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CERN inaugurates the LHC

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

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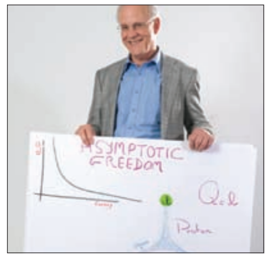
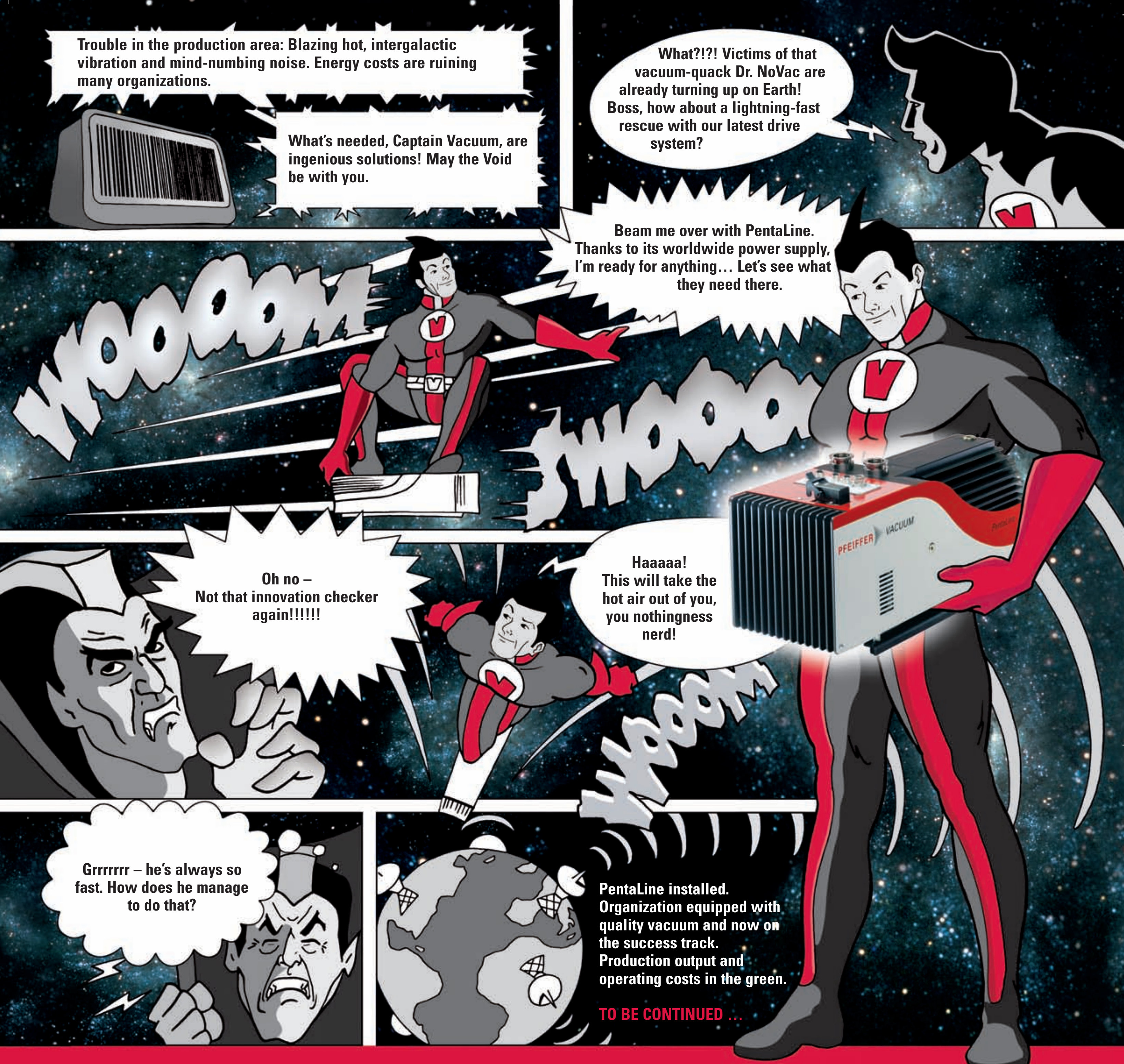
A statesman of science p13


Celebrations for the LHC p23



From partons to strings p27

Cover: The Daruma Doll Ceremony was a fitting finale to the LHC inauguration on 21 October (p23). The doll was originally painted with only one eye to mark the start of the LHC project and presented to the former CERN director-general, Chris Llewellyn Smith (image in background). To mark the successful culmination of the project, Toshio Yamauchi (left), senior vice-minister of education, culture, sports, science and technology in Japan, added the second eye and presented the completed doll to the current director-general, Robert Aymar (right). Llewellyn Smith (second right) witnessed the ceremony together with Swiss president, Pascal Couchepin.


Trouble in the production area: Blazing hot, intergalactic vibration and mind-numbing noise. Energy costs are ruining many organizations.
What's needed, Captain Vacuum, are ingenious solutions! May the Void be with you.
What?!?! Victims of that vacuum-quack Dr. NoVac are already turning up on Earth! Boss, how about a lightning-fast rescue with our latest drive system?
Beam me over with PentaLine. Thanks to its worldwide power supply, I'm ready for anything… Let's see what they need there.
WOOOOM
SWOOO
Oh no – Not that innovation checker again!!!!!!
Haaaaa! This will take the hot air out of you, you nothingness nerd!
PFEIFFER VACUUM
Grrrrrrr – he's always so fast. How does he manage to do that?
PentaLine installed. Organization equipped with quality vacuum and now on the success track. Production output and operating costs in the green.
TO BE CONTINUED …

NEWS

CERN

Breaking ground for Linac 4

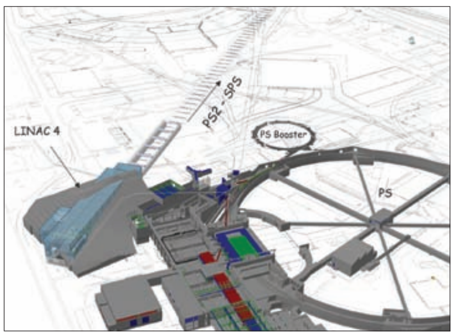
CERN's director-general, Robert Aymar, in position to excavate the first piece of earth at the start of civil engineering work for Linac 4. The new linac will play a key role in the LHC upgrade.

Civil engineering work has started on Linac 4, a major new renovation project for the CERN accelerator complex. It will replace Linac 2 as the first link in the proton-injector chain after commissioning is completed, which is scheduled for 2013.

Linac 4 is the first project to be built in the framework of the programme of new initiatives approved by CERN Council in June last year, with additional resources amounting to SFr240 million for the period 2008–2011. The consolidation and upgrade of the LHC and its injectors figure among the initiatives and include the construction of Linac 4 and design studies for other injectors to be built in a second phase.

Linac 2 has recently celebrated 30 years of service and its replacement is an essential component of the future LHC upgrade. This aims to extend the physics reach of the machine with a gradual increase in the luminosity beyond its nominal value. The existing injector chain is the main impediment to an increase in luminosity. In addition, although of excellent and proven reliability, the injection complex is beginning to show signs of ageing: the PS will be celebrating its 50th anniversary next year.

With a length of 80 m, Linac 4 will supply beams at an energy of 160 MeV, as compared with the 50 MeV beams from the 36 m long Linac 2. The new linac will feed the PS Booster, which in turn feeds the PS and then the SPS, before the particles finally enter the LHC. It will enable the PS Booster to deliver twice the beam intensity and contribute to increasing the LHC's luminosity. Moreover, it has been designed with future upgrades in mind. In a second phase, the PS Booster will be replaced by the Superconducting Proton Linac and the venerable PS by a new machine known as PS2 (*CERN Courier* July/August 2008 p17).



Schematic diagram showing the positioning of Linac 4 next to the PS and the PS Booster.

Linac 4 will use four types of accelerating structure with different focusing devices, each adapted to the beam energy. As in Linac 2, the particles are initially accelerated and focused by a RF quadrupole, and then by a drift tube linac (DTL). The DTL houses 120 specially designed permanent magnets that are smaller and more reliable than the electromagnets of Linac 2. These two initial structures will be followed by another type of linac: a cell-coupled drift tube linac, where quadrupoles are interleaved with accelerating cells. Pi-mode structures – accelerating structures similar to the copper cavities used in LEP – will provide the final boost of acceleration. Linac 4's hardware will also include a chopper line to cut up the beam at the same frequency as that of the PS Booster (i.e. 600 kHz). Synchronizing the frequencies of the two accelerators substantially reduces the particle losses at the injection point into the PS Booster.

The Linac 4 project is part of an international collaboration. The R&D work is being undertaken as part of a European project, notably involving institutes in France, India, Italy, Russia, Pakistan and Saudi Arabia. However, in the grand tradition of CERN, some components will be recycled. For instance, the RF power will be provided by reconditioned klystrons from LEP.

Sommaire

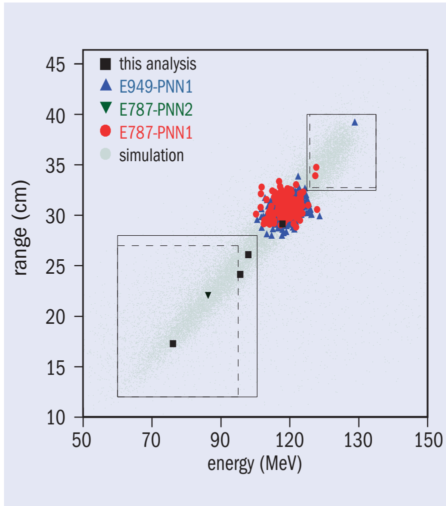
KAON PHYSICS

Brookhaven finds more rare kaon decays

The E949 collaboration at Brookhaven National Laboratory has observed three new events of the rare kaon decay $K^+ \rightarrow \pi^+\nu\bar{\nu}$. This brings the total number observed to seven, four of which were found by E949 and three by its predecessor E787. The branching ratio from all seven candidate events is $(1.73 + 1.15/-1.05) \times 10^{-10}$, which is consistent with the Standard Model prediction of $(0.85 \pm 0.07) \times 10^{-10}$.

The decay, $K^+ \rightarrow \pi^+\nu\bar{\nu}$, which is one of the rarest and most challenging particle decays ever observed, is highly sensitive to physics beyond the Standard Model (SM). The uncertainty of the SM prediction, which involves second-order weak interactions – that is, the exchange of two weak force carrier bosons – is less than 10%. Any deviations uncovered by a precise measurement of this branching ratio could unambiguously signal the presence of new physics effects that are predicted in extensions to the SM.

The experimental signature for $K^+ \rightarrow \pi^+\nu\bar{\nu}$ decay is the detection of a solitary positively charged pion, since the emitted neutrino and anti-neutrino pair interact too weakly to be detected, but unfortunately the sought-after signal resembles many other kaon decay channels. To identify the pion positively and ensure that no other observable decay particles were present, the collaboration created one of the most efficient particle-detection systems ever built. They also employed unbiased "blind" analysis techniques, which were pioneered by E787 and are now frequently used in modern high-energy physics experiments.



Kinetic energy vs. range of all events passing all other cuts. The squares show events selected by the latest analysis by the E949 collaboration. The circles and triangles represent events selected by previous E787 and E949 analyses, while the solid (dashed) lines show the limits of the signal regions for the different E949 (E787) analyses. The points near E = 108 MeV are from $K^+ \rightarrow \pi^+\pi^0$ decays that survived the photon veto cuts. The light-grey points are simulated $K^+ \rightarrow \pi^+\nu\bar{\nu}$ events that would be accepted by the trigger. (For more details see Artamonov et al. *2008.)*

The three new events, which were obtained in a sample of 1.7×10^{12} kaon decays, were observed in a low-energy pion region (see figure). This presented an even greater experimental challenge relative to the high-energy pion region, owing to additional processes that can mimic the $K^+ \rightarrow \pi^+\nu\bar{\nu}$ decay signature. The total background expected was 0.93 ± 0.17(Stat.) $+0.32/-0.24$(syst.) events, primarily from π^+ scattering in the stopping target.

The result confirms detailed predictions of the SM at higher orders. Given the level of statistical uncertainty associated with the result, only limitations on new physics beyond the SM can be inferred. However, a new generation of $K^+ \rightarrow \pi^+\nu\bar{\nu}$ measurements from the NA62 experiment at CERN aim for a precision comparable to that of the current SM prediction.

● The E949 and E787 experiments at Brookhaven's Alternating Gradient Synchrotron included more than 100 collaborators from Canada, China, Japan, Russia and the US.

Further reading

A V Artamonov *et al. Phys. Rev. Lett.* 2008 **101** 191802.

HADRON THERAPY

New training PARTNERship joins the battle against cancer

On 16–17 October members of a new four-year, EU-funded project met at CERN for the kick-off meeting of the Particle Training Network for European Radiotherapy (PARTNER). Coordinated by CERN, the project received €5.6 m as part of the European Commission's Marie Curie funding scheme.

The aim of PARTNER is to train researchers in the rapidly emerging field of hadron therapy, thus paving the way for improved cancer treatments. Hadron therapy uses beams of protons or carbon ions instead of X-rays to target malignant tumours. The technique penetrates deeper and more precisely into the body, creating minimal harm to surrounding tissue (*CERN Courier* December 2006 p17).

The project brings together 10 participating academic institutes, research centres, and leading European companies in particle therapy, and it has funding for 25 doctoral and postdoctoral researchers. In this way the network institutes enrich international co-operation and contribute to the quantity, quality and mobility of European researchers, while benefiting from the efforts and new ideas that the young people bring to the research programmes.

In turn the researchers receive excellent training opportunities, through formal programmes and hands-on experience of state-of-the-art equipment, under the supervision of world-class experts.

The start of the project is particularly timely, because two new hadron-therapy facilities are about to open in Europe: HIT in Heidelberg and CNAO in Pavia. These will be the first centres of this kind to be built in Europe, and they will benefit hugely from PARTNER as it trains a new generation of researchers.

Members of the PARTNER project gathered together at CERN for the kick-off meeting, with project coordinator Manjit Dosanjh (front row, second from left).

ASTROPARTICLES

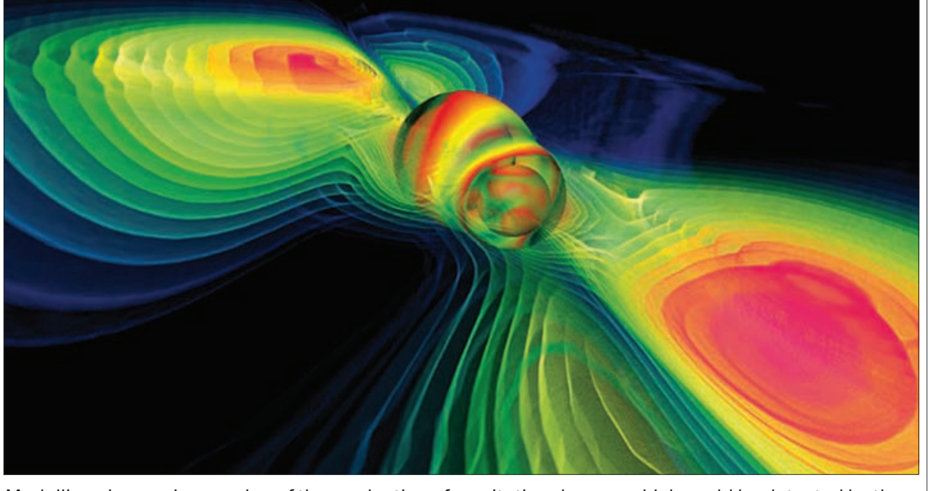
EC funds design study for gravitational observatory

The European Commission (EC) has allocated €3 million within the Seventh Framework Programme for preliminary studies for the development of the Einstein Telescope – a major new gravitational-wave observatory. The Einstein Telescope is one of the "magnificent seven" European projects recommended by the ASPERA network for the future development of astroparticle physics in Europe (*CERN Courier* November p8).

With this grant, the commission confirms the importance of gravitational-wave research for both basic and applied scientific research in Europe. The direct detection of gravitational waves will allow new insights into the universe that are inaccessible to any other technology – including clues to its origin.

The funds granted now by the EC will be used in a design study for the Einstein Telescope over the next three years. This is an important step towards the third generation of gravitational-wave observatories. It will define the specifications for the required site and infrastructure, the necessary technologies, and the total budget.

Currently, several first-generation gravitational-wave detectors are operational worldwide. The German-British GEO600 observatory operates close to Hanover while the French-Italian-Dutch Virgo project is located in Cascina near Pisa. These interferometers pool their data with the three LIGO interferometers in the US and are currently doing extensive searches for gravitational waves from astrophysical systems (*CERN Courier* December 2007 p17).



Modelling gives an impression of the production of gravitational waves which could be detected by the Einstein Telescope. (Courtesy MPI for Gravitational Physics/W Benger-ZIB.)

During the next decade all interferometric gravitational-wave detectors will be upgraded to second-generation instruments. Virgo and LIGO will gain a factor of about 10 in sensitivity at lower frequencies (up to about 1 kHz). GEO will pioneer high-frequency wide-band observing above 1 kHz, again deploying new technologies. If the current instruments do not make the first detection of gravitational waves, the second-generation interferometers should succeed.

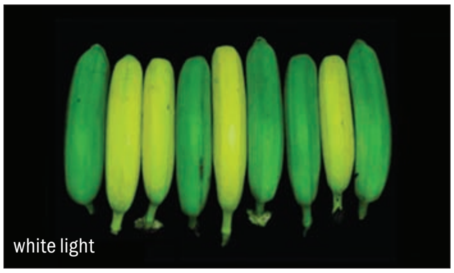
The Einstein Telescope project fits well into this scenario. After the completion of the design study and a subsequent technical preparation phase, construction could begin (probably in 2017 or 2018) after the second-generation observatories have started operating. As a third-generation observatory, Einstein should be 100 times as sensitive as current detectors, increasing the observable volume of the universe by a factor of a million. Additionally, it should cover the frequency range between 1 Hz and 10 kHz.

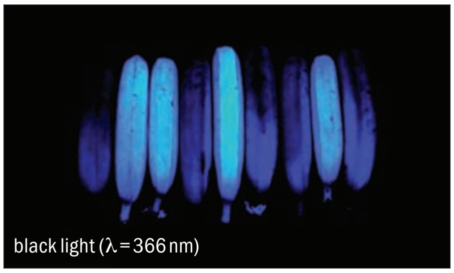
● The Einstein Telescope is a joint project of eight European research institutes, under the direction of the European Gravitational Observatory (EGO). The participants are EGO, an Italian-French consortium located near Pisa, INFN, the Centre National de la Recherche Scientifique, the Albert Einstein Institute in Hannover, the Universities of Birmingham, Cardiff and Glasgow and the Vrije Universiteit, Amsterdam.

SCIENCEWATCH

Compiled by Steve Reucroft and John Swain, Northeastern University

Ripening bananas turn blue with chlorophyll breakdown





Ripe banana peel contains natural brighteners, which may help attract animals that can see UV light.

Research by Bernhard Kräutler and colleagues of the University of Innsbruck and Columbia University, New York, shows that ripe bananas fluoresce blue under ultraviolet light. The glow is attributed to previously undiscovered chlorophyll-breakdown products, which occur as a green banana ripens and yellows. The colourless but fluorescing substances are concentrated in the banana peel and the effect disappears once the banana is too ripe.

It is not understood why these substances are produced. The breakdown products certainly help to give ripe bananas their distinctive bright-yellow appearance, and they could act as brighteners to make ripe bananas more visible. This is analogous to the brighteners in detergents that make white clothes appear brighter in sunlight and glow under ultraviolet light. The researchers point out that "most humans would consider the idea of a blue banana to be unappetizing", but the fluorescence may make the ripe bananas more distinctive to animals that can see UV light. In addition, the chemicals have antioxidant properties that could provide protection against decay, keeping the fruit ripe for longer.

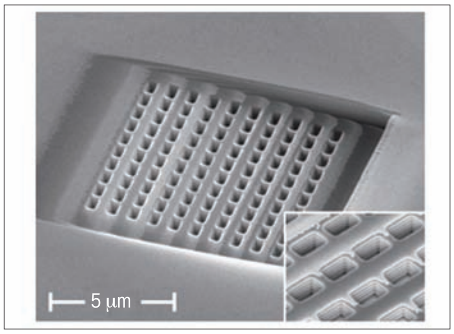
Further reading

S Moser *et al.* 2008 *Angewandte Chemie International Edition* **47** 8954.

Invisibility 'cloaks' go 3D and optical

Metamaterials that exhibit negative indices of refraction have made headlines recently with their promise of "invisibility cloaks" that bend light round an object. Hopes were probably higher than what is realistic, however, because the candidate materials had the desired response over only narrow wavelength bands and were generally "2D", so were suited only to making cylindrical cloaks.

Now Jason Valentine of the University of California in Berkeley and colleagues have reported a true 3D optical negative-index metamaterial based on a fishnet structure of metals and dielectrics. They measured the refractive index by creating a prism from the structure and observing the angle of refraction of light passing through it – the classic measurement using Snell's law. The alternating layers of silver and magnesium fluoride turn out to have a negative index over a broad range of the optical electromagnetic spectrum, from 1200–1800 nm.



Electron microscope image of the 3D structure.

Further reading

J Valentine *et al.* 2008 *Nature* **455** 376.

Solvents show they are not so simple

Solvents are usually considered to be passive participants in chemical reactions – simply a liquid environment that allows substances that react to come together. Now Arthur Bragg, Molly Cavanagh and Benjamin Schwartz of the University of California have shown that this simple idea is not the case in certain circumstances.

The team prepared neutral sodium atoms in the solvent tetrahydrofuran using two separate methods – by adding an electron to a positive sodium ion in one; and by taking an electron away from a negative ion in the other. They discovered that it took the solvent and the neutral sodium atoms twice as long to reach equilibrium after negative sodium atoms were neutralized compared with positive atoms. This is contrary to linear response theory, which states that this would not happen if the solvent atoms were simply adjusting to a newly appeared neutral sodium atom without regard for how it came into being.

Further reading

A E Bragg, M C Cavanagh and B J Schwartz 2008 *Science* **321** 1817.

Geckos are unstuck

There has been great interest recently in emulating the stickiness of the gecko's foot. The lizard uses something like a van der Waals attraction between microstructures on its feet and the (often vertical) surfaces to which it clings. Now Liangtu Qu of the University of Dayton in Ohio and colleagues have shown that a layer of carbon nanotubes can stand in for the specialized surfaces of geckos' feet. A disordered covering layer of nanotubes then provides the anisotropy in shear strength necessary to pull away from the surface at will. The idea is to be able to pull off perpendicularly to the surface, while being able to resist the downwards force of gravity. The team can now outdo the gecko by a factor of 10 and provide up to around 100 N of stickiness per square centimetre of surface.

Further reading

L Qu *et al.* 2008 *Science* **322** 238.

ASTROWATCH

Compiled by Marc Türler, ISDC and Observatory of Geneva University

Fermi discovers a gamma-ray-only pulsar

The first highlight of the recently launched Fermi Gamma-Ray Space Telescope is the discovery of a new type of object: a gamma-ray pulsar without detectable pulsations at radio, optical or X-ray wavelengths. Scientists think that most of the unidentified gamma-ray sources in the Milky Way could be such young pulsars.

The Gamma-Ray Large Area Space Telescope (GLAST) renamed in honour of Enrico Fermi after a successful launch on 11 June, is already living up to expectations (*CERN Courier* November 2008 p13). In less than two months it has gathered more than twice as many photons from the supernova remnant CTA 1 than its predecessor of the 1990s, the Energetic Gamma-Ray Experiment Telescope (EGRET) aboard the Compton Gamma-Ray Observatory.

With 900 gamma-ray photons at energies of more than 100 MeV, the Fermi collaboration has pinpointed the source inside the remnant and determined a pulsation period of 315.86 ms with an increase in period of 3.614×10^{-13} s every second. This is a great achievement, with astonishing precision, considering that the telescope was still in the commissioning phase during part of the observation and that the photons enter the detector one by one at a rate of only about one per minute.

The derived position of this gamma-ray pulsar locates it with the X-ray source RX J0007.0+7303 which was first detected by the Röntgen Satellite (ROSAT) and reobserved by the Chandra and XMM-Newton missions. No evidence of pulsation is found in those X-ray data and the source remains undetected in deep optical and radio observations. These properties are unique compared with those of the nearly 1800 catalogued pulsars that were mostly found through their pulses at radio wavelengths.

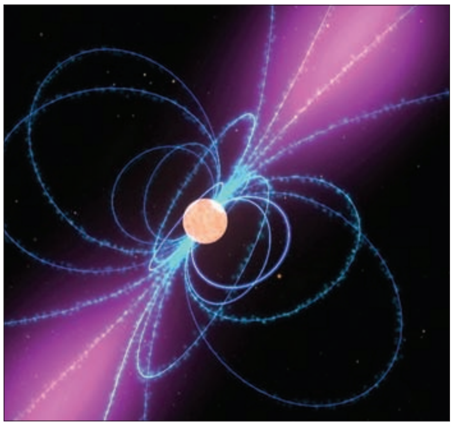


Illustration of the pulsar's magnetic field lines (blue) accelerating charged particles that emit a beam of gamma rays (purple). (Courtesy NASA.)

The pulsar phenomenon arises from a misalignment of the magnetic and spin axes of a neutron star – the crushed core left behind when a massive star explodes. A pulse is detected on every rotation when the emission beam from the magnetic pole intercepts the line of sight. The absence of radio, optical and X-ray pulses from the source in CTA 1 suggests that the emission beam is narrow enough never to point towards the Earth. However, a wider gamma-ray beam, in the order of 1 steradian, could explain the pulsed gamma-ray radiation detected by the Fermi space telescope.

The measured spin-down rate of the pulsar indicates an age of 14 000 years, which is in good agreement with the estimated age of 5000 to 15 000 years for the supernova remnant. The derived neutron star magnetic field of about 10^9 T at its surface is quite high for a normal pulsar, but still about a hundredth of that of magnetars (*CERN Courier* June 2005 p12).

Located about 4600 light-years away in the constellation Cepheus, this gamma-ray pulsar is just at the edge of the error circle of an unidentified EGRET source. The association of the pulsar with this previously observed gamma-ray source is confirmed by a consistent brightness. There are about 75 similar EGRET sources near the plane of the galaxy that are not yet identified. The scientists of the Fermi collaboration think that most of these sources – often associated with supernova remnants or star-forming regions – could be similar young pulsars emitting pulses only at gamma-ray energies. If this is correct, there should be many new discoveries in the months to come thanks to the high sensitivity of the Fermi detector.

Further reading

A A Abdo *et al*. 2008 *Science Express*.
DOI: 10.1126/science.1165572.

Picture of the month

This image, obtained by the Hubble Space Telescope on 27–28 October 2008, shows a pair of gravitationally interacting galaxies called Arp 147. It is the first picture obtained after Hubble science operations were resumed on 25 October, four weeks after a problem with the science data formatter took the spacecraft into safe mode. The sharpness of the galaxies 400 million light-years away demonstrates that the famous spacecraft is doing well. The passage of the galaxy on the left through the one on the right created a circular compression wave that triggered intense star formation, thus resulting in a characteristic blue ring (*CERN Courier* June 2004 p15; March 2006 p12; June 2008 p12). The dusty reddish knot on the ring is probably the original nucleus of the galaxy that was hit. (Courtesy NASA, ESA and M Livio (STScI).)

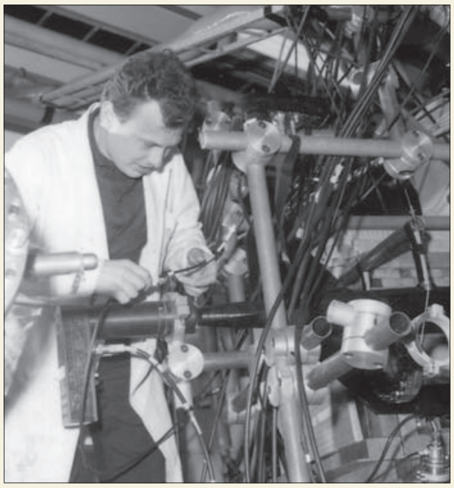
A look back to *CERN Courier* vol. 5 December 1965, compiled by Peggie Rimmer

TRAINING

Vacation students at CERN, 1965

During the popular holiday months this summer, the normal CERN population decreased considerably as staff members took advantage of the fine weather for their vacations or departed to conferences and summer schools. Their absence was partially compensated, however, by a sizeable influx of visitors, many of whom came to CERN under the vacation-student programme. But it was only one of the secondary aims of this programme, when it began with 56 students in 1962, that participants should "provide assistance to CERN groups"; the principal purpose was rather to give a widely representative number of European students an idea of CERN and its work.

In 1965 a hundred young graduates and undergraduates, specializing in physics, electrical or electronic engineering, or mathematics, at 67 different universities in the Member States, spent from two to four months at the Laboratory. Since 1962 the number of places available has increased by over 20% every year, but the level of interest has risen at a similar rate so that in 1965, as in earlier years, it was only possible to accept one in five of the candidates.



The [cover] photograph shows one of the students who came to CERN during the summer vacation this year working on the apparatus for an experiment at the synchro-cyclotron. Giovanni Matone from the University of Bologna is seen helping to mount the experimental equipment for measuring the diffusion of muon-proton "atoms" through hydrogen gas forming part of a wider experiment on the capture by protons of muons into "atomic" orbits.

Selection

The selection was carried out in collaboration with the leaders of the groups that had requested students, on the basis of confidential reports submitted by professors and supervisors, and care was exercised to ensure that each Member State was adequately represented. Those chosen were told of the assignments foreseen for them and offered appointments under which CERN paid travel expenses and a subsistence allowance for the duration of their stay in Geneva.

On arrival at CERN, each student was directed to the appropriate group, where he then took part in its day-to-day activities. About a third of the students were in the Nuclear Physics Division, where most were occupied in preparing or running experiments, for example, the study of resonance production in pion-proton interactions, or research into the quadrupole structure of heavy nuclei.

Another 27 students, who were allocated to the Track Chambers and Data Handling Divisions, were largely concerned with the analysis of bubble-chamber photographs, using the CDC 6600 computer.

Most of the others joined the Nuclear Physics Apparatus, Proton Synchrotron Machine and Accelerator Research Divisions, where they were given assignments in applied physics and engineering, such as studying high-voltage vacuum breakdown phenomena, evaluating particle detectors for monitoring PS beam losses, and computing beam blow-up in storage rings due to multiple scattering.

Lecture courses

A special series of more than 50 lectures was arranged to supplement the students' practical experience and to give them an insight into the work of other groups at CERN. Many senior staff members and visitors gave individual lectures or short courses in the series, which lasted for a period of two months. The subjects covered a very wide range of interests. Physics lecturers included V F Weisskopf, B P Gregory, A M Wetherell and C G Morgan. Courses were given by H G Burkhardt and M Veltman on the theories of the strong and weak interactions respectively, and by F Louis on Fortran programming. There were also lectures on the proton synchrotron and synchro–cyclotron accelerators and the CDC 6600 computer, followed by guided visits to the installations. The lectures were well attended by the students: moreover, many staff members and visitors took advantage of the opportunity to learn about current developments in groups other than their own.

- Compiled from the article on p190

COMPILER'S NOTE

They arrive like migratory birds at the start of summer, departing as it draws to a close. They fill the canteens at peaks hours, trample the grass with their frisbee and handball games, bring the average age down considerably and brighten up the scene. They are the CERN summer students, previously called vacation students.

Lacking a student body of its own, each summer CERN organizes a concentrated programme of leading-edge experience and world class lectures and courses for undergraduates and young graduates. Initially the students were from member states but nowadays a sizeable number are from non-member states. This year 1603 students applied, 638 were considered and 143 were allocated places. Of the 143 successful candidates, 16% were from non-member states, 72% were physicists, 21% computer scientists, 5% engineers, and 27% were female. They stayed for an average of 10 weeks, 81% of them working in CERN's Physics Department. Participation in the programme is regarded as a privilege and carries considerable kudos. With some 6000 or more young scientists having benefited over the years, it would be interesting if someone were to set up a "CERN Summer Students Reunited" Web site to garner statistics on "what happens/ed afterwards" as well as share memories of times past.

CERN pulls Strings together

On 18–23 August, CERN hosted the 2008 edition of Strings, the annual conference that focuses on superstring theory and related matters. **Ignatios Antoniadis** and **Wolfgang Lerche** report.

Strings 2008 drew a large audience from many countries. Participants at the event are pictured on the steps of CERN's well known Main Building.

The annual "Strings" conference draws together a large number of active researchers in the field from all over the world. As the largest and most important event on string theory, it aims to review the recent developments for experts, rather than give a comprehensive overview of the field. CERN was an attractive venue for the conference this year, with the imminent start-up of the LHC together with the longer-term Theory Institutes on string phenomenology and black holes taking place just before and after the event. Organized by CERN's Theory Unit, the universities of Geneva and Neuchâtel, and the ETH Zurich, Strings 2008 attracted more than 400 participants from 36 countries. It opened in the presence of CERN's management and the rector of the University of Geneva, who also represented the state of Geneva. Appropriately, the first talk was by Gabriele Veneziano, formerly of CERN and one of the initiators of string theory following his famous formula invention 40 years ago. There was a welcome reception at the United Nations in Geneva, and the conference banquet was held in the Unimail building at the university.

A framework for unified particle physics

String theory can be seen as a framework for generalizing conventional particle quantum field theory, with applications stretching across a broad range of areas, such as quantum gravity, grand unification, gauge theories, heavy-ion physics, cosmology and black holes. It allows the systematic investigation of many of the important features of such theories by providing a coherent and consistent way of formulating the problems at hand. As Hirosi Ooguri from the California Institute of Technology so aptly said in his summary talk, string theory can be viewed, depending on the application, as a candidate, a model, a tool and/or a language.

The richness of string theory makes it a candidate for a consistent framework that truly unifies all of particle physics, including gravity. It also provides a stage for analysing complicated problems, such as quantum black holes and strongly coupled systems, as in quark–gluon plasma, through the means of idealized, often supersymmetric, models. Moreover, string theory has been proved to be an invaluable tool for doing computations in particle physics in an extremely efficient manner. It also often provides a novel language, with which it miraculously transforms seemingly hard problems into simple ones by reformulating them in a "dual" way. This also includes certain hard problems in mathematics that become simple when translated into the language of string theory.

The talks displayed all of these four facets of string theory effectively. Essentially there were five key areas on which the conference focused, roughly reflecting the fields of highest activity and progress during the past year. In addition, there were three talks on the LHC and its physics by the project leader, Lyn Evans; CERN's chief scientific officer, Jos Engelen; and Oliver Buchmuller from CERN and the CMS experiment. These were intended to educate the string community in down-to-earth physics.

The first area covered was string phenomenology, which uses string theory as model and candidate for the unification of all particles and forces. The various approaches for model building reviewed were mostly of a geometrical nature. That is, many properties of the Standard Model can be translated into geometrical properties of the compactification space that is used to make strings look four-dimensional at low energies. While this translation can be pushed a long way qualitatively, it seems exceedingly difficult technically to go much beyond this stage and obtain predictions that would be testable at the LHC. On the other hand, for the most optimistic case in which the string scale is low (namely of the order of the scale of the weak interactions), concrete predictions of string theory are fully possible, as reported in one of the talks.

Another area, which has become highly visible during the past year, is the computation of certain scattering amplitudes, often in theories with extended supersymmetries and notably in $N=8$ supergravity. Extensive computations based on string-inspired methods suggest ▷

Jean-Dominique Vassalli (centre), rector of the University of Geneva, at the conference dinner with David Gross (right), who gave the final outlook talk, and Ignatios Antoniadis, one of the conference organizers. The dinner was held in the Unimail building at the university. (Courtesy E Gianolio.)

that this theory may be finite, owing to unexpected cancellations of Feynman diagrams. However, some researchers have suggested that Feynman diagrams might not provide the most efficient way to perform quantum field theory; the results may instead point to the existence of a yet-to-be-discovered dual formulation of the theory that would be much simpler. Other related results concern theories with less supersymmetry, as well as amplitudes of phenomenological relevance, such as multi-gluon scattering amplitudes.

It is well known that string theory is a theory not only of strings but also of membranes and other extended objects. A hot topic of the past year has been the "M-brane mini-revolution". This deals with a novel description of M-theory membranes and has created some controversy about the meaning of the results. Several talks duly reviewed this subject and it became apparent that the issues had not yet been completely settled.

A key topic of every string conference within the last 10 years has been the gauge theory/gravity duality, which maps ordinary gauge theories to gravitational – i.e., string – theories. This year's focus was mainly on the connection between systems that are strongly coupled – and in a sense hydrodynamical – and gravity. This leads to a stringy, dual interpretation of certain states in heavy-ion physics, such as the quark–gluon plasma. In particular, a link can be made between the decay of glueball states in QCD and the decay of black holes by Hawking radiation. While these ideas seem to work well on a qualitative level, quantitatively solid results are much harder to obtain because of the strongly coupled nature of the physics involved. The significance of this approach is the subject of ongoing debate and collaboration between heavy-ion physicists and string theorists.

A field of permanent activity and conceptual importance is that of black hole physics, to which string theory has made extremely important contributions during the past few years. As reviews at the conference showed, the identification and counting of microscopic quantum states in stringy toy models has been refined and made more precise, even to the level of quantum corrections. Moreover, fascinating connections between black holes and topological strings have been proposed, and testing those connections has been an important field of activity during the past few years. The results of topological string theory have also had a considerable impact on certain areas of mathematics, and have led to fruitful interactions with mathematicians.

Apart from these five focus areas, other subjects were reviewed at the conference. For example, there was a lecture on loop quantum gravity so that the string community could judge whether there might be connections to this seemingly different approach to quantum gravity.

Both during the conference and afterwards, many participants expressed the view that string theory continues to be a healthy, fascinating and important subject for theoretical work. This is despite the fact that the original main goal, namely to explain the Standard Model of particle physics, appears to be much harder to achieve (if, indeed, achievable at all) than initially hoped. In the final outlook talk, David Gross of the Kavli Institute for Theoretical Physics at the University of California, Santa Barbara, presented a picture of string theory as an umbrella that covers most of theoretical physics, similar to the way in which CERN has emerged as an umbrella for the worldwide community of particle physicists.

Further reading

For the further information, including complete video coverage of the talks, see http://cern.ch/strings2008.

Résumé

Des experts dans leurs cordes se réunissent au CERN

Du 18 au 23 août, le CERN a accueilli l'édition 2008 de la conférence Strings, consacrée à la théorie des supercordes et aux questions connexes. Cette conférence annuelle, la plus grande et la plus importante sur la théorie des cordes, rassemble de nombreux chercheurs du domaine venus du monde entier. Elle vise moins à donner un aperçu général de la discipline qu'à passer en revue les travaux récents des scientifiques en la matière. Cette année, le démarrage imminent du Grand collisionneur de hadrons et la tenue des Instituts théorie sur la phénoménologie des cordes et sur les trous noirs respectivement juste avant et après la conférence ont été pour beaucoup dans le choix du CERN pour accueillir la manifestation.

Ignatios Antoniadis *and* **Wolfgang Lerche**, *CERN.*

Edoardo Amaldi: a true statesman of science

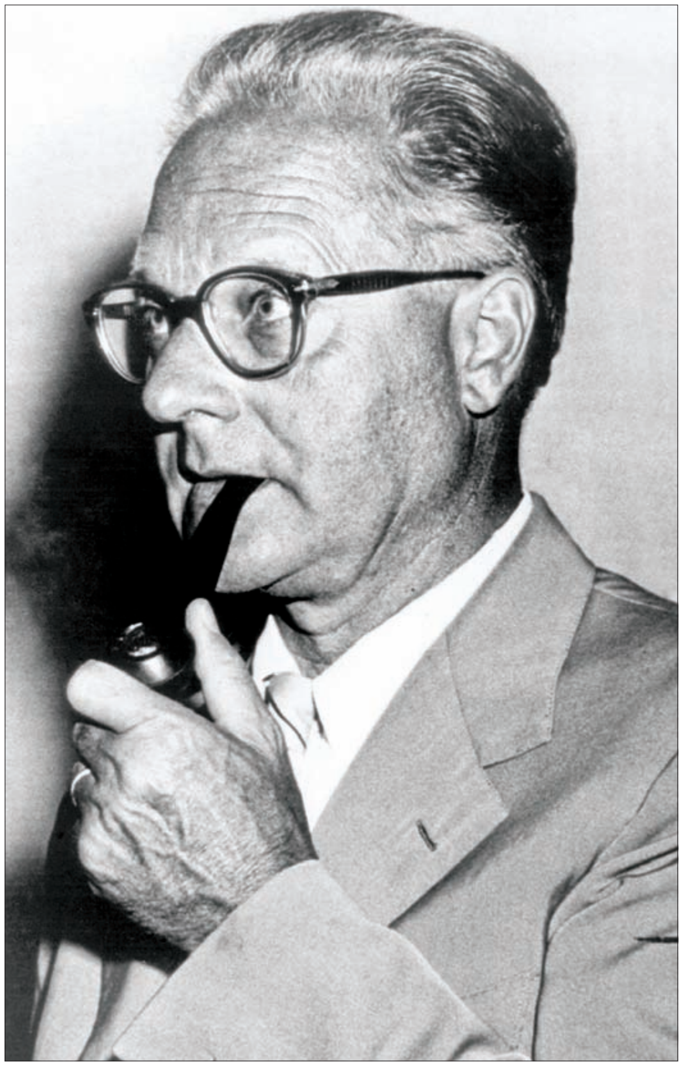
Edoardo Amaldi was a scientist who used his talent and insight to re-establish science in Italy and across Europe, particularly in fundamental physics, during the critical period following the Second World War. **Giovanni Battimelli** and **Luciano Maiani** review the life of this significant individual.

Edoardo Amaldi was a leading figure in Italian science in the 20th century, particularly in fundamental experimental physics. He contributed to nuclear physics in the 1930s and 1940s, and to cosmic rays and particle physics in the post-war years, then became a pioneer in the experimental search for gravitational waves in the 1970s. It is largely thanks to his drive that Italian physics emerged successfully from the slump following the Second World War. He was also one of the main players in the process that turned the dreams of large European scientific projects into reality, most notably CERN.

In Rome with Fermi

Amaldi was born in Carpaneto Piacentino, northern Italy, on 5 September 1908. He was the son of Ugo, a distinguished mathematician and university professor. Ugo's academic career led him from Modena to Padua and finally to the University of Rome in 1924, where he joined the outstanding Italian mathematicians Vito Volterra, Tullio Levi-Civita, Guido Castelnuovo and Federigo Enriques. Edoardo enrolled at the University of Rome as a student of engineering in 1925. Two years later he moved to physics, attracted by the presence of Enrico Fermi, as were a few other brilliant students, including Emilio Segrè and Ettore Majorana. Amaldi took his degree in physics in July 1929, with a dissertation on the Raman spectrum of the benzene molecule. His thesis advisor was Franco Rasetti, who had moved from Florence to join Fermi in Rome. By the end of the 1920s a strong group of young physicists had become established at the institute in via Panisperna and their research efforts deliberately steered towards the new frontier of nuclear physics.

Under Fermi's leadership, it became common practice to send young people abroad to stay for extended periods at leading research centres. In 1931 Amaldi spent 10 months in Peter Debye's laboratory in Leipzig learning X-ray diffraction techniques in liquids. He later spent short periods at the Cavendish Laboratory at Cambridge, Columbia University and the Carnegie Institution.

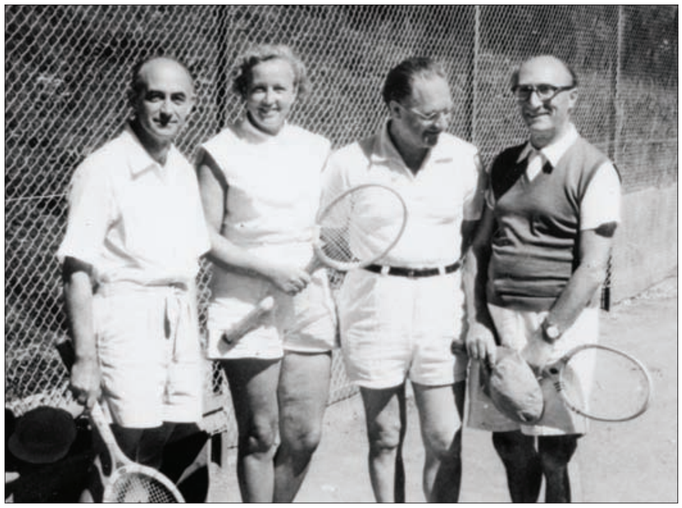


Edoardo Amaldi dedicated himself to fostering peace and science.

Following the discovery by Frédéric Joliot and Irène Curie of radio activity induced by alpha particles, Fermi and his collaborators started a methodical search in March 1934, bombarding samples of different elements with neutrons emitted by a radon-beryllium source. Their experiments culminated in October 1934 with the discovery of the efficiency of slow neutrons in activating nuclear fission. The published papers carried the signatures of all team members (Fermi, Rasetti, Amaldi, Segrè, the chemist Oscar D'Agostino and, later, the young Bruno Pontecorvo). Fermi was clearly the intellectual leader and driving force, and for these results he would receive the ▷

Nobel Prize for Physics in 1938. In the meantime, Fermi and Amaldi did most of the work for the next few years following the discovery; Rasetti and Pontecorvo were mostly out of Rome and Segrè had moved to a professorship in Palermo. Amaldi thus acquired a competence in nuclear physics, particularly in the subject of neutron properties, that turned him into a leading authority in the field.

In 1937 Amaldi won a professorship at the University of Cagliari, but he was immediately called to the chair of experimental physics in Rome, which had been left vacant by the sudden death of Orso Mario Corbino. Amaldi kept this position until retirement. He continued to work on neutron physics with Fermi and Rasetti. They designed and built a Cockcroft–Walton accelerator, which was completed in 1939 at the Istituto Superiore di Sanità. By the late 1930s, however, the general situation in Italy was deteriorating rapidly. The lack of support necessary to keep research competitive, the alignment of fascism with Hitler's Germany and the racial laws promulgated in 1938 led directly to the forced or voluntary emigration of many Italian physicists. When the Second World War began, Amaldi was the only member of the original Panisperna group still in the country.



Edoardo Amaldi (second from right) with Enrico Fermi (left), Ginestra Amaldi and Enrico Persico. (Courtesy Amaldi Archives, Dipartimento di Fisica, Universita 'la Sapienza' Rome, AIP Emilio Segrè Visual Archives.)

Left to right: Amaldi, Franco Rasetti and Emilio Segrè, together again many years after they first met in Fermi's group in Rome. (Courtesy AIP Emilio Segrè Visual Archives, Segrè Collection.)

The war years

Left alone in Rome with a small group of younger researchers, Amaldi concentrated his research efforts on nuclear fission, working with physicists from the physics institute and the Istituto di Sanità, while Gian Carlo Wick replaced Fermi on the theory side. This work was interrupted when Amaldi was sent for a few months to the African front in 1940. On his return to Rome, research on fission continued. However, by 1941 suspicion arose that working on fission exposed the group to the risk of being recruited for war-related research. As a consequence, the experimental work shifted focus to the problem of proton–neutron scattering, while some of the younger graduates started research on cosmic rays.

Though research conditions were difficult during the war, Rome was still in a better situation than research facilities in northern Italy, especially after liberation in June 1944. By war's end, most of what had been left of active research in Italy, in terms of both expertise and people, was concentrated in Rome. In collaboration with Wick and Gilberto Bernardini from Florence, Amaldi steadfastly took it upon himself to reconstruct Italian physics, starting from the vantage point offered by his location in the capital. The first move, completed successfully in October 1945, was to obtain from the reconstituted Consiglio Nazionale delle Ricerche (CNR) the establishment of a research centre for nuclear and elementary particle physics at the physics institute in Rome.

The years of reconstruction

During a trip to the US in 1946, Amaldi was offered a chair at the University of Chicago by none other than Fermi, but he declined because he felt a duty to take care of scientific development in his homeland. During the visit, Amaldi was confronted by the restrictions imposed on results and topics in "his" physics because of real or supposed military interest. He realized that, beyond a certain limit, it was impossible for him to talk freely even with Fermi about problems in nuclear physics. Amaldi found this disturbing on ethical grounds and detrimental to scientific progress. The experience strengthened his conviction acquired during the war years that genuine scientific collaboration is planned free from military control – a general policy to which he adhered strictly in the following years.

The scale of prestige acquired by nuclear and particle physics in the US after the war convinced Amaldi that the best course of action for Italian physics would be to concentrate on those research sectors where good results could be obtained with the modest means available. As a consequence, emphasis was placed on the relatively inexpensive research field of cosmic rays, where Italian physicists could rely on the solid tradition initiated by Bruno Rossi. The first step, in 1947, was to construct a high-altitude laboratory in the Italian Alps. New research centres followed: Padua in 1948, Turin in 1951 and Milan in 1952. Meanwhile, Amaldi promoted the development of applied nuclear research, training young engineers and physicists, and raising support among politicians – a programme that led to the construction of Italy's first nuclear reactor.

Amaldi, Gustavo Colonnetti and Bernardini, relying on the strength of this active network and on the support of CNR's president, were able to achieve a significant goal: the establishment in

1951 of the Istituto Nazionale di Fisica Nucleare (INFN). Bernardini was its first president and Amaldi took charge between March 1960 and January 1966.

The first important activity for INFN physicists was their participation in three international collaborations, which between 1952 and 1954 launched high-altitude balloons carrying photographic emulsions for the study of cosmic rays. Amaldi's group in Rome took part in the first and second collaborations. Soon after, a more ambitious INFN programme was initiated for the construction of a competitive accelerator for high-energy physics. The project became reality in less than five years: the electron synchrotron of the Laboratori Nazionali in Frascati started operating in February 1959. Amaldi's active role in the physics community and with politicians and administrators in Rome was decisive in winning a site close to Rome for the new laboratory. This was in line with a general scheme that assigned the development of nuclear facilities for civil purposes to the northern areas of the country and concentrated fundamental research at the nation's capital.

Building European science

Soon after the war, physicists throughout Europe came to realize that only a collaborative effort between several countries could give Europe a competitive role in fundamental research. The proposal for a great European particle accelerator was put forward by Isidor Rabi in 1950, and Amaldi was one of the strongest advocates from the beginning. He took advantage of his capacity as vice-president of the International Union of Pure and Applied Physics to back the idea. The ambitious plan quickly took form using the institutional support of UNESCO. Amaldi and French physicist Pierre Auger, director of the scientific section of UNESCO, were the driving force for a project that was attractive to the younger generations of European physicists, but which had to overcome difficulties and opposition at both the scientific and the governmental levels.

By May 1951 a selected team of experts from eight countries approved a detailed plan, and by early 1952 an intergovernmental conference established a provisional organization, which took the name of the Conseil Européen pour la Recherche Nucléaire (CERN). Amaldi was elected general secretary of the provisional CERN and he supervised all of the crucial phases in the infancy of the new institution, including the early stages of work on the laboratory site, on grounds allocated by the city of Geneva. He left the position when CERN entered into official existence in September 1954, led – among other reasons – by the desire to revert to more active research work in physics. Paralleling the development of the laboratory in Frascati, the big CERN proton synchrotron was successfully completed in 1959, reaching a record energy of 28 GeV.

Amaldi always kept strong ties with CERN, maintaining a place in the scientific bodies that helped to shape its policy. In 1963 he created the European Committee for Future Accelerators, which was an independent body charged with planning new machines to be built in Europe (both at CERN and elsewhere), and he was president until 1969. He headed up the particular group that planned the ▷

new 300 GeV proton synchrotron for CERN in the late 1960s – a project approved by the member states in 1971, with Amaldi in charge as president of CERN Council. Simultaneously occupying important positions both at INFN and at CERN, Amaldi sometimes had to make delicate choices, balancing resources between domestic developments and international co-operation. This was evident when a decision had to be taken between launching a great effort for a new Italian proton synchrotron or giving Italy's support to the project for the 300 GeV machine in Geneva. In this instance he was strongly in favour of the CERN project, convinced that priority in big science had to be granted to Europe.

In the early 1960s, when the project of a joint European effort in space was being discussed, a network of scientists and politicians similar to the one that had contributed to the success of CERN was formed, which included the French physicist Hubert Curien. Amaldi took an important role in launching the idea and pushing it through scientific and political circles. As a result, in 1964 the European Space Research Organisation was established, which later gave birth to the European Space Agency.

Research in cosmic rays and particle physics

In the time left over from academic and administrative duties, as well as acting as an organizer and planner of science, Amaldi stayed in active research, leading groups of young collaborators and moving his interest towards cosmic-ray physics. A high point came in the mid-1950s with work on one of the emulsions exposed to the cosmic radiation during the 1953 high-altitude balloon collaboration. The group found a track that could be interpreted as evidence of the annihilation of an antiproton – a particle the existence of which was taken for granted on a theoretical basis but that had not yet been observed. To gain better support for the evidence offered by the single track, Amaldi turned to Segrè at Berkeley, proposing a joint research programme aimed at the detection of similar events in emulsions exposed to the proton beam of the Bevatron. At the time this was the most powerful accelerator in the world and the only one that could reach an energy above the threshold needed to produce a proton–antiproton pair. The Rome–Berkeley collaboration lasted for a couple of years, yielding important results on antiprotons and their annihilation properties. However, the first confirmation of such a process – clearly visible in the emulsion tracks – came a few weeks after Segrè and his group had independently detected the antiproton by a different experiment that relied on counters instead of emulsions. For this discovery, Segrè and Chamberlain were awarded the Nobel Prize for Physics in 1959.

Amaldi's interest in the experimental detection of gravitational waves began with a course on gravitational-wave antennas given by Joe Weber, the pioneer of this instrumentation, at Varenna in 1962. In 1970, under Amaldi's leadership, a group formed in Rome with the aim of designing and building cryogenic detectors for gravitational waves. Initially, small-scale antennas were planned and put into operation; then larger detectors were built in succession in Rome, Frascati and at CERN – where the cryogenic antenna Explorer was installed in the 1980s, attaining by 1989 the highest sensitivity reached for many years. While leaving the direct responsibility to others, Amaldi played an active role throughout this period in both the planning and the execution of the experiments, as well as in recruiting young students to the field. The detection of gravitational waves is still an open problem almost 20 years after Amaldi's passing. Huge facilities have been built for the purpose in large international collaborations, involving many Italian physicists – the legacy of a tradition borne out of Amaldi's initial foresight.

Left to right: Pierre Auger, Amaldi and Lew Kowarski in February 1952, founding fathers of the provisional CERN.

In his mature years, Amaldi increasingly devoted part of his time to collecting his memoirs and putting on paper those moments in the history of physics that he had witnessed. He started with commemorations of friends and colleagues, then worked on recollections of important events. Amaldi's reconstructions evolved into writings with growing insight into the more general historical context, with a care for sources and documentation not usually found in similar works by scientists. He was helped by a habit developed in his early days of keeping all relevant documentation related to his work and to the institutions that he was involved with. His personal archive helped him to produce works that went far beyond the traditional scientist's recollection, resembling more the scope of scholarly research by an independent historian.

Working for peace and arms control

Amaldi's concern for peace, and his strong feeling for the responsible role that the scientific community should play in this respect, was always a natural complement to his unshakable belief in the open nature of science and the need for international cooperation. By remaining in Italy during the war, he was spared the difficult decision about whether to take part in projects related to the military use of science. He later admitted that, had this been the case, he would in the end have put his competence to the service of what looked to him, beyond any doubt, the right side on which to fight.

After the war he followed with interest the first attempts of American physicists to establish some sort of organization aimed at the control of the arms race. Following the 1955 Einstein–Russell appeal, Amaldi was involved in the Pugwash movement from the moment it was created in 1957 and became a member of the executive committee at the second Pugwash meeting in 1958, a position that he held until 1973. In 1966, with his physicist colleague Carlo Schaerf, he founded the International School on Disarmament and Research on Conflicts, which he chaired until his death.

In 1982 Amaldi led a delegation of Italian physicists to the

Amaldi (right) at the inauguration of the SPS in 1977, with Chris Llewellyn Smith. Amaldi strongly supported siting a 300 GeV machine at CERN.

president of the Italian Republic, presenting a resolution of concern with the ongoing arms race and the danger to Europe created by the deployment of cruise missiles. As a follow-up to this document, the Unione Scienziati Per Il Disarmo was founded – an active group that has since then kept the discussion on disarmament issues alive in Italy. One of Amaldi's last public official speeches was in 1987, when he led a delegation of Italian scientists to the international forum in Moscow organized by the soviet leader Mikhail Gorbachev at a time when a new climate of liberation was opening up.

Amaldi was married to Ginestra Giovene, one of the few women among the physics students in Rome during the 1930s. They bore three children: Ugo, Francesco and Daniela. Ugo followed in his father's steps as a high-energy physicist, leading to a career at CERN. Edoardo Amaldi was a member of a number of academies and learned societies and was the president of the Accademia dei Lincei, Italy's national academy, between 1988 and 1989. It was at the end of a day's work in his office at the Lincei, still in his full capacities, that a heart attack killed him in 1989, at the age of 81.

Résumé

Edoardo Amaldi : un grand homme de science

Edoardo Amaldi fut l'une des grandes figures scientifiques italiennes du XX^{e} siècle, en particulier dans le domaine de la physique expérimentale fondamentale. Il apporta sa contribution à la physique nucléaire dans les années 30 et 40 et à la physique des rayons cosmiques et des particules dans les années d'après-guerre, et devint dans les années 70 un pionnier de la recherche expérimentale sur les ondes gravitationnelles. C'est en grande partie sous son impulsion que la recherche italienne en physique put renaître de ses cendres après la seconde guerre mondiale. Il contribua par ailleurs pour beaucoup aux efforts déployés pour concrétiser de grands projets scientifiques transnationaux européens, essentiellement et avant tout au CERN.

Giovanni Battimelli *and* **Luciano Maiani**, *University of Rome "La Sapienza".*

SAES Getters unveils exciting new NEG pump options for the vacuum community

SAES Getters Group, the worldwide market leader in getter components for sealed-off devices and vacuum tubes, extends its range of Non Evaporable Getter (NEG) pumps for supporting UHV-XHV applications.

Non Evaporable Getter materials are well known in vacuum technology to be an effective means of removing molecules through the process of chemisorption on the getters' active surface, and also by providing high sorption capacity through thermally driven diffusion of the sorbed gas into the getter bulk. The getter material is carefully prepared in the form of sintered bodies or laminated getter strip and assembled into specially designed cartridge pumps resulting in a high pumping speed for active gases.

The SAES NEG pumps are extremely powerful vacuum pumps taking into account the size and power requirements. For example, a CapaciTorr® Pump (CF35 Flange) incorporating an St172 alloy (sintered porous ZrVFe alloy) in a cartridge 35 mm diameter by 132 mm length (figure 1), will provide a pumping speed of 400 l/s (for H2) and high pumping speeds also for other active gases present on UHV/XHV systems like H_2O, O_2, CO_2, CO and N_2. Since the NEG pump has no moving parts it is essentially quiet and vibration free. Once activation is achieved (typically 1 hour at 85 W using the internal heater) the pump will operate at room temperature without power. At UHV/XHV pressures the requirement for re-activation can be many months of operation.

Now SAES have responded to the needs of the vacuum community by developing a new range of flanged NEG pumps that still provide impressive performance and functionality but with an even smaller footprint. This allows the NEG pumps to be placed in areas of the vacuum system where space is at an even greater premium, ensuring localised pumping performance at a point where the pressure requirements may be at their most stringent. The new D50 and D100 pumps (figure 2) are based on the St172 alloy and have a very low power requirement (30 W and 40 W for ~1 hour respectively) during activation. The two pump options utilise the CF35 flange with minimal chamber intrusion (less than 100 cc and 200 cc respectively). The pumping performance provided by these small units is an incredible 55 l/s (D50) and 100 l/s (D100) for H_2, and also impressive pumping performance for other active gases, for example 60 l/s for CO (D100 version).

Details of the new D50 and D100 NEG pumps are available via the SAES Getters Website and local SAES Getters Group sales locations.

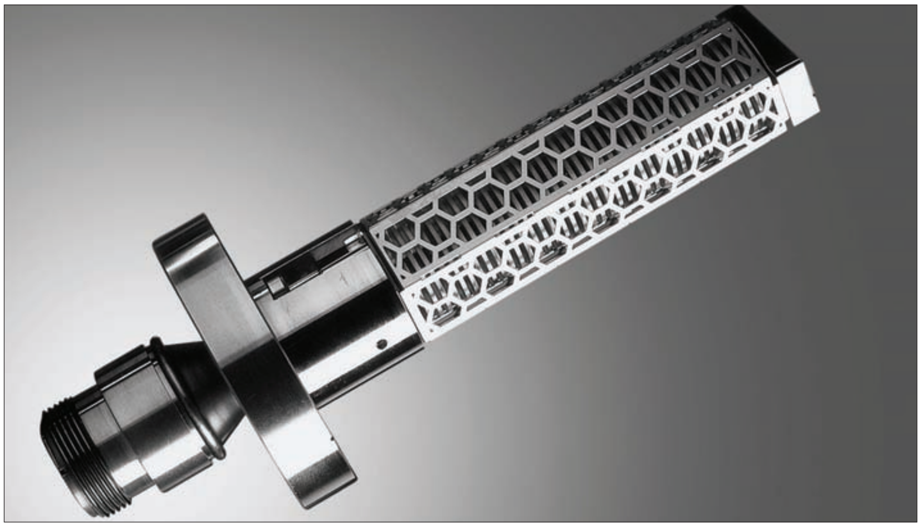


Fig. 1 (above): SEAE Getters CapaciTorr D400 Pump. Fig. 2 (right): New D50 and D100 CapaciTorr Pumps.

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Rutherford's Nobel Prize and the one he didn't get

Ernest Rutherford received the Nobel Prize in Chemistry in 1908, but why chemistry? Why didn't he win a prize for his outstanding discoveries in physics? **Cecilia Jarlskog** investigates.

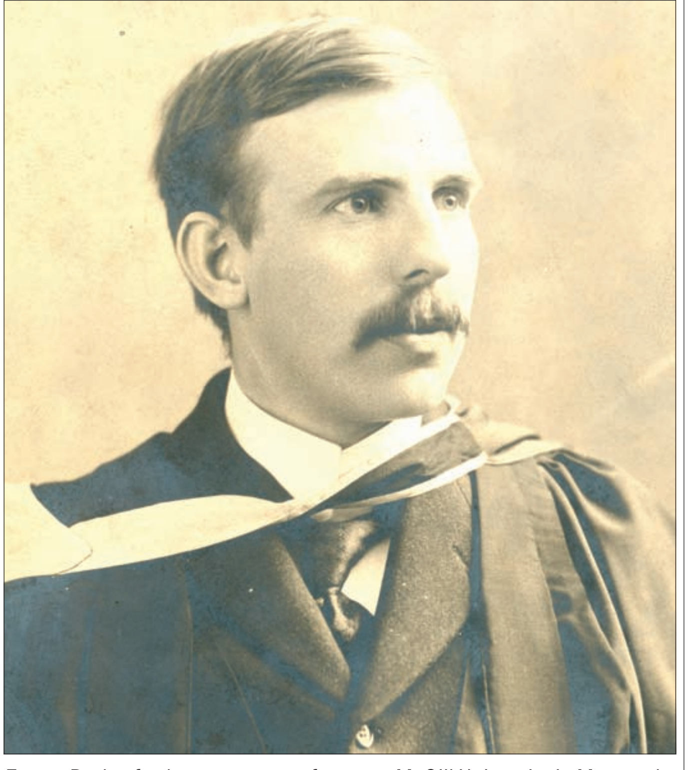
"I have dealt with many different transformations with various periods of time, but the quickest that I have met was my own transformation in one moment from a physicist to a chemist."
Ernest Rutherford (Nobel banquet 1908).

I have always been fascinated by Ernest Rutherford. He came from a poor scientific environment and yet rose to occupy "the highest position in the British Empire" (Arrhenius 1924). He was an exceptionally impressive physicist – detector-constructer, experimentalist, theorist – and a Nobel laureate in chemistry. To put the issue of his Nobel Prize into context, I will briefly describe his history.

Born in New Zealand in modest surroundings, Rutherford was one of a large family but was exceptionally talented and "had no difficulty in obtaining scholarships and prizes" (Eve 1939). In October 1895 we find the 24-year-old Rutherford in Cambridge, England, where he is welcomed to the Cavendish Laboratory by its leader, Joseph John Thomson (1906 Nobel Prize in Physics). Rutherford's exceptional talents are quickly recognized, and he is invited to give talks at several distinguished gatherings, including the Royal Society. He demonstrates his magnetic detector for sensing electrical waves at what were then large distances.

Late in 1898, at the age of 27, Rutherford becomes Macdonald professor of physics at McGill University, Montreal, Canada. Here he makes a sensational discovery: atoms are not necessarily eternal but can transform into one another. This is transmutation of the elements. He proposes the "genealogical tree" of the uranium family where he postulates the existence of a yet unseen intermediate state in the chain. This is a revolutionary idea.

A great authority at the time, William Thomson (later Lord Kelvin), and Scottish physicist Peter Tait had reported (1867): "The inhabitants of the Earth cannot continue to enjoy the light and heat essential to their life for many million years longer, unless sources now unknown to us are prepared in the great storehouse of creation." However, Rutherford applies his findings in radioactivity and discovers that the Sun will shine much longer than that. He makes the front pages with headlines such as "Doomsday postponed". He is also the guest of honour at important events, receives prizes and medals, and is elected into distinguished societies such as the Royal Society.



Ernest Rutherford as a young professor at McGill University in Montreal, where he carried out most of the research that earned him his 1908 Nobel Prize in Chemistry. (Courtesy McGill University Archives.)

To be eligible for a Nobel Prize in Physics or Chemistry, the candidate must have been nominated for the year in question. All that is required is one valid nomination (i.e. from someone who has been invited to nominate). In 1907, Rutherford has seven nominations for the Nobel Prize in Physics and one for the chemistry prize. His nominators for the physics prize are Adolf von Baeyer (1905 chemistry Nobel), Hermann Ebert, Vincenz Czerny, Emil Fischer (1902 chemistry Nobel), Philipp Lenard (1905 physics Nobel), Max Planck (1918 physics Nobel) and Emil Warburg. All of these nominations come from Germany. His nominator for the chemistry prize is Svante Arrhenius from Sweden, a member of the Nobel Committee for Physics from 1900 to 1927. ▷

In 1908 Rutherford receives five nominations for physics and three for chemistry. His nominators for the physics prize is Arrhenius, John Cox, Lenard, Planck and Warburg. The "newcomer", Cox, is a professor at McGill. Rutherford is nominated for the 1908 Nobel Prize in Chemistry by Arrhenius, Oskar Widman (a Swede) and Rudolf Wegscheider (an Austrian).

Most of these nominations are composed of just a few lines. Some of the nominators attach references, but others assume that the Nobel committee know Rutherford's work. The nominations state that he deserves the prize for his work on radioactivity. Planck nominates him for his experiments and research on radioactivity and "for having to some extent swept away the blanket of darkness that still enwraps the nature of these processes". Wegscheider writes: "This Rutherfordian idea is of such importance to chemistry that I have no problem recommending him for the chemistry prize even though he is a physicist." The chemistry nomination from Widman differs from the others because he proposes that Rutherford should share the prize with his former research student Frederick Soddy.

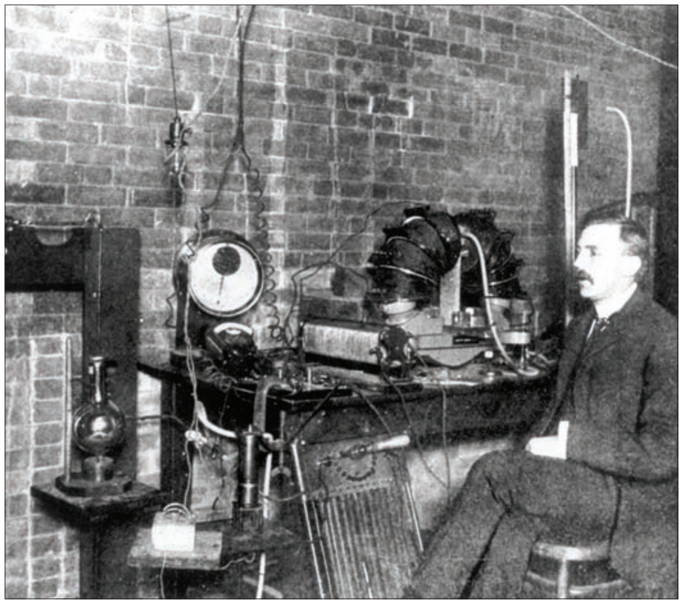
The longest nomination letter is from Cox, one of the two headhunters who had interviewed Rutherford for the professorship at McGill. Dated 8 February 1907, the letter arrives after the 31 January deadline and so is not valid for 1907. It is saved as a nomination for 1908.

You may wonder about Thomson, who was always supportive of Rutherford. Why doesn't he nominate his great student? Actually, he does. He submits a nomination in 1908, but this also arrives too late and is therefore saved for 1909. By then, however, Rutherford has received the 1908 prize, making Thomson's nomination invalid. The Nobel rules do not allow the nomination of someone who has received the prize within the previous two years. Thus in 1907, Rutherford had no nominations from England or France, where his work was well known and where there were qualified nominators, among them several Nobel laureates.

Rutherford is nominated for his work on radioactivity, the essential issue being the decay of radium. The Nobel Committee for Physics, in its 1907 report to the Royal Swedish Academy of Sciences (referred to here as the Academy), brushes him aside quickly by stating: "his observation of the decay of a chemical element (radium) should be awarded with the chemistry prize rather than the physics prize. Therefore, we deem we should not suggest him as a recipient of this year's Nobel Prize in Physics." In other words, radium is a chemical element and that's chemistry. This matter is not trivial. The 1904 Nobel Prizes in Physics and Chemistry are awarded to John William Strutt (Lord Rayleigh) and William Ramsay, respectively. Both of them receive the prize for the discovery of chemical elements (inert gases); Strutt is a physicist and Ramsay a physical chemist.

The Nobel Committee for Chemistry, in its 1907 report to the Academy, states: "Rutherford has been nominated for his studies of radioactivity, by seven nominators for the physics prize and by one nominator for the chemistry prize. This is understandable, taking into account that Rutherford uses physical methods while the results, so far as they are concerned with chemical elements, must be considered to be of fundamental importance for chemistry as well." The committee then opts for a wait-and-see strategy.

In 1908 the Nobel committees for physics and chemistry meet and decide that Rutherford's work is more relevant to chemistry than to physics. Arrhenius is worried that Rutherford might fall between two stools at the academy's plenum, where the final decision is



Rutherford at work at McGill University, where he made his Nobel Prize-winning discoveries. (Courtesy McGill University Archives.)

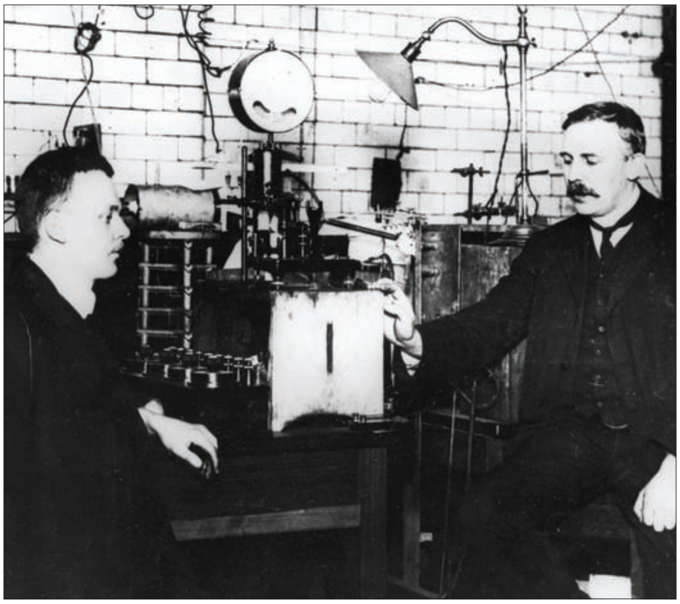
made. He writes to the academy proposing: "If the Academy should decide that it is not appropriate to give him the chemistry prize, he should be awarded the 1908 physics prize."

Nobel deliberations

Contrary to the physics committee, the chemistry committee takes Rutherford's candidacy very seriously. Their report to the academy contains about 15 pages about him, so I will give only a few excerpts. For example, the committee says: "Rutherford's theoretical work contains the formulation and development of the so-called decay hypothesis, for describing the transformation of elements and deducing the laws that govern them; he has proposed that alphas are doubly charged helium atoms; [he] has insisted on the material nature of the emanation process, and has done experiments to verify his hypothesis." The chemistry committee's report continues on and on about Rutherford's ingenious experiments and his deep insight regarding what was going on in the complicated chain of the emanation processes. Rutherford has shaken the foundations of chemistry by replacing its assumption of the immutability of chemical elements with a new and more general hypothesis.

The report also describes the theory of Rutherford and Soddy, and their introduction of the exponential decay law, lifetimes, etc. Ultimately it states: "Rutherford deserves the Nobel Prize in Chemistry without a shadow of doubt. A more difficult question concerns whether any of Rutherford's collaborators should share the prize with him."

A closer study of Rutherford's work shows that most of his assistants help him with specific tasks and that their contributions are secondary to his. The only exception is Soddy, who is not only a collaborator on some of Rutherford's most important experimental studies from 1902 to 1903 but also participates in formulating the theory of disintegration of elements. Naturally, the question of their individual contributions in formulating this theory cannot be accessed by outsiders, but it is remarkable that none of the nominators other than Widman suggests that Soddy should share the prize with Rutherford. Finally, the committee argues against honouring



In the lab at Manchester with Hans Geiger (left), in around 1908. (Courtesy AIP Emilio Segrè Visual Archives, Physics Today *Collection.)*

Soddy together with Rutherford because "a shared prize could easily be misinterpreted as an underestimation of the eminent importance of Rutherford's work for chemistry and more generally for modern natural sciences, especially since the chemistry prize, up to now, has only been awarded to one laureate at a time."

In the end, Rutherford "eclipses" his competitors for the chemistry prize. He is judged to be an epoch maker; a solid, precise scientist; and an undisputed leader. We don't know what goes on at the academy when the case of Rutherford is brought up by the physicists and chemists because no minutes are taken on such occasions. The outcome is all we know: Rutherford is awarded the 1908 Nobel Prize in Chemistry "for his investigations into the disintegration of the elements, and the chemistry of radioactive substances".

The nucleus and more

At McGill in 1901, Rutherford writes to Thomson: "The laboratory is everything that can be desired (I) greatly miss the opportunities of meeting men interested in physics." So when the opportunity of a professorship at the University of Manchester arises, Rutherford takes it. Here, he is, in his own words, very fortunate to find a most competent assistant, Johannes (Hans) Geiger.

In a letter to Otto Hahn in 1911, Rutherford writes: "I have been working recently on scattering of alpha and beta particles and have devised a new atom to explain the results, and also a special theory of scattering. Geiger is examining this experimentally, and finds so far it is in good agreement with the facts." This alludes to Rutherford's famous model of the atom, with a compact nucleus inside, and to his scattering formula.

Rutherford then makes another striking discovery. On bombarding nitrogen with his beloved alpha particles, he discovers a new particle, which he calls the proton. He publishes this just before leaving Manchester in 1919 to return to Cambridge, where he succeeds Thomson as director of the Cavendish Laboratory. He continues his work on protons by shooting alpha particles at light atoms. Rutherford predicts the existence of the neutron, deuteron, tritium and helium-3.

Having received the 1908 Nobel Prize for Chemistry, Rutherford subsequently makes even more stunning discoveries in physics. So, one might have expected him to be nominated for the physics prize. After all, Marie Curie was awarded both prizes. However, Nobel laureates are not usually nominated for a second prize: Albert Einstein, for example, was never nominated again after he received the 1921 physics prize.

The archives reveal that Rutherford is nominated for a second prize, in physics, but by only three people: Theodor Svedberg in 1922 and 1923; David S Jordan in 1924; and Johannes Stark in 1931, 1932, 1933, 1935 and 1937. He also receives a nomination for a second prize in chemistry, from the 1911 Nobel laureate in physics Wilhelm Wien. This nomination is marked as invalid because the discoveries for which Rutherford is nominated are considered to be outside the realm of chemistry.

Svedberg, a distinguished member of the academy, nominates Rutherford in 1922 for his atomic model. He wants Rutherford to be awarded the physics prize before Niels Bohr (11 nominations), because Bohr was being nominated for his atomic model, which is based on Rutherford's model. The award committee argues against Svedberg's proposal on the grounds that "giving Rutherford a prize in physics would imply that the 1908 decision to award him the prize in chemistry was wrong because the methods used in these discoveries are similar and the Bohr model of the atom is superior to Rutherford's". The outcome is that Bohr gets the 1922 Nobel Prize for Physics and Einstein (17 nominations) receives the 1921 prize.

In 1923, Svedberg repeats his nomination, adding another superb discovery of Rutherford's: the proton. This means that the matter has to be considered more seriously, and Arrhenius is charged with looking into it. He produces a report for the academy in which he argues against a second prize for Rutherford. The report includes the following statements: "There is very little sympathy for giving the same person two Nobel prizes." "None of Rutherford's countrymen have nominated him for the prize." "Sir Ernest's meritorious contributions are so great and widely known that his standing and possibilities to do research would hardly be affected by a second prize." and "He already occupies the highest position in the British Empire."

For the 1924 prize, Rutherford receives a nomination from Jordan, an ichthyologist and the first president of Stanford University. Then there are no further nominations until 1931, when Stark (1919 physics Nobel) nominates Rutherford for his work on alpha rays and atomic structure. The response of the committee to this nomination is strange, to say the least: "With all due respect for the importance of Rutherford's work, the committee is of the opinion that these lie so close to the work for which he has been given the chemistry prize that the awarding of a further prize is not justified." Stark repeats his nomination four times (1932, 1933, 1935 and 1937) – that is, until Rutherford dies.

Was Rutherford disappointed at not receiving a second prize? We don't know, but I believe that if he had wanted one, he could have given a hint to his distinguished colleagues. He was a generous person who gave a great deal of credit to his collaborators, such as James Chadwick and Soddy, as well as many other people. His Nobel nominations for these and for other scientists testify that he played down his own role. Those who knew him seem to have really "loved" him. His research fellows admired him, and several of them rose to great heights in society – for example, Sir Ernest Marsden ▷

in New Zealand and Sir Mark Oliphant in Australia. Many would have gladly nominated him, but only one person from the then British Empire – Cox – nominated him for his first Nobel Prize, and no one did so for a second. He was knighted in 1914, appointed to the Order of Merit in 1925 and in 1931 he was created First Baron Rutherford of Nelson (in honour of his birthplace in New Zealand). His ashes were interred in London's Westminster Abbey in 1937, where they joined the remains of William Thomson and Sir Isaac Newton.

Further reading

The Nobel Prize materials referred to in this article come from the Nobel Archives at the Centre for History of Science, the Royal Swedish Academy of Sciences, Stockholm. These contain the annual reports that the Nobel committees submit to the academy, although, as previously mentioned, there are no minutes taken during the Nobel deliberations at the academy's plenums. The archives also contain letters written by members of the academy who wish to state their (often conflicting) opinions. Whenever I quote this material, which is originally in Swedish, I am giving my own simple translation. In addition, the Nobel archives contain the original nominations and related correspondence. In the case of Rutherford, most of the nominations are in German and, again, I have given my own simple translation.

S Arrhenius 1924 Report to the Royal Swedish Academy of Sciences (Nobel Archives, Stockholm).
A S Eve 1939 *Rutherford* (Cambridge University Press).
Ernest Rutherford's 1908 Nobel Lecture http://nobelprize.org/.
W Thompson and P G Tait 1867 *Treatise on Natural Philosophy* (Oxford University Press).

● This is an extract from a longer article that is to be published in the Proceedings of the Neutrino 2008 conference, which was held in Christchurch, New Zealand, in May.

Résumé

Ernest Rutherford : pas le Nobel qu'on croit

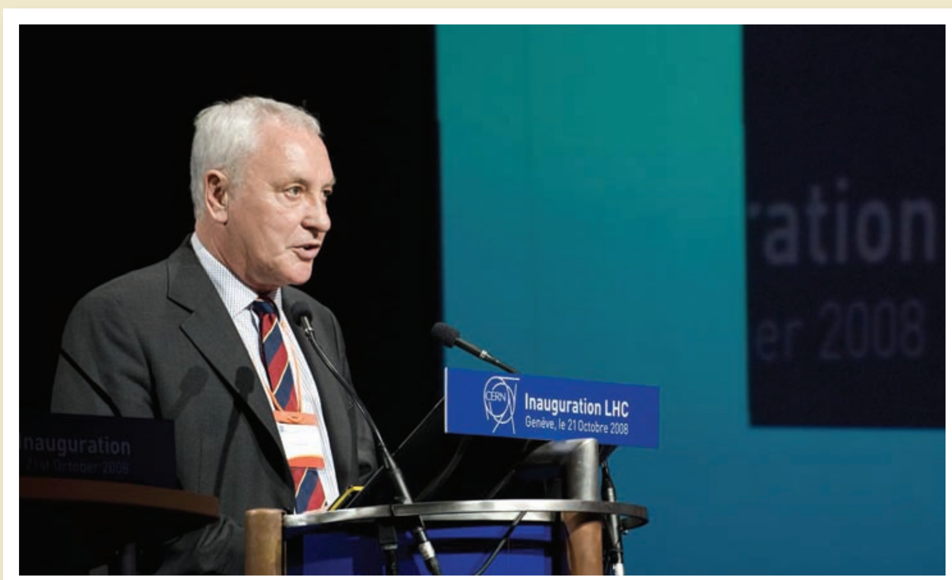
Ernest Rutherford a obtenu en 1908 le prix Nobel de chimie, mais pourquoi dans cette discipline? Et pourquoi n'a-t-il pas reçu un second prix pour les remarquables découvertes qu'il a faites plus tard en physique? Lauréat du prix Nobel de chimie pour ses travaux sur la radioactivité, qui ont mis en évidence la transmutation des éléments, Ernest Rutherford n'a toutefois jamais été distingué en physique, alors qu'on lui devra par la suite la découverte du noyau atomique et du proton. Cecilia Jarlskog a exploré les archives de l'Académie royale des sciences de Suède pour savoir qui avait proposé Ernest Rutherford pour le prix Nobel, dans quel domaine et pour quelles raisons. On trouve dans ces archives les propositions originales et la correspondance qui s'y rapporte, ainsi que les rapports annuels que les comités Nobel soumettent à l'Académie.

Cecilia Jarlskog, *Lund University.*

CERN inaugurates the LHC

The LHC inauguration ceremony was a memorable experience for everyone who attended. On 21 October the SMA18 hall, which had previously served for the assembly of hundreds of superconducting magnet systems, was fitted out to welcome more than 1500 invited guests, including official delegations from CERN's member states, observer states and non-member states.

The member-state representatives, including Swiss president Pascal Couchepin, French prime minister François Fillon and several ministers, applaud CERN's director-general, Robert Aymar, during the opening presentation. "The LHC is a marvel of modern technology, which would not have been possible without the continuous support of our member states," he said. "This is an opportunity for me to thank them on behalf of the world's particle-physics community."



The LHC inauguration ceremony officially marked the end of 24 years of conception, development, construction and assembly of the biggest and most sophisticated scientific tool in the world. After the LHC was proposed in 1984, it was 10 years before Council approved the project. "Its construction has taken more than 14 years and there have been many challenges, which have all been overcome," said the LHC project leader, Lyn Evans, in his speech at the ceremony. "We are now looking forward to the start of the experimental programme, where new secrets of nature will undoubtedly be revealed."

A highlight of the presentation by Lyn Evans was an excerpt from a recording made on 12 October when the Morriston Orpheus Choir from Swansea was joined by Welsh first minister Rhodri Morgan in the CERN Control Centre and blessed the LHC with song.

François Fillon (third from right), prime minister of France, in the LHC tunnel near the CMS experiment, together with Philippe Lebrun (right), head of the Accelerator Technology Department at CERN. In his speech later, Fillon said: "When the decision was taken to construct the LHC, I was minister for higher education and research. I fought for this project, which some regarded as an impossible dream. I believe that this dream can be realized. That was 14 years ago. Today the facility exists and it is spectacular."

Director-general Robert Aymar (centre) with leaders of CERN's two host states: Pascal Couchepin (left), president of the Swiss Confederation, and François Fillon, prime minister of the Republic of France.

Ján Mikolaj, deputy prime minister and minister of education of the Slovak Republic, during his presentation at the ceremony. "We know of the importance of fundamental research," he said. "We also know that CERN is a driving force for development of new technologies."

Annette Schavan, Germany's federal minister of education and research, being greeted by Robert Aymar. One of three ministers who gave speeches during the ceremony, she noted that CERN: "Reflects the strength of research in a special way: the strength that lies behind people's yearning to find out more about the origins of the universe."

Ministers wait in line to take their turn as José Mariano Gago (left), Portuguese minister for science, technology and higher education, signs the commemorative electronic plate, watched by CERN's Carlos Lourenço. During his speech, which was very well received, Gago referred to CERN as "a miraculous scientific laboratory that is a decisive attractor of talent from all over the world".

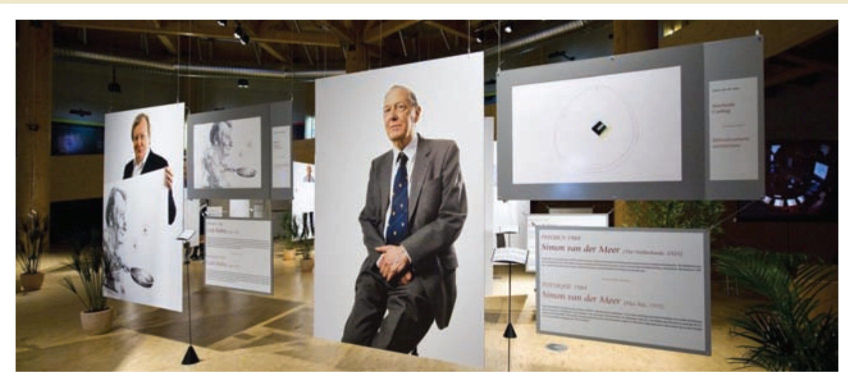
This Daruma Doll was originally painted with only one eye to mark the start of the LHC project. It was presented to former CERN director-general Christopher Llewellyn Smith 13 years ago (*CERN Courier* October 2008 p31 and September 1995 p1). To mark the end of the project, Toshio Yamauchi (left), senior vice-minister of education, culture, sports, science and technology in Japan, added the second eye and presented the completed doll to current director-general, Robert Aymar (right). Llewellyn Smith witnessed the ceremony together with Swiss president Pascal Couchepin. The Daruma Doll Ceremony is a Japanese tradition that symbolizes the completion of a project.

Carolyn Kuan conducts the Orchestre de la Suisse Romande in *Origins*, an audiovisual concert specially commissioned for the LHC inauguration. It featured the imagery of National Geographic photographer Frans Lanting and the music of Philip Glass, adapted from *Life: A Journey Through Time*, which was originally produced in California. The visual score charted the history of the universe from the Big Bang to the present day, and it included imagery from CERN's experiments.

After the ceremony, guests were treated to a buffet of molecular gastronomy. Chef Ettore Bocchia collaborated with the physics and chemistry departments of Parma and Ferrara universities in Italy to create a scientific feast of Italian cuisine, which was optimized for both taste and health. (Courtesy M Struik.)

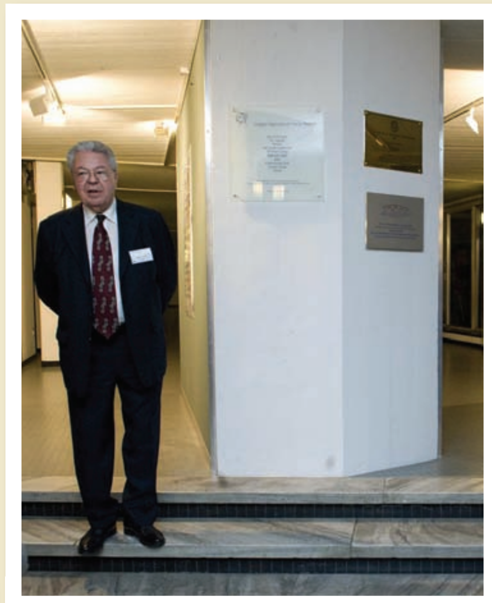
Musical highlights of the LHCfest for CERN personnel, which followed the official inauguration, included a live performance of the "LHC rap" by AlpineKat, who was joined on stage by a very special backing dancer – none other than the LHC project leader Lyn Evans. (Courtesy M Struik.)

A wall of fame in particle physics greeted VIPs as they entered the ceremony, with photos from the exhibition Accelerating Nobels, beginning (right) with Donald Glaser, inventor of the bubble chamber, who received the Nobel Prize in Physics in 1960. Between 2006 and 2008, photographer Volker Steger, with the help of CERN and the Lindau Meetings Foundation, photographed more than 40 Nobel laureates and invited each of them to draw their most important discoveries. (Courtesy M Struik.)



Accelerating Nobels is an exhibition that centres on 19 laureates whose work is closely related to CERN and the LHC. The exhibition has been on view at CERN in the Globe of Science and Innovation, where CERN's Nobel laureates, including Carlo Rubbia (left) and Simon van der Meer, took pride of place.

Over the past decade, industry has played an important part in developing, building and assembling the LHC, its experiments and the computing infrastructure. To thank industry for its exceptional contributions to the LHC project, CERN organized a special industry day on 20 October. More than 70 companies attended. Here Lucio Rossi, who led the LHC magnet construction, addresses the assembled participants.



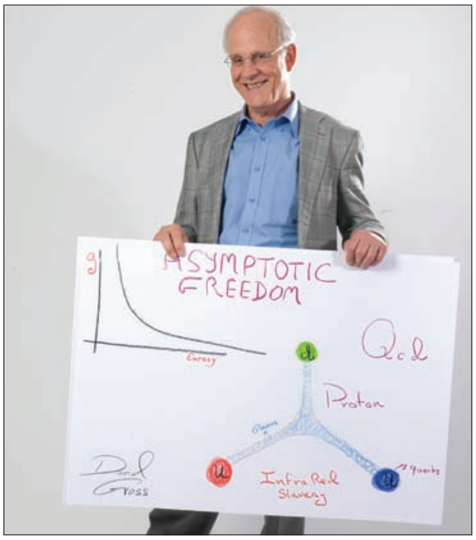
Ten firms were honoured on the industry day for their fundamental contributions to the LHC machine, detectors and computing grid: Ineo GDF Suez, Air Liquide, Alstom, ASG Superconductors, ATI Wah Chang, Babcock Noell, Intel, Linde Kryotechnik, Luvata Group and Oracle. A plaque in the lobby area near CERN's main auditorium, unveiled by the director-general during the day, commemorates their exceptional contributions.

● **For a video of the highlights of the ceremony see http://cdsweb.cern.ch/record/1136012.**

Partons, QCD and strings

Nobel laureate David Gross talks about his impressions of the changing scene in theoretical particle physics since he first visited CERN some 40 years ago.

When David Gross first came to CERN in the late 1960s, student protests across Europe, the Vietnam War and the Apollo Program were among the topics dominating world news. In particle physics the jury was still out as to the nature of quarks and the strong interaction, while not quite *terra incognita*, was hostile territory for theorists – full of wild and untamed beasts. In early 1969, Gross, who had recently taken up a faculty position at Princeton, and Chris Llewellyn Smith, a fellow in the theory division, worked together at CERN on a paper with the hot title of "High-energy neutrino-nucleon scattering, current algebra and partons". In it, they laid down a sum rule that allowed the number of valence quarks in the proton to be measured with the neutrino beam and the Gargamelle bubble chamber at CERN (Gross and Llewellyn Smith 1969).



Gross with his sketch to illustrate asymptotic freedom, from the photographic exhibition Accelerating Nobels (p26). (Courtesy V Steger.)

Today, the leading edge of research in particle theory, in its continuing search for a quantum field theory of gravity, treats fundamental objects not as the point-like partons of the Standard Model but as extended objects such as strings and membranes. The first ideas about string theory formulated in 1969, and it was strings that drew Gross back to CERN this summer. A key figure in the first "superstring revolution", he is a member of the international advisory committee for the Strings conference series and he gave the outlook talk and a public presentation at Strings 2008 at CERN in August (p11).

Fond memories of CERN

Gross remembers his first visit to CERN as being an exciting time, especially in the theory division, which celebrated the publication of its 1000th paper during his stay. "CERN was the centre of theory," he recalls, "unique in Europe, with lots of good young people." He enjoyed his time a great deal, writing some six or so papers on various topics, including the Gross–Llewellyn Smith sum rule. He has since returned to CERN for several summer visits, with longer spells in 1974 and 1993, and he has had the opportunity to work with theorists such as Gabriele Veneziano, Julius Wess, Sheldon Glashow, Sidney Coleman, Gerardus 't Hooft, John Bell...to name but a few.

Gross is now director of the Kavli Institute of Theoretical Physics (KITP) at the University of California, a position that he has held since 1997, after nearly 30 years at Princeton. He is best known for his major role in taming the dragons of the strong interaction in the 1970s. Some 40 years on from his first visit to CERN, quarks and the strong interaction are now part of the fundamental fabric of particle physics, and are well understood within the context of the Standard Model. They feature not only in high-school textbooks but also in magazines and TV programmes for the general public. The role that Gross played in establishing the theory of QCD as the pillar of the Standard Model that describes the behaviour of quarks and gluons – particularly his work with his student Franck Wilczek on asymptotic freedom in 1973 – was to lead to the Nobel Prize in Physics. He and Wilczek shared the prize in 2004 with David Politzer of Caltech, who arrived at the same conclusion independently – that strong interactions become weaker at shorter distances, allowing calculations within the context of perturbation theory (Gross 2004; *CERN Courier* November 2004 p4).

It is not surprising that this is the work of which Gross remains most proud. "How inconceivable," he says, "that we could actually have a theory, not just a phenomenology of strong interactions...it was mind-boggling that we did it." He moved on to string theory in the early 1980s, when, he says, the "easy things" had been done in QCD. "Solving QCD seemed too hard; it was easier to look for a way to solve everything." Ed Witten, another brilliant student who worked under Gross at Princeton, also joined the superstring revolution and became a leader in the field. "Ed developed an extraordinary skill in finding mathematical structures," Gross recalls. "Trying to keep up with him was quite a challenge," he admits, but adds that "it's always good to be able to learn from your students." He notes that, in particle physics today, "it's amazing how mathematically educated young people are".

Indeed, Gross sees this as a major shift in the field since he started out in theoretical particle physics in the 1960s. "The differences," he says, "are like day and night. Experiment was king in 1969." He describes working in theory then as "pretty miserable", while the experimental side of things was constantly discovering "incredible surprises". Then, in around 1970, the situation began to change, with a shift in experiments towards confirming the Standard Model. Prior to that, mathematics in particle physics was relatively primitive, but then along came input from mathematically talented ▷

young theorists who were extremely successful. This was "much to the chagrin of a generation or two of experimenters", Gross smiles, and created a "generation of middle-aged theorists who didn't know what the underlying theory was".

What does he see now for the future of particle physics, particularly in light of the LHC start-up? He believes that it is a "safe bet" that experiments will confirm the Higgs mechanism, and a "good bet" that supersymmetry will be discovered. Beyond that, he says, the LHC is in the right energy region to deliver surprises, although he adds that the abandoned Superconducting Super Collider with its reach to 40 TeV in the centre of mass would have been better. The nightmare, in his view, will be if there are no surprises, which would leave the subject in "deep trouble". It will be difficult in the absence of real clues from the LHC to argue the case for an expensive next stage. It could, he says, be like asking for "lots of money to go 1 km into a 100 km desert".

In the past, the development of new accelerator techniques has often helped to keep down the cost of the advance into unexplored energy regions. "We need to stay on the Livingston plot," Gross comments, in reference to the well known plot of the evolution of accelerators in energy. He notes that physicists working on space-based instruments face a similar problem.

Meanwhile, theoretical physicists remain relatively inexpensive, which allows them to continue to cover a broad scope of research. At KITP, Gross has been fortunate to build up a theoretical physics centre of the kind that he experienced at CERN as he was entering the field. With some 1000 visitors a year from around the world, the institute forms the basis of one "big family" and a stimulating environment for research. Particle physicists, there as elsewhere, are eagerly waiting for the LHC to reveal what nature has in store at higher energies – and, who knows, it may tip the balance back towards experiments again.

● For a video of the outlook talk by David Gross at Strings 2008, visit http://cdsweb.cern.ch/record/1121966?ln=en.

Further reading

David J Gross 2004 http://nobelprize.org/nobel_prizes/physics/laureates/2004/gross-lecture.pdf.

David J Gross and C H Llewellyn Smith 1969 *Nuc. Phys.* **B14** 337.

Résumé

Des partons, des cordes et un prix Nobel

Lorsque David Gross arrive au CERN dans les années 60, les quarks sont encore une idée théorique et l'interaction forte reste mal comprise. Ces deux concepts sont ensuite devenus des éléments fondamentaux du modèle standard de la physique des particules. En 1973, David Gross a apporté une contribution majeure à la compréhension de ces concepts par ses travaux sur la liberté asymptotique en théorie de l'interaction forte, auxquels participe Frank Wilczek, son étudiant, et qui lui valent en 2004 le prix Nobel de physique, qu'il partage avec Frank Wilczek et David Politzer. Lors de cette interview, il livre ses impressions sur l'évolution de la physique des particules théorique depuis sa première visite au CERN.

Christine Sutton, *CERN.*

Getting heavy on Capri

Over the past 10 years, flavour physics has made unique progress. In June, experimentalists and theoreticians gathered on the island of Capri to work together on heavy flavour physics.

The Second Workshop on Theory, Phenomenology and Experiments in Heavy Flavour Physics took place on 16–18 June in Anacapri, Capri, Italy – the same location as the first meeting in the series in May 2006. The aim of the series is to bring together theoreticians and experimentalists to develop a dialogue on phenomenological issues. The focus is on discussion and interaction among physicists who are active in the field. The topics this year focused on results, especially in B-physics, as well as exploring the potential for heavy flavour physics in both current and future experiments. With participation by invitation only, owing to space problems at the venue, the 60 or so attendees took part in many fruitful and lively discussions after the seminars and during the free time.

During the past decade flavour physics has witnessed unprecedented experimental and theoretical progress, opening up the era of precision tests of the Standard Model. The quark and lepton sectors of the Standard Model have been subjected to a series of stringent tests, and it has become customary to look for violations of the Standard Model by using unitarity triangles. Updates of the unitarity triangle analyses were presented by Marco Ciuchini from Rome III/INFN and Jérôme Charles from the Centre de Physique Théorique, Marseille, for the UTfit and CKMfitter collaborations, respectively.

Such updates have been possible, not only because of the large amount of data now available, but also through theoretical progress (e.g. in lattice calculations). As Chris Sachrajda from the University of Southampton and Fermilab's Paul Mackenzie reported, many approximations in typical lattice calculations have been overcome in recent years. Numerous simulations are now being performed that include quark–antiquark pairs, or a pion mass less than or equal to 300 MeV. Moreover, it is now becoming possible to generate configurations on lattices that are sufficiently fine and large to allow direct simulation of the charm quark.

An impressive amount of data has come from the two asymmetric e^+e^- B factories, PEP-II and KEKB, and their respective detectors, BaBar and Belle. The BaBar experiment concluded data taking in April 2008, having collected a total of 531 fb^{-1}, of which 433 fb^{-1} was on the $\Upsilon(4S)$ peak, corresponding to about 470×10^6 $B\bar{B}$ pairs. In 2008, BaBar also collected 30 fb^{-1} on the $\Upsilon(3S)$ resonance and 14 fb^{-1} on the $\Upsilon(2S)$ resonance, with interesting results, such as the first evidence of the η_B – the long-sought bottomonium ground state. By the time of the workshop, Belle had accumulated about 850 fb^{-1}, with 730 fb^{-1} on the $\Upsilon(4S)$ resonance.

The B factories have led the recent progress in knowledge of the unitarity triangle related to the B system, with angles α, β and γ (or $\phi 2$, $\phi 1$ and $\phi 3$). Christoph Schwanda from the Austrian Academy of Sciences and Giuseppe Finocchiaro from the Frascati National Laboratory/INFN reported on measurements of the angles

Participants in the garden of the Villa Orlandi in Anacapri, where the heavy flavour physics workshop was held. (Courtesy G Ricciardi.)

and sides of the unitarity triangle. Paolo Gambino of Torino and Francesca Di Lodovico from Queen Mary, University of London, reviewed the main theoretical problems on the way to the long-sought precise theoretical inclusive determination of $|V_{ub}|$ in the Cabibbo–Kobayashi–Maskawa (CKM) matrix.

Golden modes and penguins

The B factories' golden modes for the extraction of $\sin 2\beta$ are $b \rightarrow c\bar{c}^s$ decays, and the latest measurement from BaBar gives $\sin 2\beta = 0.714 \pm 0.032 \pm 0.018$, in agreement with the results from Belle. Other interesting decays are the $b \rightarrow sq\bar{q}$ "penguin dominated" decays, those study of which is motivated not only by the measure of $\sin 2\beta$, but mostly by the search for new physics.

The angle α can be studied in $b \rightarrow u\bar{u}d$ modes, and its determination is made complicated by the addition of the $b \rightarrow d$ penguin amplitude to the $b \rightarrow u\bar{u}d$ tree one. The first measurements of the $B^0 \rightarrow \rho^0\rho^0$ decay confirm the indication that the effect of penguin amplitudes is relatively small in $\rho\rho$ decays, which in fact yield the most stringent constraints on α.

A precise measurement of the unitarity angle, γ, unthinkable when the B factories started, is now becoming possible with the large statistics accumulated by the B factories. Several new measurements of $B^\pm \rightarrow D^0 K^\pm$ transitions have appeared recently, and strong ▷

evidence for direct CP violation in these decays is building up.

Radiative penguin and leptonic B meson decays are another area of interest at B factories because they constitute a powerful probe of new physics. John Walsh of INFN/Pisa reported on recent experimental results in this field.

On the theory side, Luca Trentadue from Parma/INFN discussed the resummation of large logarithmic terms, which otherwise spoil the convergence of the perturbative series in the threshold region, in semileptonic charmed B decays. Cai-Dian Lü of the Institute of High Energy Physics (IHEP), Beijing, analysed charmless two-body decays of the B mesons to light vector and pseudoscalar mesons in the soft-collinear effective theory.

With the first runs of the LHC on the horizon, heavy flavour physics is entering a new phase. Natalia Panikashvili of Michigan, Andrei Starodumov of PSI and Stefania Vecchi of INFN/Ferrara described the role of flavour physics at the LHC for the ATLAS, CMS and LHCb experiments, respectively. Tobias Hurth of CERN/SLAC stressed that a large increase in statistics at LHCb for $\bar{B}_d \rightarrow \bar{K}^{*0}\mu^+\mu^-$ will make measurements possible with much greater precision, allowing for an indirect search for new physics.

A main goal at the LHC is to measure CP-violating parameters, such as the B_s^0 mixing phase, which in the Standard Model is predicted to be small, and could be another way of evincing new physics. Luca Silvestrini of INFN/Roma presented a new analysis that claims evidence of new physics through a B_s^0 mixing phase, that is much larger than expected in the Standard Model. However, this had not been confirmed by independent analyses at the time of the workshop. Future data from the Tevatron or an extended Υ(5S) run of Belle may be of help in assessing the new results. Joaquim Matias of the Institute for High Energy Physics, Barcelona, discussed possible strategies to measure the weak mixing phase of the B_s^0 system using B mesons decaying into vectors.

Charm physics, charm spectroscopy, CP violation in charm decays and searches for new physics were all discussed at length during the workshop. Ikaros Bigi of Notre Dame stated that comprehensive and detailed CP studies of charm decays provide a unique window into flavour dynamics. He emphasized the importance of LHCb in achieving the statistics required to find evidence of new physics in the charm sector. There is a powerful programme at LHCb for charm physics, which includes studying D^0 mixing, observed for the first time at B factories in spring of last year, and CP violation in some specific decays. Pietro Colangelo of INFN/Bari discussed aspects of new charm spectroscopy and David Miller of Purdue presented the latest results from CLEO-c on W annihilation decays of the D^+ and D_s^+ mesons. The HERA electron–proton storage ring at DESY had come to the end of its scheduled operation roughly a year before the workshop, but data are still being analysed. Luis Labarga of the Universidad Autónoma de Madrid presented recent results from the H1 and ZEUS collaborations on charm production and fragmentation, in addition to results on beauty production.

The experiment BESII, at the Beijing Electron Positron Collider has accumulated 5.8×10^7 J/ψ events, 1.4×10^7 ψ(2S) events and 35.5 pb^{-1} ψ(3770) data. Xiaoyan Shen of IHEP reported on recent results, which include the observation of the Υ(2175) in the J/$\psi \rightarrow \eta\phi f_0$(980) decay. In the past few years a wealth of new experimental results on heavy quarkonia and exotic states has become available. Riccardo Faccini of Rome "La Sapienza"/INFN summarized recent developments in the search for excited states of the scalar nonet among the light mesons, and reviewed the experimental evidence for new states. Ruslan Chistov of the Institute of Theoretical and Experimental Physics, Moscow, discussed the experimental status of X, Y and Z states at B factories. More new states, decays and production mechanisms have been discovered in the past few years than in the previous 30 years. Besides the regular quarkonium states (mostly quark–antiquark states), new exotic states have been found the composition of which (molecule, tetraquark, hybrids...) is currently the centre of a lively debate. It was the subject of a dedicated round table at the workshop, chaired by Nora Brambilla of Milan, with Antonello Polosa of INFN/Rome, Joan Soto of Barcelona and Antonio Vairo of Milan.

A boat trip social event offered the opportunity to see more of the island's spectacular and stunning surroundings. (Courtesy G Ricciardi.)

Flavour for all

There were many lively discussions on the role of flavour to evince new physics. Andrzej Buras of the Technical University of Munich reviewed several main results on flavour physics beyond the Standard Model, analysing in particular flavour and CP-violating processes in models with supersymmetry, "littlest Higgs" and extra dimensions. Ulrich Nierste of Karlsruhe summarized the role of the decays $B^0 \rightarrow \mu^+\mu^-$, $B^+ \rightarrow \tau^+\nu_\tau$ and $B \rightarrow D\tau\nu_\tau$ in the hunt for new Higgs effects in the minimal supersymmetric Standard Model. Flavour and precision physics in the Randall–Sundrum model were the topics of discussion for Matthias Neubert of the Johannes Gutenberg University, Mainz, while Jernej Kamenik of INFN/Frascati talked about phenomenology in the context of minimal flavour violation.

While waiting for the LHC, Fermilab's Tevatron has not only demonstrated the possibility of B-physics at hadron machines but also produced measurements that are highly competitive and complementary to those of the B factories. In particular, this was via the unique access that hadron machines have to the B_s sector. Vaia Papadimitriou of Fermilab and the CDF experiment, and Brad Abbott of Oklahoma and D0, presented the latest measurements on the production, spectroscopy, lifetimes and branching fractions for B mesons, B baryons, and quarkonia. Theoretical issues for the measurement of the top mass using jets, and implications for measurements of the top mass at the Tevatron, were discussed by Iain Stewart of the Massachusetts Institute of Technology. Monte Carlo programs have already proved indispensable for making exclusive theoretical predictions at the Tevatron. Christian Bauer from Lawrence Berkeley National Laboratory presented an improved Monte Carlo framework (GenEvA) mainly based on a new notion of phase space.

Tom Browder of Hawaii and Marcello Giorgi of INFN/Pisa made a strong science case for continued heavy flavour physics measurements at future Super-B machines, underlining their complementarity to the LHC programme. One focus for the Super-B factories would be studying, and possibly discovering, new sources of flavour-changing neutral currents and CP-violation. There are plans for a Super-B factory at KEK in Japan based on the existing KEK accelerator and Belle detector, as well as a proposal for a laboratory in Italy, the SuperB project. In both cases the goal is a luminosity of around 1×10^{36} cm^{-2} s^{-1}, approximately 60 times as high as achieved at present B factories.

The conference was extremely lively, and most goals of the workshop, such as promoting co-operation and a fruitful exchange of ideas among theoreticians and experimentalists, were fulfilled. Up to now, the data agrees globally with the CKM picture, but there are also hints of discrepancies, which if confirmed could signify new physics. With the advent of the new machines, it will be feasible to investigate possible flavour structure and new sources of CP violation beyond the Standard Model through studies of flavour processes. Heavy flavour, and therefore physics, continues to play a fundamental role in particle physics and has an exciting future.

Further reading

For more information, see http://web.na.infn.it/index.php?id=b-physics-capri. Workshop proceedings are being published in *Nucl. Phys. B. (Proc. Suppl)*.

Résumé

Les quarks ont de la saveur à Capri

Le deuxième atelier « Théorie, phénoménologie et expériences en physique des saveurs lourdes » s'est tenu du 16 au 18 juin dans la petite ville d'Anacapri, sur l'île de Capri en Italie. Cet atelier a pour but de réunir théoriciens et expérimentateurs pour créer un dialogue sur la phénoménologie. Cette année, les discussions ont porté essentiellement sur les résultats obtenus, notamment en physique des B, mais aussi sur le potentiel des expériences actuelles et futures en matière de physique des saveurs lourdes. L'atelier a été extrêmement animé et la plupart des objectifs ont été atteints, et notamment l'échange fructueux d'idées entre théoriciens et expérimentateurs. La soixantaine de participants a pris part à de nombreuses discussions après les séminaires et pendant les pauses.

Giulia Ricciardi, *University of Naples "Federico II" and INFN/Naples.*

ANNIVERSARY

EPS marks 40 years – to the day

The European Physical Society (EPS) was founded in Geneva in 1968 to promote physics in Europe. Exactly 40 years later, on 26 September, the EPS came back to its birthplace for a joint press conference at CERN to celebrate the anniversary.

The movement to create the EPS started in November 1965 in Bologna during the annual Italian Physical Society Conference. Gilberto Bernardini, a former director of research at CERN, took a leading role in preparing the ground for the society through a series of meetings in Pisa, London, Geneva and Prague. On 25 September 1968, a final discussion took place at CERN, chaired by the then director-general Bernard Gregory. This cleared the remaining points for the constitution of the society, which was formally started the following morning as the first members enrolled at CERN. The official inauguration took place in the afternoon at the University of Geneva, with Bernardini as the first president of the EPS executive committee (*CERN Courier* October 1968 p238).

Today the EPS represents more than 100 000 physicists from 40 national member societies, reaching well beyond the geographical area covered by the EU. As Maciej Kolwas, president-elect of the EPS, announced at the press conference, physics is the basis of much of today's technology, it is at the forefront in building a united Europe and it is an integral part of human culture. Robert Aymar, current director-general of CERN, also spoke of the common vision for European physics on the world stage, shared by CERN and the EPS.

Former EPS president Martin Huber (centre) and CERN's director-general Robert Aymar listen to the presentation by current EPS president Fritz Wagner (left) 40 years after the society was founded.

The EPS president, Fritz Wagner, pointed out in his concluding remarks that in the 2008 Olympic Games, the nations within the geographical area covered by members of the EPS won more gold medals than China and the US together, showing that a unified Europe can compete. "This is the same for other fields including science and technology," he said, adding that the EPS is ready to play its role in setting Europe on the path towards a knowledge-based society.

The inauguration ceremony for the EPS at the University of Geneva on 26 September 1968, with (left to right) Gilberto Bernardini; Denis van Berchem, rector of the University of Geneva; and E Valloton of the Swiss Ministry of Foreign Affairs.

PUBLISHING

Physics aims to make life a whole lot easier

These days information overflow has become a significant problem for most researchers. It is one thing to stay on top of one's field, but to stay abreast of related areas is a completely different issue. The American Physical Society (APS) is addressing this problem seriously and has launched a new open-access journal called *Physics*. The goal is to highlight exceptional papers from all fields of physics within the body of research that the APS publishes each year in all of the *Physical Review* journals.

Each week *Physics* will feature brief commentaries that spotlight articles selected by the editors of *Physical Review* based on interest and importance. The papers will be explained and discussed by researchers who are noted for their knowledge of a field and their ability to communicate.

In this context it is amusing to note that just 50 years ago the APS felt that the time was right for a new journal, a publication that would feature short reports on exciting new work and foster interactions between physicists in related fields. That new journal was *Physical Review Letters*, and by 2007 it had published almost 15 000 pages. *Physics* should make the life of the physicist easier once more.

● For access to *Physics*, visit http://physics.aps.org/.

APPOINTMENT

Dosch heads DESY directorate

Helmut Dosch is to be the new chair of the directorate of the research centre DESY. He will take over from the incumbent, Albrecht Wagner, on 1 March 2009.

A solid-state physicist, Dosch is renowned internationally for research into solid-state interfaces and nanomaterials with synchrotron radiation. He is currently director of the Max-Planck-Institute for metals research in Stuttgart and professor at the University of Stuttgart. He has previously worked at the Institut Laue-Langevin, Cornell University and at the universities of Mainz and Wuppertal.

Dosch is highly experienced in research involving large-scale facilities and he serves on several international committees, review journals and research organizations. He has advised the DESY directorate as a member of the DESY scientific council, and, as a member of the German council of science and humanities, he evaluated the TESLA/XFEL project, which later developed into the European X-ray laser project (XFEL) and the International Linear Collider. He is currently vice-chair of the administrative council of the European Synchrotron Radiation Facility in Grenoble.

Helmut Dosch is the new director of DESY.

AWARDS

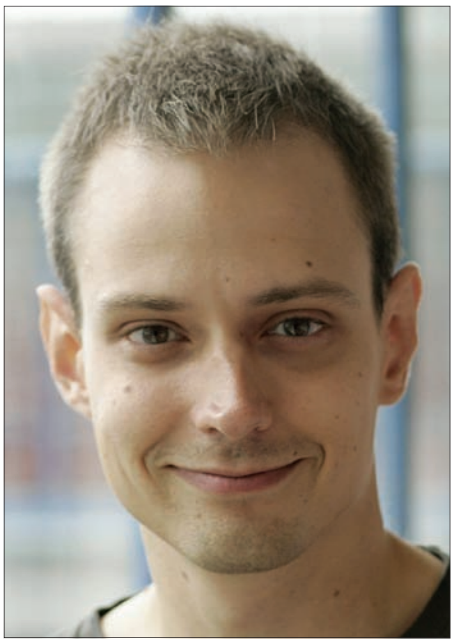
CERN theorists gather further honours

On 22 September CERN's Sergio Ferrara was awarded the Amaldi Medal, the European prize for general relativity and gravitational physics, at the congress of the Italian Society of General Relativity and Gravitation.

He received the prestigious award for his continuing research into supergravity, a theory that combines the principles of supersymmetry and general relativity. Ferrara codiscovered supergravity in 1976 with two colleagues: Peter van Nieuwenhuizen and Daniel Freedman. However, he receives this recent award for his work on black holes in supergravity.

Aleksi Vuorinen, also at CERN, has won a Sofja Kovalevskaja Award of the Alexander von Humboldt Foundation. These are given to young scientists to build up research groups at the host institute of their choice in Germany and spend five years working on a research project. They are named after the Russian mathematician who lived from 1850 to 1891.

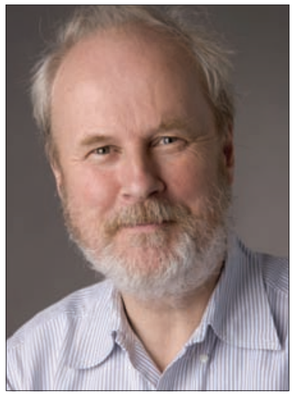
Vuorinen studied theoretical physics at the University of Helsinki, where he completed his doctorate in 2003. Following a three-year research stay at the University of Washington he became a Lise Meitner fellow at the Vienna University of Technology in Austria before coming to CERN. With his award the young Finn has decided to establish his own group in the Physics Department of Bielefeld University to carry out research focused on the properties of the hot and dense matter created in heavy-ion collisions. In particular, he will apply novel mathematical tools, relying in part on general relativity, and he looks forward to confronting the calculations with data from the LHC.



Aleksi Vuorinen. (Courtesy A Vuorinen.)

Sergio Ferrara with the Amaldi Medal.

APS announces prize-winners for 2009


Left to right: Satoshi Ozaki from Brookhaven, Keith Ellis from Fermilab and Saskia Mioduszewski from Texas A&M are among those honoured in the 2009 APS awards. (Courtesy Brookhaven National Laboratory, Fermilab Visual Media Services and Allen Pearson, Texas A&M.)

The American Physical Society has announced many of its awards for 2009, naming recipients who work in particle physics and related disciplines, from field theory to relativistic heavy-ion collisions.

Raymond Stora, emeritus director of the Theoretical Physics Laboratory at Annecy-le-Vieux (LAPTH) and a regular visitor to CERN, is one of the four theoreticians who have been honoured with the 2009 Dannie Heineman Prize for mathematical physics. This recognizes the "discovery and exploitation of the BRST symmetry for the quantization of gauge theories providing a fundamental and essential tool for subsequent developments". He shares the prize with co-workers Carlo Becchi of the University of Genoa and Alain Rouet of Science and Technology, and with Igor Tyutin of the Lebedev Physical Institute, Moscow, who worked independently on the same symmetry now known as BRST symmetry. Their work was essential in guaranteeing physical consistency in the quantization of non-Abelian field theories, and it has been valuable in the development of theories of superstrings.

Also in the theoretical physics domain, the J J Sakurai Prize for outstanding achievement in particle theory is awarded to Keith Ellis of Fermilab, Davison Soper of the University of Oregon and John Collins of Pennsylvania State University. They are recognized for "work in perturbative quantum chromodynamics, including applications to problems pivotal to the interpretation of high-energy particle collisions". While an exact solution of QCD remains elusive, perturbative methods provide valuable approximations in calcuations that have become increasingly precise. In addition to providing a better understanding of QCD, the calculations allow experimenters to separate QCD effects from other phenomena, such as weak and electromagnetic effects.

Experimental work on disentangling the electromagnetic effects of quarks in the proton is recognized in the award of the Tom W Bonner Prize, for outstanding experimental research in nuclear physics, to Robert D McKeown of California Institute of Technology. He receives the prize "for his pioneering work on studying nucleon structure using parity-violating electron scattering, in particular for the first measurement of the strange quark contribution to the electromagnetic structure of the proton".

The major award in experimental particle physics, the W K H Panofsky Prize, recognizes the importance of precision tracking in measuring the properties of the heavier quarks and the particles that they form. Aldo Menzione of INFN/Pisa and Luciano Ristori of Fermilab are honoured for "their leading role in the establishment and use of precision silicon tracking detectors at hadron colliders, enabling broad advances in knowledge of the top quark, b-hadrons, and charm-hadrons". Menzione and Ristori's vision for silicon detectors and their application are now integral to the CDF experiment at Fermilab's Tevatron collider and have been adapted for other particle detectors worldwide.

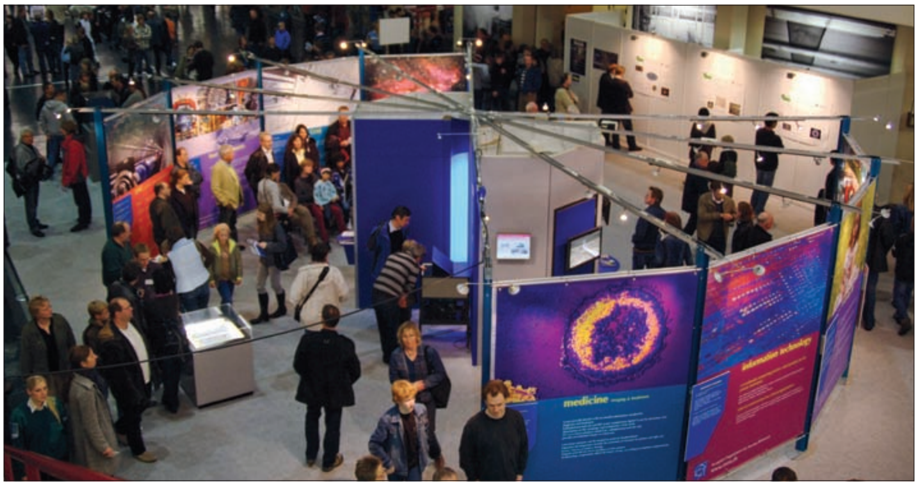
Also working on the properties of the top quark at Fermilab, this time with the DO experiment, Gaston Gutierrez has received the Edward A Bouchet Award for "contributions to the DO collaboration, in particular the 'matrix-element' method of extracting precise measurements of Standard-Model parameters, as well as his outstanding mentorship of young scientists". He developed this new analysis technique to measure the mass of the top quark.

Discoveries in heavy-ion collisions at the Relativistic Heavy Ion Collider (RHIC) at the Brookhaven National Laboratory are recognized by the APS in the award of two prizes established to recognize individuals in the early stages of their career. Brookhaven's Paul Sorensen received the George E Valley Jr Prize for "his role in the discovery of quark number scaling in the elliptic flow of hadrons in nucleus–nucleus collisions, and its interpretation showing the relevance of quark degrees of freedom in heavy-ion interactions".

Saskia Mioduszewski of the Cyclotron Institute at Texaz A&M University has received the Maria Goeppert Mayer Award for "her pioneering contributions to the observation of jet quenching and her continuing efforts to understand high-p_T phenomena in relativistic heavy-ion collisions". This award aims to recognize and enhance outstanding achievement by a woman physicist in the early years of her career.

Brookhaven's achievements with RHIC are also recognized with the award of the Robert R Wilson Prize for Achievement in the Physics of Particle Accelerators to Satoshi Ozaki. He is rewarded for "his outstanding contribution to the design and construction of accelerators that has led to the realization of major machines for fundamental science on two continents, and his promotion of international collaboration". Ozaki, along with Brookhaven's Michael Harrison, led the decade-long development and construction of the laboratory's world class particle accelerator, the RHIC.

OUTREACH



The CERN exhibition was crowded well into the small hours during the "Science Night", when the Bielefeld Science Festival stayed open beyond midnight on 10 October. (Courtesy Marcel Müller.)

CERN shows up in Bielefeld

The CERN off-site exhibition was one of the highlights of the first Bielefeld Science Festival, GENIALE, held on 3–11 October at Bielefeld University. In excess of 4000 visitors came to learn about CERN, the LHC, and the mysteries of particle physics and cosmology. The exhibition was organized by the Bielefeld Theoretical High Energy Physics Group, which includes many former members of the CERN Theory Group.

The CERN exhibition was complemented by a poster presentation of the activities of the Bielefeld group. Local students and group members answered questions and offered explanations throughout the event which was supported financially by Bielefeld Marketing GmbH and Scanlitho Teams. The next Bielefeld Science Festival will take place in 2011, by which time the first results on searches for the Higgs boson and supersymmetry at the LHC should be available.

Diffraction 2008, the fifth international workshop on diffraction in high-energy physics, took place in September at La Londe les Maures in France. Taking a break from the highly successful meeting are the organizer, Jacques Soffer (formerly from the Centre de Physique Théorique, Marseille, and now at Temple University, Philadelphia), Firooz Arash (left) from Tafresh University in Iran and Uri Maor (right) from Tel Aviv University, Israel. (Courtesy André Martin.)

CORRECTIONS

The article on Canada's contribution to the LHC in the October issue (p32) contained an unfortunate mistake. The amount quoted in the first sentence should, of course, read: "a five-year $30 million Canadian contribution". In addition, the date given for the official inauguration of the LHC on p88 should have been 21 October 2008. Many apologies.

LETTER

A mechanism for mass

James Gillies' article "A mechanism for mass", which appeared in *CERN Courier* (October 2008 p83), presented a summary of the development of what has come to be known as the Higgs mechanism. Regrettably, this article tends to marginalize our work (GHK), which for the last 40 years or so (along with the work of Englert and Brout (EB) and of Higgs (H)) has generally been acknowledged as one of the three main contributors to this pillar of the Standard Model. We find the passing mention of GHK in the odd phrase that "in lectures at Imperial College London students are told about the Kibble–Higgs mechanism, in a reference to a later paper published by Gerald Guralnik, Carl Hagen and Tom Kibble" rather insulting. The phrase "Higgs–Kibble mechanism" seems to have originated with Salam and it survives to this day, causing no little embarrassment to one of us (TK). It was probably not so much a reference to GHK as to TK's 1967 paper in *Physical Review*, which he considers to be only a relatively minor addendum to this subfield.

It is, of course, true that the work by the three of us (GHK) was published after that of EB and H. But it made distinct original and essential contributions, particularly with regard to the critical issue of current conservation and the precise way in which the mechanism avoids the Goldstone theorem, as can be confirmed by a careful reading of the three papers. Our work was complete when we learned of the two earlier papers. We added references to them without changing the content of our paper in any substantive way.

It is noteworthy that all three contributions were cited together in *Physical Review Letters*' recent summary (http://prl.aps.org/50years/milestones) of outstanding papers. (All three appeared in Volume 13, at roughly equal intervals.) Actually, one has to look no farther than the pages of *CERN Courier* (January/February 2008 p17) to find Nobelist Weinberg's summary talk "From BCS to LHC" to confirm that the three papers are equally esteemed. A study of citation indices is also quite instructive. For 40 years after the 1964 appearance of these three papers there was no discernible pattern of preference among them, with the vast majority of researchers in the field mentioning all three.

We strongly object to any downgrading of our contribution.

Gerald Guralnik, Carl Richard Hagen and Tom Kibble.

GRIDS

The WLCG becomes officially operational

On 3 October CERN and its many partners around the world held an all-day Grid Fest to mark the end of seven years of development and deployment of the Worldwide LHC Computing Grid (WLCG) and the beginning of continuous operation. The WLCG is already fully running, handling large amounts of cosmic-ray data coming from the LHC experiments. ATLAS, for example, currently stores data at a rate of nearly a petabyte per month.

More than 250 Grid enthusiasts gathered in the Globe of Science and Innovation at CERN, including representatives of worldwide industrial partners and teams that manage the distributed operations of the WLCG, which today includes more than 140 computer centres in 33 countries. As befits a cutting-edge information technology seminar, many participants joined virtually, via videolink, to mark the occasion.

To illustrate the global nature of the WLCG, the head of the LCG project, Ian Bird, took an impressive live video tour of many of the major sites. This provided a strong reminder of what a challenge it is to run a global 24 hour Grid service. Greetings came from data centres in Melbourne, Mumbai, Taipei and also Vancouver, where it was 3.30 a.m. The enthusiasm of all of the virtual participants underlined that the WLCG is very much about people, not just machines. Les Robertson, who retired in October but was present in the Globe, received an ovation for his tireless efforts as the previous head of the LCG project, guiding it from inception to its current, mature state.

In his address, CERN's director-general, Robert Aymar, highlighted the necessity of using computing to study particle physics.

Left to right: Ian Bird (LCG project leader), Les Robertson (former head of LCG project), Jos Engelen (CERN's chief scientific officer), Wolfgang von Rüden (head of the Information Technology Department) and Robert Aymar (CERN's director-general), with a sculpture unveiled at the Grid Fest – a metallic globe with the WLCG data centres indicated by light spots made, fittingly, with optical fibres.

Bob Jones, the CERN-based director of the European Commission (EC) project Enabling Grids for E-sciencE (EGEE), reminded participants that the high-energy physics community leads the way for many other disciplines that are starting to adopt Grid technology. He discussed applications in seismology, atmospheric research, astronomy, fusion and the life sciences.

Antti Peltomäki, EC deputy director general, information society and media, noted that more than €100 m had been invested by the EC in Grid technology over the past few years, putting Europe in a leading position in this area. Ed Seidel, head of the office of cyberinfrastructure at the US National Science Foundation, remarked on the huge progress of scientific computing in the past two decades, making it an essential ingredient for so much research today.

A session on the contributions of industry to the WLCG highlighted some of the ways in which CERN openlab, a partnership with several leading IT companies, has benefited both CERN and the companies concerned. Intel and Oracle received LHC Computing Awards from the director-general for their exceptional contributions over many years. HP received a similar award from ALICE last year.

On-site demonstrations, held throughout the day, showed attendees some of the applications live, including examples from the WLCG, the ALICE experiment, the ATLAS experiment, the CMS experiment, the LHCb experiment, the Health-e-Child project (paediatrics), the ITER project (fusion energy), Open Science Grid and the WISDOM project (drug discovery).

● To view some of the many demonstrations online on the "Gridcast", prepared by the EC GridTalk project, see http://gridtalk-project.blogspot.com/.

LABORATORIES

SLAC changes name to SLAC National Accelerator Laboratory

The US Department of Energy (DOE) has renamed the Stanford Linear Accelerator Center the SLAC National Accelerator Laboratory. The aim is to acknowledge both the distinguished accomplishments that SLAC has achieved throughout the years and its exciting future as a multi programme DOE National Laboratory. In recent years SLAC's research programme has broadened from its original focus on high-energy physics to include important research in photon science and particle astrophysics.

Its current science programmes are expanding to explore the ultimate structure and dynamics of matter and the properties of energy, space and time at the smallest and largest scales.

This includes the study of ultrafast processes in materials with a new state-of-the-art X-ray free electron laser, the Linac Coherent Light Source.

OBITUARIES

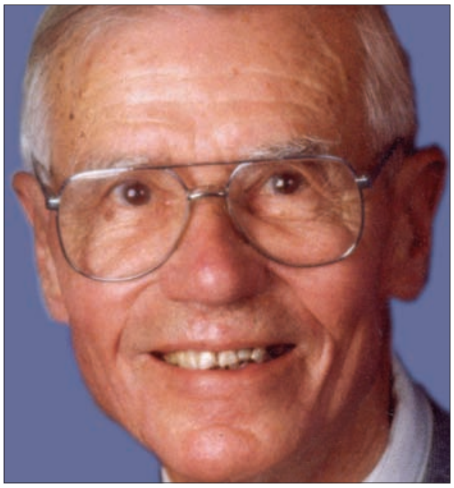
Douglas Allen 1914–2008

William Douglas Allen, an innovative physicist and engineer, was an outstanding figure in the British development of large electrostatic accelerators. He died on 7 May.

Allen, who was always known as Doug, was born in Mussoorie, India, on 27 July 1914 and spent his early life as part of a South Australian Methodist mission based at Azamgarh near Varanasi. When he returned with his parents to Adelaide he attended Prince Alfred's College and, subsequently, Adelaide University. A man of many talents, he also studied piano at the Elder Conservatorium and played hockey for Australia against India in Melbourne in 1935.

Awarded a Rhodes Scholarship for South Australia in 1937, Doug was a member of New College, Oxford, and was awarded a D. Phil in nuclear physics from the Clarendon Laboratory in 1940. He married Genevieve Thomson, also from Adelaide, in November 1939 in St James' Church, Muswell Hill, London. During the Second World War he worked initially with the pioneering radar establishment at Swanage, and then at TRE Malvern, before moving to Berkeley, California, to work on uranium-isotope separation.

After a brief return to Australia he was invited back to the UK in 1946 to join the nuclear physics division at AERE, Harwell. Together with the unrelated K W Allen, he led the team that designed and built tandem van de Graaff accelerators at Aldermaston and Harwell. The Harwell machine began operating only months after the world's first tandem, built by van de Graaff's company for the Canadian Chalk River Laboratory, and it remained a valuable resource for more than 40 years.



Douglas Allen. (Courtesy Richard Hyder.)

In 1961 Doug transferred with the Accelerator Division to the new Rutherford Laboratory near Harwell to lead the group charged with designing and installing the coupled electrostatic accelerators for the new nuclear physics laboratory in Oxford. His patent for improved accelerator tubes was the basis for tubes used in van de Graaff generators in five continents. He also invented the laddertron, a charging system for electrostatic machines adopted, among others, by the designers of the large national tandem at the Daresbury Laboratory in the UK.

Doug remained at the Rutherford Laboratory until 1977, simultaneously holding a visiting professorship in the Engineering Department at Reading University. He was also a visiting professor at the University of the West Indies (1978–1979) and at Southampton University (1978–1981), where he received an honorary D. Sc in 1984.

His wife, Genevieve, predeceased him by three months. He is survived by four children and by 13 grandchildren and great-grandchildren.

James Allen and Richard Hyder.

Horst Wachsmuth 1933–2008

Horst Wachsmuth, well known for his work over many years as a physicist at CERN, passed away after succumbing to cancer on 8 September.

Horst came to CERN in the early 1960s and started work in the Nuclear Physics Apparatus Division. This division was mainly concerned with the construction of the neutrino beams that would be used with the 1.2 m heavy-liquid bubble chamber, to carry out the first-ever, bubble-chamber neutrino experiments. Horst immediately became interested in the difficult problem of calculating the exact energy distribution of the neutrino beam and also measuring the absolute neutrino flux. To do this he developed a method of measuring the muon flux in the neutrino shielding at various depths and radial positions. These techniques were continuously developed and refined over the subsequent 20 years.

Horst Wachsmuth. (Courtesy K Wachsmuth .)

He participated in almost all of the bubble-chamber neutrino experiments at CERN, including the famous discovery of neutral weak currents with Gargamelle. In addition, the important discovery that the neutrino cross-section increases linearly with energy, therefore confirming the quark model, could be made only because of the meticulous calculations of the neutrino spectra and fluxes that Horst undertook. However, it was not only at CERN that he participated in neutrino experiments. As one of the first to do so, he fought for his two sabbatical leaves, both of which took him to the University of Wisconsin to work on experiments at Fermilab.

During the final years of his activities in neutrino physics, Horst joined the ALEPH collaboration, where he filled many functions from testbeam coordinator to CERN team leader. He also started a new activity, which he energetically pursued until his death: analysing cosmic-ray events using ALEPH and the other LEP detectors, as well as dedicated stations around the ALEPH underground areas. His dedication to the CosmoALEPH experiment encouraged a small team of colleagues to continue working in close collaboration with him, which contributed significantly to the understanding of cosmic rays that penetrate underground.

Horst's activities at CERN outside research earned him the respect of his colleagues. An early member of the staff association, he participated in the five-yearly review in 1974 and worked on the improvement of working conditions in several committees. By the late 1980s his efforts led to improved conditions both for young scientists and for visitors.

Outside his direct work for CERN, Horst was very concerned about ecology and the intelligent use of energy. He studied human ecology in 1975 at Geneva University, analysing energy problems together with colleagues in the European Physical Society (EPS) dur ing the 1990s, resulting in his organizing the EPS study conference Economy–Energy–Entropy, at CERN in 1996.

Last but not least, he was known to all at CERN, and many beyond, through *Picked-Up for You*, which he published for many years and which was eagerly read by many to keep abreast of scientific news in all fields.

At the beginning of Horst's career at CERN, Simon van der Meer wrote an assessment, characterizing him perfectly: "Doesn't work for me, but good and intelligent and does support and research work. He is a very good man and it would be a pity to lose him. Excellent relationships with other people."

Horst's devotion to his work and the good of his colleagues and the environment in every respect won him the warm regard and admiration of all who know him. He will be sorely missed.

His colleagues and friends.

Dave E Johnson 1944–2008

Dave Johnson was particularly well known in the physics community for his ability with mathematical modelling to determine the best beam characteristics for a particular accelerator – a complex and crucial set of calculations that defines the design and character of the entire machine.

Dave earned a first degree in physics from the University of California, Berkeley, in 1966 and a PhD in high-energy physics from Iowa State University in 1972. He started his career at Fermilab, where he became part of the central design group that did the preliminary planning for the Superconducting Super Collider (SSC). He was a senior scientist and deputy head of the Accelerator Department of the SSC laboratory from autumn 1989 until January 1995, and he was jointly responsible for the technical design, management, schedule and budget ($2.4 billion) of the 87 km circumference collider.

After the US Congress terminated the SSC project, Dave worked on the close-down procedures for the SSC laboratory. He spearheaded a programme to capture and archive the 200 GB technical software and data library assembled during the SSC project, and to link this repository to the web. He then worked with the Texas National Research Laboratory Commission on design review and analysis for a regional medical technology centre.

The field of high-energy physics is inextricably bound to the employment of state-of-the-art computer hardware and software. As a result, Dave acquired an integrated view of computer systems, flowing from high-level, large-project management goals to the concise understanding of the microcode required to achieve the massive transfer rates necessary for 10 MB/s data capture. He developed a computer-based lattice design using state-of-the-art computer modelling codes for Particle Beam Lasers Inc, and undertook a computer systems security analysis for the International Thermonuclear Reactor for Science Applications International Corporation. In addition, he developed a web server, internet applications and security study for Texas Instruments, as well as consulting on several projects for the Los Alamos National Laboratory. He was also co-founder and vice-president of system development for InterTech Resources Development Inc, a company developed to establish and manage large-scale scientific and computer-related collaborations between scientists in the former Soviet Union and US industry.

In his private life, Dave was a gourmet cook who especially enjoyed French cuisine. He actively monitored science blogs and answered questions about various scientific matters, mainly physics, and he was an active online gamer. He was also interested in nature and took trips to the Arctic and Antarctic. He created and maintained a stunning 200 gallon, salt water aquarium and was a devoted dog owner. He was also the owner of an old Mitsubishi sports car that he loved and rebuilt.

He is survived by one brother, Richard, and Richard's three children.

His colleagues and friends.

MEETINGS

NuFact09, the 11th International Workshop on Neutrino Factories, Superbeams and Betabeams, will take place on 20–25 July in Chicago. The main aim of this series of workshops, started in 1999, is to understand the different options for a future neutrino oscillation experiment that will attack the problems of mass hierarchy and CP violation in the leptonic sector. For further information, contact the organizers (e-mail organizers@nufact09.iit.edu) or see http://nufact09.iit.edu.

The **14th Lomonosov Conference on Elementary Particle Physics** will be at Moscow State University on 19–25 August. These biennial conferences bring together about 300 theorists and experimentalists from different countries to review the current status and future prospects in elementary particle physics. The programme of the 14th conference will include neutrino physics, astroparticle physics, gravitation and cosmology, and electroweak theory. For further information and registration (deadline 1 March), see www.icas.ru/english/14lomcon.htm.

EXON-2009, the International Symposium on Exotic Nuclei, is to be held in Sochi, Russia, on 28 September to 2 October. Organized by JINR (Dubna), GANIL (Caen, France), GSI (Darmstadt, Germany) and RIKEN (Wako, Japan), the event will be devoted to the investigation of nuclei in extreme states and, in particular, at the limits of nuclear stability (from very light neutron- and proton-rich up to superheavy nuclei). Detailed information is available at http://exon2009.jinr.ru.

NEW PRODUCTS

Elliot Scientific has announced the addition of the LDR range of laser current and thermoelectric controller driver board modules from OptoSci to its portfolio of products for the fibre, diode and telecom markets. The LDR module includes a power supply, a ZIF mount and heat sink for a 14-pin butterfly package, a USB interface and PC communications cable, and full V-DRIVE control software. For more information, contact David Welsh, (tel +44 158 276 6300, e-mail david.welsh@elliotscientific.com).

Lake Shore Cryotronics Inc has launched a line of cryogenic micromanipulated probe stations, which includes tabletop, field upgradeable, superconducting and electromagnet-based, full 4 inch wafer and closed-cycle, refrigerator-based probe stations. The tabletop series is available with up to six micromanipulated probe arms operable from 4.2 K to 475 K, with a low-temperature option to 3.2 K. For further details, tel +1 614 891 2244, fax +1 614 818 1600, e-mail info@lakeshore.com or see www.lakeshore.com/crps.html.

Ocean Optics has introduced the Optical Transmittance Spectrometer for the accurate, repeatable real-time transmittance measurement of optical lenses and other optical components. The compact system measures the tint colour, photopic transmittance and UV cutoff of lenses, optical coatings, windows and filters, as well as characterizing photochromic, electrochromic and sun lens material. For more information, contact Jessica van Heck (tel +31 26 319 0500, e-mail Jessica.vanHeck@oceanoptics.eu, see www.oceanoptics.eu).

Princeton Gamma Tech Instruments (PGT) has launched the SAHARA III, a new Peltier-cooled silicon drive detector that offers users an active detector area ranging from 10 mm^2 to 100 mm^2 and standard beryllium or low-energy polymer windows. The SAHARA III is a complement to PGT's other X-ray detector offerings, which include liquid-nitrogen-cooled Si(Li), IGX and multi-element detector arrays. For further details, contact Leong Ying (tel +1 609 924 7310, e-mail leong.ying@pgt.com).

Vector Fields has released a high-frequency, electromagnetic design tool, Concerto, to help RF designers to exploit the properties of metamaterials, as part of its work for the Advanced Materials for Ubiquitous Leading-Edge Electromagnetic Technologies research project. Metamaterials can provide a means of enhancing the performance and size of wireless components. For more information, tel +44 1865 370 151, e-mail info@vectorfields.co.uk, or see www.vectorfields.com.

RECRUITMENT

For advertising enquiries, contact *CERN Courier* recruitment/classified, IOP Publishing, Dirac House, Temple Back, Bristol BS1 6BE, UK.
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Please contact us for information about rates, colour options, publication dates and deadlines.

NSCL National Superconducting Cyclotron Laboratory at Michigan State University

Faculty Positions in Nuclear and Accelerator Science

Michigan State University (MSU) invites applications for four vacant faculty positions at NSCL. NSCL faculty normally have joint appointments in a major academic department at MSU where they are expected to teach, although other arrangements may be possible. Applications are particularly encouraged in the new and emerging areas of research at NSCL that include laser-based nuclear physics, nuclear physics and astrophysics with reaccelerated rare-isotope beams, nuclear structure physics far from stability, and accelerator physics and engineering.

The successful candidates are expected to develop leadership roles in research at NSCL, contribute new capabilities to the laboratory, and contribute to NSCL's graduate and undergraduate education programs. Depending upon the qualifications of the successful applicants, each position can be filled at the assistant, associate, or full professor level, with a competitive salary.

NSCL is the forefront facility in the United States for nuclear physics with rare isotope beams and is in the process of developing new research capabilities with stopped and reaccelerated beams. NSCL has approximately 300 employees, including 28 faculty members and over 100 graduate and undergraduate students. The existing state-of-the-art experimental equipment as well as advanced design and machining capabilities allow rapid and efficient progress from concept development to design and fabrication of new equipment. Information about NSCL can be found at the laboratory's Web site (www.nscl.msu.edu); information about NSCL faculty appointments can be found at the MSU Human Resources Web site (www.hr.msu.edu/HRsite/Documents/Faculty/Handbooks/nsclfacpos).

Applicants should send a letter of application, a résumé, including a list of publications, and the names and addresses of at least three references to **Prof. David Morrissey, NSCL, Michigan State University, East Lansing, MI 48824-1321**. MSU is committed to achieving excellence through cultural diversity. The university actively encourages applications and/or nominations of women, persons of color, veterans and persons with disabilities.

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NSCL

LEDERMAN FELLOWSHIP in EXPERIMENTAL PARTICLE or ACCELERATOR PHYSICS

The Fermi National Accelerator Laboratory (Fermilab) has an opening for a postdoctoral Lederman Fellow in experimental particle physics or accelerator physics. In recognition of Leon Lederman's commitment to the teaching of physics, we are looking for candidates who have demonstrated outstanding ability in research and who also wish to participate in physics outreach for a fraction of their time. The Lederman Fellow will have a choice of opportunity within the broad program of experimental research at Fermilab which includes experiments at the energy frontier, neutrino physics, particle astrophysics, and accelerator physics. See http://www.fnal.gov/ for more information.

The appointment is for three years with a possible extension. Candidates should either have obtained a Ph.D. in experimental particle or accelerator physics after January 1st, 2008 or should expect to obtain a Ph.D. in the same topics by July 2009.

To apply, please email LMLFAPP@fnal.gov or write to Lederman Fellowship Committee, c/o Ms. Cindy Kennedy, MS 122, Fermi National Accelerator Laboratory, P.O. Box 500, Batavia, IL 60510-0500. Applicants should provide a curriculum vitae, a publication list and the names of four references, and should describe their prior research and research interests, and their experience and interest in teaching and outreach. Applications will be accepted through January 12, 2009.

Fermilab

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MSc in High-Performance Computing

UK/EU studentships available

EPCC, School of Physics and Astronomy, University of Edinburgh offers a one-year taught MSc in High-Performance Computing (HPC). EPCC has an international reputation as a leading HPC centre of expertise. The entrance requirement is a good honours degree or equivalent work experience; candidates must be competent programmers in Java, C, C++, or Fortran.

Closing dates:
28 February 2009 for UK/EU
31 January 2009 for non-UK/EU

See **http://www.epcc.ed.ac.uk/msc/**
or email **msc@epcc.ed.ac.uk**

ASSISTANT PROFESSOR

Kansas State University seeks applicants with a Ph.D. in experimental high energy physics to join the CMS experiment at CERN.

Contact information: 785-532-1644, *hepsearch@phys.ksu.edu*, or go to *http://www.phys.ksu.edu/main/job_opp.html* for position description and application procedures. EOE. Background check required

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UNIVERSITÉ DE GENÈVE

FACULTY POSITION IN COSMOLOGY

(MER) - GENEVA, SWITZERLAND

This is a permanent fulltime position with 4 hours of teaching per week. The candidate should pursue a vigorous research program in cosmology. More precisely she/he should work on the problem of dark energy considering as well its theoretical aspects as also methods for experimental investigations of dark energy. The candidate is expected to participate in the supervision of graduate students and teaching on all levels.

Applications have to be sent to **Prof. Ruth DURRER, DPT, Université de Genève, 24, quai Ernest Ansermet, CH-1211 Genève 4, Suisse.**

Additional information can be obtained from **ruth.durrer@unige.ch**.

BERGISCHE UNIVERSITÄT WUPPERTAL

DEPARTMENT OF PHYSICS

As part of our research with the ATLAS experiment, the University of Wuppertal has an opening for a PhD physicist as a

Lecturer (Akademischer Rat)

Our group in Wuppertal has major responsibilities for the commissioning and upgrading the ATLAS pixel-detector. We are also operating an ATLAS Tier 2-center, are designing reconstruction-software for the inner detector and are preparing for physics analysis of the ATLAS data.

We are searching for a PhD physicist with an excellent knowledge in the phenomenology at hadron colliders and first-rate expertise in experimental techniques for data analyses. He/she should have the ability to play a major role in large experimental collaborations.

The position can be filled for an initial three years with a possible extension for another three years. Salary and benefits are commensurate with public services (A13).

In line with our policy of equal opportunities, we particularly encourage women to apply.

Interested candidates should send applications until Dec 31, 2008 to:
Prof. Dr. Peter Mättig
Fachbereich Physik, Universität Wuppertal, Gaußstr. 20, D 42097 Wuppertal
peter.mattig@cern.ch

UNIVERSITY OF COPENHAGEN

Associate Professorship in Experimental Subatomic Physics

The Niels Bohr Institute

The Niels Bohr Institute is searching for an experimentalist with an outstanding research profile and openness towards new research directions in experimental subatomic physics. The research area must be within physics and detector development explored at the Large Hadron Collider at CERN. The successful candidate is expected to contribute to developments of the experimental methods as well to utilizing the existing experiments at CERN. The current areas of activity in experimental subatomic physics at the institute include a strong involvement in all aspects of the two experiments ALICE and ATLAS, e.g. trigger systems, tracking detectors, GRID and physics analysis. Activities beyond the current LHC program are under discussion and the new Assoc. Prof. is expected to contribute significantly to future choices of direction.

The position is open from 1st May 2009 or as soon as possible thereafter. Duties may include the successful applicant's own research, development of the field, assessment tasks, grant applications, and research management such as supervision and training of research fellows and other staff. The successful applicant must also teach, prepare and participate in examinations, and fulfill other tasks requested by the Department. Information on the Department is linked at www.nat.ku.dk/institutter, and enquiries about the position can be made to Prof. John Renner Hansen, Head of Department, +45 35325292 and renner@nbi.dk.
Terms of appointment and payment accord to the agreement between the Ministry of Finance and The Danish Confederation of Professional Associations on Academics in the State (www.perst.dk/db/filarkiv/12811/004-06.pdf). While negotiation for salary supplement is possible, the starting salary is currently up to DKK 413,447 including annual supplement (+ pension up to DKK 70,699).

Applications must be in English, emailed as a single PDF file to science-position@science.ku.dk (Subject line: Your last name, 211-0199), and include in the following order:

- •Curriculum vitae (with applicants e-mail address & telephone number)
- •Description (max. 5 pages) of current and proposed research including its relation to other research at the Department
- •Documentation of teaching experience and other qualifications
- •Full contact details (Name, address, telephone & email) of 2 professional references
- •Complete publication list indicating max. 5 papers particularly relevant to the application
- •Reprints of the 5 particularly relevant papers (included, most recent first, in the single file).

The University wishes our staff to reflect the diversity of society and thus welcomes applications from all qualified candidates regardless of personal background. The deadline for applications is 15th January 2009 at noon, 12:00pm local Danish time. Applications or supplementary material received thereafter will not be considered.

Assessment of applicants will primarily consider their level of documented, original scientific production at an international level, including contributions to developments in their field. The teaching, managerial, out-reach, and innovative qualifications of applicants will also be considered. Assessment guidelines, pursuant to revisions, are available in English and Danish at www.nat.ku.dk/ansatte/service/loen_og_ansaettelse/ansaettelse/vip. Such guidelines include:

- •Applicants will be notified of the composition of the assessment committee
- •Applicants must provide supplementary documentation if requested by the committee
- •Applicants may be summoned for an interview and/or requested to give a trial lecture
- •Each applicant will receive that part of the assessment relating to him/herself.

Founded in 1479, the University of Copenhagen is the oldest university in Denmark. With approximately 37,000 students and 7,500 employees, the University is the largest university in Scandinavia. According to an international survey the University is ranked as number eight in Europe, and it is a member of the International Alliance of Research Universities (IARU). www.ku.dk/english

PHYSICS AT THE TERA SCALE
Helmholtz Alliance

The Strategic Helmholtz Alliance "Physics at the Terascale" (http://www.terascale.de) is a research network supported by the Helmholtz Association and comprises the research centres DESY and FZ Karlsruhe, 17 German universities and the Max-Planck-Institut für Physik. Within the framework of the worldwide investigation of the fundamental properties of matter using accelerators at the highest energies, the Alliance will sustainably concentrate and advance the expertise and strengths of the participating institutes.

DESY

Scientist

The Analysis Centre of the Helmholtz Alliance "Physics at the Terascale" at DESY, Hamburg site, is seeking a scientist to join the Statistics Tools group of the centre.

The Analysis Centre supports physicists at German institutes working on analyses at ATLAS, CMS and ILC. The centre contains three main branches: Monte Carlo Generators, Parton Distribution Functions and Statistics Tools. A major goal of the statistics tools group is to provide support and education for all kinds of statistics-related tasks and questions in high-energy physics data analysis.

The successful candidate is supposed to strengthen the activities of the group by
- contributing to the development of statistics tools,
- implementing existing tools into software frameworks like ROOT,
- taking part in the organisation of meetings, workshops and schools and
- helping to provide user support and web documentation.

The candidate is also expected to carry out research within one of the Alliance projects for about 50 % of his or her time.

The position requires
- a Ph.D. in physics,
- interest and experience in the development of statistics tools and
- programming, software maintenance and analysis experience (e. g. C++, Fortran, ROOT).

The position is initially limited until 30 June 2012, the nominal end of the Helmholtz Alliance funding period. For further information please contact Dr. Thomas Schörner-Sadenius (Thomas.Schoerner@desy.de).

GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN

Physicist
"Detector Development with the ATLAS Experiment"

The University of Göttingen offers a full-time position for a research assistant/post-doc (salary level TVL E13) beginning as soon as possible. The position is available for an initial period of two years with a possible extension by two years.

The post-doc will be member of the recently formed particle physics group to work on the ATLAS experiment at the Large Hadron Collider at CERN. The ATLAS experiment is designed to search for physics phenomena responsible for electroweak symmetry breaking and to study a variety of subjects related to physics at the TeV scale. The successful applicant is expected to participate in the supervision of students, in the start-up of the new particle physics group in Göttingen, in the research activities of the group and to play a leading role in detector development in the context of the Helmholtz Alliance, in particular in the ATLAS pixel detector upgrade.

For further information please contact Prof. Arnulf Quadt (aquadt@uni-goettingen.de).

RWTH AACHEN UNIVERSITY

Physicist
"Physics Data Analysis with the CMS Experiment"

The applicant is expected to contribute to physics data analysis within the CMS experiment, and to the Visual Physics Analysis project being developed at the RWTH Aachen. The position is funded by the Helmholtz Alliance "Physics at the Terascale" for a period of 3.5 years.

For further information please contact Prof. Martin Erdmann (+49-241-8027317, erdmann@physik.rwth-aachen.de).

LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

Physicist
"Physics Data Analysis with the ATLAS Experiment"

The Faculty of Physics at LMU Munich has an immediate opening for a physicist on the search for signals of new physics beyond the Standard Model within the ATLAS experiment. The LMU ATLAS group is contributing to the muon spectrometer, Grid computing and the preparation of the data analysis. The appointee is expected to establish a strong research programme involving diploma and Ph.D. students with particular emphasis on searches for Higgs Bosons or supersymmetric particles and to contribute actively to a successful start-up phase of the ATLAS experiment.

The position is partially funded by the Strategic Helmholtz Alliance „Physics at the Terascale" and the salary follows the standard for public employment (TVL E13). The position is vacant and initially limited to two years with the possibility of an extension. Candidates should hold a Ph.D. in experimental particle physics.

For further information please contact Prof. Dorothee Schaile (dorothee.schaile@physik.uni-muenchen.de).

Two Physicists/Engineers

The Heidelberg ASIC Laboratory located in the Kirchhoff-Institut für Physik at the Ruprecht-Karls-Universität Heidelberg will extend its scope to support scientists and Ph.D. students in the area of analogue and mixed-signal VLSI component and system design and test. The institute has openings for two Physicists/Engineers for the design of integrated microelectronics, in particular analogue and mixed-signal circuits. An excellent knowledge of state-of-the-art-design and simulation tools is required as well as experience in the design and testing of complex electronic circuits employing ASICs and FPGAs. Practical experience in electronic circuit design and construction is required. Both positions are located in the existing ASIC laboratory for microelectronics. They are immediately available and will be limited until 30 June 2012.

For further information please contact Prof. Karlheinz Meier (meierk@kip.uni-heidelberg.de).

Applications (preferably by email) including a letter of application, CV, academic record as well as a list of publications and the names of three persons who can provide further information about the candidate should be addressed to:

Prof. Ian Brock (Scientific Manager of the Helmholtz Alliance)

DESY, Notkestraße 85, 22607 Hamburg, Germany (Ian.Brock@desy.de).

For all positions, salary and benefits are commensurate with those of public service organisations in Germany. Handicapped persons will be given preference to other equally qualified applicants. DESY and the universities are equal opportunity, affirmative action employers and encourage applications from women.

Closing date for all applications is 31 December 2008.

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Post available in the Cryogenics Group at the Rutherford Appleton Laboratory. The successful applicant will have the opportunity to work in a busy and dynamic environment on a variety of projects.

The group is involved in the development of closed cycle refrigerators for space applications. These are small long-life devices that are used on spacecraft for cooling infra red sensors. The work will involve investigations into rare earth materials used in the regenerators and the development of new compressors. There will be a mix of practical and theoretical investigations.

The successful applicant will be adaptable, keen to learn new skills and will have an analytical approach as well as being capable in a laboratory environment. Some assembly of mechanical equipment will be required and an appreciation of computer based logging equipment is desirable.

The successful applicant will be comfortable working as part of a large team and have good written and communication skills. He/She will have a sound approach to safety and be capable of understanding how safety legislation applies to the work in hand.

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For further information on these posts please contact Tom Bradshaw on 01235 446149 or e-mail: tom.bradshaw@stfc.ac.uk

To apply online go to www.scitech.ac.uk/About/Vacs/current/portal/Vacs.aspx for further information about the recruitment process, please contact Technology HR on 01235 445734 (answerphone) or e-mail mailto: Technology-HR@rl.ac.uk quoting reference TBU041.

Closing date: 17 December 2008.

Interviews will be held:
Week Commencing 5 January 2009.

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IOP Publishing

BOOKSHELF

Books received

Order, Disorder and Criticality: Advanced Problems of Phase Transition Theory (Volume 2) edited by Yurij Holovatch, World Scientific. Hardback ISBN 9789812707673 £46 ($85).

This is the second volume of review papers on advanced problems of phase transitions and critical phenomena, following the success of the first volume in 2004. Broadly, it aims to demonstrate that there is still a good deal of work to be done in phase transition theory, both at the fundamental level and with respect to applications. Topics include critical behaviour as explained by the non-perturbative renormalization group; critical dynamics; a space–time approach to phase transitions; self-organized criticality; and exactly solvable models of phase transitions in strongly correlated systems. Like the first volume, this one is based on the review lectures that were given in Lviv (Ukraine) at the Ising Lectures – a traditional annual workshop on phase transitions and critical phenomena that brings together scientists in the field working with university students and others interested in the subject.

The Physics of Warm Nuclei: with Analogies to Mesoscopic Systems by Helmut Hofmann, OUP Series: Oxford Studies in Nuclear Physics, Volume 25. Hardback ISBN 9780198504016 £65 ($130).

This book offers a comprehensive survey of basic elements of nuclear dynamics at low energies and discusses their similarities to mesoscopic systems. It addresses systems with finite excitations of their internal degrees of freedom so that their collective motion exhibits features typical of transport processes in small and isolated systems. The importance of quantum aspects is examined with respect to both the microscopic damping mechanism and the nature of the transport equations, and a critical discussion of the use of thermal concepts is included. The book is considerably self-contained and presents existing models, theories and theoretical tools, from both nuclear physics and other fields, which are relevant to an understanding of the observed physical phenomena.

A Primer on the Physics of the Cosmic Microwave Background by Massimo Giovannini, World Scientific. Hardback ISBN 9789812791429 £48 ($89).

In the past 15 years, various areas of high-energy physics, astrophysics and theoretical physics have converged on the study of cosmology. Today, therefore, any graduate student in these disciplines needs a reasonably self-contained introduction to the cosmic microwave background (CMB). This book presents the essential theoretical tools necessary to acquire a modern working knowledge of CMB physics. The style, falling somewhere between a monograph and a set of lecture notes, is pedagogical and the author uses the typical approach of theoretical physics to explain the main problems in detail, while also touching on the main assumptions and derivations of a fascinating subject.

Terrestrial Neutron-Induced Soft Errors in Advanced Memory Devices by Takashi Nakamura, Mamoru Baba, Eishi Ibe, Yasuo Yahagi and Hideaki Kameyama, World Scientific. Hardback ISBN 9789812778819 £56 ($98).

Terrestrial neutron-induced soft errors in semiconductor memory devices are currently a major concern in reliability issues. Understanding the mechanism and quantifying soft-error rates are primarily crucial for the design and quality assurance of semiconductor memory devices. This book covers relevant up-to-date topics in terrestrial neutron-induced soft errors and aims to provide succinct knowledge on these soft errors by presenting several valuable and unique features. It should be of interest to students and researchers in radiation effects, nuclear and accelerator physics and cosmic-ray physics; and to engineers involved in reliability, the design/quality assurance of semiconductor devices and IT systems.

An Introduction to the Physics of Particle Accelerators (2nd edition) by Mario Conte and William W MacKay, World Scientific. Hardback ISBN 9789812779601 £86 ($46). Paperback ISBN 9789812779618 £29 ($55).

This text offers a concise and coherent introduction to the physics of particle accelerators, with attention being paid to the design of an accelerator for use as an experimental tool. In this edition, new chapters on the spin dynamics of polarized beams, as well as instrumentation and measurements, are included with a discussion of frequency spectra and Schottky signals. The additional material also covers quadratic Lie groups and integration, highlighting new techniques using Cayley transforms, detailed estimation of collider luminosities and new problems. Graduates and advanced undergraduates in physics will find this book a useful resource.

Many-Body Theory Exposed: Propagator Description of Quantum Mechanics in Many-Body Systems (2nd edition) by Willem H Dickhoff and Dimitri Van Neck, World Scientific. Hardback ISBN 9789812813794 £56 ($98). Paperback ISBN 9789812813800 £39 ($75).

This comprehensive textbook on the quantum mechanics of identical particles includes a wealth of valuable experimental data, particularly in recent results from direct-knockout reactions directly related to the single-particle propagator in many-body theory. The comparison with data is incorporated from the start, making the abstract concept of propagators both vivid and accessible. Results of numerical calculations using propagators (or Green's) functions are also presented. This edition contains an extensive presentation of finite temperature propagators and covers the technique to extract the self-energy from experimental data as developed in the dispersive optical model. While the majority of books on many-body theory deal with the subject from the viewpoint of condensed-matter physics, this one also emphasizes finite systems and should be of considerable interest to researchers in nuclear, atomic and molecular physics.

Atomic Physics: an Exploration through Problems and Solutions (2nd edition) by Dmitry Budker, Derek F Kimball and David P DeMille, OUP. Hardback ISBN 9780199532421 £55 ($110). Paperback ISBN 9780199532414 £27.50 ($55).

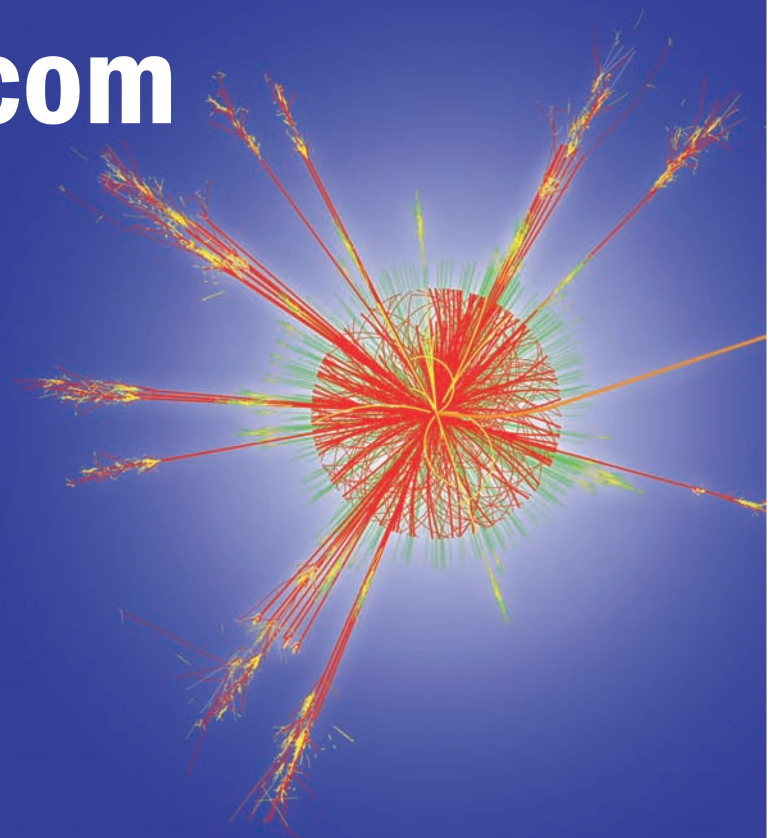
This book provides a bridge between the basic principles of physics learned as an undergraduate, and the skills and knowledge required for the advanced study and research in the field of atomic physics. The text is organized as a collection of problems, hints, detailed solutions and in-depth tutorials. This enables the reader to open the book at any page and get a solid introduction to subjects on the cutting edge of atomic physics, such as frequency-comb metrology, tests of fundamental symmetries with atoms, atom trapping and cooling, and Bose–Einstein condensates. It includes problems and tutorials on important basics that are approached from the perspective of experimentalists: formal calculations are avoided where possible in favour of "back-of-the-envelope" estimates, symmetry arguments and physical analogies. This edition contains more than 10 new problems, and it includes important updates, revisions and corrections.

Equilibrium and Non-equilibrium Statistical Mechanics by Carolyne M Van Vliet, World Scientific. Hardback ISBN 9789812704771 £75 ($138). Paperback ISBN 9789812704788 £42 ($78).

This book encompasses our current understanding of the ensemble approach to many-body physics, phase transitions and other thermal phenomena, as well as the quantum foundations of linear response theory, kinetic equations and stochastic processes. The historical methods of J Willard Gibbs and Ludwig Boltzmann, applied to the quantum description rather than phase space, are featured. The tools for computations in the microcanonical, canonical and grand-canonical ensembles are carefully developed and then applied to a variety of classical and standard quantum situations. In the second part, dealing with non-equilibrium processes, the emphasis is on the quantum foundations of Markovian behaviour and irreversibility via the Pauli–Van Hove master equation. Written as a standard text for graduate students it will also serve the specialist researcher. Some more elementary topics have been included to make the book self-contained.

Stochastic Resonance: from Suprathreshold Stochastic Resonance to Stochastic Signal Quantization by Mark D McDonnell, Nigel G Stocks, Charles E M Pearce and Derek Abbott, Cambridge University Press. Hardback ISBN 9780521882620 £80 ($160). E-book format ISBN 9780511426582 $128.

The stochastic resonance phenomenon has been observed in many forms of system and debated by scientists for 30 years. Applications incorporating aspects of stochastic resonance have yet to prove revolutionary in fields such as distributed sensor networks, nanoelectronics and biomedical prosthetics. The initial chapters review the basics of stochastic resonance and outline some of the controversies and debates that surround it. The book continues to discuss stochastic quantization in a model where all threshold devices are not necessarily identical but are still independently noisy. It also considers various constraints and trade-offs in the performance of stochastic quantizers. Each chapter ends with a review that summarizes the main points and open questions to guide researchers into finding new research directions.



VIEWPOINT

Towards a more confident future

Robert Aymar reflects on progress during five years as director-general at CERN.

The year 2008 has been an important one for CERN, with the first complete cool-down of the LHC, the highly successful start-up with beam on 10 September and the official inauguration ceremony on 21 October. Unfortunately, the impressive start-up was followed by an incident caused by a faulty electric connection. This has delayed further commissioning until spring 2009, as the sector involved must be warmed up, the repairs made and the sector cooled down again. It is certainly a setback, but one that I am certain will be overcome with the usual rigour and application of the teams at CERN, who have support from industrial contractors and our partners in other laboratories involved in the LHC project.

When I became director-general at the beginning of 2004 the LHC project was emerging from what was potentially a more serious crisis, which had arisen when an increased "cost to completion" emerged in 2001. To redirect money to the LHC, savings had been forced in various areas, including the non-LHC programme and long-term research and development, coupled with a compulsory reduction in staff and a decrease in the budget. There was a loss of confidence in CERN among certain member states, coupled with a real loss in the ability to create a long-term vision for the organization.

It was clear that the future of CERN depended on recovering the full confidence of the member states and developing clear priorities for the years beyond the immediate implementation and exploitation of the LHC. To regain confidence, my aim was to make CERN transparent and unified in the way that it worked, with improved management at all levels and increased overall efficiency – an organization that gave justice to the high levels of quality, competence and dedication of its staff. I also wished to establish CERN as an organization that could serve to unite the particle-physics community in Europe: as the place where the European programme in particle physics is coordinated, shared and supported by all of its players.

At CERN my strategy was to introduce

Robert Aymar speaking at the LHC inauguration.

more dynamic management methods in a framework that is not compartmentalized within departmental boundaries but that instead takes a CERN-wide approach, focusing on activities in which different parties would work together. In particular, the structure would centre on projects that report directly to the directorate. At the staff level there would be increased mobility within the organization and a new system to reward people on merit and recognize their talents. During the past five years these objectives have been achieved, with a new management structure brought quickly into place – followed in 2007 by the introduction of the new Merit Appraisal and Recognition Scheme to reward staff appropriately.

Looking outwards, the strategy was to strengthen and deepen co-operation with other European particle-physics laboratories. I believed that it was important for CERN Council to place more emphasis on a neglected part of the organization's original mission: to organize and sponsor international co-operation in nuclear research, including co-operation outside the laboratory (*CERN Courier* March 2004 p31).

Council has achieved this goal at the European level by agreeing to steer activities in particle physics not only at CERN but across the continent. At its meeting in Lisbon in July 2006, Council agreed the European Strategy for Particle Physics, which presented a long-term vision for the future development of the field in Europe, and which positioned Council as the body to oversee this development.

I also wanted to develop CERN's co-operation with other particle-physics laboratories in Europe, with more collaboration towards common goals, particularly in the field of accelerators. Moreover, anticipating regained confidence in CERN (in 2007) through the implemented improvements in management, I hoped that Council would be able to approve a plan with coherence between resources and scientific objectives.

The main goals to 2010 were to strive for completion of the LHC; to fulfil existing commitments; to ensure reliable LHC operation; and to promote European coordination in accelerator R&D and new infrastructure. Important goals on a longer timescale were to develop solutions for a future luminosity upgrade of the LHC in 2012–2015, including a new linac (Linac 4), and to accelerate tests of the feasibility of the Compact Linear Collider concept so as to reach by 2010 a firm conclusion on its possible use in an electron-positron linear collider operating above 1 TeV. These goals in fact matched several of the priorities set by the European Strategy for Particle Physics.

In 2007 the member states, through Council, approved an additional financial contribution of SFr240 million over four years in addition to a level annual budget for CERN. This will be dedicated towards implementing new activities that are linked to the priorities of the European strategy. Construction work on Linac 4, for example, has just begun (p5) and there is good progress with the CLIC test facility (*CERN Courier* November 2008 p5).

Through this action the member states, and particularly the host states, have provided for the future of CERN in the long term. At the same time, they have strengthened CERN's position on the European stage. Now CERN can continue to look outwards, beyond Europe, towards further international collaboration on a global scale.

I have full confidence in CERN's continued success and that it will continue to be a reference as a centre of excellence.
Robert Aymar, CERN.

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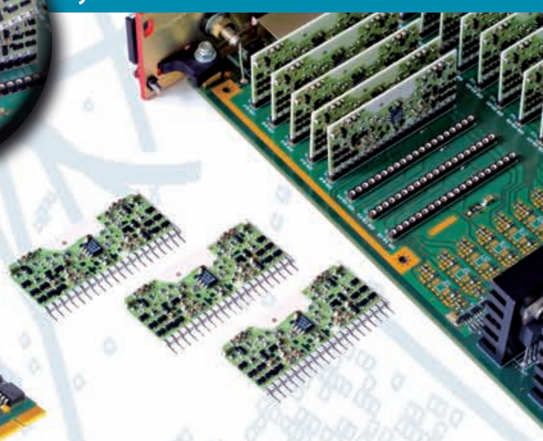

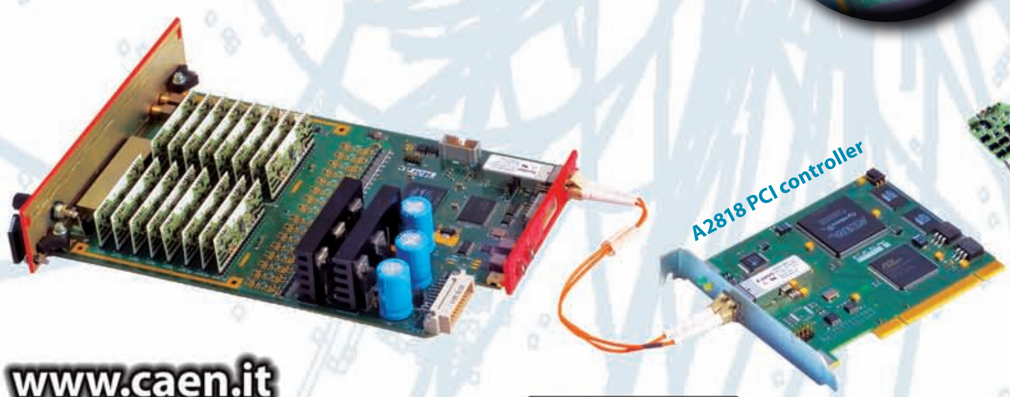

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