, 150 MHz
- Bi-directional: ECL to NIM/NIM to ECL
- Fan-out of three on NIM outputs

For details call or write your nearest LeCroy Sales Office.

Rue Cardinal-Journet 27, 1217 Meyrin 1-Geneva, Switzerland, 82 33 55. Offices: USA, (914) 425-2000; Heidelberg, W. Germany, (06221) 28192; Les Ulis, France, (6) 907.38.97; Botley, Oxford, England, (0865) 72 72 75. Representatives throughout the world.

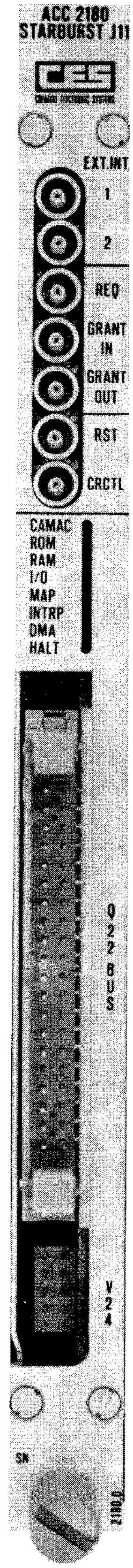
LeCroy

Creative Electronic Systems SA

Do you need the smartest ACC processor?
faster than a bit- slice processor?
running any PDP-11 standard software?

..then consider the new front-end processor from CES.

Super ACC 2180 Family



* CPU card providing:
  - 16/32-bit, 200ns-cycle DEC J-11
  - 64k 16-bit dual-port memory
  - RS 232C interface
  - Auxiliary Crate Controller logic
  - mixed EPROM/static RAM configuration
  - interval timer

* front- panel Q bus provides for extension cards eg.
  - coprocessors
  - crate controllers
  - memory extensions

* extensive use of CMOS technology for low-power requirements

The ACC 2180 is a single board CAMAC module built around Digital Equipment's latest 16/32-bit microprocessor, the J-11. This microprocessor is the most advanced in the PDP range; it's principal features are :

- PDP 11/70 performance
- multiplexed data and address buses with a 32-bit internal data path
- on-chip memory managment to address up to 4 Mbytes memory
- full PDP-11 instruction set
- 46 floating-point instructions,standard feature
- extended instruction set,standard feature

The memory bank is a full dual-port memory, i.e. it can be accessed independantly from CAMAC or from the CPU.The structure is such that the 64 K-16Bit memory can be tailored to user's requirement by mixing EPROMS and RAMs. The CAMAC addresses are memory mapped to ensure software compatibility with existing systems and for maximum throughput. The memory, CAMAC, peripherals and other resources are controlled by a PAL-based logic to ensure the fastest response time. This solution also renders the system extremely easy to "tune".

This processor is particularly suited to applications where formerly a host processor was required,such as floating-point data manipulation, or where previously only bit-slice processors have been fast enough.

The microprocessor bus is accessible on the unit's front-panel in Q22-bus form, providing easy connection of additional cards, such as peripheral controllers, memory extension cards, attached processors, etc.

The most important feature is that any PDP software can be executed in the ACC 2180 so long as it can be loaded into the ACC 2180's memory. The memory size and its flexibility in EPROM/RAM partitions renders the system extremely versatile. The unit can be used either as a runtime system without needing any additional system device, such as under MRRT-11 or RSX-11S, or as a development system with system devices attached to the Q-bus output, under RT-11, RSX-11M, RSX-11M+, etc. Application programs may be written in any DEC-supported language including the latest real-time concurrent micro-power PASCAL.

At CES, tomorrow's systems are available NOW

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

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

Belgium:	Canberra Positronika	Tel:(54)321611	Netherlands:	Canberra Positronika	Tel:(040)416355
North America:	Klotz Eng. Vancouver	Tel:(604)4647401	Japan:	Toyo Corp.	Tel:(03)2790771
France:	AB+B	Tel:(76)905540	North Germany:	PCP	Tel:(040)802046
South Germany:	Silena	Tel:(060)554021			

EIMAC's 4CW300,000G Power Tetrode. A new generation of high-performance power tubes.

EIMAC's 4CW300,000G combines all the desired features transmitter designers look for: high peak plate current, low grid emission, low internal capacitances and low internal inductance. This is the first of a new generation of high performance power tubes for LF, HF, VHF and pulse service.

Laserfab pyrolytic graphite grids

The control grid and screen structures of the 4CW300,000G are precision-cut by a laser beam. Each element is monolithic and combines extremely low coefficient of expansion with low structural inductance. These features permit the 4CW300,000G to have a very high transconductance—10^6 micromhos—and allow efficient, high-frequency operation.

Rugged mesh filament

The EIMAC mesh filament provides exceptionally high peak plate current and permits low plate voltage operation. This leads to power supply economy, making the 4CW300,000G the economic choice for 300 KW AM broadcast service or long-pulse switch service, each of which demands a reserve of peak emission.

Improved anode structure

EIMAC's multi-phase cooling technique provides high plate dissipation to extract heat evenly and quickly from the anode, contributing to long tube life and operating economy.

EIMAC expertise

EIMAC's expertise in electron ballistics pyrolytic grid production, thermodynamics and circuit techniques combine to bring tomorrow's tubes for today's transmitter designs. More information is available from Varian EIMAC. Or the nearest Varian Electron Device Group sales office.

Electron Device Group
Varian EIMAC
Application Engineering
Department
301 Industrial Way
San Carlos, CA 94070
Telephone: 415•592-1221, ext. 218

Varian AG
Steinhauserstrasse
CH-6300 Zug, Switzerland
Telephone: (042) 23 25 75
Telex: 78 841

varian