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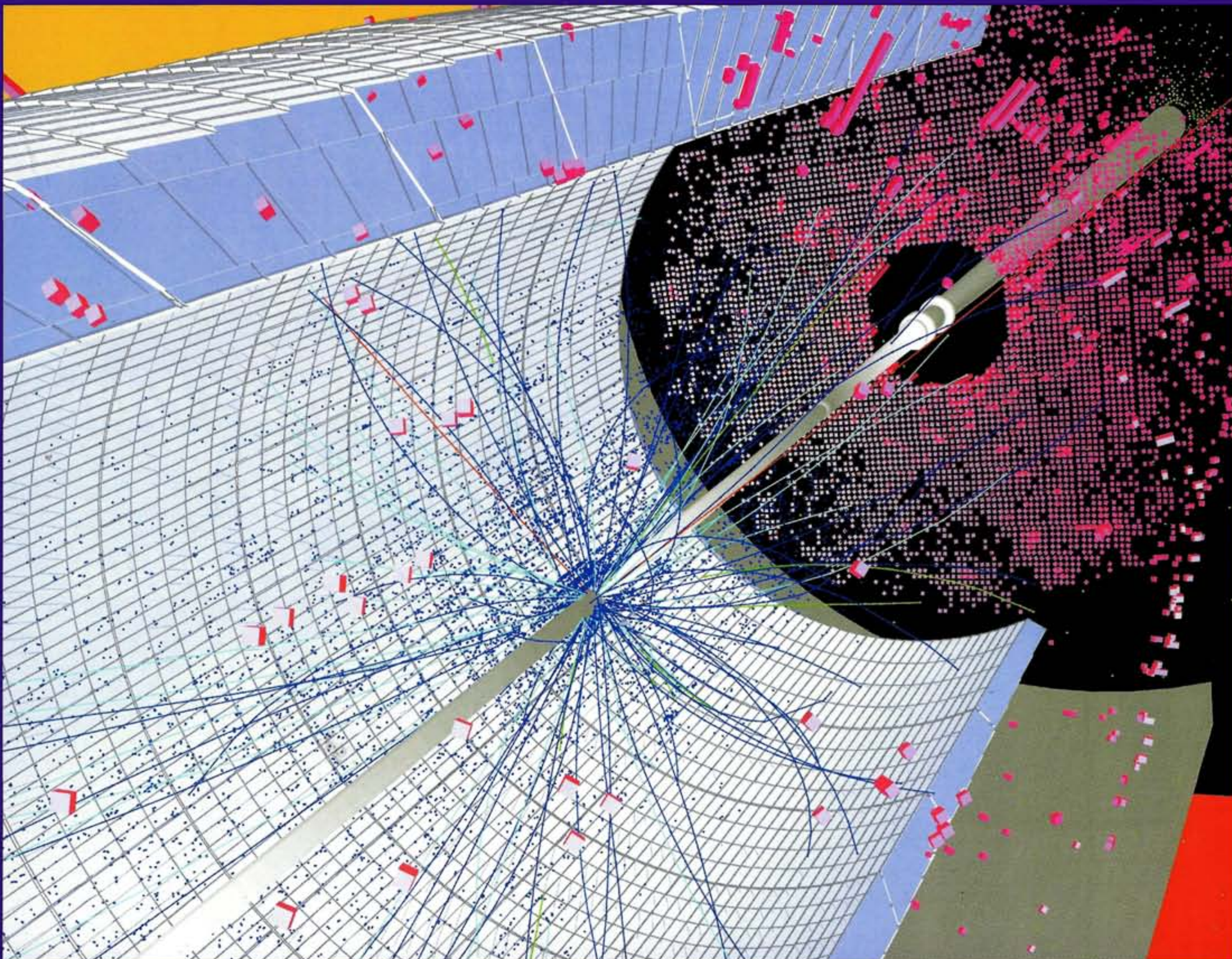

Computing enters the LHC era

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DO analysis goes offsite p16

1954-2004 CERN

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CERN COURIER

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BaBar hunts for aliens p5

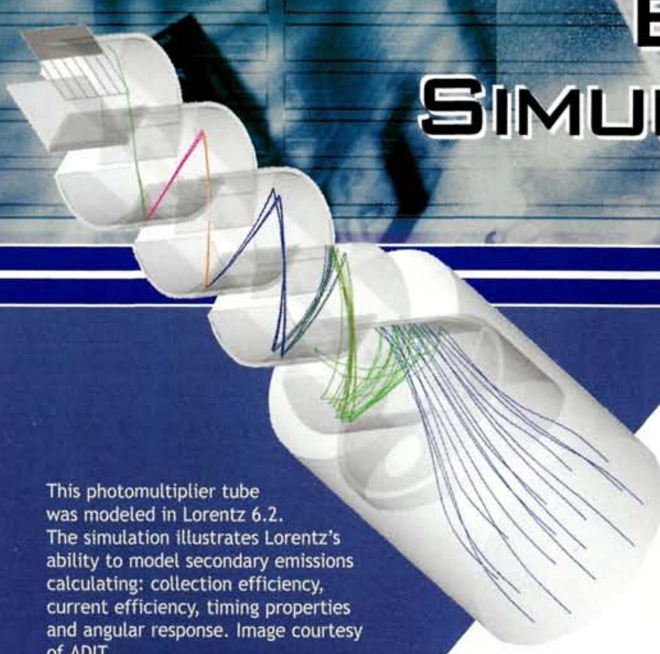
A look back at mainframes p32

Rubio takes over at CIEMAT p46

Cover: A simulation of a Higgs event in the CMS detector, in which the Higgs boson decays into two Z bosons, one of which decays to e^+e^- and the other to $\mu^+\mu^-$. The event was simulated and reconstructed as part of the CMS "Data challenge 2004" (DC04) that took place in April and May. The production of this event, from generation to appearance on a computer screen, involves a worldwide effort to prepare for the analysis of data from the LHC, including American and European Grid components and a full range of CMS and LHC Computing Grid tools and components. An article in the new Computer News section on p15 describes preparation at CERN's computer centre towards this effort.

integrated

ELECTROMAGNETIC SIMULATION SOFTWARE



This photomultiplier tube was modeled in Lorentz 6.2. The simulation illustrates Lorentz's ability to model secondary emissions calculating: collection efficiency, current efficiency, timing properties and angular response. Image courtesy of ADIT

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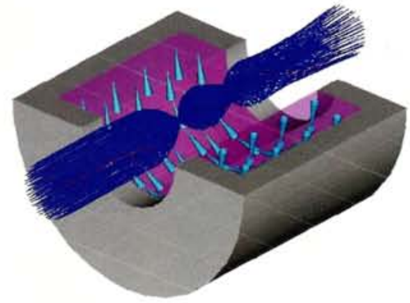
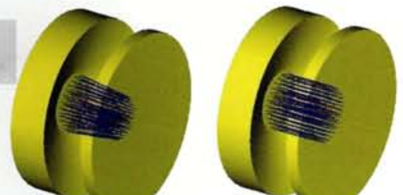


Solenoid lens with electrons traced through a magnetic field modeled in Lorentz-M 6.2.



Pierce electrode modeled in Lorentz-E 6.2. The model on the left shows no space charge, the model on the right is with space charge.

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NEWS

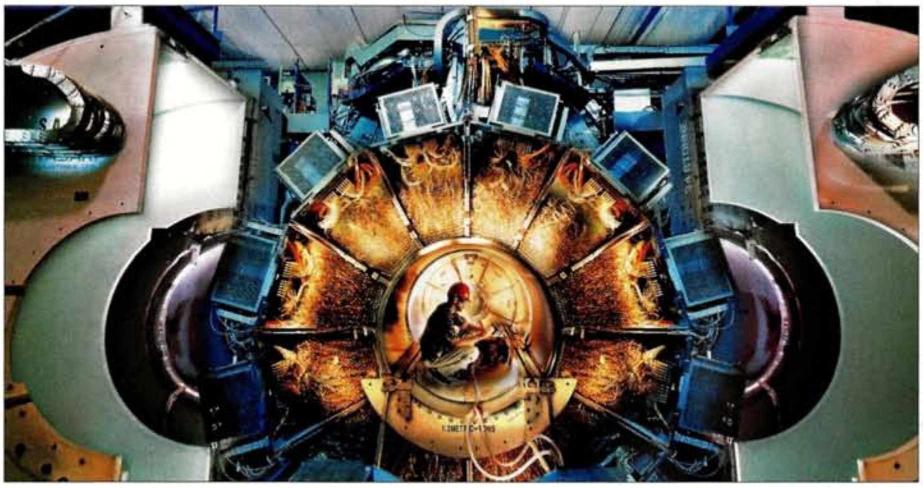
SLAC

BaBar finds direct CP violation in B decays

It is a classic example of the question to ask aliens from a distant galaxy to discover if they are made from what we on Earth define as matter or antimatter. Tell them to make neutral B mesons and anti-mesons and measure the decays to $K\pi$ pairs. Then ask whether the sign of the kaon in the most frequent decay has the same or opposite sign to the lepton orbiting the atoms that make up the galaxy's matter. If the answer is "yes", then the aliens are made from what we know of as antimatter, and it might be better not to invite them to visit Earth.

This in short is the experiment in which the BaBar collaboration at SLAC has observed direct CP violation in the neutral B-meson system – detecting the subtle effect that reveals a difference between the decays of particles and their antiparticles. Both BaBar and the Belle experiment at KEK in Japan have already established that CP violation occurs in the B-meson system, however, the earlier results related to processes that involve B^0–$\bar{B}^0$ oscillations. The key word with the latest measurements is "direct", as the BaBar collaboration has now observed CP violation in a process that does not involve oscillation, the decay of the neutral B meson to a $K\pi$ pair.

The BaBar team of 600 physicists and engineers from 75 institutions in Canada, China, France, Germany, Italy, the Netherlands, Norway, Russia, the UK and the US, has studied the decays of 227 million $\Upsilon(4S)$ particles to B–$\bar{B}$ pairs and selected the decays $B^0 \rightarrow K^+\pi^-$ and $\bar{B}^0 \rightarrow K^-\pi^+$. If CP symmetry were exact, then the two decays would be equally likely to occur, and by starting with equal numbers of Bs and $\bar{B}$s the experiment should end up with equal numbers of $K^+\pi^-$ and $K^-\pi^+$ pairs.



The BaBar detector at the PEP-II asymmetric energy e^+e^- collider at SLAC. (Courtesy SLAC.)

However, BaBar found more $K^+\pi^-$ pairs than $K^-\pi^+$ pairs in a total, $n_{K^-\pi^+} + n_{K^+\pi^-}$, of about 1600 events. The results yield an asymmetry of $(n_{K^-\pi^+} - n_{K^+\pi^-})/(n_{K^-\pi^+} + n_{K^+\pi^-}) = -0.133 \pm 0.030\,(\text{stat}) \pm 0.009\,(\text{syst})$, establishing direct CP violation in the B^0-meson system at the level of 4.2σ (Aubert *et al.* 2004). The Belle collaboration has recently published the result of a similar analysis based on around 1000 decays, in which they find an asymmetry of $-0.088 \pm 0.035 \pm 0.013$, but with a significance of 2.4σ (Chao *et al.* 2004). Belle has also reported evidence for direct CP violation at the level of 3.2σ in the decays $B^0 \rightarrow \pi^+\pi^-$ (Abe *et al.* 2004).

Direct CP violation was observed first in neutral kaons, in the NA48 experiment at CERN and the KTeV experiment at Fermilab. However, as expected theoretically, the effect now observed in the B^0 system is much larger. With an asymmetry of 13% measured by BaBar, the phenomenon is some 100 000 times stronger in neutral B mesons than in kaons.

Further reading

K Abe *et al.* 2004 *Phys. Rev. Lett.* **93** 021601.
B Aubert *et al.* 2004 www.arxiv.org/abs/hep-ex/0407057.
Y Chao *et al.* 2004 www.arxiv.org/abs/hep-ex/0407025.

JINR

ATLAS muon chambers leave Russia for CERN

On 6 July the vehicle with the first nine of 84 muon chambers made at the Dzhelepov Laboratory of Nuclear Problems (JINR DLNP) for the ATLAS experiment left Building 5 of DLNP and set out on its long journey to Geneva.

Having begun in 2000 within the framework of JINR's participation in the construction of the muon system for the ATLAS detector at the Large Hadron Collider, this work is now entering its final stage. In the coming year all the remaining muon chambers will be assembled and tested at JINR and transported to CERN.

Muon chambers for ATLAS are loaded onto the lorry at the start of their long journey.

Once at CERN the muon chambers will be tested again and put together with the "trigger" resistive plate chambers, which are being manufactured in Italian scientific centres. The complete assembly will then be given a final test before being installed in the ATLAS pit.

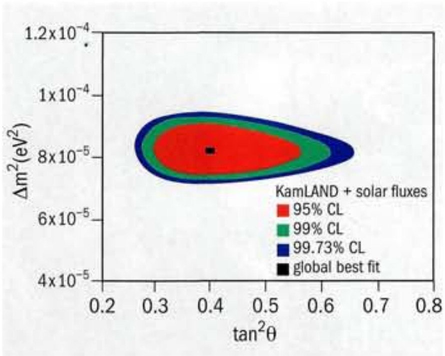
NEUTRINOS

KamLAND narrows options for oscillations

The KamLAND collaboration has announced an improved measurement of the oscillation between the first two neutrino families based on a 766.3 tonne-year exposure to reactor antineutrinos. This latest analysis also provides evidence of the distortion in the energy spectrum expected from the effects of electron–antineutrino oscillations.

The KamLAND detector, which is based on 1 kilotonne of ultra-pure liquid scintillator, is located near Toyama in Japan, where it is exposed to electron–antineutrinos from 53 nuclear power reactors in Japan, as well as Japanese research reactors and reactors outside Japan. The new results use data collected between March 2002 and January 2003 – or three times the amount of data used in the original measurement, which provided the first evidence that reactor antineutrinos "disappear" (*CERN Courier* March 2003 p7). Moreover, improvements in the analysis have allowed the fiducial volume of the detector to be increased by 33%.

With the new analysis, KamLAND observed 258 events with electron–antineutrino energies above 3.4 MeV, compared with 365.2 events expected if there were no neutrino oscillations. This puts the confidence level for the disappearance of reactor antineutrinos at 99.995%. The collaboration also found that the observed energy spectrum disagrees with the expected spectral shape in the absence of neutrino oscillations at the 99.9% confidence level. It does, however, agree with the distortion expected from electron–antineutrino oscillation effects.



The result of a combined two-neutrino oscillation analysis of KamLAND and the observed solar neutrino fluxes under the assumption of CPT invariance.

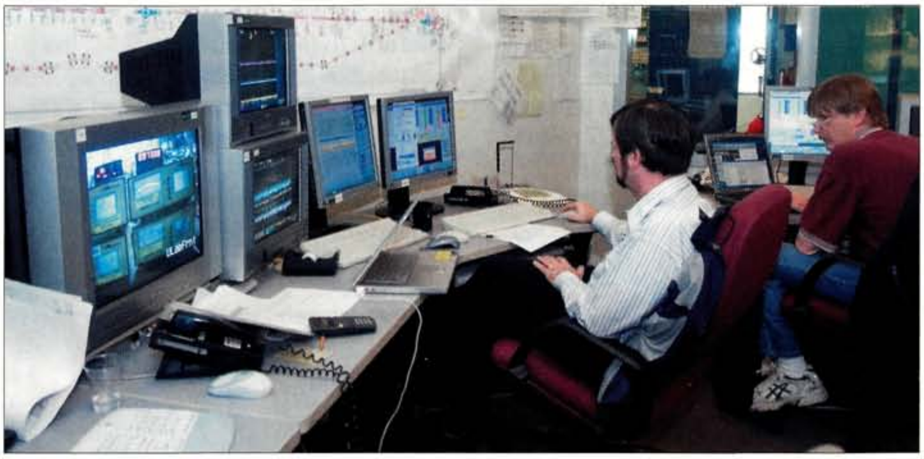
The first analysis from KamLAND, taken together with results from solar neutrino experiments, already restricted the parameter space for two neutrinos, favouring the large mixing angle solution. The latest two-neutrino oscillation analysis of the larger data sample gives a best-fit point at $\Delta m^2 = 8.3 \times 10^{-5}$ eV^2 and $\tan^2\theta = 0.41$. This disfavours the larger values of Δm^2 that KamLAND previously allowed. A two-neutrino global analysis of data from KamLAND and from solar neutrino experiments, together with the assumption of CPT invariance, further restricts the parameter space, as shown in the figure, with a best fit for the combined analysis at $\Delta m^2 = 8.2 + 0.6 - 0.5 \times 10^{-5}$eV^2 and $\tan^2\theta = 0.40 + 0.09 - 0.07$.

Further reading

T Araki *et al.* 2004 www.arxiv.org/hep-ex/0406035.

JLAB

Free-electron laser achieves 10 kilowatts



Steve Benson (left) and David Douglas (right) from Jefferson Lab tune up the free-electron laser hardware in preparation for a 10 kilowatt run. (Courtesy Greg Adams, JLab.)

The free-electron laser (FEL) located at the US Department of Energy's Thomas Jefferson National Accelerator Facility and supported by the Office of Naval Research achieved 10 kW of infrared laser light in late July, making it the most powerful tunable laser in the world. Several experiments are about to begin at the new facility, including a study of laser propagation through the atmosphere for the Naval Research Laboratory, the fabrication of carbon nanotubes by NASA scientists, and photochemistry and photobiology investigations.

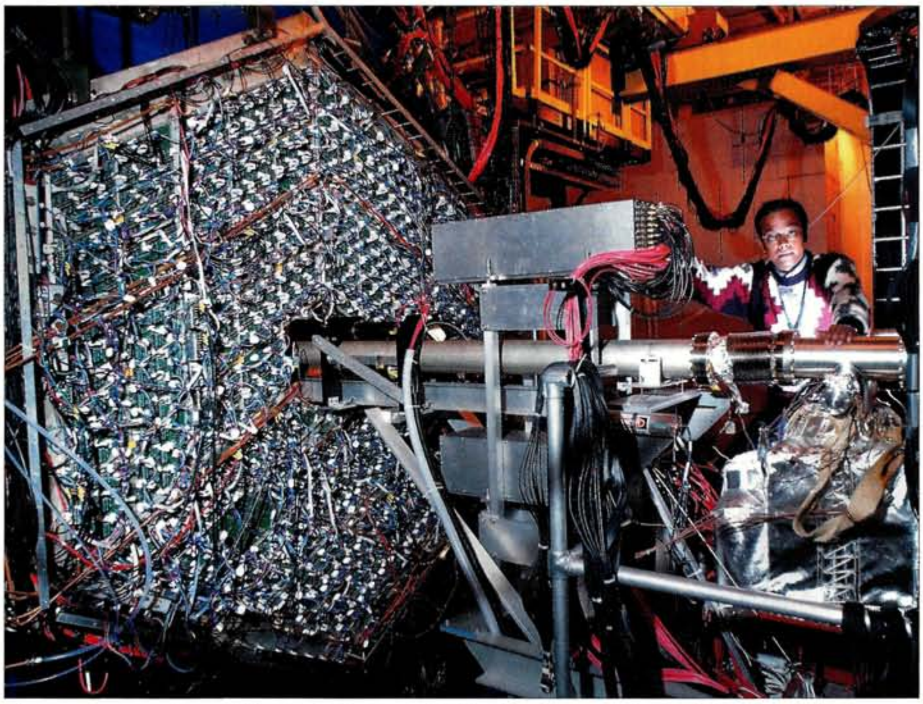
The FEL programme at Jefferson Lab began as the One-Kilowatt Demonstration FEL, which broke power records and made its mark as the world's brightest high-average-power laser. It delivered 2.1 kW of infrared light, more than twice what it was initially designed to achieve, before it was taken offline in November 2001 for an upgrade to 10 kW (*CERN Courier* September 2003 p6). During the upgrade process FEL staff installed new optics, more accelerating components, new power supplies in the injector and a new wiggler that enables the electron beam to produce laser light. These improvements increased the linear accelerator energy 300% (from 40 to 160 MeV), doubled the machine's achievable current and made it possible for the optics to take a 10-fold increase in power.

HEAVY IONS

Indian detector stars at Brookhaven

A detector built by an Indian team has begun running this year in the STAR experiment at the Relativistic Heavy Ion Collider at the Brookhaven National Laboratory. The Photon Multiplicity Detector (PMD) has been provided by a collaboration led by a group from the Variable Energy Cyclotron Centre in Kolkata, with colleagues from the Institute of Physics in Bhubaneswar and university groups from Chandigarh, Jaipur and Jammu.

The PMD is a preshower detector designed to study photon production of high particle densities in the forward region in relativistic heavy-ion collisions. This is an environment where calorimeters cannot be used due to the large overlap between particle showers. By measuring the spatial distribution of photons in phase space in common with charged particle detection, the PMD allows the study of event shapes and fluctuations in photon multiplicity and the charged to neutral ratio, thus throwing light on the deconfinement phase transition and chiral symmetry restoration. A PMD using plastic scintillators as the sensitive medium formed part of the WA93 and WA98 experiments at the CERN Super Proton Synchrotron (*CERN Courier* September 1991 p16 and January 1995 p14), and made a significant contribution to the study of relativistic heavy-ion collisions in these experiments.



The preshower plane of the STAR Photon Multiplicity Detector in the Wide Angle Hall at Brookhaven, viewed from the Relativistic Heavy Ion Collider tunnel.

The PMD built for STAR consists of a lead converter 15 mm thick, sandwiched between two planes of detectors with high granularity. The detector plane behind the lead detects photons through the electromagnetic showers they produce in the lead; the one in front helps to reject charged-particle hits. The detectors, which are based on the gas proportional counter, are formed from a honeycomb structure of cells with a copper cathode and tungsten wire anode, and a mixture of argon and carbon dioxide as the sensitive medium. The cells are 8 mm deep with a cross-sectional area of about 1 cm^2. Copper walls separate the cells in order to prevent cross-talk by confining low-energy δ-electrons to a single cell. A special feature of the design is its unusual aspect ratio, with the cell size and depth being of similar dimensions. In addition, the cathode extends on to the printed circuit boards covering the copper honeycomb so that the anode–cathode distance is less than 2 mm even though the physical separation between the copper cathode and anode wire is 5 mm. This extended cathode ensures uniform sensitivity of the detector throughout the cell volume.

The complete detector is constructed from units with a rhombus shape consisting of 24×24 cells. A number of these units, varying from four to nine, are housed in gas-tight enclosures called super-modules, and each plane of the PMD has 12 super-modules. The detector is assembled in two halves, which can be separated vertically and moved independently, with a final hexagonal shape.

The signal from the cells is processed using GASSIPLEX chips, developed at CERN, which provide 16-channel analogue multiplexed information. The analogue signals are digitized and read out using the C-RAMS ADC board. The front-end electronics board, consisting of four GASSIPLEX chips, is a 70 mm rhombus and is directly mounted on the unit module, almost covering the entire area of the detector over 8×8 cells.

The full PMD in STAR has about 83 000 cells in the two planes and covers an area of about 4 m^2. It is located near the east wall of the Wide Angle Hall at Brookhaven, 550 cm from the interaction point and behind the forward time-projection chamber.

The research and development for the design of the PMD was done in conjunction with a similar detector for the ALICE experiment at the Large Hadron Collider at CERN (*CERN Courier* November 2000 p17). The PMD has been funded by the Department of Atomic Energy and the Department of Science and Technology of the government of India, and is financially supported by the STAR collaboration.

Further reading

M M Aggarwal *et al.* 2002 *Nucl. Instr. Meth.* **A488** 131; 2003 **A499** 751.

Y P Viyogi, Variable Energy Cyclotron Centre, Kolkata, India.

EUROPE

EUROFEL and EUROTeV to receive EU support

The European Commission has selected two projects that are coordinated by DESY for support within the EU's Sixth Framework Programme.

The EUROFEL and EUROTeV projects were ranked first and second, respectively, in the referees' evaluation. From 2005 on, they will receive around €9 million each, spread over a period of three years. This corresponds to approximately one-third of the total costs estimated for each project. The remaining two-thirds will be born by the participating research institutions.

The EUROFEL project, in which 16 leading research institutions from five European countries are participating together with DESY, is a design study with the goal of developing jointly the physics and technology needed for the next generation of short-wave radiation sources, the free-electron lasers. Seven such facilities are currently being planned in Europe – in France, Germany, Italy, Sweden and the UK. Although the individual free-electron laser proposals partly differ in their choice of technology, they all share important issues such as the extremely high requirements concerning the quality of the electron beam, or the concepts of radiation generation. These are the issues on which the joint coordinated activities of the 16 participating research teams will concentrate.

The second project that was selected for support – EUROTeV – was proposed by 27 institutes from six European countries, among them DESY as the coordinating institution and CERN. This project's goal is to focus European research and development activities for the design of an international linear collider for particle physics, and to perform final-phase research and development work on essential components for the facility – in close agreement with the corresponding Asian and American committees.

There is worldwide consensus that such a linear collider is to be the next major accelerator for particle physics. One motive of the EUROTeV proposal is to develop a high-quality European structure that would later evolve into the European branch of the international planning group for a global linear-collider project.

CERN COURIER ARCHIVE: 1963

To celebrate the 50th anniversary of CERN, we look back at some of the items in the early issues of *CERN Courier*

CERN

New computer is installed

An IBM 7090 computer is now installed at CERN and has been working on a regular basis since 30 September [1963]. The presence of this machine should enable CERN to process work at about three times the rate possible with the previous IBM 709 computer, and it will undoubtedly be a valuable asset to the organization.

The computer left the factory at Poughkeepsie, USA, on 19 August and was flown to Cointrin Airport, Geneva, in a specially chartered DC-7, arriving on Saturday 24 August at 2 p.m. The CERN transport section unloaded the 26 cases, of total weight 14 800 kg, and moved them to a temporary storage location inside CERN. Until the final shut-down of the 709, the new computer remained in store, except for some of the tape units, which were moved into the computer barrack for checking.

At 6 p.m. on Friday 13 September the 709 was finally switched off and its removal started immediately. With the wonderful co-operation of CERN's transport section, the old computer was completely removed from the barrack by midnight on the same day, and on 14 September the new machine was moved in. The satellite computer (IBM 1401) used with the 709 was moved into an adjacent office and the manufacturer's engineers began to modify it. During the whole of the weekend the barrack was constantly vacuum cleaned to reduce dust, while the flooring panels were modified to provide access for the new units and cables. New doors into the computer room were made and the electrical power supply modified.

On Sunday 15 September power was turned on and testing could begin on both the 7090 and the 1401. The latter machine was functioning during the afternoon and work was processed on it the following day. The team of nine IBM engineers, coming from Switzerland, England and Germany, worked 24 hours a day to get the 7090 into operation, and testing went on continually throughout the week. Finally, on Friday 20 September, it was completed, and on the same day the 1401 was removed from its temporary position and re-installed in the computer room...

This photograph shows one of the computer operators, E Swoboda, seated at the operating console of the IBM 7090. The computer is controlled from here and monitor lamps indicate that it is functioning correctly. Looking over the console is H Klein, the senior operator.

The new computer, in contrast to the one it replaces, uses transistors instead of vacuum tubes. The consequent saving in space and a general improvement in design has resulted in a more compact machine and a consequent better general appearance.

• Taken from *CERN Courier* October 1963 p128.

NEWS FROM ABROAD

Zero-gradient synchrotron in operation

During the accelerator conference at Dubna in August it became known that the first beam had been accelerated in the "Zero-gradient synchrotron" (ZGS) at the Argonne National Laboratory, near Chicago, USA. Less than a month later came the news that on 18 September protons were accelerated to 12.7 GeV, a little above the design energy of 12.5 GeV.

The zero-gradient synchrotron is a ring-shaped proton accelerator approximately 61 metres in diameter, with the unusual feature of having a uniform magnetic field rather than one whose strength varies with radius, as in the CERN proton synchrotron (PS). The circular magnet of the Argonne machine, which is divided into eight sections, has a "picture-frame" cross-section and weighs a total of some 4000 tonnes. Focusing of the proton beam circulating in the vacuum tank inside this magnet is achieved by the special shape of the ends of each of the magnet octants, the chief advantage of this kind of design being that "multiturn injection" can be used. Thus, if the pulse of protons injected from the auxiliary linac is thought of as a continuous ribbon, in the case of the PS it cannot be longer than the circumference of the ring, whereas in the Argonne machine it can be perhaps as long as 100 turns round the ring. In this way, the ZGS is expected to produce very intense beams of particles, up to 10^{13} protons per pulse. The repetition rate is 15 pulses per minute.

The accelerator and its auxiliary buildings occupy an area of 47 acres (19 ha) and the total cost was some $50 million (215 million Swiss francs). Apart from its use by scientists at the Argonne laboratory, which is operated for the US Atomic Energy Commission by the University of Chicago, the accelerator will be available to the "Argonne Accelerator Users Group", which unites physicists from more than 50 universities and research laboratories in the "middle west" of the United States.

• Taken from *CERN Courier* October 1963 p135.

EDITOR'S NOTE

Computers have had an important role since the earliest days of CERN. The first mainframe, delivered in 1958, was a Ferranti Mercury based on vacuum tubes (p32). Four years later, the new generation of transistorized computing arrived with an IBM 7090, as described above. Now the mainframes have been replaced by "farms" of PCs (p15). The second item here describes the ZGS at Argonne, designed to produce very intense beams of protons. Attaining high intensities remains an important goal today (p29).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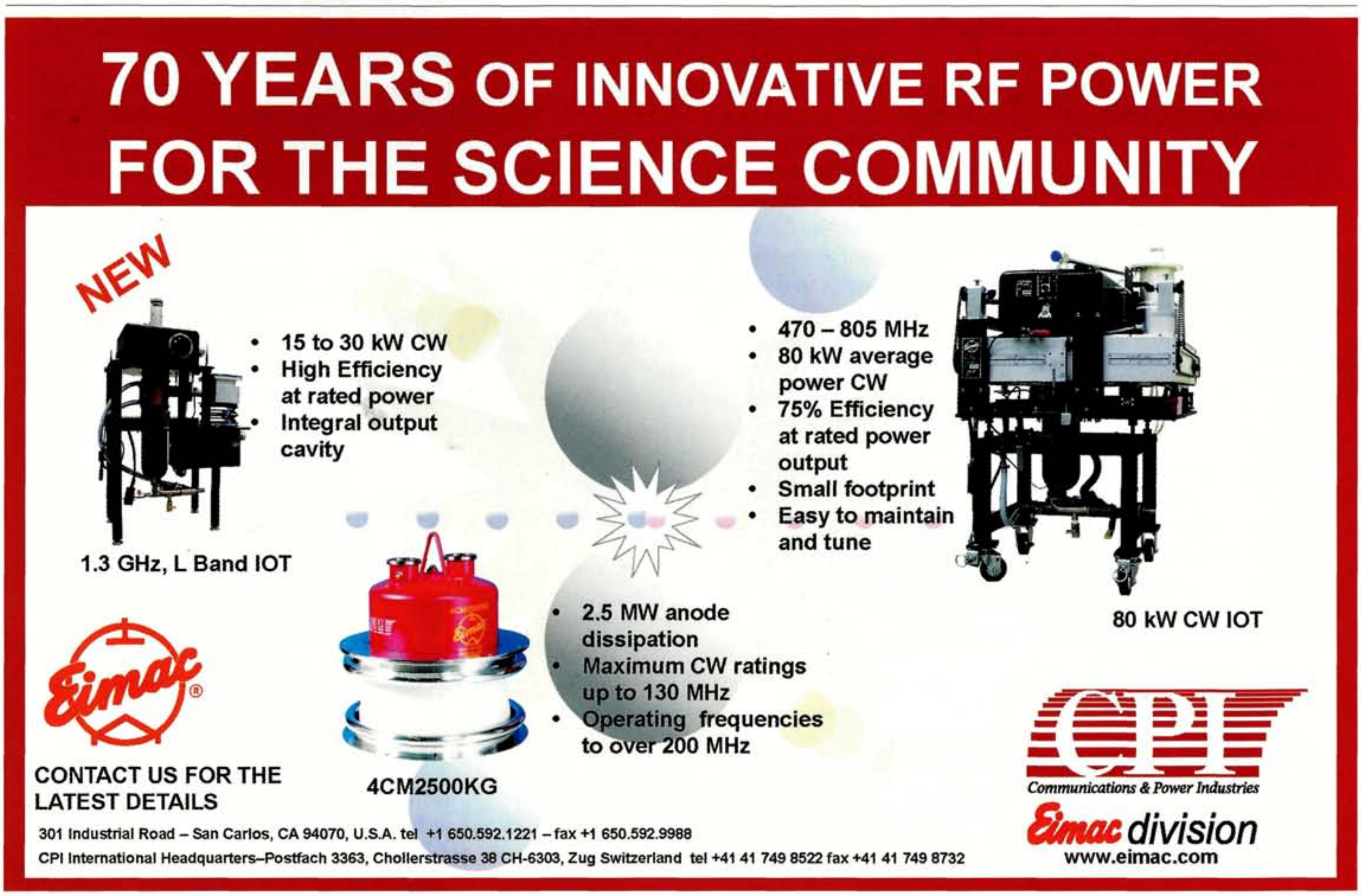
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Compiled by Steve Reucroft and John Swain, Northeastern University

Eggshells demonstrate the onset of fragmentation

A high-energy physicist contemplating fragmentation is likely to be thinking about quarks and gluons, but other things fragment too, as in the oft-cited example of eggshells. Now Ferenc Kun of the University of Debrecen and Falk Wittel and colleagues at the University of Stuttgart have considered how shell-shaped objects break into pieces. In a delightful paper they explain how they took ordinary eggs – both brown and white – made small holes in them, blew out the contents, and either catapulted them to the ground or filled them with hydrogen and blew them up.

The team found that the size of the pieces followed a power law with an exponent of 1.35 regardless of which way the eggshells are broken. This is much smaller than the known value of 2.5 obtained when solid objects break, but is in good agreement with computer models. All this means that one can make sensible estimates for how hollow objects break up. This finding has important applications for the current pressing problem of figuring out how debris in space is distributed, as well as in explosives engineering and perhaps even in understanding supernovae.

Further reading

F Wittel *et al.* 2004 *Phys. Rev. Lett.* **93** 035504.

The spin behind a transformer's hum

Sometimes the title of a paper hides the fact that it contains some fascinating physics. Take for example the article: "Origin of higher order magnetic exchange: evidence for local dimer exchange striction in $CsMn_{0.28}Mg_{0.72}Br_3$ probed by inelastic neutron scattering". If you dig deep enough in this one you'll find that it's about magnetostriction – the contraction of materials in a magnetic field which, among other things, leads to the hum of transformers whose metal cores contract and expand as the current in their coils changes with time.

Thierry Strässle and colleagues from ETH Zurich and the University of Bern have used neutron scattering to track down the effect at the microscopic level. They have found that it depends on the spin exchange interaction between pairs of manganese atoms (known as dimers), which tends to pull the magnetic moments together. These measurements on microscopic magnetostriction go beyond predictions of the traditional Heisenberg single exchange interaction model, although that still works well at macroscopic scales.

Further reading

T Strässle *et al.* 2004 *Phys. Rev. Lett.* **92** 257202.

Synchronization may underlie migraines

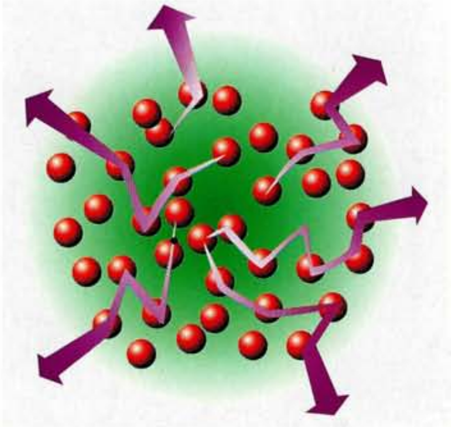
A typical physicist's approach to studying almost any system is to excite it in some way and see how it responds, and it seems this is paying off in the study of migraines. Sebino Stramaglia of the University of Bari and colleagues have flashed repeating visual patterns both at healthy people and at those suffering from migraines, and then looked at the electrical activity that their brains produced.

By decomposing this activity into various frequencies, Stramaglia's team could look at the "alpha rhythms", which correspond to 8 to 12.5 Hz and are associated with quiet alertness with closed eyes. The researchers found that in migraine sufferers these rhythms are much more synchronized across the brain than in healthy people. Of course the brain is a very complex system so it is still not clear what this means, but it does suggest that one might look for treatments that would interfere with this "hypersynchronization".

Further reading

L Angelini *et al.* 2004 *Phys. Rev. Lett.* **93** 038103.

The mysterious power of the long-distance photon



In a random laser, light scatters in the disordered material many times, keeping it trapped long enough for amplification and for laser light to emerge in random directions (Wiersma 2000).

Random lasers, which are made without conventional cavities formed by mirrors, relying instead on repeated bouncing of light in a disordered medium, have always had some mysterious features. One of these is that despite their randomness they often exhibit sharp, narrow emission lines. Now Diederik Wiersma and his colleagues at the European Laboratory for Non-Linear Spectroscopy and the Italian National Institute for the Physics of Matter, in Florence, have realized why.

The key insight is that some photons bounce around with very long path lengths, and while one might naively imagine that these rare long-distance runners would not be of much importance, this is far from the truth. A long path in an amplifying medium leads to a large gain, and this in turn means that these rare photons can be amplified by enormous amounts, picking up companions by stimulated emission at an incredible rate. So, in the end they play a role far larger than might have been expected.

Further reading

S Mujumdar *et al.* 2004 *Phys. Rev. Lett.* **93** 053903.
D Wiersma 2000 *Nature* **406** 132.

Compiled by Marc Türler, INTEGRAL Science Data Centre

Key piece for gamma-ray burst puzzle

A peculiar gamma-ray burst has been detected by ESA's INTEGRAL gamma-ray mission. This sub-energetic burst makes the link between an earlier anomalous event and all other bursts detected so far. It suggests that there is a wide population of such low-energy bursts yet to be discovered.

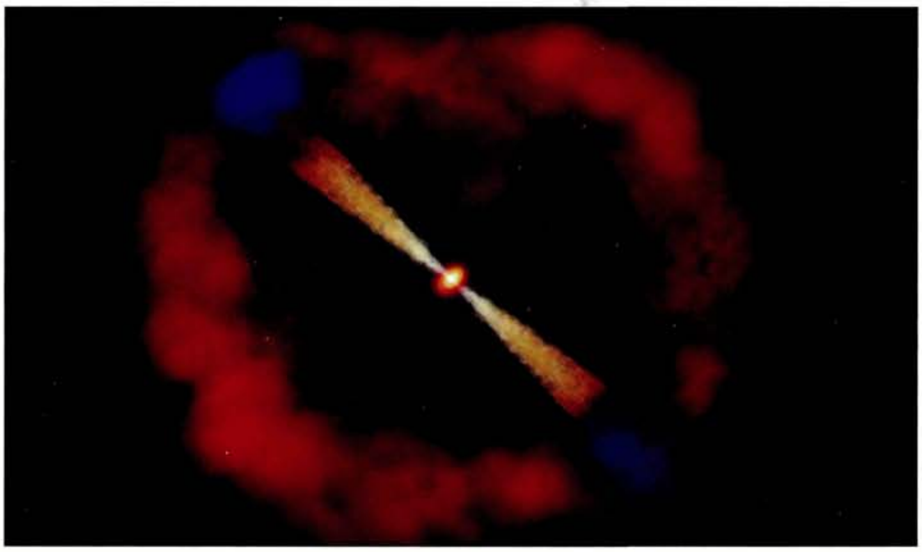
The afterglow of the gamma-ray burst, called GRB 031203, detected by INTEGRAL on 3 December 2003, has been thoroughly studied for months by space and ground-based observatories. The host galaxy of this event was identified at a redshift of $z = 0.1055$, corresponding to a distance of "only" 1.6 billion light-years. This makes GRB 031203 the second-closest burst measured so far after the peculiar GRB 980425 ($z = 0.0085$).

Since its discovery in 1998, GRB 980425 has been the subject of strong debate. It was found to be roughly coincident in time and direction with the very bright supernova 1998bw. If the two events are associated, it means that GRB 980425 is by far the nearest gamma-ray burst, only 130 million light-years away, and its inferred total energy is about 10 000 times less than for typical gamma-ray bursts. Having such a peculiar gamma-ray burst associated with an outstanding supernova was controversial, but it seems now, after further observations, that the two events are really physically linked and not a chance coincidence.

What remained unclear until recently is whether GRB 980425 was similar to the brighter gamma-ray bursts or an object of a different class. The discovery of a supernova associated with the "Rosetta stone" burst of 29 March 2003 (*CERN Courier* September 2003 p15) confirmed the link between supernova explosions and gamma-ray bursts suggested by GRB 980425. The newly discovered GRB 031203 now provides an example of a second sub-energetic gamma-ray burst like GRB 980425 and also associated with a similar supernova explosion. GRB 031203 is, however, at some greater distance and has a gamma-ray spectrum peaking at higher energies, as is observed for typical bursts.

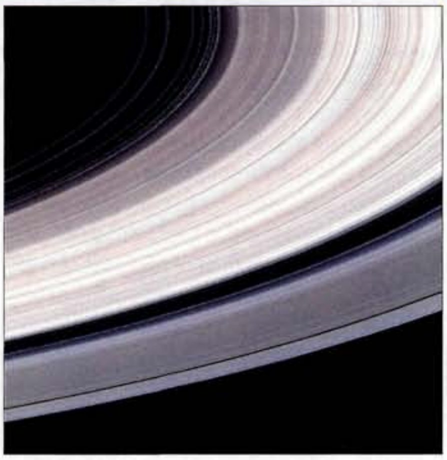
It has been suggested that all gamma-ray bursts are similar explosions and that the observed differences are mainly due to orientation effects. The authors of the two papers on GRB 031203 published recently in *Nature*, however, think that GRB 980425 and 031203 are both intrinsically sub-energetic, because of their faint afterglow and the absence of evidence that they are off-axis explosions (Sazonov *et al.* 2004, Soderberg *et al.* 2004). It seems therefore that gamma-ray bursts are a broad class of phenomena with energies varying by several orders of magnitudes. The partition of energy between the supernova and the relativistic ejecta at the origin of the burst seems likely to depend on the mass, size and rotation rate of the exploding star.

As GRB 031203 is already near the limit of detection with current instruments, astronomers eagerly await the launch of NASA's Swift mission scheduled for October. With its greater sensitivity, Swift should reveal a population of such sub-energetic bursts. Most bursts observed so far would then be only the bright tip of the iceberg.



Artist's impression of a gamma-ray burst model. A double-jet of high-energy particles ejected by a rapidly rotating black hole interacts with surrounding matter. (Credit: CXC/M Weiss.)

Picture of the month



Launched on 15 October 1997, Cassini-Huygens, the co-operative mission of NASA, ESA and the Italian Space Agency, finally reached Saturn on 1 July 2004. Twenty-three years after Voyager 2's fly-by, the ringed planet is again the subject of human curiosity. This exquisite natural colour view of its rings was taken at a distance of 6.4 million km from Saturn just nine days before the craft entered orbit. The rings are made of countless individual particles orbiting Saturn together. They range in size from large boulders to dust grains and are primarily made of water ice contaminated by rock or carbon compounds. (Credit: NASA/JPL/Space Science Institute.)

Further reading

S Sazonov *et al.* 2004 *Nature* **430** 646.
A M Soderberg *et al.* 2004 *Nature* **430** 648.

COMPUTING NEWS

Compiled by Hannelore Hämmerle and Nicole Crémel

INFRASTRUCTURE

CERN's computer centre gets ready for LHC

A major upgrade of CERN's computer centre has been underway for the past year to increase capacity for the facility's role as the heart of the LHC Computing Grid (LCG). Since services must be kept running round the clock during the upgrade, a rolling approach is needed. In a major migration last year many systems, including five StorageTek tape silos, were moved to the newly created machine room in the basement. This allowed an upgrade of the electrical distribution in half the main machine room to be done during the autumn.

A view of the new machine room in the basement of CERN's computer centre.

After this upgrade the centre can now cope with a demand of up to 1 MW in this area of the machine room, which is equivalent to about 5000 PCs. With all this power being turned into heat, adequate air-conditioning is a major concern and the first stages of a new underfloor cold-air distribution system have been installed to cope with increased demand. During the spring of 2004 equipment began to be moved over from the other half of the machine room, starting with the servers for CERN's administrative applications. These were moved to a dedicated area equipped with dual power supplies to ensure that these crucial services can be maintained even during an extended power cut – although full protection will only become available once a new substation is commissioned for the centre early in 2005.

To manage all of the equipment moves, close control over the configuration of the different systems and high levels of automation are essential. These are taken care of by ELFms, CERN's Extremely Large Farm management system. Two ELFms components, quattor (a system administration toolkit for automated installation, configuration and management of clusters and farms running UNIX derivatives) and the Hardware Management System have a particularly important role. The quattor Configuration Database, developed as part of the European DataGrid project, now holds information about more than 95% of the systems in the computer centre – information ranging from the precise details of the software installed to the location of the system in the computer centre.

Using the ELFms Hardware Management System (developed with support from the UK's GridPP as part of the LCG project) and information from quattor, the computer centre operations manager can produce a list of systems to be moved and know that the right people will be contacted in the correct order to shutdown and move systems, reinstall the operating system if required and then restart them on schedule. With almost 1500 machines moved in four months the newly deployed software has been given a thorough workout and has performed according to expectations.

Once this major move is complete the race will be on to upgrade the electrical distribution and air-conditioning in the second half of the machine room in time to house the equipment due to arrive early in 2005.

REACHING OUT TO USERS

Editor's note

This issue sees the introduction of a new section for the *CERN Courier*, containing computing news and short features. The goal is to reflect current developments in computing in high-energy physics laboratories and other centres around the world, and for the articles to address scientific computing in its broadest sense. It will appear in alternate issues, bringing some of the aspects of CERN's computer newsletter to a wider audience. There will be further articles and extended versions of some of the stories in this section available at www.cerncourier.com/articles/cnl.

Newsletter changes with the times

CERN has produced a computer newsletter for the past 38 years. During that period it has changed a great deal, reflecting the constantly evolving computing environment of high-energy physics.

The year 2004 marks yet another evolutionary step for two main reasons. First, the LHC Computing Grid (LCG), which CERN and its partners launched in the latter half of 2003, has grown this year into the first truly global computing Grid, with more than 60 participating sites by June 2004.

Second, a major project to establish an international Grid infrastructure, called Enabling Grids for E-Science in Europe (EGEE), was launched in April. This massive effort – the largest project of its kind ever funded by the EU – comprises 70 partners from Europe, the US and Russia.

In many ways the communities emerging around projects like LCG and EGEE resemble the global collaborations of thousands of scientists and engineers that build major high-energy physics experiments. It therefore makes sense to include a dedicated section on computing in *CERN Courier* for the benefit of these communities, which overlap with the magazine's traditional readership.

Robert Aymar, CERN director-general.

FERMILAB

D0 goes offsite for more power

Handling record amounts of data, particle physicists are increasingly relying on international collaboration to secure adequate computing power. The D0 collaboration at the Fermi National Accelerator Laboratory in the US is a case in point. Since the beginning of the Tevatron Collider Run II in March 2001, D0 scientists have recorded more than 1000 million particle collisions. The data fill 10 stacks of CDs as high as the Eiffel Tower – storage cases not included – and the stacks are growing daily.

"The Fermilab farms can process four million events per day," said Mike Diesburg, who manages the Fermilab cluster of 600 PCs for D0. This level of computing power can "handle the daily flow of incoming events".

Yet when the D0 collaboration decided to re-examine the entire set of collision data, encompassing more than 500 terabytes, scientists had to look for computing power beyond Fermilab. For the first time ever, D0 scientists had to send actual collision data – the crown jewels of their experiment – offsite.

"In the past, D0 and other particle-physics collaborations have used remote computing sites to carry out Monte Carlo simulations of their experiments," said D0 scientist Daniel Wicke from the University of Wuppertal, Germany, at Fermilab on sabbatical. "We are now one of the first experiments to process real collision data at remote sites. The effort has opened up many new computing resources for our collaboration. The evaluation of our experience will provide valuable input to the worldwide development of computer Grids."

"With the SAM software, a user doesn't need to know whether the data are stored on tape or on disk, at Fermilab or at Karlsruhe," said SAMGrid project co-leader Wyatt Merritt (left), pictured here with Mike Diesburg and Amber Boehnlein of Fermilab.

The reprocessing of the D0 collision data, coordinated by Diesburg and Wicke, so far involves computing resources in Canada, France, Germany, the Netherlands, the UK and the US. (Many other countries contribute to the computing of simulated D0 data and the analysis of processed data.) From November 2003 to January 2004, D0 groups in each of the six countries used local PC clusters and Grid networks, ranging from 100 to more than 1000 PCs, to reprocess data. The largest amount of offsite computing (36 million collisions) took place at the Centre de Calcul in Lyon, France.

To provide participating centres with data, the D0 collaboration relied on SAM, the Sequential Access Manager, which was developed at Fermilab.

Before the end of the year the D0 collaboration will again begin to reprocess Run II data, old and new, to apply further refined analysis tools. The new round will need even more offsite computing power, providing ample opportunity to develop the Grid further.

KEK

Farm offers real-time event reconstruction

The Belle experiment, which is a B-factory experiment at KEK in Japan, is now acquiring more and more data for the further study of CP violation in B meson decays. Recently the KEKB accelerator achieved the world's highest luminosity of $1.39 \times 10^{34}\ \text{cm}^{-2}\text{s}^{-1}$ and the value is still increasing (*CERN Courier* January/February 2003 p5). As a consequence, the consumption of data-recording media has been multiplying from the beginning of the experiment and may exceed a manageable limit in the near future.

The data used for the physics analysis are selected after a full event reconstruction performed offline. The proportion of selected events is about 25% of the recorded data. If the selection can be carried out before recording, the mass-storage consumption can be reduced drastically. For this purpose the Real Time Event Reconstruction Farm (RFARM) has been developed and added to the Belle data-acquisition system.

The RFARM consists of an input distributor node, event processing nodes, an output collector node with a fast disk system, and a control node. All of the nodes are PC servers with dual CPUs and they are operated under Linux (Red Hat v.7.3). The data flow of the RFARM is managed by a set of small programs, namely receivers, transmitters, a writer and ring-buffers. The ring-buffers are widely used to absorb a sudden change in the data-taking condition for a short period.

Control of the RFARM nodes is via the Network Shared Memory package, which is a home-grown slow-control software package and is capable of passing messages and sharing data over the network. The control network is separated from that used for the data flow. The operation of the RFARM nodes is carried out by exchanging messages with a control node. The histograms accumulated on event processing nodes are periodically collected and placed on the shared memory of the control node for the purpose of real-time data monitoring.

Following the discovery of CP violation in B meson decays, physics analysis at the Belle experiment is moving to the second stage, where the aim is not only to make precise measurements of CP violating parameters but also to probe new physics in the rare B meson decays. Fast and precise data processing is the key for these analyses. The RFARM is expected to play a major part in improving both the speed and the quality of the processing.

GRID TECHNOLOGY

The Grid gains new dimensions

A collaboration with leading IT companies is helping to make the LHC Computing Grid (LCG) a more heterogeneous place.

The ultimate dream of Grid computing is seamless access to different resources working on multiple platforms. The reality is that one has to walk before one can run, so much of the development to date is done on "plain vanilla" 32-bit processors running a standard version of Linux. The announcement in July that a cluster of 100 HP servers running 64-bit Intel Itanium 2 processors had been successfully enabled for full integration with the LCG was, therefore, a significant event. This was the result of the CERN openlab for DataGrid applications, a parternship between CERN and five leading IT companies – Enterasys Networks, HP, IBM, Intel and Oracle. Porting the LCG software to this environment was not trivial, and required several months of intense work by the CERN openlab team.

The CERN openlab, a three-year industrial co-operation formally launched in January 2003, has already tallied a number of impressive technical results (see *CERN Courier* October 2003 p31). Together, the partners have built the CERN opencluster, a state-of-the-art system for testing prototype Grid applications of increasing power and functionality. The open, collaborative environment of the partnership places an emphasis on a common development programme for data-intensive Grid computing based on open standards. This includes a 28 terabyte high-end storage system using IBM's advanced Storage Tank technology, which recently demonstrated scale-out capabilities to manage more than 100 simultaneous clients at data rates exceeding initial expectations from CERN. Other key elements of the opencluster are routing equipment from Enterasys Networks, and the advanced, grid-enabled Oracle Database 10g.

One of the spin-offs of this collaboration was the announcement by HP in January that it would be the first commercial member of LCG, contributing computing resources from its HP Labs locations in Palo Alto and Bristol, as well as from HP computing centres in Brazil and Puerto Rico. More than 150 HP nodes are expected to contribute to the LCG, and the CERN openlab team has been active in assisting HP with the initial deployment of the necessary Grid middleware. For HP, the incentive to participate in the LCG is that it provides a unique insight into the functionality and complexity of large-scale Grid environments, which may ultimately affect HP's strategy for utility computing.

CERN openlab has also introduced a status created to allow smaller high-tech companies with promising solutions to take part in this collaboration for a one-year period, along with the principal partners, who are sponsoring the collaboration over three years. Voltaire is the first company to join the CERN openlab collaboration as a contributor. For Voltaire the specific interest in joining CERN openlab is to test and verify the InfiniBand solutions that it provides. These enable high-performance Grid-computing applications to run on commodity servers and storage. Initially a 12-way switch will be evaluated between Xeon and Itanium systems. A 96-way InfiniBand switch is being installed. With InfiniBand, data can be streamed into the CERN opencluster quickly with minimal loss of CPU cycles, so that the cycles can be retained as far as possible for the data analysis.

The CERN openlab industrial partners are sponsoring equipment as well as CERN postdoctoral fellows and dedicated summer students. A conference in May attracted more than 100 companies to simultaneous events in London and Geneva. There John Manley, a research manager at HP Labs in Bristol, pointed out that engaging with CERN means, from the industry partner perspective, taking a strategic long-term view. "What seem to be extreme and specialized requirements today becomes mainstream in three to five years. To have the right technologies on that timescale it is necessary to engage with the owners of those extreme requirements today and CERN is the owner of requirements that are central to the evolution of utility/Grid computing."

The LCG at a glance

The spread of the LCG: launched in September 2003 with 12 sites contributing, the LCG has been growing very rapidly ever since. This map shows a snapshot of the 75 sites that were active by mid-August. A regularly updated map of the ongoing activity on the LCG can be accessed at http://goc.grid-support.ac.uk under the "monitoring", "LCG-2" section.

OPERATING SYSTEMS

CERN prepares for Linux changes

Gnu/Linux is the staple operating system for scientific computing, not least due to its wide availability and adaptability. The Linux distributions from Red Hat are the *de facto* standard for the high-energy physics (HEP) community, and so changes to Red Hat's distribution policy in 2003 were followed with intense interest. When the freely available Red Hat "Desktop" edition used by most of the HEP community as a base distribution disappeared, various options were explored. Most important was whether to buy the commercial "Enterprise Edition" from Red Hat or a community-supported distribution.

After negotiations between Red Hat, CERN and CERN's partner institutions, the framework for a commercial agreement has now emerged. It is based on a modest per-node fee, special conditions for very large clusters, call-in support for Red Hat modules and dedicated support for the overall release. Individual agreements under this framework would be available to all HEP sites, and modified distributions could be shared between participating sites. In parallel to these negotiations, Fermilab and CERN have worked together on "Scientific Linux", a freely available distribution based on recompiled Red Hat Enterprise 3.

CERN's next Linux distribution "SLC3" is based on Scientific Linux and is binary compatible both with the official Red Hat Enterprise 3 and other Scientific Linux variants, making it an attractive Grid platform. At the time of writing it is still being certified by the CERN user groups, but wide deployment at CERN is expected to start later this year. SLC3 will be freely available for redistribution, but comes with no formal support from CERN, Fermilab or Red Hat.

Before the next CERN Linux release, HEP laboratories will again share their experiences with the various support models at the HEPiX 2005 spring conference. CERN has licensed a limited number of nodes to gain practical experience, and other institutes such as SLAC have already decided to buy the official Red Hat Enterprise 3 version.

The feedback from users will give valuable input to the decision by CERN and other HEP sites later in 2005 to continue with a community-supported distribution or to buy the commercial product (and support) from Red Hat. A key implication of this decision would be that an external site wishing to use a commercially provided future release would be asked to license with Red Hat. As CERN prepares for such a possible scheme, feedback is being sought, in particular to learn whether such sites would be prepared to license nodes on which they wish to run CERN's future releases.

• For feedback, please contact Alan.Silverman@cern.ch or Jan.Iven@cern.ch.

SOUTH-EASTERN EUROPE

Co-operation aims to ease digital divide

SEE-GRID
South Eastern European GRid-enabled eInfrastructure Development

The National Grid Initiatives of the South Eastern European (SEE) countries have joined to form the South Eastern European Grid-Enabled eInfrastructure Development project (SEE-GRID; www.see-grid.org), which had its official start date on 1 May.

SEE-GRID aims to ease the digital divide between the SEE countries and the rest of Europe, with the ultimate objective of integrating the region into the pan-European Grid infrastructure. Initiatives like SEE-GRID can play a key role in an area where regional unrest was until recently hindering co-operation and economic growth. The activation of the Sarajevo–Belgrade communications link that was established within the SEEREN (South Eastern European Research and Education Network) project is an example of the concrete benefits that such projects can provide.

SEE-GRID will support dissemination activities about Grids, conferences and training material, demonstration test-beds for hands-on experience, operational and support centres, as well as organizing feasibility studies and preparing roadmaps for integration of the SEE region into the European Research Area via an extended Pan-European Grid infrastructure.

The initiative is coordinated by the Greek Research and Technology Network (GRNET) and the project consortium consists of representatives from National Grid Initiatives in Bulgaria (CLPP-BAS); Romania (ICI); Turkey (TUBITAK-ULAKBIM); Hungary (MTA-SZTAKI); Albania (ASA); Bosnia-Herzegovina (BIHARNET); F.Y.R. of Macedonia (UKIM); Serbia-Montenegro (UOB); and Croatia (RBI). CERN contributes in an advisory role.

To ensure the necessary critical mass, 18 regional research and academic institutions have been selected to participate as third parties to the consortium partners, and the entire project is further strengthened through close collaboration with the major pan-European Grid infrastructure project, entitled Enabling Grids for E-science in Europe (EGEE).

The SEEREN and SEE-GRID projects, co-funded by the European Commission and coordinated by GRNET, represent the commencement of new regional efforts in promising science and technology areas, and are milestones for integrating the region within pan-European eInfrastructures initiatives. This will help ease the digital divide, pave the way for future enlargement steps of the EU and contribute to overall stability and peace in the south-eastern European region.

Rewind

As CERN looks back over 50 years of history, we recall some of the moments in the life of CERN's computer newsletter.

35 years ago: multitasking CPU
What is taken for granted today, was a novelty in the 1960s.

"The CERN Computing Service has the responsibility of providing a general facility that satisfies the varied requirements of the users throughout the laboratory. CERN is equipped with large general-purpose computers that provide a 24 hour service, seven days a week.

"The principal computer is the CDC 6600, which was delivered to CERN at the beginning of 1965. The machine comprises a very fast central processor (CPU) and 10 smaller peripheral processors (PPU).

"The peripheral equipment comprises 16 magnetic tape units, 2 large disk files, 3 line printers, a card reader, punch, plotter and console. The CPU is capable of handling more than one job at a time as the monitoring PPU can direct its attention to any one of the programs in the central memory.

"In this multiprogramming mode more than one job can be in simultaneous operation, and the total resources of the computer are shared amongst the programs contained in the memory."

- *CNL* 47, 25 October 1969.

The CDC 6600 and CDC 3100 supercomputers in 1969.

E-SCIENCE UK

GridPP collaboration enters a new phase

GridPP2, the second stage of the UK's contribution to the LHC Computing Grid (LCG) will get under way in September. By 2007 this will develop the current GridPP testbed into a production grid of 10 000 CPUs that will be an integral part of LCG. GridPP2 is a £16 million collaboration of 19 UK universities, CCLRC and CERN, and is funded by the UK's Particle Physics and Astronomy Research Council.

GridPP has played a leading role in developing LCG over the past three years, both in the UK and at CERN. It has contributed more than £5 million to CERN, which has been used to support 25 staff positions and to purchase essential hardware needed for the LCG testbed. This is nearly 40% of all dedicated national resources allocated to the LCG project over those three years.

The mutual benefits for the UK and CERN were emphasized by Tony Doyle of the University of Glasgow, GridPP's project leader, at a GridPP meeting held at CERN in June. "The LCG project is the most challenging and urgent Grid project in science today, and the opportunity for many of our best and brightest young scientists and engineers to contribute has been a great educational experience."

- See www.gridpp.ac.uk.

Calendar of events

September
20–23 Global Grid Forum 12: Grids Deployed in the Enterprise Brussels, Belgium, www.ggf.org/Meetings/GGF11/GGF12.htm

20–23 Cluster 2004, IEEE International Conference on Cluster Computing San Diego, CA, http://grail.sdsc.edu/cluster2004

27–1 October CHEP'04 Computing in High-Energy Physics Interlaken, Switzerland, www.chep04.org

October
18–22 HEPiX meeting Brookhaven National Laboratory, http://cern.ch/wwwhepix/meetings.html

26 GridNets 2004 Workshop: Networks for Grid Applications San Jose, CA, www.gridnets.org

November
8 5th IEEE/ACM International Workshop on Grid Computing Pittsburgh, PA, www.gridbus.org/grid2004

22–26 EGEE 2nd Conference The Hague, the Netherlands, http://public.eu-egee.org/conferences/2nd

PRODUCT INFORMATION

Sigmer Technologies has launched Scribe v. 2, a website content-management system that enables businesses, ranging from blue chip companies to small and medium enterprises, to manage and update websites on a regular basis without the need for support from technical experts. Scribe has also been designed to help websites reach the highest level of accessibility – priority level 3 – in line with the UK's Disability Discrimination Act. See www.sigmer.com.

Systat Software, a leading developer and supplier of scientific software and services, has introduced v. 11 of its comprehensive statistical analysis software SYSTAT. This is significantly faster than the previous version and offers features such as Bayesian and robust regression, Monte-Carlo algorithms for complex simulation tasks, quality analysis features, hypothesis testing and fitting distribution procedures. See www.systat.com.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You can continually anticipate and respond to ever-changing circumstances. Making your business leaner, faster, smarter. On demand.
You can work secure in the knowledge that you have high data security and dependable firewalls. That's unbeatable peace of mind. On demand.
And you can make more informed business decisions using the right data thanks to real-time information. On demand.
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The plague of spam today

Louis McCaul, chief of the Information and Communication Technology Service at the UN in Geneva, is interviewed by **Jean Michel Jakobowicz**, editor of *UN Special*.

What is spam?
Spam is unsolicited e-mail. But the origin of the word "spam" is from a Monty Python sketch where a waitress insists on serving Spam, a brand of luncheon meat, with everything on the menu, while a group of Vikings at the next table sings "spam, spam, spam, spam", eventually drowning out the conversation. The analogy with unwanted e-mail flooding people's inboxes is very apt.

How does spam get in your mailbox?
It's sent by individuals or companies who have obtained or "made up" your e-mail address. This can be done in many different ways. There's Web-based software that does "e-mail harvesting". It searches the Web for e-mail addresses that have been left on websites. Another way is programs that automatically generate e-mail addresses. The worst thing you can do is reply to one of these e-mails saying "Take me off the list", because once you press the "unsubscribe" button, they know that it's a valid e-mail address.

How much spam is there?
According to the statistics between 30% and 50% of all e-mail is spam. The worst thing is that, globally, spam costs a lot of money – something like $8 billion per year.

What do you mean by cost?
When you send an e-mail, or when you receive an e-mail at the UN, it comes through our gateways into our network. It gets stored. It uses our connections to the Internet. All of that costs us money. If 50% of the traffic is spam then, effectively, 50% of what we are paying for is wasted. So there's real cost. And the main thing about spam is that real cost is borne totally by the person receiving it. It costs nothing to the person who is sending it.

Who's sending it?
Nobody knows for sure. For example, there are more than 300 000 different places advertising Viagra on the Internet. Many of these send spam. That's only for Viagra, but it can be anything from insurance, construction to sex – anything you can think of. The other aspect of it, of course, is the directly malicious spam containing viruses or worms.

What are viruses and worms?
A worm is something that propagates itself. It doesn't necessarily do damage on your PC. A virus will normally do some sort of damage. However, a worm can propagate itself to the extent where the whole network becomes overloaded and stops running.

What can be done?
Not a lot, actually. There are two schools of thought: block spam and throw it away, or send it through to a spam folder. I always feel uncomfortable about blocking e-mail because you can never be sure that it's spam. Either way it still uses the bandwidth for the Internet and it still ends up on a hard disk somewhere. It needs somehow to be blocked or identified as spam before it gets to our network.

Legally, what can you do against spam?
Some countries have just introduced new laws. The first prosecution took place last year in California. A company was fined $2 million for sending spam. The Internet being what it is, though, people will just go offshore, outside of Europe, or the US, and send spam from somewhere that's not under those legal restrictions. I don't think legislating will reduce the amount of spam, but it may eventually make it easier to identify.

How do we get spam from a known sender?
That's a classic virus attack on someone's PC. It happens mainly on home PCs. It frequently happens with Microsoft Outlook. The PC gets infected with a virus and the virus takes the mailing list from Microsoft Outlook and sends itself to all of the people on that mailing list.

What do you do at home where you don't have experts as you do in the office?
You have to have up-to-date antivirus software on the PC. You should download updates from the Internet on a regular basis – at least weekly [CERN recommends daily]. If you're running Windows XP you should at least have the built-in firewall. If you want to do it properly, you should invest in third-party firewall software and install it on your PC. And then you've got to manage it all.

Who's creating these viruses and worms?
Kids, hackers, people proving that they can beat big companies. The viruses come from places nobody knows, they get hidden inside codes that nobody knows about and they either do damage or they can just be a pain.

What's the alternative to the Internet?
So much business is done on the Internet now that there is no alternative. Of course, you could use dedicated lines, which is going back to the telephone, or virtually private networks. But if anything comes in from the outside, the risk is still there. Once you're connected to the Internet you're exposed.

• This is an abridged version of an article in January's *UN Special* (www.unspecial.org/UNS625/UNS_625_T10.html), reproduced with kind permission.

Alleviating spam's effects

Emmanuel Ormancey and **Alberto Pace** of CERN's Internet Services Group describe some new filter options for spam.

In principle, the best approach to tackling spam would be to use newer and more secure mail-transfer protocols that would ensure the traceability of e-mail messages (e.g. by using digitally signed messages and external, common certification authorities).

CERN is constantly evaluating new techniques for handling spam. For international organizations like CERN and the UN the challenge is to remain open to institutes that, for various reasons, are unable to deploy the latest methods promptly. It may take years for new technologies to become globally available, so people in such organizations can expect to continue to receive spam messages for some time to come, because they can't yet afford to "drop" untraceable mail messages, an important fraction of which are legitimate.

We all know the general advice that everyone should follow to avoid having their inbox flooded with spam: don't publish your e-mail address on public readable websites (forums, newsgroups or any generally indexable electronic publishing mechanism).

Unfortunately, once spammers have obtained a valid e-mail address there is no way to get it removed. You will receive increasing quantities of unsolicited messages until new e-mail distribution technologies are invented or you change your e-mail address.

The CERN mail gateways receive, on average, 800 000 messages every day with peaks of 1 200 000. More than half of these are immediately deleted with simple rules that detect evident spam, viruses and worms. For the remaining half, the probability of each being a spam message is calculated and it is always delivered to the user's mailbox, either to the inbox folder or to the "CERN spam" folder, according to the filtering level set by the user. After this additional filtering the amount of mail that is finally distributed to the inboxes of users normally represents about 20% of the mail initially received via the external gateways.

The "Spam fight" tool at CERN (at http://mmm.cern.ch) allows users to tune their spam filter configuration. They can choose between three levels of filtering, which tune the threshold at which a message with a calculated probability of being spam will be delivered to the "CERN spam" folder instead of their inbox. End users should understand the model and tune the anti-spam filter to a level that they estimate to be acceptable: a level set too low will deliver a lot of spam to the inbox; a level too high may deliver legitimate messages to the "CERN spam" folder ("false positives"), requiring constant monitoring by the user of the spam folder, which is counterproductive and thereby makes its *raison d'être* void.

The recent "Advanced mode" set-up of the CERN anti-spam filter gives additional tuning options that should help users who receive more than 150 spam messages per day. For instance, the advanced interface provides a "quarantine level", which is associated with a third, intermediate, folder between the "CERN spam" folder and the inbox, called the "Inbox.Quarantine". Only messages with a score below the "quarantine level" are delivered to the inbox, thereby reducing the burden of sifting through a very large amount of spam in search of a few false positives.

• For more details about the "Spam fight" tool at CERN, with explanations of all possible options and settings, please refer to the extended version of this article on www.cerncourier.com/articles/cnl.

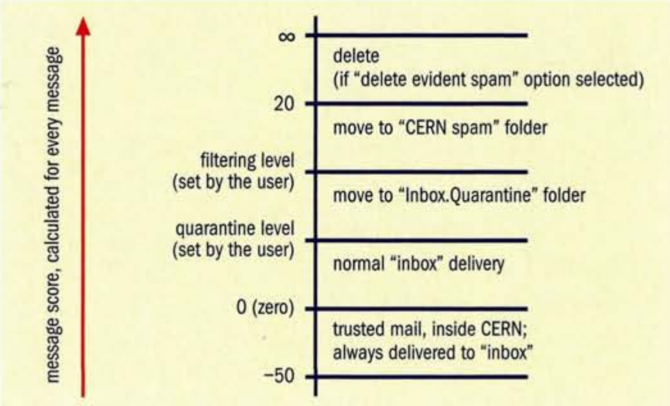
Emmanuel Ormancey *and* **Alberto Pace**, *CERN.*

Examples of spam

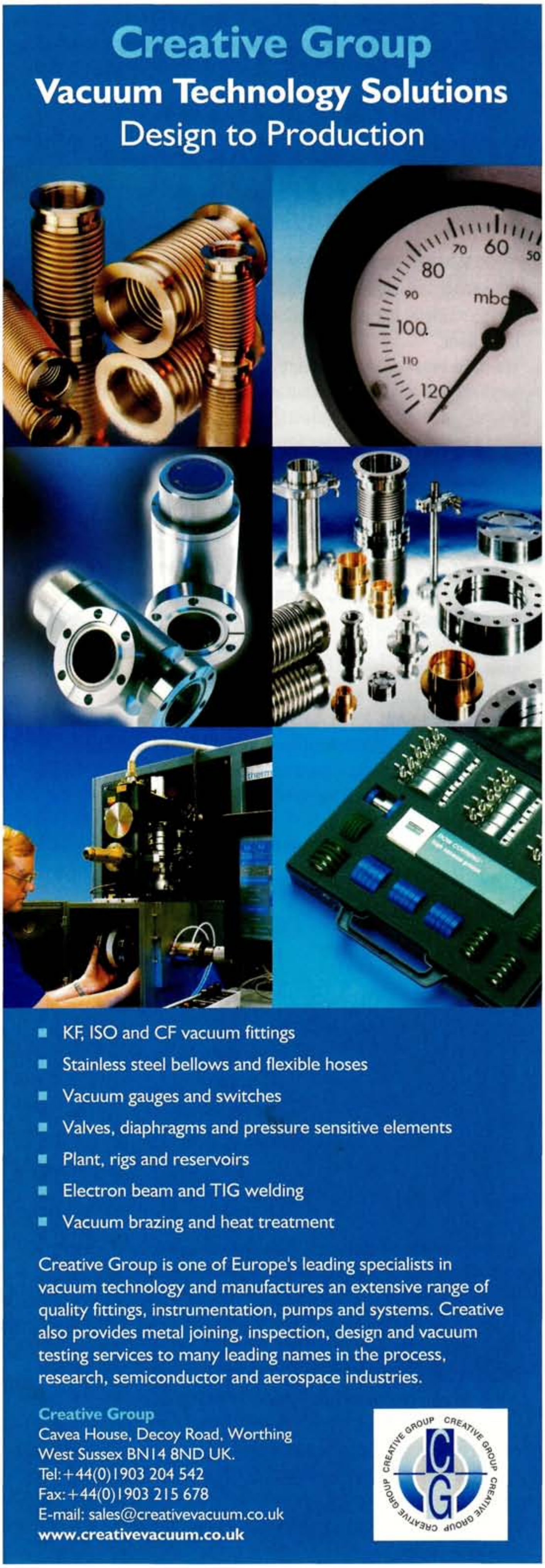
From: <official list you are subscribed to>
Dear user,
We have received reports that your email account was used to send a huge amount of spam messages...
We recommend you to follow the instructions in the attached zip file to keep your computer safe.

Subject: Security Patch for...
Welcome to Windows Update!
There are 10 critical updates available at this time...Get the latest updates available for your computer's operating system...Follow the link...Open the file, and new updates are installed...
Sincerely,
www.microsoft.com.

From: System Anti-Virus Administrator
Subject: Illegal attachment type found in sent message.
An illegal attachment type was found in an email message you sent. This email scanner intercepted it and stopped the entire message...
(for a message that you never sent)



The spam filter at CERN: a score of messages and action.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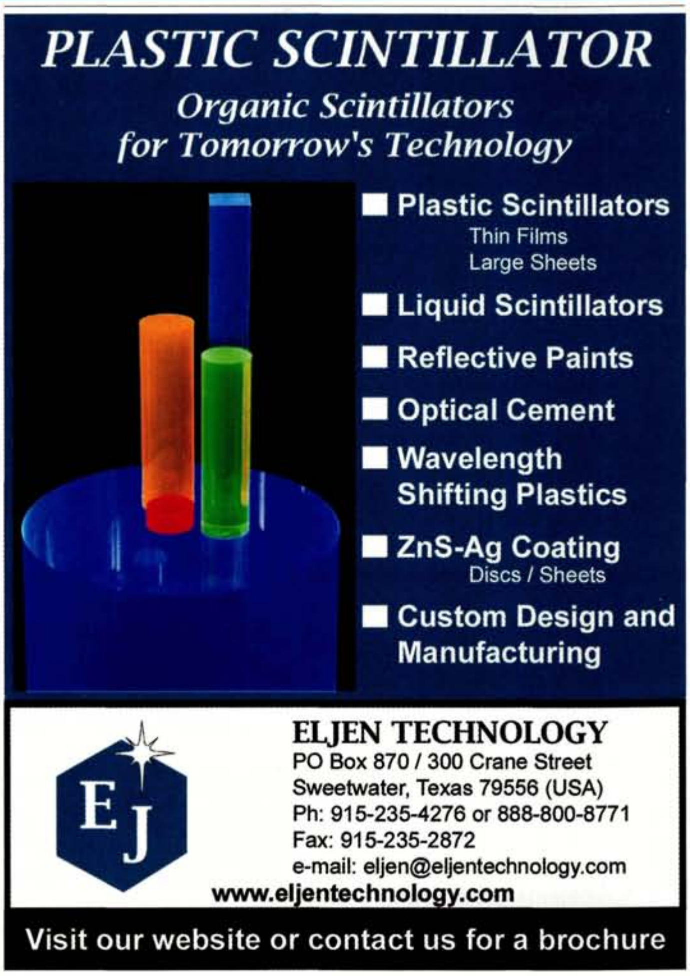
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Digging deep in the High Tatras mountains

The latest in the DIS series of workshops looked at probing the proton to reveal more about quantum chromodynamics.

DIS 2004 – the XII International Workshop on Deep Inelastic Scattering – took place in Štrbské Pleso in the High Tatras mountains in Slovakia on 14–18 April. The DIS series of workshops provides a forum for bringing together the latest experimental and theoretical results, both to increase the understanding of quantum chromodynamics (QCD) and to unravel the complicated structure of the proton. Organized by the Institute of Experimental Physics at the Slovak Academy of Sciences in Košice, in association with other Slovak high-energy physics institutes, DIS 2004 attracted 260 participants. After the welcome address by Slovak president Rudolf Schuster, the programme followed its usual well-tried format. It began with almost a full day of plenary review talks, before the participants divided up into working groups on the following topics: structure functions and low x; diffraction and vector mesons; hadronic final states; heavy flavours; electroweak and physics beyond the Standard Model; and spin physics. After three days the plenary session reconvened for reports from the working groups.

One of the hot topics was pentaquarks. Here, the experimental situation is puzzling. The narrow $\Theta_s(1530)$ state with B=S=1, predicted by the chiral soliton model, is seen by several experiments, including ZEUS and HERMES at HERA, but it has not yet been observed by HERA B. On the other hand H1 reports a narrow B=–C=±1 state at 3099 MeV, perhaps a little heavy for a Θ_c pentaquark, which is not seen by ZEUS (*CERN Courier* May 2004 p5).

Another exciting area is spin physics, which is about to enter a new era. High-precision data are due soon from the COMPASS experiment at CERN, from the Thomas Jefferson National Accelerator Facility (Jefferson Lab) and from the Relativistic Heavy Ion Collider at Brookhaven. These data will supplement the extensive information coming from HERMES and thereby probe the intricate spin structure of the proton. Jefferson Lab already has the first precise measurements of the structure function for scattering from transversely polarized neutrons, g_2^n, which allow a study of twist-3 operators.

Heavy quarks and gluons

The presentations of more accurate data on heavy flavours, together with a better implementation of QCD, showed that the discrepancy between the data and predictions on b-$\bar{b}$ production, found both at Fermilab's Tevatron and at HERA, has largely been resolved.

Participants at the DIS 2004 workshop line up against the backdrop of the High Tatras mountains in Slovakia.

Moreover, measurements were presented of the structure function F_2^b for the first time. This directly probes the b-quark content of the proton, while contributing only about 2% of the total proton structure function F_2 in the accessed region of high momentum transfer, Q^2, and Bjorken x of 0.01 (see figure 1, p28).

Indeed, there was considerable discussion on the partonic structure of the proton, which, in addition to its intrinsic interest, is so important for improving the predictions for searches at the Large Hadron Collider (LHC) at CERN. The experiments at HERA have opened up the domain of small x, and the present precision of the data allowed searching questions to be discussed at the workshop. What are the properties of the gluon? How large is the kinematic domain in which the Dokshitzer–Gribov–Lipatov–Altarelli–Parisi (DGLAP) evolution of parton densities is valid? Are $\ln(1/x)$ effects evident in the data? Is there any evidence of absorptive effects coming from parton recombination, or even of parton saturation? The experiments at HERA observe diffractive DIS events at about 10% of the rate of inclusive DIS events: what role does this diffractive process play? What is important for HERA to measure now?

One of the discoveries of HERA is the unexpected behaviour of the gluon. Analyses of the data at small x surprisingly reveal a valence-like gluon at low scales, whereas it is the sea quarks that grow with decreasing x. Moreover, the gluon is not well determined. For example at $Q^2 = 100\ \mathrm{GeV}^2$ there is at least a 10% uncertainty arising just from the statistical and systematic errors on the data, which becomes much greater at small and large x. Discussions at the workshop concentrated on the equally, and perhaps more, important theoretical uncertainties on the determinations of the partons. ▷

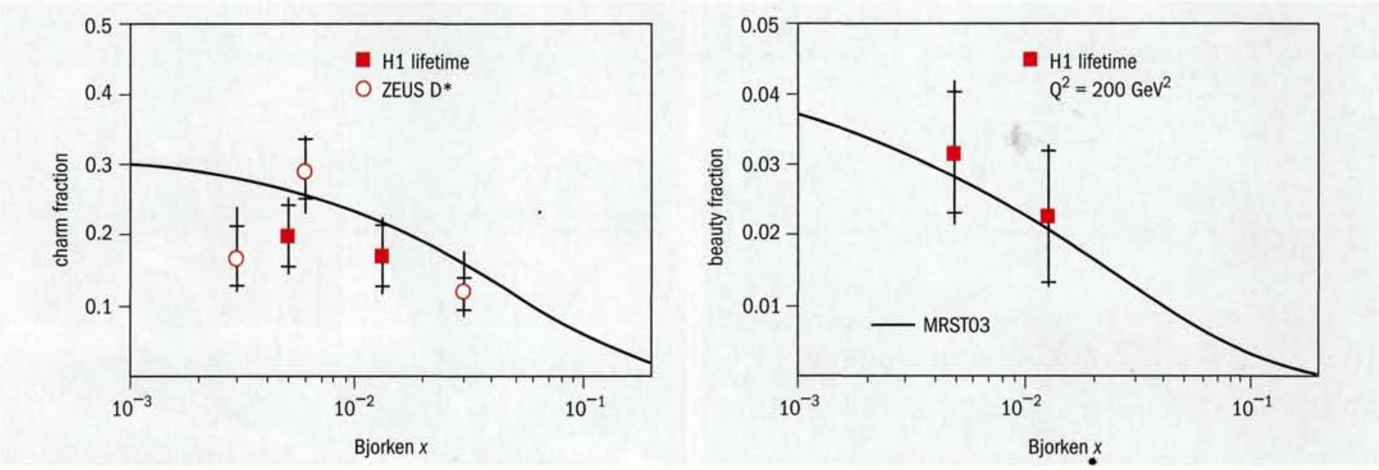


Fig. 1. Measurements at high momentum transfers of the contributions of c-quarks (left) and b-quarks (right) to the electron–proton scattering cross-section at HERA. The results are in good agreement with next-to-leading order QCD calculations by Martin, Roberts, Stirling and Thorne (MRST).

One major source of uncertainty was considerably reduced when Sven-Olaf Moch, Jos Vermaseren and Andreas Vogt presented, for the first time, the complete next-to-next-to-leading-order (NNLO) splitting functions. Their exact results lie in the middle of the approximate bounds previously determined, so the existing NNLO global analyses based on these bounds will be approximately valid. As of this workshop DIS studies have entered the NNLO era. Of course this is for evolution of the parton density within a pure DGLAP framework, which must break down at sufficiently low x and low Q^2. Presentations at the workshop showed that additional $\ln(1/x)$ effects are being brought under control; the indications are that they are not large in the kinematic domain explored at HERA.

There was also much discussion of parton saturation. The alternative non-linear equations, which describe saturation, are in fact equivalent; they simply view the parton recombination process from different Lozentz frames. Despite the theoretical activity the consensus of the workshop was that there was no evidence of saturation in the perturbative domain of the HERA data. This does not mean that absorption corrections – signalling the onset of saturation – are negligible. Indeed the recent diffractive DIS data from HERA allow an estimate of such effects, and hence of their influence on global parton analyses.

Looking at more detailed assumptions used in parton analyses, it became clear that the NuTeV experiment's anomaly in $\sin^2\theta_W$ may not exist. If we allow for strange quarks with $s \neq \bar{s}$, for isospin violating effects, and for contributions from quantum electrodynamics, then each is found to reduce the anomaly significantly. Indeed there are several aspects of the partonic structure that are within reach, if much more accurate measurements are made, including the valence d-quark distribution from charged-current positron–proton scattering; $s - \bar{s}$ from dimuon production in neutrino scattering; and the valence u+d distributions at low $x \approx 0.1$ from high statistics electron and positron data from HERA.

The identification of new physics at the LHC, Tevatron or HERA is likely to require precise predictions from the Standard Model, which in turn rely on accurately known partons. However, the gluon distribution, which is at the heart of parton analyses, is poorly known. It is determined by the scaling violations of F_2, by F_2-charm and by jet data from the Tevatron and HERA. It became clear at DIS 2004 that it is crucial to measure the longitudinal structure function F_L; it is a direct "orthogonal" measure of the gluon. Simulations that were presented showed how running HERA at four different proton energies would have a decisive effect on determining the gluon, and, in turn, much improve the determination of the QCD coupling.

Precision diffractive DIS data are now available, and diffractive parton densities were presented. These densities are not universal. Care is required to take them from one diffractive process to another, since we must allow for the probability that the rapidity gaps survive population by secondaries from the underlying event. The probabilities depend on the diffractive process. There was much discussion of the new data for these exclusive diffractive processes, both from HERA and the Tevatron. The analysis of the recent HERA data for the photoproduction of dijets was particularly illuminating in this respect.

A prosperous future?

In summary, DIS continues to flourish, with the presentation of a wealth of new results that produced vigorous debate. Much remains to be learnt and we are only just getting to grips with many basic problems, for which the data are either insufficient or even absent. It is inconceivable that HERA will not measure F_L – but it remains to be done. There are a host of processes for which a ten-fold increase in luminosity would be invaluable, even forgetting the possibility of the discovery of surprise exotic phenomena. It became clear at the workshop that probing the proton at high energies is revealing more and more information about QCD, which needs to be theoretically understood, with important implications for all high-energy phenomena and the LHC in particular. It would be a tragedy if the HERA programme ran out of time while the physics potential of the machine is just coming to its prime.

Alan Martin, *Institute for Particle Physics Phenomenology, Durham.*

The high-intensity frontier

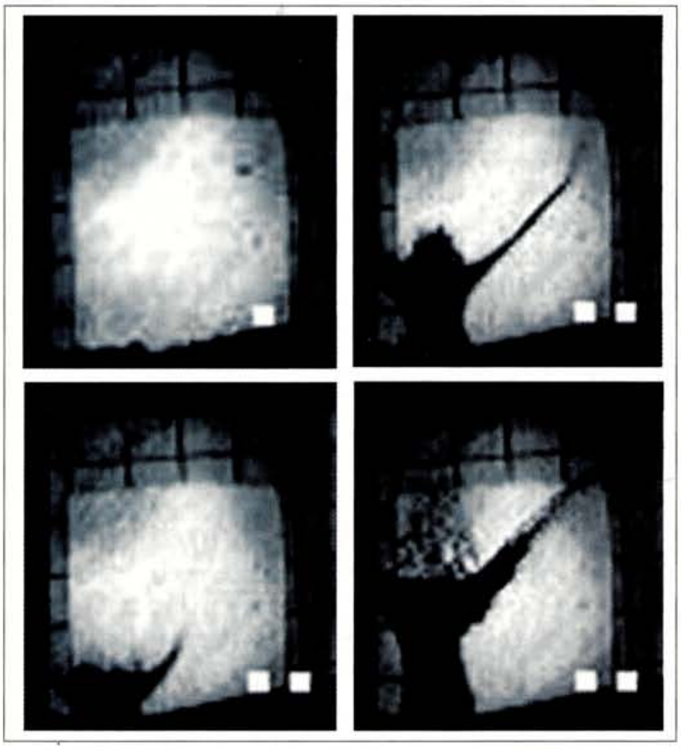
A high-intensity proton accelerator operating at a few giga-electron-volts would offer a wide range of opportunities for both particle and nuclear physics.

There are two main frontiers for particle accelerators – high energies and high intensities – and it is the latter that attracted participants to the "Physics with a multi-megawatt proton source" workshop held at CERN on 25–27 May. The meeting was organized by the ECFA Muon Study Group and the European Commission network on "Beams for European Neutrino Experiments" (BENE), in close collaboration with the community involved with the "next-generation" European isotope separation on-line radioactive ion-beam facility, EURISOL. The focus was on physics at the high-intensity frontier and the main aim was to explore the short- and long-term opportunities in Europe for particle and nuclear physics at a multi-MW, few-GeV proton accelerator.

CERN's director-general Robert Aymar opened the meeting by recalling that CERN has a history and a mission of building and operating accelerators at the high-energy frontier. The latest is the Large Hadron Collider (LHC) and a compact linear collider (CLIC) may follow. CERN also has a successful tradition of exploiting its accelerator complex, so as to address diverse issues in particle physics simultaneously – for example, with fixed-target experiments, neutrinos, radioactive ions and antiprotons. Although the LHC is currently the absolute priority, plans should be made now for future investments. Aymar concluded by asking the workshop to contribute to the optimal evolution of the accelerators at CERN, so as to permit the most ambitious and promising spectrum of physics experiments in future.

In an inspired talk, John Ellis of CERN then summarized the most compelling motivations for physics programmes at the high-intensity frontier. The discovery of neutrino oscillations has opened a new window of exploration, which is unique in several ways. Measured mass splittings and mixings for neutrinos are the first experimental data we have on physics at higher energy scales. The potential discovery of leptonic charge–parity (CP) violation promises an insight into the origin of the most fundamental asymmetries of the universe. The accelerator neutrino community in Europe, in particular the ECFA/BENE network, will do its utmost to maintain a leading role in accelerator neutrino experiments beyond the CERN Neutrinos to Gran Sasso (CNGS) project. In another direction, the manifestation of the strong and weak interaction in the atomic nucleus can be rigorously investigated by means of radioactive ion beams. Under the leadership of the Nuclear Physics European Collaboration Committee (NuPECC), a large community of European Union (EU) nuclear physicists is advocating the physics potential of the new world-leading facility, EURISOL, for nuclear, astro- and fundamental physics, which will be some 1000 times more intense than present facilities.

Presenting Japanese plans, Shoji Nagamiya, director of the Japan Proton Accelerator Research Complex, J-PARC, described the progress and physics potential at this new facility. In terms of both its physics programme – a joint venture between particle and nuclear physics – and its push for a higher power of 0.75 MW, possibly evolving to a few MW, J-PARC is the natural benchmark for any future high-power facility. Steve Holmes of Fermilab then described plans in the US for new high-power proton drivers. Studies are centred on the Brookhaven National Laboratory, with a 1.2 GeV superconducting linac and an important upgrade of the Alternating Gradient Synchrotron, and Fermilab, with two scenarios: an 8 GeV synchrotron with a 600 MeV linac or an 8 GeV superconducting linac.



Results from the CERN Passive Mercury Thimble test at the AGS at Brookhaven to investigate dense targets suitable for use with an intense proton beam at a neutrino factory. The pictures, taken at 0, 0.5, 1.6 and 3.4 ms after a pulse of 2×10^{12} protons interacted with a "thimble" of mercury, show the dispersal of the mercury by the beam.

Super-beams, beta-beams and factories

In the first of several presentations on current ideas in Europe, CERN's Roland Garoby introduced the 2.2 GeV Superconducting Proton Linac (SPL), under consideration at CERN, in which cycling at 50 Hz results in a mean beam power of 4 MW. For neutrino physics an accumulator and compressor ring would be added to reduce the beam pulse to 3 microseconds (the so-called "super-beam") and the length of the bunches to 1 ns rms. For a radioactive ion-beam facility the linac ▷

beam would be used directly. The advantage to CERN of the SPL would be as a replacement for the Proton Synchrotron Booster (PSB).

The SPL study benefits from a collaboration between CERN and the Injecteur de Protons de Haute Intensité project (IPHI) and the support of the EU's Sixth Framework Programme (FP6) and the International Science and Technology Centre for projects in Russia. If a positive decision on the SPL is taken in 2006–2007, the low-energy section could be operational in 2010–2011 and could replace Linac2 to increase the performance of the PSB and the PS; the SPL itself could be ready in 2014–2015.

Rapid cycling synchrotrons (RCSs) also offer interesting possibilities, especially for beam energies beyond a few GeV. Chris Prior from the Rutherford Appleton Laboratory (RAL) illustrated the potential of this alternative by describing RAL's machine ISIS (~0.2 MW at 800 MeV) in detail. He also presented the plans for future proton drivers with multi-MW beam power envisaged at RAL, FNAL, J-PARC and CERN. Although the experience with existing machines is encouraging, these new projects represent a significant step forward in beam power and there are technical challenges on numerous issues, such as beam loss and the stripping and capture of ions.

Exploiting the beam delivered by such an accelerator is a similarly ambitious goal. Helmut Haseroth of CERN highlighted what this means for neutrino physics. Three different production techniques are envisaged: the "super-beam", the "beta-beam" and the "neutrino factory". For the super-beam, neutrinos result from the decay of pions immediately after the target. In the beta-beam case, beta-radioactive ions are generated and accelerated to a γ factor of around 100 and stored in a few bunches inside a ring with long straight sections pointing at remote experiments (*CERN Courier* July/August 2004 p30). Neutrino bursts are generated by the beta decays. In a neutrino factory, muons from the pion decays are collected behind the target, "cooled" and accelerated to 20–50 GeV, and then stored in a ring with long straight sections pointing at remote experiments, where neutrinos result from the muon decays.

Extensive R&D is required for any of these ambitious plans with neutrinos to be realized during the next decade. The work already undertaken by the American and Japanese teams should be complemented by a similar effort in Europe, resulting possibly in a joint target experiment at CERN. The technology of the target and the focusing devices is challenging, but largely common to the super-beam and the neutrino factory. R&D is also still needed for the muon phase rotation and cooling stages of a neutrino factory. Complementary resources are eagerly expected for the international Muon Ionization Cooling Experiment (MICE), which has been approved "scientifically" at RAL. Although the development of fixed-field accelerating-gradient machines for muon acceleration may render cooling superfluous, the highest energy with lepton colliders is obtained with circular muon colliders, which require cooled beams to achieve the desired luminosities. For the beta-beam the main technological issue is the generation of the radioactive ion beam and its acceleration without excessive irradiation of the machine components.

The energy of the primary proton beam is a crucial parameter in the optimization of a neutrino beam. Marco Apollonio of Trieste described the Hadron Production Experiment (HARP) at CERN, which will provide decisive data in that respect. The data necessary for selecting the optimum energy for a proton driver is expected to be available later this year.

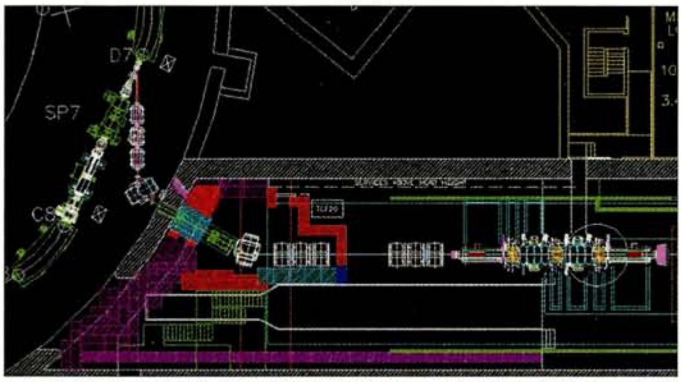
The Hadron Production Experiment at CERN will provide vital data for the optimization of neutrino beams.

The SPL would be an excellent proton driver for a future nuclear-physics facility. The additional installations that would be required were presented by Alex Mueller of IPN Orsay, based on the study carried out for EURISOL. This European project for an accelerated radioactive ion-beam facility uses the isotope separation on-line method for ion generation, with the goal of attaining beam intensities thousands of times higher than at current facilities such as REX-ISOLDE at CERN and SPIRAL at GANIL in France.

CERN's Mats Lindroos concluded the accelerator session by describing the concept of a beta-beam facility based on the original idea of Piero Zucchelli of CERN. The key feature is that "slow" accelerators can be used because the radioactive ions have a lifetime that is three orders of magnitude longer than muons. Although it will stretch the techniques mastered for nuclear physics well beyond today's performance, experts are confident that solutions can be found for the production of the required ion beams. The promises of this scheme together with the remarkable synergy between nuclear and neutrino physics justify the necessary R&D, and a feasibility study is included in the EURISOL Design Study that was submitted to the EU in March this year.

From neutrinos to exotic atoms

Opening the particle-physics session, Pilar Hernandez of Valencia presented an in-depth review of the prospects for neutrino-oscillation physics at a megawatt neutrino complex. She reviewed the excitement of recent discoveries and the relative merits of super-beams, beta-beams and neutrino factories. Luigi Mosca of Saclay outlined the status and plans for a new very-large European underground laboratory at the Frejus site. It could host detectors of unprecedented size – up to one megatonne – for the study of proton decay and astrophysical neutrinos (supernovae), as well as of the low-energy neutrinos from super-beams and beta-beams. Chan Kee Jung of Stony Brook reviewed the potential of a megatonne or half-megatonne water Cherenkov detector, as envisaged for the proposed Underground Nucleon Decay and Neutrino Observatory (UNO). This is a proven and well established technique and its extrapolation to larger mass seems



Layout of the planned Muon Ionization Cooling Experiment (MICE) at RAL, with the ISIS ring and pion-producing target at left. A muon beam produced from the decay of the pions is transferred to the MICE experiment on the right.

feasible. An exiting alternative using liquid argon time-projection chambers was also described by Antonio Ereditato of Naples. In this case the lower detector mass of about 0.1 megatonnes is acceptable, thanks to the superior granularity and pattern-recognition capability.

Steve Geer of Fermilab described the merits of physics at a neutrino factory – the most promising, ultimate neutrino facility, and the natural tool for the final and complete exploration of neutrino mixing and mass splittings, and leptonic CP violation. The higher event rates would allow smaller detectors (around 50 kilotonnes) that would need charge identification, but which could be located in existing labs. Systematic uncertainties in this case are less severe. Much accelerator R&D in this field is in progress or being planned by enthusiastic worldwide collaborations, specifically for the phase rotation and cooling of large muon "clouds" and for the acceleration and storage stages further downstream. Geer stressed that timely R&D is essential, in particular for MICE and the proposed target experiment at CERN.

Pasquale Migliozzi of Naples discussed the absolute necessity of near-detector stations for the study of neutrino oscillations. Only with the precise measurement of neutrino fluxes, interaction cross-sections and detection efficiencies, will we be able to predict reliably the interaction rate in the far-neutrino detectors, prove the existence of oscillation effects and eventually measure their CP (neutrino–antineutrino) asymmetries. Alessandro Baldini of Pisa discussed the potential for discovering leptonic-flavour violation using unprecedented fluxes of slow muons. With the SPL, sensitivity to muon-to-electron conversion may indeed test the rates predicted from supersymmetric loops. Equally fertile and promising is the opportunity at higher energies to study rare kaon decays, as outlined by Augusto Ceccucci of CERN.

The topics introduced by John Ellis on nuclear structure and nuclear astrophysics, in particular understanding nucleosynthesis via the rp- and r-process paths, were expanded by William Gelletly of Surrey and Karl-Ludwig Kratz of Mainz, while Klaus Jungmann of the Kernfysisch Versneller Instituut (KVI), Groningen, presented a menu of different experiments to investigate fundamental symmetries – for example, CP violation, forbidden decays, non V-A terms in beta-decay and unitarity of the Cabibbo–Kobayashi–Maskawa matrix – that are possible with a multi-MW facility. Francesca Gulminelli of LPC Caen explained how the nuclear liquid-gas phase transition could be investigated, and Juha Äystö of Jyväskylä made the case for combining antiprotons or muons with radioactive ions in colliding or trapping experiments so as to provide an unsurpassed probe of the charge and mass distribution of these exotic nuclei.

Yorick Blumenfeld of IPN Orsay described the technical challenges remaining for the development of EURISOL and showed the importance of the EU FP6 Design Study, while Jürgen Kluge of GSI described the laboratory's proposal for a Facility for Antiprotons and Ion Research (FAIR) at the GSI laboratory. From these presentations it became clear that the physics reach of FAIR (nuclear physics and astrophysics, low-temperature quantum chromodynamics, charmed sector, high-density plasmas, etc.) is complementary to that of EURISOL (nuclear physics and astrophysics, fundamental interactions, solid-state physics, radiobiology, etc.).

Looking to the future

The final session turned to the outlook for the future and began with Wu-Tsung Weng of Brookhaven, who underlined that the idea of using a linac driver like the SPL is realistic and feasible, although work is still needed on a number of issues such as control of beam loss and cost reduction. Development should be vigorously pursued on many technological items, such as the target and pion/muon focusing devices. A broad range of physics is possible at a multi-MW driver, however, intensive discussions among accelerator experts and physicists still have to take place to select the proper accelerator configuration (SPL or RCS). CERN should play an important, if not the leading role, in the international collaboration of R&D efforts and encourage participation from its staff, provided CERN's core mission is not compromised.

Michel Spiro, director of IN2P3, reviewed the outlook for particle physics, with an emphasis on neutrino oscillations following the "Venice road map", as formulated at the Neutrino Oscillations in Venice (NO-VE) workshop last December. After the round of experiments at CNGS and European participation in the next round at J-PARC in Japan, a European initiative could resume with a low-energy super-beam/beta-beam complex serving large detectors in a new underground laboratory, and then proceed to the final and complete mapping of neutrino phenomena with a neutrino factory and the smaller magnetic detectors that best match its potential.

The nuclear-physics outlook was provided by Muhsin Harakeh of KVI Groningen. He presented the NuPECC perspective for the future of nuclear physics in Europe. NuPECC, as a representative of the European nuclear-physics community, has declared its highest priority to be the construction of both the FAIR and EURISOL facilities (*CERN Courier* April 2004 p23); to serve the need of the estimated 1000 European nuclear scientists.

The concluding remarks came from Jos Engelen, CERN's chief scientific officer. He acknowledged the unique and compelling nature of the physics programmes proposed by the workshop, encouraged the continuation of the efforts for its definition and promised to give it careful attention. While reminding the audience of the limited resources, he voiced explicitly European pride for some of the most novel ideas and encouraged international collaboration in R&D.

From a report by **Peter Butler**, *Liverpool, with* **Helmuth Haseroth** *and* **Mats Lindroos**, *CERN.*

Computing at CERN:

Chris Jones takes a look back at the heyday of the co

In June 1996 computing staff at CERN turned off the IBM 3090 for the last time, so marking the end of an era that had lasted 40 years. In May 1956 CERN had signed the purchasing contract for its first mainframe computer – a Ferranti Mercury with a clock cycle 200 000 times slower than modern PCs. Now, the age of the mainframe is gone, replaced by "scalable solutions" based on Unix "boxes" and PCs, and CERN and its collaborating institutes are in the process of installing several tens of thousands of PCs to help satisfy computing requirements for the Large Hadron Collider (p15).

The Mercury was a first-generation vacuum tube (valve) machine with a 60 microsecond clock cycle. It took five cycles – 300 microseconds – to multiply 40-bit words and had no hardware division, a function that had to be programmed. The machine took two years to build, arriving at CERN in 1958, which was a year later than originally foreseen. Programming by users was possible from the end of 1958 with a language called Autocode. Input and output (I/O) was by paper tape, although magnetic tape units were added in 1962. Indeed, the I/O proved something of a limitation, for example when the Mercury was put to use in the analysis of paper tape produced by the instruments used to scan and measure bubble-chamber film. The work of the fast and powerful central processing unit (CPU) was held up by the sluggish I/O. By 1959 it was already clear that a more powerful system was needed to deal with the streams of data coming from the experiments at CERN.

The 1960s arrived at the computing centre initially in the form of an IBM 709 in January 1961. Although it was still based on valves, it could be programmed in FORTRAN, read instructions written on cards, and read and write magnetic tape. Its CPU was four to five times faster than that of the Mercury, but it came with a price tag of 10 millions Swiss francs (in 1960 prices!). Only two years later it was replaced by an IBM 7090, a transistorized version of the same machine with a 2.18 microsecond clock cycle. This marked the end for the valve machines, and after a period in which it was dedicated to a single experiment at CERN (the Missing Mass Spectrometer), the Mercury was given to the Academy of Mining and Metallurgy in Krakow. With the 7090 the physicists could really take advantage of all the developments that had begun on the 709, such as on-line connection to devices including the flying spot digitizers to measure film from bubble and spark chambers. More than 300 000 frames of spark-chamber film were automatically scanned and measured in record time with the 7090. This period also saw the first on-line connection to film-less detectors, recording data on magnetic tape.

In 1965 the first CDC machine arrived at CERN – the 6600 designed by computer pioneer Seymour Cray, with a CPU clock cycle of 100 ns and a processing power 10 times that of the IBM 7090. With serial number 3, it was a pre-production series machine. It had disks more than 1 m in diameter – which could hold 500 million

A panoramic view of CERN's computer centre in the mid-1980s, during the e

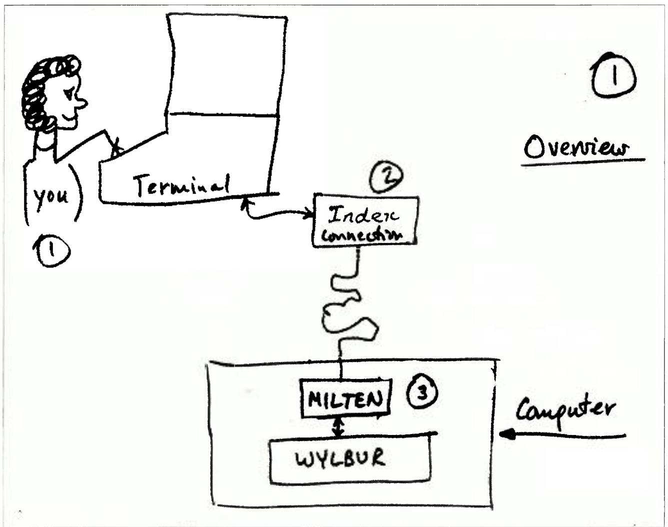
CERN's IBM 709 computer is unloaded at Geneva's Cointrin Airport in 1961, under the watchful eye of a Swiss customs officer, at right.

bits (64 megabytes) and subsequently made neat coffee tables – tape units and a high-speed card reader. However, as Paolo Zanella, who became division leader from 1976 until 1988, recalled, "The introduction of such a complex system was by no means trivial and CERN experienced one of the most painful periods in its computing

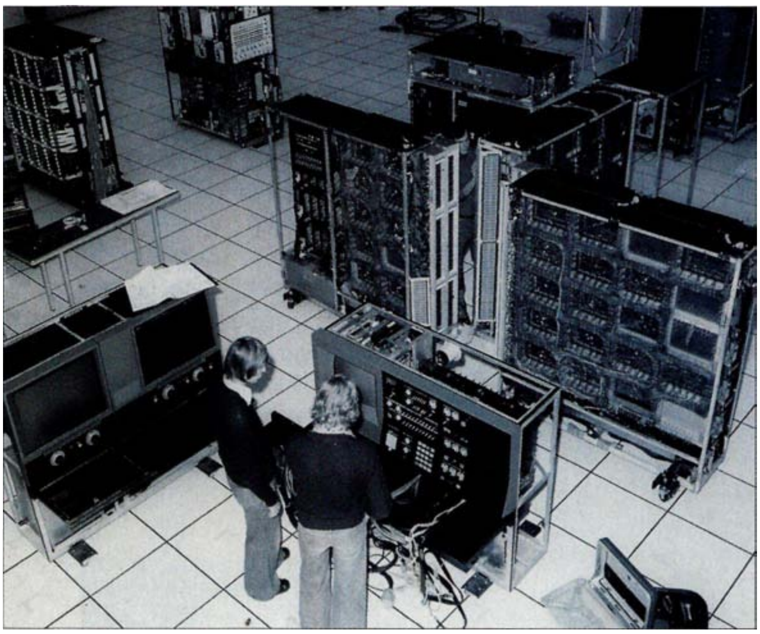
the mainframe era

nputer mainframe through a selection of "memory bytes".

ra of the combined service provided by IBM and Siemens. (Courtesy Chris Jones.)



The user-friendly nature of the WYLBUR time-sharing system, which was developed at SLAC, was reflected in its beautifully handwritten and illustrated manual by John Ehrman.



The arrival of the IBM 370/168 in 1976 ushered in the heyday of the mainframe and the "CERN unit" of physics data processing.

history. The coupling of unstable hardware to shaky software resulted in a long traumatic effort to offer a reliable service." Eventually the 6600 was able to realise its potential, but only after less-powerful machines had been brought in to cope with the increasing demands of the users. Then in 1972 it was joined by a still more powerful sibling, the CDC 7600, the most powerful computer of the time and five times faster than the 6600, but again there were similar painful "teething problems".

With a speed of just over 10 Mips (millions of instructions per second) and superb floating-point performance, the 7600 was, for its time, a veritable "Ferrari" of computing. But it was a Ferrari with a very difficult running-in period. The system software was again late and inadequate. In the first months the machine had a bad ground-loop problem causing intermittent faults and eventually requiring all modules to be fitted with sheathed rubber bands. It was a magnificent engine for its time whose reliability and tape handling just did not perform to the levels needed, in particular by the electronic experiments. Its superior floating-point capabilities were valuable for processing data from bubble-chamber experiments with their relatively low data rates, but for the fast electronic experiments the "log jam" of the tape drives was a major problem.

So a second revolution occurred with the reintroduction of an IBM system, the 370/168, in 1976, which was able to meet a wider range of users' requirements. Not only did this machine bring dependable modern tape drives, it also demonstrated that computer hardware could work reliably and it ushered in the heyday of the mainframe, with its robotic mass storage system and a laser printer operating at 19 000 lines per minute. With a CPU cycle of 80 ns, 4 megabytes (later 5) of semiconductor memory and a high-speed multiply unit, it became the "CERN unit" of physics data-processing power, corresponding to 3–4 Mips. Moreover, the advent of the laser printer, with its ability to print bitmaps rather than ▷

simple mono-spaced characters, heralded the beginning of scientific text processing and the end for the plotters with their coloured pens (to say nothing of typewriters).

The IBM also brought with it the MVS (Multiple Virtual Storage) operating system, with its pedantic Job Control Language, and it provided the opportunity for CERN to introduce WYLBUR, the well-loved, cleverly designed and friendly time-sharing system developed at SLAC, together with its beautifully handwritten and illustrated manual by John Ehrman. WYLBUR was a masterpiece of design, achieving miracles with little power (at the time) shared amongst many simultaneous users. It won friends with its accommodating character and began the exit of punch-card machinery as computer terminals were introduced across the lab. It was also well interfaced with the IBM Mass Store, a unique file storage device, and this provided great convenience for file handling and physics data sample processing. At its peak WYLBUR served around 1200 users per week.

The IBM 370/168 was the starting point for the IBM-based services in the computer centre and was followed by a series of more powerful machines: the 3032, the 3081, several 3090s and finally the ES/9000. In addition, a sister line of compatible machines from Siemens/Fujitsu was introduced and together they provided a single system in a manner transparent to the users. This service carried the bulk of the computer users, more than 6000 per week, and most of the data handing right up to the end of its life in 1996. At its peak around 1995 the IBM service provided a central processor power around a quarter of a top PC today, but the data-processing capacity was outstanding.

During this period CERN's project for the Large Electron Positron (LEP) collider brought its own challenges, together with a planning review in 1983 of the computing requirements for the LEP era. Attractive alternative systems to the mainframe began to appear over the horizon, presenting computing services with some difficult choices. The DEC VAX machines, used by many physics groups – and subsequently introduced as a successful central facility – were well liked for the excellent VMS operating system. On another scale the technical jump in functionality that was appearing on the new personal workstations, for example from Apollo – such as a fully bit-mapped screen and a "whole half a megabyte of memory" for a single user – were an obvious major attraction for serious computer-code developers, albeit at a cost that was not yet within the reach of many. It is perhaps worth reflecting that in 1983 the PC used the DOS operating system and a character-based screen, whilst the Macintosh had not yet been announced, so bit-mapped screens were a major step forward. (To put that in context, another recommendation of the above planning review was that CERN should install a local-area network and that Ethernet was the best candidate for this.)

The future clearly held exciting times, but some pragmatic decisions about finances, functionality, capacity and tape handling capacity had to be made. It was agreed that for the LEP era the IBM-based services would move to the truly interactive VM/CMS operating system as used at SLAC. (WYLBUR was really a clever editor submitting jobs to batch processing.) This led to a most important development, the HEPVM collaboration. It was possible

The CRAY X-MP brought vector capabilities – and a colourful presence – to CERN's computer centre with its arrival in 1988.

and indeed desirable to modify the VM/CMS operating system to suit the needs of the user community. All the high-energy physics (HEP) sites running VM/CMS were setting out to do exactly this, as indeed they had done with many previous operating systems. To some extent each site started off as if it were their sovereign right to do this better than the others. In order to defend the rights of the itinerant physicist, in 1983 Norman McCubbin from the Rutherford Appleton Laboratory made the radical but irresistible proposal: "don't do it better, do it the same!"

The HEPVM collaboration comprised most of the sites who ran VM/CMS as an operating system and who had LEP physicists as clients. This ranged from large dedicated sites such as SLAC, CERN and IN2P3, to university sites where the physicists were far from being the only clients. It was of course impossible to impose upon the diverse managements involved, so it was a question of discussion and explanation and working at the issues. Two important products resulted from this collaboration. A HEPVM tape was distributed to more than 30 sites, containing all the code necessary for producing a unified HEP environment, and the "concept of collaboration between sites" was established as a normal way to proceed. The subsequent off-spring, HEPiX and HEPNT, have continued the tradition of collaboration and it goes without saying that such collaboration will have to take a higher level again in order to make Grid computing successful.

The era of the supercomputer

The 1980s also saw the advent of the supercomputer. The CRAY X-MP supercomputer, which arrived at CERN in January 1988, was the logical successor to Seymour Cray's CDC 7600 at CERN, and a triumph of price negotiation. The combined scalar performance of its four processors was about a quarter of the largest IBM installed at CERN, but it had strong vector floating-point performance. Its colourful presence resolved the question as to whether the physics codes could really profit from vector capabilities, and probably the greatest benefit to CERN from the CRAY was to the engineers whose applications, for example in finite element analysis and accelerator design, excelled on this machine. The decision was also taken to work together with CRAY to pioneer Unix as the operating system, and this work was no doubt of use to later generations of machines running Unix at CERN.

Throughout most of the mainframe period the power delivered to users had doubled approximately every 3.5 years – the CDC 7600 lasted an astonishing 12 years. The arrival of the complete processor on a CMOS chip, which conformed to Moore's law of doubling speed every 18 months, was an irresistible force that sounded the eventual replacement of mainframe systems, although a number of other issues had to be solved first, including notably the provision of reliable tape-handling facilities. The heyday of the mainframe thus eventually came to an inevitable end.

One very positive feature of the mainframe era at CERN was the joint project teams with the major manufacturers, in particular those of IBM and DEC. The presence of around say 20 engineers from such a company on-site led to extremely good service, not only from the local staff but also through direct contacts to the development teams in America. It was not unknown for a critical bug, discovered during the evening at CERN, to be fixed overnight by the development team in America and installed for the CERN service the next morning, a sharp contrast to the service available in these days of commodity computing. The manufacturers on their side saw the physicists' use of their computers as pushing the limits of what was possible and pointing the way to the needs of other more straightforward customers in several years time. Hence their willingness to install completely new products, sometimes from their research laboratories, and often free of charge, as a way of getting them used, appraised and de-bugged. The requirements from the physicists made their way back into products and into the operating systems. This was one particular and successful way for particle physics to transfer its technology and expertise to the world at large. In addition, the joint projects provided a framework for excellent pricing, allowing particle physics to receive much more computer equipment than they could normally have paid for.

Further reading

This article has been a personal look at some of the aspects of mainframe computing at CERN, and could not in the space available provide anything more than a few snapshots. It has benefited from some of the details contained in the more in-depth look at the first 30 years of computing at CERN written for the *CERN Computing Newsletter* by Paolo Zanella in 1990 and available on the Web in three parts at: http://cnlart.web.cern.ch/cnlart/2001/002/cern-computing; http://cnlart.web.cern.ch/cnlart/2001/003/comp30; http://cnlart.web.cern.ch/cnlart/2001/003/comp30-last.

Chris Jones, *CERN.*

Hands across the Mediterranean

Scientists from North Africa, the Middle East and Europe came together in a meeting at CERN to discuss common projects in fields varying from particle physics to water desalination. **Robert Klapisch** reports.

Back in April 2002 AFAS (the French Association for the Advancement of Science) and the "Club de Marseille" jointly convened "WorldMed 2002", a meeting that was set up to share knowledge between the north and south regions of the Mediterranean. WorldMed's aim was to show how concrete projects could advance co-operation between countries with different cultures, thereby providing a much-needed stimulus to the political intergovernmental process. The meeting, which was attended by 850 people, of whom 150 came from North Africa, was a huge success and several projects were begun as a result of contacts initiated among the participants. This success suggested a follow-up in the form of periodic meetings to discuss projects and seek potential synergies. For this purpose, smaller meetings, which would focus on a few selected topics and so be easier to organize and permit an even better opportunity for contacts, seemed a promising concept.

The celebration this year of CERN's 50th anniversary provided a perfect opportunity for the laboratory, with its distinguished tradition along these lines, to initiate the series by hosting the event on 6–7 May. The chosen topics were the Large Hadron Collider (LHC), the Synchrotron-light for Experimental Science and Applications in the Middle East (SESAME) project, and computing – all of which are familiar to readers of the *CERN Courier* – together with two applied topics of considerable and obvious relevance: water and energy.

The conference was opened by Pascal Colombani, chairman of AFAS, who stressed the universal value of science and its ability to build bridges between peoples belonging to different cultures and religions, even in cases where they are in bitter political conflict. John Ellis from CERN introduced the first session with an overview of the LHC programme and its worldwide extent. His talk was followed by specific reports of non-member-state participation from countries in North Africa and the Middle East, with Abdeslam Hoummada from Casablanca, Hafeez Hoorani from the National Center for Physics in Islamabad, and Hessamaddin Arfaei from the Institute for Studies in Theoretical Physics and Mathematics in Teheran. The status of possible Egyptian participation was also presented by Mohammed Sherif from Cairo. A subsequent round-table discussion included CERN's director-general, Robert Aymar, together with Ali Chamseddine of Beirut and Giora Mikenberg of Rehovoth.

The overwhelming impression was of the serious and impressive contributions these relative newcomers to the field are bringing to the building of the ATLAS and CMS detectors. In the case of Pakistan and Iran, the legacy of Abdus Salam as the first Muslim Physics Nobel laureate certainly seems to have played a role in persuading the powers-that-be to support such an apparently esoteric field of research. Another interesting aspect is the case of Morocco, where bilateral ties with the French institute IN2P3 have helped to organize and bring to a high standard a consortium of universities that is now a full member of the ATLAS collaboration.

Herwig Schopper, president of the SESAME Council, presented the UNESCO-backed programme for SESAME, a regional synchrotron light facility to be located in Jordan with statutes analogous to those of CERN (*CERN Courier* July/August 2003 p8). It will be ▷

based on parts donated from the BESSY I machine at Berlin, which are in the process of being upgraded to make SESAME competitive and up to international standards. The facility should be operational in 2007 and it is remarkable that in just five years a new international organization has been created. Zehra Sayers of Istanbul outlined the scientific programme and Samar Hasnain of the Daresbury Laboratory described the first generation of beam lines. Nasser Hamdam of the United Arab Emirates recounted his former work at the Advanced Light Source at the Lawrence Berkeley National Laboratory and talked about his projects for SESAME when it comes on line.

Joining in the subsequent round-table discussion were Abdeslam Hoummada, Abderrahmane Tadjeddine of LURE, Orsay, Jean-Patrick Connerade of Imperial College, London, and Eliezer Rabinovici of Jerusalem. The first example of a regional facility, SESAME will add a south–south dimension to international scientific collaboration. Indeed, as Schopper noted, UNESCO has agreed in principle that other regional scientific centres could be considered in the future – a point that generated tremendous interest in the audience.

Guy Wormser of IN2P3 and Orsay convened a session on "Fighting the digital divide", in which Michel Spiro, director of IN2P3, first pointed out the dual importance of broadband access. As a tool, broadband would make data analysis a democratic affair, enabling researchers to do physics based on their talent rather than on their geographic location. More generally, bridging the divide could be meant as bridging the gap between people belonging to different cultures or religions, even though some may presently be in political conflict. This is really the prolongation of a 50-year-old CERN tradition.

Fabrizio Gagliardi of CERN then explained the concept of the computing Grid, stressing that it is not only very powerful but also economical. In addition to being necessary to handle the vast amounts of LHC data, it should also have obvious applications in other fields such as meteorology and genomics. Driss Benchekroun of the University of Hassan II, Casablanca, gave the view of a user from Morocco and outlined plans to update IT infrastructure within the Maghreb. These were in fact realized three weeks later when the Moroccan minister inaugurated MARWAN, a wide-area network connecting Moroccan universities among themselves and to Europe. As Dany Vandromme of the Réseau National de Télécommunications pour la Technologie, l'Enseignement et la Recherche (RENATER) explained, this was made possible because the European intra-university network GEANT had been extended to include a link to a point in each country around the Mediterranean, from Casablanca to Beirut. Lorne Levinson of Rehovot and Alberto Santoro from Rio de Janeiro then joined the round-table discussion, appropriately via an Internet videoconference.

"As a tool, broadband would make data analysis a democratic affair, enabling researchers to do physics based on their talent rather than on their geographic location."

Water desalination and re-use is of crucial interest for semi-arid countries, where there is a strong increase in population. For this discussion Miriam Balaban of the European Desalination Association and Azzedine El Midaoui of Ibn Tofa University in Kénitra, Morocco, had assembled a splendid panel of experts. Richard Morris of Glasgow, Corrado Somariva of Abu Dabi, Valentina Lazarova of the Suez Environnement company, Michel Soulié of the Agropolis Association in Montpellier, Bruce Durham of Veolia Water in the UK, and Mohamed Safi of the Ecole national d'ingénieurs in Tunis, presented all aspects of the progress in this field.

The cost of desalination, which only a decade ago was considered out of reach for non oil-rich countries, has fallen dramatically in the past five years. It is now in the region of €0.50–0.85 per tonne for large installations and further progress can be expected. The energy necessary to pump seawater through a semi-permeable membrane is currently 2 kWh for new installations, compared with 5 kWh for installations built in the 1990s, and close to the thermodynamics limit of 0.7 kWh. The focus is now increasingly on environmental aspects such as the safe disposal of the brine and chemicals, on sound water management and on safe recycling of urban and industrial wastewater for irrigation.

For countries in the sun belt, solar energy is a tremendous resource still waiting to be exploited. Augusto Maccari of ENEA, the Italian national agency for new technologies, energy and the environment in Rome, gave a report on how to harness solar energy as high-temperature heat by using concentrating mirrors and storing the heat in a molten salt at 550 °C. This circumvents the discontinuous nature of solar energy so that electricity can be generated on a continuous basis. This development was under the leadership of Carlo Rubbia, president of ENEA, and the talk was also a preview of the inauguration of the "Archimède" pilot facility (20 MW), which took place on 19 May near Syracuse in Sicily.

• The conference was organized by AFAS with the support of CERN, IN2P3, UNESCO, France Telecom, Veolia and Suez. The conference programme is available at http://lpsc.in2p3.fr/congres/CERN/indexengl.htm.

Robert Klapisch, *honorary chairman, AFAS.*

When quarks and gluons become free

Recent results and future experiments were the topics in a workshop to look into exactly what happens as strongly interacting matter becomes deconfined.

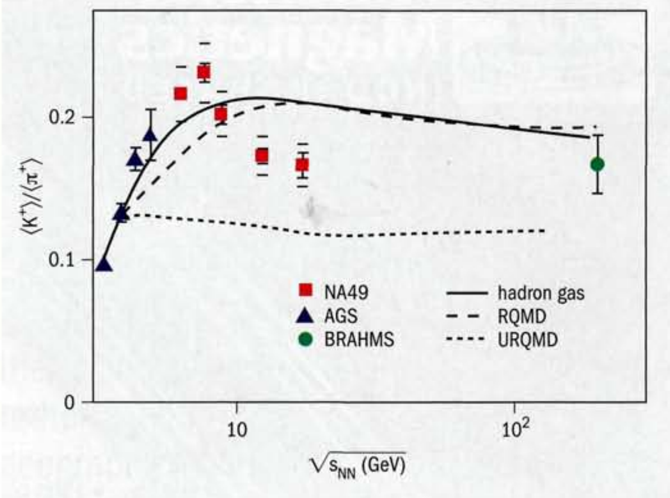


Fig. 1. Many speakers discussed the collision energy dependence of the K^+ to π^+ ratio measured in central lead–lead and gold–gold collisions. The observed "horn"-like structure in the CERN SPS energy range was predicted as being one of the signals of the onset of deconfinement. It cannot be reproduced by the models (solid and dashed lines) that do not assume the sudden change of the properties of the strongly interacting matter.

"Tracing the onset of deconfinement in nucleus–nucleus collisions" was the name of a workshop held at the European Center for Theoretical Studies in Nuclear Physics and Related Areas (ECT*) in Trento, Italy, on 24–29 April. Around 40 theorists and experimentalists from Europe, Japan and the US came together to discuss recent progress in the study of the energy dependence of particle production in nuclear collisions. The workshop focused on a prominent issue in high-energy nuclear physics: whether anomalies measured for central lead–lead collisions at low energies at CERN's Super Proton Synchrotron (SPS) signal a phase transition from confined to deconfined strongly interacting matter.

Mark Gorenstein of Kiev began the workshop by recalling the basic ideas that motivated the energy scan programme at the SPS and comparing the old predictions with recent data from the SPS and from the Alternating Gradient Synchrotron (AGS) and the Relativistic Heavy Ion Collider (RHIC) at the Brookhaven National Laboratory. (Last year the NA49 collaboration presented numerous results on collisions at the five energies – 20, 30, 40, 80 and 158 AGeV – of the energy scan programme at the SPS.) Gorenstein pointed out that the unusual energy dependence of hadron production expected in the case of the onset of deconfinement is in fact observed.

This introductory talk was followed by experimental reviews of the most recent results from SIS, the heavy-ion synchrotron at GSI, Darmstadt, as well as from the AGS, SPS and RHIC. These presentations focused on the energy dependence of a number of observables. In particular, Marco van Leeuwen of the Lawrence Berkeley National Laboratory discussed data on strange hadron yields and concluded that the relative strangeness production shows a sharp maximum (the "horn") at about 30 AGeV. Results on the change in the energy dependence of pion multiplicity (the "kink") and the anomaly in the shape of transverse mass spectra (the "step") were also reported. Finally, the results were compared with the latest predictions of the hadron gas model and microscopic string-hadronic models (RQMD and URQMD) of the collision process. Neither model is able to reproduce adequately the observed anomalies, as figure 1 indicates.

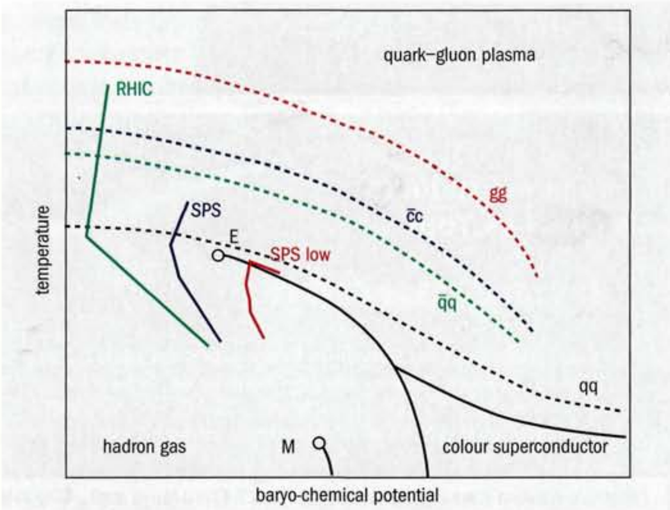


Fig. 2. Phase diagram of strongly interacting matter on a plane of temperature versus baryonic chemical potential. The three main phases of QCD are hadron gas, quark–gluon plasma and colour superconductor. A line ending at the multifragmentation point (M) corresponds to the nuclear liquid–gas transition. The critical point E separates the cross-over from the first order transition (to its right). Dashed lines are the "zero binding lines" for hadronic bound states: glueballs (gg), charmonium (c̄c) and light quarks (q̄q, qq). Solid lines are schematic adiabatic cooling paths for heavy-ion collisions at RHIC and the SPS.

Several speakers explored new phenomena related to the onset of deconfinement. Fluctuations were the focus of this discussion. Large deviations from purely statistical behaviour are expected when the trajectory on the phase diagram of the expanding and cooling matter passes close to the hypothetical critical point. Models predict that this point may be located in the region accessible in nuclear collisions at SPS energies (see figure 2).

The view on properties of the quark–gluon plasma (QGP) at $T=(1-2)T_c$, where T_c is the phase transition temperature, has recently radically changed. Instead of being regarded as a weakly interacting gas of quasiparticles, the QGP is now viewed as a near-perfect liquid. The lattice QCD results show that charmonia states (of a charm quark and antiquark) remain bound at such temperatures, contrary to the previous belief. Edward Shuryak of Stony Brook argued that similar bound states should exist for light quarks and gluons, in particular correlated coloured pairs of light quarks may be present. Andrei Starinets from Seattle demonstrated that the transition from weakly to strongly coupled QGP can be theoretically studied in an $N=4$ supersymmetric Yang–Mills theory using Juan Maldacena's conjecture of duality between gauge theories and string theories. The strongly coupled QGP explains the validity of a hydrodynamical description of matter flow and predicts a (surprisingly small) value for its viscosity.

The workshop closed with a review of new experimental projects, which in future may extend the studies begun by the energy scan programme at the SPS at CERN. Christoph Blume from Frankfurt reported on the proposal to extend the SPS programme to study the collisions of light ions and protons in the energy range 10–160 AGeV. The new experiment would be based on the upgraded NA49 detector. This programme, if approved, may start in 2006 and run in parallel to the Large Hadron Collider. It should result in a unique measurement of the two-dimensional (energy–system-size) dependence of hadron production that is necessary for a precise understanding of the onset effects observed in central lead–lead collisions, and for a search of the critical phenomena.

Ideas for the study of nuclear collisions in a fixed-target experiment at RHIC (energy 10–100 AGeV) were discussed by David Hofman of Chicago. This experiment could be based on the existing BRAHMS detector and would take data in parallel to the collider experiments at RHIC. Several options for the target are under discussion: a foil or wire target in the beam halo, a gas jet and a low-energy "crossing" ion beam. The unique feature of this project would be an almost continuous measurement of the energy dependence of inclusive hadron production while the RHIC beams are ramped to full energy.

Finally, Volker Friese of GSI presented the current status of the new experimental facility, FAIR, at GSI. The Condensed Baryonic Matter (CBM) experiment is being designed to study lead–lead collisions at energies of 2–35 AGeV with very high intensity beams. The properties of dense hadronic matter will be the focus of the study, and the first data taking is scheduled for 2012.

Overall, the workshop indicated the large theoretical and experimental interest in the study of nuclear collisions in the low SPS energy range, where a number of phenomena have been observed that could be related to the onset of deconfinement. This has motivated the idea of establishing an annual series of workshops on this matter.

Marek Gaździcki, *Frankfurt and Kielce*, **Peter Seyboth** *and* **Edward Shuryak**, *Stony Brook.*

PEOPLE

CERN

LHC suppliers win Golden Hadron awards

In a ceremony on 30 July, three of the 200 suppliers for the Large Hadron Collider (LHC) were presented with Golden Hadron awards. It is the third year that the awards have been presented to suppliers, not only for their technical and financial achievements but also for their compliance with contractual deadlines. This year the three companies are all involved in the supplies for the LHC's main magnet system.

Alstom–MSA (France) was awarded the prize for manufacturing superconducting cable for the LHC's main dipole and quadrupole magnets. Seven thousand kilometres of superconducting cable are required for the coils of these magnets and Alstom–MSA, the largest supplier, has already delivered 75% of the 3200 kilometres of cable it is providing.

Ernesto Malvestiti SpA (Italy) is the main manufacturer of the metal collars needed to ensure the rigidity of the superconducting dipoles. The firm was awarded its prize in recognition of the central role it played during the transition from aluminium to stainless-steel collars.

Simic SpA (Italy) received its award for manufacturing the vacuum vessels for the superconducting dipoles. The 937 blue cylinders manufactured by Simic will provide the thermal insulation for the magnets. Measuring 15 metres in length and 1 metre in diameter, they are designed to withstand a vacuum of 10^{-4} Pa.

Golden Hadron award winners, from left to right, Sandro Ferraris and Guiseppi Ginola from Simic SpA of Italy, Gérard Grunblatt and Phillippe Mocaer from Alstom–MSA of France, and Gianfranco Malvestiti and Ernesto Malvestiti from Ernesto Malvestiti SpA of Italy.

School reveals attraction of power converters

A record attendance of 91 students of more than 20 different nationalities helped to make a success of the specialized school on power converters held on 12–18 May in Warrington, UK. Jointly organized by the CERN Accelerator School (CAS) and the CCLRC Daresbury Laboratory, the school was the first CAS course on power converters since 1990, and so had plenty of ground to cover.

The challenging programme included a review of the state of the art and the latest developments in the field, including 30 hours of tuition. Participants came not only from Europe and North America but also Armenia, India, Iran, Taiwan, Turkey and, for the first time, fee-paying students from Australia and China. European industry also showed a welcome and solid interest in the school, providing around 25% of the attendees. Aside from the lectures, the school included a visit to the CCLRC Daresbury Laboratory, a one-day excursion to Liverpool and Chester, and a Welsh medieval dinner at the school's closure.

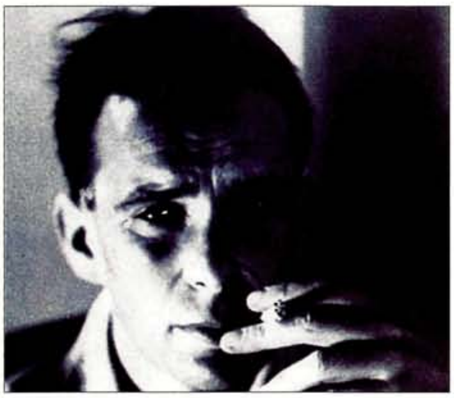
The CAS/CCLRC school on power converters attracted participants from all over the world.

SCHOOLS

Frascati remembers Touschek and the J/Ψ

Flavour physics – old as well as new – was the theme of the ninth Laboratori Nazionali di Frascati (LNF) Spring School "Bruno Touschek", which was held on 17–21 May and attended by about 40 young researchers from Italy and elsewhere in Europe.

Since its inception in 1996 the school has been instrumental in training young researchers for activity at DAFNE, but has not been limited to DAFNE physics. This year the lectures spanned from rare-K decays to the latest results from BaBar, from chiral perturbation theory to lattice calculations. The lecturers included Aneesh Manohar from the University of California at San Diego, Andrzej Buras from Munich Technical University, Ikaros Bigi from Notre Dame University, Antonio Masiero from Padova University, Augusto Ceccucci from CERN and Chris Sachrajda from Southampton University. Experimental results from B-factories were presented by Riccardo Faccini from the University of Rome, while Francesco Bedeschi presented B and D physics from the Tevatron. The future of flavour physics was presented in seminars by Franco Forti from Pisa and Paola Gianotti from INFN Frascati, and in the young-researcher session recent results from KLOE on the measurement of the hadronic cross-section, rare kaon decays and the K_S branching ratio to three π^0 were presented.



Bruno Touschek in 1955. Touschek's personality and works have been described in the recently completed movie Bruno Touschek e l'Arte della Fisica *by Luisa Bonolis and Enrico Agapito, which was shown at the LNF Spring School on 19 May.*

A still frame from an Italian television (RAI) interview of Giampaolo Murtas (at the blackboard, centre) in Frascati on 13 November 1974, just after the observation of the J/Ψ.

The participants of the ninth LNF Spring School, which was devoted to flavour physics.

In addition to lectures and seminars the school traditionally has a historical session, with distinguished speakers marking special occasions. This year there were two historical highlights: the recently completed film *Bruno Touschek e l'Arte della Fisica* by Luisa Bonolis and Enrico Agapito, and a session on "Frascati and the November Revolution", with a round-table discussion on how the ADONE machine increased its design energy to reach the J/Ψ production threshold. The film on Bruno Touschek has been produced by INFN and was shown for the first time on 19 May to the students and lecturers at the school. It describes the life and accomplishments of Touschek through a series of interviews with the physicists who knew him well, including Carlo Bernardini, Nicola Cabibbo, Carlo Rubbia and Giorgio Salvini. It also tells the story of the first e^+e^- machine, AdA, which was proposed by Touschek in 1960, through the protagonists of that adventure. The film, which is one-and-a-half hours long, is in Italian (an English version is currently under preparation) and includes a large number of previously undisclosed documents and photographs of Touschek. The film is the first extended document on Touschek's life since the biography written by Edoardo Amaldi, soon after Touschek's death in 1978, and is aimed at anyone interested in science, including high-school students and university undergraduates.

A second historical session was held on the last day of the school to mark the observation of the J/Ψ at ADONE 30 years ago. A short television movie from 1974 was shown and Giorgio Bellettini, who was director of Frascati at the time, told how he heard about the discovery first at Brookhaven and then at SLAC. At a round-table discussion following Bellettini's talk, Enzo Iarocci, Mario Greco, Sergio Tazzari and Giorgio Salvini all recalled how the Frascati Laboratory reacted to the news from the West Coast and was able, in three days, to increase the beam energy of ADONE to see the J/Ψ peak.

Further reading

E Amaldi 1981 *The Bruno Touschek Legacy* CERN 81–19.

For more about the school, see www.lnf.infn.it/conference/lnfss.

SCHOOLS

New school helps Greeks and Italians to stengthen ties in particle physics

On 20–25 May the Palazzo Palmieri in the small town of Martignano, just outside Lecce in southern Italy, was host to the inaugural Italo–Hellenic School of Physics. With the theme of "The physics of LHC: theoretical tools and experimental challenges", it attracted 52 students, mainly from around Italy but also a significant number from Greece and other countries. The school provided young researchers with the opportunity to familiarize themselves with the new techniques, both theoretical and experimental, that will be required for physics studies at the Large Hadron Collider (LHC).

The students of the inaugural Italo–Hellenic School of Physics outside the Palazzo Palmieri.

The site in Martignano afforded the refreshing atmosphere of the 16th century baronial residence of the Palmieri family against a backdrop of the lush and unspoilt Salentine region. It is also worth mentioning that Martignano is one of the member towns that forms the Union of Municipalities of the Grecìa Salentina, an area in which historically the local populace speaks "griko", which as the name suggests bears a strong resemblance to Greek. The provincial authorities, while keen to foster ties with Greece, are also deeply involved in forging a key role in Mediterranean cultural and ethnic affairs. In particular, Martignano houses the library of the Institute for Mediterranean Studies, which is also adjacent to the school site.

The specific aim of the school was to bring together young experimentalists and theorists and to encourage them to discover and appreciate the necessary tools for future physics at the LHC. It was addressed principally to Italian and Greek PhD students and post-docs, in both experimental and theoretical high-energy physics. The theory lectures were designed mainly for experimentalists and the experimental lectures for theorists. Over the six days of the course a total of 30 hours of lectures were delivered – half on theory and half on experiment – while the attendees themselves were roughly one-quarter theorists and three-quarters experimentalists.

The lecture programme was rich and varied, encompassing not only those aspects of physics that may be studied for the first time at the LHC, such as the nature of the Higgs particle, but also past experience gained, for example, at the Tevatron. On the theory side the topics ranged from the various calculational tools – quantum-chromodynamics simulation programmes (Paolo Nason), Monte Carlo techniques (Fabio Maltoni), heavy-quark physics (Matteo Cacciari) and parton distributions (Stefano Forte) – to the Standard Model, with electroweak physics (Sandro Ballestrero), the Higgs sector (Carlo Oleari) and beyond (Giuseppe Degrassi). There was even room for some well targeted string phenomenology lessons (Elias Kiritsis).

The experimental courses covered the analysis of top in the CDF experiment (Sandra Leone) and W physics (Antonio Sidoti), proton–proton accelerator physics (Walter Scandale), detector commissioning (Valerio Vercesi), tracking (Lucia Silvestris), calorimetry (Giuseppe Tartarelli), muon identification (Gabriella Cataldi) and triggers (Emilio Meschi). The general analysis tools of distributed computing (Lamberto Luminari) and Geant 4 (Tommaso Boccali) were also presented.

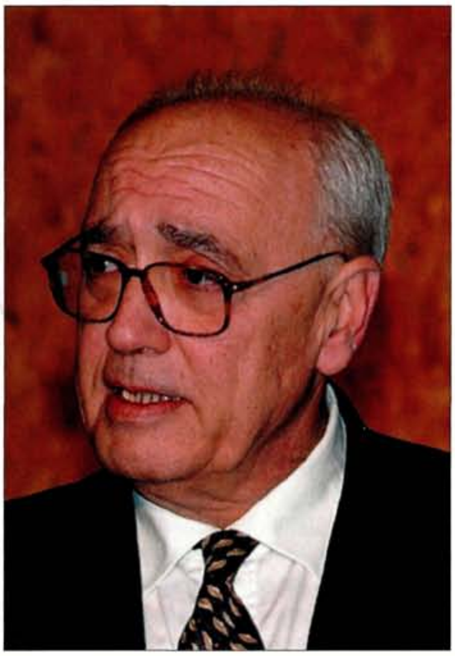
The organizing and scientific committees intend this to be only the beginning of a continuing series of such schools. The second is already planned for the same period next year, after which it will probably become biennial, with the possibility of topical workshops in intervening years. Judging by the positive feedback, in the form of a questionnaire circulated at the end of the course, the school as a whole was well received. Indeed, apart from a few useful improvements suggested by the students, which will most certainly be implemented in future, the technical level and balance between theory and experiment were generally declared perfectly appropriate.

Grateful acknowledgment must be made of the various bodies whose financial aid helped make the school not only possible but also successful: the Istituto Nazionale di Fisica Nucleare, the University of Lecce, the University of Piemonte Orientale, the Province of Lecce, the Union of Municipalities of the Grecìa Salentina and the Banca Nazionale del Lavoro. Indeed, with the enthusiastic promise of continued support by the local authorities and institutes, and the interest shown by the national funding agency, the school looks set to establish itself as a regular future appointment for young researchers in the formative years of their careers in high-energy physics.

• Further details of this year's school (including lecture transparencies) can be found at www.le.infn.it/lhcschool.

APPOINTMENTS

Rubio takes over director-general position at CIEMAT



CIEMAT's new director-general, Juan Antonio Rubio, who has moved from CERN.

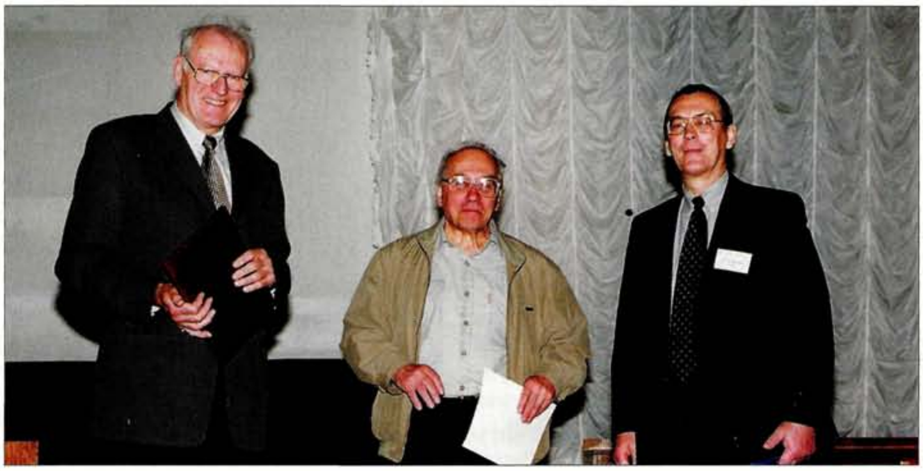
Juan Antonio Rubio has been appointed by the Spanish Ministry of Education and Science as director-general of the Research Centre for Energy, Environment and Technology, CIEMAT, as from 1 July. He moves there from CERN, where he has been head of the unit for Education and Technology Transfer (ETT), as well as the coordinator for Latin America and the commissioner for the organization's 50th anniversary.

Rubio's career in physics began at the Spanish Nuclear Energy Commission where he held the posts of investigator, head of the High Energy Group and head of the Nuclear Physics and High Energy Division.

Later, he was named director of the Department of Basic Investigation and scientific director of CIEMAT. Rubio joined CERN in 1987 as scientific adviser to the director-general and group leader of the Scientific Assessment Group, and in 2000 he took up his position as head of the newly formed ETT division.

AWARDS

Markov prize honours neutrino-mass measurements



Ernst Otten (left) and Vladimir Lobashev (centre) – Markov prize winners for 2004 – seen here with the director of the Institute for Nuclear Research, Viktor Matveev.

The M A Markov prize for advances in neutrino physics has been awarded by the Institute for Nuclear Research (INR) of the Russian Academy of Sciences (RAS) to Ernst Otten from the Johannes Gutenberg University in Mainz and Vladimir Lobashev from the INR in Moscow. Both physicists are leaders of neutrino-mass experiments, at Mainz and Troitsk, respectively. They invented, independently, a new type of spectrometer to measure the electron energy spectrum from tritium β-decay – the electrostatic spectrometer with adiabatic magnetic collimation. This type of spectrometer made it possible to lower the upper limit on the electron–neutrino mass to 2.2 eV/c^2.

The award ceremony took place on 7 June in Moscow during the opening of the biannual meeting of the KATRIN collaboration, hosted by INR RAS. KATRIN, the Karlsruhe Tritium Neutrino experiment, is an international "next generation" direct search for the electron–neutrino mass. It exploits the same type of spectrometer and a gaseous tritium source in order to achieve a model-independent neutrino-mass sensitivity of 0.2 eV/c^2. The new installation is scheduled to start operating in 2008.

The Einstein medal for 2004 has been presented to Michel Mayor in a ceremony at Bern on 10 June. Mayor, who is professor at the University of Geneva and director of the Geneva Observatory, has been honoured in recognition of his contribution to the detection and study of extrasolar planets, including the discovery of the first "exoplanet" in 1995. Mayor was also honoured in June with the award of France's Chevalier de la Légion d'Honneur. The discovery of the first extrasolar planet, in the Pegasus constellation, was made at the Haute Provence Observatory in France.

MEETINGS

FPCP 2004, the third conference on Flavor Physics and CP Violation, is being held on 4–9 October at the Convention Center in Daegu, Korea. The FPCP series came about as the result of the merging of two major high-energy physics events, the biannual Heavy Flavor Physics Conference and the biannual International Conference on B Physics and CP Violation. This year's meeting will be co-hosted by the Korea Institute for Advanced Study and the Center for High Energy Physics. The format of the conference will be all plenary. For further information, see http://newton.kias.re.kr/fpcp2004.

Baryons 2004 – the 10th International Baryons Conference – will be held at Ecole Polytechnique in Palaiseau, France, on 25–29 October. The conference will be devoted to the latest experimental results and theoretical achievements in the field of baryon structure and interactions. Topics to be covered will include: baryon structure and spectroscopy, form factors, structure functions and generalized parton distributions, baryons on the lattice, chiral physics, strange and exotic baryons, heavy-quark baryons, hadrons in the nuclear medium and diffractive physics. All correspondence and questions concerning the meeting should be addressed to baryons04@ipno.in2p3.fr, or see http://baryons04.in2p3.fr.

Channeling 2004, an international workshop of charged and neutral particle channeling, is to be held on 2–6 November in Frascati, Rome. The main aim is to discuss results and to exchange ideas among different groups so as to form the basis for future research activities and to prepare a new international network project. For further information, see the conference website at www.lnf.infn.it/conference/channeling2004.

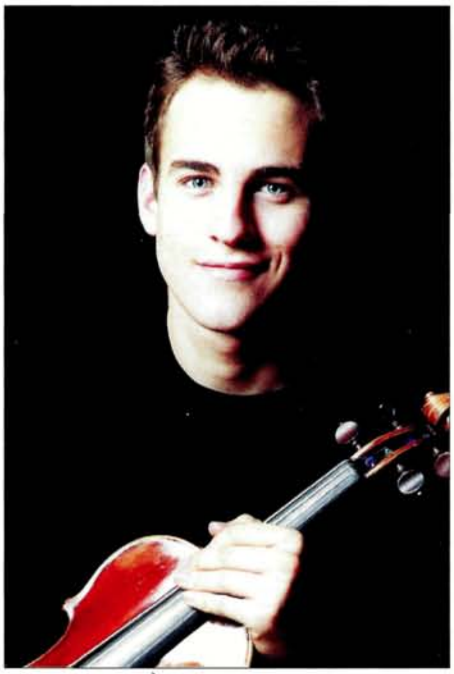
The 1st Vienna Central European Seminar on Particle Physics and Quantum Field Theory is to be held in Vienna from 26–28 November. The "Vienna Seminar" is a new series of annual seminars with invited speakers from CERN and other major European research centres. This year's subject is "Advances in Quantum Field Theory" and the lectures will focus mainly on field theoretical aspects of string dualities. Further lectures on supersymmetric gauge theories, quantum gravity and non-commutative field theory will complement the programme. Younger scientists are encouraged to apply for participation as there will be special grants available to young researchers. For further information, see www.univie.ac.at/vienna.seminar.

MUSIC

From The Creation to the 20th century

There is a long tradition of music and music making at CERN, and the laboratory's 50th anniversary this year is providing an occasion for some musical celebrations both at CERN and in the member states. Already on 8 August, as part of the last day of the 2004 Fêtes de Genève, the CERN choir, together with the Pro Musica choir from Annecy, France, performed Haydn's oratorio, "The Creation", in a concert at Geneva's Grand Casino. The choirs were accompanied by the New Orchestra of Geneva and were under the direction of Gonzalo Martinez, who regularly conducts both the CERN choir and the Annecy Pro Musica. The CERN choir was founded in 1974 by Colin Taylor and consists of CERN staff, their families and friends. They perform twice a year from a wide repertory of works.

In October CERN itself will host a gala concert by Jack Liebeck, one of the leading British violinists of his generation, and the virtuoso Russian pianist Katya Apekisheva. Together they have recently produced an exceptional debut CD of early 20th-century works for the violin and piano.



Leading violinist Jack Liebeck will perform at a gala concert at CERN in October.

Liebeck, who was born in 1980 and is based in London, has performed all over the world. In May, for example, he played the Bruch violin concerto in a live television broadcast with the Armenian Symphony Orchestra in Yerevan. His performances have been variously described in the world's press as "phenomenal", "inspired" and "stunning". The violin he plays is one of the finest instruments by the great J B Guadagnini, known as the "ex-Wilhemj", and dates from 1785.

On 11 October the special gala concert for CERN staff and their families in the CERN auditorium will see Liebeck and Apekisheva play a programme including works by Beethoven, Elgar and Debussy. The concert is sponsored by the UK's Particle Physics and Astronomy Research Council.

• For more about Jack Liebeck and his debut CD, on the Quartz label, see the websites www.jackliebeck.com and www.quartzmusic.com.

NEW PRODUCTS

CeramTec's North American Ceramaseal Division has launched a new line of in-vacuum ribbon cable assemblies. Built to order, the cable configurations include 9, 15, 25 and 50 conductor assemblies built from materials that are UHV compatible. Each stranded silver-plated copper conductor is wrapped in Kapton and woven with polyetheretherketone monofilament to form the flat ribbon. For further information and ordering, see www.ceramaseal.com.

Heinzinger electronic GmbH is offering high-voltage power supplies designed specifically for charging capacitors, as part of its standard range of products. The new PNCcap series is based on the PNC series of power supplies, with a range of accuracies and stabilities up to 0.0001%. For further information, please contact Peter Bannert on tel: +39 8031 2458 61 or e-mail: peter.bannert@heinzinger.de.

PI (Physik Instrumente) has introduced the PicoCube, the world's smallest and highest resolution closed-loop XYZ nanomanipulation and scanning stage, with picometre resolution. Applications include semiconductor and data-storage test equipment. The company has also announced an improved, lower cost system for nanopositioning. The new F-206.S Micro-Hexapod system provides 6D motion with 33 nm resolution. For further information, see www.pi.ws.

PULS GmbH has announced new MiniLine power-supply units, which now have approval for Class I, Div 2 hazardous locations, in line with the American National Electrical Code. This brings the PULS MiniLine family safety approvals for Europe, the US and Canada, for use in locations where accidents may release inflammable gases, vapours or liquids. For further information, please call the Power Supply Shop on tel: +44 845 600 3339.

LETTERS

CERN Courier welcomes letters from readers. Please e-mail cern.courier@cern.ch. We reserve the right to edit letters.

Team effort one

I was very interested to see the article from the archives highlighting the discovery of the anti-xi-minus in the 81 cm bubble chamber in 1962 (see *CERN Courier* April 2004 p9).

It leads me to the following observation on that discovery, which might amuse some of your readers, or disabuse them, depending on their taste.

The bubble chamber in question was built under the leadership of Bernard Gregory, the antiproton beam under that of Simon van der Meer (it also happened to be the project where I learned the tools of my trade), and the physics was driven by Rafael Armenteros, who recently passed away (see *CERN Courier* June 2004 p44).

Three institutions were involved: CERN, Saclay and the Ecole Polytechnique in Paris. I don't recall the exact number, but there must have been about 15 to 20 "authors", and we all considered this to be far too many. The discovery was eventually published in *Physical Review Letters* after a long tussle with the editor, who finally bowed to our demand that the author list should be limited to three names, those of the three participating institutions, cited in alphabetical order (see *Physical Review Letters* 1962 **8** 257).

An equivalent author list for the Large Hadron Collider would read as follows: Africa, America, Asia, Europe, Oceania...with Antartica to follow the day the AMANDA/IceCube laboratory applies to join.

Yours in very good humour,
Jacques Goldberg.

Team effort two

I was pleasantly touched by the archive article "Knocking out the Proton Synchrotron beam", reminding us of our early endeavours (see *CERN Courier* June 2004 p11). But you should have mentioned my old colleague and friend Günther Plass. We were the joint protagonists of the fast ejection project to which a number of persons, mentioned in the 1963 article, contributed. Your article is a heavily edited version of the (more folkloristic) original one, so it is not really correct to say "...is told here by Berend Kuiper".

Berend Kuiper.

Editor's comment

It is pleasing to see the interest in the archive page that was introduced this year to celebrate CERN's 50th anniversary. The aim is to give a flavour of the news during the first years of the *CERN Courier*. With only one page, it is often the case that only short extracts from much longer articles can be printed.

Christine Sutton.

RECRUITMENT

For advertising enquiries, contact *CERN Courier* recruitment/classified, Institute of Physics Publishing, Dirac House, Temple Back, Bristol BS1 6BE, UK.
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UNIVERSITY OF OXFORD

Royal Holloway
University of London

Directorship of Oxford/RHUL Accelerator Institute

The Subdepartment of Particle Physics at the University of Oxford and the Department of Physics at Royal Holloway University of London (RHUL) are seeking to make a joint appointment at the professorial level of an outstanding physicist with an international reputation in accelerator science as Director of the Oxford/RHUL Institute for Accelerator Science. This is a major new commitment by the two institutions to develop the study of accelerator science and forms part of an initiative by the Particle Physics and Astronomy Research Council (PPARC) to form two Accelerator Science Institutes in the UK. This initiative is also supported by the Council for the Central Laboratories of the Research Councils (CCLRC), whose Daresbury and Rutherford Appleton Laboratories will work closely with the Institute. Currently, six academic staff and a large number of technical staff are associated with the work of the Institute; Oxford and RHUL are committed to appointing a total of six further new academic staff, including the Director, bringing the total academic staff associated with the Institute to 12.

The Director will be responsible for the academic leadership and strategic goals of the Institute, for setting up a high-quality academic training programme and establishing extensive links with the UK and international particle physics communities, other academics and industry. He or she will play a major role in the appointment of the new academic staff and other staff in the Institute. He or she will be responsible to the head of the Oxford University Subdepartment of Particle Physics and the head of the Physics Department of RHUL for the current programme in accelerator science (see below) and the future development of the field. The Director will be a member of the high-level management of both departments. The Director will be predominantly based in Oxford. An Oxford college fellowship will be sought for the successful candidate, who will be employed by the University of Oxford and RHUL on a stipend in the RSIV range (Professorial equivalent) at a level to be negotiated.

Informal enquiries about this post may be made to Professor Brian Foster, b.foster@physics.ox.ac.uk or +44 (0) 1865 273323.

Further information and instructions for application are available on http://www.physics.ox.ac.uk/pnp/jobs/Accel-Dir-fp.htm or from Mrs Sue Geddes, +44 (0) 1865 273353, s.geddes@physics.ox.ac.uk The deadline for applications is 30th November 2004.

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The Nuclear Science Division at the Lawrence Berkeley National Laboratory (LBNL) is seeking a scientist with outstanding promise and creative ability in experimental nuclear astrophysics. The appointment will be as Divisional Fellow for a term of five years with the expectation of promotion to Senior Scientist. For exceptionally qualified candidates an appointment as Senior Scientist will be considered. The successful candidate is expected to develop a vigorous nuclear astrophysics program at LBNL, which could include experiments at the 88-Inch Cyclotron and other national facilities, and to assume a leadership role at the Rare Isotopes Accelerator and the National Underground Laboratory in the future.

Candidates must have a recent PhD or equivalent and several years of experience beyond the PhD in nuclear astrophysics. Demonstrated achievements in independent research and in development of instrumentation for nuclear astrophysics are essential.

Applicants are requested to e-mail a curriculum vitae, list of publications, statement of research interests, and the names of at least five references to mddavis@lbl.gov with a cc to vkoch@lbl.gov. This position will be open until filled. Applications that reach us before November 1, 2004 will be given preference. Please reference job number NS/017322/JCERN on the subject line and in your cover letter. Berkeley Lab is an EEO/AA employer.

BERKELEY LAB

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ELECTRONICS ENGINEER
PHYSICS DEPARTMENT
FACULTY OF ARTS AND SCIENCE

The Physics Department at New York University has an opening for an Electronics Engineer to work on MECO (see http://meco.ps.uci.edu), a particle physics experiment to run at the Brookhaven National Laboratory in 2009.

The individual in this role will design and prototype low-noise analogue front-end, trigger, digitizing and DAQ electronics for a lead-tungstate/APD calorimeter for a Proportional Chamber tracker. Taking the role of project engineer, work closely with the MECO Project Manager to oversee the fabrication and operation of the electronics systems for the entire experiment with 22K channels.

The ideal candidate will have a B.S. degree in Electrical Engineering or higher, and a minimum of five years' experience in high-speed analogue and digital electronics design for particle or nuclear physics experiments. Requires high degree of technical initiative, and excellent communication skills.

NYU offers a superior benefits package, which includes free NYU tuition for self and eligible family members, generous vacation, medical, dental and pension plans. For more information about working at NYU and to apply for this position online, visit our website at: **www.nyu.edu/hr/jobs/apply**. Click on **"External Applicants," "Search Openings,"** and select **2567BR** in the **"Keyword Search"** field. When asked **"How were you referred to NYU?"** please select **A3**. Application Deadline: **October 4, 2004**. *We accept online applications only.*

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The post is supported by PPARC for three years, commencing 1 October 2004. You will be expected to spend time at CERN as appropriate.

Informal enquiries to Professor P Allport, on +44 (0) 151 794 3365, email: allport@hep.ph.liv.ac.uk or Dr J N Jackson on +44 (0) 151 794 3366, email:jnj@hep.ph.liv.ac.uk **Quote ref: B/313/CC**

Closing Date: 27 September 2004 - applications will be accepted until the post is filled.

Further particulars and details of the application procedure should be requested from the Director of Personnel, The University of Liverpool, Liverpool L69 3BX on +44 (0) 151 794 2210 (24 hr answerphone), via email:jobs@liv.ac.uk or are available online at http://www.liv.ac.uk/university/jobs.html

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RHIC PHYSICS FELLOW POSITIONS

Tenure Track - Strong Interaction Theory

The RIKEN BNL Research Center (RBRC) at Brookhaven National Laboratory (BNL), together with university partners, invites applications for a program of cooperative fellowships in strong interaction theoretical physics motivated by the experimental heavy-ion and proton spin programs of the Relativistic Heavy Ion Collider at BNL. Each RHIC Physics fellow fellow will be jointly selected and supported for five years by the Center and one of the cooperating universities and will hold a tenure track faculty appointment (or equivalent) in that university's Physics Department. Each fellow will spend about half time at RBRC and the remaining time at the university. Candidates should have a Ph.D. degree in theoretical nuclear or particle physics and be interested in pursuing theoretical research within a broad range of hadron physics, such as high energy nuclear theory; RHIC physics, QCD (pertubative and lattice), hadronic spin physics, hadronic spectra and their transition matrix elements.

Scientists with appropriate backgrounds who are interested in applying should send a curriculum vitae, publication list, a brief description of their reseach interests, and arrange three letters of reference to be sent to Dr. Nicholas P. Samios, Director, RIKEN BNL Research Center, Building 510A, Brookhaven National Laboratory, P.O. Box 5000, Upton, NY 11973-5000 before December 1, 2004. Additional information, including current participating universities will be available by sending an e-mail request to: rhic_fellows@bnl.gov or by writing to the above address. BNL is an equal opportunity employer committed to workforce diversity.

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The **Physics Department at the Johannes Gutenberg-University, Mainz (Germany),** invites applications for the position of a

Professor
of Theoretical Elementary Particle Physics (Bes.Gr. W 3 BBesG - full professor) (succession of Prof. F. Scheck)

beginning October 1, 2005.

The successful candidate will have an outstanding record of accomplishments in Theoretical Elementary Particle Physics and broad interests ranging from Quantum Field Theory and its conceptual foundations and modern methods to experiment-related issues like particle physics at accelerators at highest available energies, neutrino or flavour physics or astro-particle physics. Collaboration with the experimental and theoretical elementary particle physicists at the Department and participation in the DFG-Graduiertenkolleg "Gauge Theories - experimental tests and theoretical foundations" is expected.

Applicants are expected to have a Ph.D in physics, an excellent research record and to have interest in and aptitude for teaching. Lectures are usually given in German. The Johannes Gutenberg-University promotes a concept of intensive tutoring and requests a high rate of presence at the university.

Participation in all teaching activities and academic administration duties of the Department is expected.

The Johannes Gutenberg-University Mainz aims at increasing the percentage of women in academic positions and strongly encourages women scientists to apply.

The University is an equal opportunity employer and particularly welcomes applications from persons with disabilities.

Qualified candidates are requested to submit their application, including curriculum vitae, list of publications, list of teaching experiences, information on obtainedgrants and reprints of up to five of their most important publications to the
Johannes Gutenberg-Universität Mainz, Dekan des Fachbereichs 18 – Physik – 55099 Mainz, Germany, not later than October 1st, 2004.

COURSES AND CALLS FOR PROPOSALS

TO ADVERTISE, PLEASE CALL JAYNE PURDY
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CERN COURIER

ASTeC INTENSE BEAMS GROUP

Two fixed-term vacancies exist within the Intense Beams Group of ASTeC, the UK's centre of excellence for accelerator R&D. Based at the Rutherford Appleton Laboratory in Oxfordshire, the Group's work spans machine design and beam physics for high power proton accelerators, neutrino factories, and upgrades of ISIS, the RAL's world-leading pulsed spallation neutron source. Both vacancies are part of European collaborations and offer a stimulating environment, providing excellent opportunities for new initiatives and personal development.

ACCELERATOR PHYSICIST (3-year appointment) VN2574/CC

Working in the field of high-power linear accelerators within the European Framework-Program 6 (CARE/HIPPI), you will be expected to contribute to computational and theoretical studies of high-power proton accelerator front-ends up to an energy of 200 MeV. The work involves the design and optimisation of normal conducting RF cavities, pulsed electromagnetic quadruples, and beam dynamics simulations of accelerating structures. Experience with 2D and 3D electromagnetic field solvers and/or particle tracking codes would be beneficial.

The starting salary will be between £17,134 and £26,435 per annum (pay award pending) dependent on experience.

ACCELERATOR PHYSICIST (3-year appointment) VN2575/CC

The vacancy offers an opportunity to play a leading role in developing ideas for muon acceleration as part of the UK's Neutrino Factory Programme. This includes some work on re-circulating linacs but will concentrate primarily on fixed-field alternating gradient (FFAG) machines. You will be expected to guide work programmes and coordinate the work of other members of the team. High levels of mathematical ability and computer literacy are required and experience of beam dynamics and accelerator design would be an advantage.

The starting salary will be between £22,205 and £33,559 per annum (pay award pending) dependent on experience.

Further details of both posts are available from Dr. C.R. Prior (c.r.prior@rl.ac.uk) or Mr. F. Gerigk (f.gerigk@rl.ac.uk).

An excellent index-linked pension scheme and generous leave allowance are also offered.

Application forms and a complete job description can be obtained from: HR Operations Group, Rutherford Appleton Laboratory, Chilton, Didcot, Oxfordshire, OX11 0QX. Telephone (01235) 445435 (answerphone) quoting the appropriate reference, or e-mail recruit@rl.ac.uk

All applications must be returned by 10 September 2004.

Interviews will be held on week commencing 4 October 2004.

INVESTOR IN PEOPLE

CCLRC

COUNCIL FOR THE CENTRAL LABORATORY OF THE RESEARCH COUNCILS

POSTDOCTORAL RESEARCH IN EXPERIMENTAL PARTICLE PHYSICS

The Department of Physics invites applications for a postdoctoral research position in experimental particle physics. The appointed individual will be based at SLAC to participate in data analysis, software and hardware development on the BABAR experiment at the SLAC B factory. Candidates should be recent Ph.D. recipients and should submit a resume, statement of research interests and list of publications to

Professor Owen Long, Department of Physics, University of California, Riverside, CA, 92521, USA, owen@slac.stanford.edu.

The applicant should arrange for three letters of recommendation to be sent to the above address.

Review of applications will begin September 1, 2004 and will continue until the position is filled.

UCR

UNIVERSITY OF CALIFORNIA, RIVERSIDE

The University of California is an Equal Opportunity/Affirmative Action Employer

UNIVERSITY of GLASGOW

www.gla.ac.uk

DEPARTMENT OF PHYSICS AND ASTRONOMY

Research Associate in Experimental Particle Physics (two posts)

£19,460 – £29,128

Positions are available in the areas of silicon detector hardware and software development to work on the Vertex Locator of the LHCb Experiment at the CERN Large Hadron Collider.

Post 1: You will work on the testing, installation and commissioning of the LHCb Vertex Locator. You will have an interest in semiconductor detector development and have, or expect soon to receive, a PhD in experimental particle physics. This post is available until 30 November 2007. **Ref 10733/DPL/A3.**

Post 2: You will work on the development of software for this sub-detector, focusing on alignment and reconstruction algorithms. You will have, or expect soon to receive, a PhD in experimental particle physics or experience in e-science. This post is available until 1 October 2007. **Ref 10734/DPL/A3.**

Informal enquiries can be made to Dr Chris Parkes, +44 (0)141 330 5885 or email: c.parkes@physics.gla.ac.uk

For further information on the post and method of application see http://ppewww.ph.gla.ac.uk/LHCbPPERA.html

Closing date: 1 October 2004.

The University is committed to equality of opportunity in employment.

GSI Darmstadt invites applications for a

Head of the Accelerator Division

Ref. No.: 3000-04.38

A conjoint system of heavy ion accelerators, including a linear accelerator (Unilac), a synchrotron (SIS18) and an experimental storage ring (ESR), is in operation for research with heavy ions in the fields of nuclear and hadron physics, atomic physics, physics of dense plasma, materials research, radiation biology and other related fields.

The function of the Accelerator Division is, firstly, to ensure the availability and quality of the ongoing complex beam operation and to support the further development of the existing facilities in accordance with the multifaceted requirements of international research programs. Secondly, the accelerator division must develop and implement projects with a view to assuring the future.

The Head of the Accelerator Division must be capable of motivating and leading a team of approximately 200 physicists, engineers and technicians in the field of accelerator physics in a cooperative and competent manner. Much of the development and project work is to be done in collaboration with Universities and international partners.

The applicant must have outstanding expertise in the field of particle acceleration as well as experience in successful personnel management and supervision of major projects. Further requirements are the willingness to work within the scope of international cooperation and the ability to work efficiently and effectively within a scientific environment.

Working level knowledge of the German language is expected.

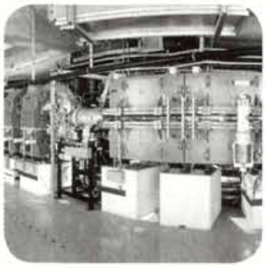
The Head of the Accelerator Division is a member of the scientific board of directors of GSI.

GSI is an equal opportunity employer and encourages women especially to apply for the position. Disabled applicants will be given preference over other applicants with comparable qualifications.

You will find further information concerning GSI on http://www.gsi.de.

Applications quoting the Ref. No. and including CV, publication list and three letters of reference should be sent by **September 30, 2004** to:

GSI Darmstadt



The National Laboratory for Heavy-Ion Research, a member institute of the Helmholtz-Society of German Research Centers

Gesellschaft für Schwerionenforschung mbH
Personalabteilung
Kennziffer 3000-04.38
Planckstraße 1
64291 Darmstadt

PHYSICS DIVISION FELLOW

The Physics Division at Lawrence Berkeley National Laboratory (LBNL) is seeking a scientist with outstanding promise and creative ability in the field of experimental high-energy physics. The appointment will be as a Divisional Fellow on the ATLAS experiment at the Large Hadron Collider for a term of up to five years, with the expectation of promotion to a career position as a Senior Staff Scientist. An immediate appointment as a Senior Staff Scientist may be considered in exceptional cases.

The successful candidate will take a leadership role in the ATLAS program at LBNL in preparation for the data taking and analysis phase of the ATLAS experiment. The current ATLAS program at LBNL includes major efforts in LHC physics and simulation, software development and the silicon pixel and silicon strip systems for the ATLAS tracking detectors. Berkeley will have a long-term leading role in physics analysis and in future detector upgrades to ATLAS. Candidates should have several years of experience in experimental particle physics beyond the PhD and have demonstrated leadership capabilities.

Applicants should submit via e-mail a curriculum vitae, a publication list and a statement describing their research experience and future interests, as well as arrange to have three letters of recommendation sent to the attention of the ATLAS Divisional Fellow Search Committee at sdcheeseboro@lbl.gov. Applications should reference job number PH/ 017298/JCERN and must be received by December 3, 2004.

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

BERKELEY LAB

Access PhysicsJobs
@
physicsweb.org

BE PART OF CERN'S 50TH ANNIVERSARY

Give your announcement:

- **Higher profile**
- **Longer shelf life**
- **More opportunities to be seen by relevant, qualified candidates**

CERN Courier will be producing a special 50th anniversary issue in October, with editorial features looking at experiments past and present, plus many more bonus articles to commemorate the last 50 years and look forward to the next 50.

This issue will have an extremely high profile throughout the world's research labs, and will be kept as a commemorative issue and referred to time and time again. This will give your recruitment messages the same prestige and extra coverage.

If you are looking to recruit physicists and engineers from the world's most important research laboratories and government organizations, the October issue of *CERN Courier* offers you a perfect opportunity to reach this highly qualified audience in a most cost-effective manner.

With flexible sizing, even the most modest advertising budget can be accommodated to allow you to reach the right candidates for your studentships, research positions and senior vacancies.

The booking deadline for this special issue of *CERN Courier* is Thursday 2 September.

Please contact me as soon as possible to discuss presenting your messages in the best possible way.

Jayne Purdy: Tel +44 (0)117 930 1027; Jayne.purdy@iop.org

Robert R. Wilson Fellows Program

The Wilson Fellowship program at Fermilab seeks applications from Ph.D. physicists of exceptional talent with at least two years of post-doctoral work. The fellowships are awarded on a competitive basis and support physicists early in their careers by providing unique opportunities for self-directed research. Fellows will work on the Fermilab particle physics experiment of their choice. The Fermilab experimental program includes collider physics at both the Tevatron and the LHC, studies of neutrino oscillations, quark flavor physics, and astroparticle physics.

The Wilson Fellowships are tenure track positions with an annual salary fully competitive with university assistant professorships. The appointment is for an initial term of three years and can be renewed for an additional two years upon the completion of a successful review after the first two years.

Each candidate should submit a research statement describing a proposed research program, curriculum vitae, and should arrange to have four letters of reference sent to the address below. Application materials and letters of reference should be received by October 31, 2004.

Materials, letters and requests for information should be sent to:

Wilson Fellows Committee
Fermi National Accelerator Laboratory
MS122, Attention: Cathryn Laue
P.O.Box 500 Batavia, IL 60510-0500
email: wilson_fellowship@fnal.gov

For more information visit:
www.fnal.gov/pub/wilson_fellowships.html

Fermilab

UNIVERSITY COLLEGE LONDON

UCL ***Department of Physics and Astronomy***

High Energy Particle Physics Group Lectureship in Experimental Physics

Applications are invited for the above position, to commence January 2005, or at a mutually agreeable date thereafter.

The HEP Group has a broad experimental programme, with strong involvement in the ZEUS experiment at HERA, the CDF and MINOS experiments at Fermilab, the NEMO III neutrinoless double-beta decay experiment, and R&D for a future linear collider and for SuperNEMO. A current priority is the ATLAS experiment, where we are involved in construction of the semiconductor tracker and the level 2 trigger and have recently greatly expanded our software and eScience activities. The Group also has interests in generic eScience applications, and in potential upgrades to some of the above experiments. Full details are available at www.hep.ucl.ac.uk. The successful candidate will be expected to take a lead in an important part of this challenging and exciting program. Further details about the post are available at www.hep.ucl.ac.uk/positions.

The successful applicant will have an established record of significant research and the potential to become a leader in the field. They will also be expected to show evidence of competence in teaching at undergraduate and postgraduate level. Candidates wishing to transfer a long-term fellowship are welcome to apply. Salary scale in the Lecturer range: £21,640 to £39,114 plus £2,330 London Allowance and relocation benefits.

Applications, accompanied by a full CV, including a statement of research interests and plans, plus contact details of three referees, should be sent to Professor J Tennyson, (hod.physast@ucl.ac.uk), Head of Department of Physics and Astronomy, University College London, Gower Street, London WC1E 6BT, UK. Informal enquiries may be made to the HEP Group Leader, Dr Jonathan Butterworth, (j.butterworth@hep.ucl.ac.uk).

The closing date for applications is **Friday, 29th October 2004.**

UCL Taking Action for Equality

PENNSTATE

Tenure-Track Faculty Position in Experimental Particle Astrophysics

THE PENNSYLVANIA STATE UNIVERSITY

The Department of Physics at The Pennsylvania State University invites applications for a tenure-track or tenured faculty appointment in particle astrophysics experiment, effective the fall semester of 2005. Current efforts in the department include AMANDA, ANITA, Auger, CREAM, CREST, HEAT and IceCube. Applicants should have a Ph.D. and an outstanding research record. Rank will be commensurate with qualifications and experience. Candidates at the junior level should submit a letter of application, a curriculum vitae, a brief description of research plans, and arrange for four letters of recommendation to be sent to **Jayanth Banavar, Box 262, Department of Physics, 104 Davey Laboratory, The Pennsylvania State University, University Park, PA 16802, USA.**

Nominations and applications for senior positions should be sent to the address above together with a list of at least six references. Applications completed by December 15, 2004 will be assured of consideration. However, applications will be considered until the position is filled. Job application assistance is available for dual career situations.

Penn State is committed to affirmative action, equal opportunity, and the diversity of its workforce.

2005 CHAMBERLAIN FELLOWSHIP E.O. LAWRENCE BERKELEY NATIONAL LABORATORY

The Berkeley Lab Physics Division invites outstanding recent PhD recipients to enter the competition for the 2005 **Owen Chamberlain Fellowship** in experimental elementary particle physics and cosmology. Students who expect to receive their PhD degree by the spring of 2005 are also invited to apply.

A Chamberlain Fellow is appointed for three years, with two years of extension possible upon review. Upon appointment, a Chamberlain Fellow is given time to review the Division's research program and may choose to participate in any aspect of it. With the Division Director's approval, he/she may also pursue new initiatives within experimental particle physics or cosmology. In addition to his/her salary, a Chamberlain Fellow receives a $5,000 annual research supplement. Funding for new initiatives is available through a competitive Laboratory-wide program.

Opportunities for collaboration in exciting and diverse physics programs are found both at Berkeley Lab and on the U.C. Berkeley campus, including research mentorship of physics PhD students. Close interactions with local astrophysics communities are possible, as are relationships with nuclear and accelerator scientists, and access to world-leading computation. For information on the Berkeley Lab Physics Division's research program, please consult http://www-physics.lbl.gov/.

This Fellowship honors Berkeley Nobelist Owen Chamberlain, who (with Emilio Segrè, Clyde Wiegand, and Thomas Ypsilantis) discovered the antiproton at the Berkeley Bevatron in 1955.

Applications must be received by October 25, 2004, and should include a curriculum vitae, publication list, statement of research interests, and names and email addresses of at least three references. Materials should be emailed to gensciemployment@lbl.gov. Please cite Job # PH/017348/JCERN in the subject line. Applicants who fail to receive an acknowledgement should contact blcu@lbl.gov. LBNL is an equal opportunity employer committed to developing a diverse workforce.

BERKELEY LAB

UNIVERSITY OF OXFORD

Departmental Lecturer or Research Assistant for the LHCb Experiment

The Subdepartment of Particle Physics, University of Oxford, is seeking an outstanding physicist to play a major role in the LHCb experiment. We wish to appoint a highly qualified person as a Departmental Lecturer, for a fixed term of up to 6 years depending on experience and qualification. However, less experienced candidates are also encouraged to apply for appointment as Research Assistant with less responsibility and teaching.

Oxford's major responsibilities in LHCb are in the hardware and reconstruction software for the Ring Imaging Cherenkov (RICH) detectors. The successful candidate will work primarily in the preparation of physics analysis, and also participate in the commissioning of the RICH electronics and/or develop RICH reconstruction algorithms.

The closing date for applications is 15th October 2004. Further information and instructions for application are available on http://www.physics.ox.ac.uk/pnp/jobs/lhcb-dl-ra-fp.htm or from Mrs Sue Geddes, +44 (0)1865 273353, s.geddes@physics.ox.ac.uk or Prof Neville Harnew, n.harnew@physics.ox.ac.uk

The University is an Equal Opportunities Employer.

BOOKSHELF

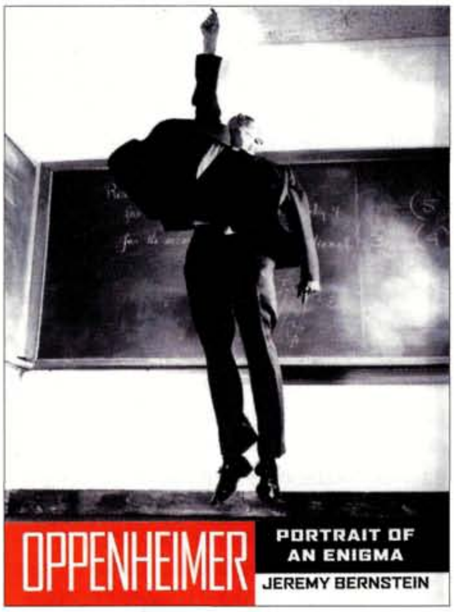
Oppenheimer: Portrait of an Enigma by Jeremy Bernstein, Ivan R Dee. Hardback ISBN 1566635691, $25.

Jeremy Bernstein, theoretical physicist and erstwhile science writer at *The New Yorker*, targets "readers whom I do not assume to be scientists, but whom I do assume to have intellectual curiosity". With *Oppenheimer: Portrait of an Enigma* he aims true. *Portrait* is an engrossing collection of vignettes of the great and the good (and the not so great and not so good) who took part in a scientific project that changed the world like no other: building the atomic bomb. Woven into the story are lucid exposés of those 20th century sciences that informed the project, as well as many insights into the geopolitical upheavals that were provoking and being provoked by it.

Portrait is less fraught with witch-hunting and soul-searching than earlier accounts of the same events. After passing sensitively through Oppenheimer's somewhat strange and sad childhood, Bernstein treats his readers to splendid tales of "Oppie" as sartorial aesthete, polyglot, poet, lover, homicide *manqué*, "left-wanderer", brilliant physicist, serial show-off and cruel critic, an insecure genius with a profound need to be admired. The supporting cast includes military and political stars, and most of the glitterati of early quantum, atomic and astrophysics, from Alvarez to Zwicky.

Though firmly in the Oppie fan club, Bernstein remains even-handed in drawing a fascinating profile of a complex man. The fellow he depicts is not particularly nice but undeniably charismatic, a magnet with both poles fully exposed, admired and hated equally. Unfortunately for Oppie, times were such that his enemies could be dangerous. Pivotal episodes are his unlikely appointment as director of the Los Alamos Laboratory in 1943 – "he had never managed anything" and "had a ton of left-wing baggage" according to Bernstein – and his almost self-induced downfall during the following years. His disgraceful testimony to the House Un-American Activities Committee in 1949 and bizarre conduct during his own "trial" before the Atomic Energy Commission (AEC) in 1954, when he finally lost his security clearance, are candidly presented and carefully analysed. In 1947 Oppenheimer was made director of the Institute of Advanced Study in Princeton, where Bernstein was later to meet him. The cold-war arms race proceeded without him.

Though not mentioned, in CERN's 50th birthday year it is fitting to recall that several



"men of science" who came out of the Manhattan Project with a feeling of "blood on their hands" were determined that things would be different for future generations of researchers. While Oppenheimer was being investigated by the AEC, his close friend Isidor Rabi and others were working through UNESCO to create CERN, a European laboratory where physicists could conduct "nuclear research of a pure scientific and fundamental character...[having] no concern with work for military requirements."

Portrait prompts other sobering reflections on "then" versus "now". For example, in July 1945 the Franck Report premised that bomb technology could not be kept secret and that it was only a matter of time before other nations would have nuclear weapons. A scant four years later Russia exploded its first nuclear bomb. In June of this year Mohamed El Baradei, director-general of the International Atomic Energy Agency, speaking at a conference hosted by the Carnegie Endowment for International Peace, said: "we are actually having a race against time...not only with regard to countries acquiring nuclear weapons but also terrorists getting their hands on some of these materials, uranium and plutonium."

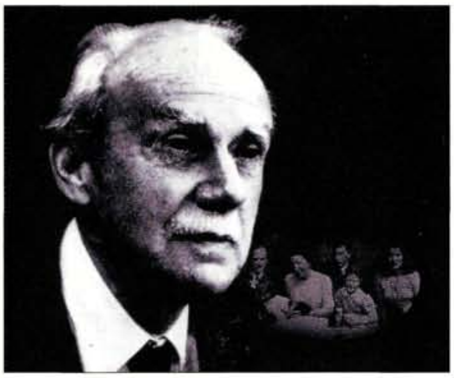
Portrait is full of personalities and is entertaining and thought-provoking. If cavils there must be, there is a brief lapse of clarity concerning fusion, later redressed, and the timeline is sometimes confusingly broken or looped, but these are minor quibbles not major complaints.
Peggie Rimmer, CERN.

Proceedings of the Dirac Centennial Symposium by Howard Baer and Alexander Belyaev (eds), World Scientific. Hardback ISBN 981238412X, $77 (£57).

Sitting in an undergraduate lecture, being introduced to the Dirac equation for the first time, I found myself wondering "How on earth did he come up with that?" My hope for this book was that it might provide some insight into what made Paul Dirac such a great physicist. I think that it was satisfied to some extent.

2002 was the 100th anniversary of Dirac's birth and this book constitutes the proceedings of a symposium held at Florida State University, where Dirac held a faculty position during his last 14 years. There are 13 contributions from the speakers, more-or-less centred around areas of Dirac's interest. The anecdotes sprinkled throughout are particularly entertaining to read, especially for younger readers who may not have heard many of them.

Dirac's daughter, Monica, writes an endearing account of her father, the family man, with obvious warmth and affection. Memories such as Dirac measuring the length of the cat's whiskers to make sure he'd fit through the cat-flap warm the heart. His love of walking, swimming outdoors and classical music also shines through.



Despite not being able to attend due to a snow storm, Frank Wilczek contributed an outstanding essay (contrary to some speakers who are named and shamed for not contributing). It starts with a discussion of the Dirac equation and leads in sometimes surprising directions: considerations of the possibility of artificial intelligence, for instance. Wilczek's views on what one may learn from Dirac's approach to physics is interesting, and we see from various contradictory quotations that Dirac sometimes changed his mind. In particular, there are several quotes about ▷

Dirac apparently not worrying too much about experimental results, but Wilczek exposes Dirac's delight when the prediction of his equation that the ratio of the magnetic moment of the electron to its spin equals two was supported by data. William Marciano follows with a nice and succinct review of this latter topic. Later, Dirac also lost faith in "his" monopole due to the lack of experimental evidence.

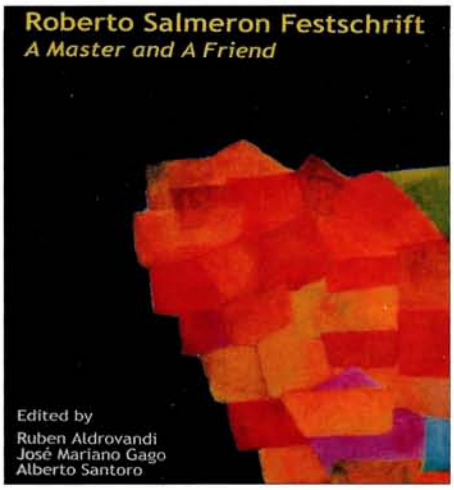
There are good introductions to time variations of fundamental "constants" by Paul Langacker and neutrino physics by Vernon Barger, which will appeal to those of a more phenomenological bent. Some of the M-theory/brane and string-oriented contributions by Pierre Ramond, Roman Jackiw and Joe Polchinski will probably appeal to the more mathematical physicist. The contribution of Leopold Halpbern is frankly annoying, however, after he starts discussing his own work in general relativity, and I found Maurice Goldhaber's resolution of the fermion mass problem bizarre and too heuristic.

So how did Dirac contribute so much important work? It seems by doggedly hanging on to an elegant idea that solves a difficult problem, then frequently changing methodology; certainly by looking for mathematical beauty but also by taking note of other theorists' work and experimental data. Oh, and plenty of long walks.
Ben Allanach, LAPP, Annecy.

Roberto Salmeron Festschrift: A Master and A Friend by R Aldrovandi, A Santoro and J M Gago (eds), AIAFEX, Rio de Janeiro. ISBN 8585806028, €40. Available from Livraria Leonardo Da Vinci, Rio, Brazil, fax: +55 21 2533 1277, e-mail: info@leonardodavinci.com.br.

This book is a token of the admiration and friendship felt for Roberto Salmeron on the occasion of his 80th birthday. Some of the authors regard him as both their teacher and mentor, and others as a respected colleague and friend. The book is thus a tribute to the scientist, the professor and the friend.

There is scarcely a domain in Brazilian science and culture where Roberto has not played an important role. He is remembered for example by his support for the Instituto de Fisica Teorica in Sao Paulo in the 1950s. He also proposed the establishment of the first ICFA Instrumentation School in Brazil, as well



as the creation of a synchrotron light laboratory in Campinas. Then came his support for the development of instrumentation to be used in experiments both at CERN and at Fermilab.

The 32 contributed papers cover a wide spectrum of topics, from general relativity and cosmology to the interaction between science and society. They touch in turn upon the physics of neutrino masses and mixings, the study of cosmic rays and particle physics, and the search for the quark–gluon plasma, the origin of masses, the development of nanotechnology and several quantum-physics issues.

They also provide vivid glimpses of Roberto's personality, such as his enthusiasm for teaching physics, the desire to develop science for the benefit of all society, and his awareness of the social responsibilities of scientists. A dramatic article by Michel Paty evokes their common struggle, in 1963–1965, in building the Institute of Physics of the University of Brazilia and defending its freedom against the intervention of the dictatorial regime. This was a fight that ended in the resignation of most of the faculty members and Roberto's exile – an example of his courage and determination in defending the dignity of science. Long live Roberto!
Emanuele Quercigh, CERN and INFN Padova.

Books received

Invitation to Contemporary Physics by Q Ho-Kim, N Kumar and C S Lam, World Scientific. Hardback ISBN 9812383026, £76 ($103); paperback ISBN 9812383034, £30 ($41).

This is a completely revised second edition of a book that presents 10 of the most important areas of modern physics. It ranges from lasers and superconductivity to particles and cosmology, and includes three new chapters on Bose–Einstein condensation, nanostructures and quantum computing. Of interest to students and teachers, the emphasis is as much on describing natural phenomena as on explaining them in terms of basic physical principles.

The Theory of Complex Angular Momenta: Gribov Lectures on Theoretical Physics by V N Gribov, Cambridge University Press. Hardback ISBN 0521818346, £65 ($95).

Published as part of the series of Cambridge Monographs on Mathematical Physics, this is an English translation of the lectures given by Gribov in 1969, when the physics of high-energy hadron interactions was emerging. It provides a rigorous introduction to the theory of complex angular momenta based on the methods of field theory. The approaches developed are useful for analysing high-energy hadron scattering in many contexts, including future analysis of electroweak processes at the Large Hadron Collider.

Introduction to Nuclear and Particle Physics by A Das and T Ferbel, World Scientific. Paperback ISBN 9812387447, £36 ($48).

This is a welcome new edition of a popular textbook for undergraduates first written 15 years ago, since when much has happened in particle physics in particular. The book begins with nuclear physics, after a first chapter on Rutherford scattering, and then passes via the practical issues of particle interactions in matter, detectors and accelerators, to particle physics, the Standard Model and beyond.

Particles and Nuclei: An Introduction to the Physical Concepts by Bogdan Povh *et al.*, Springer. Paperback ISBN 3540201688, €34.95 (£27.00/$44.95).

Now a standard reference for many undergraduate and more advanced courses, this book is a uniform presentation of nuclear and particle physics split into "Analysis" and "Synthesis" sections. "Analysis" looks at disentangling the substructure of matter, while "Synthesis" shows how the elementary building blocks combine to form hadrons and nuclei. This fourth edition has some new developments, such as double beta decay.

Going public: a new paradigm

For **David P Anderson**, project leader of SETI@home, the future of scientific computing is public.

Most of the world's computing power is no longer concentrated in supercomputer centres and machine rooms. Instead it is distributed around the world in hundreds of millions of PCs and game consoles, of which a growing fraction are connected to the Internet.

A new computing paradigm, "public-resource computing", uses these resources to perform scientific supercomputing. This enables previously unfeasible research and has social implications as well: it catalyses global communities centred on common interests and goals; it encourages public awareness of current scientific research; and it gives the public a measure of control over the directions of science progress.

The number of Internet-connected PCs is growing and is projected to reach 1 billion by 2015. Together they could provide 10^{15} floating point operations per second (FLOPS) of power. The potential for distributed disk storage is also huge.

Public-resource computing emerged in the mid-1990s with two projects: GIMPS (looking for large prime numbers); and Distributed.net, (solving cryptographic codes). In 1999 our group launched a third project, SETI@home, which searches radiotelescope data for signs of extraterrestrial intelligence. The appeal of this challenge extended beyond hobbyists; it attracted millions of participants worldwide and inspired a number of other academic projects as well as efforts to commercialize the paradigm. SETI@home currently runs on about 1 million PCs, providing a processing rate of more than 60 teraFLOPS. In contrast, the largest conventional supercomputer, the NEC Earth Simulator, offers in the region of 35 teraFLOPs.

Public-resource computing is effective only if many participate. This relies on publicity. For example, SETI@home has received coverage in the mass-media and in Internet news forums like Slashdot. This, together with its screensaver graphics, seeded a large-scale "viral marketing" effect.

Retaining participants requires an understanding of their motivations. A poll of SETI@home users showed that many are

interested in the science, so we developed Web-based educational material and regular scientific news. Another key factor is "credit" – a numerical measure of work accomplished. SETI@home provides website "leader boards" where users are listed in order of their credit.

SETI@home participants contribute more than just CPU time. Some have translated the SETI@home website into 30 languages, and developed add-on software and ancillary websites. It is important to provide channels for these contributions. Various communities have formed around SETI@home. A single, worldwide community interacts through the website and its message boards. Meanwhile, national and language-specific communities have their own websites and message boards. These have been particularly effective in recruiting new participants.

All the world's a computer

We are developing software called BOINC (Berkeley Open Infrastructure for Network Computing), which facilitates creating and operating public-resource computing projects. Several BOINC-based projects are in progress, including SETI@home, Folding@home and Climateprediction.net. BOINC participants can register with multiple projects and can control how their resources are shared. For example, a user might devote 60% of his CPU time to studying global warming and 40% to SETI.

We hope that BOINC will stimulate public interest in scientific research. Computer owners can donate their resources to any of a number of projects, so they will study and evaluate them, learning about their goals, methods and chances of success. Further, control over resource allocation for scientific research will shift slightly from government funding agencies to the public. This offers a uniquely direct and democratic influence on the directions of scientific research.

What other computational projects are amenable to public-resource computing? The task must be divisible into independent parts whose ratio of computation to data is fairly high (or the cost of Internet data transfer may exceed the cost of doing the computation centrally). Also, the code needed to run the task should be stable over time and require a minimal computational environment.

Climateprediction.net is a recent example of such an effort in the public-resource computing field. Models of complex physical systems, such as global climate, are often chaotic. Studying their statistics requires large numbers of independent simulations with different boundary conditions.

CPU-intensive data-processing applications include analysis of radiotelescope data, and some applications stemming from high-energy physics are also amenable to public computing: CERN has been testing BOINC in house to simulate particle orbits in the LHC. Other possibilities include biomedical applications, such as virtual drug design and gene-sequence analysis. Early pioneers in this field include Folding@home from Stanford University.

In the long run, the inexorable march of Moore's law, and the corresponding increase of storage capacity on PCs and the bandwidth available to home computers on the Internet, means that public-resource computing should improve both qualitatively and quantitatively, which should open an ever-widening range of opportunities for this new paradigm in scientific computing.

David P Anderson, SETI@home and BOINC, Space Sciences Lab, University of California, Berkeley.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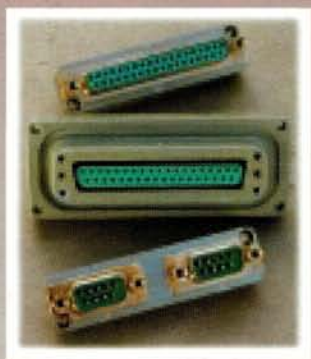

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