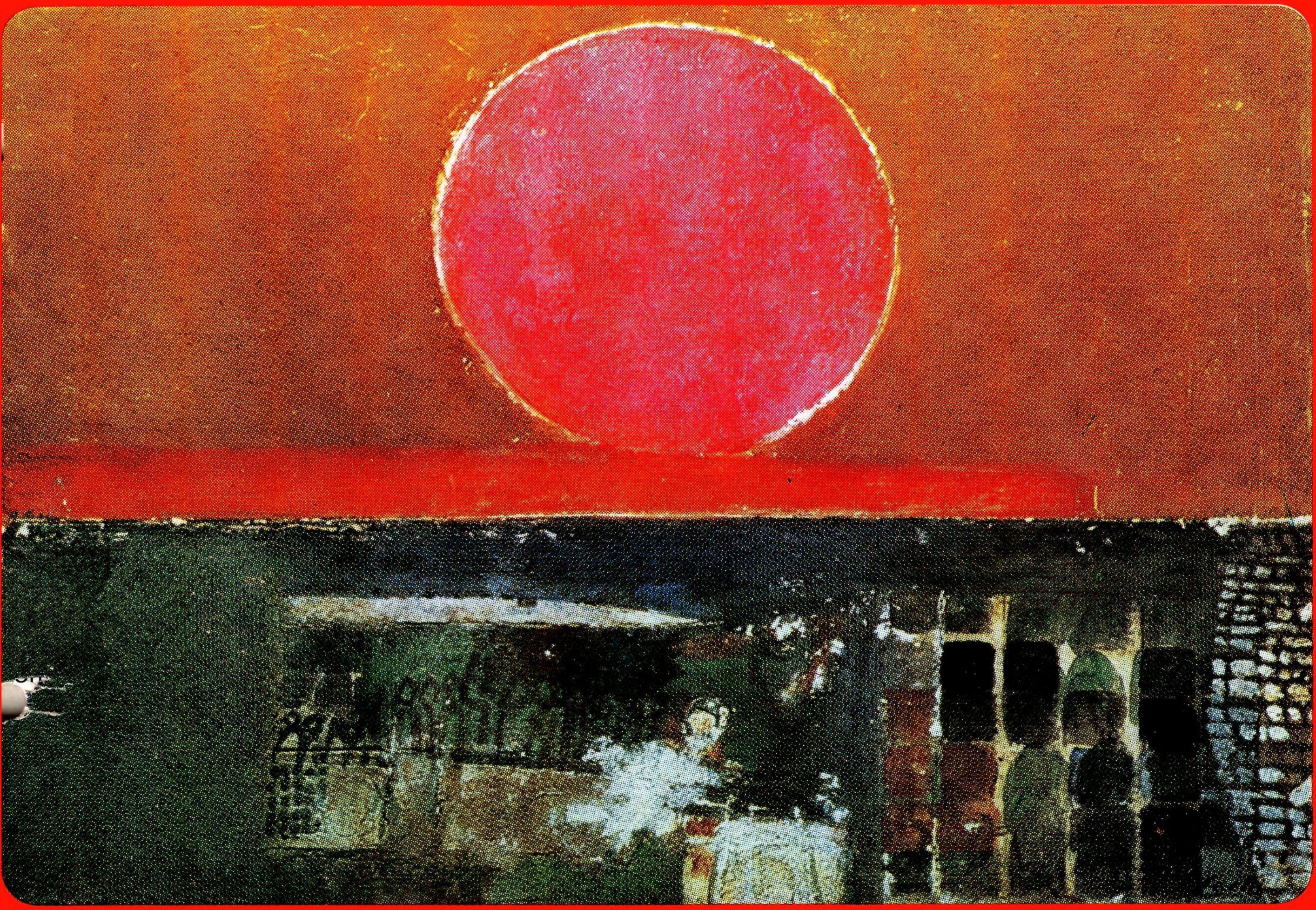
CERN COURIER

International Journal of High Energy Physics



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Laboratory correspondents:
Argonne National Laboratory, USA
W. R. Ditzler
Brookhaven National Laboratory, USA
N. V. Baggett
Cornell University, USA
D. G. Cassel
Daresbury Laboratory, UK
V. Suller
DESY Laboratory, Fed. Rep. of Germany
P. Waloschek
Fermi National Accelerator Laboratory, USA
R. A. Carrigan
KfK Karlsruhe, Fed. Rep. of Germany
M. Kuntze
GSI Darmstadt, Fed. Rep. of Germany
G. Siegert
INFN, Italy
M. Gigliarelli Fiumi
Institute of High Energy Physics, Peking, China
Tu Tung-sheng
JINR Dubna, USSR
V. Sandukovsky
KEK National Laboratory, Japan
K. Kikuchi
Lawrence Berkeley Laboratory, USA
W. Carithers
Los Alamos National Laboratory, USA
O. B. van Dyck
Novosibirsk Institute, USSR
V. Balakin
Orsay Laboratory, France
Anne-Marie Lutz
Rutherford Appleton Laboratory, UK
R. Elliott
Saclay Laboratory, France
A. Zylberstejn
SIN Villigen, Switzerland
J. F. Crawford
Stanford Linear Accelerator Center, USA
W.W. Ash
TRIUMF Laboratory, Canada
M. K. Craddock

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

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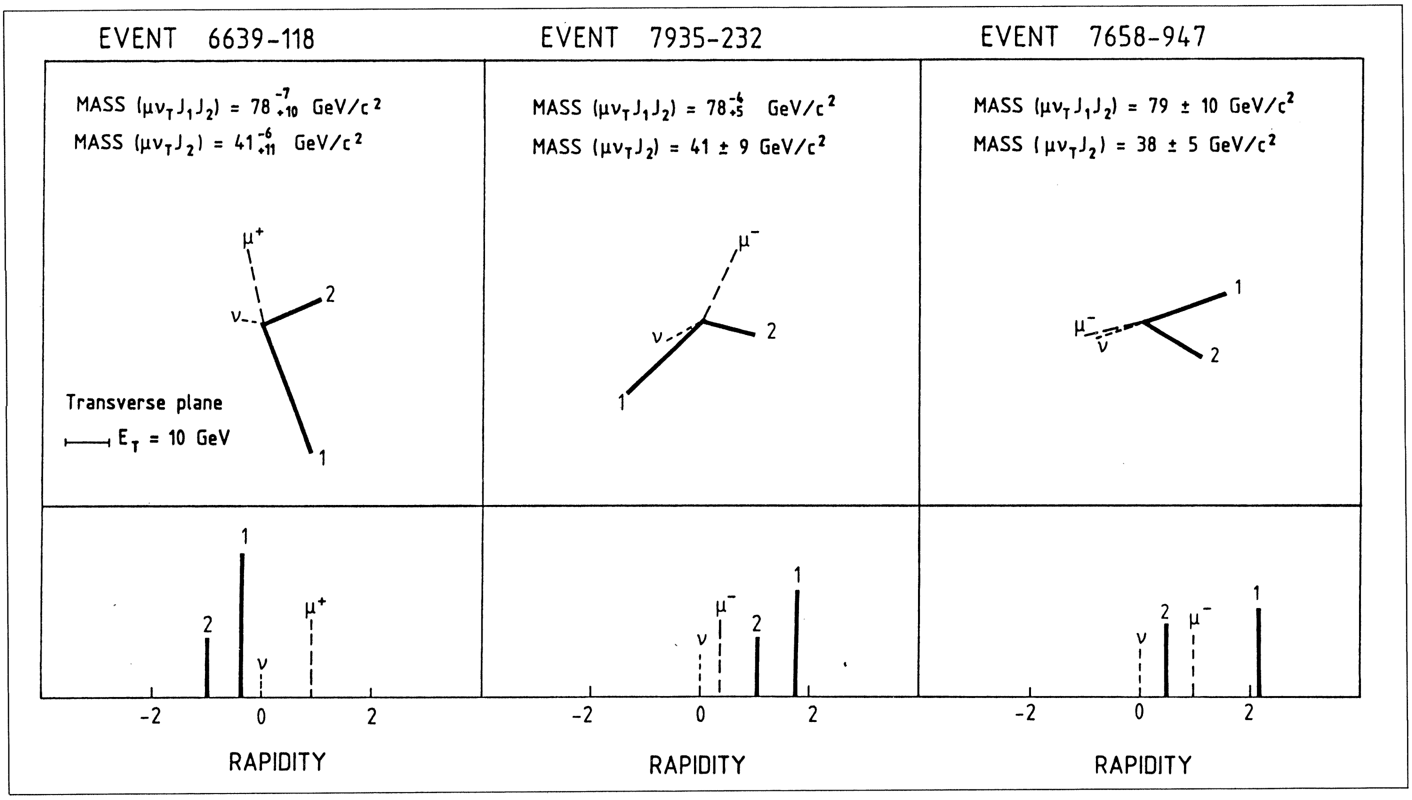
VOLUME 24 N° 7 SEPTEMBER 1984

Around the Laboratories

Physics monitor

Cover picture: 'Paesaggio col sole', by the Italian painter Bruno Saetti. The original was donated by the artist to the Italian Physical Society for the fiftieth anniversary of the first formulation of the theory of weak interactions by Enrico Fermi (see page 272).

Getting near the top?



Three events seen by the UA1 experiment with two 'jets' of hadrons, a single muon and a neutrino produced in violent proton-antiproton collisions. The wide separation of the particles suggests the decay of a W boson through a new heavy quark, the long-awaited sixth ('top') quark. Three similar events are seen with single electrons.

The big experiments at the SPS proton-antiproton Collider are preparing for their next big session of data taking, but meanwhile the data accumulated last year continues to supply interesting physics.

The major discoveries which came from this data were of course the W and Z bosons, the carriers of the weak force (see November 1983 issue). Not content with this, the physicists continued to sift through their results, and earlier this year turned up a variety of unusual phenomena which are difficult to explain using conventional ideas (see May issue, page 139).

Now comes an indication, very preliminary but nevertheless appealing, of the sighting of the long-awaited 'top' quark, completing the sextet of building blocks for the strongly interacting particles (hadrons).

(The others are 'up', 'down', 'strange', 'charm' and 'bottom', sometimes called 'beauty'. The six quarks can be nicely grouped into three pairs, each pair being associated with one of the three known weakly interacting particles, or leptons: electron, muon and tauon, each with its own brand of accompanying neutrino.)

One of the big successes of the big UA1 and UA2 experiments at the Collider has been their very clean samples of the formation of W particles (the carriers of the electrically charged version of the weak interaction) and their subsequent decay into an electron and a neutrino.

However the W should have many other decay modes. According to the rules, the positively charged W can decay into a state composed of an up quark and a down antiquark, of a charmed quark and a strange antiquark, or of a top quark and a bottom antiquark. (For the negatively charged W, the quark and antiquark labels are reversed in each case.)

The lightest of these three possibilities (up plus antidown) falls in a region dominated by other effects coming from the interaction of the quarks and gluons in the colliding protons and antiprotons. Perhaps more promising is the charm plus antistrange channel, where in violent proton-antiproton collisions, two sprays or 'jets' of hadrons might be seen emerging with a muon clinging very close to one of the jets.

What of the top plus antibottom decay? Despite cranking up the energy of the PETRA electron-positron collider at the German DESY Laboratory in Hamburg to record levels, no direct sign of the top quark has been seen in electron-positron annihilations, which puts a safe lower limit on the top quark mass.

Because it is so heavy, the top quark must come off relatively slowly in a W decay, giving a characteristic wide separation between the decay products. Likewise a lot of energy is released in the subsequent (semileptonic) decay of the top quark, which again makes for widely separated decay products.

The UA1 experiment looked at the collected sample of data from violent collisions producing a single lepton (electron or muon) and two or more hadron jets, selecting out those in which the emerging lepton and jets are well separated from each other.

Three good examples each are found of electron plus two jets and muon plus two jets. The total mass of the decay products corresponds to a W in each case, and the mass of the top quark decay products falls in a band between 30 and 50 GeV, peaked around 40 GeV. (There are also events with single electrons or muons plus three jets, but here the jet labelling problems make it difficult to come out with unique answers.)

Too early to claim that the top has been reached, but with more data from the autumn run at the Collider, the sixth quark may be soon added to the list of major physics discoveries at the Collider.

Leipzig Conference

Showcase for a memorable year of progress in particle physics, the 22nd International Conference on High Energy Physics was held in Leipzig, German Democratic Republic, from 19-25 July. After a busy three days of parallel sessions (four streams), well over a thousand participants gathered in Leipzig's Kongresshalle for the plenary talks. As at the Brighton Conference last year, these began with presentations from the big UA1 and UA2 experiments at CERN's SPS proton-antiproton Collider, still the focus of world attention despite having taken no new data since last year.

R. Böck of CERN, in the impressive style now so characteristic of UA1 presentations at major meetings, described the handful of events with widely separated jets of hadrons accompanied by single electrons or muons which could be the first indi-

Karl Marx University, Leipzig, scene of the parallel sessions of the recent International Conference on High Energy Physics.

Catching a tiger by the top! First plenary session at the Leipzig Physics Conference covered the first indications from the UA1 experiment at CERN of the sixth — 'top' — quark. The Conference plenary sessions were held in the Kongresshalle, immediately next to the city's magnificent zoo. At the Conference banquet, CERN Director General Herwig Schopper named a newly-born tiger cub — 'Top'. Looking on (right), is Prof. Seifert, the zoo's director.

(Photo: Hochschul Film- und Bildstelle, Leipzig)

cation for the long-awaited sixth quark — 'top'. Although the findings (see previous story) had been announced before, such a detailed presentation set the tone for what was to become a solid programme of physics at the Leipzig plenaries.

Immediately following Böck was J. Rohlf of Harvard who covered among other things UA1's unusual 'monojet' events (see May issue, page 139), which are difficult to explain by conventional physics ideas. These new results have already been pounced on by theoreticians with new ideas to sell (especially supersymmetry). As well as the monojets, UA1 now has an unusual three-jet event. Rohlf also mentioned the high hadronic activity seen accompanying UA1's Z°s, but not Ws. The Z appears to be 'noisier' than the W.

For UA2, J.-P. Repellin described some new UA2 results, including unexplained events (also see May issue, page 139). The UA2 oddball events are not quite the same as those in UA1. In the 'top' region, the signal-to-background ratio in the UA2 detector is appreciable and makes observation difficult.

Also with a vested interest in CERN Collider physics was P. Darriulat who abandoned his UA2 allegiance to present the concluding summary of experimental results at Leipzig. His talk paid a lot of attention to Collider results, especially in the W and Z sectors. After pointing out the difficulties inherent in UA1's candidate 'top' signal, he let it stand.

Earlier, in the parallel sessions, P. Bagnaia of CERN had showed UA2's results on hadron jet production, including the suggestion of a small signal out at 147 GeV transverse momentum in the spectrum of two jets. UA1 had nothing to say directly in the parallels, preferring to save everything for the plenaries.

The CERN Collider experiments also got good coverage from M. Jacob of CERN in his summary of 'hard' hadron collisions and jet phenomena. These reactions probe deep inside the colliding particles and reveal interesting clues about what makes quarks and gluons tick. Jacob suggested that jet spectroscopy, as illustrated by several announcements at Leipzig, has now become an established physics tool for tracking down new particle states.

According to Jacob, the hadronic activity accompanying the production of W bosons at the Collider is well described by the conventional field theory of quarks and gluons. However he was less confident about the Z in view of the hadronic activity seen by UA1.

Physicists are eager to track down the differences between the behaviour of hadron jets coming from quarks and those from gluons. However this is not easy to sort out at the Collider, where any gluon jets come from non-primordial radiations. Production of heavier quarks in the collisions of particles built of light quarks could be an indicator of gluon involvement, and Jacob seized on some UA1 data on the production of charmed mesons as a possible signature of gluon jet effects. Elsewhere, he pointed out that experiments at the Split Field Magnet at the CERN Intersecting Storage Rings (ISR) have compared pion and kaon signals, the presence of kaons (strange quarks) suggesting again that gluons are involved (see May 1983 issue, page 131).

Several speakers mentioned the initial results from experiments at Fermilab and Brookhaven studying the decays of neutral kaons into two pions, which are a little bit worrying for standard theory, and could have deeper implications.

Another new result looking for an

explanation is the observation by experiments using pion beams at the CERN SPS that the production of single photons by positive and negative pions is comparable, while a factor of two difference was expected.

New particles

The joker in the pack at Leipzig was the unexpected announcement by the Crystal Ball collaboration working at DORIS (the smaller electron-positron collider at the German DESY Laboratory in Hamburg) of a new state, the zeta, at 8.3 GeV. Initially presented in not one but two talks by H. Trost of DESY in the first day's parallel sessions, it is seen in radiative decays of the lightest upsilon particle.

Ground state upsilon decays into either a high multiplicity hadronic state or into two low multiplicity hadron jets (thus giving two distinct data samples) show extra activity at a photon energy near 1070 MeV, corresponding to the formation of the 8.3 GeV state, but the signal is almost invisible in the decays of the next (2S) upsilon.

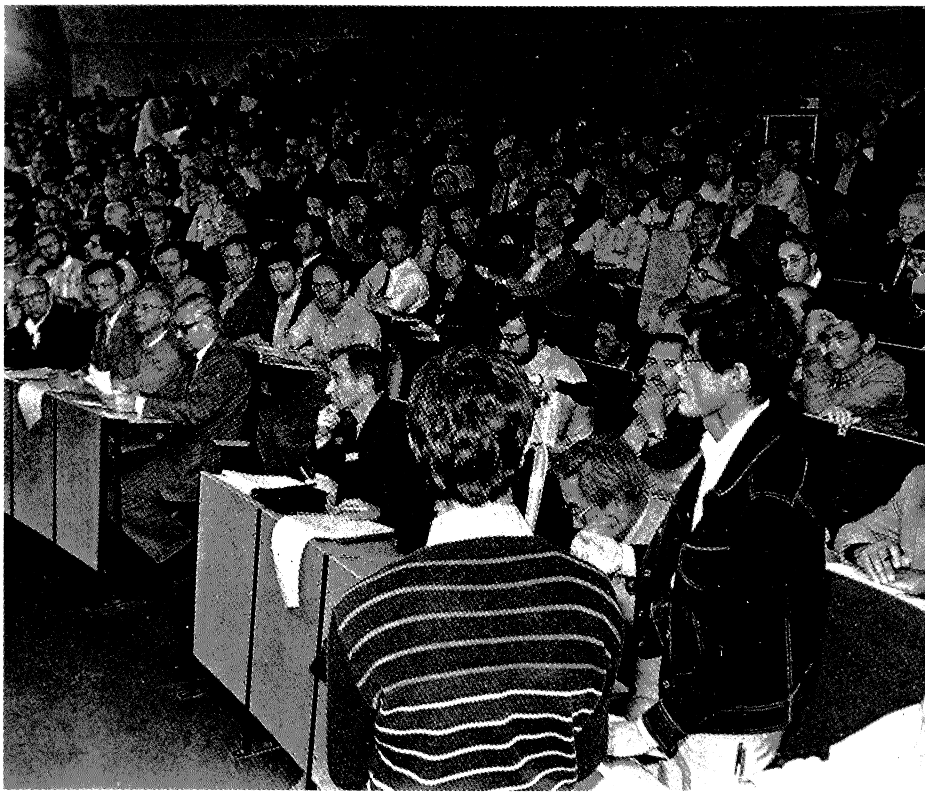
With the windfall of a totally unexpected result, there were whispers of a possible 'Higgs' particle, but the consensus view was that this is excluded because of the absence of a signal in the decays of 2S upsilons.

Over at Cornell, the other Laboratory specializing in upsilon physics, the CUSB experiment at the CESR electron-positron collider has been looking for just such states, starting at lower masses, and has tantalizingly yet to produce results in the region of the Crystal Ball's zeta signal. News is eagerly awaited.

However Cornell's cupboard is not completely bare. Both CESR experiments — CLEO and CUSB — have evidence for heavier upsilons (5S and 6S) to add to the upsilon collection, while CUSB has seen a B* meson in the decays of 5S upsilons. The mass difference between this level and the standard B (beauty) meson is about 50 MeV.

These and other new particle states were covered in the summary talk by A. Silverman of Cornell. An impressive list of experiments all over the world have now seen the F meson at 1970 MeV, following CLEO's reassessment of its mass last year. The ARGUS experiment at DESY suggests an F* 144 MeV heavier than the F.

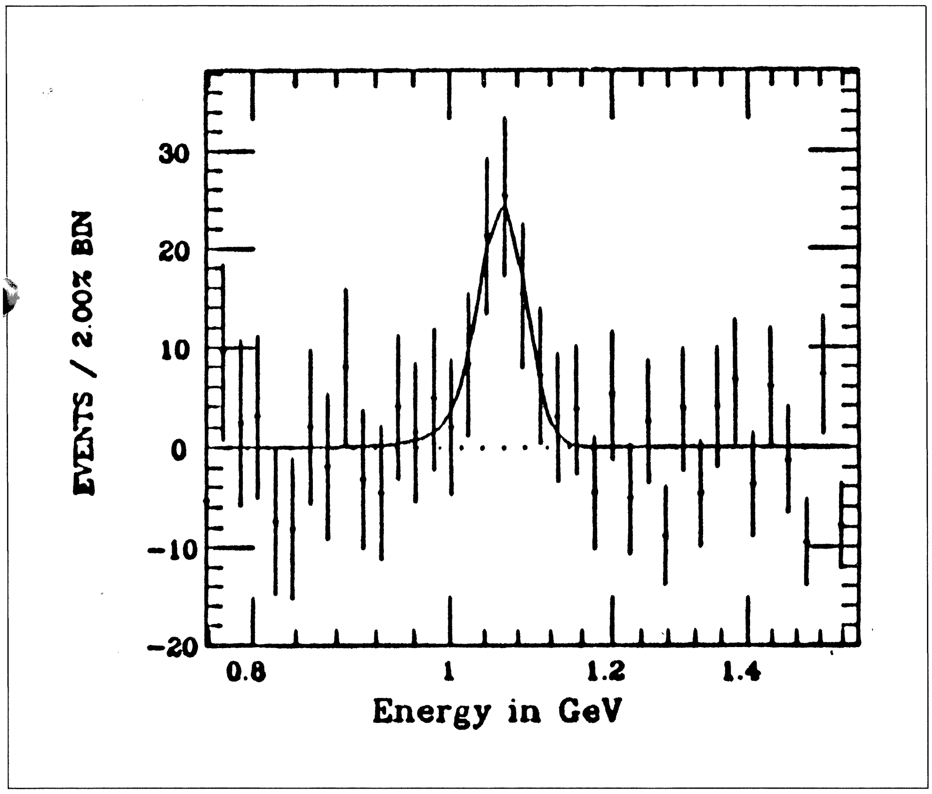
Silverman also reported the initial findings by the gas jet target experiment at the CERN ISR. This unfortunately short-lived study involved firing a carefully tuned antiproton beam in one ISR ring past a jet of hydrogen gas. This has studied a number of charmonium states difficult to get at by more conventional means.


P. Franzini poses a question on the new zeta state seen by the Crystal Ball experiment at the German DESY Laboratory in Hamburg. The zeta was the big surprise of the Leipzig Conference.

Covered in the summary talk by R. Klanner of Munich on the weak decays of heavy particles were mo[illegible] results on the lifetime of b-quark states. Initial suggestions last year from experiments at the Stanford PEP ring had indicated that this was unexpectedly long, in the 10^{-12} second region. This has now been supported by other experiments, both at DESY and at Stanford. However these values are all derived from statistical spreads and Klanner admitted that he would feel more confident about the result if the detectors actually picked up the decay paths of the unstable particles. Several other speakers also remarked on the relative longevity of b-quark.

A. Zaitsev of Serpukhov had the task of surveying the field of light quark spectroscopy, including candidate glueballs (states containing gluons as well as or in addition to quarks). The ksi (2.2 GeV) state re-

The zeta signal (after subtraction of background) seen by the Crystal Ball experiment in the decays of ground state upsilons into a photon and multiple hadrons. The 1.07 GeV photon peak corresponds to a particle mass of 8.3 GeV.



ported last year by Mark III at Stanford and yet to be seen elsewhere needs an interpretation, said Zaitsev. He also proposed the enhancements seen in some charge states of two rho mesons produced in photon-photon scattering as possible candidates for four-quark states.

Neutrinos

Very much still in the spotlight is the non-zero value for the electron neutrino mass from the ITEP (Moscow) experiment on the beta decay of tritium. Since the initial announcement at the Brighton Conference last year, the spectrometer has been recalibrated and more work has been done. According to V. Ljubimov of Moscow, Leipzig neutrino rapporteur and working on the ITEP experiment, the electron neutrino's mass should 'realistically' lie in the region between 20 and 45 eV. Other neutrino limits are also coming in, with the Mark II detector (now removed from the PEP ring at Stanford) giving an upper limit for the tau neutrino mass at 143 MeV.

Elsewhere in the neutrino sector, the Annecy / Grenoble team working at the French Bugey reactor cannot yet totally rule out neutrino oscillations. Part of the allowed area lies in a region not yet covered by other experiments. Whether this oscillation window stays open when results from other experiments come in remains to be seen. Ljubimov pointed out the range of neutrino matters still to be settled and advocated tackling a comprehensive programme of work to throw more light on this continually interesting corner of particle physics.

It is now two years since the discovery by the European Muon Collaboration at CERN that the quark structure of nucleons appears also to depend on the surrounding nuclear environment — the so-called 'EMC Effect'. This was quickly supported by historical data from electron beam scattering experiments at Stanford.

Quark structure of nucleons

The nucleon structure parallel sessions at Leipzig heard more results and a lot of healthy discussion. Plenary speaker I. Savin of Dubna was able to report that similar behaviour has been seen by the other big muon scattering experiment at CERN (Bologna / CERN / Dubna / Munich / Saclay) and by a new survey of electron scattering on heavy targets at Stanford. Other experiments, particularly those involving neutrino beams, do not see an explicit effect.

A number of experiments have now probed the relative contributions of longitudinally and transversely polarized photons in these reactions, and this also seems to be dependent on the target nucleus. Savin suggested that this effect might be responsible for some of the discrepancies between different experiments, and that the various sets of structure function data could happily coexist, even if some of the neutrino fraternity were not of the same viewpoint.

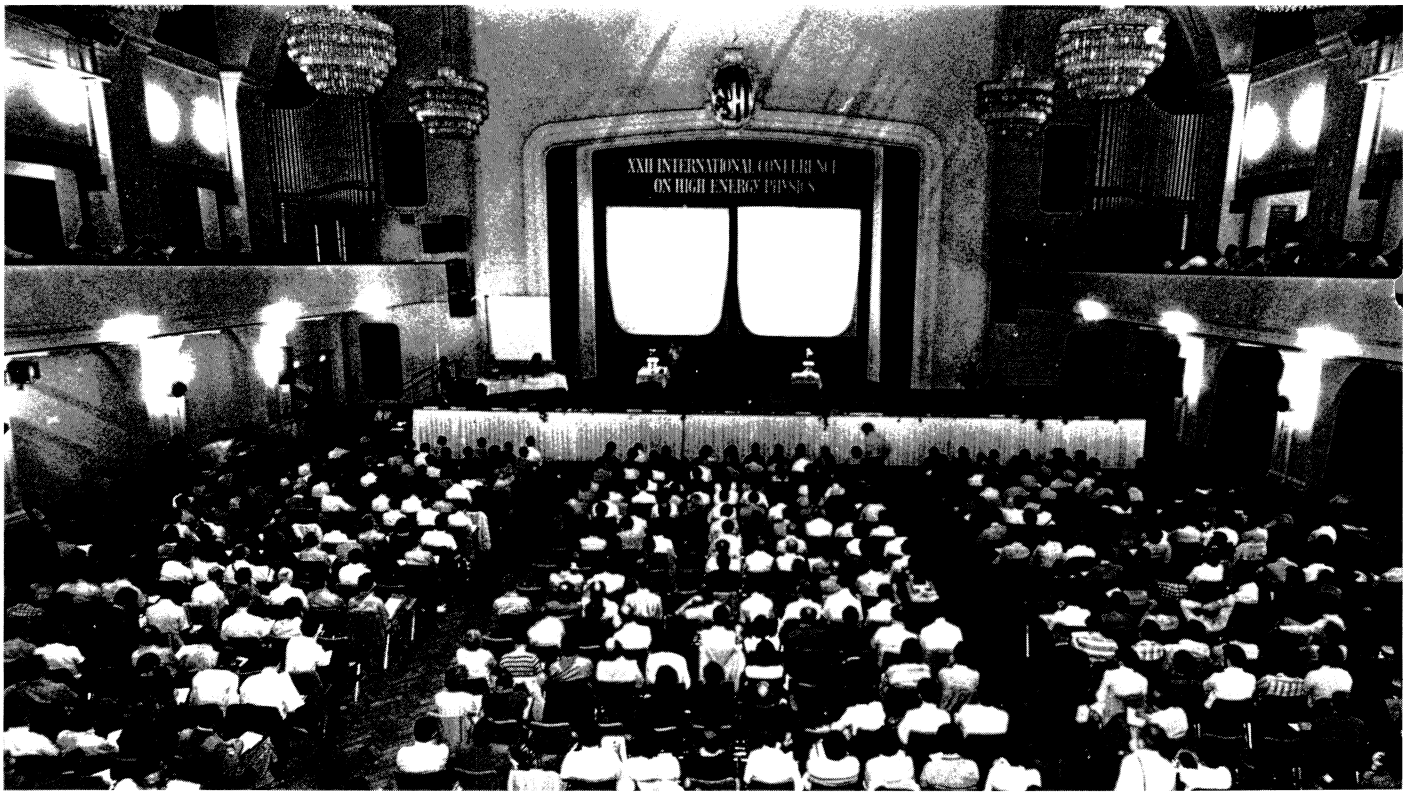
In his final summary talk, Darriulat emphasized that these effects, as well as being a subject for speculation in their own right, have important implications for the extraction of quark structure information from fixed target experiments.

The reluctant proton

Proton instability, once the flagship of grand unified theories, seems becalmed. Rapporteur M. Koshiba of Tokyo recalled the 'optimism' of 1982 after the initial results from the

A plenary session in the Leipzig Kongresshalle.

(Photos AdW/Fröbus)



underground experiment at the Kolar Gold Fields in India, followed by the 'depression' of 1983 with the negative results coming in from the big new Irvine / Michigan / Brookhaven search.

However Koshiba was optimistic about the new Kamioka experiment in Japan, pointing out the potential of the large phototubes used. He ventured that the effects now being seen in the Japanese experiment could be the edge of a genuine proton decay signal.

With the simplest theory unifying electroweak and strong interactions now ruled out by the absence of the predicted proton instability, theory has no well-defined path to follow.

In his summary talk on the phenomenology of grand unified theories, D. Nanopoulos of CERN listed the growing number of unexplained effects which nevertheless hint at a larger theory — CERN Collider results, new particles, the possibility of neutrino oscillations, the lifetime of the beauty quark, etc., as well as the large number of free parameters floating around. The two main approaches to this larger theory are supersymmetry (abolition of conventional fermion/boson classifications) and composite models (with an extra level of structure deep inside quarks). Nanopoulos preaches a supersymmetric way of life.

A 'new' feature of field theory is the Kaluza-Klein method for making larger dimensional theories more compact, thus enabling the power of a larger dimensional theory to be exploited before constructing a smaller, physical theory. The 65-year-old Kaluza-Klein approach is ironically the biggest thing to hit theoretical physics since supersymmetry (early 1970s), declared Abdus Salam in his excellent mini-summary talk earlier on in the parallel sessions.

Despite the absence of proton decay, particle physics theory is sound enough for many bold souls to venture out and attack problems on the origin and nature of the Universe. A. Linde of Moscow gave the first rapporteur talk at such an international meeting on the growing links between particle physics and cosmology. In a memorable presentation, he described how phase transitions (inflation) at the outset of the Universe's career can avoid unsightly problems such as massive magnetic monopoles.

These new developments in the technology of universe creation are challenging. Linde, who sells the 'chaotic' picture of primordial inflation, underlined Ehrenfest's ideas earlier this century on the compression of bigger theories down to our confinement in four dimensions to generate workable mechanisms of gravitation and electromagnetism.

Elsewhere in theory, much attention was paid to quantum chromodynamics, the standard picture of quark/gluon interactions. Rapporteur B. Ioffe of Moscow claimed that QCD is no longer a candidate but a real theory, despite calculational difficulties and missing connections with other established physics ideas. It is clear that much more work needs to be done before 'fragmentation' — the link between the interaction at the quark level and the observed production of free hadrons — is completely understood.

J. Kripfganz of Leipzig covered recent work in lattice gauge theories, pointing out some milestones which indicate that the right path is being followed. Even gravity is being submitted to lattice treatment these days, and Kripfganz recalled Riemann's 1854 remark that the underlying space of physics must have some discrete structure.

As always, the Conference summary speakers did a good job, but it was impossible to intercept in plenary talks everything that was covered in four streams of active parallel sessions. Detailed accounts of the experiments working at electron-positron colliders, two-photon physics (photon-photon collisions), magnetic monopoles, soft hadron phenomena, experimental techniques, particle searches, all these and more were profitably attended in the parallels.

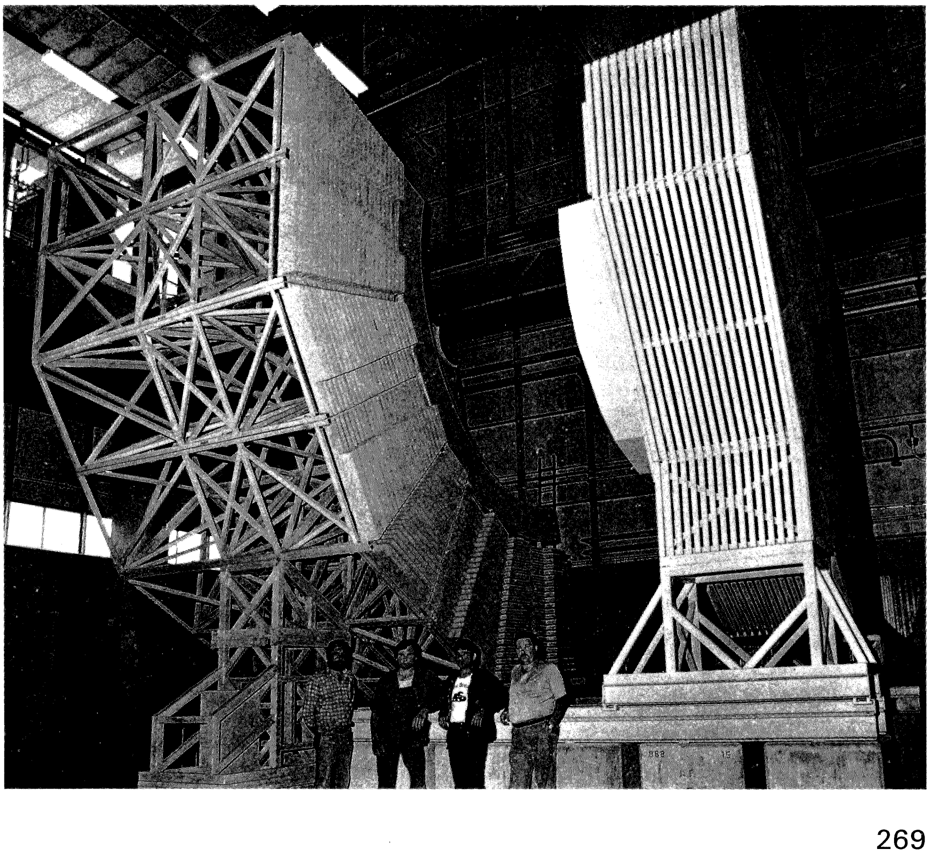
Under the general auspices of the International Union of Pure and Applied Physics (IUPAP), the Leipzig Conference was organized by the Institute of High Energy Physics of the Academy of Sciences of the German Democratic Republic, the Physics Departments of Leipzig's Karl Marx University and Berlin's Humboldt University, and the GDR Physical Society. Full marks to the organizers for catering for the intellectual and material needs of well over a thousand visitors from all over the world.

Report by Gordon Fraser

ALEPH

Our previous issue carried the first of a series of articles (DELPHI, page 227) on the four major experiments for CERN's 9 kilometre diameter LEP electron-positron ring, now under construction and scheduled to produce its first colliding beams in 1988.

This month we continue with the ALEPH (Apparatus for LEP pHysics) detector. The typical electron-positron annihilations produced in LEP will be very complex, producing many particles, distributed in turn into showers ('jets') which may turn up anywhere in the spherical volume surrounding the beam crossing point. The ALEPH detector is designed to collect as much informa-

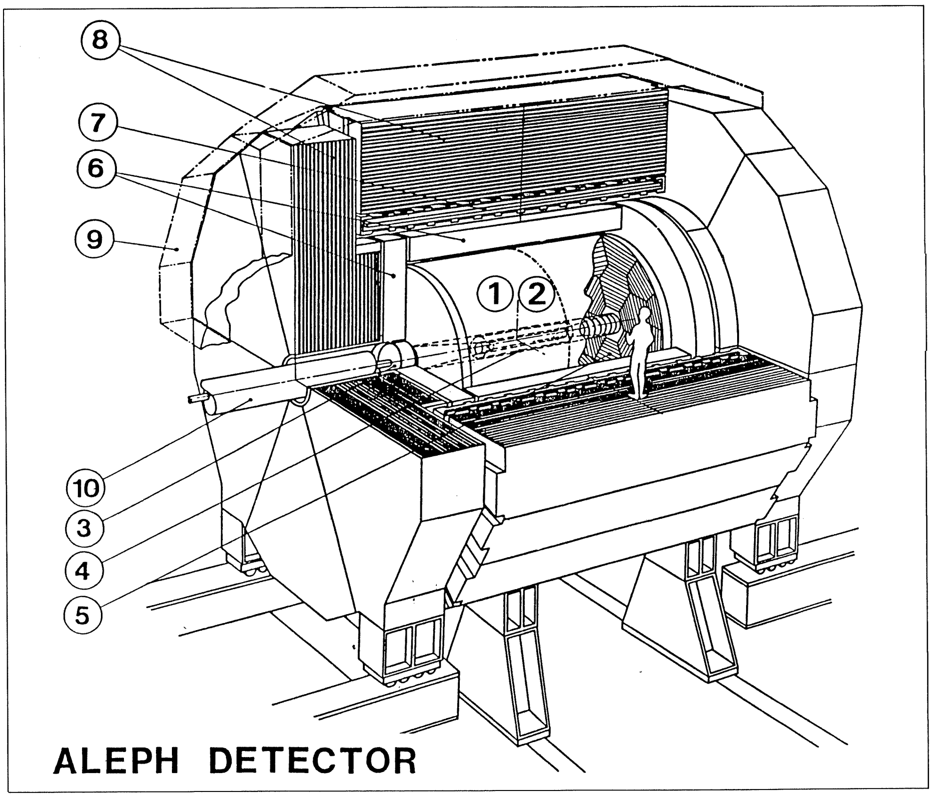


Full-scale mock-up of part of the ALEPH detector, showing (right), a portion of one end-cap, and a segment of the hadron calorimeter with (inside) the fine-grain electromagnetic calorimeter.

(Photo CERN 103.6.84)

tion about each event over as wide a spherical volume as possible.

Schematic of the ALEPH detector for the LEP electron-positron collider at CERN: 1 – beam pipe, 2 – minivertex detector, 3 – luminosity monitor, 4 – inner chamber, 5 – Time Projection Chamber (TPC), 6 – electromagnetic calorimeter, 7 – superconducting coil, 8 – hadron calorimeter, 9 – muon detector, 10 – superconducting quadrupole.



It features a large superconducting coil enclosing a Time Projection Chamber as central track detector, designed to permit precise momentum determination of charged particles over a wide energy range, and a fine-grain calorimeter measuring electromagnetic energy deposition with very good spatial resolution.

ALEPH's cost will work out at about 75 million Swiss francs at current prices, but will be 'staged', with a slightly cut-down version being ready to intercept the first beams, and final features being added later.

Like all the LEP experiments, ALEPH involves a lot of people — some 300 scientists from 25 research centres in nine countries and three continents. The line-up: Bari, Beijing, CERN, Clermont-Ferrand, Copenhagen, Demokritos Athens, Dortmund, Ecole Polytechnique, Edinburgh, Fraŝcati, Glasgow, Heidelberg, Imperial College London, Lancaster, Marseille, Munich (Max Planck), Orsay, Pisa, Rutherford Appleton, Saclay, Sheffield, Siegen, Trieste, Westfield College London, and Wisconsin.

The design is for concentric layers of detector, both inside and outside the main superconducting magnet coil, each fulfilling a separate function. The region is closed by multilayered endcaps, reflecting the configuration of the central detector.

The main solenoid, being built at Saclay, will provide a highly uniform magnetic field of 1.5 T in the central detector. The design owes much to the highly successful CELLO detector at the PETRA electron-positron ring at the German DESY Laboratory. It consists of a 6.4 m long, 5.3 m diameter main coil, with additional 40 cm compensators at either end. The superconducting cable is made of a copper-niobium-titanium composite, embedded in an aluminium band by an extrusion process.

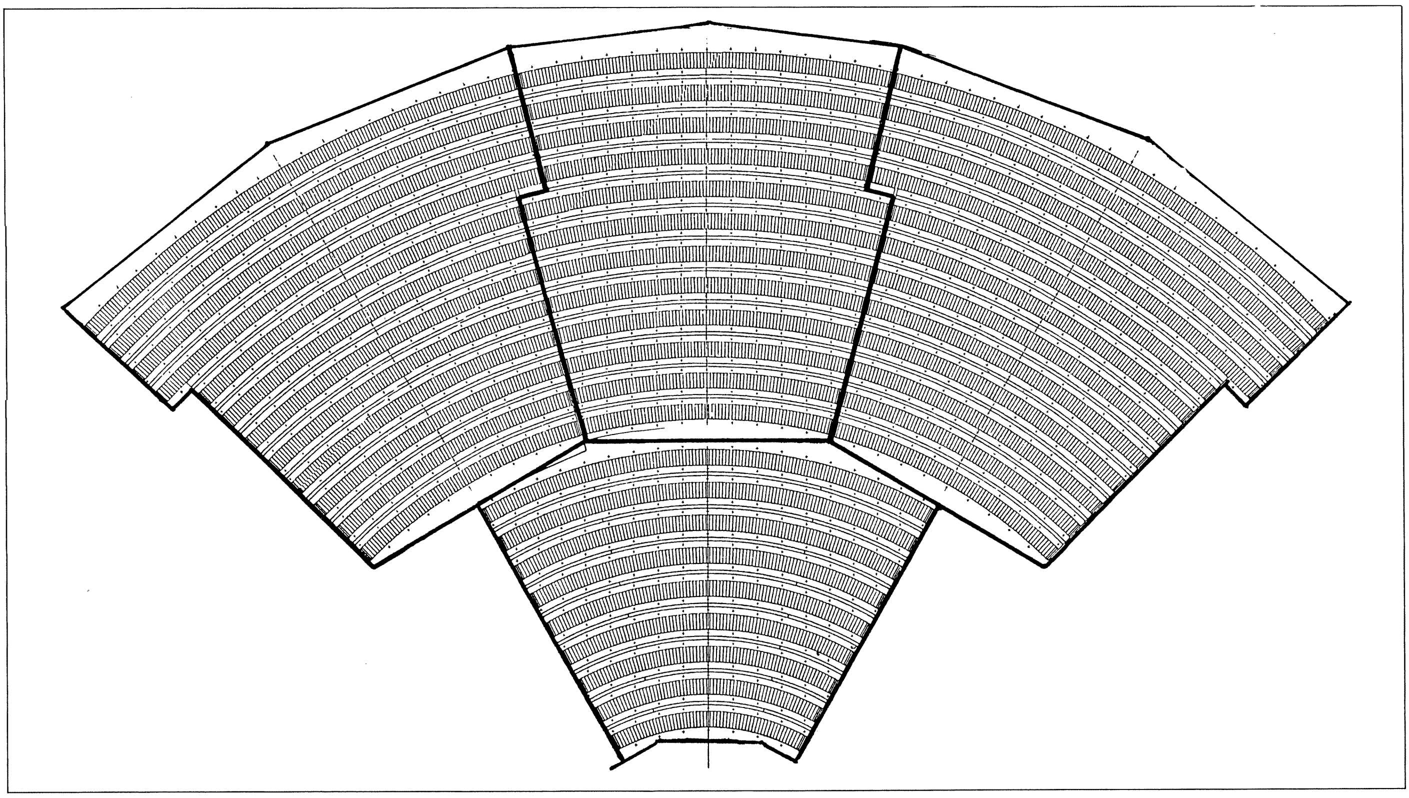
With some 25 tons of equipment involved, cooldown from ambient temperature to the 4.2 K working point will take some two weeks. The rated current in the main coil will be 5000 A, giving some 130 MJ of stored energy. The coil and its cryostat will be built in two halves and transported to CERN by road. The iron supports have to be solidly built, as they have to withstand a magnetic force of 4000 tons pulling the two opposite end caps towards each other. The iron structure, refrigeration and necessary power supplies are being constructed at CERN.

The cylindrical central tracking detector inside the solenoid has to provide good momentum and angular resolution of particle tracks, while assuring good pattern recognition and distinguishing different types of particles by rate of energy loss. Thinking soon centred on a Time Projection Chamber (TPC), using an argon-methane mixture at atmospheric pressure and an applied drift field of about 20 kV/m in a volume of 42 m^3.

Tracks of ionizing particles in the TPC will be measured by recurrent sampling of signals during the electrons' drift time of some 35 microseconds before they arrive at the endplates, where they are recorded by a system of 3000 proportional wires and 22 000 cathode readout pads. The electrode configuration reflects experience gained with the TPC used at the PEP electron-positron ring at Stanford.

An ingenious laser calibration system will take care of field irregularities inside the TPC. Time Projection Digitizer (TPD) and Time Projection Processor (TPP) electronics will naturally take care of the huge amount

Not a reservation chart for concert tickets but a diagram of four of the 18 sectors for each end-plate of the ALEPH Time Projection Chamber, showing the arrangement of some of the 22 000 readout pads.



of raw generated data, only a small proportion of which will actually correspond to useful track information.

A prototype (TPC 90, with end-plates approximately the size of one of the 18 sectors for the final version) has been constructed and is now being put through its paces, using tracks produced by laser beams.

Development and construction work for the TPC is shared by CERN, Dortmund, Pisa, Munich, Trieste and Wisconsin, with Dortmund and Glasgow supplying the calibration system.

Inside the TPC will be the ALEPH Inner Chamber (Imperial College, London), a conventional cylindrical small cell drift chamber (outer radius 280 mm, inner radius 128 mm). This will provide additional tracking close to the beam pipe and its signals will provide an essential part of the primary electronics trigger.

Inside the Inner Chamber, a 105 mm outer radius minivertex detector (Pisa) will eventually be installed. Based on multi-electrode silicon detectors, it will provide the close tracking increasingly used these days to detect the short-lived particles which decay very close to the interaction point.

Either side of the inner detectors and at the centre of the end-caps will be luminosity monitors (Copenhagen and Siegen).

Inside the solenoid but outside the TPC will be the electromagnetic calorimeter, based on a 2 mm lead plus wire chamber sandwich design providing good transverse granularity, matched to the size of the produced electromagnetic showers, and organized into 'microtowers', each with three longitudinal sections. The central barrel, made up of 12 11-ton modules, will contain 48 000 microtowers, while a further 24 000 will be in the end-caps, giving a total of 216 000 electronics channels.

The electromagnetic calorimeter end-caps are supplied by the Rutherford Appleton Laboratory and Glasgow, while the barrel involves a French (Clermond-Ferrand / Ecole Polytechnique / Marseille / Orsay / Saclay) collaboration.

Outside the solenoid, the 120 cm of iron which supports the rest of the detector and provides the magnet return yoke will be packed with instrumentation (1 cm^2 plastic streamer tubes) to measure the deposition of hadronic energy and to pick up the muons which penetrate the rest of the apparatus. The instrumentation comprises a total of 56 000 streamer tubes and a further 82 000 tubes in the 9 m diameter end-caps. The readout is organized into projective towers. The hadron calorimeter is an Italian effort, with Frascati providing the barrel, and with Pisa and Bari supplying the end-caps.

The muon detector uses double layers of streamer tubes to pick up the muons traversing the iron of the hadron calorimeter. The outer layer will probably only come into operation after the initial electron-positron collisions have been studied.

As with all experiments using high luminosity colliding beams, great emphasis is placed on ALEPH's data acquisition and handling system. A fast first level trigger, using information from the inner chamber, the hadron calorimeter, the electromagnetic calorimeter, the muon chambers and the luminosity monitor, will act within a few microseconds, priming the TPC electronics and initializing the second level trigger. Since beam crossing occurs only every 23 microseconds, this will not lose precious information.

The second level trigger will mainly use information from the TPC to ensure that tracks point back towards the beam crossing point. This will reduce the trigger rate to something less than 10 Hz.

The final trigger will reduce the data collection rate down to a level (a few events per second) suitable for writing to magnetic tape for subsequent off-line processing. The development of the triggering system is supervised by Heidelberg and Rutherford. Fastbus electronics will be prominent throughout.

There is no recipe for building a detector for discovering the unknown, especially when the unknown is likely to involve rare and complex particle interactions. However the ALEPH team believes that its detector will be able to disintangle much of this complexity, providing an optimal instrument both for studying the known and discovering the unknown.

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50 years of weak interactions

In the half century following Fermi's first formulation of the theory of nuclear beta decay in 1934, our understanding of weak interactions has slowly developed into the modern picture of electroweak unification, crowned last year with the discovery at CERN of the W and Z particles which carry the weak nuclear force.

To commemorate and review this half century of scientific achievement, a National Meeting of the Italian Physical Society was organized in April in Bologna with the participation of many of the famous names of weak interactions. This area of physics has always had a great appeal for Italian physicists. Apart from Fermi, one can think of Amaldi, Bernardini, Cabibbo, Conversi, Maiani, Oc-

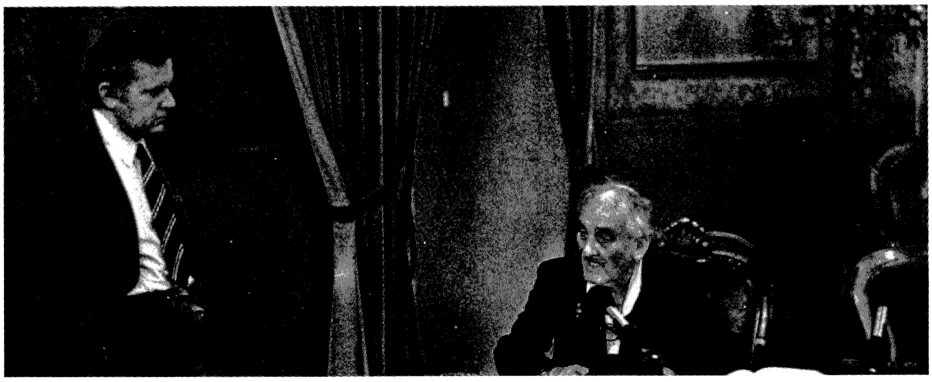
At the National Meeting of the Italian Physical Society in Bologna to commemorate fifty years of weak interaction theory: R. Gatto (left), M. Baldo Ceolin, E. Fiorini (foreground).

B. Pontecorvo (left) with A. Zichichi.

chialini, Piccioni, Pontecorvo, Puppi, Rossi, Rubbia, and many more.

In parallel with the meeting, a beautiful book has been published which includes the papers presented at the Bologna meeting together with reprints of historical interest, starting from Fermi's landmark 1934 paper and going through to the discovery of the W and Z particles last year at CERN.

The 800-page book: 'Fifty Years of Weak Interaction Physics', edited by A. Bertin, R.A. Ricci and A. Vitale and published by the Italian Physical Society, is available price 45 US dollars (including postage and packing) from Editrice Compositori, Viale XII Giugno 3, 40124 Bologna, Italy.



N. Cabibbo (left) with G. Occhialini.

Around the Laboratories

BROOKHAVEN
Large spin-orbit effect seen

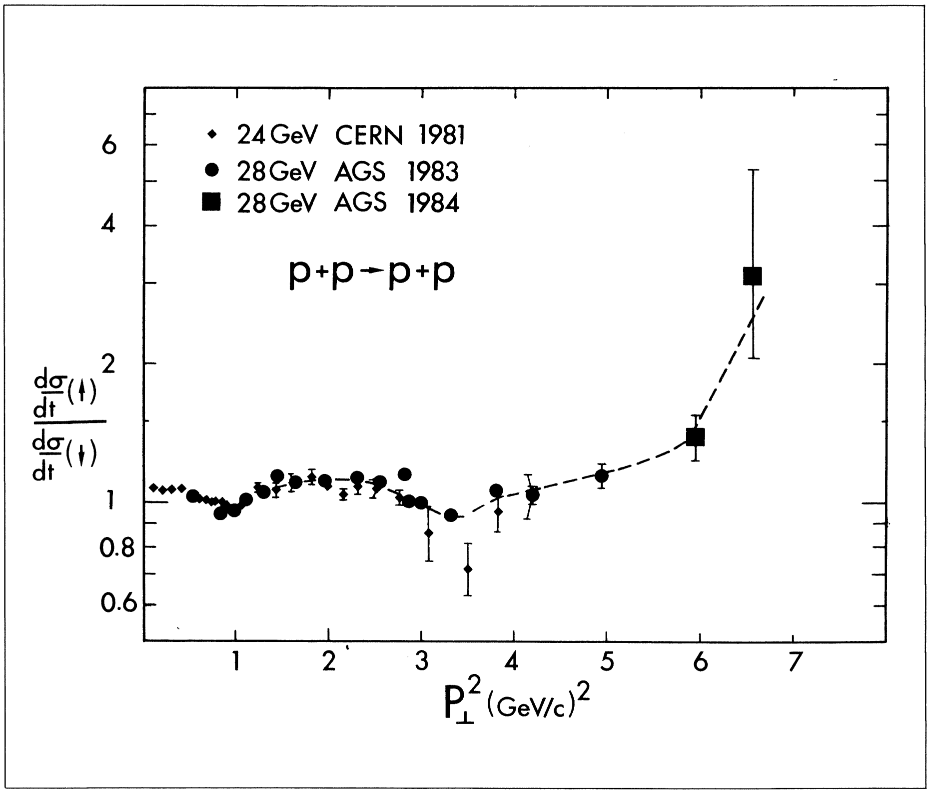
While the Alternating Gradient Synchrotron was being modified to accelerate a polarized proton beam (see April issue, page 100), experimenters busily prepared their apparatus for experiments using this new capability. The Michigan / Brookhaven / Maryland / Miami / Notre Dame / Rice / Texas A&M / ETH-Zurich team headed by Alan Krisch is aiming to measure spin-spin effects in high transverse momentum proton-proton elastic scattering using a polarized proton target. They plan to study the large and totally unexpected spin-spin effects discovered several years ago at the highest energy and transverse momentum which were available at the old Argonne ZGS.

In preparation for this polarized beam/polarized target experiment, they made a 'low priority' measurement of large transverse momentum proton-proton elastic scattering with a polarized target but a conventional unpolarized beam. The low priority came from the firm theoretical belief that there would be no significant spin effects in this 'one-spin' experiment, even though the dramatic 'two-spin' results from the ZGS are still unexplained. Current theory cannot easily account for any large spin effects at high transverse momentum, and it is even more difficult to explain simple one-spin 'spin-orbit' effects. In fact, experiments at Fermilab and the CERN SPS have found only very small spin effects out to a squared momentum transfer of 3 GeV^2.

The team was able to run with a beam intensity of almost 10^{11} protons per pulse, by using various polarized proton target tricks, including a helium 3/helium 4 mixture in the helium 3 evaporation refrigerator, and pure ammonia beads radiationdoped at the Brookhaven National Synchrotron Light Source. These techniques allowed spin effects to be measured out to a squared transverse momentum of 6.6 GeV^2.

To (almost) everyone's amazement, the resulting spin-orbit effects in proton-proton scattering appear to be huge. While theorists ponder this unexpected new result, the experimenters are trying to find ways to reach even higher transverse momentum by using a still higher intensity beam without boiling away their cold polarized proton target.

Relative behaviour of spin up and spin down behaviour with large transverse momentum (right) as seen recently in proton-proton scattering with a polarized target by an experiment at the Brookhaven Alternating Gradient Synchrotron. The appearance of such a large effect took most people by surprise.



Polarized beams at Brookhaven go higher

On 13 August, the Brookhaven Alternating Gradient Synchrotron supplied polarized beams to experiments. At a world record energy of 16.5 GeV, intensity was over 6 x 10^9 and polarization over 40 per cent. More details in the next issue.

g-2 revisited

Some forty physicists gathered at Brookhaven in June for a Workshop, chaired by Vernon Hughes, to look at the possibility of measuring the anomalous magnetic moment (g-2) of the muon to even greater precision in an experiment at the Brookhaven AGS. Three previous experiments at CERN have progressively pushed the measurement to an accuracy of 7 parts per million. The new ideas envisage improving this by a further factor of twenty.

The spinning muon behaves like a tiny magnet and 'g' is the gyromagnetic ratio, proportional to the magnetic moment. The reason for the obsession with the nth decimal place of g-2 is that the magnetic moment of the muon is affected in a small way by the effects of the electroweak force. The more precise the measurement, the more precise is our examination of these electroweak effects.

The new Brookhaven possibility would repeat the last of the CERN experiments but using the higher intensity of the AGS (a factor of fifty) and recent technological advances in magnets and instrumentation. Muons would be collected and stored in a 5 m diameter, 5 T superconducting ring magnet, compared with the 1.4 T ring of electromagnets used at CERN. The principal technological challenge is to build such a magnet with a field precision of 0.1 parts per million.

It will take more work on this and many other aspects of the project before a serious proposal can be formulated, but many people are convinced that the muon has much more to contribute towards our new understanding of the electroweak force. It was the opinion of the Workshop that more work was worthwhile and that the experiment might one day get underway.

FERMILAB
Working towards antiprotons

The plans and preparations to obtain circulating beams of high energy antiprotons (for collision with protons) continue to make encouraging progress.

As tunnelling for the new antipro-

Aerial view at Fermilab, showing in the foreground the preparations for the new antiproton storage facilities. On the right is an arc of the large ring housing the conventional and superconducting magnet machines, and stretching away into the distance are the fixed target experimental areas.

ton storage facilities comes to an end, the production of the necessary hardware forges ahead, with some 80 per cent of the small quadrupoles completed, while large diameter quadrupoles have left the agonies of the prototype stage. Dipoles will follow. Magnet installation will start as soon as the new tunnel settles.

Meanwhile measurements at the big Saver/Doubler ring have shown that the four superconducting quadrupole lenses at BO (the location of the principal colliding beams detector) substantially shrink the cross-section of the stored accelerator beam, promising good proton-antiproton collision rates. The lens system requires careful adjustment of the tune and chromaticity of the accelerator, while a special flying wire device is used to measure the very small beam profile.

Teething troubles with the lithium lens for the antiproton source and with r.f. equipment have been cured. Unless unforeseen problems occur, Fermilab eagerly looks forward to its first circulating antiproton beams next year.

Industrial affiliates

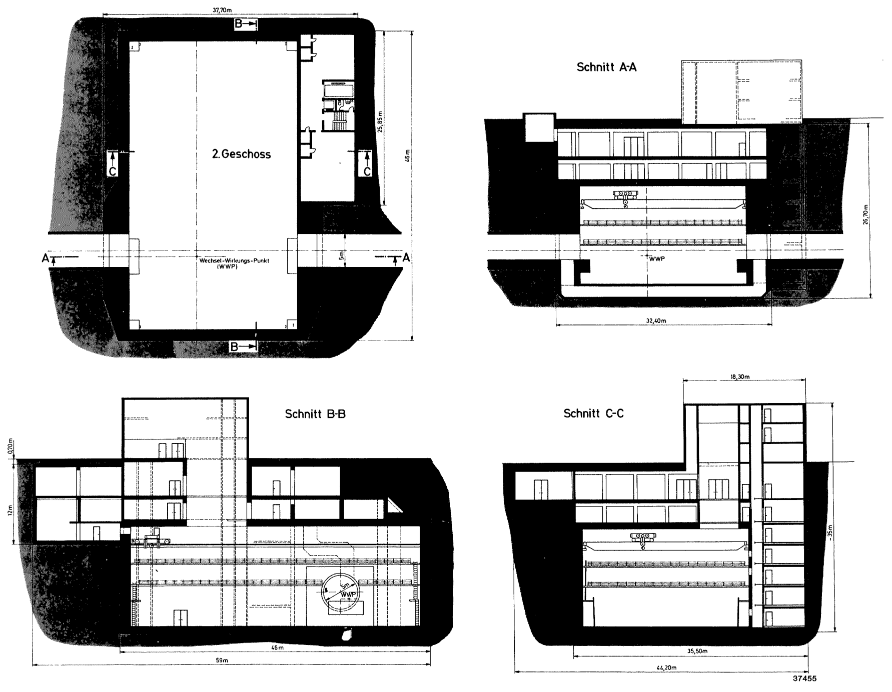
The fourth annual meeting of the Fermilab Industrial Affiliates took place in May, with the central theme of 'Industry and Large Scientific Projects — Particle Accelerators and Projections into the Future.'

Construction of a super accelerator will involve industrial participation on a scale unfamiliar to particle physics. It will require participation of many companies ranging from corporate giants to small machine shops. New innovative approaches will be needed to cement these relationships.

A highlight of the meeting was a Round Table that explored how industry could participate in projects like the super accelerator. The Table, chaired by Dick Lundy, included participants from a cross-section of industries with expertise in technologies needed for a super accelerator. Among the participants were Ray Beuligman, program director of energy systems at Convair/General Dynamics; Dick Rodenizer, manager of systems and product engineering for medical systems at General Electric; C.H. Dustmann of Brown-Boveri in Germany, now working on superconducting magnets for the HERA project at DESY; John Hulm of Westinghouse, one of the developers of modern superconducting wire and a member of the Board of Overseers for the proposed US Superconducting Super Collider (SSC); Carl Rosner, chairman and chief executive officer of Intermagnetics General; Ryusei Saito, chief engineer in the nuclear fusion division of Hitachi, now working on the Fermilab Collider Detector coil; and Ed Temple, head of the US Department of Energy working group on the SSC. The diverse perspectives of the participants led to a lively exchange of views. In particular, the discussion illuminated a range of industrial viewpoints from the US, Germany, and Japan.

The Fermilab Industrial Affiliates scheme was established in 1980 to improve university-industry research communications and to foster technology transfer from Fermilab. The annual meeting provides an opportunity for research directors and senior technical personnel from the Affiliates and other companies to visit Fermilab. Participation in the meeting included more than eighty people from outside Fermilab. Some forty US companies and six foreign concerns were represented.

Plans for one of the underground halls for HERA, showing the planned infrastructure around the 5 m-diameter tunnel.



DESY Experiments for HERA

Now that construction work for the HERA electron-proton collider at the German DESY Laboratory in Hamburg has started, attention can turn towards the experiments for this novel machine, and at the end of May an information meeting on HERA experiments was held at DESY.

Even before construction work started, preparatory meetings in Munich, Wuppertal and Amsterdam (see September 1983 issue, page 256) had surveyed the physics problems which could be attacked with the new machine, including the experimentalists' requirements for working conditions in and around the machine's beam intersection points.

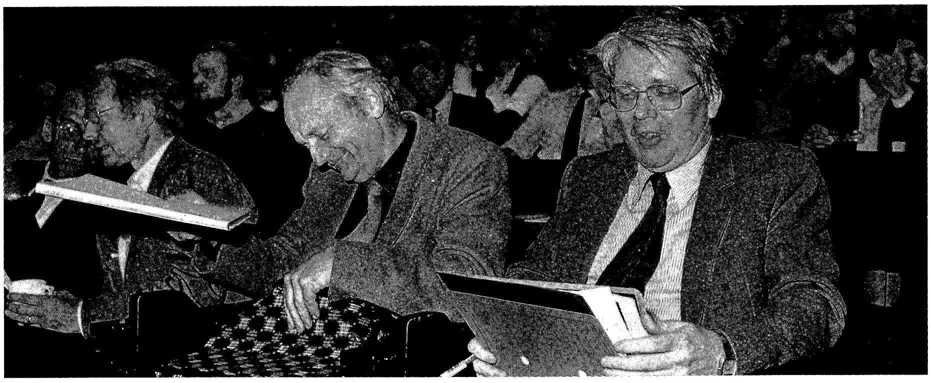
At the DESY meeting, it was reported that following earlier suggestions the three new experimental halls to be built outside the present DESY site will be increased from the planned 25 by 35 metres to 25 by 43 metres. Each beam intersection point is to be placed so that there are

HERA experiments

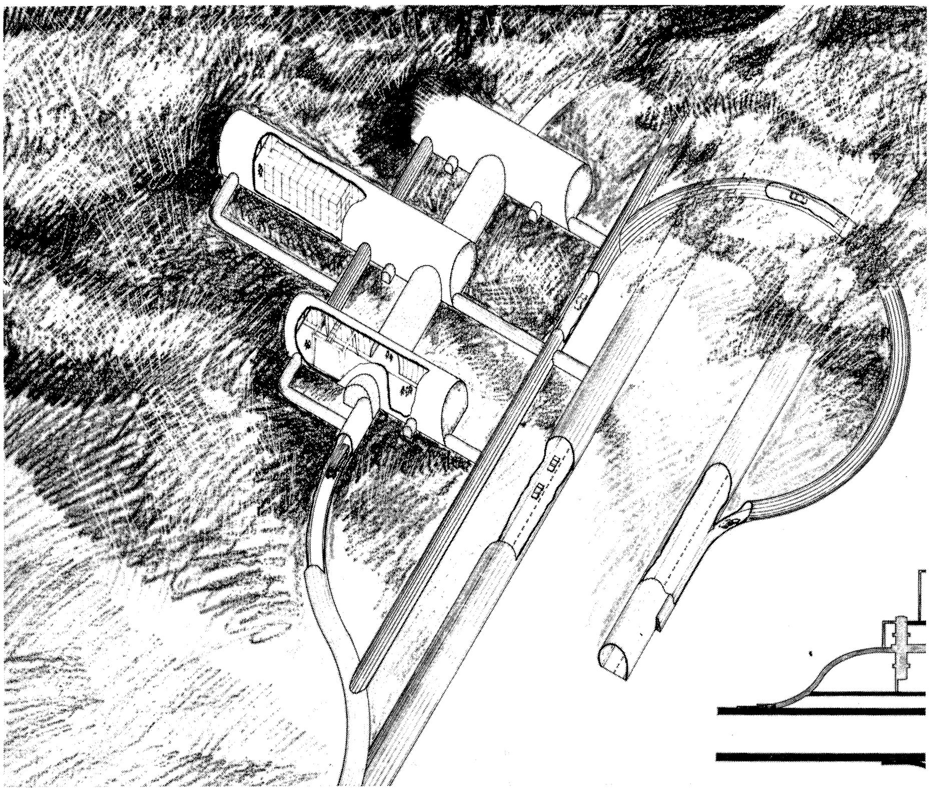
The next step for planning HERA experiments is a discussion meeting in Genoa from 1-3 October. Further information from Peter von Handel at DESY-DIB, Notkestrasse 85, D-2000 Hamburg 52, Federal Republic of Germany.

HERA project leaders Bjørn Wiik (right) and Gus Voss pack up after the recent meeting on experiments for the new HERA electron-proton collider being constructed at the German DESY Laboratory.

(Photo DESY)



Sketch of the proposed underground physics Laboratory in the Gran Sasso mountain near Rome, showing the connections with the road tunnels.



ten metres free in the direction of the 30 GeV electrons and 15 in the direction of the 820 GeV protons.

The next step is a discussion meeting to be held in Genoa from 1-3 October. Letters of intent, to be submitted before the end of June 1985, will be examined by DESY's Physics Research Committee. The recommended experiments should then be presented as technical proposals by March 1986, and a final decision is expected in June of that year. For the first HERA runs, three installations are envisaged.

Earthmoving work for the new HERA South Hall began immediately after formal approval for HERA was announced (see June issue, page 183). The machine tunnel will be between 10 and 20 metres below ground on a one per cent slope, following the surface. The original design called for a 5 m-diameter tunnel in the straight sections and 3.2 m in the arcs, but it turns out to be cheaper to construct the whole thing 5 m across.

The first quadrant of the tunnel should be ready for installation work in May 1986, with first circulating electron beam expected in March 1988. More HERA news appears in the new HERA Bulletin, to be published four times a year by DESY-PR.

GRAN SASSO
Call for proposals

A meeting of the International Scientific Committee of the Gran Sasso Laboratory was held recently in Rome under the Chairmanship of Antonino Zichichi. The preparation of the scientific programme of the underground Laboratory is now at a crucial stage.

The Laboratory is located at the Gran Sasso d'Italia mountain some 100 km from Rome and involves the largest underground excavation of its kind ever undertaken. The initial plans envisaged three experimental halls (with their axes oriented towards Geneva) each allowing the installation of a detector 9 x 9 m^2 cross-section. The total planned cross-sectional area of the halls is 290 m^2. There is some 1.5 km of rock (4 x 10^3 m of water equivalent) above the halls.

Excavation of the first of the halls is now complete and work has started on the connecting tunnels. A decision is now needed whether to proceed with the other halls as first planned or to switch to excavation of a single additional hall as large as possible. The decision is being dictated by experience with the presently operating underground Laboratories and by expression of interest in particular types of experiments for the Gran Sasso Lab from the particle physics community.

The experimental possibilities in such underground Laboratories are, of course, by now rather familiar. They range from the study of nuclear stability, neutrino astrophysics, solar neutrino flux... to other new cosmic phenomena including magnetic monopole searches.

The Laboratory is open to the full international scientific community and close contact and collaboration with CERN is assured. All physicists with proposals for underground experiments are encouraged to make contact with Antonino Zichichi at CERN or at INFN, Piazza dei Capretari 70, I-00186 Roma.

CONFERENCE
Instrumentation at Novosibirsk

In March, over a hundred physicists, including about forty from the USA

Participants at the recent Conference on Instrumentation for Colliding Beam Physics pose outside the entrance of the Novosibirsk Institute of Nuclear Physics.

(Photo Yu. Ivanov and V. Petrov)

and Western Europe, took part in the Third International Conference on Instrumentation for Colliding Beam Physics at Novosibirsk, USSR. This Conference series started in 1977, also at Novosibirsk, as a Meeting on Experimental Methods with Electron-Positron Colliding Beams, organized jointly by Stanford and the Novosibirsk Institute of Nuclear Physics. The sequel to that meeting was held at Stanford in 1982. Reflecting the increased concentration on colliding beam physics, the Stanford meeting was named the International Conference on Instrumentation for Colliding Beam Physics and this new name has stuck.

The first day at Novosibirsk was given over to review talks from the main colliding beam Laboratories. Participants then visited both the Novosibirsk electron-positron colliders: VEPP-2M (collision energy 0.4 to 1.4 GeV) and VEPP-4 (3 to 11 GeV), and were told about the development of the VLEPP Linear Collider Project aimed at the collision energy range from 300 to 1000 GeV.

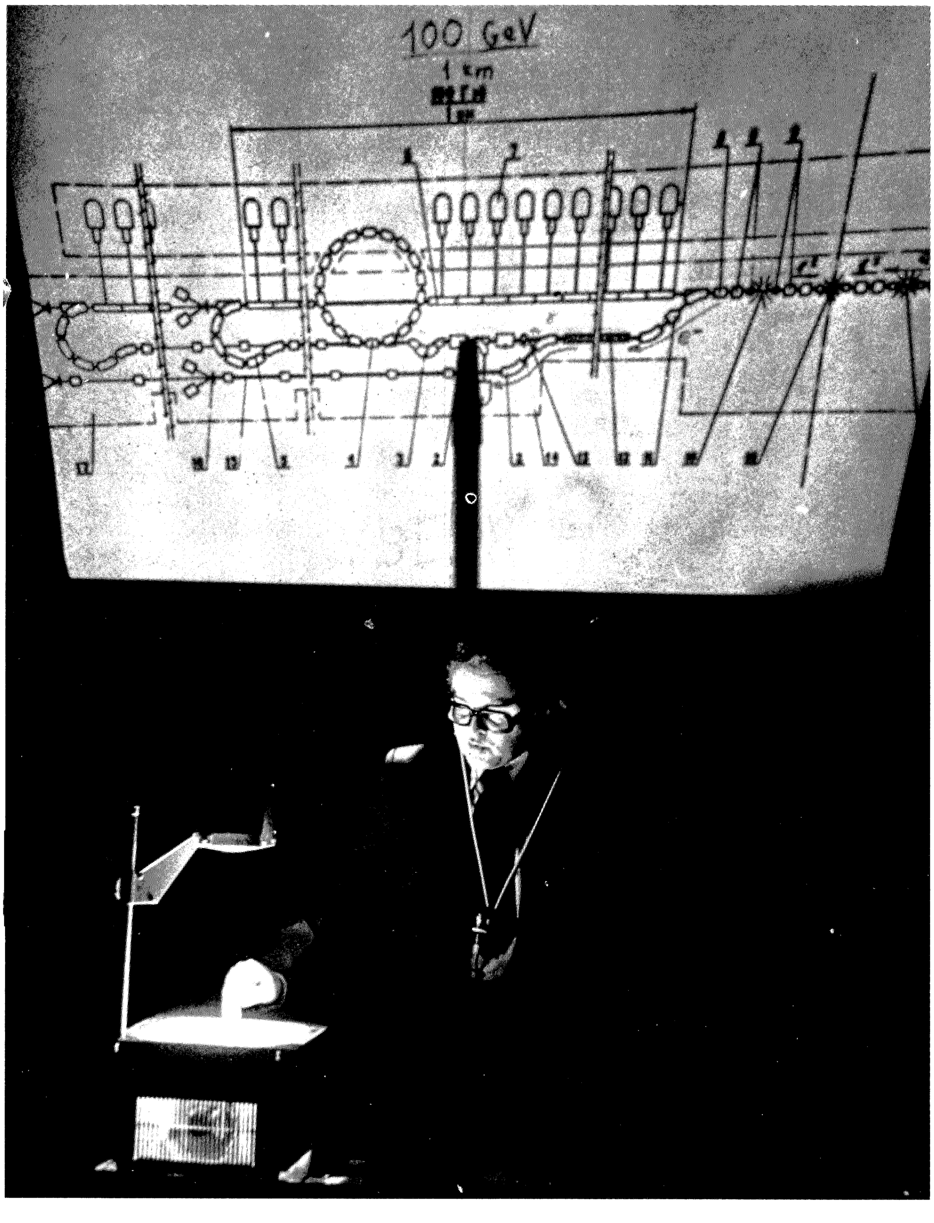
At each of the previous Conferences, promising new techniques were described and which went on to become widely used. In 1977 came the idea of the Time Projection Chamber (TPC) which in various versions is now very popular in existing and planned detectors. Also widely discussed then was the precise calibration of storage ring energy using resonant depolarization of the beam. Later, this gave high precision mass measurements of psions and upsilons at Novosibirsk, Stanford, Cornell and DESY.

At the second Conference the RICH (Ring Image CHerenkov detector) idea was presented by T. Ypsilantis. High resolution silicon strip and charge coupled device (CCD) detectors were discussed. At the latest Conference, many reports were devoted to the applications of such devices in forthcoming detectors for LEP at CERN and SLC at Stanford. In addition, G. Charpak presented a new method for Cherenkov ring imaging using the low pressure multistep chamber (see May issue, page 141). C. Akerlof from Michigan reviewed the development of high resolution detectors in recent years and concluded that both silicon strips and CCD detectors are now successfully used in fixed target experiments and feature in preparations for colliding beam detectors.

There was increasing attention from experimentalists to BGO and caesium iodide crystals as promising materials for high resolution electromagnetic calorimeters. Liquid argon calorimeters continue to be widely exploited for both operational and projected experiments. At the same time a new version of a liquid ioniza-

Novosibirsk Institute of Nuclear Physics Vice-Director V.A. Sidorov describes the development of the VLEPP electron-positron linear collider project aimed at providing 300 to 1000 GeV collision energies with an accelerating gradient of 100 GeV/km in the linacs.

(Photo V. Petrov)



tion calorimeter was proposed by J. Engler from Karlsruhe. It is based on TMS (tetramethylsilane) which remains liquid up to 27°C at atmospheric pressure. Being free of cryogenic complications, this method looks promising. First results were presented showing a clear relativistic particle signal from a TMS ionization chamber. The near future will show whether TMS could replace the popular liquid argon.

Spark counters with localized discharge (Pestov counters) may become a real breakthrough for time-of-flight measurements since their resolution is about 25 ps. At the Conference large area Pestov counters (about one metre long) were described for the first time by both Novosibirsk and Stanford groups. A 3 m-long counter is now in preparation at Stanford.

Considerable attention was given to a recently developed operational mode for proportional tubes and chambers — the so-called limited streamer mode. Many experiments are now attracted by its advantages, which provide large, nicely shaped signals. A fresh idea, to use the limited streamer mode for the detection of transition radiation, was announced by two groups from Serpukhov and Yerevan. The idea is based on the preference of the streamer to be produced by an ionization cluster. So it looks feasible to use the chambers in limited streamer mode for the detection of clusters produced by transition radiation on the large (but thin) background of relativistic particle ionization.

The Conference was successful and demonstrated the growing awareness of the problems of Instrumentation for Colliding Beam Physics, and the search for ingeneous solutions.

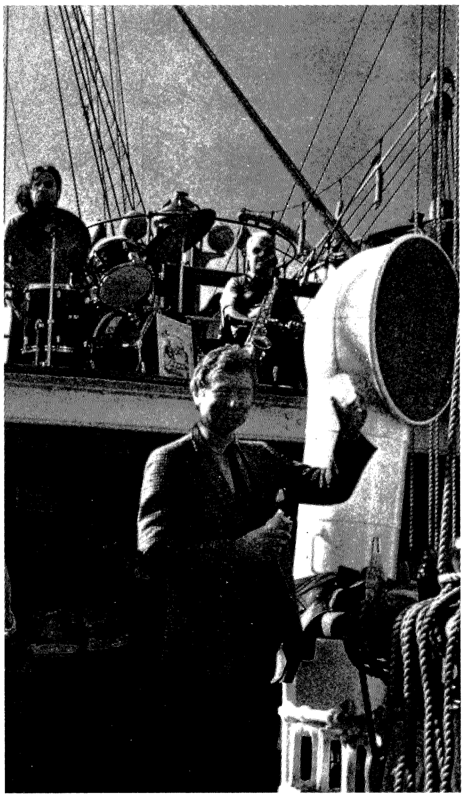
CERN School of Physics

The 1984 CERN School of Physics was held from 11-24 June, at the Ullensvang Hotel, Lofthus, by the Hardangerfjord in Norway, with C. Jarlskog and A. Halsteinslid from University of Bergen as director and deputy director.

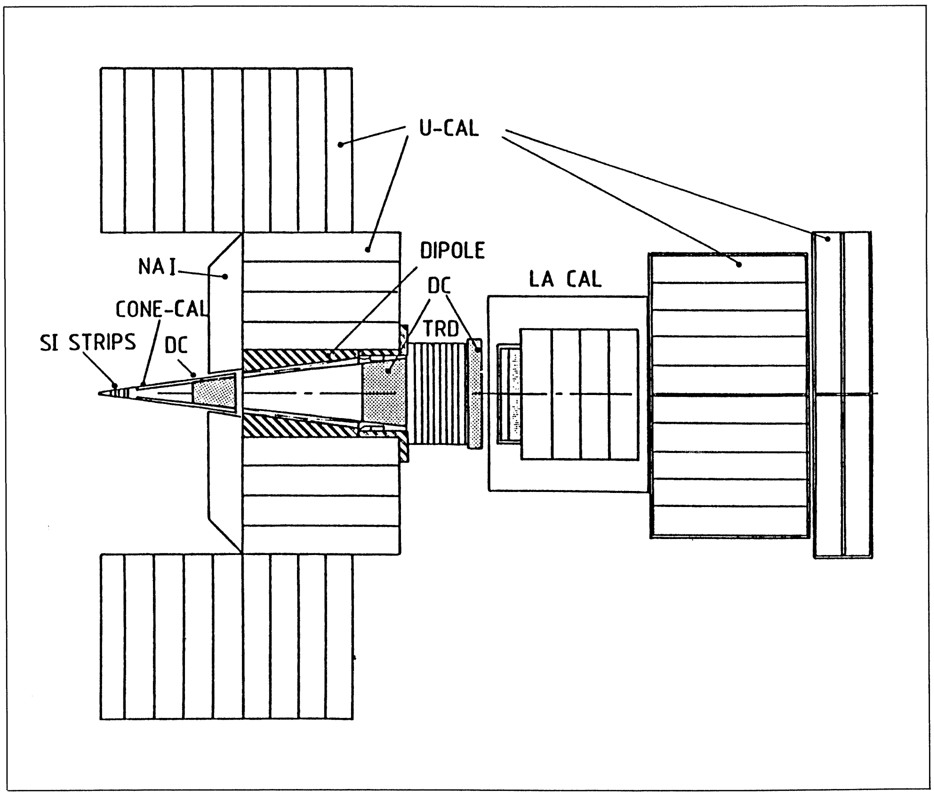
Some 70 students from eleven CERN Member States and another few from nonmember states participated. As usual, the School was intended mainly for young experimental physicists, and the scientific programme included five series of lectures: C. Jarlskog on gauge theories, R. Petronzio on quantum chromodynamics, J. Iliopoulos on grand unification and supersymmetry, D. Haidt on experimental tests of gauge theories, and J.D. Dowell on proton-antiproton physics.

The Norwegian Physical Society's annual meeting in Bergen this year highlighted the Norwegian effort in particle physics. G. Kantardjian of CERN is seen here enjoying the boat trip for the participants. The photo was taken at 11 p.m.!

(Photo E. Lillestøl)



Central portion of the detector for a new experiment (NA34) at the CERN 450 GeV SPS proton synchrotron to study the production of leptons (electrons, muons and neutrinos). Some of the equipment has a more than passing resemblance to what was used recently around Intersection 8 of the CERN Intersecting Storage Rings.



In addition to the lecture series and intervening discussion sessions there were also a number of talks including a presentation of the HERA project at DESY in Germany, by B. Wiik, random dynamics by H.B. Nielsen, more on supersymmetry by S. Rudaz and F. Ravndal, and a survey of Norwegian particle physics by C. Jarlskog and E. Lillestøl. Highlights from this year's Neutrino Conference were presented by I. Bigi, and the new evidence for the top quark from the UA1 Collaboration at the CERN Collider was discussed by J.D. Dowell (see page 263).

Besides physics questions, what seemed to intrigue the students most was the strange behaviour of our nearest star. Indeed a rather common question put to the organizers was 'doesn't the sun ever go down?'. Fascinated by the bright nights, many participants even dared, and enjoyed, taking a short plunge into the fjord at midnight!

The social programme included an excursion to Bergen and a visit to the famous Vøringsfossen waterfall, and a closing banquet during which a 'Mr Fjord' was elected. Winner was Jürgen Schukraft from Germany and runner-up was J.D. Dowell.

From C. Jarlskog

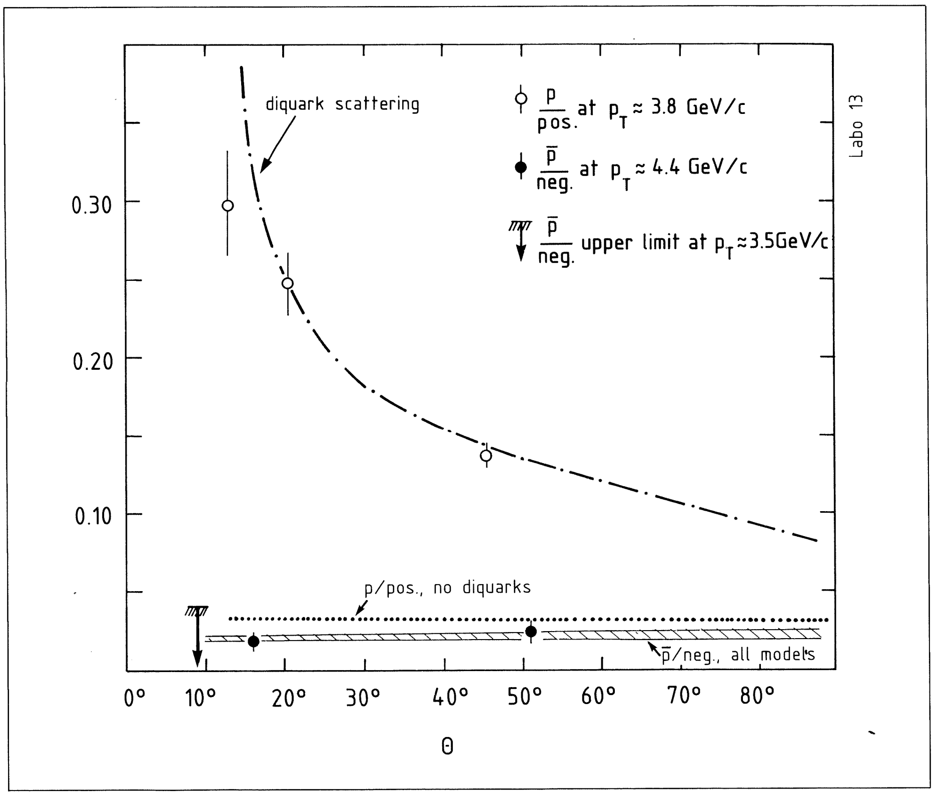
Looking to fix leptons

More than ten years have passed since the 'direct' production of leptons (weakly interacting particles) in strong interactions was first seen in experiments at Serpukhov, Fermilab and the CERN Intersecting Storage Rings. At first they were a great mystery, but these days most of these 'prompt' leptons are assumed to come from decays of heavy, short-lived states, such as charm and beauty particles, produced in the primary collisions.

However despite much effort charm production rates calculated from strong interaction information have yet to be universally reconciled with the observed levels of electron production. In electron production, the experimental situation is far from satisfactory. The series of neutrino 'beam-dump' experiments at CERN and Fermilab, which look for prompt particles, fail to find total accord. There are other riddles, such as the origin of lepton pairs containing two similarly-charged particles, and low mass lepton pairs of opposite charge.

To make a precision study of prompt lepton production, a new experiment (NA34) is being mounted at the CERN 450 GeV proton synchrotron by a Brookhaven / CERN / Heidelberg / Lund / McGill / Montreal / Moscow (Lebedev Institute and Phy-

Single proton and antiproton production rates at wide angles (high transverse momentum) from proton-proton collisions in the CERN Intersecting Storage Rings, as measured by an Ames / Bologna / CERN / Dortmund / Heidelberg / Warsaw team working at the Split Field Magnet. These rates, and in particular the large difference between the proton and antiproton rates, do not agree with primitive calculations using single quarks and gluons. When diquarks (quark pairs) are included, the agreement improves dramatically.



sical Engineering Institute) / Novosibirsk / Pittsburgh / Rutherford / Saclay / Syracuse / Tel Aviv collaboration. The apparatus is designed to trigger on and measure a variety of muon, electron and neutrino final states.

The primary SPS beam will be focussed down to less than 100 microns and hit a small beryllium target, matched to the 10 micron precision of vertex measurement by silicon detectors. The compact electron spectrometer, containing special drift chambers to handle multiparticle tracks with 80 micron resolution, will track the electrons between the vertex detector and a transition radiation detector providing good electron-hadron discrimination.

The big electromagnetic/hadron calorimeter will measure energy flow, providing a valuable 'missing energy' trigger to search for otherwise invisible neutrinos. The calorimeter, composed at small angles of uranium-liquid argon modules in front with uranium-scintillator modules behind and at large angles, reflects the years of experience of physicists who worked at Intersection 8 of the CERN Intersecting Storage Rings, many of whom figure in the NA34 line-up.

The outer muon spectrometer uses many essential components from the NA3 experiment (CERN / Collège de France / Ecole Polytechnique / Orsay / Pisa / Saclay) which has made a long study of dimuon production at the CERN SPS.

Diquarks in action?

The Ames / Bologna / CERN / Dortmund / Heidelberg / Warsaw collaboration which worked at the Split Field Magnet of the CERN Intersecting Storage Rings (ISR) made a speciality of studying the single particles emerging at wide angles (high transverse momentum) from proton-proton collisions.

Although these single particle wide angle triggers are only a small fraction of the debris produced in violent proton-proton collisions, their very clean signature provides deep insights into the scattering mechanisms at work when the protons' quarks actually hit each other (see May 1983 issue, page 131).

The experiment measured the relative production levels of single protons, antiprotons and positive and negative mesons (pions and kaons).

The relative levels of single positively charged kaons and pions is found to be relatively constant over a wide kinematic range, suggesting that pions and kaons are produced through the same scattering mechanism. If single protons, as well as mesons, are produced by this mechanism, then the ratio of single proton production to that of all positively charged single particles would also have little kinematic dependence, and moreover would be comparable to the corresponding ratio of antiproton production to that of all negatively charged single particles. This is not found to be the case.

The observed kinematic dependence of these ratios, and the large difference between the observed ratios for protons and antiprotons, does not agree with primitive calculations using the field theory of quarks and gluons (quantum chromodynamics—QCD). However this is not the first instance where primitive QCD calculations have failed to reproduce the observed behaviour.

One possibility is to resort to additional QCD ('higher twist') recipes, and the experimental group puts forward diquarks—quark pairs—as a candidate mechanism. Using standard techniques to calculate the diquark composition of the proton, encouraging results are obtained, reproducing the general features of the relative single particle levels. However more information is needed before the role played by diquarks in high energy proton scattering can be clarified.

Other experiments have found evidence for unexpectedly large proton yields in high transverse momentum lepton-hadron collisions, which could be due to a similar mechanism.

COMPUTING International symposium

Recent Developments in Computing, Processor, and Software Research for High Energy Physics, a four-day international symposium, was held in Guanajuato, Mexico, from 8-11 May, with 112 attendees from nine countries. The symposium was the third in a series of meetings exploring activities in leading-edge computing technology in both processor and software research and their effects on high energy physics.

Topics covered included fixed-target on- and off-line reconstruction processors; lattice gauge and general theoretical processors and computing; multiprocessor projects; electron-positron collider on- and off-line reconstruction processors; state-of-the-art in university computer science and industry; software research; accelerator processors; and proton-antiproton collider on- and off-line reconstruction processors.

The bottleneck of computing is a critical problem for most existing and pending experiments. Many groups recognize that finding highly cost-effective, yet user-friendly solutions to the computing problem will be a contribution to physics of the highest importance. The major emphasis at Guanajuato was on large projects working in this area: the CERN/SLAC 3081/E emulator effort; the Fermilab Advanced Computer Program's multi-microprocessor project; Berkeley's Midas Project; the Nevis Data Driven Processor; and CERN's UA1 multiprocessor upgrade. With the exception of the Nevis processor, all of these high priority efforts are focusing on multiprocessor environments with well-supported Fortran. The projects differ in the number of nodes, ranging from fewer higher performance processors in the 3081/E approach to hundreds of microprocessors with the equivalent of at least ½ VAX power each in the Fermilab ACP project. With reasonable confidence, one can expect that next summer there will be available the power equivalent of 50 VAX 11/780s for about the cost of one commercial system.

Many reports were given on low-level triggering systems for fixed-target and colliding-beam experiments. Though sophisticated and powerful, these systems did not show any tendency toward a uniformity of approach as seems to be developing in the Fortran multiprocessors for high-level triggers and off-line computing.

Theorists and accelerator builders are also feeling the computing crunch and are learning to 'roll their own' computers. At CalTech and Columbia, grids of microprocessors have been successfully assembled to attack the lattice gauge calculation. At Carnegie-Mellon, even a quantum electrodynamics calculation is being treated in this manner. At the German DESY Laboratory, a multiprocessor system has been constructed for simulation of the HERA proton ring. This appears to be a forerunner of much future work on processors for accelerator calculations.

Representatives of industry were present and were involved, along with a few stalwart physicist allies, in an intensive debate on the merits of commercial turnkey systems versus physicist-designed efforts. Industry is certainly feeling the pressure from the highly cost-effective multiprocessor/emulator efforts. The issue for industry is to what extent the activities in high energy physics foreshadow a potential market outside this field.

Finally, serious research in software aimed at improving physicist productivity was visible for the first time at such a conference. One of the most ambitious undertakings is Cornell's Gibbs Project which is trying to develop a higher level than Fortran (see June 1983 issue, page 172). The idea is for physicists to write down their problems, mathematics

Estudiantinas serenade attendees in the calles of Guanajuato during a traditional 'callejoneada' at the Recent Developments in Computing, Processor, and Software Research for High Energy Physics Symposium.

(Photo Tom Nash)

and algorithms, in a naturally readable form using standard scientific notation and have this compiled automatically to Fortran.

The intensity of efforts in computing research for high energy physics throughout the world was clearly felt at Guanajuato and the NIKHEF representative volunteered Amsterdam as a site for another meeting in a year.

From Tom Nash

At the recent Steamboat Springs Conference on Particle and Nuclear Physics, Wonyong Lee (Columbia) covered neutrino interactions.

CONFERENCE
Steamboat for particle and nuclear physics

The ever-growing number of topical conferences normally reflects the increasing specialization of physics. Instead, the Steamboat Conference on the Intersections between Particle and Nuclear Physics had the goal of bringing together traditionally different areas of physics. In his summary talk, R.H. Dalitz (Oxford) declared that a 'valuable level of constructive interference' was achieved at Steamboat. Dalitz also noted that no constraints were apparent on the energy range, which covered 10^{-6} to 10^{15} eV; nor in the tools employed, which included reactors, deep underground experiments, balloon experiments, as well as accelerator beams.

The Conference, held from 23-30 May, brought about 275 high energy and nuclear physicists to the isolated village of Steamboat Springs, high in the Colorado Rocky Mountains. Its main purpose was to discuss cooperation and common interests between the two different fields. The increasing interest in new facilities and major upgrades made this meeting seem especially timely. The contacts between the two sets of physicists were certainly aided by the beauty and isolation of the setting.

Many people presented plans for upgrades or new facilities, including H.A. Thiessen (LAMPF II at Los Alamos), R.B. Palmer (AGS II at Brookhaven), E.W. Vogt (TRIUMF Kaon Factory in Canada), J.S. McCarthy (Southern Universities' Research Association CEBAF), S.B. Kowalski (Bates Electron Upgrade at MIT), P.T. Debevec (Illinois Electron Upgrade), L.S. Schroeder (Berkeley Heavy Ion Facilities), N.P. Samios (Brookhaven Relativistic Heavy Ion Collider), R.G. Arnold (Stanford NPAS Electron Facility), and P.F.M. Koehler (Fermilab facilities). The audience was prepared for this formidable session on new facilities by three very instructive 'scholarly' lectures on the general nature of proton, electron, and heavy ion facilities by L.C. Teng (Fermilab), G.A. Loew (SLAC), and G.R. Young (Oak Ridge).

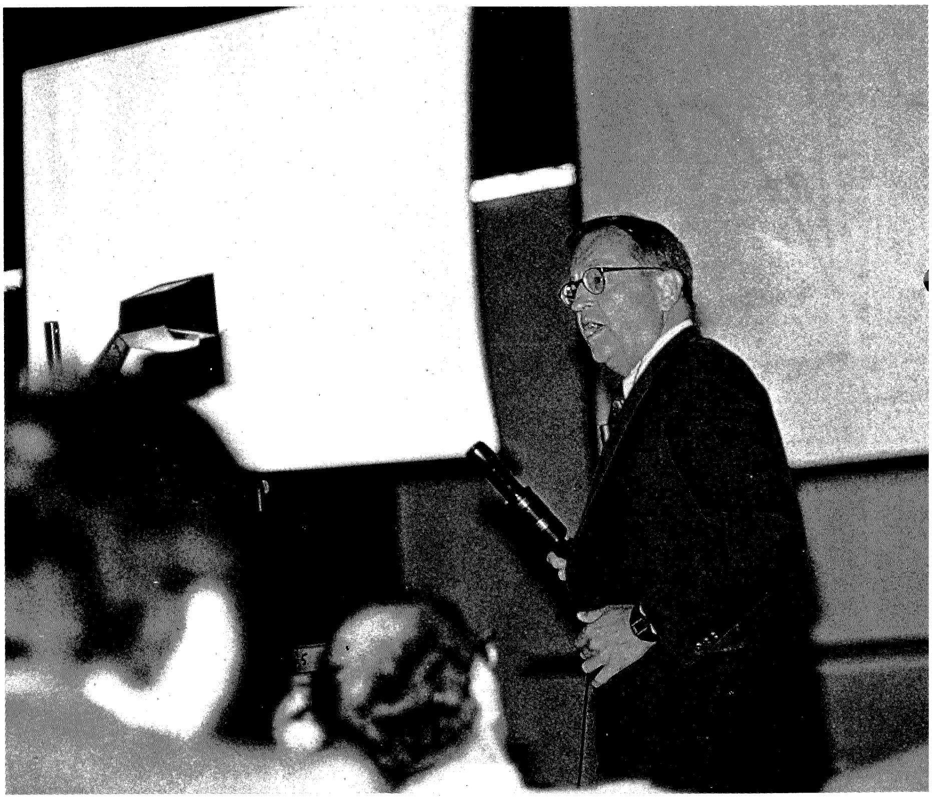
In the accelerator summary talk, F.E. Mills (Fermilab) noted the trend toward 'standard' configurations of accelerator facilities: MIT's Bates as a prototype for the electron linac-recirculator-stretcher: heavy ion machines with several stages of stripping and acceleration; high intensity proton accelerators using a booster/accumulator, a rapid-cycling synchrotron, and perhaps a stretcher. Similarly, the Brookhaven AGS, KEK in Japan, and Saturne in France are developing a standard technology for handling depolarizing resonances in the acceleration of polarized protons. Other new technical developments are cooling rings for nucleon physics (Indiana) and possible cooling techniques to balance beam emittance growth in heavy-ion colliders. An exciting new idea for using plasmas to accelerate particles was described by J. Dawson (UCLA).

The interesting new development of 'quantum hadrodynamics' was cited by J.D. Walecka (Stanford) in his excellent introductory lecture on Electroweak Interactions. QHD is a more fully relativistic theory of nuclear constituents including meson fields. This gives a simplified and improved fit to nuclear charge form factors in electron scattering and dramatically simplifies the picture of polarized proton scattering from nuclei. The experimental situation in electron scattering was reviewed by J.H. Heisenberg (New Hampshire).

Both QHD and quantum chromodynamics were discussed in many of the interesting lectures on hadronic physics. G.R. Farrar (Rutgers) and G. Bunce (Brookhaven) stressed large transverse momentum tests of QCD while J.W. Negele (MIT), D.F. Geesaman (Argonne) and S.E. Koonin (Caltech) stressed nuclear tests of both QCD and QHD. H.J. Lipkin (Weizmann) gave an inspiring and amusing lecture on Quark Model Spectroscopy while Th. Walcher (CERN) described the LEAR antiproton programme. D. Sivers (Argonne) located the intersection of the particle and nuclear highways at a corner labelled long-range QCD. This theory uses lattice gauge simulations requiring hundreds of Cray-hours to perform even a modest calculation with a grid size of about 0.5 fermi. A new calculation reported by J. Kogut (Illinois) included Fermi sea quarks; and estimated the first-order phase transition at a particle temperature of 200 MeV.

In the lectures on Heavy Ion Collider Physics, both A.S. Goldhaber (Stony Brook) and T.W. Ludlam (Brookhaven) discussed the beam energy and luminosity required to reach deconfinement. One wants to exceed an energy density of perhaps 2 GeV per cubic fermi and then search for new phenomena associated with this unexplored region. Signatures of a possible phase transition may have been seen at Fermilab in a power-law dependence of heavy fragment yield, and in the recent Bevalac evidence for compression and flow of nuclear matter. Goldhaber stressed that it is impossible to predict exactly what will be found in very high energy heavy ion collisions. Heavy ion enthusiasts hope for exciting discoveries about the nature of quark-gluon plasmas and the 'stuff' of the early universe. Dalitz and Ludlam noted that recent cosmic-ray exposures by the Japanese-American collaboration JACEE and fixed target accelerator experiments give a clearer view of the target-fragmentation region, however only high energy colliding beams will allow studies of the central region and of energy densities above 3 GeV per cubic fermi.

Dirk Walecka (Stanford) covered electroweak interactions with nuclei at Steamboat.



The 'EMC effect' (see July/August issue, page 239) was discussed by both G. West (Los Alamos) and P.A. Souder (Syracuse). A recent Stanford experiment (American U / Rochester / Stanford / Bonn / Saclay) confirmed the logarithmic dependence of the ratio of heavy nuclei to deuterium cross-sections in deep inelastic scattering of electrons, whereas the original experiment employed muons. Dalitz said the EMC effect shows that 'nucleons do not add freely' even in response to electroweak probes; a hint of quark deconfinement in heavier nuclei?

Particle and nuclear interests also meet in strange-particle physics. According to P.D. Barnes (Carnegie Mellon) and R.A. Eisenstein (Carnegie-Mellon), introduction of strangeness into the nucleus with a kaon, which does not change baryon number, adds very special properties. For example, the tagged nucleon can then move to states previously excluded by the Pauli principle. They also discussed recent CERN and Brookhaven data on the observation of unexpectedly long lifetimes in sigma hypernuclei; meaurement of the small spin-orbit coupling in lambda hypernuclei; and formation of highly 'stretched' hypernuclear states at high momentum transfer. Eisenstein said it would be difficult to go beyond the present generation of experiments without kaon beams of higher purity and at least ten times more intensity.

R.K. Adair (Yale) gave an outstanding review of the kaon decay field. Both he and coordinator A.J.S. Smith (Princeton) expect some significant progress in strange particle decay physics in the next few years. Preliminary results from Brookhaven and Fermilab on the ratio of decay rates of neutral relative to charged pion pairs are now challenging the standard Kobayashi-Maskawa model for CP violation. Dalitz said he expected CP violation eventually to be incorporated into conventional theory with second order effects but no special interaction. The next necessary improvement in CP experiments is probably a brighter kaon beam. In the next few years, several experiments on rare decay modes, hoping to reach significant tests of theory, will go on line with major improvements in beam, detector and analysis technology. There were also impressive lectures on symmetry tests in Nuclear Physics by E.G. Adelberger (Washington) and W. Haeberli (Wisconsin)..

Carrying the Conference's spirit still further, D.F. Measday (TRIUMF), pointed out that spin phenomena were important in atomic, molecular, nuclear, and particle physics. He also said that progress in the field is paced largely by the technical progress in polarized sources, accelerators, and polarized targets. Work was reported on higher-temperature polarized targets employing deuterium or hydrogen-deuterium molecules, and on the KEK (Japan) laser-pumped polarized proton source. L.G. Ratner (Brookhaven) reported on the successful acceleration of polarized protons to 10 GeV in the AGS which involved navigating about 15 depolarizing resonances. Measday indicated that the chapter on dibaryons was probably not yet closed, and mentioned the recent result of clearly isolating single-particle spin-flip transitions with polarized protons incident upon nuclei. Measday closed by showing the totally unexpected spin effects found in a Brookhaven AGS proton-proton elastic experiment (see page 273), reported by R.S. Raymond (Michigan). Measday emphasized that this large spin-orbit effect certainly was not expected, noting that he was a member of the committee which recommended rejecting the experiment.

The conference organizers decided to arrange another meeting in two or three years in a similar isolated mountain spot in North America. They hope again to maintain the balance between particle and nuclear physicists, since this certainly helped to produce the unusual and vigorous atmosphere at Steamboat, which led Dalitz to remark 'I have not attended a meeting such as this since the 1940s when the nuclear, particle, and cosmic ray physicists held joint meetings. This Conference will probably be remembered as a watershed for the fields of particle and nuclear physics.'

SYMPOSIUM
Multiparticle Dynamics

How is the seemingly simple world of quarks and leptons related to the complicated phenomena that particle physicists see in their detectors? This was the theme of the 15th Symposium on multiparticle dynamics held in Lund, Sweden, from 11-16 June. Some hundred physicists gathered at this latest annual meeting of a series dating back to the first symposium in Paris in 1970. The 1984 symposium was organized by Bo Andersson and his experimental and theoretical colleagues in Lund.

Apart from the many results from the CERN proton-antiproton Collider, a recurrent theme during the conference was the growing awareness of the importance of quark 'hadronization'. Everyone knows that isolated quarks have never been found in Nature. Only those combinations of quarks and antiquarks that form hadrons have been detected. The dressing of the quarks to become hadrons goes under the name 'hadronization' and this process is very difficult to describe theoretically from first principles. Even the currently accepted theory for strong quark interactions — quantum chromodynamics, QCD — has difficulties. QCD has been shown to be a good theory describing 'small distance phenomena' — small compared to a hadron.

However it has so far been unable to give clearcut answers on what happens at distances comparable to the size of the proton, distances of obvious importance for the hadronization process. This was stressed among others by Guido Altarelli in his much appreciated review talk on the status of QCD. Altarelli pointed out that some of the problems in testing QCD lie in our lack of understanding of the hadronization problem.

Partly to remedy this, different models have been proposed. One of the more successful is the 'Lund' model, after its originators in Lund. In this model, crudely speaking, the quarks are connected by a stringlike colour flux field which, provided enough energy is available, is chopped up into smaller strings and finally into hadrons. This model has in fact been so successful in reproducing the experimental results that one participant at the symposium remarked that it is even better than the data. However, as the same participant reminded the conference participants, you cannot explain a myth by a miracle. It is evident that the hadronization process requires much more work by the theorists. Other model calculations were also presented, and the ideas by Brian Webber and Giuseppi Marchesini seem to be as successful as the Lund model in accounting for some of the experimental results. It is based on perturbative calculations with some extra restrictions to take into account among other things quantum interference effects.

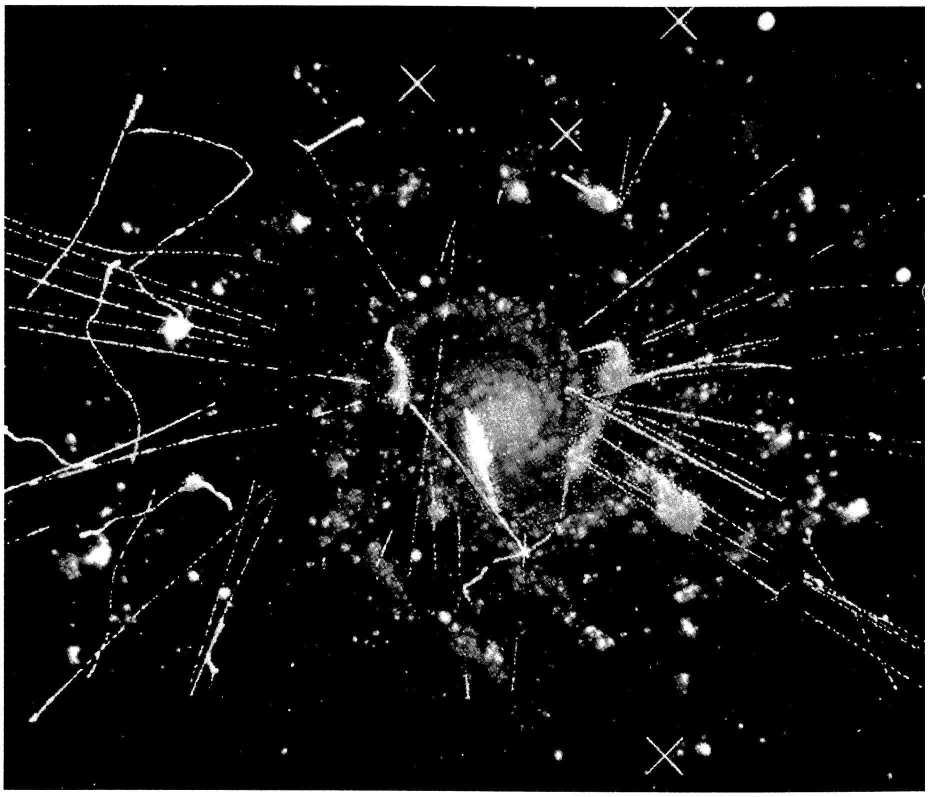
Several speakers stressed the importance of more detailed experimental tests of these hadronization models. In particular, it will be necessary to perform precise studies of production of strange particles, baryons, vector mesons, etc. Here, one should mention the quantitatively and qualitatively imposing data which are now coming in from the electron-positron machines at DESY, Hamburg, and Stanford. Another important branch of particle physics where precise hadronization studies are being performed is 'soft' hadronic reactions producing particles of low transverse momentum.

The next Symposium is to be held in Israel in June 1985.

(From Bengt Svensson)

WORKSHOP
Inner space - outer space

'Inner Space-Outer Space' was the theme of a recent workshop hosted by the Fermilab theoretical astrophysics group. Symbolizing this merger of the two frontiers of physics is this superposition of photographs of a galaxy and of particle tracks from a bubble chamber.



During the first week of May, the Fermilab theoretical astrophysics group hosted an international conference on science at the interface of particle physics and cosmology/astrophysics. The conference (Inner Space-Outer Space) was attended by a very diverse group of more than 200 physical scientists, including astronomers, astrophysicists, cosmologists, low-temperature physicists, and elementary particle theorists and experimentalists. The common interest which brought this diverse group together is the connection between physics on the smallest scale probed by man — the realm of elementary particle physics — and physics on the largest scale imaginable (the entire Universe) — the realm of cosmology.

The Fermilab conference was designed to be a comprehensive review of the status of the field. Inflation, galaxy formation, proton decay, the microwave background, nucleosynthesis baryogenesis, strings, monopoles, Kaluza-Klein models, supersymmetry, free quarks, and neutrino oscillations were discussed at the conference. All of these topics were of common interest to both astrophysicists and particle physicists.

In its infancy the Universe was probably a hot soup of quarks and leptons, closely resembling the conditions created in very high energy particle collisions. One of the intriguing connections between particle physics and cosmology is the possibility that most of the mass in the Universe resides in a yet-to-be-detected sea of elementary particles which are relics of the earliest moments of the Universe. Marc Davis (Berkeley) gave an observer's view of the large scale structure in the Universe, and Jay Gallagher (Kitt Peak National Observatory) presented the evidence that there are more to galaxies than meet the eye: perhaps most of the mass in a galaxy is not in the form of stars. If so, it probably exists in a dark spherical halo, possibly comprised of exotic relics. Simon White (Arizona) summarized the results of numerical simulations of the formation of structure (galaxies, clusters, etc.) in model universes with different types of elementary particles as the 'dark matter'. Based upon comparison of the simulations and the observations which were discussed by Davis, the preliminary

People and things

conclusion is that the dark matter is probably not massive neutrinos, but might be more exotic particles such as axions or one of the particles from the 'supersymmetric zoo'. On the final day of the conference, J.D. Bjorken (Fermilab) discussed the prospects for actually producing, at present or future accelerators, some of the more exotic (not yet known to exist) particles which have been suggested as candidates for the dark matter.

In the 15th century, Copernicus suggested that the earth is not at the centre of the solar system. Bruno in the 16th century took the Copernican idea one step further when he wrote that there are '... innumerable suns, and an infinite number of earths revolve around those suns...' In the 20th century, it was discovered that our solar system is not at the centre of our own galaxy, and that our galaxy is but one of billions in the Universe. At the Fermilab conference, equally heretical theories were put forward in which the Universe we observe might well be only one among many, that there may be more than three spatial dimensions, and that the matter of which we are made (neutrons, protons, electrons) may not be the dominant form of matter in the Universe. It is just possible that one of these ultimate extensions of the Copernican principle will be confirmed by high energy experiments at Fermilab or elsewhere. We all hope that the intrepid physicists and astronomers working in this field fare better than Bruno (who was burned at the stake in 1600)!

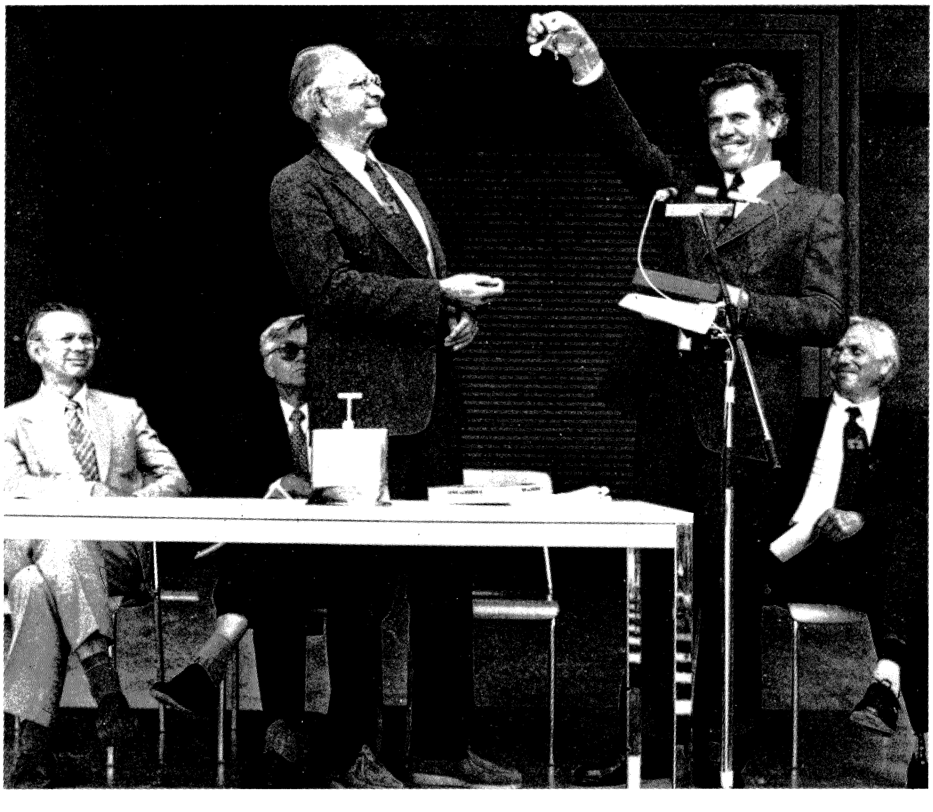
The return of the key

The symbolic act of the return of the ISR key culminated the closure ceremony for the CERN Intersecting Storage Rings on 26 June. The key had passed from Werner Heisenberg (a theorist) to Edoardo Amaldi (an experimentalist) when the ISR was inaugurated in 1971. It returned from Giorgio Bellettini (the last Chairman of the ISR Experiments Committee) to Viki Weisskopf (doyen of theorists) who as Director General of CERN in the early 60s did much to promote the construction of the ISR.

In his speech, Weisskopf claimed that the ISR, by virtue of tremendous technical success, had 'changed the landscape of high energy physics'. As a consequence, all future projects for achieving higher energies involve colliding beams. He quoted Rabi on the jump in energies that the ISR made possible... 'The ISR does not just ask questions of Nature, it grabs Nature by the throat and forces her to speak.'

Kjell Johnsen, who led construction of the machine, reviewed its record-studded history of technical achievements. From the first ideas of Donald Kearst and Gerry O'Neill in the USA in 1957, it was a spectacular journey to the world record luminosity of 1.4 x 10^{32} per cm^2 per s, to 57 A in a single beam, to loss-rates of only one particle in a million per minute, to 60 hour continuous runs, to stochastic cooling...

Herwig Schopper thanked all who had contributed to these successes and Weisskopf concluded with an exhortation to cherish CERN's double role — a place of scientific excellence and a symbol of the United States of Europe.



On the platform at the closure ceremony for the CERN Intersecting Storage Rings on 26 June, left to right: Herwig Schopper, Kjell Johnsen, Viki Weisskopf, Giorgio Bellettini and Gunther Plass.

On people

Fourth recipient of the Einstein Prize is Viktor Weisskopf. This award was established in 1979, the centenary year of the birth of Albert Einstein, when its first recipient was cosmologist Stephen Hawking. Subsequently it has been awarded to Swiss economist T. Wahlen and British applied mathematician Sir Hermann Bondi. The prize is in recognition of achievements in science and general cultural development, 'in the spirit of Albert Einstein'.

Astronomer Martin J. Rees of Cambridge (UK) received the 1984 Dannie Heineman Prize for Astrophysics at the June meeting of the American Astronomical Society. The award recognized his 'profound contributions to the theory of galaxy formation and the theory of jets and superluminal effects in radio sources'.

At the Annual Meeting of the Norwegian Physical Society, held at the University of Bergen in June, Bjørn Wiik received the 1984 particle physics prize awarded by computer manufacturer Norsk Data. He received the prize for his outstanding work in elementary particle physics, particularly his contribution in the TASSO group at the PETRA storage ring of the German DESY Laboratory which saw evidence for the gluon, the mediator particle of strong interactions.

Born in Eidslandet, Western Norway, Wiik is professor at the University of Hamburg, adjoint professor at the University of Bergen and project leader for the superconducting proton ring of the HERA electron-proton collider now under construction at DESY, Hamburg.

At its meeting in June, CERN Council reappointed R. Klapisch as Director of Research for three years from July 1984 and appointed Bernard Hyams as EP Division Leader for three years, also from July 1984, succeeding Alan Wetherell. J. Andersson was reelected Chairman of the Finance Committee for a third period of one year and R. Turlay was reappointed Member of the Scientific Policy Committee, both from July 1984.

The US Universities' Research Association (URA) has announced that Maury Tigner of Cornell has been selected as Director of the research and development effort to prepare a design for the new US high energy physics facility — the Superconducting Super Collider (SSC). The US Department of Energy is currently considering support of an R and D effort and conceptual design phase for this project.

URA, a consortium of US and Canadian universities which also acts as the governing body of Fermilab, was selected by DOE to coordinate the interim management of the R and D and conceptual design effort for the SSC. Within URA, an SSC Board of Overseers, chaired by Boyce McDaniel of Cornell, supervises and assists with this work.

UK Review calls for views on high energy physics

In March of this year, the UK Advisory Board for the Research Councils, together with the UK Science and Engineering Research Council, set up a Review Group, chaired by Sir John Kendrew, to look at future British participation in particle physics. The review was launched by Sir David Phillips, Chairman of the ABRC, and John Kingman, Chairman of the SERC, in the context of concern about inadequate funding for a wide range of science and engineering disciplines within a fixed national science budget. The funding of particle physics, and in particular the UK contribution to CERN, takes a significant slice of this budget and is therefore a rather obvious target in times of financial difficulty. (The UK Science Budget for 1984-85 is £ 550 million, of which £ 279 m goes to the SERC. £ 53 m of this goes to particle physics, including £ 36 m for the annual CERN contribution.)

It is not the UK Government itself which has initiated the review and the Science Minister, Sir Keith Joseph, has made it clear that, should there be any recommendation for change to the present situation, it would be the subject of full consultation with the UK's other European partners in CERN.

There is understandable apprehension that the review is taking place under a financial ceiling for all UK science. However there is no apprehension at the prospect of the review itself. It is a healthy phenomenon that the vitality and the contributions (broadly so defined) of the different branches of science should be examined from time to time by responsible people. And a review of particle physics could hardly be better timed. The subject has never been more buoyant and CERN's standing has never been higher. In addition, the glorious tradition of UK physicists in the science and technology of particle physics is sustained today with top quality participation in all aspects of CERN's work.

The Review Group has issued an open invitation for the 'submission of evidence' citing five topics in particular:

— the standing of the UK's contribution to experimental high energy particle physics research;
— the relevance of experimental high energy particle physics to the totality of British science and the education and training of young scientists and engineers;
— the intellectual, technical and industrial 'spin-off' from high energy particle physics;
— the standing of CERN and the advantages and disadvantages of such centralized international facilities;
— new areas, or grossly underfunded existing areas, of science and engineering research that would benefit from a significant increase in funding.

All submissions should be forwarded to the Secretary of the Review Group — Dr. Keith Root, Room 5/37, Elizabeth House, York Road, London SE1 7PH UK.

SNS acceleration

Protons were accelerated to 550 MeV in the Spallation Neutron Source at the Rutherford Appleton Laboratory in June. This was the maximum available energy at that time, given the number of installed radiofrequency cavities (four of the six required to take the protons to their design energy of 800 MeV). Just over 10^{12} protons reached the peak energy. It is hoped to achieve neutron production at 550 MeV for the first time at the end of this year.

Meetings

After the success of the initial round of physics at LEAR, CERN's new Low Energy Antiproton Ring, it is only natural for physicists to look ahead at further exploitation of LEAR after the installation of the proposed ACOL antiproton collector to improve CERN's antiproton facilities. A LEAR Workshop 'Physics with Low Energy Cooled Antiprotons in the ACOL Era' is being organized in La Plagne in the French Alps from 20-27 January 1985. Those wishing to participate should write to J.-M. Richard, c/o Mrs. A. M. Bugge, Workshop Secretariat, CERN-DG, 1211 Geneva 23, Switzerland. The scientific programme covers machine developments, new detectors, proton-antiproton interactions, spectroscopy, rare decays, antiproton-nucleus interactions, and 'new ideas'.

After the successful Workshop on Laser Acceleration of Particles held at the Los Alamos Laboratory in 1982, a Second International Workshop is being hosted by the University of California at Los Angeles (UCLA) from 7-18 January 1985. The idea is to focus the efforts of the high energy, plasma and laser communities on the exploration of laser techniques for future ultra high gradient accelerators.

In addition to media accelerators (plasma beat wave and inverse Cherenkov accelerators), far field accelerators (inverse free electron accelerator), near field accelerators (grating and two-beam accelerators) and possible new schemes, working groups will also be set up in accelerator technology and laser technology.

For applications and further information, contact Chan Joshi, UCLA Electrical Engineering, 7731 Boelter Hall, or Thomas Katsouleas, UCLA Physics Department, 1-130 Knudsen Hall, both at Los Angeles, California 90024, USA. Attendance is limited to 100 and applications should be received by 1 October.

The Sixth International Symposium on Polarization Phenomena in Nuclear Physics will be held from 26-30 August 1985 at Osaka, Japan. Further information from Dr. H. Sakai, Research Centre for Nuclear Physics, Osaka University, Mihogoaka, Ibaraki, Osaka 567, Japan.

The first particle physics detector to be built in the People's Republic of China and installed at a Western accelerator has been successfully tested in the Meson Bottom test beam at Fermilab. The device is the muon detector for Fermilab experiments 636/745 and is based on extruded aluminium proportional tube counters. A joint effort by a group at the Institute for High Energy Physics Beijing, led by Xu Shaowang and a group at the Massachusetts Institute of Technology led by Irwin Pless, the modules were built and tested in China and then assembled at Fermilab into an eight-plane array, interleaved with steel. Seen here in front of the detector in the test beam: (standing) Mao Chengsheng, Tai Yongsheng, Seog Oh, Don Goloskie, and John Harton, (kneeling) Thornton Murphy, Xu Shaowang, Mark Mars.

CEBAF (formerly NEAL)

The Continuous Electron Beam Accelerator Facility (CEBAF) invites applications for positions of

ACCELERATOR PHYSICISTS and ACCELERATOR ENGINEERS

at this new facility for electro-nuclear research. CEBAF is a 4 GeV, high intensity, CW electron accelerator facility proposed for Newport News, Virginia. The anticipated completion date is 1990. CEBAF is planned as a user oriented facility to be operated for the US Department of Energy by the Southeastern Universities Research Association. It will be a single purpose facility dedicated to research in electro-nuclear physics, with special emphasis on the exploration of the role of quarks and gluons in nuclear structure. The training of graduate students will be an essential part of its mission.

Applicants for positions as Accelerator Physicists or Engineers should have an advanced degree in physics or engineering, but need not have accelerator experience. Some will have the opportunity to receive one-the-job training at existing laboratories.

Applicants for positions as Sr. Accelerator Physicists or Engineers should have extensive accelerator experience; managerial experience would be an asset. Senior positions may have tenure at a SURA institution.

Please send a curriculum vitae, list of publications, and the names of three references to:

Prof. James S. McCarthy
Director of CEBAF
Department of Physics
University of Virginia
Charlottesville, VA 22901

CEBAF is an affirmative action/Equal Opportunity Employer. Applications from non-US citizens are invited.

Research With High Energy Heavy Ions

Brookhaven National Laboratory

The Nuclear Chemistry Group in the Chemistry Department at Brookhaven National Laboratory seeks applicants for positions at the postdoctoral and junior scientific staff levels for a new research program of studies of nucleus-nucleus collisions at relativistic energies. Injection of heavy ions from the Tandem Van deGraaff Facility into the Alternating Gradient Synchrotron will permit fixed target studies to be made at energies up to 15 GeV/A.

Applicants must have a background in experimental nuclear science. Experience with studies of proton-nucleus or nucleus-nucleus reactions using on-line counter techniques and computer-based data acquisition systems is desirable. A resume that includes the names of three references should be sent to:

A.P. Wolf, Chairman
Chemistry Department
Brookhaven National Laboratory
Associated Universities, Inc.
Upton, Long Island, NY 11973

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KERNFYSISCH VERSNELLER INSTITUUT GRONINGEN THE NETHERLANDS

Post-doctoral Position in Theoretical Nuclear Physics

The K.V.I. has a position at a post-doctoral level available for a young nuclear theorist. The initial appointment will be for a period of two years. Promotion to a permanent position thereafter is not excluded. The appointment will be with F.O.M., the Netherlands Foundation for Fundamental Research on Matter.

The Kernfysisch Versneller Instituut is a national research institute in nuclear physics, jointly sponsored by the University of Groningen and by F.O.M. It has a broad experimental and theoretical research program on nuclear structure and heavy-ion physics.

Applicants for the above-mentioned position are requested to submit, as early as possible but not later than November 1, 1984, a curriculum vitae, list of publications and the names of three persons who can provide letters of recommendation, to:

Prof. A. van der Woude
Kernfysisch Versneller Instituut
Zernikelaan 25
9747 AA Groningen
The Netherlands.

UNIVERSITY OF OXFORD

Temporary Lecturer in Physics

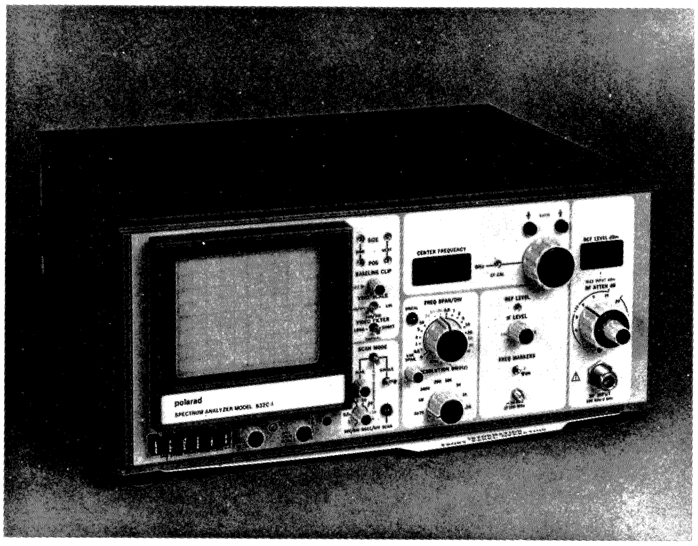
The University wishes to appoint a temporary lecturer in the Department of Nuclear Physics. The holder will be expected to join the research programme of the experimental particle physics group which is engaged in experiments at CERN, DESY, and FERMILAB, and in a search for proton decay.

The appointment is for three years. Salary will be within the range £ 7190 - £ 15 085 (under review). It is expected that a college association will be arranged.

Applicants, giving the names and addresses of two referees – who should be invited to write immediately – should be sent to

Mr. M.S. GAUTREY
Department of Nuclear Physics
Keble Road
OXFORD OX1 3RH / UK

so as to arrive by 15th September 1984. Further information may be obtained from Mr. M.S. Gautrey.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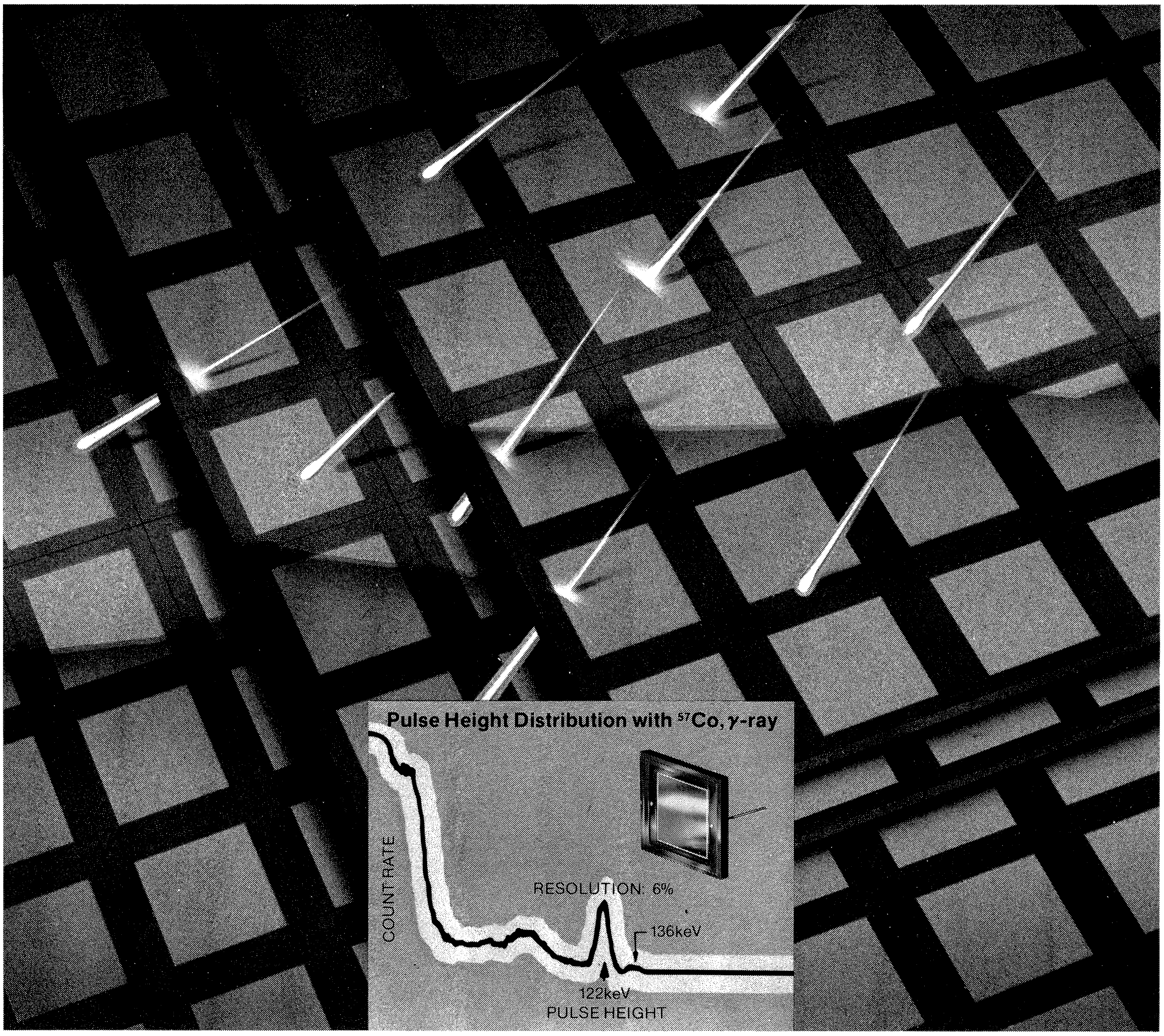
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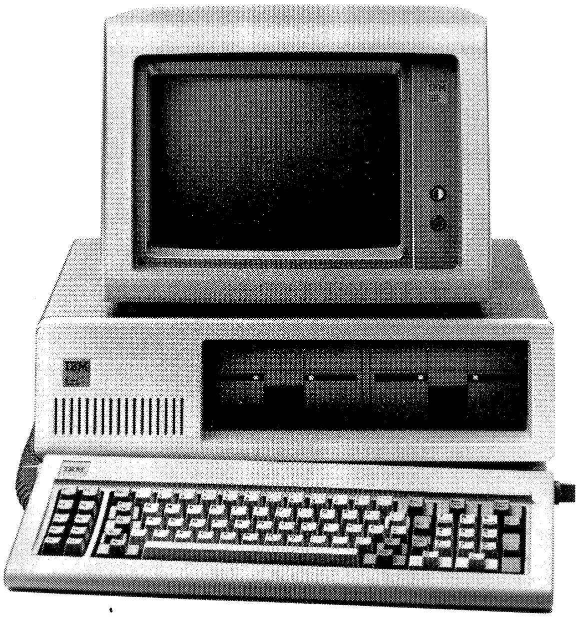

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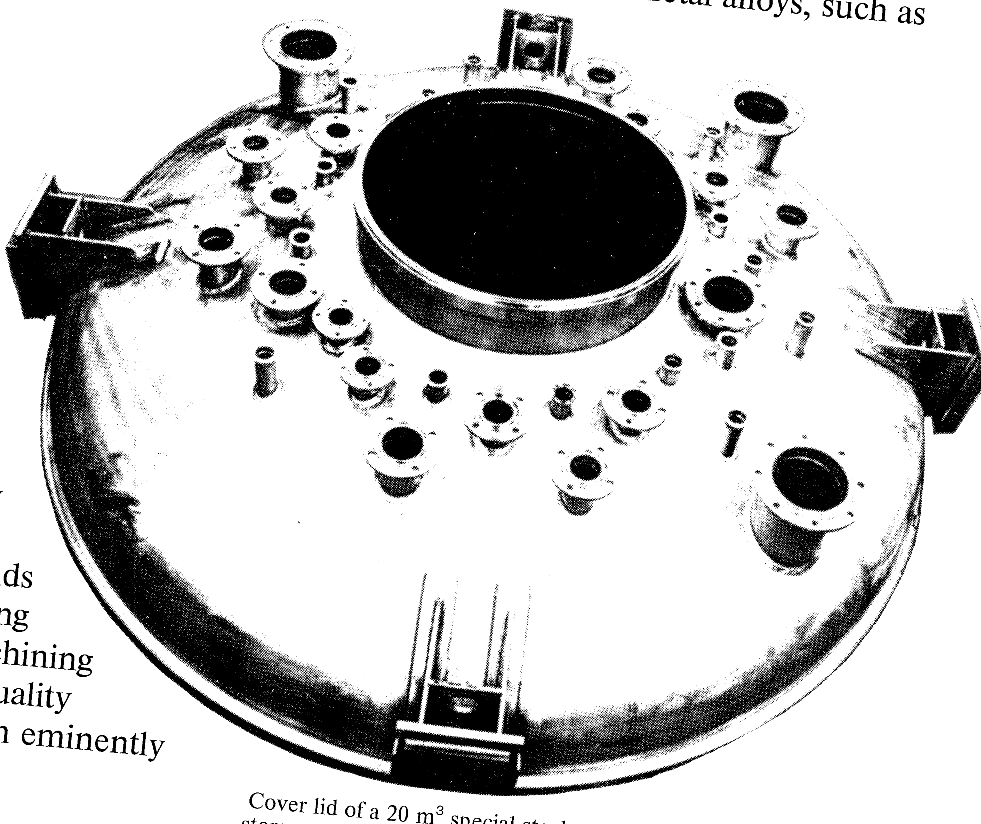

Cover lid of a 20 m^3 special steel vessel for the torus energy storage experiment (TESPE) at the Nuclear Research Centre Karlsruhe, KfK.

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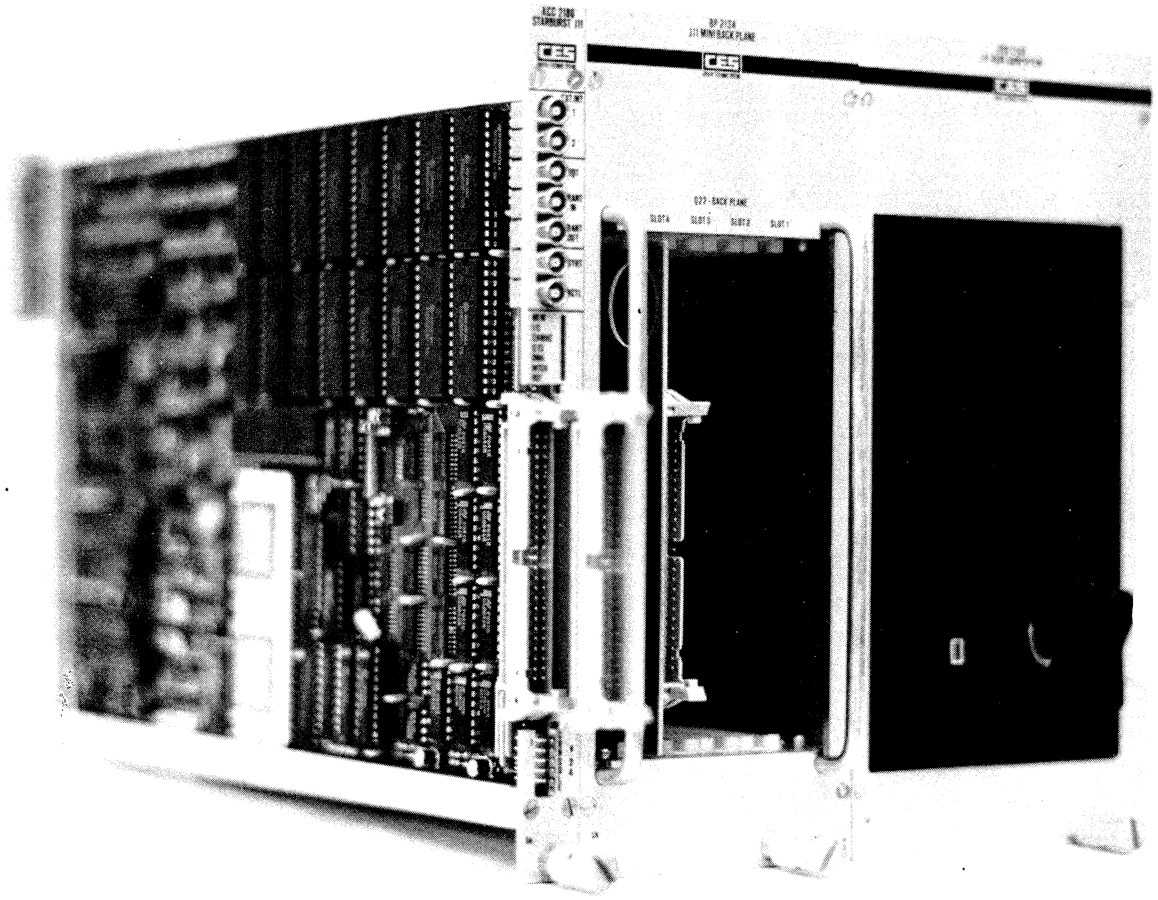

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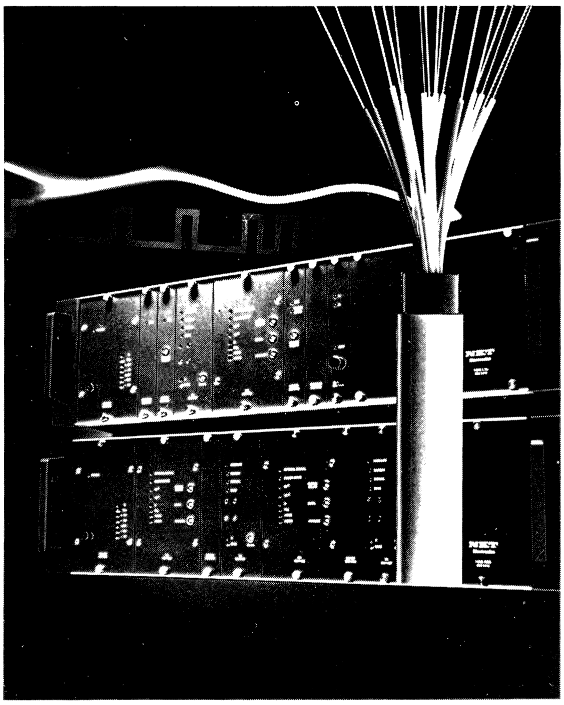

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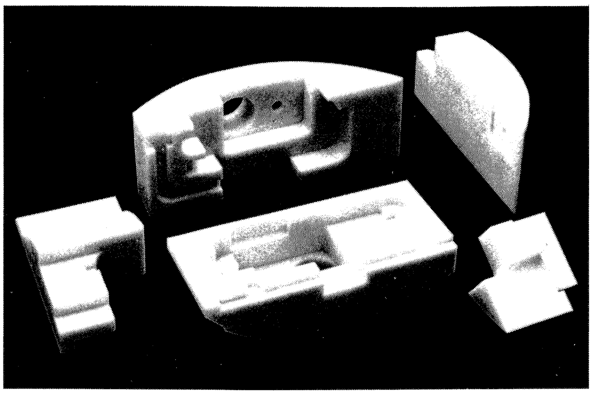

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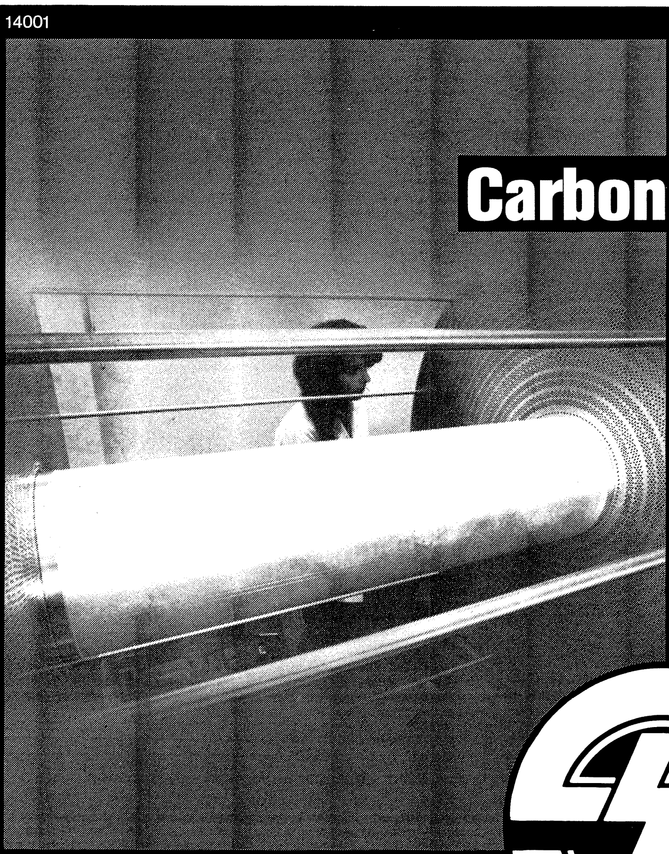

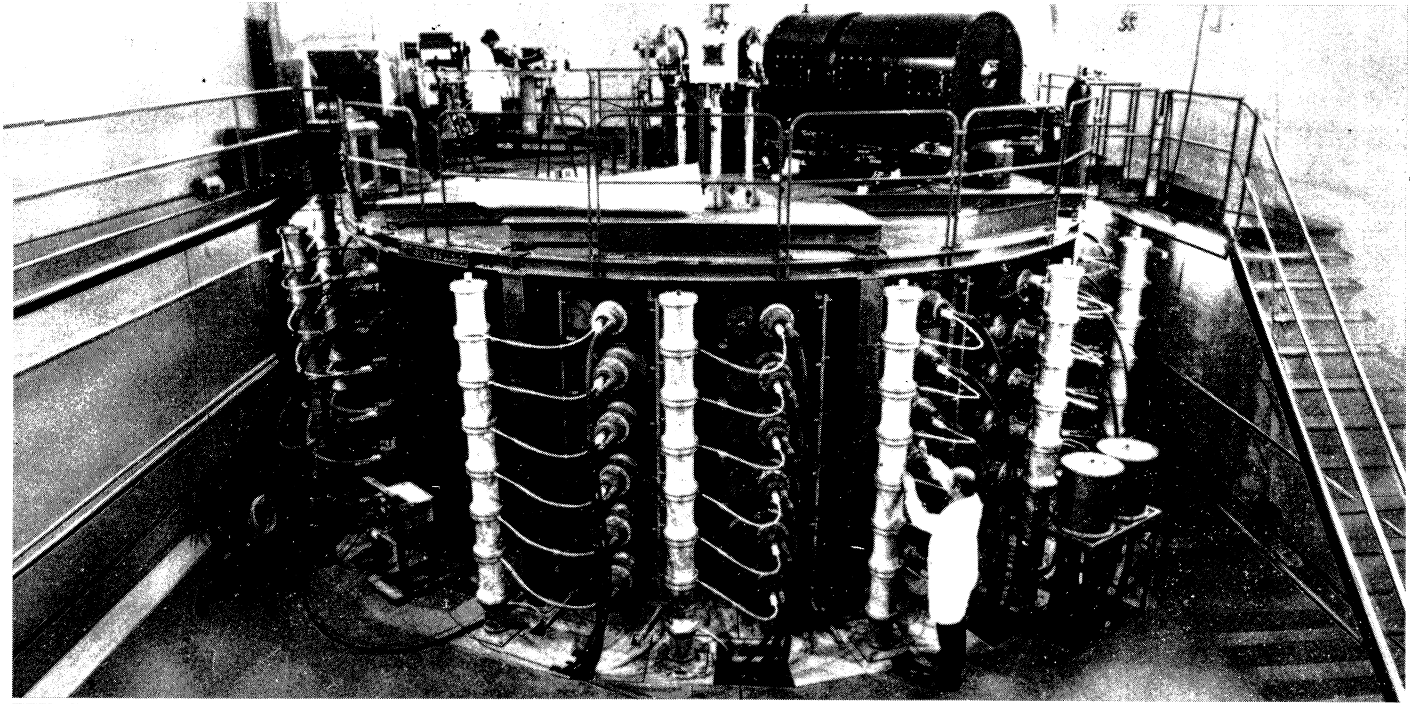

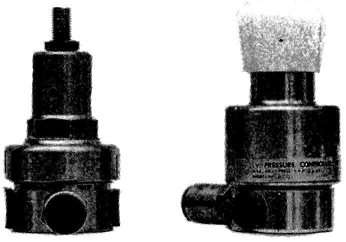

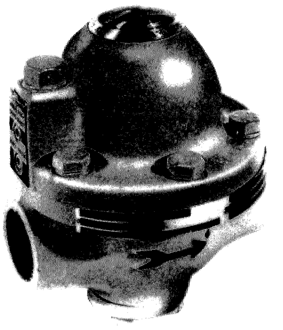

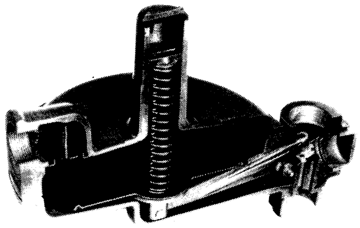

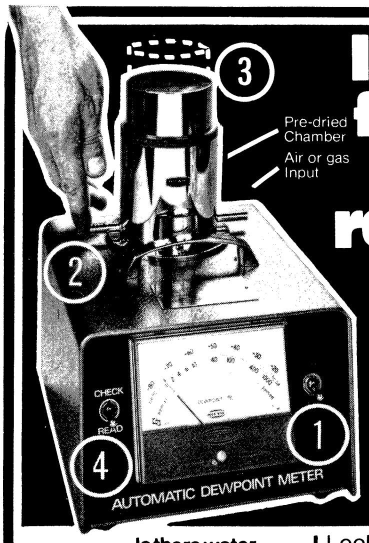

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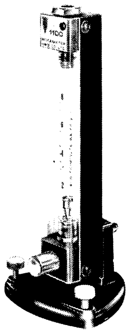

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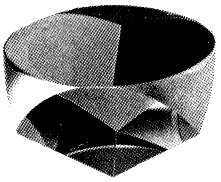

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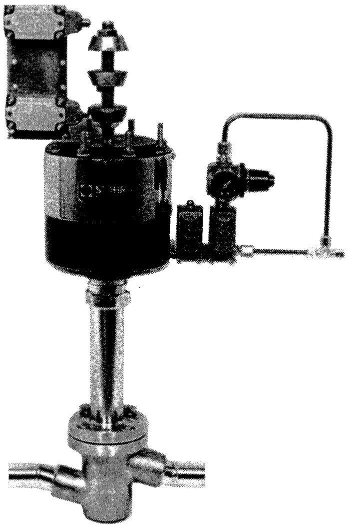

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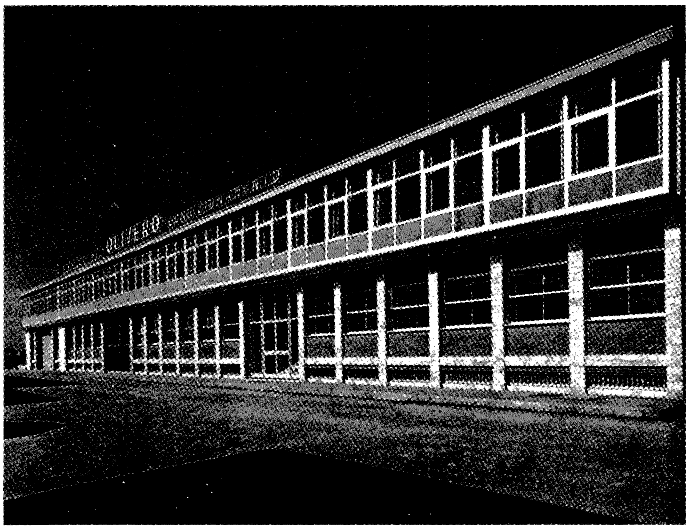

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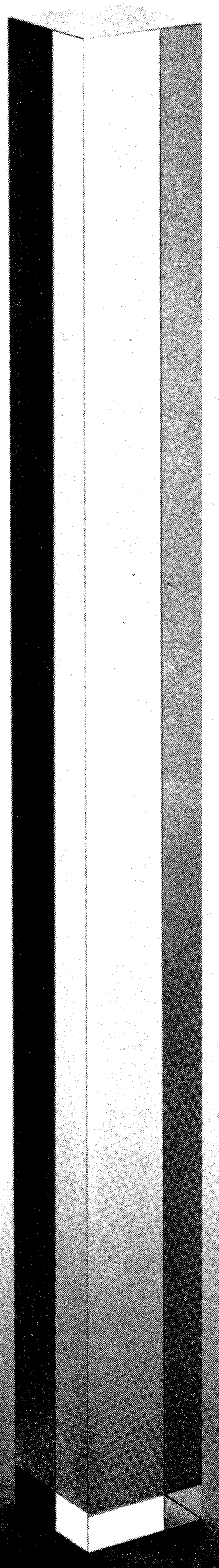

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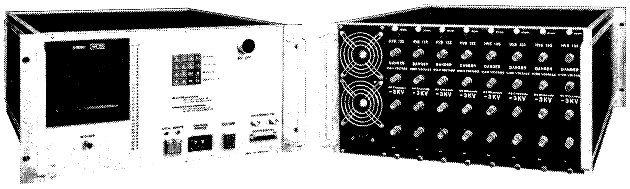

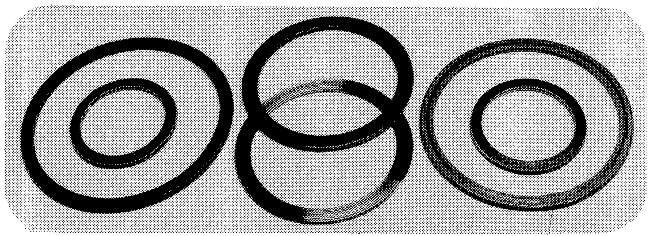

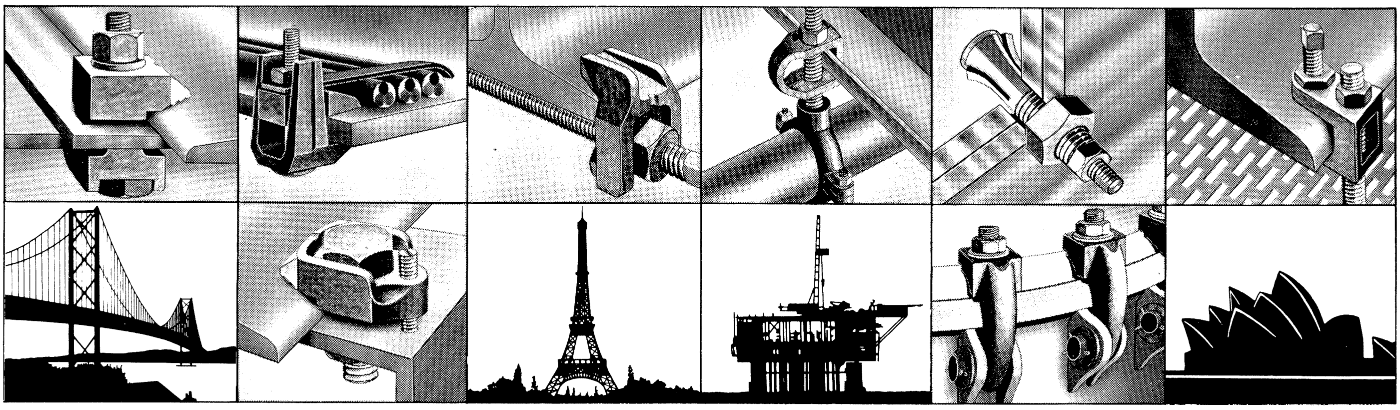

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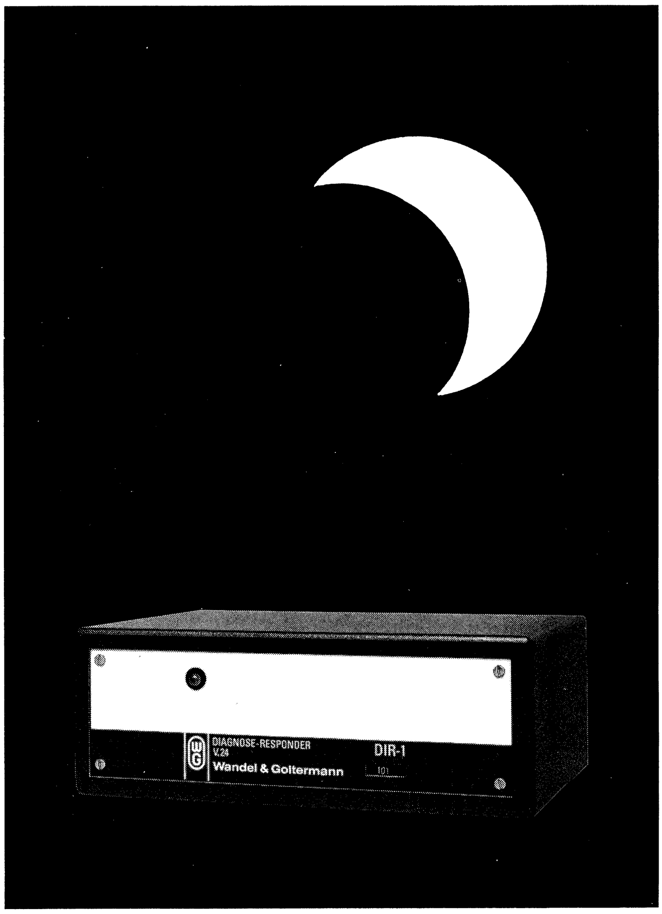

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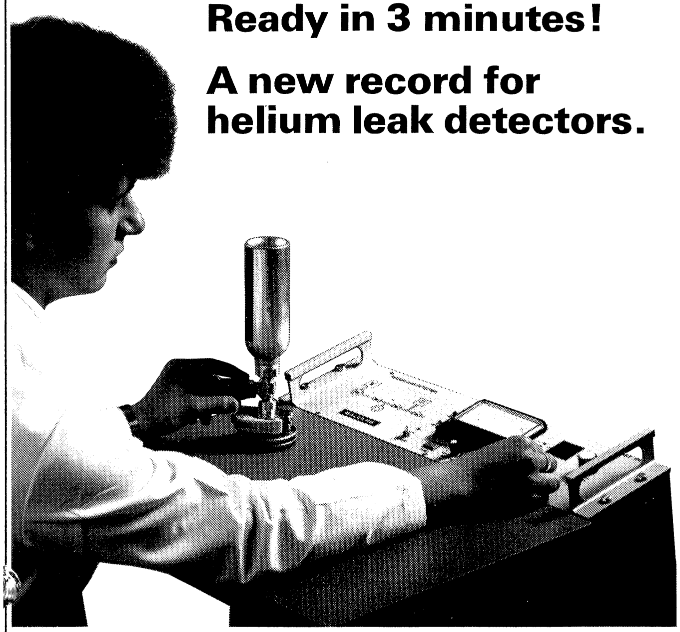

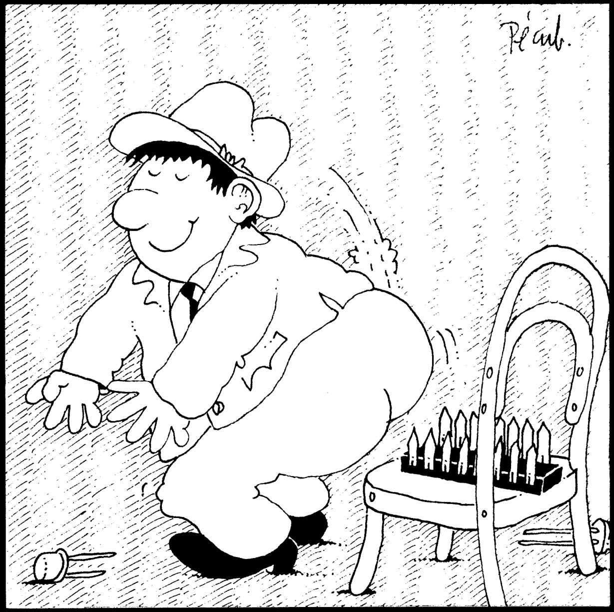
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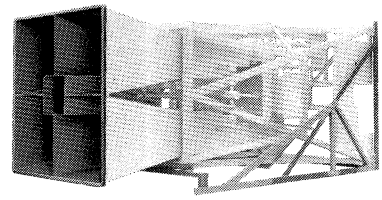

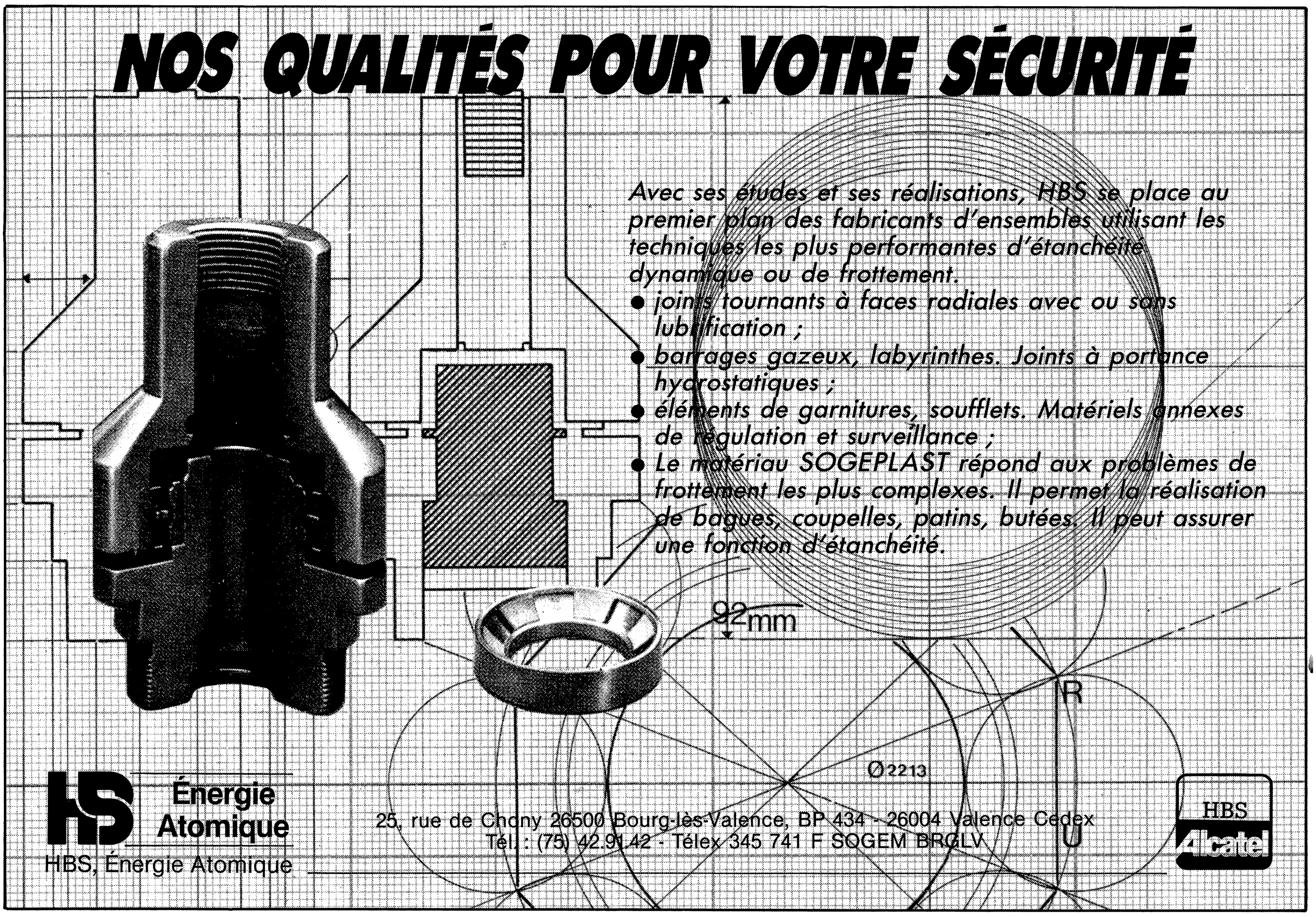

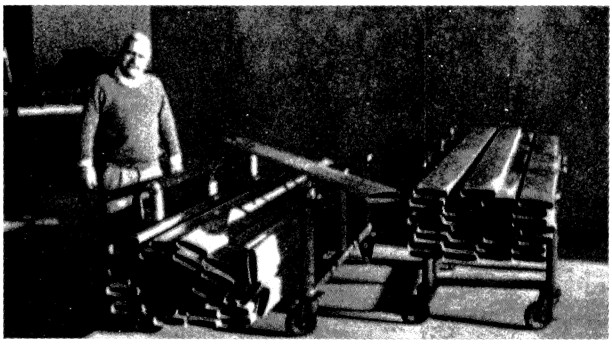

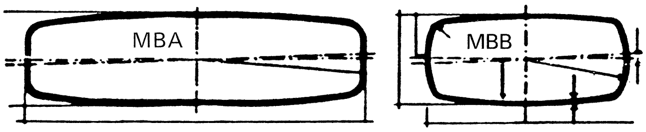

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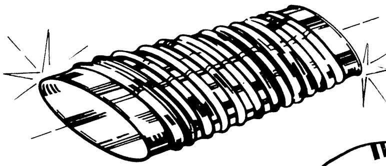
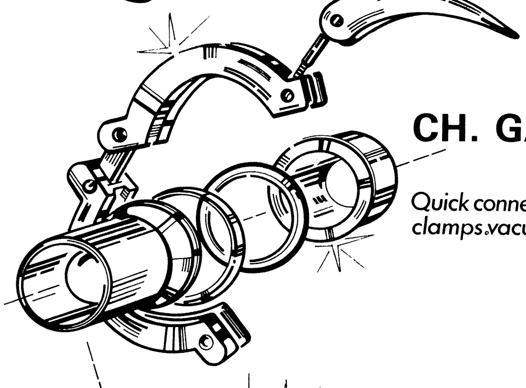
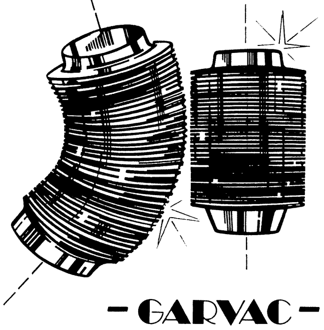


Hydroformed Bellows vacum components



CH. GABUS

Quick connect patented clamps.vacum components



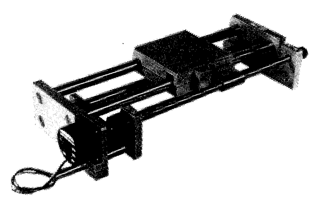
REINHOLD S.A.
CHARLES REINHOLD Ing.

Edge welded diaphragm Bellows

- GARVAC -
1, Chemin du Lac
CH-1290 VERSOIX, Switzerland
Tel. (022) 55 24 23

PHYSIK INSTRUMENTE

Micropositioning

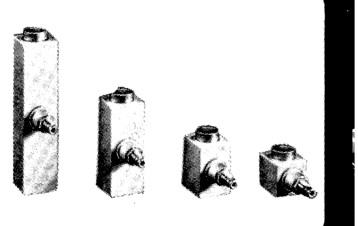


µm-positioner with stepping motor drives

with linear and rotary positioners. Available with micrometer or no backlash worm gear drives. Suitable for horizontal or vertical mounting. These modular units can be combined

with Piezo, Stepping Motor or DC Motor Drives

Piezoelectric translators for generation and measurement of distance variations to below 0,01 µm. Stepping motor drives with resolution up to 4000 steps/revolution, controls with IEC-Bus interface, programmable.



DC Motor drives for micropositioners; motorized micrometer drives; DC power supplies.

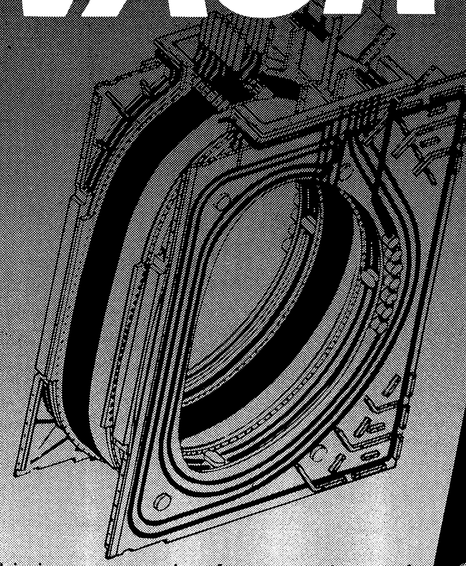
Polyscience AG
Bleichistrasse 8
CH-6300 ZUG
Tel. 042/22 15 33

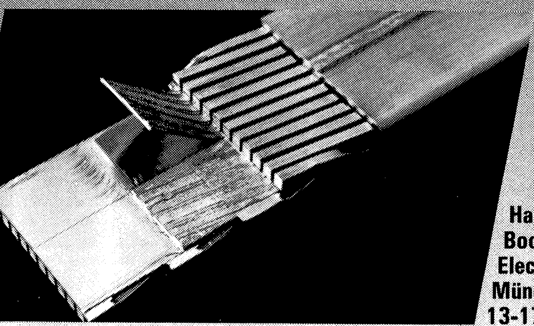
VACRYFLUX®

A Tokamak magnet system (**L**arge **C**oil **T**ask) is under construction on an international basis to be tested at the Oak Ridge National Laboratory.

VACUUMSCHMELZE produces the cable for one of the six constituting magnets, the EURATOM contribution.

Approximately 20 tons of a forced flow cooled Roebel conductor, consisting of 23 SC strands with a core and a jacket of stainless steel. Current capacity: 15 kA at 8T.

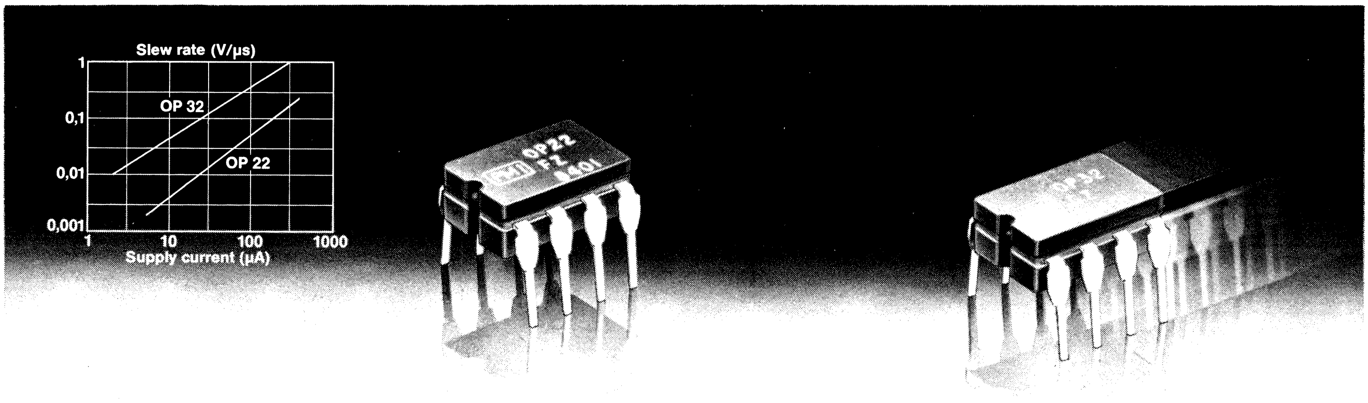




This is an example of our spectrum of multicomposite conductors for highly sophisticated magnet designs.

Hall 23
Booth 23C52
Electronica'84
München
13-17 November 1984

VAC VACUUMSCHMELZE GMBH · Grüner Weg 37 · D-6450 Hanau · Tel.: (06181) 362-1 S-9



Op-amp, low power, precision, fast...? OP-32!

We changed the old game of «low power **or** precision **or** speed». OP-32, the newest member of our big family of micropower op-amps, has programmable supply current from 1µA to 2mA. As speed varies directly with supply current, the frequency response can be matched to the application requirement. At 1mA the bandwidth is 10 MHz. And offset is less than 300µV, gain far over 1 million. OP-32 runs on single or dual supply, from 3...30 V or ±1.5...±15 V. Older brother OP-22, also programmable, is slower, but also needs only one-fifth the current – it can even run on solar cells. Cousins OP-20 and OP-21 are fixed-current Singles, draw 55/230µA and have slew rates of 0.05/0.25 V/µs, and gain over a million. OP-220/221 are Twin versions of OP-20/21, and OP-420/421 even Quads. A fine family indeed! Meet them all, ask for their complete Data Sheets!

Bourns (Schweiz) AG, 6340 Baar
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PMI Precision Monolithics Incorporated
A BOURNS SUBSIDIARY
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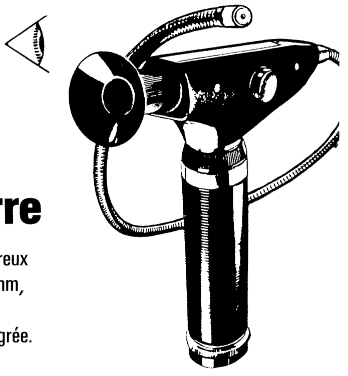
Partout où l'œil
ne peut accéder...

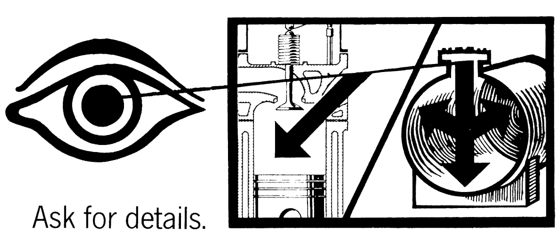


Endoscopes flexibles à fibres de verre

pour l'inspection directe de corps creux non accessibles aux yeux. ø 3-14 mm, longueurs utiles 0,5-12 m. Eclairage de l'objet par lumière halogène intégrée. Alimentation par pile et secteur.

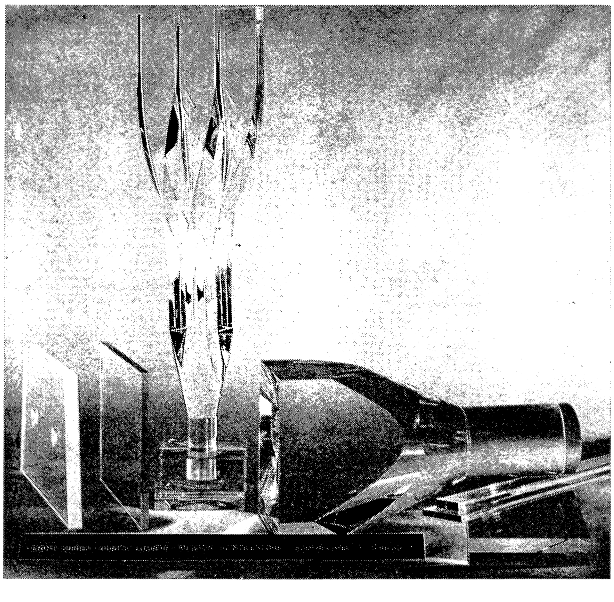
For optical interior inspections...

boroscopes, fiberscopes.



Ask for details.

TECHNOKONTROLL AG
8049 Zürich, Imbisbühlstr.144 Telefon 01 56 56 33



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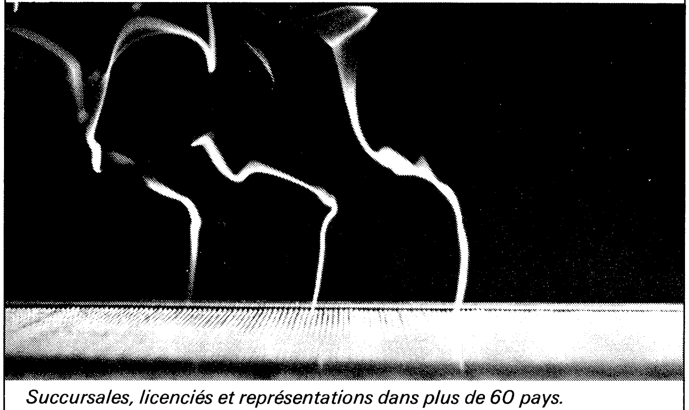

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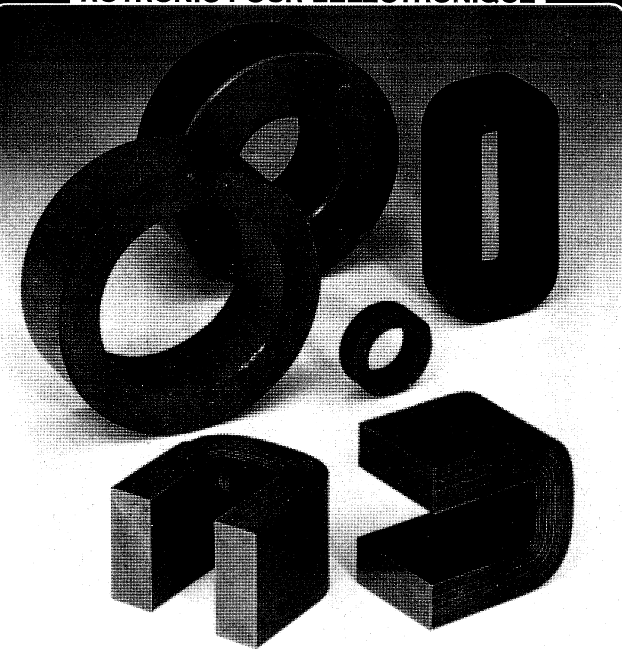

ROTRONIC POUR L'ÉLECTRONIQUE

ROTRONIC POUR L'ÉLECTRONIQUE

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Noyaux en bandes découpées
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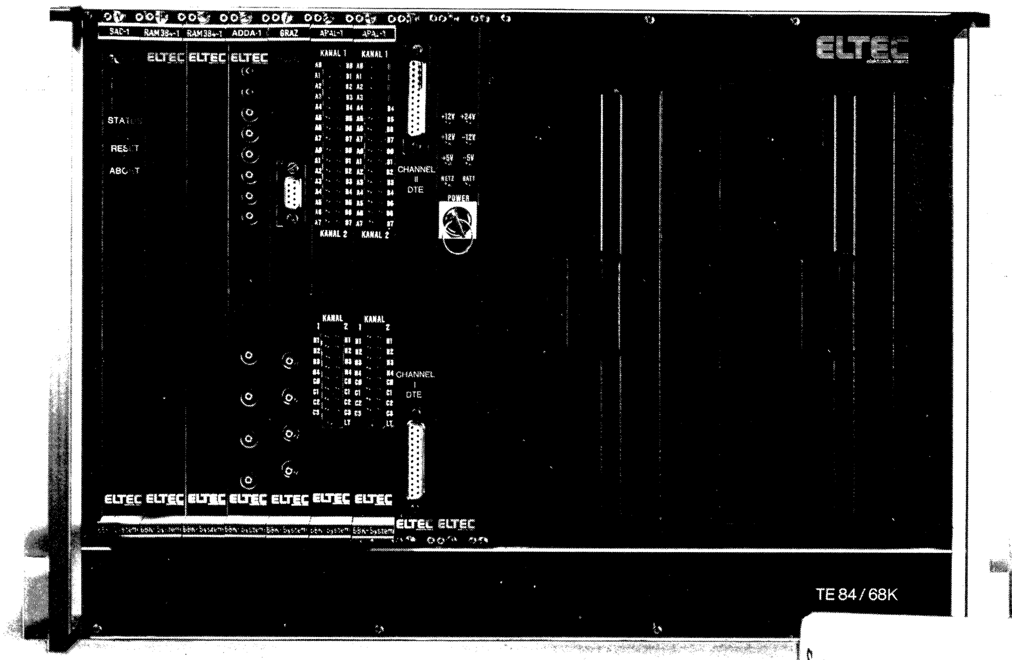
8040 Zürich, Badenerstr. 435, Tel. 01-492 32 11

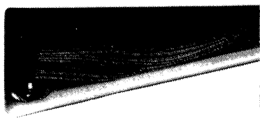
The ELTEC-VMEbus-Line

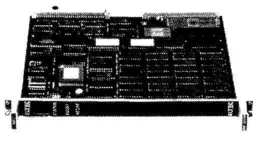
ELTEC-68K-SYSTEM



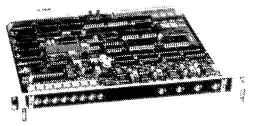
19" Housing TE84/68K
Flexible and versatile VMEbus housing!
8 or 20 slots for VMEbus boards
unique I/O Bus concept supporting VMS & VMXbus
5"- or 8" Floppy disk drives and/or
5" Winchester drives in various configurations
Power supply meeting all VMEbus Rev. B specs.
Fan-cooled Power supply and card-cage

Software:
Operatingsystems:
Single user: CP/M®-68K, UCSD®-Pascal
Multi-user: OS-9/68000® (real time),
Unix® and PDOS® in prep.
Languages:
Assembler, C-Compiler, Pascal-, Fortran-, Modula2,
PEARL, C-basic Compiler, Basic Interpreter

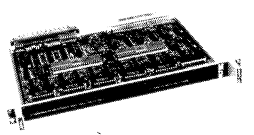




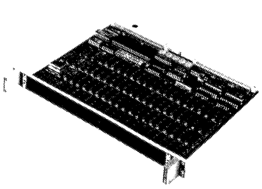
High Speed CPU Board
with Floating Point Processor
SAC-x/68K
680X0 CPU, 8-, 12- or 16-MHz, FPP meeting IEEE Format, 64 Bit float, ADD <10 μsec, 64 KByte stat. CMOS RAM without wait states, 2 serial I/O lines sync/async, 1 Timer 24 bit, 2x 8 bit parallel port, 4 (E)EPROM sockets (JEDEC standard), 4 level Bus arbitration module, debug monitor in 16 KByte EPROM



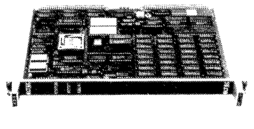
Analog I/O Board
ADDA-1/68K
8 channel analog-digital converter, resolution 12 bits, conversion time 8 μsec, 4 digital-analog channels 12 bits, settling time 9 μsec



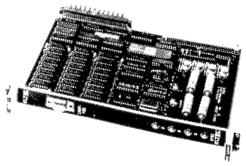
Parallel I/O Board
APAL-1/68K
2×24 inputs/outputs, max. output currency TTL 64 mA, LED-status display of each line, 2 timer modules 24 bits, supports 4 different interrupt levels



RAM512-1/68K
Dynamic RAM board with 2 Mbyte, 1MByte, 512 KByte or 256 KByte, error detection via byte-parity, 16/32 bit data bus for future use, 260 ns access time, 380 ns cycle time



Single Board Computer
with Floating Point Processor
EUROCOM®-3
680X0 CPU, 8- or 12 MHz, 1 MByte or 256 KByte dyn. RAM, Floppy controller for 5" und 8" disk drives single/double density, 2 serial I/O lines, battery backed CMOS real time clock, Debug monitor in 16 K EPROM



Colour Grafics Board
GRAZ-3/68K
Jumper selectable resolution 512×512 or 512×256, 50/60 Hz refresh rate, 8 colours/grey scales, fast vector generator, video output R-G-B TTL or 1 Vpp, software supported by EPROMs and listing

Further boards in preparation!

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Telefon 01 - 715 56 40, Telex 53 249

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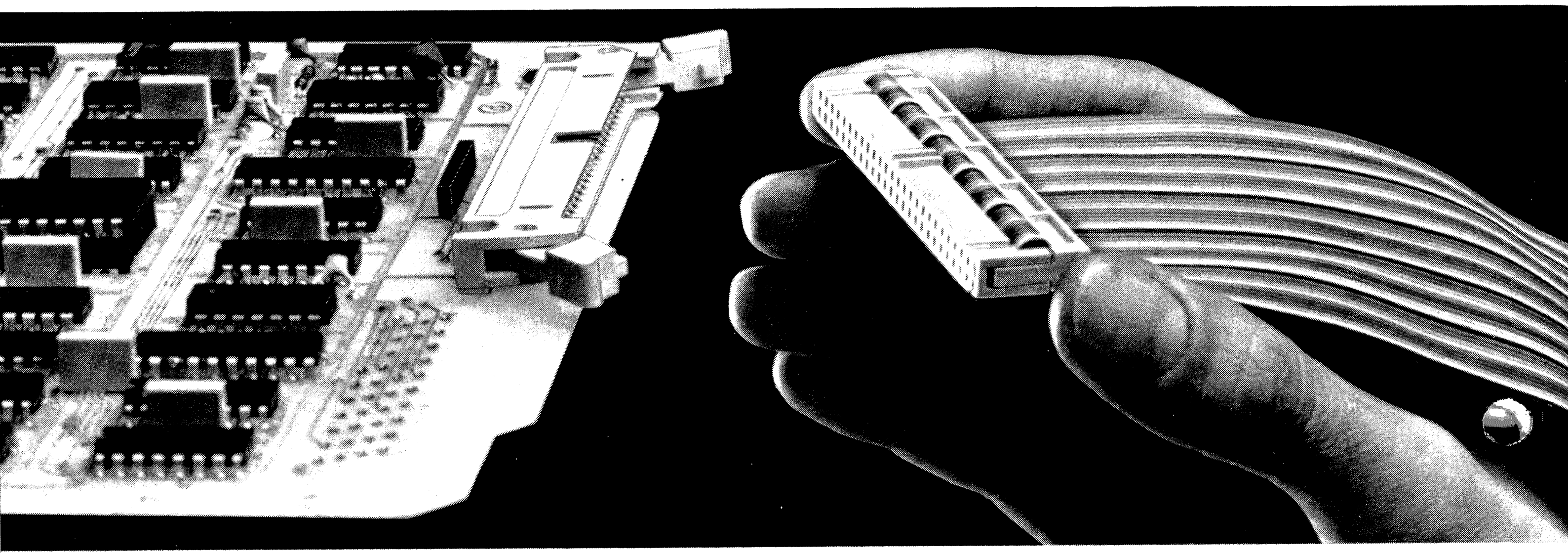
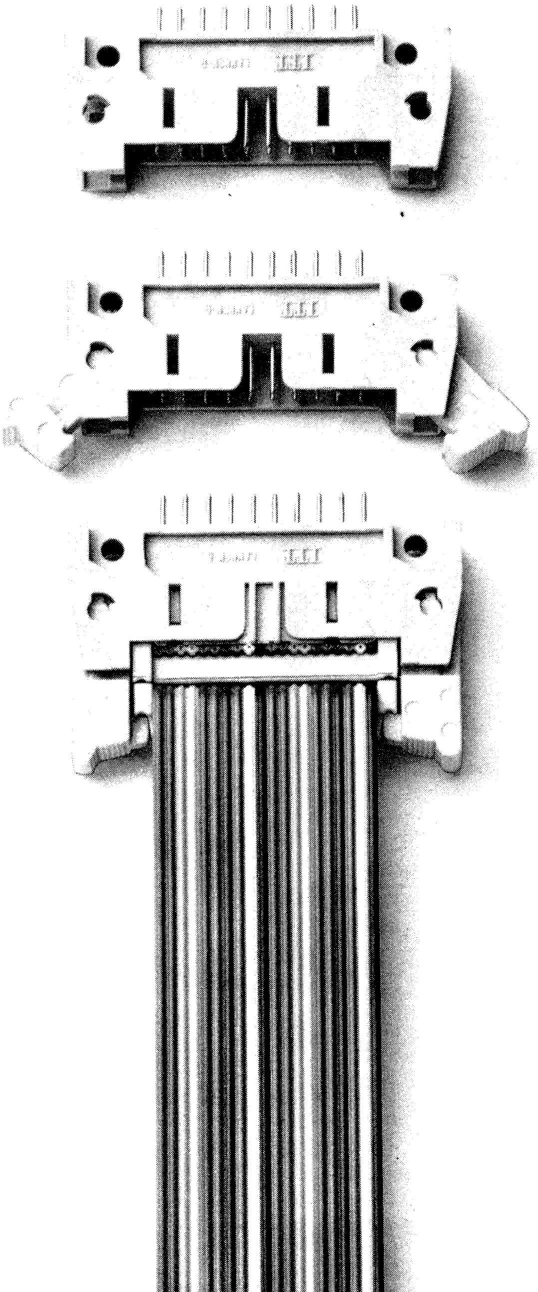
Das gute Ende für Bandkabel.
Speedy G 80.



Der neue Speedy G 80 Pfostenverbinder mit dazu passender Stiftleiste entspricht DIN 41651, MIL-C-83503 und BPO-D-2632. Damit kann Speedy G 80 mit allen vergleichbaren Produkten am Markt gesteckt oder ausgetauscht werden.

Gasdichte, korrosionsfeste Verbindungen ohne Abisolieren herstellen. Einfach, zuverlässig und kostensenkend anschlagen. Das sind die Vorzüge, die Speedy G 80 bietet.

Bei Speedy G 80 gibt es keine Fehlsteckungen: jedes Steckerpaar ist polarisiert. Die wahlweise Verriegelungs- und Auswerf-Vorrichtung ermöglicht sicheres Kuppeln und leichtes, kontaktschonendes Trennen. Viele Kontaktoberflächen sind erhältlich, um die Forderungen Ihrer Applikation zu erfüllen. Und: Speedy G 80 kann selbstverständlich mit all den zahlreichen Speedy-Bandkabeltypen von ITT Cannon verwendet werden.



Mit Speedy G 80 wird Ihre Fertigung noch rationeller. Ein guter Grund, mit unserem Beratungsingenieur oder Ihrem nächsten Cannon-Distributor zu sprechen, wenn Sie elektrische oder elektronische Systeme schnell und kostengünstig aufbauen wollen.

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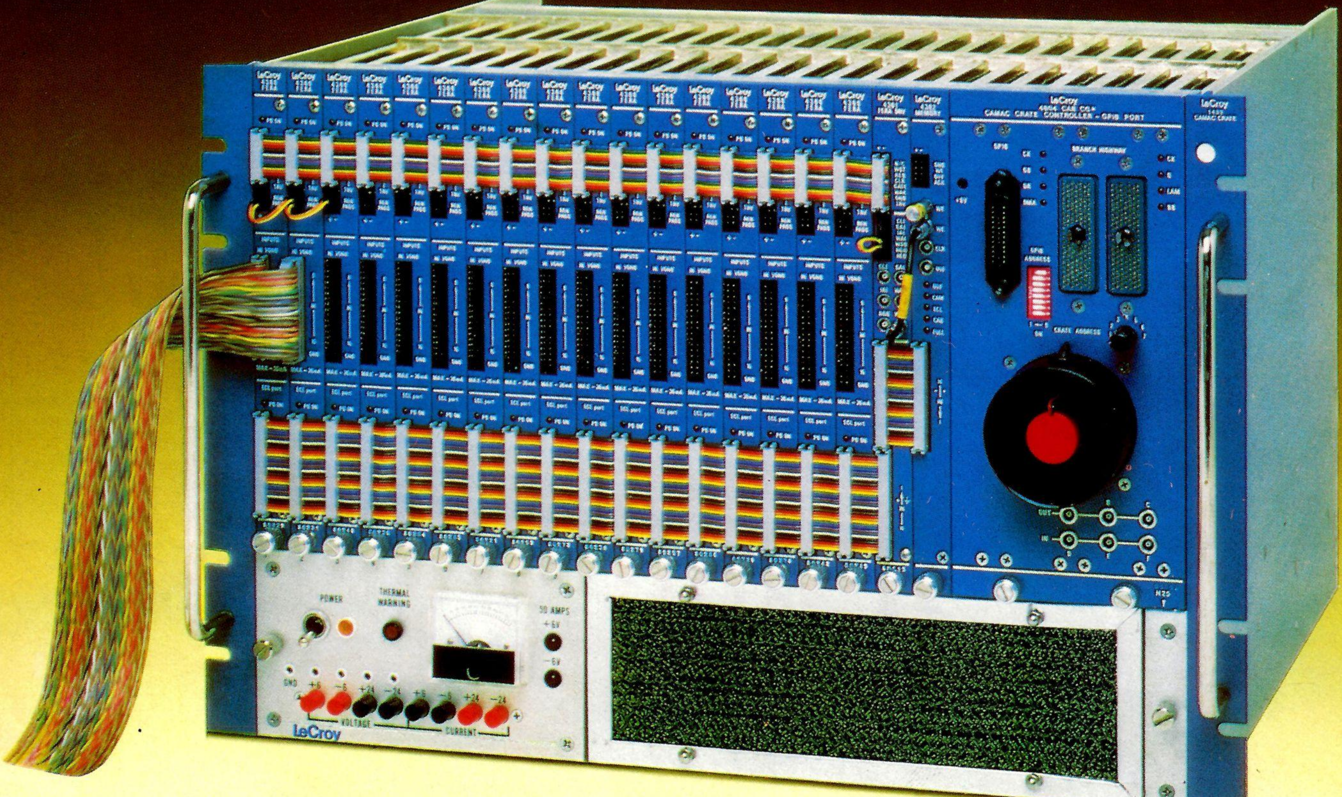
ITT CANNON

Fast 16 Channel CAMAC ADC
Faster Conversion Time
Fastest Readout Speed



Our New Fast Encoding and Readout ADC System for High Rate Analog Data Acquisition Applications, Real Time Systems, Colliding Beam Diagnostics, and Energy Based Triggers in Particle Beam Experiments

Now, an ADC system with enough precision (8 to 11 bits) to achieve high signal to noise ratios and wide dynamic range, but fast enough for real-time decisions: An ADC System that can be used for test and proto-type work and then expand to a full scale data acquisition systems.

LeCroy introduces the System 4300 Fast Encoding and Readout ADC (FERA), our new high speed, low cost, high density, analog-to-digital conversion system. Flexible modular design permits growth from single 16-channel ADC modules in existing CAMAC systems, up to multi-crate buffered installations with programmable real-time data processing.

The Model 4300 16 Channel FERA combines fast parallel conversion with an optimized readout scheme to achieve an extremely high data throughput rate. For example, if the 272 channels shown above contain 20% valid data, they can be digitized into 11 bits, have the pedestals subtracted, and be read out into the memory every 16 microseconds.

The Model 4302 Memory holds 16K of 16-bit words and can be loaded at 100nsec/word. An optional FERA Driver, the Model 4301, distributes Gate, Clear and Test signals and includes a 12-bit DAC for calibration and testing. The crate may be controlled by a Series 4800 CAB, Programmable CAMAC Processor which can perform complex algebraic operations such as cluster finding on the data as well as further data compression.

For more information on FERA, contact your local sales representative.

LeCroy

Rue Cardinal-Journet 27, 1217 Meyrin 1-Geneva, Switzerland, 82 33 55. Offices: USA, (914) 425-2000; Heidelberg, W. Germany, (06221) 49162; Les Ulis, France, (6) 907.38.97; Botley, Oxford, England, (0865) 72 72 75. Representatives throughout the world.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