INTERNATIONAL JOURNAL OF HIGH-ENERGY PHYSICS

CERN COURIER

50 years 1959–2009

VOLUME 49 NUMBER 6 JULY/AUGUST 2009

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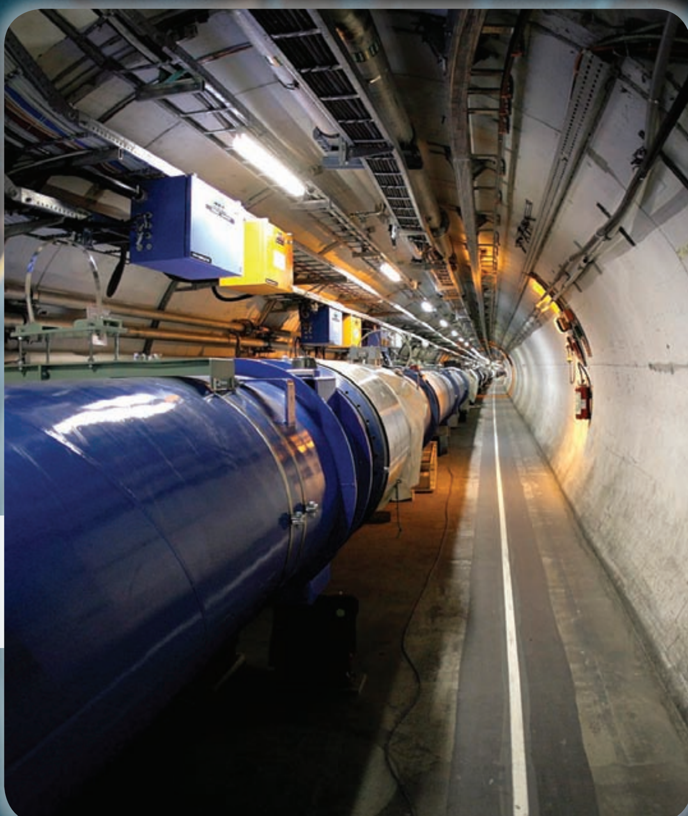

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CERN COURIER

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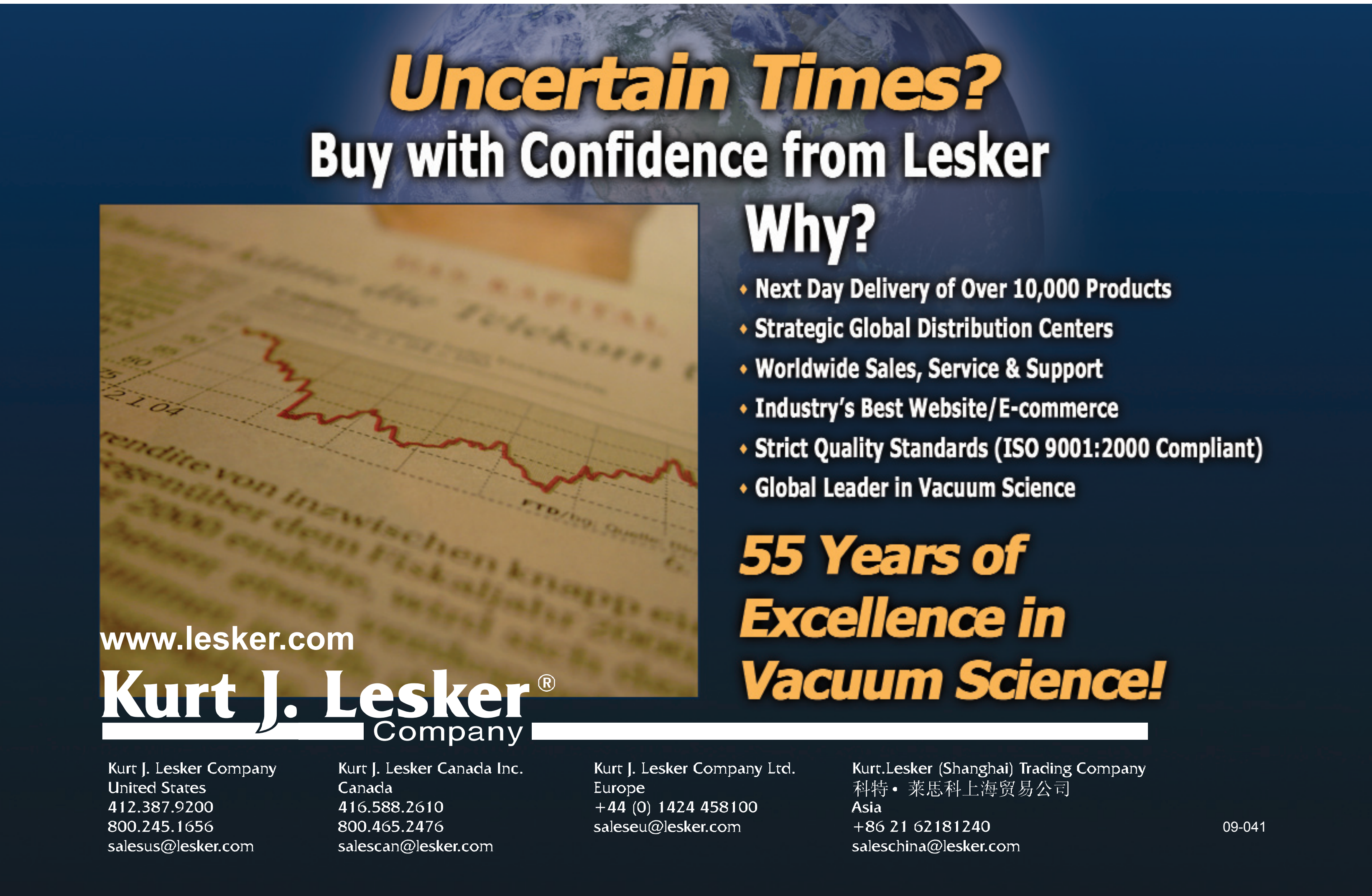
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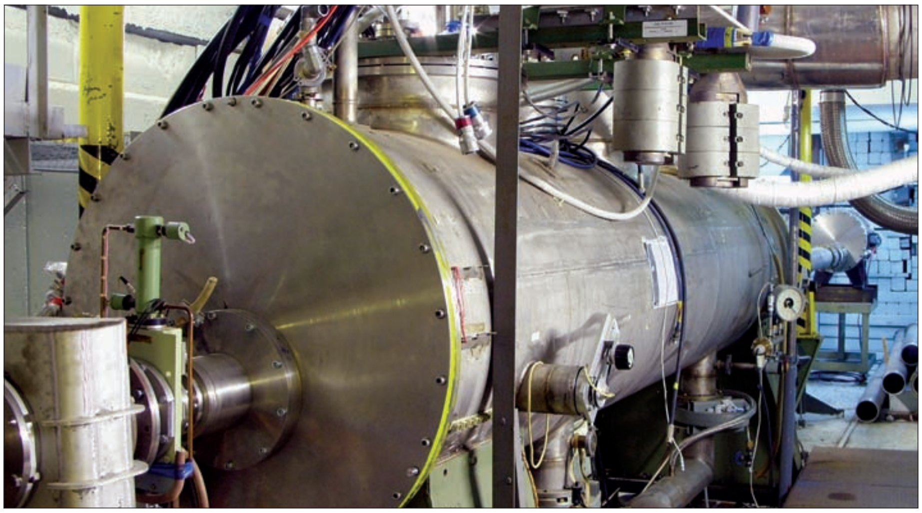
IHEP PROTVINO

Superconducting RF separator emerges from its long sleep

The first superconducting high-frequency device made for particle physics has begun a new life at the U-70 proton synchrotron at the Institute for High Energy Physics (IHEP) at Protvino. It forms a key part of the new 200 m long high-intensity beam line for 12.5 GeV/c positively charged secondary particles, which was commissioned last December. With a content of 25% kaons the beam will be used in the OKA project, which will search for new physics in rare kaon decays. The high fraction of kaons in the beam is provided by the superconducting RF separator, the two niobium deflectors of which are cooled by liquid helium at a temperature of 1.8 K.

The separator was originally designed and constructed in 1970–1977 at the Institute für Kernphysik of the Kernforschungszentrum Karlsruhe, under the leadership of Herbert Lengeler of CERN. Until 1981 it was successfully used to provide a beam enriched in kaons and antiprotons for the Omega spectrometer at CERN. On completion of the experimental programme with the separated beam at Omega, the deflectors were stored at CERN under high vacuum for 17 years. Then, after vacuum-leak tests and other necessary preparations, the deflectors were transported from CERN to IHEP in 1998 (*CERN Courier* April 1998 p12).

Preparations for a new life for the deflectors began in 2006. First, comprehensive tests took place, together with the restoration of nominal working parameters of deflector RF2, which was damaged at CERN during preparation for the shipment to Russia. Then the two deflectors were placed 76.3 m apart on the beam line and connected to the cryogenic system, which has a refrigerating power of 250 W for superfluid helium at a temperature of 1.8 K. At the same time as the tests the group led by Boris Prosin designed and implemented an RF-feed and phasing system for the deflectors, based on modern microwave elements and the rubidium frequency-standard as a source of the signal. A set of power amplifiers and the common DC power supply, previously used in the antiproton cooling system at CERN, were connected to the output of the microwave system and a completely oil-free high-vacuum system was designed and arranged for each deflector.



The cryostat for deflector RFI of the superconducting RF separator in place at IHEP. (Courtesy IHEP.)

Fridhelm Caspers from CERN and Axel Matheisen from DESY have provided important advice and practical help with some equipment for the preparation of the separator. Successful commissioning of the superconducting device was also substantially aided by the use of equipment remaining from a "warm" RF separator, which was developed at CERN 40 years ago for joint IHEP–CERN experiments at U-70 with the French bubble chamber "Mirabelle". This separator had then been preserved in a very good condition at IHEP.

Stable working of the cryogenic system and the RF separator during the April run at U-70 provided the start of the data-taking at the OKA experimental facility for the study of rare kaon decays. Future efforts will aim to increase the intensity and quality of the separated beam and thereby ensure the success of the OKA experiment.

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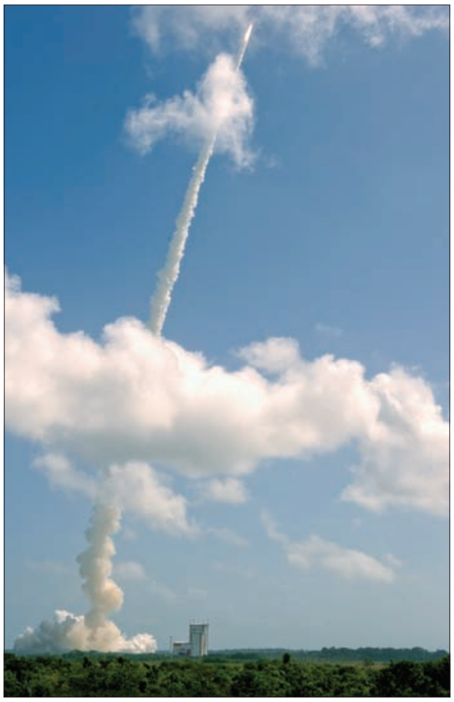
COSMOLOGY

The ESA Planck spacecraft heads off to its final destination after successful launch

Planck, ESA's new spacecraft to map the cosmic microwave background, successfully took its first steps into space on 14 May when it was launched together with the far-infrared space telescope Herschel from Europe's Spaceport in French Guiana. The two spacecraft were on board an Ariane 5 launcher that took off from Kourou at 13.12 UTC.

Planck is designed to map tiny irregularities in fossil radiation left over from the very first light in the Universe, emitted shortly after the Big Bang (*CERN Courier* April 2009 p26). Herschel, equipped with the largest mirror ever launched into space, will observe a mostly uncharted part of the electromagnetic spectrum to study the birth of stars and galaxies as well as dust clouds and planet-forming discs around stars (p12).

Almost 26 minutes after launch, Herschel and then Planck were released separately on an escape trajectory towards the second Lagrangian point (L2) of the Sun–Earth system, some 1.5 million km from Earth in the opposite direction to the Sun. This triggered the execution of automatic sequences on board, including switch-on of the high-frequency radio transmitters. Nine minutes later, the first signals from both spacecraft were acquired by ESA's New Norcia and Perth stations. Shortly afterwards, telemetry confirmed that both spacecraft were in good health.



Planck and Herschel lift off on board an Ariane 5 launcher from Europe's Spaceport in French Guiana on 14 May. (Courtesy ESA.)

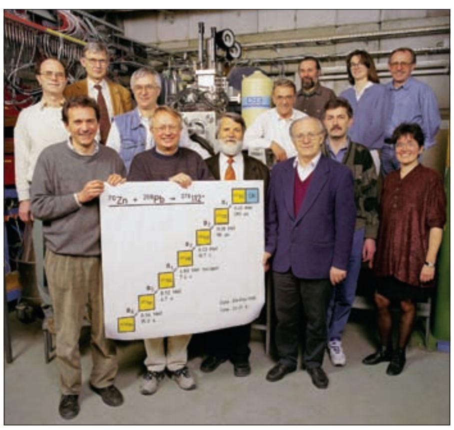
On 5 June, Planck carried out the critical mid-course manoeuvre to place the spacecraft on its final trajectory for arrival at L2 early in July. The manoeuvre, in which Planck's main thrusters make repeated "pulse burns", lasted about 46 hours. This pulse-burn technique is necessary because Planck is slowly spinning as it travels through space, rotating at 1 rpm. The thrusters, which are fixed to the spacecraft and are not steerable, can only burn when they are oriented in the correct direction, which occurs for 6 seconds during each 60 second rotation. The successful manoeuvre provided an overall change in speed of 155 m/s in an initial speed of 105 840 km/h with respect to the Sun. A "touch-up" manoeuvre was scheduled for 17 June to provide a final 5–10 m/s correction.

NUCLEAR PHYSICS

Element 112 receives official recognition

Element 112, discovered at GSI Darmstadt, has been officially recognized as a new element by the International Union of Pure and Applied Chemistry (IUPAC). IUPAC confirmed this recognition in an official letter to the head of the discovery team, Sigurd Hofmann. The letter also asks the discoverers to propose a name for the new element, which is the heaviest so far in the periodic table. Once the proposed name has been thoroughly assessed by IUPAC, the element will receive its official name.

A team of 21 scientists from Germany, Finland, Russia and Slovakia was involved in the experiments that discovered the new element. They created the first atom of 112 in 1996 when they directed a beam of zinc ions onto a target of lead at the accelerator at GSI; a second example followed in 2002. Subsequent accelerator experiments at the Japanese RIKEN accelerator facility produced more atoms of element 112, unequivocally confirming GSI's discovery.



The team presenting the production of element 112 for the first time. (Courtesy A Zschau, GSI.)

Since 1981, accelerator experiments at GSI have yielded six new chemical elements, which carry the atomic numbers 107 to 112. GSI has already named the officially recognized elements 107 to 111: element 107 is called bohrium, element 108 hassium, element 109 meitnerium, element 110 darmstadtium and element 111 is named roentgenium.

LHC NEWS

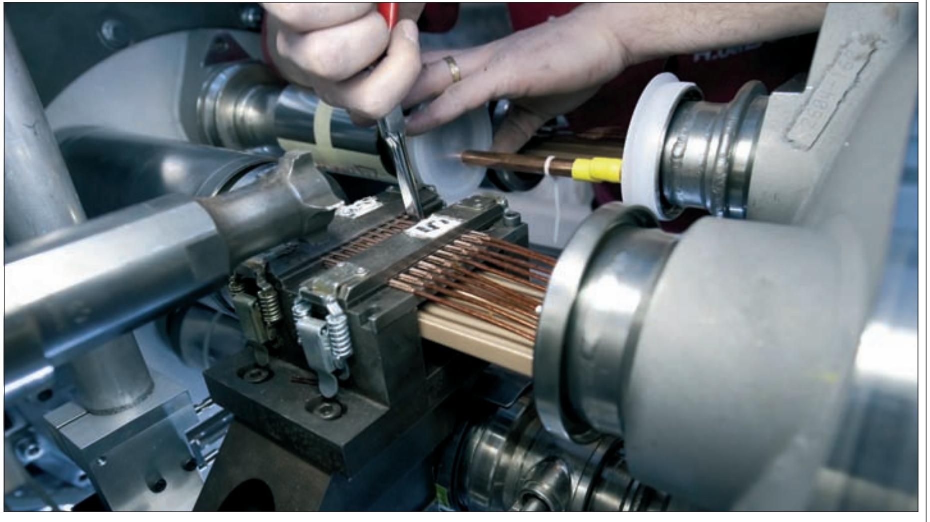
LHC restart remains on schedule

At the 151st session of the CERN Council on 19 June, director-general Rolf Heuer confirmed that the LHC remains on schedule for a restart this autumn, albeit about 2–3 weeks later than originally foreseen. Following the incident of 19 September 2008 that brought the LHC to a standstill, a great deal of work has been done to understand the causes of the incident and to ensure that a similar incident cannot happen again.

The root cause of the September incident was a faulty splice in the high-current superconducting cable between two magnets in LHC sector 3-4. New non-invasive techniques have been developed to investigate the splices, of which there are some 10 000 around the LHC ring, and to determine whether they are safe for running or whether they need to be repaired. As part of this process one more sector of the LHC, sector 4-5, is currently being warmed up. This will bring increased confidence that the splices are fully understood.

Sector 4-5 has been measured at a temperature of 80 K, indicating at least one suspect splice. By warming the sector, the results of this measurement can be checked at room temperature, thereby confirming the reliability of testing at 80 K. If the 80 K measurements are confirmed then any suspect splices in this sector will be repaired. More importantly, validation of the 80 K measurements will allow the splice resistance in the last three sectors to be measured at this temperature – thereby avoiding the time needed for re-warming. The measurements in these sectors will provide the information needed to determine the start-up date and initial operating energy of the LHC in the range 4–5 TeV. Running at 4 TeV should be possible without further repairs, whereas 5 TeV could require extra work to be done.

A key part of the modifications being made to the LHC is the quench-protection system (QPS), which triggers evacuation of the stored magnetic energy quickly and safely should a part of the LHC's superconducting system warm up slightly and cease to be superconducting. Following the September incident, a new enhanced QPS system was designed and is now under construction. The new system will be fully tested and operational in late summer 2009 and will protect the LHC from incidents similar to that of last September.



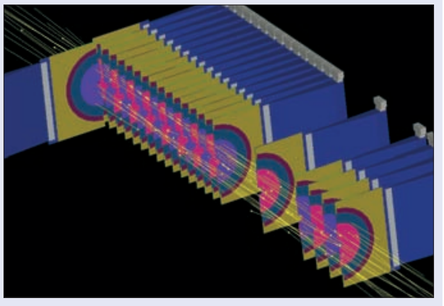
One of the many electrical interconnections on the LHC under repair.

Work on the new QPS is just one aspect of the work in the LHC tunnel being carried out by teams from CERN, who are supported by scientists from other particle-physics laboratories around the world. New pressure-relief valves are being installed, the ultrahigh-vacuum system is being improved and the systems anchoring the LHC magnets to the floor are being strengthened. All of this contributes to preparing the machine for a long and safe operational lifetime.

"We've received an unprecedented level of support from physics labs and institutes around the world through the manpower that they have provided to help us through the repairs and consolidation, as well as the invaluable advice we've received from the external committees that have studied the measures we're taking," Heuer explained. "It's a sign of the increasingly global nature of particle physics and we're extremely grateful for the solidarity we're seeing."

● CERN publishes regular updates on the LHC in its internal *Bulletin*, available at www.cern.ch/bulletin, as well as via Twitter (www.twitter.com/cern) and YouTube (www.youtube.com/cern). Further details of the 151st session of the CERN Council are available at http://council.web.cern.ch/council/en/Governance/NewsGovJune09.html.

Knocking on the door again



The LHC's anti-clockwise beam transfer system was tested on 6 and 7 June. Particle bunches were sent from the SPS through the 2.8 km transfer line towards the LHC where it intersects just before the LHCb cavern. The beam went down the transfer line and stopped just before reaching the LHC tunnel, where a beam stopper – 4 m of graphite – is physically placed in the beam line to prevent the beam from taking the last step into the LHC. Part of the LHCb detector was turned on during the beam test, allowing the reconstruction of tracks through the Vertex Locator.

NUCLEAR PHYSICS

GSI reveals new magic numbers in nuclei

In two recent experiments at the accelerator facility at GSI Darmstadt, groups led by Reiner Krücken of the Technical University Munich and Rituparna Kanungo of St Mary's University, Halifax, in collaboration with international teams, revealed further evidence for new magic shell closures at the limit of nuclear existence in the neutron-rich isotopes ^{24}O and ^{54}Ca.

The shell structure of atomic nuclei with its magic numbers (2, 8, 20, 28, 50, 82, 126) for protons and neutrons corresponding to an enhanced binding is a cornerstone in understanding the structure and dynamics of nuclei. The explanation of the magic numbers in 1949 as a result of the strong spin-orbit interaction was awarded the Nobel Prize in 1963 (*CERN Courier* October 2007 p10). Until recently these magic numbers were assumed to remain universal across the whole nuclear chart, but mounting experimental evidence and theoretical predictions indicate that the shell gaps associated with the numbers are not universal. Instead they can change locally under the influence of variations in the effective interaction of the nucleons in the nucleus. Such changes in the shell structure can have dramatic effects on the production of elements in stellar explosions.

The experiments used precise momentum measurements to study the dynamics of reactions where a single neutron is knocked out from a neutron-rich nucleus. The results provide crucial information about the energies and occupation of the neutron single-particle orbitals in the respective nuclei. In the experiment with ^{24}O (8 protons and 16 neutrons), the measurements revealed the spherical nature of the shell closure for the 16 neutrons, thus establishing ^{24}O as a doubly magic nucleus, with a new magic number of 16 (R Kanungo *et al.* 2009). The second experiment studied one-neutron knockout in ^{56}Ti (22 protons and 34 neutrons). It confirmed that shell-model calculations predicting a new shell closure in ^{54}Ca (20 protons and 34 neutrons) correctly describe the single-particle structure in the neighbouring nucleus ^{55}Ti (P Maierbeck *et al.* 2009).

The experiments were highly challenging because ^{24}O and ^{56}Ti form unstable radioactive beams, which can only be produced with a yield of a few particles a second, compared with the 10^9 ions a second that is typical of experiments with stable nuclei. The results also demonstrate the capability of the fragment separator, FRS, at GSI for high-precision momentum measurement with such extremely rare isotopes. This capability will be developed further in the near future at the Facility for Antiproton and Ion Research in Darmstadt.

Further reading

R Kanungo *et al.*2009 *Phys. Rev. Letts.* **102** 152501.
P Maierbeck *et al.* 2009 *Phys. Letts. B* **675** 22.

COMPUTING

CERN openlab enters phase three

On 2–3 April CERN's director-general, Rolf Heuer, officially launched the third phase of the CERN openlab at the 2009 annual meeting of the CERN openlab Board of Sponsors. During his introductory speech Heuer stressed the importance of collaborating with industry and building closer relationships with other key institutes, as well as the European Commission. The board meeting provided an opportunity for partner companies (HP, Intel, Oracle and Siemens), a contributor (EDS, an HP company) and CERN to present the key achievements obtained during openlab-II and the expectations for openlab-III.

Each phase of CERN openlab corresponds to a three-year period. In openlab-I (2003–2005) the focus was on the development of an advanced prototype called opencluster (*CERN Courier* October 2003 p31). CERN openlab-II (2006–2008) addressed a range of domains from platforms, databases and the Grid to security and networking, with HP, Intel and Oracle as partners and EDS, an HP company, as a contributor (*CERN Courier* June 2006 p18). Disseminating the expertise and knowledge has also been a key focus of openlab. Regular training sessions have taken place and activities include openlab contributions to the CERN School of Computing and the CERN openlab Summer Student Programme, with its specialized lectures.

With the start of the third phase of CERN openlab, new projects have already been initiated with the partners. These are structured into four Competence Centres (CC): Automation and Controls CC; Database CC; Networking CC; and Platform CC. Through the Automation and Controls CC, CERN, Siemens and ETM Professional Control (a subsidiary of Siemens) are collaborating on security, as well as the move of automation tools towards software engineering and handling of large environments. In partnership with Oracle, the Database CC focuses on items such as data distribution and replication, monitoring and infrastructure management, highly available database services and application design, as well as automatic failover and standby databases.

One focus of the Networking CC is a research project launched by CERN and HP

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

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

ProCurve to understand the behaviour of large computer networks (with 10 000 nodes or more) in high-performance computing or large campus installations. Another activity involves the grid-monitoring and messaging projects carried out in collaboration with EDS, an HP company. The Platform CC project focuses on PC-based computing hardware and the related software. In collaboration with Intel it addresses important fields such as thermal optimization, application tuning and benchmarking. It also has a strong emphasis on teaching. During the third phase, the team will not only capitalize on and extend the successful work carried out in openlab-II, but it will also tackle crucial new areas. Additional team members have recently joined and the structure is now in place to collaborate and work on bringing these projects to fruition.

The openlab team consists of three complementary groups of people: the young engineers hired by CERN and funded by the partners (21 people over the past eight years); technical experts from partner companies involved in the openlab projects; and CERN management and technical experts working partly or fully on the joint activities. The people involved are not concentrated in a single group at CERN. They span many different units in the IT department, as well as the Industrial Controls and Electronics Group in the engineering department, since the arrival of Siemens as an openlab partner.

CERN openlab

The distributed team structure permits close collaboration with computing experts in the LHC experiments, as well as with engineers and scientists from the various openlab partners who contribute greatly to these activities. In addition, significant contributions are made by the students participating in the CERN openlab Summer Student Programme, both directly to the openlab activities and more widely to the Worldwide LHC Computing Grid, the Enabling Grids for E-sciencE project and other Grid- and CERN-related activities in the IT Department. Since the inception of openlab, more than 100 young computer scientists have participated in the programme, where they spend two months at CERN. This summer the programme will be welcoming 14 students of 11 different nationalities.

● The activities carried out from May 2008 to May 2009 are presented in the eighth CERN openlab annual report available from the CERN openlab website at www.cern.ch/openlab.

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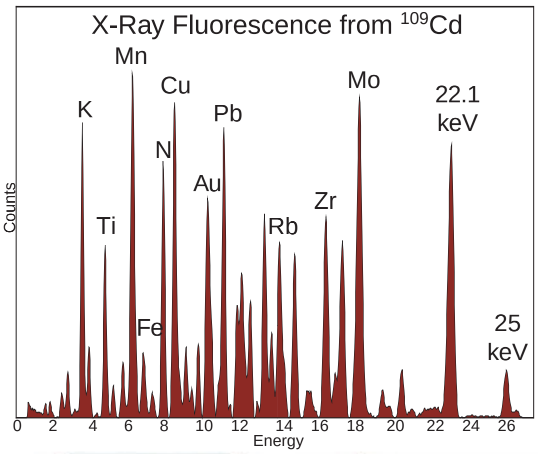

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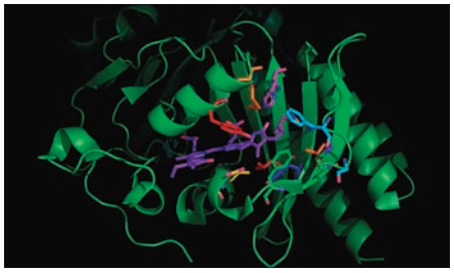
SCIENCEWATCH

Compiled by John Swain, Northeastern University

Fluorescent bacterial protein glows in the infrared range

Last year Roger Tsien of the University of California in San Diego shared the Nobel Prize in Chemistry with Osamu Shimomura and Martin Chalfie for their discovery of the famous green fluorescent protein, now widely used as a biological marker. A little lateral thinking suggests that infrared would offer much better penetration in living things owing to the reduced scattering compared with visible light. This is precisely what lies behind the latest discovery by Tsien and his team, who have engineered the first fluorescent protein to absorb and emit in the infrared.

Xiaokun Shu was able to coerce infrared fluorescence in a phytochrome – a receptor sensitive to light at the red end of the spectrum – from the bacterium *Deinococcus radiodurans*, which is best known for its extremely high tolerance to radiation. The work holds promise for imaging of small animals, but for humans, who are larger and more opaque, Tsien's team is working on different techniques.



The structure of the original phytochrome. (Courtesy Xiaokun Shu, University of California.)

Further reading

Xiaokun Shu *et al.* 2009 *Science* **324** 804.

Ultrasound could combat algal blooms

When algae have a huge growth burst or "bloom" they can cause enormous damage to local ecologies. In some cases, such as the infamous red tides involving neurotoxic algae that affect things people eat, the blooms can be deadly. Now Michiel Postema and colleagues at the University of Hull have found a simple way to single out and kill the algae.

Strands of algae keep afloat through the aid of little nitrogen-filled "buoyancy" cells. Postema and colleagues decided to see if ultrasound could rupture the membranes of these cells, causing them to sink and die. Their tests, with the blue-green algae *Anabaena sphaerica*, showed that the algae sank under the application of ultrasound frequencies normally used in medical diagnostics. One advantage of this process is that standard plant cells, not filled with air, are unaffected.

Further reading

Spiros Kotopoulisa, Antje Schommartza and Michiel Postema 2009 *Applied Acoustics*, in press; online at doi:10.1016/j.apacoust.2009.02.003.

Nanotubes hold hope of long memories

While a great deal of effort goes into increasing storage density, a question much less often addressed is that of how stably data can be stored. Alex Zettl of the University of California, Berkeley, and colleagues may have found a neat way to handle both with a simple nanomechanical device memory.

They have discovered that a tiny iron particle in a carbon nanotube can be shuttled back and forth electrically to represent a one or a zero – its location being detected by a resistance measurement. Bundles could store up to a terabit per square inch, with a thermodynamic stability of more than a 1000 million years.

Further reading

G E Begtrup *et al.* 2009 *Nano Letters*; doi:10.1021/nl803800c.

New technique beats diffraction effects in photolithography

Conventional wisdom would have it that diffraction effects will not allow photolithography with features smaller than a quarter of the wavelength of whatever light is used. However, a new trick allows you to go a factor of five better.

John Fourkas of the University of Maryland and colleagues used multiphoton emission from one 800 nm laser pulse to initiate cross-linking in a polymer, following it with a carefully phased second pulse to de-excite molecules by stimulated emission. Done correctly, this leaves an excited region much smaller than the wavelength of the light that is being used.

Further reading

Linje Li *et al.* 2009 *Science* **324** 910.

Graphene displays exotic Landau levels

Graphene – a single atom-thick layer of graphite – is an amazing laboratory for studying what would usually be thought of as relativistic effects. Its charge carriers have velocities that do not depend on their energies, rather like photons, which always move at the velocity of light. If you think of the carriers as massless, charged fermions in two dimensions and you work out the well known Landau levels that occur in a magnetic field, theory predicts something quite different from the usual states observed for massive electrons.

Phillip First and colleagues at the Georgia Institute of Technology, Atlanta, and the National Institute of Standards and Technology have managed to measure these Landau levels. They have found the predicted unequal energy levels, including a zero energy state, where the material has no electrical carriers until a magnetic field has been applied.

Further reading

D L Miller 2009 *Science* **324** 924.

Compiled by Marc Türler, ISDC and Observatory of Geneva University

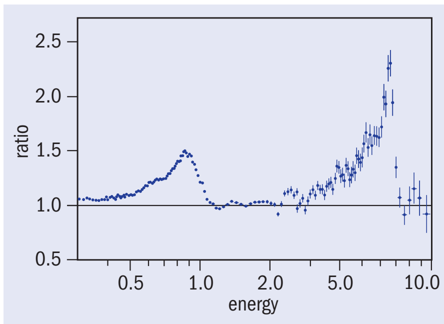
XMM-Newton observes emission from matter around a black hole

A recent observation by the XMM-Newton satellite revealed two prominent emission lines in the X-ray spectrum of the Seyfert galaxy 1H 0707-495. These lines are attributed to iron fluorescence and appear skewed towards lower energies as expected from relativistic effects in the close vicinity of a black hole. This is the strongest evidence yet for matter swirling just outside the event horizon of a super-massive black hole.

Seyfert galaxies are the less luminous analogues of quasars. They are named after Carl Seyfert, who in 1943 published the properties of 12 galaxies with peculiar optical emission lines emanating from the nucleus. These lines are now known to be emitted by atoms in gas clouds located light-weeks away from super-massive black holes.

Another emission line, this time in X-rays, has fascinated astronomers for more than a decade. Emitted at an energy of 6.4–7.0 keV, it arises from the fluorescent de-excitation of K-shell electrons in iron atoms. Excitement arose in 1995 when the Japanese Advanced Satellite for Cosmology and Astrophysics observed such a line strongly skewed towards lower energies. This was consistent with the relativistic distortion expected for matter orbiting a black hole.

With the potential to probe the inner-most stable orbit around a black hole, the precise characterization of the iron K line was an important scientific justification for ESA's XMM-Newton satellite launched in December 1999 (*CERN Courier* September 2000 p17). The superior spectral resolution of this mission enabled the identification of a rapidly spinning black hole in the galactic source XTE J1650-500 based on the shape of the iron K line (*CERN Courier* November 2003 p13). But the detailed XMM-Newton spectra also brought some confusion to the field with several studies showing evidence that the observations in some Seyfert galaxies can be interpreted without invoking a relativistically broadened iron line. The detection of similarly looking iron lines around neutron stars and even white dwarfs is also puzzling the community.



Ratio of the spectrum of the Seyfert galaxy 1H 0707-495 observed by XMM-Newton and a simple model for the continuum emission. The prominent lines of iron K and L emission are clearly detected above 2 keV and below 1 keV, respectively. They are skewed towards lower energies owing to relativistic effects in the vicinity of the black hole. (Courtesy A Fabian.)

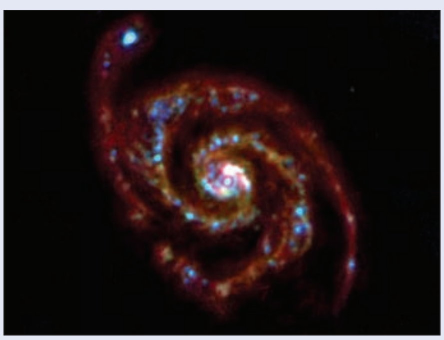
Is the relativistic broadening scenario a misinterpretation of the data?

The latest, extremely accurate observations by XMM-Newton of the Seyfert galaxy 1H 0707-495, published by Andy Fabian from the Cambridge Institute of Astronomy and collaborators, give renewed and unprecedented evidence for the relativistic interpretation. Besides the usual iron K line, for the first time they detect a second line attributed to iron L-shell transitions at an energy just below 1 keV. Both lines are so strongly distorted towards lower energies that they imply a black hole spinning at an almost maximum rate. A measured delay of about 30 s in the variations of the iron L line with respect to the continuum emission gives additional evidence for the relativistic scenario. The two iron lines would thus originate from the illumination of the inner accretion disk about one gravitational radius away from the horizon of the black hole by an X-ray continuum source located a little further out.

Further reading

A C Fabian *et al.* 2009 *Nature* **459** 540.

Picture of the month



This far-infrared view of the spiral galaxy Messier 51 is the first image taken by the Herschel space observatory. This spacecraft, equipped with a 3.5 m mirror – the largest ever sent into space – was launched together with the Planck mission on 14 May (p6). In its final orbit at a distance of 1.5 million km from the Earth in the opposite direction to the Sun, Herschel will be in an ideal location for observing the infrared and sub-millimetre sky, undisturbed by the radiation from the Sun, Earth and Moon. While the commissioning and performance verification of the two missions continue, this image of the "whirlpool galaxy" by the Photoconductor Array Camera and Spectrometer (PACS) instrument on Herschel already demonstrates the observatory's unique capabilities. It is a composition of images taken in three far-infrared bands at 70, 100 and 160 μm shown in blue, green and red, respectively. (Courtesy ESA and the PACS Consortium.)

CERN COURIER ARCHIVE: 1966

A look back to *CERN Courier* vol. 6, August 1966, compiled by Peggie Rimmer

NEWS FROM CERN

What's on at the synchrocyclotron

The 600 MeV synchrocyclotron SC began operation again on 11 July, only a few hours behind schedule after a shutdown lasting from 8 May, with an experimental programme covering nuclear structure and weak interactions.

Nuclear structure

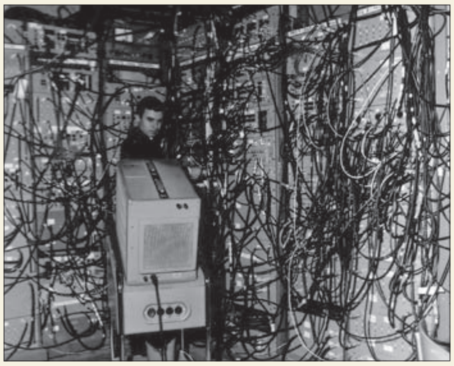
A team led by G Charpak is using a positive pion beam onto targets of light nuclei to study $\pi^+ + N \rightarrow 2p + N$ interactions. If a proton and neutron form a quasi-deuteron within the nucleus, the pion can interact with this and the two emerging protons will have a unique combined energy for a particular angle. Therefore sharp peaks in the combined energy distribution give information about nucleon groupings. The experiment employs counters and digitized spark chambers.

A second team, led by C Cernigoi, is starting a related experiment using a negative pion beam where an analogous interaction produces two emerging neutrons.

Before the shutdown, a team led by G Backenstoss started a series of measurements on pi-mesic X-rays by stopping a negative pion beam in a target. Normal X-rays are emitted when electrons orbiting a nucleus fall to lower energy levels. Pions and muons yield X-rays under similar conditions. Present-day pion intensities and means of analysis, particularly the invention of the lithium-drifted germanium detector with its high-energy resolution, make it possible to improve substantially existing information.

A further experiment on the same topic is being carried out by a team led by S Nilsson, using a crystal spectrometer designed to achieve very high accuracy. They hope to improve on the accepted "best value" of the pion mass given by a recent pi-mesic X-ray experiment at Berkeley, USA.

A special beam – called the MSS beam, after its designers R Meunier, N Spighel and J P Stroot – has been set up to give pions of very well defined momentum (± 1 MeV in 200 MeV). It will be used to bombard various nuclei to investigate pion excitation of nuclear-energy levels by measuring the energy spectra of the scattered pions.



The familiar bird's nest of wires associated with electronic-counter experiments at particle accelerators. This equipment is being used at the SC in the experiment observing the capture of muons in very pure gaseous hydrogen.

A similar motivation is behind a series of experiments by a team from Oxford University led by N W Tanner. They also use a pion beam but instead of looking at the energy spectra of scattered pions, they stop the bombardment and look at the β or γ rays emitted as an excited nucleus decays to a lower energy level.

Weak interactions

Perhaps the most difficult experiment ever to be attempted at the SC is being carried out by a CERN/Bologna University collaboration led by E Zavattini. Their aim is to re-examine the weak interaction $\mu^- + p \rightarrow n + \nu_\mu$ where the μ^- is bound in a μp atom of total spin zero. The experiment uses a target of very pure gaseous hydrogen at eight atmospheres pressure and a very clean muon beam from the SC.

The complications are many. Firstly, the interaction happens only 1 in 1000 as frequently as muon decay producing an electron. Secondly, "muon capture" increases as the fourth power of atomic number, so the slightest trace of heavier-element impurity in the hydrogen tends to hide the wanted interaction. Thirdly, when the muon is captured by a proton it can form a μp atom, which diffuses through the gas like a neutron and simulate a capture event if it hits the wall of the target vessel.

● Compiled from the article on pp156–157.

At the muon storage ring is the team carrying out the new "g-2" experiment on the anomalous magnetic moment of the muon. Left to right: S van der Meer, F J M Farley, M Giesch, R Brown, J Bailey, E Picasso and H Jöstlein. One other contributor, not with the group, is M Tannenbaum.

● *From the article on the muon "Whoever ordered that?" on pp152–155.*

COMPILER'S NOTE

The 600 MeV synchrocyclotron (SC), CERN's first accelerator, started operation in 1957. By 1964, experiments there were concentrating on nuclear physics, leaving particle physics to the newer, higher-energy 28 GeV PS. The SC provided a fertile test-bed for innovations in detector technology and saw some of the first attempts at on-line data acquisition, using newly available – though barely affordable – mini-computers. (I confess to a lingering affection for the SC, having been a member of the Tanner Group.)

With the discovery of the "unwanted" muon, quantum electrodynamics predicted that if muons and electrons were identical apart from their masses, then their magnetic moments, g, should each be a little larger than 2. Between 1959 and 1979 a series of experiments at CERN, measuring the excess g-2, confirmed this prediction to an impressive precision of 0.0007%. The enigmatic muon, initially a candidate to be Yukawa's pion, was indeed a heavy electron; but the origin of the mass difference, a factor of 200, is still not understood.

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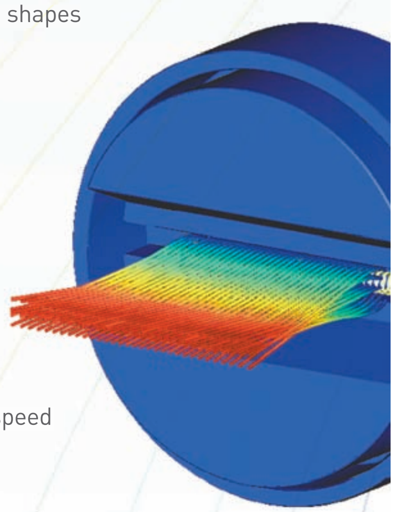

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Those were the days: discovering the gluon

Thirty years after the discovery of the gluon, **John Ellis** gives a personal account of how theorists and experimentalist friends worked together to find the second gauge boson.

In the mid-1970s quantum chromodynamics (QCD) was generally referred to as the "candidate" theory of the strong interactions. It was known to be asymptotically free and was the only plausible field-theoretical framework for accommodating the (approximate) scaling seen in deep-inelastic scattering, as well as having some qualitative success in fitting the emerging pattern of scaling violations. Moreover, QCD could be used to explain qualitatively the emerging spectrum of charmonia and had some semi-quantitative successes in calculating their decays. No theorist seriously doubted the existence of the gluon but direct proof of its existence, a "smoking gluon", remained elusive.

"...the simplest experimental situation to search directly for the gluon would be through production via bremsstrahlung in electron–positron annihilation..."

In parallel, jet physics was an emerging topic. Statistical evidence was found for two-jet events in low-energy electron–positron annihilation into hadrons at SPEAR at SLAC, but large transverse-momentum jets had not yet been observed at the Intersecting Storage Rings, CERN's pioneering proton–proton collider. There, it was known that the transverse-momentum spectrum of individual hadron production had a tail above the exponential fall-off seen in earlier experiments, but the shape of the spectrum did not agree with naive predictions that were based on the hard scattering of quarks and gluons, so rival theories – such as the constituent-interchange model – were touted.

The three-jet idea

This was the context in 1976 when I was walking back over the bridge from the CERN cafeteria to my office one day. As I turned the corner by the library, it occurred to me that the simplest experimental situation to search directly for the gluon would be through production via bremsstrahlung in electron–positron annihilation. Two higher-energy collider projects were in preparation at the time, PETRA at DESY and PEP at SLAC, and I thought that they should have sufficient energy to observe clear-cut three-jet events. My theoretical friends Graham Ross, Mary Gaillard and I then proceeded to calculate the gluon bremsstrahlung process in QCD, demonstrating how it would manifest itself via jet broadening and the appearance of three-jet events featuring the long-sought "smoking gluon". We also contrasted the predictions of QCD with a hypothetical theory based on scalar gluons.

I was already in contact with experimentalists at DESY, particularly my friend the late Bjørn Wiik, who shared my enthusiasm about the three-jet idea. Soon after Mary, Graham and I had published our paper, I made a trip to DESY to give a seminar about it. The reception from the DESY theorists of that time was one of scepticism, even hostility, and I faced fierce questioning on why the short-distance structure of QCD should survive the hadronization process. My reply was that hadronization was expected to be a soft process involving small exchanges of momenta and that two-jet events had already been seen at SPEAR. At the suggestion of Bjørn Wiik, I also went to Günter Wolf's office to present the three-jet idea: he listened much more politely than the theorists.

The second paper on three-jet events was published in 1977 by Tom Degrand, Jack Ng and Henry Tye, who contrasted the QCD prediction with that of the constituent-interchange model. Then, in 1978, George Sterman and Steve Weinberg published an influential paper showing how jet cross-sections could be defined rigorously in QCD with a careful treatment of infrared and collinear singularities. In our 1976 paper we had contented ourselves with showing that these were unimportant in the three-jet kinematic region of interest to us. Sterman and Weinberg opened the way to a systematic study of variables describing jet broadening and multi-jet events, which generated an avalanche of subsequent theoretical papers. In particular, Alvaro De Rújula, Emmanuel Floratos, Mary Gaillard and I wrote a paper showing how "antenna patterns" of gluon radiation could be calculated in QCD and used to extract statistical evidence for gluon radiation, even if individual three-jet events could not be distinguished.

Meanwhile, the PETRA collider was being readied for high-energy data-taking with its four detectors, TASSO, JADE, PLUTO and Mark J. I maintained regular contact with Bjørn Wiik, one of the leaders ▷

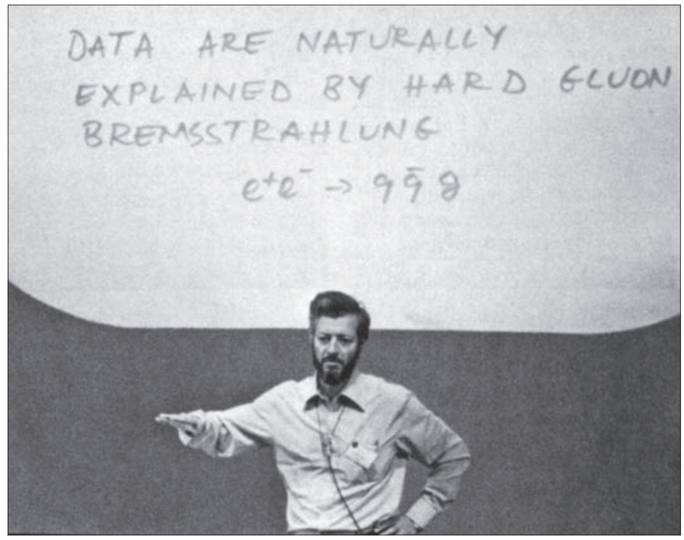
of the TASSO collaboration, as he came frequently to CERN around that time for various committee meetings. I was working with him to advocate the physics of electron–proton colliders. He told me that Sau Lan Wu had joined the TASSO experiment and that he had proposed that she prepare a three-jet analysis for the collaboration. She and Gus Zobernig wrote a paper describing an algorithm for distinguishing three-jet events, which appeared in early 1979.

Proof at last

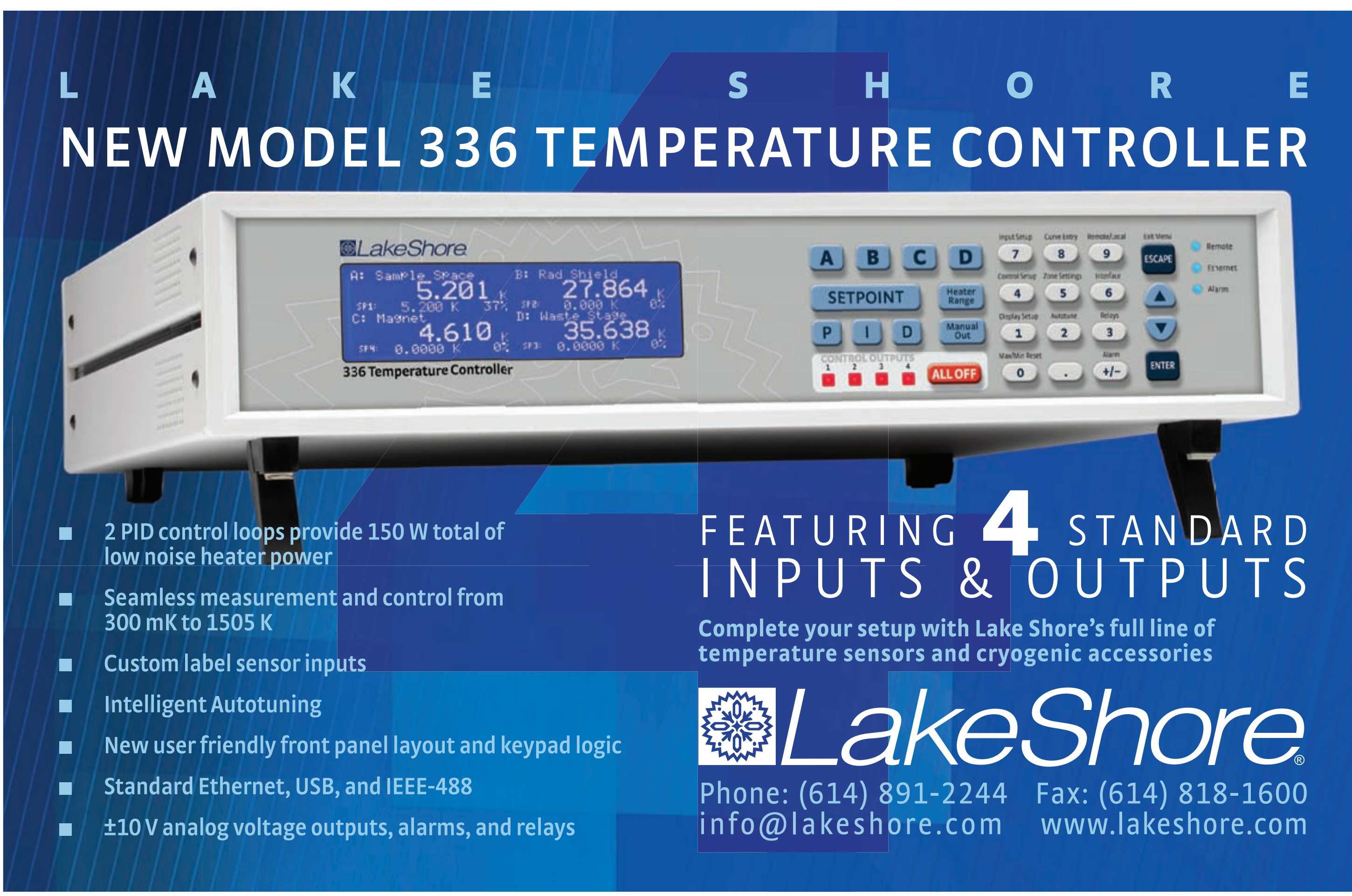
During the second half of 1978 and the first half of 1979, the machine crews at DESY were systematically increasing the collision energy of PETRA. The first three-jet news came in June 1979 at the time of a neutrino conference in Bergen. The weekend before that meeting I was staying with Bjørn Wiik at his father's house beside a fjord, when Sau Lan Wu arrived over the hills bearing printouts of the first three-jet event. Bjørn included the event in his talk at the conference and I also mentioned it in mine. I remember Don Perkins asking me whether one event was enough to prove the existence of the gluon: my tongue-in-cheek response was that it was difficult to believe in eight gluons on the strength of a single event!

The next outing for three-jet events was at the European Physical Society conference in Geneva in July. Three members of the TASSO collaboration, Roger Cashmore, Paul Söding and Günter Wolf, spoke at the meeting and presented several clear three-jet events. The hunt for gluons was looking good!

The public announcement of the gluon discovery came at the Lepton/Photon Symposium held at Fermilab in August 1979. All four PETRA experiments showed evidence: Sam Ting's Mark J collaboration presented an analysis of antenna patterns; while JADE and PLUTO followed TASSO in presenting evidence for jet broadening and three-jet events. One three-jet event was presented at a press conference and a journalist asked which jet was the gluon. He was told



Günther Wolf presents his evidence on gluon emission in high-energy electron–positron annihilations at the Lepton/Photon Symposium.



From the archives

With PETRA running at total energies of around 30 GeV, the latest results on the jet analysis of hadron production in high-energy electron–positron annihilations were eagerly awaited at the Fermilab Lepton/Photon Symposium.

The big question was the existence of the sixth quark, but none of the four groups taking data at PETRA produced any evidence for a new quark-production threshold, either from the hadronic production rate or from the topology of the observed events.

However, jet analysis by the JADE, Mark-J, TASSO and PLUTO teams now confirms preliminary evidence presented at the Geneva conference in June.

At 13 and 17 GeV-collision energies, the two-jet structure seen at lower energies is reproduced, indicating a quark and an antiquark emitted in opposite directions, producing back-to-back hadron fragments. At 30 GeV, another process becomes visible as one or other of the emitted quarks probably radiates a gluon (bremsstrahlung), which also fragments into hadrons.

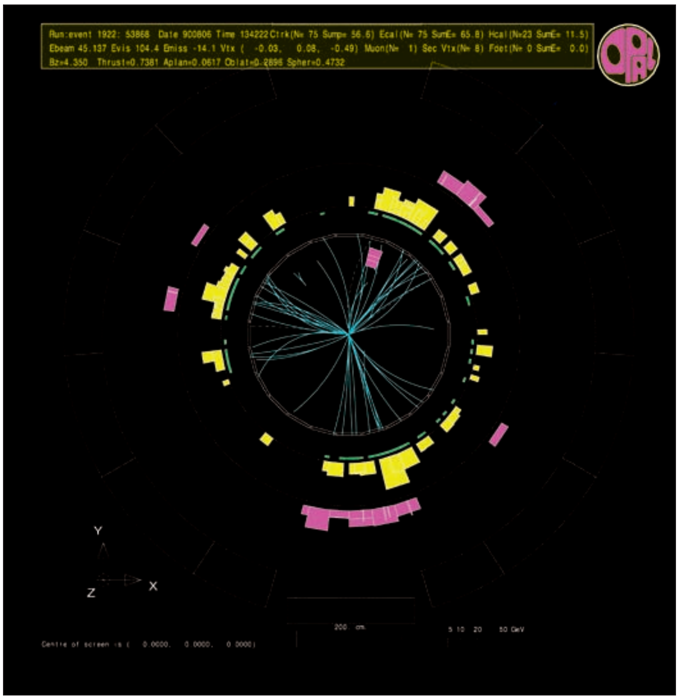
● *CERN Courier* October 1979 p307 (extract).

that the smart money was on the left-hand one (or was it the right?). Refereed publications by the four collaborations soon appeared and the gluon finally joined the Pantheon of established particles as the first gauge boson to be discovered after the photon.

An important question remained: was the gluon a vector particle, as predicted by QCD, or was it a scalar boson? In 1978 my friend Inga Karliner and I wrote a paper that proposed a method for distinguishing the two possibilities, based on our intuition about the nature of gluon bremsstrahlung. This was used in 1980 by the TASSO collaboration to prove that the gluon was indeed a vector particle, a result that was confirmed by the other experiments at PETRA in various ways.

Gluon-jet studies have developed into a precision technique for testing QCD. One-loop corrections to three-jet cross-sections were calculated by Keith Ellis, Douglas Ross and Tony Terrano in 1980 and used, particularly by the LEP collaborations, to measure the strong coupling and its running with energy. The latter also used four-jet events to verify the QCD predictions for the three-gluon coupling, a crucial consequence of the non-Abelian nature of QCD.

In the words of Mary Hopkin's song in 1968, "those were the days, my friends". A small group of theoretical friends saw how to discover the gluon and promptly shared the idea with some experimental friends, who then seized the opportunity and the rest – as the saying goes – is history. To my mind, it is a textbook example of how theorists and experimentalists, working together, can advance knowledge. The LHC experiments will be a less intimate environment but let us hope that strong interactions between theorists and experimentalists will again lead to discoveries for the textbooks!



Gluon-jet studies developed into a precision technique for testing QCD at LEP. In this event from the OPAL experiment, the most energetic jet (going to the bottom of the picture) is likely to be the quark that didn't radiate a gluon. The jet moving towards the top right can be identified as a b-quark jet, because an energetic muon (red arrow) was produced in the decay of the b-hadron. This leaves the third jet as the gluon jet and permits the comparison of the properties of quark and gluon jets – an important test of QCD. (Courtesy OPAL Collaboration.)

Résumé

Au temps où l'on découvrait le gluon

Au milieu des années 1970, alors que tous les théoriciens admettaient l'existence du gluon, on n'en n'avait aucune preuve directe. Dans cet article, John Ellis raconte comment quelques amis, théoriciens et expérimentateurs, ont travaillé ensemble pour débusquer cette particule. L'idée était de s'efforcer d'obtenir une production de gluons par bremsstrahlung dans l'annihilation électron–positon, qui révèlerait le gluon par l'apparition d'événements à trois jets. Les expériences menées au collisionneur PETRA à DESY ont commencé à rechercher ce type d'événements en 1978–79. La découverte du gluon a été annoncée publiquement en août 1979, date à laquelle les quatre expériences ont présenté leurs résultats lors d'une conférence au laboratoire Fermi.

John Ellis, *CERN.*

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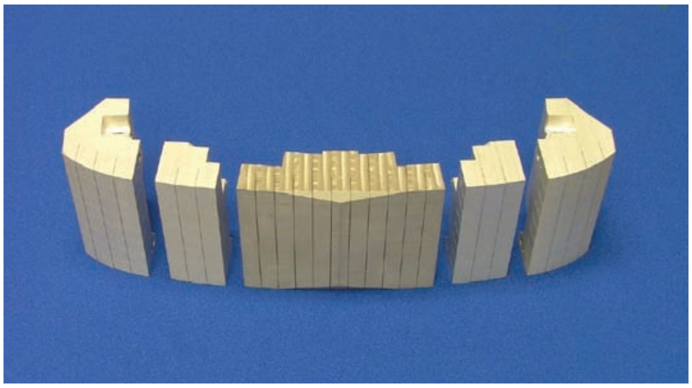

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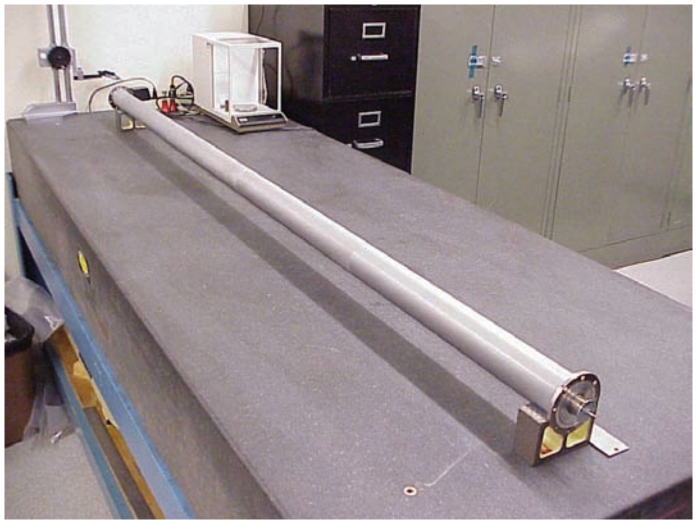

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Giuseppe Cocconi and his love of the cosmos

Friends and colleagues look at aspects of Cocconi's lifelong interest in the cosmos and recent developments in modern physics, revealing a physicist of remarkable perception.

THE UNIVERSE YOURS TO DISCOVER INTERNATIONAL YEAR OF ASTRONOMY 2009

In 1938 Giuseppe Cocconi published his first paper, "On the spectrum of cosmic radiation". His last unpublished note of December 2005 bore the title "Arguments in favour of a personal interpretation of extra galactic cosmic rays". No better indication could be given of his deep interest in astronomy and astrophysics, which lasted until he died in November 2008 aged 94 (*CERN Courier* March 2009 p36).

The fields that he pioneered are now witnessing exciting new developments. Over the past six months they have reminded us of his many contributions to physics; his simple, direct way to conceive and perform experiments; and his unique way of presenting the subjects that he loved. In this article we describe some of these events and recall what Giuseppe contributed to the various fields.

Giuseppe and Vanna Cocconi check cosmic-ray shower detectors. This photograph appeared in an article in the world famous magazine Life *in November 1948. (Courtesy Time & Life Pictures/Getty Images.)*

Ultra-high-energy cosmic rays

Giuseppe's interest in the cosmos began when he was in his teens. He would design sundials for friends' villas around his home town of Como, observe the sky and read as much about it as he could. Late one evening, he happened to observe the fall of some Perseid meteors at an unexpected time. Noting quickly their number and time he transmitted the information to a fellow astronomer – probably the first of his observations to be "published".

He entered the cosmic-ray scene in February 1938 when he was invited to Rome for six months by Edoardo Amaldi and started working with Enrico Fermi on the construction of a cloud chamber to study cosmic radiation. When Giuseppe returned to Milan he continued to pursue his new interest in cosmic rays, in particular extensive air showers, using Geiger counters to detect them. This was to be the focus of his research for the next 22 years.

At the time, Pierre Auger had just begun his intensive investigations of air showers. Today this work is honoured in the name of the Pierre Auger Observatory, which is taking the study of the highest-energy cosmic rays to new levels through the detection of very widespread showers (*CERN Courier* July/August 2006 p12). In 1938, electromagnetic showers were understood; mesotrons (muons) were known, but not their interactions; and pions were yet to be discovered. The existence of multiple-particle showers, spread over many square metres, was known – nothing, however, of their origins and little about their composition.

Giuseppe's work concentrated on the study of the composition of such showers – as a function of their lateral extent, zenith angle, and altitude – in experiments both at sea level and at 2200 m above sea level, at Passo Sella in the Dolomites. Many of these experiments were conducted with Vanna Tongiorgi, who became his wife in 1945. The couple moved to Cornell in 1947 and continued their experiments (some in collaboration with Kenneth Greisen) at Echo Lake on Mt Evans, Colorado, as well as at sea level and at 1600 m water equivalent underground. This vast range of experiments, from 1939 to 1958, contributed considerably to the understanding of cosmic-ray showers: they are produced by the interaction of high-energy nuclei – chiefly protons – with the nuclei of the upper atmosphere.

Even before the discovery of the feature called the "ankle" in the energy spectrum of the primaries in 1960s, Giuseppe realized clearly that the charged primaries with an energy in excess of 10^{19} eV must come from extragalactic sources because their radius of curvature in the galactic magnetic field is of the same order as the size of our galaxy. In a talk at the 5th International Cosmic Ray Conference (ICRC) in Guanajuato, Mexico, in 1955, ▷

he said: "These particles are cosmic, indeed, because even the galaxy seems too small to contain them."

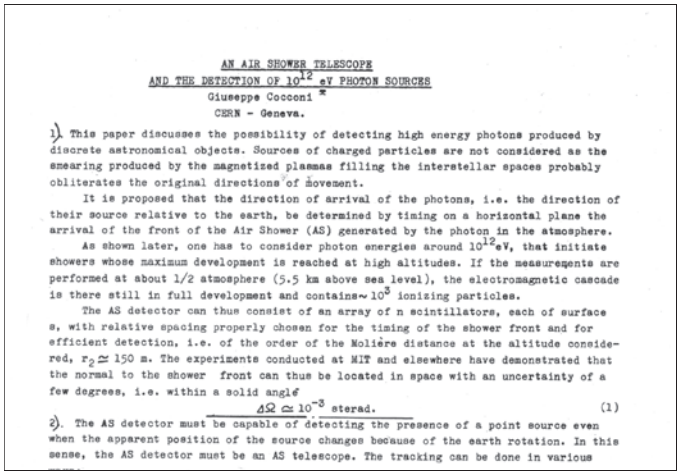
Giuseppe maintained his great interest in the physics of cosmic rays throughout his life. When he was informed that the Pierre Auger Observatory had started to operate in 2002 and had detected high-energy showers, he replied by writing "*Mi ringiovanisci di cinquant'anni rinfrescando i miei primi amori* (You make me 50 years younger by reminding me of my first love)". His first love was, of course, the physics of cosmic rays. Jim Cronin, founder and first spokesperson of the observatory, recalls receiving "a wonderful congratulatory letter following our publication on 28 November 2007", when the collaboration announced the discovery that active galactic nuclei are the most likely candidates for the source of the ultra-high-energy cosmic rays arriving on Earth (*CERN Courier* December 2007 p5). The discovery confirmed Giuseppe's hypothesis from 50 years earlier that the highest-energy component in cosmic rays is of extragalactic origin. The Pierre Auger Observatory was inaugurated a year later, on 14 November 2008, only a few days after he passed away. One of us (GM), a long-time collaborator of Giuseppe, gave a speech as the current spokesperson of the collaboration.

Gamma rays from the cosmos

The vast majority of cosmic-ray showers originate with charged primary particles, mainly protons and nuclei not heavier than iron, but a small fraction arise from the interaction of high-energy gamma rays in the atmosphere. At the 1959 ICRC in Moscow, while on leave at CERN from Cornell, Giuseppe suggested the possibility of detecting cosmic sources of high-energy photons using coincidence techniques to separate unidirectional photons from the isotropic background. He proposed that the Crab Nebula might be a strong source of gamma-rays in the tera-electron-volt range. The paper motivated Aleksandr Chudakov of the Lebedev Institute to build a pioneering gamma-ray telescope in the Crimea, designed to detect the short bursts of Cherenkov light generated in the atmosphere by extensive air showers, which had been first observed by Bill Galbraith and John Jelley at Harwell in the UK in 1953. Finally, in 1989, the Whipple air-Cherenkov telescope in the US detected the Crab Nebula as, indeed, a source of tera-electron-volt gamma rays.

Second-generation imaging air-Cherenkov telescopes (IACTs) – HESS, MAGIC and VERITAS – now cover the northern and southern hemispheres, detecting point-like and extended sources with a typical angular resolution of an arcminute. This means that galactic sources, such as supernova remnants (SNRs), can be imaged with a resolution smaller than their angular extension. A recent result from the HESS telescopes in Namibia on the emission from the nearest active galactic nucleus, Centaurus A, could explain the small cluster of a few events of ultra-high-energy cosmic rays that the Pierre Auger Observatory has observed in this direction.

Giuseppe enjoyed the discovery last year by MAGIC of very high-energy gamma rays from the active nucleus of the 3C279 galaxy (*CERN Courier* June 2009 p20). This quasar is at a distance of roughly half the radius of the universe, which is more than twice the distance of objects previously observed in gamma rays. The MAGIC Collaboration thus concludes that the universe appears more transparent at cosmological distances than previously believed, precluding significant contributions from light other than from sources observed by current optical and infrared telescopes.


AN AIR SHOWER TELESCOPE
AND THE DETECTION OF 10^{12} eV PHOTON SOURCES
Giuseppe Cocconi *
CERN - Geneva.

1). This paper discusses the possibility of detecting high energy photons produced by discrete astronomical objects. Sources of charged particles are not considered as the smearing produced by the magnetized plasmas filling the interstellar spaces probably obliterates the original directions of movement.

It is proposed that the direction of arrival of the photons, i.e. the direction of their source relative to the earth, be determined by timing on a horizontal plane the arrival of the front of the Air Shower (AS) generated by the photon in the atmosphere.

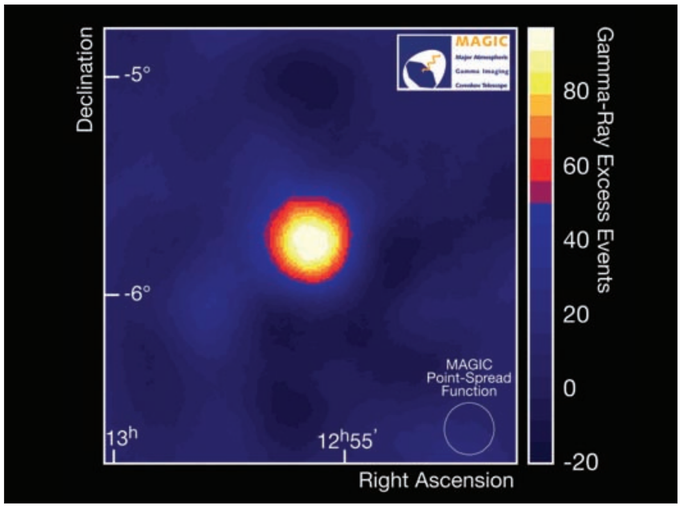
As shown later, one has to consider photon energies around 10^{12}eV, that initiate showers whose maximum development is reached at high altitudes. If the measurements are performed at about 1/2 atmosphere (5.5 km above sea level), the electromagnetic cascade is there still in full development and contains $\sim 10^3$ ionizing particles.

The AS detector can thus consist of an array of n scintillators, each of surface s, with relative spacing properly chosen for the timing of the shower front and for efficient detection, i.e. of the order of the Molière distance at the altitude considered, $r_2 \simeq 150$ m. The experiments conducted at MIT and elsewhere have demonstrated that the normal to the shower front can thus be located in space with an uncertainty of a few degrees, i.e. within a solid angle

$$\Delta\Omega \simeq 10^{-3} \text{ sterad.} \quad (1)$$

2). The AS detector must be capable of detecting the presence of a point source even when the apparent position of the source changes because of the earth rotation. In this sense, the AS detector must be an AS telescope. The tracking can be done in various

The paper Giuseppe presented at the ICRC in Moscow in 1959, which suggested the possibility of detecting gamma-ray sources.



Sky Map of 3C279 in very-high energy gamma-rays by the MAGIC telescope on the Canary Island of La Palma. The active galactic nucleus from which these photons originated is a quasar at a distance of over five billion light-years from the Earth. (Courtesy MAGIC Collaboration.)

The new IACTs are now complementing observations by gamma-ray telescopes in space. Giuseppe was interested in the results from two recent missions: AGILE, launched on 23 April 2007 (*CERN Courier* July/August 2007 p8); and Fermi, launched on 11 June 2008 (*CERN Courier* November 2008 p13). These missions are collecting important data on galactic and extragalactic sources in the energy range 100 MeV–100 GeV and should provide a wealth of information for understanding the sources of particle acceleration. These include gamma-rays bursts (GRBs), which are the highest-energy phenomena occurring in the universe since the Big Bang. It is no surprise that Giuseppe developed a recent interest in GRBs, reinforced by frequent discussions on the subject with Alvaro de Rújula at CERN. In 2008 the Fermi mission detected the most energetic GRB so far observed, GRB 080916C, at a distance of 12.2 thousand million light-years (*CERN Courier* April 2009 p12).

It was his interest in gamma rays that sparked the work for which Giuseppe became most widely known outside particle and astrophysics, after he and Philip Morrison (visiting CERN from Cornell) published a two-page article in *Nature* on "Searching for interstellar communications". Morrison recalled that: "One spring day in 1959, my ingenious friend Giuseppe Cocconi came into my office and posed an unlikely question: would not gamma rays, he asked, be the very medium of communication between stars?" Morrison agreed but suggested that they should consider the entire electromagnetic spectrum. In the resulting paper they argued for searching around the emission frequency at 1420 MHz, corresponding to the 21 cm line of neutral hydrogen. Giuseppe contacted Sir Bernard Lovell at Jodrell Bank in the UK, which had the largest radio telescope at the time, but Lovell was sceptical, and nothing came of the proposal to devote some time towards searching for an extraterrestrial signal. The first radio search for an alien signal was left to others, initially to the Ozma project, which was started independently by Frank Drake in 1959. Later, the Search for Extraterrestrial Intelligence (SETI) became a serious research topic, capturing the public's imagination. Now, anyone with a computer can contribute to the search through SETI@home (*CERN Courier* September 2004 p62).

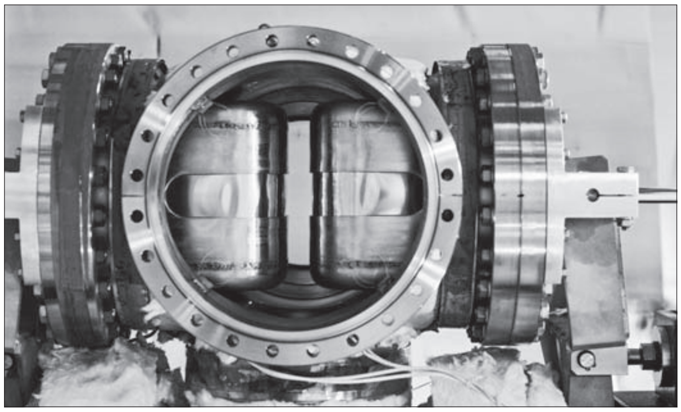
Rising cross-sections

The letter quoted above written to one of us (GM) in 2002 ends as follows: "We do not yet know from where the local cosmic rays are coming. Will I live long enough to know? Move fast and keep me informed ... Meanwhile cross-sections and scatterings continue their quiet life, following the new machine with the square of the logarithm." The last sentence refers, of course, to the LHC and to the proton–proton total cross-section experiments planned by the TOTEM Collaboration. Giuseppe's second main physics interest, after cosmic rays, was proton–proton scattering. This began at CERN at the PS in 1961, continuing at Brookhaven with measurements at the highest momentum transfer so far and, from 1971, at the Intersecting Storage Rings (ISR).

In 1965 Giuseppe proposed with Bert Diddens and Alan Wetherell the use of the first extracted proton beam from the PS to measure elastic and inelastic cross-sections. The first experiment was on proton–proton scattering with large momentum-transfer. A few years earlier the same group had measured the shrinking of the forward elastic peak. This discovery gave an enormous boost to the phenomenology of Regge poles, which was fashionable at the time. The ensuing interpretation of the energy dependence of the total hadron–hadron cross-sections in terms of Pomeron exchange predicted an almost constant value of the cross-section with energy – a high-energy regime called "asymptopia", which seemed to be round the corner and would be characterized by increasing interaction radii and decreasing central opacity.

In 1970 Giuseppe's group joined the Rome ISS group of two of us (UA and GM), who had proposed to the ISR Committee the measurement of elastic-scattering events through the detection of protons scattered only a few millimetres from a circulating-proton current of many amperes. The movable parts that contained the detectors were soon called "Roman pots". Giuseppe very much enjoyed such a small and delicate experiment. He would spend long hours gluing together thin scintillators and measuring the position of the counters in the ISR reference frame with theodolites.

By applying the optical theorem, the CERN–Rome group found that the proton–proton cross-section rises with energy. The results were published together with a paper by the Pisa–Stony Brook collaboration, who had detected the same phenomenon by measuring the total interaction rate. In parallel, the movable pots were used to measure the interference between the Coulomb amplitude and the nuclear amplitude, which was discovered to be positive and rising with energy; a consequence – through dispersion relations – of the fact that the total cross-section continues to rise at collision energies that were not directly attainable at the ISR.



"Roman pots", as used by the CERN–Rome group at the ISR to measure elastic scattering by detecting protons scattered close to the beam line.

The ISR best-fit gave a total proton–proton cross-section that rose as the square of the logarithm of the energy, behaviour that was confirmed by later experiments with Roman pots at the SPS and the Tevatron. It was to this that Giuseppe was referring when he wrote of cross-sections "continuing their quiet life" while waiting for TOTEM. He may have been disappointed that most physicists did not seem to realize the importance of this discovery. In the 1960s, asymptopia dominated; essentially, nobody thought that the cross-sections could rise with energy. Even Vladimir Gribov made the hypothesis that they might be slowly decreasing, despite the observation at Serpukhov that the kaon–proton cross-section was increasing slightly. Some theoreticians – such as Marcel Froissart and André Martin, Nick Khuri and Tom Kinoshita – envisaged, from a purely mathematical point of view, that there could be a rising cross-section and tried to see the consequences. The only serious model was the one proposed by H Cheng and T T Wu in 1968.

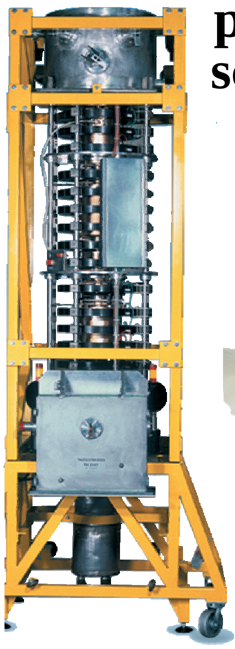
Giuseppe was very interested in seeing what would be found in the new energy range and one of his last topics of conversation was the incident on 19 September that brought the commissioning of the LHC to a halt. He was clearly disappointed because he hoped to see proton–proton collisions at really high energies.

Unity in physics

Whenever he could Giuseppe would use accelerator data to illuminate an open problem in cosmic-ray physics, and vice versa. A typical example is the paper published with one of us (GB) in *Nature* in 1987 in which a relevant limit is put on the neutrino electric charge by calculating the dispersion of the time of flight of the neutrinos produced by SN1987a and detected by Kamiokande. He later applied a similar method to the photon pulses emitted by the millisecond pulsar PSR 1937+21 to get a limit on the photon's electric charge.

His view of a basic unity in physical science, from galaxies to elementary particles, was clear in a series of lectures that he delivered at CERN more than 20 years ago. Following an invitation ▷

THALES with a broadening offer strengthens its partnership with the scientific community




For more than fifty years, Thales has been building a long term partnership with the accelerator community and has been involved in most of the major Particle Physics projects all around the world. With a large offer of high power RF sources and solutions, Thales did participate to the most recent particle accelerators constructions and upgrades. For the LHC program, the majority of the amplifier tubes for the whole injector chain and main ring have been manufactured in Europe.

In addition Thales now offers new solutions like passive devices (RF couplers) for superconducting accelerators and turn key systems. Recently the National Synchrotron Radiation Research Center in Taiwan has awarded Thales, for the supply of two 500MHz / 300kW CW RF transmitters for the new 3GeV synchrotron storage ring.

Maintaining a leading edge development activity, Thales has invested in a new testing facility enabling the commissioning of our RF sources at full performances in a large range of testing configurations (pulsed and CW, up to several MW). This outstanding capability may provide accelerator designers' community with cost effective and safer solutions.

With such design and testing capabilities, Thales remains a key partner for the scientific projects to come in the next decades.

from André Martin, who at the time was chairperson of the Academic Training Committee, Giuseppe gave a course on "Correlations between high-energy physics and cosmology" in 1980. In these lectures he illustrated what he believed, at the time, were the important problems that could strengthen the relations between particle physics and cosmology – the field now known as astroparticle physics. The main themes of the past 20 years were all present: from the analysis of extragalactic emissions (with particular attention to the cosmic microwave background radiation) to the measurements of the deceleration parameter of the cosmic expansion. The series was so successful that the committee invited him to lecture again in 1984, this time on "A new branch of research: Astronomy of the most energetic gamma rays". It, too, was a great success.

In a paper written to celebrate Edoardo Amaldi's 60th birthday, Giuseppe expressed his continuing vision of science: "A common aim of people interested in science is that of improving the comprehension of phenomena that can be observed in the world." Throughout his long life in science he made many contributions to improving this comprehension, through his particular approach to research. Many years after his retirement, he continued to impress younger colleagues at CERN, some of whom would hand him their recent papers for comments and advice, as Massimo Giovannini recalls. "His comments were always sharp and precise ... for Giuseppe one aspect of research was the art of phrasing the complications of a phenomenon in simple numerical terms." This was perhaps best summarized by Nobel laureate Sam Ting in his Nobel prize speech in 1976: "...I went to CERN as a Ford Foundation Fellow. There I had the good fortune to work with Giuseppe Cocconi at the Proton Synchrotron, and I learned a lot of physics from him. He always had a simple way of viewing a complicated problem, did experiments with great care and impressed me deeply."

Further reading

For a list of Giuseppe Cocconi's many publications, see: http://library.web.cern.ch/library/Library/cocconi_biblio.pdf.

● The authors are grateful to Jack Steinberger and André Martin for contributions on Cocconi's cosmic-ray experiments and on the meaning of the discovery of the rising proton–proton cross-section.

Résumé

Giuseppe Cocconi : l'amour du cosmos

Giuseppe Cocconi, qui nous a quittés en 2008 à l'âge de 94 ans, avait connu une longue carrière dans la physique. Il avait notamment travaillé sur les gerbes atmosphériques de rayons cosmiques ainsi que sur les collisions proton–proton à haute énergie aux anneaux de stockage à intersections, au CERN. Les domaines défrichés par Giuseppe connaissent à présent des développements passonnants. Les amis et collègues de Giuseppe Cocconi n'ont pas oublié ses nombreuses contributions à la physique, sa façon simple et directe de concevoir et mener à bien les expériences, et sa façon très spéciale de présenter les sujets qui lui étaient chers. Dans le présent article, ils évoquent son activité et rappellent ses contributions aux différents domaines.

Ugo Amaldi, **Guido Barbiellini**, **Maria Fidecaro** *and* **Giorgio Matthiae**.

1959: the birth of the CERN Courier

When **Roger Anthoine** stepped out of CERN administration's "Norwegian" barrack (now building 553) on 1 May 1959, little did he know that he was entering into an editorial and public relations venture that would still be thriving over half a century later.

The story of *CERN Courier* all began about a year earlier when an advertisement in the Belgian press mentioned that a international research organization based in Geneva was going to start its own periodical. It was intended to be an internal public-relations gesture meant to inform its staff of what was going on within its premises. The organization's acronym, CERN, meant little, to say nothing, to the average reader – this writer included. Nevertheless, some months later he found himself the new member of the organization's diminutive Public Information Office. Here he was endowed with the task of initiating a publication that reflected the high motivation of a staff dedicated towards building and operating a couple of large "atom-smashing" accelerators.

The job was a typical public-relations venture aimed at fewer than 900 souls, which may nowadays seem mild and benign compared with the complexity of today's communication assignments. Still, the task featured several aspects that had to be addressed by a newcomer in a foreign environment. This was to be carried out within an organization that, for all its culture of openness, was far from familiar with disseminating its doings in simple terms.

The first editor, Roger Anthoine, in May 1986 when he retired from CERN.

Questions first

Among the challenges to be resolved, the most prominent was: what support could be expected from management? Fortunately, this proved to be just an academic question because the project was the brainchild of Cornelis Bakker. As director-general, his ideas on the subject were not challenged by his administration.

Then, among the practical problems, one had to secure a budget, which meant coaxing the finance office (FO) into allocating the odd sum. In fact, the amount was small enough that it could not be found recently in the FO's archives. Fortunately the princely figure of SFr 7200 a year has surfaced out of this writer's notes from the time. No need then, to wonder why the inclusion of paying advertisements in an international house publication was also first invented at CERN. This "invention", although not quite as resounding as that of Tim Berners-Lee 30 years later (*CERN Courier* May 2009 p24), certainly helped in the survival of the infant *CERN Courier*. It must be said, however, that the scheme did not prove easy to manage, leading to some controversies about what contents could or could not be accepted. Still, the proof of the idea's soundness was in its longevity and that the model was soon borrowed by other organizations.

The format was a major topic that covered several questions such as title, contents and illustration, language, size, paper weight, periodicity and distribution. Considerations on the publication's title led to some hesitation. The name *CERN Reporter* was initially suggested but finally our one-man, self-appointed committee stumbled on *CERN Courier*, a "*nom de guerre*" that was accepted by the powers that were. It has stuck so far.

Deciding what the contents would include was perhaps the easier part of the production chain to tackle. Indeed, the development phase of CERN, with its two large (for the time) contraptions called accelerators – a 600 MeV synchrocyclotron and the 25 GeV (initially 24.3 GeV at 12 kG) proton synchrotron – was ripe with a myriad of possible stories that were both scientific and mundane. Editorial content that involved policies was routinely submitted to the director-general, ▷

who was always readily available for advising or checking. The approval of "reported" articles was, of course, always obtained from the interviewees themselves. As for illustrations, financial considerations (restricted to between 25% and 30% of the budget) and printing state-of-the-art limited them to black and white.

Another question concerned which language (or languages) to use but the answer was obvious, because English and French were the two official languages of the organization – and still are. Initially, and for many years, two separate editions came out – *Courrier CERN* and *CERN Courier*. A decision by the CERN management in 2005 reduced the French edition of the current *Courier* to an embryo-sized state, thus jeopardizing the interest of a large segment of non-English-speaking staff and workers. Perhaps a bilingual formula could have been chosen to alleviate production costs.

Deciding what format, frequency and circulation should be adopted for the publication proved to be tricky questions, with answers that were, of course, set by costs. However, another factor soon came to light: the time available for editorial production. Indeed, the choice of a monthly versus weekly periodical suddenly became self-evident when, in view of his superior's untimely death, the budding editor found himself responsible not only for his new-born publication but also for most of CERN's other public relations involvements such as visits – be they general or by VIPs – and press contacts. The initial print run of 1000 copies allowed for a distribution to staff, who numbered 886 at the end of 1959. However, the interest generated from outside circles – the press, individuals and other organizations and labs – warranted that circulation quickly rose to 2000 copies by March 1960.

Meanwhile, the choice of a printer had arisen. Who could supply an 8-page, A4-size product printed on machine-finish paper? Three quotes were obtained from local printers and Chérix & Filanosa Cy in Nyon was selected. For distribution it was decided to have the publication sent through external post, primarily to the homes of staff members – with the hope of involving and interesting their respective families, whose influence on staff morale could not be underestimated.

The world premiere

With all of those items mastered, the first issue appeared in mid-August 1959. It was a modest 8-page endeavour but even so it was well received by the "Cernois/Cernites" (yes, we coined the name that early!). Even outsiders responded favourably as witnessed among others by Albert Picot, a Geneva statesman doubling as an inveterate autodidact, and by a British member of CERN Council, H L Verry, who found it "excellent".

Over the years, the advent of the *Weekly Bulletin* in 1965 allowed the *CERN Courier* to switch from being the house publication to a scientific journal. The *Courier* thus became the ambassador of CERN and particle physics to a large community of knowledgeable specialists and inquisitive people. Indeed, the trend had been set when, soon after its inception, a special issue of the *Courier* was devoted entirely to the PS, coming out in time for the machine's inauguration on 5 February 1960.

Today, reflecting on the perspective of the *CERN Courier* after 50 years, it is rewarding to see that the once-straightforward attempt at promoting subnuclear research survived the vagaries of time. Personally, the privilege of having worked at CERN half a century ago makes one proud to have been associated – albeit in a small way – in the building and strengthening of what was, as the then president of council, François de Rose, said, "the greatest venture in international co-operation ever undertaken in the world of science".

The cover of the special issue dedicated to the PS. The January/February issue came out just in time for the inauguration in 1960.

Résumé

1959 : La naissance de Courrier CERN*.*

Lorsque Roger Anthoine arriva au CERN le 1er mai 1959 il ne se voyait pas entamant une aventure éditoriale et de relations publiqes qui allait se perpétuer durant un demi-siécle. Tout cela avait commencé un an auparavant par une annonce publiée en Belgique, indiquant qu'une organisation internationale de recherche basée à Genéve comptait se doter d'un péroidique d'entreprise. Il s'agissait en fait pour le CERN de démarrer une action de relations avec son personnel consistant à l'informer de ce qui se passait dans ses murs. Dans l'article ci-dessus Roger Anthoine décrit les débuts de Courrier CERN *et se souvient des actions qui aboutirent à la parution du premier numéro en août 1959.*

Roger Anthoine.

CERN COURIER ARCHIVES: 1959–2009

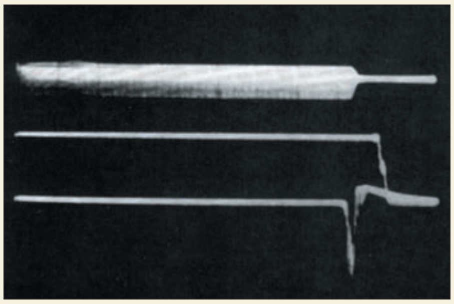
Beam in four months

The most important event that has yet happened at CERN is the subject of the press release issued on 25 November. This news, which came just as the first proofs of this issue were coming off the press, was important enough to warrant rearranging the lay-out.

On July 27th the 100 units forming the magnet of the proton synchrotron were energized for the first time ... On 13 October, after the radio frequency accelerating system had come into operation, events moved fast. On the 15th, an accelerated beam was observed during a few milliseconds. On 22 October the energy reached 400 MeV.

It was 7.40 p.m. on 24 November when the beam was accelerated to approximately 24 GeV, twenty-four thousand million electronvolt, i.e. the maximum energy under normal operating conditions. The acceleration was steady; moreover, 90% of the proton beam trapped by the synchrotron reached maximum energy. According to the physicists, this proportion is surprisingly high.

On the morning of 25 November all of the members of the Proton Synchrotron Division gathered in the main auditorium. John B Adams, under whose leadership CERN's gigantic project has been successfully carried out, gave an account of the operations of the last few days. Expressing his gratitude to all those who, at CERN, had played a part in constructing and bringing the accelerator into operation, he announced: "Nuclear physicists will soon be able to use the machine."



Six year's work led up to this photograph: that of the oscilloscope traces when the first acceleration up to 24 GeV was carried out with the CERN proton synchrotron on 24 November.

Next, Professor C J Bakker, director-general of CERN, said: "Of course, such a machine could only be the result of team work. But the team could not have worked at full pitch without the impetus of a leader: this leadership was provided by J B Adams. It is with the greatest of pleasure that I convey to him and his division the warmest congratulations of the president of the Council."

● November 1959 pp1, 6–7 (extract)

Inauguration of the PS

Prof. J Robert Oppenheimer, director, Institute for Advanced Study, Princeton, speaking on behalf of the American Physical Society and of the National Academy of Sciences: "We wish you a future of new discovery, of increased understanding of nature, as a bright example of that co-operation which is required of us, for our survival and for the flourishing of high culture.

...We salute the vision and devotion of those who have made possible the proton synchrotron. We recognize not only that it marks a technical achievement of high significance, but also that it is a symbol of the common enterprise of people from many nations to give to all mankind new understanding of the forces that shape our physical environment.

...May those that work at CERN in the years to come find there, in steadily growing knowledge of the wondrous order of nature and of nature's laws, ever renewed challenge for the questing mind and ever deepening satisfaction for the questing spirit."

● March 1960 pp6–12 (extract).

Quarks and aces come to CERN

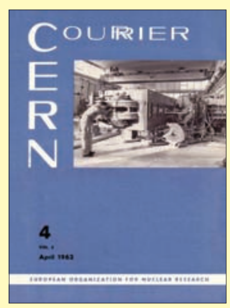
In February, a number of events combined to provide the kind of excitement for the physicists that more than makes up for the long periods of monotony and to make the rest of the staff somewhat more aware than usual that interesting things were happening.

The clues to part of the excitement had, in fact, been available in the library for a week or two, in the form of "preprints" of two theoretical papers, one by M Gell-Mann, of the California Institute of Technology, US, and the other by G Zweig, of the same Institute but at present a visiting scientist at CERN. Gell-Mann's paper was published in *Physics Letters* on 1 February; Zweig's, the more detailed of the two, is expected to appear later in *Physical Review*. Produced independently, both papers put forward a possible new way of looking at the theory of "unitary symmetry" known as SU_3...

...The new ideas had a basic simplicity that was very appealing, and difficulties that had to be explained away in the former versions of the theory did not seem to arise this time, yet the idea of fractionally charged particles seemed quite preposterous. Even those who had suggested it seemed to share the doubts; Gell-Mann called his new particles "quarks", bringing together literature and science with a reference to *Finnegans Wake!* Zweig turned to the field of card games for inspiration, and called his particles "aces", with their combinations "deuces" and "treys".

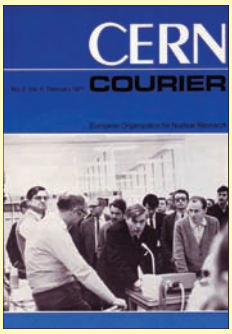
● March 1964 pp26–27 (extract).

The first g-2 experiment



The issue for April 1962 featured the g-2 experiment, with a photo of the 6 m magnet appearing on the cover. The magnet was the heart of the first g-2 experiment, the aim of which was to measure accurately the anomalous magnetic moment, or g-factor, of the muon. This experiment was one of CERN's outstanding contributions to physics and for many years was unique to the laboratory. Indeed, three generations of the experiment were performed at CERN during its first 25 years (*CERN Courier* December 2005 p12).

The first proton collider



The cover for February 1971 featured one of the iconic images of the past 50 years at CERN. Taken in the control room of the Intersecting Storage Rings on 27 January at 13.40, it shows the historic moment when project leader Kjell Johnsen announced that the experimental teams watching two of the intersection regions had observed the first ever proton–proton interactions in colliding beams. The collision energy was equivalent to 500 GeV in a fixed-target experiment.

The new particles

Anyone in touch with the world of high-energy physics will be well aware of the ferment created by the news from Brookhaven and Stanford, followed by Frascati and DESY, of the existence of new particles. But new particles have been unearthed in profusion by high-energy accelerators during the past 20 years. Why the excitement over the new discoveries?

A brief answer is that the particles have been found in a mass region where they were completely unexpected with stability properties which, at this stage of the game, are completely inexplicable...

...Two new properties have recently been invoked by the theorists – colour and charm. Colour is a suggested property of quarks which makes sense of the statistics used to calculate the consequences of their existence. This gives us nine basic quarks – three coloured varieties of each of the three familiar ones. Charm is a suggested property which makes sense of some observations concerning neutral current interactions. It is the remarkable stability of the new particles that makes it so attractive to invoke colour and charm.

Yet another possibility is that we are, at last, seeing the intermediate boson.

● December 1974 pp415–419 (extract).

Instrumentation at Versailles

Wednesday 14 October looked like being a day like any other for Georges Charpak. Except that he had an unwelcome appointment with the dentist early that afternoon. Later that day he had to cancel the appointment: "I have a small problem...," he explained. The problem was the announcement that he had received the 1992 Nobel prize in physics "for his invention of particle detectors, in particular the multiwire proportional chamber".
● December 1992 p1 (extract).

This year, the Palais des Congrès at Versailles welcomed the International Symposium on Nuclear Electronics from 10 to 13 September. The presence of such well known scientists as Professors Otto Frisch and Francis Perrin, and 700 of their younger colleagues at the Versailles symposium, shows how vital the topic has become in less than a generation.

One advance, which is at an early stage but nevertheless exciting considerable attention, is the multiple-wire proportional chamber (developed at CERN by a group led by G Charpak). A plane of independent wires is placed between two plane electrodes and the system immersed in a gas such as an argon-propane mixture. If a particle passes between two wires, the pulse received on each of them is proportional to the energy lost in the sensitive volume around them. Each wire acts as an independent proportional counter down to distances of 0.1 cm between the wires. Resolution times below 0.4 μs are easily obtained; detection efficiency is close to 100%; using suitable gas mixtures, high amplification is possible so that simple, cheap amplifiers can take the signals from the wires; selection between particles of different ionizing power is possible; the chambers can operate in high magnetic fields. Several of these features represent advances on conventional spark chambers

● September 1968 p220 (extract).

Physicists convene at Bonn and Aix

Two important conferences came close together at the end of the summer. First the 6th International Symposium on Electron and Photon Interactions at High Energies, held from 27 to 31 August [at Bonn], and then the 2nd Aix-en-Provence International Conference on Elementary Particles, held from 6 to 12 September.

At both conferences the highlight and main talking point was the evidence of neutral currents. The discovery came in a CERN experiment with a neutrino beam into the bubble chamber Gargamelle and was confirmed at the National Accelerator Laboratory US, with a neutrino beam into a huge counter-spark chamber array.

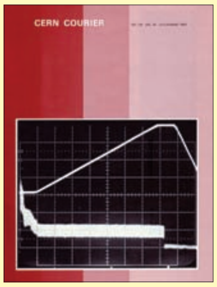
The CERN result has emerged from the copious data on neutrino interactions using the large heavy-liquid bubble chamber, Gargamelle. The word "large" is the key to the first evidence of neutral currents. They had obviously been looked for before, especially in neutrino experiments at CERN and elsewhere, but the scale of the detectors has been such that a neutral current interaction could not confidently be pinned down. Gargamelle, with its 5 m of heavy-liquid detector along the direction of the neutrino beam makes it possible to identify the emerging particles much more surely and this is crucial to deducing that neutral currents are at work...

...The count comes out at 90 neutrino-induced neutral-current events and 50 antineutrino-induced neutral-current events. When this is compared with the charged current events – 400 neutrino and 100 antineutrino after corrections – neutral currents are obviously quite a large effect. Neutral currents are here to stay and the CERN experiment will continue to gather statistics giving more precise rates for the neutral current events to line up against the theories.

● October 1973 pp291–293 (extract).

The SPS hits 400 GeV

On 17 June 1976 John Adams, CERN's director-general, addressed the CERN Council and announced that at mid-day the SPS had reached 300 GeV, the design energy approved by the member states. He then consulted Council about going to 400 GeV, and at 15.30 the higher energy was approved. At 15.35 the SPS accelerated protons to 400 GeV. The first pulse at 400 GeV featured on the cover for July/August 1976. The upper trace shows the current to the bending magnets, while the lower trace is from a beam detector in the ring.



Fermilab opens new horizons

The observation of 1600 GeV (1.6 TeV) proton–antiproton collisions on 13 October capped a spectacular week of commissioning for the new US Fermilab Collider. By far the highest-energy particle collisions ever induced, they were observed in the Collider Detector at Fermilab (CDF).

On 10 October, antiproton beam was observed in the Tevatron for the first time during a series of seven shots and two days later more than 10^{10} antiprotons were stored in the Accumulator. Antiprotons and protons were successfully synchronized and squeezed together in a Tevatron interaction region about 1 m long. That evening a strong antiproton signal was observed at 800 GeV and first collisions were seen.

● December 1985 pp419–422 (extract).

The cover for January/February 1986 showed one of the first 1600 GeV proton–antiproton collisions observed in the CDF detector.

The first signs of the W...

Excitement was high at CERN during January when results emerged from the recent, very successful proton–antiproton collision run at the SPS ring. The big UA1 and UA2 experiments have unearthed a handful of events suggestive of the long sought carriers of the weak force.

Preliminary information was given at the Rome Topical Workshop on Proton–Antiproton Collider Physics and fuller information was announced at packed CERN seminars on 20 and 21 January when Carlo Rubbia (for UA1) and Luigi Di Lella (for UA2) took their scientific audiences through the brilliant analyses of the complex data emerging from collisions at the highest man-made energies.

This brings us to the threshold of a new era in physics...Work by a host of theoreticians, crowned by the efforts of Abdus Salam, Steven Weinberg and Sheldon Glashow, has led to the formulation of a combined "electroweak" theory. This links together the familiar phenomena of heat, light, electricity and magnetism on one side, with the relatively less well known world of nuclear radioactive decay on the other.

The weak component of the electroweak force is mediated, according to the theory, by carrier particles called bosons, in much the same way that the electromagnetic component is carried by photons. However, the weak bosons are very massive (some 90 times the mass of the proton) and come in three versions: W^+, W^- and Z^0, carrying different electric charges. It is the Ws that have been looked for in the latest proton–antiproton run, since the neutral Z is expected to be about 10 times scarcer than the charged bosons.

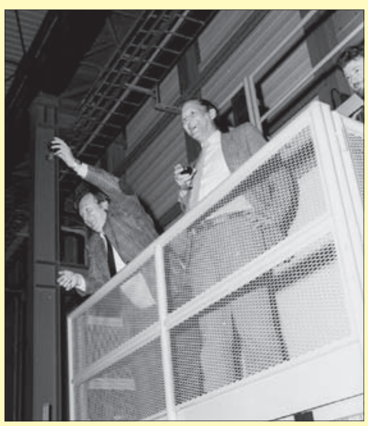
● March 1983 pp43–44 (extract).

...and the first sign of the Z?

The big UAI experiment at the CERN SPS collider has seen a 540 GeV proton–antiproton collision that produces a very energetic electron–positron pair, very suggestive of the production and decay of the long awaited Z^0 particle. A second Z-candidate event, this time producing a muon pair, has also been found.

To have a good chance of intercepting a single Z the experiments needed to amass at least several times the amount of data already recorded. As the 1983 run got under way it proved difficult at first to boost the collision rate, and hopes of a quick Z sighting began to fade. But luck seems to have been with the experimentalists, and the UA1 team triumphantly unearthed a Z-candidate event on 4 May (from data recorded a few days earlier). A first estimate of its mass from the single event puts it in the range near 100 GeV, as predicted.

● June 1983 p167 (extract).



There was jubilation at CERN following the announcement on 17 October that Carlo Rubbia and Simon van der Meer had been nominated for the 1984 Nobel prize in physics "for their decisive contributions to the large project which led to the discovery of the field particles W and Z, communicators of the weak interaction". Rubbia, together with David Cline and Peter McIntyre, put forward the bold idea to collide beams of protons and antiprotons in existing machines. Stochastic cooling [invented by van der Meer in 1968] was the key in making antiproton beams sufficiently intense for the scheme to work.

● **December 1984 pp419–420 (extract).**

First physics from LEP

On 13 October, four days after the end of the first physics run of CERN's new LEP electron–positron collider, all auditorium space and every closed-circuit TV vantage point was taken for presentations by the four experiments – Aleph, Delphi, L3 and Opal.

With good performance from the machine, the experiments had amassed between them more than 10 000 Z particles – the electrically neutral carriers of the weak nuclear force – and physicists were eager to learn the first fruits of the world's largest catch of Zs.

The Z had, until earlier this year, been reserved for the big experiments at the proton–antiproton colliders, first at CERN and then at Fermilab. With the advent of physics this year at Stanford's SLC linear electron–positron collider, the Mark II detector also joined the action, supplying the first few hundred examples of Zs produced in electron–positron annihilations. Mark II's physicists improved on previous measurements of the mass of the particle; they also got an improved limit on the different number of lightweight neutrino types allowed in nature. These results showed that there was very little room left for a fourth neutrino type to complement the three (electron-, muon- and tau-types) known so far.

With the deluge of statistics from LEP, the four experiments could significantly refine the accuracy of the Z mass measurement. The LEP team was able to calibrate the absolute energy of the machine to 45 MeV, only a few parts in a thousand at the Z mass of 91.1 GeV. This is now the largest uncertainty in the Z mass.

The most significant of the initial wave of LEP results is the removal of the remaining uncertainty in the count of neutrino species, with the chances of a fourth light neutrino now down to less than one in a thousand.

● December 1989 pp18–19 (extract).

Results from the four experiments

experiment	Mz (GeV)	total width (GeV)	number of neutrinos
ALEPH	91.174	2.68	3.27 ±.30
DELPHI	91.06	2.42	2.40 ±.40 ±.50
L3	91.132	2.588	3.42 ±.48
OPAL	91.01	2.60	3.12 ±.42

With a total of well over 10 000 Z particles between them, the four experiments at CERN's LEP electron–positron collider give a precision fix on the mass and width of the Z and the allowed number of light neutrinos (with respective errors: the figures leave out a 45 MeV uncertainty in the LEP energy calibration).

LHC building work

On a drawing of CERN's 27 km LEP/LHC tunnel, the civil engineering work needed to accommodate CERN's new LHC accelerator appears minor. However, it is anything but. The total cost of civil engineering will amount to some 50% of the original cost of digging the tunnel (before adjusting for inflation), and due to the amount of work required, contracts are being awarded in three separate packages each valued at around SFr100 million.

Following a market survey of 113 firms in 17 of CERN's member states, calls for tender were sent out in March and April 1997. Decisions to negotiate contracts were then taken by the laboratory's finance committee in November. Package one is for all of the surface buildings and caverns for the ATLAS experiment. It is the only package to require surface building in Switzerland. Following the go-ahead from the Swiss authorities, a joint venture between Austrian, German and Swiss firms has started work.

Package two is for the surface buildings and caverns for the smaller CMS experiment. It will be awarded to an Italian–Spanish consortium and work is expected to start in June. Little civil engineering is required by the ALICE and LHC-B experiments, leaving package three to deal mainly with the clockwise transfer tunnel, the two beam dumps at Point 6, and various other modifications around the ring to accommodate LHC equipment. Package three will be awarded to a Franco–British consortium and work will begin in June.

● May 1998 pp2–3 (extract).

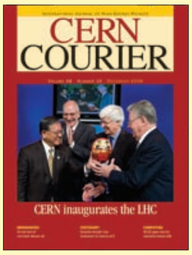
Caught in the Web

The World Wide Web may have taken the Internet by storm, but many people would be surprised to learn that it owes its existence to CERN. Around half of the world's particle physicists come to CERN for their experiments, and the Web is the result of their need to share information quickly and easily on a global scale. Six years after Tim Berners-Lee's inspired idea to marry hypertext to the Internet in 1989, CERN is handing over future Web development to the World Wide Web Consortium, run by the French National Institute for Research in Computer Science and Control, INRIA, and the Laboratory for Computer Science of the Massachusetts Institute of Technology, MIT, leaving CERN free to concentrate on physics.

The Laboratory marked this transition with a conference designed to give a taste of what the Web can do, while firmly stamping it with the label "Made in CERN". More than 200 European journalists and educationalists came to CERN on 8–9 March for the World Wide Web Days, covered widely in the media.

● June 1995 pp1–4 (extract).

LHC: from start to finish



From the PS to the LHC, the *CERN Courier* has covered the start-up and inauguration of all of CERN's major particle accelerators. The cover for May 1998 (left) featured Swiss Federal Councillor Kaspar Villiger (right) being greeted by the director-general, Chris Llewellyn Smith (left), on arrival at CERN's heliport on 27 February prior to signing an agreement under which CERN could use land for the LHC. A decade later, the LHC inauguration was the cover story in December 2008, again with Llewellyn Smith (second right) and Pascal Couchepin, then president of the Swiss confederation.

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Cern Courier 50th anniversary.
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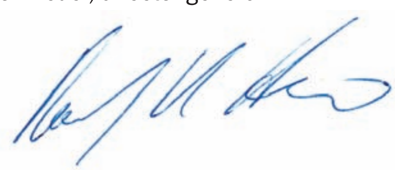
Happy 50th, CERN Courier

This August, the *CERN Courier* is 50 years old. That's a good excuse to take stock of what's changed and what's stayed the same, so I found myself a copy of issue number 1 (reprinted in the following pages). With the *Courier*, it's remarkable to see the ambition contained in that first edition, and to see how much the magazine has remained faithful to its founder Cornelis Bakker's original vision.

Visually the *CERN Courier* has changed beyond recognition, as has the laboratory itself. The audience has changed too. Originally conceived as an internal newsletter, the *Courier* today addresses a global readership of more than 25 000. One thing that has stayed the same, however, is the magazine's openness to the world. Issue number 1 reported not only on progress towards starting up the PS, but also carried news of the City of Hamburg's purchase of a 40 MeV linac for a new lab known as the Deutsches Elektronen Synchrotron. Back then, the *Courier* felt the need to spell out the DESY acronym. There was also news from the US, including bold ambitions for linear accelerator developments at Stanford University. CERN's mission of bringing nations together for peaceful collaboration is witnessed by a report from a trip to the USSR, precursor to a long and fruitful collaboration with the Joint Institute for Nuclear Research at Dubna.

The introduction on the first page of that first issue asks the question "what will the *CERN Courier* be?" It goes on to explain that it is there to "maintain the ideal of European co-operation and the team spirit which are essential to the achievement of our final aim: scientific research on an international scale". Fifty years on, the world has changed immeasurably, but those words still ring true. Let's look forward to the next 50 years!

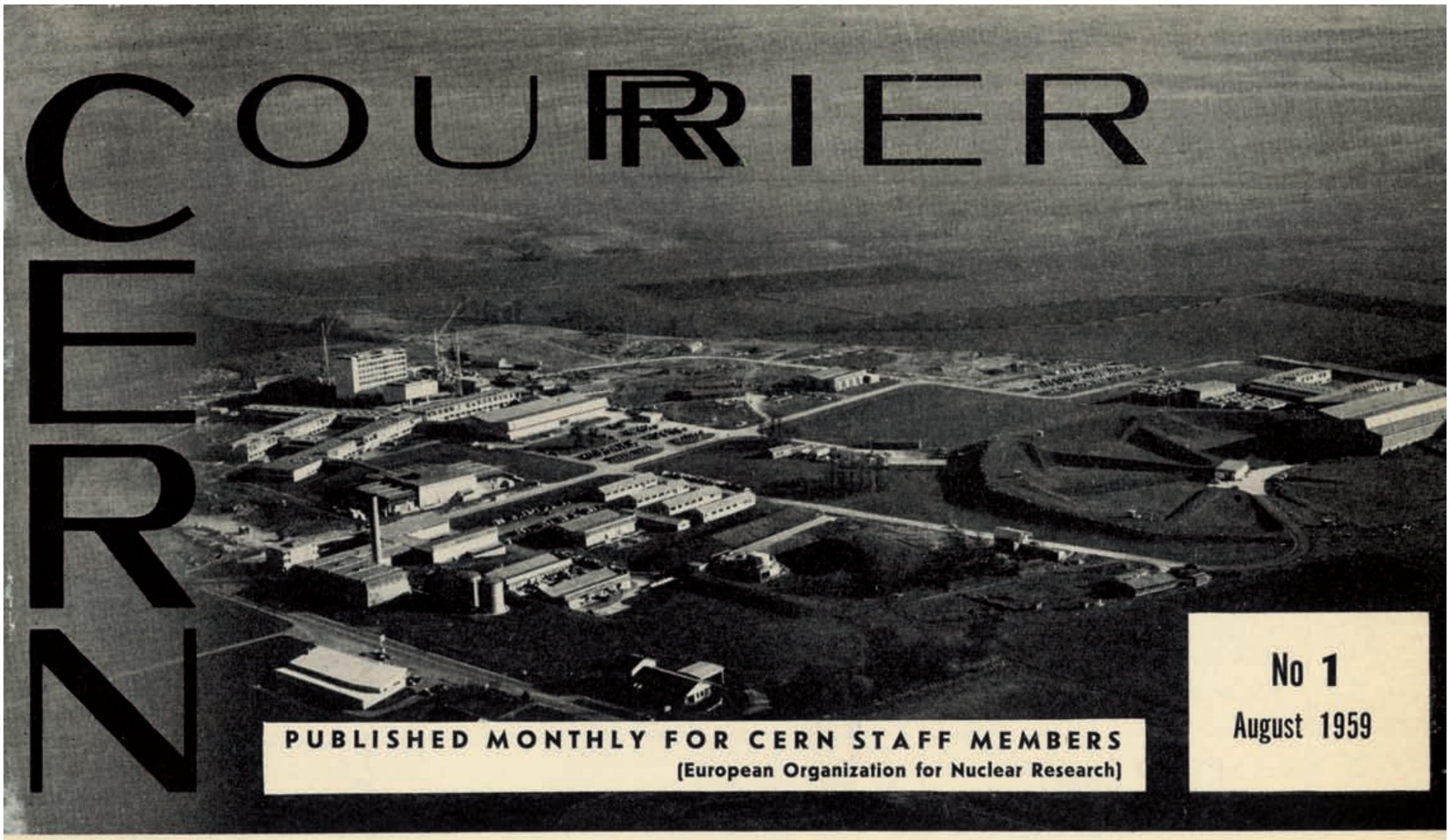
Rolf Heuer, director-general.



To celebrate the 50th anniversary of the *CERN Courier*, in this issue we have reproduced the original edition in its entirety. Since then the magazine has covered numerous dramatic discoveries and breakthroughs at CERN and elsewhere. On pages 25–28 we give just a small selection of highlights.

Pour célébrer le 50e anniversaire du *Courrier CERN*, nous reproduisons dans le présent numéro l'édition originale dans son intégralité. Depuis cinquante ans, le *Courrier CERN* a rendu compte de bien des découvertes mémorables au CERN et ailleurs. Extraits pp. 25–28..

CERN COURIER



PUBLISHED MONTHLY FOR CERN STAFF MEMBERS
(European Organization for Nuclear Research)

No 1
August 1959

Introducing the «CERN Courier»

For a long time, the need has been felt for a publication giving news of CERN to its staff.

The Director-General pointed out this need very early. Plans were made, but circumstances unfortunately prevented them from being carried out.

Now that the practical difficulties have been overcome, we are pleased to be able to present the first issue of our magazine to you.

What will the « CERN COURIER » be? Essentially an information paper intended to help every staff member to feel at home in the Organization and to maintain the ideal of European co-operation and the team spirit which are essential to the achievement of our final aim: scientific research on an international scale. Accordingly we want to keep CERN staff members informed of what is going on, so that they should not feel isolated through now knowing how their work fits into the general scheme.

Our news service will cover all aspects of the official activities of the Organization - scientific, technical and administrative. Every month we shall try to present this news in fairly simple form.

These are the main ideas behind the publication of this periodical. We feel we may help in this way to establish close ties between those who have come from many countries to contribute to CERN's scientific and European achievements.

A Word from the Director-General

It is a pleasure to introduce our long expected internal bulletin. I hope it will benefit not only from your attention but also from the many suggestions which will certainly arise in CERN's fertile minds.

C. J. Bakker

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of No 1

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In our next issues

- The first of a series of articles on CERN's non-stop offensive against the atom: **« 24 hours of SC life »**
- CERN scientists talk to you about the Kiev Conference.
- Nuclear physics for all

Who is who in CERN

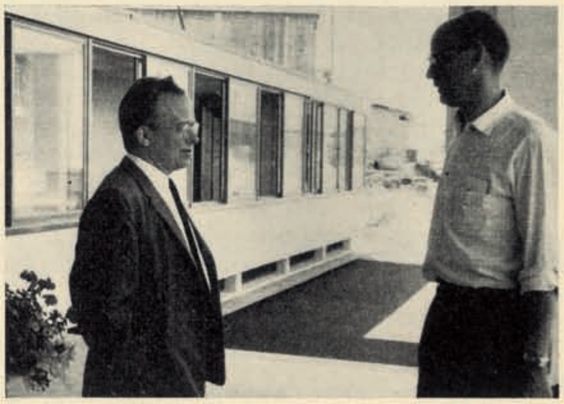
Professor W. Panofsky to work at CERN

On his way to Russia on July 14th, Professor Wolfgang Panofsky called at CERN and submitted himself with good grace to our interview.

Professor Panofsky was born in Berlin on April 4th 1919. He received an A. B. (Bachelor of Arts) degree et Princeton in 1938, and a Ph. D. (Physics) degree at the California Institute of Technology in 1942, the very year he became an American citizen.

Then began his striking career in high energy nuclear physics. First a technical director at the Office of Scientific Research and Development, he was assistant professor of physics at the Radiation Laboratory of California from 1945 until 1948. That year he joined Stanford University as an Associate Professor ; he became full Professor in 1951.

Director of the Stanford University High Energy Physics Laboratory since 1953, Prof. Panofsky has supervised the work of several research groups operating two of Stanford's linear accelerators : the 700 and the 40 MeV machines. One of the research groups headed by Prof. Panofsky himself was conducting experiments on basic electro-dynamics and pion physics. In charge of another group was Prof. Hofstadter—now also with CERN—whose work was more specifically centered on electron scattering.



Professor Panofsky talking to Dr. Lofgren the day before they left for the Kiev Conference. Dr. Lofgren, who is at present at CERN, was in charge of the 6.2 GeV Bevatron group at the University of California Radiation Laboratory (Berkeley). (CERN Photo)

Professor Panofsky's interests—besides his five children—are all in nuclear physics, especially high energy physics. He has been called upon in connection with various nuclear matters. Consultant in New Mexico for the Atomic Energy Commission in 1945, Wolfgang Panofsky is now a member of the National Academy of Science and of the President's Scientific Advisory Committee.

Scheduled to begin work at CERN late in June, Prof. Panofsky was then appointed head of the American technical experts discussing ways to control high altitude nuclear tests. Three weeks later an agreement had been reached. Only then was our new guest professor able to join the Organization ... only to fly off to Russia the next day as American rapporteur on the progress at Stanford.

After his return from the Annual International Conference in Kiev, Professor Panofsky will spend some five months in CERN under a Ford Foundation grant. He will work in Professor Bernardini's Synchro-Cyclotron Division (S.C.).

SWEDISH OFFICIALS IN CERN

Statssekreterare Hans Löwbeer, a high official of the Swedish Ministry of Education, was welcomed in CERN on June 4th. He and one of his closest collaborators, the byrachef Sven Moberg were welcomed by Professor C. J. Bakker and Mr. S. A. ff Dakin.

After an introductory talk about the general purposes and aims of CERN, the Director-General and the Director of Administration took their guests for a tour of the site.

Our visitors were shown around the SC, where they met two of their compatriots, Mr. O. Frederiksson and Mr. G. von Dardel. In the STS Division, Mr. Moberg expressed particular interest in the Mercury computer.

The party had lunch in a well-know establishment of Echenevex, then came back to the site for a visit of the PS under Mr. Adams's guidance.

After the Thirteenth CERN Council Session

A view of CERN Auditorium taken during the last Council Session. (CERN Photo)

Is there a need to say any more about the 13th session of the CERN Council which was held here on May 27th last?

We think there is because, owing to the lack of space, we had to concentrate on the more spectacular aspects in the brief account which appeared in the Staff Association Journal. Paradoxically enough, the first of the articles which should have figured here appeared in another publication! The event was of such interest that the Association's kind offer to grant us some space in its Journal was enthousiastically accepted.

What is the Council!

What else should be said about the Council session? Should we tell you about the progress in all the Divisions, which was reported then? We thought it best to discuss this in separate articles.

As regards the Council, we simply propose to describe what it is in some detail, for although everyone is always perfectly aware of its existence, its composition and the reasons behind its sessions are perhaps less well known.

Briefly then: each Member State sends at the most two delegates to the Council, who may be accompanied by advisers. The Council elects a President and two vice-Presidents who hold office for one year and may be re-elected on not more than two consecutive occasions. As for the purposes of the meetings, they are many:

a) to determine the Organization's policy in scientific, technical and administrative matters;

b) to approve detailed research plans and decide on any supplementary programmes;

c) to adopt the budget and determine financial arrangements;

d) to control expenditure and approve and publish the audited accounts of the Organizations;

e) to decide on the staff establishment required;

f) to publish an annual report;

g) to have such other powers and perform such other functions as may be necessary for the complementation of the Convention.

The Austrian flag being hoisted alongside the flags of the other Member States, ten minutes after the CERN Council had decided to admit Austria as a member of the Organization. (CERN Photo).

And what is the object of the Convention may you ask? It lays down the very purposes of CERN, which it may be useful to recall over again.

On 1st July 1953, the Convention laid down that an international laboratory should be created for the purpose of carrying out an agreed programme of nuclear research of a pure scientific and fundamental character.

Article II of the Convention says: « The Organization shall provide for collaboration among European States in nuclear research of a pure scientific and fundamental character and in research essentially related thereto. The Organization shall have no concern with work for military requirements and the results of its experimental and theoretical work shall be published or otherwise made generally available. »

When it was established, in 1953, the basic programme of the Organization comprised:

1. The construction of an international laboratory for research on high energy particles, including work in the field of cosmic rays. This laboratory was to consist of:
   a) a proton synchrotron for energies above 10 gigaelectronvolt 10^{10}eV) (Editor's note: energy since increased to 25 GeV);
   b) a synchro-cyclotron capable of accelerating protons up to approximately 600 million electronvolt (6×10^8 eV);
   c) the nessessary ancillary apparatus for use in the research programmes carried out by means of the machines referred to in a) and b) above;
   d) the necessary buildings to contain equipment referred to in a), b) and c) and for the administration of the Organization and the fulfilment of its other functions.
2. The operation of the laboratory specified above;
3. The Organization and sponsoring of international co-operation in nuclear research, including co-operation outside the laboratory. This co-operation may include, in particular:
   a) work in the field of theoretical nuclear physics;
   b) the promotion of contacts between, and the interchange of, scientists, the dissemination of information, and the provision of advanced training for research workers;
   c) collaboration with and advising of national research institutions;
   d) work in the field of cosmic rays.

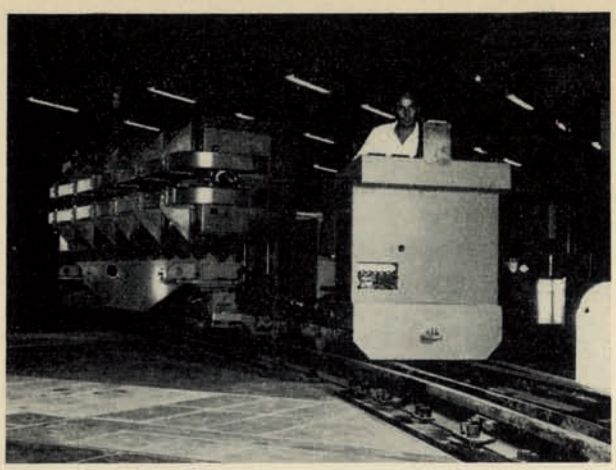
It should be noted that any supplementary programme has to be submitted to the Council and requires approval by the two-thirds majority of all the Member States.

Article II ends very judiciously by advocating co-operation between CERN and laboratories and institutes in the territories of Member States: « So far as is consistent with the aims of the Organization, the laboratory shall seek to avoid duplicating research work which is being carried out in the said laboratories and institutes ».

These, then, are the main points of the Convention which established our international Organization.

Other articles of the Convention deserve mention here, especially those relating to the conditions for the admission of a country to membership of CERN. These will be dealt with in a subsequent article.

«PS» APPRO OPERA

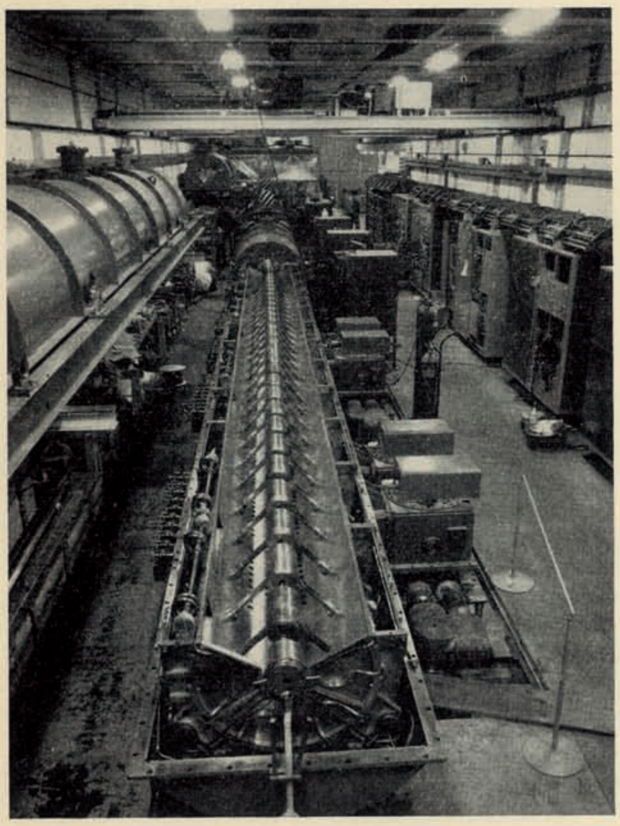


The last magnet unit being towed towards the PS ring. (CERN Photo)

Originally scheduled to begin operation in 1960, the 25 thousand million electronvolt proton synchrotron building at CERN is now reaching its final stage. Since January the total PS staff has increased from 230 to 287. The mechanical workshop has started to make room for the shielding wall in the South Experidental Hall. Nearby, pneumatic drills are hewing out the rock for the foundations of the experimental apparatus generator hall.

However, it is in the ring of the synchrotron itself that the biggest changes have occurred.

Here is a brief account of the situation on the 25th of July as regards the assembly of the gigantic particle accelerator, 600 ft. in diameter.



The CERN linear accelerator, which will inject protons into the PS at 50 MeV. The two cavities in the background at present supply a 30 MeV beam. (UKAEA Photo)

All 100 magnets in position

Friday the 10th of July was a flag day for the PS Division. At 3.10 p.m. the squat electric locomotive which pulled all the magnets units into the ring, slowly towed its last load towards the tunnel. With the hundred 38-ton units of the electromagnet in position, a major phase in PS construction can be regarded as terminated.

In the South Experimental Hall, the reference unit which measured the magnetic properties of the 100 functional units, has been hauled away from its concrete cradle and the rails laid for the transport of the units into the ring building have been removed. These events can be looked upon as a historical «burning of bridges». There is of course a permanent track running from the tunnel to the north experimental hall, inside the ring circle. Nevertheless these removals symbolize the prevailing confidence of the Division, now that all separate components of the machine have been carefully tested.

But by no means was the work on the magnets positioning finished. Certainly not in the opinion of the team surveying final alignment of the electromagnets. It takes 2 hours to align each of the 100 units to a radial tolerance of $^{1}/_{10}$ mm over a circle 600 ft. in diameter. Therefore the magnitude of the survey team's task can be appreciated. Even after the magnets have been energized for some time, further checks and adjustments will be necessary. And later on, measurements will have to be performed twice a year, taking advantage of a temporary stoppage...

Those who have business in the ring will have spotted a notice with two flickering lights, saying : « Tunnel blocked at 46th magnet ».

This warnig anticipated 27 July, the date of the first energizing of the magnets. In preparation for it there was a final test of connections and a so-called « superficial examination » to make sure no tools or foreign objects subject to magnetic influence had been left on the units or in their gaps. The ring was blocked to ensure that this thorough examination should be final.

Two Linac cavities in operation

The first two cavities of the 50 MeV linear accelerator designed to inject particles into the annular vacuum chamber, have been in operation since the end of May. They have produced 30 MeV protons, i. e. three fifths of the linac ultimate energy.

Thirty MeV protons are produced only on a few evenings a week. High energy, high intensity beams of this sort create ionizing radiations and a radioactivity hazard is involved. So that fitters can carry out their job safely on the third and last cavity, the beam delivered during tests by the first two is usually cut down to 10 MeV.

As for the intensity of the proton current—the number

ACHING
TIONAL STAGE

of particles produced as separate from their energy—this reached 3.5 milliamperes at this printing. The value, explains J. B. Adams, Director of the Division, is exceptionally high. The current expected at this stage was only 1 milliampere.

Assembly of the last cavity has been slowed down by leaks in the vacuum system. « The linac has a thousand high vacuum joints and we are not in the least surprised to have run into trouble in this field », the vacuum technicians point out.

The difficulties which they have the habit of facing are responsible for the particular attention they bring to their designs. The vacuum system of the « big machine » numbers no less than 72 pumps all of which are installed at this writing. About 30 % of the 628 m long annular vacuum chamber has been pumped down to a pressure of 2.10^{-6} mm of mercury, which equates approximately 3 parts in a thousand million of the normal atmospheric pressure.

This elaborate pumping system is necessary to permit circulation of the stream of protons in the vacuum chamber so that as few as possible collide with air molecules thus being slowed down and scattered.

Sixteen accelerating units

The vacuum chamber passes through radio-frequency-controlled accelerating units designed to impart successive pushes to the protons.

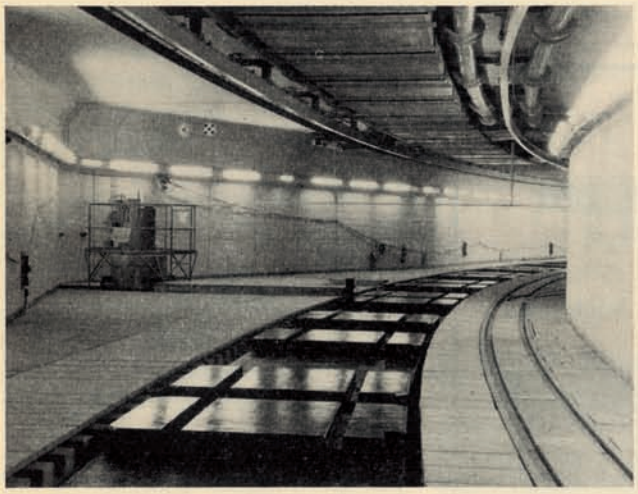
CERN PS has 16 such acceleration units. All have been mounted in the ring and connected to their power supplies. The only component of the radio frequency system on which work still remains to be done is the beam control apparatus. All parts of this have however been finished and individually tested and only their assembly remains — mostly in the upper room at the ring centre—and their final testing in situ.

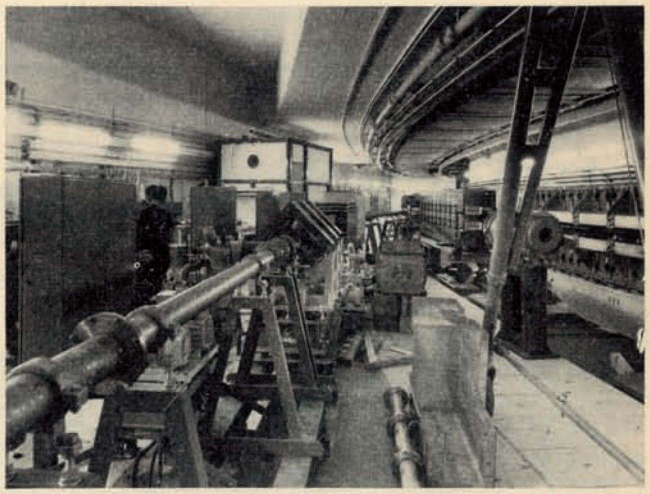
The frequency programming system having already been set up for some time, its final testing awaits excitation of the magnets. In point of fact, the assembly of the entire machine has reached the point where all vital components fit together in order to constitute a functionally integrated unit. For instance, trials of the magnet power supply could not be performed with its final load before 27 July, since it was impossible to simulate the special load conditioned by all the magnet units.

The full importance of this date, 27 July, can therefore be stressed : it was the day when the 3,800-ton electromagnet was energized for the first time. It then became possible to begin to evaluate the performance of the accelerator components operating as a unit.

On going to press, this evaluation has not yet been completed. Nevertheless the outlook is very promising, as echoed by the words of H. G. Hereward, who gave many of the facts mentioned above : «We are very optimistic...»

Optimistic is indeed the word and with such perspectives and the keenness they breed, there is very little doubt that the PS team will succeed in producing a proton beam in time for Christmas.





The view of the 25 GeV accelerator tunnel taken two years ago (left) and that on the right taken a few weeks ago at the output end of the Linac, show the progress made in the construction of the machine. (CERN and UKAEA Photos)

THE «RECEPTION» TRENCH

We have been asked : « What is the enormous excavation at the CERN main entrance ? »

The Technical Services section of the SB Division have given us the answer. The main tunnel containing the water pipes, electric cables etc., linking the Power House to the rest of the CERN site, had to be dug underneath the concrete slab supporting the road. It was considered at the time that this slab would be sufficient to prevent water from draining into the tunnel.

Experience showed that this was not so. It was therefore decided to make the tunnel watertight—and this is the work that has been done.

Other Peoples' Atoms

Under this heading, we shall publish from time to time the latest news about foreign accelerators or nuclear research.

We expect thus to keep CERN members well informed of what is going on in our particular field and help them to fit CERN into the accelerator's international picture.

The Editor

A 40 MeV LINAC FOR GERMANY

The manufacturers of CERN's 50 MeV linac announce they have obtained an order for a 40 million electronvolt linear accelerator from the City of Hamburg for DESY, the **D**eutsches **E**lectronen **SY**nchrotron.

The new linac, which is of the travelling-wave type will by energized by short wavelength radio-frequency power ; the electrons will be accelerated along a specially shaped waveguide. The equipment comprises five sections of accelerating waveguide, each 1.5 m. long, and has an overall length of about 10.7 m. (35 ft), together with an electron gun and pre-buncher at the injector end.

Each accelerator section will be fed by high-power klystron. The value of the whole order, together with controls and other services amounts to about 250 000 sterling pounds.

Signing of the Site Agreement

One of the most important announcements made at the last Council session concerned the signing of the Site Agreement between the « Etat de Genève » and CERN.

The Agreement was signed before a notary on 11 February last. The Director-General, Professor C. J. Bakker, represented CERN, while Messrs. Dutoit and E. Chamay, Conseillers d'Etat, respectively in charge of the Public Works and the Finance and Taxation Departments, signed on behalf of the Etat de Genève.

Before the signature of the Convention of Ist July 1953 establishing the European Organization for Nuclear Research, the Swiss Confederation and the Conseil d'Etat of the Republic and Canton of Geneva had put at the disposal of CERN the land it required for the construction of its installations. This land amounted to 40 hectares, 63 ares and 29 m^2 within the boundaries of Meyrin and Satigny.

Under the agreement signed on 11 February, the Etat de Genève grants CERN a «personal right of use» for an indefinite period in respect of the present site ; this right of use is transferable and will also apply to any other land which the Etat de Genève may place at CERN's disposal.

The Agreement also specifies that CERN will assume full responsibility for all maintenance charges relating to its installations. On the other hand, expenditure incurred for the installation of water and electricity supplies will be shared between the Etat de Genève, CERN and the «Services industriels de Genève».

The Agreement concluded between CERN and the Etat de Genève is the result of a long series of negotiations.

This new advance towards putting CERN on a permanent footing is characteristic of others made by our Organization in the course of its short but fruitful existence.

U. S. TO DOUBLE ACCELERATORS BUDGET BY 1963 ?

It was announced in Washington last May, that the Presidential Science Advisory subcommittee headed by Dr. Piore, had recommended that the U. S. more than double its investment in atom smashers. This would increase accelerator research expenditure from the present $ 59,000,000 annually to $ 135,000,000 by 1963. Of course no official decision has been taken yet, and the recommendation has still to get successive clearings from Dr. James Killian, President Eisenhower and the United States Congress.

While aiming at developing U. S. accelerators, the recommendations also suggested increasing international co-operation in high energy nuclear research.

The report issued by the Committee points to the « most urgent » need of high energy electron accelerators, of which the Stanford 40 GeV linac (see below) is a typical example. On the other hand, there should be no immediate requirement for building proton accelerators more powerful than the 30,000,000,000 eV now under construction at the Brookhaven National Laboratory, Long Island. Finally, there is an « urgent need » for lower energy proton accelerators producing more intense beams of particles.

It is of interest to note the United States now has 15 accelerators with energies above 200 MeV and 4 with energies above 1 GeV.

STANFORD UNIVERSITY STIRS EXCITEMENT

Stanford University, in California, already has a leading position as far as linear accelerators are concerned. It operates a whole family of linacs, several of which are used for medical purposes. The 220 ft. machine in operation there produces 700 MeV electrons and its energy will be stepped up to 1050 MeV.

Late in May, Stanford made the scientific headlines, again with a linac.

Addressing a science research symposium in Manhattan, President Eisenhower announced he would recommend to the U. S. Congress the financing of a « large new electron linear accelerator... a machine two miles long, by far the largest ever built ».

This machine intended for Stanford University would be one of the most spectacular atom smashers ever devised. Two parallel tunnels would have to be driven for 2 miles into the rock of a small mountain in the vicinity of Palo Alto. Such natural cover would of course stop any dangerous radiations. One of the tunnels, the smaller in diameter, would house the accelerator proper, while the bigger one would be used for maintenance purposes.

The proposed new linac for Stanford would initially produce 15 BeV (GeV) electrons ; it is announced this energy could later be raised to 40 BeV. It is believed the machine would take 6 years to build, at a cost of 100 million dollars.

Approval of the project now only taken after Congressional hearings depends upon the decision to be held in July.

OFF TO RUSSIA

BETWEEN July 14-17, several CERN scientists left Geneva «en route» for Russia. They were to return to the Organization between July 28-30 after a stay in Kiev and a visit to Dubna.

In Kiev they attended the 1959 Annual International Conference on High Energy Physics, held under the sponsorship of the IUPAP (International Union of Pure and Applied Physics).

CERN participants in the Conference were Professor C. J. Bakker, Director General of CERN and Chairman of the IUPAP High Energy Commission, Professor G. Bernardini, Director of our Synchro-cyclotron Division (SC), Doctor S. Fubini from the CERN Theoretical Studies Division (TH), Doctor W. Glaser (TH), Doctor A. W. Merrison (SC), Professor W. Paul (SC), and Professor C. Peyrou from the Proton-Synchrotron Division (PS)

The Conference was the 9th of its kind to be held and the first to take place in Russia. Our readers will remember the 1958 Conference on High Energy Physics was held at CERN.

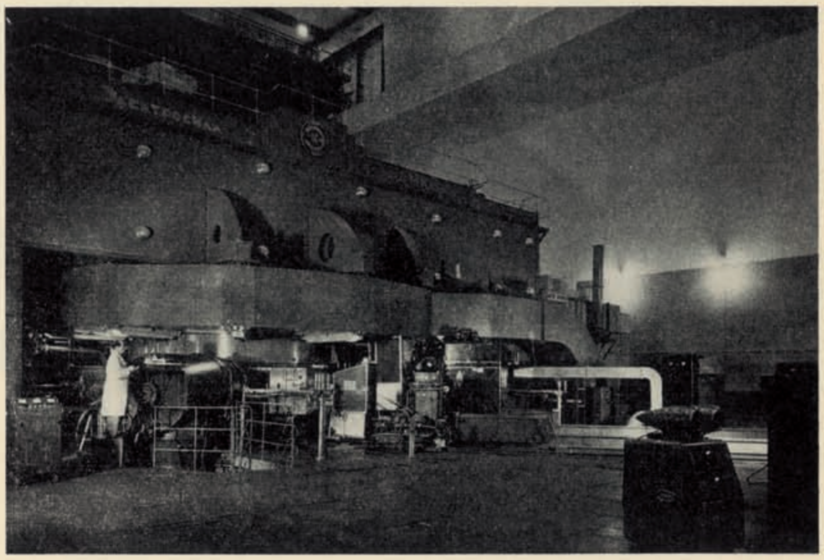
The Kiev Conference was to last from July 15 to July 25 and to be followed by a visit to the Russian equivalent of CERN : the Dubna center near Moscow.

We expect to publish an account of this trip in our next issue. As for now, it may be said that besides CERN participants, other prominent names in the field of nuclear physics are found in the agenda of the Conference. Among them : Alvarez, Panofsky and Segré for the U.S., and Tamm and Veksler for the USSR.

A few other members of CERN also went to Kiev as delegates of their respective countries. They were :

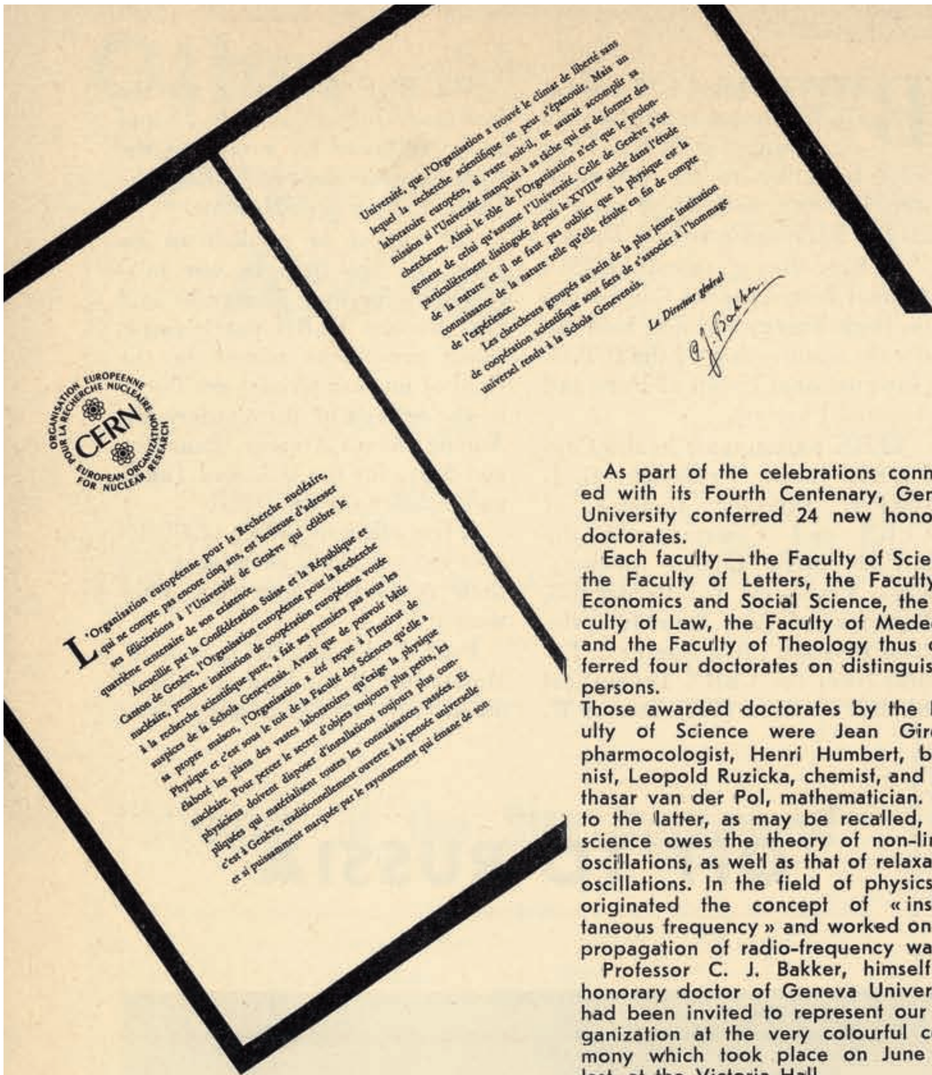
Prof. J. Ashkin (US), Prof. R. Hofstadter (US), Prof. L. Ledermann (US), Dr. A. Lundby (Norway), Prof. Ph. Meyer (France), Prof. R. G. Sachs (US), Prof. H. Tolhoek (The Netherlands).

Last but not least, there was still another member of our Organization who went to Russia on official business this summer : Dr. F. Farley (SC) who was in Moscow from 6 to 11 July, to attend a colloquium on cosmic rays.



The CERN scientists who took part in the Kiev Conference visited the 680 MeV synchro-cyclotron in service at the Dubna Research Centre in the Soviet Union. Note the characteristic shape of the oscilloscope in the foreground (Dubna Photo).

CERN in the News


L'Organisation européenne pour la Recherche nucléaire, qui ne compte pas encore cinq ans, est heureuse d'adresser ses félicitations à l'Université de Genève qui célèbre le quatrième centenaire de son existence.

Accueillie par la Confédération Suisse et la République et Canton de Genève, l'Organisation européenne pour la Recherche nucléaire, première institution de coopération européenne vouée à la recherche scientifique pure, a fait ses premiers pas sous les auspices de la Schola Genevensis. Avant que de pouvoir bâtir sa propre maison, l'Organisation a été reçue à l'Institut de Physique et c'est sous le toit de la Faculté des Sciences qu'elle a élaboré les plans des vastes laboratoires qu'exige la physique nucléaire. Pour percer le secret d'objets toujours plus petits, les physiciens doivent disposer d'installations toujours plus compliquées qui matérialisent toutes les connaissances passées. Et c'est à Genève, traditionnellement ouverte à la pensée universelle et si puissamment marquée par le rayonnement qui émane de son Université, que l'Organisation a trouvé le climat de liberté sans lequel la recherche scientifique ne peut s'épanouir. Mais un laboratoire européen, si vaste soit-il, ne saurait accomplir sa mission si l'Université manquait à sa tâche qui est de former des chercheurs. Ainsi le rôle de l'Organisation n'est que le prolongement de celui qu'assume l'Université. Celle de Genève s'est particulièrement distinguée depuis le XVIII^{me} siècle dans l'étude de la nature et il ne faut pas oublier que la physique est la connaissance de la nature telle qu'elle résulte en fin de compte de l'expérience.

Les chercheurs groupés au sein de la plus jeune institution de coopération scientifique sont fiers de s'associer à l'hommage universel rendu à la Schola Genevensis.

Le Directeur général

C. J. Bakker

Facsimile of the address presented to Geneva University on the occasion of its 4th centenary. Note the CERN seal — the original is blue on a white background.

As part of the celebrations connected with its Fourth Centenary, Geneva University conferred 24 new honorary doctorates.

Each faculty — the Faculty of Science, the Faculty of Letters, the Faculty of Economics and Social Science, the Faculty of Law, the Faculty of Medecine and the Faculty of Theology thus conferred four doctorates on distinguished persons.

Those awarded doctorates by the Faculty of Science were Jean Giroux, pharmocologist, Henri Humbert, botanist, Leopold Ruzicka, chemist, and Balthasar van der Pol, mathematician. It is to the latter, as may be recalled, that science owes the theory of non-linear oscillations, as well as that of relaxation oscillations. In the field of physics he originated the concept of « instantaneous frequency » and worked on the propagation of radio-frequency waves.

Professor C. J. Bakker, himself an honorary doctor of Geneva University, had been invited to represent our Organization at the very colourful ceremony which took place on June 6th last, at the Victoria Hall.

The Director-General added the tribute of CERN — whose first steps were taken under the wing of the « Schola Genevensis » — to those of institutes of learning from all over the world.

... and in the Press

The Press Conference held at CERN on May 27th, after the last session of the Council, resulted in a few dozen articles whose importance should not be underrated in connection with the good name of the Organization.

By the end of June our press-cutting service had spotted 65 reports on the proceedings of the last Council session and CERN's general activities.

Among the most interesting reports was that of David Nott in the Geneva « Weekly Tribune », which carried a first-page headline : World's Top Atom-smasher to open in Geneva ».

As for Jacqueline Juillard's article in the « Gazette de Lausanne » of June 1st, it is on the whole a good example of concise, accurate and objective scientific reporting for the general public.

Finally, there was Hans Ostl's long illustrated article in the « Rhein-Neckar-Zeitung » of Heidelberg. This drew a clever parallel between the purposes of atomic energy research, on the one hand, and fundamental nuclear science, on the other. The article ended with a description of the PS and a few ideas regarding the construction of accelerators in the future.

Any suggestions?

Our latest Annual Report, the one covering CERN activities for the year 1958, has been issued to you a couple of weeks ago.

For that publication as well as for this very first vintage of our Bulletin, we seek your comments.

You don't have to sign them. If you believe you might blush in seeing your name in print in our next issue, or if modesty prevents you from being further associated with your idea, then just drop us a note « incognito ».

You may be sure your appeal will always receive due consideration, even if it is not so tender to us. Editors are—and should be—rugged people...

Do not misunderstand us. Your congratulations will also be welcomed and they will get first class treatment. Anyway, quite between ourselves, we don't expect much difficulty in selecting the entries...

One more thing. Not only should we like to have your advice but we need your cooperation as well. How ? By using the attached blank to tell us about your everyday work, about the developments in your own division and, in short, about anything you believe might be newsworthy. This is important because if it is true we have ways of gathering the news and sometimes of making it, we don't know yet of reporters who come fully equipped with antennae which vibrate every time some news is in the making. You simply have to tell them.

Thank you for your help to come. Thank you also for taking the trouble of reading all this.

The Editor

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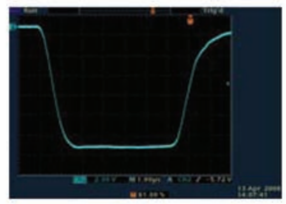

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CHEP '09: clouds, data, Grids and the LHC

Prague was the setting for CHEP '09, the 17th International Conference on Computing in High Energy and Nuclear Physics. **Alan Silverman** reports on some of the programme's many highlights.

The old city of Prague blends with its modern aspects to provide a suitable setting for CHEP '09. (Photos courtesy CHEP '09 organizers.)

The CHEP series of conferences is held every 18 months and covers the wide field of computing in high-energy and nuclear physics. CHEP '09, the 17th in the series, was held in Prague on 21–27 March and attracted 615 attendees from 41 countries. It was co-organized by the Czech academic-network operator CESNET, Charles University in Prague (Faculty of Mathematics and Physics), the Czech Technical University, and the Institute of Physics and the Nuclear Physics Institute of the Czech Academy of Sciences. Throughout the week some 500 papers and posters were presented. As usual, given the CHEP tradition of devoting the morning sessions to plenary talks and limiting the number of afternoon parallel sessions to six or seven, the organizers found themselves short of capacity for oral presentations. They received 500 offers for the 200 programme slots, so the remainder were shown as posters, split into three full-day sessions of around 100 each day. The morning coffee break was extended specifically to allow time to browse the posters and discuss with the poster authors.

A large number of the presentations related to some aspect of computing for the up-coming LHC experiments but there was also a healthy number of contributions from experiments elsewhere in the world, including Brookhaven National Laboratory, Fermilab and SLAC (where BaBar is still analysing its data although the experiment has stopped data-taking) in the US, KEK in Japan and DESY in Germany.

Data and performance

The conference was preceded by a Worldwide LHC Computing Grid (WLCG) Workshop, summarized at CHEP '09 by Harry Renshall from CERN. There was a good mixture of Tier 0, T1 and T2 representatives in the total of the 228 people present at the workshop, which began with a review of each of the LHC experiment's plans. All of these include more stress-testing in some form or other before the restart of the LHC. The transition to the European Grid Initiative from the Enabling Grids for E-sciencE project is clearly an issue, as is the lack of a winter shutdown in the LHC plans. There was discussion on whether or not there should be a new "Computing Challenge", to test the readiness of the WLCG. The eventual decision was "yes", but to rename it STEP '09 (Scale Testing for the Experimental Programme), schedule it for May or June 2009 and concentrate on tape recall and event processing. The workshop concluded that ongoing emphasis should be put on stability, preparing for a 44-week run and continuing the good work that has now started on data analysis.

Sergio Bertolucci, CERN's director for research and scientific computing, gave the opening talk of the conference. He reviewed the LHC start-up and initial running, the steps being taken for the repairs following the incident of 19 September 2008 as well as to avoid any repetition, and the plans for the restart. He compared the work currently being done at Fermilab, and how CERN will learn from this in the search for the Higgs boson. Les Robertson of CERN, who led the WLCG project through the first six years, discussed how we got here and what will come next. A very simple Grid was first presented at CHEP in Padova in 2000, leading Robertson to label the 2000s as the decade of the Grid. Thanks to the development and adoption of standards, Grids have now developed and matured, with an increasing number of sciences and industrial applications making use of them. However, Robertson thinks that we should be looking at locating Grid centres where energy is cheap, using virtualization to share processing power better, and starting to look at "clouds": what are they in comparison to Grids?

The theme of using clouds, which enable access to leased computing power and storage capacity, came up several times in the meeting. For example, the Belle experiment at KEK is ▷

experimenting with the use of clouds for Monte Carlo simulations in its planning for SuperBelle; and the STAR experiment at Brookhaven is also considering clouds for Monte Carlo production. Another of Robertson's suggestions for future work, "virtualization", was also one of the most common topics in terms of contributions throughout the week, with different uses cropping up time and again in the conference's various streams.

Other notable plenary talks included those by Neil Geddes, Kors Bos and Ruth Pordes. Geddes, of the UK Science and Technology Facilities Council Rutherford Appleton Laboratory, asked "can WLCG deliver?" He deduced that it can, and in fact does, but that there are many challenges still to face. Bos, of Nikhef and the ATLAS collaboration, compared the different computing approaches across the LHC experiments, pointing out similarities and contrasts. Femilab's Pordes, who is executive director of the Open Science Grid, described work in the US on evolving Grids to make them easier to use and more accessible to a wider audience of researchers and scientists.

The conference had a number of commercial sponsors, in particular IBM, Intel and Sun Microsystems, and part of Wednesday morning was devoted to speakers from these corporations. IBM used its slot to describe a machine that aims to offer cooler, denser and more efficient computing power. Intel focused on its effort to get more computing for less energy, making note of work done under the openlab partnership with CERN (p8). The company hopes to address this partially by increasing computing-energy efficiency (denser packaging, more cores, more parallelism etc) because it realizes that power is constraining growth in every part of computing. The speaker from Sun presented ideas on building state-of-the-art data centres. He claimed that raised floors are dead and instead proposed "containers" or a similar "pod architecture" with built-in cooling and a modular structure connected to overhead, hot-pluggable busways. Another issue is to build "green" centres and he cited solar farms in Abu Dhabi as well as a scheme to use free ocean-cooling for floating ship-based computing centres.

It impossible to summarize in a short report the seven streams of material presented in the afternoon sessions but some highlights deserve to be mentioned. The CERN-developed Indico conference tool was presented with statistics showing that it has been adopted by more than 40 institutes and manages material for an impressive 60 000 workshops, conferences and meetings. The 44 Grid middleware talks and 76 poster presentations can be summarized as follows: production Grids are here; Grid middleware is usable and is being used; standards are evolving but have a long way to go; and the use of network bandwidth is keeping pace with technology. From the stream of talks on distributed processing and analysis, the clear message is that much work has been done on user-analysis tools since the last CHEP, with some commonalities between the LHC experiments. Data-management and access protocols for analysis are a major concern and the storage fabric is expected to be stressed when the LHC starts running.

Dario Barberis of Genova/INFN and ATLAS presented the conference summary. He had searched for the most common words in the 500 submitted abstracts and the winner was "data", sometimes linked with "access", "management" or "analysis". He noted that users want simple access to data, so the computing community needs to provide easy-to-use tools that hide the complexity of the Grid. Of course "Grid" was another of the most common words, but the word "cloud" did not appear in the top 100 although clouds were much discussed in plenary and parallel talks. For Barberis, a major theme was "performance" – at all levels, from individual software codes to global Grid performance. He felt that networking is a neglected but important topic (for example the famous digital divide and end-to-end access times). His conclusion was that performance will be a major area of work in the future as well as the major topic at the next CHEP in Taipei, on 17–22 October 2010.

Sergio Bertolucci, CERN's director for research and scientific computing, opens the conference with a talk on the LHC and its experiments.

Further Reading

Material for this article is taken from the *CHEP '09 Trip Report* by Simone Campana, Jose Benito Gonzalez Lopez, Andrew Maier, Ricardo Salgueiro Domingues Da Silva, Alan Silverman (editor) and Juraj Sucik. The full report can be read at http://cdsweb.cern.ch/record/1173073?ln=en and most talks presented at the conference are available at http://indico.cern.ch/sessionDisplay.py?sessionId=1&slotId=5&confId=35523#2009-03-24.

Résumé

CHEP '09 : tout savoir sur les données, les grilles et le LHC

Les conférences CHEP, qui ont lieu tous les 18 mois, couvrent le vaste domaine du calcul en physique des hautes énergies et en physique nucléaire. CHEP 09, la 17e édition de cette manifestation, a eu lieu à Prague les 21 et 22 mars, et a rassemblé 615 participants provenant de 41 pays. Étant donné l'actualité de la physique, un grand nombre des exposés portaient sur des aspects divers du calcul pour les expériences du LHC, mais il y a eu également des contributions portant sur des expériences ayant lieu dans d'autres régions du monde. Les grilles étaient un thème commun dans ces exposés, de même que l'utilisation de l' « informatique en nuages » et la virtualisation. La conférence a été précédée d'un atelier sur la grille mondiale de calcul du LHC (WLCG).

Alan Silverman, *CERN.*

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Z: Energy Harvesting—From Fundamentals to Devices
AA: Renewable Biomaterials and Bioenergy—Current Developments and Challenges
BB: Green Chemistry in Research and Development of Advanced Materials

MATERIALS ACROSS THE SCALES

CC: Phonon Engineering for Enhanced Materials Solutions—Theory and Applications
DD: Microelectromechanical Systems—Materials and Devices III
EE: Metamaterials—From Modeling and Fabrication to Application
FF: Mechanical Behavior of Nanomaterials—Experiments and Modeling
GG: Plasticity in Confined Volumes—Modeling and Experiments
HH: Multiscale Polycrystal Mechanics of Complex Microstructures
II: Mechanochemistry in Materials Science
JJ: Multiscale Dynamics in Confining Systems
KK: Nanoscale Pattern Formation
LL: Multiphysics Modeling in Materials Design
MM: Ultrafast Processes in Materials Science
NN: Advanced Microscopy and Spectroscopy Techniques for Imaging Materials with High Spatial Resolution
OO: Dynamic Scanning Probes—Imaging, Characterization, and Manipulation
PP: Materials Education

HEALTH AND BIOLOGICAL MATERIALS

QQ: Responsive Gels and Biopolymer Assemblies
RR: Engineering Biomaterials for Regenerative Medicine
SS: Biosurfaces and Biointerfaces
TT: Nanobiotechnology and Nanobiophotonics—Opportunities and Challenges
UU: Molecular Biomimetics and Materials Design
VV: Micro- and Nanoscale Processing of Biomaterials
WW: Polymer Nanofibers—Fundamental Studies and Emerging Applications
XX: Biological Imaging and Sensing Using Nanoparticle Assemblies
YY: Compatibility of Nanomaterials

GENERAL INTEREST

X: Frontiers of Materials Research

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APPOINTMENTS

Lucia Votano takes the helm at Gran Sasso

Lucia Votano is to be the next director of the National Laboratory in Gran Sasso of Italy's National Institute of Nuclear Physics (INFN). The appointment was made by INFN's Board of Directors following the proposal of the Council. Votano will take office in September, when the second and last term of the current director, Eugenio Coccia, expires. This is the first time that a woman has been named as director of one of INFN's four large national laboratories.

Votano received her degree in physics from "La Sapienza" University in Rome in 1971 and in 1976 she began her career at the INFN laboratories in Frascati. She has collaborated on important research projects at CERN and at DESY. In 1988, she was promoted to senior researcher and became a research director in 2000. Votano is currently a member of the Peer Review Committee of the Astroparticle Physics European Co-ordination (ApPEC) and of the Roadmap Committee of the Astro Particle ERAnet (ASPERA), which last September produced a roadmap on the future of astroparticle research in Europe.

The laboratory under the Gran Sasso mountain is the world's largest underground laboratory for astroparticle physics. Research there includes the CERN Neutrinos to Gran Sasso project, in which neutrinos travel approximately 700 km from CERN for detection by the OPERA experiment, for which Votano was the co-ordinator, and in the near future by the Imaging Cosmic and Rare Underground Signal Experiment (ICARUS), developed by Carlo Rubbia.

Lucia Votano is to become director of the National Laboratory in Gran Sasso. (Courtesy INFN.)

After the honorary-degree ceremony, from left to right: Pascal Lamy, Lyn Evans, Desmond Tutu, Jean-Dominique Vassalli, rector of the University of Geneva, and Mary Robinson.

DEGREES

Geneva awards Evans honorary degree

Lyn Evans, who led the project to build the LHC from its inception in 1994 until start-up on 10 September 2008, was made doctor *honoris causa* by the University of Geneva in a ceremony held on 5 June. It was one of four honorary degrees bestowed on people renowned for their activities in bringing nations together. The other recipients were Pascal Lamy, director-general of the WTO; Mary Robinson, former President of Ireland and UN Commissioner on Human Rights from 1997–2002; and Desmond Tutu, archbishop-emeritus of Cape Town, renowned church leader and opponent of apartheid.

The ceremony was held in St Peter's Cathedral in Geneva and it was preceded by a procession in full academic regalia that included representatives from Europe's oldest universities. This year the University of Geneva is celebrating its 450th anniversary.

SCHOLARSHIPS

Erice announces new Weisskopf Scholarships

The United Nations has declared 2009 as the International Year of Astronomy, 400 years after Galileo Galilei first turned his telescope on the heavens. These celebrations have opened the way to a special grant awarded by the Italian government to the Subnuclear Physics School in Erice.

This school, the first in the field, was founded in 1963 at CERN by Patrick Blackett, Isidor Rabi and Victor Weisskopf, together with two fellows John Bell and Antonino Zichichi – in Weisskopf's office when he was director-general at CERN.

The special grant covers 50 fellowships named after Weisskopf, which will cover fees, full board and lodging for 50 new talents in the field of subnuclear physics. For details on how to apply for the Weisskopf Scholarships and information on the programme for the 2009 school, see www.ccsem.infn.it/ef/emfcsc2009/pdf/ISSP.pdf.

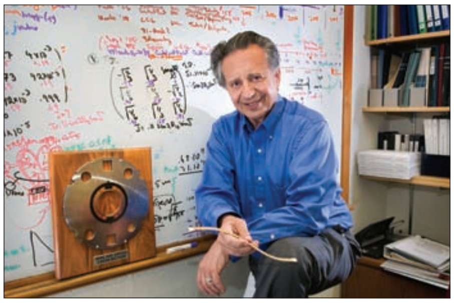
- The International School of Subnuclear Physics, Erice, takes place on 29 August to 7 September: www.ccsem.infn.it/issp/.

AWARDS

Samios receives Gian Carlo Wick award…

The World Federation of Scientists (WFS) has chosen Nicholas Samios, former laboratory director and director of the RIKEN BNL Research Center at the US Department of Energy's Brookhaven National Laboratory, as the recipient of the 2009 Gian Carlo Wick Gold Medal award, which is given annually to a theoretical physicist for outstanding contributions to particle physics.

Samios was cited "for his visionary role in the successful construction of the Relativistic Heavy Ion Collider, and for his intellectual leadership in a series of remarkable experimental discoveries, which established the existence of quark gluon plasma, a new phase of strongly interacting nuclear matter".



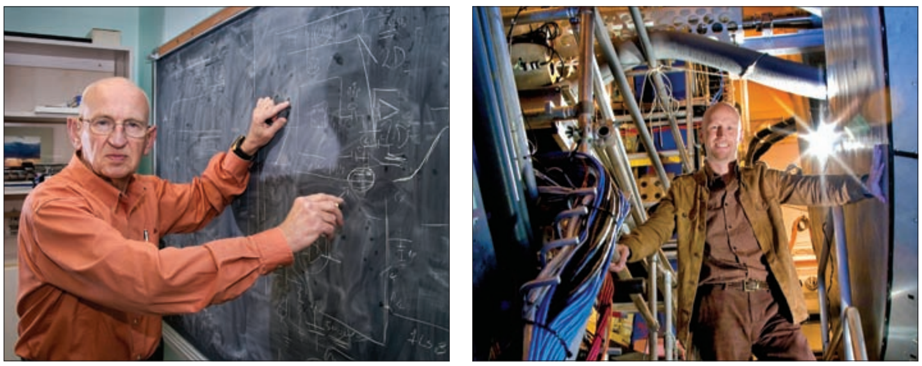
Nicholas Samios. (Courtesy BNL.)

The WFS was founded in 1973 in Erici by a group of eminent scientists led by Isidor Isaac Rabi and Antonino Zichichi. Now an association of more than 10 000 scientists from 110 countries, the WFS aims to share knowledge among all nations so that everyone can experience the benefits of scientific progress. The award is named in honour of Gian Carlo Wick (1909–1992), a native of Italy and an eminent theoretical physicist who led the theory group at Brookhaven from 1957 to 1965. Samios will receive the prestigious award on 20 August at a WFS meeting to be held in Erice.

…while Radeka and Sorensen are honoured by IEEE and APS

The Long Island Section of the IEEE has honoured Veljko Radeka, head of the Instrumentation Division at Brookhaven, with the Harold Wheeler award for "outstanding leadership and accomplishments in detector development, which enabled discoveries in many areas of science and technology in a career of sustained productivity spanning over 50 years".

Radeka and colleagues have developed numerous state-of-the-art detectors that are used in major laboratories around the world. For example, in the 1970s, he worked with Bill Willis to develop liquid-argon calorimeters, which are used at most major particle physics facilities, including CERN. This early work led to Brookhaven's contributing key components to the ATLAS detector in the LHC. Continuing these developments, Radeka and colleagues are working on the technology for large neutrino detectors to be used in the future.



Veljko Radeka, left, and Paul Sorensen, right, have both received professional honours. (Courtesy BNL.)

Physicist Paul Sorensen at Brookhaven has received the 2009 George E Valley Jr Prize from the American Physical Society (APS), awarded at the April meeting of the APS in Denver. The prize is awarded biennially to an individual in the early stages of his or her career for an outstanding scientific contribution to physics that is deemed to have significant potential for a dramatic impact in the field. Sorensen was to receive the prize at the April 2009 APS meeting in Denver.

He was recognized for his role in discovering that quarks are important throughout the expansion of the matter created in heavy-ion collisions at the Relativistic Heavy Ion Collider. With his colleagues, he measured the mass, momentum and direction of subatomic particles from data derived from the STAR detector. Sorensen and his collaborators proved that the "perfect" liquid depends on the interactions of quarks, rather than on more obvious properties, such as mass.

CORRECTIONS

In the issue of June 2009, errors crept into figures quoted in the following articles. The uncertainty quoted on p8 for the mass measurement of ^{70m}Br at NSCL should be 15 keV not 0.15 keV. In the article about results from Borexino, there should be no horizontal error on the data point close to 1 MeV in the plot on p13 of electron–neutrino survival probability at Earth (as this point refers to monoenergetic neutrinos from ^{7}Be). The telescopes used in the HEGRA project described on p21, had an area of 8.5 m^2, not a diameter of 8.5 m. Apologies to all concerned.

In the issue of April 2009, the caption to the photo in the archive article on p13 refers to the inner conductor of the neutrino "horn". In fact it shows the inner conductor of one of the reflectors, as correctly indicated in the article.

Markov prize goes to Bolotov and Obraztsov

Vladimir Bolotov from the Institute for Nuclear Research (INR) of the Russian Academy of Sciences in Moscow and Vladimir Obraztsov from the Institute for High Energy Physics (IHEP) in Protvino have been awarded the Markov prize for 2009. INR established the prize in 2002 in memory of Moisey Alexandrovich Markov, one of the founders of the institute. The awards were made at the 7th Markov Readings held in Moscow on 15 May.

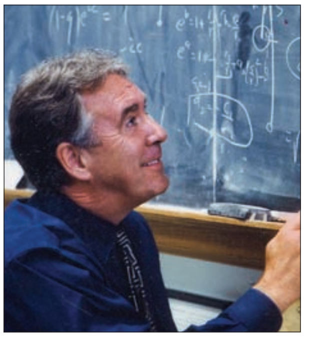
Bolotov and Obraztsov have received the prize for their outstanding contribution to the study of rare meson decays and the creation of the ISTRA+ facility at the IHEP U-70 proton synchrotron. Bolotov, who leads a large collaboration from INR, IHEP and JINR, was responsible for the creation of the ISTRA facility. Obraztsov, who has found a number of rare decays, has worked on experiments at IHEP and at CERN. Both physicists have also contributed a great deal to the creation of new facilities for studying rare decays – ISTRA+ and its successor OKA (p5) – and put forward an idea to elaborate a new experiment, KLOD, at IHEP to search for the super-rare decay $K_L^0 \rightarrow \pi^0 \nu \bar{\nu}$.

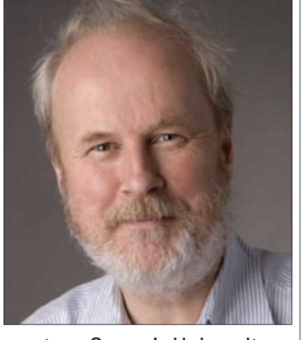
Left to right: Vladimir Kravchuk, a former Markov prize winner, Victor Matveev, director of the INR, Vladimir Obraztsov, Vladimir Bolotov and Valery Rubakov. (Courtesy INR.)

Particle physicists join the ranks of FRS

On 15 May the Royal Society in London announced the election of new fellows, including three leading figures in the field of particle physics. Michael Duff of Imperial College London is elected for his key contributions to developing quantum ideas in supergravity, string theory and M-theory. Fermilab's Keith Ellis is distinguished for his seminal contributions to quantum chromodynamics, the theory of the strong interactions, having performed many of the key calculations that led to the acceptance of QCD as the correct theory. Art McDonald of Queen's University, Ontario, and director of Sudbury Neutrino Observatory is honoured for his outstanding research in nuclear structure physics, into the charge symmetry of nuclear forces and the influence of the weak interaction on quark interactions.

In addition, Rashid Sunyaev, director of the Max Planck Institute for Astrophysics and chief scientist of the Space Research Institute, Russian Academy of Sciences, becomes a Foreign Member of the Royal Society, "as the greatest Russian astrophysicist of our time".





Left to right: Art McDonald, Michael Duff and Keith Ellis. (Photos courtesy Queen's University, Ontario, M Duff and Fermilab Visual Media Services.)

IPS honours Kakodkar with Chugani Award

Anil Kakodkar, chairman of the Indian Atomic Energy Commission and secretary in the Department of Atomic Energy, has received the Indian Physics Association's 2008 M M Chugani Memorial award for excellence in applied physics "in recognition of his outstanding contributions to Indian Nuclear Science and Technology". The prize ceremony took place on 11 May, National Technology Day in India, at the Nehru Centre in Mumbai, where Kakodkar received the award from Bikash Sinha, president of the IPA and director of the Variable Energy Cyclotron Centre and the Saha Institute of Nuclear Physics, Kolkata. Kakodkar played an important role in the design and construction of the Dhruva reactor at the Bhabha Atomic Research Centre, where several new technologies related to electron-beam welding, reactive material fabrication and dissimilar metal joints were deployed on a large scale.

Bikash Sinha, left, presents the M M Chugani award to Anil Kakodkar. (Courtesy IPA.)

PhD thesis prize for Couet and Röhrs

This year's PhD thesis prize of the Association of the Friends and Sponsors of DESY is shared by Sebastien Couet and Michael Röhrs, both from the University of Hamburg. The annual prize acknowledges the best doctoral thesis on DESY physics. Couet receives the prize for his thesis on "The structural and magnetic properties of Fe/native oxide systems resolved by X-ray scattering and spectroscopy methods". His results point out a new way of stabilizing novel magnetic structures. Röhrs receives the prize for his thesis on the "Investigation of the Phase Space Distribution of Electron Bunches at the FLASH Linac Using a Transverse Deflecting Structure". His work covers high-resolution beam diagnostics at the free-electron laser, FLASH.

Left to right: Sebastien Couet, DESY director Helmut Dosch and Michael Röhrs. (Courtesy DESY.)

CONFERENCE

ICNTS '08 follows nuclear tracks in Bologna

The 24th International Conference on Nuclear Tracks in Solids (ICNTS) took place in September 2008 at the Belmeloro Conference Complex of the University of Bologna. Organized by the university together with the International Nuclear Track Society (INTS), INFN and the Italian National Agency for New Technologies, Energy and the Environment (ENEA), the conference as usual provided an opportunity for very different scientific communities to meet, with topics ranging from fundamental research in physics and astrophysics to applied research in the environment, health and advanced technologies, such as nanotechnologies.

Participants at the 25th ICNTS in Bologna. (Courtesy Fabio Bisi INFN/Bologna.)

INTS has a long tradition in nuclear track detectors (NTDs) and their applications. NTDs can record the passage of heavily ionizing particles through the production of a nanometre-scale damage zone (the "latent track") along their trajectories. The latent track can be amplified by applying appropriate chemical etching and it appears, under an optical microscope, as a cone-shaped etch-pit. The technique, which employs materials such as polymers, glasses and minerals, is relatively low cost and so may be used by small groups of researchers in developing countries. It becomes more costly if automatic scanning systems are needed to analyse large surface areas.

With their resistance to radiation and excellent charge resolution (which can be as low as 1/20th of the electron charge), NTDs allow searches at accelerators for the production of heavily-ionizing particles, such as point-like magnetic monopoles, and studies of ion-fragmentation processes. In many cases, when the event rate is expected to be small – as in searches for exotic particles in the cosmic radiation – NTDs provide a viable detection technique as they are passive, reliable on long runs and easy to deploy. In applied physics they are widely used for radon monitoring, neutron dosimetry and in medical applications.

More than 140 people from 30 countries (mainly from Europe, China, India, Pakistan, Russia and South America) attended the 24th ICNTS. The conference programme included invited plenary talks on hadron therapy, radiation protection in space, searches for exotic phenomena, and the status of large projects. Parallel sessions for oral and poster presentations (with about 300 abstracts submitted) covered the following topics: particle and nuclear physics; high-energy interactions and cosmic rays; radiation environment monitoring; neutron dosimetry; medical applications; radiation-induced damage; Earth and planetary sciences and dating; and nano and microstructure technology, methods and instrumentation. In addition, a special session on the "Energy problem" was open to students and the general public.

During the conference, Denis O'Sullivan, emeritus at Dublin Institute for Advanced Studies, was awarded the R Walker Medal, in acknowledgement of his outstanding contribution to the field. Yi Lun Law, a student at the City University of Hong Kong, was awarded the V Perelygin Prize for the originality of her research work and presentation skills. There were also awards for several posters, the first prize going to "School Education by Observation of Nuclear Tracks in Solids" by T Tsuruta of the Atomic Energy Research Institute, Kinki University in Japan. The poster was chosen for its originality and the application of scientific ideas in everyday life and for teaching.

● The proceedings of the conference are being published in *Radiation Measurements* (Elsevier). The 25th ICNTS will be held in Puebla, Mexico, in 2011.

JINR

Golutvin celebrates 75th birthday at Dubna

Igor Golutvin, one of the leading scientists at JINR, Dubna, celebrates his 75th birthday in August. He is well known for several generations of large-scale experiments at JINR's synchrophasotron and at the accelerator of the Institute for High Energy Physics in Protvino, as well as at CERN.

Golutvin began to develop and study wire spark chambers for neutrino experiments during his first visit to CERN in 1964, at the time when online computers were first used. This experience helped him involve electronic methods in experiments at the synchrophasotron and at the U-70 accelerator at Protvino. Under his leadership, the USSR then had its first – and one of the world's first – apparatus to study elastic pp-scattering and K^0–$\bar{K}^0$regeneration.

In 1974 Golutvin was one of a group of physicists sent to CERN to establish a joint JINR–CERN experimental programme. The successful work by Golutvin and the Dubna team strengthened the participation of the JINR physicists at CERN and promoted the development of co-operation. As a result the first joint experiment, NA4, by the Bologna–CERN–Dubna–Munich–Saclay collaboration, was approved in 1975. Golutvin led the R&D and construction of large proportional chambers for this experiment.

Igor Golutvin. (Courtesy A Zarubin.)

At Dubna he organized a powerful base for R&D and mass-production of different types of wire detectors and their electronics. Drift and proportional chambers constructed under his leadership were used in experiments at Dubna and Protvino, and large-area chambers manufactured at Dubna were used in the SMC experiment at CERN and in HERA-B at DESY. In 1988 Golutvin initiated the Dubna silicon programme to develop applications of radiation-hard silicon detectors in experiments at colliders.

For the past 16 years Golutvin has been an organizer of international co-operation in the CMS project at the LHC. He has been spokesperson for the Russia and Dubna Member States (RDMS) collaboration in CMS since 1994. The RDMS–CMS collaboration, which involves 24 research institutes, was responsible for the design, construction and commissioning of the endcap hadron calorimeter and first forward muon stations, with active participation in the design and production of several other sub-detectors. Golutvin has also paid meticulous attention to development of the RDMS physics programme, grid-based computing and the CMS upgrade for the proposed Super-LHC.

● A session of the 13th Annual RDMS–CMS Collaboration Conference dedicated to Golutvin's 75th birthday will be held in Dubna on 10 August.

WORKSHOP

Leimen provides a charming welcome

The CHARM 2009 workshop, organized by GSI, took place on 20–22 May in the mediterranean ambience of Hotel Villa Toskana in Leimen. A total of 60 experts from four continents met at this international workshop on the physics of charm quarks to discuss the current state of research.

The main subjects apart from the production mechanisms of the medium-weight representatives of the quark family were hidden-charm and open-charm states and spectroscopy, as well as measurement of the properties of charmed baryons and mixing of neutral D mesons. Special attention was given to the discussion of experiments currently running, such as BESIII, which started last summer in Beijing, and to future experiments such as LHCb at CERN and the PANDA experiment proposed at the Facility for Antiproton and Ion Research, which will allow significant improvements in the precision of all kinds of measurements in this field, owing to the superior statistics. The next and fourth workshop in this series will most likely be held in autumn 2010 in Beijing.

Participants pose for the "family photo" at CHARM 2009 in Leimen. (Courtesy GSI.)

● For more information about CHARM 2009 visit http://charm09.gsi.de/.

OBITUARY

James V Allaby 1936–2009

Jim Allaby, a well known figure at CERN and in the international particle physics community passed away on 7 April.

Jim was born in Preston, England, in October 1936. After obtaining a first degree in physics at King's College, London, he went to Liverpool to study for his PhD at the university's synchrocyclotron. This was his first proton–proton scattering experiment and was the start of a lifelong friendship with Bert Diddens, who was there as a CERN fellow.

In the early 1960s Jim moved to SLAC where he worked with Dave Ritson on electron inelastic scattering. Ritson greatly appreciated Jim's calm and systematic approach to any kind of problem that he was confronted with. It was natural for Jim to visit SLAC later and for Ritson to join the DELPHI collaboration in the 1990s.

Jim came to CERN in 1965 and joined the group of Giuseppe Cocconi, Bert Diddens and Alan Wetherell, who were preparing proton–proton scattering experiments in a slowly extracted proton beam at the highest PS energies. This led to the discovery of structures in large-angle scattering and the "black disc" behaviour of elastic scattering.

In 1968 a CERN group – formed around Alan, Bert and Jim – initiated a collaboration to study particle production and the total hadron–hadron cross-section at the new 70 GeV accelerator of the Institute for High Energy Physics (IHEP) at Protvino, near Serpukhov. Jim took this mission very seriously and learned Russian much better than the others did. The bureaucracy was tough; the people in Protvino were not allowed non-professional contact with the CERN team, but Jim excelled in overcoming this, thanks to his character, social skills and knowledge of the language. His role in the development of relations with eastern Europe continued during the time of the SPS at CERN, when he served on the Joint Scientific Committee for co-operation between CERN and IHEP. Later he was co-chairman on a similar committee for co-operation between CERN and JINR.

In 1970 the CERN group joined the Rome–ISS (Istituto Superiore di Sanità) group, which had proposed measuring small-angle elastic scattering at the nearly completed Intersecting Storage Rings, using the technique that became known as "Roman pots". Jim participated in the initial phase of the experiment, which brought several discoveries including the rising proton–proton cross-section. However, he was becoming more involved in serving the physics community, as PS co-ordinator in 1970 and later as a member of the team preparing the SPS experimental programme. John Adams, then director-general, appointed Jim as physics co-ordinator for this programme, working in close collaboration with the Experimental Areas Groups, in charge of designing the areas and the beams. This fruitful co-operation led to the construction of the initial complement of beams with the required particle detection and identification devices. Here Jim displayed his very special qualities, by implementing his own vision, but always making reasonable compromises and decisions without upsetting his partners.

James V Allaby.

His own interest at the SPS was in studies of the neutrino neutral-current interactions performed by the CERN–Hamburg–Amsterdam–Rome–Moscow (CHARM) collaboration. These included tests of the nature of the charged-current interactions, which were based on the measurement of the polarization of muons produced upstream in the iron calorimeter of the CDHS experiment. This required transforming CHARM's 400 tonne marble calorimeter into a muon polarimeter. Jim was very active in the construction of the detector and in this transformation in particular.

At the end of the 1970s Jim became one of the founding fathers of the DELPHI experiment. He played an important role in the genesis of the ring-imaging Cherenkov detector during the phase that led from the initial spherical design to the final cylindrical shape. DELPHI was the first collaboration to form an interdivisional group at CERN and to separate the responsibilities of the leader of the "CERN team" from the ones of the spokesman. Jim covered the role of team leader for many years with his usual dedication, efficiency and friendly style of management. In parallel he led the DELPHI Data Acquisition Project from the design to the implementation phase in 1989.

Jim was nominated division leader when Carlo Rubbia was director-general, and in this role continued his strong support for the programme at the Large Electron–Positron (LEP) collider. He was also put in charge of relations with CERN's non-member states.

After completing his term as division leader, Jim joined the L3 collaboration at LEP. He made important contributions to many of the collaboration's publications and was chairman of the L3 Publication Board. After L3 he worked on the Alpha Magnetic Spectrometer (AMS), participating in the preparations for the experiment's first shuttle flight and for the AMS mission on the International Space Station.

After retirement he became a member of the Committee of the CERN–ESO Pensioner's Association, once more serving the community – this time the CERN pensioners and their family members.

We share our sorrow with his family and we convey our deepest condolences and sympathy to Jean and Peter.
His colleagues and friends.

NEW PRODUCTS

ACT/Technico offers Interface Concept's fully managed IPv4/IPv6 ComEth4300a 10 Gbit Ethernet switches. Designed for demanding networking applications and built on Marvell's Prestera GigE packet processors, the new family of Gbit Ethernet switches ranges from 24 to 28 ports, with four of them able to reach 10 Gbit. For more, contact Valerie Andrew tel +1 800 445 6194; e-mail sales@acttechnico.com; or visit http://ww3.acttechnico.com.

AMS Technologies has announced the PPMCI series, the latest addition to the Leclanché Capacitors family. This capacitor offers extreme mechanical stability owing to the rugged 16-pin contact and uses the latest self-healing polypropylene and polyester films. Models offer voltage/capacitance combinations such as 600 VDC and 35 μF, including a 2800 VDC version. For more information tel +49 89 89 5770; e-mail salesinfo@ams.de; or visit www.ams.de.

INTEGRATED Engineering Software has introduced the LORENTZ simulation software, which includes meniscus calculations for charged particle extraction from a plasma source. LORENTZ is an easy-to-use solver for analysing charged particle trajectories in the presence of electric and magnetic fields. The technique can also be applied to determine cathode shapes for uniform flux electron guns. For more information tel +1 204 632 5636; or visit www.integratedsoft.com.

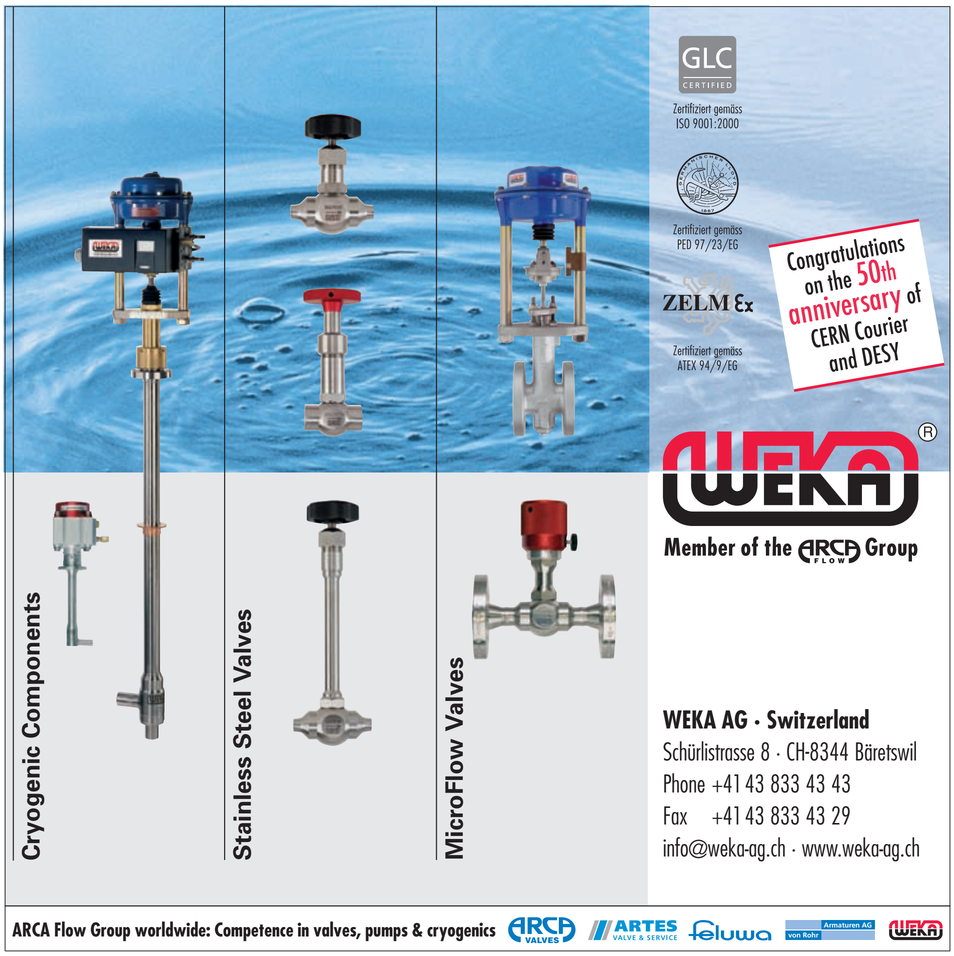
KLASTECH-Karpushko Laser Technologies GmbH has launched its new DPSS laser, CRESCENDO, which for the first time provides continuous-wave output at the ruby wavelength, 693.4 nm. Available initially in 100 mW and 150 mW versions, the laser produces a single longitudinal frequency of <1 MHz line-width with a coherence length in excess of 100 m. For more information contact Chris Madin, tel +49 231 47730 640; fax +49 231 47730 620; e-mail info@klastech.de; or visit www.klastech.de/CRESCENDO/html.

Pfeiffer Vacuum has introduced OmniStar and ThermoStar, two benchtop analysis systems for precise monitoring of process analysis for up to 28 different gases. They are also able to identify unknown gases and detect low limits of gases. The units cover a mass range of 1–100 amu, 1–200 amu and 1–300 amu. For more information, contact Sabine Trylat, tel +49 6441 802 169; e-mail Sabine.Trylat@pfeiffer-vacuum.de; or visit www.pfeiffer-vacuum.net.

Princeton Gamma Tech Instruments has launched the Sahara III, a new silicon drift detector that delivers fast cool-down periods of less than five minutes. The reduction in cool-down times allows an improvement in throughput and data collection. The Sahara III is useful for end-users who are changing samples frequently, or in a shared vacuum requiring thermal cycling. For more, tel +1 609 924 7301; or visit www.pgt.com.

Sofradir has introduced the avalanche photodiode MWIR detector that uses mercury cadmium telluride technology. Designed for active imagery, spectrometry and a range of scientific applications, its micron-pitch IR detector enables users to operate cameras with small apertures or with narrow wavebands in extreme low-light detection. For more information, contact Carol Leslie or Marie-Laure Melchior, tel +33 156 5407 00; e-mail carol@ala.com or marielaure@ala.com; or visit www.ala.com.

TREK Inc has announced a new high-voltage power amplifier, Trek Model PZD350A, which provides a large signal bandwidth of 250 kHz and a small signal bandwidth greater than 350 kHz. It has high speed and precise control of output voltages (DC or peak AC) in the programmable ranges of 0 to +/−350 V with an output current range of 0 to +/−200 mA (bipolar model); 0 to 700 V with +/−100 mA (unipolar model); 0 to −700 V with +/−100 mA (unipolar model). For more information, contact Mary Spohn, tel +1 800 367 8735; e-mail marketing@trekinc.com; or visit www.trekinc.com.



SYMPOSIUM

Special APS session focuses on global physics projects

CERN's LHC has ushered in an era of physics projects that are truly global in scale. These projects are massive in scope, take decades to plan and execute, and cost billions of dollars. A prime example is ITER, the joint international research and development project that aims to demonstrate the scientific and technical feasibility of fusion power. During its annual meeting in Denver on 2 May the American Physical Society (APS) held a special symposium and a panel discussion on "Global Physics Projects", co-organized by the APS Forums on Physics & Society and International Physics.

The panel, from the right: Dennis Kovar, Pier Oddone, Chris Llewellyn Smith and Jack Gibbons, with chairs Lawrence Krauss and Pushpa Bhat (far left). (Courtesy C Bhat and Don Prosnitz.)

The panel included Christopher Llewellyn Smith, who is currently chairman of the ITER Council and president of the council for the Synchrotron-light for Experimental Science and Applications in the Middle East (SESAME) facility. He was director-general of CERN at the time the LHC was approved in 1994 and when the US and CERN signed an agreement on the LHC in December 1997. Jack Gibbons, who was then director of the White House Office of Science and Technology Policy and presided over the signing ceremony, was also on the panel. Other panelists were Dennis Kovar, the associate director of science for high-energy physics in the US Department of Energy; Pier Oddone, director of Fermilab; and Lawrence Krauss, director of the Origins Initiative at Arizona State University. The session was chaired and organized by Fermilab's Pushpa Bhat, who collaborates on the D0 experiment at the Tevatron and the CMS experiment at the LHC.

The symposium began with a keynote address by Llewellyn Smith on "International Scientific Collaboration", followed by brief remarks by other panelists. The ensuing panel discussion considered the lessons learned so far from large projects, and questions and issues to be addressed for future projects. Are the mechanisms and procedures in place adequate? What and who should be the drivers for decision making? How should we fund, manage and execute global projects?

Global projects are essential for addressing important scientific and technical challenges in the 21st century. They could also help to build political bridges between nations and across diverse societies, as Llewellyn Smith pointed out. Krauss reinforced this, saying that such projects "have been remarkable in allowing countries that will not otherwise interact to interact, and not just at a peripheral level, but at a fundamental level. The fact that the LHC can be built by thousands of physicists in hundreds of countries speaking dozens of languages is remarkable."

VISITS

President of the government of the former Yugoslav Republic of Macedonia Nikola Gruevski (left) visited CERN on 27 April. He visited the CMS experiment, together with CMS spokesperson Jim Virdee and was given a presentation about the LHC grid project before touring the Computing Centre. He also visited the LHC tunnel.

On 3 May the Japanese minister of state for science and technology policy, food safety, minister of consumer affairs and minister of space policy, Seiko Noda (right), visited CERN. Together with Taka Kondo of KEK and the ATLAS Collaboration, she toured the ATLAS control room and the LHC tunnel, where she saw the inner triplet magnets to which KEK contributed. She also visited the CERN Control Centre before meeting with Japanese researchers and students based at CERN.

Carlos Martinez Alonso (right), the Spanish secretary of state for research, ministry of science and innovation, toured the CMS experimental cavern on 13 May with Guido Tonelli, deputy CMS spokesperson. He also toured the Computing Centre and the ATLAS experiment and met with members of CERN's Spanish community.

RECRUITMENT

For advertising enquiries, contact *CERN Courier* recruitment/classified, IOP Publishing, Dirac House, Temple Back, Bristol BS1 6BE, UK.
Tel +44 (0)117 930 1027 Fax +44 (0)117 930 1178 E-mail sales@cerncourier.com
Please contact us for information about rates, colour options, publication dates and deadlines.

LIGO

OPTO-MECHANICAL SIMULATION PHYSICIST

Laser Interferometer Gravitational-Wave Observatory (LIGO) in Pasadena, CA

The candidate will develop code for the simulation of interferometric gravitational wave detectors under the direction of a senior LIGO scientist. The candidate will begin by working on existing models which have been under development for some years and will work to extend the models to simulate a full Advanced LIGO interferometer. In addition, they will spend time working at the sites using the results of simulations to facilitate the commissioning of the Advanced LIGO Detectors. This is 3-year term, renewable position.

Masters degree in a related discipline with at least 8 years of relevant experience is required. Good programming skills using object oriented design, experience in the simulation of complex opto-mechanical systems or other equally complex scientific experiments and a strong knowledge of physics. The candidate must have an excellent working knowledge of C++ and will be required to supply samples of their code as part of the application process. In addition to strong experience in the simulation of complex systems, the candidate must have a good background in physics including: 1) basis optics including optical beam propagation, 2) mechanics, and 3) heat transfer.

To be view a full job description and/or to be considered for this position, please submit your resume at the following link:

http://tinyurl.com/dx5lju

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European Synchrotron Radiation Facility

We Highlight Science

The ESRF is a multinational research institute, employing 600 staff, located in Grenoble in the heart of the French Alps. The ESRF is financed by 19 countries and carries out fundamental and applied research with synchrotron (X-ray) light.

In the context of an upgrade of the accelerator systems, we are currently seeking:

A Post-doctoral Fellow (m/f)

for the development of a cryogenic permanent magnet undulator, Ref.PDAS02
For further information please consult:
http://www.esrf.fr/Jobs/Research/PDAS02

To apply send a letter and CV + application form (available on http://www.esrf.fr/Jobs/Applying), bearing the reference PDAS02 before 20 August 2009 to recruitment@esrf.fr or ESRF, Personnel Group, 6 rue Jules Horowitz BP 220, 38043 Grenoble cedex 09.

Deadline for applications: 20 August 2009.

TRAVAILLER À L'UNIVERSITÉ DE GENÈVE

The Faculty of Sciences at Geneva University opens the application of position of

Full Professor, Associate Professor or Assistant Professor win Theoretical Physics

POSITION: This is a permanent full time position with 6 hours of teaching per week as well as research activities at the interface of quantum information and condensed matter theory or theoretical quantum optics. The candidate is expected to pursue a rigorous program in this field and to participate in the supervision of graduate students and teaching on all levels.

CHARGE: 100%
REQUIREMENTS: PhD in physics or equivalent.
STARTING DATE: September 1, 2010 or as agreed.

Applications, including curriculum vitae, list of publications and list of references are to be sent before 31st October, 2009 to the Secretary of the Dean of the Faculty of Sciences, 30, quai Ernest Ansermet, CH-1211 Genève 4 (Switzerland), where further information concerning this position and the working conditions can be obtained, or by e-mail to: lisette.marques@unige.ch.

The University of Geneva is an equal opportunity employer and encourages female candidates.

UNIVERSITÉ DE GENÈVE

TECHNISCHE UNIVERSITÄT DRESDEN

At the **Faculty of Science, Department of Physics**, in the **Institute for Nuclear and Particle Physics** we have an opening for a

Postdoctoral Fellow in Experimental Particle Physics (E 13 TV-L)

The position is starting after 01.12.2009 for an initial period of three years with a possible extension of two years. The period of employment is governed by the Fixed Term Research Contracts Act (Wissenschafts-zeitvertragsgesetz – WissZeitVG).

The ATLAS group in Dresden is a member of the "Forschungsschwerpunkt FSP-101" of the BMBF, the Helmholtz-Alliance "Physics at the Terascale" and of the Graduate school 1504 "Masse, Spektrum, Symmetrie" of the DFG. Activities of our group include studies of signal and background processes for Higgs boson searches both within and beyond Standard Model, reconstruction and identification of tau-leptons as well as operation and maintenance of the ATLAS Liquid-Argon calorimeter.

Duties: The successful candidate is expected to play a leading rôle in our data analysis activities. He/She will contribute to the maintenance of the local computing cluster in close collaboration with the Dresden Center for High Performance Computing (ZIH). Participation in the development of digital readout electronics at the interface to the trigger system for the upgrade of the liquid-Argon calorimeter in the context of the sLHC project and contributions to the teaching activities at the faculty are possible.

Qualification: A Ph.D. in experimental high energy physics is required. The successful candidate should have an excellent record of scientific achievements and the ability to coordinate the scientific activities of the group. Experience in the field of "Distributed Computing" or in digital electronics and fast serial networks would be an asset. Exceptional candidates will be offered the possibility of a "Habilitation".

Applications from women are particularly welcome. The same applies to disabled people.

Please submit your application by **August 27, 2009** (Deadlines refer to the date on the postmark of the University's Post Room Service) including your CV, a summary of research interests, list of publications with own contributions, a copy of the certificate of your highest academic degree and three names of referees to **TU Dresden, Fakultät Mathematik und Naturwissenschaften, Fachrichtung Physik, Institut für Kern- und Teilchenphysik, Herrn Prof. Dr. M. Kobel, 01062 Dresden, Germany** or to **IKTP@physik.tu-dresden.de** (Please note: We are currently not able to receive electronically signed and encrypted data).

The Excellence Cluster for Fundamental Physics

'Origin and Structure of the Universe'

The Cluster of Excellence 'Origin and Structure of the Universe' is a research institution at the Technical University Munich funded by the Excellence Initiative of the Federal Government of Germany. It is a co-operation by the physics departments of the Technical University Munich and the Ludwig-Maximilians University, four Max-Planck Institutes (MPA, MPE, MPP, IPP) and ESO. The main goal of the Cluster is to solve fundamental questions of astrophysics and cosmology.

RESEARCH FELLOWS

In the **Fellow Program** we are looking for excellent young scientists (experienced postdocs). One of the most prominent goals of the Cluster is to foster interdisciplinary work between particle and astrophysics. Therefore, we are especially interested in candidates who can contribute to the following fields:

- Dark matter and SUSY,
- Leptogenesis and matter-antimatter asymmetry,
- Neutrinos and stellar explosions.

Beside these vacancies, candidates can also apply with research issues chosen by themselves. Research fellows with the Cluster are expected to engage in a strong collaboration with existing research groups. They will receive their own budget for running costs. The duration of their contracts is two years.

POSTDOCTORAL RESEARCHERS

DOCTORAL STUDENTS

Postdoctoral Researchers will work in specific groups and in well-defined projects, outlined in more detail in the specific job description on our website.

Doctoral Students will be assigned to specific projects and supervisors. The students will be enrolled at the supervisor's University that will also award the doctoral degree in physics. The duration of the PhD program is three years.

Candidates of all groups are chosen in a competitive manner. They will benefit from the outstanding scientific infrastructure at the Garching Campus and the team-oriented, interdisciplinary work atmosphere. Regular seminars, conferences and our extensive visiting-scientists program offer excellent opportunities for researchers to broaden their scientific horizon and embark upon new collaborations.

The advancement of women in science is an integral part of the Cluster's and the University's policies. Therefore, we especially encourage women to apply. Persons with disabilities will be given preference to other applicants with equal qualifications.

Application:
Details on job vacancies and research of the Cluster can be found on our website **www.universe-cluster.de**. Applicants should complete the web-based application form in the respective job description **(-> jobs button)**. Here you also find further information on deadlines and the application documents required.

Contact:
Technische Universität München · Excellence Cluster Universe
Dr. Andreas Müller · Boltzmannstrasse 2
85748 Garching · Germany

The Abdus Salam International Centre for Theoretical Physics

SENIOR RESEARCH SCIENTIST POSITION

The Abdus Salam International Centre for Theoretical Physics (ICTP) is a world-class institution focused on research in basic sciences with responsibility for the promotion, dissemination and support of science, especially in developing countries. It operates under the aegis of UNESCO and IAEA.

P-4 post - ref: EU/TP/ITA/SC/0824

- Physics at Large Hadron Collider (LHC) and future accelerators

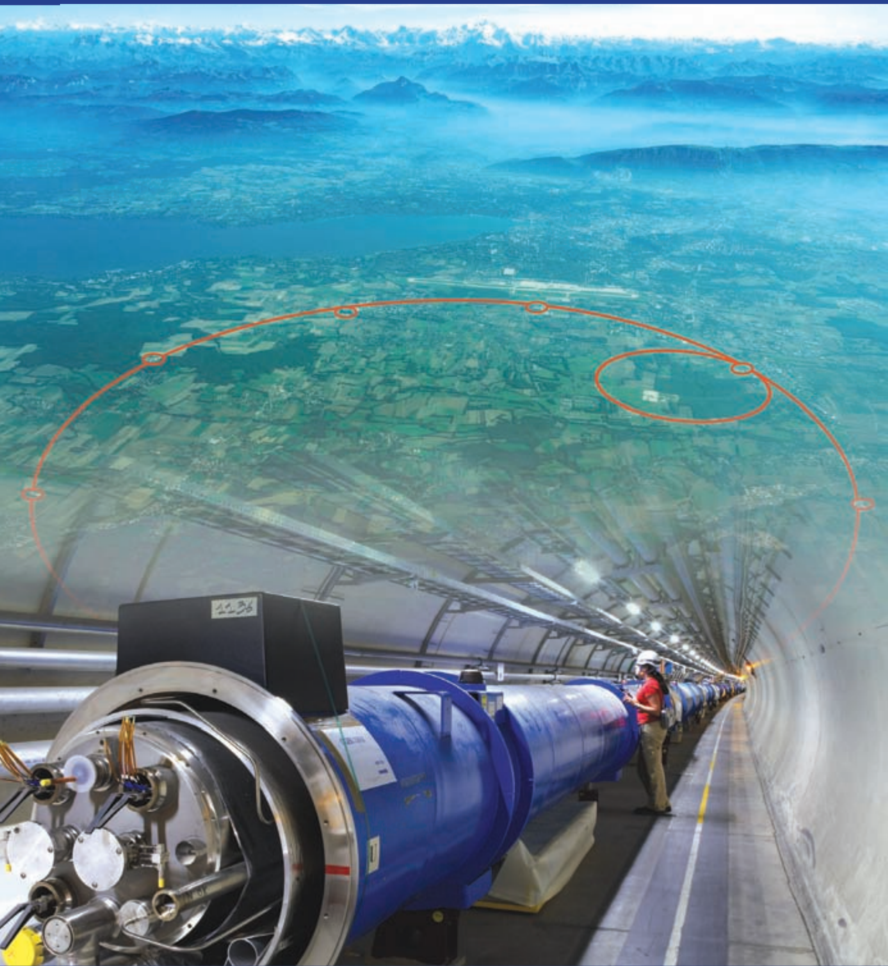
The successful candidate is expected to undertake forefront research in "Physics at LHC and Future High Energy Colliders". He/she should create and lead a research team composed of post-doctoral fellows and visitors. He/she should establish and maintain scientific contacts with CERN and other accelerator centres and act as a liaison between the High Energy group and another groups around the world. He/she is expected to lecture in the High Energy Diploma Programme, to coordinate and supervise the organization of schools and conferences and run the visiting programme in the area of Physics at LHC and Future High Energy Accelerators.

Requirements:
- Ph.D. or equivalent doctoral level in physics, with speciality in High Energy Physics
- 7-10 years of progressively responsible relevant experience, of which preferably 5 - 7 years acquired at the international level after completion of Ph.D
- An established record of accomplishment in a broad area of research and be engaged in independent research at the frontiers of his/her field; an established record of publications in high-impact scientific journals
- Excellent knowledge of written and spoken English
- A positive attitude towards the international and multicultural characteristics involved in the assignment

Information and applications: **http://portal.ictp.it/vacancy.**
Deadline: 30 November 2009.

Advertise your vacancy to a global audience
on the new jobs website from IOP Publishing.

www.brightrecruits.com



CERN is at the forefront of technologies in many fields, and there are opportunities for both working and learning at CERN, including student and graduate programmes, as well as vacancies in many fields.

• Student Programmes

Opportunities in physics, engineering and computing

How about spending a paid training period in an exciting multidisciplinary and multicultural environment together with leading scientists from all over the world? Various possibilities are offered to students from the CERN Member States to come and join the world's leading particle physics laboratory.

• Fellowship Programme

Particle physics research and a broad range of applied science, computing and engineering opportunities

Boost your career and contribute your ideas to the Organization! Have you recently graduated from university or an advanced technical institute? Are you interested in working for one or two years in an international environment at the forefront of research? There are currently over 300 Fellows working throughout CERN.

• Staff Employment

Opportunities ranging through the phases of R&D, administration, design, production, operation and maintenance

Are you qualified in computer science, electronics, physics, electricity, radio frequency, cryogenics, ultrahigh vacuum, radiation protection, cooling and ventilation, operation of accelerators or superconductivity? CERN recruits around 100 engineers, technicians and applied physicists each year. We also seek administrative staff in finance, personal management, law, purchasing and accounting.

More info on www.cern.ch/jobs

CERN

European Organization for Nuclear Research | Organisation européenne pour la recherche nucléaire

MANCHESTER
1824

The University of Manchester

Faculty of Engineering & Physical Sciences
School of Physics & Astronomy

Research Fellow in Detector Development for Ionising Radiation

£36,533 to £44,931 p.a. **Ref: EPS/90718**

Applications are invited for a research fellow in detector development for ionising radiation including charged particles, heavy ions and gamma rays. The post will support research in nuclear physics at the University and is funded by a Science and Technology Facilities Council Rolling Grant. The nuclear physics programme involves development/exploitation activities at a number of overseas accelerator facilities. You will be expected to lead detector developments for ionising radiation, support exploitation of existing equipment, coordinate the technical support team and manage the research laboratory. You will be expected to hold a PhD, or equivalent record of research, in a relevant field, and have extensive experience of developing detectors for ionising radiation. The appointment is funded for up to 4 years in the first instance.

Informal enquiries may be made to Prof. SJ Freeman
Tel: +44 (0) 161 275 4154, Email: sean.freeman@manchester.ac.uk.

Further particulars are available from our website www.manchester.ac.uk/jobs

If you are unable to go online you can request a hard copy of the details from The Directorate of Human Resources, Faculty of Engineering and Physical Sciences, Tel: +44 (0) 161 275 8837, Email: eps-hr@manchester.ac.uk

Closing date: 21 September 2009.

The University will actively foster a culture of inclusion and diversity and will seek to achieve true equality of opportunity for all members of its community.

www.manchester.ac.uk/jobs

BROOKHAVEN
NATIONAL LABORATORY

The **Physics Department at Brookhaven National Laborator**y is seeking to fill two Postdoctoral Research Associate positions. These positions require a Ph.D. in physics, high energy nuclear physics or high energy physics. Experience in experimental particle or high energy nuclear physics and knowledge of physics event generators and detector simulation packages are highly desirable. These positions will involve work on physics and detector simulations to further develop the physics case of a new electron-ion collider (EIC) and guide the design for the detector. BNL has recently initiated a dedicated program of research in this area and is seeking talented individuals to actively participate in this effort. Work on the preliminary design of an EIC at BNL (eRHIC) is underway. The successful candidates will get involved in studies of ep and eA collisions and the referring physics topics and document the feasibility of a broad range of measurements. In addition, the candidates will be expected to spend a fraction of his/her time on one of the existing RHIC experiments, either in the spin or the heavy-ion program. BNL policy states that Research Associate appointments may be made to those who have received their doctoral degrees within the past five years. Under the direction of E. Aschenauer and T. Ullrich, Physics Department. **Please go to http://www.bnl.gov/hr/careers/ and click on Search Job List to apply for this position. Please apply to Job ID # 14899**. Brookhaven National Laboratory is an equal opportunity employer committed to building and maintaining a diverse workforce.

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Call Moo Ali on **+44 (0)117 930 1264** or e-mail **moo.ali@iop.org**.

cerncourier.com/jobs

*Combined visitor numbers to **cerncourier.com** and **physicsworld.com**; publisher's own data.

ESO is opening the position of

Director of Programmes

Career Path VII

Purpose of the job:

The Director of Programmes reports directly to the Director General and assists him in developing the overall strategy for ESO Programmes and is accountable for their execution. The Programmes Directorate comprises currently three Divisions with approximately 150 staff responsible for VLT, VLTI, VST, VISTA, E-ELT, instrumentation and adaptive optics development, and provision of technical support to ALMA. As an active scientist and Full Astronomer in the ESO Astronomy Faculty he/she also maintains personal scientific and technical contacts internationally at the highest level.

Key Activities:

The Director of Programmes will:

- Be responsible for the setting of programmatic priorities and resource planning;
- Conduct regular Programme reviews;
- Provide regular information and status reports to the Director General;
- Report on ESO Programmes as required by Council and other external committees and to the community at large via conferences and special events;
- Work together with the Director General, the other Directors and the Division Heads to develop and implement ESO-wide policies and strategies;
- Identify opportunities for improvement/development within and across Divisions, and for further development/growth of the organization; and
- Assist the Director General in developing strategic plans for ESO's overall programmes.

The tasks are not limited to the above and a flexible approach and ability to adapt to an evolving situation is required.

Professional Requirements / Qualifications:

Basic requirements for the position include a PhD in astronomy, astrophysics, physics or related fields; a proven record of scientific leadership and at least 10 years' experience in international scientific collaborations. Substantial management and leadership experience within a scientific organisation, preferably international, is also required. Excellent communication skills and a very good knowledge of English are essential.

The Director of Programmes is a member of the ESO Astronomy Faculty and is encouraged and expected to conduct active astronomical research.

Key Competences:

- The ability to think strategically, to take effective decisions and provide leadership.
- Seeks to understand the perspective of key decision makers and partners – thinks through their needs and interests to identify their agenda.
- Builds strong and effective links within and outside the organization.
- Demonstrates initiative, pro-activeness and good negotiation skills.

Duty Station: Garching near Munich, Germany, with regular duty travels to Chile.

Starting Date: As soon as possible.

Remuneration and Contract: We offer an attractive remuneration package including a competitive salary (tax-free), comprehensive social benefits and financial help in relocating your family. The initial contract is for a period of three years with the possibility of a fixed-term extension. Either the title or the grade may be subject to change according to qualification and the number of years of experience.

Serious consideration will be given to outstanding candidates willing to be initially seconded to ESO on leave from their home institutions.

Application: If you are interested in working in areas of frontline technology and in a stimulating international environment, you are invited to apply online at https://jobs.eso.org/. Applications must be completed in English and should include a motivation letter and CV. The position requires three **letters of reference** to be sent to vacancy@eso.org.

The review of application will start on 1 September 2009; however applications will be accepted until the position is filled.

Although recruitment preference will be given to nationals of ESO Member States (members are: Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Italy, the Netherlands, Portugal, Spain, Sweden, Switzerland and United Kingdom) no nationality is in principle excluded.

The post is equally open to suitably qualified female and male applicants.

Max Planck Institute for Physics
(Werner Heisenberg Institute)

The Max Planck Institute for Physics invites applications for a

Postdoctoral position

to participate in a new effort on proton-driven plasma wakefield acceleration.

The concept of proton-driven plasma wakefield acceleration has recently been proposed as a means of accelerating a bunch of electrons to high energies with very high gradients. Initial calculations are promising, as shown in *Nature Physics* ***5***, 363 - 367 (2009), and a demonstration experiment is now under consideration. The successful candidate would help in producing a proposal for such an experimental demonstration. The focus of the work would be on developing characterization techniques for the plasma wakefields and for the drive and witness bunches. An experimental technique under consideration to extract time and space resolved information on electric fields is single-shot electro-optical sampling.

Formal requirement for this position is a PhD in experimental particle, plasma or accelerator physics. Previous experience in plasma wakefield experiments, terahertz physics and/or nonlinear optics are an advantage.

Salary and benefits are commensurate with public service organization (TVöD) rules. The contract is initially limited to 2 years with the possibility of an extension. The Max Planck Society is an equal opportunity employer. The goal is to enhance the percentage of women where they are underrepresented. Women, therefore, are especially encouraged to apply. The MPG is committed to employing more handicapped people. Applications of handicapped people are particularly welcome.

Interested applicants should submit an application letter, a statement of research interests, a curriculum vitae, a list of publications, and arrange for three letters of support to be sent to

Max-Planck-Institut für Physik
Frau F. Rudert
Föhringer Ring 6
D-80805 München
Germany

MAX-PLANCK-GESELLSCHAFT

Further information can be obtained from Prof. Allen Caldwell (EMail: caldwell@mppmu.mpg.de).
Applications should be sent at the latest by August 30, 2009.

JOHANNES GUTENBERG UNIVERSITÄT MAINZ

The Department of **Physics, Mathematics and Computer Science** has an opening for a

University Professor for Experimental Physics (Bes.Gr. W 2 BBesG)

at the Institute of Physics to be filled immediately.

Internationally renowned researchers who will strengthen or broaden the research activities of the Experimental Particle and Astroparticle Physics group are invited to apply. Currently the group is involved in the ATLAS and NA62 experiments (CERN), D0 (Fermilab) and IceCube (Amundsen-Scott Station). To maintain the breadth of the research program in the long term, the department is open for new research activities in other areas of particle and astroparticle physics that build on the current research program of the working group, for instance in the area of dark matter searches. Applicants with an interest in the area of detector development are also welcome. A collaboration with the research centre „Fundamental Forces and Mathematical Foundations", which provides financial support for this position, is expected.

Applicants are expected to have a Ph.D. in physics, a proven first rate research record and to have interest in and aptitude for teaching. The Johannes Gutenberg-Universität promotes a concept of intensive tutoring and requests a high rate of presence at the University. Participation in all teaching activities, in particular in courses for students studying to teach physics, is expected.

The Johannes Gutenberg-Universität Mainz aims at increasing the percentage of women in academic positions and strongly encourages female scientists to apply. Moreover, the University seeks to apply for additional funds via the Professorinnenprogramm initiated by the federal ministry (BMBF) provided that the conditions for eligibility are satisfied.

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

Qualified candidates are asked to submit their applications by **July 20th, 2009**, including curriculum vitae, list of publications, list of teaching experience, list of past research grants, and a description of current and future research interests to the

Dekan des Fachbereichs 08
- Physik, Mathematik und Informatik -
Johannes Gutenberg-Universität Mainz
Staudingerweg 7, D-55128 Mainz

BERGISCHE UNIVERSITÄT WUPPERTAL

Funded by the German Research Foundation (DFG), an interdisciplinary project of particle physicists, philosophers and historians of science will start in January 2010 on

Epistemology of the Large Hadron Collider (LHC)

We invite applications for three positions as Research Associates for each of the topics

- **Epistemic dynamics of model development,**
- **Data selection between theory ladenness and exploration,**
- **Ontology and epistemology of the Higgs mechanism (subject to financial approval)**

The positions will be filled for three years with a salary according to TVL-13.

Candidates are required to have a PhD. in either particle physics or philosophy/history of science as well as basic knowledge in the respective other field. Please present your c.v., publication list, topic(s) of interest and provide two letters of reference.

Send your applications until September 1, 2009 to
lhc-epistemologie@uni-wuppertal.de
Bergische Universität Wuppertal, IZWT, Prof. Steinle, 42097 Wuppertal, Germany.

Informal inquiries should be directed to either one of the following persons: Peter Mättig **(peter.mattig@cern.ch)**, Friedrich Steinle **(steinle@uni-wuppertal.de)**, Holger Lyre **(lyre@uni-bielefeld.de)**.

Details of the project can be found under www.lhc-epistemologie.uni-wuppertal.de

The University of Wuppertal is committed to employing more female scientists and particularly welcomes applications from qualified female physicists.

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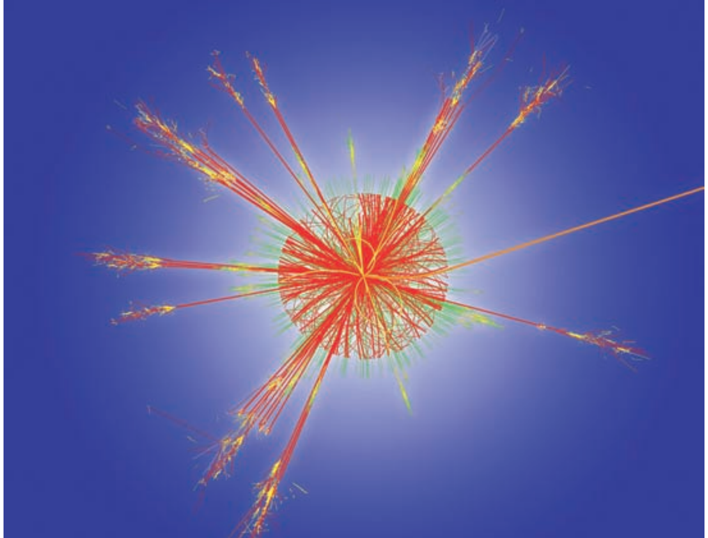

Your free online resource for articles from the print magazine, covering worldwide developments in particle physics, scientific computing and other related areas.

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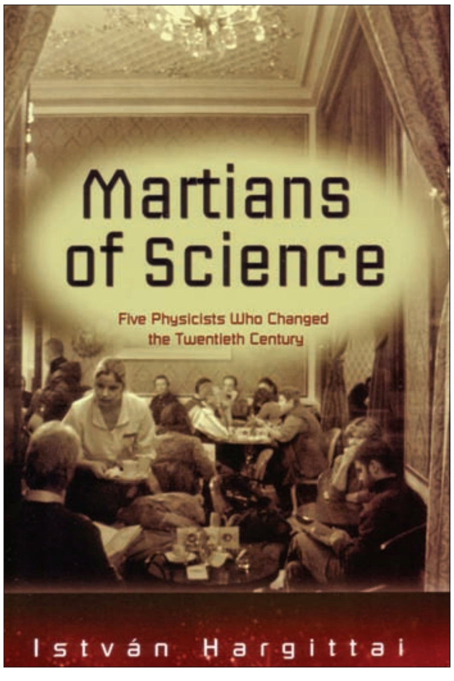
Summer Bookshelf

Summer for physicists is the season of conferences as well as (or instead of!) well earned holidays, perhaps providing more time for reading about topics away from mainstream particle physics. This Bookshelf reviews a selection of less technical books for more relaxed reading, at home or on those long plane journeys.

The Martians of Science: Five Physicists Who Changed the Twentieth Century by István Hargittai, Oxford University Press. Paperback ISBN 9780195365566, £8.99 ($15.95).

The music was enchanting. The Dysons stopped before the door, not wanting to break the magic of the superbly played Bach prelude. When the last cadence had rung down they walked in to find Edward Teller sitting at the piano apologizing that he was just passing by and that the instrument begged to be played while he was waiting for them to return home. It was a remarkable journey that had brought Teller, best known as the father of the hydrogen bomb, to the Dysons' home at Berkeley. Even more remarkably, his journey was not without parallels.

If we were to trace back the wordlines of influential physicists to their birth, we would find several of them to converge in a tiny domain of space–time: Budapest, *fin de siècle*. In fact, those of Theodore von Kármán, Leo Szilard, Eugene Wigner, John von Neumann and Edward Teller never really diverged significantly. These compatriots all went from Hungary to Germany and eventually to the US. And they all changed the history of the 20th century.

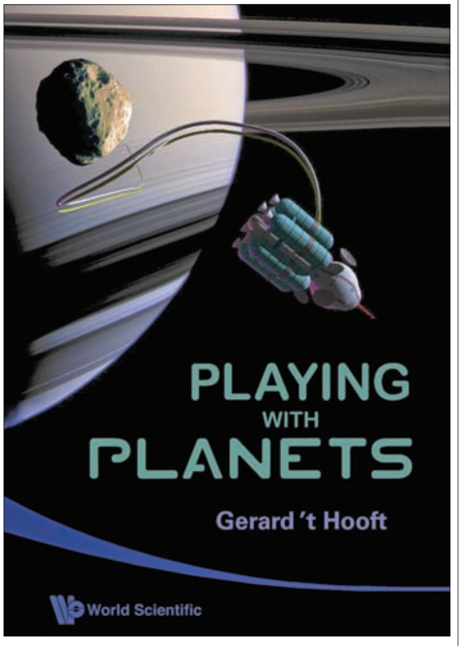


Kármán Tódor, Szilárd Leó, Wigner Jenő, Neumann János and Edward Teller (Teller Ede in Hungarian) were all born to well-to-do Jewish families living within walking distance of each other. They all completed their studies in Germany, learning from masters such as Ludwig Prandtl, Albert Einstein and Werner Heisenberg. Eventually they found refuge in the US from the menace of anti-Semitism, where they all joined the defence effort: von Kármán helped establish the modern US Air Force and founded the Jet Propulsion Laboratory; Szilard patented the nuclear chain reaction and triggered the Manhattan Project, through a letter signed by Einstein to President Roosevelt; Wigner played an instrumental role in building the first nuclear reactor; von Neumann did important calculations for the Manhattan Project and described the principle of modern computer architecture; and Teller drove the creation of thermonuclear weapons.

In his book, first published in 2006 and now available in paperback, István Hargittai follows the lives of these five "Martians of Science", and asks the inevitable questions: What was behind this remarkable surge of talent? Was it just a random rogue wave? What made these broadly educated, brilliant men seek the ultimate weapon? How did they see the role of scientists in society?

The author makes a critical assessment in the final chapter of their roles and weightings in science in comparison with other scientists of the 20th century. He even ventures to answer the intriguing counterfactual: What if they had stayed in Hungary?

That these five represented just the crest of a bigger wave is borne out in George Marx's *Voice of the Martians* (Akademiai Kiado 2001). In addition to them, Marx presents personalities such as Dennis Gabor, the inventor of hologram; Arthur Koestler, the writer whose *Darkness at Noon* can be compared in its influence to George Orwell's *1984*; Paul Erdõs, the vagabond mathematician of "Erdõs number 0"; Val Telegdi, whose experiments explored the



nature of weak interactions and who spent much of his time at CERN until his death a few years ago (*CERN Courier* September 2006 p49); and many others. From this long list of portraits a broader picture emerges, that of the fate of the central-European scientist in the 20th century.

Both authors draw on existing biographies but they supplement them with a wealth of detail from their personal conversations with their subjects or their respective colleagues, friends and family. Even so, with their scope and emphasis on exploring trends and connections, these books cannot do justice to each individual. They are instead excellent introductions that invite, and provide a guide to, further reading.

Károly Banicz, Fermilab.

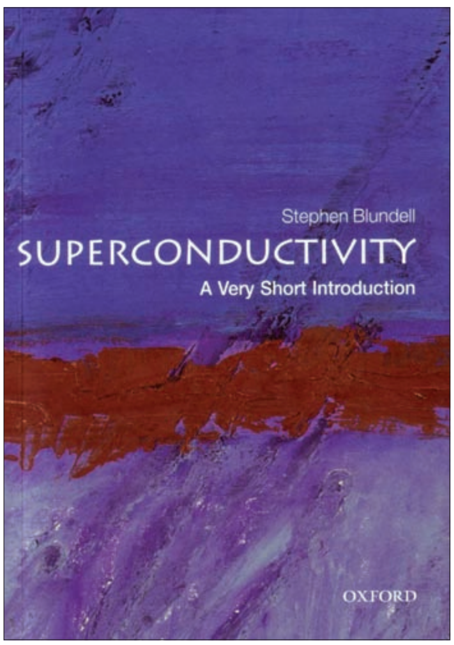
Playing with Planets by Gerard 't Hooft, World Scientific. Hardback ISBN 9789812793072, £25 ($48). Paperback ISBN 9789812790200, £14 ($23).

At the Rijksmuseum in Amsterdam they currently offer an audio tour by the artist Jeroen Krabbé. In a lovely, soft-accented English he recounts his personal experiences with the various exhibits over the many years that he has been visiting the museum – from the view as a child, a painter and actor, a parent and as a grand parent. His insights are both moving as well as fascinating and deep.

While reading *Playing with Planets*, I heard a similar voice in my head. Starting with personal experiences, Gerard 't Hooft lets his mind wander over the various aspects of life, speculating on the affects of new scientific developments on our lives in the future. The topics that he covers include flying kites (What is the highest you can possibly let a kite fly?), rising sea levels from global warming, modern dike construction and building floating cities on the ocean or in the sky. The topic that really grips his mind, however, seems to be space travel and colonization (mainly by robots), as well as ultimately moving around asteroids or even planets. (The latter is the origin of the title of the book.)

It is clearly important to 't Hooft that each of these speculations is firmly based on current scientific knowledge. They can thus be a motivation or even inspiration for actual scientific progress or technical developments. On this point he seems to take issue with the unfounded, wild speculations that he perceives to feature in most, if not all of, science-fiction writing. I am not much of a sci-fi buff myself, but to me such novels were always more of an enquiry into human nature – by placing people in unusual circumstances – rather than a real attempt at predicting or driving scientific progress. All the same, the author is well aware that he is stretching the limits of the possible when considering astro-mechanics.

My only criticism of his space-related speculations is that I believe they are severely constrained by the limited resources on Earth. When we realize that we have hit Peak Oil (or the equivalent for other materials), any interest in space travel and colonization will be put on the back burner. Nevertheless, I much enjoyed wandering the world, following this enquiring and original mind.
Herbi Dreiner, University of Bonn.



Superconductivity: A Very Short Introduction by Stephen Blundell, Oxford University Press. Paperback ISBN 9780199540907, £7.99 ($11.95).

One of the best non-technical science books I read around the time that I decided to study physics was *The quest for absolute zero* (Weidenfeld and Nicolson 1966). In it Kurt Mendelssohn, one of the early workers in low-temperature physics at Oxford University, told the story of the race to liquefy helium and the subsequent discoveries of the remarkable phenomena of superconductivity and superfluidity. With just enough diagrams and equations to make it comprehensible but not unpalatable, the book opened up a fascinating new world of physics that was far more intriguing than most of the syllabus taught at school.

Much has happened since then. Low-temperature superconductors are now regularly put to work in many hospitals in MRI scanners and there have been big strides towards high-temperature superconducting materials. Stephen Blundell, who follows in Mendelssohn's footsteps by working at Oxford's Clarendon Laboratory, brings the story up to date in this volume from OUP's successful series of "Very Short Introductions". In fewer than 150 small-format pages he manages to cover much of the story told by Mendelssohn and what has happened since, in particular the dramatic discovery of "high temperature" superconductors in the 1980s.

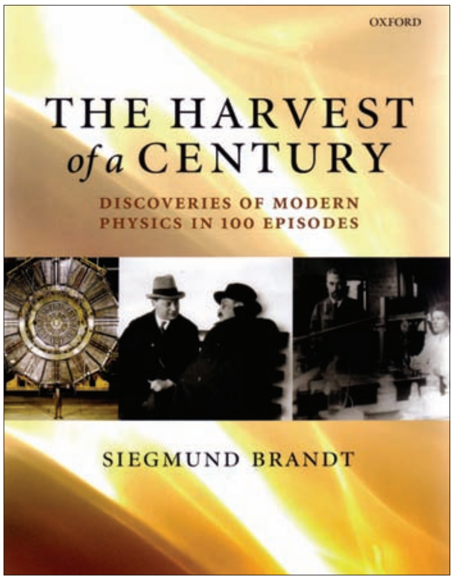
Blundell certainly succeeds in squeezing a great deal into the small package. It is a story full of excitement and intrigue, with accidental discoveries and major deception, complete with a cast of Nobel laureates. He keeps the narrative moving at a good pace, peppering it with brief biographical sketches and photos of key players, as well as a few useful diagrams (and no equations!). He not only manages to give space to the connection between spontaneous symmetry breaking in superconductors and particle physics – where he refers to the search for what "probably should be called the Anderson-Nambu-Higgs-Brout-Englert-Guralnik-Hagen-Kibble boson" at the LHC – but also refers to the large-scale use of superconductivity at the LHC and mentions the incident that put commissioning on hold in September 2008. There are also interesting "asides" on topics such as the rise of preprints and the server arXiv.org.

In short, the book is a worthy successor to Mendelssohn's, perfectly geared to today's "faster" times. I hope it inspires future students to look deeper into physics. It is certainly ideal for slipping into your luggage during summer travels, being small and light enough for the even the smallest travel bag.
Christine Sutton, CERN.

The Harvest of a Century: Discoveries in Modern Physics in 100 Episodes by Siegmund Brandt, Oxford University Press. Hardback ISBN 9780199544691, £35 ($70).

No century before was so full of advances in physics as the 20th, which witnessed a complete revolution in scientific thinking. There were significant advances in many fields, including medicine, engineering and computing, which all had a deep impact on daily life. While some people consider modern physics to be born in the year 1900, with the landmark introduction of the quantum of action in Planck's radiation law, others prefer to place its birth year in 1895, with the discovery of X-rays, immediately followed by the discovery of radioactivity and the electron, as well as the alpha, beta and gamma rays. This was the option taken, for example, by João Varela in his book *Século dos Quanta Gradiva* (*The Quantum Century* 1996). Wilhelm Röntgen's X-rays are also the opening act of *The Harvest of a Century* – a collection of the 100 most important advances in physics, many of them recognized with Nobel Prizes – by Siegmund Brandt, Emeritus Professor at the University of Siegen.

After a brief overview of the 19th century heritage the reader is taken through many fundamental discoveries, which are always described in a very appealing style. Naturally, Brandt gives emphasis to the development and testing of quantum mechanics, to important breakthroughs in atomic and nuclear physics and to recent advances in particle physics and cosmology. But many other "episodes" are also included, such as the invention of the transistor and the laser.



The book is profusely illustrated with photographs of the main players and respective apparatus, often complemented by pedagogical diagrams, and includes detailed references to original publications. It provides a stimulating way of learning about the basic concepts of modern physics and how they were brought to life.

Indeed, this "harvest" will surely please a broad audience interested in concrete examples of scientific progress, whether they are physicists or not. The episodes are often cross-linked and the reader is invited to jump back and forth, unbound by the chronological flow. Moreover, Brandt contributes his own personal memories, such as when he describes the discovery of the gluon, and sprinkles the text with nice anecdotes. For instance, we learn that before entering university Max Planck sought the advice of Philipp von Jolly, professor of physics in Munich, who answered that "he considered the edifice of physics to be essentially completed and that only a few details might still be discovered in this field". Undeterred, Planck devoted his energy to physics and laid the foundations of quantum theory.

There are, of course, books with much more information about Albert Einstein's relativity theory or "the eightfold way", as well as books that place more emphasis on the biographical aspects of 20th century physicists, such as *The Genius of Science: A Portrait Gallery* (OUP 2000) by Abraham Pais (*CERN Courier* December 2001 p41) or *Remarkable Physicists* by Ioan James (CUP 2004). *The Harvest of a Century*, however, provides a much broader collection of interesting scientific discoveries in a single book of 500 pages written in a fluent style. In short, once you start reading this book, it is difficult to stop.
Hermine K Wöhri, LIP Lisbon.

Cosmic Imagery: Key Images in the History of Science by John D Barrow, The Bodley Head. Hardback ISBN 9780224075237, £25.

John Barrow's latest book, *Cosmic Imagery*, is a collection of 89 short and profusely illustrated essays, mostly related to astronomy, Earth sciences, mathematics and physics. Just open the 600-page book at random and enjoy reading about "aperiodic tilings", Bucky balls, snowflakes, Kekulé's benzene ring dream, DNA's double helix and many other "picturesque" topics, including the symmetries of Leonardo da Vinci's Vitruvian Man (depicted on the cover).

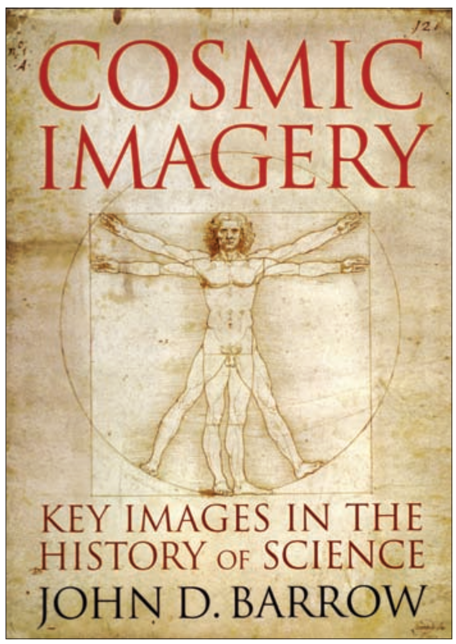
A cosmologist and mathematician, Barrow highlights the power of pictures in discovering and understanding our universe, selecting many spectacular images of galaxies, nebulae and other cosmic players, as well as equally fascinating mathematical landscapes such as the truly complex Mandelbrot set – the ultimate artful display of nature's fractal beauty. Despite being packed with facts, the accompanying texts are fluid and clear, and are introduced by curious and often humorous quotations ("Why did the chicken cross the Möbius strip? To get to the other... er, um...").

True to his reputation for excellence in communicating science, Barrow's latest book targets a general readership while leaving hundreds of detailed "Notes" to the last 45 pages. Here we are told, for instance, that Hermann Minkowski triggered David Hilbert's famous lecture in 1900 – when he listed 23 problems that would become mathematicians' homework for a very long time – and see the touching words that Hilbert pronounced when Minkowski died suddenly, aged 44. Another note reports that the Mandelbrot boundary, a curve on a flat surface, "needs as much information to specify as a whole two-dimensional area". This book is sure to provide enjoyable summer-time reading, despite a few minor "misprints". For instance, Pedro Nunes was a 16th century Portuguese mathematician (not a 15th century navigator) and the Nobel Prize was awarded to David Politzer, David Gross and Frank Wilczek in 2004 (not in 2005).

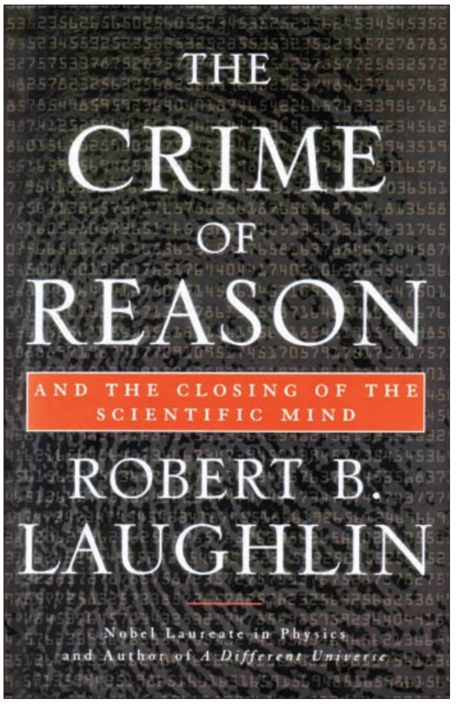
Just searching for suitable quotations to introduce the chapters in a spirited way must be a long-term job for prolific writers such as Barrow. Consider, for instance, what Marcus Chown must have endured to find the quotation that opens one chapter in *The Universe next door: Twelve Mind-blowing Ideas from the Cutting Edge of Science* (Headline 2003): "Time is nature's way of keeping everything from happening at once," attributed to "graffiti, men's room, Austin, Texas".

This pocket-sized book, which presents some amazing ideas that Chown came across as cosmology consultant to *New Scientist*, is ideal to take on a long flight (I read it on a trip to Japan). It has no pictures but these weird chronicles will certainly twist the most imaginative minds. Can there be regions in the universe where time runs backwards? And an invisible universe made of mirror matter occupying the same space as the visible universe? Chown clearly shares Max Tegmark's view: "Nature is under no obligation to make things easy for human brains" or to "respect our sensitivities and behave in a way that appeals to everyday common sense".

Richard Feynman had a more poetic perspective when he wrote: "Nature has a great simplicity and, therefore, a great beauty" (*The Character of Physical Law* MIT Press 1965). This viewpoint connects the 11 (not always easy) pieces that compose a



book that looks at invisible beauty in science, *It Must be Beautiful: Great Equations of Modern Science* (*CERN Courier* March 2002 p45) – a compendium of essays edited by Graham Farmelo, which also makes good summer reading. After guiding us through Schrödinger's waves, agitated by Copenhagen's winds, Arthur I Miller compares the difficulties in interpreting quantum theory's subtle concepts with Pablo Picasso's simultaneous representations of many perspectives on a single canvas. Christine Sutton presents the Yang-Mills equation with so many twists and turns it almost seems a detective story. Equally fascinating is Frank Wilczek's detailed report on Paul Dirac's equation: a "piece of magic", both "obviously right" and "catastrophically wrong", whose discovery is an example of creative physics resulting from the recognition of patterns, the trying of explanatory assumptions, and the recognition of mathematical beauty. Further insight into the dramatic evolution of our understanding of this equation comes in the "afterword", where Steven Weinberg – maybe inspired by Magritte's "*Ceci n'est pas une pipe*" – explains that the correct representation of an electron is a quantum-mechanical field-operator (not a wave function and without direct connection to the probability of finding the particle) that satisfies an equation mathematically identical to the wave function equation of Dirac; it is "by coincidence" that Dirac's equation gives correct numerical solutions. This adds another twist to Dirac's comment: "My equation is smarter than I am."
Carlos Lourenço, CERN.



The Crime of Reason: And the Closing of the Scientific Mind by Robert B Laughlin, Basic Books. Hardback ISBN 9780465005079, £15.99 ($25.95).

Robert Laughlin, Nobel laureate in physics, presents a gloomy, doomsday outlook in his latest literary offering, *The Crime of Reason*. The title is defined by the author as "the unsocial nature or outright illegality of understanding certain things". He suggests that "Information Age" is a misnomer for the current era, which should be re-named the "Age of Amnesia", owing to the inaccessibility of valuable knowledge that could be used for monetary gain or considered life-threatening. Such knowledge is not truly free to access and in some cases considered private property and secret. Those who find out such things could find themselves sued or in prison.

Knowledge is dangerous, Laughlin admits, beginning to sound paranoid when he suggests that such things as knitting needles, lace curtains or pruning shears could be lethal. When he turns to the threats of nuclear weapons plans or biological cloning, however, his concern seems valid.

In discussing the scientific community he notes that university professors whose research findings do not correspond to – or even go against – their big company or government donors could find themselves having difficulties in procuring additional funding for further research proposals and problems with promotions. However, Laughlin does not provide concrete examples about how these researchers have been "silenced". He also points out that gene sequences, certain physical principles pertaining to nuclear energy, and software codes are now patented or classified by governments.

The book is a quick read of just 149 pages but the author falls short of successfully making all of his points. He provides many intriguing arguments, such as the notion that the worldwide web has created a sense that the world is at our fingertips, but in reality inundates us with useless information while not disseminating any real knowledge. This is not fully explored, however. For those

working at CERN, where there is a sense of openness in publishing physics results and sharing ideas with colleagues, Laughlin's suggestion that important details may be purposely left out of technical documents to keep a monopoly on knowledge and therefore generate money, may seem wide of the mark.

Finally, it seems strange to have a book that discusses such weighty subjects as the deliberate hiding of valuable information from the general public, to end on a daydream of living on the Moon and wishing that they would "send up more girls" from Earth. Remarks like this, and the lack of concrete examples, in the end detract from what is potentially an important subject for debate.
Carolyn Lee, CERN.

Energia per l'astronave Terra by Nicola Armaroli and Vincenzo Balzani, Zanichelli. Paperback ISBN 9788808063915, €11.50.

"A politician cares about the next election, a statesman cares about the next generation." This quote by Alcide de Gasperi, chosen by the authors to introduce the last chapter of this book, illustrates the spirit of the work. Throughout the book, Nicola Armaroli and Vincenzo Balzani emphasize the fact that the energy problem can only be understood (and solved) if each one of us accepts the responsibility to do something about it.

The authors are experts of energy-related problems at Consiglio Nazionale delle Ricerche and the University of Bologna, respectively. In this book they address the problem of energy management on our planet and emphasize its importance by showing the countless links with human activities, which may jeopardize the survival of the environment. Thanks to this book, the reader realizes that this is "the" problem of the planet and that, technically speaking, "the" solution doesn't exist yet.

Unlike other publications on the subject written for the general public, this book is enriched with scientific facts, which make it attractive to a more specialized audience. However, thanks to the effort that the authors have made to integrate and explain the mathematical statistics, any reader will understand the figures and the conclusions that they lead to.

I found the book interesting overall, although in some places a little superficial, with logical shortcuts that lead to too general conclusions. However, I really appreciated the capacity of the authors to focus the attention of the reader on the two basic facts that actually "make" the energy problem: first, the planet's resources (whatever they are) are limited and, second, only a better redistribution of them among the Earth's population can lead to real and durable progress. Regarding this second point, a striking fact mentioned in the book is the observation that, if you take the global stock of primary energy (the energy that is globally available) and divide it by the number of inhabitants, you obtain about 60 GJ – that is the energy consumption of a citizen of a Balkan country. In Western Europe today, we consume three times as much.

In May the book received a prestigious award in Italy (the Premio Letterario Galileo) for the best science popularization publication. The jury was composed of 2500 young students from more than 100 high schools.

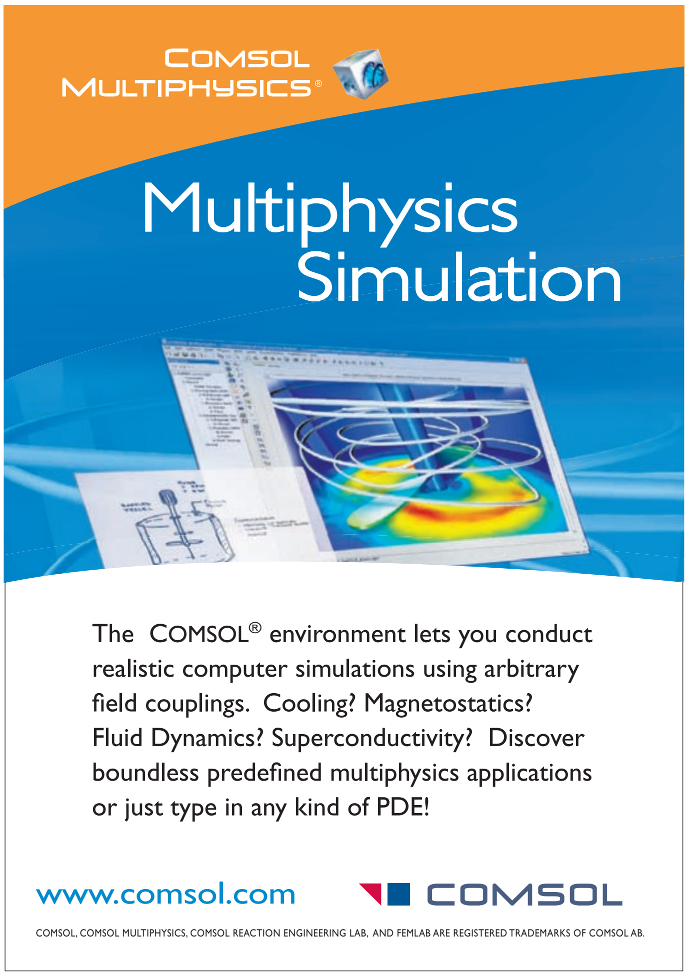
Antonella Del Rosso, CERN.

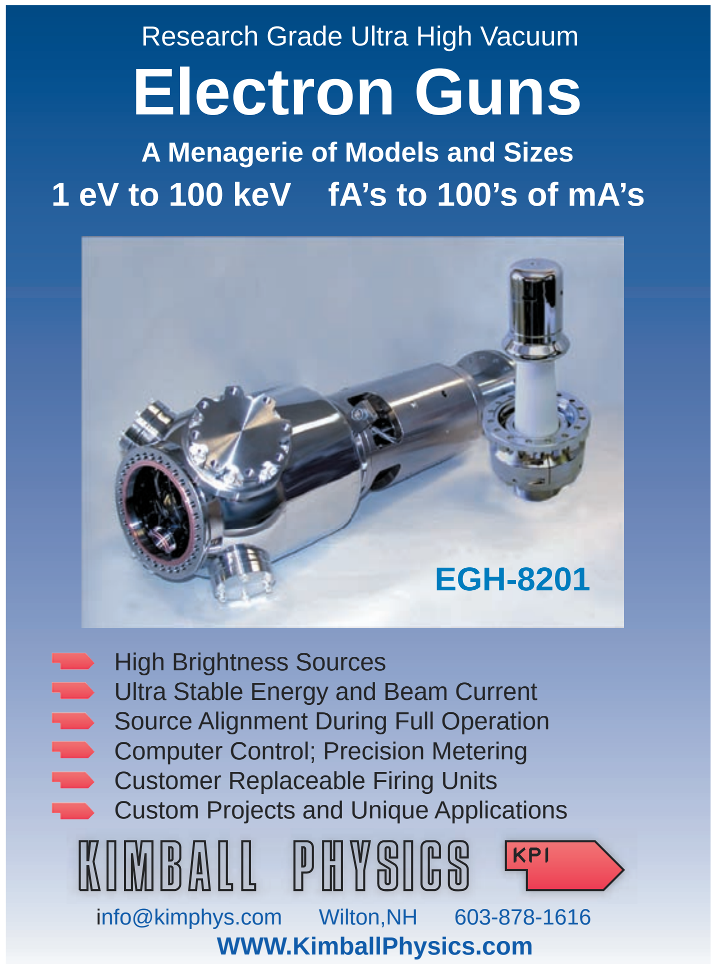
Books received

Nobel Faces: A Gallery of Nobel Prize Winners by Peter Badge, Wiley-VCH. Hardback ISBN 9783527406784, €72.90.

Peter Badge's striking black-and-white portraits, accompanied by short biographies, result in a fascinating word-and-image tableau of all of the Nobel Laureates alive at the time of writing (2007).

The book consists of more than 270 photographs of Nobel Prize winners including Nelson Mandela, the Dalai Lama, author J M Coetzee, physicist Roy J Glauber, molecular biologist James Watson and former US president Jimmy Carter. Each portrait is accompanied by a brief description celebrating the laureate's outstanding contribution to science, literature or world peace, written by journalist Chris Richmond with scientific advice from Jürgen and Leonore Uhlenbusch. There is also an "afterword" by the well known German filmmaker, playwright, photographer and producer, Wim Wenders.





Meet the particle-zoo keeper

Julie Peasley talks about the inspiration behind her unusual zoo, a colourful set of handmade plush toys that represent the particles of the Standard Model and beyond.

Julie Peasley presents her particle zoo in the library during a visit to CERN on 15 May.

Physicists consider that they have "seen" a particle when their detectors send an electronic signal and a spot appears on their computer screen. The American artist Julie Peasley has gone much further than that. She has started sewing soft toys so that we can not just see what particles look like but even play with them.

Julie, who is based in Los Angeles, has been passionate about physics since she was a teenager. She eventually opted for art studies but she never stopped reading physics books and her library at home is full of all sorts of scientific publications and even audio books to accompany her long hours spent sewing toys. "I have always been interested in physics and cosmology," Julie explains. "A year and a half ago I went to a craft fair and I saw that people were making little soft creatures of various things and it just seemed to me that particles I was studying had personality. So, why not turn them into little characters!"

She has no doubts that particles have strong personalities, "because this is what is needed to make up the whole universe". At first, says Julie, "my plushies weren't smiling, they were just a face. Later on, I realized that I wanted them to all be happy and to appear like they are having fun – except for the neutron, which insists on remaining neutral."

Julie had little sewing experience to start with but she decided to give it a go and soon she was selling her wares on the web. Less than three months later, in May 2008, she quit her job as a graphic designer and started designing and making the particle zoo full time. *Physics World* magazine soon noticed her web site and then other scientific publications and blogs took over and spread the word. "Initially, I did not have the idea that this could be as popular as it is today," says Julie. "Now I think it has reached the point where people who are interested in physics, scientists, teachers, know about it."

During the week of the LHC start-up in September 2008, Julie experienced a big spike in her sales to the point that she had to work more than 12 hours a day to satisfy the requests. "During a slow period I make about 5–10 particle plushies per day but I can make 30–40 a day when it gets really busy," she explains. She has also tried to mass-produce her particles in China "but I only did it for the electron because mass-producing the whole zoo would require an investment of a lot of money up front and I don't have enough business yet".

Julie's sales imply that the public seems to appreciate the theoretical, yet undiscovered, particles more than the others. Despite the big publicity that antimatter is receiving following the release of the Hollywood blockbuster *Angels & Demons*, "antimatter doesn't sell particularly well. The Higgs is the real top-seller and in second place is dark matter. The charm quarks are very popular at Valentine's day because they are pink and have a rose." All particles are cute and full of positive energy. Her favourites are the proton and the photon whereas, she says, nobody seems to like the tau.

Like any good scientist, Julie will soon explore new territories. Her next toy will be the "quantum duck", due to be made available this summer. "The quantum duck is my secret project," reveals Julie. "It is going to be Russian dolls – you keep opening the doll and you have the duck, the molecule and it's going down to quarks and keeps going further and further down." Why a duck? "I think at the time, when the idea came to me, my calendar had some ducks on it. So, I decided to do a duck!"

Nothing is out of reach for Julie's artistic imagination. In her zoo, particles can decay and reveal new objects created in the interaction. "I did the decaying top quark for Fermilab. It is a plushie that reverses inside out with a zipper to a big bottom quark and has a mini anti-muon and a mini muon–neutrino inside. I would like to do the neutron decay in the same way."

When particles have exhausted their inspiring power, Julie will turn her attention to cosmology. "In future I am going to do more objects from space, such as black holes and pulsars," she confirms. A first example represents the cosmic microwave background radiation. In the meantime, she also wishes to see her particles animated.

● To find your favourite particle, visit the zoo at http://www.particlezoo.net/.

Antonella Del Rosso, CERN. (First published in CERN's Bulletin *issue 24-25/2009.)*

As Time Goes by ...

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								Form factor / Interfaces			
								VME	NIM	Desktop	PCI
Series	Type (1)	# Ch	Dead Time (µs)	Max. Sampling Rate (MS/s)	Bandwidth (MHz)	Resolution (bits)	Memory (MS/ch)	VME64 Opt. link	USB2.0 Opt. link	USB2.0 Opt. link (4)	PCI Express
724	WD + DPP	8/4/2	0	100	40	14	0.5/4	Ready	NEW	NEW	COMING SOON
720	WD	8/4/2	0	250	125	12	1.25/10	Ready	NEW	NEW	COMING SOON
721	WD	8	0	500	250	8	2	Ready	-	-	-
731	WD	8-4/2-1	0	500-1000	250/500	8	2-4	Ready	-	-	COMING SOON
740	WD	64/32	0	65	30	12	0.19/1.5	Ready	NEW	NEW	-
751	WD + DPP	8-4/4-2	0	1000-2000	500	10	1.8-3.6	NEW	COMING SOON	COMING SOON	-
742 (2)	WD + DPP	32+2/16+1	33 (3)	1000÷5000	Tbd	12	0.128	COMING SOON	COMING SOON	COMING SOON	-

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