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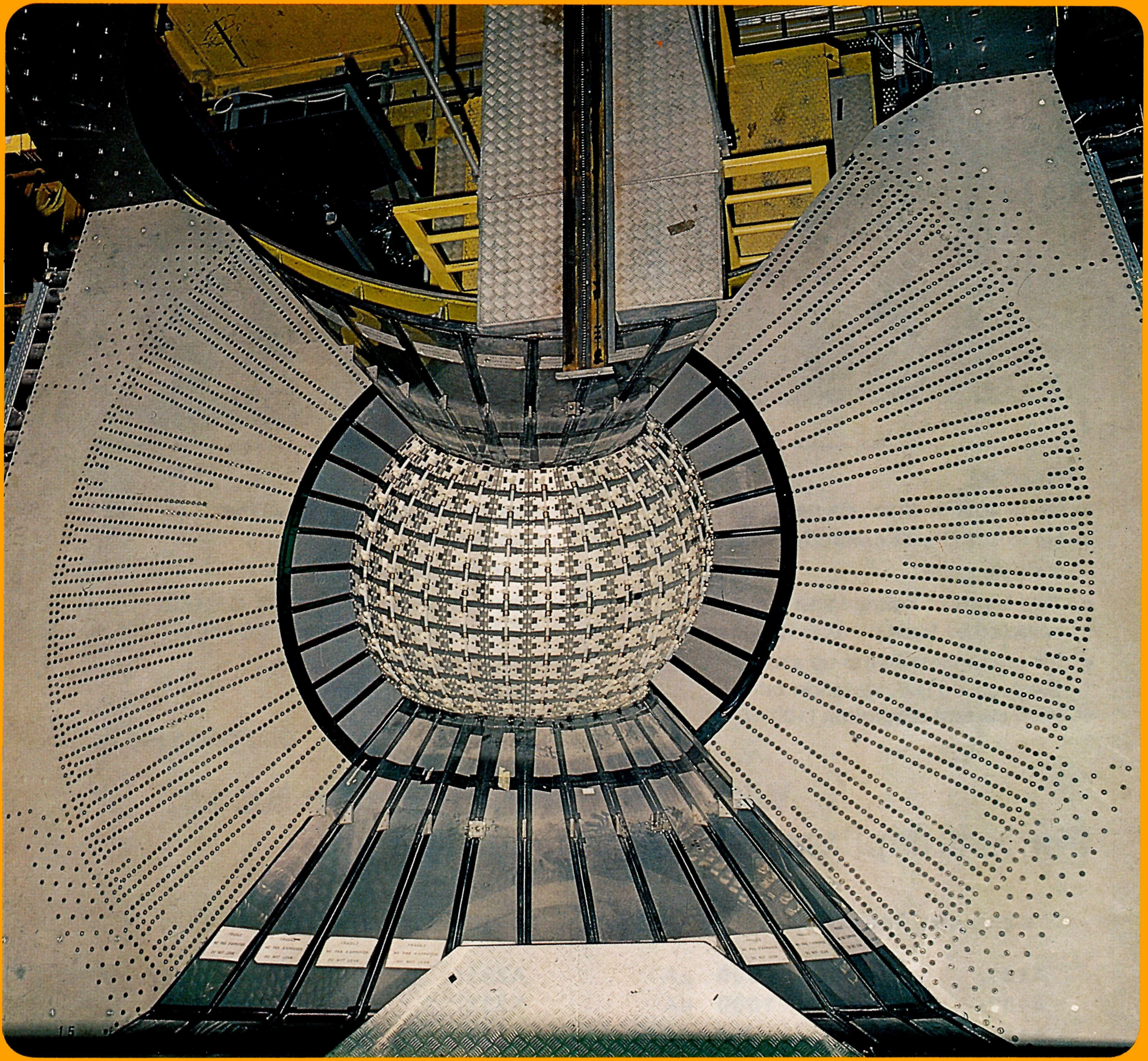
International Journal of High Energy Physics



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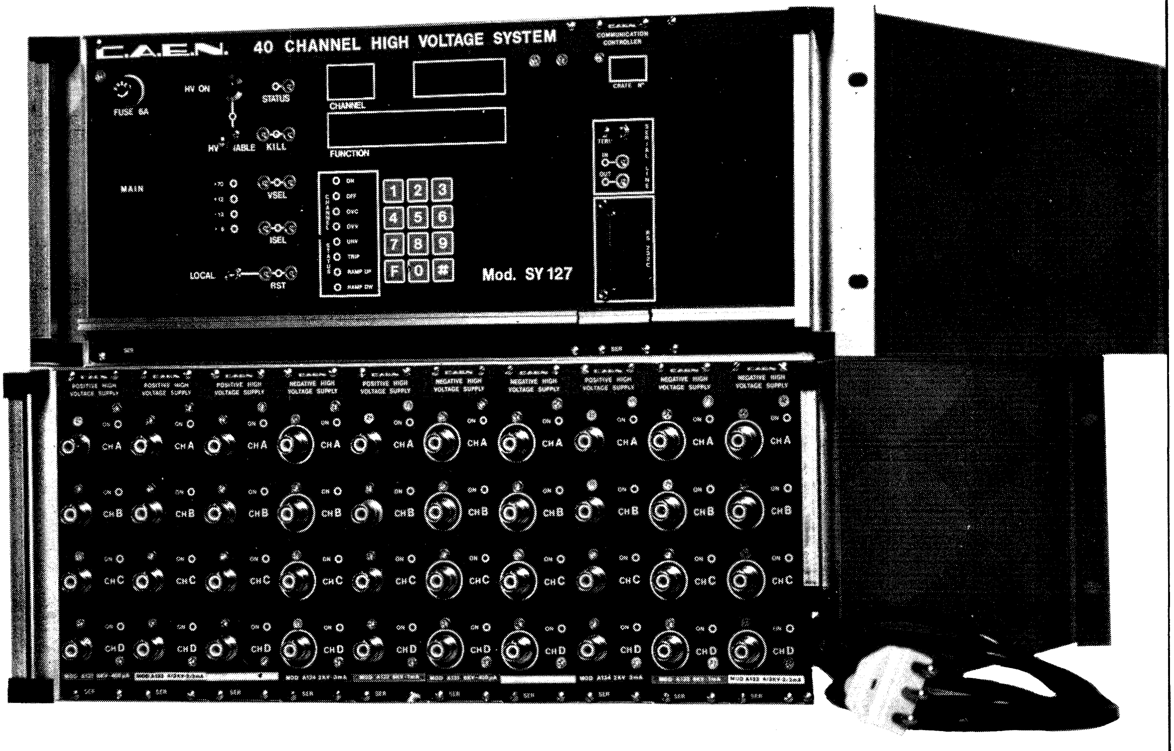

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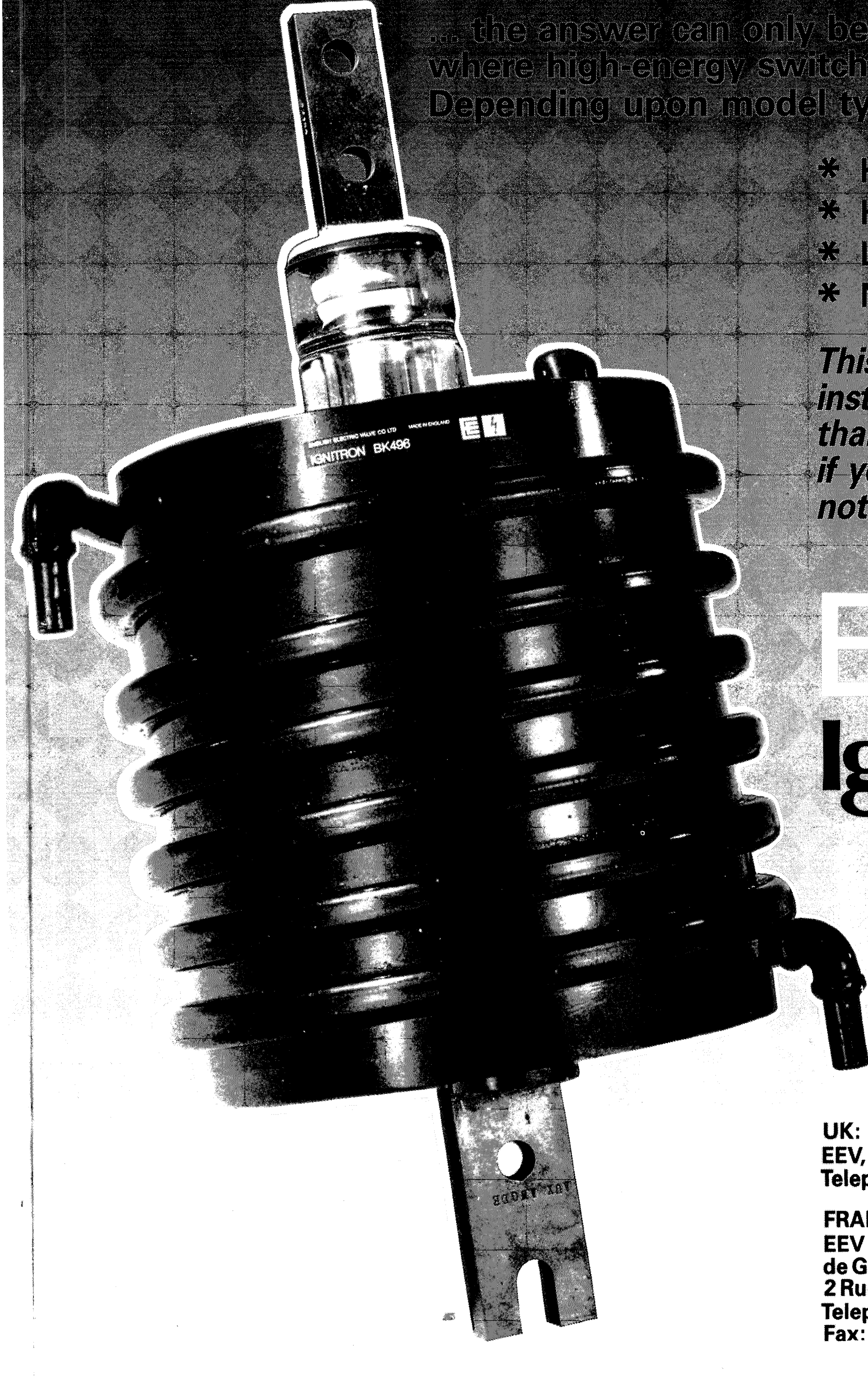
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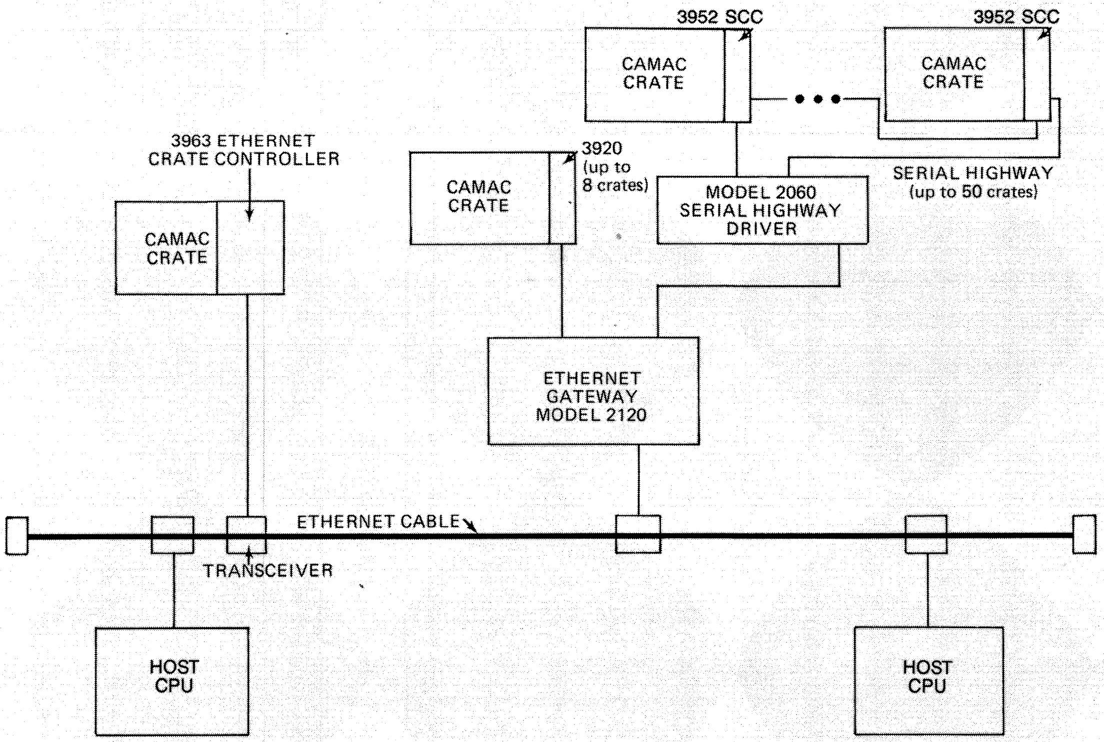
VOLUME 26 N° 5 JUNE 1986

Around the Laboratories

Cover photograph: Top view of the UA2 detector at the proton-antiproton Collider during dismantling, showing the bottom half of the calorimeter. The upgraded apparatus will have a new vertex detector fitted into the central hollow volume, and new end-caps in the segments (top and bottom) along the beam direction (Photo CERN X619.2.86 by François Julliard).



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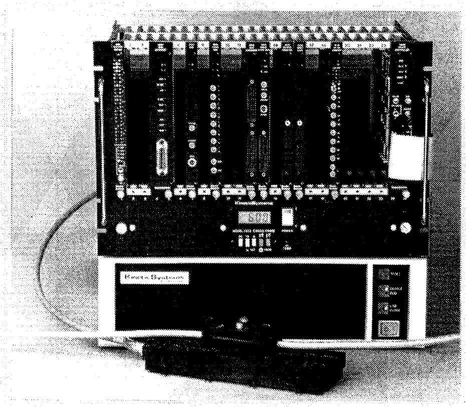
This set of three CAMAC modules houses a CAMAC controller, LSI-11 processor, RAM, Ethernet interface, and down-line boot ROM. Software licenses are included. It occupies five slots in the crate. Software documentation and distribution are provided as part of the Host Support Package.



2120 Ethernet-to-CAMAC Gateway

This interface requires a powered LSI-11 box to house system components (LSI-11 processor, RAM, Ethernet interface, and boot ROM. Software licenses are included). Space is provided for up to eight 2920/3920 crate controllers and one 2060 serial highway driver. Software documentation and distribution are provided with the Host Support Package.

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LEP physics

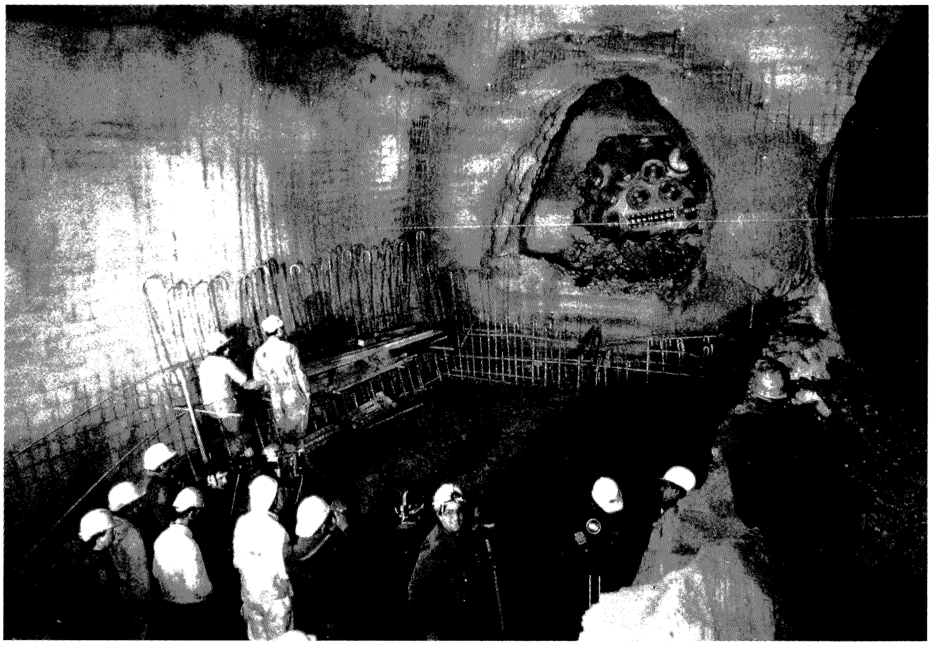
Construction of the 27 km LEP electron-positron Collider at CERN pushes relentlessly forward. Less evident, but just as vital, is the work for the four big detectors which will be ready to intercept LEP's first colliding beams towards the end of 1988 (see May issue, page 1). Despite these day-to-day preoccupations of construction and preparation, the ultimate aim of this mammoth project is to do new physics.

The possibilities for opening up new areas of physics for exploration and measurement were spelled out in detail before the project was accepted by CERN Council in 1981. However in the meantime the W and Z particles, the carriers of the weak nuclear force, were discovered at CERN in 1983, providing dramatic confirmation of electroweak unification.

At CERN and elsewhere, evidence continues to accumulate in favour of the Quantum Chromodynamics (QCD) picture of inter-quark forces. Together, electroweak unification and QCD are the twin pillars of the 'Standard Model' of today's physics.

Electron-positron collisions at presently available machines at the German DESY Laboratory in Hamburg and at Stanford in the US have revealed no sign of the long-awaited sixth 'top' quark, the big missing link in the Standard Model. However some clues are provided by the UA1 experiment which benefits from the higher energies at CERN's proton-antiproton Collider.

Meanwhile theorists have continued their efforts to extend the Standard Model. No evidence for any of these new ideas, some of them very appealing, has been found, but they will stand or fall by what is found at LEP.



Another breakthrough for the LEP electron-positron Collider at CERN.

(Photo CERN 612.3.86)

Günther Wolf, then chairman of the LEP Experiments Committee, suggested to John Ellis and Roberto Peccei, the two theorists on the Committee, that the time was ripe for a further survey of the physics possible with the new machine. Five main areas were identified, and working groups were set up containing experimenters from the four LEP collaborations and theorists.

The five areas are — precision studies around the Z (the carrier of the electrically neutral part of the weak nuclear force); so-called 'toponium' consisting of a top quark bound to its antiquark; searches for new particles; high energy LEP running beyond the foreseen initial level of around 50 GeV per beam; and QCD and heavy quark physics.

Called 'Physics at LEP', the findings of the working groups have now been published in two weighty tomes which should serve as a useful handbook for the experimentalists once the data starts to roll in.

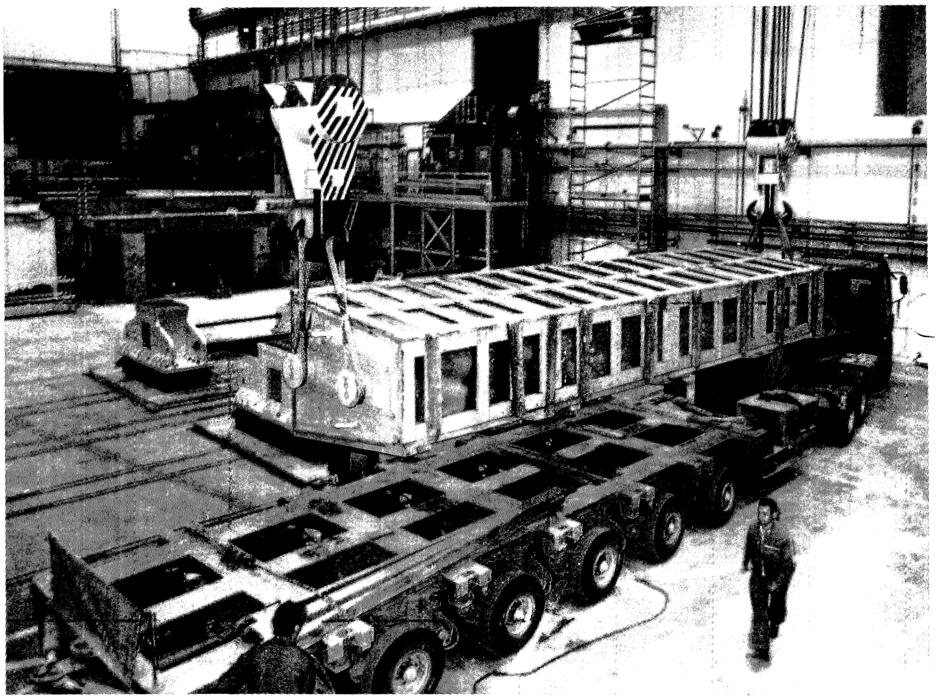
Z physics

The working group commissioned to look at physics around the Z came to number of definite conclusions:

- the mass and width of the Z peak should be easily measurable at LEP;
- the use of polarized (spin oriented) beams is seen as a 'natural' requirement;
- inferring the number of types of neutrino should be easy;
- any new heavy particles (fermions) coming from additional quark families should have detectable effects;
- the elusive Higgs boson (the source of mass in the electroweak theory) might remain so if the particle is heavier than about 50 GeV;
- the delicate forward-backward asymmetries in this sector should give important precision measurements.

After an epic journey from the Soviet Union by ship, barge and lorry, one of the modules for the magnet of the DELPHI experiment at LEP finally arrives at CERN.

(Photo CERN 108.4.86)



Toponium

The study of the bound states of top quarks and their antiquarks is seen as an ideal laboratory for the Standard Model, but a lot depends on just where the states are going to be found. If they fall right on top of the Z near 93 GeV then a lot of work will be required to unravel them.

If the toponium ground state turns out to be lighter than the Z (as UA1 hints), current estimates of LEP performance indicate that it should be possible to find several higher states in experiments taking a few months.

If toponium is heavy, it becomes more difficult to manufacture and its physics becomes correspondingly more difficult.

Toponium physics is seen as complementary to Z physics, providing incisive tests of many current theoretical ideas.

New particles

In their efforts to unify all the forces in Nature and to correlate their very different strengths, theorists have conjectured many different new particles.

The working group entrusted with looking at the implications for LEP of these new particles stressed the importance in their view of the 'Mass Problem' — the origin of mass in the electroweak sector through the 'Higgs mechanism'. Their report provides experimenters with a comprehensive listing of many of the predicted properties of the Higgs and related particles and how they might be picked out from the LEP data, if they weigh less than about 100 GeV.

Higher energies

The task of the fourth working group was to look into the physics implications of running LEP beyond the initially planned level of about 50 GeV per beam.

'In the course of this study', their report states, 'it became evident to us that the physics potential of running LEP II (i.e. higher energies) is considerable, of a level comparable, if not greater, to that of the initial stage of LEP'.

As well as opening up the possibility of producing new particles (as looked into by the third working group), higher energies could also find evidence for any deeper substructure of matter inside the quarks and leptons, considered as pointlike and indivisible in the Standard Model. The discovery of a new layer of matter would in itself make LEP a turning point in the history of physics.

In addition, higher energies would explore new areas of the Standard Model, where there are still many unmeasured parameters.

In conclusion, the group reiterates 'it is of interest to push the beam energy to the maximum possible value'.

The importance of higher energies at LEP has stimulated a workshop on this physics to be held in Aachen from 29 September to 1 October. (Further information from Workshop LEP 200, III. Physikalisches Institut RWTH Aachen, Physikzentrum, Sommerfeldstrasse, D-5100 Aachen, West Germany.)

QCD and heavy quark physics

The fifth working group underlined the importance of electron-positron annihilation as a window on quark dynamics, pointing out the successes obtained at existing (lower energy) electron machines.

The expected physics around

Around the Laboratories

the Z peak and the high expected Z yield of several million a year (compared with the hundred or so found in several years at the CERN proton-antiproton Collider) open up detailed QCD studies.

This group also covered photon-photon collisions, where photon messenger particles interact with ch other rather than an electron or positron target, providing an additional physics window.

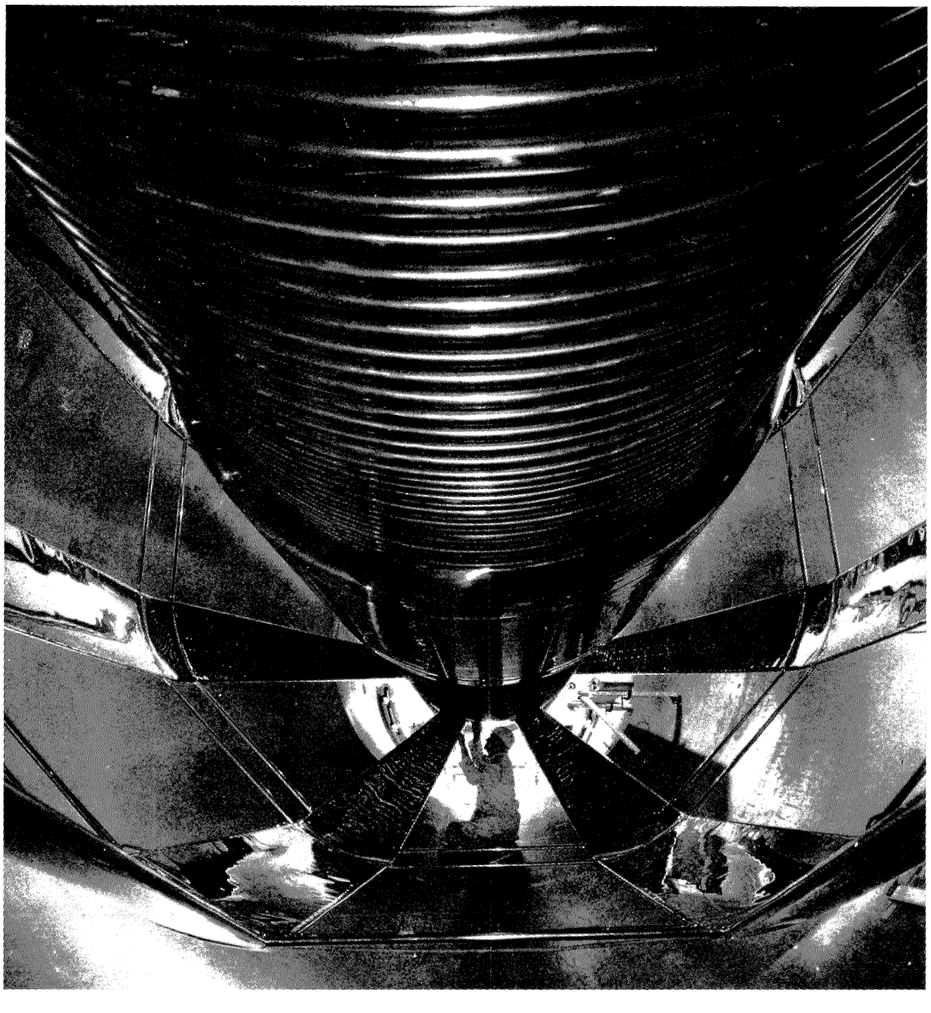
As well as probing for the top quark, LEP would open up the spectroscopy of the fifth (beauty) quark, of which only the surface has been scratched so far.

This could provide a further batch of particles which have unusual properties under the combined CP operation (switching particle to antiparticle and left to right). CP violation, currently restricted to the neutral kaons, is not well understood. 'It will not surprise many of us if CP violation becomes the Achilles heel of the Standard Model', the group concludes. 'LEP experiments are certainly well equipped to take aim at that!'.

When the data starts to roll in, the pronouncements of the 'Physics at LEP' study may reflect more our current ignorance than enlightenment. But that is why LEP is being built — to explore the unknown.

Heavy ions

CERN's venerable Linac 1, which normally provides 50 GeV protons, accelerated in april a beam of oxygen 6+ ions to MeV (12.5 MeV/nucleon), the injection energy required for CERN's heavy ion research programme later this year. Meanwhile Brookhaven takes another step towards its long term project of a relativistic heavy ion collider (RHIC). In April, oxygen ions from the Tandem Van der Graaff were transferred to the AGS, Alternating Gradient Synchrotron, the first time this venerable 26-year old machine had seen anything other than proton beams. The heavy ion programme will be helped by the advent of a Booster at the AGS (enabling, amongst other things, fully stripped ion species beyond sulphur to be injected into the AGS) for which construction has been authorized (see January/February issue, page 21). A prototype magnet for the Booster is now under test.



Inside the pressure vessel of one of Brookhaven's twin Van de Graaff machines which now provide heavy ions ready for acceleration in the Alternating Gradient Synchrotron.

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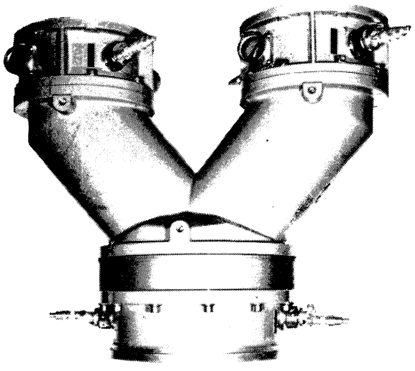

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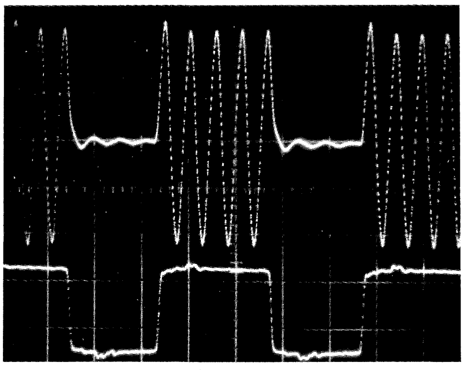

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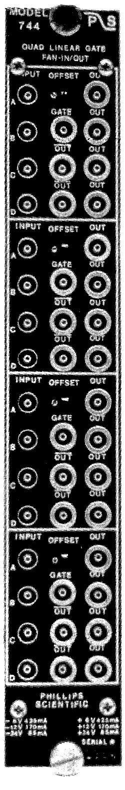

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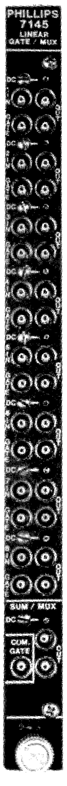

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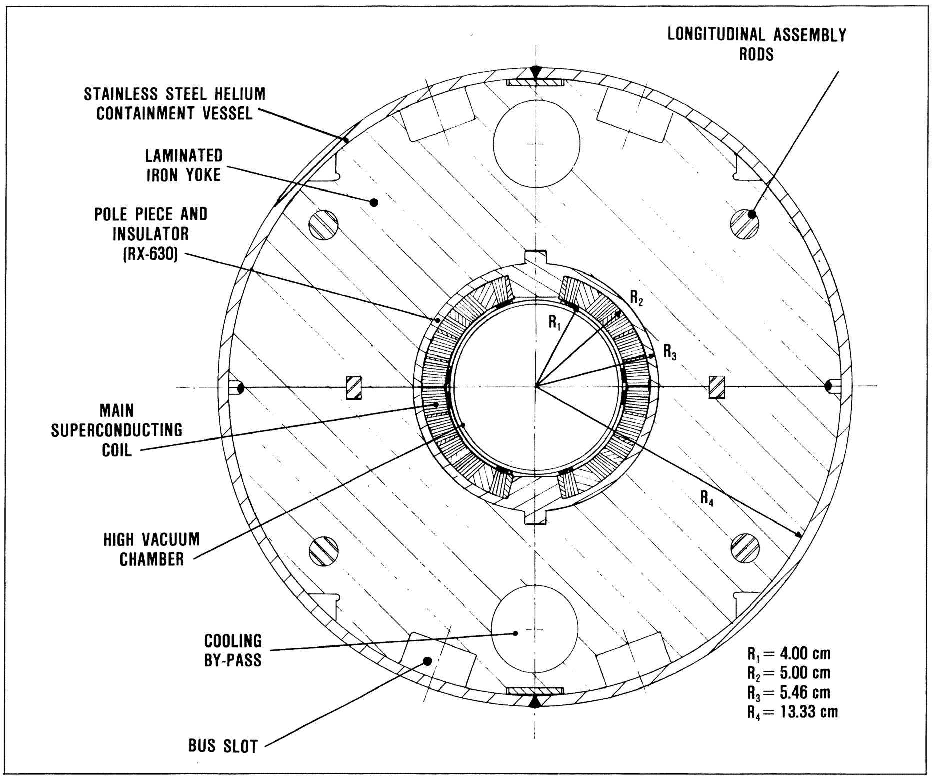
Cross-section of a prototype superconducting dipole magnet for the Relativistic Heavy Ion Collider (RHIC) being proposed for Brookhaven.



BROOKHAVEN
RHIC rarin' to go

With heavy ions now available in the Alternating Gradient Synchrotron (AGS — see box, page 3), Brookhaven's dream of a Relativistic Heavy Ion Collider (RHIC) takes a step nearer to reality. RHIC would open up new physics horizons and would handily fill the tunnel left from the abandoned Isabelle/CBA collider project.

A RHIC milestone was recently achieved with the successful test of a prototype superconducting dipole. The magnet was conservatively designed for a collider operating with heavy ions having atomic masses up to 200 at energies up to 100 GeV per nucleon per beam.

For heavy ion operation over the energy range from below injection to 100 GeV per nucleon, a large aperture is required, but the required central field in the existing tunnel is a relatively modest 3.4 T. For superconducting magnets with this central field, a single layer coil is sufficient. The dipole field needs to be uniform to a few parts in 10 000; this is achieved by the use of spacers between turns in the moulded coil. An iron yoke provides both field enhancement and a method of 'collaring' or clamping the coil. The saturation sextupole introduced by close proximity of the iron is removed with the same correction coils which cancel the natural chromaticity of the lattice and correct the magnetization of the superconductor. (These correctors will be outside of the dipole field.) The magnet is curved to the 250 m radius of the existing tunnel to further reduce cost, since a curved magnet uses less horizontal aperture.

The prototype 4.5 m dipole was built and tested to verify these design concepts. The first quench of the magnet, 3.6 T, was above the required operating field of 3.4 T. With a little training, the magnet reached 4.5 T, allowing for a reasonable safety margin that should eliminate the need for training prior to magnet installation. The allowed multipoles were small, as designed, and the unallowed terms were within the estimates developed from previous experience.

This test follows the excellent performance of three engineering models built to study collaring ideas and to provide an opportunity for industrial involvement. Brown, Boveri et Cie (BBC) assembled the magnets with coils made by Fermilab, using some parts and tooling developed for HERA magnets at DESY, Hamburg. These engineering models have both magnetic and non-magnetic collars. All three exhibited little or no training. The one with iron collars gave the desired safety margin which led to establishing the criteria for the prototype model. The fourth and last magnet in this series will be tested shortly.

Plans are being made for the construction of full-length (9 m) dipoles at Brookhaven and at Brown, Boveri et Cie, again using some of the tooling built for HERA. The coil design has been slightly altered from that of the 4.5 m magnet in order to make use of cable developed for the outer coil of Superconducting Supercollider magnets. The longer magnets will be used to check reproducibility of field shape, quench propagation, cryogenic design, alignment and related items. After individual testing, these long magnets will be assembled for a test of a full cell of four magnets.

The plan for RHIC as a whole was recently reviewed by a technical committee headed by Bill Willis of CERN. The review was timed to coincide with the final preparation of an updated proposal. The report of the committee was extremely favourable, summarizing the level of preparation by stating: 'The RHIC project is now technically ready to proceed to construction.'

Hot little bangs

What might happen when two heavy nuclei, such as uranium, smash together at energies as high as those now used by particle physicists — of the order of 100 GeV per nucleon?

Nobody knows for sure what will happen, but there is no shortage of opinions on what might happen. These ideas, and the techniques for investigating them, were the subject of 'Quark Matter 86', the fifth International Conference on Ultra-Relativistic Nucleus-Nucleus Collisions, held from 13–17 April in Asilomar, California. Organized by Berkeley, the meeting brought together some 160 physicists from the nuclear physics and particle physics subcultures.

Although there is precious little data on these collisions other than a handful of cosmic ray events, this has not deterred theoretical speculation. The consensus conclusion is that if enough energy is pumped into a nucleus, normally considered as a loosely bound collection of protons and neutrons, it will eventually transform into a completely new state: the protons and neutrons will lose their separate identity and fuse together into the quark-gluon plasma or 'quagma'. The whole Universe could have been in such a state a few microseconds after the initial Big Bang, and quagma may still exist, for example in the cores of neutron stars.

Even if synthetic quagma can be produced, it will not live long, exploding in some 10^{-23} seconds into several thousand (for uranium on uranium) particles, which will carry information to the waiting detectors about the highly transient initial state. Expected signatures include an overabundance of strange particles and flashes containing several hundred photons, as well as fluctuations in particle density ('hot spots'). Searching for these effects in the copious debris may not be easy.

Late in its career, the CERN Intersecting Storage Rings were used to study the collisions of high energy alpha particles (helium nuclei), but these are too light to provide quagma. However Brookhaven is preparing to accelerate ions up to sulphur in the Alternating Gradient Synchrotron with energies up to about 15 GeV per nucleon, while CERN has scheduled the acceleration of oxygen ions to 225 GeV per nucleon.

Whether or not these initial studies see any signs of quagma, there is a strong case for pushing on to the ultimate conditions provided by the Relativistic Heavy Ion Collider, RHIC, being pushed by Brookhaven for its still vacant tunnel built for the Isabelle-CBA project (see page 5).

A RHIC workshop will be held at Brookhaven in about a year, and is expected to get to grips with designing experiments for the RHIC project. (Those interested should contact T. Ludlam at Brookhaven.)

From Mike Albrow

LOS ALAMOS
Proton milestone

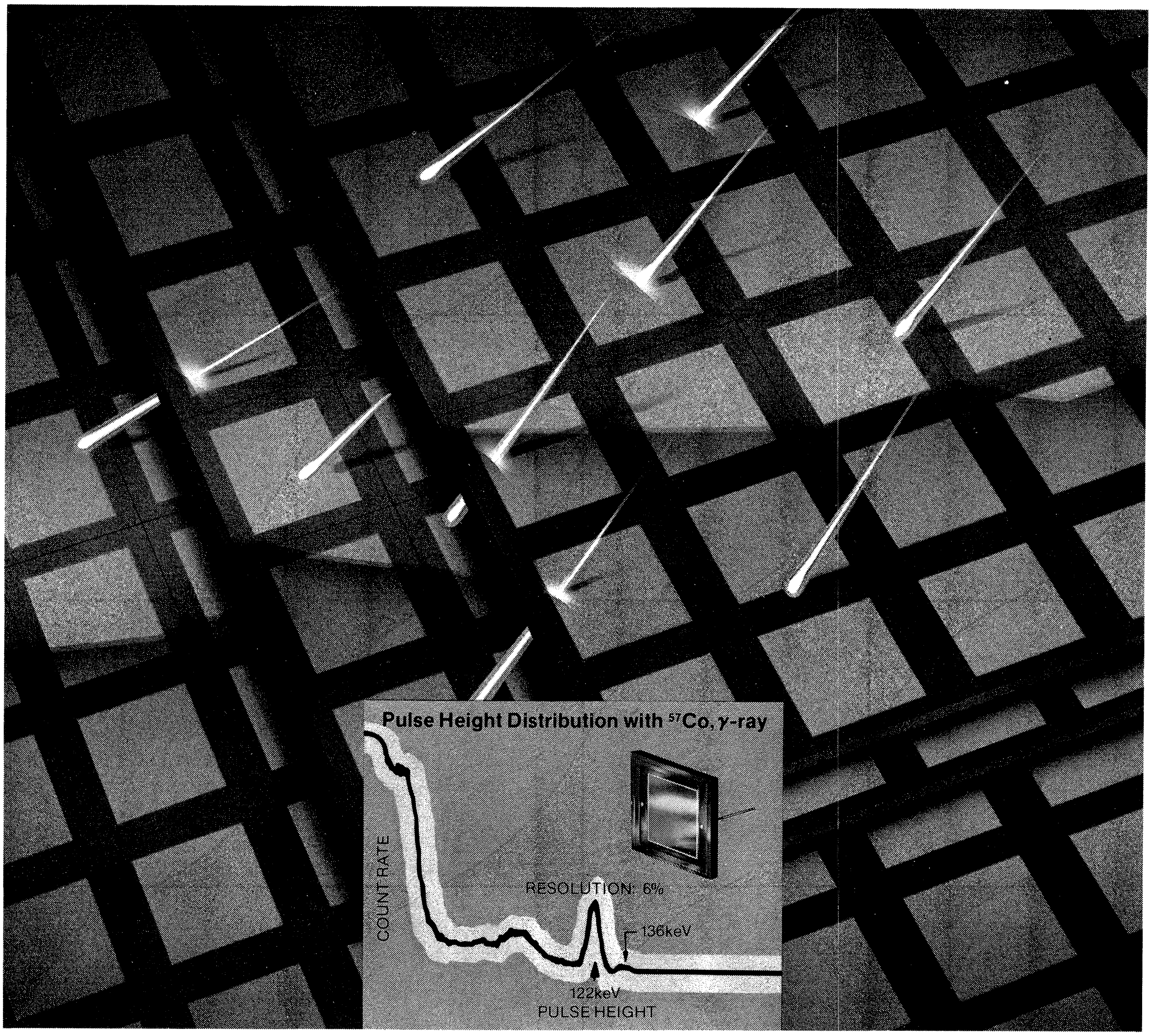
In December, the Proton Storage Ring at the Los Alamos Meson Physics Facility (LAMPF) passed a major milestone when it operated at up to 30 microamps average beam current to service the experimental programme at the Laboratory's Neutron Scattering Center.

The Proton Storage Ring is a major addition to LAMPF's existing high current proton linear accelerator, accumulating large numbers of protons from the linac and delivering them to the neutron generating target in intense short pulses.

Operation at 30 microamps was achieved by accumulating 1.5 x 10^{13} protons per pulse in the storage ring at a repetition rate of 12 pulses per second. Circulating beam current losses were estimated to be less than two per cent on the basis of beam lifetime measurements at reduced repetition rate and long storage times. Losses at extraction are at a comparable level.

The present achievement demonstrates performance at 30 per cent of the design goal (at 12 Hz) and has been accomplished early in the commissioning cycle. Commissioning work at the Neutron Scattering Center will continue when beam resumes after a six-month shutdown. Major goals for the next phase are to increase current, decrease beam losses, and achieve stable use for the neutron scattering program.

Experiments in powder diffraction, chemical spectroscopy, and condensed matter physics are underway with some publishable results expected from present data-taking.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STANFORD
Collider pushes forward

Work on the new Stanford Linear Collider (SLC) is on schedule for first machine tests at the end of ıe year.

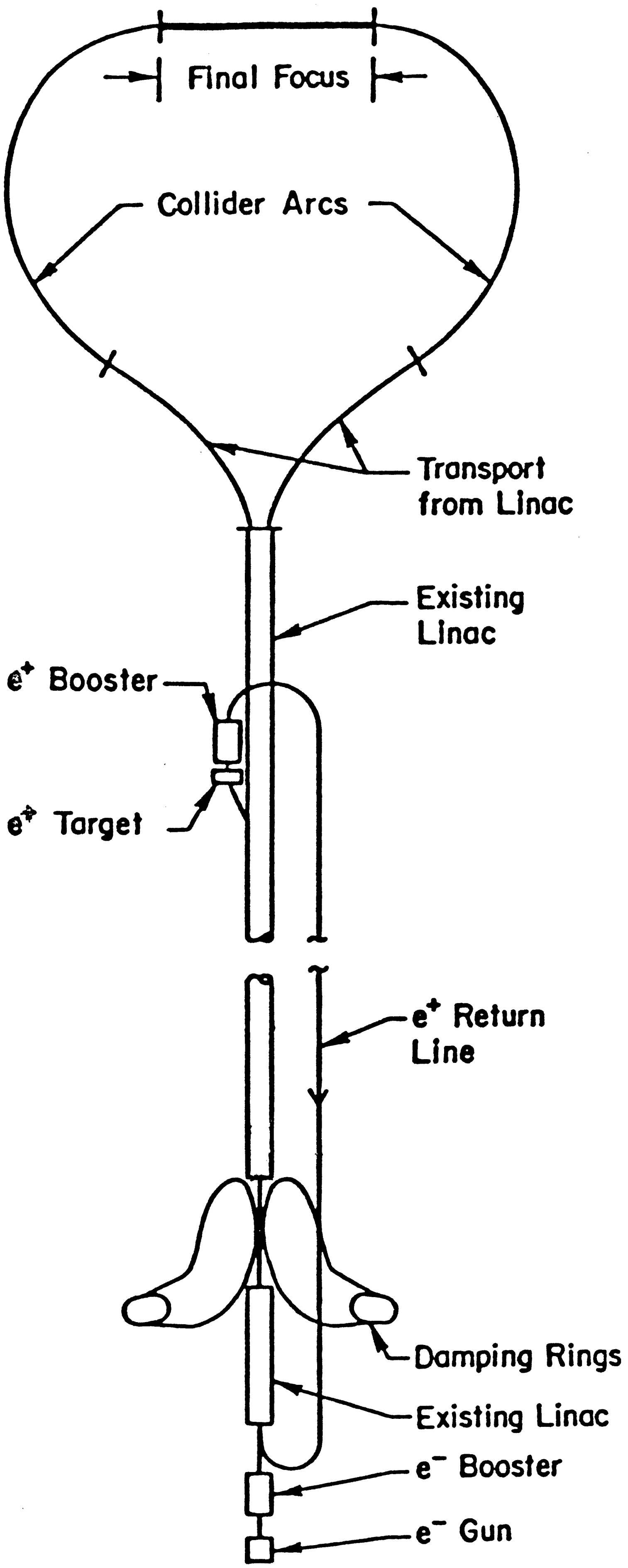
Construction of the North damping ring (to improve the quality of the initial beam prior to final acceleration down the linac) is essentially complete and the ring has been in operation. The now rebuilt South damping ring has also handled beam.

The electron extraction system (to produce the positrons) has been installed ready for testing. The positron return line is in place and under vacuum. Once the positron target is complete, the 'three-ring circus' of the two damping rings and the positron source will be put through its paces.

Production of 50-megawatt klys-ons is on schedule, and some ı30 of these new klystrons have been installed in the main linac gallery and are running routinely. Fabrication of all alternating gradient magnets for the arcs is complete, and the magnets are being installed.

The arc tunnels have been complete for some months and installation of the mechanical and electrical utilities in the tunnels is nearing completion.

There have been delays in the construction work for the Collider Experimental Hall, but completion is imminent ready to receive the Mark II detector, rebuilt after action in the SPEAR and PEP rings for a



Schematic diagram of the SLC Stanford Linear Collider, scheduled for first tests towards the end of the year.

third lease of life at a Stanford electron-positron collider.

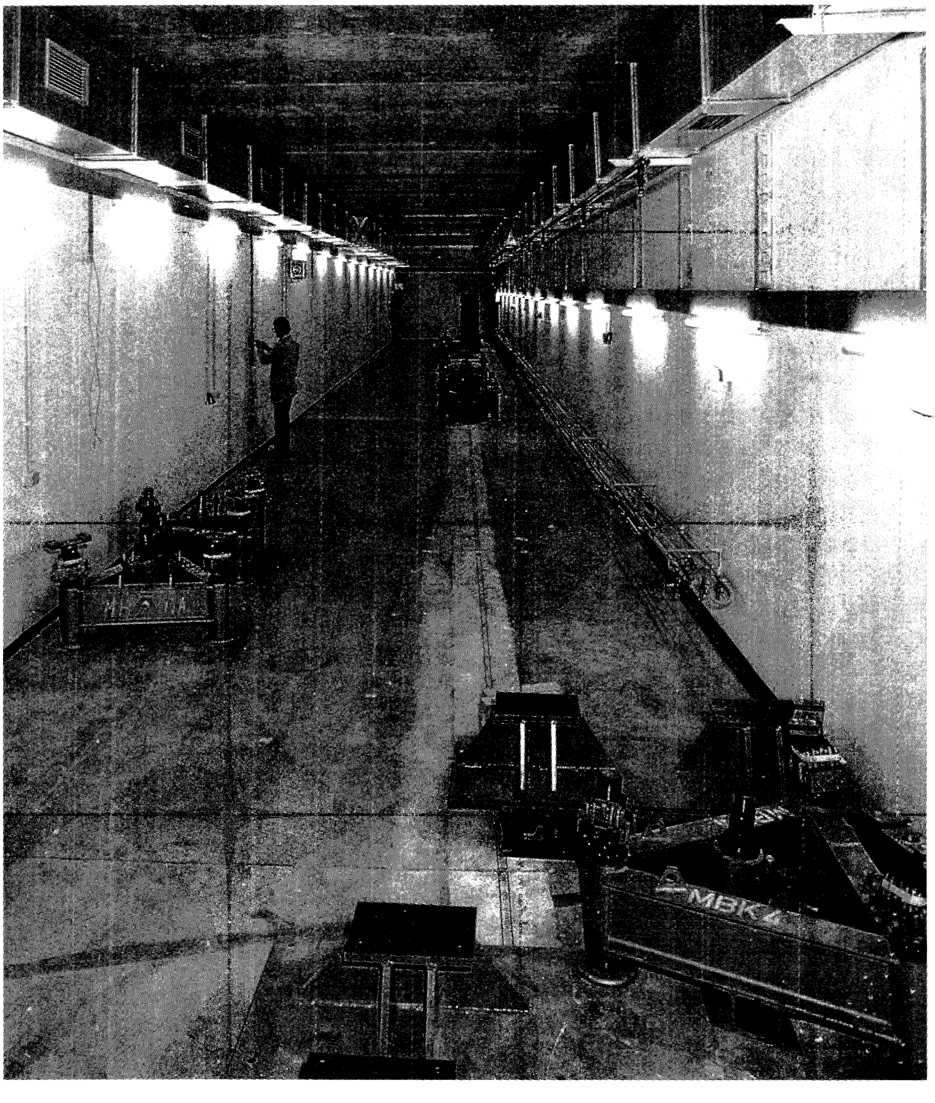
Work towards the Stanford Linac Detector (SLD) also pushes steadily forward, where problems that had been besetting the Cherenkov Ring Imaging Detector (CRID) or Ring Imaging CHerenkov (RICH), depending on which side of the Atlantic the physicists work, have been sorted out and the way now seems to be clear towards good particle identification.

▶

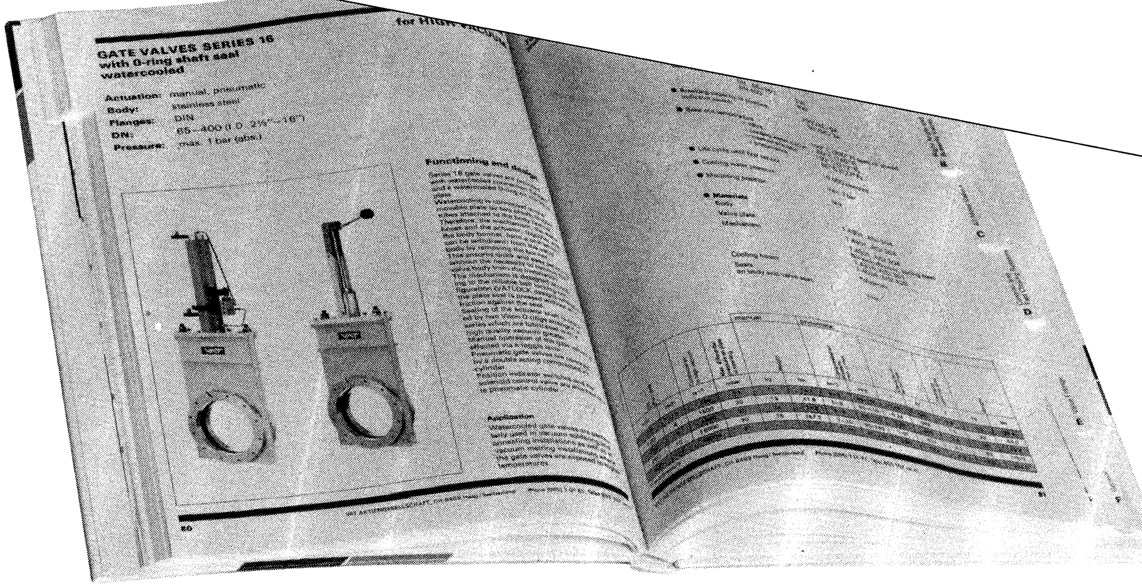
Laboratory Director Volker Soergel, flanked by project leaders Gus Voss (right) and Bjorn Wiik, pose in front of the tunnelling machine after its arrival at the West Hall of the HERA electron-proton Collider being built at DESY. Research Director Paul Söding (extreme right) shuns the camera, preferring to take a closer look at the machinery which had traversed 1530 metres of Hamburg underground.

DESY
HERA progress

At the German DESY Laboratory in Hamburg, construction of the HERA electron-proton Collider continues to progress according to schedule. A quarter of the 6.3 km ring tunnel has been built: on 13 February the tunnelling machine emerged into the West Hall after setting out from the South Hall last summer. The machine is now cutting the second quadrant. Also complete now is the hall for the proton linac. 50 MeV particles will be fed from the linac to the proton ring through an 80 metre-long beamline using magnets ordered by the Canadian TRIUMF Laboratory in Vancouver. Linac equipment should be ready for shipment towards the end of the year.



The completed hall to house the proton linac which will feed HERA.



A weekend between two weeks of physics in the latest 'Moriond' meetings in the French Alps was devoted to future colliders. CERN Director General Herwig Schopper (left) gave the introductory talk. Right is Moriond organizer Jean Tran Thanh Van of Orsay.

(Photo P. Franzini)

WORKSHOP
Collider sandwich

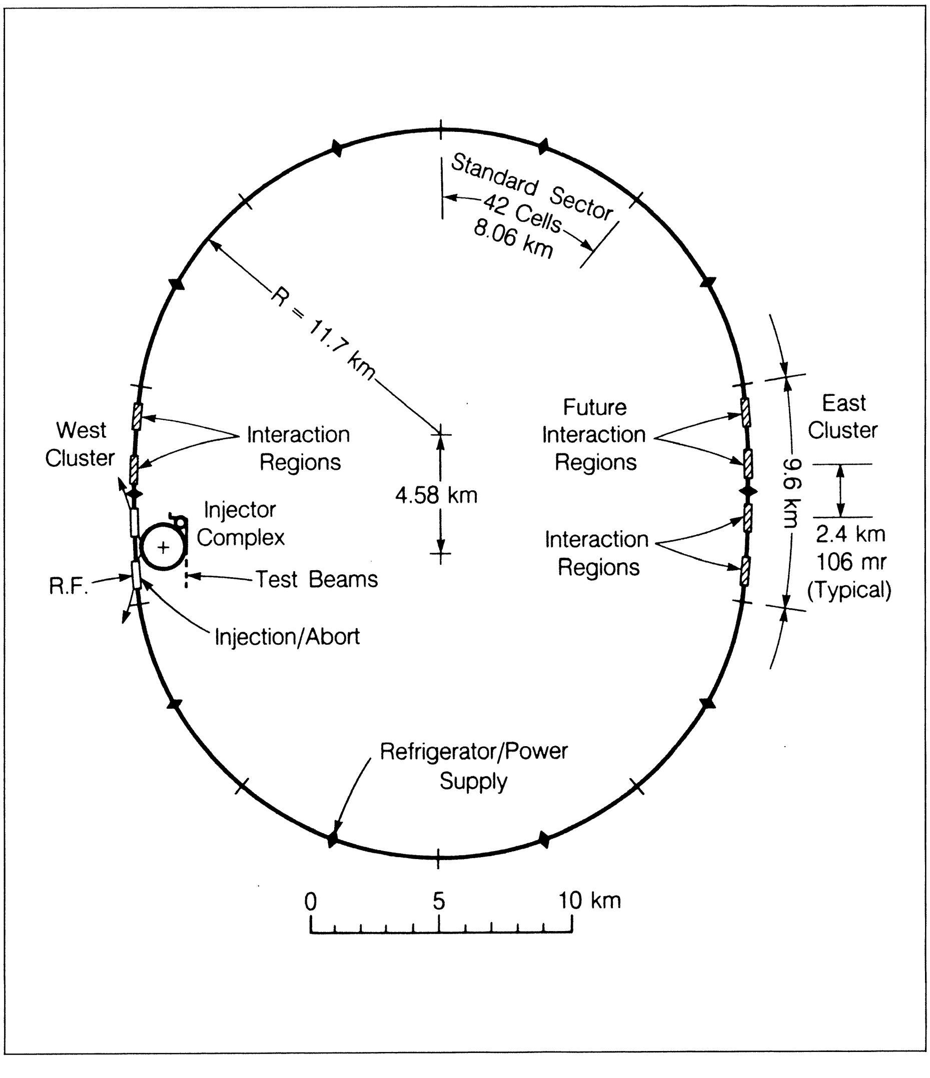
Sandwiched between two consecutive weeks of physics sessions at the latest 'Rencontre de Moriond' in March at Les Arcs in the French Alps was a weekend devoted to future colliders, arranged so that participants from both halves of the Moriond programme could attend. In addition, several people came from the US just for the weekend presentations.

The programme was arranged by Laboratory Directors Herwig Schopper of CERN and Leon Lederman of Fermilab (the latter unfortunately could not attend due to Congressional hearings in Washington).

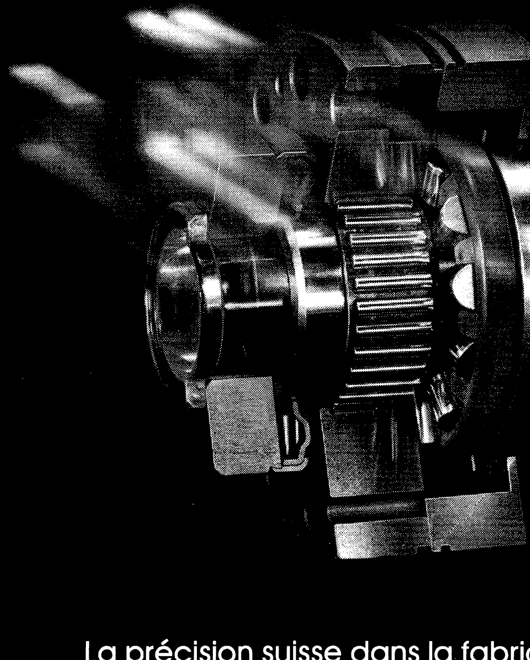
In his introductory talk, Schopper described the status of discussions on international cooperation on future machines, and tried to peer through the present financial fog to see what might happen some years hence.

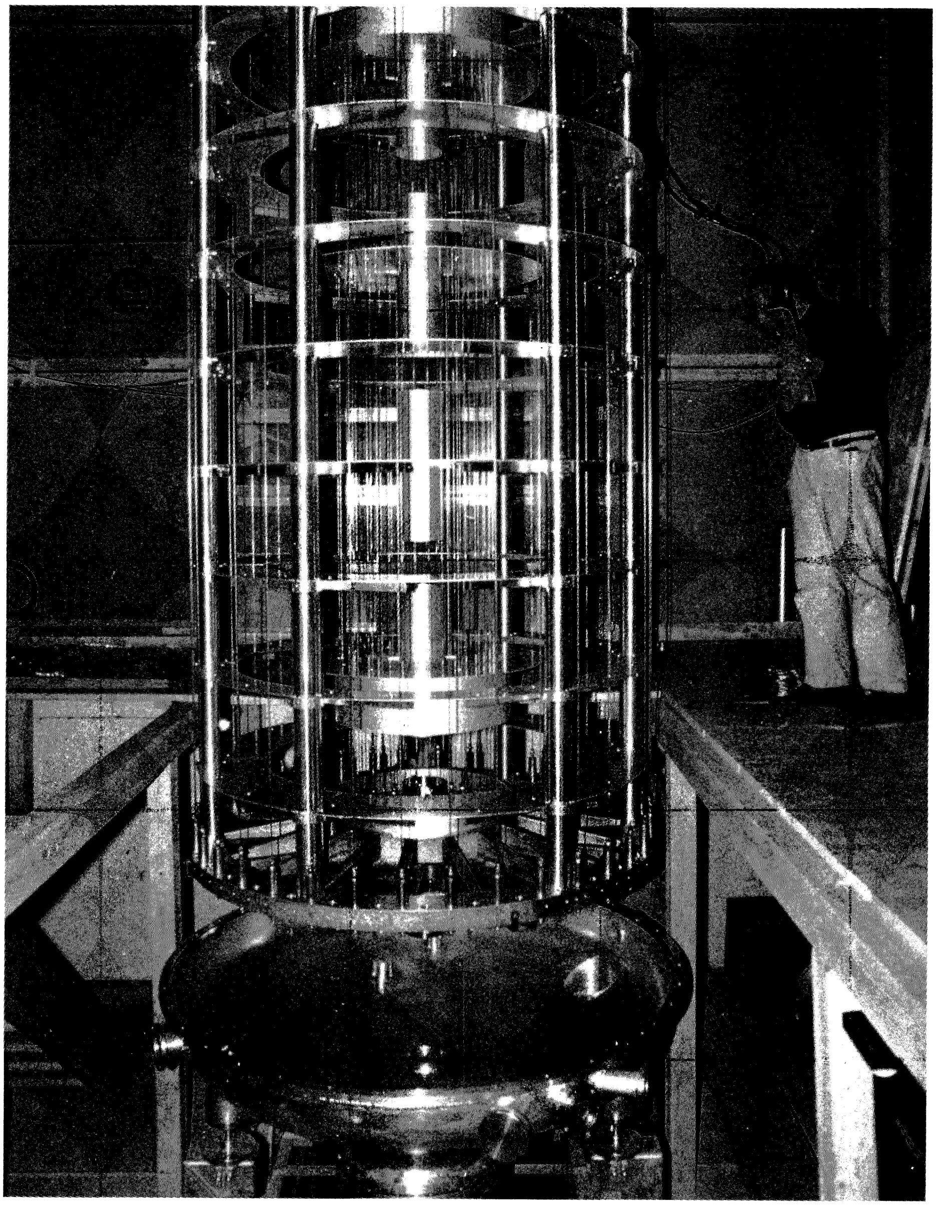
Don Edwards covered the latest ideas for the US Superconducting Supercollider (SSC) which had been submitted to the Department of Energy with a view to recommending its inclusion in the US budget for 1988.

Roy Schwitters turned to the problems of making detectors work at the high collision rates needed to get at very rare high energy processes. However he felt there was no reason to be pessimistic, with the limitations being in terms of money and manpower rather than technological breakthroughs.



Latest version of the 40 TeV (40 000 GeV) proposed US Superconducting Supercollider, SSC.





Ion source assembly of the Zurich experiment at the Swiss Institute for Nuclear Research (SIN) which finds no evidence for a (electron-type) neutrino mass, in contradiction with the findings of a study at Moscow's Institute for Theoretical and Experimental Physics (ITEP).

Tom Himel and Bob Palmer went over the research going on in the US for electron-positron linear colliders. Earlier efforts to find new acceleration techniques seem to have faltered with the growing realization that most approaches gave collision rates too small for useful physics. Growing emphasis was now being placed on improving power sources and efficiencies, and a new US linac testbed is soon expected to get the go-ahead.

On the European side, Ugo Amaldi dealt with ideas for future colliders, both for hadrons and for electrons on positrons.

SIN/ZURICH
New neutrino mass limits

The neutrino was discovered in the 1920s when it was realized that not all the energy released in nuclear beta decay was being picked up — the forerunner of the 'missing mass' technique of today. Direct evidence for the neutrino was not seen until 1953.

In the early days it was widely believed that the neutrino would be massless. Although they interact only feebly with matter, neutrinos are omnipresent in the Universe and any evidence for a nonzero mass has important implications for cosmology as well as for particle physics.

For several years, an experiment at the Institute for Theoretical and Experimental Physics (ITEP, Moscow) has been reporting limits for the mass of the electron-type neutrino, the latest range being between 20 and 45 electron volts. This is now being challenged by a University of Zurich team working at the Swiss Institute for Nuclear Research (SIN) at Villigen.

Just as the missing mass due to the neutrino was originally discovered in nuclear beta decay, experiments are returning to beta decay in an effort to pin down the neutrino mass.

The ITEP experiment looks at the beta decay of tritium (hydrogen 3) bound in large organic (valine) molecules. The final result involves complicated calculations to estimate molecular effects and the experiment's conclusions have been criticized (see November 1985 issue, page 380).

The Zurich study uses tritium ions implanted into carbon cleaned in a hydrogen gas discharge to remove weakly bound surface tritium. Initially, the carbon was evaporated onto aluminium foils, but a later method used an assembly of aluminium discs and an implantation technique which shielded the collector from the hot filament producing the initial ionization. This also avoided having to handle delicate ion-implanted foils.

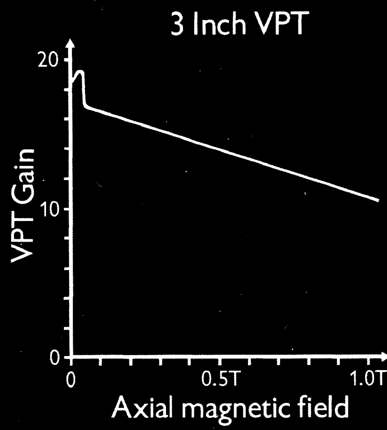
The response of the toroidal field magnetic spectrometer was the subject of a detailed analysis. Before calculating the results, this response had to be compounded with the energy lost by electrons in leaving the source, and allowance made for final state effects.

The latest data come from four runs with three sources, totalling 27 days of measurement. After careful analysis, the resulting upper limit for the mass of the neutrino is 18 electron volts.

The experimenters conclude — 'We find no indication of a nonzero mass for the electron antineutrino, which is in strong contradiction with the results of the ITEP experiment. We see no possible source of error in our experiment large enough to account for this discrepancy'.

ONE T?

The OPAL and DELPHI end-cap calorimeters at CERN require lead-glass arrays to be read out in full axial fields up to 1.2 tesla. Not a task for conventional PMTs. So, building on our experience in vacuum photo diodes, we developed a family of Vacuum Photo Triodes to do the job. In 1½″, 2″ and 3″ sizes, and with low capacitance to minimize contribution to preamplifier noise. With gains ≈10 at 1 T axial. Even at 20° from axial, gains still high enough to lift the signal well clear of preamplifier noise. We're prepared to discuss versions for fields up to 70° from axial.



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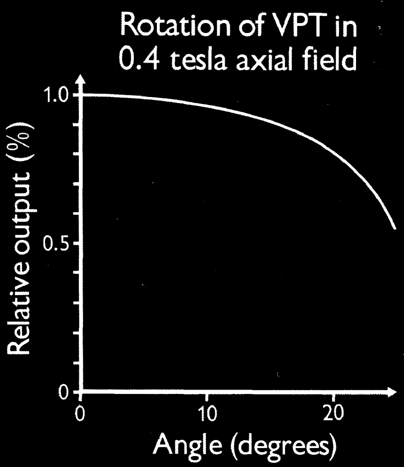

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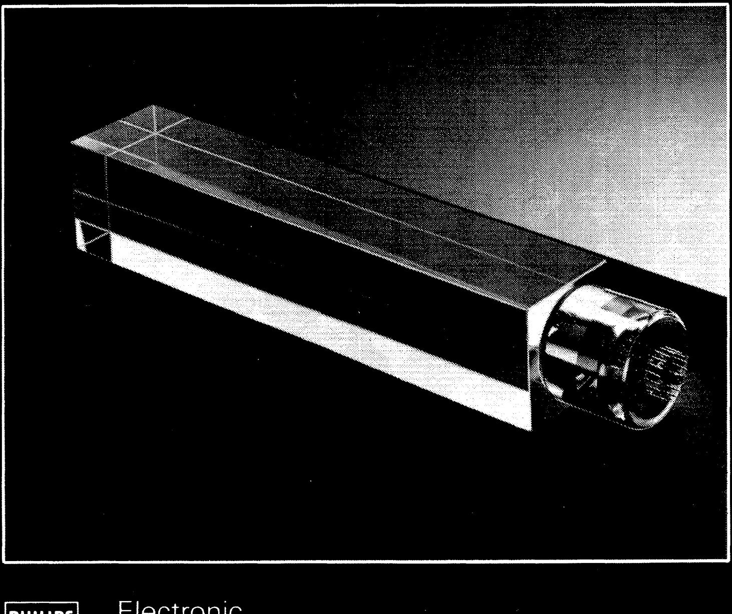

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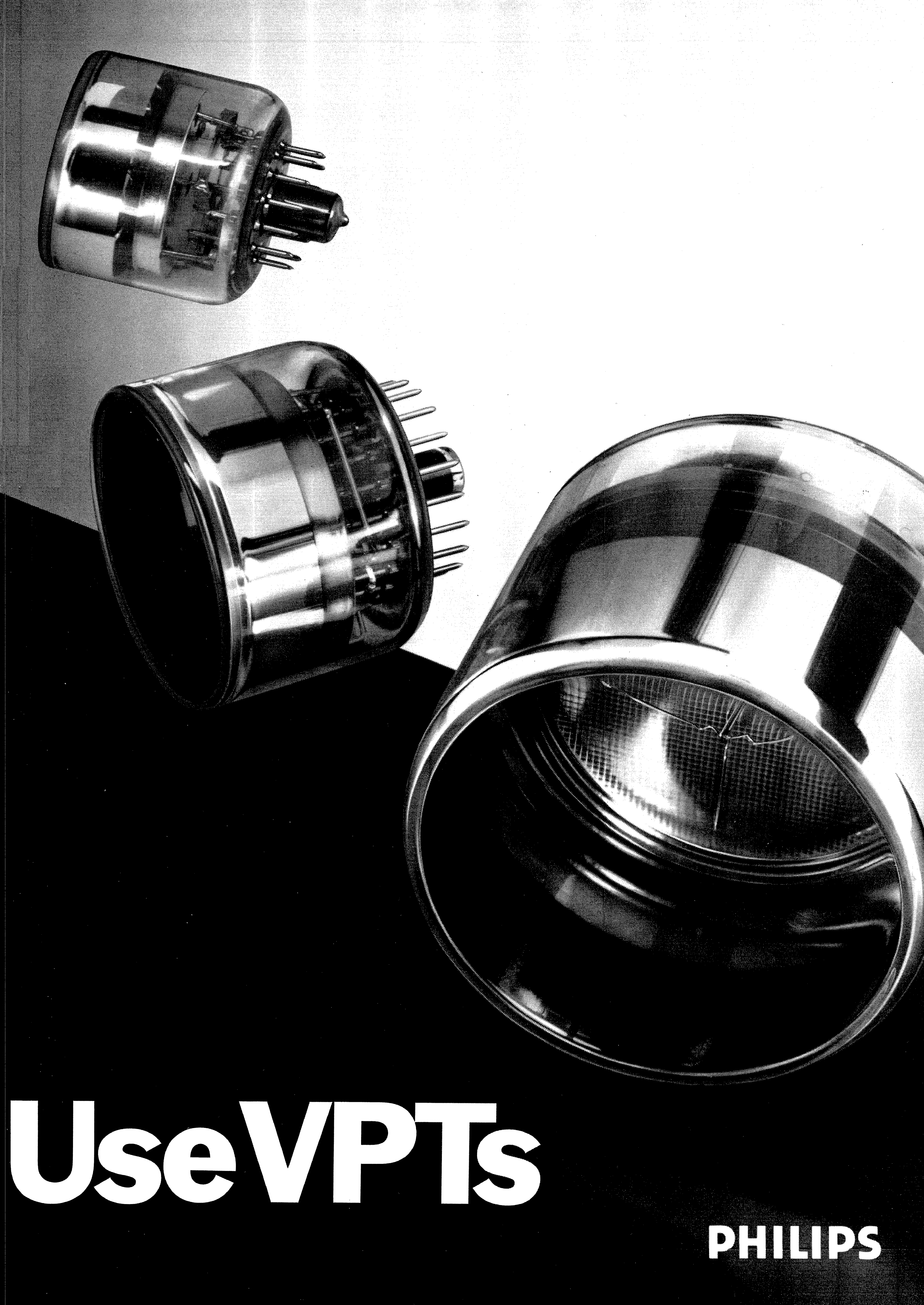
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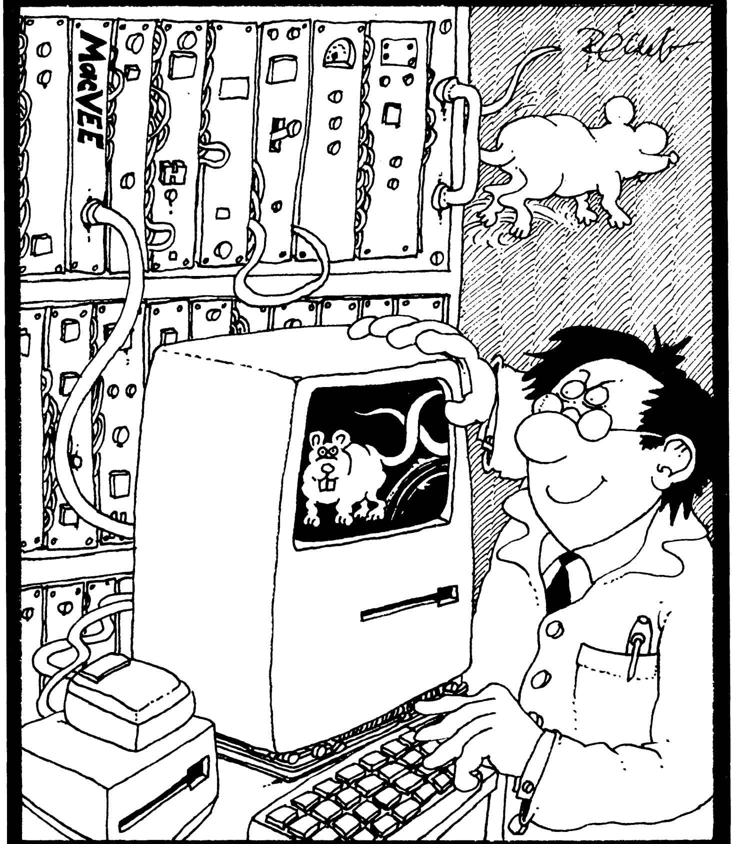
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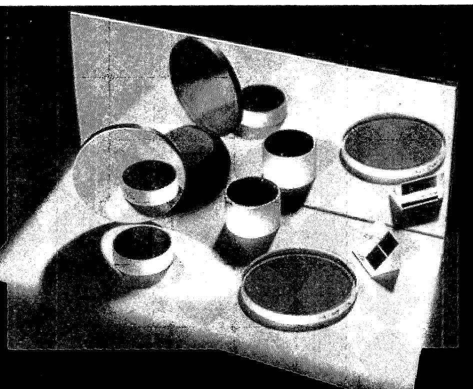
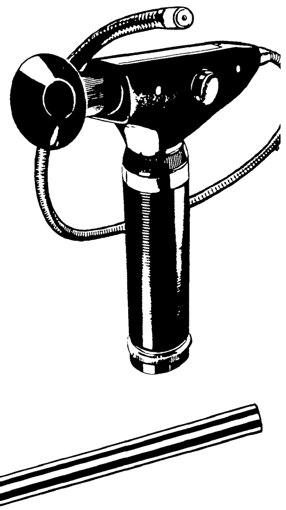
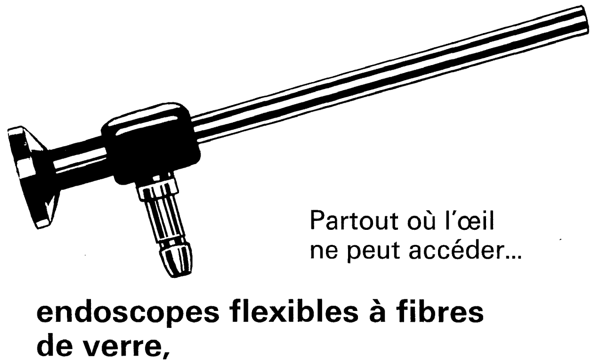
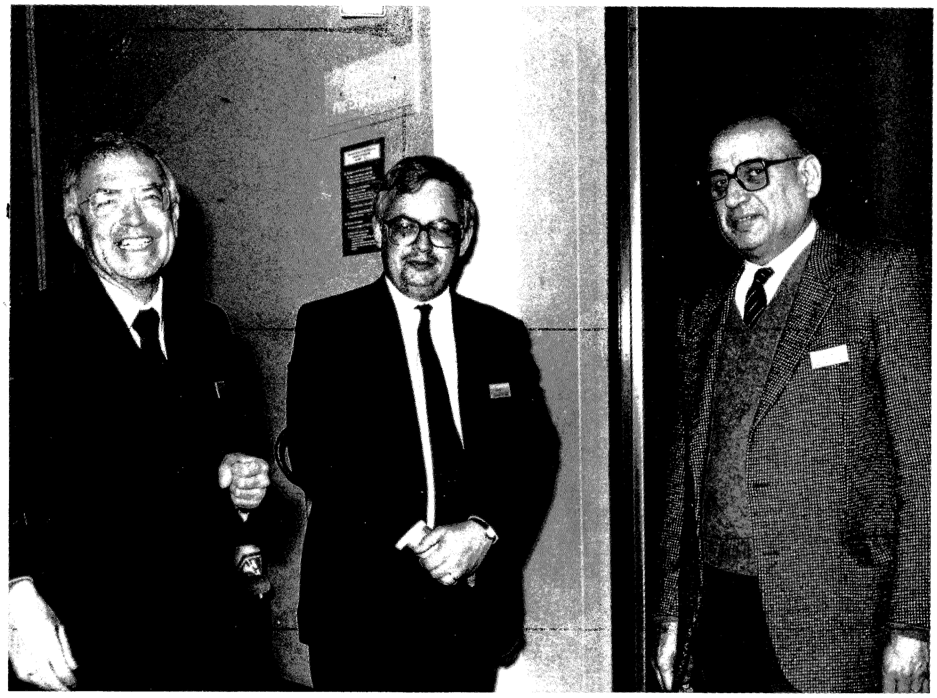








The course on geodesy for particle accelerators, arranged by the CERN Accelerator School, attracted an impressive number of participants from outside. Left to right, Helmut Moritz of Graz Technical University, Austria, and Claude Boucher and Henri-Marcel Dufour of the French National Geographical Institute.

(Photo CERN 248.4.86)

Accelerators at school

Latest subject covered by the CERN Accelerator School was 'Applied Geodesy of Particle Accelerators', which attracted an impressive number of outside participants to CERN for a week in April.

Since the forerunners of today's particle accelerators were demonstrated over 50 years ago, the positioning of accelerator components has progressed from the laboratory bench-top to tunnels tens of kilometres long. Despite this phenomenal growth in size, sub-millimetre accuracy is still required.

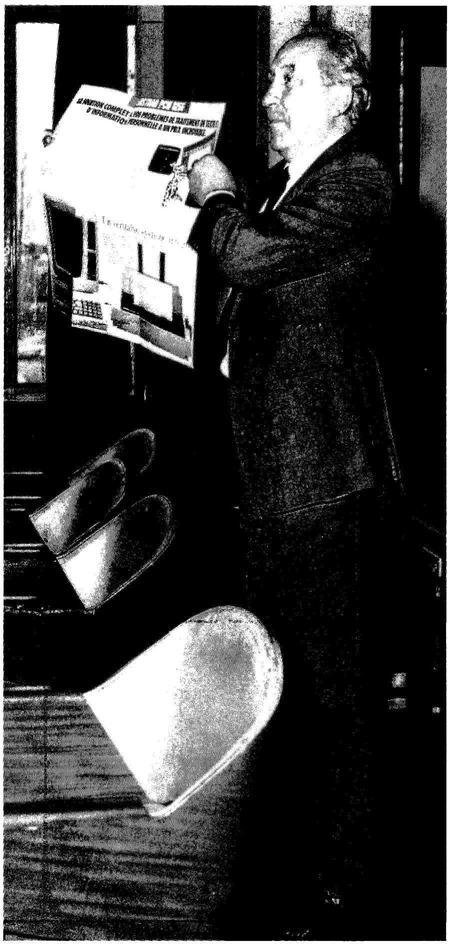
Even with new aids such as satellite-based positioning and two-wavelength laser measurement, ensuring such precision for big machines with thousands of separate components has posed special problems. In its inimitable way, CERN has made its own special mark on the technology of geodesy over the years.

The school also coincided with the retirement of Jean Gervaise, doyen of the CERN Applied Geodesy/Survey group.

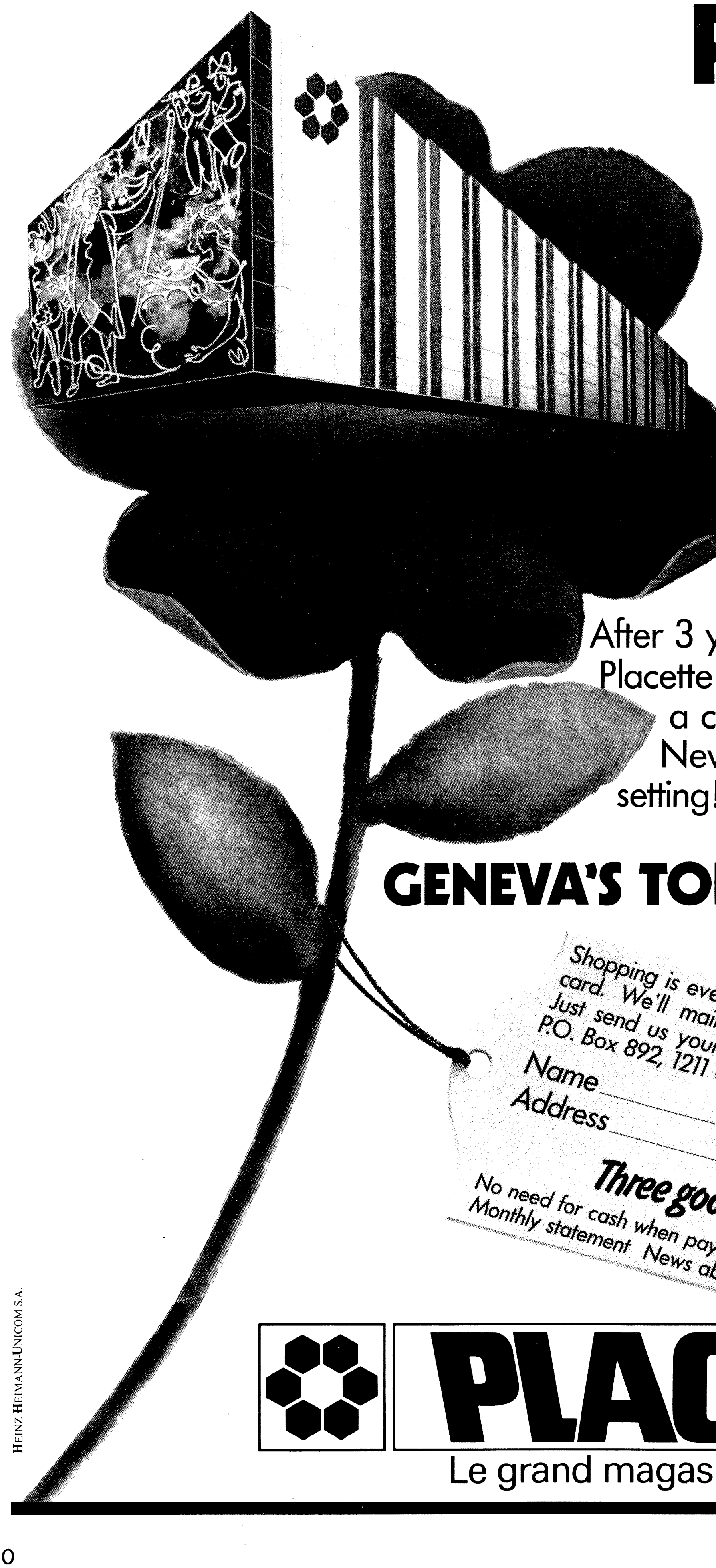
The next session of the CERN Accelerator School is a basic course on General Accelerator Physics from 15–26 September at Aarhus, Denmark, and will lead on to a more advanced course in about a year. More information from Mrs. S. von Wartburg, CERN Accelerator School, LEP Division, CERN, 1211 Geneva 23, Switzerland.

Jean Gervaise retires

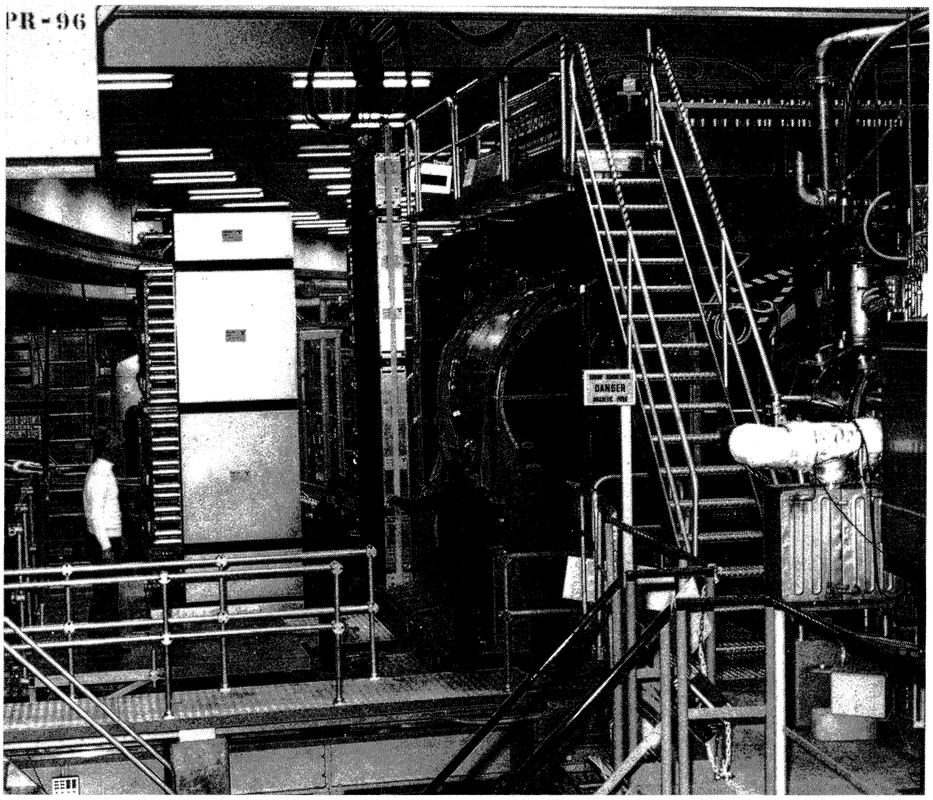
High energy accelerators only function well if someone has taken the trouble to put them in the right place and ensure that all their thousands of components are precisely positioned. Thus on his retirement in April, numerous tributes were paid to Jean Gervaise, a member of CERN's brilliant survey and alignment team from the days of the construction of the Proton Synchrotron in the 1950s. Under his leadership, the group has always been at the forefront of technology and has developed new versions of several instruments which have gone on to be used in other fields. In his meticulous work he retained the human touch and could regale his listeners with apocryphal stories about Roman villas and toilet doors.



Jean Gervaise — a remarkable professional reputation.



DETECTORS
Alternatives



An unusual 'exploded' view of the detector used several years ago at Intersection 8 of the CERN Intersecting Storage Rings, showing (left) a wall of uranium-scintillator hadron calorimeter. This experiment pioneered the use of several new detector techniques.

(Photo CERN 306.1.82)

The quest to find the 'perfect' detector continues. Current preoccupations include the correlation between measured energy deposition due to electrons and due to hadrons, and the use of alternative active media such as silicon or room temperature liquids rather than the traditional scintillators or liquid argon.

Using a calorimeter consisting of alternate layers of inert material and active detectors, the response due to electrons is often larger than that due to hadrons. This is because of the energy 'lost' in invisible low energy nuclear reactions.

To bring the hadron and electron responses back into line requires either artificially weighting the two types of signal or else finding some way of boosting the measured hadronic energy. One idea on the market is to use uranium plates, so that the energy released by induced fission could compensate for the lost energy.

This idea has worked, but the results seem to depend on the running conditions. For example the team developing the SLD detector at Stanford decided to reject uranium in favour of conventional lead plates (see January/February issue, page 21).

To try and understand better what happens, a CERN / INFN Frascati / Milan / McGill / Tel Aviv team recently looked at the behaviour of electromagnetic showers in their new silicon calorimeter (see September 1985 issue, page 285) using both uranium and tungsten absorbers.

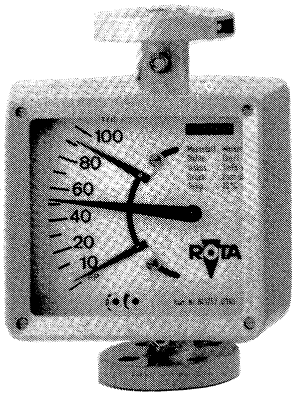
The detected energy with uranium absorber is found to be about 11 per cent higher than with tungsten, and many other shower characteristics were investigated, hinting at additional insights into the complicated energy loss mechanisms.

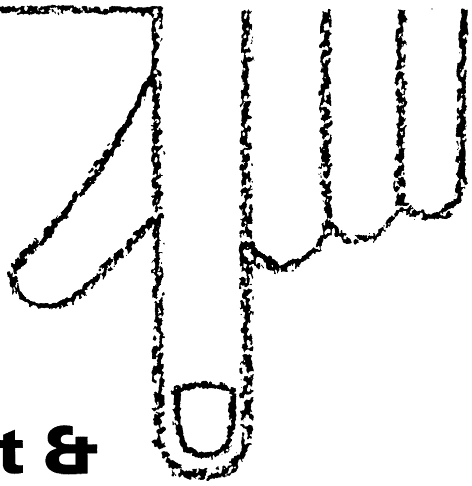
At CERN, a Bari / Brussels / CERN / London (Birkbeck and University Colleges) / Rome / Turin team carried out tests using 135–350 GeV beams with iron and uranium absorbers, using scintillator as the active detecting medium. With iron, the hadron energy signal is depressed, but with uranium, the hadron signal became higher than for electrons, showing an 'overcompensation'. A mixed configuration of iron and uranium gave a better performance.

Other studies investigate the use of warm liquids as the active detectors, so as to avoid the cryogenics required to handle liquid argon. The UA1 collaboration at the CERN proton-antiproton Collider is looking at uranium and room temperature liquids for its planned detector upgrade (see November 1985 issue, page 384).

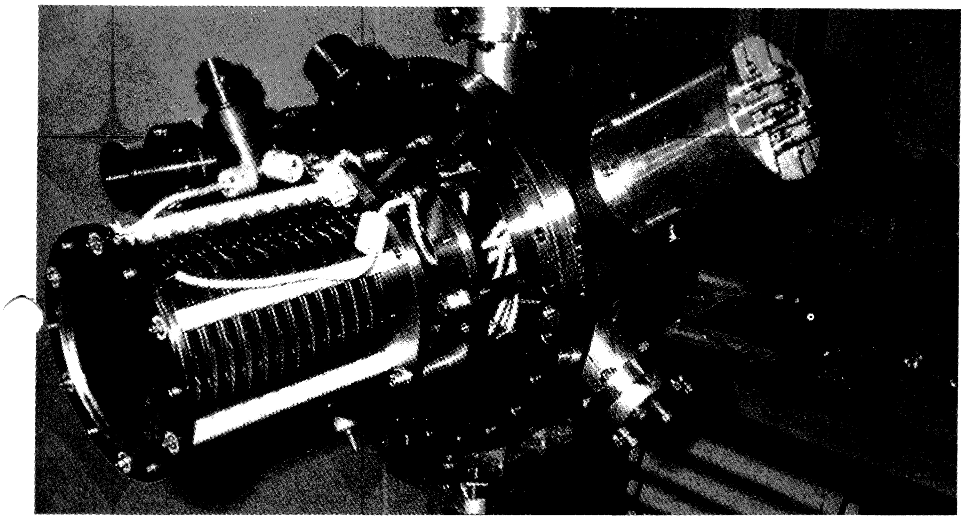
UA1 recently tested a prototype electromagnetic calorimeter consisting of twenty 10 cm^2 boxes, each 3 mm thick, filled with TMP (Tetra-methyl-pentane) and separated by 4 mm uranium plates. The energy resolution for 5 GeV electrons was measured at 9.5 per cent, in agreement with expectations, and the use of 2 mm uranium plates, as planned for the final calorimeter, will improve this by a factor of 1.4.

A full electromagnetic and hadronic calorimeter prototype is under construction with 2 mm uranium plates in the electromagnetic sections and 5 mm plates in the hadronic. TMP has the advan-





Beam profile monitor developed by a CERN/LAPP (Annecy) group based on a high gain dynode.



tage of a higher boiling point than the more usual TMS (122C compared with 26.5C) and is therefore much safer to handle.

Meanwhile a group at the Karlsruhe Kernforschungszentrum has successfully operated a calorimeter module consisting of 400 kg steel plates immersed in 35 litres of TMS. It has been tested in an electron beam at the DESY Laboratory in Hamburg, and the results are in line with expectations. Despite the small electronic signal in a molecular liquid, even smaller than in liquid argon, satisfactory results have been obtained. Encouraged by these results, the group is confident that warm liquid chambers can form part of large detectors, and the use of carbon iron shows that even magnet yokes could be instrumented in this way.

For the L3 experiment at LEP, a uranium-gas sampling calorimeter is being developed. Prototypes consisting of proportional chambers interleaved with 4.5 mm plates of depleted uranium absorber and using several gas mixtures have been tested in beams at Moscow's Institute for Theoretical and Experimental Physics (9 GeV proton synchrotron) and at CERN. The response to pions (but not to electrons) depends very much on the hydrogen content of the gas.

Beam profile monitor

A CERN/LAPP (Annecy) group has developed a new type of beam profile monitor based on a high gain dynode developed in association with Hamamatsu Photonics. This has already demonstrated its capabilities as a position sensitive photomultiplier (see July/August 1983 issue, page 226).

A prototype beam monitor used 13 stages of double layer grid dynodes 10 cm in diameter. A 50 micron aluminium foil placed in front of the first dynode released secondary electrons when traversed by the beam. After multiplication by the dynode system, the collected secondary electrons hit an array of 20 anode cells, 3 mm wide and 1 mm apart.

Using a weak axial magnetic field of about 400 gauss, the natural spread of the secondary electrons was contained within two adjacent anode cells, in line with the performance shown by position sensitive photomultipliers of the same type. Better definition was obtained by handling the centroid of the collected signal.

More studies of background are required, but the instrument's designers are confident that its high vacuum compatibility, resistance to radiation and ability to handle both low and high energy high intensity fields make it worthy of further attention.

CERN Review Group named

Earlier this year a special CERN Council meeting voted for the formation of a Review Group to look at the way CERN runs (see April issue, page 25). The members of the Group are: Anatole Abragam (Chairman) of the Collège de France in Paris and for a long time a director of the French Atomic Energy Commission; Miguel Boyer, one-time Spanish Economics Minister and now President of the Banco Exterior de España; Carlo de Benedetti, Managing Director of Olivetti in Italy; Brian Fender, Vice-Chancellor of Keele University, UK, and one-time Director of the Institut Laue-Langevin in Grenoble; Wolfgang Paul of Bonn University, formerly Director of the DESY Laboratory in Hamburg; Haakon Sandvold, Director General of Ardal of Sunndal Verk A/S, Norway; and Jean Vodoz, President of Swiss engineering concern AMYSA SA of Yverdon. The Group is expected to report to the CERN Council by June 1987.

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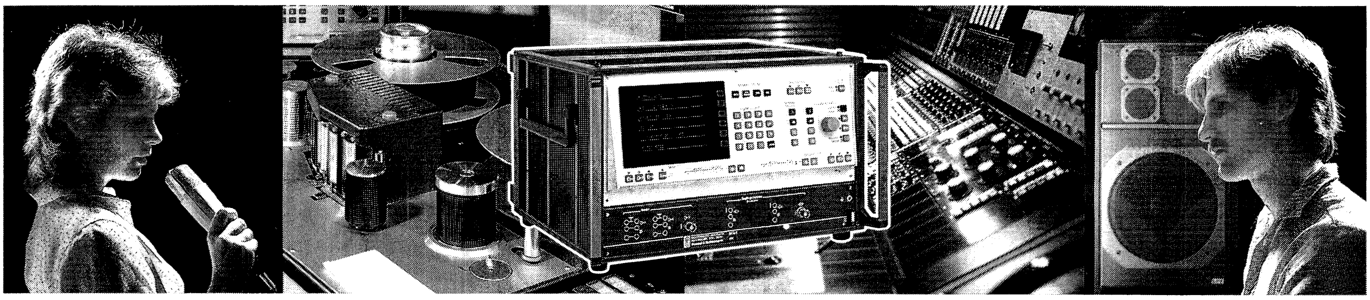

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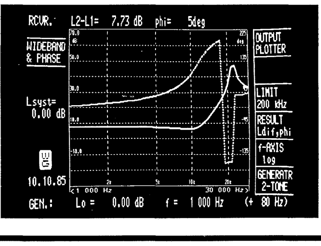

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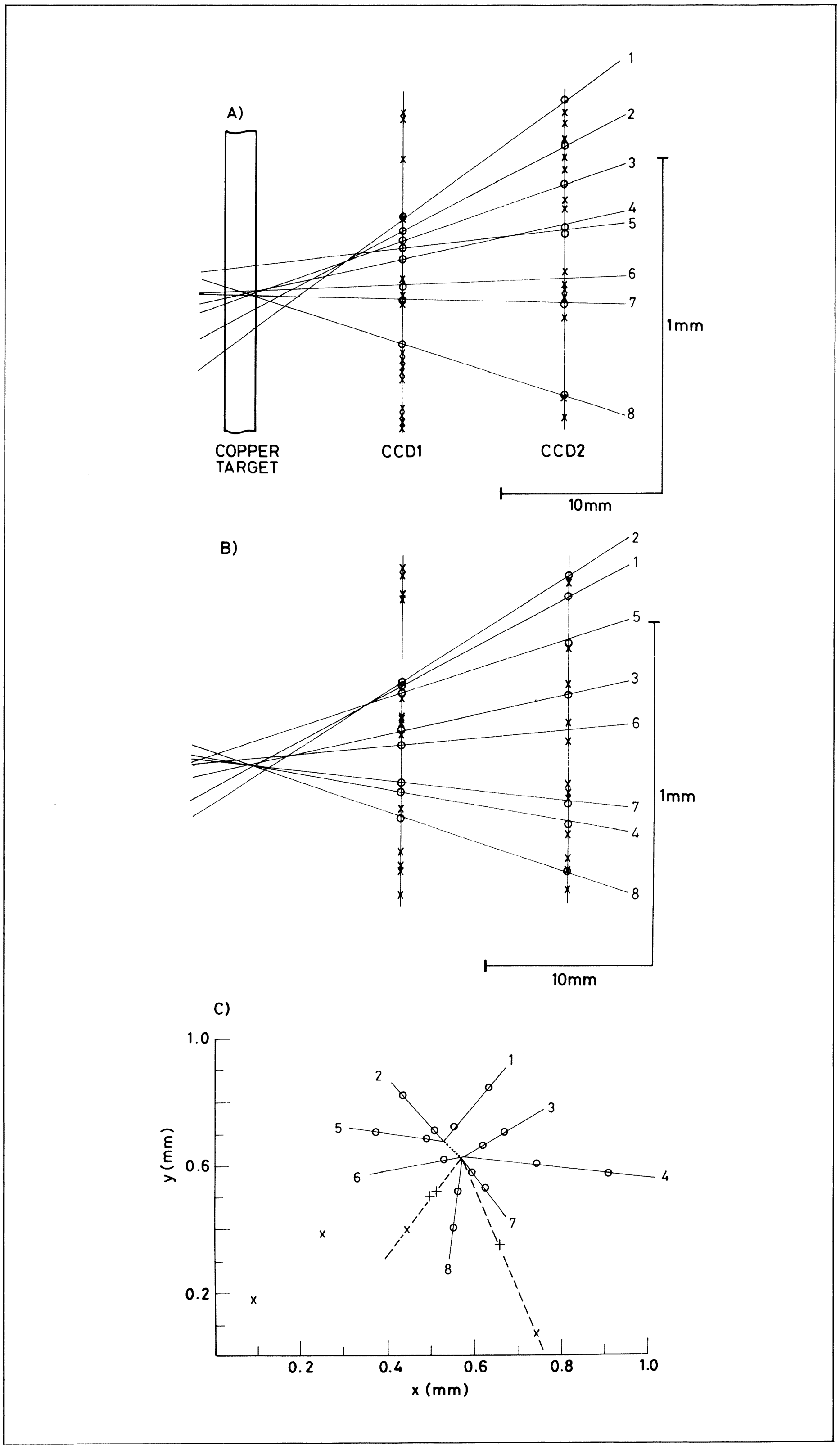
RUTHERFORD APPLETON
CCDs for charm

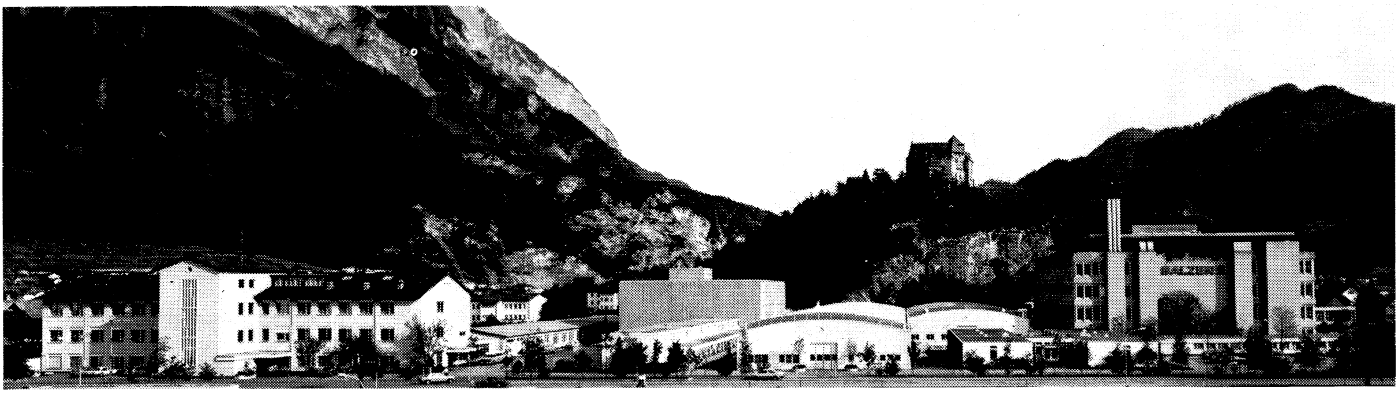
An article in our May issue (page 3) described the increasing use of semiconductor image processing techniques in particle physics. One aspect of this work is the use of Charge Coupled Devices (CCDs), on-chip amplifiers consisting of arrays of cascading capacitors.

Five years ago, a Rutherford Appleton Laboratory group started to apply imaging CCDs for precise tracking of high energy particles. The aim was to detect the decays of the short-lived charm particles produced in high energy collisions. This work has come to fruition in an experiment at CERN by the ACCMOR collaboration (Amsterdam/Bristol/CERN/Cracow/Munich/Rutherford).

In the first charm decay to be found (there are now many), 230 GeV pions collide with nuclei in a 2 mm-thick copper target. The tracks of the outgoing particles are reconstructed by computer (A). A distorted scale is used for visual clarity; the real tracks are all in a very small forward cone. Also shown are the CCD hits used in the track fitting (circles) and unused background hits due to out-of-time beam tracks (crosses). Apart from the production vertex, a clear decay vertex is made up of tracks 1, 2 and 5 and possibly 3, which looks compatible with both vertices. The beauty of CCDs is that they measure space points (being pixel-based devices) and so

Three views of the production and decay of a charmed particle by an experiment at CERN using charge-coupled devices (CCDs) to pinpoint the particles emerging from 230 GeV pion-nucleus collisions. (For details, see text.)





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Unser Kundenlabor für Beschichtungsanlagen organisiert und koordiniert unter anderem auch die internationalen Einsätze unserer speziell ausgebildeten Service-Ingenieure.

Ihre Aufgaben

- Inbetriebnahme von neuen Beschichtungsanlagen bei unseren Kunden
- Wartungs- und Reparaturdienst im weltweiten Einsatz
- Technische Beratung unserer Kunden vor Ort und im Stammhaus Balzers

Ihre Ausbildung

- Abgeschlossenes HTL-Studium in einer der Fachrichtungen Elektro-, Feinwerk- oder System- und Regeltechnik
- Gute englische Sprachkenntnisse und eventuell weitere Fremdsprachen
- Erwünscht, jedoch nicht Bedingung, sind praktische Erfahrungen als Service-Ingenieur

Ihre persönlichen Stärken

- Eigeninitiative und Selbständigkeit
- Improvisationstalent sowie Flexibilität
- Freude an einer intensiven Reisetätigkeit

Unser Angebot

Selbstverständlich bilden wir Sie auf Ihrem neuen Arbeitsgebiet umfassend aus, bieten Ihnen eine vielseitige Aufgabenstellung und grosszügig ausgebaute Sozialleistungen.
Wenn Sie darüber mehr erfahren möchten, wird Ihnen unser Herr Fritz Bossard, Personalabteilung, gerne einen Termin für Ihre erste Reise nach Balzers geben. Seine Telefonnummer (Direktwahl): 075 / 4 42 27.
Wir freuen uns auf ein Gespräch mit Ihnen.

Entwicklungsphysiker

Ihr zukünftiges Arbeitsgebiet

Unser rasch expandierende Bereich Dünnschicht-Elektronik produziert für die Halbleiter-Industrie hochwertige Chrom-Masken, die in qualitativer Hinsicht permanent weiterentwickelt werden.

Ihre Aufgaben

- Entwicklung neuer Schichtsysteme für Chromblanks
- Entwicklung von Maskenblanks für die IC-Technologie von morgen
- Mitwirkung bei der Verfahrensverbesserung, der Blanks-Verarbeitung und bei der Prozessoptimierung unserer Beschichtungsanlagen

Ihre Ausbildung

- Abgeschlossenes Hochschulstudium der Richtung Physik oder verwandter Disziplinen
- Erfahrungen in der Halbleiter- oder Dünnschicht-Technologie sind erwünscht, aber nicht Bedingung
- Englische Sprachkenntnisse

Ihre persönlichen Stärken

- Ideenreichtum und Innovationsfreudigkeit
- Sinn für das Teamwork innerhalb einer Entwicklungsgruppe
- Verantwortungsbewusstsein und Selbständigkeit

Unser Angebot

Nach einer gründlichen Einführung in Ihr zukünftiges Arbeitsgebiet wartet auf Sie eine nicht-alltägliche Aufgabe, die Ihre beruflichen Ambitionen ebenso vielseitig wie befriedigend fordern wird.
Für detailliertere Fragen steht Ihnen unser Herr Fritz Bossard, Personalabteilung, unter der Telefonnummer (Direktwahl) 075 / 4 42 27 gerne und jederzeit zur Verfügung.

Physiker oder El.ing. ETH

Ihr zukünftiges Arbeitsgebiet

Im Dünnschichtbereich «Prozessanlagen Optik/ Mikroelektronik» ist ein engagiertes Spezialistenteam für das moderne, marktorientierte Produktmanagement verantwortlich.

Ihre Aufgaben

- Eingehende Analysen der Marktbedürfnisse und die sorgfältige Umsetzung in Pflichtenhefte sowie in Marketing-Strategien
- Projektkoordination in enger Zusammenarbeit mit Entwicklung und Fertigung
- Fundierte technische Beratung einer anspruchsvollen Kundschaft als auch unserer Verkaufsingenieure

Ihre Ausbildung

- Abgeschlossenes Studium als Physiker oder Elektroingenieur
- Erfahrung in der industriellen Halbleiterfertigung oder im Management von High-Tech-Produkten
- Gute Sprachkenntnisse d/e/ eventuell f

Ihre persönlichen Stärken

- Ein hohes Mass an Kooperationsbereitschaft
- Durchsetzungsvermögen und Entscheidungsfreudigkeit
- Dynamischer Arbeitsstil

Unser Angebot

Diese Position mit den entsprechenden Kompetenzen bietet einem initiativen Bewerber eine faszinierende Aufgabe im Gebiet der modernsten Hochtechnologie. Weitere Informationen über unsere zeitgemässen Anstellungsbedingungen, Sozialleistungen sowie über Ihre neue Tätigkeit gibt Ihnen gerne unser Herr Fritz Bossard, Personalabteilung, unter der Telefonnummer (Direktwahl) 075 / 4 42 27.
Wir freuen uns auf Ihren Anruf.

Entwicklungsingenieur

Ihr zukünftiges Arbeitsgebiet

Innerhalb unserer Entwicklung befasst sich eine Gruppe mit Robotern und Handlingsystemen für Vakuumbeschichtungsanlagen und Reinräume.

Ihre Aufgaben

- Recherchen in der Literatur und auf dem Markt mit anschliessender Know how-Erarbeitung für unsere Systeme
- Konzeption und konstruktive Bearbeitung von neuen Handlingsystemen
- Betreuung der Entwicklungsprojekte vom Prototypenbau bis zur Serienreife

Ihre Ausbildung

- Abgeschlossenes Studium an der ETH oder an einer HTL der Fachrichtungen Maschinenbau bzw. Feinwerktechnik
- Grundlagenkenntnisse im Gebiet der Automatisation
- Erwünscht sind ebenfalls Englischkenntnisse

Ihre persönlichen Stärken

- Zielorientierte Arbeitsmethodik
- Einsatzfreude und Selbständigkeit
- Kreativer Innovationsgeist

Unser Angebot

Verbunden mit einer echten Herausforderung an Ihre beruflichen Fähigkeiten bieten wir Ihnen fortschrittlichste Anstellungsbedingungen und ein ausgezeichnetes Betriebsklima. Wenn Sie sich also für diese Position interessieren, wird unser Herr Fritz Bossard, Personalabteilung, gerne einen ersten Gesprächstermin mit Ihnen vereinbaren. Seine Telefonnummer (Direktwahl): 075 / 4 42 27.
Wir freuen uns auf Ihren Anruf.

Entwicklungsingenieur

Ihr zukünftiges Arbeitsgebiet

Ein kleines, gut eingespieltes Mitarbeiterteam betreut die technologische Entwicklung von Elektronenstrahl-Verdampfungsquellen für unsere Beschichtungsanlagen.

Ihre Aufgaben

- Technologische Verbesserung bestehender Systeme
- Grundlagenentwicklung im gesamten Bereich der Elektronenstrahl-Quellen
- Planung von Entwicklungsaufträgen, Lancierung von Prototypen, Labortests und deren Auswertung

Ihre Ausbildung

- Abgeschlossenes HTL-Studium der Richtung Feinwerk- oder Elektrotechnik
- Erwünscht, aber nicht Bedingung, sind praktische Erfahrungen in den Bereichen Hochvakuumtechnik oder Plasmaphysik

Ihre persönlichen Stärken

- Ein ausgeprägtes Verständnis für physikalische Zusammenhänge und Phänomene im Gebiet der Plasmaphysik
- Die Fähigkeit, technische Probleme ganzheitlich zu betrachten und dementsprechend unkonventionell zu lösen

Unser Angebot

Wir bieten Ihnen mit dieser Position nicht nur eine aussergewöhnliche Aufgabenstellung an, sondern auch überdurchschnittliche Sozialleistungen und ein kollegiales Abteilungsklima. Über alles Weitere würden wir gerne mit Ihnen persönlich reden. Rufen Sie doch einmal unseren Herrn Fritz Bossard, Personalabteilung, kurz an. Seine Telefonnummer (Direktwahl): 075 / 4 42 27. Er wird mit Ihnen einen ersten Termin vereinbaren.

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(see also p. 28)

one can get further information by rotating the viewing direction about the beam axis, where one sees (B) that track 3 indeed comes from the primary vertex.

The clearest visualisation (C) is to look face-on at the CCDs along the beam. Virtually all the background hits disappear and the event topology becomes obvious. Note that this reveals two additional tracks (broken lines) from the primary vertex, which were not found by the reconstruction program as they eluded the rest of the spectrometer.

The decay tracks 1, 2 and 5 are identified by Cherenkov hodoscopes and the magnetic spectrometer to be a 18.80 GeV negative pion, a 22.35 GeV positive kaon and a 43.22 GeV negative pion respectively. This corresponds to an effective mass of 1869 ±6 MeV, a negative D meson, decaying with a lifetime of 5.48 x 10^{-13} s.

Note that CCD1 reconstructs 8 hits within 0.04 mm^2, a density of 200 hits/mm^2. Such accurate detectors placed so close to the interaction point provide a 'vertex microscope' of unprecedented precision. It is hoped, using data already on tape, to determine also the lifetimes of the shorter lived charm particles.

A much larger CCD vertex microscope, containing 200 rather than just two detectors is being prepared by RAL and Brunel University for a study of multi-vertex events in the SLD spectrometer for the new Stanford Linear Collider. The Z^0 particles produced at this machine should provide a particularly rich source of new physics via the decays of all kinds of short-lived particles — heavier quark flavours beyond charm, tau leptons, and possible new states. The special low noise CCDs used are produced by the GEC Company of England.

COMPUTERS

On the right track

Particle physics experiments rely heavily on wire chambers to pick up the tracks of their particles. Easier said than done. One of the major tasks in any experiment is to convert the 'hits' from the wire chambers into the actual tracks of the particles, however over the years a variety of computer programs have been developed to help in this mammoth task.

Becoming available now are the new breed of 'vector' supercomputers which offer dramatic increases in processing power over traditional sequential machines.

In a conventional computer, instructions are executed one by one, with each single instruction dealing at most with a single data operation (e.g. an addition). Multiple data stream machines allow a number of identical data operations on different data. Even more power is obtained by 'pipelining' in vector computers with segmented processing units. This gives a production line approach: once the vector pipeline is fully operational, the time to complete a task is only the time needed to carry out one sub-task.

There had been a widespread conviction that track reconstruction programs would not convert easily for vector processing. However a feasibility study at Florida State University (one of the new US Supercomputer Centres) showed otherwise, using as guinea-pig the E711 fixed target experiment recently run at Fermilab.

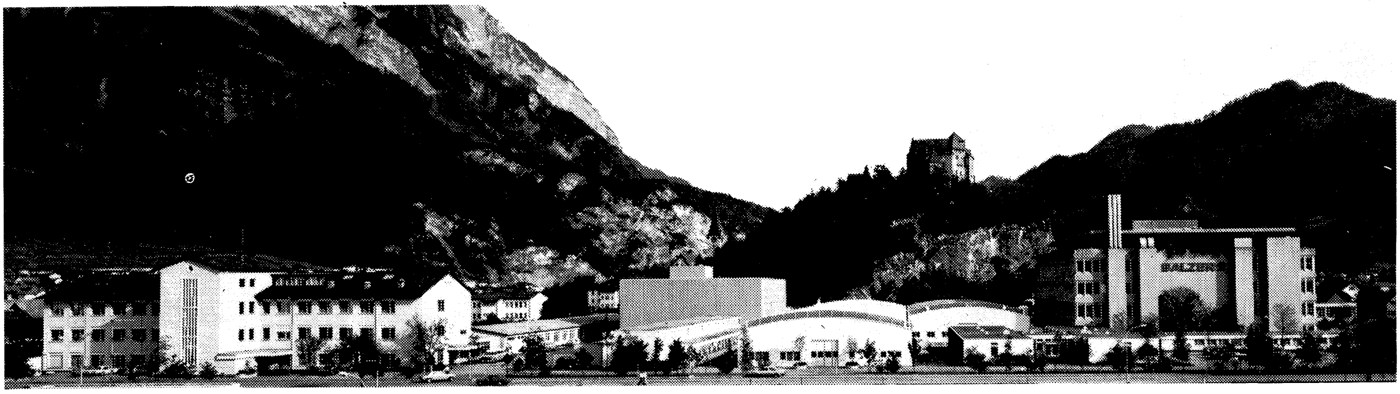
Two generations of track reconstruction software were developed. The first generation consisted of two separate algorithms, implemented on a VAX-11/780, which are numerical in nature, that is they do local point-to-point searches and require algebraic calculations. These two algorithms are completely different and serve to cross-check the efficiency of the track finding. Both algorithms give the same results, at a rate of 1.6 CPU s per event.

The second generation of software was developed for a CYBER 205, is non-numerical in nature, and uses the vector features of the CYBER 205 to improve the processing speed. An algorithm for global track finding uses bit patterns rather than local point searches. All the numerical calculations are done just once, prior to the analysis, which later finds all the possible tracks in one sweep.

With this algorithm a fully reconstructed event takes approximately 7.7 msec, 200 times faster than the code developed for the VAX-11/780. Since the scalar (conventional processing) mode of the CYBER 205 is no more than 20 times faster than that of the VAX-11/780, vectorization speeds things up tenfold.

This method of non-numerical calculations has several advantages:

- the CPU time consumption does not depend on the number of particles, while in scalar numerical methods the time consumption increases dramatically when there are more particles to handle;
- code development, maintenance and understanding is simplified, since vectorized logic is easier to debug due to the highly



Unser Unternehmen: Konsequentes Qualitätsdenken, Pioniergeist und eine aufgeschlossene Führungspolitik prägen das Leitbild eines Unternehmens, das sich heute mit weltweit über 3000 Mitarbeitern in den Bereichen Vakuumtechnik und Dünne Schichten auf einem ebenso erfolgreichen wie zielsicheren Kurs in die HIGH-TECH-Zukunft befindet.

BALZERS BIETET ZUKUNFT

Produktmanager

Das Arbeitsgebiet
In unserem schnell wachsenden Marktbereich «Dünnschicht-Metallurgie» ist ein kleines Spezialistenteam für das Produktmanagement unserer neuen Verschleissschutz-Schichten sowie der entsprechenden Prozessanlagen verantwortlich.

Ihre zukünftigen Aufgaben
- Marktforschung, Konkurrenzanalysen und Erschliessung neuer Marktsegmente
- Ausarbeiten von Fachartikeln, Referaten, technischen Verkaufsunterlagen, Prospekttexten und Pflichtenheften für Anlagen sowie für die Schutzschichten
- Kompetente Unterstützung des Aussendienstes

Ihre Ausbildung
- Abgeschlossenes Hochschulstudium der Richtung Maschinenbau, Produktionstechnik oder Physik
- Industrie-Erfahrung von etwa drei Jahren ist erwünscht
- Sprachen: deutsch und englisch (ev. französisch)

Ihre persönlichen Stärken
- Weitblick in Marketingfragen
- Entscheidungsfreude und Selbständigkeit
- Dynamischer sowie kooperativer Arbeitsstil

Unser Angebot
Diese Aufgabe, die auch gelegentliche Geschäftsreisen in Europa, den USA und den Fernen Osten bedingt, bietet einem initiativen Produktmanager eine vielseitige Herausforderung an sein berufliches Können. Für weitere Fragen steht Ihnen unsere Frau Margrit Ritter, Personalabteilung, unter der Telefonnummer (Direktwahl) 075/4 43 03 gerne jederzeit zur Verfügung.

Projektingenieur

Das Arbeitsgebiet
Zu den Hauptaufgaben einer unserer Sonderabteilungen gehören Planung und Realisation von schlüsselfertigen Produktionslinien sowie weitere damit verbundene Aktivitäten wie Technologietransfer und organisatorische Betreuung der Projekte während verschiedener Phasen.

Ihre zukünftigen Aufgaben
- Vorbereitung von Verträgen mit internen und externen Stellen sowie die Mitwirkung bei Vertragsabschlüssen
- Koordination zwischen internen und externen Lieferanten während der Realisationsphase; Überwachung an Ort der Installationsarbeiten, der Inbetriebnahme sowie des Technologietransfers
- Kostenerfassung, Rentabilitätsberechnungen und Statistik

Ihre Ausbildung
- Abgeschlossenes technisches Hochschulstudium
- Sprachen: deutsch und englisch in Wort und Schrift
- Wenn möglich praktische Erfahrung im Projektmanagement

Ihre persönlichen Stärken
- Überdurchschnittlicher Einsatzwillen
- Dynamik und sichere Entscheidungsfähigkeit
- Ausgesprochen gutes Organisationstalent

Unser Angebot
Diese Top-Position mit den adäquaten Kompetenzen wird Ihnen in beruflicher und persönlicher Hinsicht ungewöhnliche Perspektiven eröffnen.
Zur Abklärung weiterer Fragen würden wir mit Ihnen gerne einen ersten Gesprächstermin festsetzen. Dafür steht Ihnen unser Herr Fritz Bossard, Personalabteilung, gerne zur Verfügung. Seine Telefonnummer (Direktwahl): 075/4 42 27. Wir freuen uns auf Ihren Anruf.

Produktingenieur

Das Arbeitsgebiet
Im Rahmen unseres modernen Marketingkonzeptes befasst sich ein Stab jüngerer Ingenieure mit der marktgerechten Produktbetreuung von Partialdruck-Messgeräten der neuen Generationen.

Ihre zukünftigen Aufgaben
- Systematisch geplante und kontrollierte Einführung neuer Produkte auf dem Markt
- Preisberechnungen, Erarbeiten von Preislisten und Offerten
- Beratung und Ausbildung von Kunden sowie Aussendienstleuten
- Mitwirkung bei Ausstellungen, Seminarien und Publikationen

Ihre Ausbildung
- Abgeschlossenes HTL-Studium der Fachrichtung Elektronik, Elektro- oder Verfahrenstechnik
- Kenntnisse der Vakuummesstechnik sind von Vorteil
- Englische Sprachkenntnisse

Ihre persönlichen Stärken
- Ausgesprochenes Interesse am Produktmanagement
- Initiative und Selbständigkeit
- Dynamischer Arbeitsstil

Unser Angebot
Zusammen mit einer echten Herausforderung an Ihre beruflichen Ambitionen bieten wir Ihnen zeitgemässe Anstellungsbedingungen und ein ausgezeichnetes Betriebsklima.
Wenn Sie sich für diese Position interessieren, wird unser Herr Fritz Bossard, Personalabteilung, gerne ein erstes Gespräch mit Ihnen arrangieren. Seine Telefonnummer (Direktwahl) 075/4 42 27. – Wir freuen uns auf Ihren Anruf.

Verkaufsmitarbeiter

Das Arbeitsgebiet
Innerhalb unserer Sparte Dünne Schichten betreut eine junge, dynamische Mannschaft den Verkauf und das Marketing der entsprechenden Produkte für die optische Industrie.

Ihre zukünftigen Aufgaben
- Technische Beratung der Kunden aus aller Welt
- Auftragsabklärungen und -abwicklung
- Erschliessen neuer Märkte
- Mitarbeit bei der Marktforschung, Planung, Budgetierung und Produktgestaltung

Ihre Ausbildung
- Abgeschlossene technische Berufslehre
- Oder eine kaufmännische Ausbildung mit praktischer Erfahrung in einem technischen Bereich
- Sprachen: deutsch, englisch und italienisch

Ihre persönlichen Stärken
- Verkaufs- und Organisationstalent
- Eigeninitiative, verbunden mit einem flexiblen Arbeitsstil
- Sinn für Teamwork

Unser Angebot
Mit dieser anspruchsvollen Position bieten wir Ihnen nicht nur ein selbständiges Arbeitsgebiet und Verantwortung, sondern auch attraktive Anstellungsbedingungen und ein sehr gutes Betriebsklima.
Weitere Informationen über Ihre neue Tätigkeit und über unsere aufgeschlossene Personalpolitik gibt Ihnen gerne unsere Frau Margrit Ritter, Personalabteilung, unter der Telefonnummer (Direktwahl) 075/4 43 03.

Software-Ingenieur

Das Arbeitsgebiet
Unsere Abteilung «Software-Entwicklung» untersucht die Einsatzmöglichkeiten der BALZERS-Quadrupol-Massenspektrometer in der analytischen Messtechnik, bearbeitet entsprechende Kundenaufträge und verbessert die bestehenden Standardsysteme.

Ihre zukünftigen Aufgaben
- Problemanalyse, Erarbeitung von Pflichtenheften sowie Programmentwürfen
- Systemtests, Inbetriebnahmen (zum Teil auch bei unseren Kunden) und Wartung

Ihre Ausbildung
- Abgeschlossenes Studium der Fachrichtung Elektrotechnik oder Informatik
- Erfahrung in der Programmgestaltung
- Gute Englischkenntnisse

Ihre persönlichen Stärken
- Interesse für numerische Mathematik und Statistik
- Kooperative Arbeitseinstellung
- Einsatzfreude und Verantwortungsbewusstsein

Unser Angebot
Wir bieten Ihnen einen modern eingerichteten Arbeitsplatz mit den neuesten Software-Entwicklungsinstrumenten. Selbstverständlich führen wir Sie systematisch in Ihr Arbeitsgebiet ein und garantieren überdies grosszügige Anstellungsbedingungen.
Mehr darüber kann Ihnen unser Herr Fritz Bossard, Personalabteilung, unter der Telefonnummer (Direktwahl) 075/4 42 27 mitteilen.
Wir freuen uns auf ein erstes Gespräch mit Ihnen.

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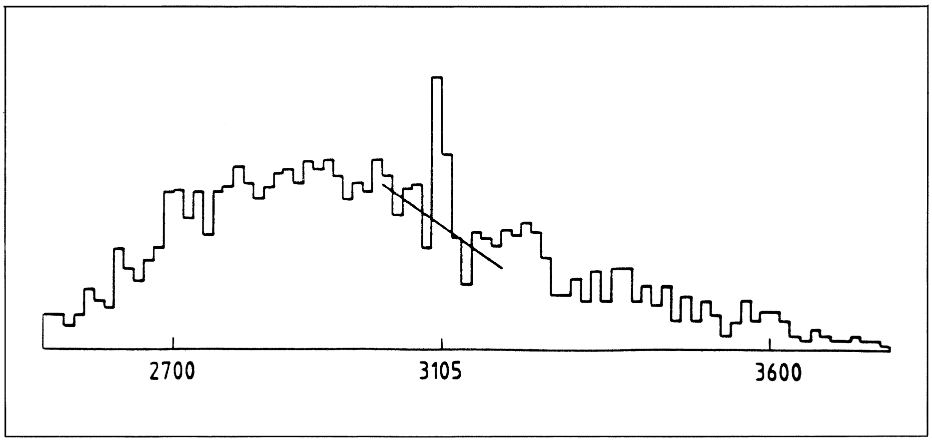
The unexplained U⁺ signal at 3.1 GeV seen by the CERN hyperon beam collaboration.



organized nature of the calculations;

- unusual patterns of hits and noise can easily be recognized and removed.

The technique should be even more valuable for experiments at colliding beam machines, which have to handle very high numbers of produced particles.

Other candidate programs for vectorization are under study at Florida State, including the GEANT simulation/tracking package from CERN used by three of the experiments for the LEP electron-positron Collider.

CERN
U for unconventional

In these days of quark/gluon physics and jet spectroscopy, 'bump hunting' — the practice of looking for new particle resonances — is less fashionable than it used to be. However from time to time new bumps are found which have important implications.

One of the unique features of the SPS when it came into operation in 1976 was its beam of high energy hyperons — heavy particles related to nucleons but carrying the strangeness quantum number — and used by several experiments involving Bristol/Geneva/Heidelberg/Lausanne/London/Orsay/Rutherford/Strasbourg teams.

Over the years, these collaborations amassed a wealth of information which cleaned up our understanding of hyperon behaviour, particularly their weak (beta) decay (see December 1983 issue, page 419). Another highlight was the discovery of the A^+ baryon carrying both the strangeness and charm quantum numbers (see March 1983 issue, page 54).

This A^+ signal was seen at 2.46 GeV in interactions producing a lambda and a negative kaon, accompanied by two positive pions. To check that it was not due to something else, the collaboration analysed all events under different assumptions for the final state particles.

When the kaon mass was replaced by that of the antiproton, a prominent peak at 3.1 GeV was seen, and the events making up this signal had no overlap with those giving the A^+ with the negative kaon assignment. Looking at production of a lambda and an antiproton together with up to three charged pions, the team found other peaks at 3.1 GeV, showing that whatever it is exists in three charge states — positive, neutral and negative. The widths of the signals are compatible with the resolution of the apparatus.

The lifetime of the state, called U, was found to be less than 2×10^{-12} s. Its mass is compatible with the famous J/psi 'charmonium' state consisting of a bound charm quark-antiquark pair. However the quantum numbers of the U are incompatible with charmonium, or with anything else!

People and things

On people

On his retirement from the University of Tokyo at the end of March, Yoshio Yamaguchi also stepped down as director of Tokyo's Institute for Nuclear Study and moved to Tokai University. One of the first Japanese theoreticians to visit CERN many years ago, Yamaguchi is one of the leading figures in Japanese involvement in international physics. He is a member of the International Committee for Future Accelerators (ICFA), and in October will begin a one-year stint as President of the Physical Society of Japan. His place as Tokyo's INS Director is taken by T. Yamazaki from Tokyo's Meson Science Laboratory.

Among the new Fellows recently elected to the prestigious Royal Society in the UK are John Dowell of Birmingham, a member of CERN's Scientific Policy Committee and of the UA1 experiment, and E. W. ('Bill') Mitchell, currently Chairman of the UK Science and Engineering Research Council.

Bob Watt recently retired from SLAC at Stanford after a career spanning some twenty years. On arrival, he was commissioned with overseeing the move of the Lawrence Radiation Lab's 72 inch bubble chamber, which managed to grow by 10 inches in the process. Shortly afterwards he became head of the Bubble Chamber Operations Group at Stanford. He was widely regarded for his ability to nurse sick machines to full health.

◀ Los Alamos line-up: (left to right) John Browne, the Laboratory's Associate Director for Research; Louis Rosen, who stepped down as Director of the Meson Physics Facility (LAMPF) last year (see January/February issue, page 31); new LAMPF Director Gerald Garvey; and Don Hagerman who takes over from Rosen as Division Leader for Medium Energy Physics.

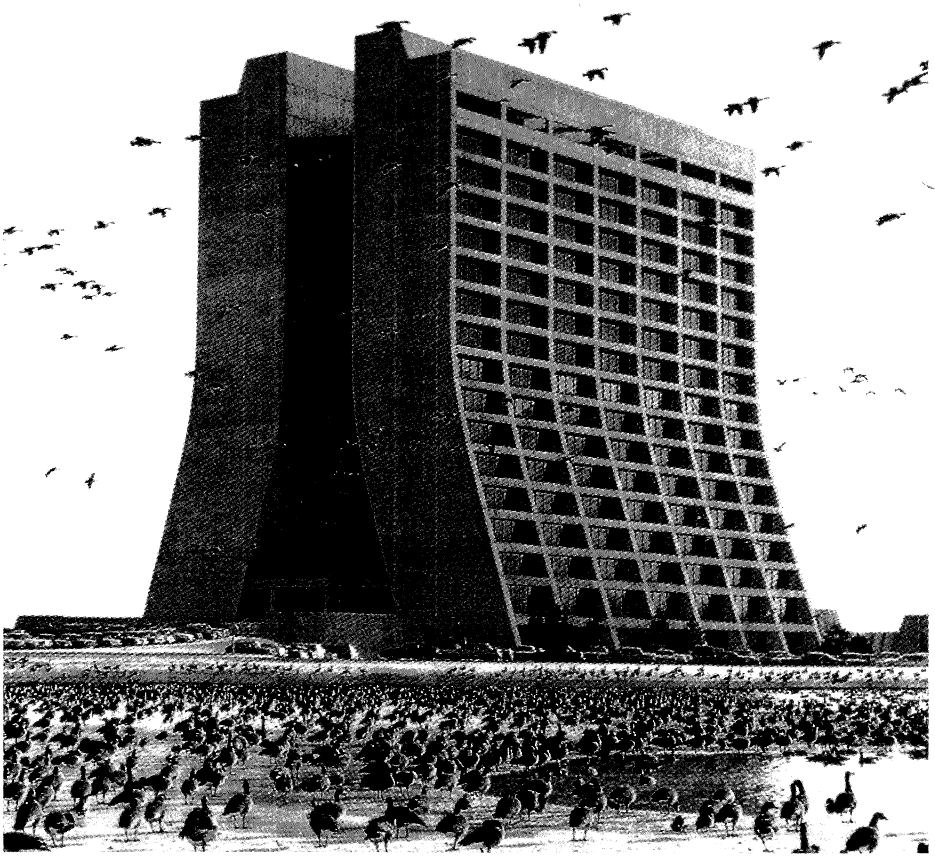
(Photo Los Alamos)

Moves at Los Alamos

Donald Hagerman becomes new Medium Energy Physics Division Leader at Los Alamos (US) National Laboratory, succeeding Louis Rosen as manager of the Los Alamos Meson Physics Facility (LAMPF) organizational unit. Hagerman, along with Rosen and Darragh Nagle, was a member of the original LAMPF design team. This move follows Gerald Garvey's appointment as LAMPF Director, also succeeding Rosen, an assignment which also moves LAMPF scientific policy development into the Central Laboratory's Directorate.

Meanwhile Darragh Nagle leaves the post of Medium Energy Physics Research Group Leader to devote all his efforts to the Cygnus X3 experiment. This incorporates two of the LAMPF neutrino detector cosmic ray shields into a wide area array to measure extensive air showers from the X-ray pulsar. Nagle's successor is Hywel White from Brookhaven.

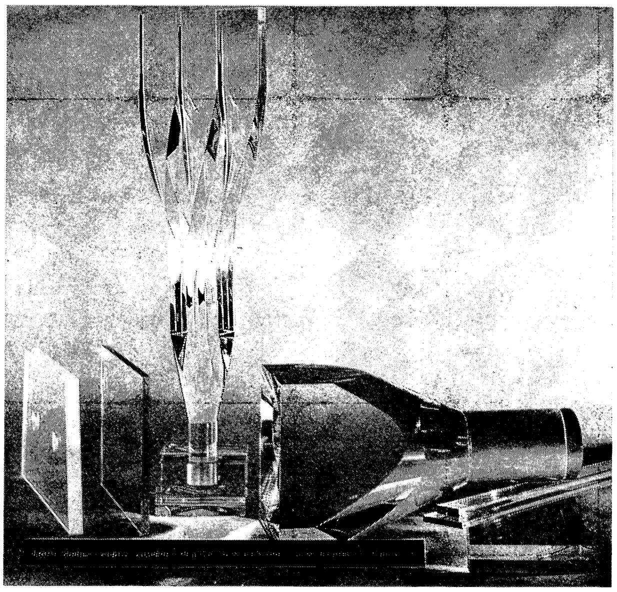
Over the last few winters more and more geese have been wintering over at Fermilab to enjoy the relatively mild Chicago Januaries. This year the population reached more than ten thousand. The open water from cooling ponds at Fermilab and other nearby developments may be a factor in their choice.



Twenty years ago

The theory of general relativity was fifty years old. Sites for the proposed next generation of accelerators were under study. CERN Director General Bernard Gregory was visiting a 300 GeV site at El Escorial in Spain, and Greece put forward a site near Athens. On the other side of the Atlantic, the list of proposals for the US 200 GeV machine had narrowed to six, including Weston (Batavia) near Chicago. Amongst the rejected sites was South Barrington, also near Chicago, where an objection was that the influx of scientists would 'disturb the moral fibre of the community'.

Electrons were accelerated to 10 GeV in the two-mile linac at Stanford. The Swiss government authorized construction of a 500 MeV cyclotron at Villigen near Zurich, which became the SIN Laboratory. The CERN PS linac accelerated a 100 mA current for the first time following installation of a duoplasmatron source.



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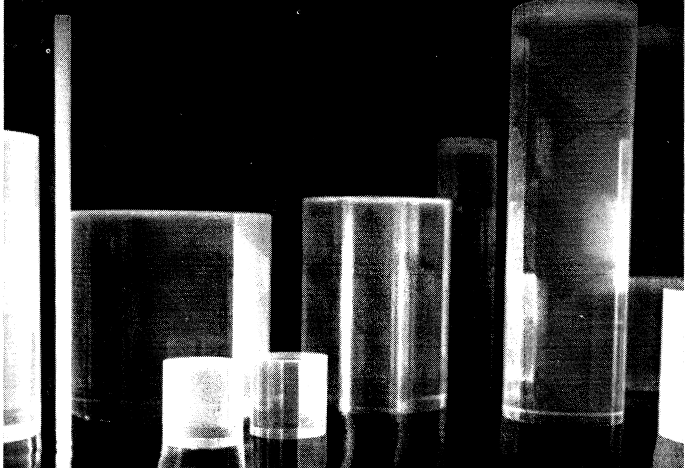

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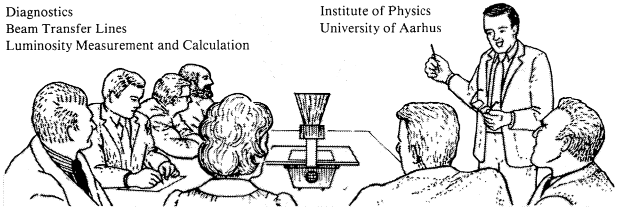

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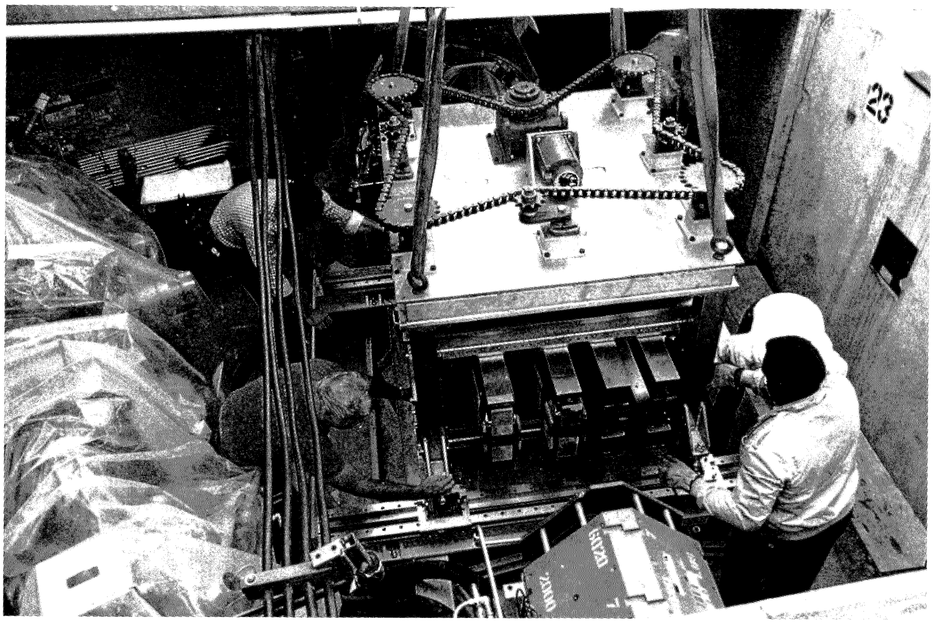
Synchrotron radiation at Trieste



The 'multi-undulator' being installed on the SPEAR ring at Stanford. Undulators crowd the emerging flux of radiation into particular spectral lines providing the highest possible radiation intensities.

(Photo Brad Youngman, SSRL)

The fast developing field of synchrotron radiation has its origins in the mastery of storage rings in high energy physics and is a prime example of spinoff from pure science.

Intense electromagnetic radiation streams off when beams of high energy electrons are bent or shaken. This synchrotron radiation was once an annoying waste of energy in particle storage rings, but now the wheel has turned full circle, with dedicated machines supplying this radiation for a wide range of science.

The astonishing growth rate in this field was highlighted at an International Conference on Synchrotron Radiation, held at the International Centre for Theoretical Physics (ICTP), Trieste, Italy from 7–11 April.

The Conference was appropriately sited since the construction of a 1.5 to 2 GeV 'third generation' synchrotron radiation source has been approved for Trieste. In addition, the precise venue of ICTP illustrated the extension of the interests of the Centre into fields considered to be of more immediate practical use (see panel).

The emphasis was on the lower energy storage rings, up to 2 GeV, for research using radiation in the vacuum ultraviolet (VUV) rather than the higher energy rings, up to 6 GeV, for research using hard X-rays like the European Synchrotron Radiation Facility, ESRF, to be built at Grenoble and its proposed American equivalent which would probably be built at Argonne. Thus the stars of the Conference were the Trieste machine presented by Sergio Tazzari and the Lawrence Berkeley Laboratory equivalent presented by Max Cornacchia. The Berkeley proposal is in the US President's budget from Fiscal Year 1987 but has yet to pass through Congress. There are similar machines in gestation elsewhere, such as BESSY II for the Laboratory in Berlin.

It is clear that the maximum amount of flexibility must be built into the designs of the new generation of machines because there is no single figure of merit for machine operation — the definition of ideal conditions varies throughout the user community and the users have to be involved in the machine design decisions. Also there is not enough experience with the operation of undulators (around which the third generation machines are constructed) to fix parameters too rigidly. A lot of work is going into developing machine magnet lattices with abilities beyond the best presently available (the lattice of the late Rena Chasman and Ken Green which made the VUV ring at the Brookhaven National Synchrotron Light Source the brightest in the world).

Good beam monitoring and control become more important because the low emittance machines will be sensitive to operate. This means also that, though injection of the beam at the storage ring operating energy is still probably preferable, the control systems could handle injection at lower energies and acceleration to operating energies. It is clear, however, that the injection of positrons rather than electrons will give longer lifetimes and more stable beams by avoiding the problems due to ion trapping. When positive ions, liberated by any mechanism, are pulled into the negative region of an orbiting electron beam they can cause havoc with beam stability. This phenomenon, which is still not well understood or predictable, has caused trouble at many machines and positron injection would circumvent it.

One of the machines which suffered from the disruptive effects of ion-trapping during its commissioning phase was the Aladdin ring at Wisconsin which has been under sentence of death for the past year. The latest news is that beam currents as high as 200 mA have been stored and, now that this

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level of performance has been reached, it is likely that the US National Science Foundation will resume funding.

Neither the Trieste nor the Berkeley teams have frozen their designs though Trieste intends to have ideas fixed firmly enough by the end of the summer to produce a detailed cost estimate.

These new machines are 'third generation': the light intensities they aim to achieve will reach beyond the first generation machines (drawing radiation parasitically from the bending magnets of high energy physics storage rings) and beyond the second generation machines designed as 'dedicated' synchrotron radiation sources. They advance in the light fluxes they can deliver to experiments by using 'wigglers' and 'undulators' — new dense periodic magnet structures to extend or amplify the spectrum of radiation which can be delivered to experiments.

Herman Winick covered experience with these devices at the Stanford Synchrotron Radiation Laboratory, which has pioneered their use, and even managed the extraordinary feat of explaining the difference between wigglers and undulators in less than one hour. There are two 8-pole wigglers to serve three experimental stations each (which is possible because of the wide emerging beam), a 64-pole wiggler and a 'multi-undulator' on the SPEAR ring and an undulator on the PEP ring. SSRL has been helped in forefront work on wigglers and undulators by the comparatively relaxed operating conditions on the SPEAR and PEP rings — high energies and high emittances. Life will not be easy with these devices on the newly proposed rings.

Food for a lifetime

The International Centre for Theoretical Physics, ICTP, in Trieste was founded in 1964 under the inspiration of Abdus Salam who combines a deep social commitment with his outstanding ability as a theoretical physicist. If CERN can be described as a centre of excellence in particle physics, ICTP can be described as a centre for the spread of excellence. By now well over 2000 visiting scientists attend the extended courses and workshops at the Centre every year, coming from some 130 nations, more than 80 per cent of them being developing countries.

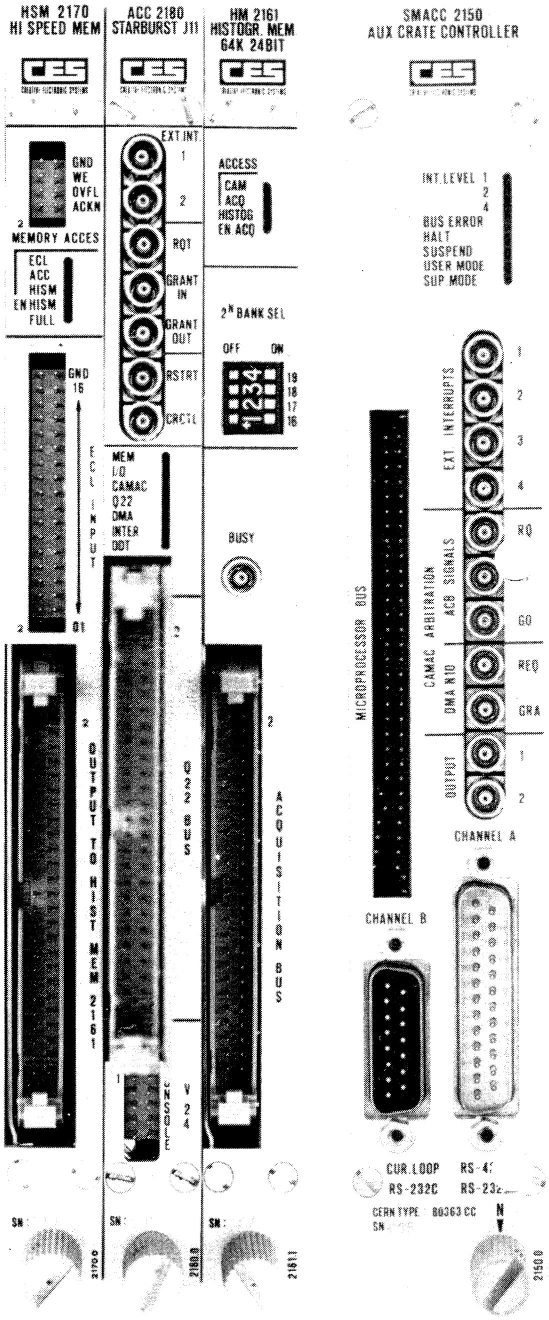
In the early years the emphasis at ICTP was on particle, nuclear and plasma physics. Some ten years ago it swung towards 'applicable' physics to help the transfer of the science behind many of the important modern technologies. Thus topics such as condensed matter, energy sources, laser physics etc. have since figured prominently in the programme. Since 1981 CERN has helped in preparing very popular courses on microprocessor applications.

The synchrotron radiation conference was well in line with this policy since it involves physics close to applications. During the conference a 'North-South Roundtable on Synchrotron Radiation', chaired by J. Danon from Brazil, was held under the auspices of the Third World Academy of Sciences. During a debate on the extent of 'self-help' with such facilities, Xian Ding-Chang, Director of the Beijing Synchrotron Radiation Centre quoted the proverb 'Give a man a fish, feed him for a day. Teach a man to fish, feed him for a lifetime'... a proverb which could be the motto of ICTP.

Much of the Conference was devoted to the research at VUV rings in solid state physics. The intensity and quality of the synchrotron radiation makes it possible to extract astonishing detail about bulk structures and the intricacies of surfaces and interfaces. (A revealing remark is that 'God prepared the solids and the Devil prepared the surfaces'.) The Conference closed with the latest news on angiography — diagnostic heart scans with synchrotron radiation promoted particularly by E. Rubenstein (see July 1985 issue, page 228). Human heart scans are imminent at the Stanford Synchrotron Radiation Laboratory.

These abilities have come with the increase in light flux from synchrotron radiation sources, compared to the X-ray tubes of twenty years ago. When the new facilities discussed at the Conference come into action, this increase in flux will be of fifteen orders of magnitude and there is further increase on the horizon with the proposal of Claudio Pellegrini to add a free electron laser by-pass to synchrotron rings.

by Brian Southworth



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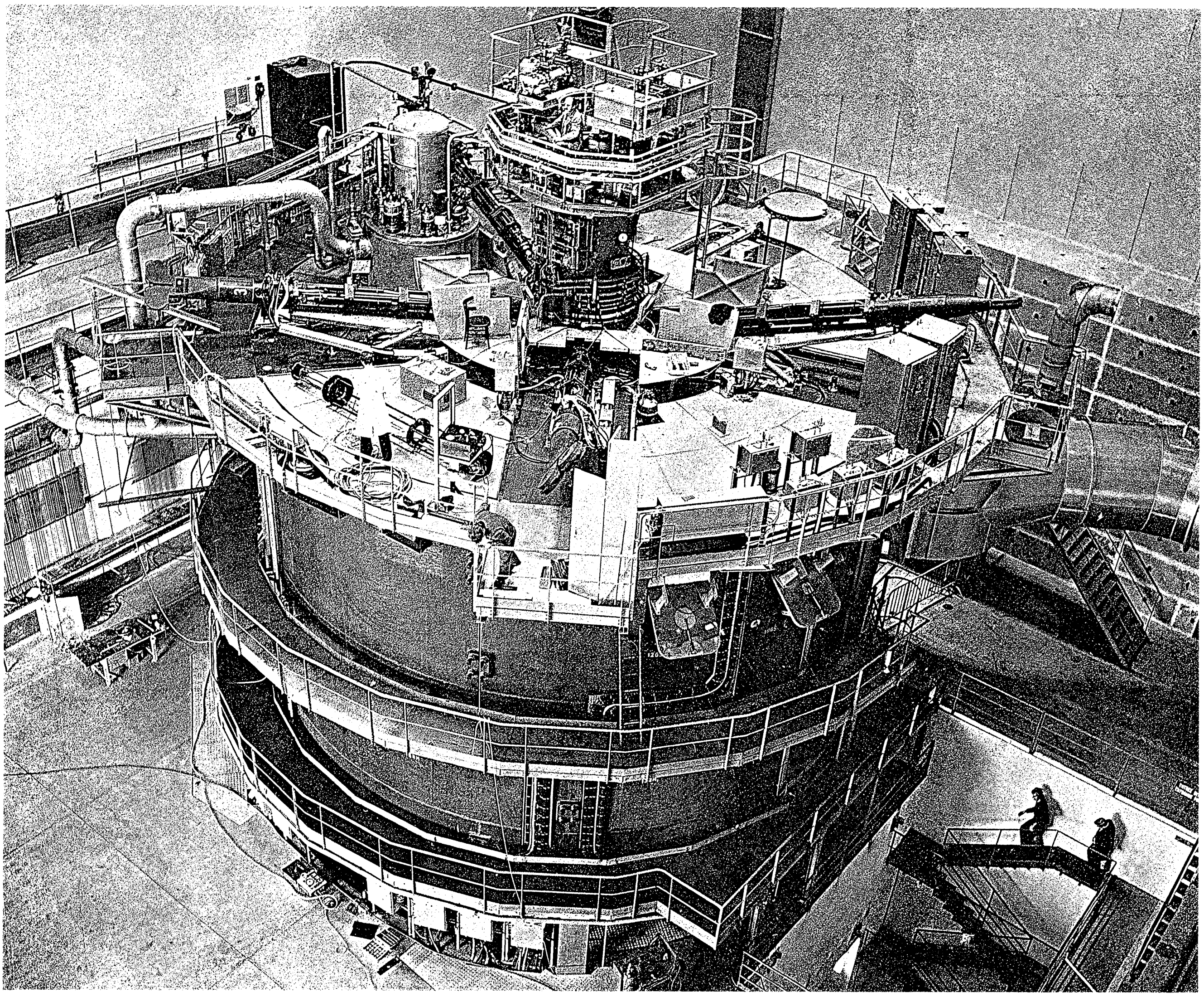

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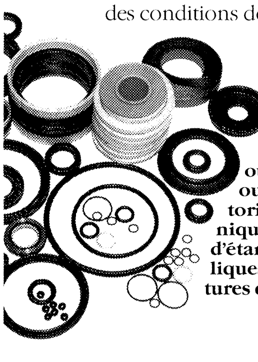

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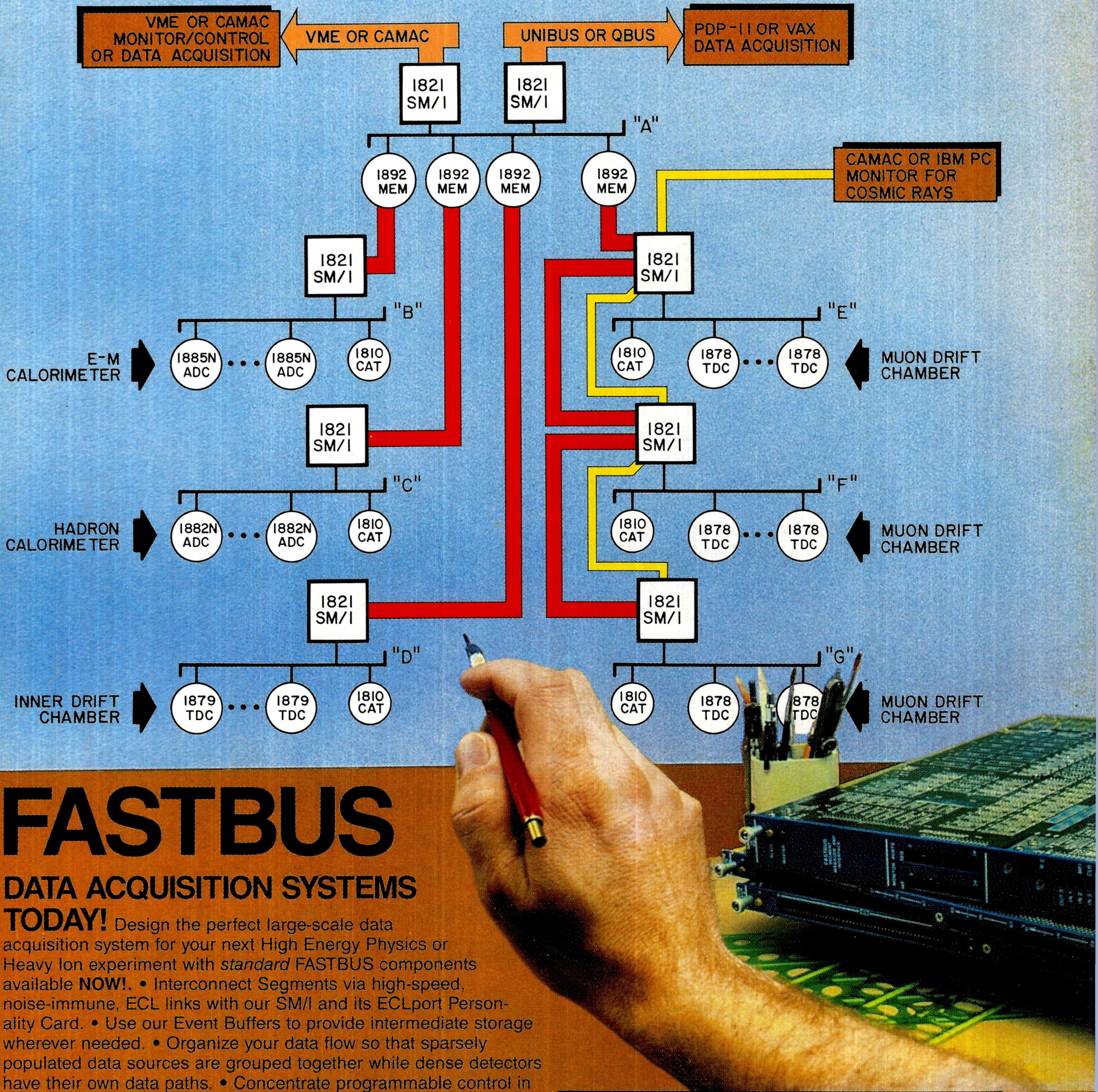
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