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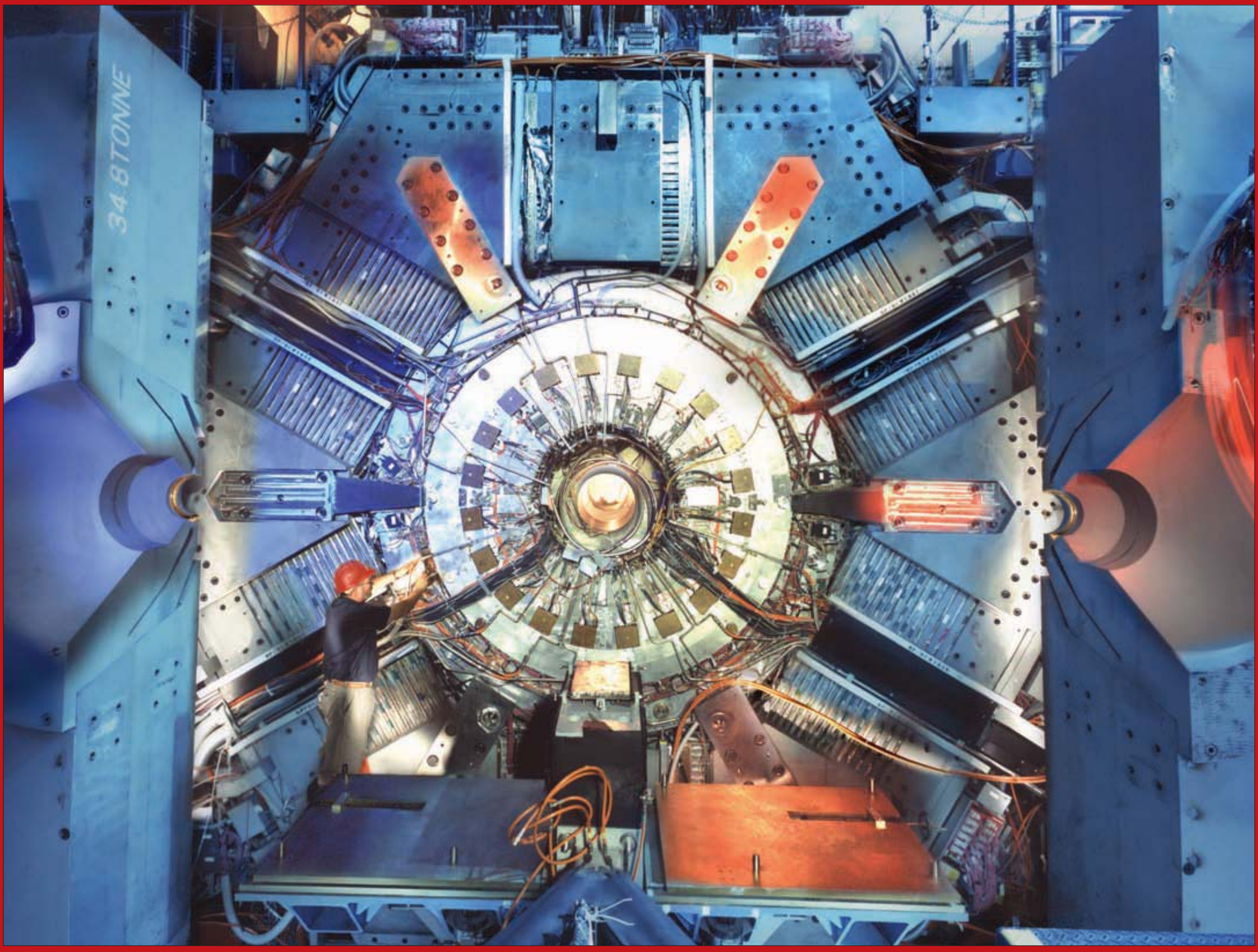

BaBar celebrates rich harvest

NUCLEON STRUCTURE
HAPPEx finds proton is not so strange p6

COMPUTING NEWS
CERN openlab begins its second phase p18

PARTICLE DETECTORS
Workshop focuses on GEMs and Micromegas p37


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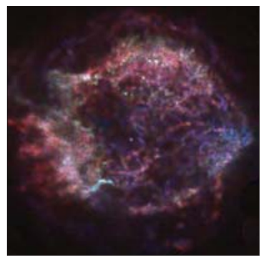

Synthesis of heavy elements p7

The second phase of openlab p18

Precision laser spectroscopy p30

Cover: The BaBar collaboration at SLAC has now notched up 200 publications, not only on the B physics for which the detector, seen here, was designed, but also on the physics of charm and tau particles (p9). (Photo courtesy Peter Ginter.)

OCEM® Power Converters Successfully Commissioned at the Diamond Light Source

OCEM has been awarded two contracts to supply more than 400 highly stabilized power converters for the diamond synchrotron, which have now been installed in the largest science facility in the UK.

Launched in Bologna in 1946, OCEM focused its activities on design and production, starting from magnetic amplifiers and current regulators for public lighting, and soon becoming a key player in the design of custom power converters for physics labs and universities involved in plasma and particles physics.

Hundreds of power supplies have already been delivered to the most advanced laboratories around the world, especially during the construction of CERN: since the 1960s, in fact, OCEM has grown up side by side with the CERN physicists and engineers, with a significant increase in know-how, always at the top in the state of the art of power electronics. Even today, CERN is still one of the main customers of OCEM, and at the beginning of this year two prestigious jobs were completed for CERN:

1. storage ring superconducting dipole power converters;
2. dipole and quadrupole diode stacks.

Concerning the first job, the nine (8+1 spare) dipole two-quadrant power supplies, rated 13 000 A/ ±190V, will feed the dipole magnets around the 27 km circumference of the LHC ring. Concerning the second job, 1718 dipole and quadrupole bypass diode stacks have been designed and manufactured in a multiyear contract, which has seen a collaboration between CERN as the contractor, OCEM as the industrial partner, taking full responsibility for the contract, and ENEA, the association partner for the superconductive tests. These quadrupole and dipole stacks are currently being installed in the LHC ring.

Today OCEM is located in San Giorgio di Piano, a small town near Bologna, in the north-east region of Italy. The company is divided into the following divisions: Airports, Railroads, Physics and Streetlighting. Thanks to the recent acquisition of MultiElectric in Chicago, US, Augier in Nice, France, and Argos S.p.A. in Rome, OCEM nowadays is an international marketing-oriented company that is well known and highly respected all over the world.

OCEM has been awarded two contracts to supply more than 400 highly stabilized power converters for the Diamond synchrotron. This is the largest science facility built in the UK for more than 30 years.

The facility was built and is operated by Diamond Light Source Ltd, a joint venture company established in 2002 and funded by the UK government via the Council for the Central Laboratory of the Research Councils (CCLRC) and the Wellcome Trust. It is situated in south Oxfordshire on the Rutherford Appleton Laboratory site (www.diamond.ac.uk). The Diamond synchrotron will provide intense beams of light for up to 40 optical beamlines. The frequency of the light ranges from the infrared to soft X-rays. The majority of users will be university researchers pursuing long-term fundamental research and companies – both large multinationals and high-tech start-ups. The Diamond synchrotron will be supported by a team of 300 staff , including engineers, scientists, technicians and support staff from around the world.

The majority of the power converters provided for Diamond by OCEM are being used to power the quadrupole and sextupole magnets in the synchrotron storage ring. The power to each of the 408 magnets is individually controlled by the power converters. The output regulators are of a modular design for ease of maintenance and they include redundancy to improve reliability. The power converters are digitally controlled using control cards designed by the Paul Scherrer Institute, built under licence by Diamond and issued to OCEM.

In addition to the power converters, OCEM was also awarded the contract for the large power converters required by Diamond. These are a 1500A/500 V DC supply to power the 48 storage ring dipoles, a 1000 A/2000 V, 5 Hz supply providing an offset sine waveform to drive the booster dipole circuit, and a power converter providing two outputs rated at 200 A/400 V, 5 Hz, also with an offset sine waveform for the booster quadrupoles. Like the other power converters, these are of modular design, include redundancy and use the same digital controllers.

Contact OCEM SPA
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B PHYSICS

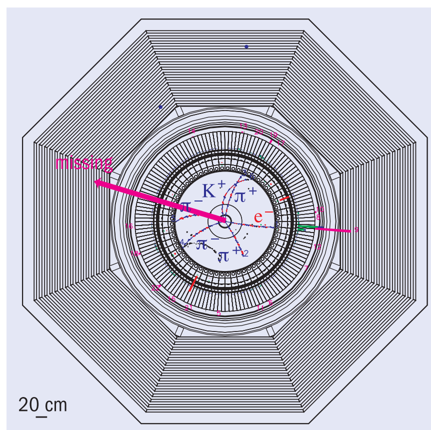
Belle experiment finds evidence for rare missing-energy decay

The Belle experiment has recently revealed evidence for a rare and long-sought missing-energy decay of the B meson, $B^- \rightarrow \tau^- \nu$. This has allowed the Belle Collaboration to measure the B-meson decay constant, f_B, for the first time. The results were announced at the Flavor Physics and CP Violation conference in Vancouver, and have been submitted to *Physical Review Letters* (Ikado *et al.* 2006).

The Belle experiment is a collaborative effort of scientists from universities and laboratories in America, Asia, Australia and Europe. It operates at the KEK High Energy Physics Laboratory in Japan – home to KEKB, the world's highest-luminosity particle accelerator, which recently achieved a peak luminosity of $1.6 \times 10^{34}\ cm^{-2}s^{-1}$ (*CERN Courier* January/February 2006 p6).

In the decay mode $B^- \rightarrow \tau^- \nu$, the B meson (a strongly interacting bound state of a b quark and anti-u quark) transforms into a final state containing only leptons. Previously, because this decay process had not been seen, researchers had to rely entirely on either calculations in lattice quantum chromodynamics (QCD) or models to obtain the parameter f_B, which is needed to interpret many other measurements in particle physics, including the Cabibbo–Kobayashi–Maskawa unitarity triangle constraints from B_d–$\bar{B}_d$ mixing.

The decay mode $B^- \rightarrow \tau^- \nu$ is especially hard to find. Not only is it rare – about 1 in 10 000 charged B decays contains such an event – but tau leptons often decay to an electron or muon together with two neutrinos, which escape the detector unseen. This means that the experimental signature is simply a single charged track accompanied by missing energy, and is frequently mimicked by less-interesting background processes.



A typical $B^- \rightarrow \tau^- \nu$ candidate event at the Belle experiment. This candidate decays to an electron and missing energy/momentum.

The Belle experiment operates at the $\Upsilon(4S)$ resonance where each B meson is produced accompanied by an anti-B meson partner and nothing else. The experimental breakthrough that allowed the discovery of the missing-energy decay mode involved detecting all the decay products of the B meson accompanying the sought-after decay, thereby constraining the energy and momentum of the missing or undetected particles. This technique has a very low efficiency and is only possible because of the unprecedented luminosity of the KEKB accelerator, which provided the Belle experimenters with 457 million charged B mesons to study. Even so, this was barely sufficient to discover this rare and unusual process.

Based on the events that they have found, the Belle team reports a preliminary value of $f_B = 176^{+28}_{-23}$ (stat.) $^{+20}_{-19}$ (syst.) MeV, which is compatible with the most recent calculations in unquenched lattice QCD. Conversely, if f_B is taken from lattice QCD, the Belle measurement of $B \rightarrow \tau\nu$ gives a tight constraint on charged Higgs masses at high $\tan\beta$ in extensions of the Standard Model, where $\tan\beta$ is the ratio of vacuum expectation values.

This breakthrough in the detection of a rare missing-energy decay is the first step towards the observation of exotic decays such as $B \rightarrow K\nu\bar{\nu}$, $B \rightarrow$ dark matter, and other possible types of unusual and new physics processes. Although the experimental technique for observing a rare missing-energy mode has now been established, two orders of magnitude more $B\bar{B}$ pairs are probably needed to find $B \rightarrow K\nu\bar{\nu}$ and exploit all of the possibilities this technique has to offer. This will be possible at the proposed KEK Super B-Factory facility.

Further reading

K. Ikado *et al.* The Belle Collaboration 2006 http://arXiv.org/pdf/hep-ex/0604018.

Sommaire

JLAB

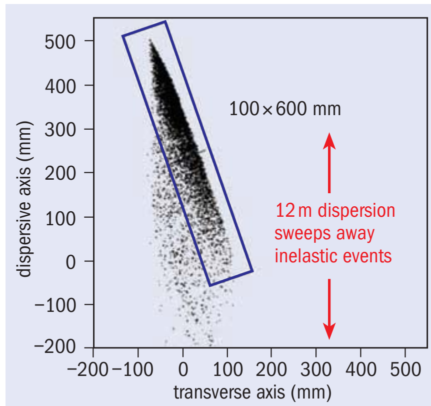
HAPPEx shows the proton is not so strange

Two more rounds of data taken by the Hall A Proton Parity Experiment (HAPPEx) at the US Department of Energy's Jefferson Lab have provided the most precise constraint yet on nucleon strangeness. The result, presented at the American Physical Society April meeting in Dallas, reveals that the strange-quark contribution to the proton's overall charge distribution and magnetic moment is small. It amounts to no more than 1% of the proton's charge radius and no more than 4% of its magnetic moment – and in both cases, the final value could be consistent with zero.

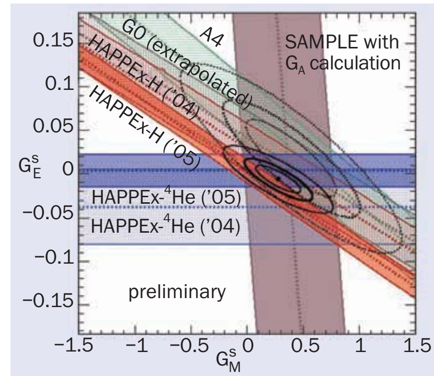
It may seem unusual that strange quarks should be important in determining the properties of the proton as, unlike up and down quarks, they are not thought of as permanent residents of the proton. However, the strange quark may appear as part of the proton's quark-gluon sea, the seething mass of particles that constantly blink in and out of existence due to strong force energy.

A useful method of accessing strange quarks is through parity-violating electron scattering, in which the interference of the electromagnetic force and neutral weak force is measured by scattering a beam of polarized electrons off target particles. Since the electromagnetic force is parity-symmetric, while the weak force is not, a longitudinally polarized electron beam allows experimenters to separate the electromagnetic and weak components, and by comparing their strengths they can disentangle the contributions of the up, down and strange quarks.

The HAPPEx Collaboration measured a combination of strange-quark contributions to the charge distribution and magnetization of the proton, which are represented via G_E^s and G_M^s, the strange electric and magnetic form factors, respectively. To disentangle the two form factors, the collaboration took data on two different targets: hydrogen and helium (^{4}He). ^{4}He has no net spin and hence no magnetic moment, and so allowed the researchers to isolate G_E^s.



Jefferson Lab's Hall A HRS allowed a very clean separation of elastic events, with an average value of $Q^2 = 0.1\,(\text{GeV}/c)^2$.



New fit of world data (with G0, A4 and SAMPLE) near $Q^2 \sim 0.1\,\text{GeV}^2$. The combined fit is approximate; correlated errors and assumptions are not taken into account.

HAPPEx took data on both targets during 2005, using a longitudinally polarized 3 GeV electron beam from Jefferson Lab's Continuous Electron Beam Accelerator Facility. A gallium arsenide superlattice photocathode provided an average beam polarization of 86% with rapidly flipping helicity. The beam was sent into a 20-cm long cryogenic aluminum target vessel containing either hydrogen or ^{4}He in Jefferson Lab's Hall A. Septum magnets then deflected elastically scattered electrons, which were at a forward angle of 6°, to the Hall A High Resolution Spectrometers (HRS), located at 12.5°.

The HRS allowed a very clean separation of elastic events, with an average value of momentum-transfer squared, $Q^2 = 0.1\,(\text{GeV}/c)^2$. A Cherenkov electromagnetic shower calorimeter covered the distribution of elastic events in the spectrometer focal plane. The signal was integrated over each period of constant helicity. A blinding factor was placed on the data and removed only a week before the result was presented in Dallas.

The HAPPEx results indicate small values for the strange form factorss $G_M^s = 0.12 \pm 0.24$ and $G_E^s = -0.002 \pm 0.017$. While these results are consistent with previous results from HAPPEx (Aniol *et al.* 2006) and world data, they reveal that the large values and possible radical Q^2 dependence of the strange form factors suggested by previous data in this kinematic region, are highly unlikely. Also, while these new data are accurate enough to eliminate many models of strangeness content, they do not rule out sizable contributions at higher Q^2. They are also compatible with a new analysis of world data, the result of which is in excellent agreement with modern calculations based on non-perturbative quantum chromodynamics using lattice methods and chiral extrapolation (Young *et al.* 2006).

Further reading

K A Aniol *et al.* 2006 *Phys. Lett. B* **635** 275 and *Phys. Rev. Lett.* **96** 022003.
R D Young *et al.* 2006 www.arXiv.org/abs/nucl-ex/0604010, submitted to *Phys. Rev. Lett.*

Les physiciens des particules du monde entier sont invités à apporter leurs contributions aux *CERN Courier*, en français ou en anglais. Les articles retenus seront publiés dans la langue d'origine. Si vous souhaitez proposer un article, faites part de vos suggestions à la rédaction à l'adresse cern.courier@cern.ch.

CERN Courier welcomes contributions from the international particle-physics community. These can be written in English or French, and will be published in the same language. If you have a suggestion for an article, please send your proposal to the editor at cern.courier@cern.ch.

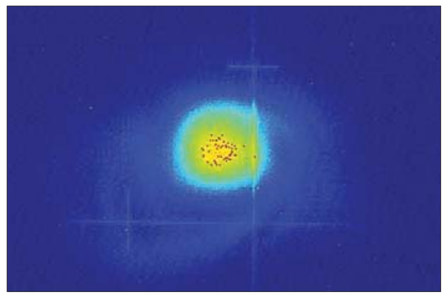
DESY

FLASH produces the shortest wavelength yet

On 26 April, the vacuum-ultraviolet and soft X-ray free-electron laser (FEL) facility at DESY generated pulses at the shortest wavelength yet, using electron bunches supplied by the TESLA Test Facility (TTF) linac. The laser facility already produced the shortest wavelengths achieved with a FEL, with pulses at 32 nm. Now it has reached a new record with a wavelength of only 13.1 nm.

Equipped with five superconducting accelerator modules, the TTF linac can accelerate electron bunches to an energy of 700 MeV. This is sufficient for the bunches to emit laser pulses at 13.1 nm as they subsequently traverse the undulator. A sixth module, to be installed in 2007, will allow a further increase in energy to 1 GeV, making it possible to generate wavelengths as low as 6 nm. The pulses produced are shorter than 50 fs, leading appropriately to the new name for the facility, FLASH, which was chosen to be simpler and more attractive than VUV-FEL.

After a successful first data-taking run that ended in February, on 8 May the newly named FLASH began once again to serve its users for a second measuring period.



Single-shot image taken when the radiation pulse at 13 nm from DESY's free-electron laser hits a scintillating Ce:YAG crystal.

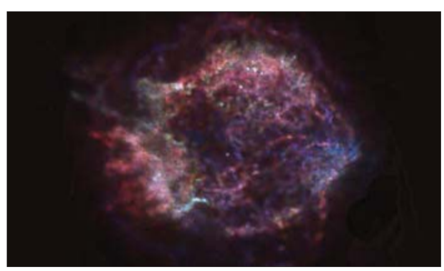
NUCLEOSYNTHESIS

Neutrinos provide new route to heavy elements in supernovae

During their long lifetimes stars generate their energies by nuclear fusion in their interiors, which are generally accepted to be the breeding grounds for carbon and heavier elements. The heaviest elements made this way are iron and nickel; heavier elements are thought to be built by slow and/or rapid neutron-capture reactions, the s- and r-processes. Although these mechanisms for nucleosynthesis have been known for some time, the abundances of some heavy elements have remained a mystery. Now Carla Fröhlich of the Universität Basel and Gabriel Martínez-Pinedo of the Gesellschaft für Schwerionenforschung, Darmstadt, and colleagues have proposed a novel nucleosynthesis that might solve these puzzles.

When a massive star forms a supernova, part of the matter in the stellar interior forms a neutron star, and the liberated energy, mainly in the form of neutrinos, contributes to the ejection of the stellar mantle into the interstellar medium. The temperature of the deepest ejected layers is so hot that nuclei are decomposed into free protons and neutrons. The tremendous flux of neutrinos and antineutrinos, which accompanies the birth of the neutron star, can be absorbed by the nucleons and so determines the relative abundance of protons and neutrons and hence the composition of the nuclei that form when the ejected matter reaches cooler regions.

During the later stages of the explosion the matter is expected to become rich in neutrons, so supernovae are believed to be the site of heavy-element production by the r-process. However, it has been realized very recently that during the first second of the explosion the ejected material is rich in protons.



Neutrinos may play a role in the synthesis of heavy elements in the material thrown out from supernovae – made visible here in the supernova remnant Cassiopeia A by the Chandra X-ray Observatory. (Courtesy NASA/CXC/SAO/Rutgers/J Hughes.)

When Fröhlich and colleagues studied the nucleosynthesis in this proton-rich environment they discovered possible solutions to two long-standing problems. First, they could reproduce the abundances of elements such as scandium, copper and zinc, for which calculations had previously fallen notoriously short. More surprisingly, they also noticed the appearance of heavier elements such as strontium, molybdenum, ruthenium and beyond (C Fröhlich *et al.* 2006).

This heavy-element production can be attributed to a novel nucleosynthesis process, which Fröhlich and colleagues named the νp process after the two main contributors: proton capture, which transports matter sequentially to higher charges, and (anti)neutrinos, which are captured by free protons and so change the protons to neutrons. This presence of neutrons allows the flow in element creation to circumvent long-lived nuclei such as ^{56}Ni and ^{64}Ge, so enabling the synthesis of heavier elements.

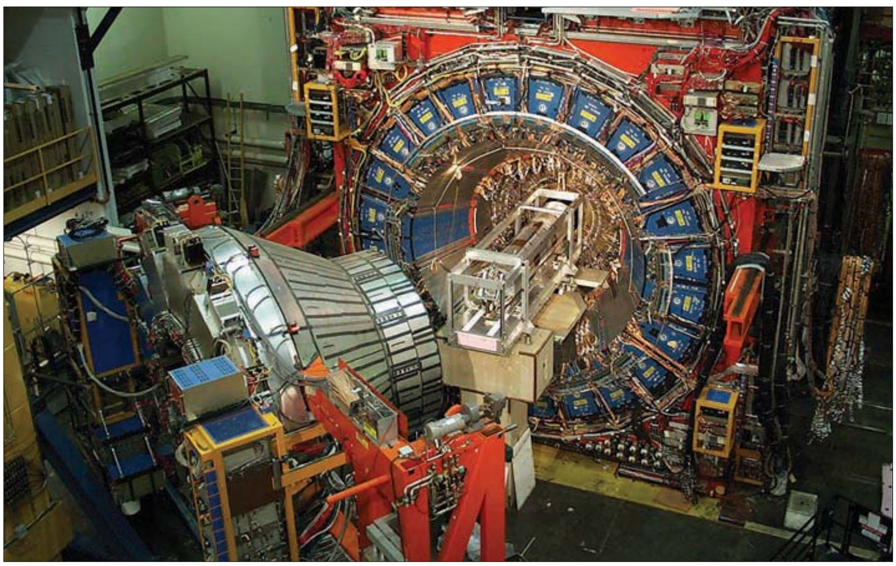
The νp process is a primary process, that is, it should occur in all core-collapse supernovae. As a consequence there should already be fingerprints of νp nucleosynthesis in the earliest and most primitive stars. Indeed, finding strontium in the most metal-poor, and hence oldest, star observed so far came as a big surprise last year. This might now be explained as debris from the νp process that had operated in an earlier supernova. Further observations of elemental abundances in metal-poor stars combined with progress in supernova modelling and improved knowledge of the nuclei involved – as expected from future facilities such as the Facility for Antiproton and Ion Research – will help to disentangle the importance of the νp process for the abundances of the elements in the universe.

Further reading

C Fröhlich *et al.* 2006 *Phys. Rev. Lett.* **96** 142502.

FERMILAB

CDF measures matter–antimatter B_s^0 transition



The CDF detector provides a window onto B_s^0 oscillations through precision measurements.

The CDF collaboration at Fermilab has announced the precision measurement of the matter–antimatter transitions for the B_s^0 meson, which consists of a bottom quark bound to a strange anti-quark. The announcement came less than a month after the news that the D0 collaboration had measured the first upper and lower bounds on the oscillation frequency (*CERN Courier* May 2006 p6).

In a seminar at Fermilab on 10 April, the CDF Collaboration reported on their analysis of 1 fb^{-1} of proton–antiproton collision data acquired by the CDF detector between February 2002 and January 2006, during Tevatron Run II. Within the 700-member CDF Collaboration – from 61 institutions and 13 countries – a team of 80 researchers from 27 institutions performed the data analysis leading to the precision measurement just one month after the data-taking was completed.

The team used semileptonic and hadronic decays of the B_s^0 and found a signature consistent with B_s^0–$\bar{B}_s^0$ oscillations, with a probability that the data could randomly fluctuate to mimic such a signature of 0.5%. Analysis yielded a preliminary result for the B_s^0–$\bar{B}_s^0$ oscillation frequency, Δm_s, of $17.33^{+0.42}_{-0.21}$(stat.)±0.07(sys.) ps^{-1} – in agreement with D0's result of $17 < \Delta m_s < 21$ ps^{-1}. The CDF Collaboration also derived a value for the ratio of the related parameters of the Cabibbo–Kobayashi–Maskawa matrix, $|Vtd|/|Vts| = 0.208+0.008-0.007$ (stat.+sys.).

This precision measurement from CDF will immediately be interpreted within different theoretical models, in particular in the context of supersymmetry. General versions of supersymmetry predict an even faster transition rate than has been measured, so some of those theories can be ruled out based upon this result. More information will come from combining precise measurements of B_s^0–$\bar{B}_s^0$ oscillations and searching for the rare decay of B_s^0 mesons into muon pairs. Both the D0 and CDF experiments expect to achieve improved results in these areas in the near future.

Further reading

For more information see www-cdf.fnal.gov/.

QED

Highly ionized uranium produces best test of theory

Researchers at the Lawrence Livermore National Laboratory (LLNL) in California have made the most precise test so far of quantum electrodynamics (QED). In studies of highly ionized, lithium-like uranium, they have measured the two-loop Lamb shift for the first time (Beiersdorfer *et al.* 2005).

QED is a well-established theory that describes at the quantum level all phenomena involving the electromagnetic force. Its extremely accurate predictions have been tested by various experiments, including measurements of the tiny shift in the energy levels in hydrogen discovered by Willis Lamb in 1951, owing to the self-interaction of the electron. Tests of so-called one-loop QED (self-energy and vacuum polarization) confirmed the theoretical predictions with high precision, and theorists and experimentalists are now looking to evaluate higher-order QED processes.

Highly charged ions offer an opportunity for high-accuracy calculations of atomic properties within QED, in that they provide a strong-field environment and relatively simple spectra. These conditions allow high-precision measurements of some transitions. Moreover, measurements of lithium-like systems such as U^{89+} are more sensitive to higher-order QED terms than those of hydrogen-like systems.

Using the SuperEBIT high-energy electron-beam ion trap at LLNL, the researchers measured the 2s(1/2)–2p(1/2) transition in U^{89+} with an accuracy that is nearly an order of magnitude better than previously available. The team monitored X-ray emission from the ions with a high-purity germanium detector, and used a spectrometer specifically developed for this experiment for spectroscopy at extreme ultraviolet wavelengths.

The results allow the researchers to infer a two-loop Lamb shift in lithium-like U^{89+} of 0.20 eV. This is also in excellent agreement with the recent calculation of the two-loop Lamb shift for the 1s level in hydrogen-like U^{91+}.

Further reading

P Beiersdorfer *et al.* 2005 *Phys. Rev. Lett.* **95** 233003.

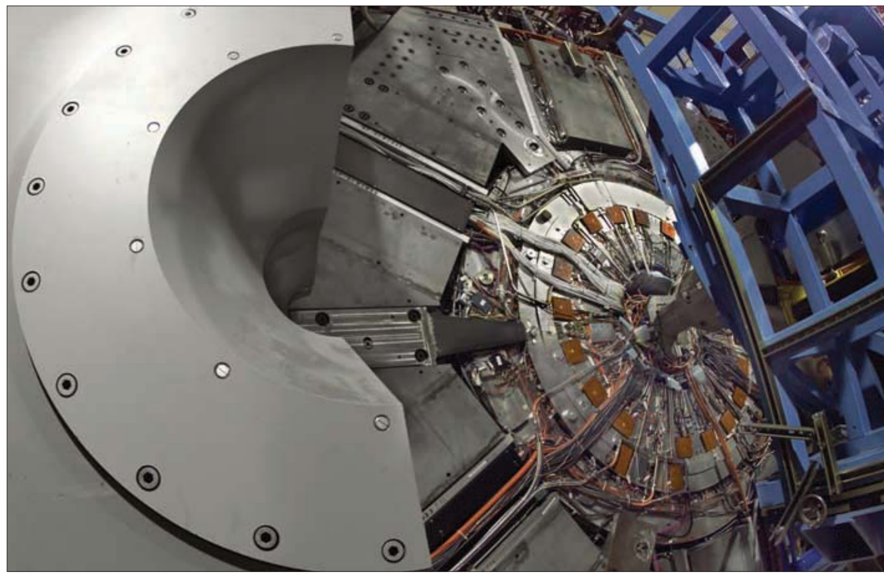
SLAC

BaBar Collaboration submits its 200th paper

A paper entitled "Measurement of $\bar{B}^0 \rightarrow D^{(*)0}\bar{K}^{(*)0}$ Branching Fractions" became the focus of celebrations in early April, as it became the 200th to be submitted for publication by the BaBar Collaboration. With this submission, BaBar can also look back on five years of broad-ranging, significant science publications.

On average, BaBar has published one paper a week since mid-2004 in *Physical Review Letters* or *Physical Review D*. Among the latest publications on the decays of the B mesons, the main purpose for building BaBar, are results from the study of the properties of the leptons in the $B \rightarrow X_s ll$ decays, which are highly sensitive to possible contributions from unseen physics processes; a search of CP violation with an unprecedented sensitivity of 0.3% in events where both the B mesons decay through semileptonic channels; and the most accurate single measurements of the side V_{ub} of the unitarity triangle.

The 200th paper describes a new approach to measuring accurately the angle γ in the unitarity triangle, one of three angles governing CP violation in B mesons (BaBar Collaboration 2006). Although the new approach does not appear to work as well as theorists expected, it illustrates the approach at BaBar of constantly trying to invent new methods and helps in understanding what may or may not be possible in similar studies at the Large Hadron Collider.



BaBar – a factory for more than B physics. (Courtesy Lawrence Berkeley National Laboratory.)

The wide breadth of physics addressed in BaBar's publications is equally impressive. The detector was built to study the decay of B-mesons, yet about 30% of BaBar papers focus on charm and tau particles – research for which the detector was not specifically designed, but at which it excels. The recent list of publications includes the observation of a new charmed baryon, the $\Lambda_c(2880)$, a detailed study of the decays of the recently discovered $D_{sJ}(2316)$ and $D_{sJ}(2460)$ mesons, the search for the lepton-flavour violating decay of the tau lepton into an electron and a photon, and the first observation of decays of the $\Upsilon(4S)$ mesons into other Υ mesons and two pions.

The researchers on BaBar look forward to many more publications in the future and appear on track to have submitted 250 papers by early 2007.

Further reading

BaBar Collaboration, B Aubert *et al.* 2006 http://arXiv.org/abs/hep-ex/0604016.

EXHIBITION

Paris hosts research and innovation expo

From 8–11 June, the 2nd European Research and Innovation Exhibition, being held at Porte de Versailles Exhibition Centre in Paris will open its doors to the public. Aimed both at professionals in research and industry and at the general public, including university and high-school students, the exhibition brings together the major European players in research and innovation. These include CERN, the Dapnia Laboratory of the Commissariat à l'Energie Atomique at Saclay, and the Institut National de Physique nucléaire et de physique des particules (IN2P3) of the Centre national de la recherche scientifique (CNRS).

The first exhibition, held in 2005, attracted 24 000 visitors (*CERN Courier* November 2005 p30). This year, to emphasize the international nature of the event, Germany is guest of honour, with participation by SIEMENS, one of the country's leading exponents of industrial innovation, along with the French–German Association for Sciences and Technology.

The widely varied programme of conferences and round tables allows visitors to familiarize themselves with the achievements and ambitions of research and innovation and their fundamental importance to the future of the European Community, both in the scientific field and research funding and applications. A Young Scientists' space also will also give exhibitors a chance to meet high-calibre young graduates who are seeking employment.

Presentations include a talk on on elementary particles by Christelle Roy from the CNRS Laboratoire de Physique Subatomique et des Technologies Associées (Subatech) in Nantes, and Michel Spiro, director of IN2P3 in Paris. The stands include an exhibit by CERN, highlighting aspects of technology transfer.

● For further information see www.european-research-exhibition.com/index.php.

FACILITIES

New centre to take control of J-PARC

The High-Energy Accelerator Research Organization, KEK, and the Japan Atomic Energy Agency (JAEA) have established the J-PARC Center to take entire responsibility for operating the Japan Proton Accelerator Complex (J-PARC), under construction in Tokai, Ibaraki. The centre's mission will be to operate and maintain the high-intensity proton-accelerator facilities at J-PARC, to pursue R&D for improving performance, and to support all J-PARC users and manage safety issues.

The construction of J-PARC, which started in the spring of 2001, is now in the busiest stage, with about two thirds of the facilities complete. Major components for the proton linac, which accelerates H^- beams up to 181 MeV, have been installed in the tunnel, and linac operation should start in December. Magnets for a 3-GeV rapid-cycling proton synchrotron, as well as for a 50-GeV proton synchrotron, are also being installed. The first beam from the 50 GeV synchrotron is expected in 2008.

A brass plate for the J-PARC Center, held by J-PARC director Shoji Nagamiya (centre), together with former KEK director-general Yoji Totsuka (right) and the executive vice-president of JAEA Toshio Okazaki.

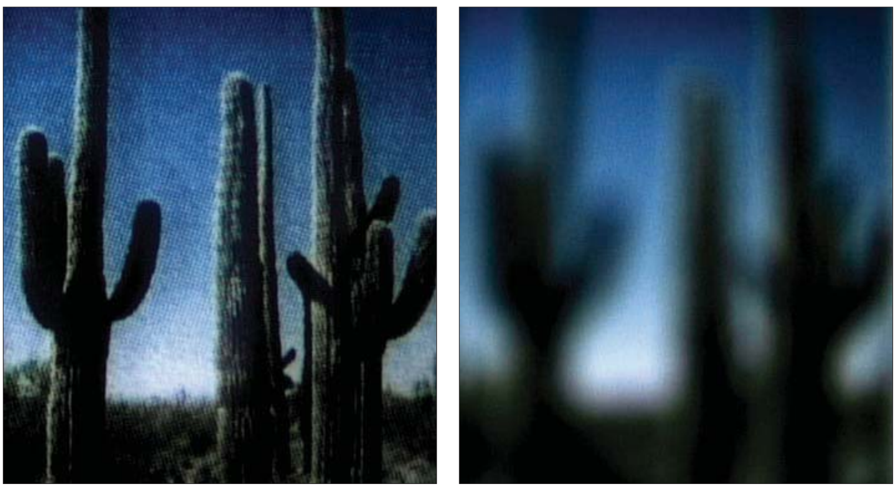
KEK and JAEA have jointly constructed J-PARC, with each organization taking entire responsibility for the items budgeted to it. However, for the operational stage KEK, and JAEA have recently established that J-PARC will be controlled and managed by a single organization, the J-PARC Center.

The J-PARC Center was established in February, ready for the start-up of the linac at the end of 2006, and has begun partial operation with 62 staff and J-PARC director, Shoji Nagamiya. There are three divisions at this stage, covering accelerators, safety and administration. The number of staff will increase to around 330 by 2008 in about 10 divisions.

Many places in Japan, including the central government, prefecture and local government, and other research organizations, have congratulated the J-PARC Center. In its meeting in February, the International Advisory Committee of J-PARC, chaired by J W White of Australian National University, stated: "We recommend that the vision of the J-PARC Center be that of a centre of excellence in quantum-beam science for a broad user community and an 'in house' scientific community of such quality as to achieve international respect for their science."

Compiled by Steve Reucroft and John Swain, Northeastern University

Liquid crystals could make bifocals a thing of the past



Left: A scene viewed with the new lenses switched on – to see a picture close up. Right: the scene with the lenses off – without power the picture blurs. (Courtesy UA optical sciences.)

As most people get older, they lose their ability to focus on close objects and many start to use glasses that have different focusing powers in different regions – bifocals and varifocals. Now a breakthrough from Guoqiang Li of the University of Arizona (UA) in Tucson and colleagues could make bifocals a thing of the past. The team reports a new form of diffractive lens based on a thin (5 μm) layer of fast-switching (less than 1 s) nematic liquid crystal.

The liquid-crystal layer is formed between two pieces of flat glass, each coated with indium tin oxide, which acts as a transparent electrode. A small applied voltage switches this layer between acting as normal glass (the upper part of most bifocals, used for viewing long distances) and as a lens for close-up work (like the lower part of most bifocals).

In the prototype the wearer has to switch between the two focusing regimes, but the researchers envisage automatic switching that works rather as in an auto-focusing camera. Future developments could also benefit anyone who has to wear glasses, whether young or old. Glasses with adjustable focusing power could be reprogrammed rather than replaced by an optician to match changing requirements, so that one pair of spectacles could last a lifetime.

Further reading

Guoqiang Li *et al.* 2006 *Proc. Natl. Acad. Sci.* **103** 6100.
www.pnas.org/cgi/reprint/0600850103v1.

Gentle droplets can create a big kick

There is some great physics in the simplest of systems. Even a falling drop of water can hold interesting surprises, as Denis Bartolo from the Ecole Normale Supérieure in Paris and colleagues have found.

A gently falling droplet striking a water-repellent surface can produce a jet that goes upwards at 40 times the impact speed. The large kick comes from two hydrodynamic instabilities associated with a trapped air cavity that forms when the drop hits. This is a nice example of how collective phenomena can give rise to large effective upconversions and perhaps suggests interesting applications.

Further reading

Denis Bartolo, Christophe Josserand, and Daniel Bonn 2006 *Phys. Rev. Letts.* **96** 124501.

Light rotation could be caused by axion

Researchers at the Italian National Institute of Nuclear Physics have observed the rotation of the polarization of light in a vacuum due to a transverse magnetic field. Emilio Zavattini and colleagues in the PVLAS Collaboration sent a linearly polarized laser beam through a 5 T field produced by a 1-m long superconducting dipole magnet and observed the polarization. Using light at a wavelength of 1064 nm, they made 44 000 passes, measuring an average rotation of $3.9\pm0.5\times10^{-12}$ rad for each pass.

Some rotation is predicted from quantum electrodynamics via an effective four-photon vertex. The result here, however, suggests additional, new physics, such as the presence of an axion coupling to the scalar product of electric and magnetic fields. Axions, which couple to two photons, are light, neutral bosons, originally hypothesized to explain the absence of CP violation in strong interactions. Further results are eagerly awaited.

Further reading

E Zavattini *et al.* 2006 *Phys. Rev. Letts.* **96** 110406.

Artificial muscles can run on fuel cells

Ray H Baughman of the University of Texas in Dallas and colleagues have demonstrated an effect that could change the way we think about designing robots and prosthetic limbs. The novel idea is to have a fuel cell in the artificial muscle itself as an integral part of its functioning. The artificial muscle converts the chemical energy of high-density fuels to mechanical energy without the need for batteries that must be electrically recharged.

The most striking of the new designs is based on shape-memory alloy and a platinum catalyst, and uses oxygen and either hydrogen or methanol. It provides a power density similar to that of natural skeletal muscle, but produces stresses a hundred times larger.

Further reading

Von Howard Ebron *et al.* 2006 *Science* **311** 1580.

ASTROWATCH

Compiled by Marc Türler, INTEGRAL Science Data Centre and Geneva Observatory

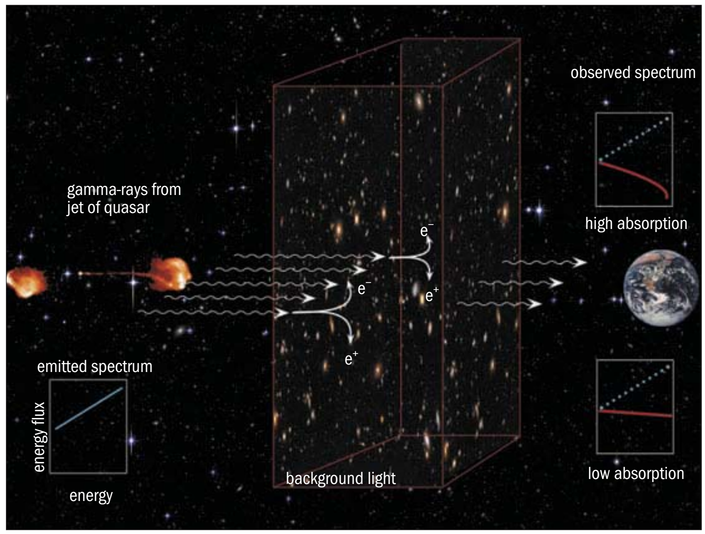
HESS helps lift the fog in intergalactic space

Observations of very high-energy gamma-rays from two distant active galaxies reveal that the universe is more transparent to this radiation than previously thought. This limited absorption of gamma-rays *en route* to Earth implies that the fog of light in intergalactic space is dominated by emissions from stars in galaxies that have already formed, rather than from the first generation of stars, which would have shone before galaxy formation.

Gamma-rays at tera-electron-volt energies can produce electron–positron pairs when they interact with visible light. These very high-energy gamma-rays can therefore be absorbed when travelling through intergalactic space filled with photons from the accumulated starlight emitted by galaxies throughout the history of the universe, as well as from other possible sources such as quasars and the very first generation of stars.

The direct detection of this extragalactic background light is made difficult because of our light-polluted environment, in particular by zodiacal light – sunlight reflected from dust clouds in our solar system. An indirect method consists of deriving this background radiation based on its opacity to tera-electron-volt gamma-rays. This can now be achieved for the first time thanks to the high sensitivity of the four Cherenkov telescopes of the High Energy Stereoscopic System (HESS) (*CERN Courier* January/February 2005 p30).

HESS has observed tera-electron-volt gamma-rays from two relatively distant active galaxies at redshifts of $z = 0.165$ and 0.186. These objects are most likely blazars, similar to Mkn 421 and Mkn 501, two nearby ($z \sim 0.03$) tera-electron-volt gamma-ray sources. The observed radiation of blazars is thought to be amplified and shifted towards higher energies because it is emitted in a relativistic jet towards us. Observations of blazars as well as theoretical shock-acceleration models in jets show that the gamma-ray spectral slope cannot be harder than $\Gamma = 1.5$. Using this property and the fact that the opacity through electron–positron pair production is energy dependent, the HESS collaboration has been able to set a firm upper limit on the absorption of gamma-ray photons and hence on the amount of extragalactic background light.



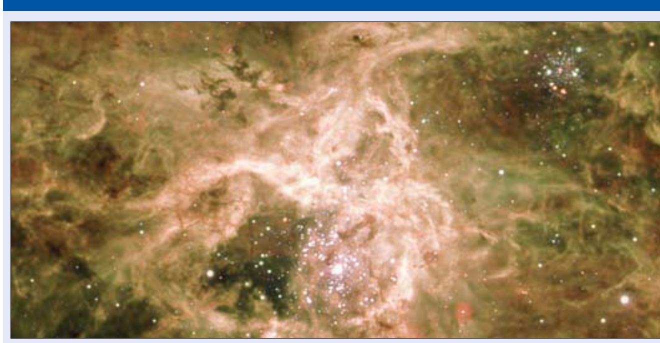
Schematic view of electron–positron (e^+e^-) pair production from the interaction of very high-energy gamma-rays with extragalactic background light. The effect of this absorption on the observed spectrum of a remote quasar is also shown. (Courtesy HESS Collaboration)

This limit is less than – and hence in conflict with – the values derived by direct measurements of the extragalactic background light. Furthermore, being only about a factor of 1.5 above the lower limit given by direct observation of galaxies by the Hubble Space Telescope, the HESS observations seriously limit the possible contribution from sources other than galaxies. This is in good agreement with recent theoretical calculations and arguments against a strong extragalactic background from first-generation stars. This is bad news for the attempts at direct detection of the glow of these population III stars (*CERN Courier* December 2005 p10), but the HESS results expand the horizon of the gamma-ray universe, allowing Cherenkov telescopes to detect many other remote active galaxies.

Further reading

F Aharonian *et al.* 2006 *Nature* **440** 1018.

Picture of the month



An impressive look inside the Tarantula Nebula hanging above the Large Magellanic Cloud, our neighbouring galaxy. This spider-shaped nebula is the largest in the sky. With a diameter of a thousand light years it is also among the largest known star-forming regions in our local group of galaxies. Its complex structure with two distinct star clusters and filaments of glowing gas is revealed in fascinating detail by the Very Large Telescope of the European Southern Observatory (ESO). The central cluster is the youngest and still contains many very massive stars. With masses several tens of times the mass of our Sun, these stars will die in the gigantic firework of a supernova within the next million years. (Courtesy ESO.)

CERN COURIER ARCHIVE: 1963

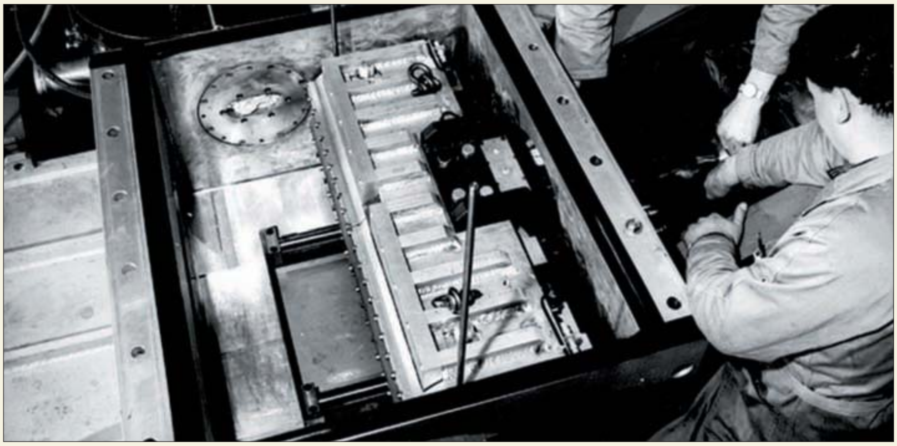
A look back to CERN Courier vol. 3, June 1963

ACCELERATORS

Fast ejection of protons from PS

May 1963 will be remembered in the history of CERN as the month in which, for the first time, protons with energies as high as 25 GeV were extracted as a focused beam from an accelerator, as this extract recalls.

Until recently, the only method of using the primary beam of the PS has been to scatter protons out of the machine. For instance, a thin foil may be pushed into the circulating beam and protons colliding with nuclei in the foil will be deviated. A few will proceed in the right direction to arrive in some experimenter's apparatus. Some protons are scattered with almost their original energy, but in most collisions secondary particles are produced [pions, kaons, neutrons, etc] and the energy of the protons is greatly diminished.



The kicker magnet from the first stage, installed in its vacuum tank (with cover removed).

As a result of the high energy of the incident protons, the greatest number of secondary particles is produced within a few degrees of the direction in which the protons are travelling and in which most of the components of the accelerator are located. Thus, there is always the difficulty of obtaining a good compromise between the obstruction presented by the PS itself and the fact that relatively few particles are produced at large angles. If the proton beam can be guided out of the machine to interact with an external target, many of the difficulties vanish, and for experiments requiring intense secondary beams the advantages can be spectacular.

The proton beam inside the synchrotron is divided into 20 bunches. Each bunch takes about 6 ns to pass a given point, with about 100 ns between the different bunches.

Suppose somewhere along the orbit of the circulating protons a magnetic field can be made to appear in the time between two successive bunches, sufficiently strong that it would deviate the bunches passing through it so much that they left the machine completely. To achieve such a powerful magnetic field switched on in such a short time is beyond present techniques. However, by working in two stages the technical difficulties have been spread and the construction of each has become possible, though still difficult.

In the first stage, a kicker magnet creates a magnetic field that changes from no field to full field in less than 95 ns, such that after the undisturbed passage of a certain bunch its successor can be deflected sufficiently to enter a second magnetic field, that of a bending magnet or, more correctly, a fast-ejection magnet. This second field is sufficiently powerful to direct the bunches completely out of the accelerator and can be far enough away from the normal orbit of the protons to be left on most of the time.

Already the extracted proton beam is being utilized to produce the most intense beam of muon neutrinos ever obtained, opening the way to a new step forward in our knowledge of the constitution of matter.

● Assembled from a tutorial-style article by C A Ramm and other members of the Nuclear Physics Apparatus Division (pp79–82).

LAST MONTH AT CERN

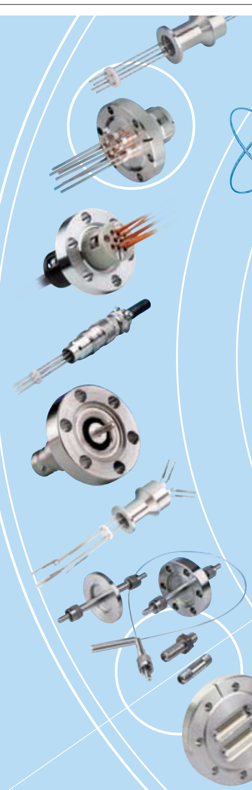
Experiment at PS measures strange particle parities

The results of an important CERN experiment on the properties of so-called strange particles were published in *Physical Review Letters* on 1 May. They concern the relative parity of the sigma and the lambda. Parity is a concept of the wave nature of all elementary particles; it is said to be even (plus) if the wave function calculated for the mirror image of a particle is identical to that of the particle itself, and odd (minus) if one wave function has a positive value and the other an equal negative one. Naturally parity is involved in any theory of sub-nuclear particles, and in some cases different theories predict different values. According to the global-symmetry model, the sigma and lambda should have the same parity, while some other models predicted that one should be opposite to the other. Combining the results of several experiments at the Lawrence Radiation Laboratory, Berkeley, the former prediction seemed more likely but the CERN experiment is the first to prove it.

About a million negative K-mesons in the PS k_3 beam were brought to rest in the Saclay/Ecole Polytechnique 81-cm liquid-hydrogen bubble chamber, and there they reacted with protons to produce neutral sigma hyperons. Many of these decayed into a lambda hyperon and a pair of electrons (one positive, one negative). Measurements on the electron tracks showed that the sigma and lambda have the same parity.

The measurements and calculations on the bubble-chamber pictures were carried out at CERN, the University of Maryland and the US Naval Research Laboratory, Washington, DC.

● Extracted from p78 and p82.



Compiled by Hannelore Hämmerle and Nicole Crémel

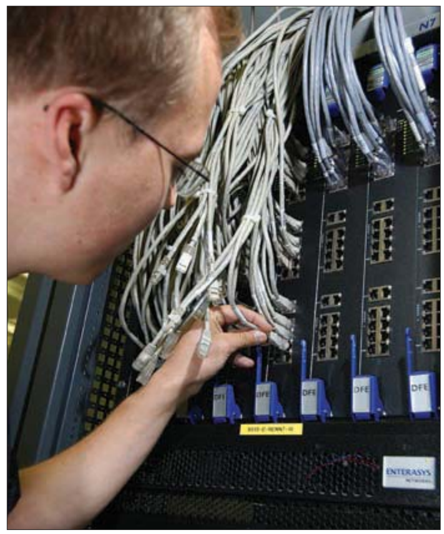
COLLABORATION

Second phase of openlab begins

The second phase of the CERN openlab was officially launched with a ceremony at CERN on 17 May. The industry partners in the second phase are HP, Intel and Oracle. It will build on experience from the first three-year phase, during which time the partnership between CERN and leading IT companies produced many excellent technical results.

The flagship project of the first phase of openlab was the CERN opencluster, an advanced computing and storage cluster, which contributed to several landmark results in CERN's Grid and high-speed networking activities. The partners during the first phase were Enterasys, HP, IBM, Intel and Oracle. The opencluster results showed that CERN openlab is a novel and effective framework for collaboration between multiple industry partners, in a pre-competitive spirit and based on open standards. Activities for the start-up of the second phase of CERN openlab are based around a platform competence centre, a Grid interoperability centre and IT security activities.

The Platform Competence Centre focuses on platform virtualization, as well as software and hardware optimization. Platform virtualization enables Grid applications to benefit from a highly secure and standardized environment presented by a virtual-machine hypervisor, independent of all the hardware intricacies. Software and hardware optimization is a vital part of the deployment of the Large Hadron Collider Computing Grid, as the demand for resources by researchers is likely to outstrip available resources, even inside the Grid.



Jarno Laitinen, a CERN openlab student, checks the routers for the CERN opencluster.

The Grid Interoperability Centre is proposed as a reinforcement of the second phase of the Enabling Grids for E-science (EGEE) project led by CERN, allowing the CERN openlab partners to take part in integrating and certificating Grid middleware. The project will focus on three activities: testing and certification of the EGEE middleware stacks on testbeds provided by the partners; support, analysis, debugging and problem resolution to deal with the problems encountered on the contributed testbed; and interoperability efforts that review current levels of Grid interoperability, also with middleware stacks proposed by the partners.

In addition to these centres, CERN openlab has launched an initiative in computer security. Initially, the bulk of this effort will be in malware protection, anti-spyware, intrusion detection and intrusion prevention, with a particular focus on client security and mail-server security. The Finnish companies F-Secure and Stonesoft will join CERN openlab as contributors, a status created to allow smaller IT companies to participate on targeted topics for a shorter period. The Helsinki Institute of Physics was instrumental in setting up these activities.

SIMULATION STUDIES

KEK installs Japan's fastest simulation supercomputer

The High Energy Accelerator Research Organization, KEK, in Japan has installed a new supercomputer system for simulation studies of high-energy accelerator science, including elementary-particle physics and nuclear physics. The new supercomputer system, which started up on 1 March, consists of the Hitachi SR11000 model K1 with a peak performance of 2.15×10^{12} floating point operations a second (2.15 Tflops) and the IBM Blue Gene Solution with a peak performance of 57.3 TFlops. At the time of installation, this system constituted the highest computing power in Japan.

The supercomputer is used mainly for the lattice simulation of quantum chromodynamics (QCD), the fundamental theory of strong interactions. By simulating QCD on a computer, the researchers expect to develop their understanding of the masses and reactions of particles such as protons, neutrons and mesons (*CERN Courier* June 2004 p23). The supercomputer system at KEK is shared with researchers from other Japanese laboratories and universities working on particle- and nuclear-physics simulations, as well as those working on the accelerator facilities at KEK.

Les gros titres de l'actualité informatique

EVENTS

EGEE forum unites Grid users

One of the plenary sessions in full swing at the first EGEE User Forum, held at CERN in March.

The first User Forum of the Enabling Grids for E-science (EGEE) project took place on 1–3 March at CERN. The event allowed members of the expanding community of Grid users to meet to compare experiences and strengthen ties, and it enabled leaders of the EGEE project to update users on the status and recent developments within the project and the infrastructure.

More than 90 abstracts from new and established applications were considered for presentation and the some 250 attendees considerably surpassed the target of 150. The abstracts submitted showed the variety of Grid applications, from the more standard in biology and high-energy physics, for example, to others in more unusual fields, such as online gaming and archaeology.

Scientists at the meeting shared their research results and plans through presentations and posters. Protein sequencing, medical imaging, fusion-energy research, gamma-ray astronomy, climate modelling, earthquake simulations and quantum chemistry were just a few of the applications discussed. Digital radio broadcasting and financial modelling, as well as research from outside Europe, such as Taiwan's National Digital Archive Project, were also highlighted.

The forum mixed plenary sessions, describing the EGEE infrastructure and the achievements of several application communities, with two afternoons of parallel sessions. The first set of parallel sessions was organized around application domains, the second was thematic with presentations grouped by different issues in Grid computing.

This User Forum was the first in a series, with the next event planed for spring 2007. The next major EGEE event will be the EGEE'06 conference on 25–29 September in Geneva.

● The full programme and all presentations of the User Forum are available online, together with a booklet containing all 90 abstracts submitted to the event. For details see http://indico.cern.ch/conferenceTimeTable.py?confId=286.

PRODUCT INFORMATION

Stylus Studio, the industry-leading provider of XML development tools and components for advanced data integration, has announced the availability of **Stylus Studio 2006 Release 2 XML Enterprise Edition**. The new release provides powerful new XML tools and utilities to simplify the XML data-integration tasks faced by developers. The significant performance and extensibility enhancements to XML-deployment adapter technologies provide a compelling, standards-based solution for working with heterogeneous data sources. For a free trial download go to www.stylusstudio.com/xml_download.html.

CNL ARCHIVE

CNL is 40 years old

After CERN's 50th anniversary in 2004, this year there is another (admittedly smaller) anniversary: the first *CERN Computer Newsletter (CNL)* was circulated in 1966. As *CNL* celebrates its 40th year, we will take a look back at some of the highlights – and historical curiosities – of the early years of computing at CERN, seen through its pages. You will find a brief look at previous issues of the *CNL* here; for an extended retrospection read the *CNL*, which is also available online from www.cerncourier.com.

WARNING: Future electronic-mail address change for CERN
In order to conform to new *de facto* standards, and to prepare for transition to international standards, we are planning to introduce new electronic mail addresses for CERN users, namely user@host.CERN.CH or, for users of VMS Mail, user@host.decnet.CERN.CH [...] (currently addresses are user@host.CERN or user@host.DECNET.CERN). (*CNL* 193 Sept–Dec 1988.)

View of part of the Computer Centre in 1988. The CRAY X-MP/48 supercomputer can be seen in the background against the rear wall.

Computerized foolishness
An electronic-mail chain letter has recently been intercepted at CERN. Not only is such foolishness a waste of time and money (yes, electronic mail has to be paid for!), but also the superstitious nonsense in chain letters about "bad luck if you break the chain" might actually worry some people. If you receive such a letter, please have the common sense to break the chain and send an appropriate comment to the person who wasted your time by sending it. (*CNL* 188 March–May 1987.)

Removal of central card punching and card-reading services
The last central card punch and card reader, presently connected to the CDC 835, will not be available after the Christmas–New Year shutdown. (*CNL* 171, Nov–Dec 1983.)

CRAY introduction
At the June meeting of the Finance Committee, the acquisition of a CRAY X/MP-48 computer was agreed, for installation in October 1987. The system has 4 processors with a basic clock period of 9.5 ns, 8 million 64-bit words of bipolar main memory organized in 32 banks with a 38 ns cycle time, and 128 million 64-bit words of secondary memory. (*CNL* 185 May–Sept 1986.)

STORAGE MEDIA

Brookhaven creates magnetic nano-dots

An individual magnetic element showing local magnetization under an applied field via magnetic phase imaging and various reconstruction methods. From left to right: Lorentz contrast; phase image; phase contours; colour vector map; and section of colour vector map showing cross-tie structure. (Courtesy Yimei Zhu, Brookhaven National Laboratory.)

Researchers from the US Department of Energy's Brookhaven National Laboratory presented new work assessing the properties of materials that may lead to magneto-electronic devices on the scale of billionths of a metre at the March American Physical Society meeting in Baltimore, Maryland.

Yimei Zhu and his group at Brookhaven have fabricated patterned magnetic films by depositing magnetic materials such as Permalloy and cobalt in patterns of dots, squares or ellipses across a surface of nonmagnetic substrates such as carbon or silicon nitride. With each dot measuring about 100 nm across, these materials could serve as building blocks for new nanoscale magneto-electronic devices and data-storage media.

Using a state-of-the-art, field-emission transmission electron microscope equipped with a custom-made objective lens, the group can probe the magnetic properties (including spin orientation) of each dot, and map how the spins flip in response to an external magnetic field – or other variables such as temperature, environment and crystal defects. The technique uses an extremely coherent source of electrons to produce high-resolution images of unprecedented quality in which the amplitude and direction of local magnetization can clearly be seen.

HIGH-SPEED LINKS

Fibre-optic network sets world record

In March, scientists from a MultiTeraNet project, funded by the German Federal Ministry of Education and Research, established a new world record with colleagues from Fujitsu. They transmitted data at 2.56 Tbit/s over 160 km – equivalent to 60 DVDs a second. The fastest high-speed links currently carry data at a maximum 40 Gbit/s, around 50 times slower. The Berlin-based group smashed the existing record of 1.28 Tbit/s, held by Japanese researchers, which had stood for five years.

To enable telecommunications networks to cope with the massive surge in data traffic from the Internet community, researchers are focusing on new systems to increase data transmission rates. In fibre-optic cables, data are transmitted using ultrashort pulses of light and are normally encoded by switching the laser on and off to represent binary data. The researchers have squeezed more data into each pulse by packing four, instead of the previous two, binary data states in a light pulse using phase modulation.

INNOVATION

New Braille keyboard extends independence

Researchers from the Universitat Autònoma de Barcelona (UAB) and Spain's Organization of the Blind (ONCE) have developed a Braille keyboard for PCs that provides more applications for blind people and is particularly useful for scientific texts and musical scores. Until now, this kind of task required assistance from a sighted person.

The new keyboard connects to the PC through the USB port. It will make using a computer much easier for blind people who are accustomed to using Braille typewriters because this is the first Braille keyboard to combine the function and movement keys of a conventional keyboard with eight Braille keys that allow the user to write in any language. Users can also select between a cumulative and a corrective writing mode. In the cumulative mode, the dots of a Braille symbol are indicated by pressing the keys one after another; in the corrective mode, this is done by pressing the necessary keys simultaneously.

UAB professor Jordi Roig with the new Braille keyboard developed in Spain.

The new Braille keyboard has eight Braille keys, which allow typing in any language.

The project, proposed by ONCE, began in March 2004 and was coordinated by UAB Department of Microelectronics and Electronic Systems researcher Jordi Roig, who has been visually impaired for three years and is a member of ONCE. Teachers from the UAB School of Engineering and the UAB School of Computer Science in Sabadell participated in the research. The group is currently working on other projects that will enable blind people to work autonomously with technological applications. These projects include developing an automatic conversion tool for websites that are not currently accessible to blind people and creating touchable screens that raise the information so that it can be felt.

Calendar of events

June

18–21 PARA'06
Umeå, Sweden,
www.hpc2n.umu.se/para06/

19–23 15th IEEE Symposium on High-Performance Distributed Computing (HPDC-15)
Paris, France, www.hpdc.org/

27–30 21st International Supercomputer Conference (ISC2006)
Dresden, Germany, www.supercomp.de/

July

3–5 EuroPython conference
CERN, www.europython.org

4–7 26th International Conference on Distributed Computing Systems (ICDCS 2006)
Lisbon, Portugal,
http://icdcs2006.di.fc.ul.pt/

10–12 VECPAR'06: High Performance Computing for Computational Science
Rio de Janiero, Brazil,
http://vecpar.fe.up.pt/2006/

15–19 2nd Euroscience Open Forum (ESOF2006)
Munich, Germany, www.esof2006.org

16–18 GRIDNS 2006
Silicon Valley, California, US,
www.iaria.org/conferences/ICNS06.html

17–21 22nd Asia–Pacific Advanced Network (APAN) meeting
National University of Singapore, Singapore,
www.apan.net/meetings/future.htm

August

1–4 IFIP International Conference on Embedded And Ubiquitous Computing (EUC'2006)
Seoul, Korea, http://.euc06.euc-conference.org/

29–1 September European Conference on Parallel Computing (Euro-Par 2006)
Dresden, Germany, www.europar2006.de/

September

13–15 HPCC-06
Munich, Germany,
http://hpcc06.lrr.in.tum.de/

25–29 EGEE'06
Geneva, Switzerland,
www.eu-egee.org/egee06

25–28 Cluster 2006
Barcelona, Spain, http://cluster2006.org

28–29 The 7th IEEE/ACM International Conference on Grid Computing (Grid 2006)
Barcelona, Spain, www.grid2006.org

December

4–6 e-Science 2006
Amsterdam, Netherlands,
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ADVERTISING FEATURE

Intelligent networking – a vital part of today's IT infrastructure

By Wenceslao Lada
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Whether you consider a computer in its traditional sense to be a means of calculating large numbers quickly or your understanding is closer to the French word for a computer – ordinateur – which implies a tool for organising and managing work, it is clear in this day and age, such a device has a limited use unless connected to other computers via a reliable and intelligent network.

This is as true for a nuclear research establishment as it is for a commercial office although the amount of computing power available to each may be vastly different. Each organisation needs its employees to be able to communicate quickly and easily with each other and the outside world; it needs to be able to add and remove users from the network with the minimum of fuss and effort, and it needs to be able to guarantee its security and integrity.

As a key supplier of networking equipment to CERN, ProCurve Networking by HP has had to ensure that the networks we supply are able to deliver on all the requirements of a world-class organisation. That we are able to do so owes a lot to our own commitment to research and development and careful attention to the most important part of a modern network – the ability to manage it so that control is firmly in the hands of management but the ability of the individual users to operate it is not impaired.

This conundrum is not as easy to solve as it may appear. Traditionally, network security could be realised quite simply by concentrating all decision making in the hands of those controlling the central core of the network and imposing great restrictions on access, bandwidth and flexibility to users throughout the organisation.

An alternative, to have loose central control and devolve responsibility for access control, security and bandwidth control to departments at the edge of the network gave great freedom to users but left the way open for all manner of abuse – ranging from unauthorised access to company data to inefficient use of network infrastructure.

Adaptive EDGE Architecture™

ProCurve Networking by HP has met this challenge with a strategy we call the Adaptive EDGE Architecture™ or AEA. This underpins our whole product design and the intention is to allow control of policies regarding security and resource allocation to be decided upon at the centre of the network while allowing implementation to be pushed out to PC users at the edge. To do this we have had to build in significant intelligence to all our products ranging from the large complex switches and routers which sit in the centre of the network to intelligent switches which are to be found at the edge.

All ProCurve's networking products and solutions are based on proven open industry standards such as Ethernet switching, 802.11 wireless networking and other open standards for delivering power to network devices via the network connection itself, the so-called Power over Ethernet standard. Adhering to open industry standards means we are able to offer our customers best in class value as well as maximum choice and flexibility.

Furthermore, the majority of ProCurve Networking products and solutions are based on our own custom designed ASICs (application specific integrated circuits) which capture our design expertise in mass-produced silicon chips. By cutting down the number of components needed, these ASICs allow us to offer life-time guarantees on many of our products and to offer free software upgrades to enable our installed base of equipment to take advantage of new networking protocols as they become available.

Today's networks are no longer just about connecting computers in a server room to computers on a desktop. As employees become more mobile, they want to access their corporate networks from notebook computers, PDAs or even the latest generation of mobile phone. They will be calling in from wherever they happen to be, which may be from a hotel room, an airport or an Internet café. The modern network has to be able to handle these requests from a variety of media and to respond without sacrificing ease of use or security.

As such, the need to devise policies centrally is as important as ever, so that standard operating procedures can be developed and maintained, but the necessity to devolve the implementation of such policies to the edge of a network is also vital. Otherwise, traffic to the centre would become so congested as to be unworkable and the likelihood of employees attempting to circumvent such policies would increase. Far better for employees to have a workable system that they can trust than to have a well-meaning but autocratic and totally unworkable system that they will lose faith in.

ProCurve Networking by HP has over 25 years experience in the networking industry and has been responsible for many innovations. Its customers include some of the world's leading companies such as SAP, Hilton Hotels and Kodak. Its products are also used in leading universities and research establishments throughout Europe including Sahlgrenska in Sweden, the British Library and the University of York in the UK.

Further information on ProCurve Networking solutions and products is available at: www.hp.com/eur/procurve

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Computing conference in India gets ready for LHC

Sunanda Banerjee reports from the CHEP06 conference held this year in Mumbai, India.

Computing in High Energy and Nuclear Physics (CHEP) is a major series of conferences that has been held at roughly 18-month intervals since 1985, alternating between Europe, North America and other parts of the world. The Tata Institute of Fundamental Research (TIFR), Mumbai, India, organized the 15th in the series, CHEP06, on 13–17 February. The main theme of the conference was to review progress in making the Grid a powerful and reliable computing resource in time to process data from the Large Hadron Collider (LHC). This was the reason for a three-day workshop on the 4th Service Challenge in the Worldwide LHC Computing Grid (WLCG) that preceded the conference. The conference also aimed to learn from the experience of experiments that are currently running, to stay in touch with Grid applications in other sciences and to look to the future.

The conference opened with a note that this may be the last conference in this series before LHC start-up. Consequently the emphasis on the readiness of the LHC accelerator, experiments and computing services was of major interest. In the opening talk Jos Engelen, chief scientific officer at CERN, confirmed that the LHC project, the machine, detectors, and the WLCG are well underway for physics in 2007. Schedules are tight, but not impossible to meet. There is a large potential for exciting physics.

The presence of the President of India, A P J Abdul Kalam (left), showed the importance of high-level IT services for India and proved to be a main attraction at this year's CHEP conference.

Grid computing

Jamie Shiers of CERN elaborated on the readiness of the LHC computing facilities. There has been excellent progress on the three key areas addressed by the WLCG, namely data-transfer tests, service availability and time to resolve problems, and provisioning of resources. A clear plan has been established for the remaining work that is needed to meet the computing challenges of the LHC, and success can be achieved through a pragmatic, focused and co-operative approach.

Focusing on WLCG services, Les Robertson of CERN explained where expectations have been fulfilled and where more efforts are needed to be ready for the first LHC beams. Two Grid infrastructures, LCG and the Open Science Grid (OSG), are now in operation for the computing services for the LHC and the main priority is to set up a reliable operation of baseline services. Ruth Pordes from OSG emphasized the interoperability aspects of different Grids in view of the various Grid infrastructures that exist around the world today, and the many ongoing efforts in this field.

Kenichi Miura of the National Institute of Informatics in Japan and Gang Chen of the Institute of High Energy Physics in Beijing presented Grid activities in Japan and China. The primary objective of the National Research Grid Initiative project in Japan is a seamless federation of heterogeneous resources. It started with computations in nano-science and Grid technology and expanded its scope to high-energy physics, astronomy and biology. The Grid activities in China encompass a variety of disciplines from high-energy physics and bioinformatics to environmental science, material science, computational chemistry and others, which are driven by experiences from LCG. Grid activities in the Asia Pacific Federation span many fields, from high-energy physics and atmospheric science to nano- ▷

Anil Kakodkar, secretary to the Department of Atomic Energy in India, spoke about the importance of CERN–India collaboration in the LCG project at the opening session of the conference.

and biomedical applications, as pointed out by Simon Lin from Academica Sinica in Taipei.

Piergiorgio Cerello of the Istituto Nazionale di Fisica Nucleare showed the role of the Grid in medical applications, and Rajiv Gavai of TIFR, addressed computing challenges in lattice quantum chromodynamics. Mathai Joseph of the Tata Research Development & Design Centre, elaborated on the software development process and computing challenges for astronomy experiments, such as the Square Kilometre Array.

Software and data taking

Paris Sphicas of CERN focused on the start-up of LHC data taking and the state of readiness of the software for LHC experiments. Most of the common software is in place and much of the experiment-specific software is either complete or has a fully functional prototype. Important tests such as calibration or Grid utilization are underway, deployment has begun in earnest and performance studies are in progress. There is still a long way to go to get some of the complicated analyses carried out, but all of the experiments are approaching that goal.

Rene Brun of CERN presented the successful ROOT project, an object-oriented framework for large-scale data analysis, in particular its adaptation in the era of the multi-core CPU. Instead of pushing gigabytes of source or shared libraries to Grid working nodes, he proposed a pull technique, where only the software necessary to run an application is downloaded in an incremental way. While the core ROOT software is being consolidated to be ready for LHC data taking, prototyping work is underway for the new concept.

Beat Jost of CERN discussed design criteria and the resulting architecture of future data-acquisition systems, which have to change owing to a move towards eliminating hardware triggers. For more flexible triggering and optimal efficiency, the readout will be at bunch- or train-crossing points at the detectors and data will be sent out to CPU farms for event selection.

The PHENIX experiment at the Relativistic Heavy Ion Collider at Brookhaven has data rates similar to the ones expected from the LHC. Martin Purschke of Brookhaven talked about the experiences from the experiment, which was originally designed for a data rate of 20 MB/s, but eventually operated 60 times faster. Data compression and buffering were key ingredients in dealing with these amounts of data. Peter Elmer of Princeton University discussed distributed data-management issues in high-energy physics experiments in general. Gaining from experience in the ongoing experiments, a great deal of effort is put into understanding the data access pattern in the next generation of LHC experiments. Elmer foresees much exciting work related to data management in the next 3–5 years.

Elizabeth Sexton-Kennedy of Fermilab talked about the social and technical challenges of the event-processing framework. She concluded that frameworks should be judged by how well they meet the technical challenges of complexity and scalability. In addition, frameworks provide a set of tools that organize a large group of developers into moving in the same direction.

Networking

Networks used by high-energy physics and other data-intensive sciences are advancing rapidly, as shown by Harvey Newman of CalTech. These fields are also learning to use long-range networks more effectively. Hybrid dark fibres are emerging as the means for rapidly increasing communication speed in many countries. He emphasized that it is now important to close the digital divide to allow scientists in all world regions to take part in discoveries. Focusing on connectivity issues in India, Ashok Jhunjhunwala of the Indian Institute of Technology, Madras, showed that Internet technology will have a huge impact on the lives of rural communities in developing countries if there is a big enough vision. In India, there should be 50 million broadband connections by 2010 and this will double the *per capita* GDP in rural India. Many innovations are needed to meet this effort and, in particular, the need for an uninterrupted power supply will cause a bottleneck.

Industrial contributions

There were several exciting presentations from IT industries from all over the world. Tony Hey of Microsoft talked about the capability to access, move, manipulate and mine data in collaborative science applications. He emphasized the continuing trend towards decentralized, networked resources and using the Internet and open access for promoting the global scientific knowledge base.

Alan Gara of the IBM T J Watson Research Center discussed the role of high-performance computing in a variety of physics applications. He also talked about scalability issues in supercomputing and emphasized that architectural innovation is critical to continuing performance scaling. David Axmark of MySQL AB explained how to make a scalable database system. In favour of free software, he spoke of software patents as a threat to software innovation. Free access to the source code means that the database system becomes more robust, as well as secured.

Google's approach to organizing the entire world's information and making it universally accessible and useful was explained by Lalitesh Kathragadda of Google India. He explained their in-house solution for data storage, for running jobs on pools of machines, and for simplifying large-scale data processing. Anirban Chakrabarti from Infosys

Participants at CHEP06 read one of the 144 posters displayed in the foyer of the Tata Institute of Fundamental Research.

Technologies, a leading software company in India, elaborated on various themes of Grid applications from middleware to specific applications where Infosys is focusing its current research activities.

Key attractions

A key attraction at the conference was the visit of A P J Abdul Kalam, the Indian president, who gave the valedictory address. He summarized the missions for CHEP06: computing in particle physics, space and particle research, and energy. He encouraged a collaboration between CERN and the Indian Department of Atomic Energy on Grid activities and emphasized that Grid activities should be enlarged to encompass the Knowledge Grid, the e-Governance Grid and the Health-Care Grid, and interconnect with the Providing Urban amenities in Rural Areas Grid that connects a billion people across India.

Another attraction of CHEP06 was the setting up of a 622 MB/s link to the US through Japan, over which several application jobs were demonstrated. This was achieved through a collaboration between CalTech, Internet-2, the World Bank and the Centre for Development of Advanced Computing (CDAC) in India. This effort drew the attention of the funding authorities of India who appreciated the role of the high-bandwidth network for research and education.

The final session of CHEP06 was a panel discussion to address the importance of bridging the digital divide between different countries. The panellists, S Ramakrishnan (CDAC, Pune), Harvey Newman (CalTech), Viatcheslav Ilin (Moscow State University), Alberto Santoro (Universidade do Estado do Rio de Janeiro) and A S Kolalskar (University of Pune), tried to formulate possible ways to address this problem for nations where low bandwidth connectivity still prevails.

Co-conveners Sunanda Banerjee and Atul Gurtu of TIFR concluded the conference by thanking the 478 participants, the more than 250 speakers and chairs in the plenary and the eight parallel sessions, the members of the International Advisory and Programme committees, as well as the funding agencies, sponsors and all those who worked hard to make the conference a success. The next conference in the series will be held in Victoria, Canada, in September 2007.

Events around CHEP06

The three-day pre-conference workshop on LCG service challenges, organized by Jamie Shiers of CERN, attracted 155 participants. It was devoted to the primary activities of the programme for the WLCG Service Challenge in the run-up to the full WLCG production service due to commence in October. The topics concerned were data and storage management, WLCG services in general and the experiments' computing models and plans to validate their offline frameworks using the WLCG services during 2006.

The workshop was highly interactive, with many profitable discussions and breakout sessions. The first day of the workshop was spent on storage management, focusing on questions of interoperability between different implementations of storage resource managers, as well as deployment issues. Key issues that were discussed during the second day were the service-level targets defined in the WLCG Memorandum of Understanding, how they could be met and how they would be measured. The third day was spent discussing the impact of the computing models of the different LHC experiments on the service requirements at a multi-disciplinary Tier-1 or Tier-2 site.

In the two days before the conference, François Fluckiger of CERN organized a tutorial programme with six lecture series on the fundamentals of Grid technology, cryptography and security protocols, fundamentals of quality of service in networking, security from theory to implementation, pragmatic software engineering and databases. The 55 participants found the experience extremely positive.

A one-day workshop, organized jointly by TIFR and CDAC, followed the conference and focused on ways to improve connectivity issues in India. Delegates from the Knowledge Commission in India and the government ministries on information technology attended the workshop. Internet-2, CDAC and the Education and Research Network signed a Memorandum of Understanding to promote high-bandwidth connectivity in India.

Further reading

For further information see www.tifr.res.in/~chep06/.

Résumé

Conférence sur l'informatique à Mumbai

Entre le 13 et le 17 février s'est tenue à l'Institut Tata de recherche fondamentale la conférence CHEP06, consacrée à l'informatique en physique nucléaire et des hautes énergies. Elle a fait le point sur l'avancement de la Grille de calcul, une ressource informatique puissante et fiable qui devra être prête à temps pour traiter les données du Grand collisionneur de hadrons (LHC). La conférence visait également à tirer les enseignements des expériences en cours, à suivre les évolutions des applications de grilles dans d'autres domaines scientifiques et à se tourner vers l'avenir. Elle a été précédée d'un atelier de trois jours sur le quatrième essai d'exploitation de la Grille mondiale de calcul du LHC (WLCG).

Sunanda Banerjee, *TIFR.*

ENLIGHT++ extends cancer therapy research network

The preparatory meeting of the ENLIGHT++ network was held at CERN in March, bringing together Europe's leading players in the emerging field of light-ion therapy.

Many concepts and developments from particle physics find applications in health care. High-performance detectors, accelerators and beam technologies are essential for particle physicists to complete their quests. These developments also benefit society by providing better diagnostic tools and tailored radiation treatment of cancer and other diseases. One of the most promising fields in this respect is hadron therapy.

On 24 March more than 100 scientists – including clinicians, oncologists, physicists, radiobiologists, information and communication technology experts and engineers – from about 20 European countries arrived at CERN for the preparatory meeting of the second European Network for Research in Light-Ion Hadron Therapy (ENLIGHT++). This one-day workshop aimed at coordinating European efforts using light-ion beams for cancer therapy. The two plus signs in ENLIGHT++ refer to more countries and more hadrons (specifically protons), and emphasize these extensions to the previous project, which carried the same name (*CERN Courier* October 2005 p31).

ENLIGHT, which had its inaugural meeting at CERN in February 2002, was established to coordinate a pan-European effort with a common multidisciplinary platform for using light-ion beams for radiation therapy. It has been instrumental in promoting the advantages of using hadrons, particularly carbon ions. A collaboration of scientists from various European centres and institutions formed the original network, which the European Commission funded for three years. In these centres resides the core expertise in the physics and engineering of accelerators and detectors, which can be used towards the design, advancement and realization of new hadron-therapy machines and other equipment to benefit health.

The importance of hadrons

There are many instances of tumours located near critical organs for which conventional radiation therapy with X-rays is inappropriate. In these cases successful tumour control often means that the dose delivered must reach such a high level that it can damage the surrounding critical organs. For this reason, hadrons – protons or light ions – are more appropriate for radiotherapy of deep-seated tumours. These particles penetrate the patient with practically no diffusion and can easily be formed into narrow "pencil" beams; most importantly, they have a well-defined variable penetration depth, delivering most of their dose at the end of their range in matter. Because of these properties, hadron beams allow highly conformal treatment that follows the shape of the deep-seated tumours with millimetre accuracy, while delivering only very small doses in the surrounding area, hence sparing the healthy tissues.

Ugo Amaldi addresses the preparatory ENLIGHT++ meeting .

The idea of hadron therapy dates back to 1946, when Robert Wilson, physicist and founder of Fermilab, was the first to propose using hadrons for cancer treatment; almost 10 years later, 30 patients were treated with protons at the Lawrence Berkeley Laboratory (LBL). In the late 1960s, pioneering studies were carried out at CERN and, in the early 1990s, Ugo Amaldi at CERN vigorously promoted the development of new proton-ion accelerators. In 1999, CERN, the Gesellschaft für Schwerionenforschung (GSI) in Germany, Med-Austron in Austria, Onkologie 2000 in the Czech Republic and the Terapia con Radiazioni Adroniche (TERA) foundation in Italy realized the Proton-Ion Medical Machine Study (PIMMS) to design an ion synchrotron that is optimized for medical applications (*CERN Courier* September 1998 p20).

The success of therapy projects at nuclear-research centres, along with improved accelerator technology, dose delivery systems and dose calculations, has led to a number of dedicated proton-therapy facilities. These include the Loma Linda University Medical Center in California and the Northeast Proton Therapy Center in Massachusetts in the US, and the Kashiwa and Tsukuba centres in Japan. Proton-therapy facilities also exist in France, Germany, Italy, Russia, ▷

Sweden, Switzerland and the UK. In Switzerland, at the Paul Scherrer Institute (PSI), Europe's leading centre for treating deep-seated tumours with scanned proton beams, a new superconductive cyclotron has been built exclusively for proton therapy and related research. Since Wilson's initial proposal, about 45 000 patients have been treated with protons with excellent results for head and neck tumours.

Treatment of deep-seated tumours with light ions is less well established and it is this area that the ENLIGHT network targeted. About 10 years ago, radiobiologists and radiotherapists concluded that the optimal ions for therapy are found in the mass range between lithium and carbon. This was based on the results of the treatment of about 2000 patients in the US with helium ions between 1957 and 1987, and of about 400 patients with neon ions from 1975 until 1993, when LBL's accelerator was closed down.

Since then, clinical results have come from the Japanese Heavy-Ion Medical Accelerator Centre in Chiba and the GSI facility in Germany, where sophisticated raster scanning techniques, in conjunction with online real-time imaging by positron-emission tomography, are used for treatment with carbon-ion beams. The results obtained at these facilities agree with theoretical expectations, thus demonstrating that carbon-ion therapy is an important avenue to follow. Epidemiological data indicate that in Europe about 30 000 patients each year – affected by certain types of cancers, such as those of the pancreas, the saliva-producing parotid gland, uveal melanomas, chordomas and chondrosarcomas of the skull base – would benefit from treatment with ion beams.

The importance of ENLIGHT++

Jos Engelen, CERN's chief scientific officer, opened the ENLIGHT++ preparatory meeting. He noted that it was appropriate that the workshop took place at CERN as the laboratory has a task in stimulating the application of its technologies, for example, in hadron therapy. CERN has extensive knowledge and expertise in accelerators and related technologies, and indeed hosted and coordinated the PIMMS project.

Following Engelen's welcome, keynote presentations began with Jean-Pierre Gérard, director-general of Centre Antoine-Lacassagne and past chair of the European Society for Therapeutic Radiology and Oncology, who illustrated the compelling reasons why ion therapy is essential. He pointed out that ENLIGHT++ is a new step that should bring the use of carbon ions into an era of clinical reality.

Ugo Amaldi from the Università di Milano Bicocca and the TERA Foundation – who has promoted hadron therapy for many years – later underlined that, since the beginning of the previous ENLIGHT initiative, the Heidelberger Ionenstrahlen-Therapie facility in Germany and the Centro Nazionale di Adroterapia Oncologica in Italy have begun construction, while Med-Austron in Austria and the European Light Ion Oncological Treatment Centre in France have been approved. (Since the meeting, it has been announced that another facility for hadron therapy will be built in Germany. Hosted by the Marburg–Giessen Klinikum, it will use carbon ions and protons and will be functional in four years.)

Amaldi continued by adding that the hadron-therapy community needs to put in place two kinds of collaboration: the first to develop a common view on issues such as authorization protocols and patient selection, and the second, crucial for ENLIGHT++, to provide R&D involving European groups as a follow-up of ENLIGHT activities and new research initiatives. The community should identify and define the key areas in which further work is needed and obtain funding from the European Commission to carry out the necessary research.

Following the introductory talks, the participants split up into working groups to discuss such an aim. The groups then reported back and the meeting agreed that studies on clinical trials, radiobiology focused on treatment therapy, modalities to improve the delivery of the radiation dose, novel designs of detectors and equipment, and information sharing should all be pursued with the highest priority. Lastly, Manjit Dosanjh was chosen as official coordinator for the ENLIGHT++ initiative.

In summary, the main objective for ENLIGHT++ is to form a consensus from representatives of different disciplines and national programmes in a way that most benefits the patient. It is now agreed that this goal can be met by reinforcing the existing pan-European network, focusing on the areas of research needed for effective hadron-therapy centres, and establishing and implementing common protocols for treating patients.

Further reading

For more information see www.cern.ch/enlight.

Résumé

ENLIGHT++ étend le réseau de recherche sur le traitement du cancer par les ions légers

La réunion préparatoire du réseau ENLIGHT++ s'est tenue au CERN en mars, rassemblant les plus éminents chercheurs européens du domaine naissant de la thérapie par les ions légers. L'objectif du réseau est de coordonner les travaux menés dans ce domaine en Europe pour le traitement du cancer. Les deux signes "plus" symbolisent l'augmentation du nombre des pays participants et des hadrons (en particulier des protons) par rapport au projet ENLIGHT précédent. Fort des structures de traitement spécialisées déjà mises en place en Europe, ENLIGHT++ se concentre sur les recherches nécessaires à la création de centres de traitement hadronique efficaces et travaille à l'établissement et à la mise en œuvre de protocoles de traitement communs pour renforcer le réseau paneuropéen actuel.

Beatrice Bressan *and* **Manjit Dosanjh**, *CERN, and* **Giulio Magrin**, *TERA.*

Nobel inspiration: a p

Carolyn Lee talks to Theodor Hänsch, who shared the 2005 Nobel Prize in Physics

Theodor Wolfgang Hänsch's interest in science began when he was six years old and living in Heidelberg, Germany. He grew up on Bunsen Strasse and one day asked his father about the name of the street and what someone had to do to have a street named after him. His father had worked in a pharmacy during the First World War and knew about Robert Wilhelm Bunsen, his burners and chemistry. So Hänsch senior brought home a Bunsen burner and would sprinkle table salt into the blue flame to reveal the yellow colour of sodium. This experience ignited the interest of the younger Hänsch and led him to study light, atoms and chemicals.

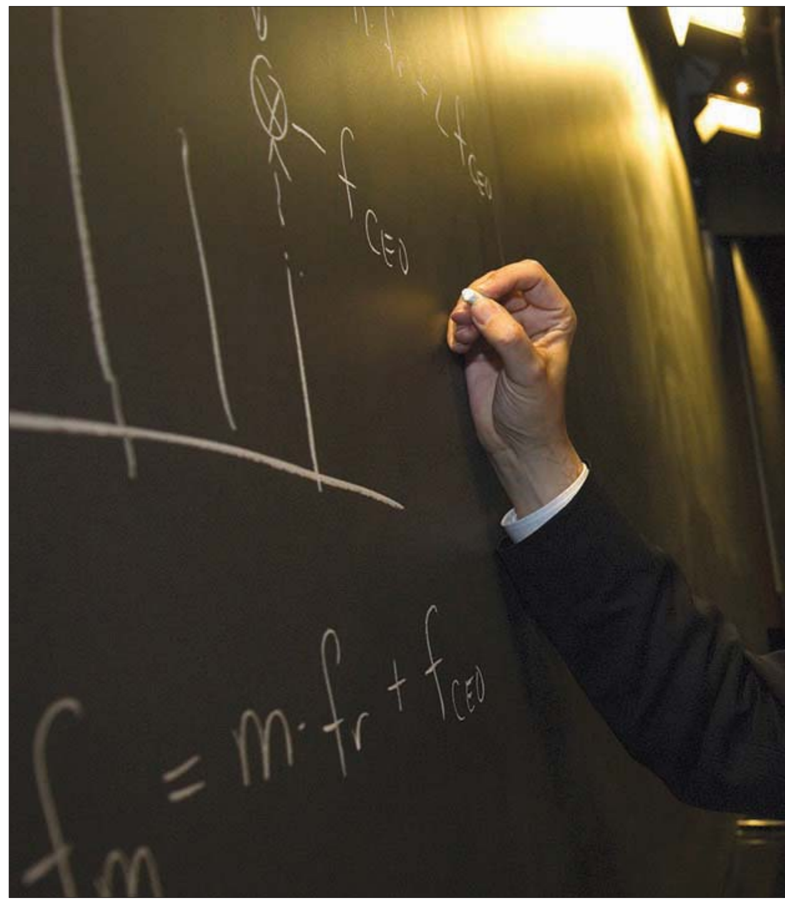
At Heidelberg he earned his doctorate from the Ruprecht Karl University in 1969. He then moved to research and teaching at Stanford University from 1975 to 1986, which was a very positive experience. "I enjoyed it right from the beginning because in Germany there were many obstacles to deal with, whereas in California administrative things seemed to be extremely easy and people were helpful," explained Hänsch. This was the first time he had been so far away from home, experiencing different teaching styles. In the US students would see a professor after class to discuss the lecture or assignments. However, in Germany there was more of a barrier between professor and students, as there were many more students to each professor.

It was while working at Stanford that Hänsch found his mentor, Arthur Schawlow, co-inventor of the laser and Stanford University professor, who received the Nobel Prize in Physics in 1981. Although he was widely recognized, Schawlow was an easy-going person who offered a great deal of good advice for young professors.

Hänsch followed his mentor's interest in lasers and in 1970, at the age of 28, he invented the high-spectral resolution laser. According to Hänsch, it was a simple invention that caused a great deal of excitement. This was the first laser for which the colour – wavelength – could be changed while keeping the light extremely monochromatic. This opened the door to new types of spectroscopy and greater precision in measuring frequencies, such as the transition frequency of the red Balmer line of atomic hydrogen.

A new era in laser spectroscopy began as the high-spectral resolution laser was quickly reproduced and used in laboratories around the world. Atoms and molecules are very particular about which wavelengths will excite them to higher energies. Therefore, it is necessary to use a laser that can produce the wavelength needed to excite them and to find out what that precise wavelength is.

Hänsch returned to Germany in 1986, where he became director of the Max-Planck-Institut für Quantenoptik and professor of experimental physics and laser spectroscopy at the Ludwig-Maximilians University in Munich. It was here that the challenge of finding out the particular wavelength that excited certain atoms or molecules led to Hänsch's second invention in the mid-1990s: the optical-frequency



Theodor Hänsch has pioneered precision laser spectroscopy; among other

comb generator. This invention allowed for extraordinary precision in measuring the Lyman line of atomic hydrogen, which made it possible to look for changes in the fundamental physical aspects of the universe. It was for this invention that Hänsch received his share of the Nobel Prize in Physics in 2005, the other recipients being Roy J Glauber, for his contribution to the quantum theory of optical coherence, and John L Hall, who also worked on the optical-frequency comb technique (*CERN Courier* November 2005 p8).

When asked if he was surprised to receive the Nobel prize, Hänsch explains that his friends had thought he had a good chance: "I think the year before [2004] there had been some game on the Internet where you could place bets on possible candidates, and I had come up pretty high at that time." So he began to believe he had a real chance, but he did not expect the prize to be given for work in optics so soon; in 1997 the Nobel Prize in Physics was awarded for laser cooling and in 2001 for the Bose–Einstein con-

passion for precision

cs for his contributions to the development of laser-based precision spectroscopy.

r work, he is now involved in studies of antihydrogen at CERN.

densation in dilute gases of alkali atoms.

A little-known aspect of Hänsch is his love of toys, and his own private little laboratory at the Ludwig-Maximilians University. "My students don't even have a key to it, so I can start an experiment, give a talk somewhere, and come back to find my experiment still there," he says. In his private laboratory Hänsch mostly works on ideas with light and is now working on how to deal with beam that is produced in a non-linear crystal, to find out its wavefronts and to correct it so that one can do meaningful experiments with it.

So what does Hänsch say to would-be Nobel laureates? His advice to young scientists is to find something that really interests you and is fun to work on. "Of course, no one can plan to win any prizes, but if you work hard at something that interests you, then every step along the way can lead to something new. One has to be prepared to put in long hours, but it makes the little triumphs extra sweet," he said.

A precision ruler for optical frequencies

The technique of the frequency comb uses a mode-locked laser to provide a train of very short pulses that last only a few femtoseconds. These pulses (created through interference between different frequency modes in the laser) naturally contain a range of evenly spaced frequencies, forming a frequency comb. This can be used to measure an unknown frequency with high precision, by observing which frequency in the comb is picked out by interference with the unknown frequency. In the mid-1990s Hänsch realized that suitable lasers were available to create an optical-frequency comb, which could be referenced to the frequency standard of a caesium atomic clock. Instruments based on the technique have since been developed both by Hänsch and his team, and by John Hall and colleagues at the University of Colorado and National Institute of Standards and Technology in Boulder.

Currently, Hänsch is also working with the ATRAP Collaboration at CERN, which is studying hydrogen and antihydrogen atoms. If it were possible to measure precisely up to 14 or 15 digits, then it might be possible to see whether matter and antimatter are the same or if they differ in some unexpected way. This could explain why there is more matter than antimatter in the universe. To explore these questions, researchers have to look where no-one has ever looked before, and for that reason, Hänsch has a passion for precision.

Résumé

Un passionné de la précision couronné par un prix Nobel

Theodor Hänsch, actuellement membre de la collaboration ATRAP du CERN, a été l'un des lauréats du prix Nobel de physique de 2005 pour sa contribution au développement de la spectroscopie laser de précision. Il évoque ici un épisode de son enfance qui a éveillé son intérêt pour la science ainsi que ses travaux révolutionnaires, aux États-Unis en tant que jeune chercheur, puis en Allemagne, son pays natal, comme professeur et maintenant directeur du Max-Planck-Institut für Quantenoptik. Selon ce "passionné de précision", pour explorer des questions fondamentales, les chercheurs doivent s'aventurer là où personne n'est encore allé. Et sa passion lui a valu le prix Nobel.

Carolyn Lee, *CERN, interviewed Theodor Hänsch when he visited CERN to give a colloquium "A passion for precision" on 6 April. For a video of the colloquium see http://agenda.cern.ch/fullAgenda.php?ida=a061226.*

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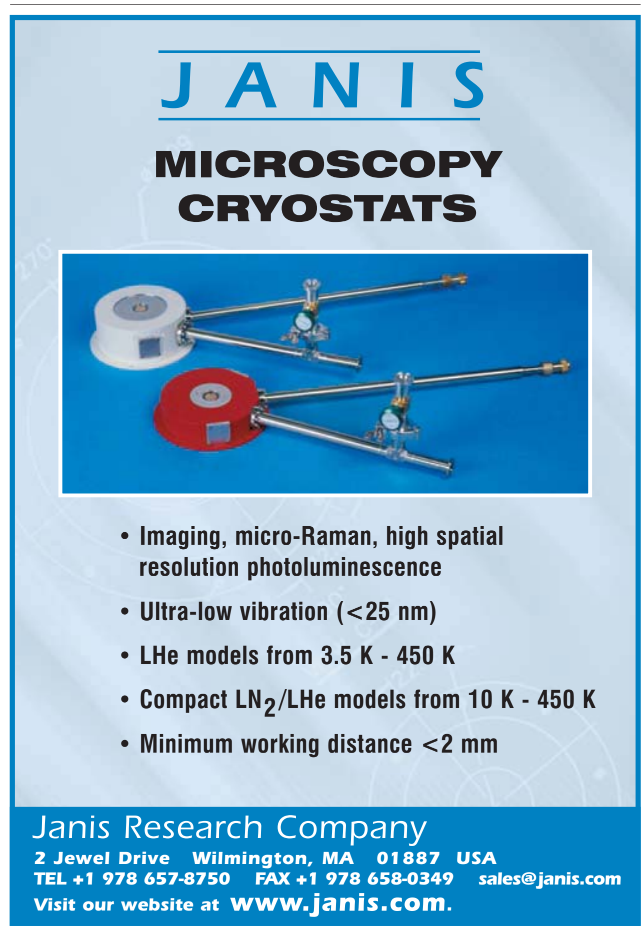

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CLEO cleans up below the charm threshold

The charmonium spectrum provides fertile ground for investigating the force that binds quarks together, and the CLEO detector is revealing some previously missing states, as **David Cassel** and **Jonathan Rosner** report.

It is slightly more than 30 years since the discovery of the J/ψ, the first bound state of a charmed quark, c, and its antiquark $\bar{c}$, near a mass of 3.1 GeV/c^2. This discovery ushered in the era of heavy-flavour physics, which now includes studies of the tau lepton and its neutrino, and the b and t quarks. As the mass of the charmed quark is quite large, the velocities of the c and $\bar{c}$ in a bound state are small enough that many important features of these states can be described using non-relativistic potential models. Also, at typical separations of the quark and antiquark, the shape of the $c\bar{c}$ potential is somewhat like that of the Coulomb potential. Hence, many features of $c\bar{c}$ states – collectively called charmonium – are familiar from the physics of the hydrogen atom, or more precisely, from the spectroscopy and dynamics of positronium, a bound state of an electron and a positron.

After its discovery, the J/ψ was soon identified as a $^3S_1$ $c\bar{c}$ bound state, that is, a spin-triplet (S = 1) S-wave (L = 0) level with total spin J = 1. Several other $c\bar{c}$ levels were observed soon after, including the $\psi(2S)$, or ψ', an excited version of the J/ψ; several orbitally excited triplet P-wave ($^3P_{J=0,1,2}$) levels χ_{cJ}; a D-wave level at 3.77 GeV/c^2; and a spin-singlet $^1S_0$ level known as the $\eta_c(1S)$. Figure 1 illustrates the low-mass charmonium spectrum and the principal transitions between charmonium states expected from the analogy of $c\bar{c}$ states with positronium states. Among the low-mass states expected, only the $\eta_c(2S)$, an excited version of the $\eta_c(1S)$, and the h_c, a spin-singlet P-wave $^1P_1$ level, steadfastly refused to make significant appearances, despite reported sightings that were not confirmed.

A few years ago, with the conclusion of its 20-year programme of studies of the decays and spectroscopy of the bottom quark, the CLEO Collaboration at the Cornell Laboratory for Elementary-Particle Physics turned its attention to the study of charm and charmonium. The National Science Foundation supported converting the Cornell Electron Storage Ring (CESR) to CESR-c, including installing wiggler magnets to enhance luminosity in the charm threshold region (*CERN Courier* May 2003 p7). The new programme benefits enormously from the versatility of the CLEO detector, upgraded to CLEO-c (figure 2 p34), which is unrivalled by other detectors that have operated in this energy region. This latest version of the CLEO detector features excellent charged-particle tracking, neutral-shower energy resolution, and particle identification.

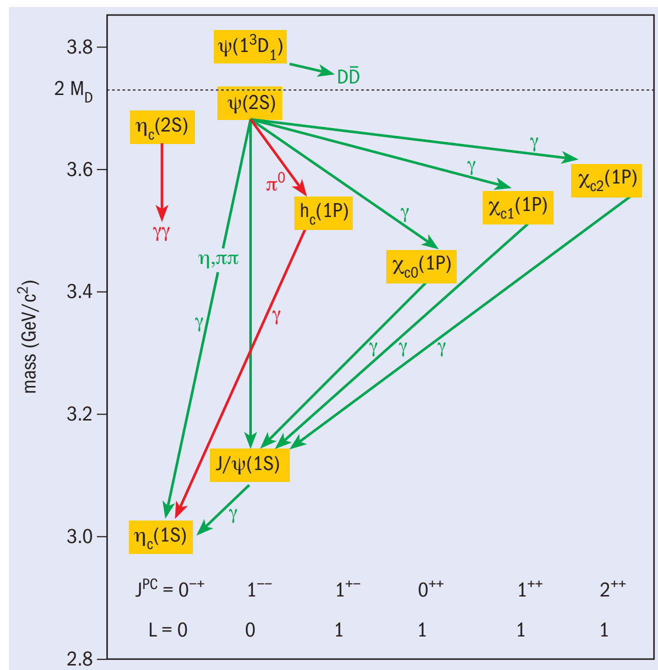

Fig. 1. The lowest-mass charmonium states. This illustration includes only a few of the hadronic decays. Transitions that are discussed in the text are denoted by the red arrows. For each $c\bar{c}$ state, the values of the orbital angular momentum L, the total angular momentum J, the parity P and charge conjugation C are indicated along the bottom edge of the figure.

The ease of studying the lower-mass charmonium states is due in part to their narrow decay widths (long lifetimes), which are much smaller than the mass differences among the states. Above the charm threshold, where production of a pair of charmed mesons, D, becomes possible – that is, above $2M_D \approx 3.73$ GeV/c^2 – charmonium states are much broader and they may overlap, so the spectroscopy becomes more complicated.

The charmonium spectrum provides fundamental information about the nature of the strong force holding quarks together. If current ideas about the nature of the interquark force are correct, the mass of the h_c, $M(h_c)$, is expected to be near the spin-weighted average of the masses of the χ_{cJ} levels, $\langle M(^3P_J)\rangle \approx 3525$ MeV/c^2. This prediction for $M(h_c)$ is based on the expectation that the dominant ▷

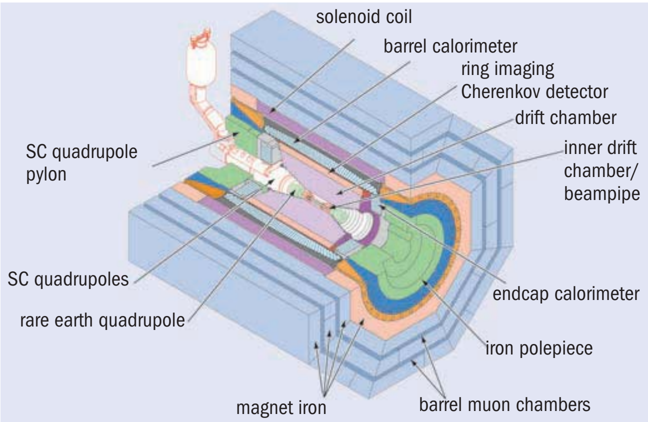

Fig. 2. CLEO-c provides enhanced charged-particle tracking, neutral-shower energy resolution, and particle identification.

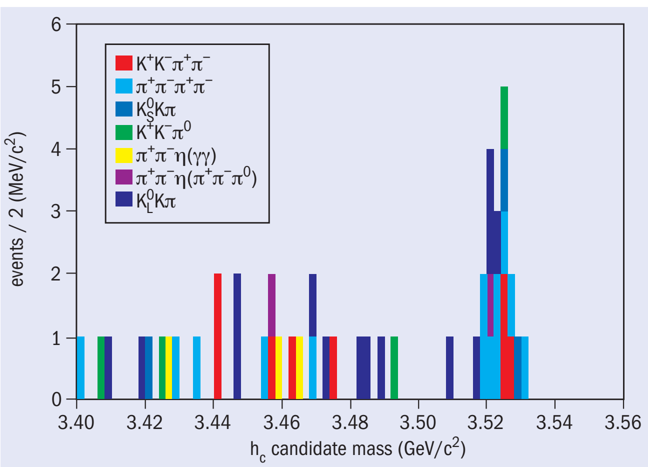

Figure 3. Exclusive signature for the h_c as measured in the CLEO-c detector. The colours indicate different observed decay modes of the $\eta_c(1S)$ produced in the decay $h_c \to \gamma\eta_c$.

spin-dependent interquark force is Coulomb-like, as predicted by quantum chromodynamics (QCD), the theory of the strong force. It is borne out by calculations in lattice gauge theory, which predict a difference of at most a few mega-electron-volts/c^2 between the masses of the spin-singlet and spin-triplet P-wave states.

Charm and charmonium data taken at CLEO so far include a sample of slightly more than 3 million $\psi(2S)$ decays, as well as continuum data below the $\psi(2S)$, charm data just above $D\bar{D}$ threshold, and data at higher energies for a nascent programme of D_s investigations. The $\psi(2S)$ data were used to search for the isospin-violating transition $\psi(2S) \to \pi^0 h_c$. A similar transition in the $b\bar{b}$ system (from the $\Upsilon(3S)$ level) was proposed some time ago as a way to search for the $^1P_1$ state h_b (Voloshin 1986). The transition was expected to occur with a branching fraction of only about 10^{-3}, and so substantial suppression of background was required. The h_c was expected to decay to the η_c and a photon of energy around 500 MeV with a branching fraction of roughly 40%, so this photon was sought in coincidence with the slow π^0 (energy around 160 MeV) from the first transition.

The search for the h_c using just the 160 MeV π^0 and 500 MeV photon at CLEO produced good results (Rosner *et al.* 2005 and Rubin *et al.* 2005). Analyses of this inclusive signature yielded $M(h_c) = 3524.9 \pm 0.7 \pm 0.4$ MeV/c^2 and a product of branching fractions $B_{\psi'}B_h \equiv B(\psi(2S) \to \pi^0 h_c)B(h_c \to \gamma\eta_c) = (3.5 \pm 1.0 \pm 0.7) \times 10^{-4}$, both in good agreement with expectations.

The inclusive h_c signal sits on a considerable background. Further reduction of this background is possible if one reconstructs the decay of η_c into specific final states. The h_c peak stands out quite distinctly under such circumstances (figure 3). This exclusive analysis yielded values of the h_c mass and product branching fraction consistent with those of the inclusive measurement, but with slightly larger errors. However, as a result of the low background, the statistical significance of the exclusive measurement is higher than that of the inclusive measurement, providing a more conclusive observation of the existence of the h_c. The combined inclusive and exclusive analyses yield $M(h_c) = 3524.4 \pm 0.6 \pm 0.4$ MeV/c^2 and $B_{\psi'}B_h$ $(4.0 \pm 0.8 \pm 0.7) \times 10^{-4}$, very close to theoretical expectations.

The h_c thus lies at $1.0 \pm 0.6 \pm 0.4$ MeV/c^2 below the average ^3P_J mass, supporting the QCD prediction and indicating little contribution from a long-range spin-dependent quark-confining force or coupled-channel effects, which could cause a displacement from this value. It is barely consistent with an interesting (but non-relativistic) bound that predicted the h_c should lie no lower than $\langle M(^3P_J)\rangle$ (Stubbe and Martin 1991).

An independent experiment at Fermilab, E835, has produced additional evidence that the h_c is nearly degenerate with $\langle M(^3P_J)\rangle$ (Andreotti *et al.* 2005). By forming h_c candidates using collisions of antiprotons in the Accumulator Ring with protons in a gas-jet target, the E835 Collaboration found 13 candidates for the process $\bar{p}p \to h_c \to \gamma\eta_c \to \gamma(\gamma\gamma)$. Utilizing the carefully controlled energy of the antiproton, the team found $M(h_c) = 3525.8 \pm 0.2 \pm 0.2$ MeV/c^2 and a decay width $\Gamma < 1$ MeV.

The CLEO Collaboration plans to collect more $\psi(2S)$ data, enabling a better measurement of the h_c mass and production rate. It is hoped that the predictions of lattice gauge theories will keep pace with these improvements.

Further discoveries

The h_c is not the only new charmonium state below charmed threshold to which CLEO has contributed substantially. Several years ago, the Belle Collaboration observed a candidate for $\eta_c(2S)$ in $B \to K(K_SK\pi)$ (Choi *et al.* 2002) and $e^+e^- \to J/\psi + X$ (Abe *et al.* 2002), the mass of which was incompatible with that of the previously claimed observation. By studying its production in photon–photon collisions, the CLEO collaboration has confirmed the presence of this state (Asner *et al.* 2004), as has the BaBar Collaboration. The mass of the $\eta_c(2S)$ is found to be only 48 ± 5 MeV/c^2 below the corresponding spin-triplet $\psi(2S)$ state, a hyperfine splitting that is considerably less than the difference of 117 MeV/c^2 seen in the 1S charmonium states, that is, between the J/ψ and the $\eta_c(1S)$. This difference may well be due to the proximity of the charmed meson-pair threshold, which can lower the mass of the $\psi(2S)$ by tens of MeV/c^2.

Researchers at the CLEO Collaboration found that the product $\Gamma(\eta_c(2S) \to \gamma\gamma)B(\eta_c(2S) \to K_SK\pi)$ is only $0.18 \pm 0.05 \pm 0.02$ times the corresponding product for $\eta_c(1S)$. This could pose a problem for descriptions of charmonium if the branching ratios to $K_SK\pi$ are equal. More likely, the heavier $\eta_c(2S)$ has more decay modes available to it, so its branching ratio to $K_SK\pi$ is likely to be less than that of the $\eta_c(1S)$.

Altogether it is remarkable that more than 30 years after the first discovery, charmonium continues to yield new information and new challenges to elementary-particle physics, thanks to improvements in collider luminosities and detector capabilities. Recent advancements include surprises from charmonium spectroscopy above charm threshold to which CLEO is also contributing (*CERN Courier* January/February 2004 p9 and July/August 2005 p13).

With the recent discoveries of the h_c and the $\eta_c(2S)$, all of the expected bound states below charm threshold have now been observed. With the exception of the mass of the $\eta_c(2S)$, the observed masses and branching fractions are in quantitative agreement with theoretical expectations, while the lower-than-expected $\psi(2S)-\eta_c(2S)$ mass splitting stresses the importance of the nearby $D\bar{D}$ threshold. The quantitative agreement between theory and experiment for the states below charm threshold provide a firm foundation for developing an understanding of the new states found above the threshold.

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Résumé

CLEO met de l'ordre sous le seuil du charme

Il y a quelques années s'achevait au Laboratoire de physique des particules élémentaires de Cornell une étude de 20 ans menée par la collaboration CLEO sur les désintégrations et la spectroscopie du quark b. L'amélioration de la luminosité des collisionneurs et des capacités des détecteurs, a permis à CLEO de se tourner vers l'étude du charme et du charmonium, qui n'a pas encore livré tous ses secrets. Une nouvelle orientation payante pour CLEO, qui a observé avec précision deux états manquants du charmonium, h_c et $\eta_c(2S)$, en dessous du seuil du charme. Ces résultats concourront à la compréhension de nouveaux états découverts en dessus de ce seuil.

David Cassel, *Cornell University, and* **Jonathan Rosner**, *University of Chicago.*

Micro-pattern technology gets set for more challenges

A recent meeting at CERN reviewed the progress in the development of micro-pattern gas detectors for current and future particle-physics experiments.

George Charpak opens the Workshop on Micro-pattern Gas Detectors: status and prospects, which was held at CERN.

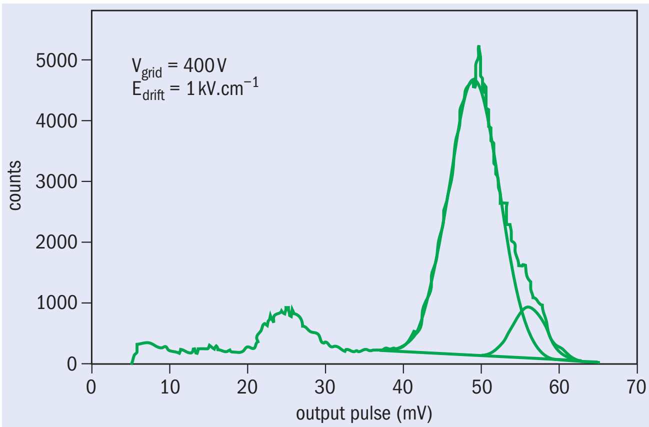
Two hundred people gave a warm reception to Nobel laureate and detector pioneer Georges Charpak when he gave the opening talk at the Workshop on Micro-Pattern Gas Detectors at CERN on 20 January. The meeting began with a welcome from Jean-Jacques Blaising, head of CERN's Physics Department, and continued with considerations of future challenges for particle detectors, overviews of the progress made on micro-pattern gas-detector technologies, and detailed presentations that emphasized production and running with these detectors. As the first in a series of workshops dedicated to reviewing the status of various particle-detector technologies, the formula adopted for this meeting was approved by the accumulated experts.

Aurore Savoy-Navarro of LPNHE-Université de Paris 6 addressed the basic questions surrounding the challenging future for particle detectors. With the Large Hadron Collider (LHC), particle physics will penetrate into the tera-electron-volt world, in explorations that will later be pursued together with another machine characterized by more stringent parameters. So what challenges do we expect? There will be increases in both the importance of the physics and the difficulty of the environment in the forward and very forward regions; increases in the number of jets and in the dynamic range required to observe them; an increase in the need for tagging particle flavours; increases in the flow of information, in the need for real-time decision-making, filtering and full processing of the data, together with an increasing demand for easy and worldwide access to the data; and there will, of course, be a need for increased robustness and reliability. So how do we cope with such a demanding future? Savoy-Navarro encouraged the exchange of information, R&D and the pioneering of new technologies, also in collaboration with industry. However, the core question at the meeting was: "Can the micro-pattern gas detectors be an appropriate technology for future experiments?"

CERN's Fabio Sauli described the recent developments and applications of the gas electron multiplier (GEM), a powerful detector concept that he introduced several years ago. In a GEM, a thin, metal-plated polymer foil is chemically pierced by a high density of microscopic holes. When a suitable voltage difference is applied between the two sides of the foil, each hole acts as an individual proportional counter, amplifying the ionization charge released in the gas. Several electrodes can be cascaded, leading to large gains and stable operating conditions in harsh radiation environments – a major point for the four speakers supporting GEM technology.

Sauli underlined two innovations in GEMs. With a caesium-iodide photosensitive layer deposited on the first electrode in a cascade, GEM devices provide efficient and fast detection of photoelectrons. With a resolution of a few nanoseconds and single-photon position accuracies better than a tenth of a millimetre, a GEM-based detector could form the basis of a new generation of ring-imaging Cherenkov particle identifiers. A large "hadron blind" detector exploiting these principles is being constructed for the upgrade of the PHENIX detector at the Brookhaven National Laboratory. Recent work at the Budker Institute for Nuclear Physics in Novosibirsk has demonstrated that GEM detectors can also work at cryogenic temperatures, which could lead to electronic bubble chambers.

Ioannis Giomataris of the Commissariat à l'Energie Atomique (CEA), Saclay, reviewed the micromesh gaseous structure chamber (Micromegas) detector. He recalled that the amplification process in a small gap has a fundamental feature: the gain reaches its maximum value for gaps in the range 30–150 µm. This key point in the Micromegas operation leads to extraordinary performance in several areas: stability, relative immunity to defects in flatness, and excellent energy resolution. The small amplification gap produces a narrow ionized avalanche, giving rise to excellent spatial and time resolution – several experiments measure 12 µm accuracy and time resolutions in the sub-nanosecond range. Giomataris pointed out that thanks to the fast collection of ions, the Micromegas can safely sustain particle fluxes larger than $10^5\ mm^{-2}s^{-1}$. He also introduced ▷



The spectrum of a ^{55}Fe source in an InGrid chamber, which exploits the Micromegas mesh. The excellent energy resolution resolves the two quantum energies, 5.90 and 6.49 keV.

the Micromegas bulk, a new technology that is easy to implement, which has recently been developed in collaboration with the printed circuit board workshop at CERN. The detector, built in a single process, is light, low cost and robust.

In addition, Giomataris also presented applications of Micromegas in areas other than high-energy physics. These included a high-resolution detector for thermal neutron tomography; a detector with high time resolution for fast neutron detection in inertial confinement fusion experiments; and the novel compact, sealed Piccolo Micromegas detector, designed to provide in-core measurements of the neutron flux at a nuclear reactor and to give an estimation of the neutron energy.

The COMPASS fixed-target experiment at CERN has pioneered the use of multi-GEM and Micromegas detectors for tracking close to the beam line with particle rates of 25 kHz/mm^2. Both technologies have shown excellent performance. Bernhard Ketzer of the Technischen Universität München and CERN gave a detailed description of the production and running experience accumulated with 22 large (31 cm^2) GEM detectors with a triple amplification stage. All detectors operate with single-plane efficiencies greater than 97%, with a spatial resolution of 70 μm at a rate of 4×10^7/s. In addition, Fabienne Kunne of CEA-Saclay emphasized the excellent tracking capabilities of the largest Micromegas built to date, with an area of 40 cm^2: they achieve a spatial resolution of 90 μm with full efficiency at a moderate gain.

Both speakers pointed out that no degradation of performance was observed in the COMPASS detectors after several years of operation with an accumulated charge of a few millicoulombs/cm^2. With these results COMPASS has demonstrated the large-scale feasibility and reliability of the micro-pattern detector concept, and several years of flawless running have demonstrated its robustness and resistance to high radiation levels.

A Micromegas detector has also been developed for the CERN Axion Solar Telescope (CAST) experiment, which is searching for axions produced in the Sun's core. George Fanourakis of the National Centre for Scientific Research "Demokritos", Athens, explained that to find these rare events, the CAST Micromegas required demanding features – efficient detection of photons of 1–10 keV, stability, linearity and very good spatial and energy resolution with low background – all of which have been achieved. The detector has an X–Y strip structure on the same plane and reaches, after software filtering, an average background event rate of 5×10^{-5} keV^{-1} cm^{-2} s^{-1}. In this way, the Micromegas detector at CAST has established the enormous potential of the technique in experiments to study rare events.

The NA48 experiment at CERN is using Micromegas detectors, and Kunne presented the spectrometer comprising three Micromegas stations coupled to a time projection chamber (TPC). Tracking of kaons, at rates exceeding several 10^7/s, is performed with a time resolution of 0.6 ns and a spatial resolution better than 100 μm. Kaons are tagged with a momentum resolution of 0.6%, which improves the resolution on missing masses significantly. A thin-gap (25 μm) Micromegas was also developed for the new proposal, P326, where the study of the rare decay $K^+ \rightarrow \pi^+\nu\nu$ requires tracking a flux of around 1.5×10^8/cm^2/s.

Exploiting the technology

For the new LHC programme, two experiments, TOTEM and LHCb, have adopted GEM technology. Leszek Ropelewski of CERN described the TOTEM telescopes, made of triple-GEM detectors, which will be placed in the forward region of the CMS detector, where the charged-particle densities are estimated to be in the region of 10^6 cm^{-2} s^{-1}. Each of the telescopes will contain 20 half-moon detectors arranged in 10 planes, with an inner radius matching the beam pipe. TOTEM will exploit the full decoupling of the charge-amplification and charge-collection regions, which allows freedom in the optimization of the readout structure, a unique property of GEM detectors.

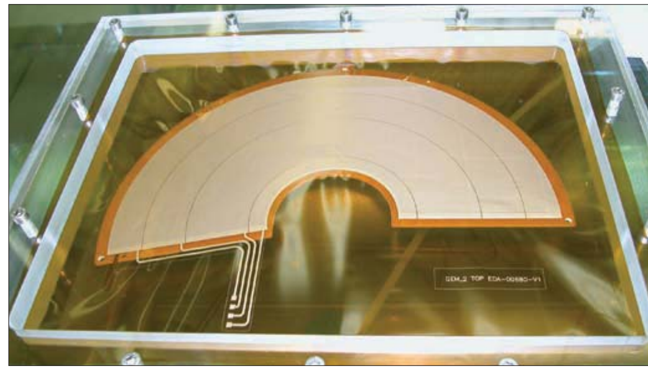
LHCb will use triple-GEM detectors with digital-pad readout to generate a fast and selective level-0 muon trigger in a small region close to the beam pipe. To trigger at 40 MHz a very fast gas mixture is needed. Alessandro Cardini from INFN Cagliari presented a detailed study performed on fast gas mixtures and showed that a triple-GEM detector fulfils the LHCb requirements in terms of efficiency in a 25 ns window, pad multiplicity, cross-talk and radiation hardness.

Many groups worldwide develop the GEM and Micromegas technologies for future experiments at accelerators. An interesting use is in end-cap detectors for the TPCs of detectors for the International Linear Collider (ILC). The physics goals at the ILC require a detector with unprecedented tracking capabilities to be developed. Two major questions on the feasibility of a TPC based on a gas micro-pattern detector were addressed at the meeting, namely the problem of ion feedback and the two-track separation ultimately reachable. Stefan Roth of RWTH (Rheinisch-Westfälische Technische Hochschule) Aachen and Vincent Lepeltier of the Laboratoire de l'accelérateur linéaire, Orsay, responded by showing the excellent results obtained in a 4 T magnetic field with TPCs based on GEM and Micromegas detectors, namely a relative ion feedback of a few per-mille and position resolutions of less than 100 μm.

Harry Van der Graaf of NIKHEF presented two new detector concepts suitable for coupling to a TPC. The GridPix detector (95% efficient for single primary electrons) consists of a grid placed directly on top of the MediPix2 chip. A modification of MediPix2 is foreseen so as to record the arrival time of the drifted charges, allowing full 3D track reconstruction. With the InGrid technique, the grid is produced in wafer post-processing technology and integrated with a complementary-metal-oxide semiconductor pixel chip. This detector has shown an unprecedented energy resolution.

In the concluding discussion session, chaired by CERN's Lucie Linssen, the community underlined a key point that must be solved to promote micro-pattern detectors: industrialization of the production and manufacture of larger-size detectors. There was applause for the team at CERN that optimized the production technique and that still devotes a great deal of effort to fulfilling the increasing demands for micro-pattern detectors.

The meeting unanimously agreed a concluding statement: the high radiation resistance and excellent time and spatial resolution, combined with a light structure, make these detectors attractive for high-precision tracking in future high-rate projects. It also became evident that pioneering and R&D in detector technology are fundamental for cultivating synergy between the LHC and the ILC communities. There are many common issues to resolve and a mixture of the two cultures of e^+e^- and pp colliders, along with an adventurous mind, is what we need to confront future detector challenges successfully.



Each half-moon GEM foil for the TOTEM detector is 30 cm across.

Further reading

For the workshop programme and presentations see http://indico.cern.ch/event/473.

Résumé

De nouveaux défis pour la technologie des micromotifs

Le CERN a accueilli l'atelier sur les détecteurs gazeux à micromotifs (MPGD), que suivront une série de réunions visant à faire le tour des technologies de détection actuelles. Plus de 200 participants y ont étudié le développement des MPGD pour les expériences de physique actuelles et futures. Des exposés détaillés ont mis l'accent sur la production et l'exploitation avec les détecteurs GEM (multiplicateur d'électrons à gaz) et Micromégas (chambre gazeuse à microgrilles). Leur grande résistance aux rayonnements, leur excellente résolution temporelle et spatiale et la légèreté de leur structure les rendent très intéressants pour suivre avec précision la trajectoire des particules dans les futurs projets d'avant-garde.

Ariella Cattai *and* **Jean-Pierre Revol**, *CERN.*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AWARDS

APS honours particle physicists

Left to right: Dan Freedman, Peter van Nieuwenhuizen and Sergio Ferrara, after the award of the Dannie Heineman Prize.

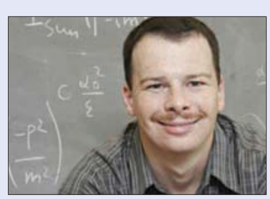
Left to right: Mikhail Shifman, winner of the Julius Edgar Lilienfeld Prize; Savas Dimopoulos, winner of the J J Sakurai Prize; and Yuri Orlov, recipient of the first Andrei Sakharov Prize.

The 2006 April meeting of the American Physical Society (APS), held in Dallas, Texas, saw several prizes bestowed on physicists for outstanding contributions in high-energy physics. Sergio Ferrara of CERN, Dan Freedman of the Massachusetts Institute of Technology and Peter van Nieuwenhuizen of State University New York, Stony Brook, won the prestigious Dannie Heineman Prize for constructing supergravity. Mikhail Shifman of the University of Minnesota received the Julius Edgar Lilienfeld Prize for his contributions to strong-interaction physics and supersymmetric gauge dynamics. Savas Dimopoulos of Stanford University won the J J Sakurai Prize for his creative ideas on technicolour, supersymmetry and extra dimensions.

Yuri Orlov of Cornell University, a renowned accelerator physicist and human-rights activist, was first to receive the new Andrei Sakharov Prize for his distinction as a creative physicist and a life-long leader in the defence of human rights. Orlov spent 10 years in a Soviet gulag. It was largely the solidarity of international physicists, exemplified by the "Save Yuri Orlov" campaign, that forced the Soviet government to release Orlov in 1986.

Two researchers working in nuclear and particle physics have won the 2006 Raymond and Beverly Sackler Prize in the Physical Sciences. Thomas Glasmacher (top) of Michigan State University is rewarded for developing new sensitive methods of studying nuclear structure utilizing Coulomb excitation with fast beams of rare isotopes. Yuri Kovchegov of Ohio State University receives his share of the prize for a number of ground-breaking contributions to theoretical understanding of quantum chromodynamics at very high energies and gluon densities.

The Sackler Prize supports dedication to science, originality and excellence, and is intended for young scientists who have made outstanding and fundamental contributions in their fields. Prizes are awarded each year in either physics or chemistry.



At a recent session of the Committee of Plenipotentiaries of the governments of JINR member states, JINR scientific leader Vladimir Kadyshevsky (right) won the Nikolai Nikolaevich Bogoliubov Prize for 2003–2005 for his outstanding contribution to theoretical physics and the development of new algebraic and geometrical approaches to the formulation of quantum field theory. He is seen here with the JINR director, Alexei Sissakian.

Robert Aymar wins 2006 energy prize

CERN's director-general Robert Aymar is one of three laureates to win the 2006 Global Energy International Prize for "the development of the scientific and engineering foundation for the ITER project". ITER will be built at Cadarache, France, and will show the scientific and technological feasibility of a full-scale fusion power reactor. The other laureates, who worked with Aymar on the project, are former president of the ITER Council, Evgeny Velikhov, and Masaji Yoshikawa, ITER's former vice-president. Aymar headed ITER from 1994 to 2003.

Founded in 2002 and awarded annually since 2003, the Global Energy prize is for outstanding theoretical, experimental and applied research, development, inventions and discoveries in energy development and power generation. Russian president Vladimir Putin will make the award in St Petersburg at the G8 summit on 14 June.

ANNIVERSARY

JINR celebrates 50 golden years


From left to right: CERN's director-general Robert Aymar congratulates JINR staff members on the jubilee; IN2P3 director Michel Spiro (left) presents a jubilee medal to JINR's director Alexei Sissakian; and the performance of the Igor Moisseev folk-dance group at the concert.

On 26 March, 50 years to the day since the Joint Institute for Nuclear Research (JINR) was established in Dubna, a celebratory joint meeting of the JINR Committee of Plenipotentiaries and the Scientific Council took place in the Mir cultural centre. It was attended by delegations from various countries, numerous honourable guests, and veterans of the institute.

In his opening address to the audience, Andrey Fursenko, plenipotentiary of Russia at JINR and the Russian Federation Minister of Science and Education, referred to the anniversary as "the golden wedding of Dubna and Big Science". He pointed out that science is shaped by centres of excellence and superiority, and that the international research centre in Dubna possesses both qualities. It allows scientists from different countries to follow their challenging studies and be proud of their work. Fursenko said that the decision of JINR member states to increase their contributions as of 2007 indicates their unanimous commitment "to invest in the future of mankind".

In his presentation, "JINR: Yesterday, Today, Tomorrow", the current director Alexei Sissakian focused on the establishment of JINR as a successful international project in Dubna. He gave a brief review of 50 years of activities at JINR and recalled the institute's outstanding scientist founders, citing one of them, Polish academician Henryk Niewodniczanski: "Dubna is our home and we have every reason to look forward with optimism."

The president of the Russian Federation Vladimir Putin and Prime Minister Mikhail Fradkov, as well as leaders of other states, addressed the JINR community with messages of congratulation. The governor of the Moscow region, Boris Gromov, also conveyed his appreciation through the deputy-chairman of the Moscow region government, Peter Katsyv. The jubilee day speeches all showed how the activities of JINR are valued highly, not only in science but in strengthening peace and co-operation among nations.

Michel Spiro, director of the Institut national de physique nucléaire et de physique des particules (IN2P3) and of the Department of Nuclear and Particle Physics at the Centre National de la Recherche Scientifique also congratulated JINR, as did CERN's director-general Robert Aymar on behalf of CERN's scientific community. Aymar noted the landmarks of the long-standing fruitful co-operation between the two centres.

During the celebrations, JINR received the Order of Friendship of the Socialist Republic of Vietnam. The current director, Sissakian, and former director, now JINR scientific leader, Vladimir Kadyshevsky, were both awarded the Polar Star Order of the Republic of Mongolia. Andrzej Hrynkiewicz, the plenipotentiary of the government of the Republic of Poland at JINR, presented a number of JINR staff with a medal commemorating "50 years of Poland's membership at JINR". In addition, leading JINR scientists from various countries received honorary awards from the Russian Federation Ministry of Science and Education and the governor of the Moscow region.

For the 50th anniversary the Committee of Plenipotentiaries decided to name several avenues in the institute's sites after outstanding scientists who have influenced scientific activities at JINR: N Amaglobeli (Georgia), A Petrosyants (USSR, Russia), Wang Ganchang (the People's Republic of China) and J Theillaque (France). The committee also named an avenue after CERN to honour 50 years of co-operation with JINR.

Artistic teams from the Mir cultural centre performed between the speeches and awards. The day ended with a performance of the folk-dance group of Igor Moisseev and a firework display beside the Volga river in the evening.

INDUSTRY

ALICE Awards honour European companies

The third annual ALICE Awards ceremony, held at CERN in March, recognized three companies for their exceptional work on the ALICE detector. VTT Microelectronics of Finland received an award for producing the thin bump-bonded ladders (detector arrays, each comprising 40 960 active cells) for the silicon pixel detector in the inner tracking system. The company had to overcome a number of technical hurdles: complex and expensive equipment was procured or upgraded and processes underwent a detailed study and careful tuning. The ladders are the thinnest ever produced and mounted on a pixel detector.

The Belgian company Canberra Semiconductors NV received its award for producing silicon detectors, also for the inner tracking system. The technologies involved for the pixel, drift and double-sided micro-strip detectors required high performance and technological expertise. The most demanding detector, the silicon drift, was developed in a joint programme between ALICE and Canberra. The delivery of the pixel and the double-sided strip detectors was on time, and Canberra increased its micro-strip production when another company was unable to produce the amount expected. Delivery of the drift strips is also expected to be on time.

The ALICE Awards winners stand with CERN's secretary-general, Maximilian Metzger.

The third company to receive an award was Note Lund AB of Sweden for manufacturing the 4800 front-end cards for the time projection chamber (TPC). These contain the complete read-out chain for amplifying, shaping, digitizing, processing and buffering the TPC signals. The board has to process and store signals with high resolution and range. The company first produced two prototypes and then, together with ALICE TPC engineers, refined the layout of the board and the manufacturing procedure. Mass production started in September 2004 and has progressed on schedule and within budget.

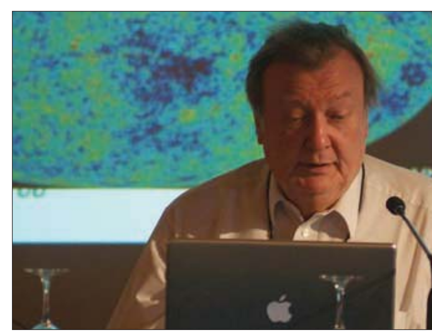
CONFERENCE

La Thuile meeting celebrates 20 years

This year saw the 20th meeting in the series "Les Rencontres de Physique de la Vallee d'Aoste". Nature's gift for the first of the series in 1987 was the type-II supernova explosion SN1987A in February that year, which gave participants a major topic to discuss. The 20th meeting was not accompanied by such a bang on the cosmic scale, but four Nobel laureates and many distinguished speakers provided participants with enough ammunition for discussions to continue into the night.

The organizers of the meetings, Giorgio Belettini and Mario Greco (later joined by Giorgio Chiarelli), began with the vision of a winter conference composed only of plenary talks, in contrast to the well-established Moriond series (*CERN Courier* May 2005 p37). In the La Thuile meetings, researchers not only talk about their own work and experiments, but also cover the whole subject in their respective fields in concise, self-contained, 30-minute talks – a recipe that has proved successful. With the support of the local government of the Aosta valley the organizers soon homed-in on the small village of La Thuile and the new hotel and conference complex that had just opened. The cooking school on site also helped to attract European and American physicists alike.

Conference organizers (left to right) Mario Greco, Giorgio Bellettini and Giorgio Chiarelli cut the 20th anniversary cake in La Thuile.



Carlo Rubbia presents his talk about the universe, dark matter and thinking big.

The 55 talks at the 20th meeting included four from Nobel laureates. Carlo Rubbia talked about thinking big in dark-matter searches and proposed replacing existing dark-matter detectors with new ones weighing tonnes instead of kilograms. Sheldon Glashow reviewed neutrino physics "from desperate remedy to profound enigma", while Samuel Ting described the Alpha Magnetic Spectrometer project and space physics. James Cronin presented the Pierre Auger project and even some first results.

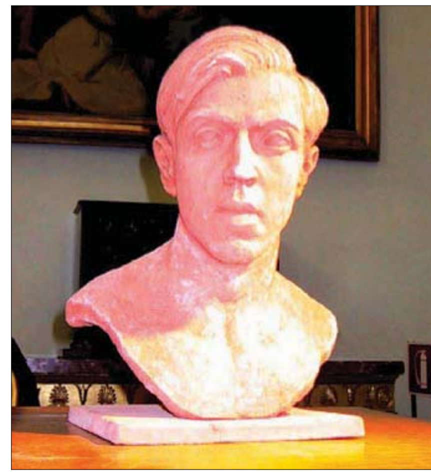
Other highlights included Rocky Kolb's talk about astrophysics since SN1987A, and his second talk on dark matter and dark energy in which he explained how the field has come of age 20 years on. Nicola Khuri gave an interesting presentation on science and development, discussing the problems that developing countries face in pursuing fundamental science. In the many talks from all fields of particle physics, a sign of the times perhaps was the relatively little time given to accelerator experiments – with the Large Hadron Collider still around the corner, these days much information comes from neutrino, cosmic-ray, microwave-background, gravitational-wave and other non-accelerator-based facilities.

● For further information see www.pi.infn.it/lathuile/lathuile_2006.html.

CENTENARY

Rome starts Majorana celebrations

The opening ceremony in Rome, with (from left to right): Samuel Ting, Bruno Maraviglia, Antonino Zichichi, Athos De Luca, Giovanni Bornia, Giovanni Ducrot and Renato Guarini.



The clay bust, to be cast in bronze, of Ettore Majorana by the sculptor Giuseppe Ducrot.

Celebrations to mark the centenary of the outstanding Sicilian physicist Ettore Majorana began on 28 February with the opening ceremony in the beautiful Pietro da Cortona Hall on Capitol Hill in Rome. A lecture by Antonino Zichichi on "La genialità di Ettore Majorana vista da Enrico Fermi", commemorating the great scientist, formed the central part of an event organized by the Comitato Panisperna, which is promoting the Ettore Majorana centenary celebrations taking place during 2006.

The cultural association Comitato Panisperna helped to set up the Enrico Fermi Centre in Italy and recover the building of the Physics Institute on Via Panisperna in Rome, where Fermi and his group achieved their important scientific results. Senator Athos De Luca, chair of Comitato Panisperna, made the proposal to recover the building and transform it into a museum, which was approved in 1999. Comitato Panisperna also aims to stimulate activities that lead to more understanding about the personal roles of Fermi and his collaborators, as well as promoting scientific culture in general. The event to open the Ettore Majorana centenary celebration acted as a starting point for deepening the understanding of the role of Majorana's rather entangled personality.

Athos De Luca chaired the opening ceremony and, after welcoming the audience and describing the achievements and activities of Comitato Panisperna, introduced others present. These included the Nobel laureate Samuel Ting, Renato Guarini, Rector of the University of Rome La Sapienza, and Giovanni Bornia, the Assessore alla Cultura of the City of Rome, and Zichichi, who is president of the Enrico Fermi Centre. Bruno Maraviglia, a member of Comitato Panisperna, followed this introduction. He stressed that the Enrico Fermi Centre has not only generated more historical interest in Fermi's period but has also produced new, innovative and interdisciplinary research directions, one of which, in particular, concerns brain-function studies by magnetic resonance based on very advanced instrumentation.

In his lecture, Zichichi emphasized how from the early 1960s he made efforts to convince scientists and others of the greatness of Majorana's scientific thought and activities. He recalled that the Ettore Majorana Foundation and Centre for Scientific Culture (EMFCSC) was founded at CERN in 1963 – with an instituting act signed by J S Bell, P M S Blackett, I I Rabi, V F Weisskopf and Zichichi – and named after the outstanding Sicilian physicist who was almost unknown at the time. The EMFCSC, located in the ancient and enchanting city of Erice in Sicily, was intended both to expand the impact of science to the maximum level and to establish a permanent reminder of Majorana's role. Zichichi also noted Fermi's opinion of Majorana: "There are various categories of scientists in the world of second and third rank, who do their best without going far. There are also scientists of first rank, who make discoveries of great importance, fundamental for the development of science; but then there are the geniuses like Galilei and Newton. Well, Ettore was one of these."

Many other interesting points were stressed during the event. Ting, at the end of Zichichi's lecture, commented on the great contributions of Italian physicists to science and noted the discovery of the antideuteron and the first search for the heavy lepton, both performed at CERN by Zichichi and his collaborators, at a time when CERN was starting to compete with the major laboratories of the US.

This first successful event of the Majorana Centenary Celebrations attracted a large audience, in particular members of the Majorana family. It was followed by the presentation to the public of the new clay bust of Ettore Majorana made by the young sculptor Giuseppe Ducrot. A bronze cast will be made of the bust, to be located at the Enrico Fermi Centre.

TRAINING

HELEN brings Latin Americans to CERN

Latin American students who have arrived at CERN to take up fellowships during the first months of 2006 relax in front of the LHC collaboration buildings, together with the deputy coordinator of HELEN, Veronica Riquer (centre), from Rome University and INFN.

The training programme supported by the High Energy Physics Latin American–European Network (HELEN) is in full swing. For 2006, the programme has assigned about 70 fellowships to be spent at CERN by Latin American students and young physicists. The fellowships are centred on the experiments at the Large Hadron Collider (LHC), theory, the DataGRID and technology transfer. Other fellowships are to be spent at European and Latin American universities, bringing the total for the first year of the programme to more than 100 fellowships, with an average duration of three months.

Now a small but active HELEN community is building up at CERN, and has established a HELEN club to allow the exchange of views and to help newcomers in the complex CERN environment. Jose Salicio Diez of the Physics Department coordinates HELEN at CERN.

NEW PRODUCTS

Bede X-ray Metrology has launched the BedeMetrix-F with ScribeView, a new strained-silicon process-control system for high-volume semiconductor manufacturing. ScribeView gives a very small spot that enables inline measurements in the scribe line or on pads on patterned wafers. The overall system uses high-resolution X-ray diffraction to measure epilayer strain, composition, thickness and relaxation. For more information tel: +44 191 332 4700, e-mail info@bede.co.uk or see www.bede.com.

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Southern Scientific now supplies the indentiFINDER, a digital, hand-held, gamma-spectroscopy and dose-rate system, in a number of different versions, providing gamma dose-rate measurements up to 1 Sv/h. Versions are also available with He-3 neutron detectors. Combining high sensitivity with a wide dose-rate range, the systems can identify different isotopes from within an extensive library. For further details contact Steve Kidd, tel: +44 1903 604000, e-mail info@ssl.gb.com or see www.ssl.gb.com.

Varian Inc has introduced a new series of helium mass-spectrometer leak detectors for testing the integrity of systems, chambers etc, using helium as a tracer gas. The new VS series includes portable and cart-mounted mobile leak detectors. For further information contact Lauren Lum, tel: +1 650 424 5286, e-mail lauren.lum@varianinc.com or see www.varianinc.com.

MEETINGS

The next **Crimean Summer School and Conference on New Trends in High-Energy Physics**, will be on 16–23 September in the hotel Parus, Yalta, Crimea. For further details see http://crimea2006.bitp.kiev.ua/. Applications should be sent to Crimea-2006, BITP, Kiev-143, 03680 Ukraine; e-mail crimea@bitp.kiev.ua; or fax +38 044 5265998.

The **10th Topical Seminar on Innovative Particle and Radiation Detectors** will take place at the University of Siena, Italy, from 1–5 October. Attendance will be by invitation. Interested physicists should write to the organizing committee, indicating name, address, affiliation and, if applicable, the title of a contribution. The deadline for submitting an abstract is 15 July. For further information see www.bo.infn.it/sminiato/siena06.html.

HQL06, the International Conference on Heavy Quarks and Leptons, will be held on 16–20 October in the Deutsches Museum in Munich. Organized by the Physics Department of the Technical University Munich and the Max-Planck Institute for Physics, the conference will cover topics including heavy-quark decays, CP violation and mixing, D and B rare decays and neutrino oscillations. For further information and details on registration see http://hql06.physik.tu-muenchen.de/.

CORRECTIONS

- In the April issue of the *CERN Courier*, a mistake was made in the first name of the Russian Federation's plenipotentiary at JINR, Andrey Fursenko (p36). Many apologies.
- In the May issue, the news about the CMS tracker should have said that the first sector has demonstrated "a channel inefficiency of less than 1%" (p7). Apologies to all concerned.
- In the article in May "High schools focus on the extreme universe", the area for the EEE project is 10^6 km^2 (p21).
- In the article in May "Closed-loop technology speeds up beam control", the citation given on page 28 at the end of the paragraph about the coupling problem should have been to Jones *et al.* 2005 and Luo *et al.* 2005, the first of which refers to the paper: R Jones *et al.* 2005 "Towards a Robust Phase Locked Loop Tune Measurement System", DIPAC 2005, Lyon.

RECRUITMENT

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+44 (0)117 930 1028
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CERN COURIER

Spallation Neutron Source Project

Oak Ridge National Laboratory

Scientists and engineers at Oak Ridge National Laboratory (ORNL) conduct basic and applied research and development to create scientific knowledge and technological solutions that strengthen the nation's leadership in key areas of science; increase the availability of clean, abundant energy; restore and protect the environment; and contribute to national security. ORNL also provides an environment that encourages collaborative research and development, and promotes access to the Laboratory's facilities by researchers from other research organizations, industry and academia.

The Spallation Neutron Source (SNS) at the Oak Ridge National Laboratory invites applications for scientific and technical positions. SNS will be the most powerful short-pulse spallation neutron source in the world. This unique facility will provide opportunities for up to 2000 researchers each year from universities, national labs, and industry for basic and applied research and technology development in the fields of materials science, magnetic materials, polymers and complex fluids, chemistry, and biology. Funded by the U.S. Department of Energy's Office of Science, SNS will begin operations in June 2006.

Current and future job opportunities include:

- Accelerator Operators
- Instrument Scientists
- Instrument Scientific Associates
- Mechanical Designers
- Technicians
- Technical Managers
- Postdoctoral Fellows including the Clifford G. Shull Fellowship Program

For more complete job descriptions visit our web site at **www.sns.gov** and select jobs. Qualified and interested candidates must submit a current resume with a list of three references to our web site to ensure consideration.

ORNL, a multiprogram research facility managed by UT-Battelle, LLC, for the U.S. Department of Energy is an equal opportunity employer committed to building and maintaining a diverse work force.

SNS SPALLATION NEUTRON SOURCE

GSI Darmstadt

JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

The Justus-Liebig-Universität Gießen (JLU) and the German National Laboratory for Heavy-Ion Research (GSI), a member of the Helmholtz-Association, plan to fill the position of a

Professor (W2) for Theoretical Physics (Nuclear and Hadron Physics)

The appointment is based on a cooperation agreement between the JLU and GSI and will become effective in the winterterm 2006/2007. Prerequisites for this appointment are specified in § 71 HHG and § 70 Abs. 6 HHG.

The successful candidate is expected to have a high reputation for his/her theoretical work in the field of structure and reactions of nuclei and hadrons. He/she should be interested in nuclear astrophysics to supplement and strengthen the theoretical and experimental efforts at JLU. Active participation in the project FAIR (Facility for Antiproton and Ion Research) at GSI as well as in the European Graduate School „Complex Systems of Hadrons and Nuclei" will be required.

It is expected that the successful candidate will participate in the teaching duties in the Bachelor-Master curricula in physics as well as in the curricula for science teachers. Besides an outstanding scientific qualification commensurate teaching abilities are expected as well as participation in the academic self-governance process. Teaching language is German.

The Justus-Liebig-Universität Gießen and GSI are committed to increase the number of female faculty members. They therefore encourage especially suitably qualified women to apply. Applications of physically handicapped persons will receive preference – provided they have equal qualifications.

Applications quoting Az. 7-14/06 should be sent **twofold** until **June 23, 2006** to: **Präsident der Justus-Liebig-Universität Gießen, Ludwigstr. 23, 35390 Gießen, Germany**

For further information about the requirements for employment and the instructions on how to apply and submit an application, please consult the following website: http://www.uni-giessen.de/stellenmarkt/merkblatt.pdf

Jefferson Lab

Hall B 12 GeV Upgrade Research Scientist

(Term position ending two years from hire date)

SALARY RANGE: $49,400 - $78,000

The Hall B Group at Jefferson Lab is seeking a Research Scientist to play a leading role in the development of the Silicon Vertex Tracker (SVT) for the CLAS12 detector. CLAS12 is a large acceptance detector and a major part of the experimental equipment planned in support of the research program at the energy-upgraded electron accelerator at Jefferson Lab. The SVT will provide tracking of charged particles in a 5 Tesla solenoid magnet and in a high electro-magnetic background environment. The successful candidate is expected to provide leadership in the design, prototyping, construction, and testing of the SVT, and to work closely with the in-house Fast Electronics Group, the Hall B instrumentation and tracking groups, and University groups.

The position will initially be available for a two-year term and may be extended for several more years based upon mutual agreement and the availability of funds for the detector construction. Although the development of the SVT will be the main focus of the research, the position also offers the possibility of participating in the ongoing research program of the Hall B Group with the CEBAF Large Acceptance Spectrometer (CLAS). CLAS supports a strong research program in the exploration of the structure of nucleons and nuclei.

Candidates must have a PhD in Experimental Nuclear or Particle Physics or an equivalent combination of education and experience. Postdoctoral experience in a technical area such as detector development and/or detector instrumentation is preferred. Prior experience with silicon detector technology is a plus.

For prompt consideration, please apply online at www.jlab.org/jobline submitting a curriculum vitae and copies of recent unpublished work. In addition, please arrange to have letters from three references sent to:

Human Resources Consultant, Mail Stop 28D, Jefferson Lab, 12000 Jefferson Avenue, Newport News, VA 23606.

Jefferson Lab is an Affirmative Action/Equal Opportunity Employer.

Mechanical Engineers

Lawrence Berkeley National Laboratory (LBNL) is located in the San Francisco Bay Area on a 200-acre site in the hills above the University of California's Berkeley campus and is managed by the University. A leader in science and engineering research for more than 70 years, LBNL is the oldest of the U.S. Department of Energy's National Laboratories. We are currently seeking Mechanical Engineers to join our team.

Mechanical Engineers – 018920, 018973
Accelerator Mechanical Engineer 5 – 018655

FOR MORE DETAILED INFORMATION ON EACH OF THESE POSITIONS PLEASE GO TO: http://jobs.lbl.gov. Go to "Search Jobs", and enter the appropriate job number in the keyword search field. To apply online, select the "Upload Your Resume" option, and follow the on-line instructions to complete the application process. As part of the online application process, please submit a single attachment that includes both your resume or CV and a statement of your research interests or cover letter. Be sure to indicate "CERN Courier" as your source. Feel free to apply to other posted positions that match your interest and skills.

Further information can also be found on: http://www.cerncourier.com/jobs/ and **http://physicsweb.org/jobs/**.

Berkeley Lab is an Affirmative Action/Equal Opportunity Employer committed to the development of a diverse workforce.

BERKELEY LAB

LIP

LIP - Laboratory for Instrumentation and Experimental Particle Physics, Lisbon

Postdoctoral Research in Experimental Particle Physics

LIP-Lisbon invites applications from outstanding candidates for a postdoctoral researcher position in the CMS experiment at the CERN LHC.

The LIP group has the responsibility of the data acquisition system of the CMS electromagnetic calorimeter and is active in extra-dimensions physics analysis. The successful applicant is expected to play major roles in these areas. The position will be based at CERN. The appointment is renewable annually for a period of up to six years.

Qualifications required include a PhD and a clear demonstration of the ability to carry out a research program. Good knowledge of modern programming techniques is required. Experience in the development of data acquisition systems for HEP is a major asset.

Applicants should send the CV, including a statement of physics interests, and three recommendation letters to:

Prof. Joao Varela
Email: joao.varela@cern.ch
LIP, Av.Elias Garcia, nº 14, 1000-149 Lisbon, Portugal

Submission of application material via email is recommended. The nominal deadline for the receipt of the application is July 1st, 2006, but the position remains open until a suitable candidate is found.

ILLINOIS INSTITUTE OF TECHNOLOGY
Transforming Lives. Inventing the Future. www.iit.edu

Postdoctoral Position

The muon cooling group at Illinois Institute of Technology anticipates a postdoctoral opening starting July. We work closely with Fermilab on high-gradient RF cavity development for muon-beam cooling and we lead the U.S. contingent on the Muon Ionization Cooling Experiment (MICE) at Rutherford Appleton Laboratory. For more information, please see **http://capp.iit.edu/**, **http://mice.iit.edu/**, and **http://www.fnal.gov/projects/muon_collider/**.

To apply, send resume and have three letters of reference sent to:
Prof. Daniel M. Kaplan, kaplan@iit.edu (preferred) or 3101 S. Dearborn St., Chicago, IL 60616.

Equal opportunity/affirmative action.

Call for tender

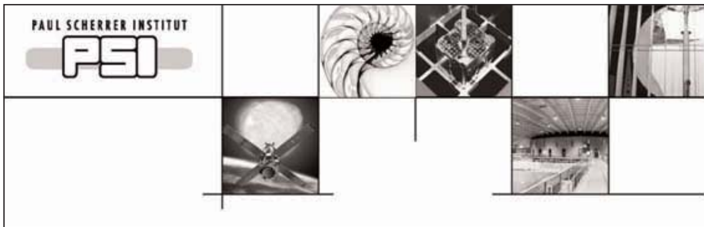
INFN Istituto Nazionale di Fisica Nucleare

NATIONAL INSTITUTE OF NUCLEAR PHYSICS

MARKET SURVEY

INFN is setting up the procedure to alienate 101 metric tons of Gallium Chloride (about 30 metric tons of pure Gallium) and therefore is soliciting expression of interest of potential buyers

Expression of interest should be sent by a registered mail to the following address: **INFN-Direzione Affari Contrattuali e Patrimoniali, Via Enrico Fermi, 40-00044 FRASCATI (Rome) ITALY**, not later than **May 31st, 2006**, to the attention of
Dr. Dolores Federici - Tel. +39-06-94032491 email: Dolores.federici@lnf.infn.it
For further information please contact
Dr. Marco Balata, Tel. +39-0862-437292 email: marco.balata@lngs.infn.it



Postdoctoral Fellow

The Paul Scherrer Institut is a centre for multi-disciplinary research and one of the world's leading user laboratories.With its 1200 employees it belongs as an autonomous institution to the Swiss ETH domain and concentrates its activities on solid-state research and material sciences, elementary particle and astrophysics, energy and environmental research as well as on biology and medicine.

Within the framework of an international collaboration on the European X-ray Free-Electron-Laser project, PSI contributes with the design, fabrication and implementation of a fast, intra-bunch train feedback system to stabilize the electron beam in a multi-dimensional phase space volume.

For that project, the GFA (Large Research Facilities) diagnostics and instrumentation division is looking for a Postdoctoral Fellow:

Your responsibilities

The correction signals of the intra-bunch-train feedback system are transferred to the electron beam via pulsed broad band amplifiers in the kilowatt range. In collaboration with groups at PSI and DESY, you will be responsible for the design and the fabrication of the amplifiers. As an important part of the positional beam feedback system, the amplifiers will be integrated in the existing VUV-FEL accelerator and you will participate actively in the commissioning of the system.

Your profile

The successful candidate should have a PhD in physics or in electrical engineering with excellent knowledge in RF power electronics and RF measurement techniques. You are experienced in using the standard simulation programs and enjoy working in an interdisciplinary, multinational research environment. You communicate well in English and German and you are an enthusiastic researcher and a good team player with the willingness of temporary work abroad (at DESY, Hamburg). These attributes will help to ensure your success in completing your post-doctoral position in this exciting field of study.

We are looking forward to your application.

For further information please contact, Dr Volker Schlott, e-mail: volker.schlott@psi.ch, Ph. +41 (0)56 310 42 37.

Please send your application to: Paul Scherrer Institut, Human Resources, Mr. Thomas Erb, ref. code 8440, 5232 Villigen PSI, Switzerland.

Further job opportunities: www.psi.ch

BOOKSHELF

Books received

Modeling Black Hole Evaporation by Alessandro Fabbri and José Navarro-Salas, Imperial College Press. Hardback ISBN 1860945279 £34 ($55).

This book gives a detailed and pedagogical presentation of the Hawking effect and its physical implications, and then discusses the backreaction problem, especially in relation to exactly solvable semiclassical models that analytically describe black-hole evaporation. The book aims to link the general relativistic viewpoint on black-hole evaporation and the new CFT-type approaches. The discussion on backreaction effects is valuable for graduate students and researchers in gravitation, high-energy physics and astrophysics.

Soft Multihadron Dynamics by W Kittel and E A De Wolf, World Scientific. Hardback ISBN 9812562958 £60 ($98).

This book comprehensively covers the development and status of soft (i.e. non-perturbative) phenomena encountered in the production of (multi-) hadronic final states by high-energy collisions of various particles. Phenomenological models used to describe the data are in general inspired by quantum chromodynamics (QCD) and the book often crosses between soft and hard (perturbative) QCD. Postgraduate students, researchers and academics interested in multihadron production will find this useful reading.

The QCD Vacuum Hadrons and Superdense Matter, 2nd edition by Edward V Shuryak, World Scientific. Hardback ISBN 9812385738 £75 ($101). Paperback ISBN 9812385746 £43 ($58).

This book is invaluable for particle and nuclear physicists and comprises extensive lecture notes on non-perturbative quantum chromodynamics. The original edition from 1988 had a review style. In this edition the outline remains, but the text has been rewritten and extended. As well as incorporating new developments, this edition has benefited from several graduate courses taught by the author at Stony Brook during the past decade. The text now includes exercises and about 1000 references to major works, arranged by subject.

Modern Supersymmetry: Dynamics and Duality by John Terning, Oxford University Press. Hardback ISBN 0198567634 £55.

The book begins with a brief review of supersymmetry and the construction of the minimal supersymmetric Standard Model and approaches to supersymmetry breaking. It also reviews general non-perturbative methods that led to holomorphy and the Affleck–Dine–Seiberg superpotential as powerful tools for analysing supersymmetric theories. Seiberg duality is discussed with example applications, paying special attention to its use in understanding dynamical supersymmetry breaking. Alongside an overview of important recent developments in supersymmetry the book covers topics of interest to both formal and phenomenological theorists.

How to join the virtual revolution

For cost-effective computing it's hard to beat virtual machines. **Stephen Childs** and **Brian Coghlan** from Trinity College Dublin describe the solution offered by Grid-Ireland.

Brian Coghlan (left) and Stephen Childs with the machines of the Grid-Ireland Operations Centre at Trinity College Dublin, including the TestGrid testbed built using VM technology.

Virtualization has a whiff of magic about it: it offers the promise of turning one computer into many, allowing multiple operating systems (OS) to run at once. No wonder that it's one of the hottest buzzwords in the computer industry at the moment. With virtualization, each OS runs in its own isolated virtual machine (VM), which presents all the essential features of a real machine. In one sense it is not a new technology – most of the ideas were originally implemented in the earliest mainframes. But the continued growth of processor performance is now making virtualization viable on commodity hardware in a way that it hasn't been in the past. Established companies such as VMWare and newcomers such as XenSource are offering a stream of new products designed to make virtualization more powerful and easier to manage.

VMs are a natural companion to the Grid, as it itself is a method of virtualizing resources. Grid-Ireland was one of the first in the European Grid community to seriously investigate VM technologies. In fact, we have been using virtualization on our production infrastructure since early 2004. We started off with Grid User Interfaces (UI) VMs hosted on User-Mode Linux, and then switched to Xen in late 2004 as it offers much greater performance.

VMs have enabled us to increase cost-efficiency and to simplify management. Last year we connected 11 new sites to Grid-Ireland and, through this regional Grid, to the larger infrastructure of the Enabling Grids for E-science (EGEE) project. This wouldn't have been possible without the use of VMs. Each new site hosts a gateway – a single physical machine that runs five virtual machines, each hosting a different service node of the EGEE Grid. One physical machine is all that's needed to connect a site to the Grid.

Is this a real advantage, given that recent releases of the EGEE Grid middleware already allow combining different services on one machine? Yes, because that approach produces weak security: you don't want interactive services (such as on a UI) in the same OS as your core Grid services. We believe that VMs are a better solution as they provide real isolation.

There are many other promising possibilities. For example, VM-based worker nodes could be dynamically created at job submission, based on a custom image provided by a virtual organization. As well as permitting much greater customization of execution environments, this approach would increase security by isolating each job in an independent environment.

We have also used VM technology to build up an extensive testbed (known as TestGrid) for certification, porting and development of Grid software. TestGrid contains 40 machines hosting a multitude of VMs including replicas of machines on the real Grid-Ireland infrastructure. It is a realistic testbed in an isolated network using the same network addresses as the real sites: an ideal environment for porting and validating middleware and for testing configuration changes. Our developers use it to construct custom testbeds: VMs make it easy to set up and tear down new environments without time-consuming installation and configuration.

These are exciting times. Virtualization has already changed the face of commercial computing. For the Grid, the virtual revolution is just beginning.

Further reading

For more about Grid-Ireland see www.grid.ie.
B A Coghlan, J Walsh and D O'Callaghan 2005 "Grid-Ireland Deployment Architecture" *Proc. EGC'05, LNCS* 3470.
S Childs *et al.* 2006 "A virtual TestGrid, or how to replicate a national Grid" *Proc. ExpGrid workshop at HPDC* 15.

Stephen Childs and Brian Coghlan, Grid-Ireland/Trinity College Dublin.


937A GAUGE CONTROLLER
MICROVISION PLUS

Tools for Discovery

CAEN

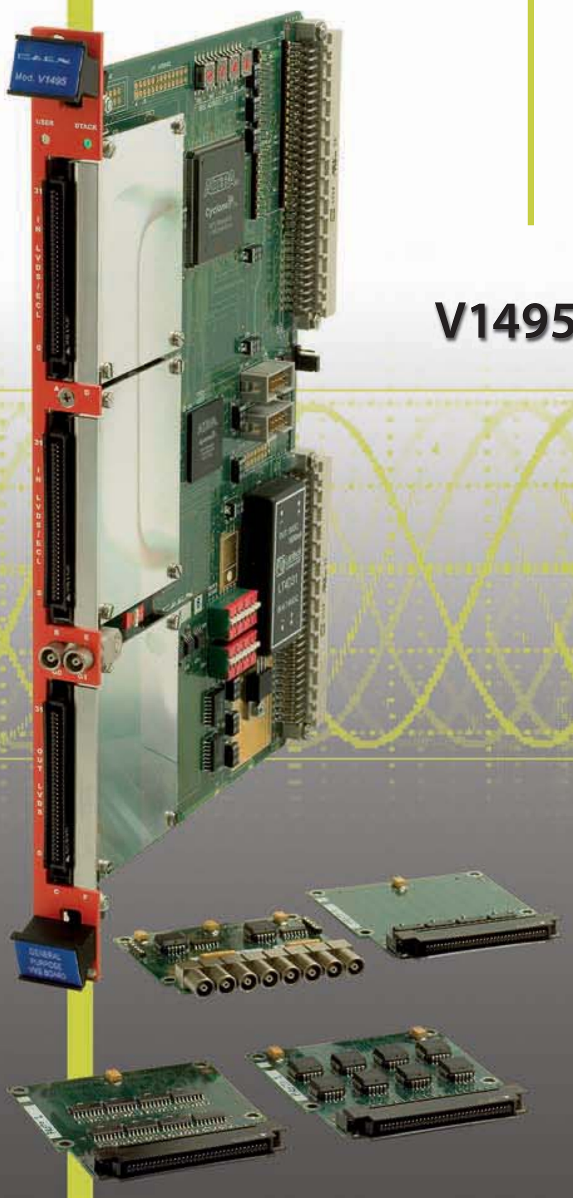
Overview

The V1495 is a fully programmable General Purpose VME board, suited to a variety of different applications. The heart of the board is a large FPGA (ALTERA® Cyclone), whose firmware can be directly customized by the user for his specific application.

The V1495 has a modular architecture: a mother-board with 98 I/O channels (64 inputs LVDS/ECL/PECL, 32 outputs LVDS, 2 I/O NIM/TTL) can be either used alone or expanded with 1, 2 or 3 additional piggy-back, choosing any combinations of the 4 available types:

- A395A: 32 LVDS/ECL/PECL input channels
- A395B: 32 LVDS output channels
- A395C: 32 ECL output channels
- A395D: 8 NIM/TTL input/output channels

V1495 General Purpose VME board



Highlights

- User programmable FPGA
- Up to 194 I/O channels
- LVDS / ECL / PECL / TTL / NIM signals
- 200 MHz min. bandwidth
- I/O delay < 15 ns
- 4 asynchronous independent timers

Applications

- Logic / Coincidence / Trigger
- Gate and Delay Generator
- Translator
- Fan in / Fan out
- I/O Register
- Test Pattern Generator

CAEN Nuclear

For more information, call us at +39.0584.388.398 or visit our website at

www.caen.it