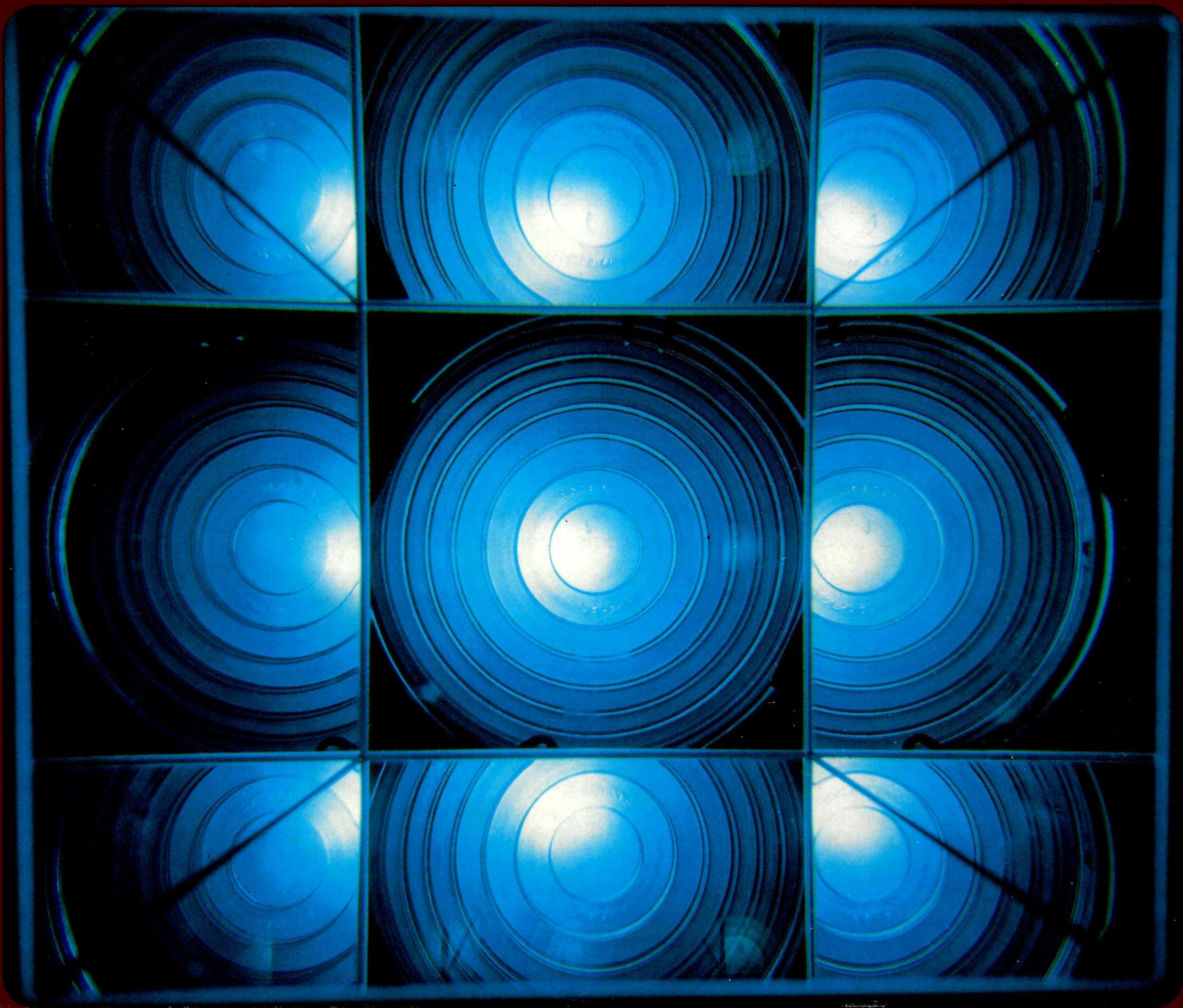
CERN COURIER

International Journal of High Energy Physics



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CERN COURIER

International Journal of the High Energy Physics Community

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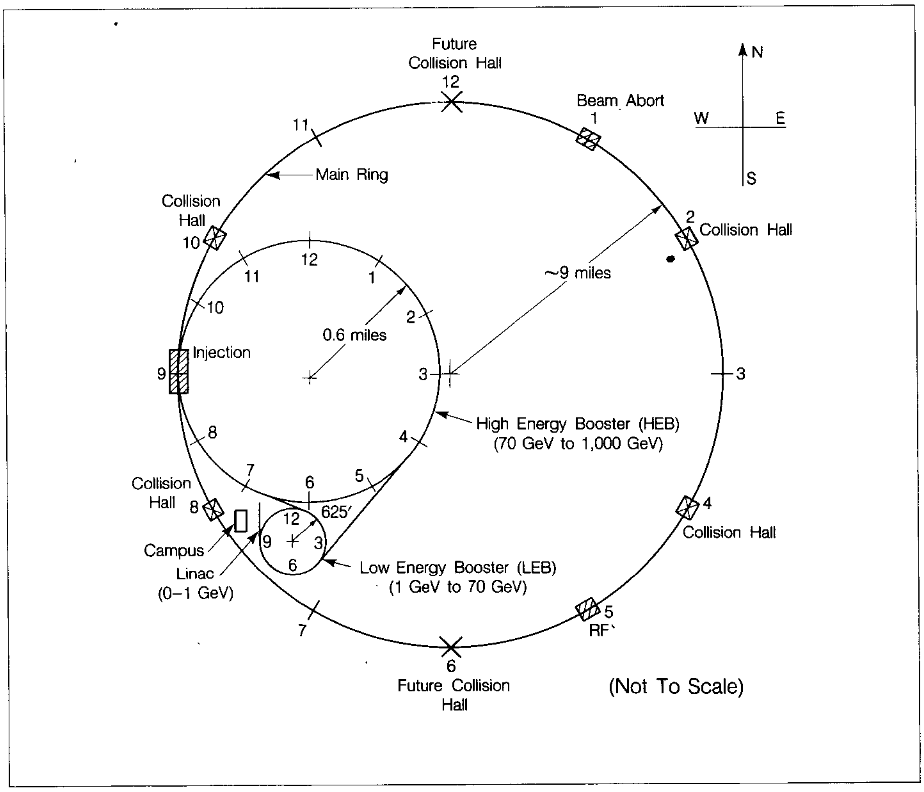
Cover photograph: Images in lead glass, captured by CERN photographer Gilbert Cachin (Photo CERN X908.5.84).

Supercollider — USA machine for the future

The envisaged principal features (not to scale) of the proposed US Superconducting Super Collider (SSC).



In the summer of 1983, the US high energy physics community, via its representatives on the High Energy Physics Advisory Panel (HEPAP), took the important decision to place its eggs, for the next stage of this field of research in the USA, in the single basket of a Superconducting Super Collider (usually abbreviated as SSC). The aim is to enter the TeV range of physics phenomena by colliding protons at beam energies up to 20 TeV.

The decision was difficult. It involved abandoning the Colliding Beam Accelerator project at Brookhaven, which was by then well underway. It required faith in the physics potential of colliding hadron beams (the alternative of colliding lepton beams is recognized to be some five years behind, in any case, in terms of technical feasibility). It implied full confidence that superconducting technology for accelerators is mastered. It also required faith that the US governmental authorities would rise to a basic research project of a scale and cost which has not been confronted before (the project implies a doubling of the US high energy physics budget over a period of time). Behind these acts of faith was the physics bonanza emerging from the CERN proton-antiproton Collider, the successes of Fermilab and Brookhaven with superconducting magnets and the pride of the American physics community, accustomed to being in the front line of this research, coupled with the resurgence of confidence in the country as a whole.

After the trauma of the initial decision, progress on the project has been fast. By summer 1984, a Reference Design Study, chartered by the Directors of the US high energy accelerator Laboratories, was presented to the Department of Energy (DOE). The Study aimed to clarify technical feasibility, to get some idea of the project cost, and to map out the research and development which will be needed to arrive at a final design.

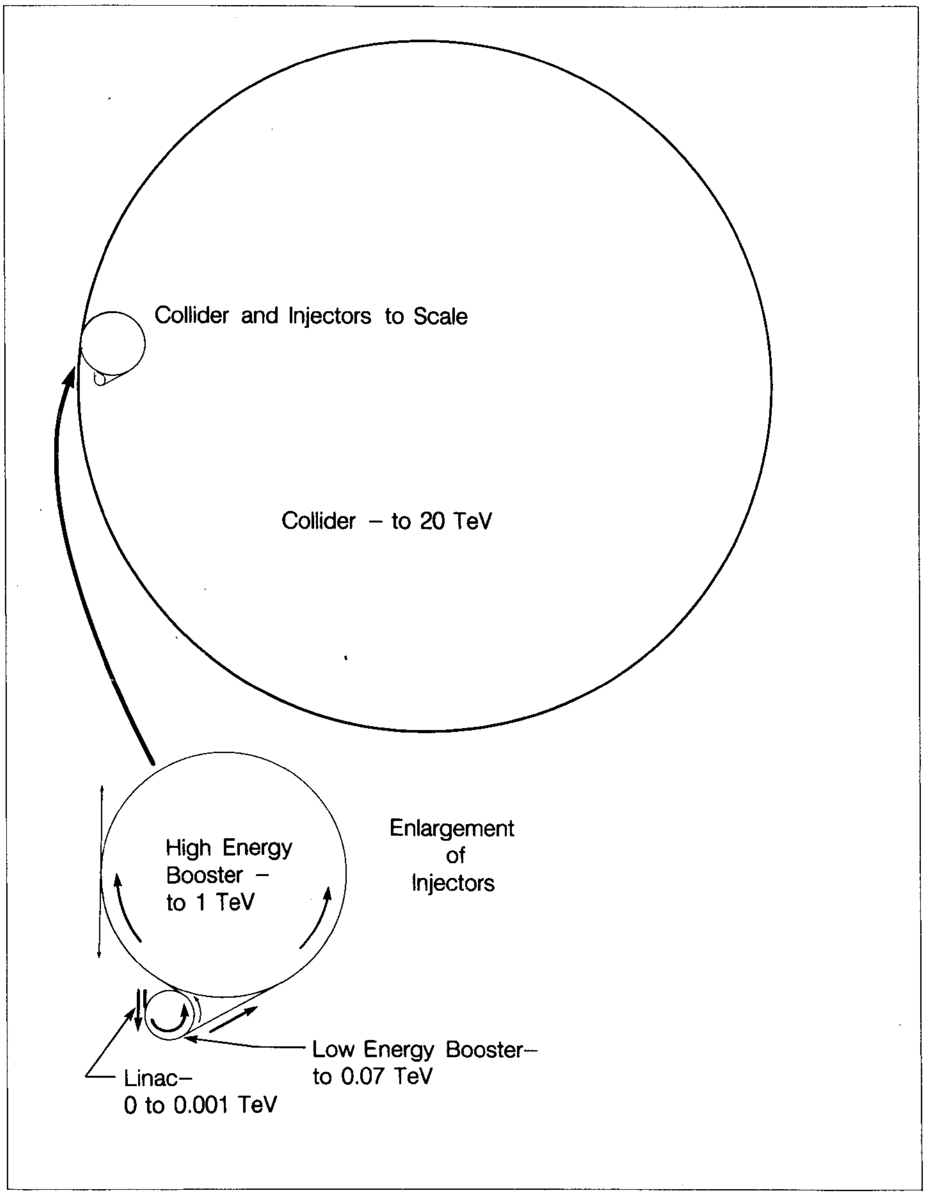
The DOE decided to proceed with research and development and selected the Universities Research Association, which operates Fermilab, as contractor for this phase of the project since the URA has the widest national representation. URA created a Board of Overseers with Boyce McDaniel as Chairman. A Central Design Group, led by Maury Tigner, is now housed at the Lawrence Berkeley Laboratory and work on various aspects of the design is underway at several other Laboratories also. The cost of the R and D phase is estimated at 250 million dollars (mainly for superconducting magnet development).

The Reference Design Study emerged with several major machine parameters agreed and with three approaches to achieve these parameters listed for further study. The maximum beam energy is set at 20 TeV with a maximum luminosity of 10^{33} per cm^2 per s to give up to 10 interactions per bunch crossing at six interaction regions (only four of which might be used initially). The injection energy is set at 1 TeV. Obvious options, such as the possibility of having electron-proton collisions or of having external beams, have been examined, but the emphasis in defining the project has been to concentrate on colliding proton beams and to avoid diluting the development programme with secondary objectives (though they remain under consideration).

The three approaches are associated essentially with the choice of the superconducting magnet. At Brookhaven and Berkeley the highest field magnets, 6.5 T, corresponding to a machine circumference of 90 km, are under development. They are of the 'two-in-one' (two beam channels in one magnet core), cold iron (magnets completely enclosed in cryostats) type. Successful tests on prototypes were reported in the December 1984 issue, page 430. At Fermilab the emphasis is on magnets based on the successful superconducting magnets installed in the Tevatron. They have a field of 5 T corresponding to a machine circumference of 113 km. The Fermilab team is trying new high-homogeneity niobium-titanium superconductor which has 50 per cent better short-sample characteristics. In Texas, development is concentrating on low field magnets in the hope of easing the problems of cheap mass-production. The magnet field is set at 3 T, corresponding to a machine circumference of 164 km. Magnet prototypes have been built and successfully tested at the Texas Accelerator Centre. Higher magnet fields even than the 6.5 T type are, of course, potentially available by the use of niobium-tin rather than niobium-titanium and work continues on this possibility at Brookhaven and Berkeley. However this technology is not developed enough at present to be a serious contender.

To arrive at a tentative cost estimate, the three possible machine configurations were fed on to an imaginary site (so as to steer well clear at this stage of the tricky problem of site selection). All three approaches gave essentially the same cost for the machine — in the region of 3 Gigadollars. Frightening though this figure may seem, it represents another advance in collision energy per dollar which has improved by five orders of magnitude since the early accelerators.

A possible SSC injection scheme.



The whole of the US high energy physics community is involved in the shaping of the project. In June-July 1984 a Summer Study was held at Snowmass in Colorado on the 'Design and Utilization of the Supercollider' attracting some 250 participants — experimentalists, theorists, and accelerator specialists. It was the latest in a series of meetings and workshops on collider-related topics such as electroweak symmetry breaking, a fixed target option, and a proton-antiproton option. The discussions covered the physics, the detectors and the accelerator design.

Groups covered such physics topics as jets, structure functions, rare decays, the electroweak sector, new theories, etc. It was clear that there is a wealth of intriguing physics to be studied, but a lot of initial simulation studies are required to achieve optimum use of the new facility. The simulation packages now on the market give some very different answers, and some initial tidying up is needed.

Groups looked at components for vertex detection, lepton identification, calorimetry, electronics, and computing, while others looked at detector design. To keep in touch with reality, a rough cost estimate was requested for each detector. One important conclusion was that detectors could be built and operated for the Supercollider with luminosities up in the 10^{33} range, with the exception of vertex detectors, where new technology is called for to avoid radiation damage problems. Calorimetry should not be affected by the high luminosity and these will probably be the most important parts of the SSC detectors.

Specialized detector ideas were developed for specific topics, while wide solid angle detectors were envisaged as general-purpose devices with the emphasis on new physics. Of the three which were eventually proposed and costed, one was non-magnetic, one was a conventional magnetic design and the third was magnetic with scintillating fibres.

Timescale from first serious discussion to final installation is estimated at about eight years, and each detector could involve some 500 physicists. It looks as if about 600 million dollars will be required overall for detector development and construction, and the necessary computer power will also be large.

The accelerator specialists looked at interaction region layout and design, electron, fixed target and antiproton options, dynamic aperture and tracking, magnetic field quality and the injector. Here again the conclusion was that a lot of computer simulation work, with Tevatron measurements as benchmarks, must be carried out before the final design is selected. Beam extraction options studied included stochastic type extraction as well as more esoteric ideas such as the use of bent crystals to filter out primary protons or other secondary beams from the proton-proton collisions in the experimental areas.

The hope is to have the conceptual design of the Superconducting Supercollider in place for April 1986. The problem of site selection is the subject of a document to be submitted to the US Department of Energy in April. Actual construction would then start in October 1987 with first beams scheduled for 1993. It is a project of great vision being attacked with courage and enthusiasm. It would open a new region of physics where the theoreticians promise much.

(We thank Jorge Morfin for information on the Snowmass meeting.)

Physics in a spin

Organizing committee chairman Jaques Soffer (right) talks with André Martin of CERN during the recent Spin Physics Symposium at Marseille.

(Photo H. Ely-Aix)

Observers at major particle physics meetings these days could easily come away with the impression that our understanding of Nature is in good shape. With the electroweak theory now established and with the picture of quark fields (quantum chromodynamics) well advanced, it seems sometimes that all that remains to be done is to explain the origin of the Universe.

This is surely an oversimplifica-

Other applications of spin at Marseille: below, 1957 Nobel prizewinner Owen Chamberlain and, opposite, Jon Rosner of Chicago try their hand at 'petanque'.

(Photos: Mairie de Cassis)

tion. There are many questions in conventional physics still to be solved, and until these are, our understanding must be regarded as suspect. Many of these outstanding questions are in the area of spin physics.

About two hundred physicists travelled to Marseille in September to attend the 6th International Symposium on High Energy Spin Physics; this series began at Argonne in 1974, and the previous symposium was held at Brookhaven in 1982. Under the chairmanship of J. Soffer (Marseille) and a distinguished International Advisory Committee, the Symposium gathered specialists in polarization physics from all over the world. The meeting reflected optimism about the future of spin physics, an optimism clearly driven by the successful start-up of many new polarized beam projects and by the discovery of several new spin effects.

The topics covered included spin effects at large transverse momentum, hyperon polarization, analysing power in elastic processes, and experiments at intermediate energies including dibaryon resonances. There were reports on new polarized beam developments at many Laboratories and on perspectives, plans, and theoretical predictions for the spin physics in future machines.

One highlight was the report of successful acceleration of polarized protons to 17 GeV at the Brookhaven AGS. Both this project and the discovery of a large and totally unexpected one-spin effect in high transverse momentum proton-proton elastic scattering at the AGS were covered by Alan Krisch (Michigan) — see October 1984 issue, page 328. J. L. Laclare (Saclay) presented a short movie on spin motion at Saturne in his review talk on the polarized proton capabilities and experimental programme at Saturne II. New results and future projects with polarized beams and targets at KEK (Japan) were discussed by A. Masaike, and L. Van Rossum (Saclay) presented the Fermilab project.

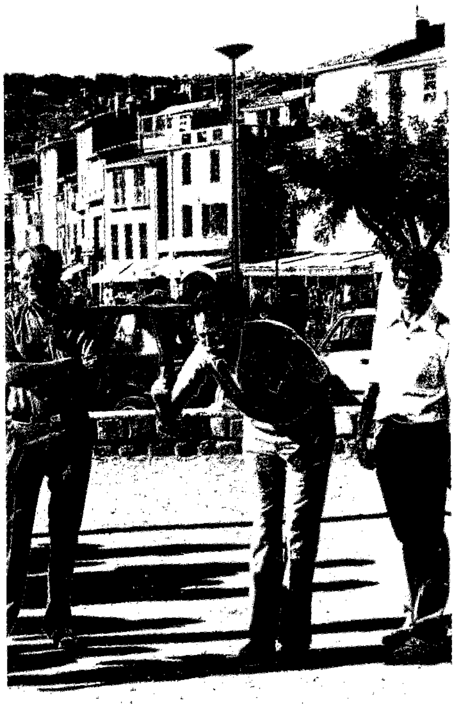
One major highlight was the sharp increase in the electron community's interest in spin. This is especially evident at DESY which was well represented at the Symposium. V. Soergel and K. Steffan presented detailed plans for polarizing the electrons at the HERA electron-proton collider, now under construction. P. Schmuser and D. Barber discussed the many exciting and important experiments that will be done with these polarized electrons. Many participants, led by E. Courant (Brookhaven) and O. Chamberlain (Berkeley) also stressed the need for proton polarization at HERA.

Significant progress on obtaining polarized gas jets was reported by D. Kleppner (MIT). He discussed the CERN projects and the Michigan/MIT/Brookhaven project. Hopefully there will soon be 'junk-free' pure polarized proton gas jets to allow inclusive spin studies.

G. M. Bunce (Brookhaven) reported on a new AGS experiment which aims to study several two-body processes at high energy and large angles. He presented the striking spin alignment properties of the rho meson produced in pion-proton scattering; these results are difficult to interpret theoretically and might be a serious signal of non-perturbative phenomena as suggested by G. Nardulli (Bari) and in the talk by G. Preparata (Bari) who presented an alternative approach based on the Massive Quark Model.

K. Heller (Minnesota) gave an extensive review of lambda and hyperon polarization in hadron-hadron inclusive reactions at high energy; a number of known results have consolidated such as the strong polarization of all the hyperons except the antilambda. Other new results were discussed such as the measurement of a large fraction of lambdas produced in the sigma radiative decay at Brookhaven or the dilution of the lambda polarization by nuclear targets. The large lambda polarization, first observed in 1976 at Fermilab, still lacks a convincing theoretical interpretation.

E. Gabathuler (Liverpool) discussed the new experiment of the European Muon Collaboration at CERN with a polarized muon beam and a polarized proton target. The aim of the EMC experiment is to investigate spin-dependent effects



in deep inelastic scattering to test theoretical predictions, to understand the spin structure of the proton, and look for a possible polarization of the 'sea' of additional gluons and quark-antiquark pairs inside the nucleons.

Spin effects, especially at short distances, provide demanding tests for quantum chromodynamics. In particular, the 'perturbative' approach (taking into account only the lowest terms in a series expansion) seems insufficient. Theoretical approaches have been suggested to get over this hurdle, and in addition other mechanisms have been put forward. These ideas were the subject of many presentations at Marseille.

Heavy quark spectroscopy was considered from a theoretical perspective by J. Rosner (Chicago) who also gave an extensive review of the present status of magnetic moments and the spin-dependent potentials among quarks.

A theoretical summary was given by E. Leader (Birkbeck College, London) who discussed the importance of measuring spin-dependent nucleon structure, relevant both for present machines and for future ones, such as HERA, which will probe very deep inside the proton. Leader also stressed the apparent incompatibility of perturbative QCD with the newly discovered spin-dependence in proton-proton elastic scattering. There was extensive heated theoretical discussion on this subject with most experimentalists keeping their heads well down.

One important part of the programme was devoted to spin phenomena at intermediate energies. Contributions from Laboratories all over the world were presented in a workshop jointly organized by C. Lechanoine-Leluc (Geneva) and R. Silbar (Los Alamos). A detailed study of proton-antiproton scattering is made at the LEAR ring at CERN and at KEK in Japan, where a narrow resonance was observed in the charged kaon mode. Experiments at intermediate energies are now using excellent polarized proton beams and there are polarized neutron beams at Saturne produced from deuteron beams. The activity in proton-deuteron scattering with polarized particles was discussed by A. Boudard (Saturne). The nucleon-nucleon system is investigated in great detail and the precise measurements of various spin correlation parameters in proton-proton scattering can be compared to theoretical models. A new effort is being made both at SIN in Switzerland and at Saturne in neutron-proton scattering which is crucial to complete the picture. Measurements using a polarized deuterium target are now planned at SIN and TRIUMF in Canada with the hope of solving the present disagreements in pion-deuteron elastic scattering.

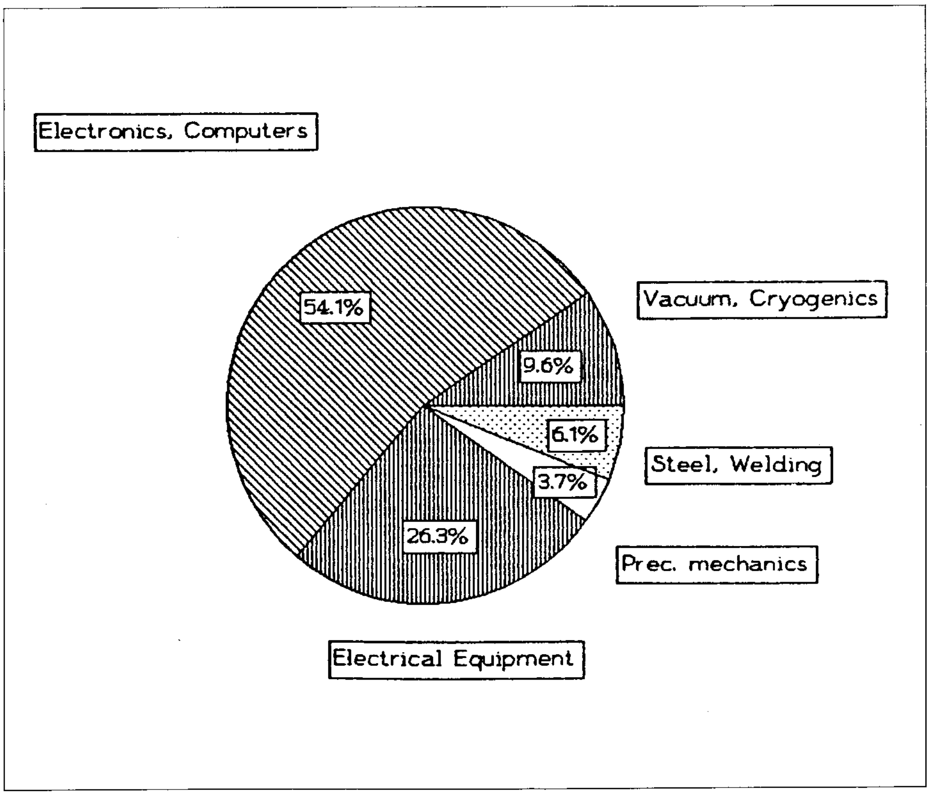
The future of spin physics was discussed in a round-table meeting that examined the possibilities offered by the CERN Collider and future machines. The participants —'Moderator' R. Cool (Rockefeller) with D. Cline (Wisconsin), E. Courant (Brookhaven), L. Evans (CERN), A. Martin (CERN), G. Sauvage (Orsay) and T. L. Trueman (Brookhaven) discussed the new windows that could be opened by having polarized beams in accelerators, existing, under construction or proposed. The physics with polarized beams and/or targets at these energies would allow deeper insights into the inner structure of the nucleons and the very clear signals of the underlying theory often achieved by polarization measurements could test new theories.

The Symposium closed with a talk by O. Chamberlain (Berkeley), who spoke about the early spin experiments in the fifties. These pioneering experiments, where Chamberlain played a prominent role, were the roots of the spin physics community. During the last thirty years this community has worked to successfully convince both itself and the physics community at large that spin is not a 'useless complication' and that many important aspects of particle physics can be best clarified by polarization experiments. Hopefully the next Symposium, to be held at Serpukhov in autumn 1986, will again give new exciting and unexpected spin physics results.

(Information from C. Lechanoine-Leluc, A. Krisch, G. Nardulli and J. Soffer.)

Economic spin-off from CERN

A survey of CERN's high technology suppliers shows that work for CERN produces valuable spin-off effects. This shows a breakdown of the 520-odd suppliers. In the largest category (Electronics and computers) every Swiss franc spent by CERN has generated over four francs of new business for the firms involved.



About ten years ago, a famous study by Helwig Schmied on the economic 'spin-off' resulting from CERN contracts revealed that every Swiss franc spent by CERN on high technology had produced about 3.5 francs of new business for the firm involved.

This is a useful bonus for a major European Laboratory whose basic objective remains, as always, pure scientific research. CERN's scientific achievements may well go on to revolutionize the 21st century in the same way that the technology of today is the direct result of the basic breakthroughs in electrodynamics by Faraday, Maxwell, Hertz and others about a hundred years ago. But this can never be proved, and these 19th-century researches certainly did not require multinational budgets.

Now a repeat of the initial survey on CERN's economic impact*, using more data and more sophisticated methods, essentially comes out with the same result for the period 1973-87. The results are based on interviews with a sample of 160 of CERN's 520-odd suppliers of high technology, who were asked to estimate the 'Secondary Economic Utility' (increased turnover plus cost savings) directly generated by CERN orders placed during the period 1973-82. The Economic Utility for the years 1983-87 is based on forecasts.

The total utility for the period 1973-87 amounts to 4800 million Swiss francs (1982 prices), while CERN's purchases from the firms involved in the period 1973-82 amount to 1380 million francs. Allowing for the continuing economic utility from orders placed before 1973, the survey clearly finds that one franc spent by CERN in the high technology sector has generated three useful francs for the suppliers.

Broadly, this high technology business can be grouped into five categories — Electronics, optics and computers; Electrical equipment; Vacuum, cryogenics and superconductivity; Steel and welding; Precision mechanics. The utility to sales ratio is especially impressive (4.2) in the first category.

All this concrete spin-off is especially remarkable when, unlike big research centres working on energy sources, communications, etc., CERN's end-product — scientific culture — has in itself little immediate practical application or economic relevance. How does CERN make such a big economic impact?

The major part of the equipment needed for CERN's research is beyond the manufacturing capabilities of CERN's workshops and has to be supplied by industry. Often the necessary specifications and requirements are beyond the 'know-how' currently available and present a challenge to the supplier. Once accomplished, this produces positive effects — quality improvements, increased productivity, new products, etc. Added to the fact that this is happening in an already rapidly expanding market, the results soon become evident.

Some examples. Without large orders, some high technology sectors are naturally reluctant to embark on substantial research and development programmes without an assured market. Thanks to CERN orders, European firms have been able to develop new products and widen their interests. There are other instances of new firms created essentially out of CERN requirements which have gone on to become highly successful in the export market. Equipment at CERN frequently sets new industry stand-

Around the Laboratories

ards or serves as a long-term testbed whose stringent criteria are widely recognized and respected. CERN business also stimulates inter-company collaboration and produces cost savings.

But the news is never all good. In one case, the rigorous technical requirements of CERN work made one company change its assembly line procedures. Later it was found that productivity fell! However such examples are very much the exception. The new study clearly shows that CERN continues to provide a powerful stimulus for European high technology industry.

* Economic Utility Resulting from CERN Contracts — a study by M. Bianchi-Streit, N. Blackburne, R. Budde, H. Reitz, B. Sagnell, H. Schmied and B. Schorr, available from CERN Publications, 1211 Geneva 23, Switzerland.

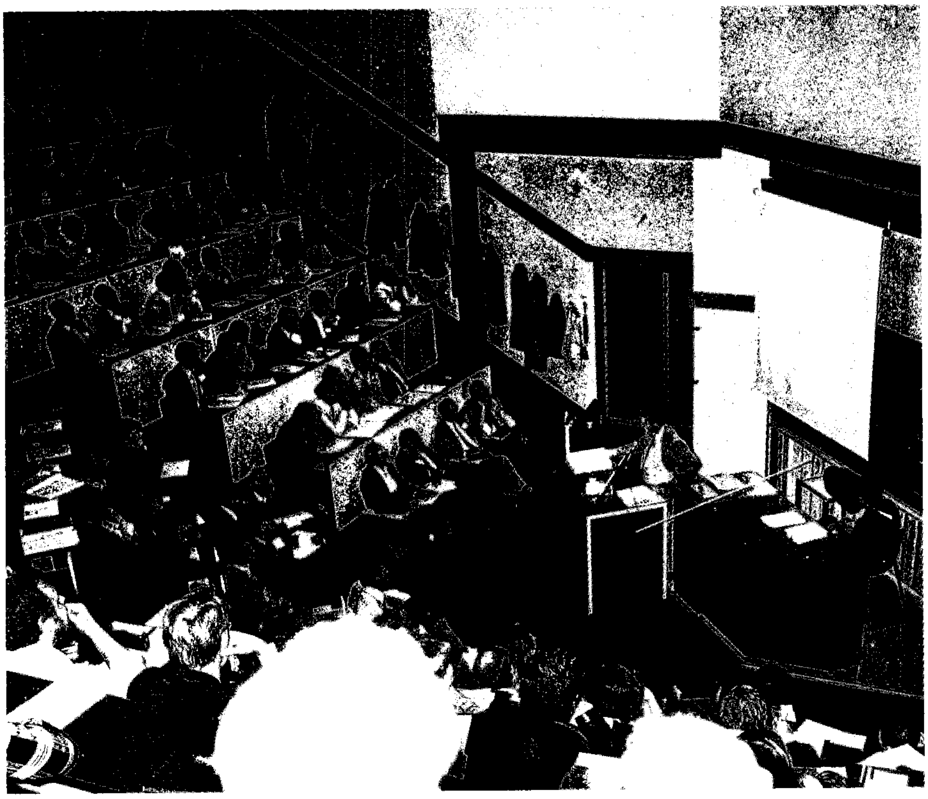
DESY
Experiments for new machine

From October 1 to 3 last year, about 280 physicists from many countries, including the US, met in Genoa to discuss experiments to be performed at the new HERA electron (30 GeV)-proton (820 GeV) collider being built at DESY in Hamburg and which should be ready for experiments in 1990.

The main auditorium of the brand new Institute of Physics of the University of Genoa was packed full for all sessions and some additional meetings took place in adjacent lecture rooms. The meeting was excellently organized by Alberto Santroni with the Genoa Section of the Istituto Nazionale di Fisica Nucleare INFN and by Peter von Handel at DESY. Sponsors were ECFA, the European Committee for Future Accelerators, and INFN.

Talks and discussions concentrated on physics, detector design and detector techniques, with particular emphasis on jet calorimetry. Also the new head-on collision scheme introduced recently for HERA was discussed in detail (see October 1984 issue, page 331).

Björn Wiik started the first session with a precise review of the present state of the construction work and of the planning for HERA. A summary of theoretical arguments was given in two invited talks by Roberto Peccei (who has just taken a position as senior scientist at DESY) and Guido Altarelli (Rome). Volker Soergel, chairman of the DESY Directorate, gave an introduction and later summarized the final results of the meet-



The main auditorium of the University of Genoa's Institute of Physics was filled to capacity during the recent meeting on experiments for the HERA electron-proton collider now being built at the DESY Laboratory in Hamburg.

(Photo INFN, Genoa)

ing. He repeated the schedule for letters of intent for experiments (June 1985) and proposals (March 1986). A final decision on at most three experimental facilities will be taken in June 1986 (see September 1984 issue, page 277).

Case studies for detectors were presented in Genoa by John Martin from Toronto, David Saxon (Rutherford), Horst Oberlack (Munich), Franz Eisele (DESY), Friedhelm Brasse (DESY) and Umberto Dosselli (Padua). Carlo Rubbia (CERN/Harvard) showed how the now famous UA1 detector from CERN could be re-assembled (and modernized) to be used for the asymmetric electron-proton collisions at HERA. There were interesting contributions by David Cline (Wisconsin) on the use of a thin superconducting shield (against magnetic fields) around the beam pipe and by Ugo Gastaldi (CERN) on a spiral projection chamber which can be easily used as a central detector with cylindrical symmetry and a minimum of material.

All detector ideas presented at Genoa made use of some type of calorimeter consisting of a sandwich of heavy material and readout planes. A full afternoon was specially devoted to this subject. The session was led by Bill Willis (CERN) who gave an introduction and overview of the principles and practice of calorimetry. Another interesting presentation was given by Peter Jenni (CERN) who generously shared with the audience much of the experience gained with the UA2 detector working on jets.

The energy of a jet should be measured as independently as possible of its development as a hadronic or electromagnetic shower. The use of uranium, as proposed about ten years ago by Bill Willis, seems still to be the best solution to this problem, due to the additional effect provided by the fission processes. This method has to contend with the high cost and the difficult handling of the uranium metal. Though these problems can be solved — depleted uranium (without 235) will be used — strict regulations will make life difficult. Therefore efforts are being made to use other materials like iron, copper or lead.

The read-out of the ionization can be done with several methods, like scintillators, gas chambers, liquid argon, some room temperature liquids and silicon detectors. These methods were discussed in several contributions by Bill Willis and Peter Jenni, by Wolfgang Walraff (Aachen), H. J. Meyer (Siegen), P. G. Rancoita (Milan), Hartwig Spitzer (Hamburg), Joachim Engler (Karlsruhe) and Carlo Rubbia. No method seems at present to be ideal and some recent developments, like cheaper silicon wafers, may yet change the situation before final decisions are taken for HERA experiments.

On the question of the layout of the intersection regions of HERA and on various types of background, the audience heard an excellent presentation of the experience with proton background from CERN's Intersecting Storage Rings and proton-antiproton Collider, given by Hans Hoffmann (CERN).

A subject of crucial importance for experiments at HERA is the geometry of the crossing beams with the new head-on collision scheme. The main problem is the separation of the two beams on both sides of the interaction region. From one of the required separating dipole magnets, synchrotron radiation from the electron beam would go into the experimental region with up to 25 kW power if a strong bending magnet is used. However even the few kW from a weaker magnet is still a problem. Acceptable designs seem to come up, as was explained by Reinhold Kose, a member of the DESY machine group, and by Wulfrin Bartel (DESY) from the experimental side. For 30 GeV electrons, care must also be taken to avoid high energy synchrotron radiation photons which can scatter in all directions from an absorber and reach the detector.

The separation of the beams in the head-on scheme will require the strong quadrupoles for the 820 GeV protons to be placed further away from the interaction points, which will somewhat reduce the luminosity of HERA.

These problems did not discourage the enthusiastic electron-proton physics community. There were a lot of offers to help building the accelerator, and solidarity between those working on the machine and those preparing experiments was reflected in many corridor discussions. The important information on particle structure and new insights into the understanding of the fundamental interactions, which everybody hopes to obtain from the new machine, amply justify the efforts being put into this ambitious enterprise.

CERN/ORSAY A section of collaboration

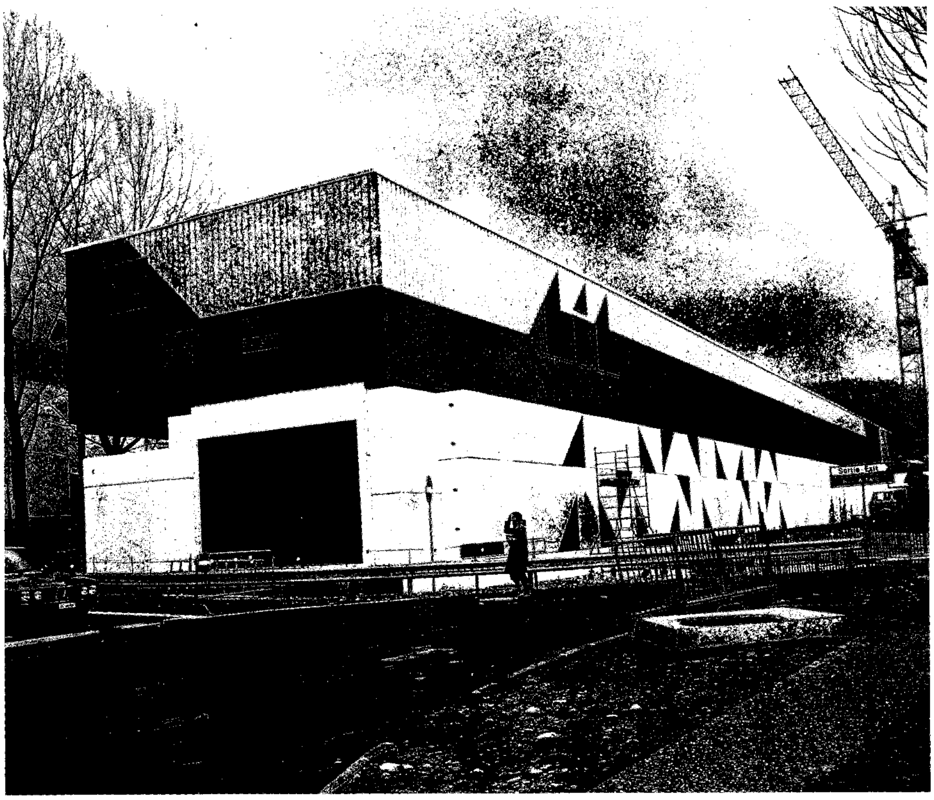
Just before Christmas, a lorry trundled through the CERN gates carrying the first of the twelve complete accelerating sections for the 600 MeV injector linac which will feed the giant LEP electron-positron collider now being built at CERN.

The 600 MeV linac will provide LEP's electron and positron beams, while a smaller machine upstream will furnish the 200 MeV high current electron beam for creating the positrons.

Under a special agreement between CERN and the Laboratoire de l'Accélérateur Linéaire (LAL) at Orsay, France, linac sections are assembled at LAL from components manufactured all over Europe. These manufacturers succeeded in meeting tight specifications in close collaboration with experts from CERN and LAL.

The new building to house the LEP Injector Linac (LIL) at CERN. Installation is now underway and first linac beam is scheduled for later this year.

(Photo CERN X536.2.84)



First LEP linac beam is scheduled for the autumn. Installation is starting of the Electron-Positron Accumulator for the linac beams, and first electron beams are scheduled to be injected into the 'Proton' Synchrotron in the summer of 1986.

CERN
Back from the North

With the first big experiments to be mounted in the West Experimental Area of the SPS 450 GeV Super Proton Synchrotron now having accomplished their mission (see December 1984 issue, page 431), the North Area, which came into operation in 1978, two years after the West Area, is also seeing some notable retirements.

After a distinguished career studying first lepton pair production and then direct photons, the NA3 experiment (a CERN/Collège de France/Ecole Polytechnique/Orsay/Pisa/Saclay collaboration) is packing up.

The experiment's first objective was the study of the production of muon pairs using different hadron projectiles — pions, kaons and antiprotons as well as protons from 150 to 400 GeV. Using heavy metal and liquid hydrogen targets, the produced dimuons were analysed in a large acceptance spectrometer which included a big superconducting magnet.

Away from sharp resonances which can decay into muon pairs (mainly the 3.1 GeV J/psi, but also the 9.7 GeV upsilon), the background lepton pair spectrum is dominated by the so-called 'Drell-Yan' mechanism — a quark and an antiquark from the colliding hadrons annihilate electromagnetically into a short-lived energetic photon, producing in turn a lepton pair.

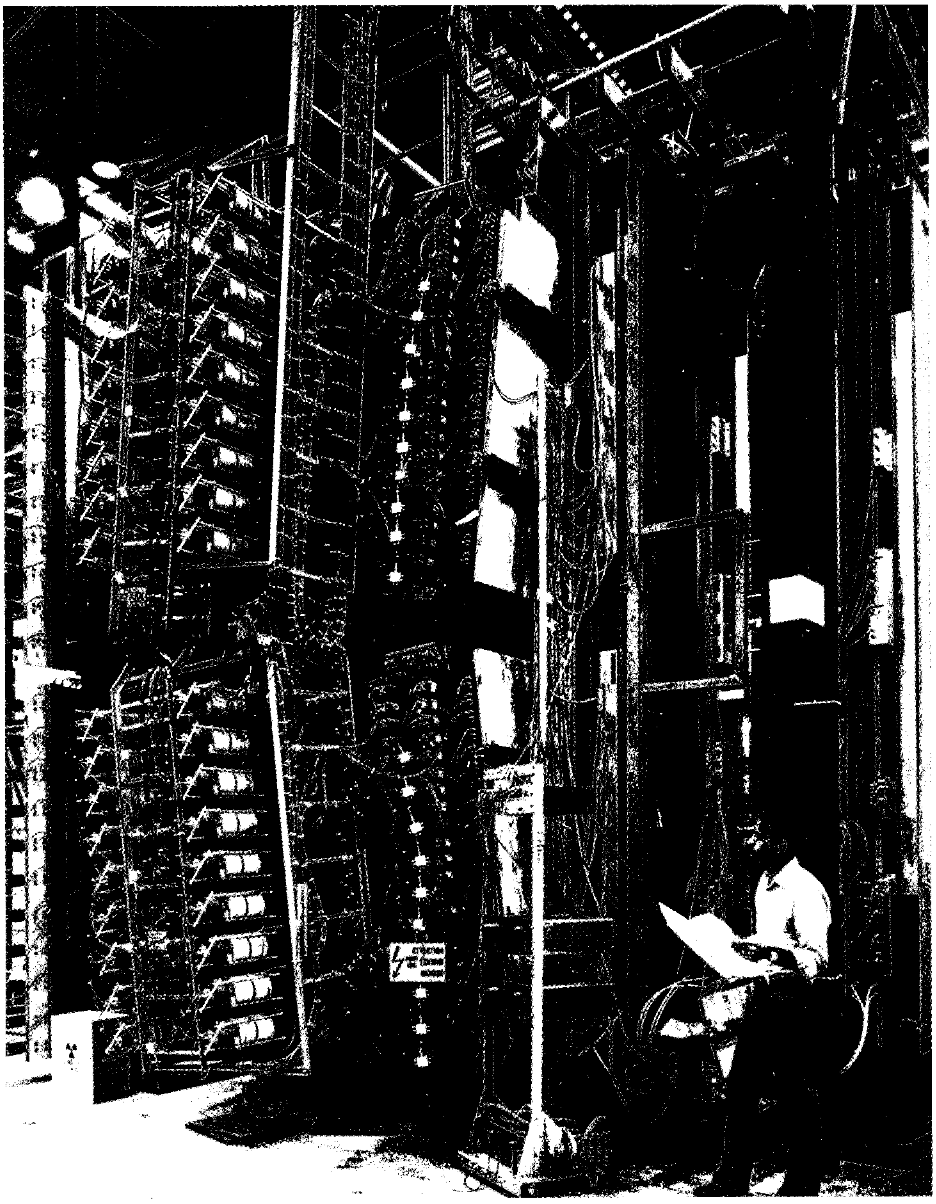
The observed shape of the dimuon spectrum gives a window into the deep interior (structure functions) of particles which cannot be directly studied in fixed target experiments — pions, kaons and antiprotons (see March 1980 issue, page 16). From a detailed study of J/psi production it was even possible to measure the gluon content of the pion.

However using the measured structure functions to calculate the expected overall magnitude of the dimuon signal, the observed levels are systematically higher. This difference — the 'K factor' — has since been the subject of much experimental and theoretical attention, and has yet to obtain a universally accepted explanation.

The study of rare events has also proved fruitful — data on pro-

Downstream portion of the NA3 (CERN Collège de France/Ecole Polytechnique/ Orsay/Pisa/Saclay) experiment, showing its big proportional chambers (right) and the calorimeter used in the study of single photon production.

(Photo CERN 64.8.79)



duction of triple muons and of muon pairs with the same electric charge gave an upper limit for the production of hadrons carrying the 'beauty' quantum number, and events containing four muons revealed the production of pairs of J/psis — particles which only ten years ago were worth a Nobel prize just singly.

After its thorough coverage of muon production in 1981 the experiment turned to another aspect of quark electrodynamics — the production of single photons (at wide angles). In hadronic collisions, these particles originate either from quark-antiquark annihilation (as in the 'Drell-Yan' mechanism), or from quark-gluon interactions.

Extracting the tiny single photon signal from the overwhelming neutral pion background is an experimental challenge in fixed-target physics, and for this the apparatus was supplemented by a fine-grain shower chamber.

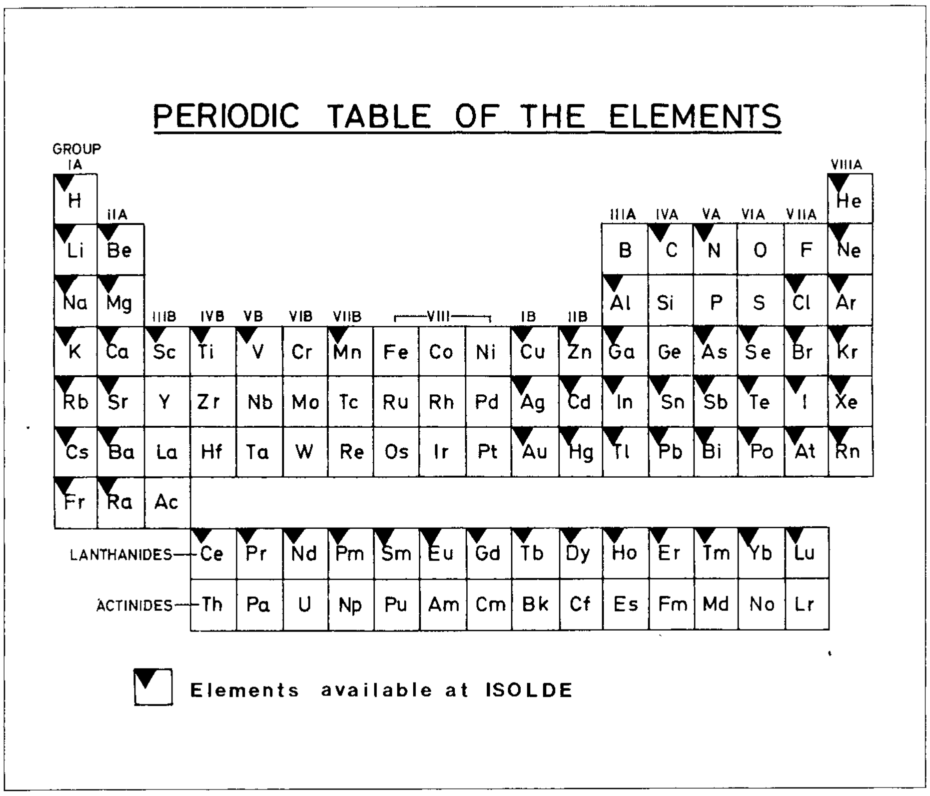
The use of different hadron beams could probe the underlying production mechanism. In particular, the simplest theoretical picture predicts a large difference between single photon yields from negative and positive pion beams, reflecting the very different quark composition of the beams. In fact the experiment has found similar yields using different charged pion beams, and using protons. (Similar results are obtained by the NA24 experiment by a Bari/Freiburg/Moscow/Munich collaboration.)

As was the case with the K-factor with muon pairs, this result seems to indicate that something other than the simplest quark picture is required, perhaps gluon contributions. Results should soon be available on the production of two prompt photons, which in the simplest picture should be even more beam dependent than single photon spectra.

After a final search for unusual penetrating particles, the apparatus was partly dismantled, but a large portion of the spectrometer will find a new lease of life in the big NA34 experiment to study high energy production of leptons (see September 1984 issue, page 280).

Getting the Periodic Table on-line

Although rarely in the limelight, the ISOLDE on-line isotope separator at the CERN 600 MeV synchro-cyclotron is a flourishing part of CERN's research programme. It provides beams of exotic radioactive nuclei for some hundred physicists from Scandinavia, *Nuclear beams covering more than half the Periodic Table are already available from the ISOLDE on-line isotope separator at the CERN 600 MeV synchro-cyclotron.*



France, Germany and the United States.

Building on this success, the latest version (ISOLDE-3) of the separator is now being prepared (see November 1984 issue, page 380). One of the major objectives is to extend the range of particle beams available, where a key role is played by the continuous development of targets and sources. These systems serve as the injection end of the electromagnetic mass-separator and its associated beam optical system and determine the quality and intensity of ISOLDE's beams of radioactive nuclei. Concurrently with the introduction of new experimental techniques, the source requirements have been increased to the level where each experiment could need its own system made to measure. Recent results of this work are tantalum foil and calcium oxide targets for production of additional isotope beams.

The future target and ion-source development does not seem to be limited by the lack of new ideas, in fact there exists at ISOLDE and in collaborating institutes a large capital of physico-chemical techniques and ideas in principle capable of making all elements available as ISOLDE beams.

The status is that 66 elements are available as on-line beams. They can roughly be divided into two groups: one which consists of some 30 elements that are successfully separated with chemical selectivity and in high yields, and some 40 elements that are available but do still leave room for improvements in yield and selectivity.

The target and ion-source development is planned to continue along the path which has been so successful so far, tailored to the high resolution and intensity of the new ISOLDE-3 separator under six headings:

A Search for target/ion-source combinations that make hitherto inaccessible elements available.

B Development of methods for obtaining selectivity so that only beams of one element are transmitted to the analysing magnet.

C Reduce the hold-up time in the target and ion-source system which often is responsible for decay losses of up to a factor of 1000 for the most short-lived nuclei.

D To improve the ion-sources in order to increase the ionization efficiency which for about 40 of the elements still remains below one per cent.

E To study the emittance and energy spread of the ion-sources in order to match them to the high resolution property of the ISOLDE-3 separator.

After six years as leader of the ISOLDE group at CERN, Bjorn Jonson soon returns to Sweden to become Professor at Chalmers University of Technology. Under his leadership the group has admirably combined the development and application of new experimental techniques with a vigorous research programme of physics with new and rare radioactive decays. He is succeeded by Jürgen Kluge from Mainz, well-known at ISOLDE for his work in optical pumping and laser spectroscopy.

After 3000 kilometres of 70 mm film, the last photograph from the BEBC bubble chamber at CERN emerges from the processing unit.

(Photo CERN 99.12.84)

F Develop thin targets of less refractory materials which, in conjunction with the future intense helium 3 beam and consumable target technique, could increase the number of accessible elements.

On all these six fronts, ideas and techniques are well advanced, promising that the new ISOLDE-3 separator could well attain the alchemist's dream of supplying the whole Periodic Table of elements on-line.

From Helge Ravn

Track record

The 3.7 m diameter Big European Bubble Chamber (BEBC) recently retired from CERN physics after eleven years of operation, first with beams from the 28 GeV Proton Synchrotron, then fed by the 450 GeV SPS Super Proton Synchrotron (see December 1984 issue, page 432).

During 13 million expansions, 6.3 million photographs were taken, mostly with four or five separate views, making up 3000 kilometres of 70 mm film! 25 runs were made for 22 experiments using exposures to neutrino and hadron beams, with the magnet (the largest store of superconducting energy in the world) being kept cold for 86500 hours (ten years), and at full current for 25000 of those hours. The chamber was filled with liquid hydrogen, deuterium or neon/hydrogen mixture.

As the years progressed, BEBC became more a 'hybrid' detector, being supplemented for neutrino exposures with a two-plane External Muon Identifier (EMI) containing 150 square metres of wire chambers and an internal picket fence (IPF) covering almost 360°. Also for neutrinos, the Track-Sensitive Target (TST) was used, offering the simplicity of a liquid hydrogen target with the stopping power of a surrounding heavier liquid. For hadron experiments, an External Particle Identifier (EPI) was used to identify the emerging particles.

Some 50 Laboratories participated in the analysis of BEBC film. Not counting contributions to conferences, over 100 papers have already been published. However a lot of BEBC film, mainly from neutrino exposures, has not yet been analysed, so the final total will be much higher.

The precise number of researchers who used the chamber over the years is impossible to determine precisely, but it is at least 550. Some two-thirds of these users participated in only one experiment, the remaining stalwarts being involved over the years in up to nine experiments. Almost a quarter of the physicists now active at CERN participated at one time or another in studies using BEBC.

BEIJING Groundbreaking

On 7 October 1984, ground was broken for the new Beijing electron-positron collider, BEPC. Wielding the first shovel was Chinese Premier Deng Xiaoping, followed by many other Chinese dignitaries and visitors, including US Presidential Science Advisor George Keyworth.

The ceremony was very impressive mainly because it demonstrated to the world the commitment to high energy physics on

Chinese Premier Deng Xiaoping participates in the groundbreaking ceremony for the new Beijing electron-positron collider, scheduled to provide 5.2 GeV collisions in 1988.

the part of the highest levels of the Chinese government. In the various addresses, continuing reference was made to the desirability of completing BEPC on schedule, which means beam by 1988. There was a major banquet in the evening attended by about 400 people including many from the Chinese leadership. State Counsellor Feng Yi and George Keyworth presented toasts to the success of BEPC and similar sentiments were expressed by James Leiss of the US Department of Energy and the President of the Chinese Academy of Science Lu Jiaxi.

As is often the case with groundbreaking ceremonies, ground had already been broken prior to the occasion, in fact the excavation for the injector section is well advanced and work on many of the components and subsystems had been in progress for some time. Subsequent to the groundbreaking ceremony the 5th Cooperative Agreement between the US and China was signed by James Leiss for the US and Madam Gu Yu, Counsellor to the Academy of Sciences, representing the Chinese government. This agreement provides for a large number of specific items in which US physicists and engineers will be involved in support work for BEPC.

BEPC is to operate up to 5.2 GeV collision energy, hopefully at luminosities in excess of that now obtained at the SPEAR ring at Stanford, which is the only Western machine operating at this energy region. The reason for this choice of energy was the observation that with the exception of SPEAR all other electron-positron colliders in the world were operating either below or above the BEPC energy, while at the same time the fields of investigation accessible in that energy region are demonstrating continuing richness. Since SPEAR is only operating for high energy physics half-time, with the other half dedicated to synchrotron radiation, the work at SPEAR has uncovered new physics questions more rapidly than it has answered them.

BEPC will also have numerous external beams for synchrotron radiation and its linear accelerator injector could be used for nuclear physics. However, the primary goal is high energy particle physics and work on the construction of a detector is proceeding in parallel with the machine construction.

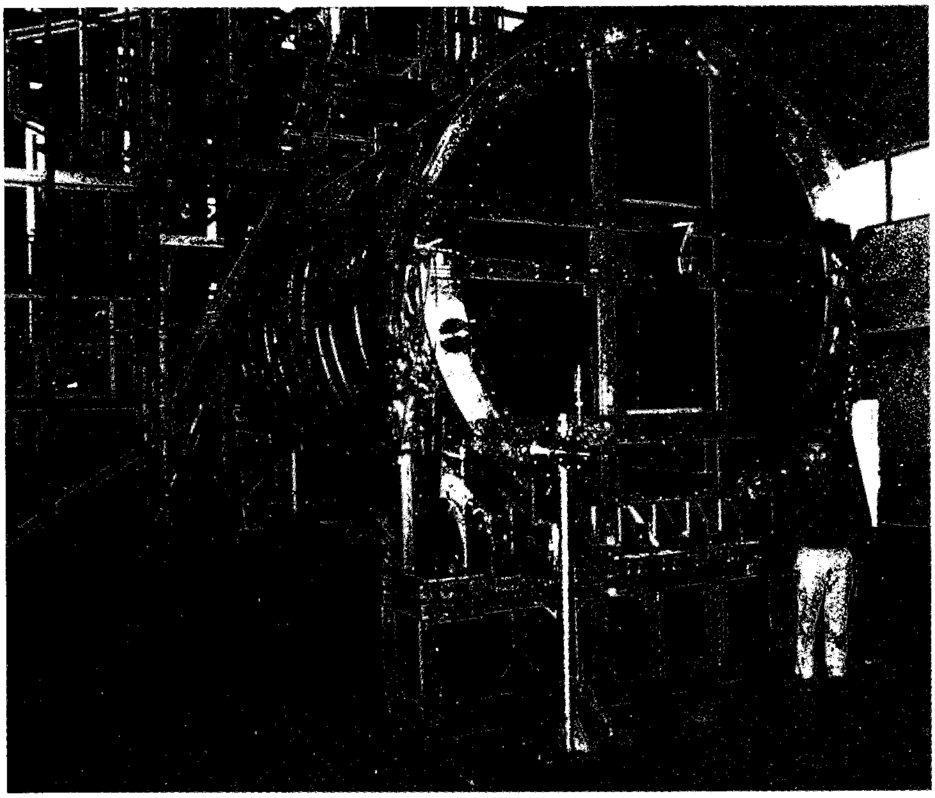
KEK
Testing TOPAZ

KEK, the Japanese National Laboratory for High Energy Physics, recently carried out successful tests of a thin shell superconducting solenoid of 2.9 m in diameter and 5.1 m in length with only 0.71 radiation length thickness. The solenoid is for the TOPAZ electron-positron colliding beam detector, one of three major detectors currently being built at TRISTAN.

TOPAZ is a general purpose detector, which features an improved version of a Time Projection Chamber (TPC) to record three dimensional tracks and ionization densities for emerging charged particles. This solenoid, when used with iron-yoke structure, provides a very uniform magnetic field of 1.2 Tesla and enables the TPC to make a good momentum measurement. Outside the solenoid, there will be a lead glass barrel calorimeter, which requires the solenoid

Designer A. Yamamoto of KEK stands beside the thin shell superconducting solenoid for the TOPAZ experiment at the TRISTAN electron-positron collider now under construction at KEK. In the background can be seen the cryogenic assembly used in testing the new solenoid.

(Photo KEK)



be as thin as possible. A newly-developed 'internal winding method' for the coil was an essential step in fabricating this solenoid.

The TOPAZ thin superconducting solenoid was built jointly by Furukawa Electric and KEK in cooperation with Ishikawajima-Harima Heavy Industries and Fuji Electric. The single layer coil is designed to produce a maximum magnetic field of 1.2 Tesla with a stored energy of 19 MJ at 3650A when operated with an iron return yoke. The niobium-titanium/copper superconductor, stabilized by high-purity aluminium, was wound on the inside of a 9 mm-thick high strength aluminium alloy cylinder.

This 'internal winding method' developed at KEK has many advantages over the conventional fabrication technique of winding a coil on a cylindrical bobbin. A strong electromagnetic force causes the coil to swell outwards. With the conventional design, an additional banding of the coil is needed to withstand this force. With the internal winding method, an outer cylinder naturally provides reinforcement against this force. The 0.71 radiation length 'thinness' of the coil was a direct result of this technique, together with the adoption of design criteria for aerospace applications to reduce the thickness of the cryostat wall, while still meeting the safety requirements. The internal winding method also allows cooling pipes to be welded to the surface of the outer cylinder before the coil is fabricated. This guarantees far better reliability in the cooling characteristics than conventionally epoxied cooling pipes.

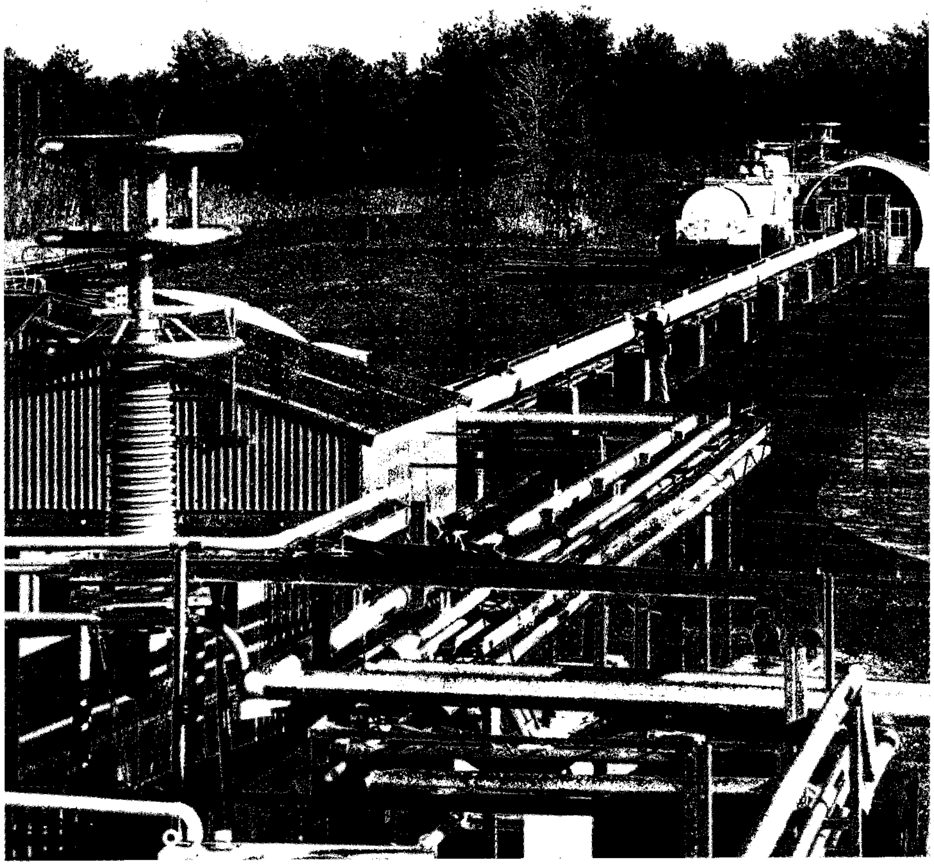
The test of the solenoid was performed without an iron yoke during September and October 1984 at the Furukawa-Teisan Cryogenic Test Facility. A central magnetic field of 0.86 Tesla was obtained in air at a current of 3000 A, in agreement with the design values. The coil was indirectly cooled down by a forced flow of two-phase helium at a rate of about 2 K/hour from 300 K to 130 K and 4 K/hour from 100 K to 4.2 K in order to avoid thermal stress and mechanical damage. The temperature difference within the coil was kept within 50 K. It took about five days to cool down the coil from room temperature to 4.2 K. Under the stable operating condition at a coil temperature of less than 4.5 K, the total amount of refrigeration power required was less than 42.6 W with a helium mass flow of 2.23 g/s.

A number of tests were repeated to measure the quench behaviour of the coil. Sudden switch-off at 3000 A showed that a quench occurred within 1-1.5 sec after cutting off the power and the entire coil went back to normal without creating any hot spot. Forced quench tests were also made with use of a heater at excitation currents of 1000, 1500 and 2500 A. Equivalent quench propagation speeds of 2.6, 5.0 and 7.7 cm/s along the axis of the coil were obtained from these tests. All these results show that the coil is well protected against possible damages due to quenching, and that the design criteria for safety are satisfied.

The TOPAZ solenoid is now transferred to KEK and will be put into an iron return yoke which is under construction at the Tsukuba experimental hall, where the TOPAZ detector is to installed. A magnetic field measurement with the return yoke is scheduled in June.

A view of the superconducting power transmission system at Brookhaven, with the pipe containing the superconducting cables seen in the centre. In the left foreground is one of the four terminations which make the transition from the 7 K environment of the cable to the ambient temperature electrical bus bars connected to the power supplies.

(Photo Brookhaven)



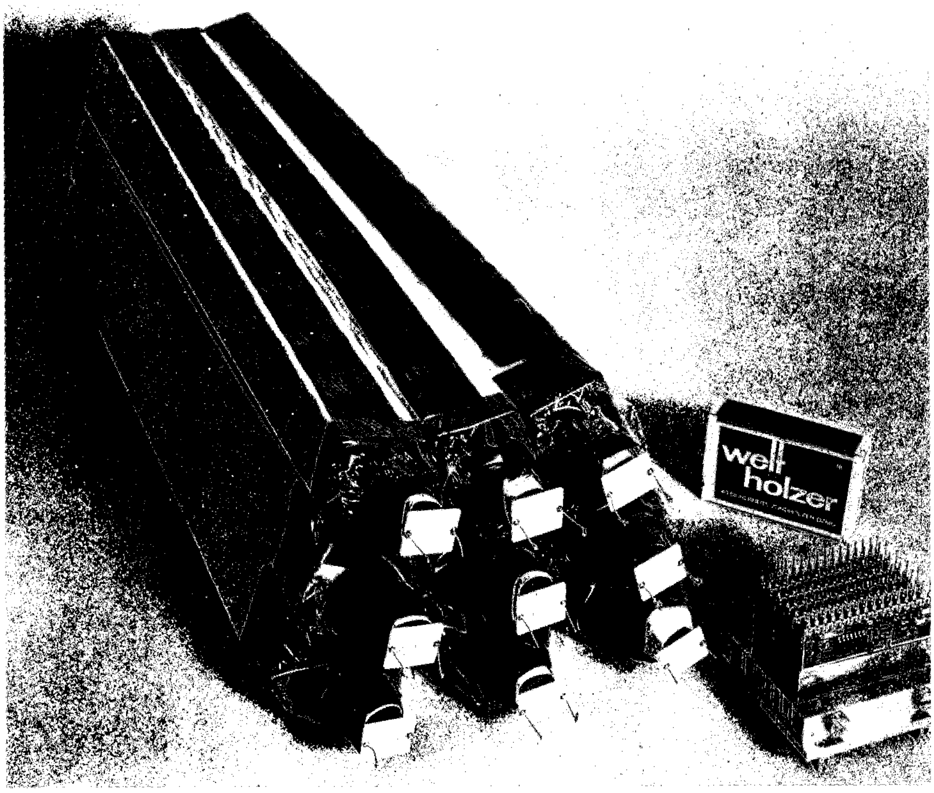
BROOKHAVEN Superconducting power transmission

Back in the early 1970s members of the Accelerator Department at Brookhaven began to apply the expertise gained in the development of superconducting magnets to the problem of using superconductors in other power engineering devices such as underground transmission lines and synchronous alternators.

Since 1972 Brookhaven has been developing an underground superconducting power transmission system. The technical characteristics of the system are comparable to overhead transmission lines, i.e., the power transmitted is very large and such a system could carry power for hundreds of kilometres without electrical network problems or big losses. Of course, the big attraction of a superconducting system is that the physical size is orders of magnitude less than overhead lines carrying the same power. The difference in size is illustrated by the demonstration test facility at Brookhaven. This site tests cable rated for 1000 MVA (three-phase) in a pipe with an outside diameter of 40 cm, whereas the towers for an overhead three-phase line of this power rating would be about 30 m wide and 40 m high. Construction of the test facility began in 1975. Prior to this the emphasis was on the development of superconducting and insulating materials for a cable operating at 60 Hz. A considerable effort also went into cryogenic and systems engineering.

The cables under test at Brookhaven are rated for a maximum continuous current of 4100 A and line-to-ground voltage of 80 kV (60 Hz), corresponding to 1000 MVA on a three-phase basis. The cable was made at Brookhaven in one length of about 300 m in 1981, then cut and installed in a vacuum-insulated pipe in two lengths of 150 m each. After the terminations were added at each end, the system was operated for the first time in 1982. The Brookhaven site is the only one in the world designed to test cables with simultaneous voltage and current excitation at the 1000 MVA level. More than 2000 hours of operating time have been accumulated since 1982. In October 1984, the sixth run at the site was performed. It lasted for 27 days, of which about two weeks formed an electrical life test, one week was run at 3000 A and 80 kV per

This array of nine modules of lead/ scintillator read out via a wavelength shifter to a silicon phototriode, built by a Hamburg/DESY/Max Planck Institute Munich team, has been giving good results. The aim is to build a 144 module version to measure electron energies in the CELLO detector at the PETRA electron-positron collider at the German DESY Laboratory in Hamburg.



cable, and another week at 4100 A and 80 kV per cable. At the end of the life test the current was raised to 6000 A for 30 minutes, an emergency rating specified to correspond to electric utility company needs. As there was no distress after the specified period the voltage was then raised to 110 kV, corresponding to 2000 MVA per three-phase circuit. The tests were completed without damage to the cables or cryogenic equipment. The site operates unattended except for the normal day shift — if the control computer detects problems, a standby operator is called on the phone and the computer delivers a voice synthesized message on the system status.

Numerous papers have been published over the years on the development and operation of the superconducting transmission system. Anyone wishing more information should drop a line indicating their field of interest to Mrs. E. Taylor, Building 815, Brookhaven National Laboratory, Upton, New York 11973, USA.

DETECTORS Scintillating developments

Many electromagnetic calorimeters measure the location and amount of electromagnetic energy deposited by particles by picking up the light produced in scintillating materials (see October 1984 issue, page 338).

Conventionally, these tiny flashes of light are measured by high-gain, multistage photomultipliers. However under certain conditions photomultipliers can develop non-linear responses and/or other shortcomings which limit their usefulness for high precision calorimetry. Monitoring the voltages of arrays of thousands of photomultipliers poses its own special problems. In addition, some new calorimeter designs employ high internal magnetic fields which prevent the use of photomultipliers.

Preliminary investigations of the use of large photodiodes by a Max Planck Institute (Munich) team several years ago were promising. Now alternatives to photomultipliers are coming into more general use. New projects are planning the use of both photodiodes (which do not directly amplify the signal) and phototriodes (effectively single stage photomultipliers).

Intrigued by the successful applications of photodiodes to BGO crystals by the Munich team, a group at Hamburg University and DESY performed tests with lead-scintillator sandwiches read out by silicon photodiodes. One of the objectives is to build a compact electron tagging counter for the CELLO detector at the PETRA electron-positron collider, in a location where a magnetic field of 1 T has to be contended with.

Initial results proving the feasibility of the scheme were reported last year. Recently MPI Munich joined the collaboration, providing low cost, low noise amplifiers to amplify the small photodiode signals.

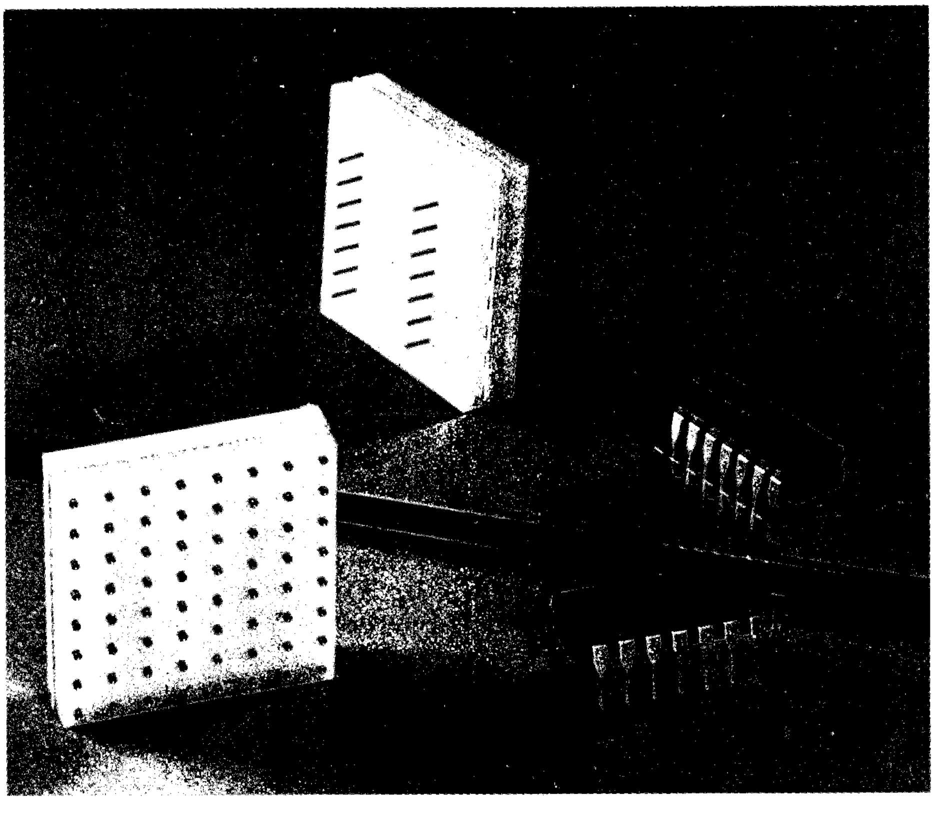
In order to successfully apply photodiode readout, the light yield from the sandwich has to be optimized. By concentrating the scintillation light on a small area diode via a wavelength shifter bar, acceptable signal-to-noise ratios have been obtained. A low cost scintillator was combined with a specially-matched wavelength shifter emitting in the green (around 500 nm) to profit from the relative high quantum efficiency of the silicon photodiode used (Hamamatsu S1790).

Work at the Rutherford Appleton Laboratory (UK) aims at developing a readout system for the end-caps of the electromagnetic calorimeter for the OPAL detector being built for the future LEP electron-positron collider at CERN (see November 1984 issue, page 375). Lead glass instrumented with vacuum phototriodes (VPTs) has been operated in a test beam while subject to strong magnetic fields, achieving performance which can equal that obtained with conventional photomultipliers.

To work efficiently, the VPT had to achieve gains of 10-20. The anode signal from the triode is small and a supplementary low-noise, high-gain amplifier is required. VPTs from three manufacturers (Hamamatsu, EMI and Radiotechnique Compelec) were used in the tests. A similar project is afoot with the readout for the time-of-flight scintillators and the lead glass electromagnetic calorimeter end-caps for the DELPHI experiment for LEP (see July/August 1984 issue, page 227).

The L3 experiment for LEP, where all the instrumentation is enclosed in a large magnetic 'room', plans to use silicon photodiodes coupled to low noise amplifiers to read out the 12000 crystals of BGO (bismuth germanate) scintillator used in the electromagnetic calorimeter.

The MH64V hybrid circuit developed at Saclay has 64 sockets corresponding to the 64 parallel electronic input channels and 2 groups of 7 pins corresponding to the 2 series outputs and the operating signals of the 2 fully independent half-modules. Inserted into a suitable rig, it provides an example of a detector with integrated electronics.



Photodiode readout is also envisaged for a new experiment at Cornell's CESR electron-positron collider as a remplacement for the original CLEO detector.

Integrated-electronics

More and more sophisticated micro-electronics methods are continually improving dimensional aspects and electronic or logic functions while at the same time increasing the power dissipation or the resistance of circuits to ionizing radiation.

The size of experimental equipment used for particle physics is ever increasing. For detectors, the ever greater precision in location demanded means that the number of sensor elements needed for one experiment is rising alarmingly.

In an attempt to provide at least a partial solution to this type of problem, the Instrumental Methods Section of Saclay's Elementary Particle Physics Department is developing a 25 x 25 x 6 mm hybrid electronic circuit combining 64 electronic channels. Each channel amplifies, discriminates, shapes and delays the input signal before it is stored in a shift register by the action of a trigger. Internal logic makes readout possible from a given time and at the desired rate.

Owing to its sensitivity, this module can be operated with the signals from conventional proportional chambers. The registers are at present shifted at 25 MHz, which means that readout times are very short, even for fairly large detectors. Because of their low power consumption, modules can be coupled to cover areas covering sev-

Delegates to the 7th International Conference on Atomic Masses and Fundamental Constants held near Darmstadt enjoy a choral concert in the monastery of Eberbach.

(Photo A. Zschau)

eral square metres.

The module, inserted in a suitable rig with its 64 spikes acting as anodes, has demonstrated its ability to detect and locate photoelectrons released by ultra-violet radiation, thus providing an example of a self-contained, integrated-electronics detector (with electronic multiplication in the gases).

If the module is judiciously used, its characteristics would seem to offer a wide range of applications in physics, data processing or elsewhere.

Further information from G. Comby, Service des Techniques Instrumentales, CEN-Saclay, 91191 Gif-sur-Yvette Cedex, France.

CONFERENCE What happened at AMCO 7?

The 7th International Conference on Atomic Masses and Fundamental Constants (AMCO-7), organized by the Gesellschaft für Schwerionenforschung (GSI) and Technische Hochschule Darmstadt, was held in September at Seeheim, near Darmstadt. 150 participants from 19 countries met to discuss the progress in the field of measuring and calculating atomic masses as well as in related fields.

Generally speaking, the mass of an atom reflects besides the bulk contribution — the mass of the spherical droplet-nucleus made out of Z protons and N neutrons plus electronic effects — the influence of nuclear structure, as there are contributions to the mass from shell effects or from nonspherical shapes of nuclei. At AMCO-7, theoretical models for describing masses and moments were reviewed extensively, following the 'traditional' lines of the Liquid Drop Model, the Shell Model and of Hartree-Fock calculations. A general comprehensive compilation of atomic mass predictions from various model calculations was proposed at the conference, with P. Haustein acting as a coordinator. As a common data base the experimental masses of more than 2000 nuclei can be used which have been critically compiled in a new mass table presented by A. Wapstra.

The importance of shape degrees of freedom was shown for nuclei around radium 222, which theory predicts to have an octupole pear-shape deformation (A. Sobiczewski). This deformation is seen in the level schemes of the nuclei and is inferred from charge radii of radium isotopes measured recently at CERN (K. Wendt). An additional binding energy of a few MeV is due to the appropriate degree of freedom. Large sausage-shape deformations have been shown to increase the binding of the heaviest nuclei (K. H. Schmidt). An increase of fission barriers by a few MeV for the heavy elements ($Z = 106$-114) for neutron numbers around 162 is predicted and additionally stabilizes heavy elements against spontaneous fission. The detection of the elements 107-109 in recent years by alpha decay became possible, as these latter deformations increase the fission lifetime by orders of magnitude.

High precision mass measurements corroborate the interesting finding of a mutual enhancement of neutron and proton shell closures and other nuclear structure effects.

As nearly all recent mass measurements deal with nuclei far from stability, the properties of these nuclei become more and more an important part of the AMCO programme. New experimental devices for on-line mass measurement have been presented (K. Sharma, A. Müller).

Besides reviews on the status of neutrino mass measurements, new measurements of beta decay couplings were presented, including that of the relative level of parity violation in the decay of polarized neutrons with a precision better than one per cent (E. Klemt).

Recently new radioactive decay modes have been discovered. New examples for proton-radioactivity out of the ground state have been presented (S. Hofmann, T. Faestermann). These measurements allow a precise location of the proton drip line and contribute to a mass determination at the limits of stability. The decay of radium 223 by emission of carbon 14 has been seen at Orsay as well as Oxford and CERN. Lithium 11 decays through beta-delayed emission of tritons (M. Langevin).

Reflecting the growing contact between nuclear physics and quark physics, the meeting concluded with a session on quantum chromodynamics (QCD), the theory of quark interactions. The understanding of spin-orbit coupling, which governs the shell closures in nuclei, now finally can be understood from the fundamental interaction constant of QCD (K. Bleuler). The masses of nucleons follow from lattice calculations as presented by G. Schierholz.

The new relevance of QCD for nuclear physics revives the old dream of being able to deduce the masses of nuclei from one fundamental quantity — the coupling constant of strong interactions.

However this is not for tomorrow, and in view of the interesting and active nuclear physics programme presented at Seeheim, a continuation of the series of AMCO conferences is planned with AMCO-8 to be held in 1989. At AMCO-7 proposals were made to organize this meeting in Israel, Poland or the USA.

From P. Armbruster and E. Roeckl.

People and things

On people

The Soviet State Prize for Science and Technology has been awarded to the renowned field theory team of N. Bogolyubov, A.A. Logunov and D.V. Shirkov for their set of papers 'the renormalization group method in the theory of fields', written in the mid-1950s and which combined the use of perturbation theory with differential group equations.

Sidney Drell, deputy director of the Stanford Linear Accelerator Center and co-director of Stanford's Center for International Security and Arms Control is the recipient of a five-year award from the MacArthur Foundation.

Fermilab Director Emeritus Robert R. Wilson receives the Enrico Fermi Award, the highest scientific honour of the US Department of Energy, for his 'outstanding contribution to physics, particle accelerator design and construction'.

Theorist Efim Samoilovitch Fradkin of the Lebedev Institute in Moscow recently celebrated his sixtieth birthday. His many contributions to quantum field theory and quantum statistical mechanics cover thirty years and have earned him widespread recognition. Corresponding Member of the Soviet Academy of Sciences, he has been awarded the USSR State Prize and the I.E. Tamm Prize.

The US Department of Energy recently sent some of its officials to CERN to visit the UA1 experiment which has collaborators from Harvard, the University of California at Riverside and Wisconsin University. Left to right, Carlo Rubbia (CERN and Harvard) head of the UA1 experiment, Bernie Hildebrand (DOE), David Cline (Wisconsin) and James Rohlf (Harvard) are seen here in discussion at UA1.

CERN Council President for 1985 is Wolfgang Kummer of Austria (right) seen here with outgoing President Sir Alec Merrison (UK). At the December Council session, tributes were paid to Sir Alec's skill in leading the work of Council over the past three exciting years.

(Photo CERN 211.12.84)

CERN Council

At its December session, CERN Council elected Wolfgang Kummer of Austria as its President for 1985, succeeding Sir Alec Merrison of the UK, President since 1982. J. Rembser of West Germany was reappointed as Vice-President for 1985.

For the Scientific Policy Committee, D. H. Perkins of Oxford was elected Chairman for 1985, and K. Tittel of Heidelberg was reappointed as member for three years. J. Cronin of Chicago becomes a member of the committee for the next three years.

Within CERN, Roy Billinge was reappointed as Leader of the Proton Synchrotron Division for three years and Paolo Zanella reappointed Leader of the Data Handling Division for one year.

IUPAP elections

The General Assembly of the International Union of Pure and Applied Physics (IUPAP) met in Trieste in October. At this meeting the People's Republic of China became a full member of IUPAP. Officers and members of the various IUPAP international commissions were elected for the next term of office (1985-87). The C11 Commission on Particles and Fields which was created in 1957 is responsible for sponsoring the major high energy physics conferences and is the parent body of the International Committee for Future Accelerators (ICFA). The 1985-87 membership of the C11 Commission is: I. Mannelli, Italy (and CERN) (Chairman); K. Strauch, USA (Harvard) (Secretary); M. Blazek, Czechoslovakia; A. Donnachie, UK; T. Fujii, Japan; G. 't Hooft, The Netherlands; P. Lehmann, France; E. Lohrmann, West Germany; P. K. Malhotra, India; V. A. Matveev, USSR; W. K. H. Panofsky, USA; Zhao Zhou Guan, People's Republic of China.

The Executive Council of IUPAP also appointed as associate members to the C11 Commission B. Povh, West Germany, with the task of liaising with the Commission on Nuclear Physics; D. N. Schramm, USA, liaison with the newly created Commission on Astrophysics, and R. C. Shellard, Brazil, as representative of developing countries.

American Physical Society

Last year, voting took place for the new Executive Committee of the Division of Particles and Fields of the American Physical Society. The new composition is: James Cronin (Chicago): Chairman, Stephen Adler (Princeton): Vice-Chairman, Gerson Goldhaber (Berkeley): Divisional Councillor, John Peoples, Jr. (Fermilab): Past Chairman, Maris Abolins (Michigan State), Gary Feldman (SLAC), Robert Palmer (Brookhaven), Chris Quigg (Fermilab), Jonathan Rosner (Chicago), Lawrence Sulak (Michigan), and Thomas Ferbel (Rochester): Secretary-Treasurer.

Meetings

A NATO Advanced Study Institute 'New Vistas in Electro-Nuclear Physics' will be held in Banff, Alberta, Canada, from 22 August to 4 September. Applications to E. Tomusiak, Department of Physics, University of Saskatchewan, Saskatoon, Saskatchewan, Canada, S7N OWO.

As mentioned in previous editions (see, for example, December 1984 issue, page 442), the 1985 International Symposium on Lepton and Photon Interactions at High Energies is being held in Kyoto from 19-24 August (further information from the Secretariat, Research Institute for Fundamental Physics, Kyoto University, Kyoto 606, Japan). In addition, a symposium celebrating the 50th jubilee of Yukawa's meson theory will be held, also in Kyoto, immediately beforehand. As well as surveying the developments of the past half-century, the symposium, which aims to attract 200 invited participants, will also look to future fundamental theories. Further information from the address above.

A conference on Computing in High Energy Physics will be held at Amsterdam, the Netherlands,

Antiprotons 1984

After a break of more than a year, the CERN SPS Collider started operation at the end of September and when the last colliding protons and antiprotons were dumped on 20 December the integrated luminosity recorded for the period (a measure of the accumulated number of proton-antiproton collisions) attained 395 inverse nanobars (nb^{-1}), compared with 153 nb^{-1} during the historic run in Spring 1983 which discovered the Z^o particle and produced the first evidence for the 'top' quark.

From the start the energies of the colliding proton and antiproton beams were increased from 270 to 315 GeV as a result of the installation of water booster pumps, providing a new collision energy record of 630 GeV. The squeezing of the beams in the region of the experiments was also improved so that the combined effect even from the initial coasts gave luminosities above $10^{29}cm^{-2}s^{-1}$, rivalling the best levels of 1983.

In the initial month of the run, the accumulated luminosity marched steadily forward to the 50 nb^{-1} level, with initial collision luminosities increasing to above 2 x $10^{29}cm^{-2}s^{-1}$. A crop of power supply problems and other glitches hampered progress for a while, but by the eighth week the Collider was progressing again and the skill of the operating teams showed itself as initial luminosities bounded to over 3 x 10^{29}, reaching a record level of 3.6 x $10^{29}cm^{-2}s^{-1}$, 2.3 times that of the 1983 run.

Despite improving the stability of the accelerating system, the luminosity lifetime (the combined effect of proton and antiproton beam lifetime and emittance growth) was for most of the period no better than in 1983. Then, the consequences of a vacuum leak on a main ring dipole were realized and repaired. Later a resonant kick from the thyristors of the main power supplies transmitted through the main dipoles was eliminated. By the end of the period the luminosity lifetime was as high as 24 hours and increasing even to above 30 hours at the end of long coasts. With coasts lasting this long, the integrated luminosity per coast became regularly 15 nb^{-1}.

The Antiproton Accumulator behaved remarkably well throughout the period and achieved a new record for stacking antiprotons with a maximum of 3.8 x 10^{11} and regularly achieving more than 3 x 10^{11}.

First tests on separating the beams in the unwanted crossing points were very successful with the beams behaving remarkably calmly as the protons and antiprotons were moved apart and then brought back again. This bodes well for the future operation with ACOL when six proton bunches will collide with six antiproton bunches and unwanted crossing points need to be avoided to keep the beam-beam non-linear tune spread within the available space of the tune diagram.

Some express data processing enabled physicists to keep score of interesting physics events, promising a good crop of results for the 1985 conference season and ensuring that CERN remains in the world physics spotlight.

from 25-28 June. It is jointly organized by the section H of the Netherlands National Institute for Nuclear Physics and High Energy Physics (NIKHEF-H) and the Computer Science Department (FVI) of the University of Amsterdam and will be devoted mainly to three subjects: networking, embedded systems and vector and parallel processing. It may be regarded as a sequel to the conferences held in Padua, Italy, in 1983 and in Guanajuato, Mexico, in 1984. For further information please contact Ms. I. van der Velde, NIKHEF-H, PO Box 41882, 1009 DB Amsterdam, Netherlands.

The Sixth Workshop on Grand Unification is to be held at the University of Minnesota from 18-20 April. This will be the sixth in a regular series of workshops, the latest of which was held at Brown University in Providence, Rhode Island in April 1984. Topics will include grand unified theories and proton decay, supersymmetry, Kaluza-Klein Theories and cosmology.

Further information from the organizers, Serge Rudaz and Tom Walsh, Physics Laboratory, University of Minnesota, 116 Church Street S.E., Minneapolis, Minnesota 55455, USA.

The 1985 CERN/Joint Institute for Nuclear Research (JINR, Dubna, USSR) School of Physics, the ninth in the series, will be held from 1-14 September at Urbino, Italy. The basic aim of these schools is to teach various aspects of high energy physics, especially theoretical, to young experimentalists drawn mainly from CERN and JINR Member States. Further information from Miss D. A. Caton, Scientific Conference Secretariat, CERN, 1211 Geneva 23, Switzerland, or Mrs. T. S. Donskova, Joint Institute for Nuclear Research, PO Box 79, Head Post Office, 101000 Moscow, USSR.

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- Please send C.V. including a list of publications and the name of 2 references by the 20th of February to,

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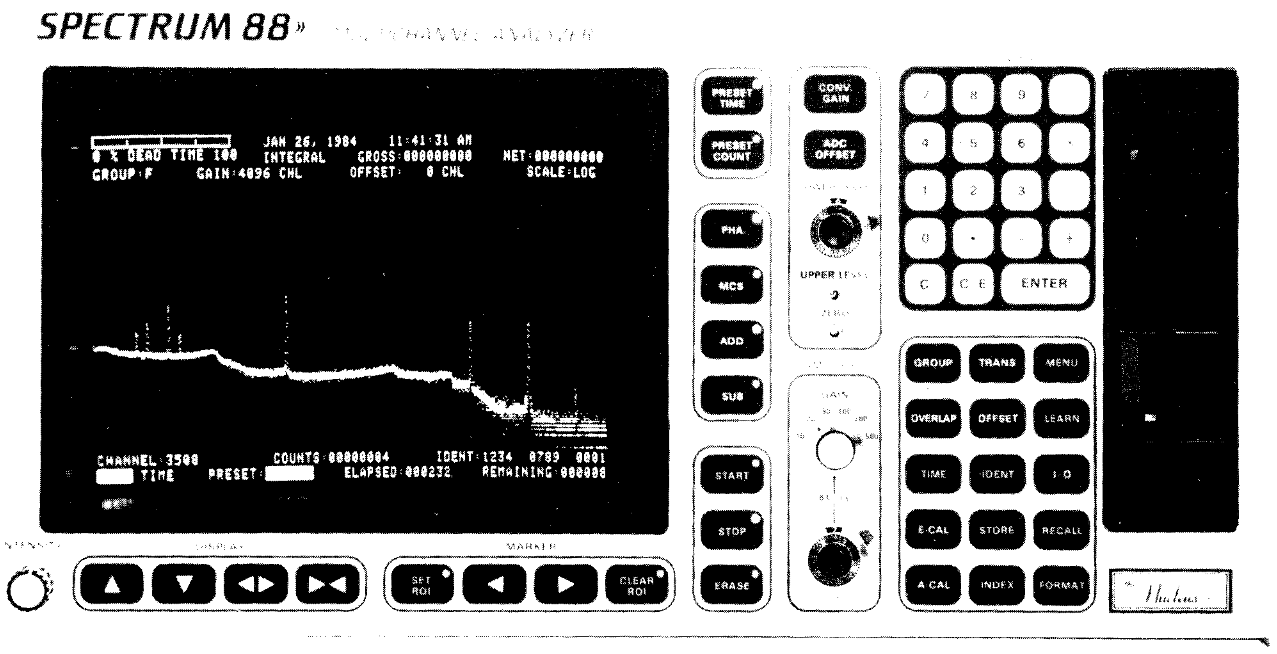

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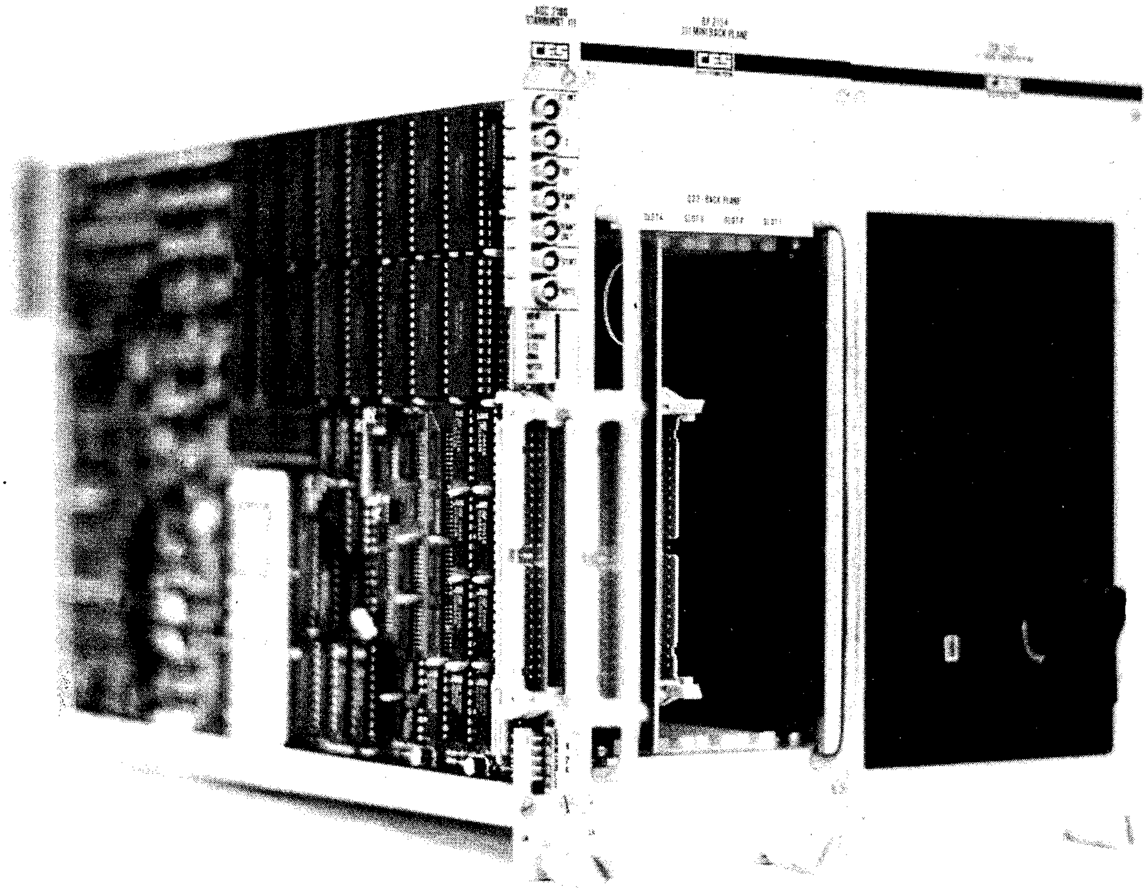

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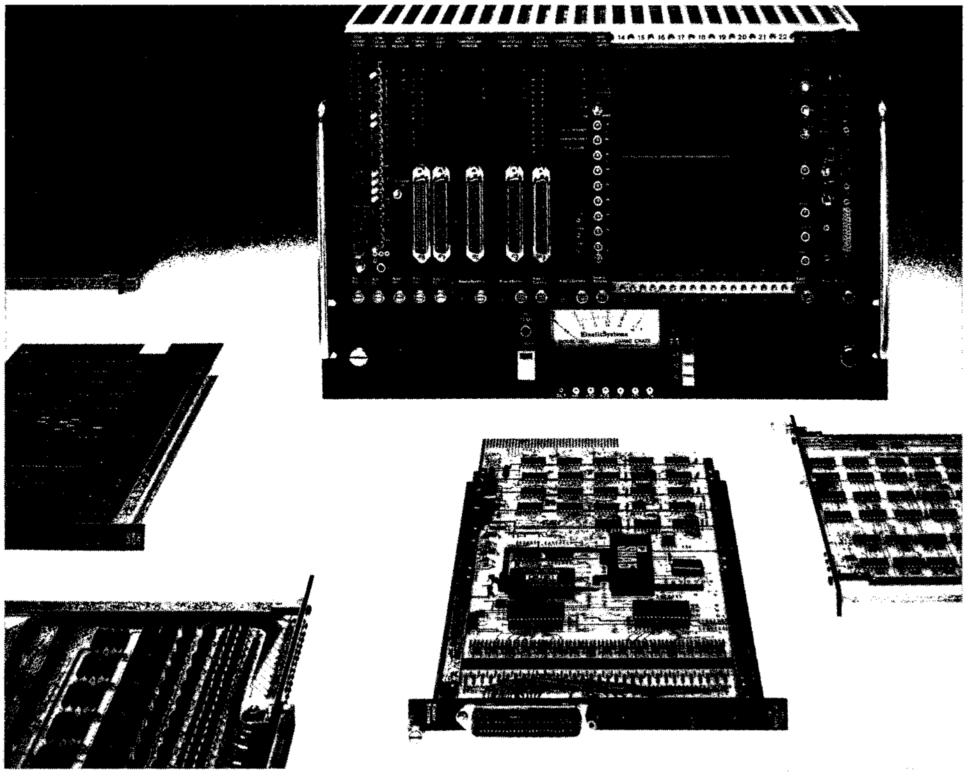

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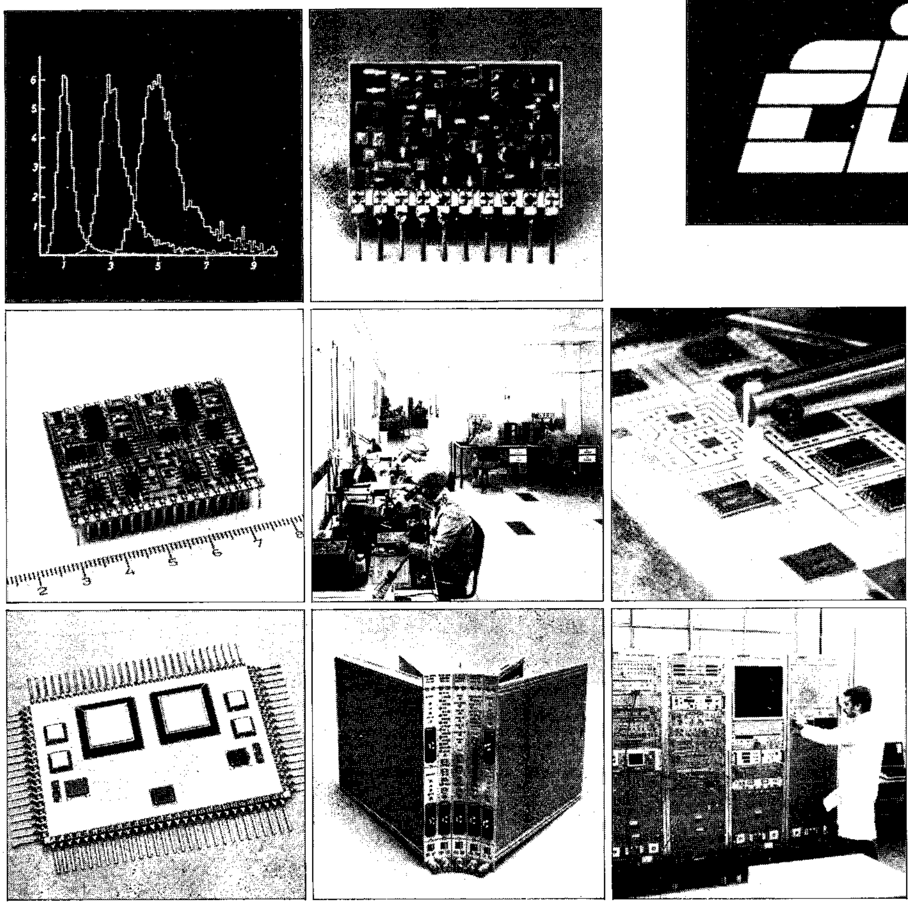

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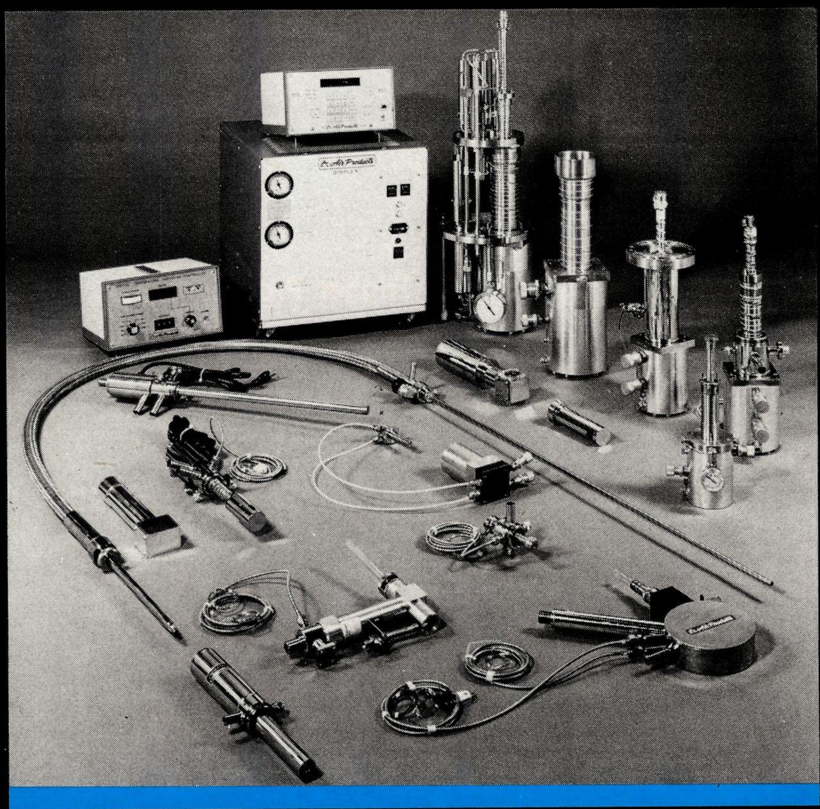

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