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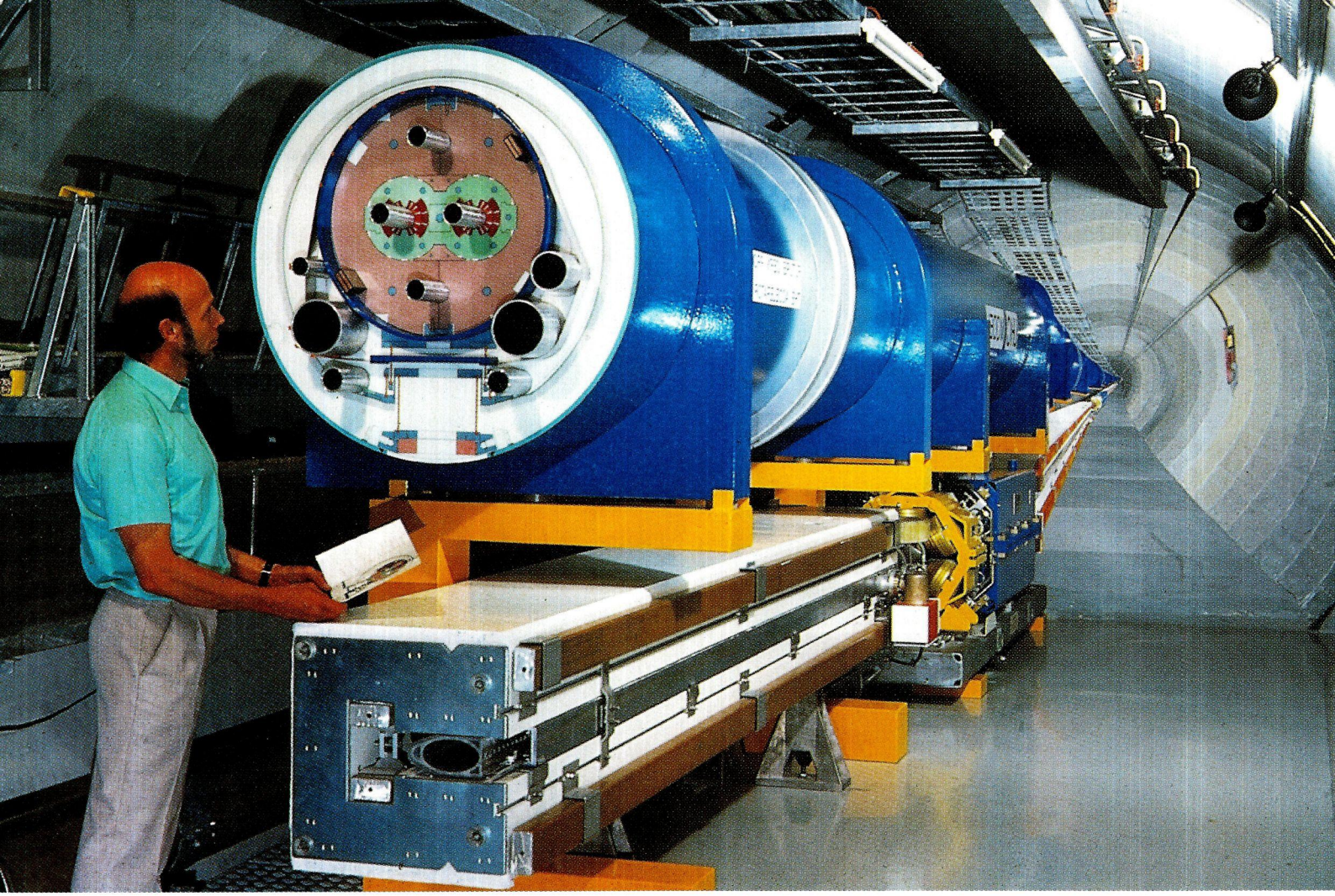

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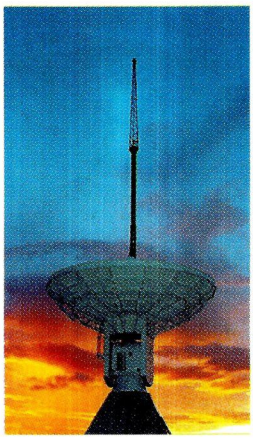

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Cover photograph: Detail from 'From Quarks to the Stars' - an exhibition organized by CERN and the Nuclear Physics Institute, Cracow, Poland, held in Cracow's ancient Arsenal, in October. Originally planned to run for two weeks, the exhibition was extended for a third week (Photo Georges Claude).

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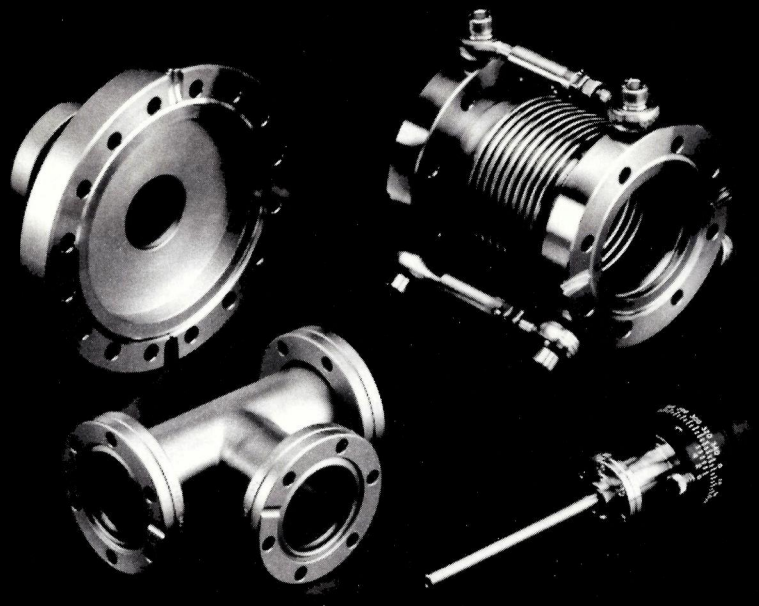

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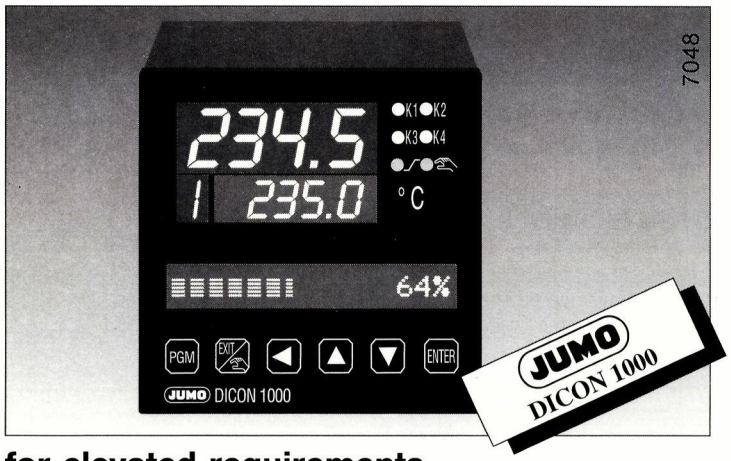

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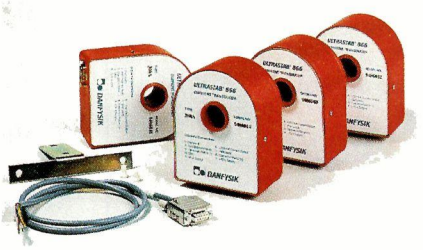

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Around the Laboratories

New-look LHC. After experience with a string of prototype superconducting magnets, the design of CERN's future 27-kilometre LHC proton-proton collider foresees a separate cryoline alongside the superconducting LHC magnets. In the initial design, the helium supply lines were integrated into the magnet cryostat.

CERN
LEP to higher energy

At 19.45 on 31 October, CERN's LEP electron-positron collider, equipped with superconducting radiofrequency accelerating cavities, registered its first events at a record collision energy of 130 GeV. During November, LEP went on to operate in the 130-140 GeV collision energy range.

Fabrication and installation of the superconducting radiofrequency accelerating cavities needed to boost the energy of LEP's electron and positron beams have speeded up as confidence and expertise have increased. 16 additional cavities were installed in a brief technical stop during October.

For the substantially upgraded machine to supply 65 GeV beams immediately and at luminosities comparable to those routinely attained before shows that the complicated technology needed for the superconducting cavities and mastering the machine itself are well under control - yet another remarkable achievement in CERN's tradition of remarkable achievements.

Before the end-1995 run, LEP had been operating around the Z resonance at 91 GeV ever since its commissioning in 1989. LEP precision data on the Z, the electrically neutral carrier of the weak nuclear force, is now complete, and attention shifts toward the next major objective, accumulating data on the W, the Z's electrically charged counterpart.

Unlike the Z, produced singly in electron-positron annihilations, the electrically charged Ws have to be produced in pairs. During the coming long shutdown, more superconducting modules will be installed to prepare for recommencement of operations in June, this time at collision energies of 161 GeV, allowing a first step across a long-awaited 2W threshold. Later in the year more cavities will be ready to boost collision energies to 176 GeV.

However in the meantime the LEP experiments, no longer blinded by the Z resonance, will be keeping a sharp eye open for new physics, and in particular for signs of as yet unseen supersymmetric particles.

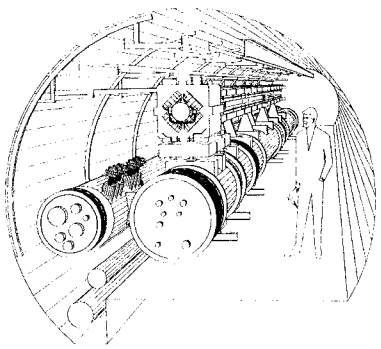
Theorists have long been convinced that our current picture of physics is mirrored by a world inhabited by supersymmetric particles, or 'sparticles'. At the cost of doubling the total number of particles from which the Universe is made, supersymmetry can make for a more satisfactory symmetry of the underlying equations.

LHC magnet string test

Encouraging results from the 'string test' of cryogenic magnets for CERN's future LHC proton-proton collider are helping to refine the machine design.

The string test team is celebrating its first year of successful operation in which highly successful results have been fed into the new LHC machine design report ('Yellow Book') which appeared at the end of October.

The string test (September, page 4) consisted initially of two 10m bending magnet prototypes and a short straight section incorporating a prototype quadrupole. This system, first cooled down and powered at the end of last year, has been used to study the 1.9K cryogenic system, the

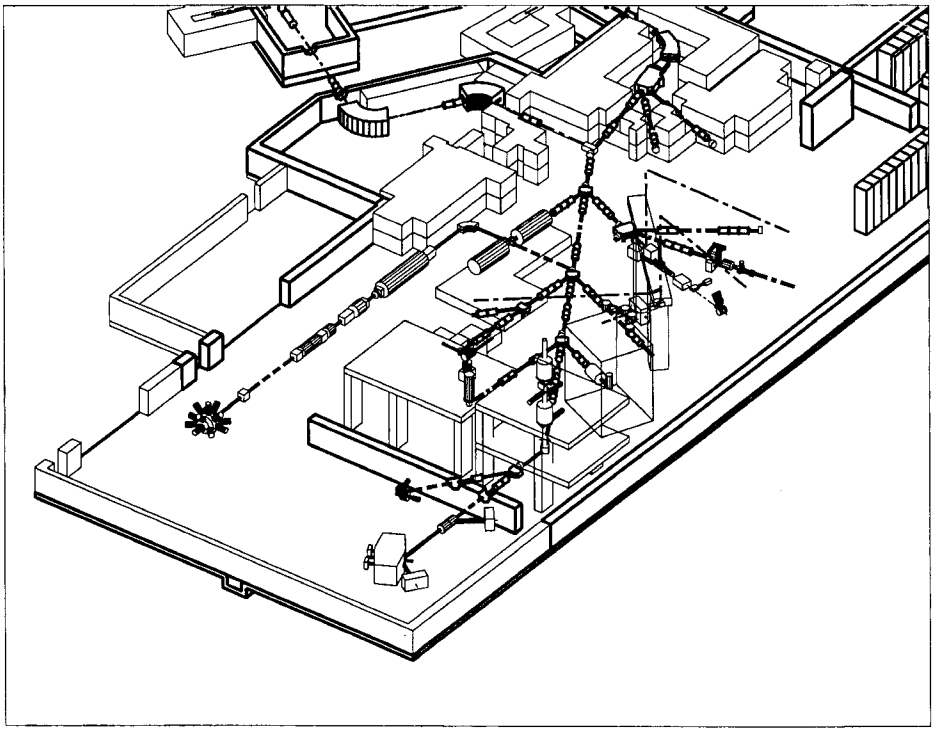


powering scheme and the vital quench protection system. The latter must safely dissipate 7.4MJ of energy stored in each of the dipole magnets in the event of a superconducting magnet quench. Quenches (rapid transitions to a resistive state) can be provoked by pulsing heaters installed next to the superconducting coils, simulating LHC quenches caused by accidental beam losses.

During a quench, the temperature and pressures within the magnet string rise rapidly and would do permanent damage without a sophisticated protection system to dissipate the stored energy and pressure relief valves to release helium gas. The protection worked better than expected and the maximum pressures measured during a quench from full power never exceeded 10 bar even when all but one of the three installed relief valves were kept closed. As a result only one relief valve per half-cell will be needed, which has revived the idea of a separate cryogenic service line in the LHC/LEP tunnel (see illustration).

A large number of helium supply lines must pass around the machine tunnel and to avoid the extra cost of a separate cryoline they were initially envisaged as integrated into the magnet cryostat. The fact that a linking valve box incorporating the quench relief valve would only be

In the foreground is the planned extension to the experimental hall of the ISOLDE on-line isotope separator served by CERN's Booster synchrotron. On the left in the extension is the beamline for the new REX-ISOLDE studies with highly unstable neutron-rich nuclei, while on the right the extension will house a radiofrequency spectrometer. Behind is the existing ISOLDE hall, housing a wide array of experiments.



needed every 50 m and that the separate line would allow the increased pipe diameters needed for only four cryogenic installations, at points where the cryo-plants of LEP II are already installed, swung the economic balance the other way. A separate cryoline design has now been adopted as it is both economic and will simplify installation work.

This summer the string was warmed up for cryogenic modifications and the addition of a third bending magnet. The new string was at operating temperature and ready to be powered by the end of October. During recommissioning, so-called counter flow cooling was used, in which the low pressure gaseous helium in the superfluid helium heat exchanger flows in the opposite direction to the liquid. This was highly successful and will allow equipment to be built in a more standard way, independent of the local tunnel slope.

A large number of experiments are scheduled for the string test. Many complete thermal cycles and several thousand electrical cycles will take almost two years, by which time second generation prototype magnets will be available, naturally with a separate cryoline.

Exotic beams

CERN's ISOLDE on-line isotope separator supplies a wide range of low energy exotic nuclear beams for an impressive range of experiments. As well as the traditional area of nuclear physics and studies of nuclear properties, the programme using these singly-charged particles includes semiconductor physics and biomedical research as well as particle searches and ion-trap mass spectrometry.

Originally sited at the 600 MeV synchro-cyclotron, ISOLDE moved in 1992 to an enlarged home at the Booster, and a first phase of ISOLDE facilities was recently completed with the commissioning of the High Resolution Spectrometer (HRS).

Recently the Radioactive beam EXperiments at ISOLDE (REX-ISOLDE) pilot experiment on neutron-rich nuclei has been approved as the forerunner of a new series of ISOLDE experiments. With an extended experimental hall, this programme will considerably increase ISOLDE's research potential.

Producing the nuclear states for ISOLDE experiments has always involved a lot of skill and ingenuity, and research and development work on new beam and target techniques progresses hand-in-hand with physics experiments. However as experiments range over wider territory, more exotic beams, particularly at higher energies, are called for.

The possibility of accelerating short-lived (radioactive) nuclear beams had been discussed at CERN in a 1977 workshop, and the requirement underlined by publication of a report in 1991 by the Nuclear Physics European Collaboration Committee (NuPECC - March 1992, page 1). Projects, at various stages of completion, are underway throughout the world.

The bottleneck in this work is the production of radioactive ions with the correct charge/mass ratio to be handled efficiently by the accelerator. At CERN, in collaboration with specialists from Stockholm's Manne Siegbahn Laboratory, Saclay's Saturne Laboratory and the Max Planck Institute at Heidelberg a new charge amplification concept will be developed. Downstream the beams will be accelerated by a radio-fre-

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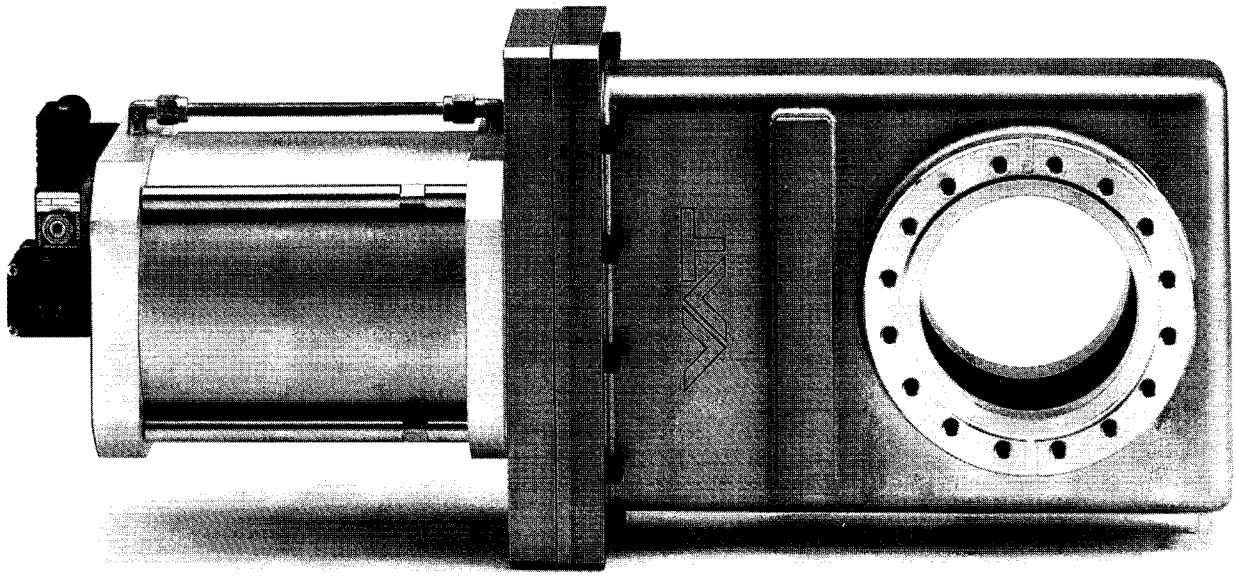

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The PEP-II injection system at the Stanford Linear Accelerator Center (SLAC) is almost half complete. In October an 11 GeV electron beam was extracted from the linac and transported to the end of the two-mile linac tunnel. Here PEP-II Injector System Manager Elliott Bloom (right) and Injector System Engineer Bruce Feerick take a breather before the next phase of installation, scheduled for next June. Also in attendance is Deputy System Manager and Head of SLAC's Accelerator Department John Sheppard (background centre).

quency quadrupole (RFQ) and a linac (October 1994, page 8).

However to optimize the beam properties (emittance), the nuclei have to be cooled in the crossed electric and magnetic fields of a Penning trap, which also serves as a beam buncher. It is a spin-off development of a mass spectrometer being developed at Mainz (also part of the REX-ISOLDE collaboration) for unstable isotopes. Continual improvements are being made to this trap apparatus, and this year precision measurements of rare earth isotopes have been very useful both in demonstrating the value of the technique and in providing physics results.

With this trap, the REX-ISOLDE pilot experiment will go on to study how to bunch, charge-breed and accelerate separated (singly charged spin-parity 1^+) ions. The neutron-rich states which can be produced using these beams will probe the nuclear shell model away from its traditional 'valley of stability', possibly revealing new kinds of nuclear deformations.

BERKELEY Collaboration on PEP-II

Since the announcement by President Clinton in October 1993 that the US Department of Energy would going ahead the PEP-II Asymmetric B Factory project (a joint proposal of the Stanford Linear Accelerator Center - SLAC, the Lawrence Berkeley National Laboratory - LBNL, and the Lawrence Livermore National Laboratory - LLNL), LBNL has continued its strong support of the project (for a review, see October, page 9).

LBNL accelerator physicists have been active in the design of PEP-II since 1988 - shortly after the original concept was suggested by LBNL Deputy Director Pier Oddone. Indeed, the original feasibility study for such a machine was a joint LBNL-SLAC-Caltech effort led by Swapan Chattopadhyay, now head of LBNL's Center for Beam Physics (CBP) in the Accelerator & Fusion Research Division (AFRD). The effort grew to include about seven full-time LBNL accelerator physicists (along with about 15 SLAC and LLNL physicists) during the formal design phase, which began in late 1989. This effort encompassed three editions of the Conceptual Design Report, along with innumerable reviews, as is typical of today's accelerator projects.

Taking advantage of an experienced engineering staff, fresh from the successful completion of the Advanced Light Source (ALS), LBNL has been assigned lead responsibility for the challenging Low Energy Ring (LER) of the PEP-II project, an entirely new storage ring to be added to the PEP tunnel. The LBNL design team is headed by CBP accelerator physicist Michael Zisman and senior engineers Ron Yourd (who served as the Project Manager for the ALS) and Hank Hsieh (a recent addition to the LBNL staff who was Project Engineer for the NSLS storage rings at BNL and most recently served as Project Engineer for the DAFNE project at Frascati). LBNL is also represented in the overall management of the PEP-II project by Tom Elioff, who serves as Deputy to the Project Director Jonathan Dorfan at SLAC. (Elioff served in the same role for the original PEP project, which was also carried out as a collaboration between SLAC and LBNL.)

In addition to participating in the accelerator physics aspects of the project, the main construction responsibilities for LBNL include providing most of the 800 magnets for the LER, the 1500 m of LER arc

vacuum chambers, the transverse multibunch feedback systems for both LER and High Energy Ring (HER), and various power supplies and diagnostics devices for the project.

As is natural, many of LBNL's PEP-II project tasks were selected based on the experience developed in building the ALS. The magnet design and production are being carried out collaboratively with the help of the Institute for High Energy Physics (IHEP) in Beijing, under the US-China International Agreement on High Energy Physics. In August 1995 an IHEP-built prototype quadrupole passed its acceptance tests and approval was granted for full production of some 300 magnets. The LER dipole prototype is also well along and should be available for testing in the next few months.

After a detailed study of the LER vacuum system, it was decided to fabricate the LER arc chambers from aluminium extrusions with discrete copper photon stops, a design patterned after that of the ALS. It is expected that this approach will result in considerably improved vacuum performance compared with the design proposed in the Conceptual Design Report (LBL-PUB-5379; SLAC-418, June 1993).

Work on the multibunch feedback systems has also benefited considerably from the availability of the ALS to serve as a test bed for the proposed PEP-II designs. Both the longitudinal and transverse PEP-II feedback systems operate in the time domain, detecting the offset of each individual bunch in the ring and providing a correction via a fast kicker. The design concept has proved to be very flexible and will be adopted by several rings, including the ALS and the DAFNE Phi Factory under construction at Frascati. Both the longitudinal and transverse feedback systems have been successfully tested at the ALS, with excellent results to date.

LBNL's role in the LER will continue through the commissioning of the ring, scheduled to begin in early 1998. Project staff are off to a good start and are looking forward to successful operation of the collider by the end of 1998. LBNL physicists are also heavily involved in the design of the BaBar detector (September, page 16).

Highlight of Russian Prime Minister Viktor Chernomyrdin's recent visit to the Joint Institute for Nuclear Research (JINR), Dubna, was the signing of an agreement underlining JINR's status in the Russian Federation. Left to right, JINR's Administrative Director A.I. Lebedev, JINR Vice-Director A.N. Sissakian, Deputy Minister for Foreign Affairs S.B. Krylov, JINR Director V.G. Kadyshevsky, Prime Minister Chernomyrdin and Russian Minister for Science B.G. Saltykov.

DUBNA
High level agreement

On 23 October Russian Prime Minister Viktor Chernomyrdin visited the Joint Institute for Nuclear Research (JINR), Dubna, with a delegation which included President of the Russian Academy of Sciences Yu.S. Ossipov, Russian Minister for Science and Technical Policy B.G. Saltykov, Russian Minister for Atomic Energy V.N. Mikhailov, First Deputy Minister of Finance A.P. Vavilov, Deputy Minister for Foreign Affairs S.B. Krylov, and Deputy Economics Minister S. M. Ignatyev.

In his speech, the Prime Minister acknowledged Dubna's achievements in science and in international scientific cooperation, particularly with CERN. 'Russia cannot stand on the sidelines of the major international project - the large new generation accelerator being constructed at Geneva,' he said, referring to CERN's LHC proton-proton collider to be built in the 27-kilometre LEP tunnel. 'It is noteworthy that JINR's specialists have already joined this long-term programme,' he declared.

The highlight of the Prime Minister's visit to Dubna was the signing by S.B. Krylov, Deputy Minister for Foreign Affairs, and JINR Director V.G. Kadyshevsky of an agreement underlining JINR's status in the Russian Federation.

Physics monitor

The Electron Laboratory for Europe project - ELFE - is the European machine initiative proposed as the optimum experimental tool to study confinement physics. The inaugural ELFE Summer School and Workshop on Confinement Physics was held in the agreeable surroundings of Christ's College, Cambridge in July.

ELFE
New machine proposed for Europe

Understanding the dynamics of non-perturbative QCD (the physics of quark and gluon interactions at large coupling) is one of the most challenging problems of modern physics. The two phenomena of quark confinement, which binds quarks permanently inside hadrons, and the dynamical breaking of chiral symmetry, which gives us pion physics and more massive constituent quarks of low energy QCD, define the interface of nuclear and particle physics.

The Electron Laboratory for Europe project - ELFE - is the European machine initiative proposed as the optimum experimental tool to study this "Confinement Physics", which is virgin territory for both particle and nuclear physicists.

Until recently, lack of data in the confinement domain had led to slow theoretical progress in understanding the quark structure of nuclear and hadronic matter. This situation has improved considerably, with new discoveries in high energy deep inelastic scattering experiments together with important advances in large acceptance detector technology and continuous electron beams at low energies.

At high energies, the CERN muon beam experiments in deep inelastic scattering (probing the remote interior of nucleons) opened an exciting new window on nucleon structure with the discovery of three unexpected effects: the EMC (European Muon Collaboration) nuclear and spin effects, and the observation of a surprisingly large difference between the the number of anti-up and anti-down quarks in nucleons.

In 1983, the EMC nuclear effect showed that the quark structure of the free nucleon is modified in the nuclear environment. The EMC spin effect (or proton spin problem) is the discovery that it looks as though quark spin contributes only 22% of that of the nucleon (July 1994, page 19).

These three results have inspired in excess of 2000 papers, together with a vigorous experimental programme at several major machines. Meanwhile, important advances have taken place at low energies with the development of large acceptance detectors and continuous electron beams in the 1-4 GeV region. Together, these enable us to study exclusive channels and to make precise measurements of low energy spin observables, including the fundamental Drell-Hearn-Gerasimov spin sum rule for real photons scattering from a polarized nucleon target (which relates to the spin structure of the nucleon in low energy QCD). These experiments will complement measurements of the proton's spin structure from high resolution polarized deep inelastic scattering.

The world centres for these continuous electron beam studies are ELSA (Bonn) and MAMI (Mainz) in Europe and CEBAF (Newport News) in the United States. Very precise MAMI measurements of pion production at threshold open up rigorous tests of chiral perturbation theory. By increasing the energy in exclusive reaction experiments, we may study the transition from nucleon and meson degrees of freedom through the realm of constituent quarks and into the high energy region of perturbative QCD. High energy measurements of exclusive reactions will map out the fundamental three quark component of the nucleon.

ELFE is the convergence of these advances in both high and low energy nuclear physics. The experimental challenge is to build a high energy (15-30 or more GeV) electron accelerator with high polarization and high duty factor.

The groundwork for ELFE was prepared by the European Steering Committee set up in 1991 under the chairmanship of T. Walcher (Mainz). The physics case for ELFE has been developed at a series of dedicated meetings, notably Dourdan (1990) and Mainz (1992). During 1994 the Nuclear Physics European Collaboration Committee NuPECC reviewed the case for ELFE, culminating in a very positive recommendation to proceed towards the construction of the new machine.

Latest thinking on the machine

configuration was presented at the inaugural ELFE Summer School and Workshop on Confinement Physics held in Cambridge, earlier this year (see following report).

ELFE Summer School

Following the above NuPECC recommendation, the inaugural ELFE Summer School and Workshop on Confinement Physics was held in the beautiful surroundings of Christ's College, Cambridge in July. This forum covered both the physics and important new machine developments, in particular the interface between ELFE and the proposed TESLA linear collider project at DESY, and the project to build a short wavelength, high power Free Electron Laser (September, page 7).

The most promising feature was the presence of a large number of highly motivated young physicists - testifying to the exciting future of this field. The scientific case for ELFE presented by two such researchers: V. Breton (Clermont-Ferrand) reviewed recent progress in high energy deep inelastic scattering and current experiments at CEBAF and Fermilab to look for colour transparency (when a small colour-neutral quark system does not interact with surrounding nuclear matter); N. d'Hose (Saclay) gave a presentation of the physics programme at MAMI and ELSA emphasising both the use of low energy effects to measure the nucleon's polarizabilities and the upcoming spin experiments to test the Drell-Hearn-Gerasimov sum rule.

An important future step is to map out the kinematical dependence of the photon-proton spin asymmetry which changes sign between photoproduction and the region of deep inelastic scattering. One of the most important parts of the ELFE programme is the study of exclusive reactions to measure a valence component in the nucleon's light-cone wavefunction (March 1993, page 14). The theory of light-cone QCD was introduced by D. Robertson (Ohio-State). This led into a series of lectures by S.J. Brodsky (SLAC) on the phenomenology of light-cone wavefunctions in exclusive reactions and the spin structure of the nucleon.

The theory of exclusive reactions was further developed by B. Pire (Palaiseau). H.P. Blok (Amsterdam) presented the latest data on exclusive meson production. The importance of polarization experiments as a probe of non-perturbative QCD and the structure of the QCD vacuum was emphasized by O. Nachtmann (Heidelberg), who proposed a simple sum rule for the kinematic dependence of the neutron form factor based on current ideas of the QCD vacuum. Motivated by the need for a microscopic treatment of the original EMC effect, A.W. Thomas (Adelaide) described recent progress in deriving a realistic theory of nuclear matter (and eventually finite nuclei) from a quark model of the nucleon. The resulting mean field theory resembles the widely-used Quantum-Hadrodynamics (or QHD).

P.A.M. Guichon (Saclay) discussed the relationship between confinement and dual-superconductivity, while the relationship between confinement and the dynamical breaking of chiral symmetry was covered by S.D. Bass (Cambridge, now Jülich). The important link with chiral symmetry was further emphasized with a presentation by K.Kilian (Jülich) of latest results from COSY at Jülich. The

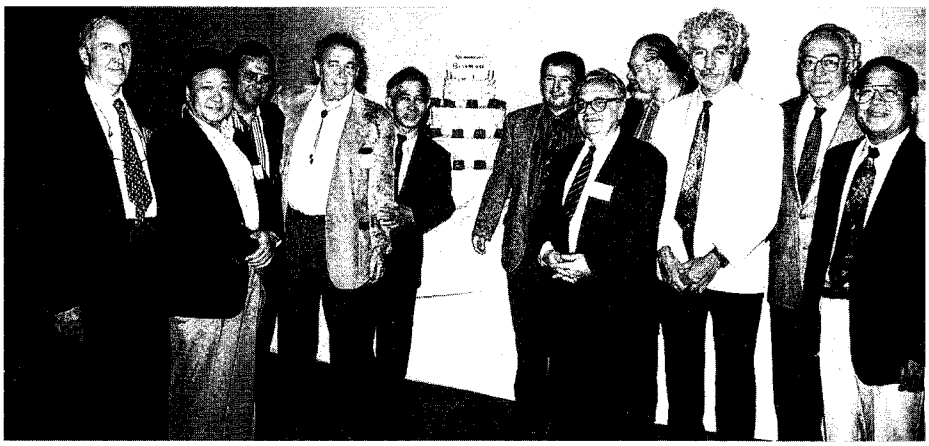
At the inaugural ELFE Summer School, Stan Brodsky of SLAC discussed the phenomenology of light-cone wavefunctions in exclusive reactions and the spin structure of the nucleon.

ELFE School covered more than just physics. Important developments in machine issues were presented by B. Bonin (Saclay) and R. Brinkmann (DESY). B. Bonin spoke about the 1992 Mainz workshop design with two circulating linacs and emphasized the common technology involved between this proposal and the TESLA test facility project at DESY (September, page 8). R. Brinkmann outlined how ELFE could be incorporated into an extended TESLA project using a 25 GeV, 0.4% duty factor linac together with the HERA electron ring as a pulse stretcher.

The consensus was that ELFE is the natural and necessary machine for the long term future of hadronic physics in Europe. Following the school, NuPECC has established an "Initiative group for ELFE at DESY" to further explore the common machine interests with TESLA. A complete ELFE physics proposal is expected in early 1997. The second ELFE Summer School will take place in France in 1997, organized by N. d'Hose and P. Guichon (Saclay).

By S.D. Bass (Jülich)

A regular feature of the international physics calendar is the International Conference on Elastic and Diffractive Scattering, known also as the Blois Workshops, after their 1985 birthplace in France, and initiated by Basarab Nicolescu and Jean Tran Thanh Van. In this photo of Blois organizers past and present are (left to right) E. Predazzi, K. Kang, A. White, M.Block, Jean Tran Thanh Van, M. Haguenauer, Basarab Nicolescu, H.M. Fried, K. Goulianos, N.N. Khuri and C.-I. Tan.



New focus for elastic and diffractive scattering

A regular feature of the international physics calendar is the International Conference on Elastic and Diffractive Scattering, known also as the Blois Workshops, after their 1985 birthplace in France.

The content of this year's meeting embraced a broad spectrum of problems ranging from the classical analysis of elastic scattering and total cross-sections to the "hard" or deep inelastic phenomena which test the underlying quark-gluon structure of hadrons.

These meetings have traditionally concentrated on broad questions of elastic and diffractive scattering, however the shift of emphasis in physics is now reflected at Blois by interest in the wide range of 'soft' hadronic processes which dominate reaction cross-sections.

On the traditional side, a substantial part of the conference was devoted to analysis of forward scattering parameters like total cross-sections, real parts etc, using dispersion relations and fundamental asymptotic theorems which bound the possible growth of those parameters with energy.

The present experimental situation in this field was summarized by S. Pruss, followed by theoretical presentations by B. Nicolescu, A. Donnachie, T.T. Wu, A. Martin and others. The data for proton-proton and proton-antiproton scattering seem to support dominance of the 'crossing-even' part of the scattering amplitude (which contributes equally to both proton-proton and proton-antiproton scattering), with little evidence for a substantial 'odderon' term which contributes with opposite sign in the two cases.

The 'pomeron' physics of high energy behaviour was a central feature of the conference. The experimental data seem to suggest that behaviour with increasing energy depends on the magnitude of the scale which characterizes the process - i.e. whether the process is "soft" or "hard".

Hard processes, in general, show a much more rapid increase with increasing energy than the soft ones. In order to distinguish between these two cases, the notions of "soft" and "hard" pomerons are introduced. The phenomenological situation was summarized by A. Donnachie. It is believed that the "hard" pomeron should be described by perturbative quantum chromodynamics (QCD), the fundamental theory of strong interactions between the quarks and gluons.

The approximate theory of the pomeron in perturbative QCD has been developed by Balitskij, Fadin, Kuraev and Lipatov (BFKL). It is now being applied to the phenomenological description of "hard" processes like deep inelastic electron-proton scattering in the kinematical range accessible at the HERA collider.

The theoretical and phenomenological issues of the pomeron in QCD were reviewed by M. Ciafaloni, L. Lipatov and N. Nikolaev, and discussed in many other presentations. The experimental data on violent (deep inelastic) electron-proton scattering were presented in several contributions from both the H1 and ZEUS collaborations at HERA. The highlights are: the rapid increase of the structure functions with decreasing Bjorken parameter x; and the detailed measurements of the structure final states aimed at pinning down the specific correlation between diffusion in transverse momentum and increase with decreasing parameter x, etc. All those measurements aim at revealing the microscopic dynamical structure of the QCD pomeron.

A valuable insight into the pomeron comes from the study of deep inelastic diffractive processes. The experimental data were reviewed by H. Abramowicz (ZEUS) and J. Dainton (H1), while the theory and phenomenology of diffraction was reviewed by A. Kaidalov. Deep inelastic diffraction reveals the quark-gluon content of the pomeron and one may intro-

duce quark and gluon distributions in a pomeron by analogy with those of ordinary hadrons.

The data prefer a "soft" pomeron in inclusive diffractive production with a "hard" gluon spectrum, but the situation in exclusive production of vector meson states is different. Several contributions discussed the possible role of a "hard" QCD pomeron in deep inelastic diffraction. It should also be emphasised that the very notion of the quark/gluon content of the pomeron as well as the "hard" diffractive processes were introduced for the first time by G. Ingelman and P. Schlein at the first Blois Workshop at 1985.

Another group of problems discussed during the meeting concerned spin physics. The experimental situation was summarized by Alan Krisch while the theory review was given by Stefano Forte. The experimental data on polarized electroproduction from both the SMC collaboration at CERN and SLAC (Stanford) were presented and several theoretical talks discussed various models for polarized quark and gluon densities.

The experimental and theoretical parts of the conference were summarized by W. Bartel and by J. Kwiecinski respectively.

The valuable content of the Blois meetings has recently become very topical following theoretical progress in understanding high energy behaviour in terms of quantum chromodynamics and its implications for both present and future experiments.

J. Kwiecinski

Channeling and related crystal effects

Channeling, the interaction of particles with oriented crystals, has been applied in a wide variety of scientific and technological areas. A workshop at Aarhus, Denmark, this summer highlighted progress and future directions.

Radiation emission has been explored and linked to coherent bremsstrahlung and other oriented crystal radiations. Dramatic effects have been found for ultra-relativistic electrons with Lorentz factors of 10^{5-6}. Single crystals are unique for investigations of quantum electrodynamics in strong external fields because probabilities for processes in axial/planar fields are determined by the magnitude of these fields in the particle rest frame.

Erik Uggerhøj of Aarhus reported on an extensive series of experiments concerning radiation emission, pair production, and shower formation carried out at CERN by the NA43 collaboration.

As Vladimir Baier of Novosibirsk and Yuri Kononets of Kurchatov noted, theoretical treatment of these interconnected radiation distributions is challenging and much work needs to be done. In general, the agreement with the CERN experiments is good, but many areas like polarization phenomena and particle production need investigation.

Prominent among high energy applications is extraction from accelerators. At the workshop, Alexei Asseev reported on beam extraction using a bent crystal at Serpukhov. Konrad Elsener and Jukka Klem reviewed recent CERN SPS studies driven by the possibility of using crystals for extraction of LHC beams.

David Cline of UCLA (left) and Friedel Sellschop of Johannesburg at the recent International Workshop on Channeling and Other Coherent Effects at relativistic Energies at Arhus, Denmark.

Thornton Murphy of Fermilab announced a step in that direction, with a demonstration this summer of extraction from the Tevatron at 900 GeV.

Bent crystal channeling is also used for handling extracted high energy beams. Niels Doble presented a beautiful example of a beam for the CERN NA48 CP-violation experiment. Yuri Chesnokov reported that beams had been deflected through angles up to 150 milliradians at Serpukhov.

Vladimir Samsonov and Alexei Khanzadeev of PNPI discussed a demonstration of channeling spin precession at Fermilab where hyperons were precessed in bent crystals. Although challenging, this technique may offer a method for measuring charm baryon magnetic moments.

'Parametric radiation' is the newcomer in the field of oriented crystal radiation. This can be thought of as Bragg reflection of virtual photons from incoming electrons in a crystal. It is monochromatic, intense, and easily tunable. Hideo Nitta of Tokyo Gakugei reported on the status of the theory while Uwe Nething reviewed recent measurements at Darmstadt.

Heavy ion channeling is used mainly to study atomic cross-sections. Jens Ulrik Andersen of Aarhus discussed resonance capture studies

at Chalk River, Canada. In France, GANIL has also been active in this field. Christoph Scheidenberger reviewed plans to continue these measurements at GSI, Darmstadt. In the future it may be possible to extend this technique to nuclear excitation. As noted by Sheldon Datz of Oak Ridge, SPS heavy ion beams might be used to good advantage for such studies.

One of the features of the workshop were "cultural" presentations to explore possible future applications. Lene Hau of the Rowland Institute reported on a Brookhaven measurement of spin densities with MeV positrons. Peter Kasper of Fermilab discussed future high energy photon beams. Coherent bremsstrahlung might be used to harden such beams. Andreas Schäfer of Frankfurt discussed the possibility of channeling for studying strong field effects. Martin Merck from Max Planck-Garching felt that oriented crystals would be hard to use for gamma-ray astronomy in the multi GeV region due to low intensity.

Perhaps the cloudiest area is the exotic accelerator field. Ron Ruth of SLAC summarized some concepts for future accelerators and the possibility of using damping in a crystal channel to provide ultra cold beams. David Cline of UCLA speculated on the possibility of laser excited crystals as accelerators imbedded in a muon collider lattice.

In general, much remains to be done. More information is needed on channeling, dechanneling, and on materials other than silicon. Polarization phenomena need to be mapped out in crystal radiations. On the other hand, some areas, such as heavy ion channeling and parametric radiation, are blossoming.

The workshop was organized by Dick Carrigan of Fermilab and Erik Uggerhøj at Aarhus.

Erik Uggerhøj

Electronics for LHC experiments

A major effort is being mounted to prepare the way handling the high interaction rates expected from CERN's new LHC proton-proton collider (see, for example, November, page 6).

September saw the First Workshop on Electronics for LHC Experiments, organized by Lisbon's Particle Physics Instrumentation Laboratory (LIP) on behalf of CERN's LHC Electronics Review Board (LERB - March, page 2). Its purpose was not only for the LERB to have a thorough review of ongoing activities, but also to promote cross fertilization in the engineering community involved in electronics design for LHC experiments.

The Workshop gathered 187 physicists and engineers from 20 countries including USA and Japan. The meeting comprised six sessions and 82 talks, with special focus on radiation-hard microelectronic processes, electronics for tracking, calorimetry and muon detectors, optoelectronics, trigger and data acquisition systems. Each topic was introduced by an invited speaker who reviewed the requirements set by the particular detector technology at LHC. At the end of each session, panel discussions were chaired by each invited speaker.

Representatives from four major integrated circuit manufacturers covered advanced radiation hard processes. Two talks highlighted the importance of obsolescence and quality systems in the long-lived and demanding environment of LHC.

The Workshop identified areas and encouraged efforts for rationalization and common developments within and between the different detector groups. As a result, it will also help ensure the reliability and the long term maintainability of installed equipment. The proceedings of the Workshop are available from LIP Lisbon*. The LERB Workshop on Electronics for LHC Experiments will become a regular event, with the second taking place in Hungary, by Lake Balaton, from 23-27 September 1996. The Hungarian institutes KFKI-RMKI have taken up the challenge of being as successful as LIP Lisbon in the organization of the event.

**Copies of the proceedings should be ordered directly from LIP, Av. Elias Garcias, 14-1°, P 1000 Lisbon, e-mail natalia@vaxlip.lip.pt*

Francois Bourgeois

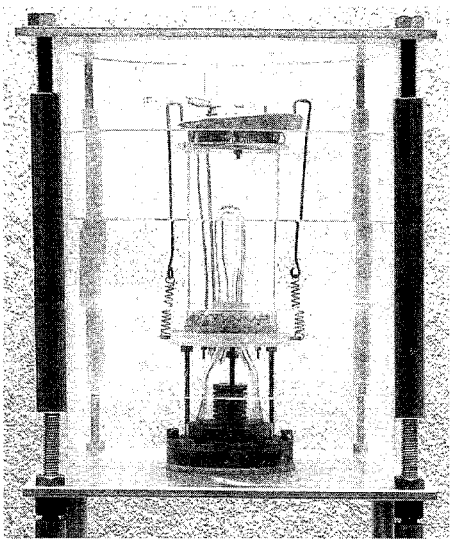
Saclay - 50 years

Central in the infrastructure through which France obtains some 80% of its electric power from nuclear energy stands the French Atomic Energy Authority (Commissariat à l'Energie Atomique - CEA). This year the CEA celebrates its Golden Jubilee.

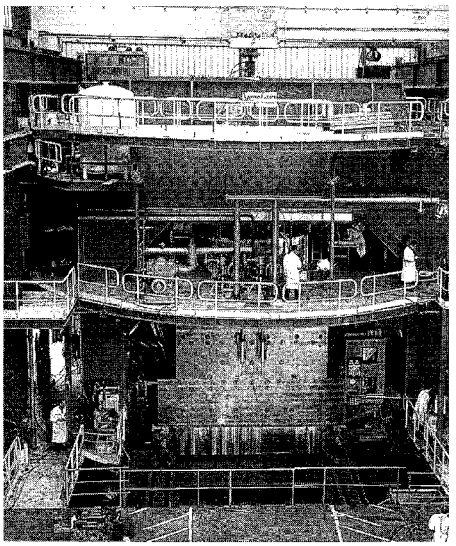
Mastery of nuclear energy goes hand-in-hand with fundamental research in the fields of nuclear and sub-nuclear physics, and the founders of the CEA, like F. Joliot and F. Perrin, considered it essential to relaunch fundamental research in France after the Second World War. In particular, A. Messiah's courses on quantum mechanics made a considerable contribution to the re-establishment of a French school of atomic and sub-atomic physics.

As the CEA expanded and nuclear industry grew up, the need was shown for close links between fundamental research and its applications. In addition, the CEA realized how important it was to become a part of the national and international scientific community as highly effective cooperation was developing. The CEA has drawn a wealth of scientific, cultural and intellectual benefits from its collaboration with CERN.

During the same period, as fundamental particle physics research has been making spectacular progress, its requirements have grown commensurately. It is not therefore surprising that CERN needs partners capable of bringing together the domains of fundamental research and major equipment and of promoting a dialogue between research and



The beginning of bubble chamber construction in Europe: the first heavy liquid bubble chamber (diameter 8 cm) built in Europe by A. Rogozinski (Saclay 1955).

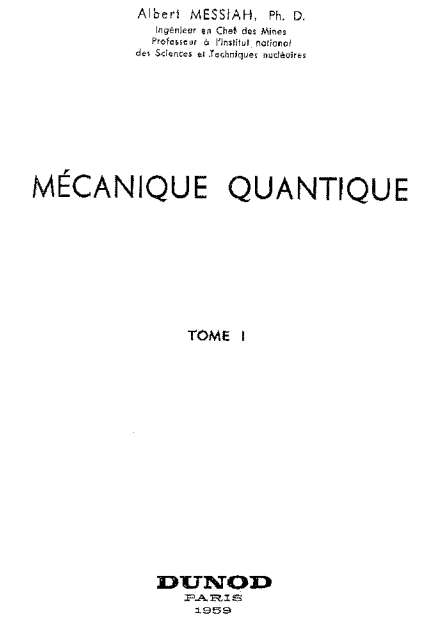


Mirabelle, the large (11 cubic metre) hydrogen bubble chamber built at Saclay under F. Frugne and put into service at the Soviet Serpukhov Laboratory.

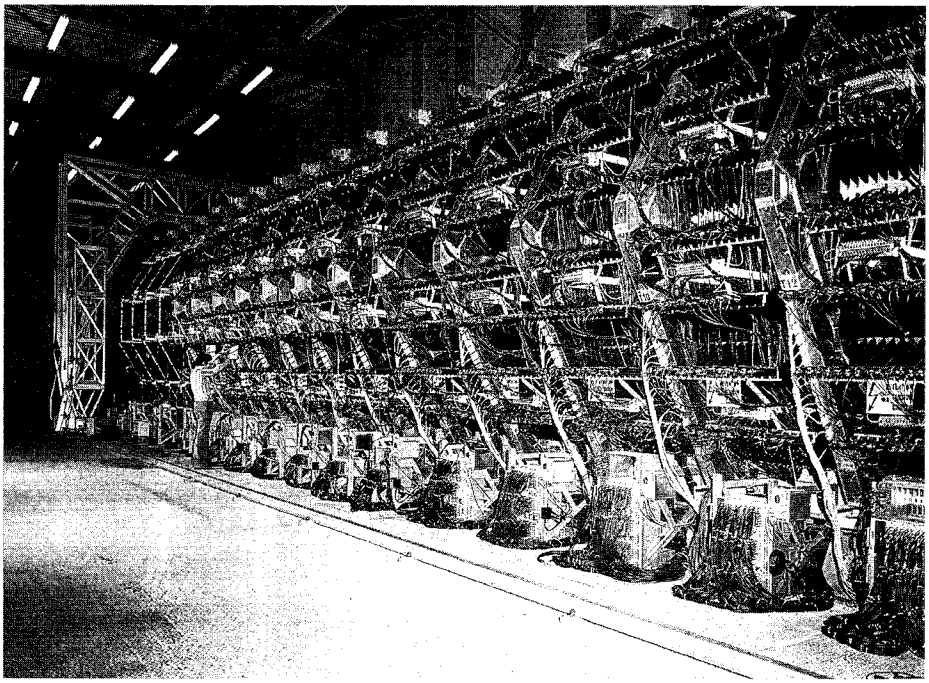
CEA 1945 - 95

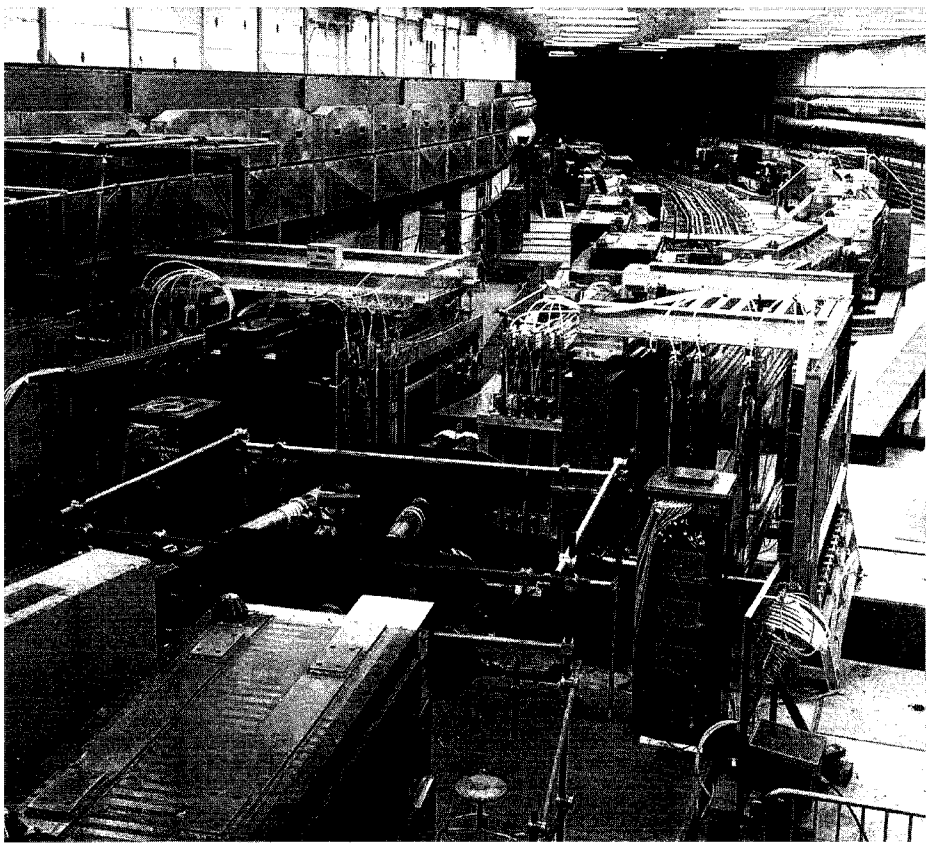
A. Berthelot, founder of particle physics at the French Atomic Energy Authority (Commissariat à l'Energie Atomique - CEA), with Pierre Auger, one of the founding fathers of CERN.

The first book on quantum mechanics published in French - the bible for several generations of French physicists.



The impressive neutrino detector of the CERN/ Dortmund/Heidelberg/Saclay (CDHS) collaboration. The French group was led by René Turlay, who went on to direct particle physics at Saclay from 1983-92.



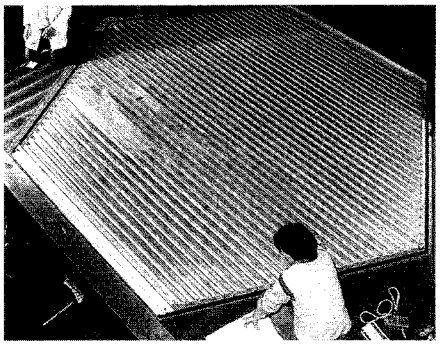


industry. As was pointed out by Jacques Haissinski, head of the Department of Astrophysics, Particle Physics, Nuclear Physics and Associated Instruments (DAPNIA), the CEA, set up to develop major programmes for applying nuclear processes, is particularly well equipped to design, build and operate the huge instruments for exploring the infinitely small and the infinitely large.

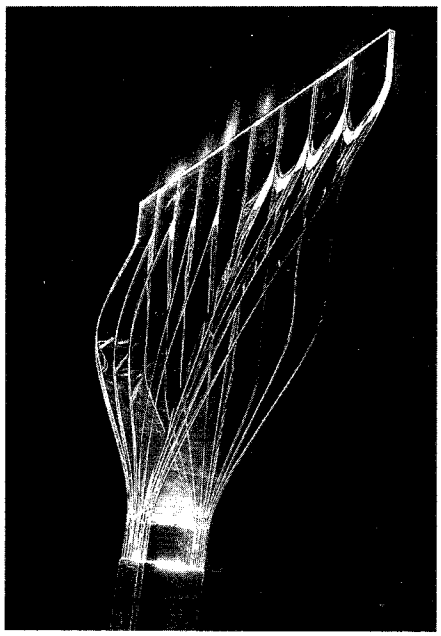
Tomorrow's nuclear industry needs and will continue to need fundamental research, with its openness and its cooperation. Particle physics needs and will continue to need motivated and steadfast supporters. CERN and the CEA can count on each other.

Experiment R607 at the CERN Intersecting Storage Rings included the Saclay group led by Marcel Banner. This revealed particles with large transverse momentum, the result of violent collisions between the quarks and gluons deep inside the colliding protons.

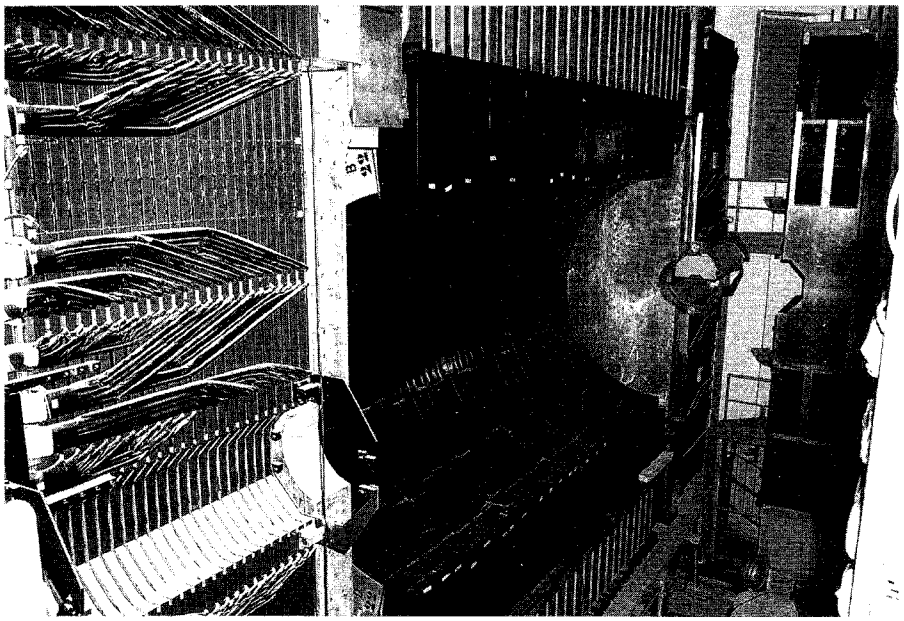
One of the large drift chambers supplied by Saclay for the CDHS neutrino experiment at CERN.

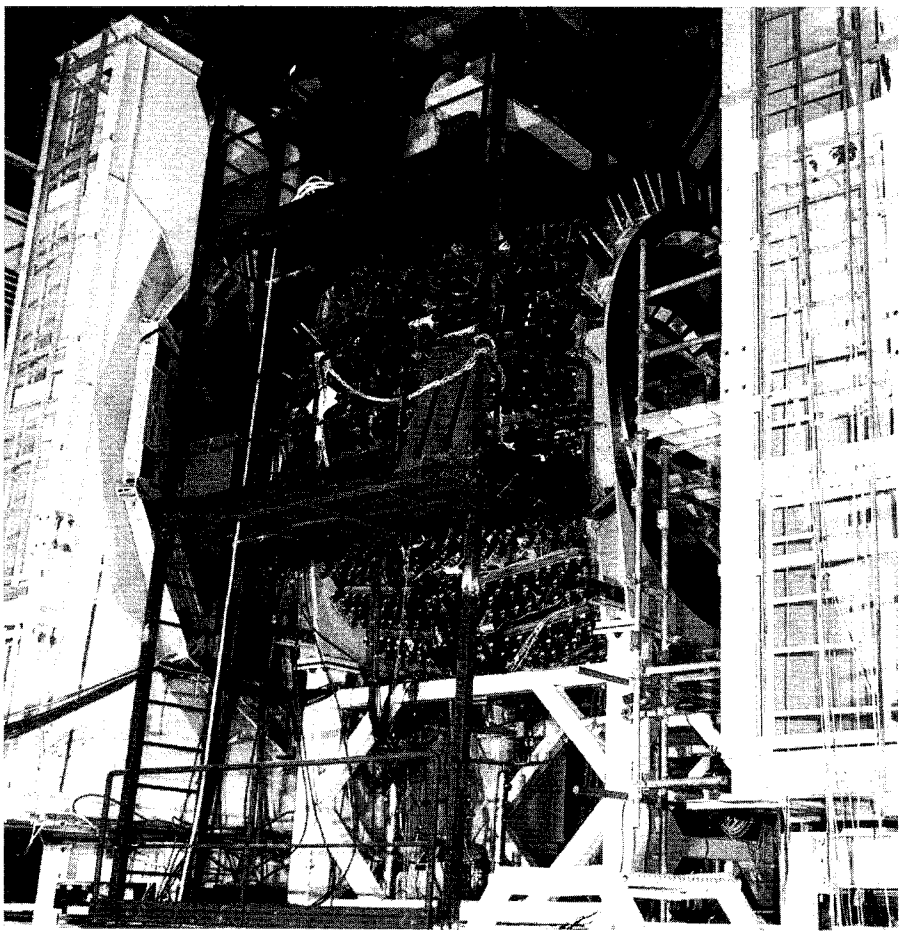


Below, one of the light guides for UA1's electromagnetic calorimeter, supplied by Saclay.

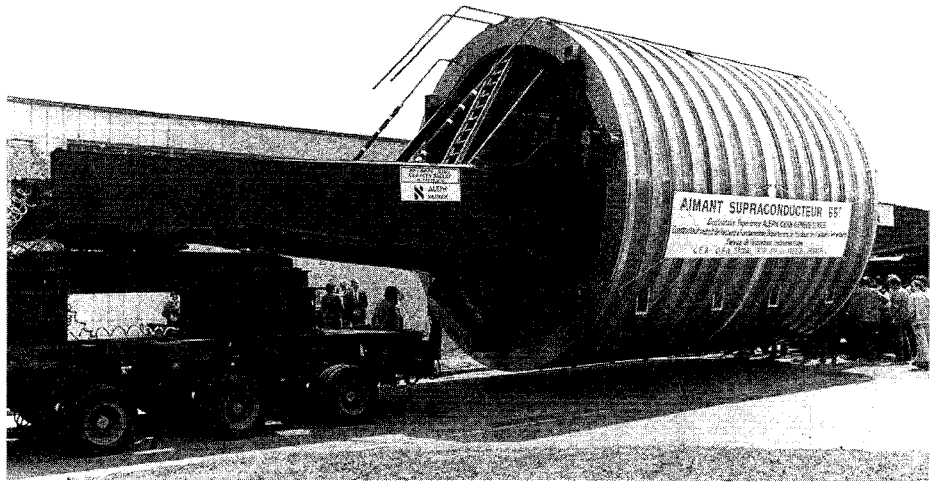


The famous UA1 (top, right) and UA2 (below, right) experiments at CERN's proton-antiproton collider. The Saclay groups were led respectively by Michel Spiro and Marcel Banner, under Pierre Lehmann, Director of Saclay's Elementary Particle Physics Department (DPhPE) from 1975-83.

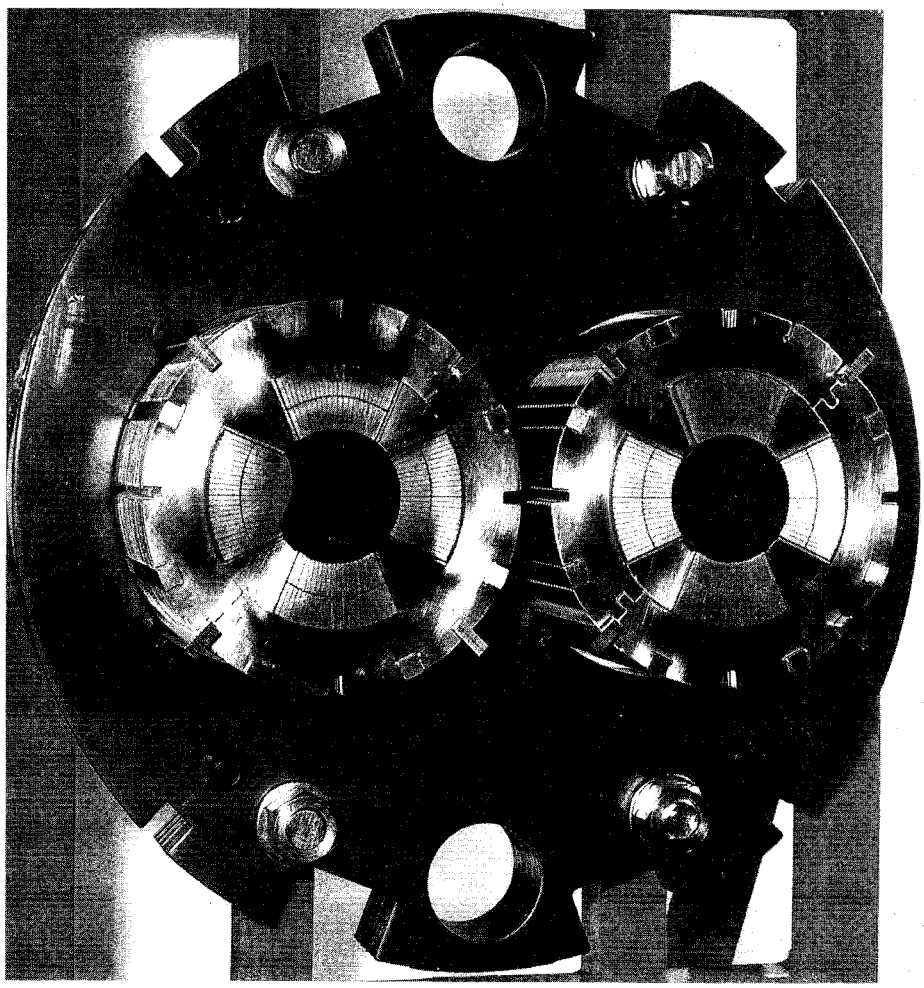




Saclay technological prowess. The 60-tonne superconducting magnet, 5 metres across and 7 metres long, for the Aleph experiment at CERN's LEP electron-positron collider.

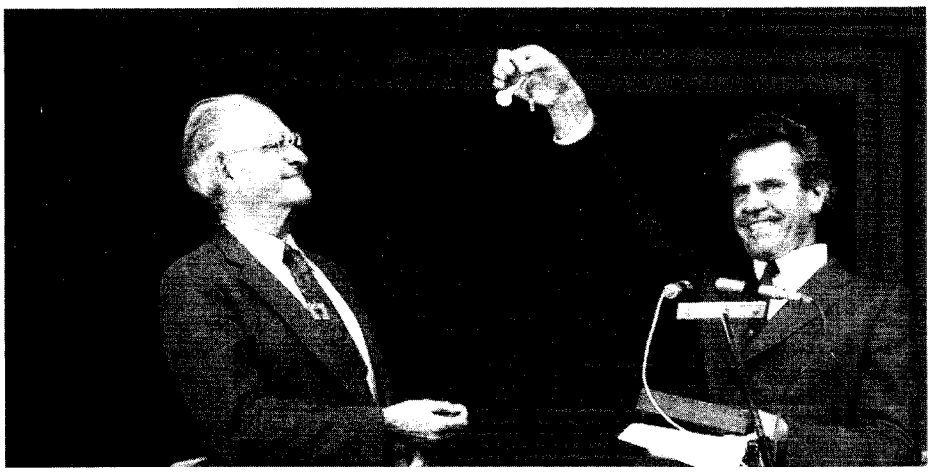


This half-century of CEA particle physics will be celebrated in the CERN Auditorium on 29 January 1996. A photographic exhibition will be set up in the concourse and remain on view until 9 February 1996.



The superconducting quadrupole for CERN's LHC proton-proton collider, designed by a CERN-Saclay collaboration.

Viewpoint



At the formal closure of CERN's Intersecting Storage Rings (ISR) in 1984, Giorgio Bellettini (right) symbolically returns the key to the machine to Victor Weisskopf, the 'father' of the ISR.
(Photo CERN 370.6.84)

The decision to build the ISR and its consequences: the role of Victor Weisskopf

by Mervyn Hine

December 1995 marks the thirtieth anniversary of the decision by the CERN Council to approve the proposal by the then Director General Victor Weisskopf to build the Intersecting Storage Rings (ISR). It was probably the Council's most important decision since setting up the Laboratory, judging by its consequences for physics and for CERN over the following three decades.

December is also the twenty-fifth anniversary of the startup of the machine which led to a period of developments in accelerator technology with far reaching consequences. They included the production of stable high current stacked beams with high interaction rates in the presence of non-linear resonances and space charge, the inventions of stochastic cooling and of beam instrumentation using Schottky scans, and the technology of large ultra-high vacuum chambers with controlled wall impedance and resonances, to name only a few.

Two results from the ISR physics programme of similar importance for the future were the first observation of large particle and photon yields with high transverse momentum (indicative of quark-gluon processes deep inside the colliding protons), and the consequent development of concepts for detectors with full solid angle calorimetry and tracking coverage, now used on all colliders.

The technical success of the machine and the significance of the physics results led to a radical switch in physicists' thinking everywhere, away from fixed targets and towards colliders as the way to higher collision energies for hadrons. The ISR ceased to be seen as a toy for accelerator builders and became a window into a future far beyond the possibilities of fixed target accelerators.

The ISR advances in accelerator and detector technology stimulated the conversion of the SPS to a proton-antiproton collider and the similar conversion of the Fermilab machine, and led to the proposals for the Superconducting Supercollider (SSC) in the USA and the LHC in Europe, to plans for a collider at UNK in Russia, as well as to LEAR with stopping antiprotons in large numbers and to the Brookhaven heavy ion collider RHIC.

In parallel with these technical consequences of the ISR decision, from which the whole world has benefited, CERN was also able to build up and strengthen its own accelerator expertise to gain a front rank in design and engineering, and to confirm its reputation for building and improving large, adventurous, projects within proposed timescales and budgets, which reach well beyond the advertised performance.

This strength allowed the CERN authorities to take the risks of converting the SPS to the proton-antiproton collider and discover the Z^0 and the W, to build LEP in Geneva, despite CERN having built no electron machine till then, and to authorize the construction of the LHC in a time of financial stringency. In the latter decision one can hope that they drew another lesson from CERN's record, the necessity of a continuing high level of on-site staff so as to be able to develop and operate the machine as well as build it in CERN's own style.

It is interesting to speculate what the development of elementary particle physics might have been in the last thirty years if the ISR decision had not been taken. At that time no other Laboratory showed any interest in a proton collider. Europe might have been able to start building the SPS earlier, and be more in competition with the Fermilab fixed target physics programme. Both labs would be reaching into the TeV proton energy region by the use of

superconducting magnets, with possibly much higher intensities and heavy ions. Electron colliders would probably have had more support, but the main national Laboratories would have been too occupied for a decade or more with the workload of the big proton accelerators to develop colliders, and a machine like LEP would have been an enormous jump for Laboratories like Cornell or even DESY at that time. Ideas on really novel accelerator design from Novosibirsk and similar laboratories might have been more supported, but could not have led early to large scale physics programmes. No part of this programme would have opened up the region of Z and W physics and beyond as we are seeing it today.

It does not look a very inspiring piece of imaginary history.

How did it happen that CERN took this critical decision, which did indeed change history, in 1965? It required the preparations of a group, the CERN accelerator research group, but above all the intuition, foresight and courage of one man, Victor Weisskopf, CERN's Director General from 1961 to 1965. Without his intuition on what was needed for the future and his faith in his staff, the lack of interest and outright opposition among a large majority of physicists in Europe would have led CERN to drop the ISR as its next project at Meyrin in favour of an immediate push for a 300 GeV machine somewhere in Europe. Viki has said that this was the most important decision he took at CERN. It was certainly one of the riskiest: very little was known of the likely problems of proton colliders; only a few small electron machines were coming into use and showing up beam instabilities which were frightening when considering the high proton beam currents needed for the ISR.

It was the recognition that the most important high energy physics results in the last twenty years are the result of Viki's intuition and conviction in 1965 that led the present Director General along with Carlo Rubbia and other beneficiaries of Viki's work to celebrate that event of thirty years ago at a recent lunch for Viki at CERN (October, page 31).

I hope this article brings to a wider audience an awareness of the debt they owe to Viki in almost all the work they do today.

Mervyn Hine

Mervyn Hine carried out pioneer work on particle accelerators at the Harwell Laboratory in the UK in the late 1940s and early 1950s. His 1952 paper with John Adams and John Lawson on the management of resonances was a landmark in the field and pointed the way forward in the design of big machines. In 1953 he and John Adams moved to Geneva to work on CERN's major new machine. After the commissioning of this, the PS, in 1960 he moved to the CERN Directorate, and went on to play an influential role in technical policy and long term planning. Subsequently he turned his vision to other rapidly evolving fields - computers, data communications and office automation. He formally retired from CERN in 1985, when the CERN Courier said 'his forward vision has helped CERN to be ready when the future arrived'.

Mervyn Hine at his formal retirement from CERN in 1985.
(Photo CERN 484.5.85)

Books received

All You Wanted to Know About Mathematics but Were Afraid to Ask, Mathematics for Science Students, Volume 1, by Louis Lyons, published by Cambridge University Press, ISBN 0 521 43465 3 (hardback, price £30), 0 521 43600 1 (paperback, price £13.95)

An agreeable and chatty introduction to the application-oriented, non-rigorous mathematics essential to first-year science undergraduates. With his long experience of teaching maths to science students, Dr. Lyons knows that these skills are like swimming: easy to get the hang of once you try it, but difficult to master if you don't; a useful accomplishment which could be vital in an emergency; where competence improves dramatically with practice; and where the theory isn't much help. Volume 2 will follow next year.

Missing from the contents list is statistics and data analysis, but Dr. Lyons has already written 'A Practical Guide to Data Analysis for Physical Science Students' and 'Statistics for Nuclear and Particle Physics', both published by Cambridge University Press (1991 and 1986 respectively).

Non-Accelerator Physics, by H.V. Klapdor-Kleingrothaus and A. Staudt, published by IOP Publishing, Bristol, UK, ISBN 0 7503 0305 0 (hardback, price £130, $260)

534 pages, including an introduction to elementary particles and their theories, and going to cover experimental searches for proton decay, neutron-antineutron oscillations and the neutron dipole moment, the neutrino mass, neutrino oscillations, magnetic monopoles, dark matter, fractionally charged particles, etc.

CERN Courier contributions

The Editor welcomes contributions. These should be sent via electronic mail to courier@cernvm.cern.ch

Plain text (ASCII) is preferred. Illustrations should follow by mail (CERN Courier, 1211 Geneva 23, Switzerland).

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Cosmic ray riddle solved?

Physicists from Japan and the United States have discovered a possible answer to the puzzle of the origin of high energy cosmic rays that bombard Earth from all directions in space.

Using data from the Japanese/US X-ray astronomical satellite ASCA, physicists have found strong evidence for the production of cosmic particles in the shock wave of a supernova remnant, the expanding fireball produced by the explosion of a star.

Primary cosmic rays, mostly electrons and protons, travel near the speed of light. Each second, approximately 4 such particles cross one square centimetre of space just outside the Earth's atmosphere. Subsequently, collisions of these primary particles with atoms in the upper atmosphere produce slower secondary particles.

Ever since the discovery of cosmic rays early this century, scientists have debated the origin of these particles and how they can be accelerated to such high speeds. Supernova remnants have long been thought to provide the high energy component, but the evidence has been lacking until now.

The international team of investigators used the satellite to determine that cosmic rays are generated profusely in the remains of the supernova of 1006 AD - which appeared to medieval viewers to be as bright as the Moon - and that they are accelerated to high velocities by an iterative process first suggested by Enrico Fermi in 1949.

Using solid-state X-ray cameras, the ASCA satellite records simultaneous images and spectra of X-rays from celestial sources, allowing astronomers to distinguish different types of X-ray emission.

The tell-tale clue to the discovery was the detection of two diametrically opposite regions in the rapidly expanding supernova remnant, the debris from the stellar explosion. The two regions glow intensely from the synchrotron radiation produced when fast-moving electrons are bent by a magnetic field. The remainder of the supernova remnant, in contrast, emits ordinary "thermal" X-rays from hot gases such as oxygen, neon, and gaseous forms of magnesium, silicon, sulphur, and iron.

The cosmic rays appear to be accelerated in the two regions that glow with synchrotron radiation. Charged particles are accelerated to energies of 100 TeV (10^{14} electron volts) in the turbulent aftermath of the supernova explosion shock wave. In the picture first proposed by Fermi in 1949, many cosmic particles are trapped inside the supernova remnant, bouncing around and continually gaining speed in repeated encounters with the shock front.

This process probably occurs in other 'young' supernova remnants too. There is estimated to be a supernova explosion in our Milky Way galaxy about once every 30 years.

The ASCA satellite was launched from Kagoshima Space Center, Japan aboard a Japanese M-3S-II rocket on 20 February 1993.

Eclipsed neutrinos

The total solar eclipse visible in Southern Asia on 24 October provided an opportunity for an unusual physics experiment.

At face value, the levels of solar neutrinos detected on the Earth's surface are difficult to understand and suggest that perhaps the composition of solar neutrinos oscillates between different neutrino types on their journey. In this way neutrinos originating in the Sun as electron-type could convert into heavy neutrinos, which could subsequently disintegrate into an electron-neutrino and a photon.

In certain neutrino scenarios, such a photon would have an energy corresponding to that of visible light, and in principle should be detectable if there are enough of them. The problem is that they would normally be swamped by the copious photons of sunlight.

The 24 October solar eclipse provided a chance to check this out. A team led by François Vannucci, spokesman of the Nomad neutrino experiment at CERN, en route to the 'Rencontres du Vietnam' physics meeting in Ho Chi Minh Ville, set up a CCD-equipped telescope. To insure against cloud cover, a second telescope followed the eclipse in the desert of Rajastan, India, where the eclipse was to last only half as long, but the chance of cloud was minimal.

No background solar signal was seen, or, expressed in physics terms, if solar radiation has any heavy neutrino component, then less than a millionth of it disintegrates into an electron neutrino and a visible photon before it arrives at the Earth. The negative result also has implications for candidate massive, unstable neutrinos from other sources, notably a component of the missing 'dark matter' of the Universe.

The next such eclipse should be visible in North Asia in 1997, when hopefully better measurements will be made.

People and things

The 1995 exhibition of the French Physical Society was officially inaugurated on 3 October by Secretary of State for Research Elisabeth Dufourq. Here Jacques Haissinski (right) , Director of DAPNIA, Saclay (see page 15) explains to Madame Dufourq the structure of a superconducting magnet for CERN's future LHC proton collider. Centre is IN2P3 Director Claude Detraz and left is Denis Linglin, Director of LAPP, Annecy.
(Photo M. Jacob)

On people

José Mariano Gago, president of LIP, the national Laboratory for experimental high energy physics and related research and development projects, in Lisbon becomes Portuguese Minister of Science and Technology. As well as being a prominent Portuguese particle physicist, Professor Gago is well known at CERN and played a vital role in his country's becoming a CERN Member State from 1986. (For a report on CERN-Portugal affairs, see September, page 22.)

CERN Research Director from 1989-93, Walter Hoogland left CERN in October to return to the Dutch NIKHEF Laboratory. Director General Chris Llewellyn Smith recalled Walter Hoogland's valuable contributions in strengthening ties between CERN and non-Member States anxious to participate in CERN's experimental programme, and in the establishment of the Detector Research and Development Committee which blazed a trail for work towards LHC detectors.

Brian Foster of Bristol has been invited to serve for the period from 1 September to 31 December 1995 as a member and for the period 1 January to 31 August 1998 as Chairman of the UK Particle Physics and Astronomy Research Council's Particle Physics Committee, succeeding David Saxon.

Aldo Michelini retires

Following a successful and wide ranging career at the forefront of particle physics, Aldo Michelini formally retired from CERN at the end of October.

He joined CERN in 1960, following a series of experiments with tracking chambers, including some time with Jack Steinberger's group in Columbia. At CERN, he first worked on the CERN Wilson chamber, which now performs valuable service as an aquarium! Four years later, he led a CERN/ETH Zurich/IC London collaboration studying strong interactions using a then novel approach - spark chambers in a large magnet.

From 1969 - 73, he led the Omega spectrometer project, a general purpose spectrometer initially equipped with optical spark chambers and downstream Cerenkov counters. Its huge superconducting magnet, and indeed all the magnets

At CERN on 23 October, Swiss Federal Councillor and head of the Department of Transport, Communications and Energy Adolf Ogi (left) contemplates the immensity of the L3 experiment at LEP with Hans Hofer of ETH Zurich.
(Photo CERN HI8.10.95)

Aldo Michelini - formal retirement from CERN

Dario Squeri, President of the Italian province of Piacenza, addresses this year's international Amaldi Conference. On his right are Giacomo Vaciago, Mayor of Piacenza, President of the Amaldi Foundation Nicola Cabibbo, and Italian Minister of Scientific and University Research Giorgio Salvini. Under the title 'Overcoming the obstacles to peace in the post-cold war era', the conference was the 8th in the series, founded in a world academy context by Edoardo Amaldi and Wolfgang K.H. Panofsky in 1988. (Photo Ballardo)

of Aldo's later experiments, were built by his good friend Mario Morpurgo. The validity of the Omega concept, which first went into action at the PS and was later resited at the new SPS proton synchrotron, is underlined, more than 20 years later, by the continuing vigour of its experimental programme.

In 1973 Michelini became responsible for a group studying a general purpose spectrometer for the SPS North Area. This led to the NA3 experiment whose valuable measurements included production of (Drell-Yan) muon pairs and of direct photons. Following the success of NA3, in 1981 he became spokesman of the Opal experiment at the LEP electron-positron collider, a demanding post which he held until recently.

The success of Opal owes a great deal to the care with which he guided the formation of the collaboration, and the construction and exploitation programme. He has always appreciated the efforts of team members at all levels and his colleagues admire and enjoy the agreeable working atmosphere which he has created.

1995 Amaldi Conference

The Fondazione Edoardo Amaldi, founded in 1992 to honour the memory of the distinguished Italian scientist and CERN founding father, hosted in October the 8th international Amaldi Conference, held this year in the Amaldi home town of Piacenza. Under the title 'Overcoming the obstacles to peace in the post-cold war era', prominent international personalities discussed pressing problems in conventional, nuclear, biological and chemical warfare. President of the Foundation is Nicola Cabibbo, who is also President of the Italian Atomic Energy Authority. The annual Amaldi Conference, founded by Edoardo Amaldi and Wolfgang K.H. Panofsky in 1988, alternates between venues in Italy and other countries.

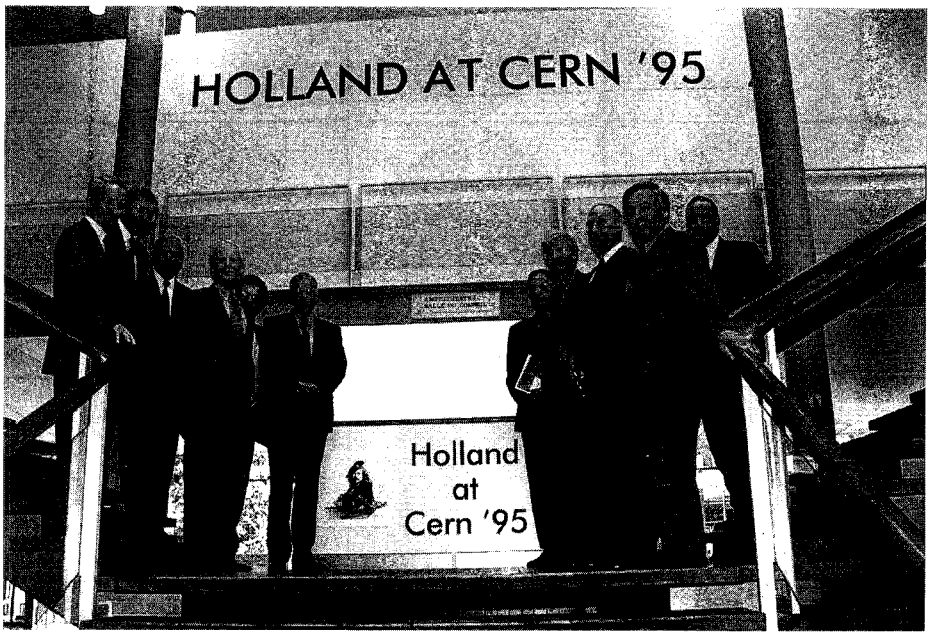
Pep progress

October saw the successful commissioning of the portion of electron injection line for the the PEP-II electron-positron collider being built at the Stanford Linear Accelerator Center (SLAC - October, page 9) This line extracts electrons from the main linac and carries them along the length of the linac tunnel. The celebration was the first PEP-II commissioning event en route to project commencement of operations in September 1998. For a PEP-II progress report, see October, page 9.

New ISIS instrument

Under a £2.5 million grant, a general materials diffractometer, GEM, will be installed at the ISIS pulsed neutron source at the UK Rutherford

The Holland at CERN industrial exhibition from 17-20 October attracted 22 high technology companies.



Appleton Laboratory in the beamline currently occupied by the LAD Liquids and Amorphous Diffractometer.

To be operational early in 1999, GEM will combine high resolution with high count rate, and be able to monitor the behaviour of a wide range of materials in varying conditions of temperature and pressure and while undergoing chemical reaction.

RHIC Summer Study at Brookhaven

Brookhaven National Laboratory has announced plans to hold a workshop devoted to physics at the relativistic heavy ion collider, RHIC, now under construction. To be held from July 8 -19 1996, it will be the first in a series of Summer Studies on RHIC physics. Future programs will juxtapose both school and workshop formats. The principal emphasis will be on topical theoretical concerns, but will also include experimental directions. The intent is to define and sharpen the scientific focus of the physics at RHIC. It is hoped that a workshop environment will encourage examination of the theoretical foundations of existing models of ion-ion collisions, and will further point these models towards observables measurable in the proposed detectors. The topics to be considered include: Thermodynamics; Hard processes; Phenomenology, Simulations and signals; and Chiral symmetry and coherent effects.

The Workshop is part of a broader programme of summer and winter meetings sponsored jointly by Brookhaven and the National Institute for Nuclear Theory at the University of Washington, Seattle.

Further information from S. Kahana (kahana@bnl.gov) or T. Ludlam (ludlam@bnl.gov). A home page updating the evolution of the Workshop is at "http://penguin.phy.bnl.gov/www/workshop.html".

Applying the accelerator

Judged by feedback, the special July/August issue of the CERN Courier - 'Applying the Accelerator', covering the uses to which particle accelerators have been harnessed - was appreciated by many readers. However as usual, when trying to cover a major topic once and for all in a single issue, some fish slipped through the net. In particular, the dynamic growth area of spallation neutron sources was overlooked and will be covered in a forthcoming issue.

Publication of that issue also drew our attention to a document 'Impact and Applications of Nuclear Science in Europe: Opportunities and Perspectives', published by NuPECC, the Nuclear Physics European Collaboration Committee, which covers similar ground, but with 184 pages compared to the 24 editorial pages of the July/August issue of the CERN Courier, could do so more lavishly.

Copies are available from the NuPECC Scientific Secretary, Gabriele-Elisabeth Körner, Physikdepartment E12 der Technischen Universität München, D-85748 Garching. Fax +49 89 3209 2297, e-mail sissy.koerner@physik.tu-muenchen.de

Meetings

The 1996 Lake Louise Winter Institute "Topics in Electroweak Physics" will be held at Lake Louise, Alberta, Canada from 18-24 February 1996. For information, contact Conference Secretary, Lake Louise Winter Institute, Department of Physics, University of Alberta Edmonton, AB

Guest of this year's European School of High Energy Physics, held in Dubna, Russia, was Z. Yakobashvili, Russian Federation Vice-Minister of Science and Technical Policy, who spoke on 'the Status and Perspectives of Russian Science'. On his right in this photograph are (left to right) JINR Vice-Director A. Sissakian and School manager Egil Lillestøl of CERN, and on his left are an interpreter, head of JINR's International Office A. Romanov, and JINR Director General V. Kadyshevsky.

Canada T6G 2J1 or by electronic mail from llwi@phys.ualberta.ca or audrey@phys.ualberta.ca

The next traditional mini-conference at NIKHEF-K (on February 1 and 2) will concentrate on the deuteron, following the exciting new results with NIKHEF's extracted beam and with the stored beam on polarized deuterium in the internal target hall. Also new developments are taking place world-wide, both on the theoretical and the experimental side. Further information from the secretary of the conference: Joppie Kohler, phone +31 20 5922142, or e-mail mini96@nikhef.nl

The organization will be similar to that of the preceding years: participants (with the exception of invited speakers) have to organize their own travel and accommodation. There will be no conference fee, the lunches will be free and the Proceedings will be made available to the participants free of charge.

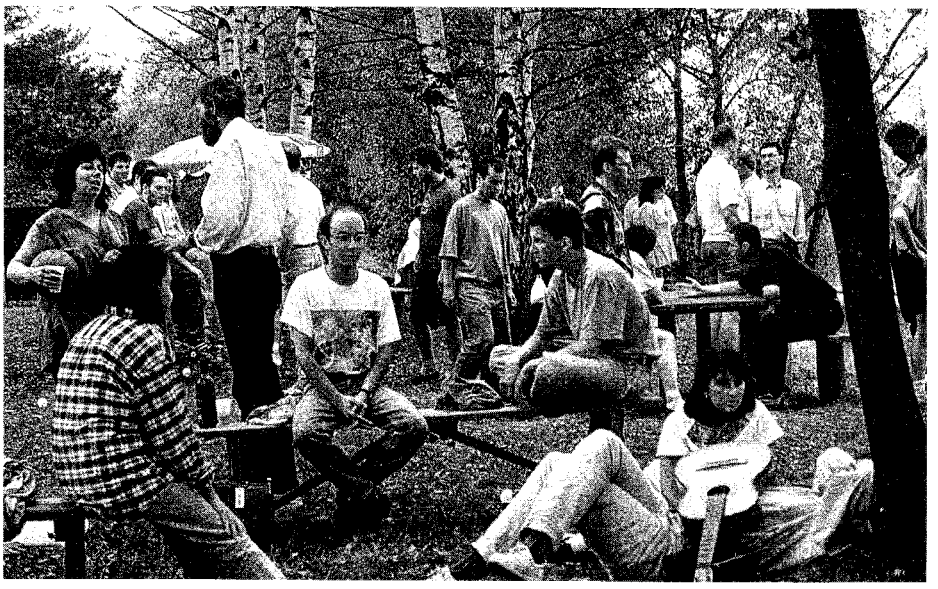
Additional information at http://www.nikhef.nl/www/pub/default/meetings.html

The XIIth Workshop HADRONS-96, organized by the Bogoliubov Institute for Theoretical Physics, National Academy of Sciences of Ukraine, will be held in Novy Svet, Crimea (Ukraine) from June 9-16. It will cover: Elastic and diffractive scattering, small-x structure functions, spin and polarization phenomena, dual and string models, confinement in QCD, collective properties of the nuclear matter, and advances in quantum field theories. Information from: Mrs. Galina Bugrij, Institute for Theoretical Physics, Kiev-143, Ukraine; E-mails: abugrij@gluk.apc.org or jenk@gluk.apc.org; fax: +380-44-2665998; phones: +380-44-2669123 /2669161 /2660988.

1995 European School of High Energy Physics

This summer, Dubna, a pleasant Russian town on the Volga river and the home of the Joint Institute for Nuclear Research (JINR) hosted the European School of High Energy Physics. Under a CERN-JINR agreement, these two-week schools, aimed at young experimentalists, have been organized every year since 1993, when the school was held in Zakopane (Poland). Last year it was held in S, Agnello (Sorrento, Italy) and next year's venue is Marseille.

Time out during this year's European School of High Energy Physics. (Photos Yu. Tumanov)



On 13 October, at a colloquium to celebrate the its tenth birthday of the CDF experiment at Fermilab's Tevatron proton-antiproton collider, CDF spokesman emeritus Alvin Tollestrup (left) and Fermilab Director John Peoples admire a bound volume of CDF's first hundred scientific papers.
(Photo Reidar Hahn, Fermilab)

CEBAF reaches design energy

Operation of CEBAF, the Continuous Electron Beam Accelerator Facility in Newport News, Virginia, recently began shifting from commissioning towards physics research. The accelerator has begun reliably producing stable continuous beam at the design energy of 4 GeV in a design-maximum five full acceleration passes. The beam power is about 100 kW, with still higher powers planned in the new year. Experimenters can now be supplied with beam from any number of passes up to the design maximum, and experimental nuclear physics is starting in Hall C. There will be a major article on CEBAF commissioning in a forthcoming issue.

Gold for RHIC

At Brookhaven, commissioning of the beam transfer line from the AGS Alternating Gradient Synchrotron to the new RHIC heavy ion collider began at the end of October, as scheduled. (A photograph of this line featured on the front cover of the October issue.)

Initial work involved commissioning the AGS 'context switching system'. Forseeing the time when the AGS menu will have to include a wider variety of beams, this new operating mode allows different AGS cycles to be interleaved, and a RHIC injection cycle was introduced among many fixed target cycles for parasitic commissioning. Debugging this new mode in a short period of time was in itself a great accomplishment for the AGS Controls Group.

Two shifts of machine time were then dedicated to the extraction of beam into the upstream portion of the injection line. Early in the morning of 9 November, the gold beam was successfully transported to a downstream dump . The 400 m from the AGS to the dump includes one 8° bend, one 20° bend, and a 1.73-m drop in beam elevation.

The gold bunch intensity was estimated to be about 1.5 x 10^7 ions. There were no pronounced beam losses, but since the intensity was at the lower limit of the instrumentation sensitivity, a quantitative statement is difficult. A systematic study of the injection line optics and parameters, as well as radiation fault studies, is continuing.

A decade of CDF

On 13 October, the CDF experiment at Fermilab's Tevatron proton-antiproton collider celebrated its tenth birthday. According to CDF's special commemorative t-shirt, this decade has seen 100 physics papers, 1,148 stores of colliding beams, 8.4 x 10^{12} collisions, 165 inverse picobarns of integrated luminosity, and 92 million collision events stored on tape, as well as one new quark - top.

CERN Research Director from 1989-93, Walter Hoogland (left) of the LHC-B experiment has returned to the Dutch NIKHEF Laboratory. He is seen here with Gerrit Bossen of CERN, who was until recently in charge of CERN's Fellows and Associates Service.

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POSTDOCTORAL RESEARCH ASSOCIATE EXPERIMENTAL PARTICLE PHYSICS

Applications are invited for postdoctoral research associate positions to participate in the D0 experiment at the Tevatron at Fermilab. The positions offer opportunities for hardware, software and physics analysis activities and could start immediately. The Stony Brook High Energy Group has been involved with the D0 experiment since its conception. The experiment studies proton-antiproton collisions at a center-of-mass energy of 1.8 TeV, and is currently collecting large data samples. The group is actively involved in several analyses: top-quark search, W and Z physics, searches for new phenomena, QCD and B physics. We are also working on the design and construction of detector elements and electronics for the D0 upgrade. We are seeking candidates holding a Ph.D. or an equivalent degree in physics, with diverse experience in experimental particle physics. We strongly encourage applications from women and minorities. Interested applicants should send a curriculum vitae, a brief summary of research interests, and arrange to have at least three letters of recommendation sent to:

Professor M. Mohammadi
Dept. of Physics, SUNY at Stony Brook
Stony Brook, NY 11794-3800, USA

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TENURE-TRACK FACULTY POSITION EXPERIMENTAL NUCLEAR PHYSICS THE OHIO STATE UNIVERSITY

The Department of Physics invites applications for a tenure-track Assistant Professor position in experimental nuclear physics. The successful candidate, who should be capable of establishing a strong, independent research program, would join an existing nuclear group, composed of three faculty members working typically with three postdoctoral fellows and about fifteen graduate students. Topics of current study include nuclear astrophysics, relativistic heavy ions, and hadron spin physics. We are particularly interested in identifying strong candidates who would be able to augment our recent move into relativistic heavy-ion physics at such facilities as CERN and RHIC, but would encourage candidates in other subfields as well. A commitment to teaching is also required. For fullest consideration, applicants should send their curriculum vitae and arrange for at least three letters of recommendation to be sent no later than February 1, 1996 to: Professor Thomas Humanic, Department of Physics, The Ohio State University, 174 West 18th Avenue, Columbus, OH 43210-1106, USA. The Ohio State University is an Equal Opportunity/Affirmative Action Employer. Qualified women, minorities, Vietnam-era Veterans, disabled veterans and individuals with disabilities are encouraged to apply.

DESY

The Deutsche Elektronen-Synchrotron DESY in Hamburg performs basic research in the field of elementary particle physics by means of a High Energy Storage Ring. It is a research institute of international repute which collaborates with similar research centres throughout the world.

We are looking for a

Realtime Software Developer

in the ZEUS collaboration at DESY

Job description:

The successful candidate will be a physicist or a computer scientist with experience of working in large high energy physics collaborations and will be responsible for designing and implementing new software within the ZEUS experiment's data acquisition system. The candidate must have an intimate knowledge of realtime applications programming (distributed control of networked tasks, multithreading, X user interfaces etc.) on Open VMS, UNIX (OSF1, IRIX) and OS9, i.e. those operating systems currently used in the ZEUS data acquisition system. Expertise is required in the C and C++ programming languages, whereby additional experience of FORTRAN and OCCAM would be advantageous. The candidate must also have knowlegde of and be interested in the use of commercial tools. In this respect the use of SUN RPC/XDR and of TCL is a prerequisite.

Qualification:

PhD in physics or computer science; experience with online data acquisition systems in large high energy physics experiments; several years of experience in designing and operating a large realtime data acquisition system; capability to work together in a team of physicists and computer scientists within an international collaboration. Good knowledge of the English language is essential. The contract will be limited until 31.08.2000. The salary will be according to the "MTV Angestellte".

Handicapped applicants with equal qualifications will be prefered.

DESY is interested in advancing the professional development of women and would encourage women to apply for this position.

Written applications (curriculum vitae, certificates and references) should be sent to our Personnel-Department before **31.12.1995**.

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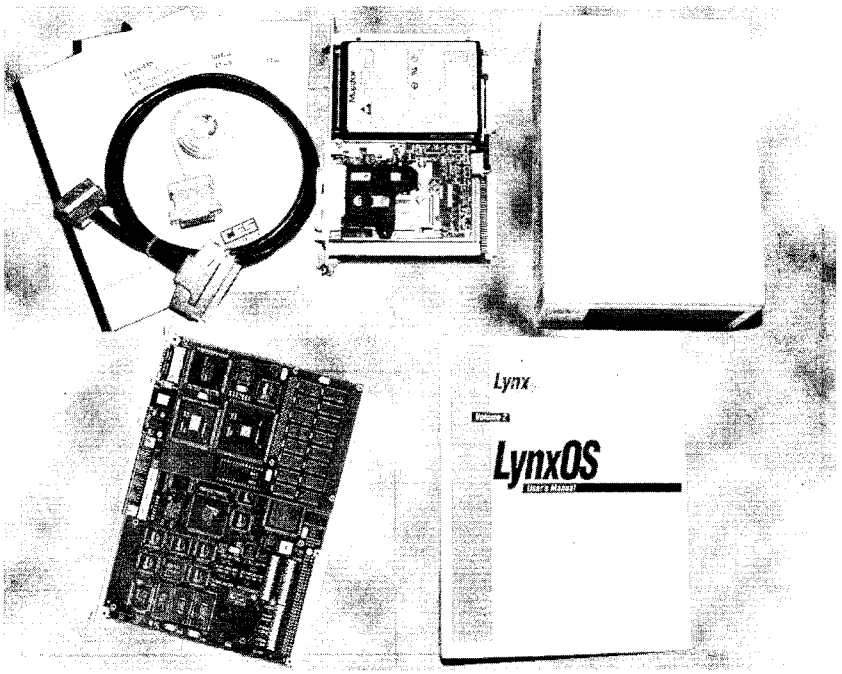

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