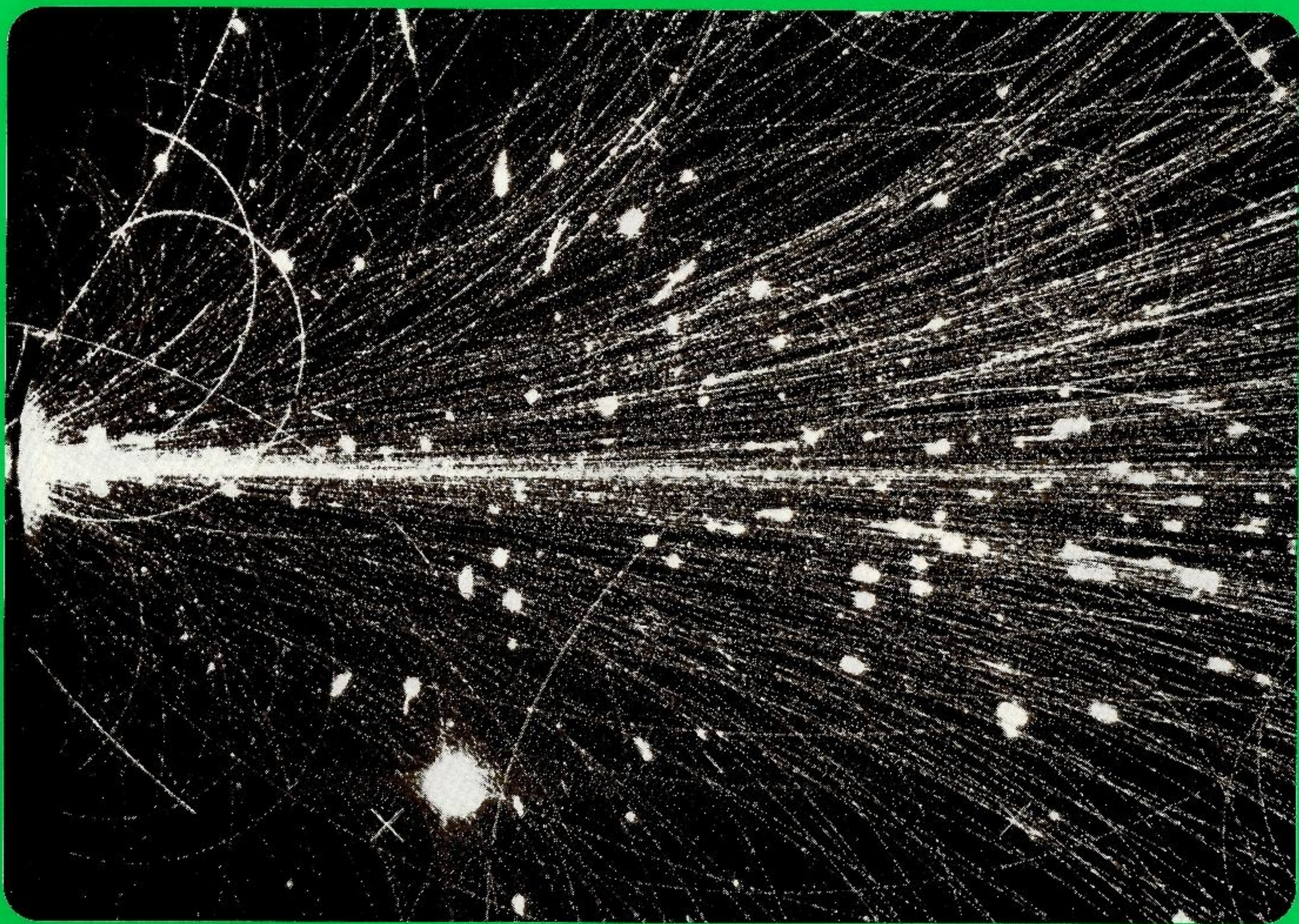
CERN COURIER

International Journal of High Energy Physics



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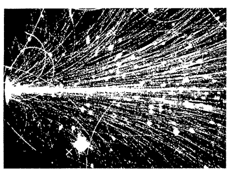

Cover photograph:
Golden physics. Tracks seen in the NA35 streamer chamber experiment at CERN when the highest energy beams in the world (sulphur ions at 200 GeV per nucleon, making a total energy of 6400 GeV) smash into a target of gold (special effects by Patrice Loïez). See also page 13.

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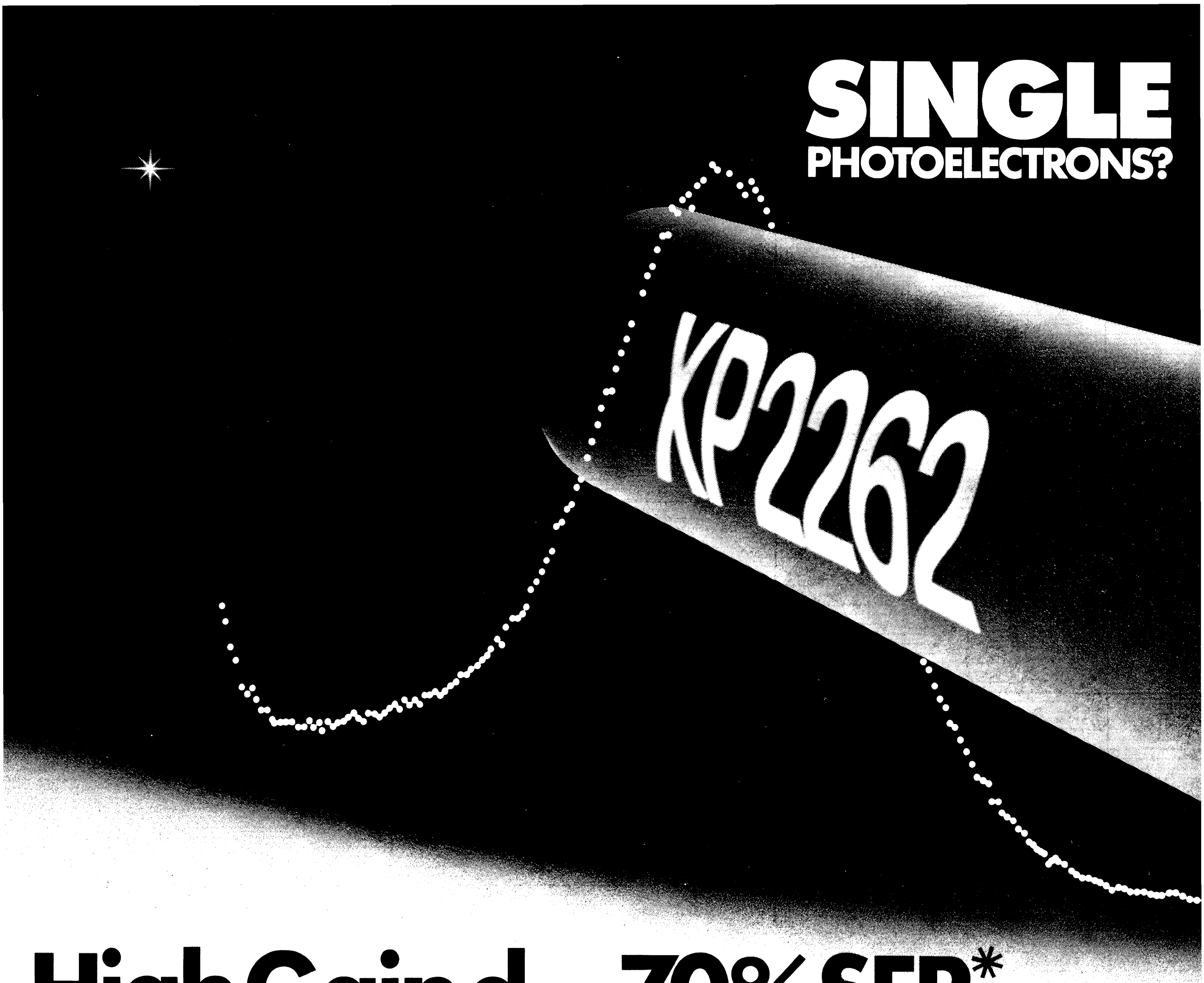

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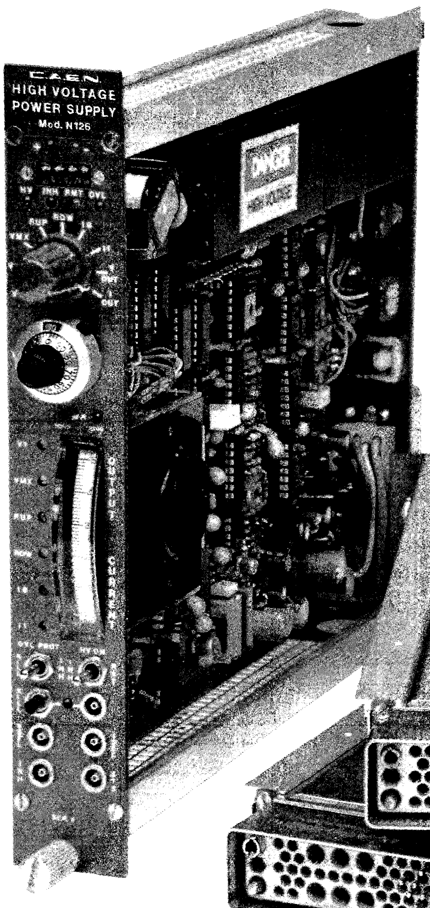

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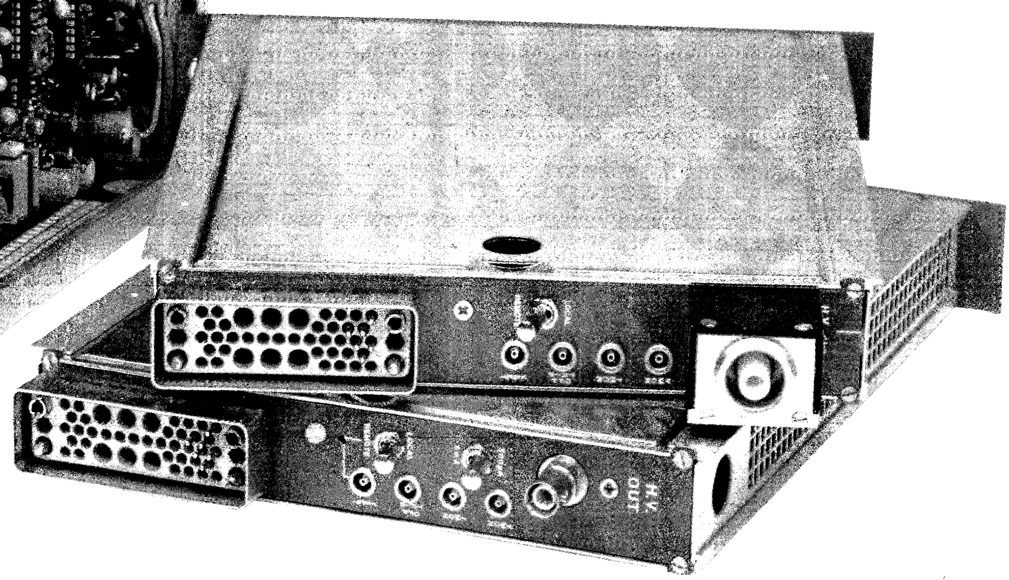

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Future perspectives

ICFA Chairman Yoshio Yamaguchi – stressing the need for more world-wide communication.

International involvement in particle physics is what the International Committee for Future Accelerators (ICFA) is all about.

When it was set up in 1976 ICFA saw its role as promoting a so-called 'Very Big Accelerator' (VBA) – an international 'world machine'. Despite the increased international involvement in the field, this idea never really caught on, and in 1984 in its first 'Future Perspectives' seminar (held at the KEK Japanese Laboratory) ICFA reformulated its goals.

ICFA's ongoing activities are now spearheaded by four panels to investigate and coordinate work in four areas – Superconducting magnets and cryogenics, Beam Dynamics, New accelerator schemes, and Instrumentation. Underlining its unique international role, ICFA sees itself as promoting collaboration in the construction and exploitation of accelerators, facilitating the exchange of information and regional plans, and organizing workshops on large accelerator schemes, particularly to foster the necessary new technology.

At the latest Future Perspectives meeting at Brookhaven from 5-10 October (after a keynote speech by doyen Viktor Weisskopf, who regretted the emergence of 'a nationalistic trend'), ICFA reviewed progress and examined its commitments in the light of the evolving world particle physics scene. Particular aims were to review worldwide accelerator achievements and plans, to survey the work of the four panels, and to discuss ICFA's special role in future cooperation in accelerator construction and use, and in research and development work for both accelerators and for detectors.

In his Brookhaven summary talk, outgoing Chairman of the European Committee for Future Accelerators (ECFA) Jean Sacton pointed out that while the goal of the VBA has foundered, today's new hopes are reminiscent of it. 'High energy physics as a whole is a World Laboratory,' he claimed, 'its scientific programme being pursued in the most balanced way.'

Earlier, in the panel discussion on future cooperation in accelerator construction, CERN Director General Herwig Schopper underlined the complementarity of various colliding beam options (proton-proton, electron-positron, electron-proton) rather than a single VBA. However Fermilab Director Leon Lederman saw a good opportunity to revive the idea, based moreover on a 'world Laboratory'.

Looking toward the next generation of accelerators, Sacton echoed the increasing belief that a 'rich vein' of new phenomena awaits discovery at energies up to and around 1 TeV (1000 GeV) for electron/positron beams or for the constituent quarks locked inside beams of nucleons.

John Mulvey, deputizing for CERN Long Range Planning Committee Chairman Carlo Rubbia, sketched the physics expected from new higher energy proton-proton, electron-positron and electron-proton colliders.

Two major hadron collider projects are on the market – the US Superconducting Supercollider (SSC), with collision energies of 40 TeV in an 84 kilometre ring, and the CERN LHC Large Hadron Collider, with up to 17 TeV collision energies using the 27 km tunnel now being completed for the LEP electron-positron collider.

On the ICFA seminar agenda, the SSC (Maury Tigner) was listed under 'Future facilities'. It has a detailed conceptual design, and a nod of approval from the US administration. However no major construction money has yet been voted, and a site has to be decided. On the other hand the LHC (Giorgio Brianti) was billed as a

Participants at the recent 'Future Perspectives' seminar of the International Committee for Future Accelerators (ICFA), held at Brookhaven in October.

ICFA – the International Committee for Future Accelerators

Chairman – Y. Yamaguchi: Secretary – W.O. Lock: Members; CERN Member States – H. Schopper, J. Sacton, V. Soergel; USSR – A. N. Skrinsky, E. Myae, Yu. Ado; USA – B. D. McDaniel, L. Pondrom, N. Samios, Joint Institute for Nuclear Research (JINR) Member States other than USSR – D. Kiss (Hungary); China – Fang Shou-xian; Fourth region – J. Tiomno (Brazil); Japan – Y. Yamaguchi; Ex-officio, K. Strauch as Chairman ot the International Union of Pure and Applied Physics (IUPAP) Commission on Particles and Fields.

'Project under design'. However the proposal benefits from the almost complete LEP tunnel. Having LHC and LEP in the same tunnel opens the door to electron-proton collisions, and CERN's new process with ion beams could lead to even more LHC options.

Mulvey echoed the opinion of the CERN Long Range Planning Committee – 'we conclude that the LHC offers the most cost-effective way for the world's high energy physics community to achieve an early access to 1 TeV energies in the constituent centre of mass'.

Lederman compared SSC and LHC costs, the latter being 2.5 times cheaper according to his accounting. 'You get what you pay for', he remarked. Schopper urged coordination of projects – 'we are all sitting in the same boat' – and painted possible future scenarios extending beyond the year 2010.

On the electron-positron collider front, feasibility studies and R and D are going on in Japan, the US, the USSR and in Europe, for a type of machine which Burt Richter called the 'Next Linear Collider' (NLC). This might be built at the lower edge of interesting energies with 'moderate extensions' of existing technology, but energies beyond 1 TeV are going to require new approaches, he maintained. One client for new technology is CERN's 2 TeV 'CLIC' electron-positron collider project and Mulvey stressed the need for investment to bring this technology about.

'The goal at Stanford is to complete the R and D required in time to start the construction of our version of the NLC around the mid-1990s,' said Richter. 'I believe the goals of our European, Japanese and Soviet colleagues are identical. Thus we ought to work out a method to avoid duplication and move the whole effort along faster and more economically.'

One Brookhaven session was given over to the physics expected at higher energies and with increased collision rates (luminosities). Daniel Froidevaux looked at the implications of these schemes for finding signs of the long-awaited Higgs mechanism which delicately breaks the underlying symmetry of the electroweak unification and gives it its physical reality. John Ellis looked at the prospects for finding new particles. There is a tradeoff between collision energy and luminosity with the lower energy LHC needing more collisions. The SSC design luminosity is 10^{33} cm^{-2} s^{-1}, while the LHC figure is at least ten times higher. 'If you have the energy, you are better off because luminosity might come later,' remarked Sacton. Roy Schwitters bravely faced the implications for the detectors required to operate at high energies and luminosities, and S. Gershtein looked far into the future.

Nikolai Tyurin of Serpukhov described ongoing work in the USSR. The 3 TeV UNK machine at Serpukhov for supplying proton beams for fixed target physics is scheduled for 1993, with a 6 TeV proton-proton collider several years further in the future. Also envisaged for Serpukhov is the 500 GeV on 500 GeV VLEPP electron-positron linear collider, opening up the possibility of high energy electron-proton collisions. Construction should begin in 1991, and development work is in the capable hands of Novosibirsk.

In keeping with ICFA's international role, international collaboration was very much a talking point at the Brookhaven seminar. Precedents include the CERN convention (cash subscriptions from participating nations within a comprehensive infrastructure) and the 'HERA model' based on the plan developed for the big electron-proton collider being built at the German DESY Laboratory in Hamburg (equipment and/or manpower from interested nations).

One morning of the seminar was devoted to a survey of the four ICFA panels, displaying various levels of success.

ICFA chairman Yoshio Yamaguchi summarized his committee's findings, stressing again the collaborative aspect of the work, the complementarity of different machines and the need for development work both for machines and for detectors. He welcomed the appearance of developing countries in this area of research, and underlined the need for improved worldwide communication – workshops, schools, conferences, and publications.

At the previous Future Perspectives meeting at the KEK Laboratory in 1984, the TRISTAN electron-positron collider there was still under construction. Since then, it has come to fruition and, at least for the moment, has the high energy electron-positron stage to itself. By the time of the next such ICFA seminar, provisionally scheduled for Europe in 1990, there will surely be a lot more progress to report.

The resourceful organization provided by Brookhaven under local chairman Horst Foelsche was much admired and appreciated.

Second ICFA Advanced Beam Dynamics Workshop

The ICFA Beam Dynamics Panel is organizing a second Advanced Beam Dynamics Workshop, to be held from 11-16 April 1988 in Lugano, Switzerland. Its subject is 'Aperture-Related Limitations of Storage Rings', and will survey and advance present knowledge, both experimental and theoretical, of those aperture-related effects which limit the performance of storage rings, and in particular the lifetime of the stored beams. Examples of elements contributing to such limitations are multipole elements, both intentionally and unintentionally present, and noise and ripple in power supplies. More specifically, the following topics will be discussed: Experiments on existing accelerators and the lessons to be learned for the planning of future experiments and the design of future machines; Analytical methods for determining amplitude limitations and diffusion rates in the tails of circulating beams; Criteria for the properties of the circulating beam, i.e. tune spreads, etc., and the resulting criteria for the quality of the magnetic field; Compensation schemes for field defects.

The organizing committee is chaired by E. Keil, CERN, LEP Division, 1211 Geneva 23, Switzerland, who may be contacted for further information.

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Window shopping

'A large window for surprises' was how Gordon Kane of Michigan summarized the potential of the proposed 84-kilometre US Superconducting Supercollider (SSC). With George Trilling of Berkeley unable to attend this year's High Energy Physics Conference at Vanderbilt University, Nashville, Tennessee, from 8-10 October, Kane played a dual role – looking ahead to SSC physics, and summarizing the meeting.

Earlier, Stan Wojcicki of the SSC Central Design Group reported on the status of the proposal for the huge machine. A list of candidate sites has been drawn up (see November issue, page 17), and after site selection (which could be as early as next July), the hope is for 20 TeV (20 000 GeV) per beam in 1996. Meanwhile a Senate committee has recommended $ 35 million for the SSC in the current financial year while the Administration explores means of funding the project, estimated at $ 3210 million, including labour costs.

The Senate report also recommends exploring international collaboration. Whatever solution is adopted, said Wojcicki, the machine should be operated under the guidelines laid down by ICFA (International Committee for Future Accelerators), with scientific merit as the major criterion for selecting experiments.

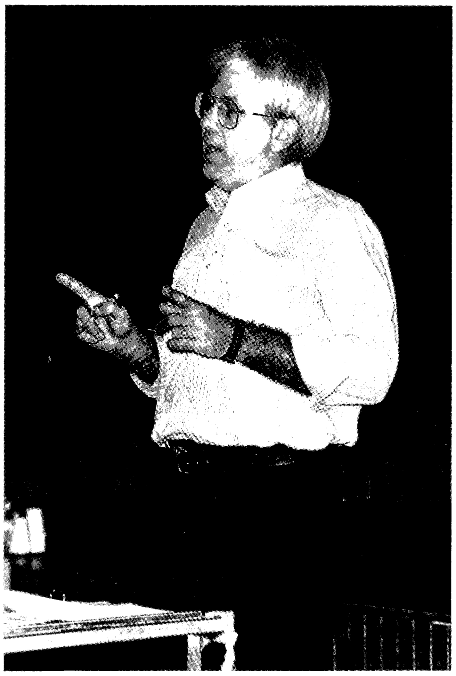
Whatever unexpected physics might come in through the SSC window, physicists are preoccupied with the search for the 'Higgs' mechanism. This provides the otherwise unchallenged electroweak picture with its missing link – the source of mass. (Why, for example, are the W and Z particles carrying the weak nuclear force almost 100 times heavier than the proton, while the proton carrier of electromagnetism has no mass at all?)

Possible Higgs scenarios and signatures were described by Tom Weiler of Vanderbilt. In the almost complete absence of experimental input, a lot of Higgs candidates jostle for attention. Kane underlined the potential complexity of the problem – 'as well as finding where the Higgs is, we have to find where it isn't'. Higgs dogma comes in three Kane variants – 'fundamentalism, theism and atheism' – which should be experimentally distinguishable.

Kane wrote off Higgs searches at the existing proton-antiproton colliders at CERN and Fermilab, claiming that the collision rates (luminosities) are too low to pick up the rare production processes. At higher hadron collider energies, such as those envisaged for the SSC and for the LHC Large Hadron Collider proposed for the tunnel being built for CERN's LEP electron-positron collider, Kane highlighted the luminosities needed to see candidate Higgs mechanisms, arguing that the higher energies envisaged for the bigger SSC demand less luminosity.

Higgs hunting was also on the agenda of Gary Feldman of SLAC, looking at the physics possible with linear colliders providing 1 TeV electron and positron beams, pointing out the increased difficulty of finding what the Higgs mechanism looks like if it only comes into play at TeV energies.

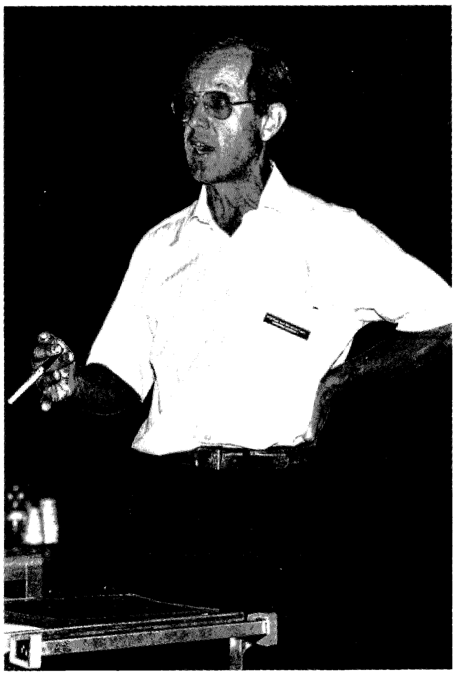
While the detectors for Feldman's machine were 'easy to build', this is not the case for the SSC. M. Gilchriese of the SSC Central Design Group highlighted the challenge of designing and building detectors for the huge machine. He saw calorimetry (measurement of deposited energy) as the highest



▲ *Gordon Kane – the proposed US Superconducting Supercollider (SSC) is a large window for surprises.*

(Photos D. Hildebrand)

▼ *Stan Wojcicki of the SSC Central Design Group – looking for money as well as love from the US administration.*



priority, where a whole list of sampler/absorber combinations are possible. Jim Rohlf of Harvard described the work going on at the UA1 detector at CERN's proton-antiproton collider to reequip with room temperature liquid (TMP – tetramethyl pentane, boiling at 122°) as the sampling medium. However Rohlf advocated the more volatile (26.5° b. p.) TMS – tetramethyl silane – for use at the SSC.

Still important but of lesser priority, according to Gilchriese, are electronics, radiation resistance, tracking and simulation. Whatever the SSC detectors would turn out to look like, Gilchriese saw them as involving highly international teams. Paul Kunz of SLAC, speaking on computing ('today's software is a mess') did not foresee any greatly increased mess for the SSC.

The Vanderbilt meeting also heard from Steve Schnetzer of Rutgers on the new results from the TRISTAN electron-positron collider at the Japanese KEK Laboratory (see page 18), while Virgil Barnes of Purdue covered the outcome of the Tevatron proton-antiproton collider run earlier this year (see page 14).

Fred Gilman of SLAC looked at the decays of heavy particles, hinting that in recent months the inconsistencies in the decay data of tau leptons, far from clearing up, were getting worse. Elsewhere on the heavy particle front, the pattern of CP symmetry (switching left and right and particles and antiparticles) violation expected with B mesons could be 'much richer' than with neutral kaons, the only known CP violation example so far explored.

'The question 'Where to B?' was taken up by Elliott Bloom of SLAC, looking at proposals for B particle factories.

In his conclusion, Kane was sceptical about recent limits on the long-awaited sixth ('top') quark, pointing out the assumptions built into these estimations.

Brookhaven at 40 – looking forward as well as back

In 1947, the famous Camp Upton Army Base on New York's Long Island switched to a new career as Brookhaven National Laboratory. The reputation the Laboratory has established as a world-class research centre and its continued attraction for scientists looking for exciting possibilities were highlighted on 9-11 September at a symposium and celebration marking forty years of Brookhaven and its parent organization, AUI (Associated Universities Inc).

For many of the visitors, Brookhaven has been a focus of their scientific careers, sometimes resulting in great discoveries. They were joined by many present and former employees, by state and

Irene Haworth and Brookhaven Director Nick Samios at the Dedication of Brookhaven's accelerators as the Leland J. Haworth Complex in memory of the Laboratory's Director from 1948-61.

federal officials, and by other scientists who came to help celebrate past accomplishments and look forward to a productive future.

Highlighting the celebration was a two-day scientific symposium featuring talks by six distinguished speakers on topics in physics, chemistry, accelerators and biology. In addition, the Alternating Gradient Synchrotron (AGS) Complex was dedicated to the memory of Leland J. Haworth, Laboratory Director from 1948 to 1961, during which time the AGS went from conception to operation. Gerald Tape, who served with Haworth as Deputy Director, said: 'Leland J. Haworth will be remembered as a master builder of research facilities, a foremost scientific administrator and, above all, a man of exceptional integrity ...'

Ground was also broken for the new AGS Accumulator-Booster ring. This will inject into the AGS, greatly increasing the beam intensity and allowing acceleration of the heaviest nuclei. As Director Nicholas Samios observed, 'We're switching now from looking backward to looking forward.'

Wilmot Hess, head of the US Department of Energy's Office of High Energy and Nuclear Physics, carried this theme further, predicting '... in not very many years we'll find that this Leland Haworth Complex is the injector into that larger machine ... RHIC (the proposed Relativistic Heavy Ion Collider) ... and I pledge to Nick that I will do everything I can to bring that day about rapidly.'

A few apt quotes reflect the atmosphere of the symposium.

T. D. Lee, who shared the Nobel Physics Prize with C. N. Yang in 1957 for their revelation that parity (space reflection symmetry) played a special role in particle reactions: 'The history of symmetry principles in modern physics is inseparable from that of Brookhaven ... The strong focusing principle, which made it possible to build the accelerators to test these principles ... theoretical papers on the questions of parity, conservation and the related subjects ... the first test of associated production of strange particles ... the symmetry of the long-lived kaon, neutrino helicity, CP violation ... confirmation of SU(3) symmetry and the generation concept of leptons, based on the discovery of two neutrinos, Omega-minus, J-psi and various resonances – they were all made at this Lab, and most of the people who made them are present in the audience.'

John Blewett, Brookhaven Senior Physicist, 1947-75: 'The Brookhaven Cosmotron came on line in 1952, first in the world to a billion volts (in 1953). Its construction was a very exciting ordeal, but was so full of innovations and hopeful solutions to problems that had never been faced before that we were all really scared. I still remember my sister Hildred visiting us and looking at the half-built machine and saying, "Where will you look for a job if it doesn't work?" But Courant and Blachman's predictions were right, our designs worked and Brookhaven had its first high energy physics facility.'

Nobel Laureates Val Fitch (left) and Sam Ting who put the Brookhaven Alternating Gradient Synchrotron to good use.

Sheldon L. Glashow of Harvard, who shared the 1979 Nobel Physics Prize with Abdus Salam and Steve Weinberg for their theory which unified electromagnetism with the weak force of radioactive decay: 'Nick (Samios) was trying to find charm particles with neutrinos, and, of course, Nick knows that if you want to find anything in the world, all you have to do is look through a few million bubble chamber photographs and it is going to be there – at least if I tell him it is going to be there. I didn't tell him its mass or its properties, but he found it and we happened to meet and our numbers jibed completely. Retrospectively, you got the honour of discovering the first charm particle, but only retrospectively because no one believed you at first – except me and a few others.'

Maurice Goldhaber, Brookhaven Director 1961-73: 'To keep a good research spirit alive, you have to allow scientists the hot pursuit of their ideas. Though this wasn't always popular when I was Director, this was one thing I had to defend: the right of my scientists to hot pursuit. Hot pursuit has led us into fields which a priori looked very improbable: who would have ever thought that chemists would look at solar neutrinos and nuclear physicists at supernovas. All this is encouraged at Brookhaven if it grows naturally out of the ideas scientists have.'

Nicholas Samios, Brookhaven's current Director: 'Our mission is essentially the same as it was at our founding: namely, the design, construction and operation of large facilities doing research at the frontiers of science with our own staff, as well as our users. We pride ourselves on being a user research laboratory: 80% of our research is done by outside users. We have pioneered dedicated facilities: the National Synchrotron Light Source is a Brookhaven concept, with a symbiosis among universities, industry and national labs. Sometimes we are number one and we are proud of that, but we are sometimes number three, such as with high temperature superconductors. Whether we are one, two or three, the important thing is that we're in the ball game.'

Bill Wallenmeyer (left) and Parke Rohrer break ground for Brookhaven's new Accumulator-Booster ring.

Thinking cLEARly

A welcome appearance at the recent workshop at Villars in Switzerland to look at the future research programme at CERN's LEAR Low Energy Antiproton Ring was I.S. Shapiro of Moscow (right), seen here with O. Dalvarov of the Lebedev Institute.

The smallest ring at CERN is also one of its big successes. The 80 metre LEAR Low Energy Antiproton Ring which came into action in 1982 has provided invaluable research material for several hundred physicists.

(The world's only other antiproton factory, at Fermilab in the US, is concentrating on high energy goals, preferring to sit on the low energy sidelines and watch LEAR with interest.)

Whilst the initial programme at LEAR, concentrating on annihilation, search for narrow states etc., is now complete, attention is turning to a second generation of experiments with a slightly shifted emphasis. These new studies now extend to basic symmetries, hadron spectroscopy and comparisons of particle and antiparticle behaviour (see December 1986 issue, page 11). The detectors are taking shape in the old PS South Hall and will later be joined by internal target experiments such as JETSET (see May issue, page 21).

However LEAR's success promises a rosy future, and with this in mind, close to 250 researchers gathered at Villars-sur-Ollon in the Swiss Alps for the fourth in a series of LEAR workshops. Following Karlsruhe in 1979, Erice in 1982, and Tignes in 1985, this one was arranged, in collaboration with CERN, by several Swiss Universities under the overall responsibility of Ernst Heer and Catherine Leluc (Geneva).

The meeting reviewed LEAR's achievements so far. Although the idea of 'baryonium' – exotic quark combinations once expected in proton-antiproton annihilation – has now been put on the back burner, LEAR experiments have removed some of the mystery from annihilation and are poised to probe deeper. An interesting debate was between I.S. Shapiro of Moscow who underlined the very short short range character of annihilation and quark modelists who on the contrary believe it extends over a range of one fermi.

Another hotly debated topic was that of the 'rho parameter' connected with the structure of the proton-antiproton scattering. Two collaborations (PS 172 and PS 173) see an oscillatory behaviour at low energy which is in agreement with antiprotonic atom experiments at LEAR but which is not accounted for by the theoretical models.

Likewise valuable new insights on annihilation could come from the role played by spin. Results from the use of polarized (spin oriented) targets were given by PS 172 (SING collaboration), while W. Haeberli and A. Penzo looked further ahead to the prospect of polarized antiproton beams, using spin 'splitters' or 'filters'. A Test Storage Ring is being built at Heidelberg to test, with protons, the latter possibility.

Several hot topics in theory have an immediate bearing on present or potential LEAR physics. R. Petronzio described how supercomputer lattice gauge calculations now hint at where the long-awaited 'glueballs' might be found. S. Brodsky reviewed the quark field theory aspects of proton-antiproton collisions, while C. Dover and J. Rafelski discussed different aspects of the interaction of antiprotons with nuclei.

K. Kleinknecht gave the news of hints from the NA 31 CP violation experiment at CERN that one of particle physics long-standing mysteries (upsetting the combined CP particle/antiparticle and left/right symmetry in the decays of neutral kaons) might be starting to crack (see November issue, page 20). C. Jarlskog and A.J. Buras gave the theoretical update on these topics which are expected to become one of the principal lines of interest at LEAR. L. Montanet gave

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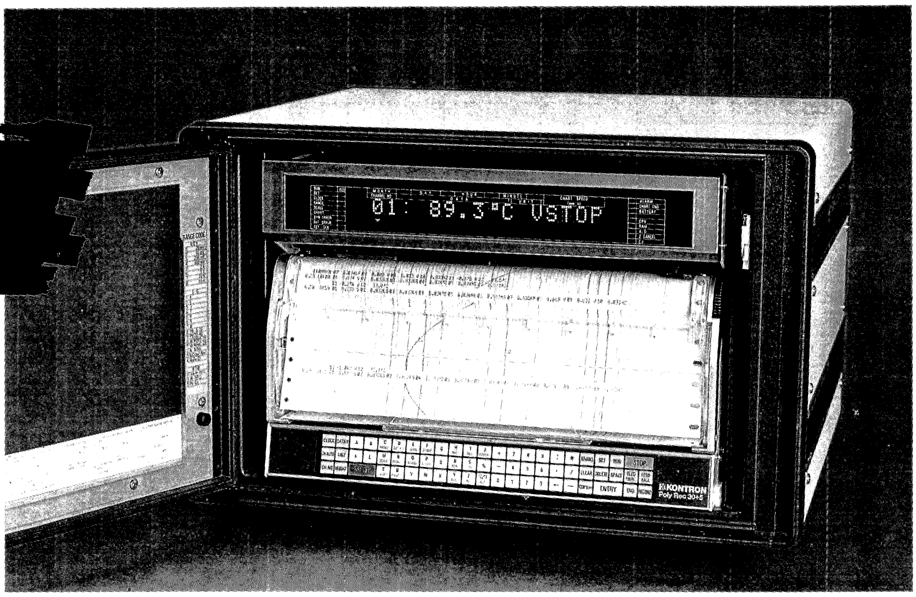

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the status of preparation of experiment PS 195 while N. Hammann suggested that CP violation could be looked at in hyperon decays.

Handling low energy antiprotons has always been a challenge for machine specialists and special sessions looked into LEAR's future requirements. The advent of beam cooling has opened up precision studies with a wide range of beams (including ions), and the meeting heard news from projects in Europe, the US and Japan.

I. Meshkov of Novosibirsk reviewed the latest developments in electron cooling, and Ishiro Katayama of Osaka reported on a new idea using a thin internal target in lieu of a gas jet in a cooling ring.

J. Peoples gave a status of the Fermilab antiproton source and of the experiment under construction to continue, using the debuncher ring, the charmonium spectroscopy initiated by a gas-jet target experiment during the last days of CERN's Intersecting Storage Rings.

Another big push at LEAR is for lower energies for measurements of static properties of the antiproton. The antiproton is thought to be the mirror image of the proton but if high precision measurements revealed even tiny differences this would have drastic consequences.

Whereas the design energy of LEAR foresaw going down to 5 MeV kinetic energy, M. de Saint-Simon described a mass spectrometer experiment that calls for 200 keV antiprotons. H. Poth of Karlsruhe outlined ideas to manufacture atoms of antihydrogen by combining antiprotons and positrons with the help of a laser and electron cooling. While antiparticles are standard fare at particle physics laboratories, neutral antimatter has yet to be synthesized.

For the long term future, several scenarios are conceivable. One candidate receiving increased attention is the SUPERLEAR project for a modest 120 metre ring of superconducting magnets to collide proton and antiproton beams in the energy range 1.5-10 GeV. This would fill the gap between CERN's two existing antiproton rings – LEAR and the SPS synchrotron, while the LEAR ring could confine its attention to the low energy frontier. SUPERLEAR, concentrating on colliding beams or gas jet target studies and with no external beams would open the door to the precision spectroscopy of heavy quark states. In view of its modest dimensions it would also be the world's first machine to use curved superconducting magnets.

On the final evening Carlo Rubbia talked about the long term future of CERN. Whilst the views of the committee he chairs are well known as regards the very high energy frontier (see September 1986 issue, page 17, and this issue, page 1) he gave a personal view on why a broad and balanced programme is also a must for the continued well-being of CERN.

Around the Laboratories

CERN
Letting them sulphur

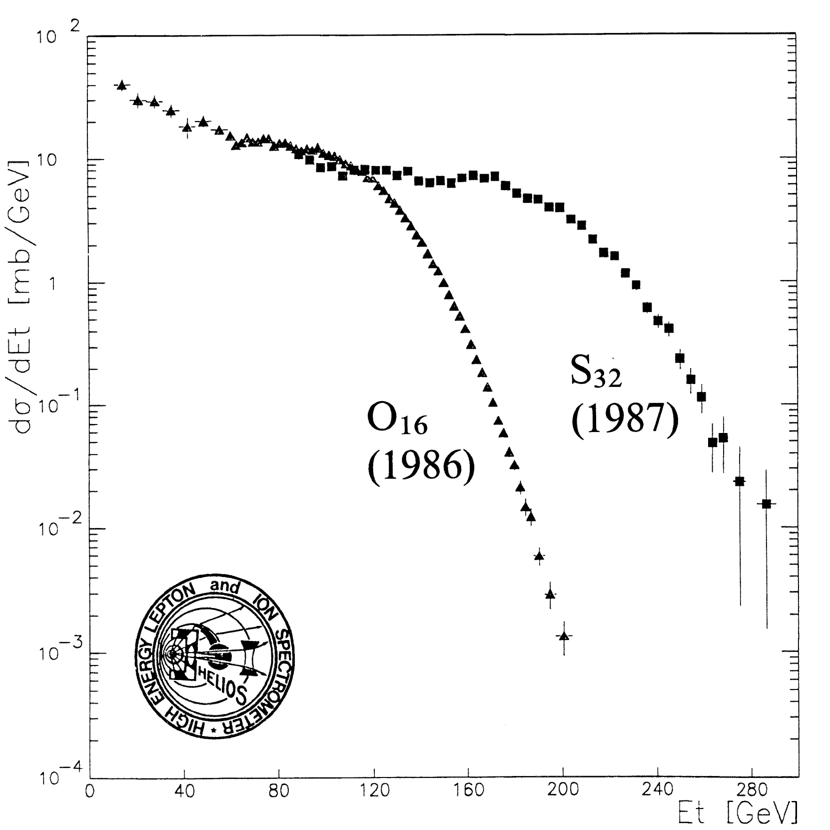
For several weeks during September and October, the CERN accelerators handled sulphur 32 ions, with the SPS synchrotron reaching 6400 GeV (6.4 TeV, 200 GeV per nucleon) surpassing CERN's previous world energy record of 3.2 TeV set last year with oxygen 16 ions at 200 GeV per nucleon.

The heavier ions provide increased energy densities to extend the physics insights into the behaviour of 'hot' nuclear matter, and in particular to look for signs of the long-awaited 'quark-gluon plasma', when quarks and gluons will finally gain enough energy to break loose from their conventional confinement in nucleons.

To provide the heavier particles, the ion source feeding the CERN accelerator chain (Linac 1/Booster/PS proton synchrotron/SPS) has been fitted with a new Electron Cyclotron Resonance (ECR) source built by R. Geller at Grenoble and installed by GSI Darmstadt and CERN.

Similar in design to the oxygen 16 source used last year, it operates with a 15 GHz ionizing radiofrequency field to boost the yield of highly charged ions such as sulphur 32 (12+) by a factor of about 20 compared to the 10 GHz oxygen 16 source. Even so, sulphur 32 is present only as a five per cent 'contamination' of the oxygen 16 supply. But this is enough to get on with and is a step towards a 20/30 GHz source being con-

The increased 'plateau' of transverse energy resulting from the collisions of 6.4 TeV (6400 GeV) sulphur ions compared to what was seen last year with 3.2 TeV oxygen ions, as seen in the NA34 (HELIOS) experiment at CERN. Complementary results come from the WA80 ('Plastic Ball') and NA35 streamer chamber experiments.



sidered for future experiments with much heavier ions.

The synchrotrons tune up using the plentiful deuterons and oxygen 16 ions available from Linac 1. With the two varieties of ions having similar charge to mass ratio, the oxygen/sulphur mixture is accelerated in Linac 1 and the Booster. Separation takes place by manipulations at the transition stage of accelerations in the PS, so that either oxygen 16 or sulphur 32 is fed to the SPS. Four PS extraction cycles are stored in the large machine, giving a current of about 2 x 10^7 sulphur 32 ions per cycle, just above the SPS minimum for controlled acceleration. Nevertheless skilled operation of the machine ensured that eagerly waiting experiments had their first taste of sulphur after only two days of setting up and only two weeks after the SPS successfully mastered positrons (see November issue, page 19).

Among the experiments now scanning their sulphur data are the four major setups which saw action with oxygen 16 last year – WA80 (Plastic Ball), NA34 (HELIOS), NA35 (streamer chamber) and NA38 (muon pairs) – together with smaller studies, mostly using nuclear emulsions, and two big newcomers – WA85 (Omega spectrometer) and NA36 (time projection chamber).

About 400 physicists are now involved in this work. The results emerging from last year's run with oxygen ions at CERN and from lower energy studies at Brookhaven were discussed at the recent 'Quark Matter 1987' Conference at Nordkirchen (see November issue, page 5). The expected indicators of a new kind of nuclear matter (J/psi formation, two-pion interferometry and transverse energy spectra) already showed significant deviations from what would be expected from a mere superposition of nucleons and physicists hope that these trends will be accentuated with the heavier projectiles.

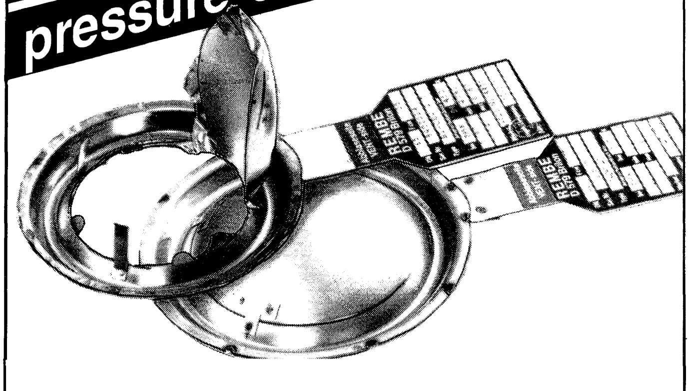
From Reinhard Stock

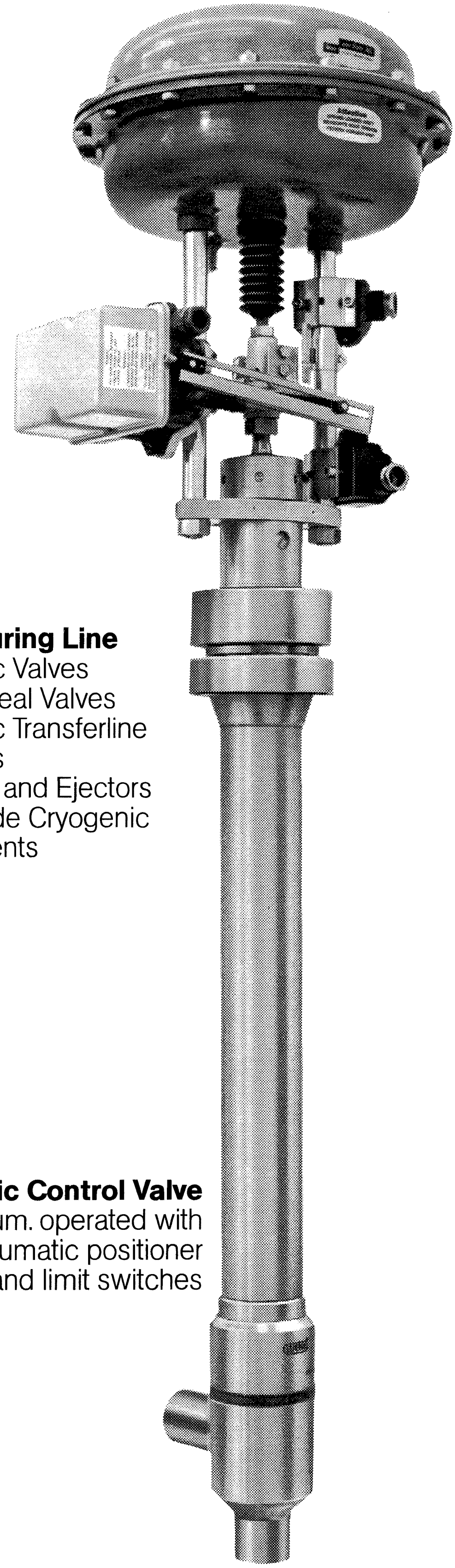
FERMILAB
First collider results

The big Collider Detector at Fermilab (CDF) intercepting the 900 GeV proton and antiproton beams in the Tevatron ring completed its first run in May. The experiment accumulated about 30 inverse nanobarns of data (about the same as the output at the CERN proton-antiproton collider in its second run back in 1982) on tape with an extremely large data acquisition system composed of 1250 FASTBUS modules of 62 different varieties. One of the most difficult things was to learn how to handle a detector of CDF's size and complexity.

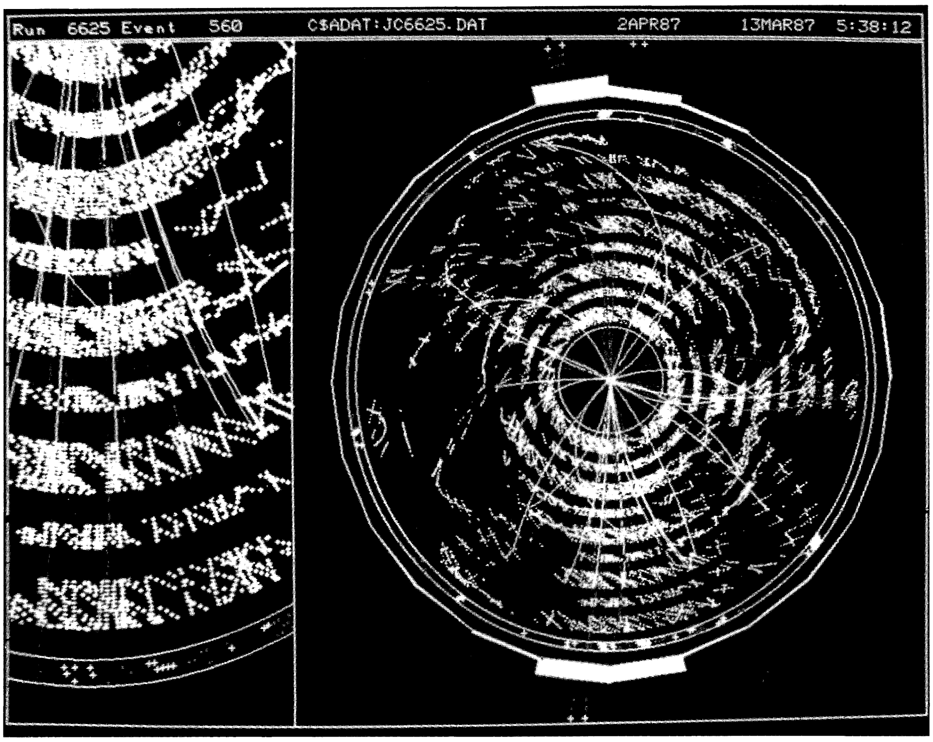
The collaboration had three initial goals – to develop the data analysis software for the data from the first run and get it ready for the next run, to check out the performance of detector hardware, and to get first hints of physics.

One of the biggest software development problems is to learn how to analyse a large amount of data involving complex events.





Production of 'jets' of hadrons in proton-antiproton annihilation, as seen in the CDF detector at Fermilab's Tevatron.



With no instruction book to follow, developing a standard reconstruction package (SRP) has been a major undertaking, involving over 1 million lines of computer code. The SRP processes a raw data tape, searching for such things as electrons, high energy jets of particles, missing transverse energy (indicative of invisible particles), and the basic types of particles expected.

The SRP then takes a subset of the data from the tape, and makes several different summary files or 'output streams' for physics analysis. This SRP processing takes several hours per tape, and with 500 tapes to process even this first pass was no mean task. The CDF collaboration is now tuning up the SRP analysis in anticipation of the upcoming run.

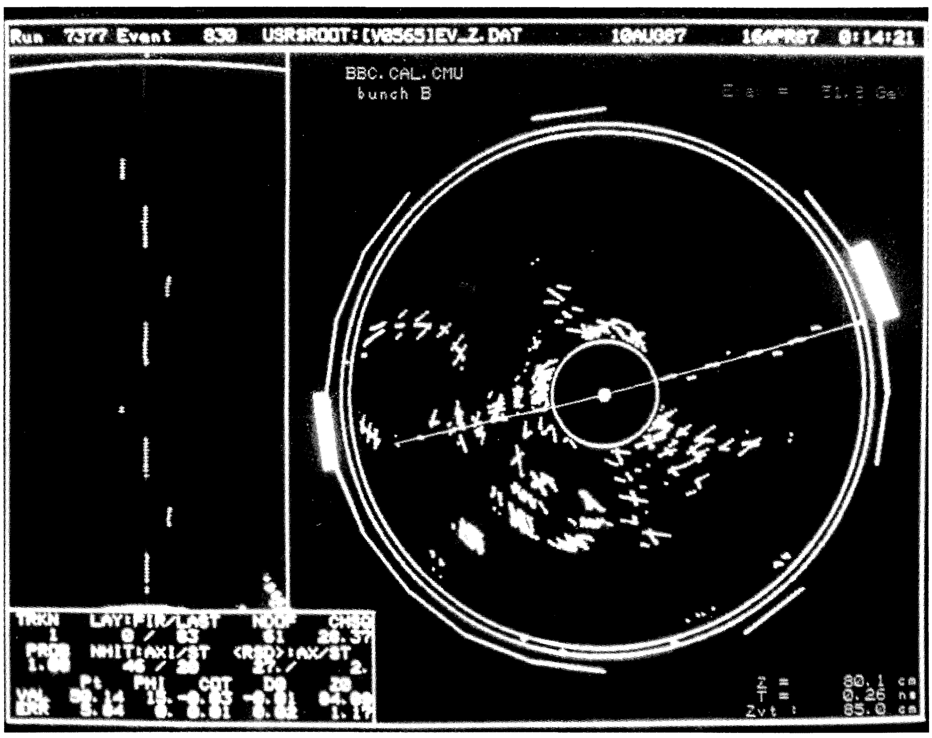
The performance of the detector hardware is gauged through 'minimum bias' analysis, looking at the average properties of all the events taken together as well as the details of each event.

Using the processed data tapes from the SRP output streams, CDF physicists have isolated promising physics events. It is premature to announce physics results during this learning process, but the electron output stream has yielded about 25 W events and 5 or 6 Z candidates (see front cover of the July/August issue). This production rate of W and Z particles – the carriers of the weak nuclear force – is roughly in line with theoretical predictions, indicating that the detector is working properly and that backgrounds are low.

The data also show a number of 'new territory' jets carrying more than 150 GeV. These particle clusters are much more complicated to analyse than the Ws and Zs because of the large number of particles produced and the complicated reconstruction process.

These preliminary 'expected'

The characteristic signal of the decay of a Z^0 – the carrier of the electrically neutral component of the weak nuclear force – seen by CDF.



physics results will probably be ready next year. With at least ten times more data expected from next year's run, the CDF team is eagerly anticipating 'discovery' physics.

With the increased energy of the Tevatron and the experience gained from the first generation experiments at CERN's proton-antiproton collider, the CDF experiment is in a good position. Co-Manager Roy Schwitters, Manager of CDF, states 'CDF's detector was built with knowledge from CERN's experiments. It's the dawn of a new generation of collider detectors both for the energy and the detector capability, and therefore one can move from the expected physics of Ws, Zs and jets into new discoveries rapidly.'

The next CDF run is scheduled to begin on 1 March.

Central computing upgrade

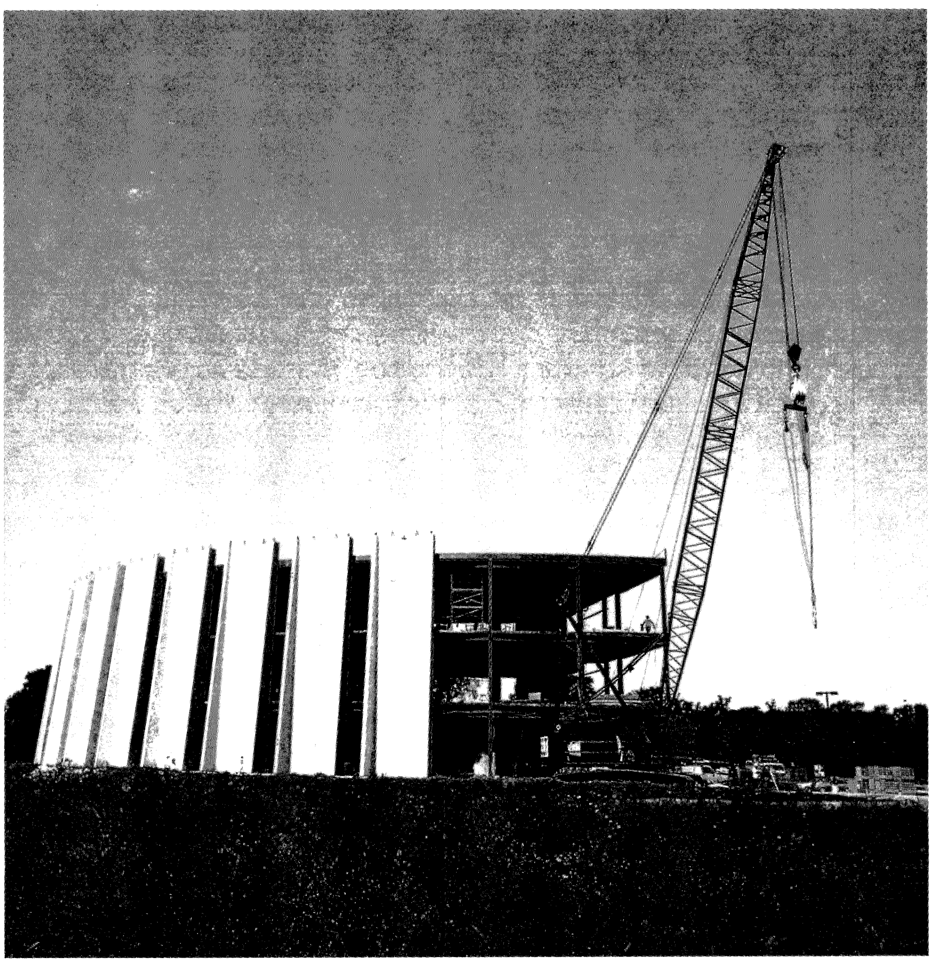
The central computing facilities at Fermilab are being upgraded in a multi-faceted project including a new building for central computing to house a new large scale scientific computer (LSSC), an expanded VAX cluster, and farms of microprocessor-based parallel processing systems. The LSSC acquisition is being evaluated prior to the award of the contract. However the building is rapidly coming to completion and is visible for all to see. The overall cost of the project is $25 million dollars, with about $9 million for the new building, scheduled for completion next spring.

The first floor will house computing hardware, a user area and a tape vault capable of storing over 150 000 10.5 inch reel tapes. In addition to the present system of 10.5 inch 6250 bpi tapes, the LSSC should be compatible with new data storage systems such as tape cartridges and optical disks.

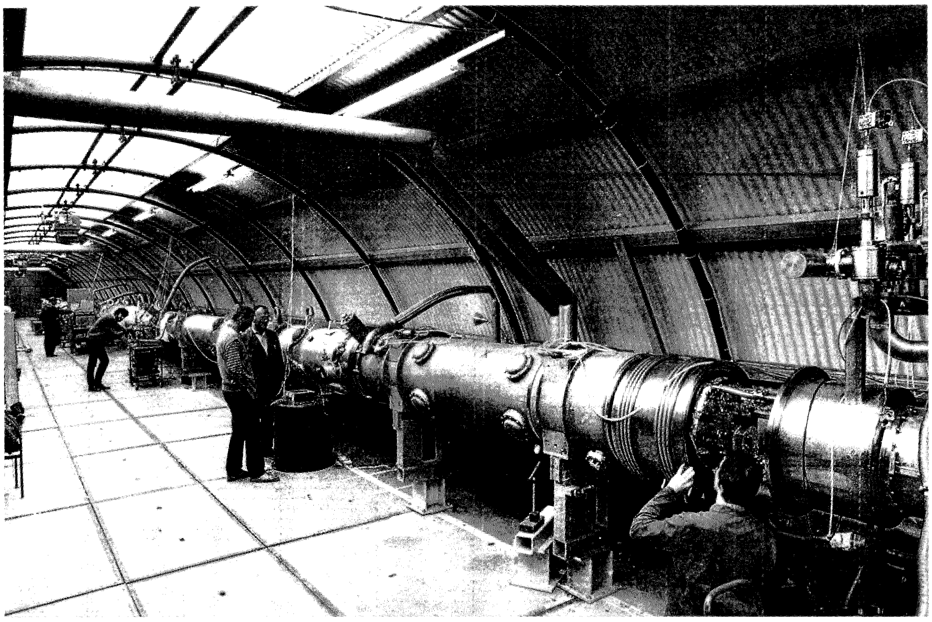
The second floor will be dominated by the LSSC mainframes and other CPUs, disk drives, and an area for maintenance. The third floor will house the Physics Research Equipment Pool (PREP) and three groups of Computing Department personnel currently housed on the 6th and 11th floors of Wilson Hall.

The Central Computing Upgrade Project is a major step to meeting the future computing needs of the Fermilab community. Now that fixed-target and colliding beam experiments are accumulating bigger data samples, the computing demand is impossible to meet with the existing computing systems. The lack of room in Wilson Hall for more equipment further complicates the problem.

Fermilab's new computer building takes shape.



36 metre chain of superconducting magnets under test at the German DESY Laboratory in Hamburg for the HERA electron-proton collider now under construction.



KEK
Eventful year

Just one year ago, the three-kilometre TRISTAN ring at the Japanese KEK Laboratory saw its first electron-positron collisions. In a few months of actual running time it has gone on to achieve its basic design aims and to supply important physics. While the Stanford Linear Collider struggles to achieve its hairsbreadth colliding beams and with CERN's LEP machine still two years away from switchon, TRISTAN has the high energy electron-positron stage to itself.

Earlier this year, TRISTAN supplied 25 and 26 GeV colliding beams and all three major experiments – VENUS, AMY and TOPAZ – collected good data samples (see September issue, page 25).

One of today's major particle physics preoccupations is the search for the long-awaited sixth ('top') quark. While other experiments have inferred that it is heavier than about 45 GeV, confirmation comes from direct scan of electron-positron annihilation.

Thus the three TRISTAN experiments looked closely at hadron production from annihilations at these newly available collision energies, but saw no sign of any increased activity. In addition, the shape of the hadron production patterns is in accord with a five quark picture. Thus the top quark was out of TRISTAN's reach. However next year the radiofrequency accelerating power will be boosted, and a higher energy region will be carefully scanned.

Physicists had been bewildered by the isolated muons accompanied by a broad spread of hadrons reported by some experiments at the PETRA electron-positron ring at the German DESY Laboratory in Hamburg in data collected several years ago (see September issue, page 37). As the first TRISTAN analyses got underway this year, there was a suggestion that these unexpected single muons were still there (see October issue, page 1), but now the combined weight of all three experiments is pushing these signals towards oblivion in the statistical junkyard. Nobody ever saw a corresponding effect with electrons anyway.

In October, TRISTAN started a new physics run at 27.5 GeV per beam.

DESY
Magnet string tests

A 36 metre chain of superconducting magnets built for the HERA electron-proton collider has been under test since April at DESY in Hamburg.

The magnet string is composed of three full-sized prototype dipole magnets (with coils made at DESY and mounted in cryostats at BBC-Mannheim) and two quadrupoles (made at Saclay). They are installed in a tunnel-shaped hall and mounted with an inclination of one per cent corresponding to the largest slope of the HERA tunnel. The system has its own 900 watt helium refrigeration plant and is provided with full quench protection and complete vacuum equipment, as they will be installed for HERA.

The magnet string has already been cycled several times between room temperature and liquid helium temperatures and has been kept cold for extended periods. It has been quenched more than 20 times at magnetic fields between 1.8 and 5.8 tesla, the latter corresponding to a proton beam energy of 1010 GeV (the HERA design value is 820 GeV). In these tests the current was limited by one of the prototype dipole-magnets, which was made using an old type of cable.

The total heat leak is in good agreement with the values previously measured for the individual magnets and no decremental effect

resulted from the inclination. No problems were found during the temperature cycling and the propagation of the cold front through the inclined magnet string agrees with the calculated values.

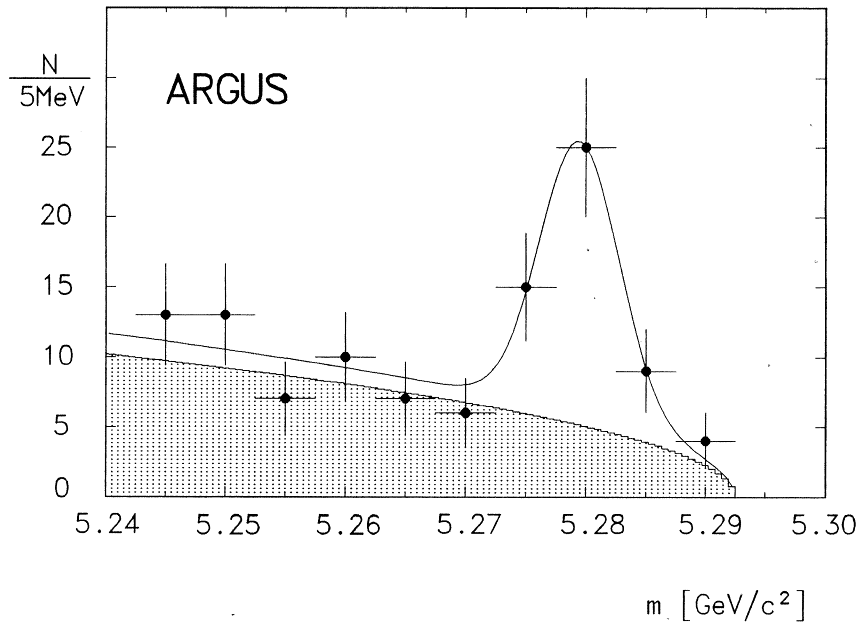
An excellent vacuum was achieved in the beampipe, kept at liquid helium temperature. The helium leak rate into the 36 metre pipe was very small and the quench protection system works reliably.

Shunt diodes kept at liquid helium temperature take over the current as soon as a magnet quenches. The resistive voltage is detected for each pair of coils in a sensitive bridge circuit and quench-heaters are fired in order to increase the quench propagation velocity in the magnet. Thus, in principle, a quench is limited to the involved coils only. However for values of the magnetic field above 4.2 tesla neighbouring magnets are also affected. The reasons for this quench propagation at higher currents are being investigated.

The reliability and easy operation of the system demonstrated that it is ready for installation in the HERA tunnel. Series production of all required components is well underway and the schedule is still in good shape.

HERA injection

In November, a 7 GeV electron beam was successfully injected into the first completed portion of the HERA electron-proton collider at DESY in Hamburg, passing through the initial 130 metres of the 6.3 km ring.



The B meson signal reconstructed from decays producing a proton and an antiproton together with one or two pions seen by the ARGUS experiment at the German DESY Laboratory.

Beauty without charm

All the beauty in a beauty (b) quark does not live for ever. Eventually it will decay through the weak nuclear force, transforming into a charm (c) quark or possibly an 'up' (u) quark. However the relevant transition rates cannot be predicted by the Standard Model of today's physics. They depend on fundamental parameters – elements of the Cabibbo-Kobayashi-Maskawa (CKM) matrix – which so far can only be measured from experiments.

Many experimental groups provided input by studying the spectrum of leptons emitted in the decay of B mesons, providing an upper limit for the ratio of the relevant CKM matrix elements, however no significant evidence was found for the charmless decay of a b quark to a u quark.

At the recent Hamburg Lepton-Photon Symposium (see September issue, page 4), the ARGUS group working at the DORIS electron-positron collider at the German DESY Laboratory in Hamburg reported the first evidence for the charmless b/u transition from the rare decays of a positively charged B meson into a proton, an antiproton and a positive pion, and a neutral B meson into a proton, an antiproton and a charged pion pair. The (preliminary) measured branching ratios are $(3.7 \pm 1.3 \pm 1.4) \times 10^{-4}$ and $(6.0 \pm 2.0 \pm 2.2) \times 10^{-4}$ respectively.

Since baryon production in B meson decays is not well understood, this new observation could only provide a lower limit for the ratio of CKM matrix elements, which is now confined to a definite range. Inevitably there have been speculations about definite relations between CKM matrix elements. Only new and more precise measurements will be able to decide if this leads to new physics.

The world's largest superconducting magnet, designed and constructed at the UK Rutherford Appleton Laboratory for the DELPHI experiment at CERN's LEP electron-positron collider, threads its way through the narrow by-ways of Southern England in October on the first leg of its journey to CERN. 7.4 m long, 6.2 m in diameter and providing a magnetic field of 1.2 tesla over a volume of 145 m³, the magnet continues its journey by ship to Rotterdam, by Rhine barge to Strasbourg and finally by road to Geneva.

(RAL Photoservices)

RUTHERFORD APPLETON
DELPHI's coil hits the road

The world's largest superconducting solenoid, designed and constructed at the UK Rutherford Appleton Laboratory for the DELPHI experiment being built for CERN's LEP electron-positron collider, hit the road in October on the first stage of its 1600 kilometre journey to Geneva.

7.4 metres long and 6.2 metres in diameter, the 84 tonne coil will supply a magnetic field of 1.2 tesla over a volume of 145 m^3. It is wound on the inside of its containing cylinder, which thus holds the magnetic pressure, equivalent to six atmospheres.

The 20 kilometres of current-carrying superconducting cable contain 17 wires 700 microns in diameter, each wire consisting of 300 niobium-titanium filaments 25 microns across, embedded in a copper matrix. The cable is sheathed in high purity aluminium.

The coil's transport arrangements include overland from RAL to Southampton, boat to Rotterdam, Rhine barge to Strasbourg, and finally overland to Geneva. Unfortunately the havoc in the wake of the freak winds which hit Southern England in October meant that the coil missed its scheduled boat. However this is not the first mishap to have hit the arrangements for DELPHI, and the experimenters are still confident of intercepting the first electron-positron collisions in LEP in 1989.

WORKSHOP
Variational methods

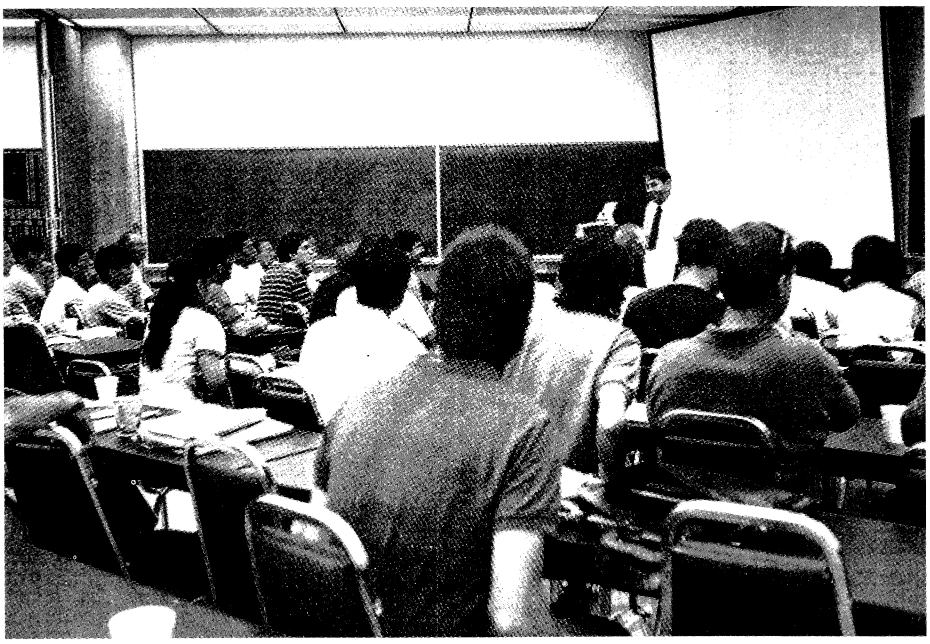
The first international workshop on the application of variational methods to quantum field theory took place on the German North Sea island of Wangerooge from 1-4 September.

Although the Rayleigh-Ritz variational principle and its generalizations have been successfully used for many years in quantum mechanics and many-body theory, it is only recently that they have attracted comparable attention in high energy physics. This intuitive approximation scheme offers an interesting complement to the primarily 'number-crunching' approaches using present-day supercomputer Monte-Carlo calculations. Topics at the meeting included accurate and improved variational methods; applications to quantum chromodynamics, both qualitative

▲ *Richard Feynman – variational methods in the North Sea.*

(Photo K. Yamazaki)

▼ *Mel Month addresses this year's US Particle Accelerator School, held at Fermilab from 20 July to 14 August.*



and quantitative; and consequences for scalar theories and spontaneous symmetry breaking.

However many problems still remain before this appealing calculational scheme can truly be considered a practical tool. This was emphasized in a final address by Richard Feynman – originator of many of the ideas discussed. Nevertheless participants were optimistic that, with due care, variational methods could provide yet another scheme for understanding the workings of Nature's fundamental forces.

The workshop was sponsored by the Volkswagen Foundation and organized by David Pottinger (Dortmund) and Ebs Hilf and Lutz Polley (Oldenburg).

From L. Polley and D. Pottinger

ACCELERATORS
School report

The expanded 1987 US Particle Accelerator School, held at Fermilab from 20 July to 14 August, included two two-week sessions. In the first, 101 students covered three university-style courses, listed as upper-division University of Chicago physics, covering the fundamentals of particle beams, magnetic optics and acceleration; relativistic electronics; and high energy storage rings.

The 180 participants in the second session profited from 24 short courses presented by experts and covering a wide variety of topics in the physics and technology of particle accelerators.

This summer also saw the second in the biennial series of advanced accelerator physics courses organized by the CERN Accelerator

People and things

School (CAS). Held at the Johannesstift, West Berlin, it benefited from the assistance of BESSY-Berliner Elektronenspeicherring-Gesellschaft für Synchrotronstrahlung. Over a hundred participants covered the intense course and supplementary seminars on accelerator-related topics.

CAS schools for 1988 include Superconductivity in Particle Accelerators (Hamburg, 30 May-3 June), the third General Accelerator Physics Course (Salamanca, Spain, 19-30 September) and Frontiers of Particle Beams – Diagnostics (jointly with the US Accelerator School, Capri, Italy, 19-26 October). Further information from Mrs. S. von Wartburg, CERN Accelerator School, LEP Division, CERN, 1211 Geneva 23, Switzerland.

The programme of the advanced accelerator course organized by the CERN Accelerator School and held in Berlin in September included a visit to the BESSY synchrotron radiation facility. BESSY also provided valuable support and assistance for the course.

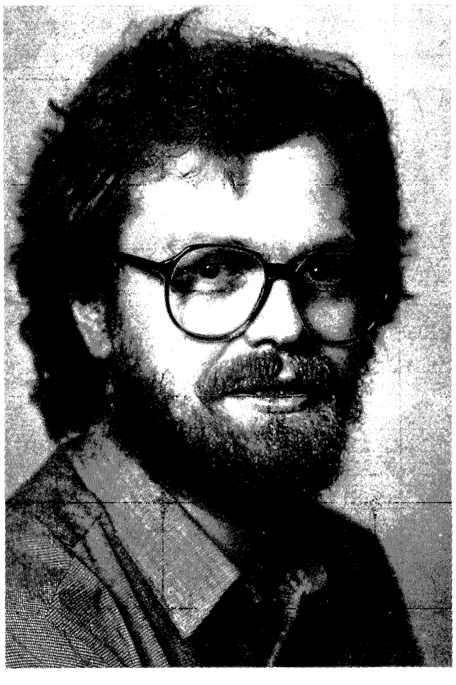
On people

Thomas Weiland from DESY, well known for his work on wake-field accelerators and for his methods for calculating electromagnetic fields under complicated geometrical conditions, was awarded one of the twelve science prizes distributed this year by the 'Deutsche Forschungsgemeinschaft'. The prize allows him to request and use up to three million DM during the next five years for his research work.

In January, friends and colleagues will gather to celebrate the 60th birthday of Andrei Amatuni, Director of the Yerevan Physics Institute, Armenia, USSR, since 1973. He is well known for his work on the theory of transition radiation, on particle physics and for his accelerator ideas. He is also an enthusiast of international collaboration.

▲ *Andrei Amatuni, Director of the Yerevan Physics Institute, Armenia, USSR.*

▼ *Thomas Weiland – German research award.*



The 20 tonne superconducting coil for the CLEO II detector at Cornell's CESR electron-positron collider leaves the factory at Oxford Instruments Ltd (UK). Producing a magnetic field of 1.5 tesla in a length of 3.8 metres and a diameter of 2.9 metres, the coil is made of fourteen kilometres of special aluminium stabilized niobium-titanium, wound in two layers on the inside of an aluminium cylinder.

Books

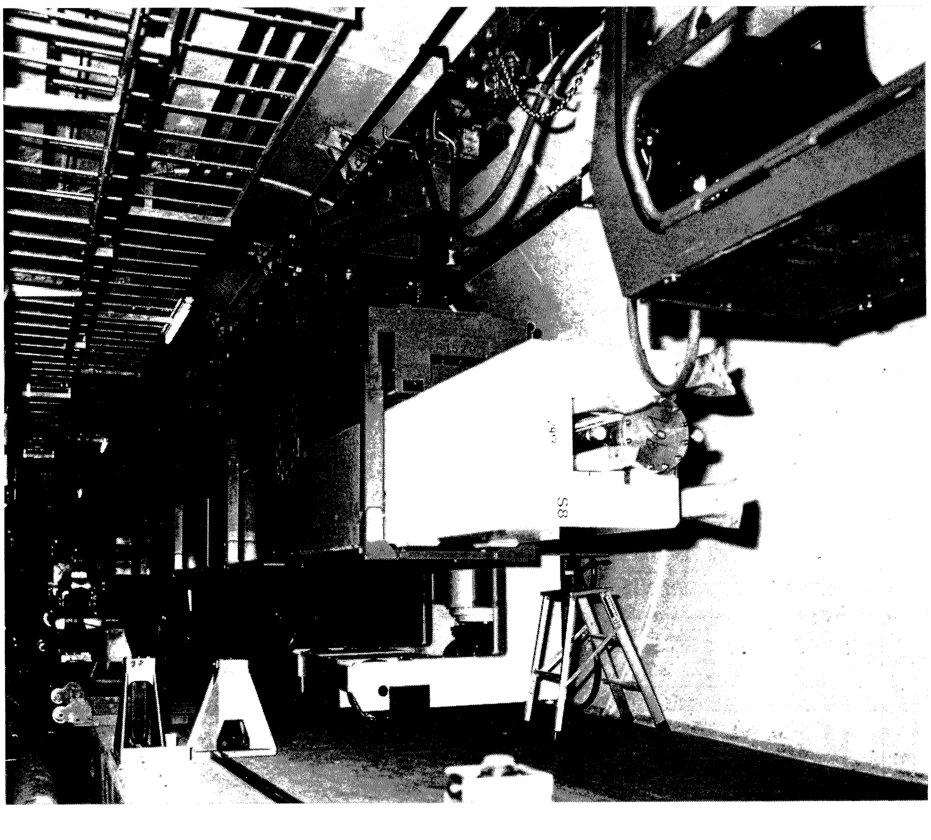
Following 'Réflexions d'un physicien' (Hermann, 1983), eminent French physicist Anatole Abragam (Chairman of the CERN Review Committee) is in print again, this time with 'De la physique avant toute chose' (Editions Odile Jacob, Paris). Although an autobiography, the book includes pen sketches of other physicists, and a mine of anecdotal material. With a system of single and double asterisks, the author signposts the more general reader through interesting areas of modern physics.

John Bell of CERN has long been regarded as one of the world's experts on the intriguing implications of quantum theory. 'Speakable and unspeakable in quantum mechanics' (Cambridge University Press) is a collection of his landmark papers on quantum philosophy.

ESO/CERN Symposium

The third symposium 'Astronomy, Cosmology and Fundamental Physics' organized by CERN and ESO (European Southern Observatory) will be held in Bologna, Italy, from 16-18 May on the special occasion of the ninth centenary of the University of Bologna. Participation is by invitation only. Further details (for particle physicists) from L. Van Hove, CERN TH Division, CH-1211 Geneva 23, Switzerland, or G. Giacomelli, Dip. to di Fisica, Via Irnerio 46, 40126 Bologna, Italy, and for astrophysicists from G. Setti - ESO, Karl-Schwarzschildstr. 2, D-8046 Garching bei München, West Germany, or A. Renzini, Dip. to di Astronomia, Via Zamboni 33, 40126 Bologna, Italy.

▼ Equipped with its vacuum chamber, the first of 1640 pairs of dipole magnets for CERN's LEP electron-positron collider ring is eased down from the monorail transporter for installation in the 27 kilometre tunnel.



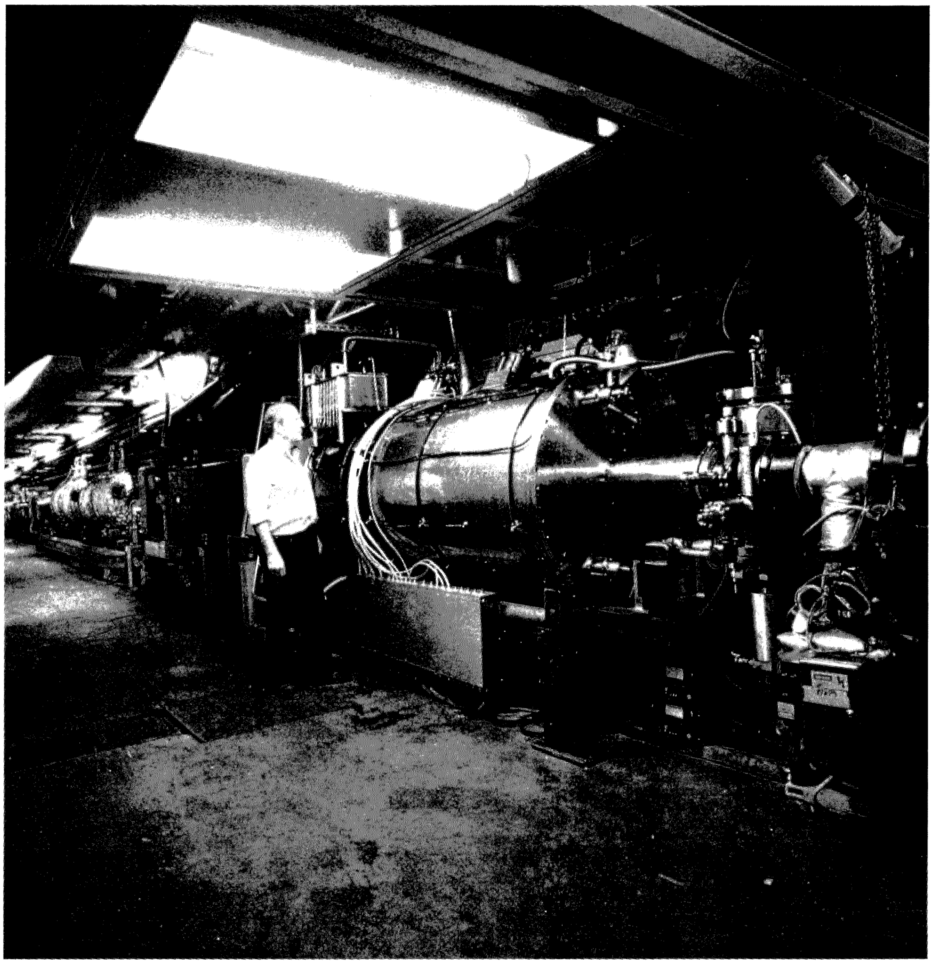
Marcello Conversi – 70th birthday symposium

Marcello Conversi 70

Friends and colleagues of Marcello Conversi gathered in Rome on 3-4 November for a symposium 'Present Trends, Concepts and Instruments of Particle Physics' to mark his 70th birthday. In 1946, Conversi, together with Ettore Pancini and Oreste Piccioni, showed that the cosmic ray 'mesotron' was the muon rather than the pion. Later his influential Pisa school produced famous Italian names in particle physics.

Superconducting accelerating cavities in action

At CERN, a prototype superconducting accelerating cavity of the type envisaged for LEP beams has been installed for tests in the SPS ring, where it helped take an electron beam to 18 GeV. Earlier, the SPS had demonstrated its ability to handle electrons (see November issue, page 19) in preparation for its new role as the LEP injector. Meanwhile at the German DESY Laboratory, a superconducting cavity designed to handle the electron beams in the HERA electron-proton collider now under construction performed well in tests at the DESY PETRA ring. At the Japanese KEK Laboratory, a test cavity was successfully tested some time ago in the Accumulator Ring of the TRISTAN electron-positron collider, providing valuable experience for the larger units proposed for boosting energies in the TRISTAN main ring.



The prototype superconducting accelerating cavity for the LEP electron-positron collider at CERN, seen here in position in the SPS ring where it has performed well in tests.

(Photo CERN X68.8.87)

THE PHYSICS DEPARTMENT
AND
THE INSTITUTE FOR NUCLEAR AND PARTICLE PHYSICS

THE UNIVERSITY OF VIRGINIA

Faculty positions in

HIGH ENERGY EXPERIMENTAL PHYSICS

Applications are invited for a new program in high energy experimental physics. In the anticipation of the formation of a new group, we invite applicants for tenure, tenure-track, and research positions. Senior applicants are expected to lead a vigorous program of research.

These positions will be in both the Physics Department and the Institute for Nuclear and Particle Physics, or could be shared between the two administrative entities. Salary, level of position, start-up funds, and other support will be commensurate with the demonstrated accomplishments and experience of the applicant.

Please send resume, statement of research interests, and references to:

The Chairman
Physics Department
University of Virginia
Charlottesville, Va. 22901

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UNIVERSITY OF HOUSTON

RESEARCH IN ACCELERATOR PHYSICS (Theory)

Post Doctoral Research Associate

An opening exists at the University of Houston for a Post Doctoral Research Associate. Recent Ph.D's (0-3 years or equivalent experience) in high energy, nuclear or plasma physics with strong background in computer usage are encouraged to apply.

The work will be in nonlinear beam dynamics, beam-beam interaction in storage rings, high-intensity linacs and other theoretical problems in accelerator physics.

This person will initially work at the Texas Accelerator Center (30 miles north of Houston) with other physicists and engineers from the University of Houston, Texas A & M University, Rice University and University of Texas, Austin.

Applicants should send curriculum vitae with names of three references to:

Sho Ohnuma,
Physics Department,
University of Houston,
University Park,
4800 Calhoun Road,
Houston, TX 77004.

The University of Houston is an Equal Opportunity/Affirmative Action Employer.

Faculty Positions

Experimental High Energy Physics Space Physics Experimental Nuclear Physics

The University of Kansas invites applications for three tenure-track positions at the Assistant or Associate Professor level in the Department of Physics and Astronomy. Individuals having strong research interests, experience, and capabilities in the experimental areas of particle, nuclear, and space physics are sought.

Two positions are tenable in fall, 1988 and one in fall, 1989. Consideration of applicants will begin on January 15, 1988 and continue until these positions have been filled.

Requirements are: PhD in physics and demonstrated research achievement in one of the specified areas. Duties include the conduct and supervision of research as well as graduate and undergraduate teaching. The particle physics group is currently involved in the ARGUS collaboration at DESY as well as research at Fermilab, and is supported by the NSF. The space physics program is currently involved in NASA flight projects for Voyager, Galileo, and Ulysses as well as solar terrestrial research funded by the NSF. The nuclear physics program is currently involved in heavy-ion accelerator physics and is funded by the DOE. Salary range is from $ 32,000 to $ 45,000 for the 9-month academic year; starting salary and rank depend on qualifications and experience.

Applications should be sent to:

Professor J.P. Davidson,
Chairman
Department of Physics and Astronomy,
University of Kansas,
Lawrence, Kansas, 66045,

and should include a curriculum vitae, a statement of professional plans and the names of three references.

The University of Kansas is an Affirmative Action/Equal Opportunity Employer. Applications are encouraged from all qualified people regardless of race, religion, color, sex, disability, veteran status, national origin, age or ancestry.

UNIVERSITÄT DORTMUND

Am **Fachbereich Physik** ist ab sofort die Stelle eines(er)

Professors/rin
(Bes.-Gr. C 4)

für «Experimentelle Physik IV» wiederzubesetzen.

Der (die) Bewerber(in) soll auf dem Gebiet der experimentellen Elementarteilchenphysik arbeiten. Am Fachbereich ist eine Infrastruktur vorhanden, die die Entwicklung und den Bau grosser Detektoren ermöglicht.

Es wird erwartet, dass der (die) Bewerber(in) das Fach in Forschung und Lehre selbständig wahrnimmt und sich an der Selbstverwaltung angemessen beteiligt.

Habilitation oder habilitationsadäquate Leistungen werden vorausgesetzt.

Bewerbungen mit den üblichen Unterlagen (Lebenslauf mit Unterlagen zum wissenschaftlichen Werdegang, Liste der wissenschaftlichen Arbeiten, Angaben über bisherige Lehrtätigkeit) sind bis zum 15. Februar 1988 zu richten an den

Dekan des Fachbereichs Physik
der Universität Dortmund
Postfach 500 500
D – 4600 Dortmund 50.

Meetings

The 13th International Conference on Neutrino Physics and Astrophysics (NEUTRINO 88) will be held in Boston, Massachusetts from 5-11 June 1988. The conference is being jointly organized by the six universities: Boston, Brandeis, Harvard, MIT, Northeastern and Tufts. Further information from J. Schneps, NEUTRINO 88, Department of Physics, Tufts University, Medford, MA 02155, USA.

The 13th International Symposium on Discharges and Electrical Insulation in Vacuum (ISDEIV) will be held in Paris (Conservatoire national des Arts et Métiers – CNAM) from 27-30 June 1988. Further information from the Secretary, Prof. A. Septier, CNAM, 292 rue Saint-Martin, 75141 Paris Cedex 03.

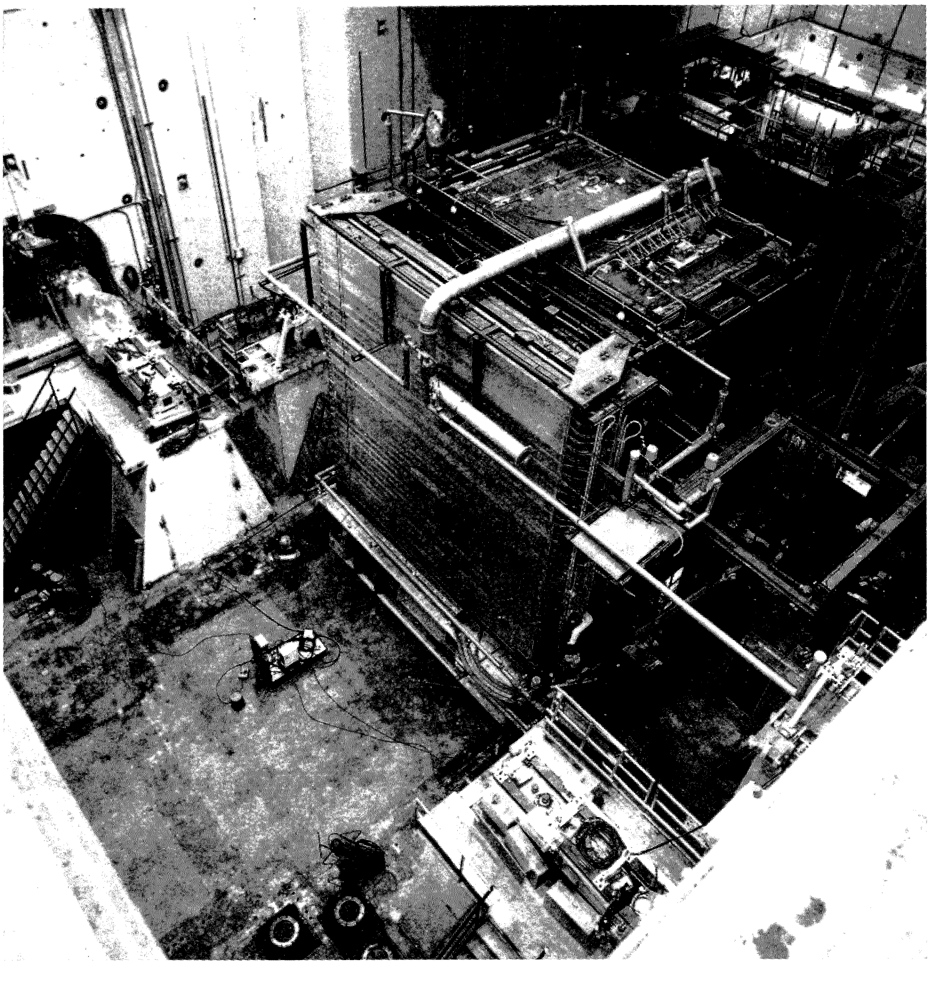
The Landau Memorial Conference on Frontiers of Physics will be held at Tel Aviv University, Israel, from 6-10 June. Topics will include quantum systems, physics far from equilibrium, topological applications, and cosmology. Further information from A. Voronel, Physics Dept, Tel Aviv University, Ramat Aviv, 69978 Tel Aviv, Israel.

The Second Argentine Seminar on Geometry, Relativity and Gravitation will be held at Vaquerias, Cordoba, from 14-18 March. Topics include superstrings, asymptotically flat spacetimes and quantum gravity. Further information from Reinaldo Gleiser, Walter Lamberti or Jorge Pullin; Relativity Group (Vaquerias 2), FAMAF, Laprida 854, 5000 Cordoba, Argentina, telex: 51822 BUCOR AR, 51739/51959/51961 ENTEL AR, tel: 0054 - 51 - 40669/40802/ 40613/36876.

Electronic Mail

The CERN Courier editorial desk can be contacted through electronic mail using the EARN/BITNET communications network. The Editor's address is

COURIER@CERNVM



In October, the considerably revamped Mark II detector was rolled into position at the beam collision point of the new SLC Stanford Linear Collider. The SLC is scheduled to restart in January, leading to physics with electron-positron collisions next spring.

UNIVERSITY OF GENEVA

(Switzerland)

Faculty of sciences

DEPARTMENT OF COMPUTER SCIENCE

Applications are invited for a tenure faculty position at the Full Professor level (or possibly Associate Professor level) starting October 1988.

Duties include research in computer science and applications, undergraduate and graduate teaching, thesis supervision and participation in administrative work.

A Ph. D. in computer science or a closely related discipline is required.

A good knowledge in French will be an asset.

Applications should be received by December 31st 1987.

Please send resume, updated list of publications and the names of three or more references to:

Doyen de la Faculté des Sciences
20, quai Ernest-Ansermet
CH–1211 GENEVA 4 (Switzerland)

UNIVERSITY OF WISCONSIN-MADISON

TENURE TRACK

FACULTY POSITION IN PHYSICS

The Department of Physics, University of Wisconsin-Madison may offer one or more tenure track positions at the assistant professor level (unless the qualifications require higher rank) to begin Fall 1988 or later.

Applicants should provide evidence of teaching skills and ability to carry out an independent research program.

Preference will be given to experimentalists in nuclear physics, elementary particle and/or accelerator physics, plasma physics, and to theorists for elementary particle and for plasma physics.

Apply before February 1, 1988 to:

Hugh T. Richards, Chairman
Department of Physics
University of Wisconsin-Madison
1150 University Avenue
Madison, WI 53706
(608) 263-3279

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VANDERBILT UNIVERSITY

Director

Free Electron Laser Center for Biomedical and Materials Research

Vanderbilt University invites applications for the position of Director, Free Electron Laser Center for Biomedical and Materials Research. The Center is a broadly based interdisciplinary collaboration including researchers from physics, molecular biology, the clinical and biomedical sciences, and materials science. The Center is funded for the construction of a broadly tunable, ultra-short-pulse FEL, and for research on thermal and non-thermal interactions of laser light with matter.

The Director will be expected to lead the construction, operation and future development of the free-electron laser; to carry on a vigorous program of research either in FEL physics / engineering or in the scientific fields represented in the Center's program; to develop long-range external funding for the operation of the FEL Center; and to fulfill appropriate academic duties of teaching, supervision of graduate students and university service. The appointment is a regular faculty position with rank, salary and home department all to be determined by the experience and interest of the successful candidate.

The selection criteria to be applied in evaluating candidates include: overall scientific excellence; experience in the construction, operation and development of free-electron lasers, storage ring radiation sources, large laser systems, or accelerators; demonstrated ability to attract significant funding for research; and demonstrated ability to manage major experimental research projects.

The deadline for applications is January 15, 1988; the University desires to fill the position no later than the fall semester, 1988. Interested persons should send a curriculum vitae, including the names of at least four references, to:

Professor Norman H.Tolk, Chair
FEL Director Search Committee
Department of Physics and Astronomy
Vanderbilt University, Nashville, TN 37235
(615) 322-6438

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THE UNIVERSITY OF LEEDS

Department of Electrical and Electronic Engineering

CHAIR OF ENGINEERING SOFTWARE

Applications are invited for a new Chair of Engineering Software. The appointment to the Chair will be associated with a further appointment to a Senior Lectureship. The successful applicant will have unusual opportunities to develop this important new area, both establishing his/her own interests and building on a wide range of existing teaching and research.

The appointment will be made from a date and at a salary to be arranged with the successful candidate.

Further particulars may be obtained from:

The Registrar
The University
Leeds, LS2 9JT
West Yorkshire, United Kingdom

quoting reference 66/45. Applications (two copies) giving details of age, qualifications and experience, and naming three referees, should reach the Registrar not later than 31 December 1987.

Applicants from overseas may apply in the first instance by cable, telex (556473 Unilds G) or facsimile (0532–420090), naming three referees, preferably in the United Kingdom.

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These rates are effective for the year 1988.

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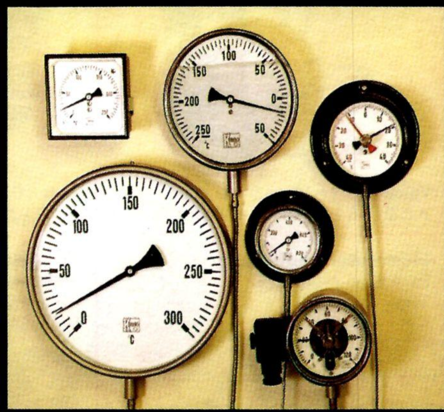
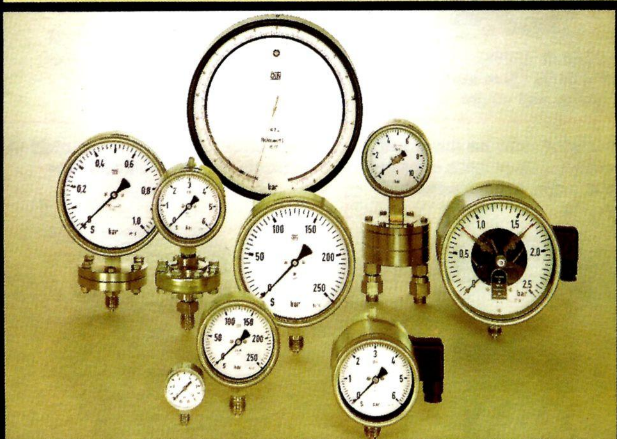


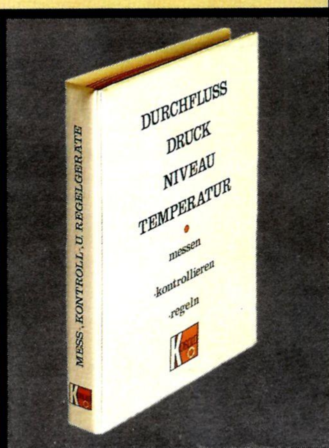
Flow measurement
Indicating instruments, controllers and recorders

Pressure measurement
Liquid column devices and switches

Level measurement
Indicating instruments, controllers and recorders

Temperature measurement
Thermometers, controllers and monitors

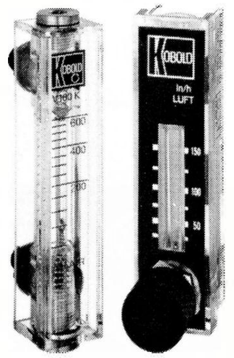




Sodener Straße 120
D-6233 Kelkheim
Postfach 2052
☏ (0 61 95) 69 11/69 72
Tx 4 072 326 komr d

Flow measurement

Microvolume flowmeters
with or without needle valve
in **polycarbonate, polysulfone and acrylic glass**

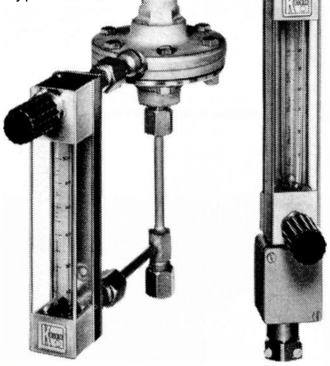


Water: 0.1 - 1.5 l/h to 5 - 80 l/h
Air: 0.5 - 5 L_n/h to 0.2 - 2.6 Nm^3/h

Microvolume flow controllers
Explosion-proof iG 5
Types: KSR and SVN

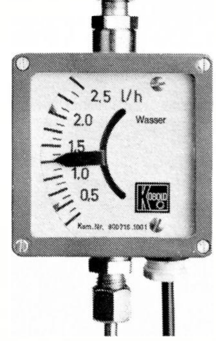
Water: 0.1 - 120 l/h
Air: 2 l_n/h - 2 Nm^3/h

Microvolume flowmeter/ controllers
Explosion-proof iG 5
Types: KDG/KDF



Water: 0.002 - 0.02 to 16 - 160 l/h
Air: 0.03 - 0.3 l_n/h to 430 - 4300 l_n/h

All-metal microvolume flowmeter/controllers
Explosion-proof iG 5
Type: KM

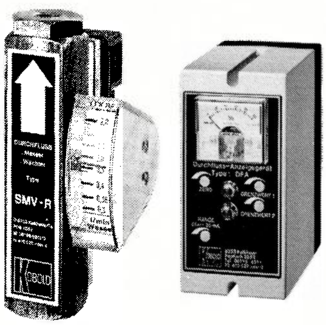


PN 40 - PN 100/–20 … +150 °C
Water: 0.1 - 1 l/h to 25 - 250 l/h
Air: 4.5 - 45 l_n/h to 0.8 - 8 Nm^3/h

Flowmeter/controllers
Explosion-proof iG 5
Type: SV-R/S-R

Water: 6 - 60 l/h to 0.5 - 9 m^3/h
Air: 0.2 - 2 Nm^3/h to 20 - 250 Nm^3/h

All-metal flowmeter/controllers with analog output
Explosion-proof iG 5
Type: SMV-R/VKM-G

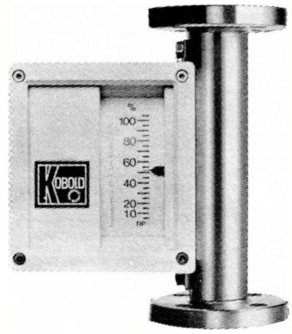


PN 350/–50 °C … +160 °C
Water: 3 - 60 l/h to 0.5 - 15 m^3/h
Air: 3 - 35 l/h to 20 - 400 Nm^3/h

Flowmeters and controllers with analog output independent of viscosity and location
Types: VKG and VKM

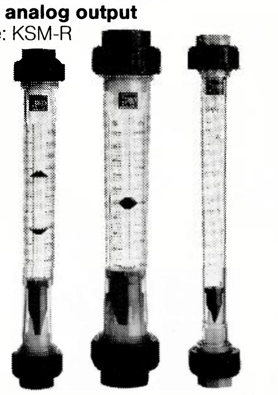
Viscosity range: 1 - 5000 mm^2/s
e. g.: 0.01 - 0.07 to 8 - 80 l/min of oil

All-metal flowmeters and controllers with analog output
Type: MC



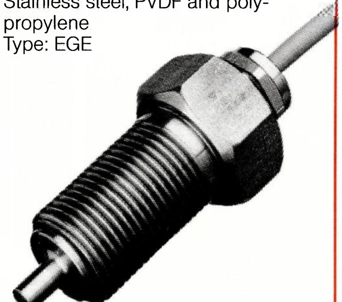
PN 40 - PN 600 / –50 … +300 °C
Water: 2.5 - 25 l/h to 10 - 100 m^3/h
Air: 75 - 750 l_n/h to 180 - 1800 Nm^3/h

Trogamid and polysulfone flowmeter/controllers with analog output
Type: KSM-R



Water: 16 - 160 l/h to 2 - 20 m^3/h
Air: 0.25 - 2.5 Nm^3/h to 58 - 580 Nm^3/h

Electronic flow controllers
for gases, liquids and powders
Media: $\triangle$p=O
Stainless steel, PVDF and poly-propylene
Type: EGE

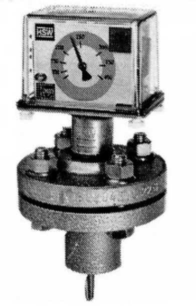


Liquids (incl. **highly viscous):**
0.01 - 4 m/s.
Gases: 0.1 - 15 m/s
PN 300/–40 … + 90 °C

Flow sensors proportional to differential pressure
Type: Beta-Probe

Error: ± 0.5% or ± 2%
R ½" - R 2"/DN 50 - 9 m lead dia
Liquids, gases and steam

Paddle-bellows flowmeters and controllers for heavily contaminated media
Types: HSW - DWU/-DWP/-DWS



Pipe connection 3/8" - 2"
Flange connection DN 10 - DN 50
Slip-on flange for DN 40 - DN 1000
1 - 4 l/min to 10 000 m^3/h
PN 6 - PN 10 / 100 °C

Paddle flow controllers

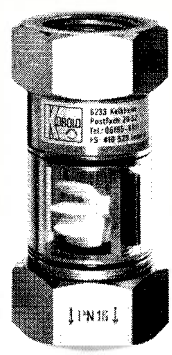
Type: PSR	Type: PPS-3S
Brass and stainless steel	Polysulfone

3 - 5 l/min to 20 - 28 m^3/h	10 - 110 l/min
PN 16 - PN 25/100 °C	PN 10/110 °C

Horizontal ball-type flow indicator
Type: DA - KU

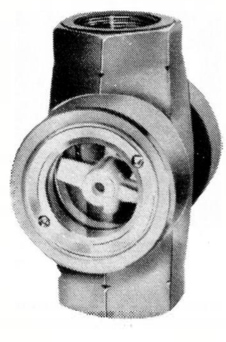
Range
Water: 0.3 l/min - 90 l/min
Air: 0.015 Nm^3/min - 200 Nm^3/h

Flow indicator, can be mounted in any position, with plastics rotor and **automatic sight-tube cleaner**
Type: DA - RA



R 1/4" - R 1 1/2"
PN 16/100 °C

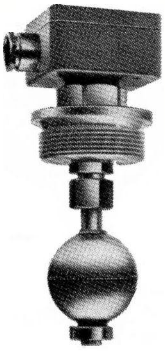
Flow indicator, can be mounted in any position, with Teflon rotor
Type: DA - R



R 1/4" - R 1 1/2" / flange DN 25/40/50
suitable for both dark opaque liquids and for gases

Measurement of level

Magnetic float switches
Type: N
180 different types in high-grade steel, titanium, brass, PPH, PVC, PVDF and PTFE

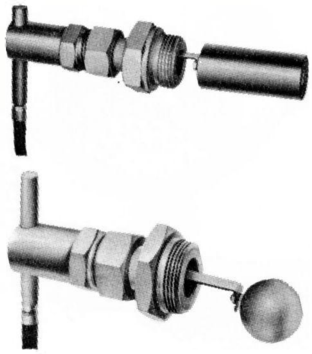


PN 100/180 °C
Den. liq. min ≥ 0.25 kp/dm³

Magnetic float switches
Type: NS
for side-fitting

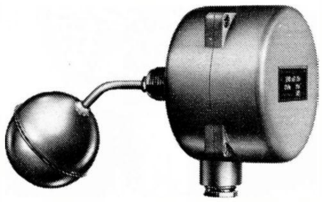
PN 100/180 °C
Den. liq. min ≥ 0.25 kp/dm³

Magnetic float switches
Type: NV ½" und NV ¾"
for side-fitting



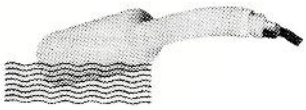
PN 18/110 °C
Den. liq. min ≥ 0.8 kp/dm³

Float switches with spring contact
Type: FNS
for side-fitting



PN 16/350 °C
Den. liq. min ≥ 0.8 kp/dm³
I_{max} = **10 A** bei 220 V ~

PTFE float switches
Type: NST
for side-fitting with **mercury contact**

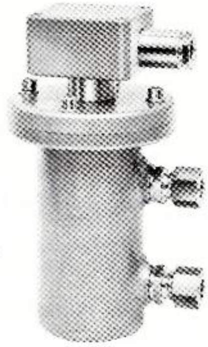


1 bar/160 °C
Den. liq. min ≥ 0.7 kp/dm³
I_{max} = **4 A** bei 220 V ~

Bypass float switches
with spring contact
Type: FNS

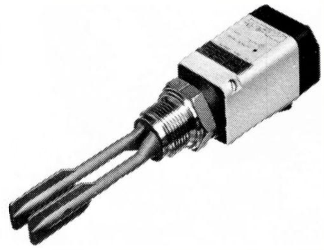
PN 16/350 °C
Den. liq. min ≥ 0.7 kp/dm³
I_{max} = **10 A** bei 220 V ~

Bypass magnetic float switches
Type: NB-10



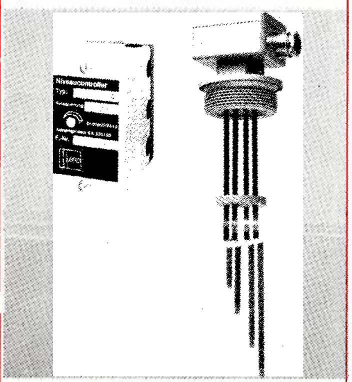
PN 10/150 °C
Den. liq. min ≥ 0.7 kp/dm³

All-purpose limit switches
for liquids
Type: FTL 160



Den. liq. min: independent
max. viscosity: 2000 mm²/s
PN 16/–40…+150° C
G x 5 Cr Ni Mo Nb 1810 austenitic steel

Limit switches for conductive fluids



PN 100/150 °C
single to quintuple electrodes

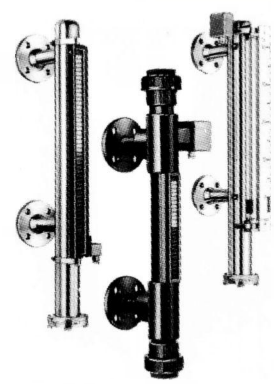
Thermal resistor switches for **nonconductive** liquids

t_{max} = –25 °C… +55 °C
max. viscosity 10 °E

Level indicators
Level pick-ups
Type: NM

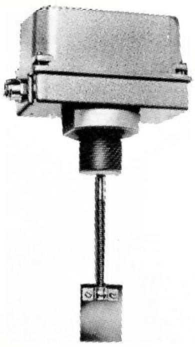
PN 25/–50 °C…+130 °C

Bypass level indicators
with magnetic transmitters
Type: BMG



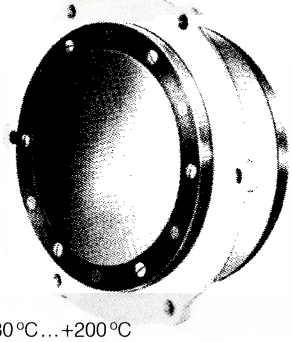
PN 350/300 °C

Vibratory level signalling devices
for heavy and viscous media with **flexible** vibratory sensor
Type: NBV



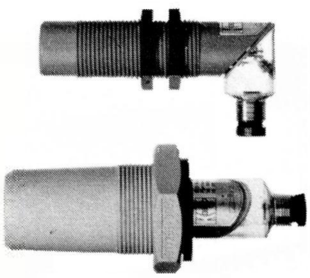
PN 6/80 °C/IP 55
R1½" or flange DN 50 - DN 150

Diaphragm-type level signalling devices for installation in silos, bunkers, etc. for coarse and fine **bulk goods**
Type: NMF



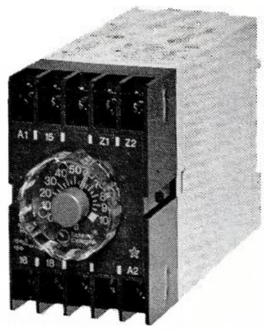
–30 °C…+200 °C
for Zone 11 explosion-proof rooms without ancillary equipment

Capacitive level switch
for fine and powder bulk goods
Type FTC 960



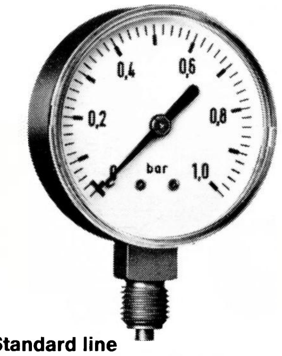
PN 6/–20…+80 °C
R1"/adapter R 1½"

Time-delay starting relays
Contact protector relays

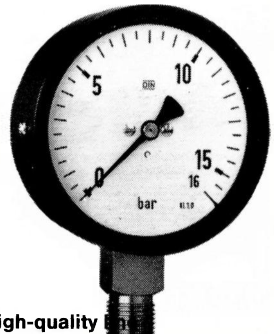


Explosion-proof relays - Zone O
Control systems

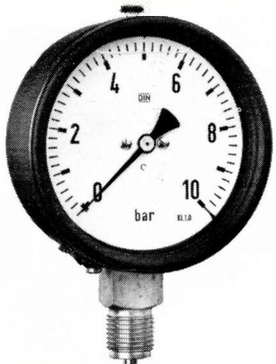
Pressure



Standard line
Diameter 40, 50, 63, 80, 100 and 160 mm,
Quality Class 2.5
Measuring range 0-1 bar to 0-400 bar

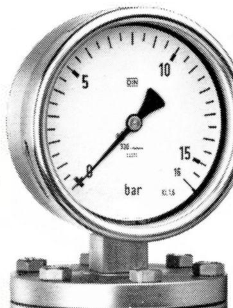


High-quality line
Diameter 52, 6[illegible], [illegible], 80, 100 and 160 mm,
Quality Class 1.0
Measuring range
0-60 mbar to 0-400 mbar
0-0.6 bar to 0-1600 bar

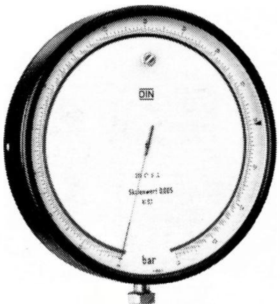


Glycerine-filled pressure gauges
Diameter 63, 100 and 160 mm
Quality Class 1.0 to 2.5
Measuring range
0-0.6 bar to 0-1000 bar

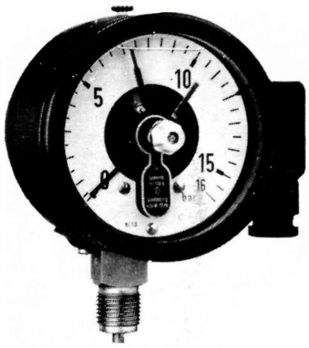
Chemical line
Diameter 40, 50, 63, 100 and 160 mm,
Quality Class 1.0
Measuring range
0-0.6 bar to 0-1000 bar



Bellows and differential pressure gauges
Diameter 100 and 160 mm
Quality Class 1.6
Measuring range
0-60 mbar to 0-400 mbar
0-0.6 to 0-25 bar

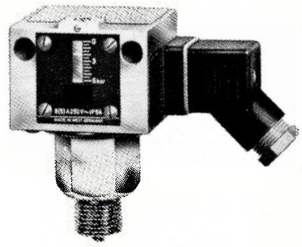


Precision pressure gauges
Diameter 160 mm, Quality Class 0.6 and 0.3
Diameter 250 mm, Quality Class 0.3, 0.2, 0.1
Measuring range
0-0.6 bar to 0-1600 bar



Contact pressure gauges
- Magnetic snap-action contacts
- Crawl contacts
- Inductive contacts
- Pneumatic contacts

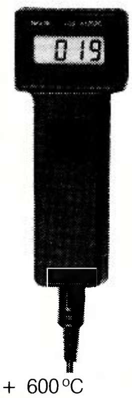
Pressure and differential pressure switches
Adjustable differential setting
Liquids, steam and gases
Type: KD/KV



–250 mbar to 100 mbar
15 bar to 63 bar
250 V AC, 10 A

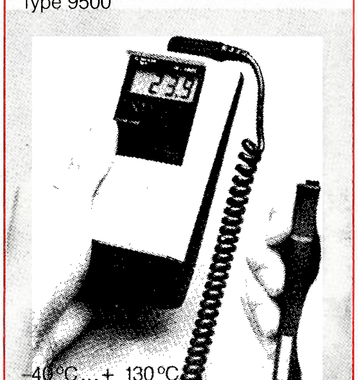
Temperature

Digital hand thermometers
Type: 7300/9300



-200 °C ... + 600 °C
- 40 °C ... +1200 °C

Digital hand thermometers
For **Zone 0** explosion-proof rooms
Type 9500

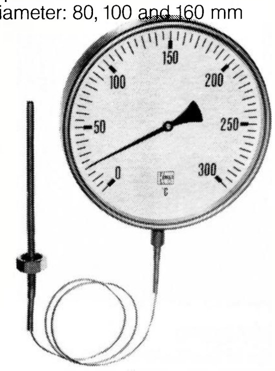


-40 °C ... + 130 °C
-70 °C ... +1200 °C
-50 °C ... +1750 °C

Precision dial thermometers
Nitrogen-filled
For food industry, etc.
Error: ±0.6 and ±1.0% of full-scale reading
Diameter: 80, 100, 160 and 250 mm

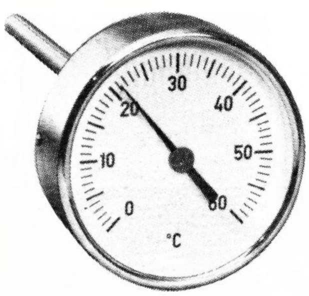
-250 °C ... +650 °C

Precision dial thermometers
Mercury-filled,
error ±1.0% of full-scale reading
Type: 610
Diameter: 80, 100 and 160 mm



-30 °C ... +500 °C

Machine thermometers
Bimetal
50, 63, 80, 100, 160, 250 mm

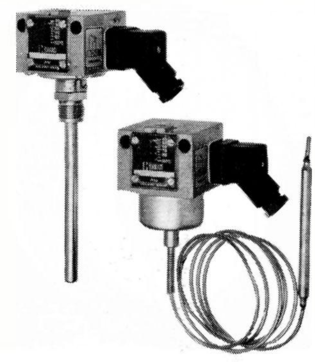


-35 °C ... + 50 °C
0 °C ... +300 °C

Digital 48x24 thermometers for panel mounting
Type: TT 4600

0 °C ... + 99.9 °C
-20 °C ... +600 °C

Temperature controllers
with adjustable set point
Type: KTAM/KTXM



-30 °C ... + 10 °C
+80 °C ... +130 °C

Temperature controllers and monitors with fixed set point
Type: TWR

+30 °C ... +120 °C
PN 16/IP 65