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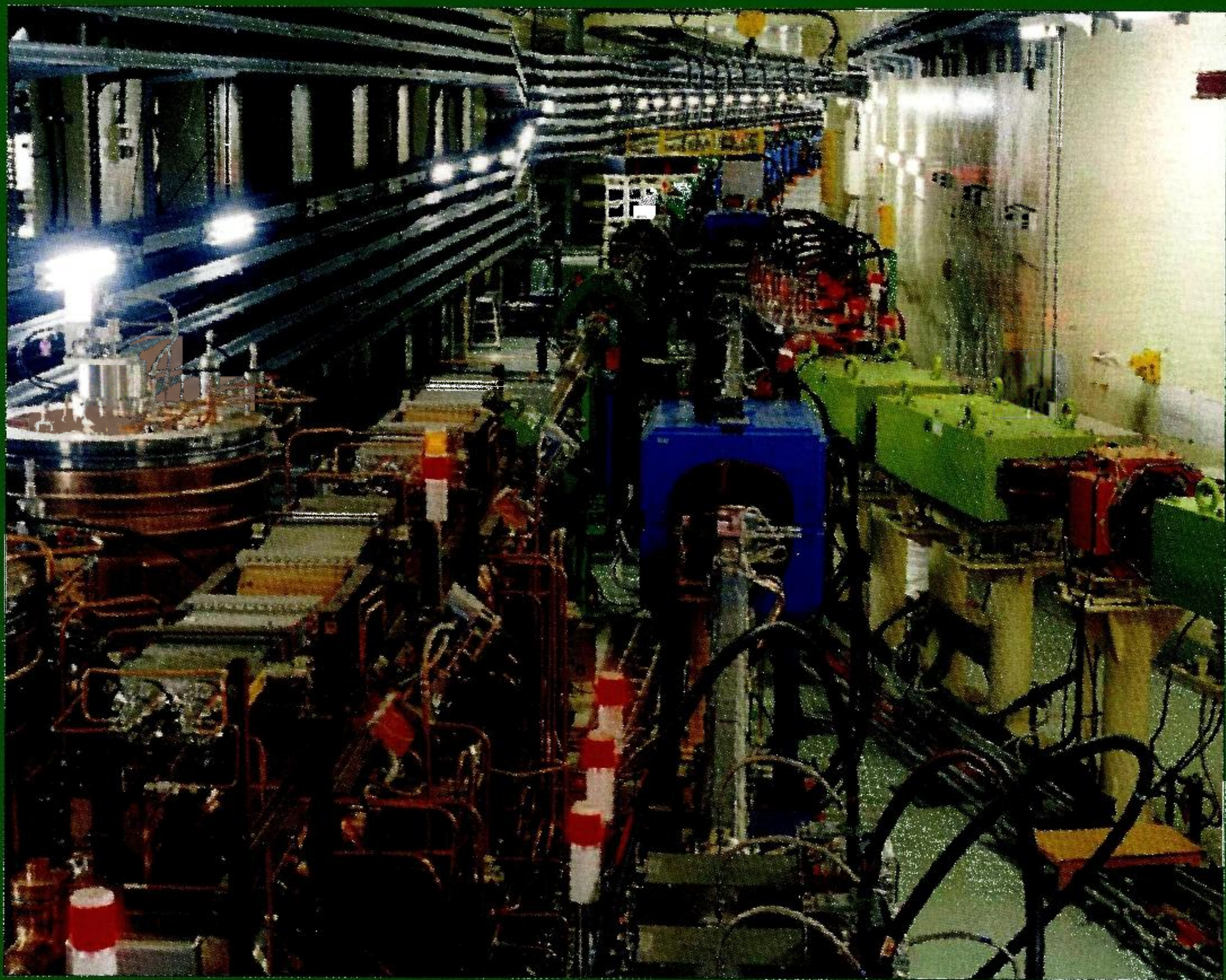

Japanese lab rings the BELLE

LA FRANCE AU CERN
18-21 octobre 1999

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Covering current developments in high-energy physics and related fields worldwide

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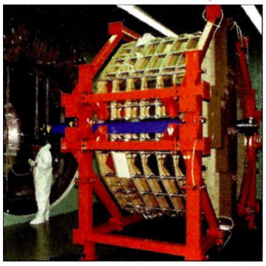
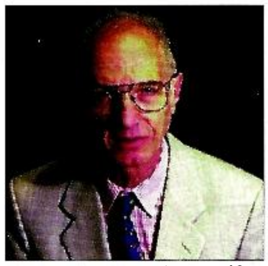


CP violation measurements p6

Synthesis of element 118 p18

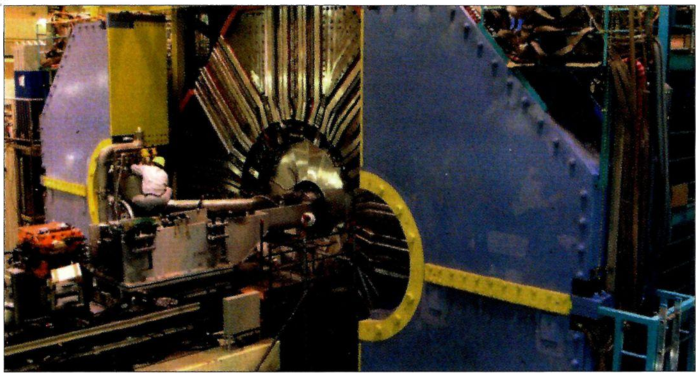


Particles and the universe p40

Cover: The Japanese KEKB electron–positron collider (p5).

KEK: initial B for BELLE

The Japanese KEKB electron–positron collider. This picture shows the injection point of the electron beam. From the right, 8 GeV electrons arrive through the beamline with light-green dipole and orange quadrupole magnets, and enter the high-energy ring with blue quadrupole magnets. A couple of ARES radiofrequency accelerating cavities for the low-energy 3.5 GeV positron ring are also visible. KEKB is in the 3 km tunnel, which formerly housed the TRISTAN electron–positron collider.



The BELLE detector at the collision point of the KEKB collider. The endplates remain open while a technician works on the control box of the cryogenic quadrupole magnet for the final focus.

On 1 June, after five years of planning and five years of construction, the BELLE detector recorded its first B meson events at the KEKB electron–positron B-factory in Tsukuba, Japan. During this first run, all BELLE systems were active, including the electron-identification software, which saw a CP-violating candidate decay into a J/psi and a short-lived kaon, with the former producing an electron–positron pair. This marks the real start of the KEKB factory and its quest to investigate the puzzle of CP violation.

The KEKB collider is an energy-asymmetric collider, its two rings handling 3.5 GeV positrons and 8 GeV electrons in the old 3 km TRISTAN tunnel. The injection linac was upgraded from that used for TRISTAN and was ready long before the commissioning of the rings began last December.

Beams were first stored in the electron ring (HER) on 13 December and in the positron ring (LER) on 14 January. After several interruptions, scheduled and unscheduled, the stored currents rose to 500 mA, corresponding to 20 and 50% of the designed values of LER and HER respectively, by mid-April.

The limiting factors are currently believed to be radiofrequency power for HER and vertical beam blow-up due to a multibunch instability. Of the two major unscheduled breaks experienced so far, the first was provoked by a false fire alarm in the tunnel. The second came when a spot of the vacuum chamber was melted by synchrotron radiation from the final focusing quadrupole during trials of a large angle bump orbit. The chamber was quickly replaced with one of heat-resistant design.

Commissioning was halted from 1 May for the installation of the BELLE detector, which crept into the collision point at a speed of 0.5 m/min, taking about 30 min to complete the "long trip". Beam tuning resumed on 25 May and collisions were achieved on 1 June.

Initially, currents in both beams were kept below 20 mA to guard against radiation damage to the BELLE detector's silicon vertex detector. Beam currents have subsequently been increased to more than 100 mA.

Prior to establishing collisions, a potentially harmful 0.45 Hz vertical beam vibration was observed in the low-energy positron ring. This was tracked down to tiny magnetic fields produced by current leads running between the power supply and the main ring of KEK's 12 GeV proton synchrotron. These leads pass through a channel above the KEKB tunnel 8 m from the beam pipes.

The proton synchrotron is currently providing a neutrino beam directed at the Super-Kamiokande detector, 250 km distant, for the high-priority K2K experiment, which is searching for confirmatory evidence for the neutrino oscillations reported by the Super-K group last year.

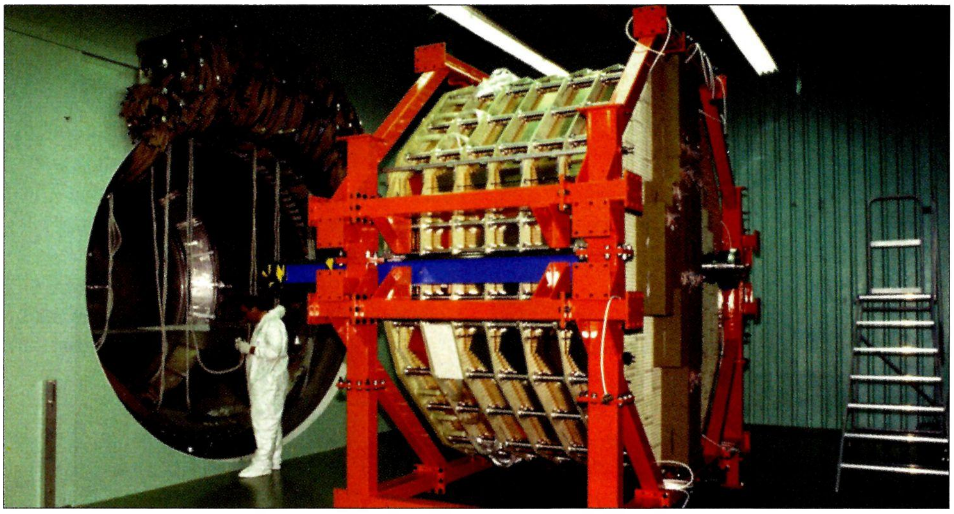
Fortunately for BELLE, KEKB's first time slot for electron–positron collisions coincided with a maintenance day for the proton synchrotron, resulting in the successful test run of 1 June The troublesome stray fields have since been reduced substantially by reconfiguring the proton synchrotron's power leads.

In addition to providing BELLE data, the successful test run verifies a number of novel KEKB design features – the finite-angle beam crossing did not result in beam-destroying synchro-betatron oscillations, and the growth times of the instability due to fundamental mode shifts in the ARES energy storage radiofrequency cavities were longer than the natural damping times of the storage rings.

KEKB has achieved stable collisions with design values of single-bunch currents. The next goal is to increase the number of bunches and boost the luminosity towards the design figure of 10^{34} cm^{-2} s^{-1}. As the number of ampere-hours of integrated beam current in the machine increases, the vacuum in the beam pipe continues to improve and background conditions in the BELLE detector decrease.

Currently the luminosity is estimated to be 2×10^{31} cm^{-2} s^{-1}, with tens of hadron events collected every few hours. This performance should soon increase and open up a rich programme of studies of B meson decays to probe the puzzle of CP violation.

NA48 measures direct CP violation



The liquid krypton calorimeter of the NA48 experiment plays a vital role in precision measurements of CP violation. The calorimeter's cryostat was built by Krunichev Industries, Moscow, and uses 22 tonnes of krypton from Russia – an arrangement organized through the International Science and Technology Center.

With a first result announced from a major experiment at CERN, 1999 looks like being a vintage year for the measurement of CP violation – the effect that enables nature to differentiate between matter and antimatter.

Earlier this year, the KTeV experiment at Fermilab (*CERN Courier* April p5) confirmed that CP is violated "directly" in the way quarks decay and transform into each other. The new result from the NA48 experiment at CERN underlines this direct CP violation and provides a valuable new benchmark.

CP violation, which is vital to our understanding of particle interactions and of the evolution of the universe in the wake of the Big Bang, is difficult to understand, hard to study and awkward to measure.

In 1956, physicists were shocked to discover that the weak force can differentiate between right and left. To reimpose order on their theories, physicists introduced charge/parity (CP) symmetry, in which physics should remain the same if a left-handed particle changes into a right-handed antiparticle, and so on.

For CP, the neutral kaon plays a special role. For CP purposes, this particle has to come in two forms: long-lived, decaying into three pions; and short-lived, decaying into two pions. In 1964, physicists received another shock when Christenson, Cronin, Fitch and Turlay discovered at Brookhaven that long-lived kaons can also decay into two pions. CP symmetry is not exact.

There are two ways in which this can happen. In the first, the long-lived kaon is a mixture of quantum states, mainly CP-odd with just a small amount of CP-even. In addition, CP could also be violated in the actual quark reactions underlying the particle transformations. In the decay of the neutral kaon, a strange quark slips off the map, producing pions composed of only up and down quarks. CP violation via this route is called "direct".

To establish whether such direct CP violation happens, physicists have to compare two ratios: that of long-lived kaons decaying into two neutral pions with those going into two charged pions and the equivalent ratio for short-lived kaons. If these two ratios do not tally exactly, direct CP violation happens. Quark effects contribute to CP violation.

For several years the results from two major experiments – NA31 at CERN and E731 at Fermilab – could not be reconciled. The former gave the difference of the ratio of ratios from unity (divided by a conventional numerical factor) of $2.3 \pm 0.65 \times 10^{-3}$. The latter gave a much smaller figure, compatible with zero.

Does direct CP violation happen or not? To resolve the dilemma, new studies were begun. The early CP violation experiment at CERN had made separate runs with long-lived and short-lived kaons, leaving the door open to possible changes creeping in from one run to the next. Both recent experiments overcame this by using simultaneous beams of long- and short-lived kaons and taking data on charged and neutral pion production by both kaon beams at the same time. Earlier this year, KTeV at Fermilab reported a value of $2.8 \pm 0.41 \times 10^{-3}$ in tune with the earlier CERN measurement, but a bit on the high side, which surprised some people. The new result from NA48 is $1.85 \pm 0.73 \times 10^{-3}$.

The NA48 flagship experiment providing the new measurement is a major research investment. Installed in CERN's highest-intensity proton beamline it uses a large and sophisticated detector. Some of the CERN protons go to make long-lived kaons, and the remaining particles are bent by a crystal and used to make a parallel beam of short-lived kaons. In this way the protons giving birth to short-lived kaons are "tagged" and the two varieties of kaons are clearly differentiated, even though they eventually decay in the same way.

Decays into charged pions are measured by a magnetic spectrometer, while the pions from the neutral pions are pinpointed by the pride of the experiment – a special liquid krypton calorimeter with better than 1% energy resolution and subnanosecond time resolution.

Handling NA48 data requires a major effort in dataprocessing power, with data from all detector modules being pipelined to CERN's main computer centre via a dedicated fast link. The NA48 result comes from data taken in 1997 and will be about 10% of the total amount of data that the experiment expects to accumulate in three years of running. However, even this initial sample amounts to almost 5 million kaon decays into pairs of pions, more than1 million of them being decays of long-lived kaons into pairs of pions, the direct descendant of the handful of events seen in 1964 that established CP violation as a physics phenomenon.

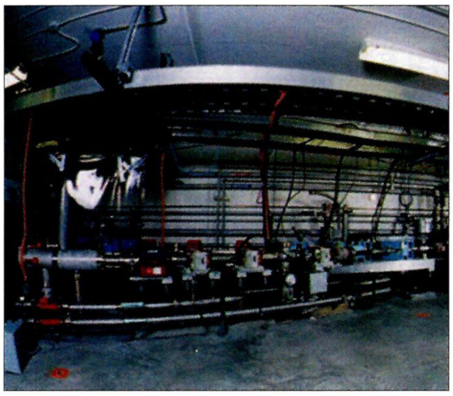
CP violation has still only been seen in the decays of neutral kaons. However new experiments are setting out to measure CP violation via new routes.

Jefferson free-electron laser exceeds kilowatt

On 15 July in *Newport News*, Virginia, Jefferson Lab's free-electron laser (FEL) produced infrared light at a wavelength of 3.1µm and 1.72 kW average power, thereby exceeding the kilowatt design goal. No FEL has previously exceeded 14 W.

The infrared Demo FEL is the first in a series of high-average-power, wavelength-tunable FELs being developed at Jefferson Lab for basic science, industrial applications and applied defence research. FEL development is a spinoff from the laboratory's main mission of accelerator-based investigations into the quark structure of nuclei. The superconducting radiofrequency (SRF) electron accelerator at the heart of the FEL is derived from the technology of Jefferson Lab's 6 GeV continuous-wave main machine.

In July's record-setting laser operation, untapped electron-beam energy was recovered by recirculating the beam back through the driver accelerator for "deceleration." The driver was operated at 4.4 mA and 48 MeV, approaching its maximum design power of 250 kW. Energy-recovery capability would contribute significantly to fully developed SRF-driven FELs' cost-effectiveness.


The beamline of Jefferson Lab's free-electron laser.

Upcoming FEL user experiments include silicon characterization studies (by a group from Vanderbilt), laser photodeposition (Norfolk State), photoablation (William and Mary), polymer surface modification (DuPont) and metal surface modification (Armco/ Virginia Power).

Crucial to Jefferson Lab's ongoing FEL effort is the support of the US Department of Energy, the Office of Naval Research, the Commonwealth of Virginia and industry and university partners in the Laser Processing Consortium.

LEP achieves its first century

On 2 August, a decade after the initial commissioning at 45 GeV per beam, CERN's LEP storage ring has collided 100 GeV beams of electrons and positrons, giving a total energy of 200 GeV and a healthy luminosity (a measure of the collision rate) of 6×10^{31} cm^{-2} s^{-1}.

This year, LEP supplied colliding beams initially at 96 GeV (*CERN Courier* July p5), and then at 98 GeV. However, the 100 GeV per beam figure was always on the cards following the delivery by LEP of a single 100 GeV electron beam in a debut 1999 high-energy run.

- Full story next month.

RHIC gold particles complete lap of ring

On 16 July, a beam of gold nuclei circulated one of the two rings of Brookhaven's Relativistic Heavy-Ion Collider (RHIC) for the first time.

Equipped with superconducting magnets, the machine operates at 4.6 K. After several "mini-ramp" cycles to test the beam-accelerating system in the first (blue) ring, the second (yellow) ring was powered in preparation for injection. The purpose of this commissioning phase is to accelerate beams in both rings for collisions. After commissioning, the RHIC research programme proper is scheduled to begin in November this year.

Beijing tests complete precision measurement

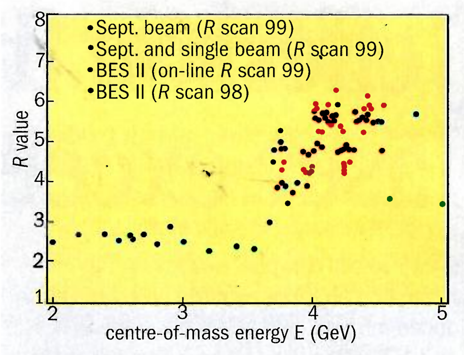
The BES II spectrometer at the Beijing electron–positron collider (BEPC) has completed a measurement of hadron production rates over the 2–5 GeV energy range which is valuable input for Standard Model calculations.

Three vital input parameters in the electroweak sector of the Standard Model are α, the electromagnetic coupling strength (which depends on energy), the Fermi constant of weak decay and the mass of the Z boson – the neutral carrier of the weak force.

To test the Standard Model, the electromagnetic coupling strength has to be evaluated at the Z resonance. The LEP measurements of the Z mass are of such high quality that now the error on the coupling strength is a limiting factor in tests of the Standard Model. Its accurate determination of α is critical for the indirect determination of the mass of the Higgs particle. A more accurate value narrows the mass window for Higgs particle searches.

Of particular importance in the extrapolation of α is the hadronic contribution to the vacuum, such as virtual quark–antiquark pairs, which cannot be calculated reliably but can be related to a factor known as *R* – the ratio of hadron to muon pair production in electron–positron annihilation. Uncertainties in the measured values of *R* in the 2–5 GeV energy range contribute to the error in α.

After the first *R* scan in spring 1998, the BES collaboration performed a finer scan in the 2–5 GeV energy region – almost the extremes of energy region that the BEPC can cover. The scan began in February and finished in early June. Data were taken at 85 energy points. To subtract background, separated beam runs were performed at 26 energy points, and single beam runs for electron and positron beams were carried out at 7 energy points. Special runs were taken at the J/psi resonance to determine the trigger efficiency and calibrate the detector. These runs show that the 12-tracking-layer vertex



Comparing hadrons and muon production at the BES II spectrometer at the BEPC.

chamber, rebuilt from the SLAC Mark III endplates and beryllium beam pipe, has a spatial resolution of about 100 µm.

The figure shows the on-line values from the new R scan. Note that the detection efficiency, the background subtraction, as well as the radiative corrections have not been taken into account. The plot includes the R values for 6 energy points measured last year. The upgraded BEPC, as well as the good cooperation and hard work of the BEPC staff, were essential for the success of the scan, which continued even through the traditional Chinese Spring Festival.

Zhengguo Zhao and Frederick A Harris.

Management practice for the global village

CERN's contribution to industry is not limited to high technology for frontier science. Through the Scandinavian CoDisCo project, the lab is also helping to define management practice for large-scale distributed projects.

CERN's Large Hadron Collider project represents not only the world's largest scientific undertaking but also a unique opportunity to study project management on a global scale. The ATLAS and CMS experiments, as well as the LHC, are collaborative projects whose members, and competencies, are distributed around the world along with the suppliers providing equipment, services and raw materials. They provide ideal case-studies for the Scandinavian Connecting Distributed Competencies (CoDisCo) project.

Some companies have already begun to adapt to a global market-place, where their suppliers as well as their customers could be anywhere in the world. Internet-based information systems are enjoying a boom as companies come to rely on them more and more for document handling. Those firms that have taken the plunge report significant savings in time and money after converting from traditional paper-based document management to digital formats. Although the paperless office is almost a reality, with some three-quarters of internal document handling being done on line, companies still resort to traditional methods for their external communications and document handling.

CERN is a natural place for a distributed project management study. The physics community has already had decades to adapt itself to the realities of working with large-scale distributed collaborations. Indeed, the World Wide Web was born out of physicists' need to communicate and share information. The LHC project, with its Engineering Data Management System, is at the vanguard of this emerging field and both the accelerator and its experiments are truly global in nature.

Funding for CoDisCo comes from the Nordisk Industrifond and seven, small and medium-sized Scandinavian companies which hope to learn from the LHC experience. The project's goal is to define methods and tools to integrate and exploit distributed resources better by collecting distributed competencies to form a single, logical, networked entity. CoDisCo is a two-year project and was formally inaugurated with a meeting at CERN last September. Since then, three students have begun work on their theses on document management at CERN. Two partners, Aker Finnyards of Finland and Hönnun og rá›gjöf of Iceland, are already testing an Internet-based document-management system. As the project moves towards its conclusion, both industry and the increasingly global field of particle physics stand to gain.

For more information see "http://www4.maskin.ntnu.no/PS2000/CoDisCo/".

PANIC99 conference in Uppsala

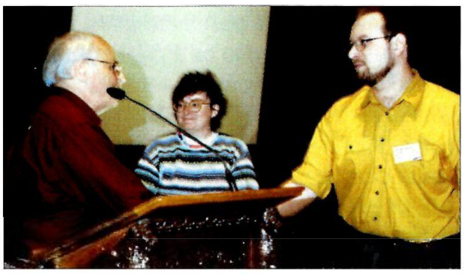
Delegates at the 15th Particles and Nuclei International Conference (PANIC99), which was held in Uppsala, Sweden, on 10–16 June.

A regular feature of the nuclear physics scene is the Particles and Nuclei International Conference (PANIC99), which was held in Uppsala, Sweden on 10–16 June. An appropriate symbol for the turn-of-the-millennium conference was a Swedish rune stone carved around the last millennium change and placed in front of the main building of the university.

The first such conference was held in 1963 at CERN and was organized by Victor Weisskopf, Amos de Shalit and Torleif Ericson. Five PANIC99 participants had also participated in the first meeting. The conference series was initially called High-Energy Physics and Nuclear Structure, and one of the main themes has been to link nuclear and high-energy physics. These two disciplines have become increasingly important in astrophysics and cosmology, which were given added weight in the programme of PANIC99.

The first plenary talk each day was designed to underline this cross-disciplinary character as well as to show how applications of instruments and methods are important to society. The lectures were "What quantum chromodynamics tells us about nature" (Frank Wilczek), "The theoretical enigma of gamma-ray bursts" (Martin Rees), "Charged particles in radiation medicine" (Gudrun Gotein), "Core collapse in supernovae" (Hans-Thomas Janka), "Transmutation of nuclear waste" (Waclaw Gudowski) and "Where in the world is the oscillating neutrino?" (Janet Conrad).

Wilczek was the keynote speaker and Gotein's talk was dedicated to the late Boerje Larsson, who carried out pioneer work in radiation surgery and therapy using charged particles in Uppsala and elsewhere.



Alessandra Filippi and Lutz Bornschein receive poster awards from Sven Kullander.

Of the 600 contributions, 200 were selected for oral presentations in the afternoon sessions, which were divided into the following topics: real and virtual photon interactions with nucleons and nuclei; meson, nucleon and hyperon interactions with nucleons and nuclei; hadron spectroscopy and structure; dense and hot matter; neutrino physics, nuclear and particle astrophysics; fundamental symmetries and the Standard Model; strong interactions in the non-perturbative region; and experimental techniques, applications and facilities for the next millennium.

Highlights in hadron and photon interactions were summarized by H Toki and A Thomas – two of the convenors of the first two sessions, which were the largest in terms of number of papers. Four contributions were selected as topical talks in the morning plenary sessions. C Perdrisat presented precise data on the proton electric and magnetic form factor ratio by polarization transfer in electron–proton scattering at the Jefferson Lab. K Seth reported on behalf of the E852 collaboration at Brookhaven on the discovery of new exotic mesons. J Belz talked about new measurements of direct CP violation in K decay and other recent results from Fermilab's KteV experiment . A Gillitzer discussed the observation at GSI Darmstadt of well resolved nuclear states.

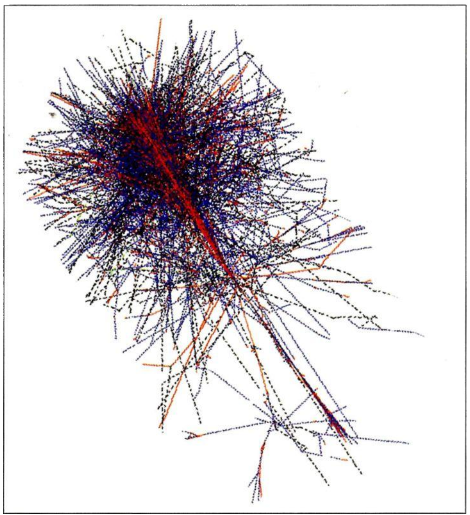
Owing to the very recent discoveries in Berkeley and Dubna of three new elements (see p18), K Aleklett commented on how they were found and their impact on research.

In addition to the morning and afternoon parallel sessions, there were poster presentations on Friday and Monday. The poster visitors could vote for the best poster presented during each of these sessions. Prizes were awarded to A Filippi for the OBELIX collaboration and J Bonn, L Bornschein, B Degen, Ch Kraus, E W Otten, H Ulrich and Ch Weinheimer from Mainz for posters on strangeness production and the OZI rule, and a study of a sensitive spectrometer for neutrino mass measurements.

The proceedings of the conference will be published in *Nuclear Physics*. PANIC99 showed that this type of event has an important role to play in bridging different subfields of physics, which was also underlined by the IUPAP C12 meeting. The 16th PANIC conference will be held in Japan and will be organized by the Osaka Research Centre for Nuclear Physics.

During PANIC99, CELSIUS/WASA – a new detector facility to be used at the CELSIUS cooler storage ring – was inaugurated at Uppsala's Svedberg Laboratory – a Swedish national facility for accelerator-based research. The new facility will be reported on in the next issue.

Electrons and nuclei meet at HERA



Simulation of a collision between a high-energy nucleus and an electron, as would be seen by an extension of the programme at the HERA collider at DESY, Hamburg.

The HERA collider at DESY, Hamburg, has been operating with proton and electron (or positron) beams since it was commissioned in 1991. The possibility of having nuclei in its superconducting proton ring emerged as an interesting option in the 1995–6 workshop Future Physics at HERA.

Such an electron–nucleus collider would explore entirely new domains of quantum chromodynamics (QCD) – the field theory of quarks and gluons deep inside protons and nuclei.

Significantly larger quark/gluon densities at very small momentum fractions carried by the struck quark/gluon would be accessible compared with the present electron–proton collisions in HERA or in fixed-target experiments. This is expected to reveal a new QCD domain, where the smallness of the coupling is compensated for by a high density of gluons, which leads to novel nonlinear dynamics.

Nuclei also provide additional handles to study diffraction and shadowing phenomena, as well as quark/gluon propagation through nuclear media, related to colour phenomena, in QCD. The nucleus can also be used as a "femtodetector", giving information on dynamics on the scale of nuclear dimensions.

The physics and accelerator aspects of electron–nucleus collisions at HERA has been investigated over the past three years. The project is considered to be a major future direction for nuclear physics – the Nuclear Working Group of the OECD Megascience Forum endorsed the project as one of three major directions for electron–nucleus physics (*CERN Courier* May p21).

To pursue these efforts further, DESY held the workshop Physics with HERA as Electron–Nucleus Collider on 25–26 May. About 70 participating theorists, experimentalists and accelerator experts reviewed the latest developments and examined the feasibility in terms of accelerator and detector requirements. In the welcome address the then DESY research director, Albrecht Wagner, emphasized the need for a detailed evaluation of the discovery potential of the project.

Review talks covered various theoretical, experimental and accelerator aspects. Important recent developments were also reported in many shorter talks. An indication of the problems was given by the review entitled "Partons, hadrons and theoreticians – muddling through the QCD vacuum".

Nevertheless, theorists were confident that the long-sought-after, nonlinear QCD effects could be found and studied in a broad kinematic range. The relative rate of so-called diffractive, or rapidity gap, events discovered in electron–proton scattering at HERA a few years ago should be much larger in electron–nucleus collisions and approach 50%. The production of J/psi and upsilon particles as small quark–antiquark systems that can be used as probes of the nuclear medium they propagate through and reveal strong absorption effects that are characteristic of the new QCD dynamics.

P Paul, Brookhaven deputy director for Science & Technology, stunned many in the audience by announcing the interest in an electron–nucleus collider at the RHIC machine at Brookhaven, which is now being commissioned. However, the energy would be about a factor of 10 lower than the energy that could be reached at HERA. It was recognized that the heavy-ion collision programmes at RHIC and CERN's LHC have important connections to electron–nucleus physics, for example in the study of gluon screening effects and establishing safe signals for the quark–gluon plasma.

Several groups are being formed to study these issues in depth. Regular meetings are planned as well as coordination with studies of the RHIC electron–nucleus option. More information is available at "www.desy.de/heraea".

Gunnar Ingelman, DESY/Uppsala and Mark Strikman DESY/Penn State.

A decade celebrated at Dubna

The Laboratory of Particle Physics (LPP) of the Joint Institute for Nuclear Research (JINR), Dubna, Russia, is celebrating its 10th anniversary. The lab was established to carry out experiments in high-energy physics at the most advanced accelerators. Its first director was Igor Savin, who played a major role in promoting particle physics at JINR.

The early days of the laboratory were marked by its participation in the NA4 and SMC experiments at CERN and in the large experimental programme at the 70 GeV accelerator at IHEP, Protvino. Now LPP physicists, headed by Vladimir Kekelidze, are participating in the CERN NA48 and NA58 (COMPASS) experiments; the H1, HERMES and HERA-B projects at DESY; the STAR experiment at Brookhaven; and the Borexino project at Gran Sasso.

The LPP physicists are actively involved in both the CMS experiment – being one of the founders of the RDMS (Russia and Dubna member states) collaboration – and the ATLAS project at CERN's LHC collider.

Special attention is paid to the development of new detectors and detector technologies. From the outset, accelerator physics has been one of the main activities of LPP. Now it covers participation in projects at CERN and DESY, the development of accelerators for radiation technology and the study of some conceptual aspects of the future "two-beam" colliders.

Physicists study photon structure

Almost a century after Einstein introduced the idea of a quantum of light, the photon (its name introduced only in 1926) continues to be a rich field of physics. Photon–photon and photon–proton interactions are prolific testing grounds for quantum chromodynamics (QCD) – the field theory of quarks and gluons – as well as the more "classical" quantum electrodynamics (QED).

Experimentalists, mainly from CERN's LEP electron–positron collider and DESY's HERA electron–proton collider, discussed their newest results with theorists at the International Conference on the Structure and Interactions of the Photon (PHOTON 99), which was held recently in Freiburg, Germany.

At close quarters the photon looks as though it contains quarks and gluons as well as electromagnetic particles. The HERA and LEP experiments have reached a new stage of precision in the measurement of photon structure. Claudia Glasman (Madrid) pointed out that the new data pose a challenge to the theorists.

The scattering of two virtual photons at LEP provides a pure test of a certain (BFKL) QCD regime. However, there are large discrepancies between the theory and the data, possibly owing to higher-order effects.

Ilya Ginzburg (Novosibirsk) explains the physics potential of the Compton Collider (Photo Arno Benen).

Photon–photon interactions are now studied from the electron-volt up to the giga-electron-volt range. Denis Bernard (Ecole Polytechnique) presented a search for elastic photon–photon scattering – a reaction that has never been observed. The best limit using lasers is still 18 orders of magnitude greater than the value predicted by QED.

At high energies the physics potential of a "Compton Collider" as part of the next (electron–positron) Linear Collider project was discussed by David Miller (UCL). In a Compton Collider (originally suggested by Telnov, Serbo, Ginzburg and Kotkin from Novosibirsk – three of them were at PHOTON 99), high-energy photons are produced by scattering laser photons off electron beams.

One of the most exciting possibilities is to produce Higgs particles directly from the scattering of pairs of such high-energy photons – a powerful way of determining fundamental Higgs properties.

Kai Hencken (Basel) pointed out that Brookhaven's RHIC will also be a rich source of photons. The first results are expected in time for PHOTON 2000, which will be held in Lancaster (UK).

The proceedings of PHOTON 99 will be published by *Nuclear Physics B*. More information can be found at "http://wwwrunge.physik.uni-freiburg.de/p99/".

Stefan Söldner-Rembold.

From Russia with load

Loading a 6 m dipole magnet at Novosibirsk for the 6000 km journey to CERN. These magnets will equip the two transfer lines to feed the LHC collider with protons from the SPS proton synchrotron.

Arriving at CERN from Novosibirsk's Budker Institute are magnets for the two transfer lines to feed the LHC collider with protons from the SPS proton synchrotron.

Some 360, 6 m dipoles and 180, 1.4 m quadrupoles will be installed in two new underground transfer tunnels, each about 3 km long, linking the SPS and LHC/LEP tunnels. One tunnel is being built by the Swiss as part of its host state contribution for the LHC.

To equip the tunnels, 10 magnet consignments per month will cover the 6000 km from Siberia over the next 18 months, each bearing two dipoles and a quadrupole.

Unlike the LHC's main magnets, these are not superconducting. The Budker Institute supplies them under the 1993 Co-operation Agreement, which covers Russian participation in the LHC.

Preliminary work for dipole elements is handled by the Efremov Institute, St Petersburg, and for quadrupoles by the ZVI factory in Moscow. Additional manufacture and final assembly for the magnets is done at Novosibirsk.

PHYSICSWATCH

Edited by Alison Wright

Except where otherwise stated, these news items are taken from the Institute of Physics Publishing's PhysicsWatch service, which is available at "http://PhysicsWeb.org".

Magnetic moment

Using data on solar magnetism from the ESA–NASA spacecraft *Ulysses*, scientists at Rutherford Appleton Laboratory have calculated that the Sun's coronal magnetic field has doubled in the past 100 years, which could have a bearing on observed climate change on Earth.

Ulysses found that the coronal magnetic field is actually unexpectedly uniform. Then the RAL team was able to use data measured at a single point in space (the Earth) to deduce the recent history of the magnetic field for the Sun.

Records of magnetic storms on Earth date back to 1868 and show cycles of intensity matching those of sunspot activity. The rate of magnetic storms has also been steadily increasing though the 20th century – pointing to an increasing solar magnetic field.

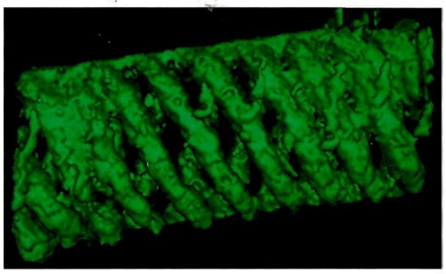
Since the solar wind is linked to the Sun's magnetic field and itself affects the amount of cosmic radiation hitting the Earth's atmosphere and seeding cloud cover, an increasing solar magnetic field may have an impact on the Earth's average temperature (which has risen by 0.6° in the last 100 years).

However, other scientists believe that man-made "greenhouse" effects due to aerosols and the burning of fossil fuels and forests must still not be ignored.

Imaging in perfect harmony

Imaging biological samples has often been hard to do with sufficient clarity. Now scientists at UC San Diego have exploited a new technique to produce a clear three-dimentional image of a living system.

A tightly-focused laser trained on a sample can generate light waves in the material at frequencies that are multiples of the original frequency – the second harmonic, third harmonic, and so on. By detecting, for example, just the third harmonic radiation and scanning the laser across the sample, a series of images can be built up (each within 2 s) to form an image with a spatial resolution equal to the focal size of the laser. *AIP*



This three-dimentional picture of an algae specimen (about $100 \times 50\,\mu m$) is formed from a series of cross-sectional images produced by scanning the sample with a laser pulse and detecting the third harmonic radiation generated.

Computing takes a quantum leap

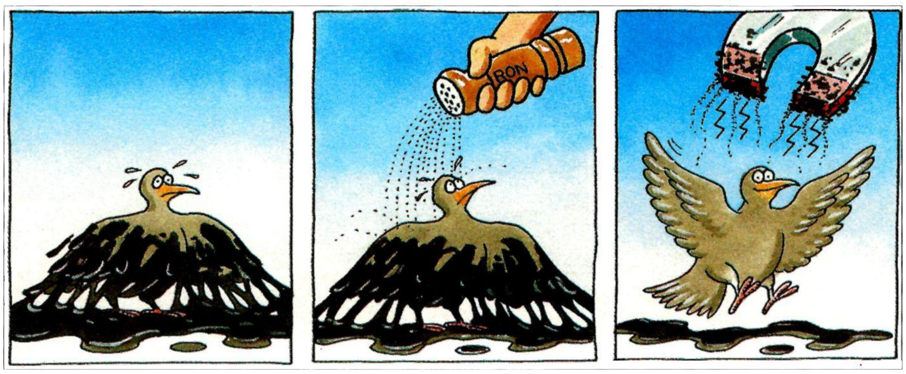
Scientists from MIT, Los Alamos and Harvard have produced the first simulation of quantum mechanical processes using a quantum computer, which, as Richard Feynman suggested, such computers are ideally suited to.

The researchers chose a familiar undergraduate physics problem – a "truncated harmonic oscillator", in this case the series of energy levels available to a quantum particle bound to another object (e.g. an electron bound to a proton), with a finite number of energy levels.

The computer is liquid 2,3-dibromothiopene, programmed by NMR techniques: an external magnetic field forces the nuclei in the liquid to align with their spin either "up" or "down" – matching the "1" and "0" of binary code. Manipulating the spins of two nuclei within each molecule reveals the possible energy states for this two-spin system and exactly simulates the possible energy states for the quantum particle. The next challenge is the extension of the simulation to the real-life model of a hydrogen atom. *AIP*

Clean quackers

Researchers in Melbourne have found a novel and effective way to clean birds caught in oil spills. Oil-soaked duck feathers were coated with iron powder and then combed with a magnet, drawing out the iron powder and 97% of the oil contaminants. Moreover, the feathers retained their structure and waterproof quality – unlike after cleaning with detergents. The process is also quick and less stressful for the birds. A portable field unit is currently being developed. *New Scientist*



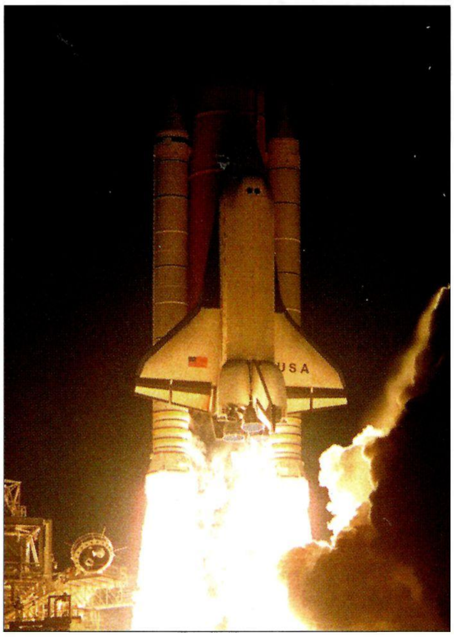
Turn down the noise

Turning up the volume of a weak radio signal amid noise increases both the signal and the noise. Sometimes actively increasing the noise can enhance the signal-to-noise ratio, in a process known as stochastic resonance.

Scientists from Italy, Germany and the US have demonstrated how to control stochastic resonance by varying the phase of an external modulation applied to a stochastic resonator. Results show that the output signal can be enhanced or suppressed and can be applied in communications, for vibration control in mechanical devices and also in biology – to understand how sensory systems can pick out faint signals and perhaps to suppress unwanted interactions between electromagnetic radiation and biological tissue. *AIP*

Edited by Emma Sanders

Chandra blasts off



Lift-off: the Chandra X-ray observatory on-board the Space Shuttle Columbia. (NASA.)

An X-ray equivalent of the Hubble Space Telescope, the Chandra X-ray observatory, was launched on 23 July. Astronomers look forward to a new view of the violent universe with the highest-quality images ever obtained of X-ray sources.

X-rays are emitted by material with temperatures of more than 1 million degrees, such as hot gas that permeates the space between galaxies, material thrown out into space by stellar explosions and huge superluminal jets ejected by active galaxies.

Astronomers expect to gain new insight into the nature of how spinning-neutron stars work as some pass through an X-ray emitting phase. In particular, magnetars, with their extremely strong magnetic fields, are thought to be at the origin of some gamma-ray bursts.

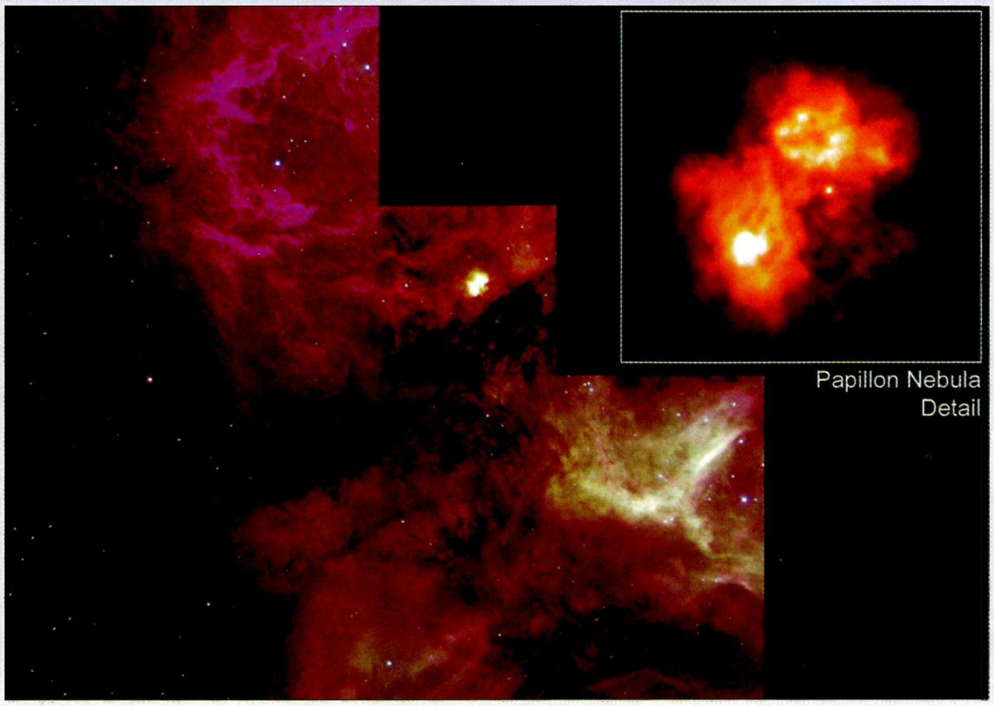
One of Chandra's most important results may be the discovery of the origin of the diffuse glow of X-rays that pervades the whole sky – the so-called X-ray background. "We think that it is composed of emissions from many distant individual sources of X-rays," said Martin Ward, director of the X-ray astronomy group at the UK's University of Leicester. "For the first time Chandra should be able to pinpoint the galaxies and quasars that are responsible for the emission, and we will solve the puzzle of what produces the X-ray background."

Chandra will also be used to make a new estimate of the age of the universe. Today's observations suggest that the universe is around 12 billion years old. By measuring the X-ray emission from giant clusters of galaxies, astronomers will make a new estimate using the Sunyaev–Zeldovitch effect. This occurs when hot gas in the clusters scatters the cosmic microwave background radiation.

Chandra is a NASA project, with contributions from the Netherlands, Germany and the UK. The observatory is named after the 1983 Indian Nobel Prize for Physics winner, Subrahmanyan Chandrasekhar, who died in 1995. He was widely known as Chandra, which means "moon" or "luminous" in Sanskrit.

The European Space Agency also plans to launch an X-ray observatory. XMM (*CERN Courier* July p13) is scheduled for launch in December. It has a larger collecting area than Chandra – better for observing faint sources – but lower resolution. X-ray astronomy can only be carried out from space because X-rays are absorbed by the Earth's atmosphere.

Picture of the month



A star-forming region in the Large Magellanic Cloud was observed using the Hubble Space Telescope. The inset detail shows the Papillon ("butterfly" in French) Nebula imaged for the first time by a team of French and German astronomers. The wing-like features are thought to be outflows of gas from a region of massive star formation obscured by dust in the centre. It is rare to see evidence of massive stars so soon after their birth. (NASA/ESA.)

Gemini to see furthest stars

Cosmology gains a twin as the first of two new international telescopes starts observations. The Gemini pair will explore the skies in both the northern and southern hemispheres at optical and infrared wavelengths.

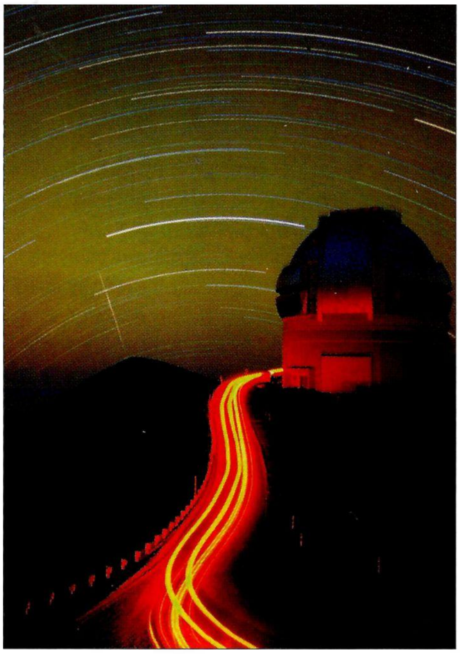
With better infrared resolution than any other telescope, Gemini will be used to make new observations of the furthest galaxies, the light of which is shifted to the red by the expansion of the universe. The telescopes will also be used for high-resolution spectroscopy, to improve measurements such as the primordial lithium abundance – a fingerprint left by the first 100 s of the universe's existence.

Gemini North is situated on Hawaii's Mauna Kea and will make its first scientific observations next year. Its sister telescope, Gemini South, is being built on Chile's Cerro Pachón and is expected to see first light by 2001.

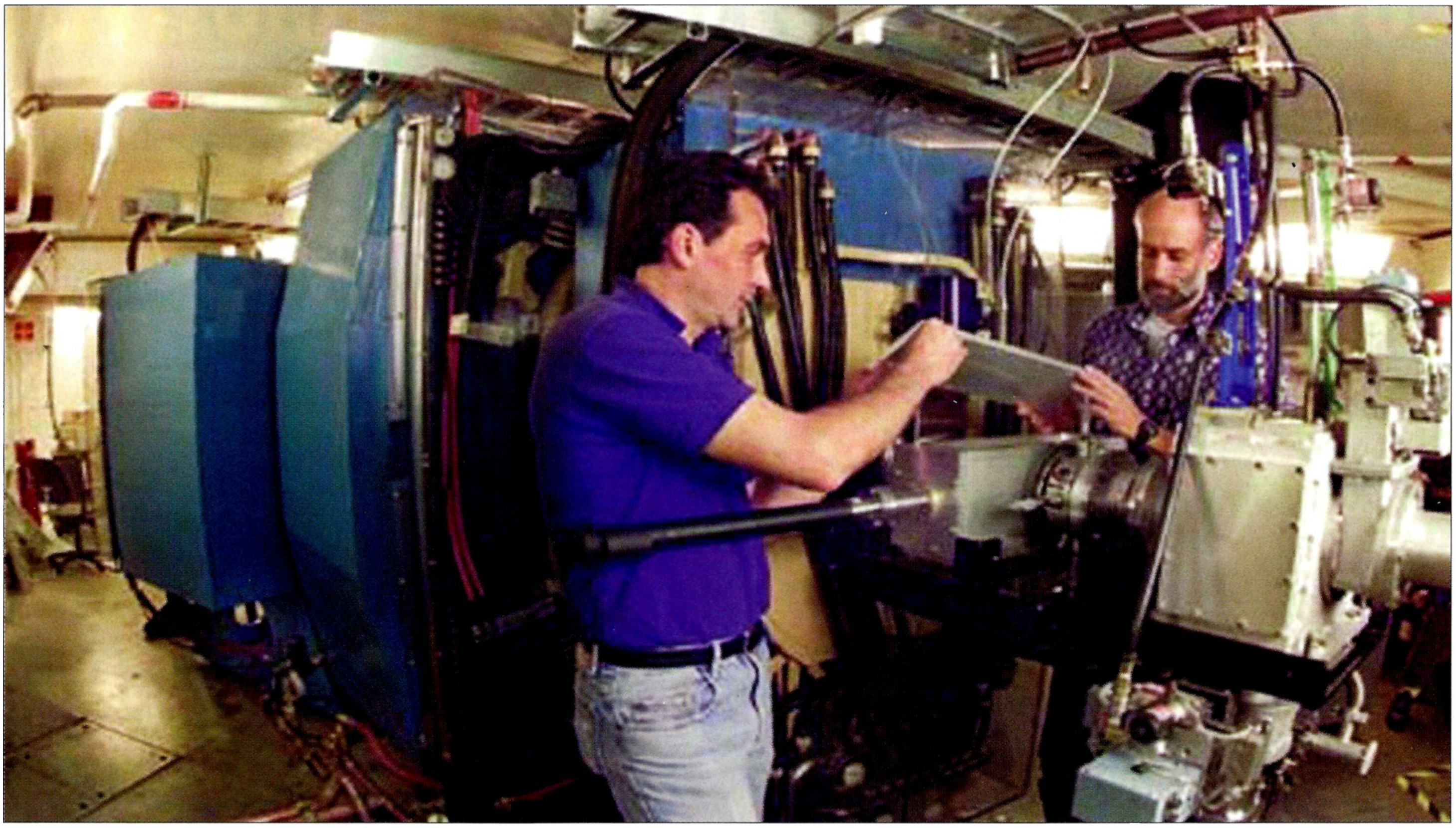
Partners in the project are the UK, the US, Canada, Chile, Australia, Brazil and Argentina.

Gemini observations will complement those made with ESO's Very Large Telescope (VLT), which is under construction in Chile. Gemini North will be considerably more sensitive in the mid-infrared range owing to the cooler, higher altitude site, which means less background noise.

A Gemini telescope in both hemispheres means that there will be complete sky coverage at all times. However, from 2005 the six VLT telescopes will be used as interferometers, capable of revealing finer detail than Gemini. Like the VLT, Gemini's 8.1 m mirrors use adaptive optics to correct for distortions to starlight passing through the atmosphere. This gives a spatial resolution three times as good as the 2.4 m Hubble Space Telescope at near-infrared wavelengths.



The Gemini North telescope in Hawaii. (Gemini Observatory.)



The newly constructed Berkeley Gas-Filled Separator was vital for the synthesis of element 118. Its strong magnetic fields focused the superheavy nuclei and separated them from the beam and all other reaction products.

Nuclear treasure island

1999 looks to be a vintage year for "superheavy" nuclei. These heavier-than-uranium isotopes are a 20th-century postcript to the Periodic Table.

Soon after the experiments at Dubna, which synthesized element 114 and made the first footprints on the beach of the "island of nuclear stability" (see p19), two new superheavy elements have been discovered at the Lawrence Berkeley National Laboratory.

Element 118 and its immediate decay product, element 116, were manufactured at Berkeley's 88 inch cyclotron by fusing targets of lead-208 with an intense beam of 449 MeV krypton-86 ions.

Although both new nuclei almost instantly decay into lighter ones, the decay sequence is consistent with theories that have long predicted the island of stability for nuclei with approximately 114 protons and 184 neutrons.

Theorist Robert Smolanczuk, visiting from the Soltan Institute for Nuclear Studies in Poland, had calculated that this reaction should have particularly favourable production rates. Now that this route has been signposted, similar reactions could be possible: new elements and isotopes, tests of nuclear stability and mass models, and a new understanding of nuclear reactions for the production of heavy elements.

The 118-isotope, identified at Berkeley, contains 118 protons and 175 neutrons in its nucleus. Less than 1 ms after its creation, it decays by emitting an alpha particle, leaving behind an isotope of nucleus 116, containing 116 protons and 173 neutrons. This alpha-decays in turn to an isotope of element 114. The chain of successive alpha decay is observed until at least element 106.

Vital to the experiment was the newly constructed Berkeley Gas-filled Separator (BGS). Another important factor was the versatility of the 88 inch cyclotron, in operation since 1961 and recently upgraded by the addition of a high-performance ion source.

It is incongruous that this new transuranic nucleus was discovered at Berkeley only a few months after the death of Glenn Seaborg, co-discoverer at Berkeley of plutonium and nine other elements heavier than uranium, the heaviest naturally occurring nucleus (*CERN Courier* May p35). □

First postcard from the island of nuclear stability

Recent experiments that took place at the Joint Institute for Nuclear Research, Dubna, near Moscow, reported evidence for element 114, the first inhabitant of a new island of nuclear stability.

Ever since the discovery of neptunium and plutonium almost 60 years ago, physicists have continually sought to synthesize additional artificial, transuranic elements. Most of these nuclei are highly unstable, but a fundamental nuclear physics prediction says that these superheavy elements would eventually reach an "island of stability" (figure 1).

This intriguing hypothesis, which was proposed more than 30 years ago and has since then been developed intensively, seems to have received recent experimental confirmation at the Joint Institute for Nuclear Research in Dubna near Moscow.

In a 34 day bombardment of a heavy target of plutonium-244 by a calcium-48 beam (total dose 5.2×10^{18} ions), an unusual decay chain was recorded by a position-sensitive detector array. This decay chain consisted of a heavy, implanted atom, three sequential alpha decays and a spontaneous fission (SF), which altogether lasted for about 34 min (figure 2a).

All five of the signals were correlated in time and position. The large values of the alpha-particle energies and the long decay times, in addition to the termination of the sequence by spontaneous fission, provide evidence for the decay of nuclei with large atomic numbers. Under the experimental conditions given, the probability of being able to simulate such a decay chain occurring by random coincidence is significantly small.

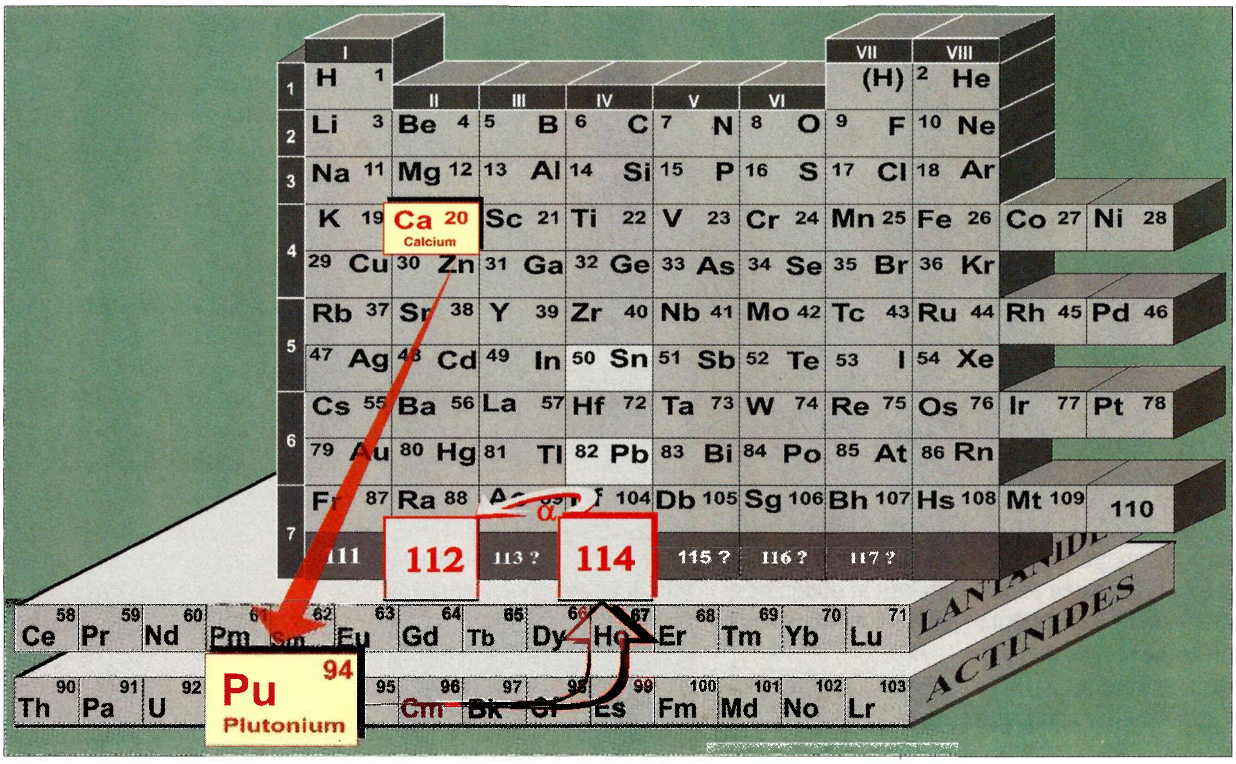


Fig. 1: Another brick in the wall. The Periodic Table of elements, showing the position of the new element, 114, which can be synthesized by bombarding an isotope of plutonium with another of calcium.

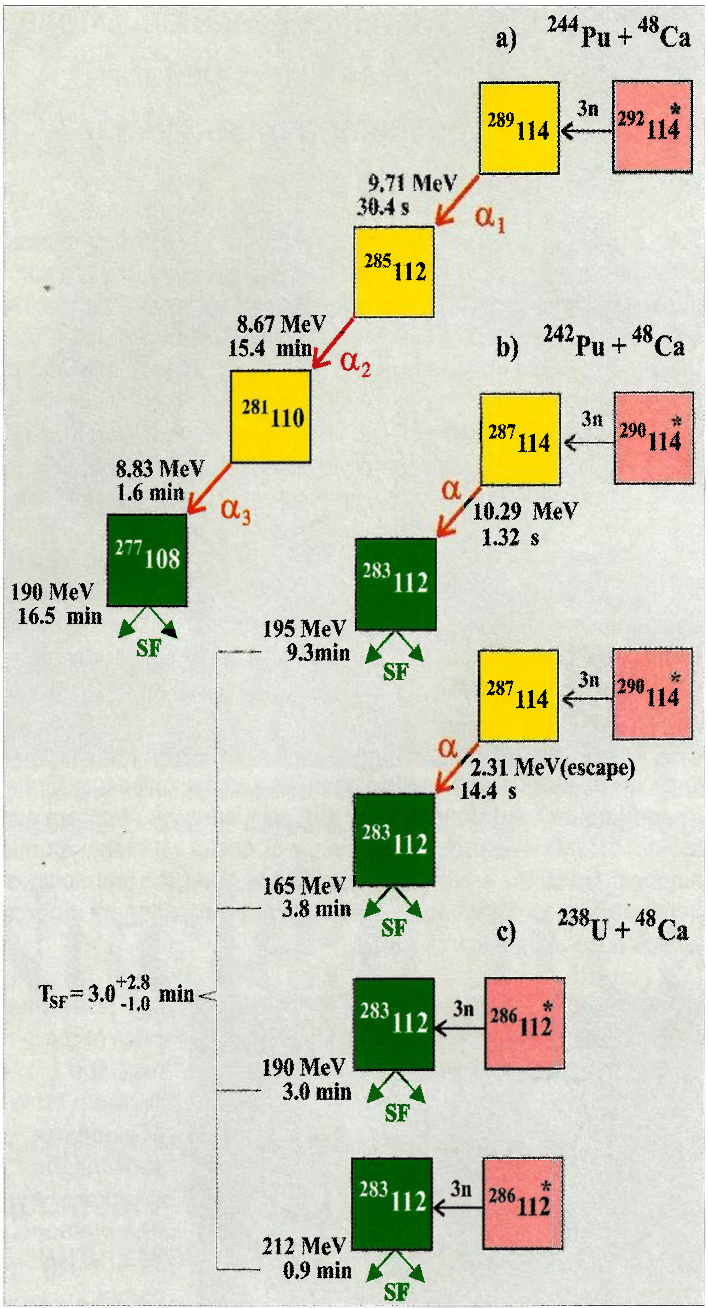


Fig. 2: The different decays of element 114 and its daughter isotopes.

Second attempt

The authors consider this to be an excellent candidate for a decay chain originating from the alpha decay of a parent nucleus with atomic number 114 and mass 289, produced by the evaporation of three neutrons from a compound nucleus with a cross-section of about 1 pb. There are plans to make another attempt at obtaining a second event in a forthcoming experiment in July 1999 and to make a final interpretation of the results then.

The experiment was performed in Dubna's Flerov Laboratory of Nuclear Reactions in November and December of 1998 in collaboration with the US Lawrence Livermore National Laboratory. The Dubna gas-filled recoil separator (DGFRS), which is capable of separating, in flight, the superheavy nuclei evaporation residues from projectiles and other reaction products, was employed to extract single atoms.

The increasing neutron number should change the shape of the nucleus from elliptical to spherical

The beam intensity at the U400 heavy-ion cyclotron was approximately 4×10^{12}/s – at the consumption rate of 0.3 mg/h of the unique calcium-48 isotope in the ion source.

A follow-up experiment was carried out in March and April (with the participation of GSI, Darmstadt; RIKEN, Tokyo; and Comenius University, Bratislava). The objective on that occasion was the synthesis of a new isotope of element 114 with a mass number 287 in reactions between calcium-48 and plutonium-242. The VASSILISSA electrostatic recoil separator sifted the reaction products and recorded the decays of the new nuclides.

The experiment lasted for about 30 days, which involved a total beam dose of 7.5×10^{18}. Two similar events were recorded as a short decay chain. They consisted of a recoil nucleus, an alpha particle emitted a few seconds later and final SF with a half-life of a few minutes (figure 2b). In each case, all three signals of the decay sequence were correlated in time and position.

Third example

The spontaneously fissioning emitter (which has a lifetime of about 1.5 min) had been observed in an earlier experiment that was performed by the same collaboration in reactions between calcium-48 and uranium-238. On that occasion, the two observed spontaneous fission events had tentatively been assigned to the decay of the new isotope of element 112 with mass number 283 (figure 2c).

In the latest experiment, the same nucleus has been produced as the daughter product owing to the alpha decay of the mother nucleus of mass 287 and proton number 114. The atomic numbers of the synthesized nuclei will be determined chemically. The first experiment, which is aimed at the chemical separation of element 112, is now being prepared.

The half-lives of the new nuclides are estimated to range from seconds to tens of seconds. Their daughter nuclei – the decay products – live for minutes: almost a million times as long as the lighter isotopes 110 and 112 with neutron numbers 163 and 165.

This is exactly in line with theoretical predictions. When approaching the closed 184-neutron shell, the increasing neutron number should change the shape of the nucleus from elliptical to spherical. This spherical shell, coming after the 126-neutron shell in the stable lead-208 nucleus, is so strong that its influence, according to the calculations, extends even to those nuclei that have more than 170 neutrons, thus increasing their lifetime by many orders of magnitude.

From this point of view the properties of the new nuclei, synthesized in reactions induced by calcium-48, could be considered a first experimental indication of the existence of the island of stability of superheavy spherical nuclei. □

COMPASS course to

A major new spectrometer that is being installed at CERN will be a flagship fixed-target experiment for the millennium. Its voracious appetite for data requires new computing solutions, opening the door for subsequent 21st-century studies.

Hall 888, of the north area of CERN's SPS synchrotron, is muon beam country. For almost two decades this hall hosted the European Muon Collaboration (EMC) spectrometer (companioned downstream by the NA4 apparatus), subsequently adapted to the needs of the NMC experiment and then the SMC experiment. Using CERN's high-energy muon beam and a variety of targets, these experiments provided a wealth of insights into the quark/gluon content of nuclear particles.

Their successor will be Common Muon and Proton Apparatus for Structure and Spectroscopy (COMPASS), proposed in March 1996 by a large community of physicists with a keen interest in nucleon structure and hadron spectroscopy. The experiment aims to address remaining questions using all of the artillery available today.

One central issue is to look at the contribution of gluons to the nucleon spin. EMC and SMC made decisive advances towards the understanding of the nucleon spin in terms of its constituents, but the role of the gluon needs to be clarified.

The other major physics objective is to look for particles such as glueballs, composed of gluons rather than quarks, quark–gluon hybrids and quark–antiquark combinations. Such exotica have long been searched for and a few candidates have been identified, but nothing like the rich spectrum expected from theory.

The experiment was approved in February 1997 and the construction of new detectors is proceeding fast. Key features of the new spectrometer (actually a two-stage spectrometer, to allow for large geometrical and dynamical acceptance) are:

- full particle identification (charged particles using high granularity RICH ring-imaging Cherenkov counters);
- calorimetry for energy measurement;
- high rate (beam intensities of 10^8 particles per pulse).

Coping with such a high beam rate is the main feature of the new spectrometer. On the detector side, many novelties will be implemented:

- for the first time a large quantity of an unusual material (Li6D) will be used for the polarized target;
- large-area trackers using "straw tubes" at large angles;
- Micromegas developed at Saclay will cover the central part of the first spectrometer;
- a small-area tracker of the "double GEM" type (*CERN Courier* December 1998 p19) will cover the central part of the second spectrometer;
- the Cherenkov photons in the RICH will be detected with a large array (6 m^2) of wire chambers with caesium iodide photocathodes, a new technique developed at CERN in the RD26 project.

Moving a 420 ton magnet for the COMPASS experiment, a CERN flagship fixed-target study for the next decade.

Swallowing data

Such a voracious appetite for data influences the detectors, the data acquisition system and data storage and analysis.

COMPASS will be able to trigger 10^5 times per second and store 10^4 events per second, each typically 30 Kbytes, for a total data size of 300 Tbytes peryear at a mean acquisition rate of 35 Mbytes per second. Data will be sent via an optical link directly to CERN's main computer centre using the Central Data Recording (CDR) facility pioneered for the NA48 CP violation experiment.

Still, the quantity of data that COMPASS will handle is such that a host of new problems had to be faced and solved quickly for data-

future computing

Prototype of the COMPASS computing farm. The PCs are mostly dual Pentium II 300 MHz running Windows NT 4.0 SP3. The data servers are DEC1200 and SUN 450 machines.

taking next year. Handling the stream of data propelled by the CDR system is a major challenge.

The estimated power needed to process COMPASS data is five times that of the already impressive supercomputer used by NA48. The analysis plan foresees processing the data at CERN, while almost all final physics analysis as well as most of the simulation will be done in the collaborating institutes. The performance of COMPASS computing and analysis will be a useful guide for the high-rate experiments at CERN's LHC collider which are scheduled to begin operation in 2005.

New software tools

Fortran has had its day, and a move from top-down structured programming to object-oriented programming is in sight. In object-oriented analysis and design, software systems are modelled as collections of co-operating objects, treating individual objects as instances of a class within a hierarchy of classes.

Compared with the well known "top-down structured" programming, object-oriented programming looks more abstract and moves the complexity of development to the first step – the definition of classes and relations. On the other hand, object-oriented programming, with its encapsulation, polymorphism and inheritance features, helps the maintainability of elaborate software, particularly when many authors are involved.

Codes

For an experiment that will be active over many years, and with off-line computing having to keep pace with incoming data, a new off-line code was called for, with object-oriented compatibility.

Of the many programming languages that support object-oriented programming, only two are widespread: C++ and Java.

The main reason behind the C++ success is its backward compatibility with the C language which is used extensively for on-line and system applications. This also means that C libraries can easily be used within a C++ program. C++ limitations mainly come from the necessity to be compatible with C, also allowing structured top-down programming.

Java is a pure object-oriented programming language, but it is still under development with no compilers available. Right now, C++ looks like the best choice for an object-oriented programming language.

Data and databases

Handling extremely large data volumes and rates is the key feature of COMPASS. C++ provides only low-level access to disk files. In particular, there is no means of managing tape input/output or, in general, tertiary storage devices at the language level.

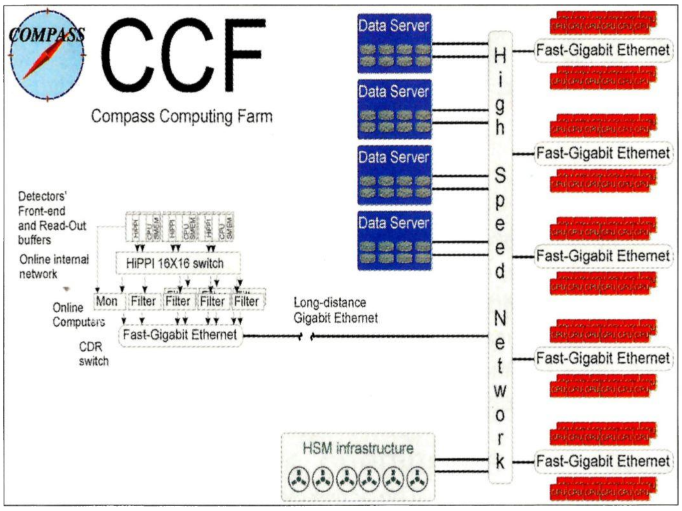
Database programs can provide extended disk input/output power, giving a consistent framework with many new functions. As well as plain data, the C++ language is capable of handling objects and object collections.

To take advantage of C++ means storing and retrieving structures (which can be very complicated and can evolve with time) in a transparent way and without adding too much complexity.

The most natural choice is object-oriented databases that use C++ language and can handle memory and disk transparently. CERN plays a leading role in the development and use of such systems in high-energy physics. The RD45 collaboration was set up five years ago and COMPASS (as well as the NA45 heavy-ion study at CERN and BaBar at SLAC, Stanford) are taking advantage of this work.

Given 10^{10} events per year and all of the associated complexity calls for:

- minimal duplication of information;
- seamless access to the data from different sources (events, calibration and alignment);



Conceptual scheme of the COMPASS computing farm. The on-line farm sends data via a long-distance gigabit fibre connection to the computer centre. The data servers (blue) receive all of the data and store them on their local disks. They are equipped with gigabit Ethernet interfaces and hold the disk pool (up to 10 Tbyte). All of their processing power is devoted to deal with the network and disk activity (35 Mbyte/s from on-line; some 200 Mbyte/s total throughput). The CPU clients (red) are PCs with minimal disk equipment and fast Ethernet interfaces. They read data from the data servers, perform the CPU intensive operations and send the results back to the data servers. A hierarchical storage manager system that uses the tape storage complements the disk pool.

- direct access to specific parts of the event information for some selected sample;
- transparent data access from local and remote sites.

Currently the most promising candidate for these tasks is Objectivity/DB, and in 1997 COMPASS decided to use this commercial product to store all data for off-line analysis, keeping them under "federated" databases (consisting of separated files on different computers).

The internal structure of the database should allow easy access to the physical quantities needed in the analysis without external bookkeeping. One major advantage is the possibility of "tagging" events by physics properties. Users should thus be able to select subsets of data and access the full information.

The transparent navigation among the events and other analysis objects is very attractive, and Objectivity/DB promises to be able to handle a very large "federation" of database files.

Storage

COMPASS will probably be able to afford up to 10 Tbytes of disk space, while the total data will be of the order of 300 Tbytes per year of operation. A "hierarchical storage manager" (HSM) is needed to move data between disk and tape.

To solve this problem, which will become even more acute for the LHC experiments, CERN is already testing a high performance storage system (HPSS), which may be appropriate for COMPASS. CERN's Information Technology (IT) division is also developing alternative solutions. IT's physics data processing group (PDP) and RD45 are also implementing solutions to reconcile the requirements of the database and the hierarchical storage manager.

The Central Data Recording (CDR) scheme developed by CERN's IT/PDP group aims to connect an experiment's data acquisition system with a high-speed network link and store the data using the CERN computer centre's tape drives. The CDR was launched for the NA48 experiment and is now routinely used by many other CERN experiments.

The present COMPASS data recording scheme forsees:

- raw data written onto files in byte-stream format by the on-line computers on their local disks (10–20 parallel streams). (The typical sizes of each of these files will range from a few megabytes to a few gigabytes);
- files transferred by the CDR to the COMPASS computing farm at the computer centre, where they are formatted into a federated database with objects created and stored. After formatting the corresponding on-line files are deleted;
- the databases written to tape and the corresponding off-line files deleted.

Computing farm

Large physics experiments can be serviced by "farms" of dedicated PCs. In 1998 an IT/PDP task force looked at the requirements for high-rate experiments (NA48, NA45 and COMPASS). The model proposed for the COMPASS computing farm (CCF) is a hybrid farm with a few (fewer than 10) Unix "data servers", to cope with the data rate, and about 200 mass-market PCs as CPU "clients".

In the present data flow scheme the on-line system performs the event building. If necessary it filters out events and then sends them to the CDR and to the off-line farm at a typical rate of 35 Mbyte/s.

In the off-line farm the data servers will handle the network traffic from the CDR, distribute raw data to the CPU clients, receive them back from the PCs and finally send them to the HSM. In parallel, the data servers will receive data from the HSM, send them to the PCs where the data are processed and collect and send the output to the HSM. The server disk space will be of the order of 10 Tbyte.

Since the computing power required by COMPASS depends on the large number of CPU clients, the analysis program should incorporate some degree of parallelism. Parallelism is already present at the on-line level, where a farm of event builders receives the events and sends data to the off-line farm in multiple streams.

Although Objectivity/DB allows the user to access both remote and local data, the CPU-intensive jobs should be scheduled on those machines with an important fraction of local data. The database model can be used to maximize this "data locality".

Such resource allocation should be done outside and before the user code, which is written in the most general way, accessing data via physical queries without entering into details of data location.

The CCF prototype

COMPASS began to investigate the CCF scheme and Objectivity/DB in 1998. The emphasis has been on performances in terms of data rate and on schemes for recovery after hardware or software failures.

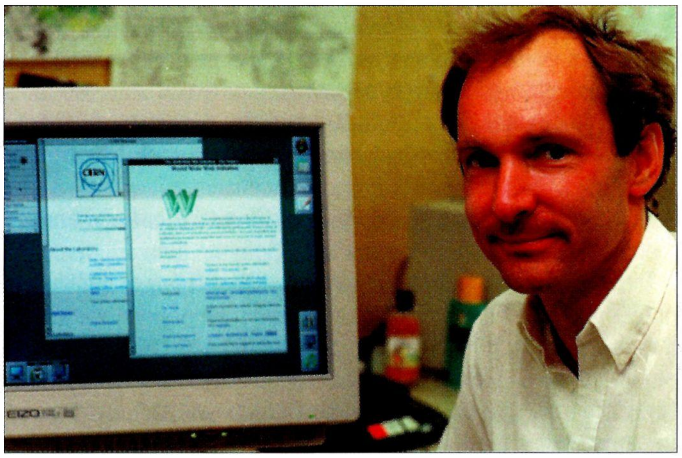
Weaving a better tomorr

The World Wide Web is 10 years old, but it is only just beginning to fulfil its potential. At the eighth World Wide Web conference in Toronto in May, *James Gillies* learned what the next decade might have in store.

"It was a weird conference," said Ethernet inventor and self-styled technology pundit, Bob Metcalfe, summing up the eighth World Wide Web conference (WWW8). "Imagine," he continued, "sitting there listening to a senior executive of IBM wearing a tee-shirt and a beard." Appearances were not deceptive as Big Blue's vice president for Internet Technology, John Patrick, captured the spirit of the conference. "Power to the people," he said, would be the driving force behind the computing industry as we enter the new millennium. For if one thing is abundantly clear, it's that the political geography of information technology has been turned on its head by personal computing and the World Wide Web. "Stand aside, besuited corporate executives", came the message. Make way for the altruistic geeks: the future belongs to them.

It's rare to find such an optimistic bunch of people. The pony-tail count may have been way above average and the word "cool" still cool, but WWW8 delegates have their hearts in the right place. They are the ones who have made the Web, motivated only by the fun of playing with computers and the belief that the Web can make the world a better place. Some were concerned at Microsoft's conference sponsorship. There was grumbling that the delegates' pack included complementary Microsoft CD-ROMs (for Windows only). "Next year," one delegate was overheard to say, while tucking into a spring roll and sipping Chardonnay at the evening reception (courtesy of Bill Gates), "Microsoft will have bought the World Wide Web." However, his fears were not universally held. There is just too much grass-roots stuff going on out there for one company, however powerful, to take over completely.

Technical support at the World Wide Web conferences is traditionally s
wall, assembled during the conference to mark the Web's 10th annive
work, just for the pleasure of being there.



Web inventor Tim Berners-Lee, seen here with his original Web browser, began his WWW8 presentation with a tribute to Mike Sendall, his boss at CERN in 1989 (who died on 15 July, see p42). With the Web, as with many inventions, credit is due to the people who did not say "no". Presented with Tim's original proposal, Mike scribbled on the cover the words "vague but exciting", and by saying "why not?" allowed the Web to happen.

Information revolution

It may seem from the outside that the information revolution has arrived, but in John Patrick's view, "we're right at the beginning". The Web's inventor, Tim Berners-Lee, doesn't even go that far. The Web we're going to see emerging over the coming decade, he believes, is none other than the one he had running almost 10 years ago on an obscure computer called a Next cube at CERN. "Ask him about control-shift-N," said one delegate, referring to the combination of key strokes that instructed that early browser/editor to create a new document linked to the one you were already in. That simple manoeuvre encapsulates Berners-Lee's vision of what the Web should be, "a common space in which we could all interact", a medium in which we'd all be creators, not just consumers. Expediency prevented that reality from coming sooner as Berners-Lee and his team at CERN concentrated on providing Web services

ow: the future of the Web

plied by volunteers. The WWW8 crew is seen here in front of the Web history ry. Volunteers pay their own way to get to the conference for a week's hard

IBM Vice-President of Internet Technology, John Patrick, with Internet personality Cynthia Clark. Patrick predicts that ordinary people will be the driving force behind the information revolution as we enter the new millennium.

to the particle physics community leaving the stage free for the entrance of Mosaic, a browser with no editing capacity, in 1994.

Even when the passive Web took off, Berners-Lee did not abandon his dream. To most users of the Web the choice of browsers comes down to two: Netscape Navigator and Internet Explorer. However, there's actually a lot more choice available. Many of the early browsers can still be found, and there are new companies turning out more. The Web consortium (W3C) has produced a browser/editor, called Amaya, that allows the kind of interactive Web use that Berners-Lee envisaged from the start. If you want to see what the Web was meant to be, open Navigator or Explorer for the last time, go to "http://www.w3.org" and click on "Amaya browser/editor".

Improving the Web

Content that the Web is finally catching up with his original vision, Berners-Lee is now devoting his energies to improving it. The Web's biggest problem is caused by its success. There's so much information out there that it's often hard to find what you want. The answer, according to Berners-Lee, is what he calls the semantic Web. The kind of information on the Web today is understandable to humans but not to computers. If, for example, Berners-Lee wanted to buy a yellow car in Massachusetts and his neighbour wanted to sell a primrose automobile in Boston, how would his search engine know that what he wanted was right on his doorstep? If a current W3C project is successful, some kind of logical schema will tell the search engine that primrose is just a kind of yellow and that automobiles and cars are in fact the same thing.

Reminding delegates that there's nothing new under the Sun was IBM's John Patrick who spelled out his vision of how the Internet is poised to change our lives. Top of his list of next big things was instant messaging, which is just around the corner. Curiously familiar to anyone who used BITNET or DECNET in the 1980s, instant messaging is a sort of halfway house between e-mail and the telephone. Patrick demonstrated IBM's version by typing in "How is the weather in Heidelberg" to a colleague in Germany. Out boomed the mechanical words "*Wie ist das Wetter in Heidelberg*", followed, presumably after the Heidelberger had typed "*Es ist kalt und regnerisch*", by "It is cold and rainy". That's fine if all you want to do is discuss the weather, but IBM's translation software might have problems with more complex topics. Nevertheless, it served to show what's coming.

E-business

Symbiotic video came next on Patrick's list. That's clickable television to you and me. A coffee advertisement took us to a Web site where, you've guessed it, you could order coffee to be delivered to your door. This is an example of where e-business might be taking us and, as anyone who's looked at an IBM advert recently knows, e-business is IBM's next really big thing. Defined on their Web pages as "the transformation of key business processes through the use of Internet technologies", e-business, says Patrick, will force a new character onto the keyboard. (I don't have one, so to see what he means you'll have to look at IBM's Web site yourself, "http://www.ibm.com/") What it boils down to is businesses maximizing their potential through computers and the Web with the help, of course, of IBM.

Education is already benefiting from the Web. LEGO's high-tech programmable Mindstorms invites young engineers to submit their best designs and programs to a Web site ("http://www.legomindstorms.com/"). Mindstorms impressed Patrick so much that he felt inspired to submit his own, but was distressed to find that the "date of birth" choice only went back to 1970, so that's what he clicked. The Mindstorms design that most impressed him was posted by someone who had clicked on 1992.

Can the Internet handle all of these new big things? Yes, believes Patrick. Bandwidth is booming, and the much-touted address-space problem – simply running out of new addresses – will soon be a thing of the past. The next version of the Internet protocols will bring enough addresses for every proton, according to Patrick. "That ought to do it."

Metcalfe had predicted that the coming 12 months would see an Internet "Gigalapse". So confident was he that he promised to eat his words if there had not been one. Two years later, he took a copy of his column and ate it for all to see.

There were no surprises from Greg Papadopoulos, Chief Technology Officer at Sun Microsystems. He looks forward to the day when computers will not need to rely on complicated protocols to talk to each other and to peripheral devices. Instead, there will be just one simple protocol and it will be used for sending "objects" – executable programmes – around the Web. Coming from the company that filled our Web pages with Java applets, what else could he be expected to say? The example he gave was printing from a Web phone, a device still far from most people's everyday reality but familiar to WWW8 conference-goers. One way to do that would be to define specific high-level protocols for the purpose and standardize them. Sun's preferred route is to standardize the basic protocol for sending bytes across the network, effectively already done, and then use it to send objects to create a distributed application. The phone and the printer would then communicate through that application.

Patents

Conference co-chair Murray Maloney began the closing plenary session by presenting the Yuri Rabinsky award to Richard Stallman. Rabinsky was a pioneer of the Open Software movement making Stallman, founder of the Free Software Foundation and author of the operating system GNU (GNU's Not Unix, "http://www.gnu.org/"), an appropriate recipient and Microsoft an unlikely sponsor of the award. This was an irony not lost on Stallman who graciously accepted the award while urging vigilance against those who would patent everything. His acceptance speech, delivered by cable from California, brought to a head a sub-theme of the conference.

In the US, software can be patented and in Tim Berners-Lee's opinion, "the bar for what's patentable is far too low". As a consequence, a substantial part of W3C's energies are tied up in fighting patent applications covering things that the consortium believes should be standards. Stallman urges Europe not to succumb to American pressure to adopt software patents. "I ask everyone who is a citizen of the European Union," he said, "to take a look at the Web site 'www.freepatents.org'." His parting shot was to urge the award committee to keep a sense of proportion. "It's more important," he said, "to keep safe from the software patents than to keep the awards rolling."

To sum up, Bob Metcalfe singled out the semantic Web of Tim Berners-Lee, whom he referred to as "The Duke of URL" (pronounced "Earl"), as the principal subject of the conference. He checked on Patrick's assertion that we are right at the beginning by calculating that just 2.5% of the world's population is currently connected to the Internet. There was also a broken illusion in store for Patrick. Metcalfe admitted that he'd visited the Mindstorms Web site, submitted a design and clicked on the 1992 button.

Predictions

A pundit's role is to stick his neck out, and Metcalfe is famous for doing that. Four years ago at WWW4, he predicted that the coming 12 months would see an Internet "Gigalapse"–a single network outage that would cost a billion man-hours. So confident was he that he promised to eat his words if there had not been one. Two years later, at WWW6, he took a copy of his column and ate it for all to see. The year's biggest outage had been estimated at a tenth of a Gigalapse.

Among his predictions at WWW8 was, again, the Gigalapse, but this time with no promises attached. Metcalfe also believes that microcharging is just around the corner. He surveyed his readers to find out how much they'd be prepared to pay to read his column. 0.2 cents came the reply, but, with half a million readers, he's quite happy about that. He had bad news for both Microsoft and Stallman, predicting that the former has peaked but the latter's Open Source will still never catch Mr Gates. The Internet stock bubble, he predicted, will burst on 8 November 1999.

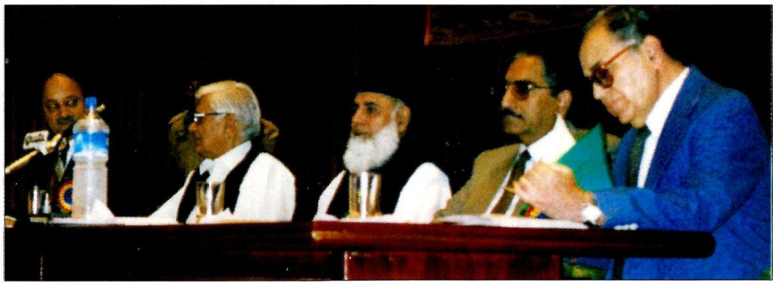
How could he be so bold? He was recently invited to a meeting of venture capitalists and asked his opinion on this. After carefully explaining that he knew nothing of stock markets, he told them 8 November and was amused to see them all writing it down. Y2K will be a non-event. "Why?" he asked himself. "Are computers reliable?" he replied. "And anyway," he went on, "31 December is a Friday so we'll have the whole weekend to sort things out." So on that note, delegates were able to leave the conference looking forward to a restful last night of the millennium, whatever year they happen to believe that might occur.

James Gillies, *CERN.*

CERN Courier **news editor** ***James Gillies*** **is currently working with Robert Cailliau of CERN on a book about the history of the World Wide Web. Due to be published early next year by Oxford University Press,** ***How the Web was Born*** **will trace the history of the Web from the first murmurings of an idea back in the 1940s to the mid-1990s, when the Web took the world by storm.**

Pakistani physics

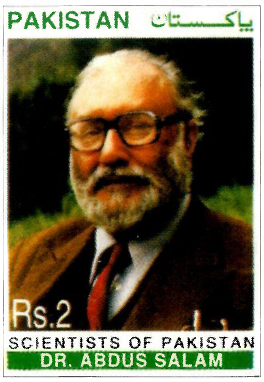
With LHC increasingly a focus for world physics, distant communities become key partners in the preparations for the big experiments. In Pakistan, an annual International Summer College on Physics and Contemporary Needs provided an Asian platform for CERN physics.



The opening of the 1999 International Nathiagali Summer College on Physics and Contemporary Needs at the National Library, Islamabad. Left to right: summer college scientific secretary Syed Arif Ahmad, chairman of the Pakistan Atomic Energy Commission Ishfaq Ahmad, Pakistan National President Muhammad Rafiq Tarar, technical member of the PAEC and College Organizing Committee chairman Samar Mubarakmand and National Centre for Physics director Riazuddin.

The summer heat presses down relentlessly on the plains of Pakistan, but the hills overlooking the capital city of Islamabad from the north perch above the worst of the steamy blanket, and in only an hour and a half's drive the mercury drops from 40 to 25 °C. Historically, towns in the Murree Hills have been the traditional summer retreat for local administrations, but with improved communications they now throng with plains-dwellers eager to escape the oppressive heat below.

Since 1974 the Murree Hills have also been the scene of a notable annual physics event. In Pakistani physics, the influence of the late Abdus Salam, the first Pakistani to be awarded a Nobel Prize, is everywhere. Throughout the world, Salam is remembered for his physics contributions and for founding the International Centre for Theoretical Physics in Trieste, Italy, which now bears his name. In 1974 he also suggested setting up a regular international forum in Pakistan, to attract scientists from all over the world, particularly from the developing countries. Salam knew that these scattered scientists can easily become isolated and often lack the contact so necessary to keep pace with, and contribute to, contemporary research.



A new Pakistani postage stamp commemorates Abdus Salam, co–architect of the unified electroweak unification.

The summer college was established at the leafy haven of Nathiagali (at 2600 m), the former site of the summer residence of the North West Frontier Province. More recently the College has moved to a modern tourist complex in Bhurban, overlooking the Jhelum Valley and facing the foothills of Kashmir.

The summer colleges have attracted a prestigious list of speakers, each year having special keynote topics. This year the 25th International Nathiagali Summer College on Physics and Contemporary Needs focused on three themes: high-energy physics and accelerator-driven fission in the first week; and laser cooling, quantum computing and nanotechnology during the second week. Students came from all over Pakistan and from neighbouring countries in Central Asia.

Pakistan's increasing involvement in experimental particle physics was reflected in the lectures on high-energy physics. Presentations were given by Hafeez Hoorani of CERN on the subject of W Physics at LEP, Felicitas Pauss of ETH Zurich on Physics at the LHC, Daniel Treille of CERN on the Standard Model and Physics at LEP, Tejinder Virdee of CERN and London's Imperial College on LHC Detectors, and Oswald Gröbner of CERN on the LHC machine.

In the lectures on accelerator-driven fusion, Jean-Pierre Revol of CERN described experiments by Carlo Rubbia's group and spoke of future plans at CERN, while Günter Bauer and Sandro Pelloni of the Swiss PSI Institute covered accelerator-driven reactors and neutron reaction rates respectively. Giovanni Ambrosi of Geneva spoke on the AMS particle physics experiment in space, and *CERN Courier* editor Gordon Fraser surveyed some recent history in "Physics and the 20th century".

Since Salam's death in 1996, the college has featured a Salam Memorial Lecture, which this year was given by distinguished theorist Sergio Ferrara of CERN, speaking on "Superspace and supergravity – the quest for unification".

At the official inauguration of the summer college, held at the National Library in Islamabad, a new collaboration agreement was signed between CERN and Pakistan's recently established National Centre for Physics (*CERN Courier* March p5). Pakistan's President, Muhammad Rafiq Tarar, said he hoped that the collaboration would flourish and that such international ventures would strengthen contacts between Pakistan and the rest of the world. □

Looking for Higgs and supersymmetry

The Higgs particle is the missing link in today's particle physics. Is the Higgs just round the corner, or do we have to be patient? Likewise, supersymmetry could soon make a dramatic stage entry? A recent meeting in Florida assessed the chances.

Some of the most compelling questions in particle physics today are to do with the Higgs boson and supersymmetry (SUSY). Is the Higgs mechanism responsible for electroweak symmetry breaking and the origin of mass? Can SUSY (the symmetry under which bosons and fermions are equivalent in nature which thus predicts that for every particle there is a partner "sparticle") point the way to the ultimate unification of forces? Where is the Higgs? Where is SUSY? How can they be found? What if we don't find them?

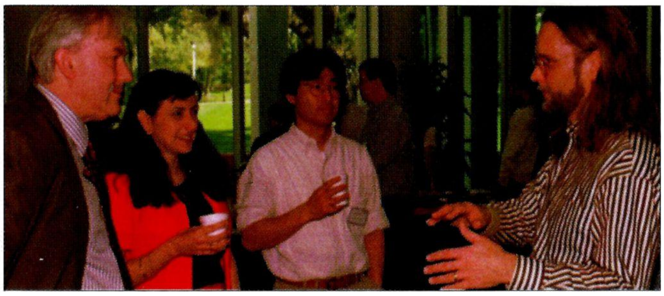
To address these questions in depth, more than one hundred physicists gathered at the University of Florida, Gainesville, for the international conference entitled Higgs and Supersymmetry: Search and Discovery, earlier this year.

The goal of the conference was to provide a forum for physicists involved in Higgs and supersymmetry searches in which the present status of the research could be summarized and new directions for searches and the potential for discovery established.

The conference agenda focused on Higgs and SUSY presentations (see "http://www.phys.ufl.edu/~rfield/higgs_susy.html"). One exception was M Spiro's (CEA/Saclay) talk on dark matter. Even then SUSY was in the limelight: the lightest supersymmetric particle is one of the best candidates for dark matter in the universe.

The elusive Standard Model

G Altarelli (CERN/Rome 3) pointed out in his presentation on "The Standard Electroweak Theory and beyond" that, in spite of the great experimental work done in the 1990s, which included high-precision electroweak measurements at LEP (CERN) and SLC (SLAC, Stanford) and the discovery of the top quark at the Tevatron (Fermilab), a clear view beyond the Standard Model (SM) continues to elude researchers. Even so, there are good reasons for optimism in the coming decade as CERN's LEP2 electron-positron collider continues towards its highest achievable beam energy (around 100 GeV), and surprises may be just around the corner.



Discussing new particle prospects. Left to right: Guenakh Mitselmakher (Florida), Marcela Carena (Fermilab), Hitoshi Murayama (Lawrence Berkeley Laboratory) and Michael Schmitt (Harvard).

At the same time, physicists at Fermilab's Tevatron collider, the scene of the CDF and D0 experiments, get ready to finalize their upgrades for Run 2. The increased collision energy (2 TeV) and the large data samples expected in the first two years of running (from integrated luminosities of 2 fb^{-1} or more: 20 times those gathered previously) may be the key to finding the Higgs and SUSY.

Just over the horizon the ATLAS and CMS experiments at CERN's LHC collider await their turn to push back the high energy frontier. However the Higgs could be nearby. The most recent fit results of precise electroweak measurements, discussed by F Richard (LAL-Orsay), favour a relatively light Standard Model (SM) Higgs (91 +71 -41 GeV). The newest results on the SM Higgs search from LEP2, with electron-positron annihilation producing a Higgs with a Z particle (the former decaying into a beauty ["b"] quark and antiquark and the Z to any quark and antiquark being the primary search channel), give a Higgs mass greater than 95.5 GeV (95% c.l.). LEP's ultimate sensitivity to the SM Higgs is expected to be between 105 and 110 GeV. The window for discovery remains open.

The current Tevatron Higgs searches, described by E Barberis (Berkeley), focus on Higgs production associated with W or Z bosons. The levels for these processes are still an order of magnitude away from the SM expectation. The Tevatron's reach during Run 2 and beyond, presented by M Carena (Fermilab), has been studied extensively at the Run 2 SUSY/Higgs workshop (see "http://fnth37.fnal.gov/susy.html").

For a Higgs mass less than about 130 GeV the Higgs decays predominantly into b-quarks. The key to the analysis is to have excellent b-tagging capabilities and good energy resolution for b-quark jets (to reconstruct a narrow Higgs mass peak over the quark-gluon jet

Daniel Denegri (CEA/Saclay) and a Florida alligator.

background). For the SM Higgs, updated results show that, with an integrated luminosity of 2 fb^{-1} per experiment, the 95% exclusion limit can reach about 115 GeV. However, in 10 fb^{-1} this sensitivity can reach about 185 GeV and, if the Higgs is in that mass range, a signal could be detected for a mass of less than 125 GeV or of 150 to 175 GeV (when the Higgs decay into W pairs dominates the b-quark-antiquark decay favoured at the lower Higgs masses).

An integrated luminosity of some 50 fb^{-1}, although difficult to envisage, would be able to exclude a Higgs below 180 GeV. Beyond the SM, where new particles enter the game, the coupling strengths of the Higgs particle(s) can change and affect the outcome. In the popular Minimal Supersymmetric extension to the SM (MSSM), two Higgs doublets result in five physical states, the masses of which can be determined by two parameters. Radiative corrections owing to the sixth "top" quark and "stop" (supersymmetric top) can be large.

The model predicts the lightest SUSY Higgs at 130 GeV. However, the reaction rates at the Tevatron for the MSSM channels can, at best, be only slightly larger than the SM in some parts of the kinematically allowed region but mostly they are expected to be somewhat smaller. Still, with enough collisions, the lightest SUSY Higgs seems to be within the Tevatron's reach in Run 2.

Limits from LEP on MSSM Higgs masses currently reach about 85 GeV and will increase. The Higgs searches at LEP and the upcoming Tevatron run are definitely worth keeping a close track on. A surprise could be in store before the onset of the LHC, which has the goal of ultimately reaching 300 fb^{-1} in 10 or so years of running, at a collision energy of 14 TeV, and finding all there is to be found.

The prospects for Higgs and SUSY at the LHC were covered by K Jakobs (Mainz/ATLAS) and D Denegri (Saclay/CMS). Extensive detector simulations of all relevant Higgs channels have been performed to understand the various detector efficiencies and resolutions needed to optimize the physics yield. Excellent lepton and photon detection and b-quark tagging are paramount. With 30 fb^{-1} of integrated luminosity expected after three years of running, and by combining all signatures, both detectors show the capability of detecting the SM Higgs unequivocally up to a mass of 1 TeV.

The SM Higgs mass can be measured with a precision of 0.1% up to masses of some 400 GeV.

If the decays of MSSM Higgs bosons to SUSY particles are not allowed kinematically, then at the LHC the full parameter space can readily be covered. Open decay channels producing SUSY particles complicate the Higgs searches, but still a good fraction of the available parameter space can be probed.

If SUSY exists at the electroweak scale, the LHC will discover it easily. Gluinos and squarks (the supersymmetric partners of gluons and quarks), up to masses of about 2 TeV, will be copiously produced and their decays will give signatures that differ significantly from the SM. Sleptons (the leptons' SUSY partners) can be detected directly up to about 400 GeV.

The status of the LEP SUSY searches was reviewed by M Schmitt (Harvard). A slew of searches for gauginos, squarks and sleptons have yielded limits on SUSY masses in the 80 to 95 GeV range. In addition to the MSSM model, other models have been addressed but no signals have been observed.

SUSY searches at the Tevatron, covered in part by D Stuart (Fermilab), are also a busy industry, and in many cases the kinematic region, excluded by the LEP experiments, has already been extended significantly: the sbottom (stop) mass limits have reached 148 (119) GeV and the gluino limits almost 270 GeV.

Promising indications

At DESY's HERA electron-proton collider, "looking for non-Standard Model effects is alive and well," affirmed F Sciulli (Columbia), who showed that promising indications in the large-x (large mass in the electron-proton collision) region persist in data from both the ZEUS and the H1 experiments.

Higgs and SUSY prospects at the proposed Next Linear Collider (NLC), Muon Collider and Very Large Hadron Collider were covered by D Burke (SLAC), J Lykken (Fermilab) and D Denisov (Fermilab) respectively.

H Baer (Florida State) discussed the interface between theorists and experimentalists in the context of simulations beyond SM physics, and G Kane (Michigan) predicted that, unless we are missing some basic ideas, in the next six years or so SUSY particles and the light SUSY Higgs will be discovered either at LEP or at Fermilab.

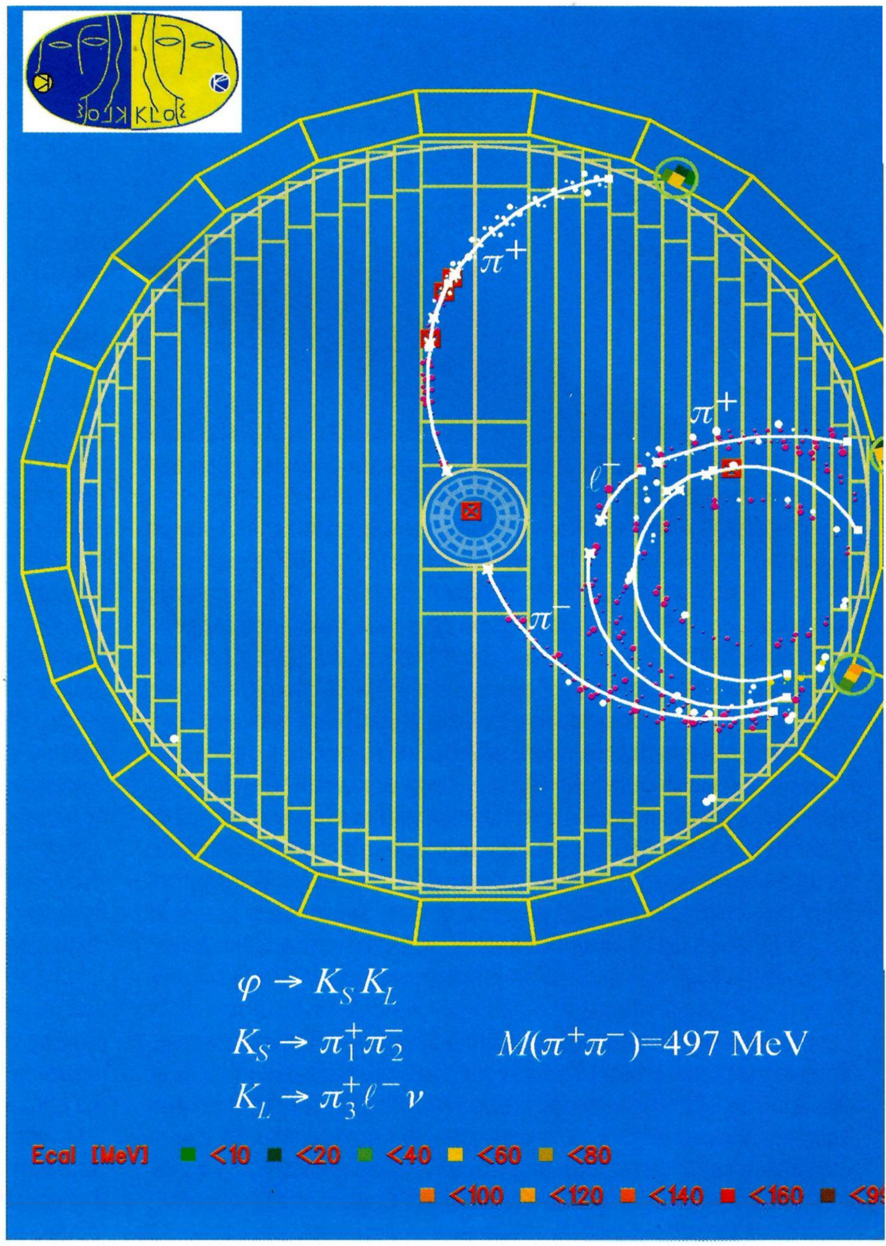
In the final presentation of the conference, J Bagger (Johns Hopkins) argued that perhaps not all sparticles may be light, given that several rare processes, such as lepton-flavour violation and proton decay, prefer unnaturally heavy scalar particles (in the 5-10 TeV range). Supernaturally superheavy supersymmetry provides a scenario in which the superparticles mass spectrum is the reverse of what is encountered with ordinary particles, but still has enough particles below the searchable 1 TeV scale.

As conference participants headed for other Florida attractions, the feeling was that the near future in particle physics was as bright as the sunshine.

Jacobo Konigsberg, *University of Florida.*

K for KLOE...

The first kaons from the new DAFNE phi-meson factory at Frascati underline a fascinating chapter in the evolution of particle physics.



The decay of a phi-meson into two kaons, as seen in the KLOE detector at the Frascati DAFNE phi factory.

As reported in the June issue (p7), in mid-April the new DAFNE phi-meson factory at Frascati began operation, with the KLOE detector looking at the physics.

The DAFNE electron-positron collider operates at a total collision energy of 1020 MeV, the mass of the phi-meson, which prefers to decay into pairs of kaons. These decays provide a new stage to investigate CP violation, the subtle asymmetry that distinguishes between matter and antimatter. More knowledge of CP violation is the key to an increased understanding of both elementary particles and Big Bang cosmology.

Since the discovery of CP violation in 1964, neutral kaons have been the classic scenario for CP violation, produced as secondary beams from accelerators. This is now changing as new CP violation scenarios open up with B particles, containing the fifth quark – "beauty", "bottom" or simply "b" (June p22).

Although still on the neutral kaon beat, DAFNE offers attractive new experimental possibilities. Kaons produced via electron-positron annihilation are pure and uncontaminated by background, and having two kaons produced coherently opens up a new sector of precision kaon interferometry. The data are eagerly awaited.

Strange decay

At first sight the fact that the phi prefers to decay into pairs of kaons seems strange. The phi (1020 MeV) is only slightly heavier than a pair of neutral kaons (498 MeV each), and kinematically this decay is very constrained. At first sight, phi decay via a rho-meson (770 MeV) and a pion (140 MeV) should be easier.

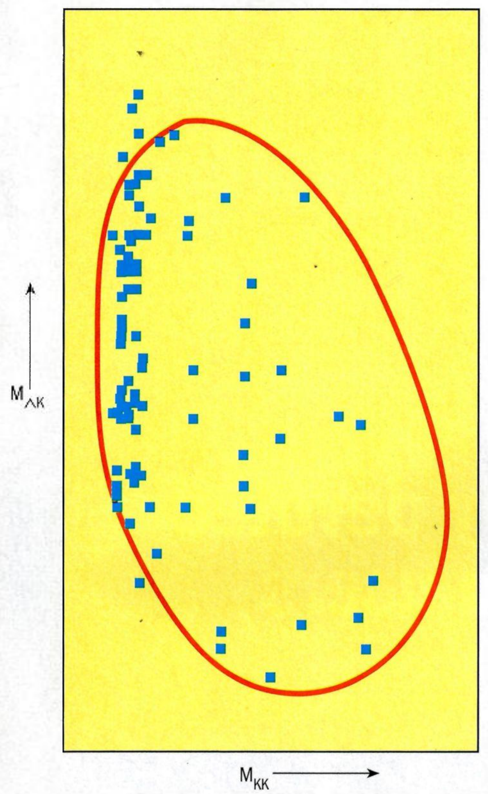
The phi-meson was first seen in bubble chamber experiments at Brookhaven in 1962. A subsequent paper, published the following year, outlined the properties of the new particle.

In 1963 the name of the game was to assign particles into SU3 multiplets, the Eightfold Way of Gell-Mann and Ne'eman. SU3 had to be some reflection of an underlying symmetry. At the time, physicists had little idea what this symmetry was, other than that it had to have a threefold structure. Quarks had not yet been talked about.

The 1963 paper said that the phi was a "vector" (spin-one, negative parity) meson. It could be accommodated as an SU3 singlet, supplementing an octet of other vector mesons, the rho and its cousins.

George Zweig, just completing his PhD at Caltech under Richard Feynman, looked at the paper and was immediately intrigued by the

...and Z for Zweig



1963 Brookhaven bubble chamber data. These show how a negative kaon beam on a proton target produces a lambda baryon and two kaons (particle and antiparticle). The ellipse marks the boundary of the kinematically allowed region. The horizontal axis is the effective mass of the kaon pair, while the vertical axis is the effective mass of the lambda and one kaon. Note the striking band on the left, which is signalling the presence of a resonance – the phi – which prefers to decay into pairs of kaons, despite being right at the edge of the kinematically allowed region.

huge signal for the decay into two kaons, right at the edge of the kinematically allowed region, while the apparently easier rho-pi decay was suppressed.

"Feynman taught me that in strong interaction physics everything that can possibly happen does, and with maximum strength," said Zweig. "Only conservation laws suppress reactions. Here was a reaction that was allowed but did not proceed."

This worried Zweig, who had been quietly toying with the idea that perhaps strongly interacting particles had constituents. The bizarre decay behaviour of the phi convinced him that constituents made sense. Moreover, he felt that, instead of being just some mathematical symmetry reflected as SU3 multiplets, these constituents had to be real.

His idea was that the phi has something in common with the kaons, but not the rho and the pi. This constituent, whatever it is, has to survive phi decay, and this can only be done by producing kaons, which are known to carry the quantum number strangeness.

This legacy of the phi we now call the strange quark – the phi contains a strange quark–antiquark pair. When the phi decays, the strange quarks have to go somewhere, and the kaon route is the only possibility: the strange quark goes into one neutral kaon and the strange antiquark goes into a neutral kaon antiparticle.

Gell-Mann had focused on a threefold underlying symmetry and had pounced on the "quark" word from a call at the bar in James Joyce's *Finnegan's Wake*: "Three quarks for Muster Mark".

Trying to sell his quark ideas, Gell-Mann recalled his earlier experience, when he had invented the name "strangeness" for a new quantum number. Physicists were used to dealing with particles denoted by Greek letters. If a new word had to be invented, they looked for derivations from classical Greek. Not Gell-Mann, who had gleefully flung his unorthodox "strangeness" into the arena and was accused of being frivolous. Remembering those difficulties, Gell-Mann, working in the US, sent his quark paper to the European journal *Physics Letters*, where it was published in 1964.

Four aces

However, in 1963 Zweig did not know about the quark ideas then going around in Gell-Mann's head. Zweig thought that there should be four constituents (because there were four weakly interacting particles, or leptons) and called them "aces". After leaving Caltech, Zweig worked at CERN for a while, bringing his aces idea with him. His paper appeared as a CERN internal preprint in January 1964. Wanting to publish in a US journal, Zweig came under pressure from CERN to publish in Europe. However, with no reputation, his idea fell on infertile ground and his paper was not widely published until several years later, when the value of his ideas had been recognized and the CERN "aces" preprint reproduced.

In Israel in the the early 1960s, Yuval Ne'eman and Haim Goldberg also concocted a threefold underlying symmetry pattern, but it too fell by the wayside, despite being accepted for publication.

Zweig's suspicion that there were four basic constituents, rather than three, was ahead of its time, anticipating the elucidation and discovery of the fourth quark – "charm" – in the early 1970s.

Later, Zweig wrote: "The reaction of the theoretical physics community to the ace model was not benign. Getting the CERN report published in the form I wanted was so difficult that I finally gave up."

Despite the demise of the ace picture, Zweig's contributions are still remembered. The selection rule that recognizes that constituent quarks have to survive (for example that phi prefers to decay into two kaons) is called the "Zweig rule".

Zweig subsequently turned his talents to research in sensory physiology, where, in 1975, his work led to the development of what is now called the continuous wavelet transform – a way of displaying and extracting time and frequency information in a signal. More recently he has proposed a model of cochlear mechanics that predicts that the ear makes sounds when it listens to sounds. These predictions were confirmed in experiments. He became a fellow of the US Los Alamos National Laboratory in 1985. □

LETTERS/BOOKSHELF

LETTERS

CERN Courier welcomes feedback but reserves the right to edit letters. Please e-mail "cern.courier@cern.ch".

Civil rights

The standfirst of your July article "How Martin Luther King almost came to Fermilab" reads oddly. I refer to the phrase "when human rights were as important as protons". I am sure it was unintentional. However, it seems to imply, by omission, that nowadays things are different and that there has been a renewed tilt towards protons.

I think there has not. Things are perhaps less strident now, but the lab's human rights statement is still in effect and is implemented by a number of programmes, such as the Summer Internships in Science and Technology for Minority Students (see "http://sist.fnal.gov/").

If anything, to garner the necessary broad-based public support for science in the US, it is even more important that there be fully-fledged support of human rights by those doing experiments with public funds. Were we to compromise the former in order to do the latter, a disaster in public support would certainly ensue.

We must ensure that there is wide participation and benefit – not only perceived but actual – for all parts of US society in scientific endeavours. I believe my colleagues understand this. This is particularly crucial when the endeavours are big, expensive and destined to take place outside the US, because there is the implication in the mind of the voters that their money is going out as well.

In addition to ensuring wide participation and benefit, it is also important that we tell them about it. We cannot rely on the news media to do the job. For example, as projects like the US participation in CMS progress, it is important that the many scientific personnel come back regularly, fan out across the country and make presentations – not just at academic gatherings, but at forums attended by many different segments of US society.

The participants need to talk about their work and thank the public for their support. This needs to be done well in advance of, and without any mention of, asking for money. I think this is a necessary (but not sufficient) condition for continued public funding in our field in the US.

Dr David J Ritchie, Fermilab, Illinois.

CERN Courier *replies:*

Many thanks for your letter. Things like standfirsts are frequently written at high speed. Nevertheless, "when human rights were as important as protons" was not meant to imply that these important issues have been sidelined. The point was that a major scientific project – Fermilab – emerged as an explicit champion of civil rights issues. Civil rights, like scientific objectivity and the free availability of results, remains an important implicit criterion in appraising the efforts of the international particle physics community.

Gordon Fraser, editor CERN Courier.

BOOKSHELF

The Bible According to Einstein, Jupiter Scientific Publishing Co, New York, ISBN 0 9655176 9 1

Putting the word "God" in the title of a popular science book is a sure-fire way of boosting the sales figures. Now an anonymous group of authors has gone one better in producing *The Bible According to Einstein*. This is a curious book, from its sombre black cover, complete with Star of Bethlehem (or is that just a symbol of scientific enlightenment?) to its chapter-and-verse structure. In place of authors, the book has a spokesman, Stuart Samuel, a New York-based physicist. Why no authors? "The publisher decided not to list authors and contributors as a means of achieving two of the book's goals: to mimic the Bible as much as possible in its style and structure while replacing religious issues with scientific ones and to create a feeling of awe.

There's no doubt that the first goal has been achieved. "In the 'beginning', there was no beginning. Before the Planck time, there was no time and there was no space," claims the opening line of Genesis I: The Planck Epoch. As for the second goal, I'm not so sure. It's true that the book shares the Bible's feeling of authority; this is no mere suggestion, this is the gospel truth. However, in that approach lies the book's main shortcoming.

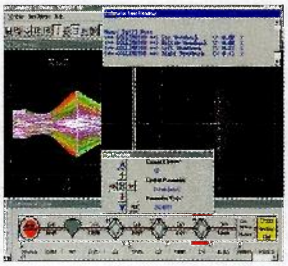
What attracted me to science was the realization that the universe is a mysterious place. There's a great deal we don't know about it and science is the great adventure of finding out. The book makes no attempt at analysis. It simply presents the whole canon of modern science as one fact after another, and that somehow takes away the excitement of finding out. So why did the anonymous authors choose the biblical style? Were they trying to provide a scientific alternative to the Christian Bible? According to Stuart Samuel, the book wasn't written with scientific evangelism in mind. Rather it was designed to draw a distinction between the things that science is good at and the things that spirituality is good at. "When it comes to the universe that we observe with our senses, science is the best means of obtaining understanding," said Samuel. "On the other hand, science cannot say anything about the purpose of life, about morality, nor about proper human conduct." This point is driven home repeatedly throughout the book. The introduction notes that the moral code written down in the religious texts of all of the major religions hundreds of years ago is as valid today as it was then, while our scientific world view has changed beyond recognition.

Throughout history, storms of protest have greeted the gradual encroachment of science onto religion's patch. This is no more than a misunderstanding, claims *The Bible According to Einstein*. "There is a line that exists between the domain of nature and the domain of God. People long ago drew the boundary by accident, not at the true line but in the land of science." The obvious implication is that, once that misunderstanding is cleared up and the boundary finally fixed in its rightful place, science and religion will coexist in harmony.

The Bible According to Einstein is an extremely ambitious project. It contains an overview not only of every branch of science known to man, but also of the more traditional gospels. There are biographies of Moses, Christ, Muhammad and Gotama the Buddha. These are written in the same style as the rest of the book, as one fact after another. They tell the stories of some exceptional lives without developing the equally exceptional philosophies that those lives produced.

All that said, it is an enjoyable book to dip into, if only to see familiar ideas expressed in an unfamiliar way and Stuart Samuel does have a point – the Biblical style does confer authority. It's a quirky book, but there's a lot of enjoyable reading in *The Bible According to Einstein*. Keep it next to your Bible, or whatever moral text you happen to subscribe to.

James Gillies, CERN.



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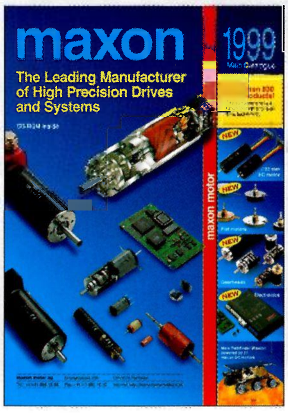

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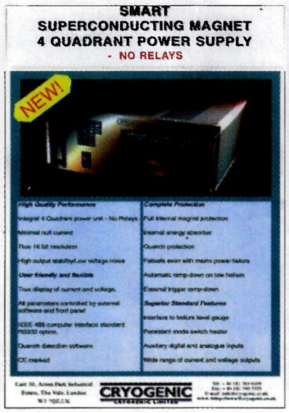

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Temperature Measurement and Control catalogue

A new Temperature Measurement and Control catalogue is available from Lake Shore Cryotronics Inc. Comprehensive details are provided for cryogenic temperature sensors, current sources, temperature transmitters, accessories controllers and monitors. The catalogue contains a comprehensive product section and a useful and detailed reference guide. Several temperature sensors are new to this year's catalogue, as are a temperature controller and a temperature monitor.

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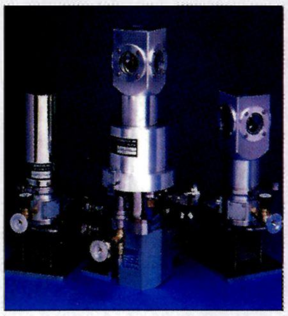

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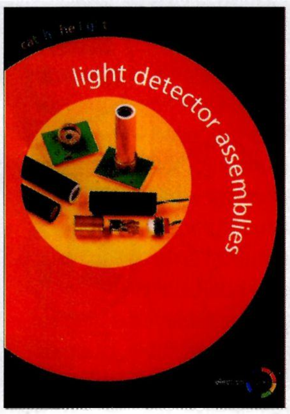

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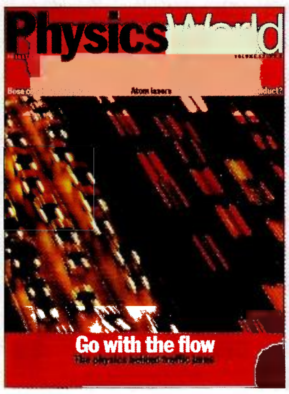

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Wagner heads DESY

Albrecht Wagner (58), professor of experimental physics at Hamburg University and former research director of the DESY Laboratory, Hamburg, takes over as Chairman of the DESY Directorate. He succeeds Bjoern H Wiik, who died in a tragic accident on 26 February.

Following studies at Munich's Technical University, Goettingen, and Heidelberg, where he graduated, Wagner became a research associate at Heidelberg and the Lawrence Berkeley Laboratory. From 1974 to 1986 he carried out his scientific work with experiments at DESY's storage rings, DORIS and PETRA, and at CERN between 1989 and 1990. In May 1984 he became professor of experimental physics at Heidelberg, and in June 1991 accepted a chair at Hamburg. During that same year, he was offered the direction of DESY's research department.

Wagner has been involved in the planning, construction and operation of the Opal experiment at CERN's LEP storage ring since 1982. Since 1991 he has also focused on physics at electron-positron linear colliders. In recent years he has served as scientific counsellor for the German Federal Ministry of Research, CERN, the American SSC accelerator project, the Karlsruhe Research Centre, the GSI Heavy-Ion Research Institute in Darmstadt and the ELSA project in Bonn.

Wagner is a member of the Nuclear Physics European Collaboration Committee NuPECC, the Scientific Committee Frascati Laboratory in Italy, the Scientific Policy Committee for the Fundamental Nuclear Physics State Scientific and Technology Program in Moscow and the Lepton Collider Advisory Committee of the Japanese KEK Laboratory. In 1994 he became a fellow of the American Physical Society.

Albrecht Wagner becomes Chairman of the Directorate of the DESY Laboratory, Hamburg.

A recent meeting, Symmetries and Reflections, at the State University of New York, Stony Brook, marked the retirement of C N Yang as Einstein Professor and director of the Institute for Theoretical Physics, and it attracted many distinguished physicists from all over the world. C N Yang (left) is seen here with Robert Mills. Their joint 1954 papers led the way to the new gauge theories that have allowed so much fresh insight into physics.

Bulgaria joins CERN

At the meeting of CERN's governing body, Council, in June, Bulgaria formally became the organization's 20th member state. Bulgarian physicists already participate in the L3 and Delphi experiments at LEP and in the CMS experiment for the LHC.

Long-term objectives are firmly centred on the LHC collider, which is scheduled to come into operation in 2005. However, the LEP electron-positron collider, CERN's research programme, is scheduled to cease operations next year and director general Luciano Maiani outlined a "limited but first-class" research programme for the interim which includes the new Compass experiment (see px), the new antiproton decelerator, the ever-popular ISOLDE on-line isotope separator and several other experiments.

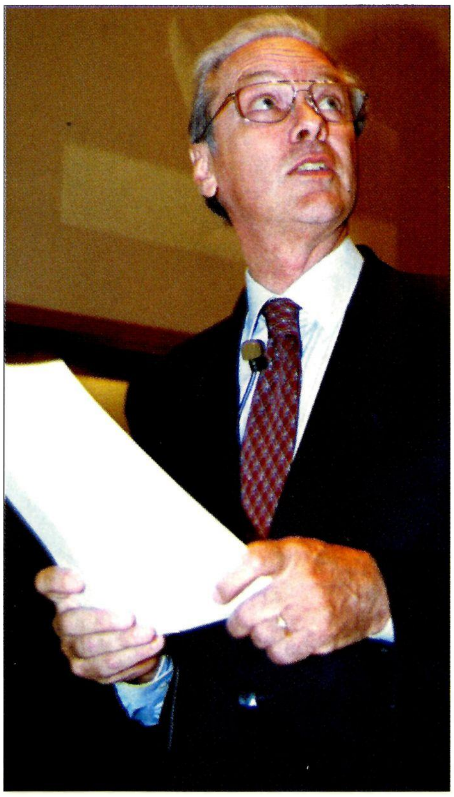
Possible additions to this approved and funded programme are the proposal to send CERN neutrinos to the Italian Gran Sasso Laboratory, 700 km away (*CERN Courier* November 1998, p13), and a new CERN facility to provide neutrons for a range of basic science and for nuclear waste transmutation studies. These projects depend on external supplementary funding being found, and, in the case of the neutrino project, the drawing up of a suitable scientific programme.

Also at the June meeting, Council approved the establishment of a new CERN Education and Technology Transfer Division (ETT) to implement a well focused action in strategic fields, in which CERN communicates to society at large its scientific results, their cultural and educational implications, and as the technologies and methods developed in the process.

Raising the flag as Bulgaria becomes CERN's 20th member state.

Jean-Pierre Delahaye was appointed leader of CERN's Proton Synchrotron (PS) division for three years from 1 January 2000. Steve Myers was appointed leader of the SL (SPS and LEP) division for three years from 1 January 2000. Juan-Antonio Rubio was appointed leader of the new ETT division for three years from 1 January 2000. Karl-Heinz Kissler was appointed leader of SPL (Supplies, Procurement and Logistics) division for three years from 1 April 2000.

Ugo Amaldi is honoured



Ugo Amaldi – widely admired.

A special seminar at CERN on 8 June, marking the 65th birthday of Ugo Amaldi, underlined his wide-ranging and widely admired contributions to science, covering experiment, theory, accelerators, applications, education and literature. Like his illustrious father, CERN pioneer Edoardo, Ugo's contributions to science appear to stem from a deep sense of duty rather than personal ambition.

Amaldi's experimental physics career spans a long series of experiments,which over the years have made significant contributions to our increased understanding of particle interactions at increasingly complex installations (described at the seminar by Paul Langacker of Pennsylvania).

Amaldi, founding father of the Delphi experiment at CERN's LEP electron–positron collider in the 1980s, gathered together an enthusiastic band of collaborators to work on a major new detector, incorporating technology that was very challenging at the time (recalled by Danielle Treille of CERN).

He was also the Chairman of the working group for what was to become the HERA electron–proton collider at DESY Hamburg, approved for construction in 1984 and now one of the major machines on the world scene (covered by Günter Wolf of DESY).

Also on the machine side, in the 1980s Amaldi made pioneer contributions to the development of far-sighted ideas on linear electron–positron colliders, including the use of superconducting radiofrequency technology. Only now are such machines emerging as one of the main avenues for future high-energy physics progress (described by Wolfgang Schnell of CERN).

As accumulated results from many experiments underlined the coherence of the contemporary Standard Model, at the end of the 1980s and early 1990s, Amaldi and his collaborators pointed out that the extrapolated results from these experiments did not converge to a common point at high energy, as would be required by a Grand Unified Theory synthesizing both strong and electroweak interactions. Convergence required the appearance of new effects, such as supersymmetry, at energies not yet attained in the lab. Langacker pointed out the irony of such heavyweight theoretical ideas coming from a physicist mainly known as an experimentalist.

Amaldi's most recent contribution returns to an early career theme. After the potential of particle beams for cancer therapy was pointed out in the 1930s, Enrico Fermi pushed for a new Istituto Superiore di Sanità in Rome to provide the necessary machines and beams. It was at this institute that Amaldi made his first contributions to physics, working on radiation protection. Some 30 years later he promoted the use of ion beams for therapy in Europe and masterminded the TERA Foundation to provide hadron beams for cancer therapy, skilfully managing administrators, funding agencies, and machine and medical specialists (recounted by M Goitein, Northeast Proton Therapy Center, Boston).

Ugo Amaldi is the scion of an illustrious Italian scientific family. Both his father and his grandfather wrote standard texts. He has continued and extended this distinguished tradition, which now even extends to a fourth Amaldi generation (F Enriques, Zanichelli, Bologna).

MEETINGS

A two-day conference, **Probing Luminous and Dark Matter**, on 24–25 September at the University of Rochester will be looking at future directions in particle physics and will also serve as a symposium to honour 40 years of achievement by Adrian Melissinos.

Speakers will include Charles Bamber, Barry Barish, David Burke, Bill Carithers, Erwin Gabathuler, Leon Lederman, Kirk McDonald, Yorikiyo Nagashima, Stephen Olsen, Joe Rogers, Nick Samios, Yannis Semertzedis, Pierre Sikivie, Pierre Sokolsky and Edward Thorndike. Lectures will cover high-energy cosmic rays, the LIGO project, RHIC, Axions, experiments with gas jets, Muon g-2, collider physics, the NLC, laser acceleration, strong-field QED, neutrinos, B physics, deep inelastic scattering and gravitational waves.

For more information and hotel reservations, see the Web page at http://www.pas.rochester.edu/" and click on "Adrianfest", or contact Judy Mack on "judy@pas.rochester.edu" or tel. (716) 275 4840.

The 3rd Workshop on Physics and Detectors for DAPHNE, the new high-luminosity Frascati Phi-Factory, will be held at the National Frascati Labs of INFN on 16–19 November. Three experiments – DEAR, Finuda and KLOE – will soon start to take data. The workshop will be devoted to a review of the experimental and theoretical issues relevant or close to DAPHNE physics.

Registration (before 1 September) and more information are available at "http://wwwsis.lnf.infn.it/dafne99/". ▷

Felicitas Pauss (right) of ETH Zurich, one of the speakers at this year's Nathiagali Summer College, Pakistan (p35) with a student from Lahore. (G Fraser.)

This year's **Neural Computation in High-Energy Physics**, also known as NCHEP-99, will be held in Maale Hachamisha in Israel on 13–15 October.

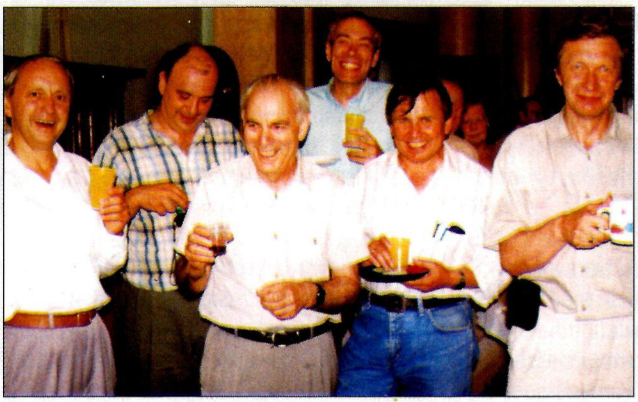
Neural computation is a developing discipline that deals with mathematical modelling of brain functions and with applications of these models to a range of problems. Its main tools are neural networks–mathematical models based on elements that possess the characteristics of neurons. In the last decade, physicists have developed many tools that make use of the neural network approach. These are successful in pattern recognition for triggering HEP detectors, as well as general classification problems.

The workshop, sponsored by the Israel Science Foundation, will follow the NCST-99 conference on Neural Computation in Science and Technology (at the same location),which covers areas of neurobiological modelling and computational applications. Information about NCST-99 is available at "http://neuron.tau.ac.il/NCST-99".

Invitations have been issued to various experiments, running or in the design phase, to present their concepts for trigger designs. Participants at this workshop will include B Denby (co-founder of the AIHENP series), C Kiesling (H1), J M Seixas (ATLAS), A Sokolov (DELPHI) and J Varela (CMS). D Horn will summarize the new trends and ideas discussed at the NCST-99 workshop. The scientific organization of the workshop is handled by H Abramowicz and D Horn from Tel Aviv. Information is available at http://neuron.tau.ac.il/NCHEP-99".

At a meeting of the European Committee for Future Accelerators (ECFA) in Denmark earlier this year, CERN director-general **Luciano Maiani** (left) had discussions with Danish research minister **Jan Trøborg**.

CERN delegation meets Chinese President Jiang Zemin in Beijing. Left to right: **Mr Shu**, vice-president of the Chinese Academy of Sciences, CERN director of Collider Programmes **Roger Cashmore**, adviser on CERN non-Member State Relations **John Ellis**, President **Jiang Zemin**, CERN director-general **Luciano Maiani**, CERN LHC project director **Lyn Evans** and Minister of Science and Technology **Zhu Li-Lan**.



Lev Okun (centre) surrounded by his former students at a special event in Moscow to mark his 70th birthday. He will be honoured at CERN on 21 September. Left to right: **Alexandre Dolgov**, **Michail Voloshin**, **Lev Okun**, **Michail Vysotsky**, **Nikolai Nikolaev** and **Victor Novikov**.

Korean Science and Technology Minister **SEO Jung-Uck** (centre) was at CERN in June with Ambassador **KWON Soon-Tae**. Among those he met was **Michel Della Negra** (left), spokesman of the CMS experiment at CERN's LHC collider.

Clifford Charles Butler 1922–1999

Clifford Charles Butler, who was the co-discoverer with George Rochester in 1946–1947 of "V-particles", died on 30 June. Their discovery can be seen as the first step towards the understanding of the quark nature of matter.

Butler spent the war years at the University of Reading. His first research contributions were in electron diffraction, but by 1947, Rochester and Butler had become members of Patrick Blackett's group at Manchester. Under Blackett's guidance they used a cloud chamber with a magnetic field to study the products of the interactions of high-energy cosmic rays in a block of lead. On 15 October 1946 they found an unusual forked track looking like an inverted "V". This was subsequently interpreted as the decay of a neutral particle (now known as a K-meson), which had to be extremely long-lived on the nuclear timescale. In May 1947 they found a second such long-lived particle. This time it was electrically charged.

To increase the cosmic-ray exposure, the Manchester magnet and chamber were transported to the Pic du Midi in the French Pyrenees, and it became clear that the "V-particles" fell into two separate classes, now known as hyperons and K-mesons.

Their long life was only explained in 1952 by Pais, who suggested that the particles were created in pairs. They could be created in fast nuclear reactions, but once separated from their partner they were no longer able to interact rapidly. Gell-Mann and Nishijima clarified this picture by identifying a new quantum number, called "strangeness".

In 1953, Butler moved with Blackett to Imperial College in London, where Butler became a full professor in 1957, heading the High-Energy Nuclear Physics group. He quickly recognized the importance of Glaser's 1952 invention of the bubble chamber, and the first West European hydrogen bubble chamber was built by his group. This led to the 1.5 m UK National Hydrogen Bubble Chamber, used at the Rutherford Laboratory and at CERN. In 1964, Butler succeeded Bernard Gregory as chairman of CERN's Track Chamber Experiments Committee.

Becoming deeply involved in science administration, Butler then became head of the Imperial College Physics Department, which was one of the largest multigroup research departments in Europe, while still leading the High Energy Nuclear Physics group. Between 1966 and 1969 he also served as dean of the Royal College of Science. Butler was a good, kind man who cared about the best interests of his staff, and he led a department that was proud of the standards and achievements in both its teaching and its research.

Butler left Imperial College to become director of the Nuffield Foundation from 1970 to 1975, and from 1975 to 1985 he served as vice-chancellor of Loughborough University of Technology. He never lost his interest in physics, playing vital roles in IUPAP – secretary-general (1963–1972), vice-president (1972–1975) and president (1975–1978). IUPAP generally, and Butler in particular, helped to maintain relations between physicists on both sides of the Iron Curtain during the depths of the Cold War.

Ian Butterworth

Clifford Butler 1922–1999.

UK Institute of Physics (IOP) President **Sir Gareth Roberts** (right) at CERN on 9 July with (right to left) IOP council vice-president and distinguished particle physicist **Peter Kalmus**, CERN engineer **Tim Watson** and IOP director of science **Peter Cooper**.

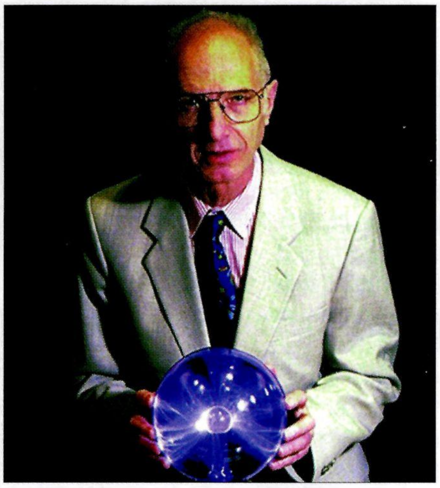
AWARDS

The High-Energy Physics prize

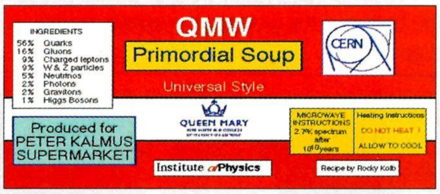
The prestigious High-Energy Physics prize of the European Physical Society goes to Gerard 't Hooft of Utrecht "For his pioneering contribution to the renormalization of non-Abelian gauge theories, including the nonperturbative aspects of those theories". The award was given at the International Europhysics Conference on High-Energy Physics held on 15–21 July in Tampere, Finland.

Russian Academy of Sciences member

CERN director-general Luciano Maiani has been elected a foreign member of the Russian Academy of Sciences.

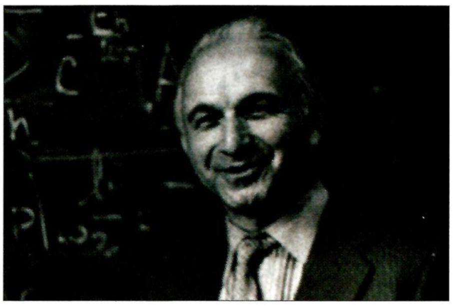


Peter Kalmus of London's Queen Mary and Westfield College recently toured the UK for the Institute of Physics Schools and Colleges lecture "Particles and the universe". The lecture was given in about 40 venues to a total audience of nearly 10 000 school students. The realization that the great diversity of the universe stems from a limited number of elementary particles interacting through a few fundamental forces is one of the major achievements of 20th-century physics. (M Kalmus.)



Among Peter Kalmus' "exhibits" was a can of "primordial soup".

Efim Fradkin 1924–1999



Efim Fradkin 1924–1999.

After 50 years of creative activity at the forefront of theoretical physics, Efim Fradkin died in Moscow on 25 May. His research extended from pioneering the functional method in quantum field theory and discovering, simultaneously with Schwinger, its Euclidean formulation, to basic work in string theory.

He was born in a Jewish neighbourhood near Minsk. At 16 he the university there for a year. The famous mathematician I M Gel'fand, who occasionally lectured there, recognized Fradkin's outstanding abilities and, to support him, gave him 100 roubles. However, the war intervened and Fradkin's family were killed. He joined the army and was wounded in the Battle of Stalingrad.

Fradkin appeared in Moscow in 1948 and was adopted by I E Tamm and V L Ginzburg at the Theoretical Department of the Lebedev Physics Institute, which became his home for the remaining 50 years of his scientific life.

"In the theatre of operations known as theoretical physics, Efim's attacks have been launched along the whole front," wrote Bryce DeWitt in Fradkin's festschrift. Fradkin pioneered conformal field theory and contributed to the theory of turbulent mixing. He developed the Batalin–Fradkin–Vilkovisky method for quantizing general constrained systems, found new ways to solve spin lattice models, tackled the problem of grand unification via exceptional groups and studied transfer processes in plasma.

Fradkin introduced the method of Green's functions in relativistic statistics and discovered, alongside Landau and Pomeranchuk, the zero-charge behaviour of QED (better known in the West as the Landau pole). He discovered open algebras and invented the first example of gauge supergravity. His relativistic eikonal approximation and the Efimov–Fradkin non-perturbative calculus gave birth to whole new trends of research.

Fradkin was awarded the Stalin state prize in 1953, the I E Tamm prize in 1980 and the Dirac medal in 1989 and was the first recipient of the Sakharov medal in 1996. He was a foreign member of Accademia Pontaniana in Naples and a full member of the Academy of Sciences of Russia. He was a member of CERN's Theory Division, as guest professor of the director-general, in 1996/7.

Fradkin acted as a magnet for young theorists. When his coffin was exposed at the Lebedev Institute, two generations of disciples kept guard. For them – and for the whole community of theoretical physics–his passing was a tremendous loss.

Werner Ruckstuhl 1952–1999

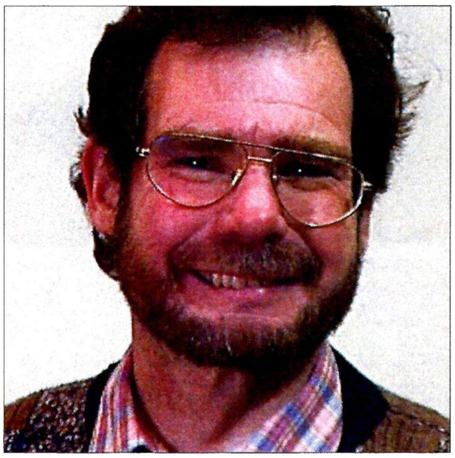
The sudden death of our colleague Werner Ruckstuhl has deeply shocked our scientific community, particularly at NIKHEF, where he worked for the last 10 years.

Werner, Swiss born and ETH-Zürich educated, did his PhD on muonic atoms, for which he was awarded the ETH medal. Via Caltech, where he studied lepton universality at the PEP ring at SLAC, and Geneva University as a member of the L3 team at CERN's LEP, he first came to NIKHEF in 1990 to set up the physics analysis for the Dutch DELPHI group at LEP. His interests soon returned to B physics – having pushed for a B factory at the Swiss PSI lab. Via the GAJET proposal he led NIKHEF into the LHCb experiment at CERN's LHC collider and became the Dutch team leader.

Werner was an excellent, all-round experimental physicist. His catching enthusiasm, in combination with his great sense of humour, stimulated many young physicists. He also made categorical choices – he came to NIKHEF, moved with his family to the Netherlands and became a Dutch citizen.

His absence is strongly felt not only at NIKHEF, but also at CERN and DESY.

Ger van Middelkoop



Werner Ruckstuhl 1952–1999.

D M (Mike) Sendall 1939–1999

D M (Mike) Sendall of CERN died on 15 July in London after a decade of illness. He would have been 60 in October.

Sendall obtained his PhD in the Cavendish Laboratory in Cambridge under Otto Frisch. He then came to CERN in 1968 to work in Lucien Montanet's group on bubble chamber studies of kaon decays.

In 1972 he became a staff member in the Data Handling Group in CERN's Nuclear Physics Division. Then in 1976 he moved to the Data Handling Division to take charge of the group, looking after data acquisition systems based on PDP-11 computers. He made important contributions in this field for many years, and was leader of the On-line Computing Group from 1985 to 1990.

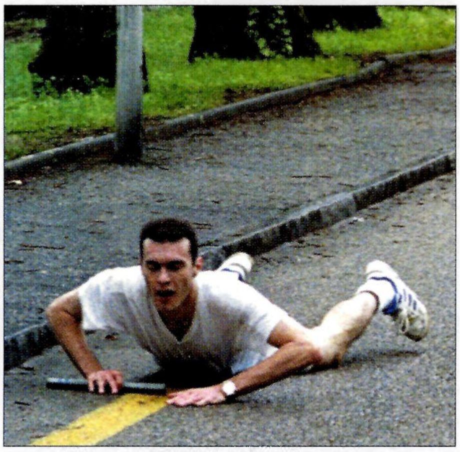
In addition, Sendall was an unsung hero of international computer networking. He understood the vast potential of open systems when others were limited to supplier-specific approaches. Between 1980 and 1985 he chaired the ECFA-LEP Network Group – known to many as Subgroup 5 – which established high-energy physics, and in particular CERN, as the focus of academic networking in Europe.

Mike Sendall 1939–1999.

Sendall's leadership style – continually pushing, suggesting and encouraging without seeking credit for himself – was a natural foil for the exuberance and enthusiasm of young researchers. Future history books are certain to recount how he was an enthusiastic supporter of Tim Berners-Lee in his pioneering work on what would later become the World Wide Web. After reading Berners-Lee's prophetic 1989 proposal, Sendall wrote on the cover: "vague but exciting", adding at the end: "And now?" The door to the Web was not yet open; but Sendall had put a key in the lock. In more recent years he played a major role in defining and implementing CERN's ongoing Web policy.

In 1992 Sendall took on an important responsibility as secretary of CERN's new LHC Committee – set up to recommend which experiments should proceed towards a full technical proposal – to monitor the development of the proposals and the subsequent progress of the experiments. He brought his customary meticulousness and diligence to this important task.

Mike Sendall was universally admired. Everyone who came into contact with him quickly appreciated his charm and intelligence, his complete devotion to duty and his profound understanding of computing and physics. His modesty masked a much deeper culture. His pronouncements were always incisive and his public talks a model of interest, precision and clarity. With a highly developed sense of humour, he was also a memorable raconteur. Towards the end of his life he faced his future with courage and dignity.



Sky Sports doesn't get all the action. There was drama at the finish of this year's traditional relay race round the CERN site when Cedric Pourcel of the Cooperants team, a clear leader when approaching the finish line, stumbled and fell. Quickly back on his feet, he still crossed the line a clear 5 s ahead. (Laurent Guiraud.)

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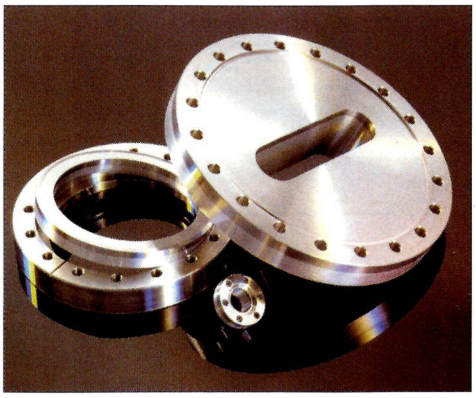

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Post-Doctoral position in accelerator physics

The Institut für Kernphysik has an opening for a post-doc research position, available for a period of two years starting at any time within the next few months.

The Institut für Kernphysik is presently developing the 1.5 GeV c.w. accelerator "MAMI C". The working field of the successful applicant would be on accelerator physics with polarized electron beams, especially concentrated on the development of a compact spin rotation system and precision polarimetry at 14 MeV beam energy.

Salary conditions apply according to the German Bundesangestelltentarifvertrag BAT II a. Application deadline is October 1st, 1999. Interested candidates are encouraged to send their curriculum vitae with the names and addresses of two referees to the personal office: Institut für Kernphysik, Johannes Gutenberg-Universität Mainz z. Hd. Frau Huhn , J.-J.-Becher-Weg 45, 55099 Mainz – Germany

Further information may be obtained by: Dr. Kurt Aulenbacher, Institut für Kernphysik Johannes Gutenberg-Universität Mainz, D-55099 Mainz Tel.: ++49 (0) 6131-395804
e-mail: aulenbac@kph.uni-mainz.de

DESY

DESY is a physics research laboratory with 1.400 employees and more than 3.000 guest scientists from Germany and abroad. The scientific program includes research in particle physics and synchrotron radiation.

In the framework of an international collaboration, DESY is developing a Free Electron Laser for wavelengths far below the visible. The project is based on the superconducting TESLA Test Accelerator Facility, which provides the technological basis for a future high-energy electron-positron linear collider.

A key contribution to the success of this installation will be the development, construction and commissioning of a number of advanced electron accelerator components. Within the scope this activity, DESY Hamburg invites applications for

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The contract will be limited to 2 years, with a possible extension for a third year. The salary will be according to the German Civil Service (IIa MTV Angestellte).

Scientists who have recently finished their Ph.D., have experience in this field and are not more than 32 years old, are invited to send their letter of application and three names of referees to:

DESY, Personalabteilung, Notkestraße 85, D-22607 Hamburg,
Tel.: 040 89983617, Fax: 040 89944305,
by October 15th, 1999 **Code-No. 92/99**

Handicapped applicants will be given preference to other applicants with the same qualification. DESY encourages especially women to apply.

EPFL

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

The Swiss Federal Institute of Technology Lausanne (EPFL) invites applications for the position of:

Maître d'enseignement et de recherche (MER) in Acoustics for the Department of Electrical Engineering

The task of the successful candidate will be to develop teaching and research activities in acoustics, more specifically for the modeling of acoustic fields (radiation and propagation). He/she will develop innovative research related to active noise control. This activity will take place within the existing Laboratory of Electromagnetism and Acoustics, in collaboration with other institutes of EPFL, as well as with other institutions and industries on national and international levels.

Aptitudes for teaching and project management, scientific excellence, personality and industrial background are major assets. He/she will supervise student projects, diploma and doctoral theses.

Deadline for registration: October 15, 1999. Starting date: upon mutual agreement. The EPFL strongly invites women to apply. Please ask for the application form by writing or faxing to: Présidence de l'Ecole polytechnique fédérale de Lausanne, CE-Ecublens, CH-1015 Lausanne, Suisse, fax nr. +41 21 693 70 84. For further information, please consult also URL: http://www.epfl.ch, http://dewww.epfl.ch/, http://admwww.epfl.ch/pres/profs.html or http://research.epfl.ch/

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Further particulars are available from http://www.gla.ac.uk/Otherdepts/Personnel/recruit/, Telephone 0044 141 330 4673 or by E-mail: d.saxon@physics.gla.ac.uk, or k.peach@rl.ac.uk. Applications, including CV, publications list, and the names and addresses of two referees, should be sent by 16 October 1999 to Prof. D H Saxon, Kelvin Building, University of Glasgow, Glasgow G12 8QQ, Scotland.

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