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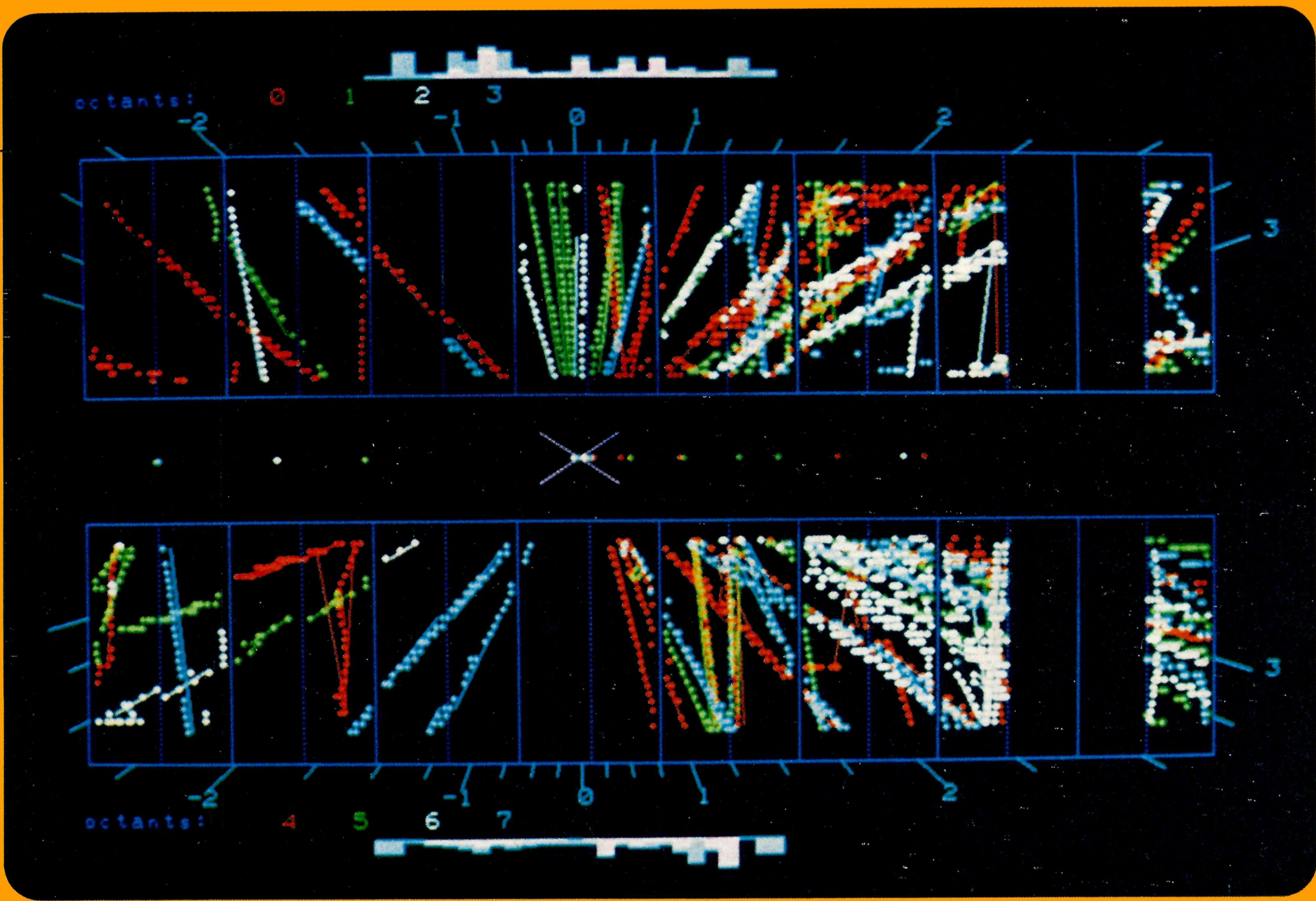
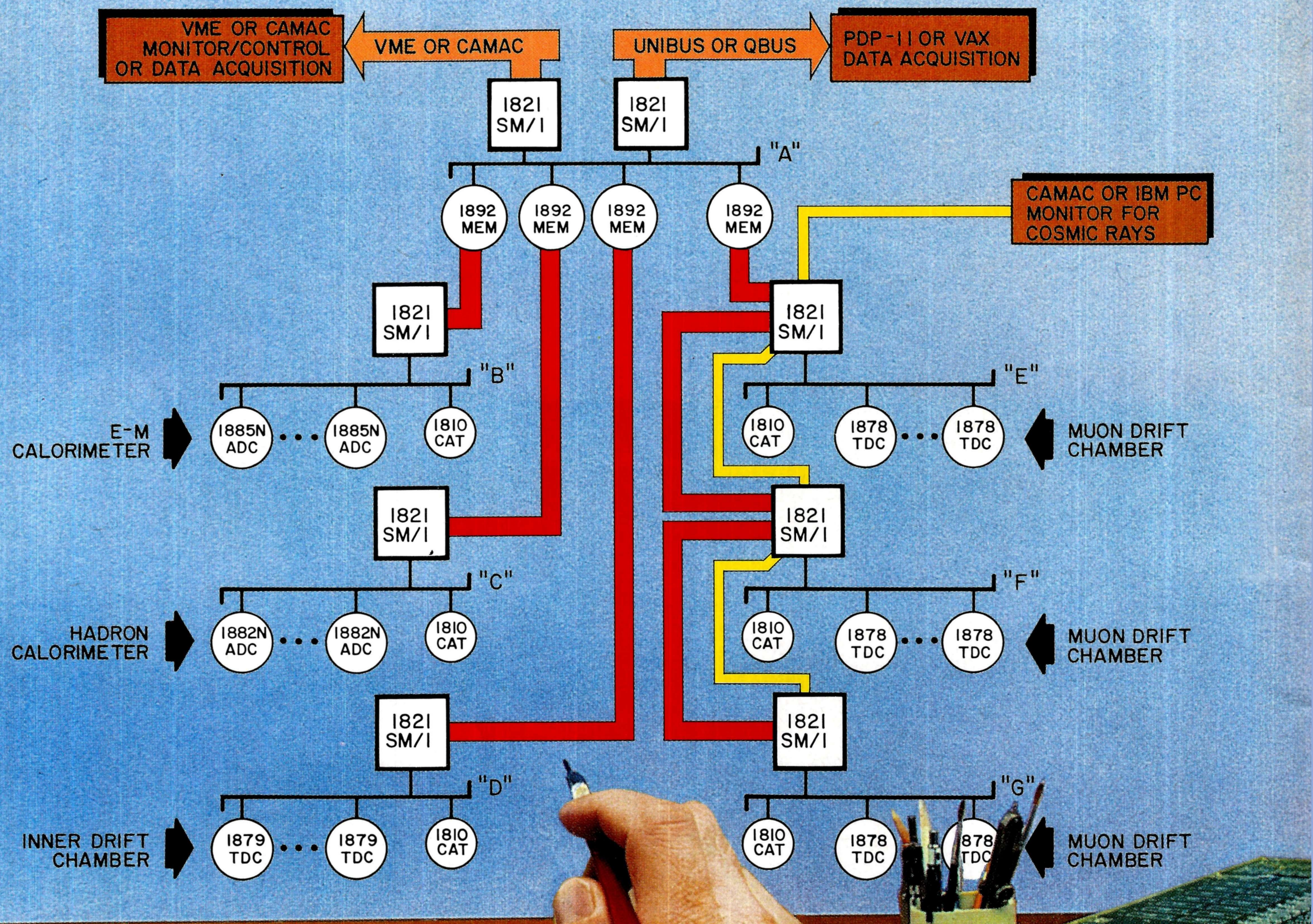
International Journal of High Energy Physics



VOLUME 26 JANUARY/FEBRUARY 1986



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Cover photograph: A colour-coded version of one of the first 1600 GeV proton-antiproton collisions as observed in the CDF detector at the Fermilab Tevatron (see December 1985 issue, page 419). These are the highest particle collision energies ever produced and open up a new physics region for exploration.

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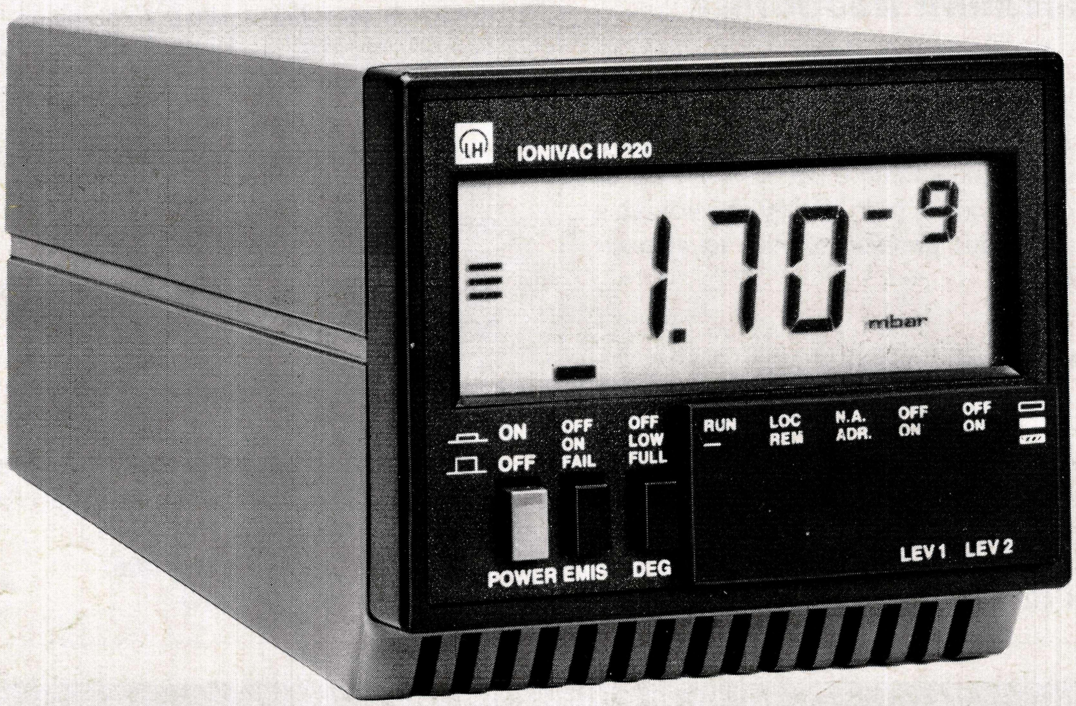

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Eureka and European particle physics

Following the initiative launched a year ago by French President François Mitterrand, European countries have begun pushing towards a concerted approach to high technology for the future. The philosophy behind this drive is to ensure that Europe keeps pace with the development of advanced technologies in other regions of the world, assuring the continued economic vitality of the Continent.

European Industry and Research Centres are, at this stage, free to put forward ideas for incorporating into a Eureka programme. It was in this context that Directors of some of the European high energy physics (HEP) Laboratories (CERN, DESY in Germany, IN2P3 in France, INFN in Italy, NIKHEF in the Netherlands and Rutherford Laboratory in the UK) discussed last summer how particle physics might contribute.

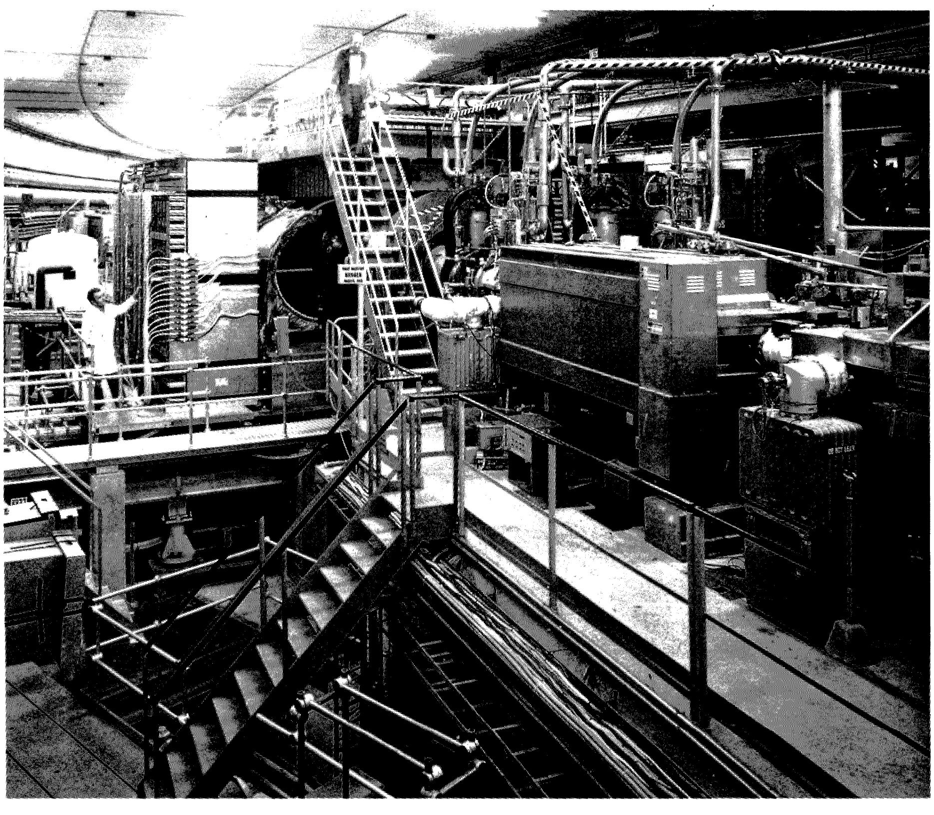
The initial outcome was a letter to national Ministries of Research saying that the HEP community believed it had something to offer. This letter had favourable responses and the community was invited to put forward proposals for possible Eureka projects. Two areas are under consideration where the high energy physics Laboratories, because of their own special needs, are at the forefront of current technology.

The first is the broadly defined area of data handling, where modern particle physics experiments need to handle large volumes of data at high speed over extensive networks. The second is the area of superconductivity, where the Laboratories are spearheading the mastery of superconducting radiofrequency cavities and of high field superconducting magnets.

It is this last topic which has subsequently been pushed furthest as much of the groundwork for high field superconducting magnets had already been prepared in the context of a possible 'Large Hadron Collider' for the LEP tunnel at CERN. A Working Group, with extensive participation from other European Laboratories, had started work.

The intention with Eureka is to convince Industry to invest in the technological development. Though some government funding is likely, the industrial firms themselves should provide most of the finance. Thus the next stage of the HEP contribution was to invite industrialists to discuss the potential of high field superconductivity. Two meetings took place, the first at DESY on 23 September and the second at CERN on 21 October 1985. Industrialists and representatives of Laboratories from Austria, Belgium, Finland, France, Germany, Italy, the Netherlands, Switzerland and the UK attended.

The interest generated at these meetings resulted in a paper for a Ministerial meeting at Hanover on 5 and 6 November which proposed a Eureka programme to push superconducting magnets to higher fields (10 T). Apart from the high energy physics interest, there are potential benefits for controlled thermonuclear fusion, nuclear magnetic resonance applications, mineral separation, coal purification, and several applications in electrical engineering (power storage,

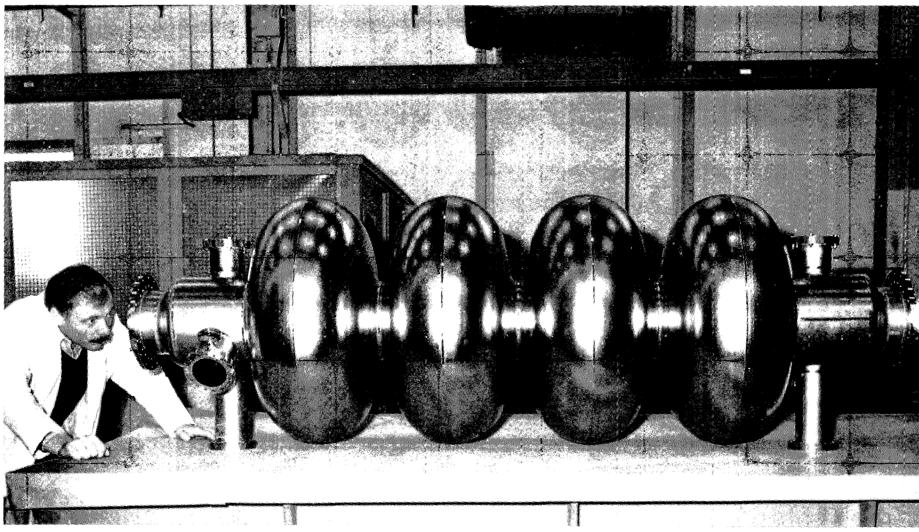


The equipment used at Intersection 8 of the CERN Intersecting Storage Rings with, to the right of the upper ladder, the large superconducting (quadrupole) magnet to squeeze the colliding beams. High field superconducting magnets are the subject of one initial proposal by European high energy physics Laboratories for European technological collaboration.

(Photo CERN 295.10.83)

A four-cell niobium superconducting radiofrequency cavity such as could be used in LEP to take the collider beam energies beyond 50 GeV. The technology which has been developed could have considerable applications in other fields. This is one of the topics being proposed as a Eureka project.

(Photo CERN 246.3.85)



generators and power transmission).

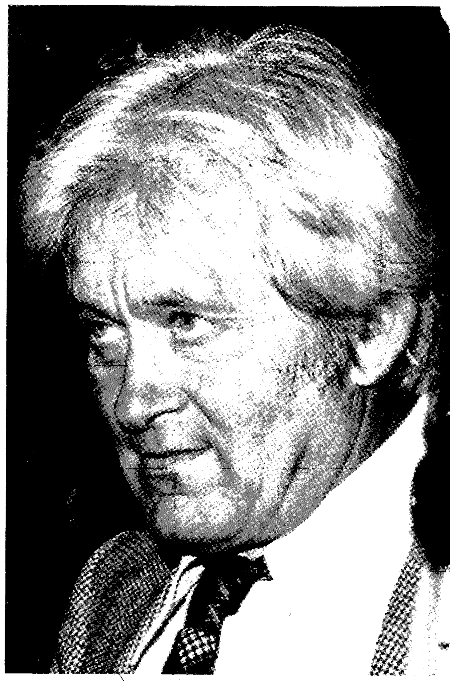
The development programme could consist of three parts — better conductor, appropriate magnet configurations and adequate cryogenic systems. The high energy physics Laboratories with expertise on these subjects are ready to act as catalysts to bring about multinational collaborations between industrial firms and to act as project co-ordinators.

A project for development of superconducting radiofrequency cavities is also gathering momentum. CERN has made great strides in this technology recently in view of the need for low power consumption cavities to take beam energies beyond the initial 50 GeV level in the LEP electron-positron collider. Mastery of industrial production of such power-efficient cavities would open applications in electron beam sources for free electron lasers, medical linacs, etc. Both the above projects would also lead to materials and cryogenics developments with further potential applications.

At the Hanover meeting, the concept of Eureka was supported more strongly than had been anticipated. The meeting did not discuss the proposals from the HEP community but they were received with great interest. The proposals remain on the table and others may follow. Industrial collaborations now have to be established so that the projects can earn Eureka status. This challenge offers a new way to ensure that particle physics research and development is fed back rapidly into the economies of the countries which support it.

Detector trends

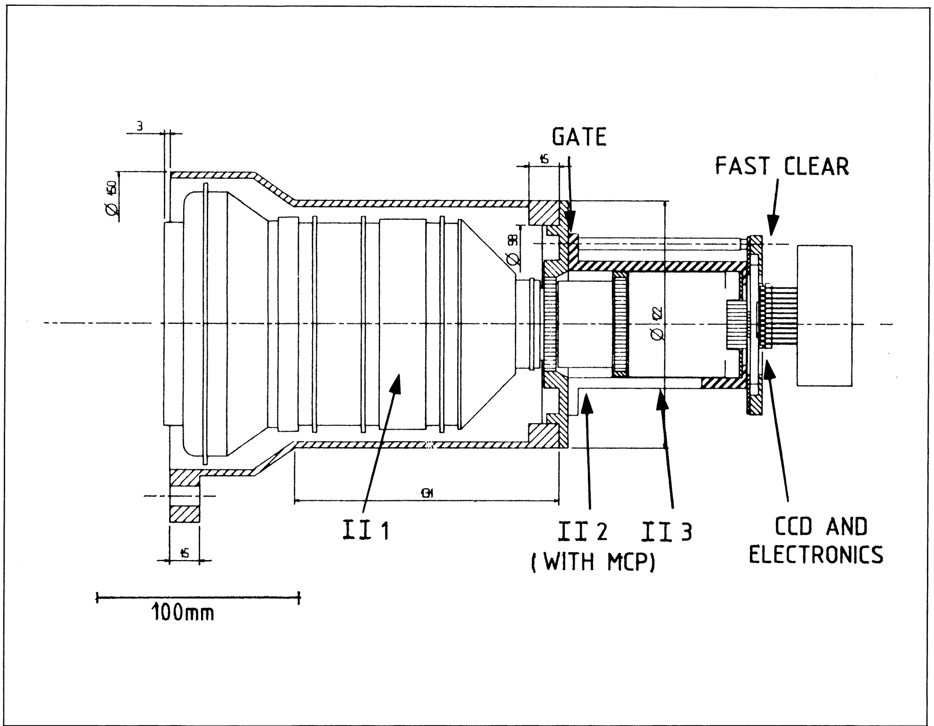
by Georges Charpak



Detector specialist Georges Charpak of CERN gave the review talk on detectors at the Lepton-Photon Symposium in Kyoto last summer, providing a useful snapshot of the work in this continually evolving field.

Every year sees the emergence of new breeds of detectors and the improvement of existing ones, but the innovations which go on to make a significant impact on physics research are limited. The large investment in man-years and money required for today's large experiments can cool the enthusiasm generated by new detector ideas. However many of the huge detectors now under construction or planned incorporate ideas which were once considered revolutionary, with no guarantee of success. The groups building these detectors are often the most active centres of detector research.

New detector techniques in action: the UA2 experiment's idea to exploit scintillating plastic fibres for its upgraded vertex detector. Light from the fibres is amplified by image intensifiers (II) and read out through a charge coupled device (CCD).



Tracking

Fixing the trajectories of the particles emerging from a collision can be accomplished by solid state or gaseous detectors. With rare particles having only a short lifetime, accuracy, with its possible concomitant space and cost reductions, is of increasing importance.

Semiconductor microstrips (see March 1982 issue, page 47) and charge coupled devices (CCD, see June 1982 issue, page 179) are now established techniques, allowing trajectories in a plane to be measured down to about 5 microns.

The initial disadvantage of microstrips was the overhead of large surface electronics, but this has diminished with the emergence of low cost, high density integrated circuits. The considerable advantages of CCDs have led to the development of improved readout to handle high data rates. Solid state drift chambers with their simpler readout also look promising.

Despite the emergence of solid state detectors, there is continual interest in the more traditional gaseous detectors, with their unrivalled flexibility and ease of construction for large surfaces. One development aimed at increasing accuracy is higher pressure, where 4 atm appears optimal.

In principle the position of an ionization cluster can be measured down to 20 microns, but difficulties arise from the geometry of the chamber wires and in measuring distances for particles not travelling exactly parallel to a wire plane. Tracks parallel to anode wires have been fixed down to about 60 microns.

New techniques strive to improve this accuracy by measuring separate ionization electron clusters (H. Walenta), by grouping small individual drift tubes (Stanford), or by fitting many sense wires inside a readily interchangeable carbon tube (CERN). Other developments aim at improving position measurements along the wires.

Visual detectors

Improving the optics of bubble chambers by holographic means (see October 1983 issue, page 317) has increased accuracies down to 10 microns. However the limitations of bubble chambers for handling many close tracks have led people to look instead towards streamer chambers. Illumination of ionization avalanches by laser light (Munich/CERN) permits smaller avalanches to be picked up. Accuracy is lost when ionization electrons start to diffuse before the triggering signal, but this can be overcome by a clever method (Yale) of temporarily attaching the electrons to a heavy (oxygen) ion, subsequently removed by laser irradiation.

At CERN, another development involves catching the avalanche electrons on mylar foil and developing the electrostatic image with an appropriate toner to give a track 'xerox'.

One new material now increasingly being used is scintillating optical fibre, offering possibilities for both tracking and, when embedded in heavy materials, for electromagnetic calorimetry (energy deposition measurement).

The UA2 experiment at the CERN Collider is using plastic scintillating fibres in its current upgrade (see Novembre 1985 issue, page 384). Other developments use glass fibres (Fermilab) and lead/fibre matrices for calorimetry (Saclay, see April 1984 issue, page 107).

Calorimetry

In the measurement of energy deposition, many developments aim to improve geometry, cost and energy resolution. Liquid argon calorimeters, a rarity not that long ago, are now firmly established, but work goes on to find liquids with more convenient ionization properties.

The electron yield of liquid argon can be improved by doping it with photosensitive liquids. However there is increasing effort to find suitable materials which operate at room temperature, in particular for the new calorimeter for the UA1 experiment at CERN (see November 1985 issue, page 384).

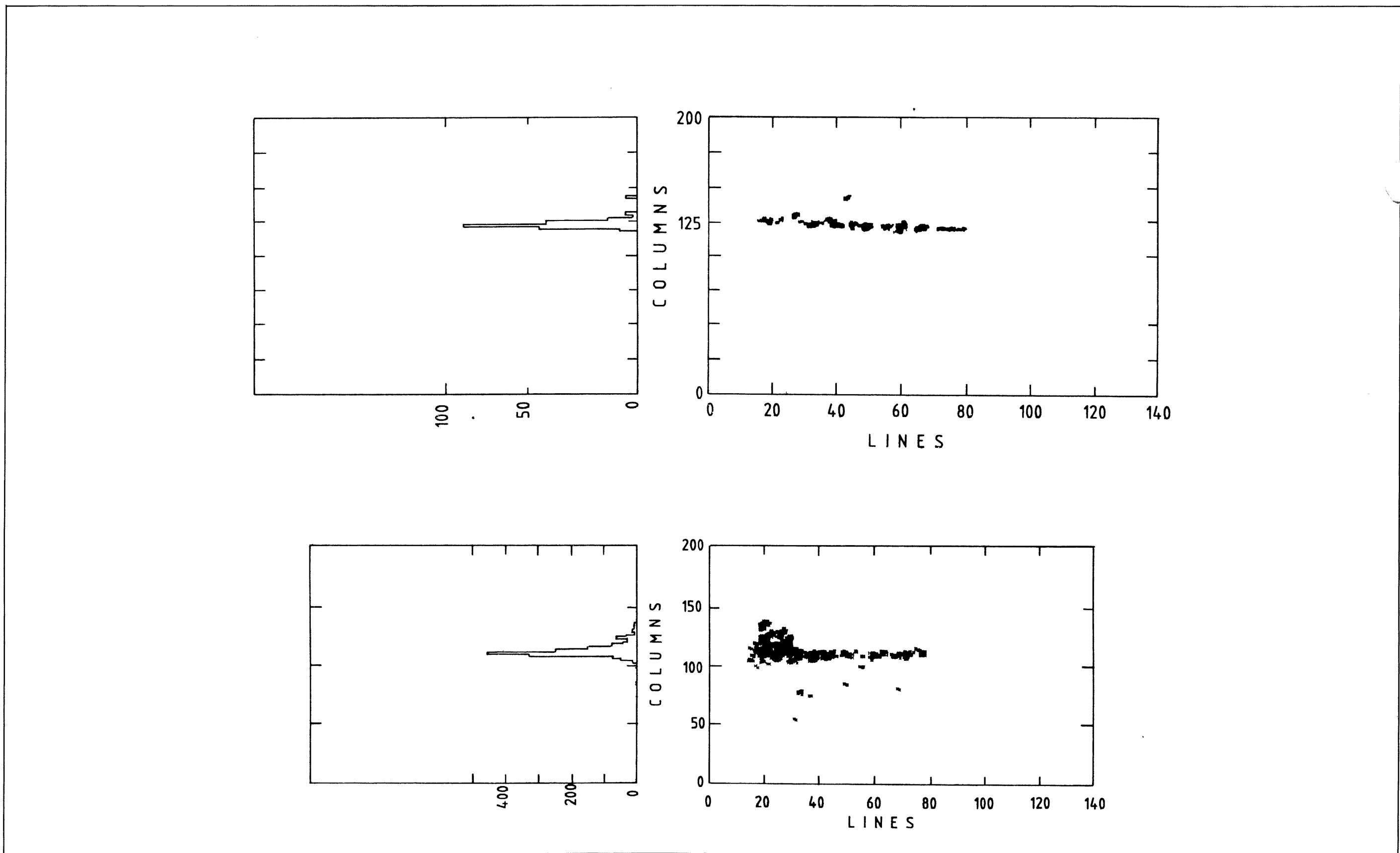
'New' methods for particle identification now being used include the Transition Radiation Detector, where optimal designs are now appearing, and the Ring Imaging Cherenkov (RICH). 100 m^2 of RICH will be installed in the DELPHI detector for CERN's new LEP electron-positron collider.

Heavy scintillators such as bismuth germanate (BGO) offer improved energy resolution for calorimetry. As a result of development work for the L3 experiment at LEP, the cost of BGO has been considerably reduced. However the more traditional and cheaper iodide materials continue to be attractive.

A newcomer material is barium fluoride, which permits scintillation photons to be measured in a wire chamber. This potentially considerable step forward, combining the photon stopping power of a heavy solid with the tested versatility of a wire chamber, enables energy deposition to be localized (see May 1984 issue, page 141).

One new and simple detector now being investigated at CERN relies on emitted light, rather than electronic signals, to localize ionization avalanches. A lot of work went into finding the best geometry and gas mixture (noble gases and triethylamine), and the payoff looks near.

If the hopes raised by these and other tests are fulfilled, experimental particle physics will have powerful new tools to exploit the conditions offered by the big machines now being built.



CCD images from a UA2 prototype array of fibres exposed to 40 GeV beams, showing (top) a hadron track, and (bottom), using lead radiator, an electron.

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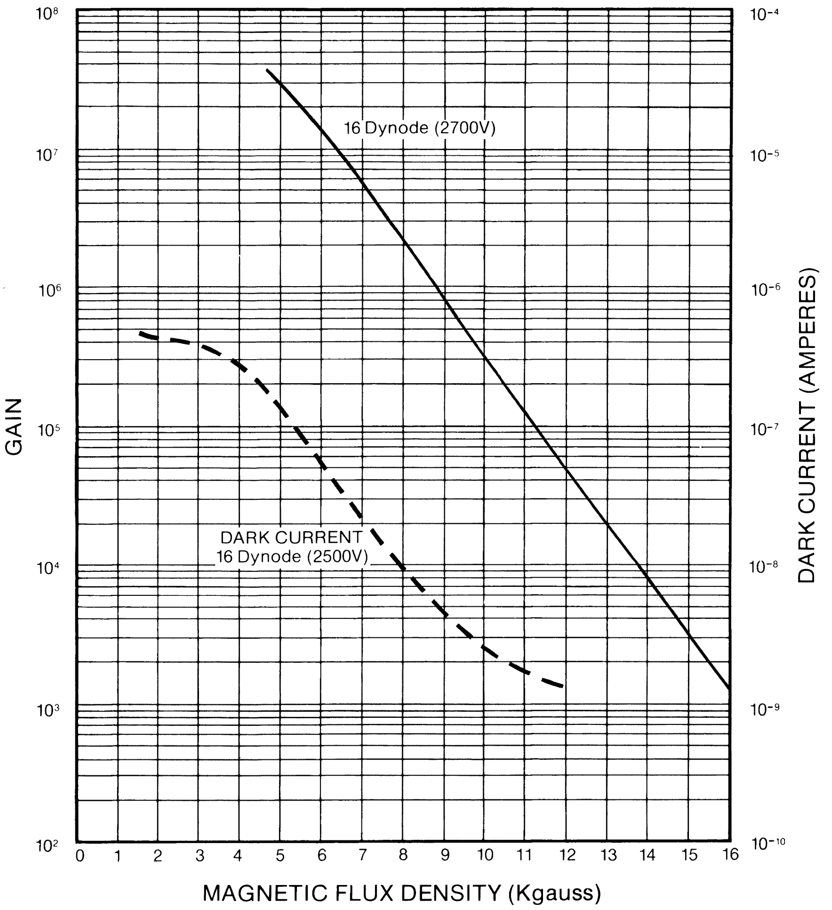

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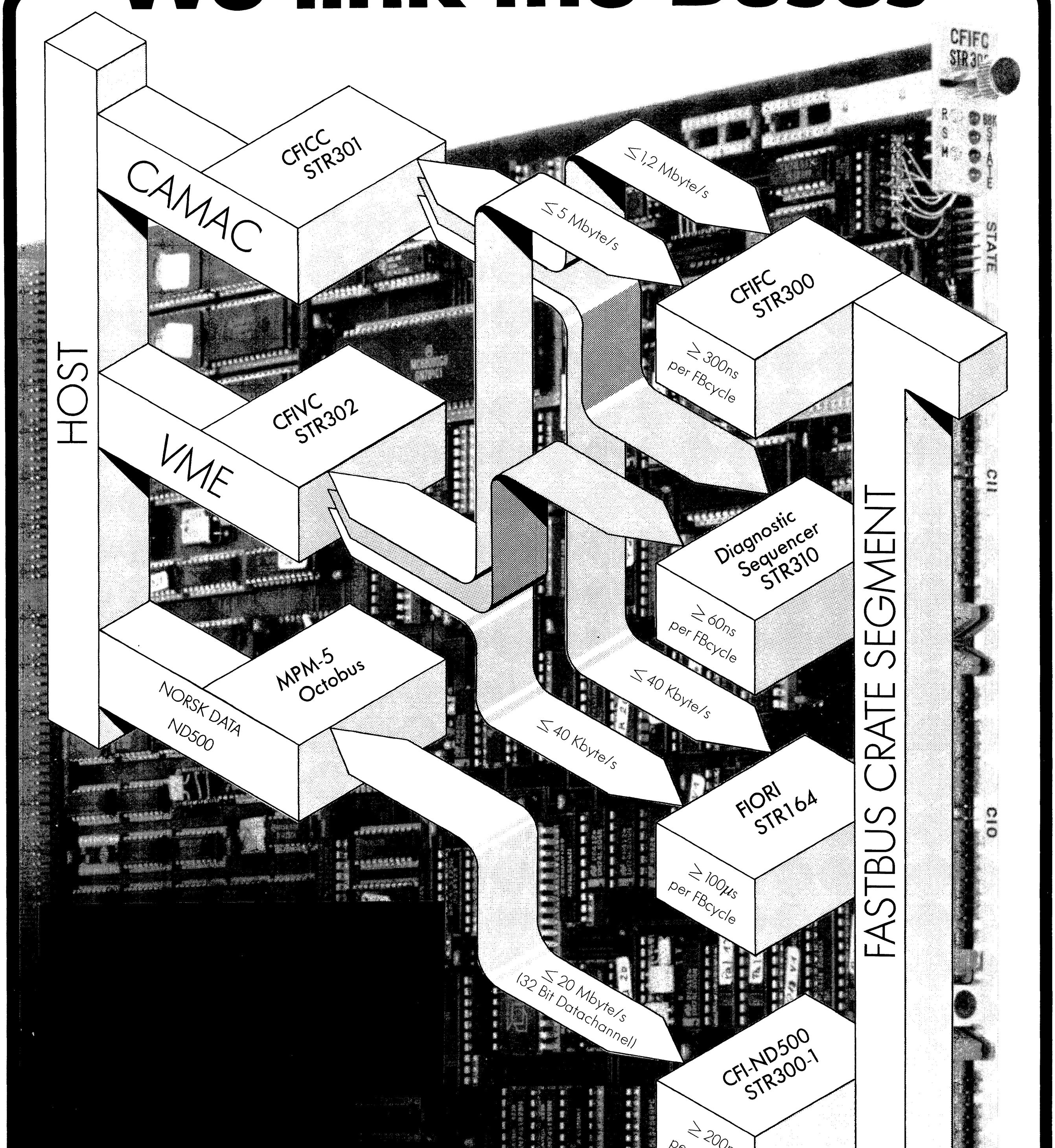

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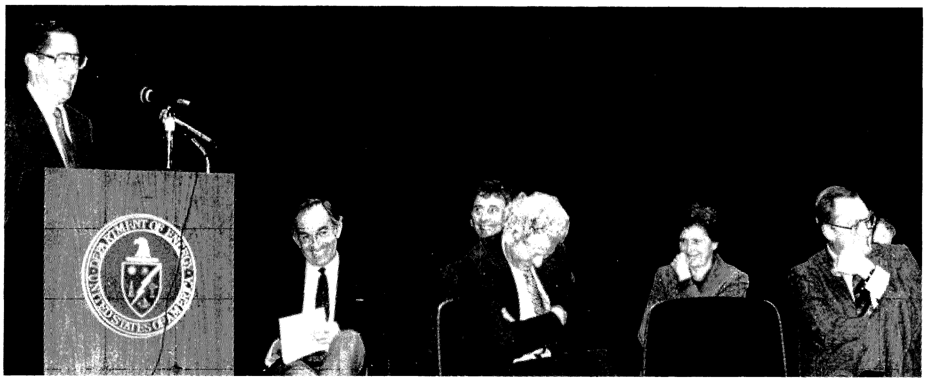
Dedicating Fermilab's Collider



At the official dedication of Fermilab's new proton-antiproton Collider, US Department of Energy Secretary Herrington's remarks amuse (left to right) Harry Woolf, John Peoples, Leon Lederman, Helen Edwards and Illinois Governor Jim Thompson.

It was a bold move to have a full-scale dedication ceremony for the new proton-antiproton Collider at the Fermilab Tevatron on 13 October, two days before the first collisions were seen.

However the particles dutifully behaved as required, and over the following weekend the Collider delivered its goods at a total energy of 1600 GeV, significantly boosting the world record for laboratory collisions (see December 1985 issue, page 419).

The impressive ceremony in Fermilab's Ramsey Auditorium was attended by Secretary Herrington of the US Department of Energy and Governor Thompson of Illinois, together with Harry Woolf, Director of the Institute for Advanced Studies and Chairman of the Universities Research Association (the Fermilab governing body) and serving as the chairman for the occasion. Other speakers in addition to Thompson and Herrington included Fermilab Director Leon Lederman, Lewis Branscomb — Visiting Professor for research at IBM, and Norman Hackerman — President Emeritus of Rice University. Daniel Terra, U.S. Cultural Arts Ambassador-at-Large, was present in that capacity. Joseph Salgado - Under Secretary of Energy, Alvin Trivelpiece - Director, DOE Office of Energy Research, and Edward Knapp - President of URA were also seated on the platform.

Lewis Branscomb opened the ceremony. 'Probing the innermost secrets of the physical world, and from them developing a detailed picture of how our Universe began in its first seconds, minutes, or hours, is along with the exploration of the origins of life, the intellectual 'Everest' of our time. We climb that mountain, not just because it is there, we climb it because we must, not to do so is unworthy of the talent given to us by our creator...

Today, here at Fermilab we are not looking at that Mount Everest from afar, awed by its massive scale, or perhaps threatened by its demeanour. We've been placed on a ledge at 29 thousand feet watching a few of our fellow humans who possess the gift, the zeal, and the commitment reach their hands over the ledges that lie between them and the summit, the summit of human knowledge about the world we inhabit. What a terrific time to be alive and what a wonderful place to be on this particular day!

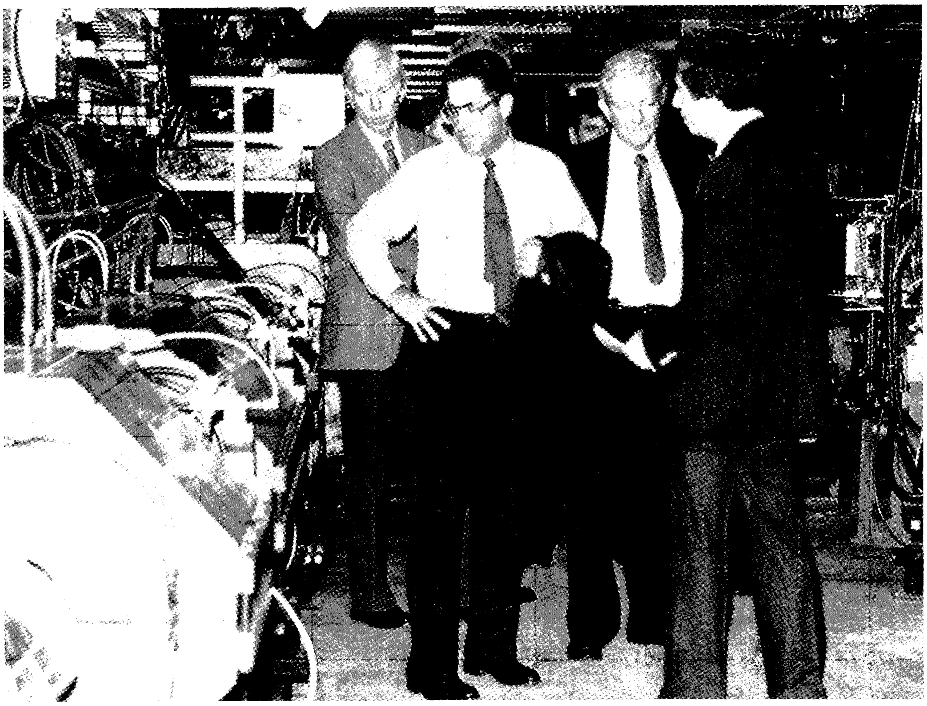
Particle accelerators have come a long way since Ernest Lawrence's little breadbox-sized cyclotron back in 1930, at the University of California. By the late 1940s, many cyclotrons were being built, at a cost of around a dollar per electron volt of energy. Today, for the $ 137 million that I understand it took to transform Fermilab's fixed-target proton synchrotron into the world's highest energy colliding beam machine, we hope soon to see two million million volts of energy equivalent, creating new matter in the collision of protons on antiprotons. I calculate that's a cost performance improvement of 700 million percent in 40 years!'

He then underlined the position of fundamental research: 'It is hard to think of any technology important to our economic competitiveness or our standard of living that has not been bolstered directly or indirectly by exploratory research into the fundamental aspects of matter and energy.

We can catalogue a number of practical immediate benefits that have real value from a project like the Tevatron. New ideas in technology and cryogenics, computing, and electrical engineering. Challenges for the vendor industries that support Fermilab. Most of all, an exceptional educational experience for hundreds of young scientists who will find their way into our universities, companies, and government laboratories. After this experience, they will never be satisfied with second best, with compromised goals, or easy work.

What applies to those students applies to our nation as a whole, and explains the most important reason for supporting scientific laboratories like Fermilab. No one seriously questions the federal government's primary responsibility for the nation's scientific vitality through the support of fundamental research. The tough question is how should the government select goals and projects to assure the

John Peoples explains the mysteries of antimatter storage on a tour of Fermilab's Antiproton Source prior to the formal Collider dedication ceremony.



greatest value from its basic research investment?

Government might well take a leaf from the book of experience in America's leading high-tech companies. We do not attempt to apply a micro-economic test to fundamental research projects. Instead we ask four questions: 'Will the project explore the limits of Nature, and will it provide us a road map to the future?'; 'Is the field of research one of interest and promise, touching on the basic issues governing our technical progress?'; 'Will the project give us a window on the scientific world, and let us understand, in-depth and quickly, the achievements of others?'; 'Will the project attract the brightest young scientists and engineers to the enterprise, bringing pride and honour and a sense of achievement?'; and, 'Will it engender in them the competence to accept equally risky commitments?'

The Department of Energy and Fermilab play this kind of role for the whole nation, indeed the world, in high energy physics and its related technologies, setting a standard for what constitutes scientific excellence and indeed excellence in engineering and project management... Fermilab challenges everybody else to stretch beyond what they might otherwise have been willing to accept as adequate performance...

This country has to commit itself to the most daring and rewarding of scientific goals... We will never reach the summit of that mountain of knowledge, but the climb will make our bodies strong and by keeping our eyes up instead of down, will prepare us for whatever challenges lie ahead.'

Secretary Herrington also brought good news. 'I had the privilege to sit in at a Cabinet Meeting recently, when John Young, who was the President of Hewlett-Packard at the time, chaired the President's Commission on Industrial Competitiveness. They were reporting back to the President and the Cabinet on America's position in the world, and pointed out that this country must exploit its advantages, the things we are doing well. They identified one particular thing, and that was our National Laboratories and the work in pure science and the ability to exchange ideas.

President Reagan has a strong belief in the importance of science and technology to our nation's future. He believes in the excellence of education and in basic research. This has resulted in the continued support for basic research even in this period of budget cutbacks. He recognizes, just as I do, that in order to be strong as a nation, we are going to have to be strong in science.

High energy physics receives more than 90 per cent of its support from the Department of Energy. This support has made possible the research that has contributed to much of our knowledge of the fundamental structure of matter. At the same time, this research has stimulated the development of various technologies. It has become a source of national pride through the recognition of accomplishments by the awarding of Nobel Prizes to over 40 individuals. This project represents one of the best examples of how government support of basic research advances our nation's goals.

I want to congratulate all of you that had a hand in bringing this about. This includes the scientists and engineers who conceived of the ideas and developed them. But last, and far from least, I want to congratulate Bob Wilson and Leon Lederman for their leadership in guiding the building and the operation of this Laboratory.'

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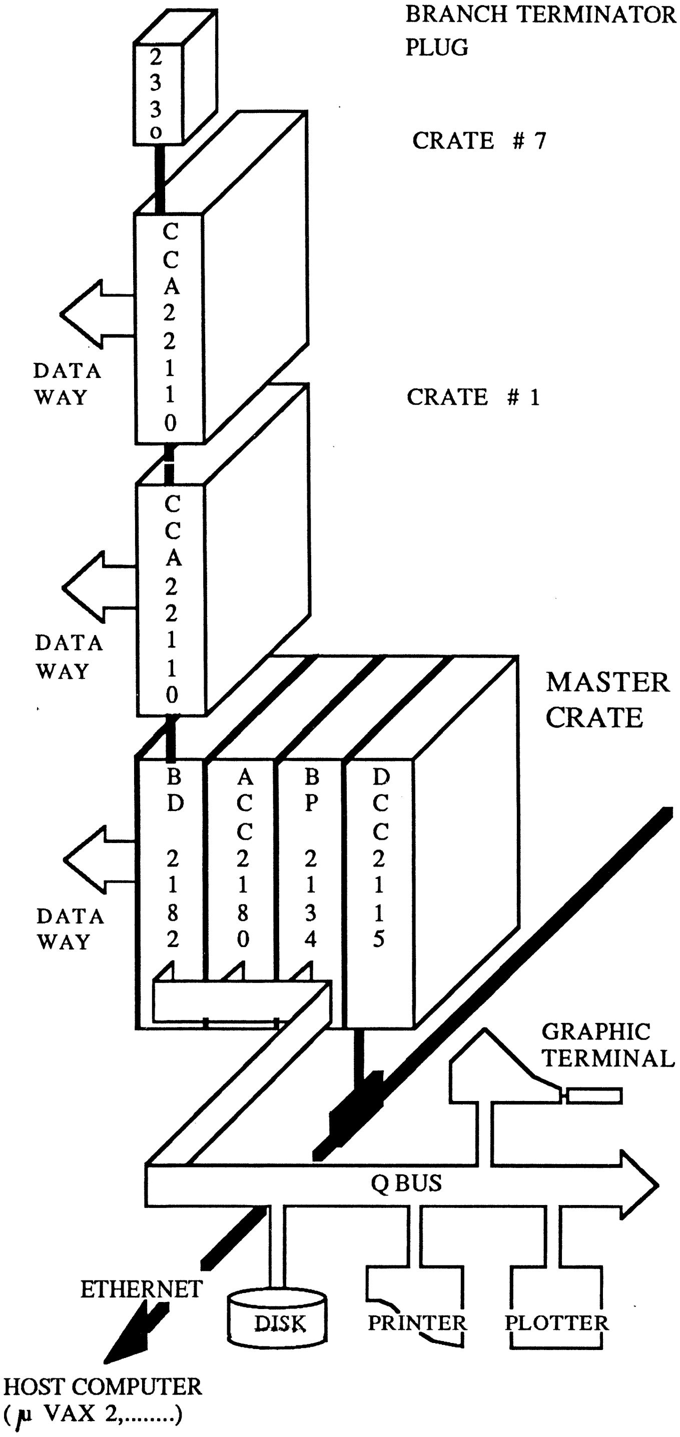

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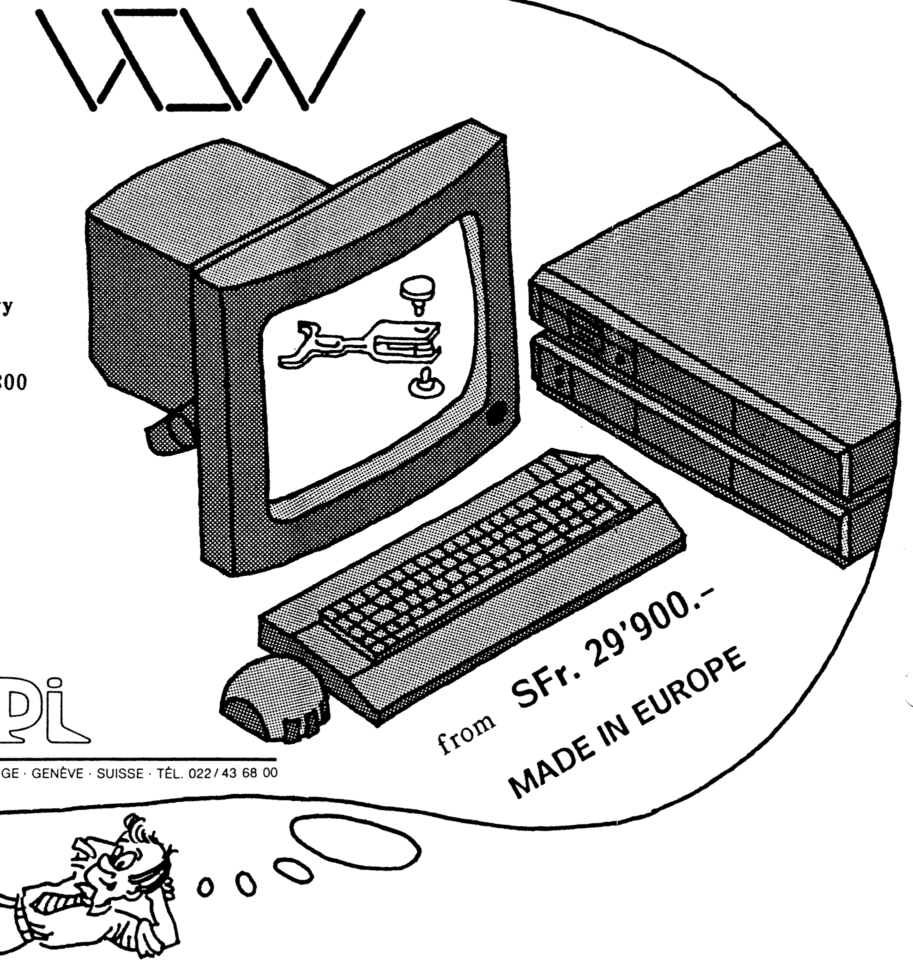

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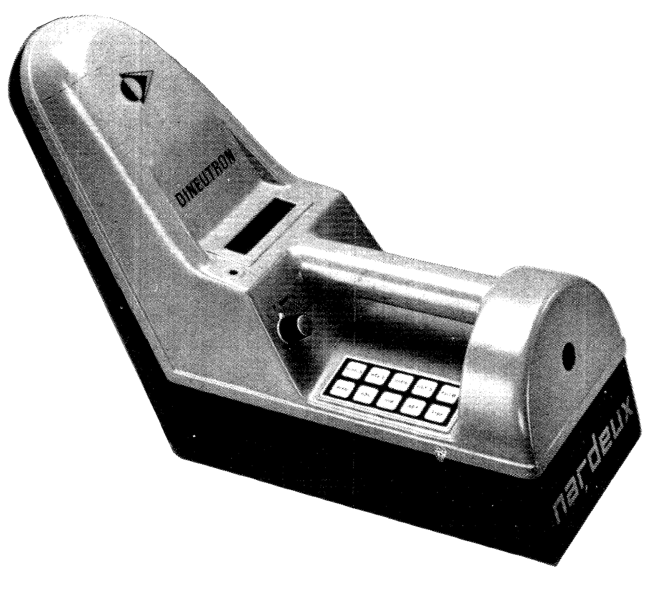

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Around the Laboratories

SUPERCOLLIDER Endorsement

Coinciding with the magnet selection decision for the US Superconducting Super Collider (the high field design, see November 1985 issue, page 383), many of the leading figures of the US particle physics community were together at the home of the SSC Central Design Group at Berkeley. A meeting, organized by Jack Sandweiss (Chairman of HEPAP) and Jim Cronin (Chairman of the Division of Particles and Fields), reviewed progress on the SSC project.

At the conclusion of the meeting, the following statement received the support of the participants:

'As a group with varied responsibilities within the US high energy physics community, we wish to emphasize the vital importance of the Superconducting Super Collider (SSC) for the future of elementary particle physics. An accelerator probing the several TeV mass scale by the mid-1990s is indispensable for continuing the remarkable recent progress in understanding the fundamental structure of matter.

The Department of Energy's contribution to the SSC R&D effort recently achieved a major milestone with the selection of the magnet type to be used in the SSC design. This is the most important part of a larger R&D effort that to date has met or surpassed all goals originally set, placing the project in position to achieve a completed accelerator by the mid-1990s. However, to maintain this date as a realistic target, increased SSC R&D funding is a necessity. Such increased support is also required to involve industry substantially in the design and fabrication of the SSC components at an early stage so that completion of the SSC by the mid-1990s will be a realistic goal.

Under the coordination of the Central Design Group, high energy physics Laboratories, universities, and industry have worked together on a nationwide basis. The success of this unique collaborative effort reflects a widespread appreciation of the importance of the SSC.

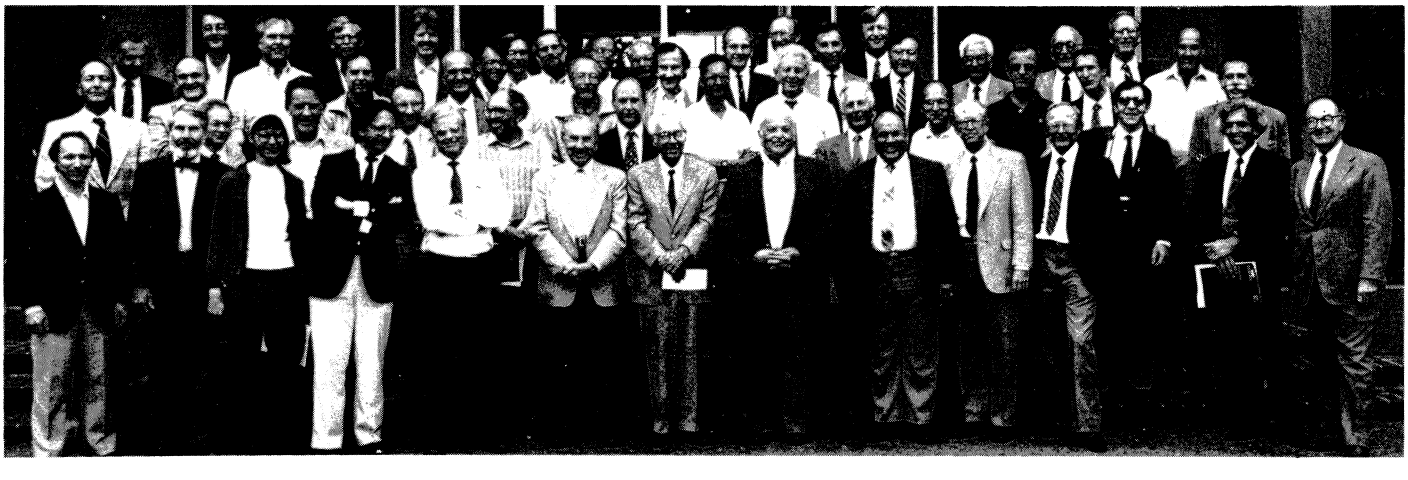
We understand the need for further discussion on project approval and the responsibilities the projected costs imply. We also recognize the need for increased international collaboration and the importance of providing the SSC funds without adverse effects on other basic sciences. Recognizing all these considerations, we urge that great emphasis be given to the effort to make the SSC a reality.

In the past 15 years, a vast amount of experimental data on the strong, weak, and electromagnetic interactions has been understood in terms of a set of constituent particles and a well defined theory of their interactions. Present knowledge indicates a further synthesis at high energies with important implications for an understanding of the very large scale structure of the universe as well as for the very small. Such a synthesis has observable consequences in the multi-TeV mass range. The SSC is essential for exploring the new energy region and will reveal fundamental aspects of this synthesis.'

The list of 57 names of those endorsing the statement, from Abolins thru Zeller, reads like a 'Who's Who' of US particle physics.

A galaxy of US particle physics stars were at a meeting at Berkeley to review and enthusiastically endorse the Superconducting Super Collider project.

(Photo LBL)



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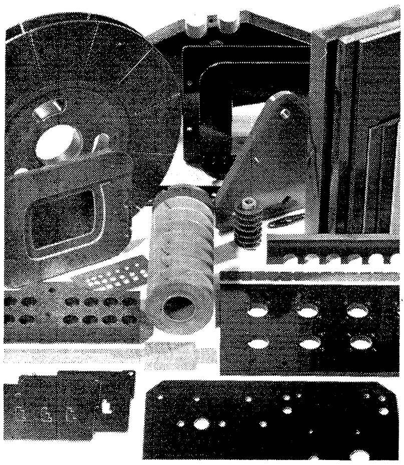

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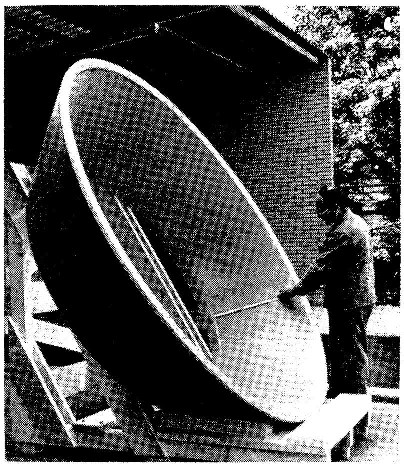

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1995 and all that

Last year the US High Energy Physics Advisory Panel (HEPAP) carried out an in-depth study of the US high energy programme projected over the next ten years.

The Panel concluded that the physics justification for a multi-TeV, high luminosity hadron-hadron collider (the proposed Superconducting Super Collider, SSC) is even stronger today than it was in 1983 at the time of the original HEPAP recommendation. Furthermore, the technical successes achieved in the SSC research and development programme reinforce the confidence that this facility can be built within the costs and on the timescale estimated in the Reference Design Study.

The Panel identified projects which, because of their intrinsic importance, their likely impact on the course of future research, and their key role in the US programme should be given priority: the Collider Detector Facility (CDF) and DO projects at the Fermilab Tevatron, the L3 programme at LEP at CERN, the Mark II and Stanford Linear Detector (SLD) projects at the Stanford linac, and the CESR programme at Cornell. The Panel also considered the smaller scale efforts involving studies of CP violation with kaons, high sensitivity studies of rare kaon decays, and certain parts of the non-accelerator programme to be in this priority category.

But the Panel felt that the SSC will require major redirection of high energy physics resources during the next ten years. However a reasonable transition into the SSC programme will be possible. Some of the existing programmes will be terminating just as extensive effort on SSC detectors will need to commence. The timely completion of the SSC will provide a truly forefront facility for the world's high energy physics community. The Panel noted, however, the inevitable deterioration of the US programme and the difficulty of maintaining continuity of the field if the SSC were delayed appreciably beyond the presently-anticipated timescale. If this were the case, there would be no frontier facility in high energy physics in the US in the mid-1990s.

Finally, the Panel stressed the importance of maintaining and strengthening the technology research in advanced accelerator R&D. This research is essential to long term progress.

RUTHERFORD APPLETON: KARMEN

Although primarily built to provide neutrons, the new Spallation Source at Rutherford Appleton, recently named ISIS by UK Prime Minister Margaret Thatcher (see December 1985 issue, page 435) is also a unique source of neutrinos.

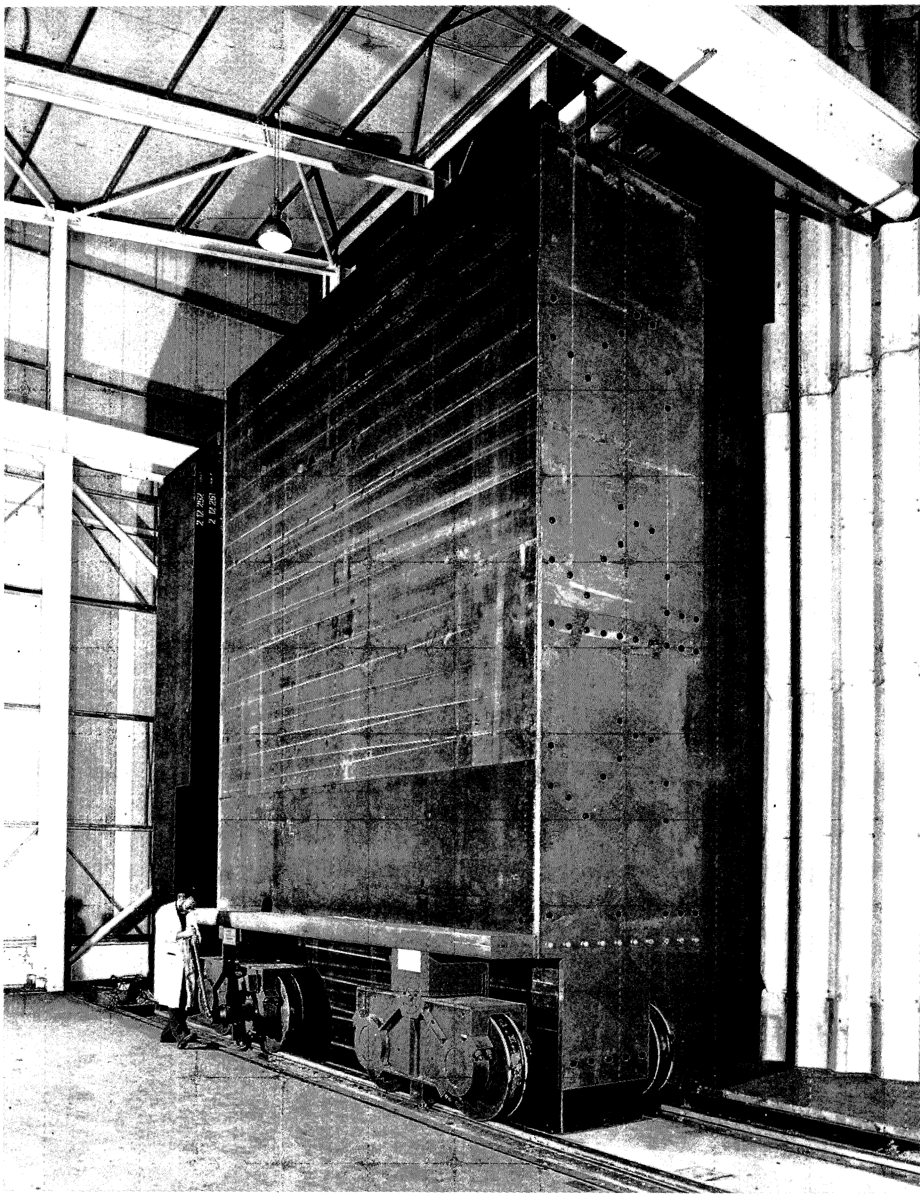
The short time pulses of the accelerator (2 x 100 nsec every 20 milliseconds) would give two pulses of neutrinos separated in time. The first pulse (of muon-type neutrinos) occurs on a nanosecond timescale from the decay of secondary pions. Milliseconds later comes a second pulse (electron-type neutrinos and muon-type antineutrinos) resulting from the disintegration of muons also produced in the decay of the secondary pions.

At full intensity, ISIS will produce 5×10^{13} neutrinos per second of each type. The muon neutrinos from pion decay will be monoenergetic at 30 MeV while those in the delayed pulse will cover an energy band up to 53 MeV.

The experiment to exploit these neutrinos is known as KARMEN — Karlsruhe Rutherford Medium Energy Neutrino experiment. Funded extensively by West Germany, it involves a collaboration of Karlsruhe (Kernforschungszentrum and University), Erlangen, Oxford, Queen Mary College London and Rutherford Appleton.

To better isolate the neutrino interactions, the detecting equipment will be housed in a 5700 ton steel blockhouse built of 486 carefully dovetailed iron slabs.

The 600 ton sliding door of the KARMEN neutrino blockhouse being handcranked into place.



There will be two detector systems; one a total energy calorimeter using liquid scintillator and the other a high precision tracking device for measuring details of neutrino-electron scattering. Each will weigh around 50 tons and be moved in and out of the bunker on air pads.

The first of these detectors is well on the way to completion. It uses 60 000 litres of mineral oil liquid scintillator to observe neutrino induced reactions with carbon and hydrogen nuclei of the organic material. Very thin totally reflecting double lucite layers are assembled to provide a structure of 512 optically separated modules (18 cm x 17.4 cm x 350 cm) viewed at each end by two phototubes. A total of 2300 phototubes are presently under test at RAL.

The double-walled tank containing the scintillator is contained in an inner 18 cm iron shield which also provides mechanical strength. An active plastic scintillator veto shield outside will identify cosmic ray background which penetrates the main iron shield.

It is hoped that the first neutrinos will be detected this year, and a series of neutrino studies initiated. The big question marks still hanging over neutrinos are whether they have mass, and whether the different types mix (neutrino oscillations). KARMEN, supplied by a unique source of medium energy neutrinos, could go on to make significant contributions to physics.

Together at the inauguration of the KARMEN neutrino facility at the Rutherford Appleton Laboratory — left to right, RAL Director Geoff Manning, and Bernhard Zeitnitz and Wolfgang Klose of Karlsruhe's Kernforschungszentrum (KfK). KARMEN is extensively funded by West Germany.

(Photos RAL)

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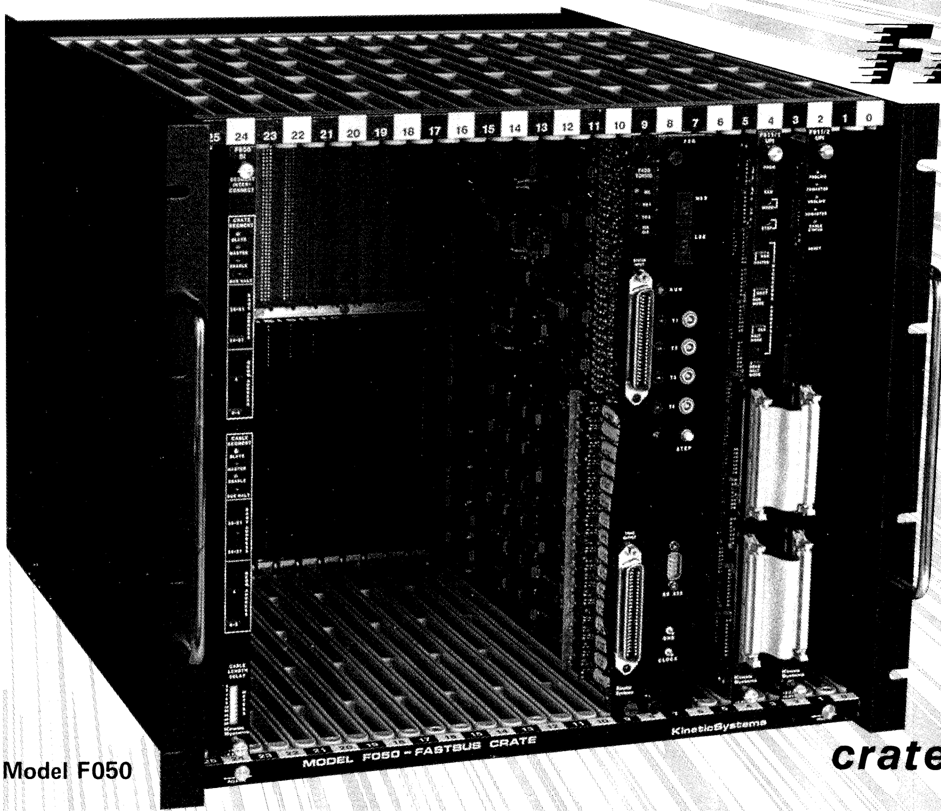

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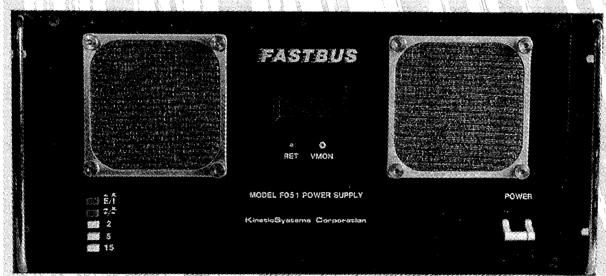

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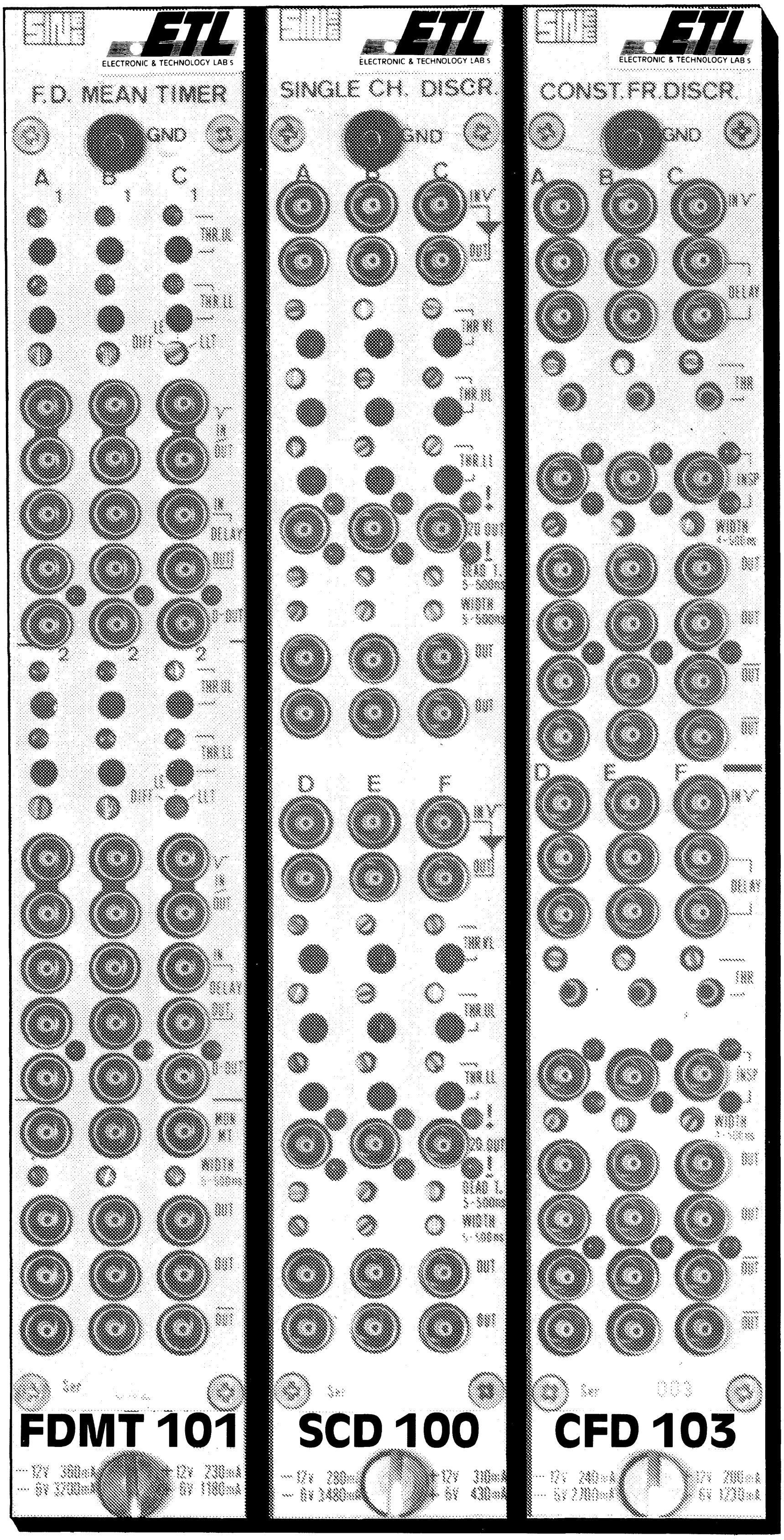

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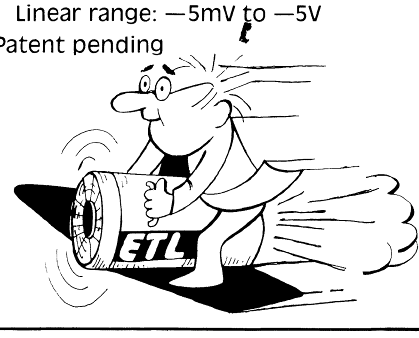

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Pole apart?

Ask a physicist whether an unconventional particle or phenomenon exists or not and he will most likely reply 'the experimental limit so far is less than x', where x is some mighty small number.

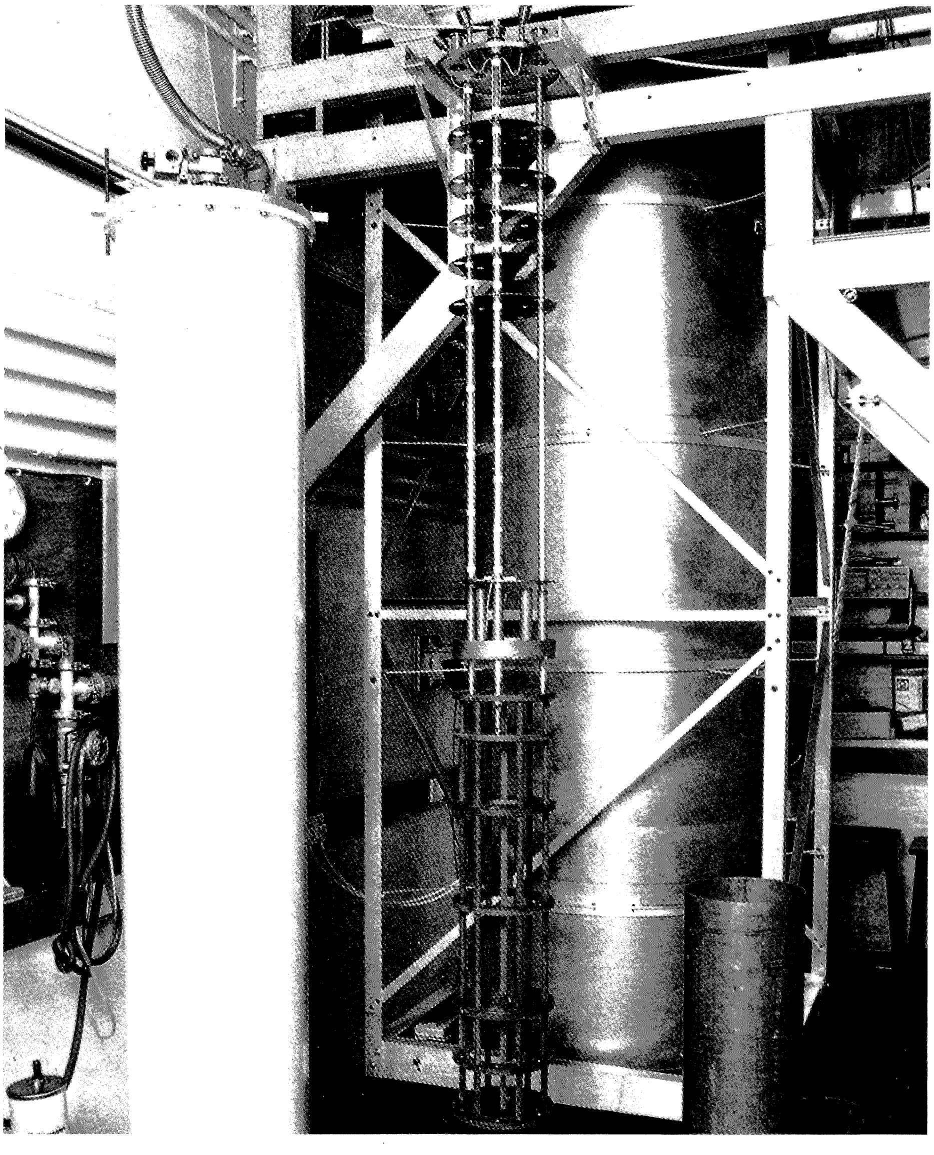
After 340 days of closely monitored running, a sophisticated Superconducting Quantum Interference Device — SQUID — operated by a team at London's Imperial College in South Kensington had nothing to report: another painstaking experiment diligently chipping away at the observational limits of something which might not be there anyway.

Then on 11 August last year came the 'South Kensington Event' — a signal compatible with the passage of a lone magnetic charge — a magnetic monopole — through a 0.2 m² loop in the magnetic vacuum of the apparatus.

The reluctance of free magnetic poles to show themselves has long intrigued physicists, as the equations of classical electromagnetism appear symmetric with respect to electric and magnetic charge. Earlier this century, Paul Dirac revived interest in magnetic monopoles, and the quest received a further boost by the formulation of bold new theories which postulated the existence of huge monopoles, relics of the 'Big Bang'. These primordial monopoles could be so big as to be weighable, and would give important clues to the mechanisms which shaped the early Universe.

Several years ago, excitement rose when a SQUID at Stanford reported a monopole-like signal in its two-inch induction detector. However this was soon found to be incompatible with limits established by ionization detectors and the event was discounted. Using improved and larger detectors, teams at Stanford and elsewhere saw no further candidates, until the 'South Kensington Event' came along.

The London team have looked at all kinds of explanations, some of which have been ruled out, others deemed unlikely but nevertheless possible. It is still too early to say that a free magnetic charge has definitely been seen, and the delicate magnetometers continue running.



The inductive detector at Imperial College, London, which has recorded a candidate magnetic monopole, seen here prior to assembly. The detector loop framework, suspended on three stainless steel tubes, is in the centre. On the right is the top half of the lead shield which surrounds the detector loops. The 100-litre helium cryostat is on the left. The detector loops and cryostat are assembled within a nest of five magnetic shields (background) weighing about 0.5 tonne, which is suspended on anti-vibration mounts. The overall height of the detector is about 3m.

(Photo I. C. Physics Photographic Group)

CERN Accelerator School

Since its creation in 1983, the CERN Accelerator School has been under the leadership of Kjell Johnsen. With the school well established and having one workshop and four courses to its credit (for a report on the most recent at Oxford see next page), Kjell Johnsen handed over the leadership to Phil Bryant on 1 October 1985. This change has enabled Kjell Johnsen to take on a new role as Chairman of an Advisory Panel on new ideas for electron-positron Colliders for CERN as part of Carlo Rubbia's Working Group on the

Don Perkins welcomes participants at the CERN Accelerator School's Advanced Accelerator Physics Course to a reception at the Sheldonian Theatre.

Hildred Blewett and John Mulvey at the Accelerator School banquet at The Queen's College, Oxford.

Scientific and Technological Long-term Future of CERN (see July/August 1985 issue, page 241).

Meanwhile the Accelerator School moves on, with three courses planned for this year. The first is a specialized one-week course 'Applied Geodesy for Particle Accelerator' from 1 April at CERN. In this field CERN has a preeminent position under the leadership of Jean Gervaise. The second course will be on basic general accelerator physics and will be held in Aarhus, Denmark, from 15-26 September. Finally, plans are now underway for the next specialized course in the series of joint courses with the US School on High Energy Particle Accelerators, to be held in the US towards the end of the year. Further information and application forms from Mrs. S. von Wartburg, LEP Division, CERN, 1211 Geneva 23.

School report

The CERN Accelerator School (CAS) offers a regular course on general accelerator physics. The first basic course was given in September 1984 at Orsay, France, and last September the advanced course was jointly organized by CAS, Oxford's Nuclear Physics Laboratory and the Rutherford Appleton Laboratory, and held at The Queen's College, Oxford.

The 140 participants came mainly from Europe, but there were 12 from the US and Canada and a few from other parts of the world. They spent two weeks in beautiful surroundings but a modest level of personal comfort.

The first week concentrated on single particle dynamics with all the subtle nonlinear effects and couplings which affect the lifetime of stored beams. The week started with an introduction to the Hamiltonian formalism needed for the analysis of these phenomena, requiring an appreciable effort by the students. The stocks of a certain famous textbook on classical mechanics were quickly exhausted in the local bookshops. As one participant remarked, 'after having bought it you already feel better'.

The first week also included an introduction to plasma physics and the Vlasov and Fokker Planck equations, which prepared the ground for the study of collective phenomena in the second week, such as bunched-beam instabilities, stochastic cooling and electron cooling, beam loading, etc.

The lecture programme reflected the enthusiasm of the lecturers but was balanced by a series of afternoon seminars on more technological topics of current interest, including superconducting accelerating cavities. In addition there were visits to the JET project at Culham and the neutron spallation source at the Rutherford Appleton Laboratory.

By Ernst Haebel

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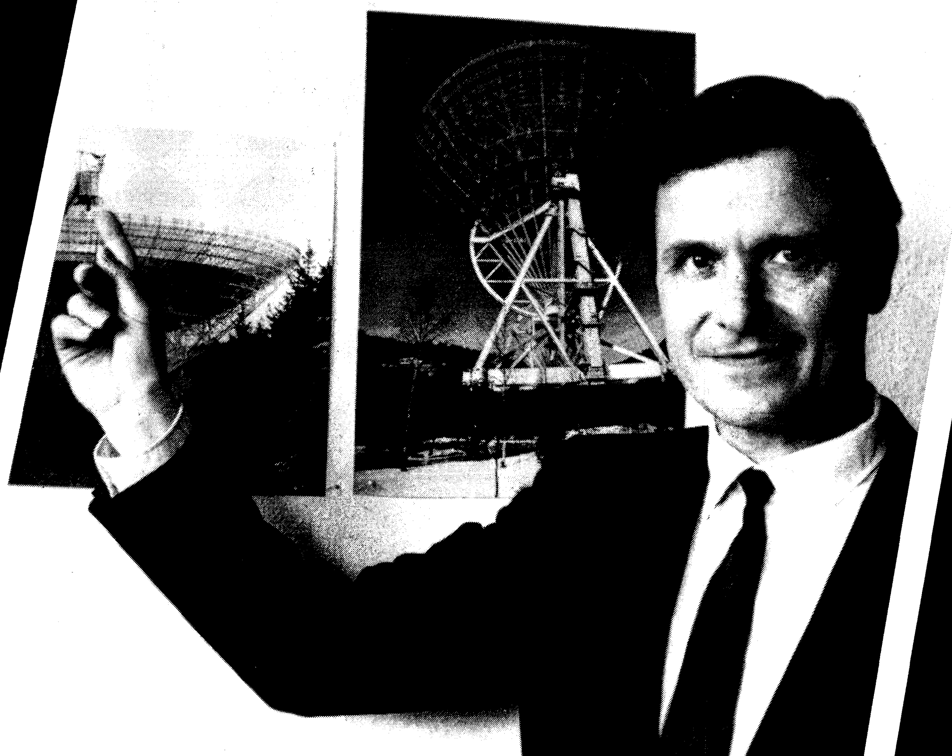

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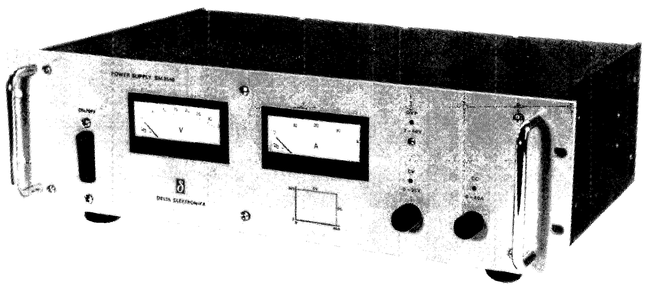

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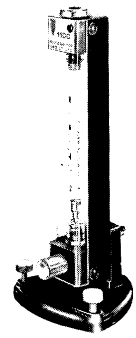

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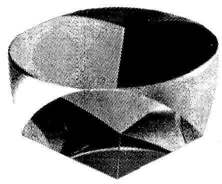

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Overview of the Brookhaven site, showing how the newly approved Booster will fit in with the existing installations and with the proposed Relativistic Heavy Ion Collider, RHIC, using the empty tunnel built for the CBA project.

(Photo Brookhaven)

BROOKHAVEN
Booster boost

Approval has been given for a 1 GeV Booster synchrotron which should significantly extend the research potential with high energy beams at Brookhaven. The initial funding covers design groundwork and some construction, and with anticipated funding over the next few years the machine and all new interconnections should be finished by 1989.

Several years ago, serious thinking began on how Brookhaven's high energy resources could be best adapted for future needs. One thing which soon became clear was the need to increase the number of particles which could be handled in the faithful Alternating Gradient Synchrotron, now in its 26th year of operation.

The initial proposal for a 2.5 GeV Booster was soon changed to a more modest 1 GeV machine. With the new booster taking the low energy particles from the injector, the AGS main ring will be able to accelerate up to 5.6×10^{13} protons per pulse, a factor of four up on the present performance (1.5×10^{13}).

Users of polarized (spin oriented) proton beams will be relatively even better off, with intensities up twenty times, from 2×10^{10} protons per pulse to 4×10^{11}, making polarized particles no longer a luxury.

The third payoff will be in the programme for heavy ions, where a new transfer line was completed last year to take particles from the tandem Van de Graaff to the AGS. With the present setup, the heaviest ions which can be handled are sulphur, mass 32 units. However with the Booster, much heavier ions could be stripped of all their electrons prior to injection into the AGS. (Acceleration of only partially stripped ions requires a higher vacuum than is available in the AGS.)

The new Booster would also be a step towards Brookhaven's dream of a Relativistic Heavy Ion Collider (RHIC) in the tunnel from the abandoned CBA project and which would enable nuclear matter to be studied under very different conditions. Research and development work for possible RHIC components, particularly superconducting magnets (see October 1985 issue, page 331), is already underway.

STANFORD
Led to lead

After extensive tests and studies, the team building the SLD detector for the Stanford Linear Collider, also under construction, have elected to use a conventional calorimeter design based on lead and liquid argon, while teams building new detectors for use at other machines are looking towards less conventional techniques.

For these new detectors, the emphasis for energy measurement is turning away from individual particles and towards the collimated clusters or 'jets' considered to be the result of quark and gluon interactions.

For these jets the problem is the response of the calorimeter to different types of particles, in particular to electrons and hadrons. These lose energy in very different ways, and designers of new detectors (or of upgrades to existing ones) have looked at ways of compensating for this difference.

Electrons (deriving from the decay of copiously produced neutral pions) prefer to produce showers of lower energy particles which then lose energy through ionization in the detector. On the other hand hadrons lose energy through nuclear interactions during the formation of showers. This energy is 'lost', and the performance of the detector can be degraded by the different behaviour of hadrons and electrons.

One solution developed by the CERN / Dortmund / Heidelberg Saclay/Warsaw neutrino group was to build in an appropriate weighing algorithm. Another idea, also put forward at CERN, was to use uranium plates so that some of the otherwise undetectable hadron energy producing low energy particles would induce fission in the uranium, putting particles back into circulation and making up for the lost energy.

Uranium calorimetry was a feature of the big detector used by a Brookhaven / Cambridge / CERN / Copenhagen / London (Queen Mary College) / Lund / Pennsylvania / Pittsburgh / Rutherford / Tel Aviv team which studied interactions with large transverse momentum at the CERN Intersecting Storage Rings.

Some of these physicists have moved on to the NA 34 'HELIOS' experiment on lepton production at the CERN Super Proton Synchrotron (see September 1984 issue, page 280), for which uranium/liquid argon calorimetry is being constructed.

The team building the DO detector for Fermilab's Tevatron collider are looking towards a uranium/liquid argon sampling calorimeter (see October 1985 issue, page 384). For the upgrade of the UA1 experiment at the CERN Collider, thinking is also turning towards uranium but possibly with a room temperature liquid as the detecting medium, if this can be made to work satisfactorily (see November 1985 issue, page 384).

However the SLD team at Stanford had some indications that the compensation mechanism was smaller than expected, at least in the configuration under study. However in heavy materials, additional absorption effects with electromagnetic particles could also come into play, and would help bring the electron and hadron signals in line. These effects would also occur in a heavy but non-fissionable material like lead. The Stanford team also felt more comfortable with an easier construction technique.

This new detector work was highlighted by a Workshop on Compensated Calorimetry, held at Caltech last September, which included results from tests by SLD and DO teams using uranium/liquid argon prototypes and from UA1 using an uranium/scintillator approach.

Also covered were new ideas based on photosensitive dopants in liquid argon, the use of warm liquids as envisaged by UA1, and barium fluoride. Results were also presented from computer simulations of hadron cascades.

Work in progress on the innards of one of the uranium-based calorimeter prototypes tested last year for the SLD detector being built for Stanford's new Linear Collider. After extensive studies, a lead-liquid argon design was chosen.

(Photo Stanford)

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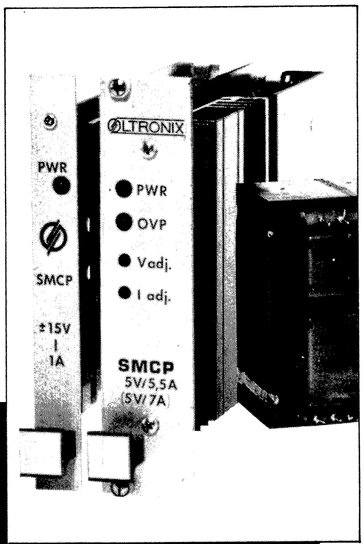

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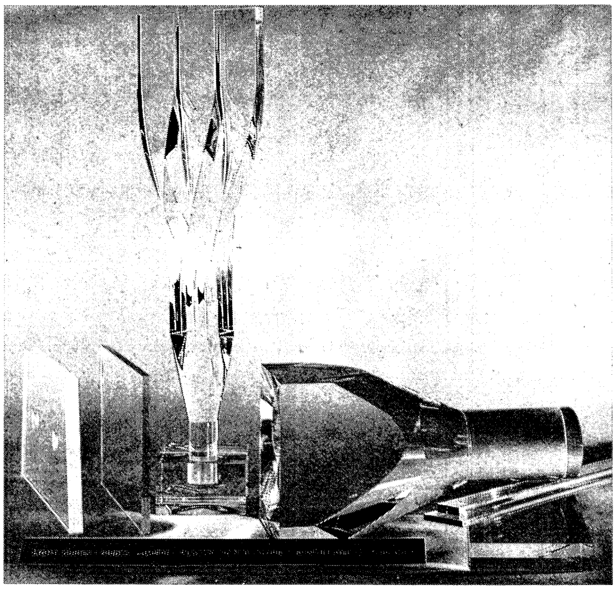

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At the DESY Theory Workshop, left to right, Christoph Wetterich and Fridger and Barbara Schrempp.

(Photo DESY)

DESY
Physics at the Fermi scale

The theme of the traditional DESY Theory Workshop, held last October, was 'Physics at the Fermi scale' (the energy region near 90 GeV, covering the masses of the W and Z bosons which carry the weak force). Fourteen lecturers presented experimental results and theoretical ideas on the origin of the electroweak symmetry breaking, while younger physicists added short but useful contributions.

The Workshop started with a thorough review by W. Marciano (Brookhaven) of the status of radiative corrections in the standard model. Marciano ended his balanced talk in a more speculative vein, by suggesting that possible small discrepancies in the Kobayashi-Maskawa matrix (three generations of quarks) could signal the existence of a fourth quark generation. R. Eichler (SIN) followed with a discussion of the impressive progress achieved in setting bounds on rare processes. He also discussed future ideas on high intensity kaon factories which may one day push these bounds even further down (or even discover a violation of the standard model!).

The second day of the Workshop became more speculative, with discussions turning to (quark) substructure. H. Georgi (Harvard) explained his idea of composite Higgs bosons and how this can generate small masses for composite quarks and leptons. Although it is too early to tell whether Georgi's scheme is valid, his 'Moose' calculus seems a friendly animal.

Barbara Schrempp (Hamburg) clearly explained some of the results of having the Higgs sector strongly coupled. She suggested that, contrary to initial expectations, one should expect a broad resonance to remain in the spectrum, even for very large coupling.

Haim Harari (Weizmann), after officially welcoming Georgi to the compositeness fold, presented a comprehensive overview of the achievements and the problems of composite models. He emphasized how (colour octet) composite neutrinos may exist and provide a first look into the next layer of matter.

These theoretical speculations were balanced by two experimental talks by S. Yamada (Tokyo) and M. Jonker (SLAC). Yamada comprehensively reviewed the limits obtained at high energy electron-positron storage rings on phenomena beyond the standard model, indicating the bounds for both substructure motivated objects, like excited leptons, and for particles suggested by supersymmetric extensions of the standard model.

Jonker added to this discussion by presenting some new data from the ASP collaboration at Stanford's PEP ring. By studying photon production plus missing energy, the collaboration is able to say that unconventional (scalar) electrons have to be heavier than 50 GeV, assuming that (supersymmetric) photinos are massless.

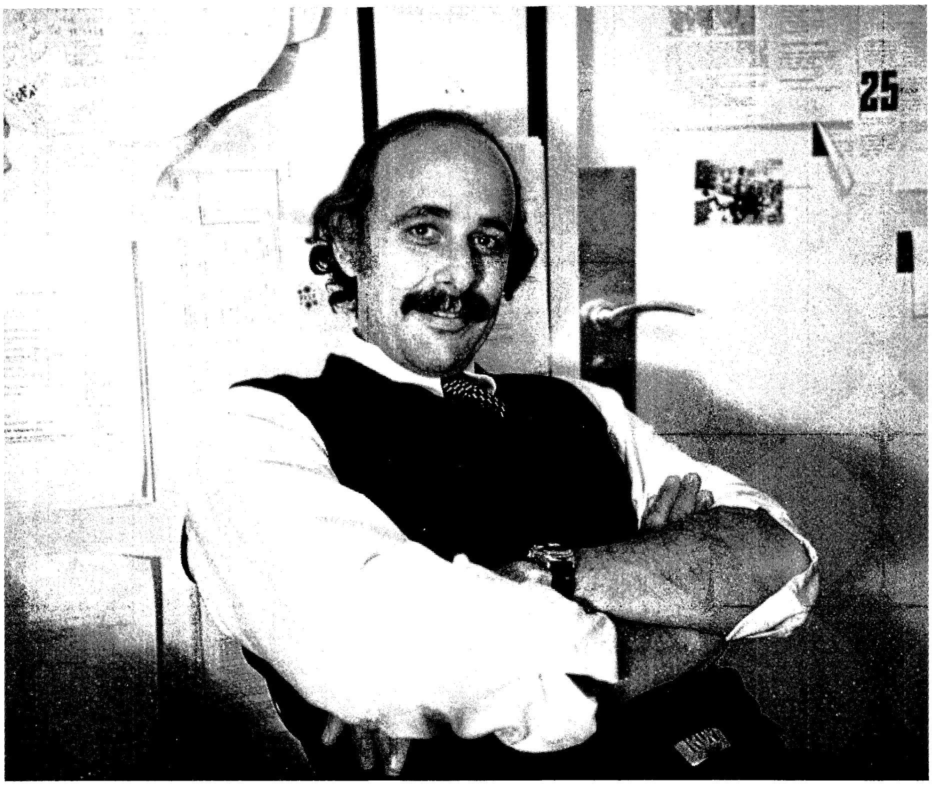
P. Jenni (CERN) opened the third day with an overview of both the physics accomplishments and the planned upgrade of the UA2 detector at the CERN Collider.

Supersymmetry and superstrings then took centre stage for the remainder of the meeting. H. Kowalski (DESY) and H. Haber (Santa Cruz) discussed in detail the implications of the UA1 'monojets' for supersymmetry at low energy. Although the 1983 events seemed to suggest the possibility of having relatively light squarks or gluinos, the 1984 data appear to be incompatible with this scenario.

In their talks on the implications of superstrings H. P. Nilles (Geneva)

Roberto Peccei, who took over from Tom Walsh as Speaker of DESY's Theory Group.

(Photo P. Waloschek)



and L. Ibañez (CERN) did not seem to be perturbed that no signs for supersymmetry had yet been seen. Superstring physics would occur at the 'Planck scale', energies of about 10^{19} GeV, while the Fermi scale is really a 'low energy' scale in comparison! Ibañez emphasized, however, that superstrings do have some implications at the Fermi scale, since in many instances one is left with a larger symmetry group than that of the standard model at low energy. C. Wetterich (DESY) also discussed how some of the Kaluza-Klein theories, whose extra dimensions 'compactify' near the Planck scale, can set the low energy pattern of the fermions we know. In both cases, standard model physics is connected to a deeper theory bringing in gravity.

It was left to M. Veltman (Michigan) to summarize the disparate attempts to understand physics at the Fermi scale. This he did in characteristic fashion by castigating all speakers (and the audience!), irrespective of whether they voted composite or supersymmetric. He suggested instead that the clue to electroweak symmetry breaking would probably be found through the observation of weak boson interactions at high energy.

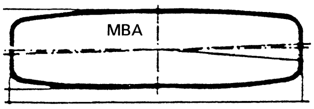
The members of the organizing commitee of the 1985 DESY Theory Workshop were R. Klanner, E. Reya, R. D. Peccei and F. Wagner. Meanwhile planning for the next Workshop (6-9 October) is already underway. It will move from weak to strong, and focus on the theoretical and phenomenological status of quantum chromodynamics.

From Roberto Peccei

Brussels ICFA meeting

The International Committee for Future Accelerators (ICFA) met in Brussels on 2 October last year. Following the establishment of four panels (Superconducting Magnets and Cryogenics, Beam Dynamics, New Accelerator Schemes and Instrumentation — see March 1985 issue, page 64), the Committee heard reports from two Panel Chairmen — Giorgio Brianti (CERN) on Superconducting Magnets, and Tord Ekelöf (Uppsala) on Instrumentation. Plans were approved to hold an ICFA workshop on Superconducting Magnets and Cryogenics at Brookhaven from 12 to 16 May (attendance by invitation only). The Committee also took note of the second Panel's intention to publish a regular newsletter (the first issue came out recently) and heard its preliminary plans to hold an Instrumentation School at the International Centre for Theoretical Physics, Trieste, in April 1987.

Finally the Committee reviewed its revised mandate, as approved by the International Union of Pure and Applied Physics Particles and Fields Commission at its meeting during the Kyoto Conference in August 1985: 'To promote international collaboration in all phases of the construction and exploitation of very high energy accelerators. To organize regularly world-inclusive meetings for the exchange of information on future plans for regional facilities and for the formulation of advice on joint studies and uses. To organize workshops for the study of problems related to super high energy accelerator complexes and their international exploitation, and to foster Research and Development of necessary technology.'



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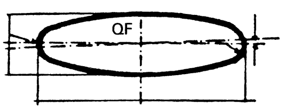

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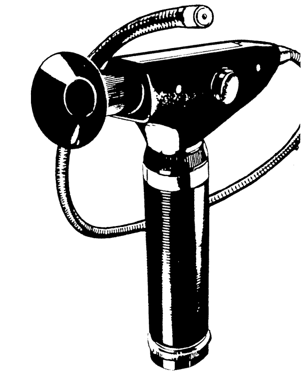

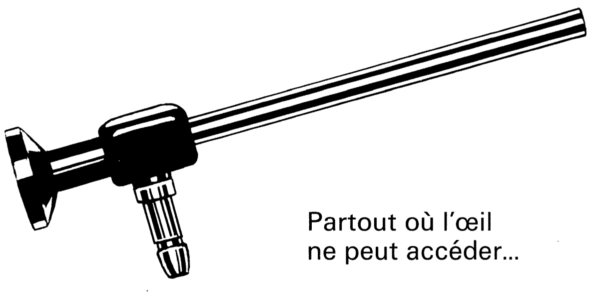

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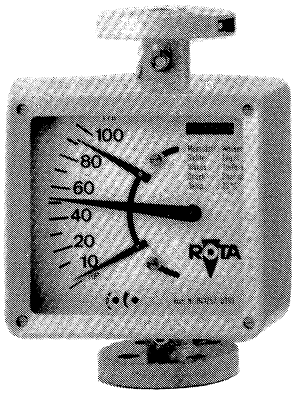

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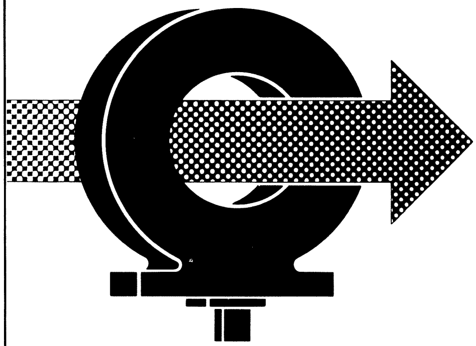

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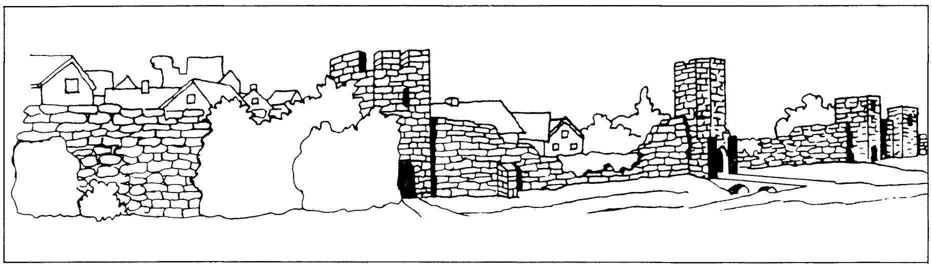
The walled town of Visby, on the Swedish island of Gotland, scene of the Second International Conference on Nucleus-Nucleus Collisions, held last summer.



CONFERENCE
Nuclear visions

Last summer, four hundred visitors of about 30 different nationalities descended on the ancient town of Visby on the Swedish island of Gotland for the Second International Conference on Nucleus-Nucleus Collisions.

The conference organizers, representing most Swedish universities and physics research institutes, had chosen to launch the conference in a surrounding of culture and history, far away from academic institutions. In his closing address, D. Scott of Michigan expressed the hope that the meeting would set a standard for future such conferences. Among other imaginative ideas, the conference fee included one week's use of a bicycle for countryside tours.

For the conference itself, sessions were organized not according to conventional topics like low, intermediate and high energy reactions, but along phenomena-related lines that brought listeners together instead of splitting them up. Examples were 'phase transitions', 'new facilities' and 'breaking nuclear matter into pieces'. This made for good participation. The concluding talk was turned into a round table session. Instead of one victim having to give a diplomatic account of everything, instead a few prominent physicists discussed the merits of different conference highlights.

The scientific success of the Visby conference was due to the interdisciplinary nature of heavy-ion research, something that was obvious at the first conference in this series, held at Michigan in 1982.

In his opening talk, D. Scott, chairman of the 1982 conference, fascinated his audience with the full story on what happens 'When Heavy Ions Collide', helped by a computer-generated cartoon.

The main theme of the conference turned out to be 'exotism' — new phenomena in nuclear matter under extreme conditions, and in particular as understood by phase transitions.

When looking for new phenomena it is necessary to have a fair understanding of how 'normal' nuclear matter behaves, and this is far from easy. A central question for creating exotic nuclear matter, such as quark-gluon plasma, or for understanding the mechanism behind supernovae explosions, is to what degree nuclei can be compressed. H.-G. Ritter, Berkeley, covered the celebrated data from the Plastic Ball and Streamer Chamber at the Bevalac, which establish the 'side-splash' of participating nucleons and 'bounce-off' of spectator fragments in heavy ion collisions at an energy of 250 MeV per nucleon (see July/August 1984 issue, page 243). The theoretical aspects were discussed by H. Stöcker, Michigan, and J. Cugnon, Liège. Most models seem to accept the data as the first signature of a compression of nuclear matter, but there are also efforts to explain the effect with a purely thermal equation of state for nuclear matter, with no separate compressional energy. More work is obviously needed before a reliable equation of state can be extrapolated into the unknown.

An understanding of how quarks and gluons react in normal nuclear matter is required to identify any possible plasma phase in future experiments at higher energies. M. A. Baldin, Dubna, reviewed the current knowledge of quark distributions in nuclei, and B. Andersson, Lund, reported on recent work to extend the popular string model of quark 'hadronization' to high energy heavy ion collisions.

There was no lack of reports on evidence for exotic nuclear matter, nor of theoretical speculations. Low energy experiments concentrate on creating and probing individual nuclei in extreme states. S. Bjørnholm, Niels Bohr Institute, reviewed pictures of the excited nucleus as a liquid and as a gas, and D. Boal, Vancouver, discussed the possibility of a mild phase transition between two such forms of nuclear matter.

There is also a special interest in high masses and high spins. The creation of giant nuclei in heavy ion collisions might open up new frontiers in physics, both by giving a new dimension to the study of nuclear forces, as discussed by S. Hofmann, GSI Darmstadt, and as a source of the supercritical electric fields necessary for vacuum decay, as reviewed by W. Greiner, Frankfurt. On the high spin side, there are new impressive data from Berkeley and Daresbury, presented

Face (!) transitions when Visby Conference Chairman Ingvar Otterlund (left) collides with David Scott, who chaired the first meeting in the series, held at Michigan State University in 1982.

(Photo Gotlands Tidningar)

by F. Stephens and J. Sharpey-Schafer, giving detailed nuclear spectra at spins as high as 40-50 units. I. Ragnarsson, Lund, discussed the possibility that this is a termination of the rotational band for some heavy nuclei at these high spin values. R. Broglia, Niels Bohr Institute, interpreted the new data as an indication that the spin-induced transition from a superfluid to a rigid rotation is not as abrupt as earlier believed. A rapidly spinning nucleus might therefore be a good place for studying the more general problem of smooth phase transitions.

Interesting things happen also at intermediate energies, and detailed analyses of various transitional phenomena, whether 'exotic' or not, will help to unify the rather scattered picture of nuclear matter in this energy region. One example was reported by J. Galin, Orsay, D. Guerreau, GANIL (Caen), and H. Nifenecker, Grenoble. In very recent experiments the energy interval of 27 to 44 MeV per nucleon has appeared as the region where the fusion peak in argon-tin reactions disappears completely, signalling a transition in the nuclear fragmentation mechanism. Another promising piece of fresh data, presented by W. Loveland, Corvallis, demonstrates that target fragments from 35 MeV per nucleon krypton-gold reactions are often similar to the projectile in both size and momentum; a correlation that seems hard to understand. A now well known phenomenon, first studied at CERN, that also needs a better understanding is the production of pions at 'subthreshold' energies — heavy ion velocities lower than those required in pure nucleon-nucleon reactions. H. Ströbele, GSI, discussed the possibility of similar investigations of subthreshold kaon production by heavy ions.

When it comes to the much discussed transition to a quark-gluon plasma in heavy ion collisions, there is no clear experimental evidence at present, but the ambitious build-up of new experiments promises an interesting future. The programmes at Brookhaven and CERN were presented by T. Ludlam, Brookhaven, R. Stock, GSI, and H. J. Specht, Heidelberg. With the help of complicated detector systems these experiments will try to find any produced plasma. L. Van Hove, CERN, reviewed the possible experimental signals, as suggested by theorists in the field, and G. Baym, Urbana, explained the role of the quark-gluon soup in the early Universe. Our understanding of the present Universe needs a much deeper insight into the behaviour of quarks and gluons in unusual nuclear matter. Other heavy ion projects reported at Visby included the future storage ring CELSIUS in Uppsala (L. Westerberg), the Scandinavian multidetector system Nordball (B. Herskind), the powerful future machines at GSI, Darmstadt (P. Kienle), and the ambitious heavy ion programme at SATURNE (P. Radvanyi).

The Visby conference showed that there are three main sources of optimism in heavy ion physics. Firstly, the experiments have begun to highlight fundamental questions in particle, nuclear and astrophysics. Secondly, many of the problems are interdisciplinary, such as the relevance of quarks in nuclei or of particles and nuclei in astrophysics. Thirdly, many more heavy ion experiments are planned.

Those wanting to share the visions from Visby, or learn more about those newsy nuclei, could start with the conference proceedings, recently published in Nuclear Physics A.

From Sverker Fredriksson

Professorship in theoretical physics (Nuclear Physics at High Energies) at the University of Bergen, Norway

The University of Bergen invites applications for a professorship in Theoretical Physics (nuclear physics at high energies) at the Department of Physics.

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The nuclear physics group is engaged in experiments studying quasi-elastic collisions and heavy-ion reactions in the intermediate energy region, carried out at the CERN synchrocyclotron, at the French centre GANIL for heavy-ion physics in Caen and at SARA in Grenoble.

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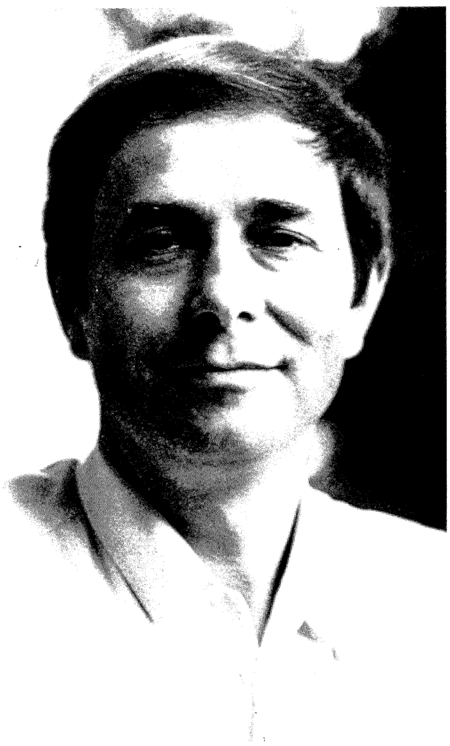
People and things

On people

On 23 November, Carlo Rubbia was awarded the degree of Dottore Honoris Causa by the University of Udine, Italy.

Michel Davier has been appointed Director of the Laboratoire de l'Accélérateur Linéaire at Orsay, France, succeeding Jean Perez-y-Jorba. The new director is also no stranger to CERN, where he is a collaborator in the ALEPH experiment being built for the new LEP electron-positron collider.

Louis Rosen, who has directed the Los Alamos Meson Physics Facility, LAMPF, for twenty years, has been awarded the highest honour of the Los Alamos National Laboratory — the position of Senior Fellow — as he hands over leadership of LAMPF to Gerald Garvey. He set the style of LAMPF from its inception and has had great influence on the evolution of the broad programme of research in both pure and applied science. Louis Rosen will remain leader of the Medium Energy Physics Division and will be senior scientific advisor to LAMPF.



Klaus Rith of the University of Freiburg, presently spokesman of the big new NA37 collaboration using CERN's high energy muon beams, has been awarded the Röntgen Prize of the University of Giessen for his contributions towards the discovery and further investigation of the 'EMC Effect' — the dependence of nucleon quark structure on the surrounding nuclear environment.

CERN elections and appointments

At the December meeting of CERN Council, Wolfgang Kummer (Austria) was reelected as Council President together with Vice Presidents Josef Rembser (West Germany) and Jan Kluyver (Netherlands). Jan Bezemer (Netherlands) becomes Chairman of the Finance Committee and Don Perkins (UK) was reelected as Chairman of the Scientific Policy Committee. Four new SPC members were elected: Marcel Banner (France), Peder Gregers Hansen (Denmark), Chris Llewellyn Smith (UK) and Italo Mannelli (Italy). Marcello Gigliarelli Fiumi was elected as Chairman of the Consultative Committee on Employment Conditions (CCEC). At CERN, Fritz Ferger becomes Leader of the newly established Technical Support Division, while Division Leader reappointments include Gunther Plass (LEP), Marcel Lazanski (Finance) and Charles Rufer (Personnel, until 30 April). Gunther Ullmann was reappointed Administrator of the Staff Insurance Scheme.

New Orsay Director Michel Davier

Meetings

The XXIII International Conference on High Energy Physics will be held in Berkeley, California, on 16-23 July. The meeting includes three days of parallel sessions (17-19) and three days of plenary sessions (21-23). The Conference is open but delegates must register in advance. For information or registration, please contact: Secretariat, MS 80D, International Conference on High Energy Physics, Lawrence Berkeley Laboratory, University of California, Berkeley, CA 94720, USA.

The fifth in the topical series of 'Quark Matter' meetings is being sponsored by Berkeley's Nuclear Science Division and will be held from 13-17 April at the Asilomar Conference Center, Pacific Grove, California. Further information from M. Gyulassy or L. Schroeder (Bldg. 70A/3307), Lawrence Berkeley Laboratory, Berkeley, California 94720, USA.

The 2nd Topical Seminar on Perspectives for Experimental Apparatus at Future High Energy Machines will be held at San Miniato, Tuscany, from 5-9 May. Those interested should contact the Seminar Secretary Dipartimento di Energetica, Università di Firenze Via S. Marta 3, I-50139, Florence, Italy, as soon as possible.

Twenty years at the helm

by Brian Southworth

Alert readers may have noticed a small change in the CERN COURIER masthead for this first issue of 1986 — in listing the Editors, the name of Gordon Fraser moves in front of the name of Brian Southworth implying that Gordon now takes responsibility as Senior Editor.

I will continue to write for CERN COURIER, alongside Gordon who has been doing the bulk of the work on the journal for several years, so the editorial strength will be little changed. It is, nevertheless, a significant moment to hand over a responsibility carried during precisely twenty years as Editor.

I first put pen to paper for the January issue of 1966 and there has hardly been a dull moment since. Particle physics has passed through an era of discovery beyond imagination. Accelerator physics has brought mastery of these most complex machines to near perfection. Accelerator and detector technology has found unpredictable applications in so many other fields. And so on... These developments had to be absorbed and understood, at least sufficiently to distil stories for our readers. Add the delight of using that very flexible instrument, the English language, and you have the ingredients for a lively and satisfying Editorship.

The high energy physics/high energy accelerator community is also a stimulating environment in which to work. On the one hand, this comes from the intellectual content. I often feel that the 'sciences' of our century are the 'arts' of centuries gone by — attracting the keenest brains, liberating the most imaginative flights of the human mind (and, incidentally, earning the benevolent sponsorship of today's masters of the purser-strings, the national governments).

On the other hand, the stimulating environment comes from the international nature of the field. It still remains a source of wonder that nationalities are submerged by enthusiasm for our physics and that Laboratories, which can be in intense rivalry, co-operate to push the physics and the technology further for the good of the whole field. I know of no other environment where this is true to anything like the same extent.

Brian Southworth — hardly a dull moment in twenty years

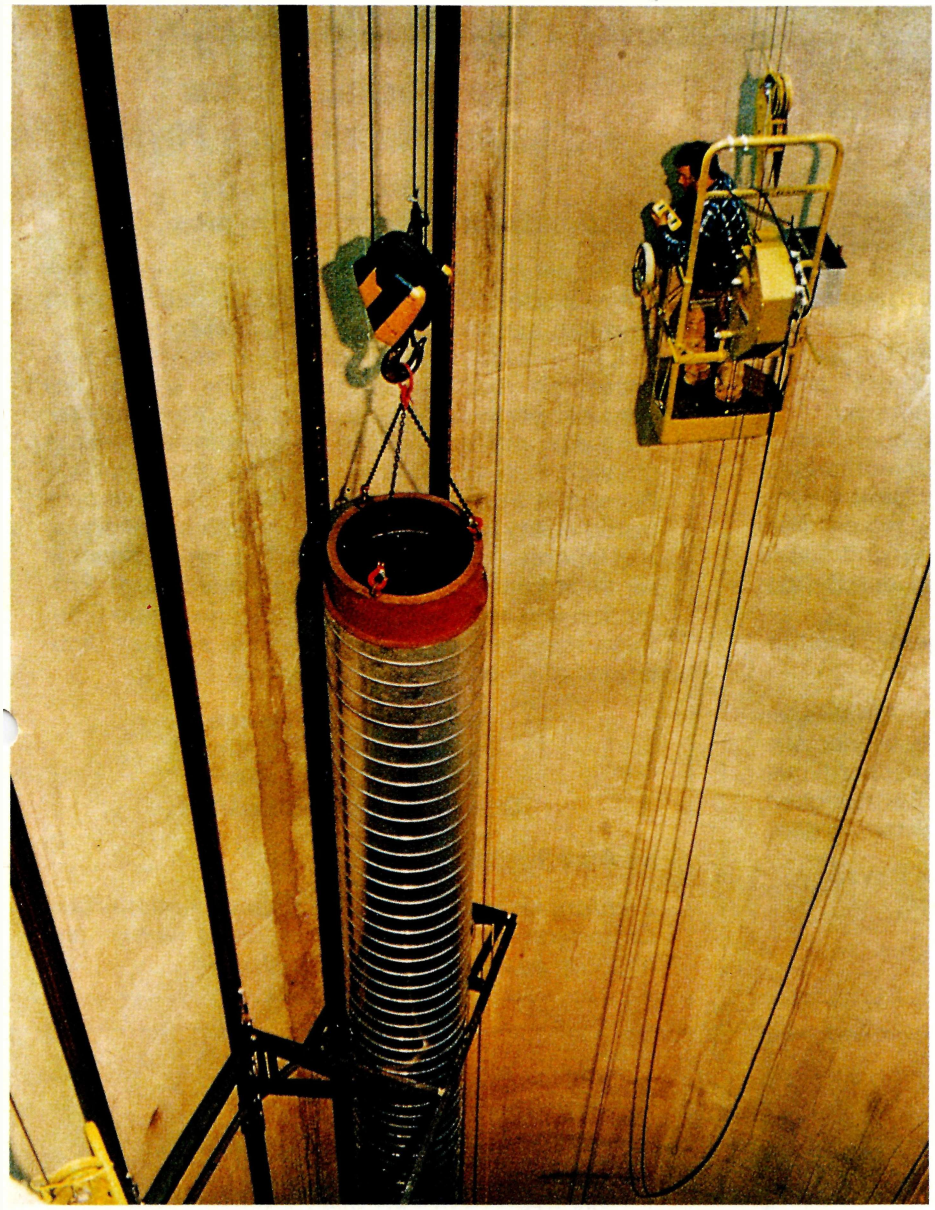
At a time when there are indications that particle physics is less in favour, it is worth asserting that whenever the great achievements of man are compiled, the unfolding of the nature of matter will surely be amongst them. It has been wonderful to help chronicle this adventure during the past twenty years. I hand over the helm to Gordon Fraser in complete confidence that the reputation of CERN COURIER will continue to grow and that the remarkable support and friendship from which I have profited is extended to him also.

Denis de Rougemont 1906-1985

Denis de Rougemont, Swiss writer, tireless campaigner for Europe, founder of the European Cultural Centre in Geneva, and one of the major figures behind the move to establish CERN died on 6 December. His writing talents brought him many literary prizes, but his epic piece in the Gazette de Lausanne on 17 June 1940 after the fall of Paris will always be remembered as a fine expression of contemporary feeling.

After the War, he was one of the main organizers of the historic European Cultural Conference in Lausanne in December 1949, where the idea for a European scientific research centre was first aired. Progress was rapid over the next five years, and on 7 October 1954, as Secretary General of the European Cultural Movement, he attended the first meeting of CERN Council.

One of his last visits to CERN was in September 1984 for the Organization's 30th anniversary, where guest of honour King Juan Carlos of Spain concluded his address with a de Rougemont quotation: 'The only way to define Europe is to build it, not so much in time and space, but rather by continuing to refresh its own, universal, genius'.

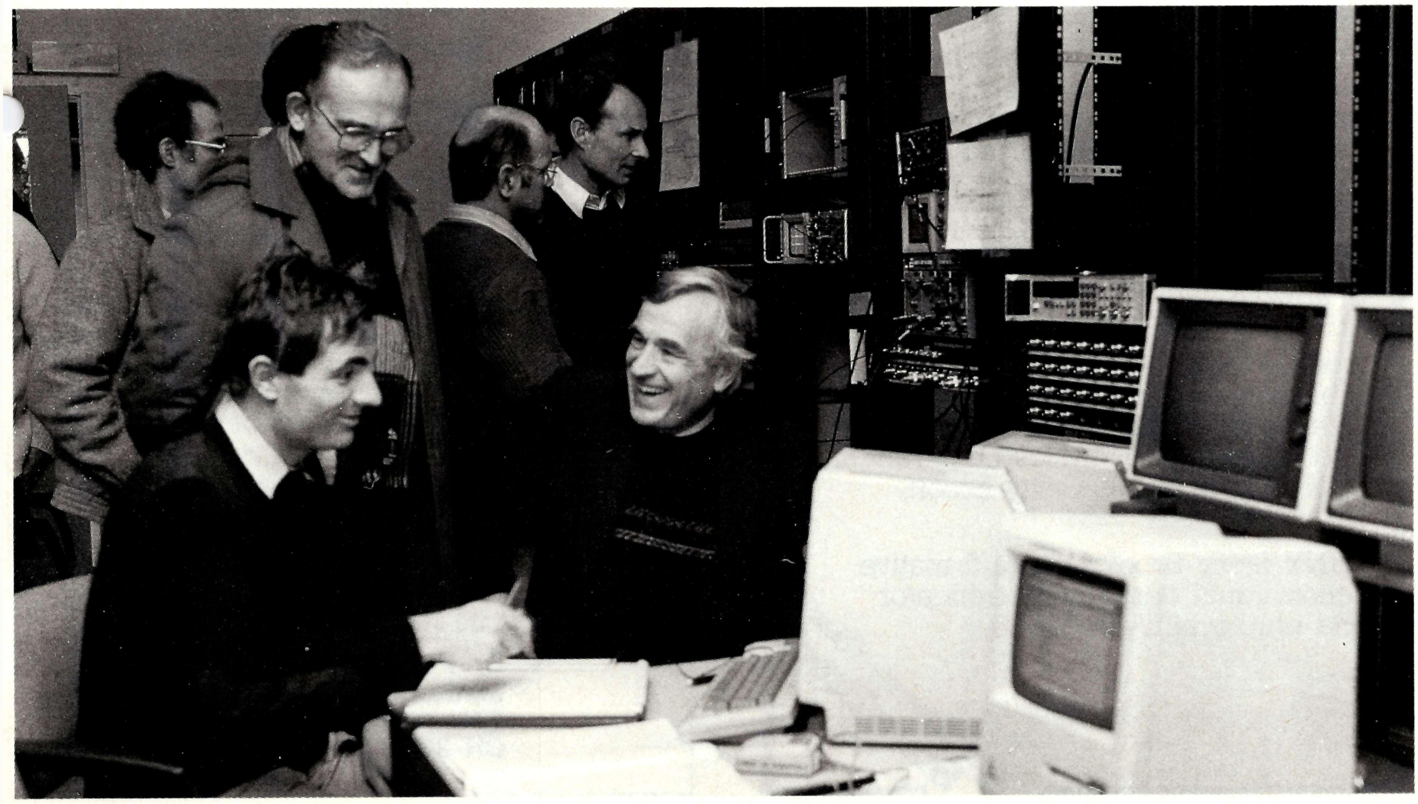


While tunnelling for the LEP electron-positron collider at CERN forges ahead at the rate of some 100 m per day, installation work starts in the vertical shafts serving the tunnel. A section of ventilation ducting is seen here being lowered into position. Some 10 kilometres of LEP tunnel have been excavated and 80 per cent of the additional excavations have been completed.

LEP progress

Just before Christmas, a jubilant PS Controls Group called open house at Cern to celebrate the arrival of a good quality 4 MeV 25 milliamp electron beam in the first fully operational section of the LEP Injector Linac, with all systems fully integrated into the Injector control system.

(Photo CERN 454.12.85)



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Bewerbungen mit den üblichen Unterlagen (Lebenslauf mit Unterlagen zum wissenschaftlichen Werdegang, Liste der wissenschaftlichen Arbeiten, Angaben über bisherige Lehrtätigkeit) sind bis zum 15. Februar 1986 zu richten an den

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Professor S.S. Hanna
Department of Physics
Stanford University
Stanford, CA 94305/USA

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Applications, including resume, bibliography and the names of three references should be sent to: Professor Rod Engelmann, Physics Department, SUNY Stony Brook, Stony Brook, N.Y. 11794 U.S.A.

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of ETH Zürich/Switzerland

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The successful candidate will participate in Zürich and CERN in the UV Laser Calibration and precision alignment of the myon spectrometer of the L3-LEP experiment. Test experiments and studies for further improvements are also part of the responsibilities.

The duration of the contract is two years with a possibility of one year prolongation.

Applicants should submit a curriculum vitae, list of publications and arrange for two letters of recommendation to be sent to

Dr. P. G. Seiler
Institut für Hochenergiephysik,
ETH Hönggerberg,
CH-8093 Zürich

UNIVERSITY OF GENEVA

The Department of Nuclear and Particle Physics has an opening for a position of

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(Maître-assistant)

to join a group preparing a polarization experiment at SIN. The candidate must have a PhD or equivalent experience in high energy physics. This is a non permanent position limited to a maximum of 6 years.

Applications should be sent before March 31 1986 to:

Prof. E. Heer, Director
of Departement de physique nucléaire et corpusculaire
24, quai Ernest-Ansermet
CH-1211 Geneva 4

A postdoctoral position in Medium Energy Physics

is available at the University of Karlsruhe. The successful candidate will be member of a research group working in the field of exotic atoms both at the Antiproton — Facility LEAR at CERN and at the Swiss Institute of Nuclear Research in Villigen (SIN). Experience in experimental Nuclear or Particle Physics is desired. Duties will include hard- and software development. The initial appointment will run until the end of 1987. An extension of a maximum of five years is possible. Salary is commensurate with qualifications.

Applicants should send a resumé, list of publications and names of two references to:

Mrs. E. Haas
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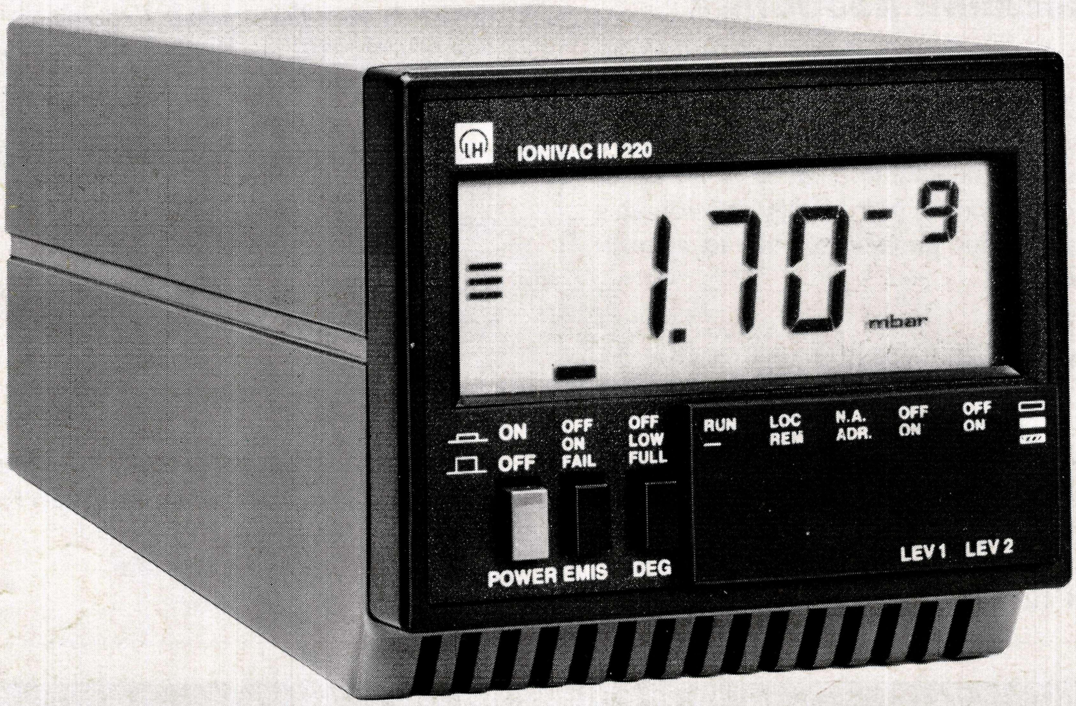

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