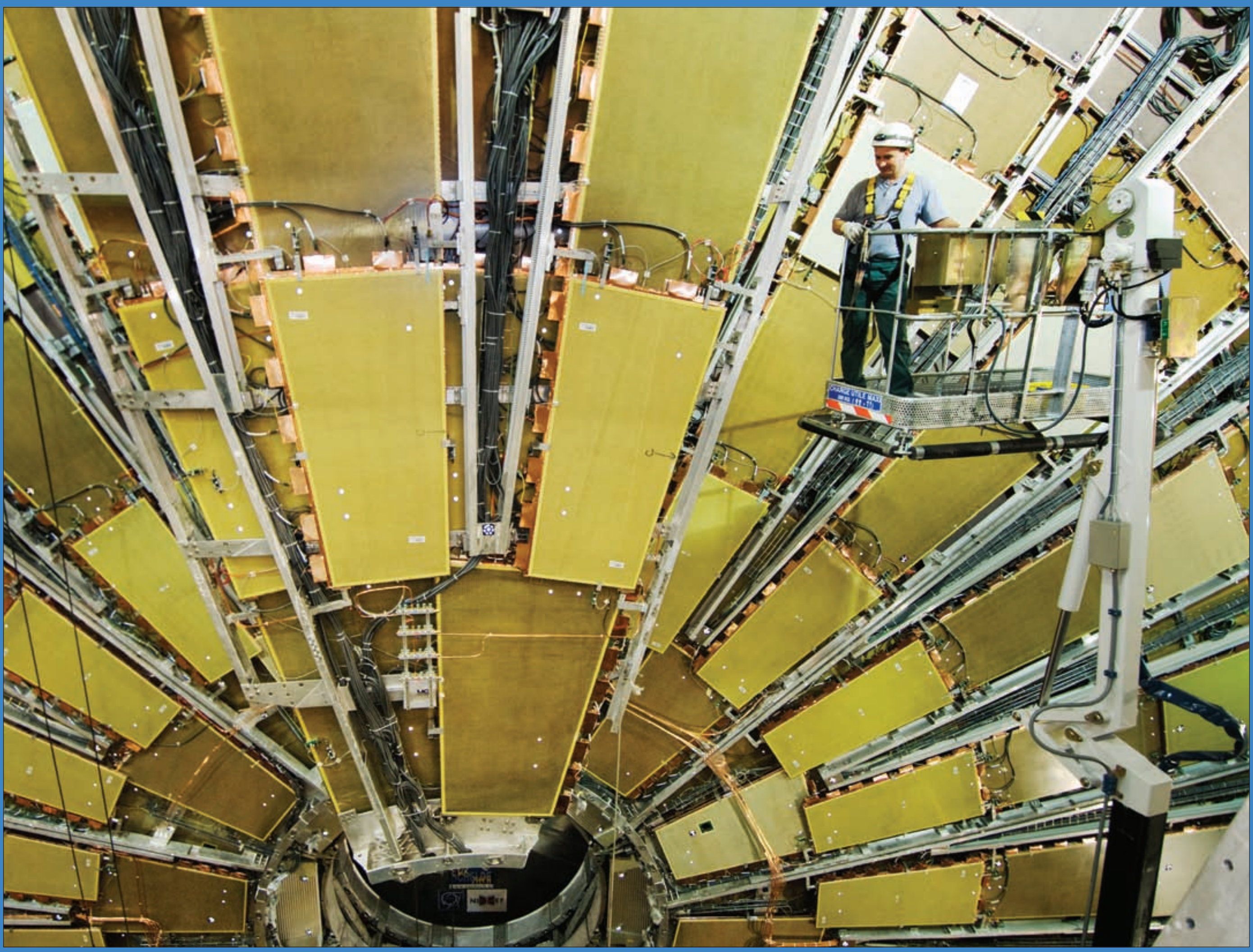
International Journal of High-Energy Physics

CERN COURIER

Volume 47 Number 9 November 2007



ATLAS installs final big wheel

DESY
FLASH makes pulses at design energy p8

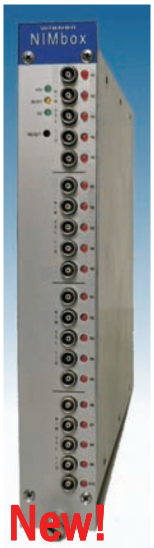
LHC FOCUS
Preparing for the data onslaught p17

BROOKHAVEN
Ernest Courant looks back 60 years p26

Modules

NIM

NIMbox
A programmable NIM Module with USB Interface



- **NPN20** - Progr.Logic Unit, 20 NIM I/O
- **NPT20** - Progr. Logic Unit, 20 TTL I/O
- **NDL8** - Leading Edge 8-fold Discriminator
- **NAD4** - 100 MHz 4 channel F-ADC
- **NDA8** - 100 MHz 8 channel DAC, e.g. for detector simulation
- Scaler, TDC, MLU, and more...

USB cable, driver and software included

Desk version (Nembox) for didactical experiments available

Developed in collaboration with University of Heidelberg

CAMAC

CC-USB
Controller with USB Interface

PCI and VME adapters for CAMAC are also available

CQ16
16 channel 12 bit CAMAC QDC, down to 25fC/count

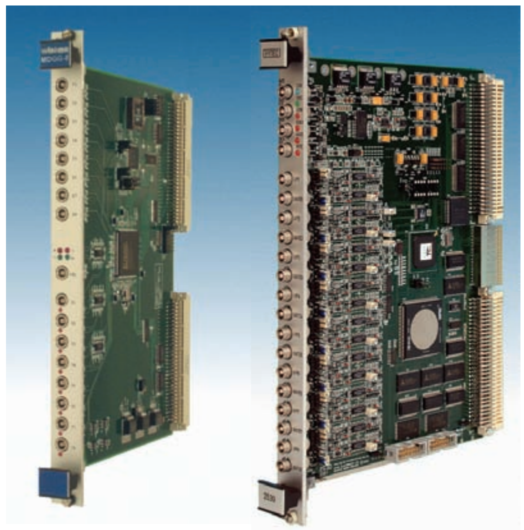
VME

VME-USB
Controller with USB Interface

VDIS2
Diagnostic Module for VME

MDGG8
Progr. Delay and Gate Generator, Scaler

ADC2530
8 channel peak sensing 13 bit ADC



www.wiener-d.com

Plein & Baus GmbH. Muellersbaum 20, 51399 Burscheid, Germany
Phone: +49 (0)2174 6780, Fax: +49 (0)2174 678 55

WIENER Plein & Baus Elektronik

Werk für Industrie-elektronik, Nuklear-elektronik, Regelungs-technik

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

CERN Courier is distributed to member-state governments, institutes and laboratories affiliated with CERN, and to their personnel. It is published monthly, except for January and August. The views expressed are not necessarily those of the CERN management.

Editor Christine Sutton
CERN, 1211 Geneva 23, Switzerland
E-mail cern.courier@cern.ch
Fax +41 (0) 22 785 0247
Web cerncourier.com

Advisory board James Gillies, Rolf Landua and Maximilian Metzger

Laboratory correspondents:
Argonne National Laboratory (US) Cosmas Zachos
Brookhaven National Laboratory (US) P Yamin
Cornell University (US) D G Cassel
DESY Laboratory (Germany) Ilka Flegel, Ute Wilhelmsen
EMFCSC (Italy) Anna Cavallini
Enrico Fermi Centre (Italy) Guido Piragino
Fermi National Accelerator Laboratory (US) Judy Jackson
Forschungszentrum Jülich (Germany) Markus Buescher
GSI Darmstadt (Germany) I Peter
IHEP, Beijing (China) Tongzhou Xu
IHEP, Serpukhov (Russia) Yu Ryabov
INFN (Italy) Barbara Gallavotti
Jefferson Laboratory (US) Steven Corneliussen
JINR Dubna (Russia) B Starchenko
KEK National Laboratory (Japan) Youhei Morita
Lawrence Berkeley Laboratory (US) Spencer Klein
Los Alamos National Laboratory (US) C Hoffmann
NIKHEF Laboratory (Netherlands) Paul de Jong
Novosibirsk Institute (Russia) S Eidelman
NCSL (US) Geoff Koch
Orsay Laboratory (France) Anne-Marie Lutz
PSI Laboratory (Switzerland) P-R Kettle
Saclay Laboratory (France) Elisabeth Locci
Science and Technology Facilities Council (UK) Peter Barratt

Produced for CERN by IOP Publishing Ltd
IOP Publishing Ltd, Dirac House, Temple Back, Bristol BS1 6BE, UK
Tel +44 (0)117 929 7481

Publisher Joseph Tennant
Art director Andrew Giaquinto
Senior production editor Jonathan Cailes
Production editor Lizi Brown and Jesse Karjalainen
Technical illustrator Alison Tovey
Advertising manager Ed Jost
Recruitment advertisement manager Moo Ali
Recruitment and classified sales Adam Hylands and Sonia Nardo
Recruitment and classified sales North America Mark Gaglione
Advertisement production Jayne Boulton
Marketing executive Chinh Dinh

Advertising
Tel +44 (0)117 930 1026 (for UK/Europe display advertising), +1 215 627 0880 (for North American display advertising), or +44 (0)117 930 1196 (for recruitment advertising); e-mail sales@cerncourier.com; fax +44 (0)117 930 1178

General distribution Courrier Adressage, CERN, 1211 Geneva 23, Switzerland. E-mail courrier-adressage@cern.ch
In certain countries, to request copies or to make address changes, contact:
China Keqing Ma, Library, Institute of High Energy Physics, PO Box 918, Beijing 100049, People's Republic of China. E-mail keqingma@mail.ihep.ac.cn
Germany Veronika Werschner, DESY, Notkestr. 85, 22607 Hamburg, Germany. E-mail desypr@desy.de
Italy Loredana Rum or Anna Pennacchietti, INFN, Casella Postale 56, 00044 Frascati, Rome, Italy. E-mail loredana.rum@inf.it
UK Mark Swaisland, Chadwick Library, Daresbury Laboratory, Daresbury, Warrington, Cheshire WA4 4AD, UK. E-mail m.r.swaisland@dl.ac.uk
US/Canada Published by Cern Courier, 6N246 Willow Drive, St Charles, IL 60175, US. Periodical postage paid in St Charles, IL, US. Fax 630 377 1569. E-mail vosses@aol.com
POSTMASTER: send address changes to: Creative Mailing Services, PO Box 1147, St Charles, IL 60174, US

Published by European Organization for Nuclear Research, CERN, 1211 Geneva 23, Switzerland. Tel +41 (0) 22 767 61 11
Telefax +41 (0) 22 767 65 55

Printed by Warners (Midlands) plc, Bourne, Lincolnshire, UK

 ISSN 0304-288X

IOP Publishing

CERN COURIER

VOLUME 47 NUMBER 9 NOVEMBER 2007

The AMS arrives at CERN p7

Lee Teng in the fast lane p23

BNL celebrates 60 years p36

Cover: Under the watchful eye of Sergey Yukhimchuk, the last sector of muon trigger chambers is lowered carefully into place in the final "big wheel" for the ATLAS detector at the LHC (p7).

ADVERTISING FEATURE

What Does a Bear Named Francka Have To Do With Beam Stability?

The 3rd Libera Workshop took place in Solkan, Slovenia, on the 24 and 25 September 2007. Instrumentation Technologies organizes the workshop each autumn for both new and advanced users to exchange their ideas and experiences. The workshop is an opportunity to get answers to very specific questions and learn more about Libera and advanced deployment techniques.
The Workshop had more than 25 participants from 13 laboratories (Alba, Anka, Astrid, Australian Synchrotron, BNL, Diamond, Elettra, ESRF, HLS, INFN LNF, LNLS, Petra III, Soleil) and commercial companies such as Dimtel (US) and MTT (Japan), representing 11 countries and 4 continents.

The Libera community has formed around the Libera product family, which has become an indispensable cornerstone for beam stabilization. Libera is being used or evaluated on 29 particle accelerators around the world. Eight machines, including Synchrotron Soleil, Diamond Light Source, Australian Synchrotron, Elettra, Alba, SSRF, GSI SIS18, and Petra III are completely equipped with Libera.

The participants were welcomed by Rok Uršič, Instrumentation Technologies President and CEO, and Carlo Bocchetta, Director of the Scientific Liaison. Both expressed enthusiasm at the growing number of laboratories attending the workshop and pointed to the importance of the successful ongoing collaborations between the scientific community and industry.

New projects and major facility upgrades are facing increasing challenges due to limited resources and demanding time-lines. Early involvement of industry has the benefit of joint development and prototyping of key accelerator components. This guarantees systems are built to well defined user specifications following best industrial practices and allows accelerator groups to concentrate on frontier developments. Furthermore, since institutes naturally collaborate on cutting edge developments, industrial components that are jointly developed with one institute have the added value of having characteristics useful for many projects. The Libera Workshop represents a continuation of the initial industry-institute collaboration, by sharing the repository of industrial information and just as important sharing user experience.

On the first day participants concentrated on the presentation and demonstration of the new Libera Brilliance functionality, its straightforward integration into the control system and the building up of the fast orbit feedback. The afternoon sessions looked at how to cope with coupled bunch instabilities and on the development potential of the Libera family towards the field of low-level RF and single bunch measurements. The latter developments are especially important for fourth generation light sources. Every presentation was followed by a lively discussion in true workshop style.

The discussions continued into the breaks and meals, and there were additional exchanges of opinions together with the opportunity for informal discussions between long-time friends working in the demanding field of beam diagnostics. There was a specially enthusiastic response to the Monday evening event, a dinner in a traditional ambient in between the green vineyards of Vipava valley, which will not only be remembered for the delicious food and wine, but also for the very special concert of folk music.

The Libera Wish List for future software releases is a valued initiative born with the Libera users who independently met and prepared the list with requests for new features to be included in the coming releases. The users themselves are shaping future developments of the system and make it fit even better to their needs. The Libera Wish List was presented to the staff of Instrumentation Technologies and discussed in detail at the workshop. All parties agreed to continue meeting and discussing new needs on a regular basis. In addition, there is a regular exchange of fresh ideas and questions on the Instrumentation Technologies internet forum at
http://www.i-tech.si/forum/.

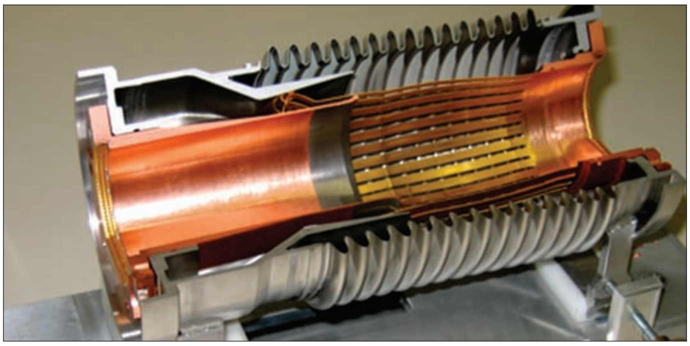
The morning of the second day focused on the presentations from the Libera users themselves. K. Scheidt, ESRF (The Reasons for the ESRF BPM Upgrade Plans), J.C. Denard, Synchrotron Soleil (Liberas Operating on the Soleil's Storage Ring), E. Huttel, ANKA (Turn-by-Turn Beam Position Measurements at ANKA with the Libera Electron), I. Krouptchenkov, Petra III (High Peak Voltage Input Signal and the Libera), M. Lonza, Elettra (Elettra's Global Orbit Feedback), G. Rehm, Diamond Light Source(Fast Orbit Feedback System at Diamond), E. Plouviez, ESRF (Optimization of the Parameters of a Fast Orbit Correction System), and M. Abbott, Diamond Light Source(The EPICS Interface to Libera) shared with the participants their valuable experience from using Libera during regular operation and for the building of the fast orbit feedback system. The integration into the control system, the suitability of Libera for planned machine upgrades and solutions to machine specific issues were also presented and discussed in this session. The closing session was dedicated to an open discussion of the Libera Wish List for future upgrade releases. The Libera Workshop was concluded with an informal wrap-up made by Rok Uršič and a warm invitation to meet again next year.

Still wondering what a bear has to do with beam stability? To find out the details about the bear vs. beam stability relationship you can go to http://www.i-tech.si/products.php?meni1=8, where you can see presentations from the workshop, and learn how to participate yourself at the next workshop. For answers to these and other questions please visit www.i-tech.si or contact info@i-tech.si.

NEWS

LHC NEWS

40 MHz ball reveals sticky fingers



A section of a plug-in module in its low-temperature position.

Inner triplet assemblies positioned in the LHC tunnel in 2006.

The LHC, with its "two in one" magnet structure cooled by superfluid helium for operation at 1.9 K, is its own prototype. It is therefore no surprise that problems arise that demand ingenious solutions, such as a newly invented diagnostic tool. Slightly larger than a ping-pong ball, it contains a tiny 40 MHz transmitter and fits just inside the beam pipe. Its purpose is to check interconnections within a sector (an eighth) of the machine without the need to open it up.

The need for such a device came to light when teams detected a fault in one of the interconnections during the warm-up of sector 7-8, the first to have been cooled to 1.9 K (*CERN Courier* May 2007 p5). One of the "plug in" modules responsible for the continuity of the electrical circuit in each of the LHC's two vacuum chambers was damaged as the sector warmed up.

The plug-in modules ensure that mirror currents produced by the beams in the walls of the vacuum chambers can circulate freely. Any impedance would create hot points and reduce the intensity of the beam. The modules consist of copper "fingers" that slide along a cylinder and allow for contraction and expansion of the LHC's components during cooling and warming. Each module expands or shrinks by about 40 mm, but the fingers always remain in contact with the cylinder in which they are sliding. In the faulty unit, the fingers failed to slide properly when the vacuum pipes returned to their original length, buckling into the space where the beam would normally pass.

It is difficult and time-consuming to open the magnet cryostats to check interconnections; it takes three weeks to open a sector and five weeks to close it again. X-ray studies revealed four more faulty modules in sector 7-8, but it was clear that a device that could check the space inside the beam pipes would be extremely useful. The solution is a ball 34 mm in diameter, which transmits at 40 MHz – the frequency of beam bunches in the LHC. A pumping system propels it through the vacuum pipe and beam-position monitors located every 50 m pick up the emitted signals. As the ball is a fraction smaller than the 36 mm beam screen, any obstacles will stop its progress and there will be no signal in the next monitor. This information allows the team to concentrate on the small number of interconnections between the two beam-position monitors concerned.

A first test on 13 September proved successful as the ball travelled 800 m through one vacuum pipe, detecting a sixth faulty module in the process. Altogether, only 6 out of 366 modules have proved to be damaged as sector 7-8 warmed up, and repairs are now in progress. An extra benefit is that the device allows the team to inspect the beam pick-ups around the ring.

Elsewhere around the LHC, by the end of October teams had cooled a second sector to 80 K and begun pressure testing on a third. Any vacuum leaks that were found have been isolated and are currently being repaired. Cooling of further sectors should begin in November.

In addition, all of the inner triplet magnet assemblies have been repaired and are in position in the tunnel (*CERN Courier* September 2007 p5). Three of them had passed their pressure tests by the beginning of October. The cryogenic electrical distribution feedboxes (DFBX), which form part of the triplet assembly, have also undergone repairs. Only the triplet that was damaged during the spring test, plus one DFBX, have been removed from the tunnel. The others have been repaired *in situ*, a prerequisite for a solution.

Sommaire

LABORATORIES

Cyclotron lab reconfigures for better service

Following a summer shutdown, the National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University is looking ahead to new experiments with fast and reaccelerated beams.

The NSCL is a user facility and during the course of several years and hundreds of users, the list of experimenters' requests became long enough to warrant a significant reconfiguration of the laboratory's experimental area. The four-month long reconstruction project, which concluded successfully at the end of September, achieved a number of goals set by the users. These include a new capability to detect neutrons at larger angles to the beam axis and enhanced two-neutron detection; improved means for filtering proton-rich rare isotope beams and studying neutron-deficient nuclei; increased agility and flexibility in delivering beam to the experimental vaults; and performing an array of reaction studies, including precise measurement of neutron time-of-flight.

The reconfiguration, which cost $2.7 million, was the largest construction project at NSCL since the completion of the Coupled Cyclotron Facility seven years ago (*CERN Courier* October 2002 p21). During the shutdown, more than 600 tonnes of concrete wall blocks were moved, as well as 1350 tonnes of roof beams. To speed up the rebuilding of the experimental vaults and to make it easier to change the layout of the facility in the future, NSCL installed 18 modular 22.5-tonne wall sections.

NSCL doctoral student Josh Stoker checks the radio frequency fragment separator, which provides additional capacity to study neutron-deficient nuclei. The separator, initially proposed by NSCL users in 2004, is available for experiments following the lab's reconfiguration. (Courtesy NSCL.)

Following the reconfiguration, NSCL users now have access to a next-generation radio frequency separator, funded by the US National Science Foundation. The separator has performed well in early tests, for example, in selecting proton-rich isotopes near doubly magic ^{100}Sn.

Laboratory upgrades will continue into 2008 and beyond. Current plans call for the implementation of two gas stoppers – a cyclotron gas stopper and a linear gas cell. The relative performance of each will be measured to determine the most efficient way to stop ions produced in flight and the best option for the NSCL reacceleration superconducting linear accelerator. This linac, being designed for use at NSCL and in a next-generation facility, will be able to reaccelerate thermalized beams of rare isotopes to energies of 3.2 MeV/nucleon with the option to upgrade it to 12 MeV/nucleon over the entire mass range.

● For a video of the reconstruction see www.nscl.msu.edu/ourlab/2007reconfiguration.

INTERNATIONAL COLLABORATION

DESY laboratory forms new research links with Russia

DESY is to establish a new research group in which young scientists from DESY and three Russian institutes will work together to resolve current questions in particle physics. DESY's proposal for "Physics and Calorimetry at the Terascale" is one of eight applications selected from 26 submissions to form a Helmholtz–Russia Joint Research Group. This comes as part of an initiative launched in 2006 by the president of the Helmholtz Association, Jürgen Mlynek, and the chair of the Russian Foundation for Basic Research, Vladislav Khomich. One aim of the new three-year support programme is to promote scientific co-operation between DESY and Russia and to provide attractive research opportunities for young scientists in particle physics. Within the joint research group, DESY will collaborate with three institutes based in Moscow: the Institute for Theoretical and Experimental Physics, Moscow State University and Moscow Engineering Physics Institute. The group will be involved in physics analyses of experiments at HERA and the LHC and for the proposed International Linear Collider (ILC), as well as in detector design and construction for the LHC and ILC.

The approval of this joint research group acknowledges the long and successful collaboration between DESY and its Russian partner institutes. The proposed activities will complement those of the Helmholtz Analysis Centre at DESY and the strategic alliance between DESY and German universities.

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

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

LHC EXPERIMENTS

ATLAS installs the final big muon wheel

The ATLAS collaboration recently celebrated installing the last of the eight "big wheels" that form part of the endcap muon spectrometer of the detector. The big wheels harbour ATLAS's middle layer of muon chambers in the forward region and are one of the last large pieces to be installed. Each is 25 m across, weighs between 40 and 50 tonnes and contains around 80 precision tracking chambers or 200 trigger chambers.

Because of their sheer size, each wheel had to be made in 12 pieces for the trigger planes and 16 pieces for the tracking planes. Designing a suitable support structure was a unique challenge, and the result is a uniquely thin and light structure that is precise to less than a millimetre.

Each wheel was assembled at CERN using components from all over the world. The 100-member collaboration from China, Europe, Israel, Japan, Pakistan, Russia and the US began assembly of components in 2005 and installation in 2006. Now, just two smaller-scale wheels and the end-wall chambers remain to be installed. The big wheels have already begun to take part in test runs using cosmic-ray data that ATLAS performs on a six-weekly basis (*CERN Courier* September 2007 p23).

Jos Engelen, CERN's chief scientific officer, congratulates the team members involved with completion of the ATLAS "big wheels".

PARTICLE ASTROPHYSICS

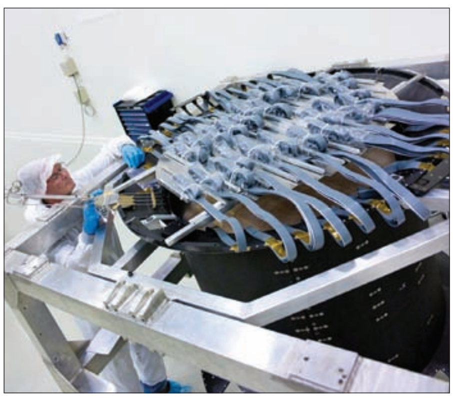
AMS en route to outer space via CERN

The central tracker detector of the Anti Matter Spectrometer (AMS) arrived at CERN on 25 September ready for assembly with the other components of the experiment. One of the main goals of AMS is to search for antimatter from the early universe. To achieve this, it will fly on board the International Space Station (ISS).

The antiparticles – mainly positrons – that are detected in cosmic rays on Earth or in the atmosphere are almost certainly the by-products of interactions. By going above the atmosphere, AMS should detect any antimatter among the primary cosmic rays. Detection of a significant quantity of antimatter on the ISS would constitute irrefutable proof that there is still an active source of antimatter in the cosmos. AMS will also look for dark matter by trying to detect the annihilation products of the hypothesized supersymmetric particles, and measure more precisely the composition of cosmic rays.

The central tracker was constructed at the University of Geneva and will soon be surrounded by a powerful cryogenic magnet and other high-precision detectors. The assembly and construction of the whole experiment, which will weigh more than 7 tonnes, will be finalized next spring.

AMS must be ready and delivered to the Kennedy Space Centre in Cape Canaveral, Florida, by the end of 2008 at the latest. It will be launched on a space shuttle and will remain on board the ISS for several years.



The AMS central tracker detector arrived for assembly at CERN on 25 September.

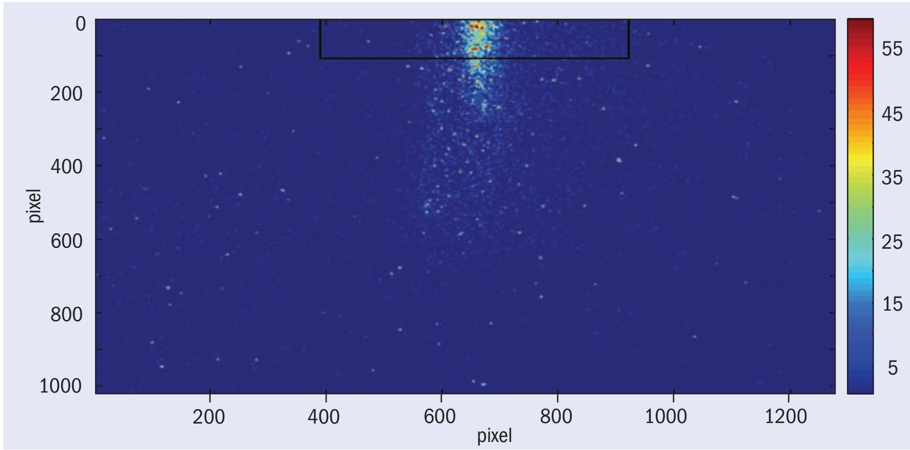
FELS

FLASH makes laser pulses at design energy

On the evening of 4 October, the team in the control room at FLASH, the soft X-ray, free-electron laser facility at DESY, observed lasing at a wavelength of 7 nm for the first time. Just 24 hours later, the team achieved the design value of 6.5 nm. This comes two weeks after the facility had reached the design beam energy of 1 GeV.

In FLASH, superconducting modules accelerate electrons before they pass through an undulator. The aim is for the spontaneous radiation that they emit in the undulator to amplify itself to form free-electron laser radiation pulses. During the latest shutdown, researchers installed the sixth and final accelerator module and replaced another so that the operators could begin to take FLASH to its design energy for the first time.

On 21 September, the DESY team observed a peak around 6 nm in the wavelength spectrum of the spontaneous radiation generated in the undulator. This proved that all six accelerator modules were working as planned and accelerating the electron bunches to an energy of 1 GeV. Then, on 4 October the team observed the first laser pulses at 6.5 nm.



The wavelength spectrum at 6.5 nm from FLASH operating at 1 GeV. (Courtesy DESY.)

Compiled by Steve Reucroft and John Swain, Northeastern University

Beetles go red with switchable reflector

Many animals, such as squid and chameleons, alter their colours by changing the size of pigment-carrying cells, but the Panamanian golden tortoise beetle *Charidotella egregia* has a completely novel way of going from metallic gold to matt red. Jean Pol Vigneron and colleagues from the University of Namur in Belgium have found that the beetle has a layered shell, and that each layer reflects a different colour and bears patches of nanoscale grooves.

This particular beetle normally has body fluid between these layers, filling the grooves and giving rise to mirror-like reflections that result in the insect's metallic gold appearance. When the fluid is withdrawn, the mirror-like effect disappears and the layers act as windows, displaying the red pigment below. This is an entirely novel mechanism for the control of colour and has the potential to give rise to innovative new display technologies.

An adult tortoise beetle switches from gold (top) to red (bottom). The minimum time for this conversion is typically 1.5 minutes.

Further reading

Jean Pol Vigneron *et al.* 2007 *Phys. Rev. E* **76** 031907.

Wave-power pumps could reduce global warming

With evidence mounting that we seem to have changed carbon dioxide levels on the planet for the worse, is there anything we can do to fix the situation? James Lovelock of Oxford University (and father of the Gaia model of the Earth) and Chris Rapley of the Science Museum in London have suggested a radical approach to planetary medicine.

They suggest putting pipes, some 100–200 m in length and 10 m in diameter, with one-way flap valves onto the ocean floor. These would use wave power to pump nutrient-rich deep water to the surface, boosting the growth of algae, which would then reduce carbon dioxide levels and also produce dimethyl sulphide. This substance contributes to the nucleation that produces clouds, which reflect sunlight. The net effect should be a cooler planet. Of course there would be other impacts of such a plan, but perhaps it makes sense to, as Lovelock and Rapley put it, "help the planet heal itself".

Further reading

James E Lovelock and Chris G Rapley 2007 *Nature* **449** 403.

Rising radiation levels did not kill the dinosaurs

Surprisingly enough, scientists have found that they can test the hypothesis that some rise in radiation level was related to the demise of the dinosaurs by looking for fossil evidence of a rise in cancer. L C Natarajan and colleagues at the University of Kansas found one example of metastatic bone cancer in a sample of 708 dinosaurs. Based on this result, and comparisons with estimated cancer rates in modern vertebrates, the team concluded that elevated levels of ionizing radiation did not play a significant role in the Cretaceous–Tertiary extinction event 65 million years ago.

Further reading

L C Natarajan *et al.* 2007 http://arxiv.org/abs/0704.1912.

Paper becomes a supercapacitor and power source

Novel power sources could be built from thin sheets of a material that is little more than paper. Robert Linhardt and colleagues of Rensselaer Polytechnic Institute in Troy, New Jersey, have discovered that cellulose dissolved in an ionic liquid and poured over carbon nanotubes could dry to form a thin paper layer with a backing layer made from carbon nanotubes.

Folding the paper over forms a supercapacitor, while adding a coating of lithium oxide makes it into a battery. These functions can be combined to make a supercapacitor charged by a battery, with both components based on the same technology. This could ultimately be useful for electrically powered vehicles, which need large bursts of power that a capacitor could provide more easily than a battery alone.

Further reading

Victor L Pushparaj *et al.* 2007 *Proc. Nat. Acad. Sci.* **104** 13574.

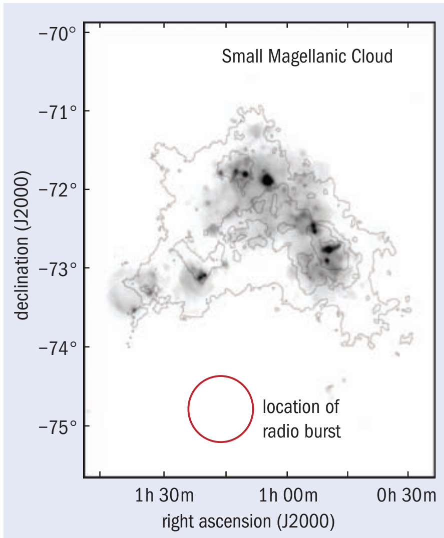
Compiled by Marc Türler, INTEGRAL Science Data Centre and Observatory of Geneva University

Astronomers detect mysterious phenomenon

Analysis of six-year old archival data of the Parkes radio telescope in Australia has revealed a giant burst of radio waves. Extremely bright, brief and distant, this unique event seems to come from a completely new type of phenomenon. Its detection could open a new field in astrophysics similar to the discovery of gamma-ray bursts in the 1970s.

Pulsar surveys are best suited to detect short radio bursts and to discriminate them from terrestrial interference. The pulsar survey at the 64 m Parkes antenna in New South Wales led to the discovery of a new population of spinning neutron stars – known as rotating radio transients – which emit repeated bursts of radio waves (*CERN Courier* April 2006 p10). Now, astronomer Duncan Lorimer of West Virginia University and colleagues have reported a burst that is 10–100 times brighter than these periodic events emitted in the galaxy. In February, David Narkevic, an undergraduate student at West Virginia, discovered this unique event by chance when he re-analysed observations from a Parkes radio survey of the Small Magellanic Cloud (SMC). The flare was recorded on 24 August 2001 and is located near, but clearly outside, this neighbouring dwarf galaxy.

The observed properties of the radio burst provide additional evidence that the event cannot be of terrestrial origin, nor be associated with our galaxy or the SMC, but probably comes from an object at a cosmological distance. Astronomers can use the shift of the burst arrival time as a function of radio-wave frequency to estimate the distance to the source. The frequency-dependent refractive index of ionized gas within our galaxy or in intergalactic space induces this time delay. An accurate measurement of this delay allows the team to estimate the projected density of free electrons along the line of sight – the dispersion measure – and hence the distance to the source. The dispersion measure that Lorimer and colleagues obtain suggests a cosmological distance of more than a thousand million light-years (redshift $z \sim 0.12$) when assuming a realistic contribution from ionized gas in our galaxy and in the source's host galaxy, which is still unidentified.



This map of the distribution of both ionized (greyscale) and neutral (contours) hydrogen in the Small Magellanic Cloud shows the location of the radio hyperburst. (Courtesy Lorimer et al.*, NRAO/AUI/NSF.)*

The observed radio flux of this flare and its derived distance match well that of 3C 273, the brightest quasar in the sky. This makes it an extremely energetic event lasting 5 ms at most, which limits the size of the source to about a tenth of the size of Earth. Although these properties are reminiscent of gamma-ray bursts, there was no such high-energy event detected at the time of the radio burst, and the burst characteristics also differ from expectations for the radio counterpart to gamma-ray bursts.

This exotic event seems to be a new class of phenomenon that could occur several times a day but have so far remained unnoticed. The search for other radio hyperbursts in the complete archive of the Parkes telescope is ongoing. As astronomers detect new events, they will have a better idea of the possible origin. The best candidates to date are merging neutron stars or the last "cry" of a black hole as it evaporates completely through Hawking radiation (*CERN Courier* November 2004 p27).

Further reading

D Lorimer *et al.* 2007 *Science* (DOI: 10.1126/science.1147532).

Picture of the month

This Hubble Space Telescope image of the gigantic nebula NGC 3603 shows in extraordinary beauty one of the most prominent young star clusters in the Milky Way. It is located in the Carina spiral arm of our galaxy at a distance of about 20 000 light-years. Most of the bright stars in the image are hot, blue stars with intense ultraviolet radiation and violent winds that have formed an enormous cavity in the gas and dust surrounding the cluster. Star clusters such as these are formed by the gravitational collapse of a huge cloud of gas and dust. They offer an opportunity to study the evolution of stars with differing masses, but similar composition and age. (Courtesy NASA/ESA/The Hubble Heritage Team STScI/Aura.)

A look back to *CERN Courier* vol. 4, November 1964, compiled by Peggie Rimmer

CERN

European Organization for Nuclear Research celebrates 10 years

The British party: (left to right) Sir Richard Clarke, CP Scott, HL Verry, Dr Porter, Mr Brook and the Earl of Bessborough. On the right, E Ratcliffe (CERN PS Division) is explaining the operation of the Proton Synchrotron, and between him and Lord Bessborough is Dr MGN Hine, CERN's directorate member for applied physics.

The French party: in the foreground (right to left) Prof. B Gregory, CERN's directorate member for research, talking to M Habib Deloncle, Prof. J Teillac, Dr C Germain, from CERN's Nuclear Physics Apparatus Division, and M Lennuyeux-Cournene. Visible between the last two is Prof. L Kowarski, one of the first to discuss the idea of a European scientific organization and who became an original member of the board of consultants.

On 29 September 1954, the convention establishing the European Organization for Nuclear Research came into force, and the first meeting of the new CERN Council was held just over a week later. To commemorate the 10th anniversary of these events, many of the government ministers responsible for CERN in its 13 member states, permanent representatives or delegates of the member states at the international organizations in Geneva, other senior officials with an interest in the organization, and members of the council were entertained at CERN on 10 October.

On 30 October it was the turn of the staff, including the several hundred "visitors" who are not actually paid by the organization. They gathered in the administration building for celebrations that included a speech by Prof. Weisskopf, a reply by Tom Ball on behalf of the personnel, and the consumption of numerous barrels of wine.

● Compiled from the 10th anniversary article pp151–153.

COMPILER'S NOTE

In 1954, 12 member states founded CERN, one of Europe's first joint ventures. Its composition has reflected the economic and political fortunes of the continent and today there are 20 member states: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, the Netherlands, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland and the UK.

Half of the world's particle physicists, around 8000 visiting scientists, do their research at CERN. They currently represent 111 nationalities from 578 institutes and universities, 259 of these in non-member states. For more information visit the public pages at www.cern.ch.

The scene in the CERN Council chamber on 10 October 1964, during the welcome speech by JH Bannier, president of the Council, to the ministers and other guests. Also on the platform are (in front, left to right) Sir Harry Melville and J Wilems, vice-presidents, Prof. VF Weisskopf, director-general, Prof. CF Powell and Prof. E Amaldi, members of the scientific policy committee, and (behind, left to right) Dr MGN Hine, Prof. B Gregory and GH Hampton, members of the directorate. Banners representing the flags of CERN's 13 member states provide the background.

President of the council, JH Bannier (left), and director-general Prof. Weisskopf (centre), talk with Prof. Pierre Auger who, in a sense, was the first head of CERN. In 1951, Prof. Auger, as director of UNESCO's department of natural sciences, was responsible for setting up the board of consultants that decided the aims and scope of the future European laboratory.

COMPUTING NEWS

Compiled by Nicole Crémel and François Grey

LHC EXPERIMENTS

ATLAS data chain passes full test

In September, the ATLAS collaboration ran an "end to end" data chain for the first time, confirming that data distribution from the LHC to physicists across the globe will be possible. The challenge was to test the entire data chain, from the measurement of a cosmic-ray muon in the detector to the arrival of reconstructed data at computers located around the world in Tier-2 centres of the Worldwide LHC Computing Grid (WLCG).

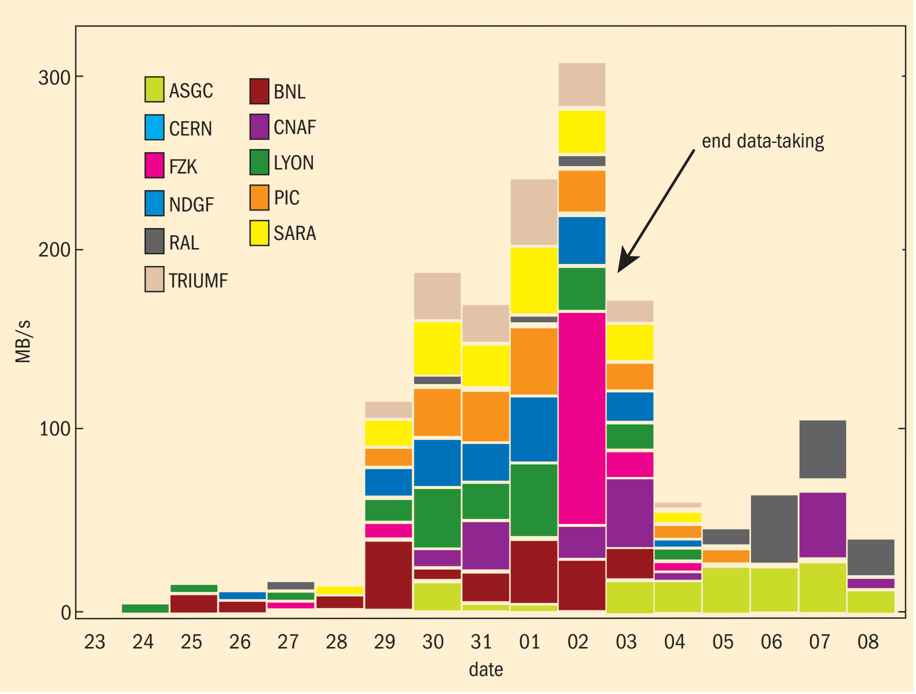
The ATLAS detector measured about 2 million muons over a two-week period during testing, with data beginning to flow after a week of setting up. The detector measured real particles, with real analysis at sites across Europe and the US, in quasi-real time. The whole process worked with minimal human intervention.

Quasi-real time means that the transfer was achieved in hours. With real LHC collision data, however, there will be a greater delay. This is because processing and the subsequent data transport will have to wait for regular calibrations to take place. The data chain is designed to cope with this delay and there are sufficient disk buffers at the Tier-0 stage to retain the data for as long as several days.

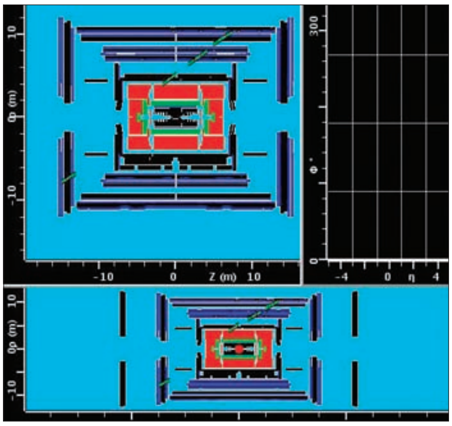
A particle entering the ATLAS detector produces a signal and triggers the data chain. Muons are easily singled out and once detected they set the data chain in motion. The raw data are sent to the Tier-0 centre – the computer centre at CERN – where they are recorded onto tape before being sent to a different part of the centre for reconstruction.

The reconstructed data are also taped before being exported to the Tier-1 centres, and then sent to their respective Tier-2s. Physicists can then commence their analyses. While researchers will be analysing the data in different ways using different Tier-2s, they will be confident that they are all analysing the same data independent of where the data are stored. This consistency is ensured by the Grid middleware provided by the Enabling Grids for E-sciencE, NorduGrid and Open Science Grid infrastructures, which support computing for ATLAS.

Terabytes of ATLAS data travelled from the Tier-0 site at CERN to Tier-1 sites. These included seven sites across Europe, one site in the US, one site in Canada, and one site in Taiwan. Data transfer rates reached the expected maximum during the early part of September.



Data throughput from CERN to Tier-1 sites during the test of the "end to end" data chain in August–September 2007. The ATLAS detector measured about 2 million muons over two weeks with a healthy stream of data flowing after a week spent setting up.



Muon tracks recorded by ATLAS were successfully used to test the data chain.

Les gros titres de l'actualité informatique

LHC COMPUTING

GridPP tackles Tier-2 performance problems

The GridPP team is assessing the readiness of clusters across the UK, including this cluster at Birmingham University, which is part of SouthGrid. (Courtesy GridPP.)

With the LHC scheduled to start up next year, Grid sites worldwide are ramping up their equipment and service levels in anticipation of a flood of data.

In the UK this summer, a team from GridPP, the UK particle physics Grid, completed a round of visits to 17 GridPP sites, aiming to assess how ready they are for the LHC data. Dave Britton, GridPP's project manager, co-ordinated the process, which ensured that each site would be ready for next year and found out how to deal with any difficulties. The personal visits allowed GridPP experts to talk to people at each centre in confidence. Despite initial scepticism, this proved a useful exercise, as it allowed sites to explain their priorities, constraints and concerns directly to the GridPP management.

Since March this year, GridPP review groups have toured each of the four regional centres – ScotGrid, NorthGrid, SouthGrid and London Tier-2 – searching for signs of problems and challenges to come. Tier-2s differ from their larger Tier-1 counterparts in that Tier-1s are primarily for reconstruction and long-term storage of LHC experiment data, while Tier-2s are typically used to produce simulated data and for data analysis by end users.

Although each site had a slightly different story, many of the same issues arose, and reviewers identified a mixture of good practice and areas where lessons could be learnt from other sites. The site visits unearthed several issues that the GridPP team is now addressing, including difficulties for smaller sites in meeting the two-hour response time required from Tier-2 sites, the complexity of installing new virtual organizations, and training in-site monitoring using Nagios and Ganglia software.

GridPP has already responded to many of the concerns raised. For example, the team has developed a policy on when sites should stop stalled jobs; has helped to ensure that security policies are harmonized so that the appropriate response to any security incident is clear; and is working on middleware support and release issues.

DATA TRANSFER

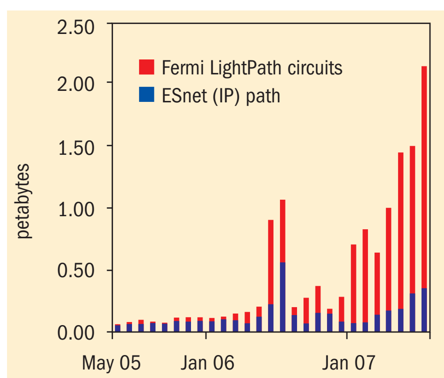
Fermilab passes new milestone for data traffic

Fermilab recently reached a record 6 PB of data permanently recorded on tape. At the same time, data sent from the laboratory exceeded 2 PB – more than double the amount leaving three months earlier.

Traffic onto the site has been growing as the CMS experiment ramps up in preparation for the LHC at CERN – Fermilab is one of seven Tier-1 sites for CMS. Prior to a year ago, traffic never exceeded a quarter of a petabyte in a month. The increase in both outgoing and incoming data is attributable not only to CMS, but also to the collaborations on the DØ and CDF experiments at Fermilab actively moving data for analysis.

Although the amount of incoming and outgoing data is growing quickly, the computing division at Fermilab is keeping pace when it comes to infrastructure capacity. The external network capacity is currently 60 Gbit/s. If upgrades are necessary, the infrastructure is already in place to add capacity at a low marginal cost, using different wavelengths, through a metropolitan optical fibre network to the US Department of Energy's network interchanges in Chicago.

The volume of data sent from the Tier-1 Fermilab computing centre to Tier-2 sites continues to increase. The sites form part of the international Grid being constructed in readiness for the start-up of the LHC.



FNAL outbound data. Fermilab has achieved record data traffic. (Courtesy Fermilab.)

Calendar of events

November

5–9 HEPiX Fall 07
St Louis, MO, US
https://indico.fnal.gov/conferenceDisplay.py?confId=805

10–16 SC07
The International Conference for High Performance Computing, Networking, Storage and Analysis
Reno, NV, US
http://sc07.supercomputing.org/

26–30 MGC 2007
5th International Workshop on Middleware for Grid Computing
Newport Beach, CA, US
http://mgc2007.lncc.br/

26–30 GLOBECOM 2007
IEEE Global Communications Conference
Washington, DC, US
www.ieee-globecom.org/

December

8–9 WITS 2007
17th Annual Workshop on Information Technologies and Systems
Montreal, Canada
http://zen.smeal.psu.edu/wits07/

10–13 e-Science 2007
3rd IEEE International Conference on eScience and Grid Computing
Bangalore, India
www.garudaindia.in/e-science_2007.asp

16–19 IDEAL 2007
8th International Conference on Intelligent Data Engineering and Automated Learning
University of Birmingham
Birmingham, UK
http://events.cs.bham.ac.uk/ideal07/

18–21 HiPC 2007
14th IEEE International Conference on High Performance Computing
Goa, India
www.hipc.org

January

13–16 IUI '08
12th International Conference on Intelligent User Interfaces
Canary Islands, Spain
www.iuiconf.org/

22–25 GRAPP 2008
Third International Conference on Computer Graphics Theory and Applications
Madeira, Portugal
www.grapp.org/
www.visapp.org/

22–25 VISIGRAPP 2008
International Joint Conference on Computer Vision and Computer Graphics Theory and Applications
Madeira, Portugal
www.visigrapp.org/

February

4–7 WSCG 2008
Sixteenth International Conference in Central Europe on Computer Graphics, Visualization and Computer Vision
Plzen, Czech Republic
http://wscg.zcu.cz/wscg2008/

12–14 PDCN 2008
Parallel and Distributed Computing Networks 2008
Innsbruck, Austria
www.iasted.org/conferences/home-597.html

12–15 Mobilware 2008
International Conference on Mobile Wireless Middleware, Operating Systems, and Applications
Innsbruck, Austria
www.mobilware.org/

13–14 15th DFN Workshop
"Security in Networked Systems"
Hamburg, Germany
www.dfn-cert.de/events/ws/2008/cfp.html

25–28 ARCS 2008
21st International Conference on Architecture of Computing Systems
Dresden, Germany
http://arcs08.inf.tu-dresden.de/

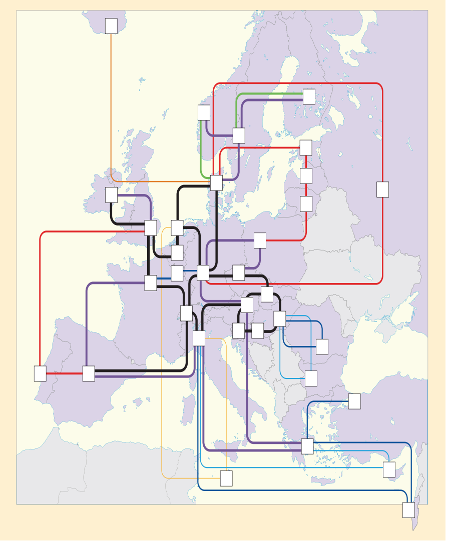
SUPERCOMPUTING

European supercomputer network ramps up to 10 Gbit/s

The Distributed European Infrastructure for Supercomputing Applications (DEISA), which consists of 11 of Europe's major supercomputers, is boosting connectivity speeds between all of its sites 10-fold to 10 Gbit/s. It uses dedicated links designed and deployed by the GÉANT2 pan-European research and education network.

This upgrade will allow researchers in projects such as SEISSOL, for research into earthquake simulations, and COMSIMM, looking at current and future climate trends, to harness the combined processing power of DEISA's 200 teraflops of supercomputing infrastructure. Requests for supercomputing resources in scientific research domains are on the increase, with 23 projects scheduled for operation in 2007. Among these applications, projects in progress include ICAROS, for stratospheric ozone research and climate change, gyro3d, for plasma instability studies, and HELIUM for radiation–matter interactions.

GÉANT2 connects 34 countries on the continent and has extensive links to North America and Asia. Europe's National Research and Education Networks (NRENs) and the European Commission co-fund it, and the international research and education network provider, DANTE, provides the management.



DEISA employs dedicated 10 Gbit/s wavelengths in the GÉANT2 network, including "dark fibre" links that provide multiple wavelengths. (Courtesy GÉANT2.)

GÉANT2 and its partner NRENs already connect seven DEISA sites across Europe – BSC (Spain), IDRIS (France), FZJ, HLRS, LRZ, RZG (all Germany) and SARA (the Netherlands) – via dedicated 10 Gbit/s wavelengths, all managed by a central switch. Thanks to an upgrade this year, the remaining sites, including CINECA (Italy), CSC, the Finnish IT centre for science (Finland), EPCC (UK) and ECMWF (UK), are also being connected at 10 Gbit/s.

DEISA provides leading scientific researchers with access to a European cluster of state-of-the-art high-performance computing (HPC) resources. The "private network" of point-to-point links deployed by GÉANT2 will enable researchers to gain faster and more efficient access to DEISA's shared file system. DEISA's aim is to create an integrated European "HPC ecosystem" before the end of the decade.

INTERNATIONAL COLLABORATION

Gigabit Ethernet links CERN with Mumbai

Flag Telecom, providers of undersea cable networks, announced an agreement in September with CERN and the Tata Institute of Fundamental Research (TIFR) in Mumbai to provide gigabit Ethernet connectivity between the two. This milestone demonstrates how large-scale scientific projects such as the LHC unify communities around the globe.

The increased connectivity with India will enable the TIFR to collaborate fully as a Tier-2 centre of the Worldwide LHC Computing Grid (WLCG). This Grid links more than 150 institutes worldwide in the storage and analysis of petabytes of scientific data from the LHC.

Flag Telecom owns and operates the world's largest private undersea cable system spanning four continents and 65 000 route kilometres. The world Ethernet market is expected to grow to $25 billion by 2010.

LHC computing stability emphasized at CHEP '07

As preparations for the LHC proceed, this year's main conference on computing in high-energy physics focused on getting ready for the fast-approaching onslaught of data.

A CHEP '07 plenary session. This year, the conference was held in Canada for the first time. (Courtesy Albert Pace.)

The latest in the series of conferences devoted to computing in high-energy and nuclear physics, CHEP '07, took place in Victoria, Canada, on 2–7 September. This was the first time that this conference, which takes place every 18 months, had visited Canada. TRIUMF and the University of Victoria hosted the meeting at the Victoria Conference Centre, and more than 470 people attended from all over the world. There were 400 presentations during the week, split evenly between talks and posters.

Prior to the conference, almost 200 people attended a two-day workshop on the Worldwide LHC Computing Grid (WLCG). Following a review of the status of WLCG and its various components, storage services were identified as one of the biggest issues affecting many of the sites. The need for improvements in stability and reliability as sites ramp up for the start-up of the LHC was also a major topic. Nevertheless, the readiness of the WLCG service, individual sites and experiments has shown great improvements since previous reviews, although much remains to be done to reach production levels. The ATLAS and CMS collaborations have proposed a Common Computing Readiness Challenge (CCRC) in which all LHC experiments should participate, and work is underway to prepare this for early 2008. Meanwhile, there will be another workshop at CERN during the week starting 26 November to discuss the service reliability of WLCG.

The directors of the two hosting organizations opened the conference with the welcome address, followed by CMS spokesperson Jim Virdee who gave a talk on the status of the LHC and the experiments. He presented the latest news on the timetable and discussed what physics could be expected and how computing was vital in understanding the data. Les Robertson of CERN then spoke on the progress of WLCG. Talks on the different components of, and experience with, WLCG formed a major part of the week's remaining programme. These included contributions from the experiment collaborations on their preparations for production running. WLCG now runs some 2.5 million jobs a month, but the ▷

Participants get away from it all with a spot of whale-watching, including this orca. (Courtesy P Mato Vila and U Schwickerath.)

target for LHC beam conditions is 9 million, meaning that WLCG still needs a great increase in installed capacity. Nevertheless, Robertson concluded: "We are getting there."

Other plenary talks covered different aspects of LHC computing; experiment data-acquisition systems; Grid computing (where Miron Livny of the University of Wisconsin noted that the era of easy funding for Grid projects is drawing to a close); and high-performance networking. Richard Mount of SLAC gave an interesting view of how SLAC is transforming itself from a purely high-energy physics institute into a laboratory supporting different sciences, and the challenges this creates. Invited speakers from the sponsoring industrial partners gave an insight into some of the future technologies that they are developing, which may be of interest to high-energy physics in the future. Also on the technology track, Sverre Jarp of CERN presented some thought-provoking ideas on how to extract more performance from advanced chip and CPU designs that are currently entering the market.

The programme also included talks on projects other than the LHC. Frank Wuerthwein of San Diego described the benefits of Grid technology for experiments currently up and running. He gave examples of how Grid technologies are benefiting PHENIX and STAR at Brookhaven National Laboratory, CDF and DØ at Fermilab, and experiments at DESY and SLAC. Looking to the future, one presentation considered advanced computing being used in studies for the proposed International Linear Collider.

Apart from the morning plenary sessions, there were parallel sessions held on most afternoons, covering (in more detail) Grid middleware, distributed data analysis, event processing, online computing, collaborative tools, software components and computer facilities. Poster displays took place over two sessions, presenting more than 100 at a time, with each session on display for two days. During extended coffee breaks, poster authors made themselves available for discussions on their material.

The summary talks at the end of the conference noted that there appeared to be more emphasis at this conference than at previous meetings on stability, ramp-up and getting computing systems ready for production. There was not so much that was "new", but perhaps this was to be expected as the experiment and software development teams are all fully occupied with installation and commissioning, including their computing facilities. It is by design that most of the current work is going into bug fixing, reliability improvements and service stability, rather than new developments or extra features. Efforts are also ongoing to make the different Grids interoperate, and the experiments are now exploiting Grids to perform real work.

Matthias Kasemann, of CERN and DESY, reminded the audience in his conference summary that the LHC should be operational next summer, and that the experiments must therefore be ready to take data by spring 2008. He concluded that there is already quite good experience on the Grid, but all is not yet perfect. However, he agreed with Robertson's comment at the start of the week that we are getting there, albeit slowly.

All of the summary speakers agreed that the conference facilities had been excellent, the programme interesting and that there had been plenty of opportunity for useful interactions. It was also agreed that the social events, whale-watching afternoon and a buffet in the Royal British Columbia Museum, had been most enjoyable.

● The next CHEP will be in Prague in spring 2009, see www.particle.cz/conferences/chep2009.

Further reading

For access to most of the material presented at CHEP '07, see www.chep2007.com. For the WLCG workshop, see http://indico.cern.ch/conferenceTimeTable.py?confId=20080.

Résumé

CHEP '07 met l'accent sur la stabilité de l'informatique LHC

La dernière en date des conférences sur l'informatique en physique nucléaire et des hautes énergies, CHEP '07, s'est tenue à Victoria (Canada) du 2 au 7 septembre. La mise en service du LHC devenant imminente, relativement peu de nouveautés ont été présentées à l'édition de cette année, qui a surtout traité des préparatifs pour l'énorme quantité de données que produiront les expériences LHC et du besoin de fiabilité et de stabilité. Les sessions ont porté sur divers aspects de l'informatique LHC, les systèmes d'acquisition de données pour les expériences, l'informatique de la grille de calcul et la création de réseaux hautes performances. La conférence a été précédée par un atelier de deux jours sur la Grille de calcul mondiale pour le LHC.

Alan Silverman, *CERN.*

CASTOR2 rises to LHC's data storage challenge

Tony Cass reports on the latest developments in CERN's mass-data storage system.

CERN's mass storage infrastructure has developed progressively since the early 1990s when Unix-based systems started to replace the mainframes. A significant step was the development in 1999 of CERN's Advanced STORage system (CASTOR), which allowed users to refer to files using logical names in a hierarchical namespace, replacing references to tape numbers. This was a great help in managing the data from post-LEP experiments such as COMPASS and NA48, but by 2003 it was clear that CASTOR would not be able to cope with the data rates, data volumes and number of files predicted for the LHC experiments. The latest incarnation, CASTOR2, deployed in production from 2006, was designed to address these issues, to improve scalability and resilience in today's environment based on PC servers and to improve efficiency of resource usage. In particular, it is designed both to exploit the capabilities of today's high performance tape drives and to match the I/O load on disk servers to hardware capabilities, so guaranteeing consistent performance for users.

Part of the CASTOR mass-data storage system at CERN.

The architecture

A key aspect of CASTOR2 is the database-centred design (figure 1). The overall system state, as well as the status of all user requests, is held in a central relational database. A set of stateless daemons queries the database for the next operation to perform, e.g. to schedule the next transfer for a client, or to issue a tape recall. By making all of these daemons stateless, the design improves scalability and fault tolerance as the daemons can be replicated on different machines. It also simplifies operation by allowing the updating and restarting of daemons while another instance is supporting the load. Isolating key components, such as the stager, from direct user access (all user queries interact with a request-handler daemon) improves overall resilience – one of the design goals for CASTOR2. Of course, a single central database is potentially both a performance bottleneck and a single point of failure. At CERN, however, the central Oracle servers are configured for redundancy (exploiting Oracle's RAC and Data Guard features); tests have shown them to be more than adequate for handling the expected load.

Some of the more important CASTOR daemons are the nameserver, the request handler, the stager and the scheduler. The nameserver manages a global hierarchical namespace that allows users to name files in a Unix-like manner under a directory hierarchy starting "/castor". As there is only one CASTOR nameserver for each site, speed and efficiency are primordial and – since it is developed at CERN – CASTOR, as opposed to commercial mass storage

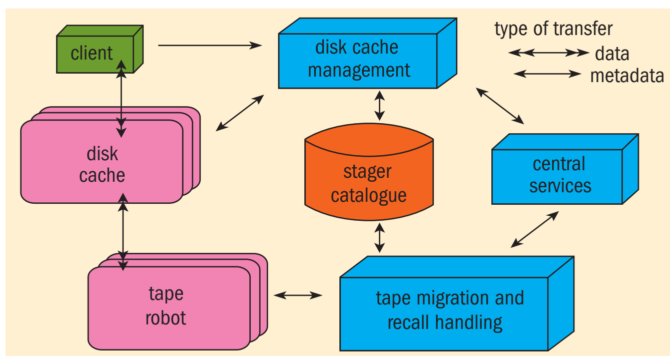


Fig. 1. The architecture of the database-centred design of the CASTOR system, tailored for mass-data storage at CERN.

systems, can focus on optimizing the functions most needed by high-energy physics users. All user interaction passes via the request handler, which is a lightweight gateway that stores requests in the central database, handling peaks of more than 100 requests a second without any service degradation. In today's Grid-enabled world, however, many clients will interact with CASTOR via the storage resource manager (SRM), a generic interface to mass-storage systems. Today's interface can scale up to 1.7 million requests a day. A new interface developed at the UK's Rutherford Appleton Laboratory, implementing version 2.2 of the SRM specification, is expected to be deployed in production in the near future.

At the heart of CASTOR lies the stager, the daemon responsible for handling user requests. One of the more innovative features of CASTOR is that the stager does not itself decide which disk server to use when fulfilling a request. Instead, the stager passes processed requests to a scheduler, which will pick the most suitable disk server based on information collected by the resource monitor. A request from an experiment production manager can, for example, take priority over requests from other users. Unfortunately, the first interface to the scheduler daemon turned out to be rather inefficient, which limited the overall performance and prevented request prioritization – a situation that caused major problems for an ATLAS experiment test earlier this year. Fortunately, the redesigned scheduler interface (which caches disk server status in shared memory) works well and can support more than 50 000 user requests simultaneously. This is comfortably more than we expect to handle.

Four important daemons look after the interface with the tape layer – both tape drives and automated tape libraries. Apart from the principal tape daemon, which supports a variety of tape drives and related robots, the volume manager and the volume and drive queue manager handle the status of tapes and tape drives, allocating tape space to files as necessary and orchestrating the mounting of tape cartridges onto a suitable tape drive. The remote tape copy (rtcopy) daemon handles the transfer of data between tape and disk. The rtcopy daemon also computes a checksum of the files while they are transferred and compares this against a reference value that is stored in the nameserver to detect any transfer errors. This is in addition to arranging the speed streaming of data to support today's high-performance tape drives (with bandwidths of up to 120 MB/s) and dynamically selecting files for migration to or from tape to maximize utilization of the precious tape drives – which was a design requirement for CASTOR2.

Understanding what is happening in such a distributed system is both crucial and difficult, so CASTOR2 comes with a distributed logging facility (DLF) that centralizes recording of logging and accounting information from the various daemons. The DLF comes with an intuitive and easy-to-use web interface to browse the data, and can process and store thousands of events a second. Through regular monitoring of the DLF data, together with status and load information from the disk and tape servers, any problems that threaten service stability can be recognized early on. The modular design of CASTOR2 allows, in many cases, automatic corrective action. For example, individual disk servers can be quiesced when disk errors occur, with files being replicated as necessary to satisfy user requests with other servers. This enables service quality for end users to be maintained despite inevitable hardware failures – another design requirement for CASTOR2.

In terms of performance, CASTOR must cope with the aggregate data rates from the LHC experiments – up to 1 GB/s in proton mode or up to 2 GB/s during heavy-ion running – and the usual load for reconstruction and analysis. The system must also cope with the simultaneous export of data to the Tier-1 sites, leading to the overall bandwidth requirements shown in figure 2.

Bottlenecks and performance problems have been identified and removed thanks to a series of data challenges during the past two years, driven largely by the ALICE collaboration with their enormous central data recording requirements during heavy-ion running. As figure 3 shows, a single CASTOR instance at CERN can easily support sustained data rates up to 2 GB/s and accept incoming data at up to 3 GB/s (the data rate to tape being limited by the number of tape drives available).

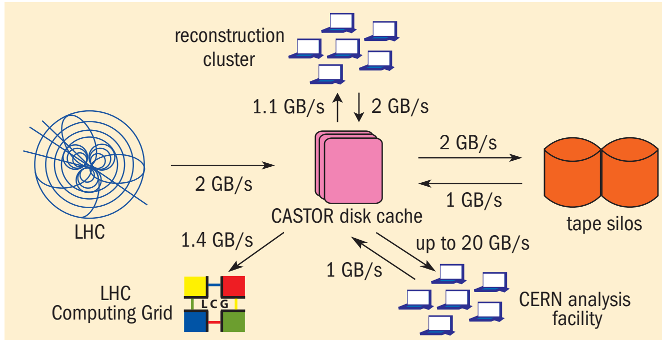


Fig. 2. The bandwidth requirements of the current CASTOR system, which acts as a central hub between components..

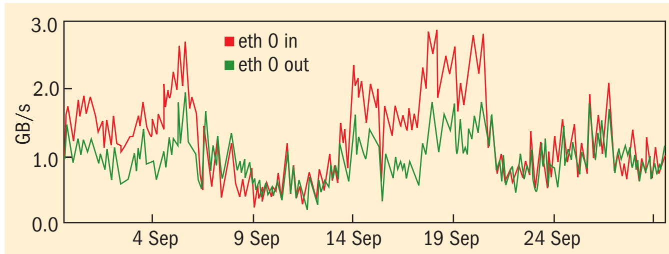


Fig. 3. A plot of I/O bandwidth for the CMS CASTOR instance.

With dedicated instances for each of the four LHC experiments, the CASTOR service at CERN looks set to meet their data recording and export needs. Admittedly, CASTOR has yet to demonstrate performance, reliability and robustness in the face of both data acquisition and an unquantifiable analysis load as physicists seek to exploit the initial LHC data. However, experience over the past year shows that the software and design is flexible and robust, so the CASTOR development and operations teams look forward with confidence to the forthcoming full dress rehearsals, the Combined Computing Readiness Challenge and, above all, first LHC data.

Résumé

CASTOR2 relève le défi du stockage de données du LHC

L'infrastructure de mémoire de masse du CERN se développe progressivement depuis le début des années 1990, époque où les systèmes Unix ont commencé à remplacer les gros ordinateurs. En 1999 a été mis au point le gestionnaire de stockage avancé du CERN, CASTOR, qui a fait ses preuves dans le cadre des expériences COMPASS et NA48. En 2003, cependant, il est apparu que CASTOR ne serait pas à même de gérer le débit et le volume des données, ni le nombre de fichiers prévus pour les expériences LHC. La nouvelle version du gestionnaire, CASTOR2, utilisée depuis 2006, a été conçue pour répondre à ces exigences dans l'environnement informatique actuel s'appuyant sur des serveurs de PC.

Tony Cass, *CERN, with thanks to the CASTOR team, in particular* **Sebastian Ponce** *and* **Giuseppe Lo Presti***.*


www.danfysik.com
DANFYSIK
Accelerating
Technology


www.ces.ch
For over 25 years
CES is your safe, long-term, committed partner
BOARDS
- RIO4 8072 / RIO3 8064
- MFCC 8443 / GPIO 8409
- I/O Adapters
+
SOFTWARE BUNDLES
- Linux Toolkits
- Lynx, VxWorks BSPs
- FPGA Development Toolkits
+
SUPPORT
- Free
- Qualified
MFCC 8443
DIO 6452
FND 6451
and others
RIO3 8064
GPIO 8409
TRG 6453 compliments ILL
You pay once, and we will go with you all the way!
BSP
ISLE
RLDRAM
CES
CREATIVE ELECTRONIC SYSTEMS

Lee Teng: a passion for the accelerator fast lane

Diana Lin finds out about the long career of renowned accelerator physicist Lee Teng.

Each year, the American Physical Society (APS) confers awards to outstanding researchers across the field of physics. This year, those honoured include Lee Teng, senior physicist emeritus at the Advanced Photon Source, Argonne National Laboratory (ANL). Officially, the award is for his inventions, not his passion. Unofficially, everyone who knows Teng knows him for his passion for speed – particle speed, that is – and for his sincere desire to direct his passion for the benefit of the public.

Teng received the 2007 Robert R Wilson Prize for achievement in the physics of particle accelerators during the 22nd Particle Accelerator Conference in Albuquerque (see p29). The APS honoured him for "the invention of resonant extraction and transition-crossing techniques critical to hadron synchrotrons and storage rings; for early and continued development of linear matrix theory of particle beams; and for leadership in the realization of a facility for radiation therapy with protons." The award not only marks the zenith of a distinguished career, but also a 60-year journey that began in 1947 when Teng arrived in the US from China.

Reviewing Teng's career is like studying the history of particle accelerators of the past 50 years. "I am very blessed to have been involved with particle accelerators at this time. The field witnessed great advances and I was able to contribute to all phases of the progress," says Teng. "Since the early development of particle accelerators in the 1930s, there have been significant breakthroughs every five years or so, and we have experienced rapid progress with tremendous momentum."

Starting out at the University of Chicago, Teng worked as a graduate assistant on the "Fermi" synchrocyclotron project, which at the time was the most powerful accelerator available. It was there that he made his first major achievement, discovering the method of "regenerative extraction" – now known as "resonant extraction" – to extract the beam after the proton is accelerated. To this day, this is the only beam extraction system for cyclotrons, with an extraction efficiency of nearly 50%.

Teng obtained his PhD from the University of Chicago in 1951 and he soon joined the University of Minnesota, as the university was in the midst of building a linear proton accelerator. To increase beam intensity, Teng designed a quadrupole focusing system for the linac using a matrix formulation derived from his regenerative extraction system – the first application of a matrix formulation to alternating gradient focusing systems.

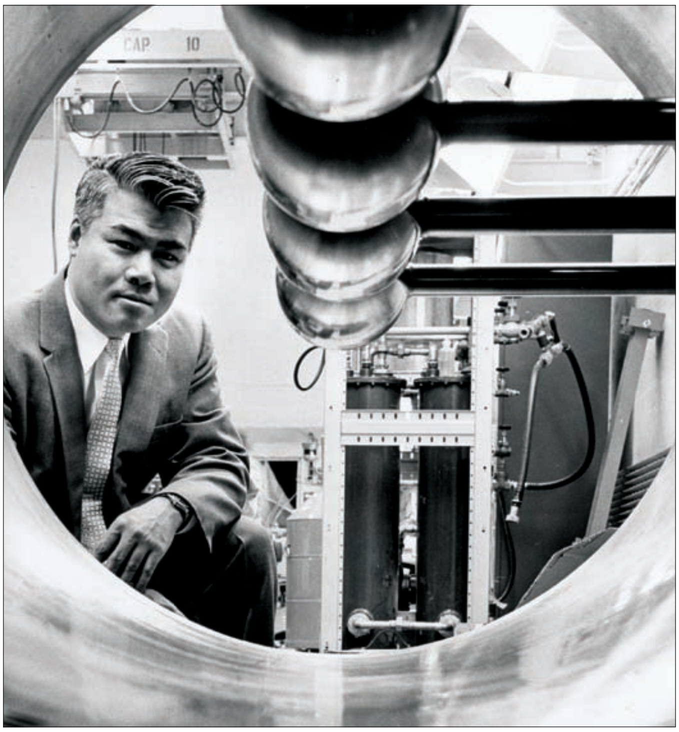
Teng joined ANL in 1955 after a short period at Wichita State University. He rose to become director of the particle accelerator division in 1961, responsible for constructing and operating the Zero Gradient Synchrotron (ZGS) and the associated beam transport lines and bubble chambers. During his tenure, the division accomplished several important innovations in accelerator design and operation, making the ZGS the highest-energy weak-focusing synchrotron ever built – and possibly the last.

Lee Teng in 2004 at the symposium organized by Argonne National Laboratory and Fermilab to honour his official retirement – though he is still active. (Courtesy Mike Borland.)

If passion plays a role in Teng's adventure in exploring the world of particle accelerators, it is his risk-taking, sound judgement, and willingness to step forward that make him stand out from the crowd. He joined Fermilab in 1967 as the head of accelerator theory and remained there for 22 years. During this time, Teng witnessed the changing world of accelerators and anticipated the enhancement of synchrotrons from 70 to 900 GeV, including Fermilab's launch of the world's first superconducting accelerator in February 1984. He served briefly as the associated director of the Accelerator Division in the early 1980s, later becoming head of the Advanced Accelerator Project.

Once the commissioning of the Tevatron collider system had passed smoothly, Teng began to look for projects that required shorter construction times and delivered faster pay-offs than high-energy machines. It was then that his life took another turn, parting from the exciting frontier of high-energy physics to choose an avenue that he hoped would "make something that is more immediately useful for human lives".

This change in direction led him to Asia, and he took a two-year partial leave of absence from Fermilab in 1983 to serve as the founding director of what is now the National Synchrotron ▷



Early days: Lee Teng looking through a linac section, one of 10 such components that made up the linear accelerator portion of the Zero Gradient Synchrotron at Argonne National Laboratory. Teng was director of the particle accelerator division. (Courtesy ANL/AIP Emilio Segrè Visual Archives.)

Thomas Roser (left), chair of the APS Executive Committee, presents the 2007 Robert R Wilson Prize to Lee Teng during the 22nd Particle Accelerator Conference for achievement in the physics of particle accelerators. (Courtesy APS.)

Left to right: Keng Liang, director of the NSRRC, Yuan-Tseh Lee, Nobel laureate and chair of NSRRC's board of trustees, Lee Teng, and Chien-Te Chen, director of the NSRRC 1997–2005. Here they are surveying the future site, in Hsinchu, of the Taiwan Photon Source. (Courtesy NSRCC.)

Radiation Research Centre (NSRRC) in Taiwan. He led the design and construction of the first third-generation synchrotron radiation facility in Asia. The Taiwan Light Source boasted more than 7000 running hours a year after its completion in 1993, and more than 95% reliability. It now has 30 beamlines and nearly 1500 scientists and students use it. In 2004, the NSRRC began the planning of a second facility, a 3-GeV synchrotron radiation source.

Back at Fermilab, in a meeting of the Proton Therapy Coordination Group in 1986, Jim Slater, the head of the radiology department of Loma Linda Hospital in California, proposed that Fermilab should design and build a proton accelerator for cancer therapy. Teng, naturally, took on the project. The accelerator had to provide a rapidly variable energy up to 250 MeV and an extracted beam with a uniform long spill for raster-scan irradiation across tumours. By choosing a weak-focusing synchrotron with slow resonant extraction, Teng's design fulfilled the criteria. The facility established Loma Linda as the first hospital with a clinical capability for proton therapy. The entire project took nearly two years, and during that time Teng had to learn a great deal about the techniques and standards of radiation oncology.

In 1989, the project for the new 7-GeV Advanced Photon Source started at ANL and the laboratory invited Teng back as head of the project's accelerator physics contingent. He retired 15 years later (in 2004), but maintains his association with ANL through his honorary appointment as emeritus senior scientist. He also remains a member of the board of trustees of the NSRRC and travels to China at least once a year to serve on review and advisory committees and to give talks at workshops or conferences.

Back in 1947, when Teng arrived in the US, the only tools available to physicists were essentially pencils and calculators. Creativity was clearly the main force driving progress. In turn, passion proved to be the driving force behind Teng's unique creativity in accelerator physics. He has met the increasingly challenging needs of accelerator technology by collaborating with, among others, Brookhaven National Laboratory, Los Alamos National Laboratory, TRIUMF, KEK, the Budker Institute of Nuclear Physics and CERN. His interest in problem solving has never faded over the years, and this has been a blessing for the design of modern accelerators.

Résumé

Lee Teng: une carrière passionnée dans les accélérateurs

Cette année, la Société américaine de physique a décerné le prix Robert R Wilson de la meilleure réalisation en physique des accélérateurs de particules à Lee Teng, du Laboratoire national d'Argonne. Ce prix marque non seulement l'apogée d'une carrière prestigieuse, mais reflète aussi un parcours de 60 ans, qui a commencé en 1947, lorsque Teng a quitté la Chine pour les États-Unis. Sa carrière, qui a débuté au Synchrocyclotron Fermi, à Chicago, illustre les cinquante dernières années des accélérateurs de particules, car il a déployé sa créativité dans tout le domaine, notamment en inventant l'extraction résonnante et en dirigeant la conception d'une installation de protothérapie.

Diana Lin, *NSRRC.*

ADVERTISING FEATURE

SAES® Getters' Ultra-High Vacuum Pumps boost UHV conditions in Beijing Electron Positron Collider (BEPC 2)

SAES' CapaciTorr getter pumps

Ranked among the eight largest high-energy accelerator centers in the world, the Beijing Electron–Positron Collider – BEPC II (www.ihep.ac.cn) has been recently upgraded to improve its performance by one hundred times the previous level. The old storage ring has been replaced by a new double ring, with a circumference of 240 meters, which enables electrons and positrons to move in their own rings and to collide with each other at defined interaction points. Phenomena originating from these subatomic collisions help scientists study the fundamental properties of the basic building blocks of matter, deepening understanding about the laws of the physical world.

To ensure this challenging target the vacuum system has been completely redesigned and more efficient pumps adopted.

More than 200 CapaciTorr® D 400 non-evaporable getter (NEG) pumps have been mounted all along the electron-positron collider's storage ring to keep the vacuum in the 10-10 torr region, as required for the correct operation of the system.

NEG pumps have been selected due to the proven, outstanding chemical sorption action for hydrogen and all active gases, as well as for their capability to operate in the presence of high magnetic fields.

In addition to the CapaciTorr D 400, larger CapaciTorr B 1300 pumps, featuring 1300 l/s pumping speed for hydrogen, have been mounted before the quadrupole magnets and in the interaction regions, where electron and positron collide and the gas load is particularly high.

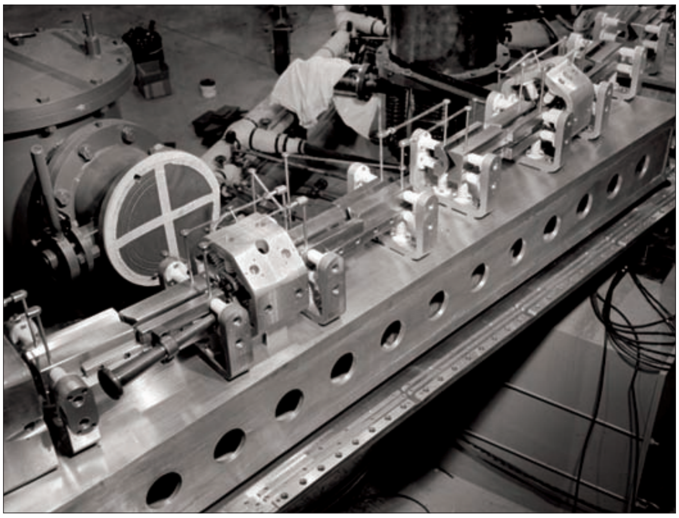
In the interaction regions NEG pumps are the only type of pump mounted since no ion pumps nor titanium sublimation pumps can be installed due to tight space constraints. It is therefore key that they possess extremely high sorption capacities to ensure very long lifetime between two activations and an extended number of venting-reactivation cycles.

The BEPC II collider, which saw its first beam in November 2006, is now making steady progresses towards the achievement of the design performance.

For more information:
Paolo Manini
SAES Getters
Business Area Manager Vacuum Systems
e-mail: paolo_manini@saes-group.com
www.saesgetters.com

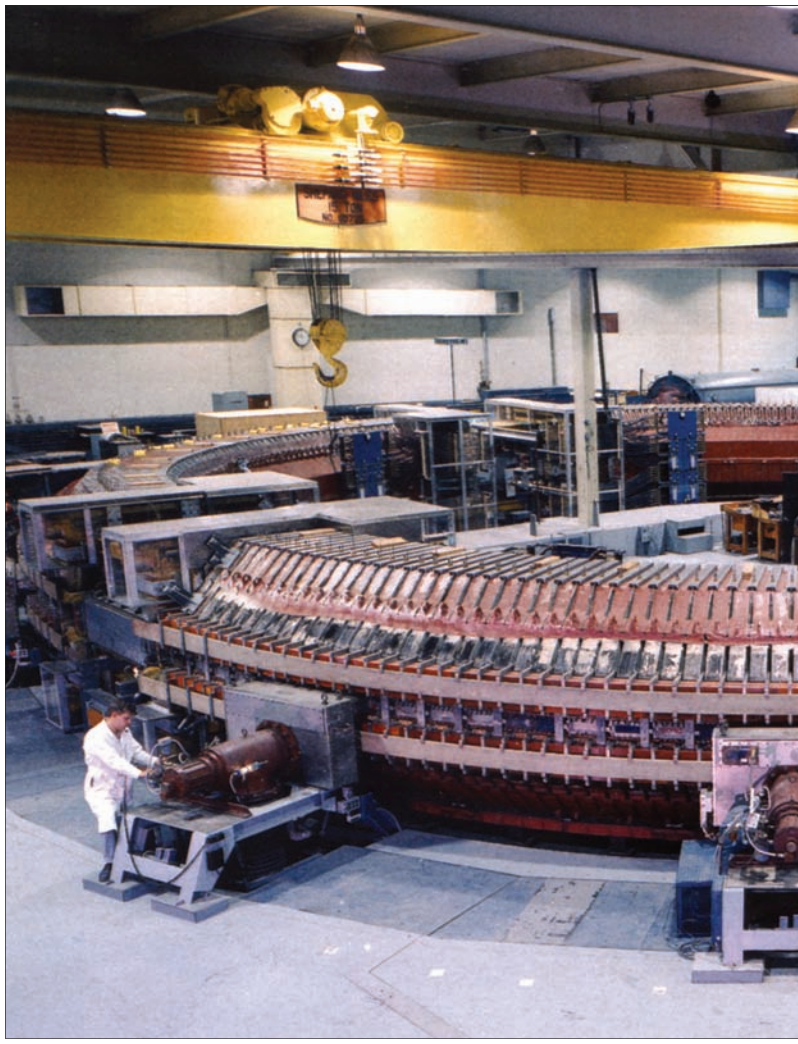
Brookhaven and CER

This year the Brookhaven National Laboratory cel
Ernest Courant looks back to the early days o



Section of the Electron Analog small-scale model showing electrostatic dipole and quadrupole lenses. (Courtesy BNL.)

Celebrating the first beam at the Alternating Gradient Synchrotron on 29 July 1960. Left to right: Julius Spiro, Ralph Kassner (back to camera), Ernest Courant, John Blewett, Leland Haworth, Martin Plotkin and Hildred Blewett. (Courtesy BNL.)



The 3 GeV Cosmotron at Brookhaven was the world's highest energy acce

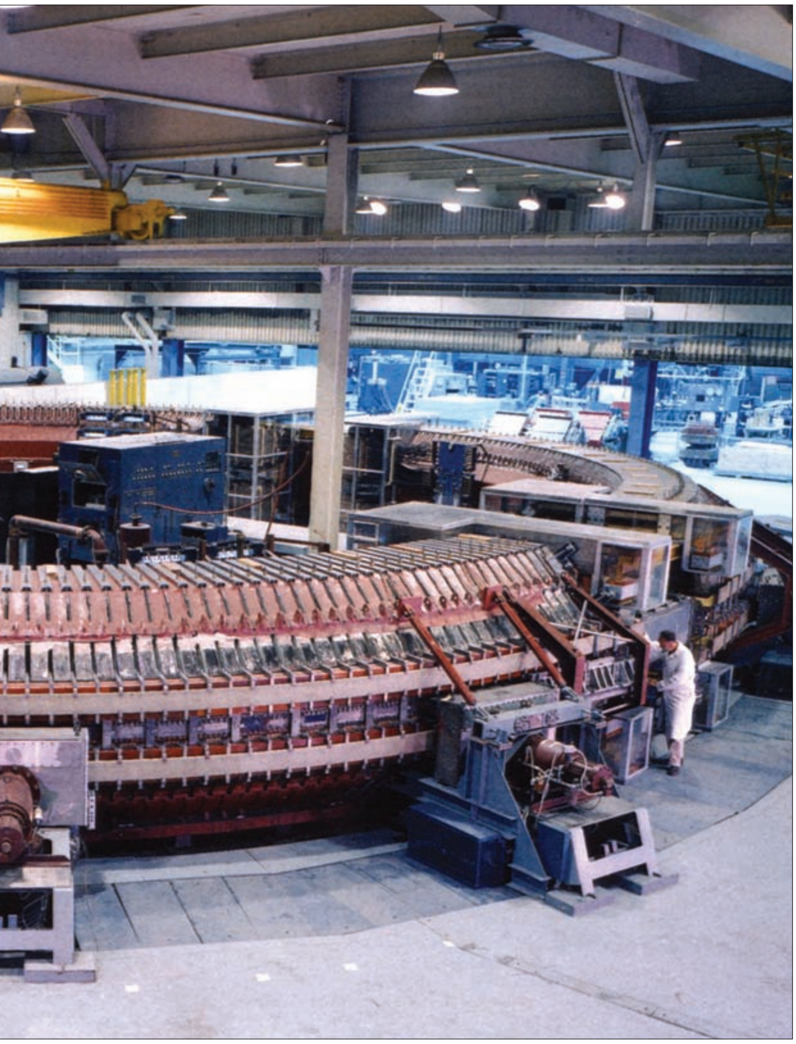
In the spring of 1947, Philip Morse and M Stanley Livingston visited Cornell University, where I was a post-doc working in nuclear physics under Hans Bethe. They talked about the newly established Brookhaven National Laboratory (BNL), where Morse was the director and Livingston was in charge of a project to build a gigantic accelerator that would reach 3 GeV – which was 10 times what anyone had achieved previously. This fascinated me, and I accepted their invitation to join the project for the summer. I worked with Nelson Blachman at BNL on some of the orbit problems of the proposed machine, and discovered that I enjoyed this type of work. I returned to Cornell, and joined the laboratory permanently the following year.

The project to build the Cosmotron (so called because it would almost emulate cosmic rays) proceeded, and by early 1952 success was in sight. French physicist Edouard Regenstreif of the University of Rennes visited us in the spring. He represented a consortium of 12 European countries (Conseil Européen pour la Recherche Nucléaire – the provisional CERN) that aimed to establish a new laboratory featuring an accelerator like the Cosmotron, only bigger. We showed him what we had, and he was duly impressed.

On 20 May 1952, the Cosmotron accelerated a beam of protons to a little more than 1 GeV – by far the highest energy ever attained by artificial acceleration – just 20 years after Livingston

N: the AGS and the PS

lebrates its 60th anniversary. Accelerator pioneer of the first big synchrotrons there and at CERN.



elerator when it started up in 1952, and impressed many. (Courtesy BNL.)

Left to right: George Collins from Brookhaven National Laboratory with the provisional CERN delegation in 1952, Odd Dahl, Rolf Wideröe and Frank Goward. (Courtesy BNL.)

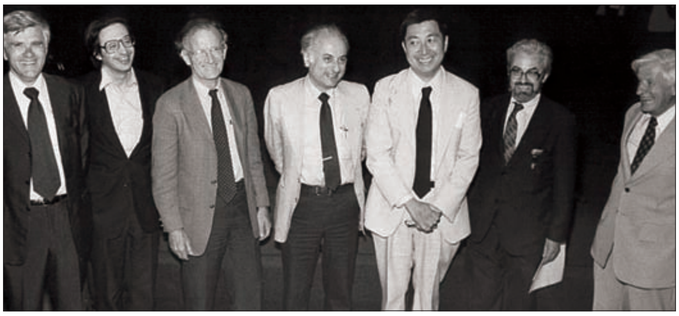
In the control room during the first exciting hours of the start-up of the Proton Synchrotron at CERN, from left to right: John Adams, Hans Geibel, Hildred Blewett, Chris Schmelzer, Lloyd Smith, Wolfgang Schnell and Pierre Germain.

and Ernest Lawrence had achieved the first million volts with a cyclotron. The energy soon came close to the design value of 3 GeV and almost immediately we started to ask ourselves how our success could be extended to higher energy. Livingston (who had returned to the Massachusetts Institute of Technology in 1948) came back for the summer to lead a study group.

A delegation from CERN was due to follow up on Regenstreif's visit to see whether they could pick up some pointers from us. They were planning to build a proton synchrotron similar to the Cosmotron as the centrepiece of their new international laboratory, but with an energy of around 10 GeV. Our study group considered what advice we could give them.

The story of how we came upon the "strong focusing" or "alternating gradient" scheme, which enhances orbit stability, has been told many times. The most important consequence of this enhanced stability is that the magnets for an accelerator may be much smaller, making it feasible to go to higher energy at a reasonable cost. We promptly considered the possibility of building new accelerators in the range of 30–100 GeV.

A week or two later the delegation from CERN arrived, comprising Odd Dahl, who had worked with high-voltage machines in Washington before the war; Frank Goward, one of the first people to make a working synchrotron; and Rolf Wideröe, the Norwegian who had first devised a scheme to use radio frequency ▷



Celebrating the 20th anniversary of the Alternating Gradient Synchrotron (AGS). From left to right: Kjell Johnsen, Nick Samios, Val Fitch, Mel Schwartz, Sam Ting, Ernest Courant and John Blewett. Fitch, Schwartz and Ting all received the Nobel prize for their work at the AGS. (Courtesy BNL.)

repeatedly to produce more energy than the corresponding voltage, and whose 1928 paper led to Lawrence's invention of the cyclotron. The visitors were impressed, and they returned home recommending the new method to build an accelerator for 30 GeV, rather than the planned 10 GeV.

Shortly afterwards, John and Hildred Blewett and I received an invitation to travel to Europe to discuss the new idea with CERN physicists. We set out in November – in sleeper berths on a Boeing Stratocruiser – on a 12-hour, non-stop flight to Paris. We met a number of interested people in a meeting led by Pierre Auger at UNESCO headquarters. It was there that I met Kjell Johnsen, leading to a friendship lasting until his death this summer (*CERN Courier* October 2007 p41). A number of people went to Geneva to look at an empty field as a possible site for the accelerator.

I left Geneva for my native city of Göttingen, to give a talk (the only one I have ever given in German) to Werner Heisenberg and people at the Max Planck Institute. I went on to Copenhagen to see Niels Bohr and his people, some of whom had built a mechanical model illustrating how alternating focusing and defocusing can give stability. The Blewetts went to Bergen for discussions with Dahl and I concluded my European trip with a visit to Harwell in England – which, as far as I can recall, is when I first met John Adams and Mervyn Hine.

Back at BNL, we went to work on exploring the requirements for actually building an accelerator – and of course the CERN people did the same. Both groups decided to aim for an energy of around 30 GeV – and the race was on. However, we collaborated in this race as much as we competed, sharing internal reports and informal communications. The Blewetts took six months' leave in 1953 to work with Dahl in Bergen. At the time, CERN was scattered over several sites prior to the establishment of the central laboratory in Geneva. At a conference at the University of Geneva in October 1953, participants discussed the theoretical and technical design issues for an alternating gradient synchrotron. I was one of several American participants and Hildred Blewett edited the proceedings – I still have a copy after all these years.

The rivalry and collaboration between the projects at BNL and CERN continued. As a result, the two accelerators are similar in overall design, not only in size but in most of the details. The machine at BNL is called the Alternating Gradient Synchrotron (AGS) and the one at CERN is the Proton Synchrotron (PS); in fact, both names apply to both machines.

There were still some differences. One possible problem was a phenomenon called the "transition energy", an energy where the mechanism of phase stability demands a sudden change of phase of the accelerating field. All the theory – by Kjell Johnsen at CERN and me at BNL – predicted that this should be easy to deal with. The people at CERN were convinced that this was correct, while some of the powers-that-be at BNL decided that they would feel safer if there was an experimental demonstration of the feasibility of going through this critical energy. As a result, BNL built a small-scale model (the Electron Analog) to verify that calculation, while CERN did not. The Electron Analog worked perfectly, but it cost us some time. Consequently, CERN won the race – they had an accelerated beam in 1959, while ours came in 1960. Each was the world's highest-energy accelerator when it came on.

There are numerous accelerators and colliders today with energies exceeding the PS and the AGS. These two venerable machines are approaching their 50th anniversaries and are breaking records in longevity rather than energy. They now function as injectors for their successors: the AGS for RHIC at BNL, and the PS for the SPS at CERN – which the LHC will soon succeed. Continued collaboration between BNL and CERN – and other high-energy laboratories around the world – is a matter of course.

Résumé

Brookhaven et le CERN: l'AGS et le PS

Cette année, le Laboratoire national de Brookhaven (États-Unis) fête ses 60 ans. Ernest Courant, pionnier des accélérateurs, évoque ici les débuts des premiers grands synchrotrons dans ce laboratoire et au CERN. Il raconte la collaboration – et la compétition amicale – qui s'est instaurée entre eux en 1952, lors de la première visite d'une délégation du CERN provisoire. Le Cosmotron de 3 GeV de Brookhaven était alors sur le point de devenir l'accélérateur de la plus haute énergie du monde. En 1959, le CERN avait construit le Synchrotron à protons (PS) et Brookhaven le synchrotron à gradients alternés (AGS). Tous deux servent aujourd'hui d'injecteurs à leurs plus volumineux successeurs.

Ernest Courant, *BNL.*

Accelerator experts meet in Albuquerque

PAC '07 was the major accelerator conference for 2007, bringing specialists together to discuss current and future challenges, from low to high energy. **Robert Garnett** reports.

The 22nd Particle Accelerator Conference, PAC '07, held in Albuquerque on 25–29 June was one of the largest yet. Nearly 1400 participants and 70 vendor companies attended, and more than 1400 papers were published, again demonstrating the important and prolific work that worldwide collaborations are doing in a multidisciplinary field. In all, it was a great success. This article briefly reports the highlights (see "A packed programme).

The high-energy frontier is still luring particle physicists and challenging accelerator designers and builders, with the next big step being the LHC at CERN. Following the accumulation of several minor delays, CERN dropped the plan for a low-energy run of the new collider later this year. The schedule foresees the commissioning of the machine at full energy starting in spring 2008 (*CERN Courier* July/August 2007 p5). At the conference, talks and posters dealt with schemes for optimizing the performance of the LHC, as well as the potential for upgrades.

Meanwhile, US efforts at RHIC at the Brookhaven National Laboratory (BNL) now include luminosity improvements that will require the development of a facility at the cutting edge of beam cooling. Estimates suggest that electron cooling will require electron energies up to 54 MeV at an average current of 50–100 mA, and in a particularly bright electron beam. The aim is to generate this electron beam in a superconducting energy-recovery linac (ERL) using a superconducting RF gun with a laser–photocathode. An intensive R&D programme is currently underway. There are also plans for RHIC to produce 200 GeV polarized protons routinely, once there is a better understanding of the effects of polarization loss owing to intrinsic high-energy spin resonances. The acceleration of electrons at the proposed e-RHIC will allow continuity in the experimental programme, followed earlier at HERA, the electron–proton collider at DESY that shut down in July after 16 successful years of operation.

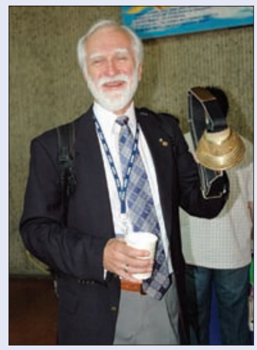
At Fermilab, the luminosity of the Tevatron proton–antiproton collider continues to improve, setting the record for hadron colliders. Fermilab has achieved the first electron cooling of a relativistic hadron beam (8 GeV antiprotons in the Recycler), contributing heavily to the success of Run II at the Tevatron. Studies of ways to improve further the beam–beam compensation efficiency in the Tevatron are also underway. Tests have already demonstrated compensation using electron lenses, paving the way for beam–beam compensation in RHIC and the LHC.

The conference also heard reports on the commissioning of multibatch slip-stacking in the Fermilab main injector. This technique has allowed doubling of the neutrino intensity for the Neutrino beam for the Main Injector (NUMI) project. Incorporating the Recycler for proton accumulation yields a four-fold increase in the neutrino source and may lead to a project dubbed SuperNUMI, although this could face strong competition from the Japan Proton Accelerator Research Complex (J-PARC) and an upgraded CERN Neutrinos to Gran Sasso (CNGS) project. Further steps will be necessary to ensure a leading position for the US in long-baseline neutrino experiments, such as Fermilab's proposed Project X.

The high-energy frontier brings challenges that can only be met ▷

A packed programme

The programme of PAC '07 consisted of up to three parallel sessions a day, as well as several special events, workshops and an awards ceremony (see "Accelerator awards" p31). In addition, there was an science day for the public on the weekend before the conference, plus a physics teachers' day, held mid-conference. There was also a special poster session by students, with the best poster receiving an award. One of the successful workshops was on magnet simulations for particle accelerators, with presentations covering magnet simulation activities in many accelerator laboratories, institutions and companies. A successful special industrial session, the International Industrial Forums for the ILC, focused on the anticipated cavity, cryogenic and RF needs for the ILC.



Stan Schriber, the conference chair, rings the bell to round up everyone for the plenary sessions.

A familiar sight at many conferences today: participants consult their laptops. (All photos courtesy Marion White, ANL.)

Ice Mountain Dancers from the Oke Owingeh Indian pueblo near Albuquerque provided some local entertainment.

by strong, successful international collaborations. Barry Barish, director of the Global Design Effort for an International Linear Collider (ILC), reviewed the status, plans and main issues towards an ILC project. The *Reference Design Report* for the ILC, which will be based on superconducting (SC) RF technology, should be released in the coming months. The current baseline configuration uses the TESLA project's SC cavity shape for the 500 GeV stage and assumes an accelerating gradient of 31.5 MV/m. The R&D programme includes work on alternative cavity shapes that promise higher gradients, but the designs are not yet mature enough to adopt as the baseline. The ILC will complement the LHC by allowing precision measurements at well-defined energy and angular momentum in the same regime, without the complications of the complex composite structure of the protons.

The push towards even higher energies requires innovative approaches. Visiting researchers from the University of California Los Angeles and the University of Southern California are working with researchers at SLAC to investigate plasma wakefield acceleration and have already demonstrated the energy-doubling of the 42 GeV electrons from the three-kilometre long SLAC linac in a plasma device less than a metre long (*CERN Courier* June 2007 p28). The implied acceleration gradient of 50 GeV/m is more than three orders of magnitude greater than in the SLAC linac. The same team had presented at PAC '05 the results of a first demonstration of an energy gain greater than 1 GeV. It is remarkable that they extended their work in such a short time to test the concept of a plasma afterburner for doubling the energy of a beam from a real collider. This concept is expected soon to become a realistic technology for building future accelerators.

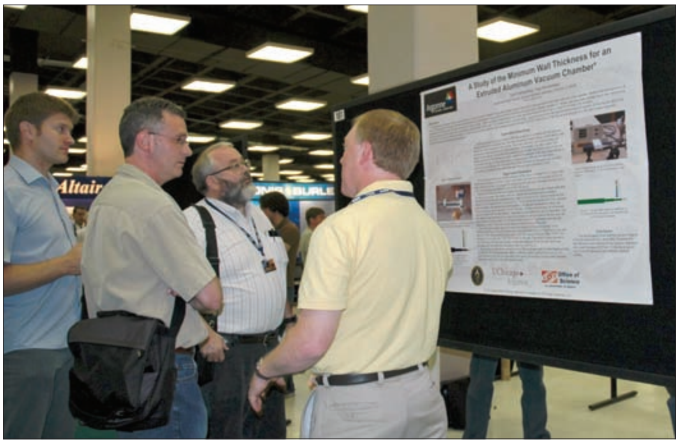
Lower energies, higher powers

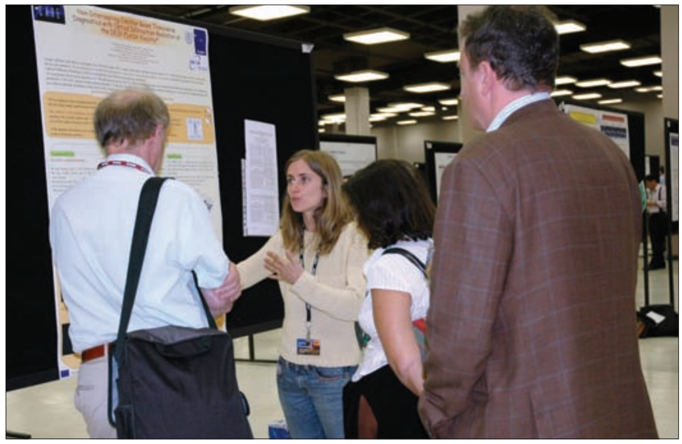
At low to medium energies, the emphasis is often on achieving higher powers, either in sources or injectors for higher-energy machines or to deliver final beams at lower energies. The conference heard the latest results from commissioning studies at J-PARC and at the Spallation Neutron Source (SNS) at Oak Ridge. Both facilities are producing exciting results and are on track for ramping up to high beam powers. There were also reports on the successful first-stage commissioning of TRIUMF's Isotope Separation and Acceleration (ISAC) facility, ISAC-II; the status of the Dual-Axis Radiographic Hydrodynamic Test phase II commissioning at the Los Alamos National Laboratory; and the results from commissioning of the proton linac for the Low Energy Neutron Source at Indiana University. Talks about non-scaling, fixed-field alternating gradient (FFAG) accelerators discussed new developments in this class of machine. There were also reports on the status of the Facility for Antiproton and Ion Research (FAIR) at GSI and on the results of longitudinal profile measurements made in the SNS linac.

Invited speakers on the latest source and injector technology looked at the development of reliable high-current, low-emittance injectors for various applications, particularly high-power spallation sources and heavy-ion fusion. Specific topics included GaAs-based photoguns with a high degree of polarization, and laser-driven sources of heavy ions with an emphasis on direct plasma injection into the subsequent accelerator structure. The general design principles for an electron cyclotron resonance (ECR) source of heavy ions were illustrated with a design for an advanced ECR. The meeting also discussed a multi-beamlet injector for a heavy-ion fusion accelerator, as well as the test and production versions of a high-performance electron-beam ion source for very highly charged heavy ions. In addition, contributed papers presented an optically pumped source of polarized H^- ions with a very high degree of polarization; new development approaches with RF-driven H^- ion sources; model-based optimization of plasma parameters for ECR ion sources; and a comparison of measured and simulated beam inhomogeneities found with ECR ion sources.

Applied accelerators

Accelerator-based facilities support a rich and diverse set of user programmes in basic and applied science, but at the same time there is an increasing number of varied applications for accelerators. The interest in hadron therapy continues to grow around the world as the number of new facilities in both design and construction stages demonstrates. Although cyclotrons and synchrotrons are the technologies of choice for these facilities, efforts to optimize cost and performance have reinvigorated interest in other technologies, such as FFAGs. New concepts for strengthening US national security involving accelerator technology and the production of particle and photon beams are also emerging, as scanning systems are tailored to address specific concerns. In addition, high-power, energy-recovered free-electron lasers (FELs) are enabling new applications for accelerators in research and industry.





The extensive poster display at the conference allowed attendees plenty of opportunity to discuss new developments.

The next generation of advanced light sources will provide many exciting research possibilities. Recent advances, such as ERLs, are making intense, broadly tunable sources of X-ray and XUV radiation feasible. These will allow real-time studies of reaction dynamics in chemical systems on the femtosecond timescale – previously thought impossible. The only short-wavelength FEL currently in operation is the FLASH facility at DESY. Important "pump probe" experiments are already underway there to test the theory. Future facilities may lead to quantum-level chemical control and reaction initiation at room temperatures, and may offer new insights into the dynamic behaviour of matter at the atomic level.

The success and continuing progress of three operating FELs based on ERLs (the Jefferson Lab IR FEL, the Japanese Atomic Energy Authority's FEL and the high-power THz FEL at the Budker Institute for Nuclear Physics) promise many future applications in ERL technology. Besides high-power FELs and light sources, applications also include electron cooling and high-luminosity electron–ion colliders. The challenge will be in achieving high electron source brightness, maintaining high beam brightness during beam transport and acceleration/deceleration, and controlling high and peak current effects in superconducting RF systems. Some of these challenges are already being addressed within the projects now underway to build X-ray FELs at SLAC, Spring-8 and DESY. All three of these XFELs will rely on the principle of self-amplified spontaneous emission, which does not require mirrors and allows wide wavelength tunability. Talks and posters covered current progress at these facilities as well as new concepts based on computer modelling and theory.

As is now the trend, the largest number of contributions at the conference concerned beam dynamics and the accurate computation of electromagnetic fields. Implementation of 3D electromagnetic simulations for complex geometries and processes continues to advance in direct proportion to advances in computer hardware and storage capabilities. The direct link between these calculations and the ability to optimize the performance and operation of modern accelerators is clear. Scientists are developing sophisticated models to address many of the difficult technical issues facing the next generation of machines, such as beam losses and halo formation in high-intensity hadron beams, space-charge driven resonances, tailoring beam phase-space distributions, and understanding electron cloud effects. Talks and posters at the conference presented a broad range of topics, including collective effects and instabilities, developments in codes and simulations, single- and multi-particle dynamics, ▷

Accelerator awards

The winners of a variety of prizes for the physics and technology of accelerators received their awards in a special session at PAC '07. The Robert R Wilson prize of the American Physical Society (APS) was awarded to Lee Teng, emeritus scientist at Argonne National Laboratory (see p23). A second APS prize, the Award for Outstanding Doctoral Thesis Research in Beam Physics, honoured Jeroen von Tilborg from Lawrence Berkeley National Laboratory and Technische Universiteit Eindhoven. The IEEE Nuclear and Plasma Sciences Society Particle Accelerator Science and Technology Award went jointly to Satoshi Ozaki and Michael Harrison from Brookhaven National Laboratory, and individually to Victor Malka from the Centre National de la Recherche Scientifique. Finally, Sergei Nagaitsev from Fermilab and Yaroslav Derbenev from Jefferson Lab individually won the US Particle Accelerator School Prize for Achievement in Accelerator Physics and Technology.

and beam optics. In particular, the conference heard of the latest simulation and experimental results of bunch compression in high-intensity electron bunches – important for both current and next-generation FEL projects.

Talks on instabilities and feedback emphasized new results in controlling collective effects through wideband feedback and in impedance or instability computation, benchmarked with instability observations. These included the successful demonstration of wideband feedback against electron–proton instability and for longitudinal stochastic cooling of a high-energy bunched beam. Two studies of the suppression of the electron cloud effect have led to *in situ* tests of TiN/Al-coated flat and grooved chambers and an idea for a distributed, low-impedance clearing electrode. Other contributors described analytical and/or experimental studies of novel instabilities in cooled antiproton beams, the possible interplay between resistive wall and fast beam-ion instability, and vertical instability in a proton bunch tail; they also discussed cures. Finally, impedance computation remains an important subject, in particular the accurate computation of the transverse impedance of LHC collimators verified with beam tests, reduction of taper impedance through nonlinear tapering, and the use of the impedance database computation method to predict accurately single bunch limits and collective effects.

The integration of sophisticated beam modelling and computer controls continues to advance. The conference heard about recent progress in developing software tools for commissioning the SNS, while posters and talks also discussed modern accelerator control architecture and its use in machine and personnel protection. A concluding overview of modern accelerator control systems emphasized the continuing need for global standardization and collaboration. Although construction of the ILC is not imminent, much thought has already been given to the control and operation of this machine of the future.

● The next PAC conference will be in Vancouver in June 2009.

Further reading

The proceedings are available through open-access from the Joint Accelerator Conferences Website (JACoW) at www.jacow.org.

Résumé

Des spécialistes des accélérateurs à Albuquerque

La 22e conférence sur les accélérateurs de particules, PAC '07, tenue à Albuquerque du 25 au 29 juin, a connu une affluence exceptionnelle. Avec près de 1400 participants, 70 sociétés invitées et plus de 1400 communications publiées, la conférence a de nouveau démontré la portée et la fécondité des travaux des collaborations mondiales dans ce domaine très pluridisciplinaire. Autour de thèmes allant des défis de la frontière des hautes énergies aux applications à basse énergie, comme les lasers à électrons libres, le programme, très dense, comprenait des ateliers, une cérémonie de remise de prix, une journée scientifique «grand public» et une autre pour les enseignants de physique.

Robert Garnett, *Los Alamos National Laboratory, on behalf of the PAC '07 scientific programme committee.*

AWARDS

LHC, RHIC, cosmic rays and neutrinos reap a batch of honours

Left: Lyn Evans, LHC project leader at CERN, honoured by the APS. Middle: Lucio Rossi (centre) receives the award from John Spargo, chair of the IEEE Council on Superconductivity (left) and Martin Nisenoff, chair of the Council on Superconductivity's Awards Committee. (Courtesy IEEE Council on Superconductivity.) Right: Philippe Lebrun (left) with his honorary doctorate at Wrocław University of Technology, from Maciej Chorowski (right), dean of the faculty of mechanical and power engineering. (Courtesy Laurent Tavian.)

The science and technology of modern collider-beam machines, as well as the physics that they are beginning to access, are earning awards for the pioneering scientists and engineers involved. In particular, three of the key people in the LHC project at CERN have received recent recognition for their work. At the same time, particle physics that goes back to its roots in studying particles from the Sun and natural cosmic accelerators also figures in the latest awards.

The American Physical Society (APS) has recognized the LHC project leader, Lyn Evans, with the award of the 2008 Robert R Wilson prize. Evans receives the prize in recognition of his outstanding achievement in the physics of particle accelerators, and for his "sustained career of technical innovation and leadership in the SPS proton–antiproton collider, culminating in the construction and commissioning of the LHC". Evans played a key role in bringing the SPS at CERN to operate as a proton–antiproton collider, which led to the discovery of the W and Z bosons in 1983 and the award of the Nobel Prize in Physics to Carlo Rubbia and Simon van der Meer in 1984. He has since been a leading figure and driving force behind the project to build the LHC.

Earlier in the year, the Institute of Electrical and Electronic Engineers (IEEE) Council on Superconductivity honoured Lucio Rossi, head of the Magnet and Superconductor Group in CERN's Accelerator Technology Division, with its Award for Continuing and Significant Contributions in the Field of Applied Superconductivity. The IEEE recognized Rossi's leadership of the group responsible for procuring the superconducting dipole and quadrupole magnets for the LHC; his contributions to the design of various superconducting magnet systems, including the ATLAS barrel toroid magnet; and his teaching work at the University of Milan and INFN, where he trained future leaders of the superconducting magnet community. He received the award during the International Conference on Magnetic Technology (MT-20), held in Philadelphia at the end of August.

More recently, Philippe Lebrun, head of CERN's Accelerator Technology Department, received the title of doctor *honoris causa* in a ceremony at Wrocław University of Technology on 2 October. The university honoured Lebrun, who leads his department's work on magnets, cryogenics and vacuum technology for the LHC project, for his contributions to the development of helium cryogenics and its application to accelerator technologies. The university rector, Taddeus Luty, chaired the ceremony and Maciej Chorowski, dean of the faculty of mechanical and power engineering at Wrocław and member of the Polish delegation to CERN's finance committee, awarded the degree.

Work on the pioneering heavy-ion collider RHIC at Brookhaven National Laboratory (BNL) has also received awards from the APS and IEEE. Satoshi Ozaki and Michael Harrison, who led the decade-long development and construction of RHIC, received the 2007 Particle Accelerator Science and Technology Award at the 22nd Particle Accelerator Conference in June (see p29). The Nuclear and Plasma Sciences Society of the IEEE sponsors this award, which they shared with Victor Malka of the Centre National de la Recherche Scientifique. Malka was honoured for his groundbreaking work on laser-plasma accelerators.

The APS has recognized further work at RHIC with the 2008 Tom W Bonner prize for outstanding experimental research in nuclear physics. Arthur Poskanzer of Lawrence Berkeley National Laboratory receives the award "in recognition of his pioneering role in the experimental studies of flow in relativistic heavy-ion collisions". Poskanzer co-founded the STAR collaboration at RHIC and is a co-discoverer of elliptic flow there – important evidence for quark–gluon plasma.

The APS also recognizes the returning influence of cosmic-ray studies in high-energy physics by awarding the 2008 W K H Panofsky prize in experimental particle physics to George Cassiday and Pierre Sokolsky of the University of Utah, for "the pioneering development of the atmospheric fluorescence technique as a method for exploring the highest energy cosmic rays". The method was used at the Fly's Eye and High-Resolution Fly's Eye cosmic-ray detectors at Dugway Proving Ground, and in the new Telescope Array cosmic-ray observatory in Utah. The method also features in the Pierre Auger project.

BNL's Michael Harrison and Satoshi Ozaki with their 2007 Particle Accelerator Science and Technology Award. (Courtesy BNL.)

The importance of non-accelerator physics has come to the fore in recent years with the solution of the long-standing solar neutrino problem in terms of neutrino oscillations and neutrino mass. The APS recognizes this with the J J Sakurai prize for outstanding achievement in particle theory, awarded jointly to Stanislav Mikheyev of the Russian Academy of Sciences and Alexei Smirnov of the Abdus Salam International Centre for Theoretical Physics. They receive the prize for their "pioneering and influential work on the enhancement of neutrino oscillations in matter, which is essential to a quantitative understanding of the solar neutrino flux".

SUMMER SCHOOL

Trest Castle provides school for young high-energy physicists

The European School of High-Energy Physics, for PhD students in experimental high-energy physics, has a well deserved reputation for its lecture courses by distinguished physicists. It is also famous for its discussion sessions, which are important both for the students and for the future careers of the young discussion leaders. The active social programme is a third important ingredient and is a good training ground for future collaborative work in large experimental teams. The school moves around Europe, and avoids big cities to minimize the temptation of competing attractions. This year it returned to the Czech Republic after many years, this time to the castle at Trest.

Organizers devoted the first week to courses on the Standard Model of electroweak and strong interactions, where Ronald Kleiss of Nijmegen swiftly ruined all expectations as he reconstructed the basic properties of the electroweak interactions on the blackboard without ever using the notions of symmetry and gauge principles. In his lectures on QCD, James Stirling of the University of Durham offered students his description of how to understand and use their "bread and butter": the parton distributions. Hitoshi Murayama from the University of California transmitted in a charming lecture course his fascination with the observable phenomena that arise from the neutrinos' masses. The expected notions of symmetry and gauge principles did finally come into play in the rich lecture course on flavour physics and CP violation by Thomas Mannel of the University of Seigen.


The poster session at the summer school, where students presented their research and results. (Courtesy E Lillestøl.)

The second week looked mainly to the alluring scientific prospects for the near future. Nobel laureate Jim Cronin from the University of Chicago described how the Auger Project is investigating the properties of ultrarelativistic cosmic rays, and in a successful after-dinner talk the president of the Czech Academy of Sciences, Vaclav Paces, offered a tasty post-dinner presentation from genetics, entitled: From the peas of Gregor Mendel to the human genome. Jean Iliopoulos from the Centre National de la Recherche Scientifique, fresh from receiving the Dirac medal for his contributions to the Standard Model, looked at the popular views beyond it. CERN's Urs Wiedemann described what hadronic matter should look like under extreme heating in heavy-ion collisions. Mike Turner of Chicago convinced the young high-energy experimentalists of the beauty and importance of cosmology and astrophysics. To end with, talks on the upcoming LHC, by Alexey Sissakian from JINR and Philippe Lebrun and Jos Engelen from CERN, described the bright future ahead.

The mandatory "work" also included a lively evening poster session organized in the music room, where students presented their research work and results.

On the social side, an evening with the famous Martinu string quartet playing Dvorák and Janácek was a great success. On another evening, a local orchestra set the atmosphere for tasting the local wines by playing and singing folk songs. As the Czech Republic is often associated with beer, a short visit to a brewery was inevitable. Returning to the spirit of learning, there was also a visit to the Carolinum, the historical building of Charles University in Prague.

ANNIVERSARY

Brookhaven celebrates 60 years

Hundreds of staff gathered on a local field on 1 May to form a giant "BNL 60" in honour of the laboratory's 60th anniversary. The living logo was photographed and videotaped by Roger Stoutenburgh and Michael Herbert from the top of a 30 m water tower overlooking the field. A total of 680 people took part: 165 in the B, 132 in the N, 112 in the L, 132 in the 6 and 139 in the 0. (Courtesy BNL.)

In 1946, representatives from nine major universities in the eastern US – Columbia, Cornell, Harvard, Johns Hopkins, Massachusetts Institute of Technology, Princeton, University of Pennsylvania, University of Rochester, and Yale – formed a non-profit corporation to establish a new science facility. The site they chose was a surplus army base on Long Island, New York – now known around the world as the location of the Brookhaven National Laboratory (BNL). On 21 March 1947, the US War Department handed the Camp Upton site on Long Island to the US Atomic Energy Commission, predecessor to the US Department of Energy.

The plan was to promote basic research in the physical, chemical, biological and engineering aspects of the atomic sciences. Equally important was establishing a national laboratory in the north-eastern US to design, construct and operate large scientific machines that individual institutions could otherwise not afford to develop on their own. The laboratory was to resemble a university as much as possible.

In particle physics, this concept got off to an excellent start with the construction of a 3 GeV proton synchrotron, the Cosmotron, in 1952, which was followed eight years later by the Alternating Gradient Synchrotron (see p26). The latter machine led to famous discoveries, including the Ω^-. The discoveries of the muon neutrino, CP violation and the J/ψ particle were all rewarded with the Nobel prize. The laboratory was also the workplace for Raymond Davis, the Nobel-prize winning pioneer of solar neutrino experiments.

More recently, BNL has taken the lead in the study of heavy-ion collisions at RHIC, where experiments are investigating strongly interacting, hot, dense matter with exciting new properties. The laboratory also has an illustrious presence in other areas of research, served in particular by the National Synchrotron Radiation Light Source.

BNL's 60th anniversary celebrations throughout this year culminated on 19 October with a day-long symposium for employees, guests, media and others interested in hearing about past and present developments in the laboratory's fields of research. Sam Aronson, the current director of BNL, opened the symposium. Topics covered ranged from nuclear and particle physics to neuroimaging, nanoscience, climate change and energy. Speakers included Robert Palmer and Veljko Radeka on accelerator design and instrumentation, and William Zajc and Nicholas Samios on nuclear and particle physics. A celebratory reception followed the talks.

OUTREACH

Lillestøl receives award for excellent communication

Norway rewards experimental particle physicist Egil Lillestøl for his efforts in public outreach. (Courtesy Arne Langleite.)

The Research Council of Norway has honoured Egil Lillestøl from the University of Bergen with its Award for Excellence in Communication for 2007. Lillestøl received the award on 26 September at the Oslo Concert Hall as part of the Research Council's annual Evening of Excellence.

Lillestøl, an experimental particle physicist particularly well known at CERN, has made a great effort over many years in communicating physics to the general public through lectures, television programmes, newspaper articles and by hosting research schools and camps for young people. He is the current director of CERN's high-energy physics schools in Europe and Latin America (see p35). Norway is seeing among its young people a resurgent interest in the natural sciences, and the prize jury attributes some of the credit for this to Lillestøl, who has been an innovator in communicating the fundamental concepts of physics and natural science in his home country.

APPOINTMENT

Persis Drell takes the helm at SLAC

Persis Drell has stepped in as acting director of SLAC while the search for Jonathan Dorfan's successor continues. The president of Stanford University, John Hennessy, appointed her to the position, which took effect from 10 September. The international search for a director at SLAC is expected to be completed by the end of the year.

Dorfan announced in March his intention to step down this autumn as SLAC's director after eight years (*CERN Courier* May 2007 p37). He has relocated to the university's main campus and become an assistant to the president. In this role, he will focus on the relationship between Stanford University and SLAC, including the renewal of the SLAC site's lease to the US Department of Energy (DoE) and Stanford's contract to continue overseeing SLAC on behalf of the DoE.

The university's operating contract with the DoE for SLAC was due to expire on 30 September, but the DoE has indicated that it will grant Stanford a two-year extension. The lease agreement between Stanford and the DoE for the SLAC site is not due to expire until 2012.

Persis Drell takes over at SLAC until a permanent director is found. (Courtesy SLAC)

INTERNET

Website tells of US role in LHC project

To see the new site, visit www.uslhc.us.

The US Department of Energy's Office of Science has launched a new website to tell the story of the role of the US in the LHC project. The aim is to provide a one-stop site for anyone seeking information about the US and the LHC. Updated daily, it features news and information about the LHC, along with high-resolution images, scientists' blogs, resources for students and educators, and contact information for the media. The US has a leading role in the design and construction of both the LHC accelerator and the experiments, with over 1300 scientists from more than 90 US institutions participating in the project.

OBITUARIES

Helmut Faissner 1928–2007

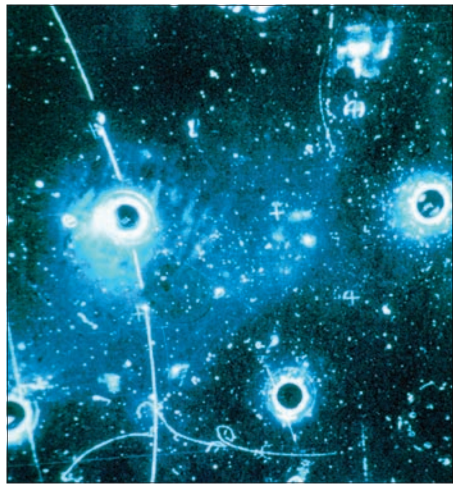
Helmut Faissner, one of the pioneers of neutrino experiments at CERN, died on 3 August 2007 aged 79.

Faissner was born in Kempten in southern Germany and studied physics at the University of Heidelberg. He passed his Diploma of Physics examination in February 1952 and obtained a PhD in October the same year. His thesis on the anomalous dispersion of the lines of yellow-green bromium vapour was under Walter Bothe, and his theory teacher was Hans Jensen. This led to a position as assistant at the Max Planck Institute near Heidelberg under the direction of Bothe.

Faissner gained a position as research associate at CERN in June 1958 and joined a team studying the capture of negative pions in carbon-12. He spent most of his time finishing off studies he had begun earlier, mainly on the spallation of heavy nuclei by 600 MeV protons. He became a staff member at CERN in June 1959, and the following spring joined a group of physicists who were investigating the experimental possibilities of detecting high-energy neutrinos, under the direction of Gilberto Bernardini. In addition, Faissner was given the task of setting up a neutrino-counter group.

The first neutrino experiment at CERN operated from 1963 to 1964 in an external proton beam. It used magnetic focusing on the produced pions, and had spark chambers and a heavy-liquid bubble chamber as detectors. The results that Faissner obtained included the first evidence of an electron-neutrino (ν_e) and solid evidence beyond doubt of the muon-neutrino (ν_μ).

Helmut Faissner. (Courtesy D Rein/RWTH.)



The first weak neutral current found on the scanning tables in Faissner's group at RTWH Aachen in December 1972.

At the end of 1963, Faissner accepted a position as full professor at RTWH Aachen, and in the summer of 1964 he began lecturing on weak interactions, symmetries and other topics of elementary-particle physics. The same year, Murray Gell-Mann put forward the quark model of particles and Faissner soon began a search for quarks in cosmic air showers carrying a characteristic electric charge of 1/3 – but without success. He then joined the effort to study neutrino physics using the Gargamelle bubble chamber at CERN. This made the first observations of weak neutral currents by detecting elastic scattering events $\nu_\mu e \rightarrow \nu_\mu e$ and one event of $\bar{\nu}_\mu e \rightarrow \bar{\nu}_\mu e$. It was Faissner's student at Aachen, Franz-Josef Hasert, who recognized the first candidate $\nu e \rightarrow \nu e$ in December 1972. The statistics were later improved on by building an experiment with a massive spark chamber as detector. In 1980, Faissner was awarded the Max-Born prize jointly by the UK Institute of Physics and the German Physical Society for his contribution to the physics of high-energy neutrinos and to the discovery of the weak neutral current.

Faissner leaves behind his wife, Ursula, two sons and a daughter. He will be remembered as a kind person by all who worked with him and he will be missed sorely by all of his friends.

Klaus Winter, Gland.

Julius Wess 1934–2007

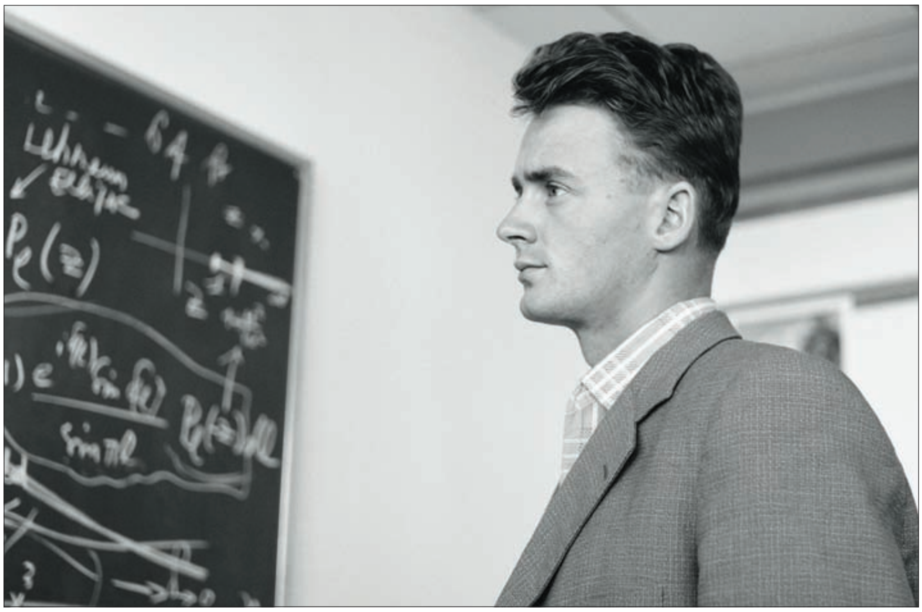
Julius Wess was an imaginative, technically strong and influential theoretical physicist. He died suddenly in Hamburg on 8 August at the age of 72.

Julius, an assistant to Walter Thirring in Vienna, went on to be a professor first at Karlsruhe University and then at the University of Munich, later becoming a director of the Max Planck Institute for Physics in Munich. He was an excellent and friendly teacher and taught many students who now have positions in universities and research institutes. He was also awarded several honorary doctorates, as well as physics prizes and medals.

Julius's scientific work was influenced strongly by the recognition that the dynamics of quantum field theories is dictated largely by symmetries. His first pioneering work was on the consequences of conformal invariance for quantum fields. He then studied the representations of SU(3) for the classification of hadrons. This work was done with Thirring two years before Murray Gell-Mann and Yuval Ne'eman, but not with the same representation as in the "eightfold way". Instead, it included only the Λ in the same representation as the nucleons; at that time it seemed too daring to include the other five particles as well, as their properties seemed to be unduly different. Working with Tom Fulton, Julius went on to formulate an SU(6) theory in an attempt to unify spin and isospin in agreement with special relativity.

Julius also worked in collaboration with Bruno Zumino on the mathematical structure of anomalies in non-Abelian gauge quantum field theory. This work showed that anomalies must satisfy a consistency condition and that they give rise to interaction terms (usually called Wess–Zumino terms) which have interesting topological properties. This pioneering work has had numerous ramifications for both physics and mathematics.

Julius also wrote a number of papers on supersymmetry (SUSY) and supergravity in collaboration with Zumino. This work shows that there exist 4D, local, relativistic quantum field theories that admit a symmetry between Bose and Fermi fields and that are renormalizable in the conventional sense. SUSY implies that these theories are more convergent (for instance, have no quadratic divergencies) than generic theories and require fewer renormalization constants. It is possible to formulate SUSY extensions of the Standard Model (SM) of particle physics that do not have the difficulties of the conventional SM. These extensions imply new particles and fields, which could be found at CERN's LHC, which is due to start up in 2008. Some of these theories predict particles (e.g. neutralinos) that are candidates for the dark matter of the universe.



Julius's path took him to many places around the world, and through his lovable, unassuming manner and his contagious zest for life, he rapidly made many friends. We shall all miss him greatly.

Walter Thirring and Bruno Zumino.

Leszek Łukaszuk 1938–2007

The Polish theoretician Leszek Łukaszuk died aged 69 on 12 July 2007.

Leszek was a bright young theoretical physicist from the Institute of Nuclear Physics in Hoza Street in Warsaw when he came to CERN in 1964 and worked with me. Together, we found, among other things, the constant in front of the Froissart bound, π/m_π^2. He later envisaged, with Basarab Nicolescu, the possibility of a dissymmetry between particle and antiparticle scattering, the so-called "odderon". Though this possibility seems rather far-fetched, it has never been ruled out from first principles and the Russian theoretician L N Lipatov has given arguments in favour of its existence.

Leszek was an active and courageous member of Solidarity, and, for that reason, he was exiled to Szczecin. When Solidarity triumphed, he left politics because he was disgusted by the way people were taking advantage of their being members (some very new) of the movement.

Leszek will be remembered as an excellent physicist and a very fine friend.

André Martin, CERN.

Igor Solovtsov 1952–2007

Friends and colleagues were saddened to learn that the well known theoretical physicist Igor Leonidovich Solovtsov died in Gomel, Belarus, on 28 July 2007. Aged 55, he suffered an unexpected heart attack.

Igor was born in Belarus, then part of the Soviet Union, on 9 January 1952. He graduated from secondary school in Gomel in 1970, and then went to Moscow State University where he studied particle physics and quantum field theory, graduating with honours. He became a trainee researcher at the Bogoliubov Laboratory of Theoretical Physics at the Joint Institute for Nuclear Research (JINR) in Dubna in 1976 and received his Candidate of Science degree (first doctoral degree) there in 1979 with a dissertation on Harmonic analysis of the Lorentz group in composite models of elementary particles.

After teaching for three years at Gomel Polytechnical Institute, he became head of the Mathematics Department there in 1981. He held this post until 1993, when he returned to the Bogoliubov Laboratory as a senior scientist and there defended his dissertation for Doctor of Science in 2000. A year later, he returned to Belarus (although he retained his affiliation with JINR) as head of the Department of Higher Mathematics at Gomel State Technical University. He also became head of the International Centre for Advanced Studies in Gomel, which was jointly established by Gomel State University and JINR.

Igor was a leading expert on QCD, devising clever approximation schemes for extracting phenomenologically relevant information from this rather intractable theory. For example, he popularized a technique in the mid-1990s called variational perturbation theory. It was this work that first brought him to my attention, and together we wrote a proposal to the US National Science

Foundation in 1996, which, together with generous support from the University of Oklahoma, allowed him and his wife to make extended visits to the US. It was during these visits that we applied analytic perturbation theory – a new idea developed by Igor and Dimitri Shirkov in 1997 – to study many inclusive processes in QCD. This work still has an impact.

It was during a theoretical conference in Gomel, after he had given a review talk on 10 years of development of this subject, that Igor fell ill and died. He leaves behind his fellow-physicist wife, Olga, and two sons, Alexander and Dmitry.

Igor was a wonderful family man, a brilliant scientist and a true friend. His loss is tremendous for theoretical physics, as well as for all those who wish to make progress in understanding how the Standard Model really describes nature. I am sure that his wife Olga Solovtsova will be able to carry on their joint work.

Kimball A Milton, University of Oklahoma.

NEW PRODUCTS

Oerlikon Leybold Vacuum has introduced the new LEYCON Valve Program with improved flexibility. LEYCON Valves are available as ISO-KF angle and straight-through valves. All types are bellows-sealed and available in two materials for housing, in either aluminium or stainless steel. There is the choice of hand or pneumatic operation, as well as electro-pneumatical or electro-magnetical actuation. For further information see www.oerlikon.com.

SEDI Fibres Optiques now offers comprehensive solutions for fibre-optic hermetic feed throughs. These are associated with connectors: FC for single-mode or graded-index fibres; SMA for large-core fibres from 140 μm to 1000 μm; ST connectors for all types of silica fibres from 140 μm to 1000 μm; and FC/APC for single-mode fibres. For further information, tel +33 169 366 400; e-mail info@sedi-fibres.com or see www.sedi-fibres.com.

Hamamatsu Photonics has introduced new high-sensitivity photomultipliers. The super bialkali (SBA) tubes offer 35% quantum efficiency (QE) and the ultra bialkali tubes have up to 45% QE. This QE is close to that of many semiconductor sensors. For further information, tel +44 170 729 4888; e-mail Europe@hamamatsu.com or see www.sales.hamamatsu.com.

Agilent Technologies Inc has introduced the first time-to-digital converter from its Acqiris product line. The TC890 records multiple events or hits on each of its six input channels, with a timing-resolution of 50 ps and a double pulse resolution of less than 15 ns. At full speed, it offers a data throughput of 25 million events/s. Six of the seven identical input channels are independent stop inputs, and the seventh is the common start. For more information see www.agilent.com/find/acqiris.

Metrum Information Storage offers a new cost-effective portable thermal-imaging camera. The Thermo Tracer TH9260 is hand-held and features a 1.3 megapixel digital camera. Multi-point measurement can be made over the 640 × 480 array of pixels using a comprehensive set of dynamic analysis tools over a wide range of temperatures from −40 to +500 °C standard, or 100–2000 °C. Contact Scott Foster, tel +44 118 973 3000; or e-mail thermography@metrum.co.uk.

Pfeiffer Vacuum has expanded its series of DigiLine vacuum instruments with the new MPT 100 transmitter. The combination of a Pirani and a cold cathode sensor is compatible with existing controllers and accessories, giving a measurement range from 5×10^{-9} to 1000 mbar and insensitivity to gas inrush. The MPT 100 can easily be combined with Pfeiffer Vacuum backing-pumps, turbopumps or leak detectors via the RS-485 interface. For further information, see www.pfeiffer-vacuum.net.

ETL has launched a new, portable high-accuracy barometric-pressure measuring unit. The 765–16B gives barometric-pressure readings of ± 0.08 hPa with a resolution of 0.0001%. An internal logger can automatically store more than 390 000 high-resolution data points. For further information, contact Derek Nobe, tel +44 178 447 2130; or e-mail sales@explorocean.com.

New technology developed jointly between **Southern Scientific** and the **UK National Physical Laboratory** has been incorporated into a compact electrometer module board to measure very small currents with extremely high precision and repeatability. The PAM pico-ammeter is an auto-ranging, microprocessor-controlled, single-board, low-current measurement instrument. It measures currents from 10 fA to 200 nA with a typical accuracy of ±1%, a stability of <50 fA and linearity of ±1%. For more information contact Yvonne Turner at Southern Scientific, tel +44 190 360 4000; e-mail info@ssl.gb.com or see www.ssl.gb.com.

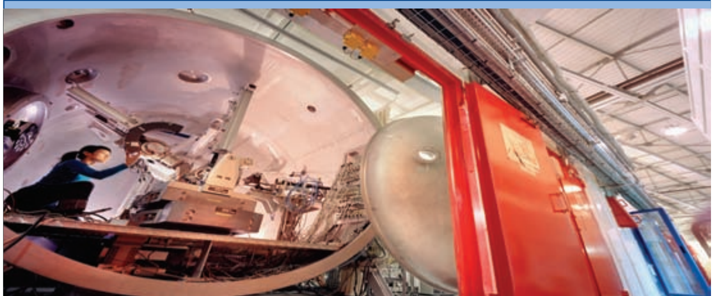
RECRUITMENT

For advertising enquiries, contact *CERN Courier* recruitment/classified, IOP Publishing, Dirac House, Temple Back, Bristol BS1 6BE, UK.
Tel +44 (0)117 930 1264 Fax +44 (0)117 930 1178 E-mail sales@cerncourier.com
Please contact us for more information for advertising options, publication dates and deadlines.

ESRF

European Sychrotron Radiation Facility

We Highlight Science



Physics and Chemistry, Life Sciences and Medicine, Earth and Environmental Sciences, Surface and Materials Sciences.

The European Synchrotron Radiation Facility (ESRF) is Europe's most powerful light source. The ESRF offers you an exciting opportunity to work with international teams using synchrotron light in Grenoble, in the heart of the French Alps.

Have a look at our vacancies at
www.esrf.eu/jobs
Contact us at recruitment@esrf.eu

Scientists - Post doctoral fellows - PhDstudents - Engineers - Technicians - Administrative staff

European Synchrotron Radiation Facility
ESRF, BP 220, F-38043 Grenoble Cedex 9, FRANCE,
Tel.+33 476 88 20 00 www.esrf.eu

INDIANA UNIVERSITY

Junior Faculty Position in Theoretical Physics

The Department of Physics at Indiana University invites applications for a tenure-track Assistant Professor position in Theoretical High Energy and/or Theoretical Nuclear Physics for an anticipated appointment beginning Fall 2008. We are seeking highly qualified candidates who will complement or expand upon current research activities of the High Energy Theory and/or Nuclear Theory group focused particularly on any aspect of sub-nuclear physics, astro-particle physics or nuclear astrophysics. The current research directions include nuclear and astro-particle physics, beyond standard model phenomenology, tests of Lorentz and CPT symmetry, lattice QCD and hadron phenomenology and nuclear structure.

Applicants should have a Ph.D., an outstanding research record and commitment to excellence in teaching at both undergraduate and graduate level. The Indiana University Physics Department currently has 37 faculty carrying out research in Accelerator Physics, Experimental Nuclear and High Energy Physics, Condensed Matter and Material Science, and Biophysics.

Applications should be submitted via email to **physsrch@indiana.edu** or by mail to:

Theoretical Physics Search, Physics Department,
Indiana University, Bloomington, IN 47405

Interested applicants should submit a letter of application and curriculum vitae with list of publications, a description of research interests, and arrange for submission of a minimum of three letters of reference. Review of applications will begin on January 15, 2008 and will continue until the position is filled. Further information about the IU physics department can be found at http://www.physics.indiana.edu.

Indiana University is an Affirmative Action, Equal Opportunity Employer committed to excellence through diversity. The University actively encourages applications of women, minorities, and persons with disabilities.

LEDERMAN FELLOWSHIP

EXPERIMENTAL PARTICLE OR ACCELERATOR PHYSICS

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

Candidates should have obtained a Ph.D. in experimental particle or accelerator physics after November 15, 2006. The appointment is normally for three years with a possible extension.

To apply write to: Dr. Vaia Papadimitriou (Chair of Lederman Fellowship Committee), Fermi National Accelerator Laboratory, MS 306, P.O.Box 500, Batavia, IL 60510-0500 or vaia@fnal.gov. Applicants should send a cover letter detailing prior research and noting any experience or interest in teaching/outreach, curriculum vitae, publication list and the names of at least four references. Applications will be accepted through January 4, 2008.

Fermilab

Fermilab is an Equal Opportunity Employer - M/F/D/V

HadronPhysics I3
Study of Strongly Interacting Matter

HadronPhysics I3
Study of Strongly Interacting Matter

European Commission

Transnational Access to Research Infrastructures

The Integrated Initiative "HadronPhysics I3", financed by the European Commission and coordinated by the Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Frascati, Italy, combines in a single contract several activities, Networking, Research Projects and Transnational Access. The Transnational Access activity involves 9 infrastructures (INFN-LNF, DESY-HERMES, FZJ-COSY, FZJ-NIC/ZAM, GSI-SIS, U. MAINZ-MAMI, ZIB, LU-MAXLAB, UU-TSL). Its objective is to offer the opportunity for European research teams, performing or planning a research project at these infrastructures, to

APPLY FOR EC FUNDED ACCESS

including the support for travel and subsistence expenses.

The only eligible teams (made of one or more researchers) are those that conduct their research activity in the EU Member States or in the Associated States.

Information about the modalities of application and the **Calls for Proposals** can be obtained by visiting the HadronPhysics I3 web site http://hadronphysics.infn.it/

Scientist Positions within the Advanced Study Group of the Max Planck Society at the Centre of Free Electron Laser Science in Hamburg

MAX-PLANCK-GESELLSCHAFT

The "Advanced Study Group" (ASG) funded by the Max Planck Society (MPG) is part of the "Centre for Free Electron Laser Science" (CFEL) presently being established in Hamburg (http://hasylab.desy.de/science/cfel/index_eng.html). The ASG shall support research activities of groups within the Max-Planck-Society at 4th generation Free Electron Laser (FEL) light sources such as FLASH in Hamburg and LCLS in Stanford.

Applications are invited for **two scientist positions**, located at DESY, to establish in Hamburg a fast-laser and pulsed x-ray laboratory for the preparation of MPG-FEL experiments, to operate and maintain single-photon counting x-ray pixel CCDs developed from the Max-Planck semiconductor laboratory. They are supported by two further scientists, two technicians and students. Specifically, we are looking for researchers experienced in

(1) time-resolved diffraction methods. The successful candidate should have a strong background in physics, chemistry or biophysics or crystallography. Experience in diffraction experiments at FEL, SPPS or synchrotrons sources, or, alternatively, in ultra-fast x-ray science based on table top pulsed x-ray sources, are of advantage

(2) x-ray spectroscopy and coherent scattering. The successful candidate should have a strong background in x-ray spectroscopy, operation of monochromators at FELs or synchrotrons and x-ray detection. Experience with CCD devises with FEL, SPPS or ESRF experiments and in coherent scattering are of advantage. This position is understood as a link between instrument developers and beamline scientists.

We expect the successful candidates to interact collaboratively among a variety of disciplines. Apart from supporting experiments actively pursued within the ASG, independent research is encouraged.

Remunerations are according to TVöD (German civil service scale). The initial appointment will be for three years, with the possibility for a two-year extension. It is intended to have a long term perspective, given excellent performance and the continuation of funding by MPG within the CFEL.

As an equal opportunity employer, the Max Planck Society seeks to increase the percentage of female employees in areas where they are under-represented. Qualified women are therefore strongly encouraged to apply. The Max Planck Society is also committed to employing more individuals with disabilities. We therefore actively encourage individuals with disabilities to apply.

To apply, please send your CV including a brief description of your research / scientific interests, a list of publications, a copy of the most relevant publication, and names and email addresses of two referees either as email attachments or hard copy to:

Prof. Dr. Joachim Ullrich
Max-Planck-Institut für Kernphysik
Saupfercheckweg 1
D-69117 Heidelberg
joachim.ullrich@mpi-hd.mpg.de

Informal enquiries may be sent to Dr. Simone Techert (Simone.Techert@mpi-bpc.mpg.de) and Dr. Lothar Strüder (lts@hll.mpg.de) for position 1 and 2, respectively.

Deadline for applications is Dec 1st 2007, desired starting date as soon as possible.

Entrepreneurship for Physicists and Engineers from Developing Countries

Workshop Programme, 17 March – 21 March 2008

Abdus Salam International Centre for Theoretical Physics, Trieste, Italy

This one week residential workshop on **'Entrepreneurship for Physicists and Engineers from Developing Countries'** is designed for physicists in developing countries who would like to learn entrepreneurial/commercialisation skills. The development of entrepreneurial skills and attitudes now form a vital part of the education programme. The aim of the workshop is to foster the culture of enterprise that will help physicists in their careers help them make positive contribution to the economy of their countries.

Vital aspects of the workshop include: how to spot opportunities, identification of market need, how to protect intellectual property, need for confidentiality, patenting, how to bring developments to market, licensing, raising capital, funding, venture capitalist route, legal issues, incubation, etc. This workshop will also provide delegates an opportunity to engage with successful role models who are expert in their field and to discuss real life issues, barriers and challenges. A number of case studies will be discussed providing an excellent opportunity to understand the issues involved and to identify the best practice from the example. Various transferable skills like negotiation, interpersonal and communication can be learned from the group activities and networking.

The workshop is organized by the International Union of Pure and Applied Physics, the Abdus Salam International Centre for Theoretical Physics, the Institute of Physics and the European Physical Society.

Grant Application & Registration

Grant Application Deadline: 15 December 2007

Grants are available to delegates from developing countries to cover the subsistence cost and travel expenses.

The application form may be downloaded from

http://www.ictp.it/~smr1996

and should be sent to Ms. Suzie Radosic (see below for full details) and should include:

a) name, address, and other contact details (email, telephone, fax);
b) a brief summary of qualifications and career to date;
c) a short statement (up to 250 words) describing why the workshop will be useful to you;
d) a letter of support from a referee;
e) amount required to cover travel expenses.

Applicable only to candidates who are nationals of, and working in, a developing country, and who are not more than 45 years old.

DUE TO VERY LIMITED FUNDS, PRIORITY WILL BE GIVEN TO CANDIDATES COVERING 50% OF THEIR OWN TRAVEL EXPENSES.

Please return your application by mail, fax or email latest by **15 December 2007.**
NOTE: Successful applicants will be notified within one month of the closing date. Due to the number of applications received we are unable to notify unsuccessful candidates. If you have not heard from us within one month of the closing date, you may assume that your application has been unsuccessful. All the selected delegates will be informed by end of January 2008.

Applications should be submitted to:
Entrepreneurship for Physicists and Engineers from Developing Countries (smr1996)
(c/o Ms. Suzie Radosic), The Abdus Salam International Centre for Theoretical Physics,
Strada Costiera 11, 34014 Trieste, Italy, Tel: 39 040 2240226, Fax: +39 040 22407226,
Email: smr1996@ictp.it Web page: http://www.ictp.it/~smr1996

APS physics — IOP Institute of Physics — The Royal Academy of Engineering — AREA Science Park knowledge is a network — ICTP — IUPAP

Science & Technology
Facilities Council

The Science and Technology Facilities Council will bring strategic leadership and an integrated approach to UK investments in large national and international research facilities, whilst continuing to deliver world-class science, technology and people for the UK. The Council is involved in some of the world's most exciting research projects – like the Diamond Light Source Synchrotron and the Large Hadron Collider – and will develop new areas of science and technology – with your help.

GRIDPP Storage Support (FBU141)

(Fixed Term, till March 2011)

£24,638 to £27,998 per annum

A post is available at the Science & Technology Facilities to support the grid access to mass storage systems in GridPP, the UK Grid for particle physics.

You will be joining the GridPP storage support team to work with storage experts within the UK and in the rest of the global Large Hadron Collider computing grid. You must have Unix or Linux system administration experience, as well as programming experience in script and C/C++, and experience with software testing, packaging, and deployment.

As you will be working with scientific communities, you should have a higher degree or equivalent in a natural science. Since many standards are emerging, experience with research and publications is also desirable.

For further information and how to apply: please visit www.scitech.ac.uk, telephone 01235 446677 or e-mail recruitment-FBU@rl.ac.uk quoting reference number FBU141. For further information about the post please refer to the STFC vacancies web site, or contact Dr J Jensen on j.jensen@rl.ac.uk

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

Closing date for applications is 9 November 2007.

Interviews to be held end of November 2007.

NO AGENCIES

www.scitech.ac.uk

VISIT RUTGERS | MAP & DIRECTIONS | EVENTS | SEARCH RUTGERS

RUTGERS
THE STATE UNIVERSITY OF NEW JERSEY

Faculty Positions in Experimental High Energy Physics and High Energy Theory

The Department of Physics and Astronomy at Rutgers (New Brunswick, NJ) invites applications for two tenure-track/tenured faculty positions, in experimental and theoretical particle physics. All ranks (assistant/associate/full professor) will be considered for the experimental position. The theoretical position will be at the assistant professor level.

The department has a strong program in High Energy Physics. Both the theory and experimental groups are involved in hadron collider physics, as well as particle astrophysics. The theory and experimental groups have a tradition of working closely.

The experimental group participates in the CDF and CMS experiments at Fermilab and CERN, respectively, and the HiRes experiment in astroparticle physics. The particle theory effort involves both the high energy theory group and the New High Energy Theory Center.Both positions aim to enhance Rutgers involvement in LHC physics.

Applicants should be committed to excellence in undergraduate and graduate education. Please send a curriculum vitae, a signed cover letter that includes a statement of accomplishments and interests, and the names of at least three but no more than five referees to the address below by December 15, 2007. Do not ask the referees to send letters at this time; any such requests will be made directly by Rutgers.

Prof. Torgny Gustafsson, Chair
Department of Physics and Astronomy
Rutgers University
136 Frelinghuysen Road
Piscataway, NJ 08854-8019, USA

In addition to the hard copy, applicants are requested to transmit an electronic version (PDF file) of the submitted application.Experimental Particle Physics: email to Amitabh Lath, lath@physics.rutgers.edu Particle Theory: email to Matt Strassler, strassler@physics.rutgers.edu

Rutgers University is the State University of New Jersey. Its New Brunswick campus is located in central New Jersey which is known for its cosmopolitan culture and diversity. The New Brunswick area offers excellent access to New York City, the New York metro area and the Boston - New York - Philadelphia - Baltimore - Washington D.C.metro corridor.

Rutgers University is an equal opportunity/affirmative action employer.

POSTDOCTORAL POSITIONS IN EXPERIMENTAL PHYSICS WITH GLAST AT SLAC

SLAC invites applications for Postdoctoral Researchers to work with the GLAST Large Area Telescope (LAT) team. SLAC hosts the LAT Instrument Science Operations Center (ISOC) and is responsible for configuration, calibration, and initial data processing. Research at SLAC focuses on search for dark matter, cosmic particle interaction and acceleration mechanisms, and relativistic outflows. For details see **http://glast.stanford.edu and http://glast-isoc.slac.stanford.edu/.**

Appointees will conduct research with GLAST and related multi-wavelength data, and play significant roles in instrument operation and performance analysis in collaboration with ISOC. Ph.D. in Physics or Astrophysics is required. The tenure is two years, with the potential renewals subject to satisfactory performance. Applicants should send a letter stating research interests, a CV, and three reference letters to raadmin@slac.stanford.edu by emails (preferred) or by postal mail to **SLAC, MS 60, 2575 Sand Hill Road, Menlo Park, CA 94025** no later than December 1, 2007.

SLAC is an equal opportunity employer committed to increasing the diversity of its staff and welcomes applications from women and minority groups.

INDIANA UNIVERSITY

Director of the Indiana University Cyclotron Facility

Applications are invited for the directorship of the Indiana University Cyclotron Facility (IUCF). The IUCF has a diverse mission of mutli-disciplinary research, service and education and also provides technical support and beam to the Midwest Proton Radiotherapoy Institute (MPRI), one of only five such facilities in the United States.

We seek a scientist or science manager with a distinguished record of accomplishment who will provide the vision, leadership and entrepreneurial spirit needed to sustain and further IUCF's outstanding scientific research efforts, and will support the partnership with MPRI in the development of new radiotherapy treatments, technologies and applications.

IUCF conducts research in a variety of areas, including accelerator physics, condensed matter physics, medical physics, nuclear physics, nuclear chemistry, radiation effects on materials and radiation biology. The facility collaborates closely with the nationally ranked nuclear physics program at Indiana University Bloomington, which is currently developing detectors for use at national facilities to study high-energy spin physics, fundamental neutron physics, and neutrino oscillations. The facility is also developing novel neutron scattering instrumentation for the Low-Energy Neutron Source at IUCF, which recently began operation.

The director will serve a five-year term starting in the summer of 2008 and will receive a tenured professorship in the College of Arts and Sciences. Salary will be commensurate with experience and qualifications. Nominations are welcome. Applications with a complete resume, including the names of four references, should be sent as soon as possible to:

Professor Alex Dzierba
Chairperson, Search and Screen Committee
Office of the Vice Provost for Research
Indiana University
Franklin Hall 116-Y
Bloomington, IN 47405-1223
Or email applications to: DLTAYLOR@indiana.edu

Indiana University is an Affirmative Action/Equal Opportunity Employer, and encourages applications from women and minority candidates.

The University of Virginia

Tenure-Track Faculty Position in Experimental High Energy Physics

The Department of Physics of the University of Virginia invites applications for an Assistant Professor tenure-track faculty position in experimental high energy physics starting in Fall semester 2008. Applicants must hold a doctorate in physics and be committed to teaching at both the graduate and undergraduate levels. Prior experience in experimental high energy physics is required. The University of Virginia experimental group has strong participation in the CMS experiment at the Large Hadron Collider and in the NOVA neutrino experiment at Fermilab. Candidates with interests in those experiments will receive special attention. Review of applications will begin on October 2, 2007; full consideration will be extended until December 31, 2007; however, the position remains open to applications until filled.

Interested candidates are to submit a curriculum vitae, a one page (minimum) or two page (maximum) summary of research and teaching interests at **https://jobs.virginia.edu/applicants/Central?quickFind=52261**. Three letters of reference are to be sent directly to phys-hep-exp-pos@virginia.edu (preferably), or to High Energy Physics Search Committee, Department of Physics, University of Virginia, 382 McCormick Road, P.O. Box 400714, Charlottesville, VA 22904-4714, USA

For information on our department, please visit our website at **http://www.physics.virginia.edu**.

The University of Virginia is an equal opportunity/affirmative action employer. Women and members of under-represented minorities are strongly encouraged to apply.

UNIVERSITY of VIRGINIA

Research Positions
LIGO Laboratory

California Institute of Technology (Caltech)
Massachusetts Institute of Technology (MIT)

The Laser Interferometer Gravitational-Wave Observatory (LIGO) has as its goal the development of gravitational wave astronomy. The LIGO Laboratory is managed by Caltech and MIT, and is sponsored by the National Science Foundation. It has built and now operates facilities equipped with laser interferometric detectors at Hanford, Washington and Livingston, Louisiana. The detectors have achieved design sensitivity and a data set spanning more than a year of coincidence operation has been collected. Analysis is ongoing, with extensive participation by the LIGO Scientific Collaboration (LSC). Further observation will be interleaved with incremental improvement of the instruments over the coming years, with a major upgrade (Advanced LIGO) in preparation. In addition, a vigorous R&D program supports the development of enhancements to the detectors as well as future capabilities.

The LIGO Laboratory expects to have positions at Caltech, MIT and at the two observatory sites. Scientists will be involved in the operation of LIGO itself, analysis of data, both for diagnostic purposes and astrophysics searches, as well as the R&D program for future detector improvements. Expertise related to astrophysics, modeling, data analysis, electronics, laser optics, vibration isolation and control systems is useful. Most importantly, candidates should be broadly trained physicists, willing to learn new experimental and analytical techniques, and ready to share in the excitement of building, operating and observing with a gravitational-wave observatory. In general, appointments will be at the post-doctoral level with one-year initial appointments with the possibility of renewal for up to two subsequent years. In some cases, appointments with an initial term of three years or of an indefinite term may be considered. Appointment is contingent upon completion of all requirements for a Ph.D.

Applications for positions at any LIGO Laboratory site (Caltech, MIT, Hanford, or Livingston) should be sent to HR@ligo.caltech.edu (Electronic Portable Document Format (PDF) submittals are preferred). OR mailed to either:

Dr. Jay Marx, c/o Cindy Akutagawa
Caltech
1200 E. California Blvd
LIGO 18-34
Pasadena, CA 91125

OR

Dr. David Shoemaker
MIT
185 Albany St
LIGO NW22-295
Cambridge, MA 02139

Applications should include curriculum vitae, list of publications and the names, addresses, email addresses and telephone numbers of three or more references. Applicants should request that three or more letters of recommendations be sent directly to HR@ligo.caltech.edu (Electronic Portable Document Format (PDF) submittals are preferred) or mailed to Dr. Marx or Dr. Shoemaker. Consideration of applications will begin December 1, 2007 and will continue until all positions have been filled.

Caltech and MIT are Affirmative Action/Equal Opportunity Employers
Women, Minorities, Veterans and Disabled Persons are encouraged to apply

More information about LIGO available at www.ligo.caltech.edu

INDEX TO ADVERTISERS

Experimental Particle Astrophysics, Fermilab
Postdoctoral Research Associate

The Center for Particle Astrophysics at Fermilab invites applicants for postdoctoral research associate positions, to conduct experimental research in particle astrophysics in collaboration with one of the experimental groups associated with the Center. The groups currently consist of the Pierre Auger Observatory, the Sloan Digital Sky Survey (SDSS), the Cold Dark Matter Search (CDMS), the COUPP experiment, the Dark Energy Survey (DES), and the Supernova Acceleration Probe (SNAP).

These experiments cover a wide range of topics in the forefront of experimental astrophysics, and deploy instruments from South America to northern Minnesota to Earth orbit. They promise exciting opportunities in instrumentation and analysis for a young researcher, with graduate work completed in either particle astrophysics or particle physics. The laboratory maintains a vibrant research environment for its scientific staff, including colloquia, seminars, and travel support. The Center for Particle Astrophysics at Fermilab provides a venue for experimental and theoretical particle astrophysicists to work on forefront research problems in a setting encouraging interaction and collaboration.

Appointments are normally for three years with one-year renewals possible thereafter. Every effort will be made to maintain support for a Fermilab RA until he/she has the opportunity to produce physics results. Applications and requests for information should be directed to Dr.Wyatt Merritt, Chair, PACF Postdoc Committee via PACF_postdoc_apps@fnal.gov. Applications should include a curriculum vitae, publication list, research statement, and three letters of reference.

Fermilab

Fermilab is an Equal Opportunity Employer - M/F/D/V

BOOKSHELF

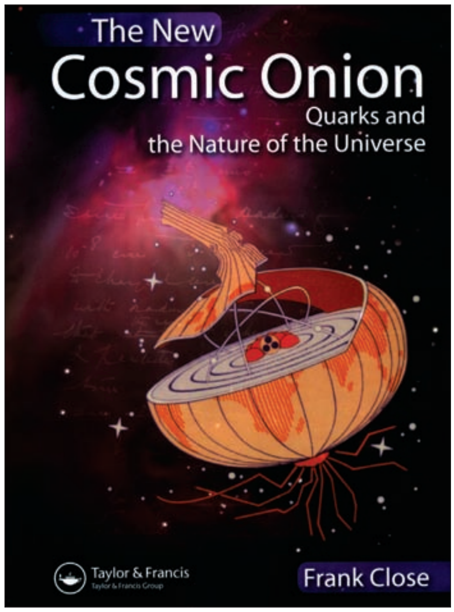
The New Cosmic Onion: Quarks and the Nature of the Universe by Frank Close, Taylor & Francis. Paperback ISBN 9781584887980 £22.99 ($39.95).

Back in 1983, the world of particle physics was very different: LEP was under construction and the LHC was just a dream for a few people; the top quark had not been discovered; the amount of dark matter in the universe was not known; and dark energy was not even imagined. However, high-school physics was much the same as it is now, with most lessons focusing on the basics and rarely touching on "modern" state-of-the-art science. "Popular science" books were not in abundance, so it came as a breath of fresh air when the first edition of *The Cosmic Onion* was published. According to Close, the original "inspired a generation of students to take up science". A grand claim indeed, but not without substance – the author of this review is living proof.

Like the original version, the revised one takes the reader through the most important periods in particle physics, from the discoveries of atoms and nuclei to our most up-to-date theories, including the Higgs mechanism, supersymmetry and grand unified theories. Close tackles some difficult topics along the way, such as QCD and the electroweak force, yet manages to convey their intricacies in a clear and concise manner. This is helped by the fact that each chapter contains a number of self-contained boxes that explain the more advanced concepts. The book finishes with a chapter devoted to the relationship between particle physics, cosmology and the Big Bang – a fitting end, or should that be start?

I found the chapter on the LEP era particularly good. Although it is relatively short, it provides a good summary of the most important findings of the previous "big accelerator" at CERN. It includes hints of new physics that should become clearer once the LHC is operating. Much of the book can be seen as explaining why we are building the LHC, and this should appeal to high school students interested in a career in particle physics – some of whom may end up analysing LHC data in years to come.

There are many differences in the content between the original and *The New Cosmic Onion*, bringing it up to date without changing the overall style. Close also manages to avoid delving into the realms of



fiction, sticking with the most likely theories and avoiding the more exotic ones. This does not make the book any less enjoyable – far from it. Even though the world has changed and the number of popular particle-physics books available has grown enormously, *The New Cosmic Onion* remains distinct and one of the few books that is enjoyable to read, plus it is a useful reference for physics students. Let's hope it will inspire another generation of particle physicists.
Dave Barney, CERN.

Soldier, Scientist, and Statesman: a Biography of Yuval Ne'eman by Andrew Watson. Ramot. Paperback ISBN 9652744263 $20.

The Israeli physicist Yuval Ne'eman passed away in 2006. This interesting biography was completed just before his death (*CERN Courier* July/August 2006 p38). Published by Tel Aviv University, Ne'eman's home university, it is based on interviews with Ne'eman and presents the story mainly – but not solely – through Ne'eman's eyes.

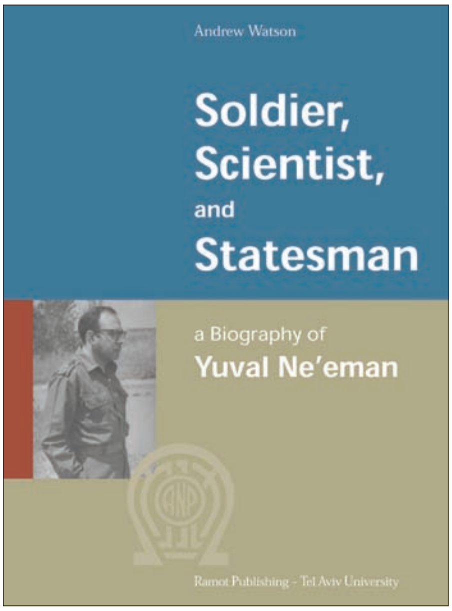
The title highlights Ne'eman's multidimensional personality. After finishing the book, the reader will not question the author's unusual need to end with not one, but two different versions of Ne'eman's résumé. The richness of his life presents a formidable challenge to any biographer. The book touches upon issues that are of interest to readers curious about physics and physicists, as well as to those who want to learn something about the movers and shakers of history. Ne'eman has indeed shaped, and was himself shaped by, the events that he lived through. He devoted his life mainly to strengthening the security of Israel, as he envisioned it, and to physics.

The biography is rich with unexpected and interesting stories. We learn that Ne'eman came from a well-to-do family. Who else in 1937 could afford to give the *Encyclopædia Britannica* as a Bar Mitzvah present? It also evokes a longing for a different period; one in which lessons at school and books suggested by teachers, one by Arthur Eddington in this case, significantly influenced the course chosen by a young child. Reading this book may well inspire a young pupil somewhere to consider doing great deeds.

We feel Ne'eman's strong sense of duty and his identification with his people. Although born in Tel Aviv, he spent a large part of his childhood in Port Said, Egypt, learning Arabic and French. We learn that at 15 he was too young to be accepted into the Technion. We learn about the texture of his underwear as well as about his joining the Haganah underground. We hear him saying: "I think Hezbollah attacking Israeli forces in Southern Lebanon is fair game." The book features strong, not often quoted words from a staunch advocate of his country.

We find out that a British physicist advised Ne'eman not to study general relativity as it was stagnant and too mathematical – advice he followed only because London's traffic made it much too complicated for him to reach King's College. He instead studied the rich spectrum of new particles produced by accelerators (may the future bring new particles upon us as well) at Imperial College under Abdus Salam. This was nearer to the Israeli embassy, where Ne'eman worked as military attaché buying things such as British submarines. We find out that the very same Imperial College felt that he could not get a PhD in physics for using algebraic methods to classify the hadrons, so awarding him a PhD in mathematics was deemed an appropriate solution (quantum mechanics was also once regarded in a similar fashion.)

Ne'eman always had an eye for new technologies. He introduced his student friends at Imperial to the photocopier, and the Israeli army to satellites. There are some words of wisdom, such as: "Somehow, we have learnt to compute the mass spectrum



of hadrons without really understanding its origins." This is something that great scientists often deplore until they are lucky enough to find something important enough to use the same method themselves. This is only a small sample of such gems.

The book chronicles the activities that spanned Ne'eman's life: study, army, science, army, science, politics and science – all outlayed on an array and not on a line. The author is at his best when he uses simple yet original and stimulating metaphors to describe rather complicated concepts in mathematical physics (such as fibre bundles and group representations) and physics. The non-specialist can learn a lot about modern particle physics thanks to the author's gentle guidance.

Watson brings to the surface interesting and infrequently discussed topics, not least of which is the issue of credit. This is something that scientists never seem to have enough of, something that is the most precious external reward that can be bestowed on the truth-seekers. (I always wonder at how those in our field who want to unify everything have very little patience for that noble idea once that their own credit is involved.) The author uncovers some of the feelings that Ne'eman had towards his not being awarded the Nobel prize for his role in discovering what Murray Gell-Man called the Eightfold way. He touches upon how Ne'eman felt towards Gell-Man and his anger at the Nobel committee personified by Ivar Waller: "He didn't even ask me what I had done and when I had done it. All he wanted to know was simply whether Salam was involved or not." While offering us a glimpse of Ne'eman's point of view, there is more to this human story than appears in the book.

Other interesting subjects are brought up, such as the price and rewards of multitasking. The attempts to function simultaneously as university president and an active scientist are dealt with in an illuminating fashion. Yet others are not as sufficiently followed up. For example, how did Ne'eman – his autodidactic history withstanding – succeed in making fundamental discoveries about nature and identify the quality of many ideas well before they became fashionable? How were the relations between the Israeli soldier Ne'eman and the Muslim Salam forged? I would have liked to learn more about the tension between the ultra-rational, nationalist Ne'eman and the humanist one. Also, the book does not discuss the tension between the ever-so-curious scientist who wants to know in detail about everything, but who supported the legal banning of meetings between PLO members and Israelis.

The history of the Arab–Israeli conflict and the destiny of the Jewish people is interwoven with Ne'eman's life. The book mentions this – readers are reminded that Egyptian forces invaded deep into Israel upon its creation, their troops reaching 30 km south of Tel Aviv and shelling Jerusalem from its southern outskirts. We also find out how Henry Kissinger learnt to manipulate Yitzhak Rabin. However, the general historical narrative is somewhat simplistic. There are few such insightful eyewitnesses to history as Ne'eman, but there are of course limits to the amount of information that can be packed into 150 pages. The burden that Ne'eman's career put on his wife and family's shoulders is well addressed. Many a spouse can believe that while devotedly attending for weeks the bed of his seriously ill wife, Devora, he finished writing a physics paper.

This biography is very interesting: it teaches with talent, it gives life (maybe even larger than life qualities) to Ne'eman's history and it leaves room for more in-depth studies of his most remarkable life.

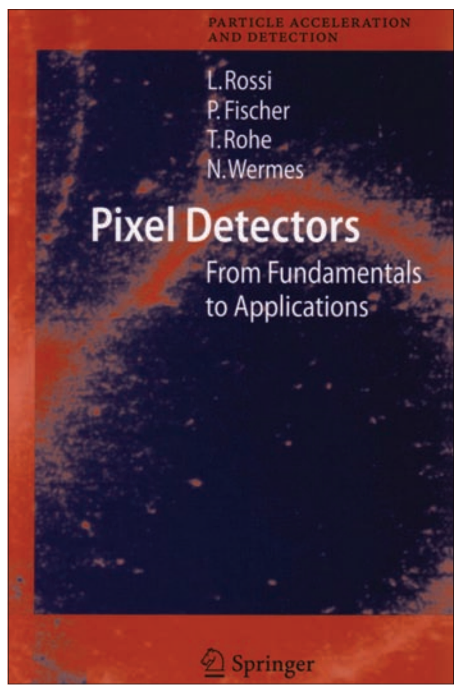
Eliezer Rabinovici, Racah Institute of Physics, Hebrew University, Jerusalem.

Matter Particled: Patterns, Structure and Dynamics (Selected Research Papers of Yuval Ne'eman) by Remo Ruffini and Yosef Verbin (eds), World Scientific. Hardback ISBN 9812567038 £78 ($135).

This unique volume contains a selection of more than 80 of Yuval Ne'eman's papers, which represent his great contribution to a large number of aspects of theoretical physics. The works span more than four decades, from unitary symmetry and quarks to questions of complexity in biological systems and evolution of scientific theories. In keeping with the major role Ne'eman has played in theoretical physics, a collaboration of distinguished scientists took part in this volume. Their commentary supplies a clear framework and background for appreciating Ne'eman's significant discoveries and pioneering contributions. Researchers in physics and mathematical physics, and scientists interested in history of physics and philosophy of science, will enjoy this book.

Pixel Detectors: From Fundamentals to Applications by L Rossi, P Fischer, T Rohe and N Wormes, Springer. Hardcover. ISBN 9783540283324 £77 (€105.45, $129).

Pixel Detectors explores the details of pixel detectors for high-energy physics, continuing where its sister volume *Semiconductor Radiation Detectors* by Gerhard Lutz left off. Here we find the



usual explanation of charge generation in semiconductor detectors, but also an excellent description of subsequent motion, the role of the weighting field and the resultant charge sharing in pixel devices.

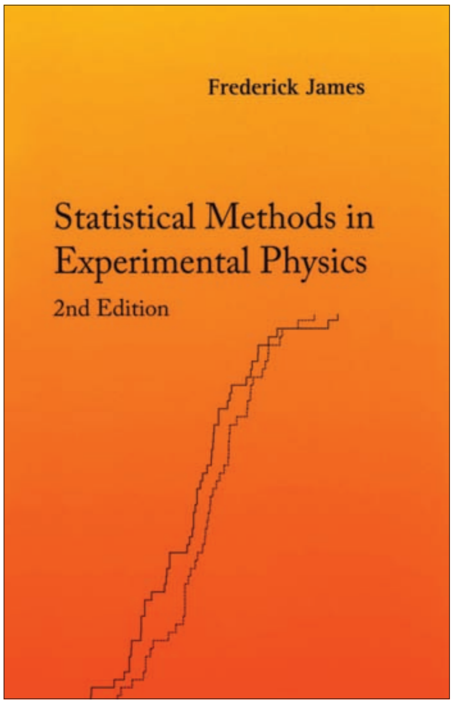
Beyond the theoretical explanations, which also extend to the origins of noise in readout electronics, the book leans heavily on practical applications in the ongoing projects for the LHC at CERN. There are many explanations of the effects of radiation damage throughout. In addition, the roles of system design and connection technologies get their own chapter, based on first-hand experience. The numerous graphs and diagrams perhaps betray this authenticity in their varied style and quality, but they always complement the textual explanations.

The book should be considered in the context of the *Particle Acceleration and Detection* series that it belongs to – as a consequence, the section on imaging for possible medical applications is brief and there is little mention of astrophysical applications. The final chapter covers new developments, possibly applicable to future experiments, including the use of novel materials such as diamond; new geometries including three-dimensional detectors; and electronic structures, such as the monolithic sensors.

On the whole, I found everything that I was looking for in this reference. It will become a "must have" textbook as it describes the fundamental sensor technologies used in pixel detectors for modern high-energy physics, as well as the reasons behind the choices in electronics and overall system design in experiments under construction.
Shaun Roe, CERN.

Statistical Methods in Experimental Physics (2nd edition) by Frederick James, World Scientific Publishing. Hardback ISBN 9789812567956 £33 ($58). Paperback ISBN 9789812705273 £17 ($30).

For challenging statistical data-analysis problems, a generation of high-energy physicists consulted the 1971 book, *Statistical Methods in Experimental Physics*, by W T Eadie, D Drijard, F E James, M Roos, and B Sadoulet. Library and desk copies remain the unique place to find explanations of numerous issues, as the book is now out of print. Despite more recent "statistics for physicists" books, a second edition was needed. Frederick James met the challenge and updated the text with fresh insights and developments, while resisting the temptation to expand its scope dramatically. Recently retired from a career as a high-energy physicist, James has been the local statistics "expert" at CERN for some four decades and is the author of MINUIT, the popular function minimization computer program for fits and error analysis.



The second edition retains the preference for statistical methods that are restricted to the definition of probability as a relative frequency ("classical" or "frequentist" statistics), and much of the theory is grounded in *The Advanced Theory of Statistics* by M G Kendall and A Stuart, and their successors. However, as with the first edition, the second also discusses the more general (Bayesian) definition of probability as subjective degree of belief, with important applications to decision theory.

The 345 pages divide into four classes of material: discursive explanations of concepts and methods in probability and statistics, often with personal notes; somewhat encyclopædic entries, such as the annotated list of probability density functions; derivations that are sometimes lengthy but that are used to emphasize assumptions, approximations and subtleties; and finally, many detailed practical examples. In this edition, the typesetting and indexing are very much improved.

The text is largely self-contained but requires a level of maturity from the reader that might only come from preparation via more accessible books; my favourite companion book is *Statistical Data Analysis* by Glen Cowan (*CERN Courier* December 1998 p31). I used the first edition as a desk reference, and, having read the second edition cover to cover, I wish I had done so with the first edition long ago. Such extensive reading generates many margin notes with exclamation marks, as subtle points are explained or mentioned. A simple example in probability theory, not as well known as it should be, is the distribution of the ratio of two normal variates (Gaussian random numbers): the ratio has undefined mean and infinite rms deviation. A more advanced example cropped up in a recent thesis defence, in which a student had used a plausible (but still questionable) approximation in performing a maximum-likelihood analysis using event weights. It was soon discovered that a thorough discussion of the validity of the approximation was in *Statistical Methods in Experimental Physics*.

James wisely chose not to expand greatly the range of topics. For example, absent are the machine learning techniques (neural nets, boosted decision trees, etc) that are used in multivariate analyses in high-energy physics. Dedicated books such as *The Elements of Statistical Learning* by T Hastie, R Tibshirani and J H Friedman are available for this area. The book is strongest in describing advanced uses of the likelihood function: classical uses in measurement, interval construction and hypothesis tests; and Bayesian uses, including when supplemented by a loss function in Bayesian decision theory. Users of either machine learning methods or "Bayes factors" should appreciate the links to the classical Neyman–Pearson lemma with likelihood ratios for hypothesis testing.

I highly recommend that this book be kept on every desk – for consultation when a question arises, for browsing when in the mood to learn something interesting, and for a straight read-though to get a grounding in the classical theory of statistics from an experimental physicist's perspective.
Robert D Cousins, UCLA.

Accelerator conferences go global

Christine Petit-Jean-Genaz, co-ordinator of the EPAC conferences, looks to the future of accelerator conferences in an increasingly global era.

The European Particle Accelerator Conference (EPAC) appeared on the accelerator conference scene in 1988 as a biennial conference. The aim was to alternate in even years with the North American Particle Accelerator Conference (PAC), which in odd years since the mid-1960s stood as the only conference catering to the needs of the world's accelerator scientists.

The inaugural EPAC took place in Rome and immediately became a victim of its own success, attracting double the number of anticipated participants. Some described the event as "controlled chaos", others labelled it "charmingly Latin". Many anecdotes marked the early and subsequent events, but the series has gone from strength to strength, attracting in excess of a thousand full-time participants at such exciting venues as Nice, Berlin, London, Barcelona, Stockholm, Vienna, Paris, Lucerne and Edinburgh. Each successive event vied to outshine the previous venues in organizational efficiency, interesting scientific programmes and the many cultural and scientific events taking place on the fringes of the conferences themselves.

In 1998, 10 years after EPAC began, the first Asian Particle Accelerator Conference (APAC) took place in Tsukuba, Japan, on a three-year cycle. While the conferences themselves resembled the European and North American versions, their style was inevitably cramped by the competition from EPAC and PAC. Travel budgets do not increase, and if there was a choice of conference, APAC often suffered.

While a move to a three-year cycle for PAC and EPAC was mooted in 1998, the topic remained somewhat on hold until 2005 when arguments for an international conference became more insistent. These included: reducing the ever-increasing number of conferences; streamlining events to make better use of resources; and giving Asia better visibility in accordance with its extensive and exciting accelerator activities.

EPAC '08 in Genoa will mark the end of 20 years of European PAC conferences.

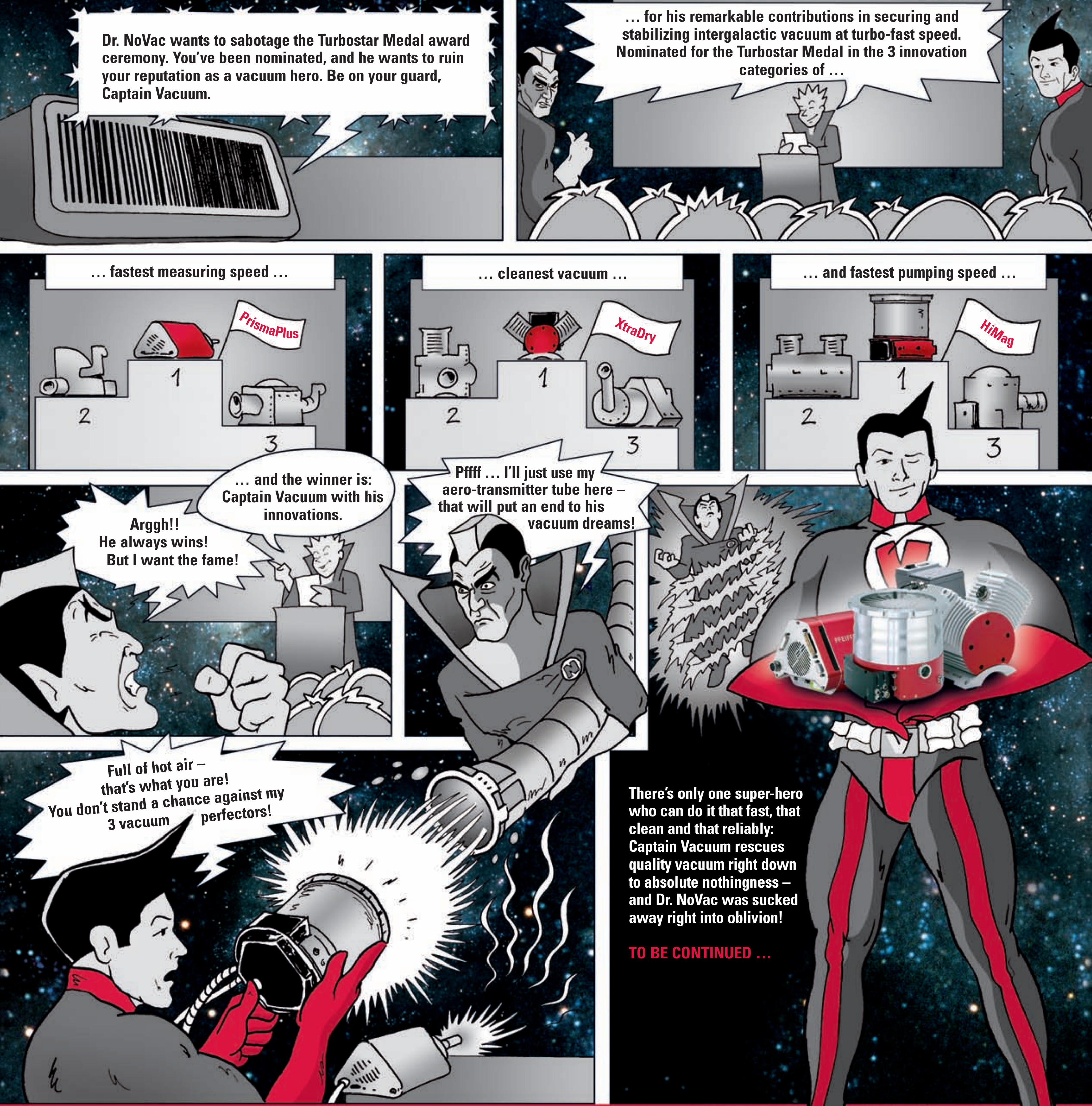
While EPAC's organizing committee, the European Physical Society Accelerator Group (EPS-AG), embraced the idea, a fair amount of soul-searching continued in North America until early this year. It was then that the American Physical Society Division of Physics of Beams (APS-DPB), an essential partner in the PAC organization, supported PAC's move to join EPAC and APAC in a three-year cycle, intermeshed with a smaller North American PAC in odd years. The PAC '07 organizing committee discussed the question at its meeting in Albuquerque two months later (see p29) and voted unanimously along the same lines.

While many issues must be discussed, understood and agreed upon between the future organizers of the international series, the first conferences are already scheduled for Kyoto, Japan, in 2010, followed by Valencia, Spain, in 2011 and a venue to be decided in North America in 2012.

The last conference in the EPAC series will take place in 2008 in Genoa, Italy – fittingly, the country of its birth. The conference poster is filled with significance – no prizes for recognizing Christopher Columbus and Marco Polo. EPAC has thus come full circle in its 20 years. During this period, the world has grown smaller, international travel has become cheaper, and accelerator projects have become increasingly diversified and global, with collaborators from around the world meeting more frequently.

The time is ripe for the three regional accelerator conferences to merge into one event. Exciting times undoubtedly lie ahead in facing the challenge of making the future conferences as successful as the former regional events. We wish our Asian colleagues much success in the organization of the first in the new series.

Christine Petit-Jean-Genaz, EPAC conference co-ordinator, CERN.


Dr. NoVac wants to sabotage the Turbostar Medal award ceremony. You've been nominated, and he wants to ruin your reputation as a vacuum hero. Be on your guard, Captain Vacuum.
… for his remarkable contributions in securing and stabilizing intergalactic vacuum at turbo-fast speed. Nominated for the Turbostar Medal in the 3 innovation categories of …
… fastest measuring speed …
PrismaPlus
… cleanest vacuum …
XtraDry
… and fastest pumping speed …
HiMag
Arggh!! He always wins! But I want the fame!
… and the winner is: Captain Vacuum with his innovations.
Pffff … I'll just use my aero-transmitter tube here – that will put an end to his vacuum dreams!
Full of hot air – that's what you are! You don't stand a chance against my 3 vacuum perfectors!
There's only one super-hero who can do it that fast, that clean and that reliably: Captain Vacuum rescues quality vacuum right down to absolute nothingness – and Dr. NoVac was sucked away right into oblivion!
TO BE CONTINUED …