WELCOME

CERN Courier – digital edition

Welcome to the digital edition of the March 2013 issue of CERN Courier.

The LHC may be currently leading studies of particle physics at the high-energy frontier but the particle-physics community has for several years been looking hard at what machine should complement the LHC in future. The favoured option, a high-energy linear electron–positron collider, has been the focus of two international efforts that are now coming closer together. This month’s lead feature reports on a meeting at the 2012 IEEE Nuclear Science Symposium, which provided the opportunity to discuss the technological developments on a broader stage. Meanwhile, after a successful period of proton–ion collisions, the LHC has entered its first long shutdown, which will see a huge effort in maintenance and consolidation.

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News

**LHC News**

**Proton–ion collisions: the final challenge**

In the last beam period before a two-year shutdown, the LHC began 2013 with a challenge: proton–ion collisions. Following a trial run in September (CERN Courier November 2012 p6), the machine went into full operation beyond its design specification, producing head-on collisions of protons with lead nuclei from mid-January to mid-February. At 5 TeV per colliding nucleon pair, the gain in collision energy is a factor of 25 above previous collisions of a similar type, making it one of the largest such gains in the history of particle accelerators.

Commissioning this new and almost unprecedented mode of collider operation was a major challenge for both the teams behind the LHC and its injector chain. The LHC configuration had to be modified quickly before and during the short run to achieve a number of physics goals.

Nonetheless, on 1 January, single bunches of protons and lead nuclei were injected into the LHC and successfully ramped to full energy. Over the following night the LHC–operations and beam-physics teams sprang into action to commission and measure the optics through a completely new sequence to squeeze the beams at collision. Interventions on the power and cryogenics systems slowed down the commissioning plan but by 20 January stable beams had been achieved with 13 bunches per beam.

In the next fill of the machine, the first bunch-trains were injected, leading to stable beams with 96 bunches of protons and 120 of ions. This important fill allowed the study of “moving”, long-range beam–beam encounters. Stationary long-range encounters occur in proton–proton or lead–lead runs, when bunches in the two beams “see” one another as they travel in the same vacuum chamber on either side of the experiments. The situation becomes more complicated with proton–lead collisions because the long-range encounters move as a result of the different revolution times of the two species—a key feature of proton–lead operation.

At injection energy, lead ions travel more slowly than protons and complete eight fewer turns a minute round the LHC (674,729 turns compared with 674,792 turns for protons). As a result, the two beams – and their RF systems – run independently at different frequencies. Once the energy has been ramped up, the frequency differences become small enough for the RF systems to be locked together in a non-trivial process known as “cogging”.

During a beam dump, the complete bunch train is spread in a spiral pattern over the beam-dump material. The different patterns of the proton beam, left, and lead-nuclei beam, right, reflect the greater ionization energy loss of the lead nuclei in the beam-dump material.

Every so often the source of the lead ions has to be replaced. A small sliver of solid isotopically pure 208Pb is placed in a ceramic crucible that sits in an “oven” and is heated to around 800°C. Depending on the beam intensity, in stable running the accelerator chain consumes about 2 mg of lead every hour – a tiny amount, but it costs some SwF12,000 (approx US$11,000). In this image the position of the oven is being measured inside the source for Linac 3.

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**ALICE and ATLAS find intriguing ‘double ridge’ in proton–lead collisions**

In analysing data from last year’s test run with proton–lead collisions in the LHC, the ALICE collaboration, followed almost immediately and independently by the ATLAS collaboration, has announced a surprising observation in the way that particles emerge from the high-energy collisions. Here the two collaborations report on their results.

To prepare for the recent LHC run with collisions of protons and lead ions, the LHC team performed a test run for a few hours last September. During this run the ALICE experiment recorded close to two million events, which have already led to new results (CERN Courier, December 2012 p6). Now, after an in-depth analysis, the ALICE collaboration has made the surprising observation of a double “ridge” structure in the correlation of the amount of jet energy flowing from the proton–lead collisions. This follows the observation by the CMS collaboration, using data from the same test run, of a “near side” ridge-like correlation structure elongated in pseudorapidity and azimuthal angle, an emerging particle takes relative to the direction of the beam (CERN Courier March 2013 p9).

The analysis performed by the ALICE collaboration characterises two-particle angular correlations as a function of the event activity, which is quantified by the angular correlations as a function of the event multiplicity. So by subtracting the correlations at different event multiplicities from one another, it is possible to remove the jet-like contribution of the correlation to a large extent and to quantify modifications as a function of event multiplicity.

First measurements of electroweak boson fusion

In proton collisions at the LHC, vector boson fusion (VBF) happens when quarks from each one of the two colliding protons radiate a W or Z boson that subsequently interact or “fuse” as in the Feynman diagram shown on p8 where two W bosons fuse to produce a Z boson. Each quark radiating a weak boson exchanges four-momentum, Q, of around mVBF/2 in the t-channel. In this way, the two quarks scatter away from the collision zone, typically inside the acceptance of the detector where they can be detected as hadronic jets. The distinctive signature of VBF is therefore the presence of two energetic hadronic jets (tagging jets), predominantly in the forward and backward directions with respect to the proton beamline. The study of VBF production of Z bosons is an important benchmark in establishing the presence of these processes in general and to cross-check measurements of Higgs VBF, where the radiated bosons fuse to form a Higgs boson. However, the VBF production of Z bosons has some intriguing differences with respect to that of Higgs bosons. In VBF-Z production, a large number of other purely electroweak non-VBF processes can lead to an identical final state and play an important role: they yield large negative interferences with the VBF process, which are related to the very foundations of the Standard Model. This situation makes VBF production of...
Z bosons more complicated but also more interesting. An additional and peculiar feature of VBF and all other purely weak interactions is that no QCD colour is exchanged in the processes. This leads to the expectation of a “rapidity gap” or suppressed hadronic activity between the two tagging jets, which can also be identified in these events.

The CMS collaboration has searched for the pure electroweak production of a Z boson in association with two jets in the 7 TeV proton–proton collision data from 2011. They have analysed both dielectron and dimuon Z decays. The leptons are required to have transverse momenta $p_T > 65$ GeV and pseudorapidity $|\eta| < 2.4$; in addition, the dilepton invariant mass is required to be consistent with that of the Z boson. The two and pseudorapidity $|\eta| < 2.4$.

A distribution of the cosine of the decay angle of the X(3872) for all candidates and for a subset with a selection on the cosine of the decay angle of the X(3872) system. The selected observed event shows a clearer separation between the hypotheses, coloured as in figure 1.

One of the most interesting discoveries of the past decade is that of an unconventional hadron, the X(3872), by the Belle experiment (Belle 2003). Its decay to $J/\psi K^*$ indicates that it is charmonium-like but its narrow width and mass above the threshold for decay to open charm do not fit any of the spectrum of predicted $c\bar{c}$ states. Several experiments have since confirmed its observation, in different production mechanisms and decay modes in parallel to these experimental investigations, many theoretical interpretations have been put forward but the fundamental question remains open of whether the X(3872) is a quark–antiquark meson or a more exotic state.

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 proposals to the editor at cern.courier@cern.ch.
Limits to growth in leaves and trees

Taller trees tend to have smaller leaves, and Kaare Jensen of Harvard University and Maciej Zwiernecki of the University of California in Davis think that they have worked out why. The reason seems to lie in the circulatory system of trees. Glucose is made in leaves by photosynthesis and despite leaves speeding up the process, it is possible that the stems, branches and trunk act as bottlenecks. At some point it is simply not worth growing larger leaves because the effect becomes more pronounced the taller the tree and the greater these bottlenecks.

Of course, leaves cannot be too small either, and detailed calculations based on data from 1925 species – with leaves from a few millimeters to more than a meter long – then constrain the maximum height of a tree to be about 100 m. The tallest California redwoods reach about 116 m.

A reason for wrinkles

Hands always suffer from wrinkling when they stay in water too long but it seems that there is a good reason for it. Kyraacos Kareklas and colleagues of Newcastle University have found that while wrinkled fingers are no better at handling dry objects, they do function better with submerged objects.

Fingers could complete a task involving passing objects from one bin of water to another through a barrier with a small hole 12% faster after soaking for 30 minutes in water. This does make some sense – after all, it is only hands and feet that wrinkle water. This does makes some sense – after all, it is only hands and feet that wrinkle water. This does makes some sense – after all, it is only hands and feet that wrinkle water. This does makes some sense – after all, it is only hands and feet that wrinkle water.

Further reading


The Sequoia sempervirens of California are among the tallest trees in the world. (Image credit: Urasr/dreamstime.com.)

Crocodile heads and the limits of genes

With all of the recent successes of genetics, it has become commonplace to think of biological patterns as arising from reaction-diffusion mechanisms controlled by genes. However, the crocodile has something to add to this.

Michael Milinkovitch of the University of Geneva and colleagues studied the patterns of crocodile-head scales and found that they are driven by physical processes. As crocodiles grow, their keratinized skin cracks in random ways, with no symmetry between one side of their head and the other – in contrast to what happens with the scales of snakes. So even a crocodile’s genome has no say in how its scales will turn out. They will be distributed by physics with some randomness, rather than by information in genes.

Further reading


Planck scale on a tabletop

As the LHC reaches ever higher energy, the Planck scale still seems a long way off – but there is reason for optimism. Jacob Bekenstein of the Hebrew University in Jerusalem has suggested a tabletop experiment, just within the reach of present-day ultrahigh vacuum and cryogenic technology.

The idea is to couple a (quantum mechanical) single photon to a macroscopic piece of dielectric material by having it go through it, causing a tiny translation. No permanent impulse has to be imparted, with the translation inferred from detection of the photon and conservation of momentum. If the photon gets through, then the material must have moved by a Planck length. If space–time is rough on the Planck scale then this should show up as a change in the odds that a photon gets through. Amazingly, the numbers suggest that this could work.

Further reading


Quantum dots from earthworms

Quantum dots – fluorescent nanocrystals – have a range of applications but they are not always easy to make. Now, Mark Green of King’s College, London, and colleagues have found an environmentally friendly way of making biocompatible cadmium telluride (CdTe) quantum dots. They spiked the ground where earthworms (Lumbricus rubellus) lived with cadmium chloride and sodium telluride. Eleven days later, they were able to recover green fluorescent CdTe quantum dots from the guts of the worms. As a bonus, the dots came out coated with a passivating layer that makes them water-soluble. In addition to being a fabrication technique, understanding the biology and biochemistry involved could help in heavy-metal remediation.

Further reading

Pulsar exhibits puzzling switches in state

Astronomers have detected simultaneous X-ray and radio-mode switches in co-ordinated observations of a pulsar. Pulsed X-ray emission is only present in states of weak radio emission. This indicates a rapid global change in the magnetosphere, which challenges current emission theories.

Pulsars were discovered in 1967 as flickering sources of radio waves and were soon interpreted as being rotating, strongly magnetized neutron stars. The radiation is thought to be emitted by high-energy particles moving along the lines of magnetic field. As the emission is concentrated in two cones emerging from the magnetic poles, the source behaves like a lighthouse. We see a pulse each time that the radiation beam is pointed towards the Earth. This happens at the spin frequency of the neutron star because the rotation and magnetic axes are generally misaligned.

Among the thousands of known pulsars, only a small fraction has been detected in X-rays or gamma-rays (CERN Courier September 2006 p3; December 2008 p9). The X-ray emission can be steady or pulsed. The steady X-ray emission is found for young neutron stars and decreases as their surface temperature falls. The pulsed emission suggests the X-ray-emitting hot-spots are located at the magnetic poles.

Astronomers know of only a handful of pulsars that shine in X-rays. One of them is PSR B0943+10, which is more than a billion years old. This source also switches suddenly from the radio mode to the X-ray mode. This idea was suggested by a team led by Wim Herman of the Netherlands Institute for Space Research (SRON) and the Astronomical Institute Anton Pannekoek of the University of Amsterdam. It then took them five years to convince the time-allocation committee to schedule some long periods of observation with ESA’s X-ray Multi-Mirror Mission (XMM-Newton) satellite co-ordinated with radio telescopes.

The satellite performed six observations of six hours each on PSR B0943+10 at the end of 2011. Radio-data were gathered at the same time by the Indian Giant Metrewave Radio Telescope (GMRT) and the international Low-Frequency Array (LOFAR) in the Netherlands. The result of the campaign was completely unexpected. The X-ray emission was found to follow the state of the radio brightness. On the contrary, it was observed to be weak when the source is bright in radio emission and vice versa.

The timing and spectral analysis of the XMM-Newton data offered yet more surprises. The source was found to pulsate in X-rays only during the X-ray-bright phase corresponding to the quiet radio state. During this phase, the X-ray emission appears to be the sum of two components: a pulsating component consisting of thermal X-rays, which is seen to switch off during the X-ray-quiet phase, and a persistent one consisting of non-thermal X-rays.

The results suggest that the entire magnetosphere around the pulsar is switching from one state to another within a few seconds. The rapidity of this change is puzzling but it is not the only issue. The observed radio and X-ray behaviour is predicted by neither of the leading models for pulsar emission. Herman and his team plan to repeat the same study for another pulsar that has similar radio properties but with a different geometrical configuration. This will allow them to test whether the viewing angle with respect to the magnetic and rotational axes has an effect on the properties of the X-ray emission. In the meantime, theorists will be busy investigating possible physical mechanisms that could cause the observed sudden and drastic changes to the pulsar’s magnetosphere.

Further reading
W Herman et al 2013 Science 339 436.

CERN News

Important experiment on the cheap

On 5 December 1969 the University of Chicago-Berkeley neutrino neutral current experiment concluded its run at the 6GeV Bevatron. The experimenters looked for the reaction K+→π+ν+π which, had it been observed, would have been evidence of the existence of such currents. During the course of the experiment the total of a 1.5×10^6 positive kaons decayed within the detecting apparatus but no example of the neutral current reaction was observed.

Preliminary analysis of the data indicates that the branching ratio for K+ decay in this manner is less than 1.2×10^{-5}. The experiment is important because the absence of this decay mode (and of the related mode K–→π–ν–e+) is an unsolved puzzle in weak interaction theory. One possible interpretation of this observation is that electron and neutrinos carry a quantum number which forbids the creation of isolated electron or neutrino pairs by weak interactions.

Computer takes over

On 29 January, a rather unusual test was made during one of the machine development periods on the CERN proton synchrotron (PS). All of the dipolar corrections guiding the beam in the horizontal plane were switched off and it was impossible to accelerate the beam to full energy. The beam would make only thirty revolutions in the machine (lasting about 200μs). The IBH 1800 machine control computer was then asked to bring the beam back on. After successive optimization procedures, the computer succeeded in accelerating a beam with an intensity of 96×10^10 protons per pulse. The intensity before beginning the tests had been about 80×10^10 protons per pulse.

The test was part of the research programme of the controls group concerning the use of online computers in accelerator control. Though the experiment does not forshadow computer-controlled operation in the near future, it does show how the use of computers can help in accelerator control. This is believed to be the first time that the intensity of an accelerator in use for physics has been optimised by computer.

Compiled from texts on p9.

Feeding the PS with nitrogen

Following successful tests carried out on sector 4 of the PS vacuum chamber, it has been decided to use dry nitrogen, before atmospheric air, to fill the vacuum chambers when the vacuum has to be broken for maintenance or modification of equipment. This trick, which is already in use in laboratories and by certain CERN groups, has the advantage of shortening pumping time by a factor of more than three when the high vacuum has to be re-established. The reduction in pumping time is due to absorption of dry nitrogen by the chamber walls, which inhibits the subsequent absorption of water vapour when atmospheric air is allowed in. This is of special importance since the PS ion diffusion pumps are at present being replaced by ion pumps, which are particularly sensitive to moisture.

Compiled from texts on p6.

Pulsar exhibits puzzling switches in state

Illustration of a pulsar in a state with glowing X-ray emission at the magnetic poles and weak radio emission from the cones that stem from the poles. Pulsed emission results from the misalignment of the magnetic and rotational axes. (Image credit: ESA/ATG medialab.)
The LHC at CERN is a prime example of worldwide collaboration to build a large instrument and pursue frontier science. The discovery there of a particle consistent with the long-sought Higgs boson points to future directions both for the LHC and more broadly for particle physics. Now, the international community is considering machines to complement the LHC and further advance particle physics, including the favoured option: an electron–positron linear collider (LC). Two major global efforts are underway: the International Linear Collider (ILC), which is distributed among many laboratories; and the Compact Linear Collider (CLIC), centred at CERN. Both would collide electrons and positrons at tera-electron-volt energies but have different technologies, energy ranges and timescales. Now, the two efforts are coming closer together and forming a worldwide linear-collider community in the areas of accelerators, detectors and resources.

Last year, the organizers of the 2012 IEEE Nuclear Science Symposium held in Anaheim, California, decided to arrange a Special Linear Collider Event to summarize the accelerator and detector concepts for the ILC and CLIC. Held on 29–30 October, the event also included presentations on the impact of LC technologies for different applications and a discussion forum on LC perspectives. It brought together academic, industry and laboratory-based experts, providing an opportunity to discuss LC progress with the accelerator and instrumentation community at large, and to justify the investments in technology required for future particle accelerators and detectors. Representatives of the US Funding Agencies were also invited to attend.

CERN’s director-general, Rolf Heuer, introduced the event before Steinar Stapnes, CLIC project leader, and Barry Barish, director of the ILC’s Global Design Effort (GDE), reviewed the two projects. The ILC concept is based on superconducting radio-frequency (SRF) cavities, with a nominal accelerating field of 31.5 MV/m, to provide e+e– collisions at sub-tera-electron-volt energies in the centre-of-mass. The CLIC studies focus on an option for a multi-tera-electron-volt machine using a novel two-beam acceleration scheme, with normal-conducting accelerating structures operating at fields as high as 100 MV/m. In this approach, two beams run parallel to each other: the main beam, to be accelerated; and a drive beam, to provide the RF power for the accelerating structures.

Both studies have reached important milestones. The CLIC Conceptual Design Report was released in 2012, with three volumes for physics, detectors and accelerators. The project’s goals for the coming years are well defined, the key challenges being related to system specifications and performance studies for accelerator parts and detectors, technology developments with industry and implementation studies. The aim is to present an implementation plan by 2016, when LHC results at full design energy should become available.

The ILC GDE took a major step towards the final technical design when a draft of the four-volume Technical Design Report (TDR) was presented to the ILC Steering Committee on 15 December 2012 in Tokyo. This describes the successful establishment of a
Apart from their dimensions, the electromagnetic calorimeters are similar for the ILC and CLIC concepts, as Jean-Claude Brient of CERN, Andrea Jeremie of LAPP/CNRS and Daniel Schulte of CERN all discussed beam instrumentation, alignment and module control, including stabilization. Emittance preservation during beam generation, acceleration and focusing are key feasibility issues for achieving high luminosity for CLIC. Extremely small beam sizes of 40 μm (1 mm) in the horizontal (vertical) planes at the two different beam energies are required. These beams are aligned with micrometre precision over several hundred metres and stabilization of the quadrupoles along the lineac to nanometres, about an order of magnitude lower than ground vibrations.

Two sessions were specially organized to discuss potential spin-off from LC detector and accelerator technologies. Marcel Demearte of Argonne National Laboratory summarized a study request from the DOE’s “Its Impact, which points to the value of sustained support for basic R&D for instrumentation. LC detector R&D has already had an impact in particle physics. For example, the DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor, DEPFET technology is chosen as a baseline for the Belle-II vertex detector; an adapted version of the MIMOSA CMOS sensor,
of firms have taken steps to extend their capabilities in this area, working closely with the accelerator community.

Steve Lenci of Communications and Power Industries LLC presented an overview of RF technology that supports linear colliders, such as klystrons and power couplers, and discussed the use of similar technologies elsewhere in research and industry. Marc Ross summarized applications of LC instrumentation, used for beam measurements, component monitoring and control and RF feedback.

The Advanced Accelerator Association Promoting Science & Technology (AAA) aims to facilitate industry-government-academia collaboration and to promote and seek industrial applications of advanced technologies derived from R&D on accelerators, with the ILC as a model case. Founded in Japan in 2008, its membership has grown to comprise 90 companies and 38 academic institutions. As the secretary-general Masanori Matsunaka explained, one of the main goals is a study on how to reach a consensus to implement the ILC in Japan and to inform the public of the significance of advanced accelerators and LC science through social, political and educational events.

The Special Linear Collider Event ended with a forum that brought together directors of the high-energy-physics laboratories and leading experts in LC technologies, from both the academic research sector and industry. A panel discussion, moderated by Brian Foster of the University of Hamburg/DESY, included Rolf Heuer (CERN), Joachim Minh (DESY), Atsuto Suzuki (KEK), Stuart Henderson (Fermilab), Hitoshi Murayama (IPMU), Steinar Stapnes (CERN) and Akira Yamamoto (KEK).

The ILC has received considerable recent attention from the Japanese government. The round-table discussion therefore began with Suzuki’s presentation of the discovery of a Higgs-like particle at CERN and the emerging initiative toward hosting an ILC in Japan. The formal government statement, which is expected within the next few years, will provide the opportunity for the early implementation of an ILC and the recent discovery at CERN is strong evidence that Japan is moving in the right direction.

The ILC Technology Roadmap; the ILC Project Implementation Plan; the ILC Technology Roadmap; and the ILC Added Value to Society. While the possibility of implementing CLIC as a project at CERN to follow the LHC was also on the table, there was less urgency for discussion because the ILC effort counts on an earlier start date. The panellists exchanged many views and opinions with the audience on how the ILC international collaboration between host/hub-laboratories and industry to build the ILC, where each country shares the costs and human resources.

Finally, accelerator and detector developments for the LC have already penetrated many areas of science. The question is how to improve further the transfer of technology from laboratories, so as to develop viable, on-going businesses that serve as a general benefit to society; as in the successful examples, such as the IARC facility and the PET-TOF detector, presented in Anaheim.

Last, but not least, this technology-oriented symposium would have been impossible without the tireless efforts of the “Special LC Event” programme committee: Jim Brau, University of Oregon, Juan Fuster (IFIC Valencia), Ingrid-Maria Gregor (DESY Hamburg), Michael Harrison (BNL), Marc Ross (FNAL), Steinar Stapnes (CERN), Maxim Titov (CEA Saclay), Nick Walker (DESY Hamburg), Akira Yamamoto (KEK) and Hitoshi Yamamoto (Tokoh University). In all, this event was considered a real success. More than 90% of participants who answered the conference questionnaire rated it extremely important.

Further reading
For all of the presentations, see http://www.desy.de/~nss2012/2012LCEvent.html.

Résumé
Technologies du collisionneur linéaire
Le colloque 2012 de l’IEEE sur la science nucléaire avait pour son programme une séance spéciale consacrée au collisionneur linéaire, destinée à faire le point sur les concepts d’accélérateur et de détecteur pour les études relatives au collisionneur linéaire international et au CLIC. Cela a aussi été l’occasion de présentations sur l’impact des technologies de collisionneur linéaire dans différentes applications ainsi que d’un forum de discussion sur les perspectives. Le colloque a rassemblé des spécialistes venant de différents horizons, universitaires, industriels et chercheurs en laboratoire, et a été l’occasion d’examiner de façon plus large la situation s’agissant des projets de collisionneur linéaire, et de justifier les investissements technologiques requis pour les futurs accélérateurs et détecteurs.

Maxim Titov, CEA Saclay, Ifha, 2012/IEEE NSS programme chair.
Workshop

The historic academic building of Utrecht University provided the setting for the 5th International Workshop on Heavy Quark Production in Heavy-Ion Collisions, offering a unique atmosphere for a lively discussion and interpretation of the current measurements on open and hidden heavy flavour in high-energy heavy-ion collisions. Held on 14–17 November, the workshop attracted some 70 researchers from around the world, a third of the participants being theorists and more than 20% female researchers. The topics for discussion covered recent results, upgrades and future experiments at CERN’s LHC, Brookhaven’s Relativistic Heavy-Ion Collider (RHIC) and the Facility for Antiproton and Ion Research (FAIR) at Darmstadt, as well as theoretical developments. There was a particular focus on the exchange of information and ideas between the experiments on open heavy-flavour reconstruction.

Heavy flavours were the focus of an international workshop held last November.

The historic academic building of Utrecht University provided the setting for the 5th International Workshop on Heavy Quark Production in Heavy-Ion Collisions, offering a unique atmosphere for a lively discussion and interpretation of the current measurements on open and hidden heavy flavour in high-energy heavy-ion collisions. Held on 14–17 November, the workshop attracted some 70 researchers from around the world, a third of the participants being theorists and more than 20% female researchers. The topics for discussion covered recent results, upgrades and future experiments at CERN’s LHC, Brookhaven’s Relativistic Heavy-Ion Collider (RHIC) and the Facility for Antiproton and Ion Research (FAIR) at Darmstadt, as well as theoretical developments. There was a particular focus on the exchange of information and ideas between the experiments on open heavy-flavour reconstruction.

Open and hidden heavy flavour

Representatives from all of the major collaborations nicely summarized recent experimental results and prospects for future measurements. In particular, with the advent of the LHC, an unprecedented wealth of data on the production of heavy quarks and quarkonium in nuclear collisions has become available. One of the more spectacular effects observed at RHIC is the quenching of the transverse momentum ($p_T$) spectra of light hadrons, related to the energy loss of quarks inside the hot quark–gluon plasma (QGP) phase produced in lead–lead (PbPb) collisions. This has now been studied in detail for the first time by the ALICE, ATLAS and CMS collaborations in the heavy-quark sector.

Among the highlights presented at the workshop, the ALICE collaboration reported a strong suppression (up to a factor around 5) of the production of D mesons in PbPb collisions at a centre-of-mass energy, $\sqrt{s_{NN}}$, of 2.76 TeV, compared with proton–proton data at the same energy. The CMS experiment has also found a sizeable suppression of the yield of $J/\psi$ coming from the decay of $B$ hadrons. When this effect is compared with the one measured by the same experiments for light hadrons, interesting hints of a hierarchy of suppression are seen, with the beauty hadrons being less suppressed than the charmed hadrons and the latter less suppressed than light hadrons. Such an observation may be connected to the so-called dead-cone effect, a reduction of small-angle gluon radiation for heavy compared with light quarks, predicted by QCD and related to the energy density reached in the medium.

In the quarkonium sector, the ALICE and CMS collaborations showed new and intriguing results on $J/\psi$ and $\Upsilon$ production, respectively. A suppression of charmonium states had been previously observed at CERN’s Super Proton Synchrotron (SPS) and at RHIC and was explained as an effect of the screening of the binding colour force in a QGP. With data from the LHC, accurate results are expected.
on the bottomonium states have proved for the first time — beyond any doubt — that the less-strongly bound Y(2S) and Y(3S) are up to five times more strongly suppressed in a QGP with respect to the tightly bound Y(1S) state, an observation that is expected in a colour-screening scenario. On the contrary, the ALICE collaboration sees a smaller suppression-effect for the J/ψ with respect to RHIC and the SPS, despite the larger energy density reached in nuclear collisions at the LHC. An interesting hypothesis relates this observation to a recombination of c̄c pairs, which are produced with high multiplicity in each PbPb collision, in the later stages when the system cools down and crosses the transition temperature between the QGP and the ordinary hadronic world.

Theoretical developments

The talks on theory provided quite a comprehensive overview of the vigorous research efforts towards a theoretical understanding of heavy-quark probes in heavy-ion collisions. The experimental findings on open-heavy-flavour suppression and elliptic flow have led to many theoretical investigations of heavy-quark diffusion in the strongly coupled QGP. Most models use a relativistic Fokker-Planck-Langevin approach, with drag and diffusion coefficients taken from various microscopic models for the heavy-quark interactions with the hot and dense medium. The microscopic models include estimates from perturbative QCD for elastic- and/or radiation-scattering processes, T-matrix calculations using in-medium lattice potentials (from both the free and the internal thermodynamic potentials) and collision terms in full transport simulations, including 2 ↔ 2 and 2 ↔ 3 processes in perturbative QCD.

First studies of the influence of the hadronic phase on the modifications of open-heavy-flavour medium were presented at the workshop. Estimates of the viscosity to entropy-density ratio, η/s, from the corresponding partonic and hadronic heavy-quark transport coefficients, lead to values that are not too far from the conjectured anti-de Sitter/conformal field theory lower bound of 1/4 in the phase-transition region, showing the characteristic minimum around the critical temperature, Tc. Results from a direct calculation of the heavy-quark transport coefficients via the maximum-entropy method applied to lattice-QCD correlation functions were also reported.

In the field of heavy quarkonia, the notion of a possible regeneration of heavy quarkonia via q̄q recombination in the medium in addition to the dissociation/melting processes leading to their suppression in the QGP has in recent years led to detailed studies on the bound-state properties of heavy quarkonia in the hot medium. Here, the models range from the evaluation of static q̄q potentials in hard-thermal-loop resummed thermal-QCD to a generalization of systematic nonrelativistic QCD and heavy-quark effective theory studies, generalizing from the vacuum to thermal field theory.

These theoretical studies have already led to major progress in understanding the possible microscopic mechanisms behind the coupling of heavy-quark degrees of freedom with the hot and dense medium created in heavy-ion collisions. In future, it might be possible to gain an even better quantitative understanding of fundamental quantities such as the transport coefficients of the QGP (for example η/σ) and the dissociation temperatures of heavy quarkonia, which could provide a thermometer for the QGP formed in heavy-ion collisions. Whatever happens, the workshop has provided an excellent framework to discuss this exciting theoretical work and trigger some fruitful ideas for its future development.

The observed signals for the QGP are expected to be even stronger in PbPb collisions at √sNN = 5.1 TeV (foreseen in 2015) and allow the properties of the QGP to be characterized further. Proton–lead data are urgently needed to measure the contribution from the effects in cold nuclear matter, such as nuclear shadowing and Cronin enhancement. The experimental teams at the LHC and RHIC are working on upgrades of the inner tracking systems of their detectors, aiming for an improved resolution in impact parameter, which will make the measurement of open beauty in heavy-ion collisions feasible in the near future.

Further reading

For more about the conference and for slides of the plenary presentations, see http://indico.cern.ch/event/HQP2012/

Résumé

Charme et beauté à Utrecht

Les saveurs lourdes étaient au centre d’un atelier international tenu en novembre dernier à l’Université d’Utrecht. Le 5e atelier international sur la production de quarks lourds dans les collisions d’ions lourds a été l’occasion d’une discussion animée, où il a été question de l’interprétation des mesures actuelles concernant les saveurs lourdes apparemment cachées dans les collisions d’ions lourds de haute énergie. L’auteur a attiré plus de 70 chercheurs du monde entier. Parmi les sujets abordés, les récentes découvertes et les futures améliorations en expérience au LHC du CERN, à l’accélérateur RHIC de Brookhaven et à l’installation de recherche sur les antiprotons et les ions de Darmstadt, ainsi que certains développements théoriques.

Hendrik van Hees, Frankfurt Institute of Advanced Studies, Paul Kulier, Nikhil, André Mischke, Utrecht University, and Enrico Scomparin, INFN-Torino.

Workshop

Participants listen to Pol-Bernard Gossiaux, of Subatech Nantes, during his talk on “Heavy-quark quenching from RHIC to LHC.” (Image credit: Ivor Pol.)

Interview

How a love of CERN and literature came together in the life of a Spanish particle physicist.

A nobel gas, a missing scientist and an underground laboratory. It could be the starting point for a classic detective story. But a love story? It seems unlikely. However, add in a back-story set in Spain during General Franco’s rule, plus a “eureka” moment in California, and the ingredients are there for a real romance – all of it rooted firmly in physics.

When Spanish particle-physicist Juan José Gómez Cadenas arrived at CERN as a summer student, the passion that he already had for physics turned into an infatuation. Thirty years later and back in his home country, Gómez Cadenas is pursuing one of nature’s most elusive particles, the neutrino, by looking where it is expected not to appear at all – in neutrinoless double-beta decay. Moreover, fiction has become entwined with fact, as he was recently invited to write a novel set at CERN. The result, Materia Extraña (Strange matter), is a scientific thriller that has already been translated into Italian.

Critical point

“Particle physicists were a rare commodity in Spain when the country first joined CERN in 1961,” Cecilia Jarlskog noted 10 years ago after a visit to “a young and rapidly expanding community” of Spanish particle physicists (CERN Courier December 2003 p30). Indeed, the country left CERN in 1969, when Juan was only nine years old and Spain was still under the Franco regime. Young Juan – or “JJ” as he later became known – initially wanted to become a naval officer, like his father, but in 1975 he was introduced to the wonders of physics by his cousin, Bernardo Llanas, who had just completed his studies with the Junta de Energía Nuclear (the forerunner of CIEMAT, the Spanish research centre for energy, the environment and technology) at the same time as Juan Antonio Rubio, who was to do so much to re-establish particle physics in Spain. The young JJ set his sights on the subject – “Suddenly the world became magic,” he recalls, “I was lost to physics” – and so began the love affair that was to take him to CERN and, in a strange twist, to write his first novel.

The critical point came in 1983. JJ was one of the first Spanish students to gain a place in CERN’s summer student programme when his country rejoined the organization. It was an amazing time to be at the laboratory: the W and Z bosons had just been discovered and the place was buzzing. “I couldn’t believe this place, it was the beginning of an absolute infatuation,” he says.

That summer he met two people who were to influence his career: “My supervisor, Peter Sonderegger, with whom I learnt the ropes as an experimental physicist, and Luis Álvarez-Gaume, a rising star who took pity on the poor, hungry fellow-Spaniard hanging around at night in the CERN canteen.” After graduating from Valencia University, JJ’s PhD studies took him to the DELPHI experiment at CERN’s Large Electron-Positron collider. With the aid of a Fulbright scholarship,
Interview

he then set off for America to work on the Mark II experiment at SLAC. From there it was back to CERN and DELPHI again, but in 1994 he left once more for the US, this time following his wife, Pilar Hernandez, to Harvard. An accomplished particle-physics theorist, she converted her husband and her specialties into astrophysics, thus setting him on the trail that would lead him through the NOMAD, HARP and K2K experiments to the challenge of neutrinoless double-beta decay.

The neutrinoless challenge

Established for 15 years as professor of physics at the Institute of Nuclear and Particle Physics (IFIC), a joint venture between the University of Valencia and the Spanish research council (CSIC), he is currently leading NEXT – the Neutrino Experiment with a Xenon TPC. The aim is to search for neutrinoless double-beta decay using a high pressure xenon time projection chamber (TPC) in the Canfranc Underground Laboratory in the Spanish Pyrenees. JJ believes that the experiment has several advantages in the hunt for this decay mode, which would demonstrate that the neutrino must be its own antiparticle, as first proposed by Enrico Mora
ger (whose own life ended shrouded in mystery). The experiment uses xenon, which is relatively cheap and also cheap to enrich because it is a noble gas. Moreover, NEXT uses gaseous xenon, which gives 10 times better energy resolution for the decay electrons than the liquid form. By using a TPC, it also provides a topological signature for the double-beta decay.

The big challenge was to find a way to amplify the charge in the xenon gas without inducing sparks. The solution came to JJ when physics took him to SLAC in 1986, as a member of Stanford University, he was allowed to sit in on the creative-writing workshop. “I was not only the only non-native American but also the only physicist,” he recalls. “I’m not sure that they knew what to make of me.” Years later, he continued his formal education as a writer at the prestigious Escuela de Letras in Madrid.

A novel look at CERN

Around 2003, CERN was starting to become bigger news, with the construction of the LHC, experiments on antimatter and an appearance in Dan Brown’s mystery-thriller Angels & Demons. Having already written a book of short stories, La agonia de las liliputas (Agony of the dragonflies), published in 2000, JJ was approached by the Spanish publisher Espasa to write a novel that would involve CERN. Of course, the story would require action but it would also be a personal story that with JJ’s love for the place. Materia Estranha, published in 2008, “deals with how someone from outside tries to come to grips with CERN,” he explains, “and also with the way that you do science.” It gives little away to say that at one and the same time it is CERN – but not CERN. For example, the director-general is a woman, with an amalgam of the characteristics that he observes to be necessary for women to succeed in physics. “The novel was presented in Madrid by Rubin,” says JJ. “At the time, we couldn’t guess he had not much time left.” (Rubin was to pass away in 2010 in CERN Courier March 2010 p35.)

When asked by Espasa to write another book, JJ turned from fiction to fact and the issue of energy. Here he encountered “a kind of Taliban of environmentalism” and became determined to argue a more rational case. The result was El ecologista nuclear (The Nuclear Environmentalist, now published in English) in which he sets down the issues surrounding the various sources of energy. Comparing renewables,
Work for the LHC’s first long shutdown gets under way

The LHC has been delivering data to the physics experiments since the first collisions in 2009. Now, with the first long shutdown, LS1, which started on 13 February, work begins to refurbish and consolidate aspects of the collider, together with the experiments and other accelerators in the injection chain.

The main driving effort will be the consolidation of the 10,170 high-current splices between the superconducting magnets. As many as 1000–1500 splices will need to be redone and more than 27,000 shunts added to overcome possible problems with poor contacts between the superconducting cable and the copper stabilizer that led to the breakdown in September 2008 (CERN Courier September 2010 p27).

The teams will start by opening up the interconnections between each of the 1695 main magnet cryostats. They will repair and consolidate around 500 interconnections at a time, in work that will gradually cover the entire 27-km circumference of the LHC. The effort on the LHC ring will also involve the exchange of 19 magnets, consolidation of the cryogenic feed boxes and installation of pressure-relief valves on the sectors that have not yet been equipped with them (CERN Courier April 2009 p6).

The Radiation to Electronics project (R2E) will see the protection of sensitive electronic equipment optimized by relocating the equipment or by adding shielding. Nor will work during LS1 be confined to the LHC. Major renovation work is scheduled, for example, for the Proton Synchrotron, the Super Proton Synchrotron and the LHC experiments.

Preparations for LS1 started more than three years ago, with the detailed planning of manpower and other resources. For example, Building 180 on the Meyrin site at CERN recently became a hive of activity as a training centre for the technicians who are implementing the various repairs and modifications. The pictures shown here give the flavour of this activity.

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SPIN 2012
Spin physics in Dubna

Experts from around the world travelled to Russia for the biennial symposium on spin.

SPIN 2012, the 20th International Symposium on Spin Physics, took place at the Joint Institute for Nuclear Research (JINR) in Dubna on 17–22 September. Around 300 participants attended from JINR and institutes in 22 countries (mainly Germany, Italy, Japan, Russia and the US). It consisted of a traditional mix of plenary and parallel sessions. Presentations covered the spin structure of hadrons, spin effects in reactions with lepton and hadron beams, spin physics beyond the Standard Model and future experiments, as well as the techniques of polarized beams and targets, and the application of spin phenomena in medicine and technology.

The symposium began with a focus on work at Dubna, starting with the unveiling of a monument to Vladimir Veksler, who invented the principle of phase stability (independently from Edwin McMillan in the US) and founded the 10 GeV Synchro-phasotron in Dubna in 1955. Talks followed about the future projects to be carried out at JINR’s newest facility, the Nuclotron-Based Ion Collider Facility (NICA). The complex will include an upgraded superconducting synchrotron, Nuclotron-M, with an area for fixed-target experiments, as well as a collider with two intersections for polarized protons (at 12 GeV per beam) or deuterons and nuclei (5 A GeV per beam). It will provide opportunities for a range of polarization studies to complement global data and will particularly help to solve the puzzles of spin effects that have been awaiting solutions since the 1970s. The spin community at the symposium supported the plans for these unique capabilities, and JINR’s director, Victor Matveev, announced that the project is ready to invite international nominations for leading positions in the spin programme at NICA.

The experimental landscape

In the US, Jefferson Lab’s programme of experiments on generalized parton distributions (GPDs) will be implemented with upgraded detectors and an increase in the energy of the Continuous Electron Beam Accelerator Facility (CEBAF) from 6 GeV up to 12 GeV (CERN Courier November 2012 p30). The laboratory is also considering the construction of a new synchrotron to accelerate protons and nuclei up to 250 GeV before collision with 12 GeV electrons. In a similar way, a new 10–30 GeV electron accelerator is being proposed at Brookhaven National Laboratory to provide collisions between electrons and polarized protons and ions, including polarized He nuclei, at the Relativistic Heavy-Ion Collider (RHIC). The aim will be to investigate the spin structure of the proton and the neutron.

Fig. 1. Comparison of Sivers parton distribution functions from COMPASS and HERMES using the new evolution equation.

At CERN, the COMPASS-II project has been approved, firstly to study Drell-Yan muon-pair production in collisions of pions with polarized nucleons, to investigate the nucleon’s parton distribution functions (PDFs). A second aim is to study GPDs via the deeply virtual Compton-scattering processes of exclusive photon and meson production. The latter processes will provide the possibility for measuring the contribution of the orbital angular momenta of quarks and gluons to the nucleon spin. The Institute of High Energy Physics (IHEP), Protvino, has a programme at the U-70 accelerator for obtaining polarized proton and antiproton beams from decay for spin studies at the SPACCHARM facility, which is currently under construction.

The participants heard with interest the plans to construct dedicated facilities for determining the electric dipole moment (EDM) of the proton and nuclei, with proposals by the Storage Ring EDM collaboration at Brookhaven and the JEDI collaboration at Jülich. The dipole moment of fundamental particles violates both parity and time-reversal invariance. Its detection would indicate the violation of the Standard Model and would, in particular, make it
possible to approach the problem of understanding the baryon asymmetry of the universe. The proposed experiments would reduce the measurement limit on the deuterium EDM down to $10^{-28}$ cm.

Classical experiments studying the nucleon spin structure at high energy through lepton-proton and lepton-antineutron scattering on polarized nucleons (e.g. in HERMES at DESY, COMPASS and at Jefferson Lab) and collisions of polarized hadrons (at RHIC, JHEP and JINR). A unified description of these different high-energy processes is becoming possible within the context of QCD, the theory of strong interactions. Related properties, such as factorization, local quark–hadron duality and asymptotic freedom, allow the calculation of the characteristics of the process within the framework of perturbation theory. At the same time, PDFs, correlation and fragmentation functions are not calculable in perturbative QCD, but being universal they should be either parameterized and determined using various processes or calculated within some model approaches. A number of talks at the symposium were devoted to the development and application of such models.

Theory confronts experiment

Experiments involving spin have brought about the demise of many theories or any other single physical parameter. Modern theoretical descriptions of spin-dependent PDFs, especially those including the internal transverse-momentum, were discussed at the symposium. In this case, the number of PDFs increases and the pictures related to them lose – to a considerable degree – the simplicity of a parton model with its probabilistic interpretation.

One of the difficulties here concerns how the PDFs evolve with a change in the wavelength of the probe particle. A new approach to solving this problem was outlined and demonstrated for the so-called Sivers asymmetry measured in data from the HERMES and COMPASS experiments (figure 1.29).

The helicity distributions of the quarks in a nucleon are the most thoroughly studied so far. The results of the most accurate measurements by COMPASS, HERMES and the CLAS experiment at Jefferson Lab were presented by the collaborations. The present-day experimental data is sufficiently precise to include them in QCD analysis. Two new alternative methods for the QCD analysis of transverse-momentum-dependent PDFs are now connected to the possible contributions of the orbital angular momenta of quarks and gluons, to be measured from GPDs. There were talks on different theoretical aspects of PDFs, as well as their experimental aspects, within the framework of the COMPASS, CLAS and COMPASS experiments.

Other important spin distribution functions manifest themselves in the leptonic DIS off transversely polarized nucleons. The processes in which the polarization of one (final or initial) particle (or quark) is known are especially interesting. However, although relatively simple from the point of view of the experiment, they are complicated from the theoretical point of view (such complementarities are related to T-odd effects, i.e. they seemingly break invariance with respect to time reversal). However, it is a case of “effective breaking” – that is, it is not related to a true non-invariance of a fundamental interaction (here, the strong interaction, described by QCD) with respect to time reversal but to its simulation by the effects of re-scattering in the final or initial states. The single asymmetries have been studied by theorists for more than 20 years. These studies have received some theoretical attention and have been applied to the interpretation of new experimental data on single-spin asymmetries in the semi-inclusive processes of hadrons off longitudinally and transversely polarized and unpolarized nucleons.

Reports from the COMPASS collaboration on transverse-momentum-dependent (TMD) asymmetries were one of the highlights of the symposium. The experiment is studying as many as 14 different TMD asymmetries. Two of them, the Collins and Sivers asymmetries (figure 2) – which are responsible for the left–right asymmetries of hadrons in the fragmentation of transversely polarized quarks and quark distributions in transversely polarized nucleons – are now definitely established in the global analysis of all of the available data, although other TMD effects require further study. The results of studies of the transverse structure of the proton at Jefferson Lab were also presented at the symposium.

The PHENIX and STAR collaborations have new data on the single-spin asymmetries of pions and η-mesons produced in proton–proton collisions at 200 GeV per beam at RHIC, with a large number of the beams polarized and the other unpolarized. They observe overwhelmingly large asymmetries in the forward rapidity region of the fragmenting polarized or unpolarized protons, with a fall to zero in the central rapidity region. A similar effect was observed earlier at Protvino and at Fermilab, but at lower energies, thus confirming energy independence (figure 3). In addition, there is no fall with rising transverse momentum in the values of the asymmetry measured at RHIC. The particular mechanism for these asymmetries remains a puzzle so far.

So although single-spin asymmetries on the whole are described by existing theory, developments continue. The T-odd distribution functions involved lose the key property of universality and become “effective”, that is, dependent on the process in which they are observed. In particular, one of the most fundamental QCD predictions is the change of sign of the Sivers PDF determined from SIDIS processes and from Drell-Yan pair production on a transversely polarized target. This prediction is to be checked by the COMPASS II experiment as part of the PANDA and PAX experiments at the Facility for Antiproton and Ion Research.

New data from Jefferson Lab on measurements of the ratio of the proton’s electric and magnetic form factors performed by the technique of recoil polarization give rise to significant interest and discussions at the symposium. The previous measurements from Jefferson Lab showed that this ratio is not constant, as had been suggested for a long time, but decreases linearly with increasing momentum transfer, $Q^2$ – the so-called “form factor crisis”. New data from the Gepp (III) experiment indicate a flattening of this ratio in the region of $Q^2 \approx 6 – 8$ GeV. The question of whether this behaviour is an outcome of the difference of radiative corrections – in particular, two-photon exchange – remains open.

The symposium enjoyed hearing the first results related to spin physics from experiments at CERN’s LHC. In particular, many discussions focused on the role of spin in investigating the recently discovered particle with a mass of 125 GeV, which could be the Higgs boson, as well as in studies of the polarization of W and Z bosons, and in heavy-quark physics. A number of talks were dedicated to the opportunities for theory related to searches for the $Z$ and other exotics at the LHC and the future electron–positron International Linear Collider.

On the technical side there was confirmation of the method of obtaining the proton-beam polarization at the COSY facility in Jülich by spin filtration in the polarized gas target. This method can also be used for polarization of antiproton beams, which will be important for measurements of different spin distributions in the nucleon via Drell-Yan muon-pair production in polarized proton–antiproton collisions in the PANDA and PAX experiments. There were also discussions on sources of polarized particles, the physics of polarized-beam acceleration, polarimeters and polarization-target techniques. In addition, there were reports on applications of hyperpolarized He and $^3$He in different fields of physics, applied science and medicine.

The main results of the symposium were summarized in an excellent concluding talk by Franco Bradamante from Trieste. For a complete list of speakers and talks see http://theor.jinr.ru/~spin2012/programme.html. The proceedings will be published in special volumes of Physics of Elementary Particles and Atomic Nuclei. The International Committee on Spin Physics, which met during the symposium, emphasized the excellent organization and success of the meeting in Dubna and decided that the 21st Symposium of Spin Physics will take place in Beijing in September 2014.

Résumé

La physique du spin à Dubna

SPIN 2012, l’édition 2012 du colloque biennal sur le spin, a eu lieu à l’Institut annifé de recherche nucléaire (JINR) à Dubna, en Russie, en septembre. Réunissant quelque 300 participants issus de 22 pays, essentiellement de Russie, des États-Unis, d’Allemagne, du Japon et d’Italie, le colloque avait adopté la formulation traditionnelle d’alternance entre sessions plénières et sessions parallèles. Après un point sur les travaux réalisés à Dubna, le colloque a évoqué les nouvelles des expériences dans le monde entier, y compris les premiers résultats relatifs à la physique du spin en provenance du LHC, au CERN. Il y a été évoqué également des développements théoriques ainsi que des futures expériences et des techniques pour les faisceaux et autres polarisés.

Anatoly Efremov, Richard Lednicky, Igor Savin and Oleg Teryaev.

JINR.
Brookhaven has new leader for nuclear and particle physics

Nuclear physicist Berndt Mueller is to lead the physics programmes at Brookhaven National Laboratory, having taken over as the associate laboratory director (ALD) for nuclear and particle physics as of 1 January. Mueller has a long collaborative association with Brookhaven and brings world-class experience to his new post as both a scientist and a manager of major research initiatives.

With a PhD in theoretical physics from Goethe University in Frankfurt, as well as postgraduate studies at Yale University and the University of Washington, Mueller has served on many physics review panels for the US Department of Energy and the National Science Foundation. He is currently chair-elect of the division of nuclear physics of the American Physical Society. He recently co-authored a paper for the journal Science, reviewing the scientific achievements of the laboratory’s Relativistic Heavy-Ion Collider (RHIC) and outlining the complementary physics opportunities for the next decade of experiments at RHIC and at the LHC, at CERN.

Mueller replaces physicist Steve Vigdor, who retired at the end of 2012 after five years as ALD. Vigdor had advanced the research programme at RHIC, guided the laboratory’s participation in the ATLAS experiment and developed programmes in cosmology, astrophysics and neutrino research. Currently a James B Duke Professor and the director of the Centre for Theoretical and Mathematical Sciences at Duke University, Mueller will continue his work there for the remainder of the current academic year, splitting his time between Duke and Brookhaven for the first five months. During this transition period, Brookhaven’s David Lissauer will act as interim ALD, sharing responsibilities and bringing Mueller up to speed on the laboratory’s existing operations and latest initiatives.

INFN inaugurates new national centre in Trento

The INFN has established a new national centre at Trento, northern Italy, dedicated to particle physics and the development of cutting-edge technologies in sensors, space research, supercomputing and biomedicine. The Trento Institute for Fundamental Physics and Applications (TIFPA) is a result of collaboration between the INFN, the University of Trento, the Bruno Kessler Foundation (FBK) and the Trento Provincial Agency for Proton Therapy (AtTeP).

The new centre will deal with research into fundamental physics as well as innovation and technology transfer by exploiting the existing infrastructures, skills and human resources of the project’s partners in Trento and by expanding specific areas of action. It will, for instance, count on the infrastructures of the Centre for Materials and Microsystems – which built the silicon detectors for the AMS experiment on the International Space Station and for the ALICE experiment at CERN – and of the European Centre for Theoretical Physics of the FBK and use the new proton therapy machine that will become operational by the end of 2013.

Francesco Proffumo, Italy’s Minister for Education, Research and University, speaks at the inauguration of the INFN national centre in Trento. (Image credit: University of Trento.)

Italy

The INFN has established a new national centre at Trento, northern Italy, dedicated to particle physics and the development of cutting-edge technologies in sensors, space research, supercomputing and biomedicine. The Trento Institute for Fundamental Physics and Applications (TIFPA) is a result of collaboration between the INFN, the University of Trento, the Bruno Kessler Foundation (FBK) and the Trento Provincial Agency for Proton Therapy (AtTeP).

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Francesco Proffumo, Italy’s Minister for Education, Research and University, spoke at the end of the inauguration ceremony on 15 January, immediately after the INFN, the University of Trento, the FBK and the AtTeP signed a declaration of intent. His presence at the event underlined the strategic importance of the initiative, both for the potential for scientific progress and in terms of building synergies among the various institutions. The declaration officially paves the way for further and closer institutional collaborations to be implemented at the cutting-edge centre.
CERN makes the headlines in 2012

The announcement by the ATLAS and CMS collaborations last July of the discovery of a new particle at CERN’s LHC made headlines around the world. These were echoed in December by a number of magazines and newspapers as they published their lists of top news from 2012. The collaborations may not yet have enough information to confirm that the new particle is the long-sought Higgs boson of the Standard Model but the discovery has made an impact beyond just the scientific media, as these examples show.

Starting with scientific magazines. Science named the discovery “Breakthrough of the Year, 2012”. Their list of runners up included more particle physics with the measurement of ωνν, “the last parameter describing how elusive particles called neutrinos morph into one another as they zip along at near-light speed” – by the Daya Bay Reactor Neutrino Experiment in China (CERN Courier May 2012 pp16). Physics World also made its award for the 2012 Breakthrough of the Year “to the ATLAS and CMS collaborations at CERN for their joint discovery of a Higgs-like particle at the Large Hadron Collider”. Nature named CERN’s director-general, Rolf Heuer, as one of its “10 people who matter” in 2012, calling him the “Higgs diplomat” and saying that his “gentle nudging … ensured that the world heard about the discovery” of the new particle. In 2011, CERN’s Mike Lamont had featured as the “Higgs mechanic”. While TIMF

Cyprus honours Herwig Schopper

On 12 December, in a small ceremony at the Presidential Palace in Nicosia, the president of Cyprus, Demetris Christofias, awarded Herwig Schopper the rare distinction of the Grand Cross of the Order of Merit of the Republic of Cyprus. Schopper, who was director-general of CERN in the years 1981–1988, received the award principally for his contribution since 2001 to the planning and development of the Cyprus Institute where he is president of the Scientific Advisory Council. He was also honoured for his involvement as founder and first president of the International Council of SÉSAME, the synchrotron radiation laboratory in Jordan. Edouard Brézin, former president of the French Academy of Sciences, was also honoured at the same ceremony.

Academy of Lyon presents the 2012 Prix Thibaud

At a ceremony on 18 December at the Hôtel de Ville, Lyon, chaired by Cédric Villani, winner of the Fields Medal 2010, the 2012 Prix Thibaud was awarded to Aurélien Barrat and Jean-Marie Laplace and Jacques-Emmanuel Marteau. They receive the prize for their high-quality contributions to nuclear, particle and astroparticle physics. Barrat is professor at the Université Joseph Fourier and researcher in the Laboratory for Subatomic Physics and Cosmology, Grenoble, where he specializes in cosmology and astroparticle physics. Laplace is a CNRS researcher at the Laboratory of Nuclear Physics and High-Energy Physics, and she works on the ATLAS experiment at CERN’s LHC, specializing in the electromagnetic calorimeter and the decay of the Higgs boson into two photons. Marteau, associate professor at the Institute of Nuclear Physics of Lyon, specializes in neutrino physics and is a member of the T2K collaboration; he was a member of the OPERA collaboration up until 2012. The prize, in honour of nuclear physicist and former president of the Académie des Sciences, Belles-Lettres et Arts de Lyon, Jean Thibaud (1901–1960), has been awarded bimannually since 1963. Candidates are European experimental or theoretical physicists, aged between 30 and 40, active in the fields of nuclear, particle or astroparticle physics and engaged by a French research organization and laboratory.

Outreach

ALBA opens its doors to the public

The Spanish Synchrotron Radiation Facility, ALBA, held its first public open day on 15 December. More than 1000 visitors, mainly from Barcelona and the surrounding region, came to the laboratory on a sunny Mediterranean winter’s day; visits by handbargers had already been sold out for future events.

The lucky ones enjoyed an itinerary round the laboratory’s installations, which took them to see the view from the top of the accelerator tunnel, past the experiment “hutches” and through one of the control rooms. There was also an opportunity to look closely at a copy of one arc of the ring, a monochromator and a radio-frequency cavity. The tour was enhanced by explanatory panels that showed the principles of particle accelerators, the production of synchrotron radiation and its uses, as well as many scientific applications of synchrotron radiation.

ALBA is a third-generation synchrotron light-source facility situated at Cerdanyola del Vallès, Barcelona (CERN Courier November 2008 p34). It began operation for users during 2012 and the seven Phase I beamlines are now operational. The accelerator routinely delivers a stable 3 GeV electron current of 100 mA, with the implementation of top-up and higher currents envisaged early in 2014. The first paper with scientific results based on data from ALBA – on inorganic chemistry – was published in December 2012.

The complete success of the open day was made possible thanks to the volunteer participation of ALBA staff, whose enthusiasm, professionalism and joy in showing their daily work to visitors.

Google Science Fair seeks the scientists of tomorrow

At the end of January, Google launched its third annual Google Science Fair in partnership with CERN, LEGO, National Geographic and Scientific American magazines. The Google Science Fair is an international competition that encourages students between the ages of 13 to 18 from all around the world to perform science experiments or create engineering projects and submit them online to compete for prizes, scholarships and once-in-a-lifetime experiences, including a trip to CERN (CERN Courier September 2012 p68 and January/February 2013 p42).

As at the Science Fair in 2012, Femilab is teaming up with CERN to offer a prize of experiencing a week as an international particle physicist, shadowing a physicist mentor at Femilab and then travelling to CERN. Previous winners have tackled cancer diagnosis and treatment, figured out more efficient ways to farm as well as explored the natural world around them.

● The competition is open until 30 April. Interested students and teachers should visit www.googlelesciencefair.com.

Please note that the competition is not open to the relatives of employees of CERN, Femilab or Google.

Google Science Fair tells 13–18 year olds that “It’s your turn to change the world”.

Meetings

FPCP 2013, the 11th conference on Flavor Physics & CP Violation 2013 will take place on 19–24 May in Bizès, Rio de Janeiro, Brazil. The aim of the meeting is to review developments – theoretical and experimental – related to the physics of heavy flavours. There will be updates on many topics, including CP violation, rare decays, spectroscopy, CKM elements and the potential for studies of heavy flavour decays to help unravel any new physics seen directly at the LHC. For further information and for registration, see http://fpcp2013.if.ufrj.br.

The 2013 Space-Cryogenics Workshop, “Space Cryogenics at Earth’s Last Frontier”, is to be held on 23–25 June in Girdwood, Alaska. Sponsored by the NASA Goddard Space Flight Center and the Cryogenic Society of America, the workshop is an opportunity for all of those engaged in low-temperature work to exchange research results and knowledge. All aspects of space cryogenics will be represented, with an emphasis on work related to previous missions as well as future research. For details, see www.spacecryogenicsworkshop.org.
Obituaries

Paul Levaux 1931–2012

Paul Levaux, a long-standing member of the Belgian delegation to CERN’s Finance Committee and Council, passed away on 3 December 2012.


In addition to holding these important offices, Levaux participated in an extensive number of CERN working groups. In particular, he was a member of the Working Group on Procedures for Payment of Member States’ Contributions (2000–2001) and the Working Group on the Review of the Tasks and Working Methods of CERN’s Governing Bodies and Committees (July–December 2003), chair of the Study Group on Pension Fund Governance in 2007, and chair of the Working Group on the Procedure for future Elections of the President of the Governing Board of the pension fund in the years 1989–2002, he was responsible for organizing and implementing the new structure of the fund, giving it a greater operational autonomy and placing it under the direct authority of the Council. His services in the pension field were recently called on again when he made an important contribution to the setting-up of the new governance structure for the Pension Fund approved by Council in 2007, whose final report now bears his name as the “Levaux Report”.

As doyen of Council and Finance Committee by a considerable margin, Levaux’s departure as a delegate represented the loss of one of CERN’s most distinguished and long-standing member-state representatives, a true mémoire du CERN.

Throughout his long association with CERN, Levaux remained a strong supporter of the organization and its activities and in honour of his achievements he was invited back to CERN last June for the Council dinner. Gratifyingly, he lived to witness the first results from the LHC, the announcement of which brought him great satisfaction.

CERN management, president and delegates of Council, and his colleagues and friends.

Paul Levaux. (Image credit: E Gröniger-Voss.)

Gordon Fraser 1943–2013

Gordon Fraser, who was editor of CERN Courier for 20 years, passed away on 3 January.

Born in Glasgow, to Ralph Jack Fasht and Ray Braverman, whose parents originally came from Russia, Gordon grew up in the east end of London. His life in physics began at Imperial College London, where he was encouraged to read Paul Dirac’s Principles of Quantum Mechanics and took mathematics as a special subject. With a demonstrated ability in mathematics, he went on to join the theory group of the future Nobel laureate Abdus Salam and obtained his PhD on diffractive scattering in 1967 under Paul Matthews. Gordon then joined the group of Yuval Ne'eman at Tel Aviv University for two years, before returning to the UK and Sussex University, where he met his future wife, physics postgraduate Gill Harbinson.

A radical change in career soon followed in 1969, when Gordon left physics to become into scientific editing at the Rutherford Appleton Laboratory in 1975 and it was from there that he was hired to join the publications team at CERN in 1977.

By 1982 Gordon had become the editor of CERN Courier. During his time at the helm, both particle physics and the Courier changed considerably. Under his careful stewardship, aspects of publishing were outsourced, leading to an attractive, professional magazine with a worldwide reputation.

These developments required the creativity and sharp writing skills for which Gordon became well known, not only through the Courier but also through his books about particle physics. The Search for Infinity (with E Lillestedt, I Sellevå) – an illustrated popular introduction to particle physics and cosmology – was translated into nine languages.

Offered a major opportunity by Cambridge Press, he joined as a journalist, at first for Computer Weekly in London and later as a freelance. He moved to the helm, both particle physics and the Courier changed considerably. Under his careful stewardship, aspects of publishing were outsourced, leading to an attractive, professional magazine with a worldwide reputation.

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Most recent work in a sense a tribute to his family’s origins and dedicated to his father, was *The Quantum Exodus – Fugitive Jews, the Atomic Bomb, and the Holocaust* (reviewed in *CERN Courier* October 2012 p49).

A well known figure at CERN, Gordon was also a keen runner and he was often seen powering around the Meyrin site on his mountain bike. He will be missed by many, especially by those who were fortunate enough to have worked with him and witnessed his skill as a writer. He is survived by his father, his wife Gill and two children, Nathalie and Ben.

*His colleagues and friends.*

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**NEW PRODUCTS**

Intersil Corporation has announced the ISL8225M, a 30A fully encapsulated power module. The ISL8225M can deliver up to 100W output power from a small 17-mm-square PCB footprint. The two 15A outputs can be used independently or combined to deliver a single 30A output. Current-sharing and phase interleaving allow up to six modules to be put in parallel for 180A output capability. Excellent efficiency and low thermal resistance permit full-power operation without heat sinks or fans. For more information, contact Kelly Maxwell, tel +1 408 546 3582, e-mail kmaxwell@intersil.com or see www.intersil.com.

Lake Shore Cryotronics Inc has introduced updated specifications for its Model CRX-VF Cryogenic Probe Station, featuring increased maximum magnetic field, improved magnetic field at elevated sample temperatures and improved vacuum performance. The cryogen-free micro-manipulated probe station is used for nondestructive testing of devices on full and partial wafers up to 51 mm in diameter. The maximum magnetic field capability at base temperature has been improved from ±2.5 T to ±2 T. For more information, tel +1 644 891 2244, fax +1 644 818 1600, e-mail info@lakeshore.com or visit www.lakeshore.com.

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**L E T T E R**

The missing life of DORIS

The article “The three lives of DORIS” (*CERN Courier* December 2012 p 22) briefly summarizes the history of DORIS. We believe the author has forgotten one “life”, in the years 1977–1978, when DORIS was upgraded from 3.5 GeV to 10.0 GeV in the centre of mass. Though being only a short life, it is worth mentioning for at least three reasons.

First, it enabled a scan of the full range of energies and confirmed that there were no new quarks (below the Y) and strengthened knowledge of the properties of jets from the hadronization of quarks. Second, it allowed the detection of the new Y resonance at 9.46 GeV, which decays mainly strongly and is very narrow, and thereby delivered the necessary confirmation of the new b quark which had been found a year earlier at Fermilab via the Y resonance at 9.5 GeV. Third, through the analysis of the hadronic decays of the Y, it provided first evidence for the decay → 3 gluons → 3 jets, for gluon jets and for the spin 1 of the gluon, and hence made an important contribution to the discovery of the gluon, confirming the expectations of QCD.

The reason for forgetting this “life” could be that the author based his article on a book published in 2009, and so missed two more recent papers. In one we put new light on the importance of the P LUTO experiment at DORIS in 1978 in contributing to the discovery of the gluon (Stella and Meyer 2011). The second is an independent review where this new perspective is mainly confirmed (Ali and Kramer 2011, see e.g. p3 and pp20–24 in chapter 4, “Gluon jets in Y decays”).

For completeness, we would like to remember not only the results of PLUTO at DORIS but also other “forgotten” experiments: DASP, Crystal Ball, DASP3, DESY-HDD and LENA.

B Stella (Stefano.Stella@roma1.infn.it) and Hans-Jürgen Meyer (Hans-Juergen.Meyer@amu.osse.de).

*Further reading*


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**Faces & Places**

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**ET Enterprises**

**ADIT Electron Tubes**

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**LakeShore**

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**Model 350 Ultra Low Temperature Controller**

Ideal for use with He-3 systems and other ultra-low temperature refrigeration platforms down to 100 mK

- Optimized performance with Cernox® RTDs
- Patented low-noise input circuitry enables super low excitation power for minimal self-heating and high resolution measurement
- 4 independent control loops and a broad range of I/O configurations can eliminate need for additional instrumentation

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**Photomultipliers from ET Enterprises and ADIT Electron Tubes**

Need to detect light down to single photon level?
Need dark counts as low as a few cps at 20°C?
Need high or low voltage?
Need to detect light down to single photon level?
Need a detection area of up to 200 cm² or more?

Photomultipliers have always offered significant performance advantages over other types of low-voltage light detection devices and this is as true today as ever before. But what has changed is the range of ready-to-use associated electronics and hardware.

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Photomultipliers can be classified into two main categories: photomultiplier tubes (PMTs) and solid-state photodiodes (SSPDs). PMTs consist of a photosensitive cathode material, an anode, and a series of dynodes that are used to amplify the electron signal produced by the incident light. SSPDs, on the other hand, do not require a high-bias voltage and are more sensitive to the incoming light.

SSPDs are ideal for applications where high sensitivity is required, such as in scientific research or medical imaging. They are also less expensive than PMTs and can be used in a wider range of temperature conditions.

PMTs, on the other hand, are more sensitive to lower energies and are used primarily in laboratory and research settings. They are also more robust and can withstand higher temperatures.

In conclusion, the choice between PMTs and SSPDs depends on the specific application and the required sensitivity. PMTs are generally more sensitive to lower energies, while SSPDs are more versatile and cost-effective.
Luvata has announced Mileon, the longest seamless hollow conductor available on the market. Unlike traditional hollow conductors, Mileon gives manufacturers the option for large continuous coils or the flexibility to specify the optimum length, reducing the required amount of scrap and pitting materials. Mileon hollow conductors are completely jointless and are produced in continuous lengths of hundreds or thousands of metres. Made from high-purity oxygen-free copper, Mileon delivers electrical conductivity of 101–102% IACS and thermal conductivity of 390 W/km. For further details, contact Paula Tappola, tel +358 2 626 6787, e-mail paula.tappola@luvata.com or see www.luvata.com.

Narda Safety Test Solutions presents two new meters for equipment that operates using industrial frequencies. The NIM-511 and NIM-513 are complete hand-held measuring systems that make standards-compliant measurements of electric and magnetic field strength and demonstrate adherence to human safety regulations. The NIM-511 covers the range 300 kHz to 100 MHz, while the NIM-513’s sensors cover the range 10 MHz to 42 MHz and are balanced during calibration at the 21.2 MHz frequency used for heat-welding equipment and induction ovens. For further information contact Narda STS at tel +49 7192/9732 0, e-mail support@narda-sts.de or see www.narda-sts.de.

Pfeiffer Vacuum has introduced energy-saving dry pumps A100L, with a compact design specially developed for flexible integration in semiconductor production facilities. These dry multistage Roots pumps are ideal for clean applications and the fully integrated ES module reduces energy use to a minimum in the low-pressure range, significantly reducing operating costs. Annual savings per pump total up to 790 kWh. In addition, the final pressure of the A100L ES is reduced to 7 × 10⁻⁴ mbar (hPa), which opens up new potential applications. For details, contact Sabine Neubrand-TRYAL, tel +49 6441 802 1223, e-mail Sabine.Neubrand@pfeiffer-vacuum.de or visit www.pfeiffer-vacuum.com.

UltraVolt Inc has announced lower output voltage ranges on its general-purpose bench-top power system, the BT-GP Series, which are now offered at 1 kW, 2 kW, 4 kW and 6 kW of output power at 30 V. The BT-GP Series is ideal for OEM-biasing applications such as air purifying, process fluid cleaning, bio pot testing and for laboratory research. The company has also announced that the –15 and –110 interface options are now available on its high-voltage modules (10A–25A Series), low-ripple modules (F Option) and standard high-voltage biasing supplies (A Series). For further details, tel +1 631 471 4444 or see www.ultravolt.com.

XP Power has announced the ECP90 series of compact low profile 60 Watt AC/DC power supplies. These units have typically 88% efficiency measure 101.6×50.8×30.4 mm and fit into an energy-saving dry pumps A100 L, with typically 88% efficiency measure 101.6×50.8×30.4 mm and fit into an energy-saving dry pumps A100 L, with typically 88% efficiency measure 101.6×50.8×30.4 mm and fit into an energy-saving dry pumps A100 L, with typically 88% efficiency measure 101.6×50.8×30.4 mm and fit into an energy-saving dry pumps A100 L, with typically 88% efficiency measure 101.6×50.8×30.4 mm and fit into an energy-saving dry pumps A100 L, with typically 88% efficiency measure 101.6×50.8×30.4 mm and fit into an energy-saving dry pumps A100 L, with typically 88% efficiency measure 101.6×50.8×30.4 mm and fit into an energy-saving dry pumps A100 L, with typically 88% efficiency measure 101.6×50.8×30.4 mm and fit into an energy-saving dry pumps A100 L, with typically 88% efficiency measure 101.6×50.8×30.4 mm and fit into an energy-saving dry pumps A100 L, with typically 88% efficiency measure 101.6×50.8×30.4 mm and fit into an energy-saving dry pumps A100 L, with typically 88% efficiency measure 101.6×50.8×30.4 mm and fit into an energy-saving dry pumps A100 L, with typically 88% efficiency measure 101.6×50.8×30.4 mm and fit into an energy-saving dry pumps A100 L, with typically 88% efficiency measure 101.6×50.8×30.4 mm and fit into an energy-saving dry pumps A100 L, with typically 88% efficiency measure 101.6×50.8×30.4 mm and fit into an energy-saving dry pumps A100 L, with typically 88% efficiency measure 101.6×50.8×30.4 mm and fit into an energy-saving dry pumps A100 L, with typically 88% efficiency measure 101.6×50.8×30.4 mm and fit into an energy-saving dry pumps A100 L, with typically 88% efficiency measure 101.6×50.8×30.4 mm and fit into an energy-saving dry pumps A100 L, with typically 88% efficiency measure 101.6×50.8×30.4 mm and fit into an energy-saving dry pumps A100 L, with typically 88% efficiency measure 101.6×50.8×30.4 mm and fit into an energy-saving dry pumps A100 L, with typically 88% efficiency measure 101.6×50.8×30.4 mm and fit into an energy-saving dry pumps A100 L, with typically 88% efficiency measure 101.6×50.8×30.4 mm and fit into an energy-saving dry pumps A100 L, with typically 88% efficiency measure 101.6×50.8×30.4 mm and fit into an energy-saving dry pumps A100 L, with typically 88% efficiency measure.
Two Postdoctoral Positions
The ALPHA Antihydrogen Experiment at CERN
Laser Spectroscopy of Trapped Antihydrogen

The ALPHA experiment at CERN has two immediate (March, 2013) openings for postdoctoral candidates.

These positions, financed by an Advanced Grant from the European Research Council, are initially for two years and renewable for up to five. The focus of the research program will be to develop the laser systems (243 nm) necessary for conducting spectroscopy on trapped antihydrogen atoms. Candidates must have a recent (within the last three years) Ph.D. in physics. Preference will be given to candidates having experience involving laser interactions with trapped atoms or ions. Knowledge of cryogenic and UHV systems is also highly desirable. The successful candidate will be expected to publish in all aspects of the experiment's activities at the Antiproton Decelerator at CERN. This includes commissioning of the new ALPHA-2 antihydrogen trap and involvement in all aspects of the experimental work, as the experiment is in an expansion into adjacent areas of cosmology.

Interested candidates should send their CV and a brief statement of their qualifications and research interests to Professor Jeffrey Hangst, Spokesperson, the ALPHA Collaboration at CERN: jeffrey.hangst@cern.ch. Please include the names and contact email addresses for three references, but do not ask for letters of reference to be sent at this time. The deadline for applications is March 11th, 2013.
The Faculty of Physics, Mathematics, and Computer Science at the Johannes Gutenberg University of Mainz (JGU) and the PRISMA Cluster of Excellence invite applications for an appointment at the level of University Professor (W2 with tenure) in Lattice Gauge Theory at the Institute of Nuclear Physics.

The position is part of the new Cluster of Excellence PRISMA “Precision Physics, Fundamental Interactions and Structure of Matter”, which focuses on key questions concerning the fundamental constituents of matter and their implications for the physics of the Universe. It consists of experimental and theoretical research groups working together in the areas of quantum chromodynamics, high energy and hadron physics, nuclear chemistry, as well as precision physics with ultra-cold neutrons and ion traps.

We seek an imaginative and internationally visible scientist who will significantly strengthen and extend ongoing research in neutrino physics or quark flavour physics. The research will be performed in the framework of the PRISMA Cluster of Excellence. The studies should concentrate on tests of the Standard Model and on probing proposed extensions by performing precision measurements of particle properties, by studying the particle mixing patterns or by searching for rare decays.

Applicants are expected to have a Ph.D. in physics, a proven first-rate research record and to possess the required pedagogical skills for teaching. Undergraduate courses are usually given in German. JGU provides a concept of intensive tutoring and expects a high rate of presence at the university. The appointment requires participation in teaching activities and in the duties of academic administration.

JGU aims at increasing the percentage of women in academic positions and strongly encourages female candidates to apply.

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

Qualified candidates are asked to submit their applications by March 1, 2013, including the usual documents (CV; list of publications; copies of up to three key publications; research proposal) as a single PDF file via the portal http://www.phmi.uni-mainz.de/stellen. Applications should be addressed to “Dekan des Fachbereichs 08, Johannes Gutenberg-Universität Mainz, Staudingerweg 7, 55128 Mainz”.

The Faculty of Physics, Mathematics, and Computer Science at the Johannes Gutenberg University of Mainz (JGU) and the PRISMA Cluster of Excellence invite applications for an appointment at the level of University Professor (W2, tenure track) in Experimental Particle Physics with emphasis on Flavour Physics at the Institute of Physics.

The position is part of the new Cluster of Excellence PRISMA “Precision Physics, Fundamental Interactions and Structure of Matter”, which focuses on key questions concerning the fundamental constituents of matter and their implications for the physics of the Universe. It consists of experimental and theoretical research groups working together in the areas of high-energy and hadron physics, nuclear chemistry, as well as precision physics with ultra-cold neutrons and ion traps.

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The Cockcroft Institute, a unique collaboration between the Universities of Manchester, Lancaster and Liverpool; Science and Technology Facilities Council and industry brings together the best accelerator scientists, engineers, educators and industrialists to conceive, design, construct and use some of the most complex research tools and facilities in the world. The Cockcroft Institute's international reputation is underpinned by its role as one of the two major national eScience facilities in the UK operating from its purpose built building on the University of Manchester campus. It is contributing towards development of advanced FEL facilities (CLARA) and creating an infrastructure for future FEL developments. The Cockcroft Institute has a strong collaboration with CERN in the areas of high energy physics, accelerator projects, anti-matter research and future developments in high energy accelerators, and with the ESS at Lund. The Institute has the strategic objective of operating from its purpose built office and laboratory infrastructure, and is focussed on one of the two major national facilities for eScience in the UK.

As a funding member of the Cockcroft Institute and with the UK's highest ranking physics department in the 2008 Research Assessment Exercise, Lancaster University is seeking to appoint a Chair (Full Professor) in Accelerator Physics who will hold a significant leadership position, Associate Director of the Cockcroft Institute from Lancaster University, to further consolidate the institution’s international profile. The incumbent will be a member of the Cockcroft Institute Executive Management Committee and will be expected to advance theoretical and/or experimental research in accordance with the Institute’s international reputation. You must have a PhD in accelerator physics, particle physics, electrical engineering or a related discipline, with an outstanding research and publications record and high level of expertise and leadership in a whole range of international experiments. You should have a deep grasp of potential future international accelerator developments. Information about the Institute can be found on the Cockcroft Institute website.

Informal inquiries about the institute may be made to Professor Simon Chattopadhyay, simon.chattopadhyay@cockcroft.ac.uk and Peter Ratoff, peter.ratoff@lancaster.ac.uk. For information about the Lancaster University Physics Department: Professor Peter Ratoff, peter.ratoff@lancaster.ac.uk. Salary is expected to be in Band 1 of the professional scale. Closing Date: 28 February 2013.
Flavor Physics at the Tevatron: Decay, Mixing and CP Violation Measurements in p\bar{p} Collisions
by Thomas Kuhn
Springer
Hardback: €119.19
Paperback: €109.00
The Tevatron collider operated by Fermilab close to Chicago was – until the LHC at CERN took over – the most powerful particle accelerator on Earth, colliding protons and antiprotons with, finally, a centre-of-mass energy of almost 2 TeV. Among many interesting results, the key discovery was the observation of the top quark by the CDF and DØ collaborations in 1995. In p\bar{p} collisions, huge numbers of B and D mesons are also produced, offering sensitive probes for testing the quark-flavour sector of the Standard Model, which is described by the Cabibbo-Kobayashi-Maskawa (CKM) matrix. A closely related topic concerns violation of the charge-parity (CP) symmetry, which can be accommodated through a complex phase in the CKM matrix. Physics beyond the Standard Model may leave footprints in the corresponding observables.

In this branch of particle physics, the key aspect addressed at the upgraded Tevatron (Run-II) was the physics potential of the B mesons, which consist of an anti-bottom quark and a strange quark. Since these mesons and their antiparticles were not produced in the e+e– factories that operated at the Y(4S) resonance, they fall in the domain of B-physics experiments at hadron colliders, although the Belle experiment could get some access to these particles with the KEK B-factory running at the Y(5S) resonance. Since the Tevatron stopped operation in autumn 2011, the experimental exploration of the B system has been fully conducted at the LHC, with its B-decay experiment LHCb.

The CDF and DØ collaborations did pioneering work in B physics, which culminated in the observation of B0 – \bar{B}0 mixing in 2006, first analyses of CP-violating observables provided by the decay B0 → J/ψK, and the dimuon B0 → J/ψµ+µ–. The latter is the highlight. An important part of the book deals with various manifestations of CP violation and the corresponding probes offered by the B system, where B0 – \bar{B}0 mixing is the highlight. Last, rare decays are discussed, putting the rarest decay processes that nature has to offer. While the book has a strong focus on the B system, it also addresses Λb decays and charm physics.

This well written book with its 161 pages is enjoyable to read and offers a fairly compact way to get an overview of the B-physics programme conducted at the Tevatron in the past decade. A reader familiar with basic concepts of particle physics should be able to deal easily with the content. It appears suited to experimental PhD students making first contact with this topic, but experienced researchers from other branches of high-energy physics may also find the book interesting and useful.

Topics such as the rare decay B0 → γγ′ , which has recently appeared as a first 3.5σ signal in the data from LHCb, and measurements of CP violation in B0 decays will continue to be hot topics in the LHC physics programme during this decade, complementing the direct searches for new particles at the ATLAS and CMS detectors.

El ecologista nuclear
By Juan José Gómez Cadenas
Espasa Calpe
Paperback: €22.95
E-book: €22.99
Also published as: L’ambientalista nucleare
Springer
Paperback: €24.99
E-book: €25.99

Juan José Gómez Cadenas is the director of the Neutrino Physics Group at Valencia University but is best known by the general public as a novelist – in 2008 he wrote Materia Extraterrestre, a scientific thriller (p23) – as an expert in science popularization. Even in a purely scientific environment he is able to deliver information in a most enjoyable way, as I found when I attended a scientific talk that he gave at CERN. This same ease in communicating is
recognizable in El ecologist nuclear, a book about the topic of renewable and green energy and the role of the nuclear energy. I read the Italian edition of the book and although I noticed that the translation was not always perfect and, especially in some cases, that it did not improve the quality of the reading, I really enjoyed the book and its factual approach to this delicate and controversial topic.

Gómez Cadenas makes his point of view clear in the first chapter: “All that glitters is not green”. This could shock the uninitiated because it immediately leads the reader to face the “problem” – climate change is a “bomb” that has been activated – and humankind is “playing with fire”. The author does not just present this scenario as an opinion. Rather, he justifies all of his statements with graphs, scientific data and evidence.

The chapters that follow are a journey through the various solutions to the problem, in which he makes a strong case for the use of nuclear energy. Using data and graphs, he successfully proves that “safe” nuclear power is the only viable solution. I emphasize the word “safe” because this is the delicate point that matters most to the general public. Unlike other authors, instead of avoiding talking about the problem of safety, Gómez Cadenas discusses it openly, with constant reference to scientific data.

I like the book, I like the author’s open and honest approach, his competence and his rigorous summaries of a global problem that concern us all. I would recommend reading it before voting for any topic related to the energy problem on our planet.

A Student’s Guide to Einstein’s Major Papers

Robert E. Kennedy

Cambridge University Press

Hardback: £25

“This is probably no physicist living today whose name has become so widely known as that of Albert Einstein.” This is the opening sentence of Svante August Arrhenius, chair of the Nobel Committee, on occasion of the award of the 1921 Nobel Prize in Physics on 10 December 1922. “Most discussion centres on his theory of relativity,” he follows and agree. Ninety years later we measure Einstein in terms of how he spearheaded the transformation of our understanding of space, time and the universe as a whole. His contributions to all other fields of knowledge, though extremely impressive and Nobel prize winning, is similar to work of the other Nobel laureates in physics. Even so, you will not learn in this book that Einstein won the prize “for his services to theoretical physics, and especially for his discovery of the law of the photoelectric effect”, discussed in chapter 2. Maybe a student does not deserve to be distracted by such a petty fact, but the volume literally overflows with extraneous historical facts.

Relativity – in its multiple reincarnations – is the work of a genius, taking an approach outside our contemporary world, so far out, indeed, that no common ground could be found for its immediate recognition. In my opinion, a present-day guide to the work of Einstein can only have one purpose and that is to show Einstein’s path to relativity, both special and general. In this book, I do not see a clear position on what is that Einstein achieved in his relativity papers that we today regard as everlasting. The big scientific ideas that Einstein introduced are, effectively, missing.

This observation is easily proved by example. The unprecedented and universally recognized contribution that Einstein made in developing his path to special relativity was to give each material object its own clock, so as to undo the idea of a universal time. Today, physicists use “proper time”, the terminology introduced by Hermann Minkowski in 1908. It was the attribution of proper time to each material body that was the paradigm-shifting idea. This “guide” does not have proper time in the index and I did not see it written down in the book. However, I did see “local time”, e.g. in a quote on page 111 from Lorentz’s book and a few more times after that. Why is there no connection to the concept of proper time? Even more perplexing, the relaxed concept of time dilation is missing. The words “time dilation” appear in the book exactly once, definitely by accident. Any student will want to know what Einstein had to say about that, after all, the twin paradox is interesting to most students. The evolution of Einstein’s views on aether is another topic on which a student reading and understanding the book and its index, yet the student seeking to understand how Einstein viewed it will not find an answer (although page 21 clearly states Lorentz’s 1905 view of aether). Einstein created the needed clarity in 1920: “We may say that according to the general theory of relativity space is endowed with physical qualities; in this sense, therefore, there exists an aether. According to the general theory of relativity, space without aether is unthinkable; for in such space there would not only be no propagation of light, but also no possibility of existence for standards of space and time (measuring rods and clocks), nor therefore any space–time intervals in the physical sense. But this aether may not be thought of as endowed with the quality characteristic of ponderable media, as consisting of parts which may be tracked through time. The idea of motion may not be applied to it.”

From Einstein and the Theory of Relativity (1920), available in Sidereus on Relativity (Dover).

In summary, Kennedy’s book is not an easy read and misses out on discussion of key conceptual ideas present in Einstein’s major papers.

Jôhna Ryssä, University of Arizona.

Book received

Foundations of Space and Time: Reflections on Quantum Gravity

by Jeffrey A.หาร. Jenkins, Amanda Witman and George F. Ellis (eds.)

Cambridge University Press

Paperback: £56

After almost a century, the field of quantum gravity remains as difficult and misunderstood as ever. Today, it finds itself a field divided, with two major contenders dominating: string theory and loop quantum gravity. However, a number of other innovative schemes are providing promising new avenues. Encapsulating the latest debates, this book details the different approaches to understanding the nature of space and time. It brings together leading researchers to explore in a comprehensive coverage all of the current approaches to solving the problem of quantum gravity, addressing the strengths and weaknesses of each approach.

FORTHCOMING INSTITUTE CONFERENCES

MARCH 2013 – APRIL 2015

2013

6–8 March

International Quantum Computation 2013

Institute of Physics, London, UK

Organised by the IOP Quantum Optics, Quantum Information, Quantum Control Group

26–21 March

AIMS Spring Meeting 2013

National University of Ireland, Maynooth, Ireland

Organised by IOP Atlantic and Molecular Interactions Group

24–27 March

Advanced Method in Soft Condensed Matter: “Solutions in the Spring”

Westwood Hall, Leeds, UK

Organised by IOP Liquids and Complex Fluids Group and the IOP Polymer Physics Group

25–28 March

Interdisciplinary Surface Science Conference 2013

East Midlands Conference Centre, Nottingham, UK

Organised by the IOP Thin Films and Surfaces Group

7–10 April

IOP Nuclear Physics Conference

University of York, York, UK

Organised by the IOP Nuclear Physics Group

10–12 April

Dielectrics 2013

University of Reading, Reading, UK

Organised by the IOP Dielectrics Group

15–16 April

PhD Graduate Magnetisation Techniques Workshop 2013

University of York, York, UK

Organised by IOP Magnetism Group

18–20 April

High-Speed Imaging for Dynamic Testing of Materials and Structures – 2nd DMAT Technical Meeting

Institute of Physics, London, UK

Organised jointly by the IOP Applied Physics and Technology Division and DMAT Association

5–6 December

Electrospinning, Principles, Possibilities and Practices 2013

Institute of Physics, London, UK

Organised by the IOP Electrophysics Group and IOP Plasma Physics Group

2014

8–12 July

International Conference on Neutron Scattering (ICN2013)

Edinburgh International Conference Centre, Edinburgh, UK

3–6 September

Electro Microscopy and Analysis Group Conference 2013 (EMAG)

University of York, York, UK

Organised by the IOP Nanotechnology and Imaging Group

4–6 September

PR 13: International Conference on Photon franching, Optics and Devices

The Winchester Hotel, Winchester, UK

Organised by the IOP Optical Group and the IOP Quantum Electronics and Photonics Group

9–11 September

Physical Acoustics of Photon Science

University of Sheffield, Sheffield, UK

Organised by the IOP Polymer Physics Group

16–18 September

 Sensors: Their Applications XIII

Institute of Physics, London, UK

Organised by the IOP Instrument Science and Technology Group

16–19 September

SENSOR 2013: 13th International Display Research Conference

University of Edinburgh, Edinburgh, UK

Organised by the IOP Optical Group and Society for Information Display

31 October – 1 November 2013

Nanoscience Conference

Institute of Physics, London, UK

Organised by the IOP Nanoscience and Nanotechnology Group

19–20 November

High-Speed Imaging for Dynamic Testing of Materials and Structures – 2nd DMAT Technical Meeting

Institute of Physics, London, UK

Organised jointly by the IOP Applied Physics and Technology Division and DMAT Association

2015

12–16 April

Electrostatics 2015

Southampton Solent University, Southampton, UK

Organised by the IOP Electrostatics Group

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Viewpoint

The incomprehensibility principle

Gordon Fraser, long-time editor of CERN Courier, ponders on paying attention.

Educators and psychologists invented the term “attention span” to describe the length of time anyone can concentrate on a particular task before becoming distracted. It is a useful term but span, or duration, is only one aspect of attention. Attention must also have an intensity – and the two variables are independent of each other. Perhaps one can postulate an analogue of the Heisenberg uncertainty principle, in which the intensity of attention multiplied by its span cannot exceed some fixed value. I call this the “incomprehensibility principle” and I have had plenty of opportunities to observe its consequences.

In the hands of skilled presenters, information can be carefully packaged as entertainment so that the attention needed to digest it is minimal. The trick is to mask the effort with compelling emotional appeal and a flashy ball-room haircut. However, the need to pay attention is still there; in fact, absorbing even the most trivial information demands a modicum of attention. How many of us, when leaving a cinema, have had the nagging feeling that although the film made good entertainment some details of the plot are not assimilated in higher education. In my case, a hint of what was to come appeared during my third year of undergraduate physics, when I attended additional lectures on quantum mechanics in the mathematics department at Imperial College London.

My teacher was Abdus Salam, who went on to share the Nobel Prize for Physics in 1979. Salam’s lectures were exquisitely incomprehensible, as I look back, I realize he was probably echoing his own experiences at Cambridge some 15 years earlier at the hands of Paul Dirac. But he quickly referred us to Dirac’s book, *The Principles of Quantum Mechanics*. At a first and even a second glance, this book shone no light at all but after intense study, a rewarding glimmer of illumination appeared out of the darkness.

Motivated by Salam’s unassimilability, I began postgraduate studies in physics only to find that my previous exposure to incomprehensibility had been merely an introduction. By then, there were no longer any textbooks to fall back on and journal papers were impressively baffling. With time, though, I realized that – like Dirac’s book – they could be painlessly decyphered “at leisure”, line by line, with help from enlightened colleagues.

The real problem with the incomprehensibility principle came when I had to absorb information in real time, during seminars and talks. The most impenetrable of these talks always came from American speakers because they were, at the time, wielding the heavy cutting tools at the face of physics research. Consequently, I developed an association between incomprehensibility and accent.

This reached a climax when I visited the US, where I always had the feeling that dubious characters hanging out at bus stations and rest stops must somehow be experts in S-matrix theory and the like, travelling from one seminar to the next. Several years later, when I was at CERN, seminars were instead delivered in thick European accents and concepts such as “muon punch-through” became more of an obstacle when pointed out in a heavy German accent.

Nevertheless, I persevered and slowly developed new skills. The incomprehensibility principle cannot be bypassed but even taking into account added difficulties such as the speaker’s accent or speed of delivery – not to mention bad acoustics or poor visual “aids” – it is still possible to optimize one’s absorption of information.

One way of doing this is to monitor presentations in “background mode”, paying just enough attention to follow the gist of the argument until a key point is about to be reached. At that moment, a concerted effort can be made to grab a vital piece of information as it whistles past.

I began postgraduate studies in physics only to find that my previous exposure to incomprehensibility had been merely an introduction.

By adopting this technique, I was able to cover frontier meetings on subjects of which I was supremely ignorant, including microprecessors, cosmology and medical imaging, among others. Journalists who find themselves baffled at scientific press conferences would do well to follow my example, for the truth is that there will always be a fresh supply of incomprehensibility in physics. Don’t be disappointed!

Gordon Fraser. Fraser, Gordon, editor of CERN Courier for many years, wrote this as a “Lateral Thought” for Physics World magazine but died before the article could be published (see obituary p68). Frans completed a staff at Physics World and is published in both magazines this month as a tribute.
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