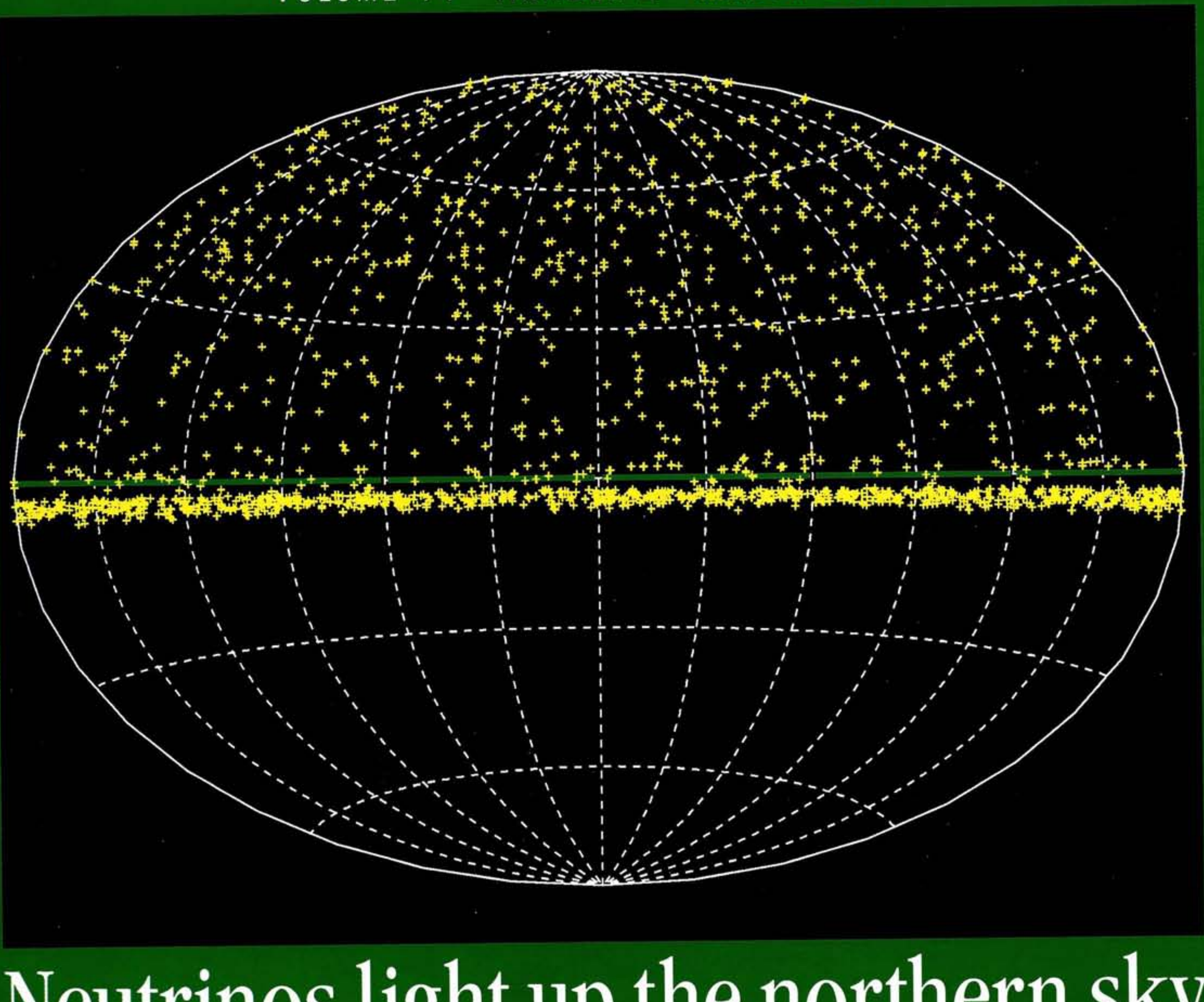
INTERNATIONAL JOURNAL OF HIGH-ENERGY PHYSICS

CERN COURIER

VOLUME 44 NUMBER 2 MARCH 2004



Neutrinos light up the northern sky

EXOTIC NUCLEI
New precision masses measured at ISOLTRAP p5

1954-2004 CERN

COLLABORATION
Robert Aymar's views on CERN's mission p46

IEEE

NUCLEAR & PLASMA SCIENCES SOCIETY

ROME 2004

October 16 – 22, 2004

www.nss-mic.org/2004

The Ergife Palace Hotel
Rome, Italy

- Plenary Sessions
- Oral Presentations
- Poster Sessions
- Special Focus Workshops
- Short Courses
- Industrial Program
- Social Events
- Companion Program

Abstract Submission Deadline

May 17, 2004

Nuclear Science Symposium

Medical Imaging Conference

Symposium on Nuclear Power Systems

14th International Workshop on Room-Temperature Semiconductor X-Ray and Gamma-Ray Detectors

General Chair Alberto Del Guerra
Dipartimento di Fisica 'Enrico Fermi'
University of Pisa, Pisa I-56127, Italy

Fax +39 050 2214333

Email ieee-rome2004@df.unipi.it

Sponsored by the Nuclear and Plasma Sciences Society of the Institute of Electrical and Electronics Engineers, the Department of Physics 'E. Fermi' of the University of Pisa, the Istituto Nazionale di Fisica Nucleare, and the Municipality of Rome. In cooperation with BNL, CERN, DESY, ESRF, LBNL, LLNL, ANL, FNAL, LANL, NASA, ORNL, Sandia National Laboratories, SLAC, Jefferson Lab, University of Washington, DOE, CEA Saclay, FZ Juelich, IN2P3, KEK, NIKHEF, University of Pisa, VUB and the European Federation of Organizations for Medical Physics.

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, in English and French editions. 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 (22) 782 1906
Web: cerncourier.com

Advisory board R Landua (chairman), P Sphicas, K Potter, E Lillestøl, C Detraz, H Hoffmann, R Bailey

Laboratory correspondents:
Argonne National Laboratory (US): D Ayres
Brookhaven National Laboratory (US): P Yamin
Cornell University (US): D G Cassel
DESY Laboratory (Germany): Ilka Flegel, Petra Folkerts
Fermi National Accelerator Laboratory (US): Judy Jackson
GSI Darmstadt (Germany): G Siegert
INFN (Italy): Barbara Gallavotti
IHEP, Beijing (China): Tongzhou Xu
Jefferson Laboratory (US): Melanie O'Byrne
JINR Dubna (Russia): B Starchenko
KEK National Laboratory (Japan): A Maki
Lawrence Berkeley Laboratory (US): Christine Celata
Los Alamos National Laboratory (US): C Hoffmann
NIKHEF Laboratory (Netherlands): Paul de Jong
Novosibirsk Institute (Russia): S Eidelman
Orsay Laboratory (France): Anne-Marie Lutz
PSI Laboratory (Switzerland): P-R Kettle
Rutherford Appleton Laboratory (UK): Jacky Hutchinson
Saclay Laboratory (France): Elisabeth Locci
IHEP, Serpukhov (Russia): Yu Ryabov
Stanford Linear Accelerator Center (US): N Calder
TRIUMF Laboratory (Canada): M K Craddock

Produced for CERN by Institute of Physics Publishing Ltd
Institute of Physics Publishing Ltd, Dirac House, Temple Back, Bristol BS1 6BE, UK
Tel: +44 (0)117 929 7481
E-mail: jo.nicholas@iop.org
Web: iop.org

Publishing director Richard Roe
Publisher Jo Nicholas
Art director Andrew Giaquinto
Senior production editor Ruth Aspinall
Technical illustrator Alison Tovey
Display advertisement manager Jonathan Baron
Recruitment advertisement manager Jayne Purdy
Display sales Ed Jost
Recruitment sales Reena Gupta
Advertisement production Joanne Derrick, Katie Graham
Product manager Claire Webber

Advertising Jonathan Baron, Jayne Purdy, Ed Jost or Reena Gupta
Tel: +44 (0)117 930 1265
E-mail: sales@cerncourier.com
Fax: +44 (0)117 930 1178

General distribution Jacques Dallemagne, CERN, 1211 Geneva 23, Switzerland. E-mail: courrier-adressage@cern.ch
In certain countries, to request copies or to make address changes, contact:
China Chen Huaiwei, Institute of High-Energy Physics, PO Box 918, Beijing, People's Republic of China
Germany Gabriela Heessel or Veronika Werschner, DESY, Notkestr. 85, 22603 Hamburg 52. E-mail: desypr@desy.de
Italy Loredana Rum or Anna Pennacchietti, INFN, Casella Postale 56, 00044 Frascati, Roma
UK Mark Swaisland, CLRC, Daresbury Laboratory, Keckwick Lane, Daresbury, Warrington WA4 4AD. E-mail: m.swaisland@dl.ac.uk
US/Canada Published by *Cern Courier*, 6N246 Willow Drive, St Charles, IL 60175. Periodical postage paid in St Charles, IL. Fax: 630 377 1569. E-mail: vosses@aol.com
POSTMASTER: send address changes to: Creative Mailing Services, PO Box 1147, St Charles, IL 60174

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

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

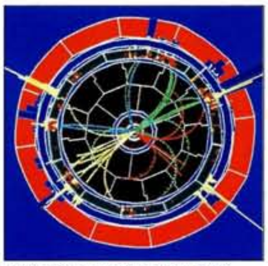
© 2004 CERN

ISSN 0304-288X

CERN COURIER

VOLUME 44 NUMBER 2 MARCH 2004

CMS module heads for CERN p6



Probabilities and particles p22

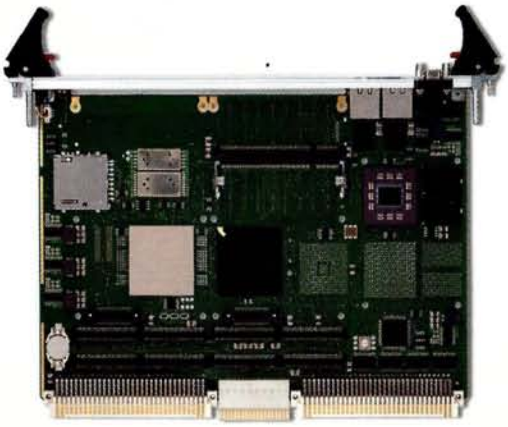
Totsuka wins Pontecorvo prize p34

Cover: the neutrino sky as seen from the South Pole by AMANDA-II, one of the astroparticle-physics experiments in which Germany participates, in a growing programme of research (p24).

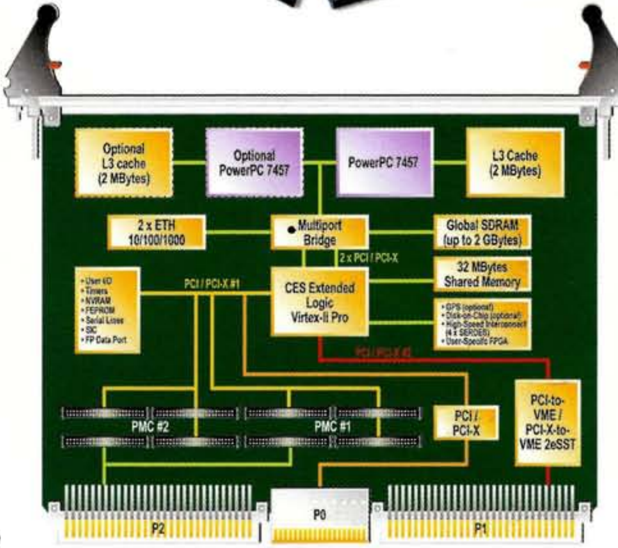
CES PHYSICS NEWS

Bridging the Gap

WE ARE PROUD TO ANNOUNCE THE BIRTH OF THE 4TH GENERATION OF CES POWERPC-BASED PROCESSORS AND GENERAL PURPOSE PMCS.



RIO4 8070



Back Panel Extension for PMC Carriers

HIGHLIGHTS:

- SINGLE OR DUAL POWERPC 7457 AT MAXIMUM AVAILABLE FREQUENCY
- TRANSPARENT EXTENSION TO UP TO 12 PROCESSORS
- FASTEST VME64X 2ESST AUTONOMOUS CONTROLLER
- SIXTEEN-CHANNEL CONCURRENT CHAINED DMA LOGIC
- VME PERFORMANCE MONITORING DEVICE
- ULTRA-HIGH-SPEED VME MULTI-TASK CONTEXT SWITCHING LOGIC
- ULTRA-HIGH-SPEED 32 MBYTES DISTRIBUTED SHARED MEMORY
- FOUR HIGH-SPEED INTERPROCESSOR SERIAL LINKS
- FRONT-PANEL GENERAL PURPOSE DATA PORT
- ONBOARD VIRTEX-II PRO FPGA FOR USER-DEFINED APPLICATIONS
- ONBOARD DISK-ON-CHIP (OPTIONAL)
- MULTIPLE THERMAL SENSORS
- BACKWARD COMPATIBLE WITH RIO3 8064 FAMILY

CES SECURE CELLS PACKAGE:

THE SECURE CELLS PACKAGE IS A DYNAMIC HARDWARE-BASED, BUT USER-ACCESSIBLE, CONTROL AND MONITORING FUNCTION SET FOR CRITICAL APPLICATIONS. IT PROVIDES BOARD-LEVEL MISSION CHANGE CAPABILITIES BASED ON HARDWARE, SOFTWARE, ENVIRONMENTAL AND BUS LOAD PARAMETERS, ALL IN MONITORED IN REAL-TIME.

Serving the Physics community for 22 years !

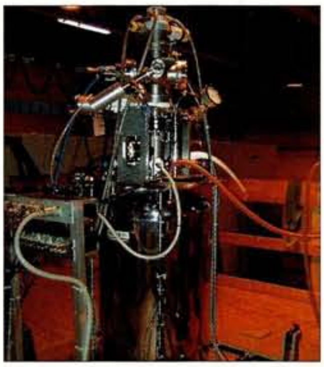
CES
CREATIVE ELECTRONIC SYSTEMS

HTTP://WWW.CES.CH

NUCLEAR PHYSICS

ISOLTRAP pins down masses of exotic nuclei

The mass of a nuclide is one of its most fundamental properties, being a unique "fingerprint", and its measurement contributes to a variety of fundamental studies including tests of the Standard Model and the weak interaction. Now researchers using the Penning trap mass spectrometer, ISOLTRAP, at the ISOLDE facility at CERN have published new high-precision measurements of the mass of short-lived radionuclides of argon and copper, which provide important information for weak interaction and nuclear shell model physics.



Far left: the vessel used for liquid nitrogen and helium cooling of the superconducting magnet coils and the detector system in ISOLTRAP's precision trap. Left: the precision trap (5 cm diameter), which sits inside the superconducting magnet.

The studies make use of recent improvements to ISOLTRAP, which can now analyse radionuclides with very short half-lives (~50 ms) produced in small numbers (~100 ions/s). The apparatus, which is fed by the 60 keV ion beam from ISOLDE, consists of three traps. A radiofrequency quadrupole ion trap accumulates and bunches the ions, and a first Penning trap then cools and purifies the beam. A second Penning trap finally provides the mass measurement by using a time-of-flight detection technique to determine the cyclotron frequency of the ions of interest.

A team from CERN, CSNSM–IN2P3–CNRS Orsay, GSI-Darmstadt and Michigan State University has measured the masses of ^{32}Ar (half-life of 98 ms) and ^{33}Ar (half-life 173 ms) with relative uncertainties of 6.0×10^{-8} and 1.4×10^{-8}, respectively (Blaum *et al.* 2003) – the greatest precision to date on these nuclides. The results provide a stringent test of the isobaric-multiplet mass equation, which relates the masses of an isospin multiplet; ^{33}Ar is a member of a quartet with an isospin of 3/2, while ^{32}Ar is a member of a quintet with an isospin of 2. Such tests are of practical importance as the equation can predict unmeasured nuclear masses and energy levels, used for example in calculations of astrophysical processes. The mass of ^{32}Ar also provides a better value for the beta-neutrino angular correlation coefficient, used to provide constraints on scalar contributions to the weak interaction.

In a second recent experiment, a larger collaboration, including members from the universities of Greifswald, Gent, Stockholm, IKS Leuven and the Russian Academy of Science, identified unambiguously three beta-decaying isomers in ^{70}Cu. In this case the unique combination of resonant laser ionization, nuclear spectroscopy and mass measurements has allowed the determination of the low-energy nuclear structure of ^{70}Cu. Using mass spectrometry the ground state (half-life of 44.5 s) and two excited states (half-lives of 33 and 6.6 s) were clearly distinguished and identified (Van Roosbroeck *et al.* 2004). As ^{70}Cu has 41 neutrons, the results provide an important step in understanding the complex structure of nuclides with one neutron less, N = 40, which corresponds to a closed sub-shell. It also demonstrates, for future nuclear-structure studies, the power of the techniques used.

Further reading

K Blaum *et al.* 2003 *Phys. Rev. Lett.* **91** 260801.
J Van Roosbroeck *et al.* 2004 *Phys. Rev. Lett.* (in print; see also CERN-EP/2003-076).

CERN

Estonia and CERN are moving closer

Estonia's parliament has recently approved special funding from the country's state budget of some €100 000 annually for the period 2004–2010. The funds are to boost scientific co-operation between Estonia and CERN, which to date involves the following Estonian research institutions: the National Institute of Chemical Physics and Biophysics, the University of Tartu (notably its Institute of Physics), the Technical University of Tallinn and the Observatory of Tartu.

Co-operation between Estonia and CERN has been actively promoted by Martti Raidal (far left) of the National Institute of Chemical Physics and Biophysics (KBFI), Endel Lippmaa (second left), the former Estonian minister of European affairs and director of the KBFI, and Diether Blechschmidt (right) of CERN. They are seen here with Ene Ergma, president of the parliament of Estonia, at the Estonian Academy of Sciences.

Estonia's co-operation with CERN will now focus on a number of objectives: consolidation of participation in the CMS experiment at the Large Hadron Collider (LHC); participation in LHC Grid Computing and other information-technology projects at CERN; collaboration with research groups at CERN in theoretical and experimental particle physics, as well as material sciences; and the creation of an Estonian graduate school, with students trained at CERN. The school already plans to send six Estonian students to participate in CERN's Summer Student Programme in 2004.

LHC EXPERIMENTS

First module for the CMS solenoid magnet heads from Genova to Geneva...

The first of five modules that will form the superconducting solenoid magnet for the CMS experiment at CERN was ready to leave the Italian port of Genova at the end of January, subject to good weather conditions. The magnet, which has an inside diameter of 6.3 m and a length of 12.5 m, has required a modular construction to allow transportation from the fabrication site in Italy to CERN. The five modules, each 2.5 m long and weighing 45 tonnes, are being transported one by one to CERN, where they will be assembled into the final solenoid.

The solenoid, which represents the "S" in CMS (Compact Muon Solenoid), is the product of an international collaboration between the French Commissariat pour l'Energie Atomic, CERN, the Italian National Institute for Nuclear Physics (INFN), ETH (Polytechnic of Zürich) and Ansaldo Superconductors of Genova. Ansaldo was entrusted with the construction of the five modules constituting the magnet, which generates a magnetic field of 4 T. Once completed, the superconducting solenoid will boast a notable record: with its 2.6 Gigajoule of energy it will hold the world record for energy stored in a magnet.

Two modules of the CMS solenoid at the manufacturers, Ansaldo, in Italy; the first module is the lower of the two. (Photo: INFN.)

INFN has been responsible for the design and construction of the so-called cold mass, i.e. the coil and mechanical structures that will be cooled to 4.2 K. Construction of the coil has required the development of some innovative technologies. Since the magnetic field is so high and the device so big, large electromagnetic forces are generated inside the solenoid causing mechanical deformation that could prevent it from working. The standard solution for such problems is to use a reinforcing mechanical structure to contain the solenoid, but this would not have been sufficient in this case. To avoid the smallest deformation, which would make the cables lose their superconducting properties, the reinforcement has been inserted directly inside the cables. This innovative solution required remarkable technical skills. It was also necessary to develop a sophisticated automated winding system to form the solenoid coils with high geometrical precision.

...while the ATLAS solenoid approaches its final position

The ATLAS superconducting solenoid has been moved for nearly the last time and is now in position in the assembly hall on the Meyrin site at CERN, opposite the cryostat that will house the liquid-argon electromagnetic calorimeter. All that remains to do now is to slide the solenoid into the insulating vacuum vessel.

Built by Toshiba, under the responsibility of KEK in Japan, the solenoid is 2.4 m in diameter, 5.3 m long and weighs 5.5 tonnes. Its axial magnetic field of 2 Tesla will deflect the particles inside the ATLAS inner detector. The inner detector, which consists of three sub-detectors, will be installed inside the solenoid at a later date, before the complete structure is transported across the road from the main site to the ATLAS cavern at Point 1 on the ring of the Large Hadron Collider.

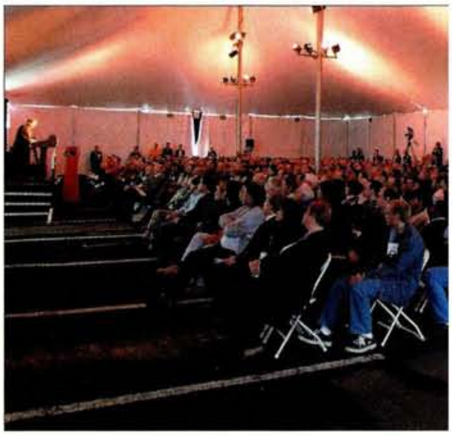
The ATLAS superconducting solenoid during one of the transport operations. Securely attached to the overhead crane, the solenoid is situated in front of the opening to the liquid-argon electromagnetic calorimeter, where it will soon be inserted.

ACCELERATORS

SPEAR ring comes to life again as a dazzling new synchrotron light source…

The latest reincarnation of the famous SPEAR storage ring – SPEAR3 – was formally opened at a dedication ceremony at the Stanford Linear Accelerator Center (SLAC) on 29 January. The new synchrotron light source incorporates the latest technology – much of it pioneered at the Stanford Synchrotron Radiation Laboratory (SSRL) and SLAC – to make it competitive with the best synchrotron sources in the world. Some 2000 scientists will use the new machine's extremely bright X-ray light each year in studies ranging from materials science to structural biology.

Thirty years ago SSRL was among the first laboratories in the world to use synchrotron-produced X-rays for studying matter at atomic and molecular scales, and the first to offer beam time to a broad user community of scientists from academic, industry and government laboratories (based on peer-reviewed proposals). The original SPEAR ring, built for particle-physics research at SLAC, yielded several major discoveries in the field and also provided fertile ground for innovating synchrotron techniques (*CERN Courier* June 2003 p16).



Keith Hodgson (left), the director of the Stanford Synchrotron Radiation Laboratory, praises his staff at the dedication ceremony (right) for the new SPEAR3 facility.

SPEAR3 is a complete rebuild and upgrade of the SPEAR2 ring, with all the magnets, vacuum and radiofrequency systems having been replaced. The new ring also has the capacity for eight to 10 more beam lines, with associated experimental stations. A gift of $14.2 million (~€11.2 million) from the Gordon and Betty Moore Foundation to the California Institute of Technology will allow scientists at Caltech and Stanford University to collaborate on the building of a designated beam line for structural molecular-biology research. The quality and brightness of SPEAR3's X-ray light is well suited to studying complex biological systems.

The SPEAR3 project was completed on time and to the budget of $58 million (~€46 million). The first electron beams circulated in the new ring in mid-December 2003 and the first experiments are scheduled to begin in March this year.

…and STELLA lights way to a better electron accelerator

Researchers at the Brookhaven National Laboratory have developed a compact linear accelerator that uses laser light to accelerate electrons with better efficiency and energy characteristics than before. The results from the experimental device, called Staged Electron Laser Acceleration (STELLA), may help in the development of linear accelerators that can deliver higher energies than are currently possible using microwaves, without becoming unfeasibly long and expensive.

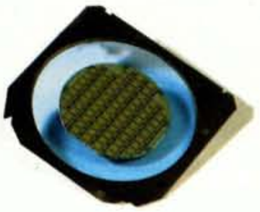
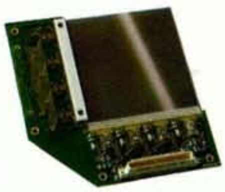
The STELLA experiment was performed at Brookhaven's Accelerator Test Facility (ATF) by a collaboration from Brookhaven and the universities of California at Los Angeles, Stanford and Washington, together with STI Optronics. Electrons from a standard linac at the ATF were injected into STELLA with an initial energy of 45 MeV. The electrons were then directed into an inverse free-electron laser (IFEL), with powerful permanent magnets that force the electrons to "wiggle" so that they radiate. Simultaneously, a laser beam was sent through the IFEL. The laser effectively regulated the electrons' energy, speeding up the slower electrons and slowing down the faster ones. As a result, the slow electrons caught up with the fast ones and grouped together to create "microbunches", each with a length of only 1 micrometre. This is one of the shortest microbunches ever created, its importance being that it makes it possible to accelerate the electrons without leaving many behind. Additionally, the microbunches were separated by only 10.6 micrometres, a distance equal to the wavelength of the laser beam.

The microbunches then travelled into a second IFEL, where they were accelerated by the laser beam to a higher energy, while staying tightly grouped. This process is in fact the essence and most difficult part of the experiment. However, the researchers were able to accelerate the microbunches without leaving behind a large number of electrons: up to 80% of the electrons remained trapped in the microbunches. Moreover, STELLA accelerated the electrons from 45 MeV to more than 54 MeV. The trapped electrons also remained more or less monoenergetic, with more than two-thirds staying within 0.36% of 54 MeV.

ideas -Your partner in radiation detection

Ideas ASA is the ASIC house in the world for multi-channel charge amplifiers for physics, medical and industrial applications. We help you defining the front-end readout ASIC that suits your detector application and design it according to specification at very low cost and short delivery time of 4 months, with warranty on functionality. The design and delivery of the circuit boards for evaluation and for your final detector, as well as dedicated DAQs and standard acquisition and control systems for the ASICs is also part of our core business.

- HEP physics customers including Belle, Cleo, Minos and Kamiokande; astro-physics (SWIFT-NASA, ESA) and well-known physics institutes (INFN, IN2P3, MIT).
- We have experience with most detector technologies, examples are: PMTs, HPDs, MWPCs, silicon pads/strips single and double sided, CZT, CdTe, flat-panels for X-ray.
- 100 ASICs available off-the-shelf, with 1-1000 channels, linear/pixelated designs, power 200 μW/ch, noise < 50e rms, dynamic from 5fC to 50pC, rad. hard to 100Mrad, SEU/SELU protection. We may have in stock the ASIC you need. Several ASIC families available.
- PC-based DAQ systems for data rates up to some 100,000 events/second. Prices starting from 5,000€.
- Solid state gamma cameras for energies in the 20-300keV range based on pixelated CZT modules. Cameras from 4cm x 4cm to 20cm x 20cm have been designed and delivered.


Our web site:
http://www.ideas.no

Contact info:

Sales manager
Bjørn Sundal
Tel: +47 6782 7159
sundal@ideas.no
sales@ideas.no

Tel: +47 67827171
Fax: +47 67827172
Martin Linges vei 25
Postbox 1
1330 Fornebu
NORWAY

Meet us at
the IEEE NSS-MIC Conference. 16-22 October in Rome.

Materials and Detectors for Your World... Where Ideas Materialize...

Plastic Scintillators and Fibers

Gas-filled Radiation Detectors

Scintillation Detectors and Arrays

Saint-Gobain Crystals manufactures Bicron® and Crismatec® brand scintillation detectors.

Contact Saint-Gobain Crystals for all your radiation detection applications...

For Scintillation Crystals and Detectors

In USA – Tel: +1 440-564-2251
In Europe – Tel: +31 (35) 60 29 700
In Japan – Tel: +81 (45) 474 5786

For Gas-Filled Tubes

In USA – Tel: +1 713-973-9461
In Europe – Tel: +31 (35) 60 29 700
In Japan – Tel: +81 (45) 474 5786

Visit our web site:
http://www.detectors.saint-gobain.com

Ask about these materials that are now available: $LaCl_3$(Ce) and LYSO.

SAINT-GOBAIN
CRYSTALS

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

HISTORIC TELEVISION PROGRAMME

Telstar shows CERN to two continents

During the evening of 23 July about 200 million television viewers in Europe and North America had a short glimpse of CERN at work.

Showing our organization to so many people was a remarkable feat in more ways than one: first, because of the large number of viewers, which clearly shows the power of modern means of communication, and also because of the preparatory work needed for this direct television transmission. Then there was the technical achievement represented by the artificial satellite, relaying electromagnetic waves from Europe to the US. Finally, it was an historic occasion to which no one could remain indifferent.

The transmission in which CERN took part was the first of its kind. Never before had so many television viewers from such a large section of the world simultaneously watched a direct "live" programme. Naturally it was not possible in Europe to judge the quality of the pictures received in the US via the Telstar satellite. However, the pictures from America on the small European screens were exceptionally clear considering the distance, the number of relays and the frequent switchovers from one system to another between camera and receiver. From 7.58 p.m. onwards on 23 July, the 20 or so people gathered round the monitoring screens placed by Swiss Television in the PS south generator courtyard clearly felt the historic importance of this moment, while the communications satellite inexorably continued in orbit thousands of kilometres away.

Before the programme, producer Walter Plüss (centre) gives instructions to cameraman H Schule in the PS control room, while L Blanc and E Ratcliff (seated right) await their turn.

Three hours later it was the turn of the Eurovision network to send its pictures to Telstar to be distributed over the North American continent. Through the Eurovision network, Austria, Belgium, France, Italy, the Federal Republic of Germany, Sweden, Switzerland, the United Kingdom and Yugoslavia gave the US a glimpse of life in Europe at that moment.

At Meyrin, 60 hours of feverish preparation were resolved in 60 seconds of direct transmission. One minute of programme time had been allotted to Switzerland, and similar times to each of the other countries taking part in the Telstar programme. Within the limits of such a short time each country was expected to transmit to American television viewers not so much a page from our continent's commercial catalogue as some evidence of our historic inheritance or cultural background. Moreover, because of the difference in time, it was the night-life of Europe that had to be shown. Although it was 10.58 p.m. in Geneva, it was early evening in New York, and California was still sweltering in the afternoon Sun.

• *Taken from* CERN Courier *August 1962 p10.*

EDITOR'S NOTE

July 1962 was a very busy month for CERN, with two consecutive major international conferences. Below we highlight the concern expressed at the instrumentation conference about the large amount of data possible from a single detector. The month also saw this historic broadcast from CERN to North America by the Telstar satellite; now high-quality transmission is possible via land-based high-speed networks being developed to handle vast data transfers between Europe and North America (see p16).

GENEVA 16–18 JULY

The 1962 International Conference on Instrumentation for High-Energy Physics

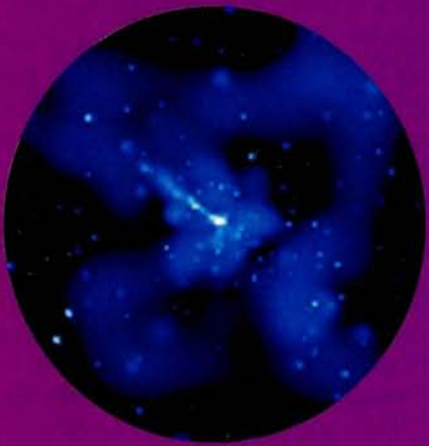
Nearly 300 participants from 24 different countries joined those working at CERN to consider and discuss the apparatus (not counting the accelerators themselves) required to carry out the kind of experiments whose results had been reported the previous week [at the 11th "Rochester conference" at CERN]. More specifically, they were interested in the development of the equipment to make possible the next advances in experimental high-energy physics.[...]

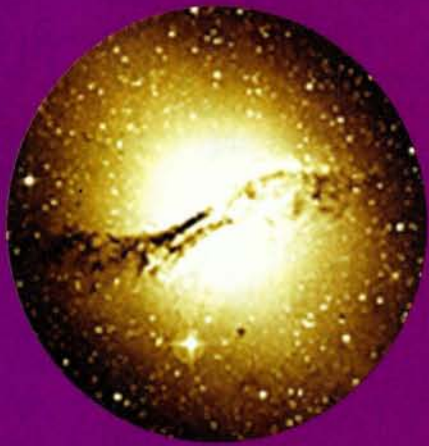
Spark-chamber photographs are at present processed in a similar way to those from bubble chambers, but the development of fully automatic methods has become imperative owing to the rate at which the photographs can be produced – the Argonne group at CERN, for example, recently took 100 000 pictures in one week, 15 000 of which contained specific tracks of primary interest. The generally lower precision required in the measurements and the almost total absence of background make the task easier than in the case of bubble chambers, but the probable need to deal with chambers of complicated shapes and the effects of operation in magnetic fields can make it more difficult. Cathode-ray-tube scanning systems of various types are currently being developed; one at CERN is designed to scan only between the plates, giving a position measurement for each spark it encounters.

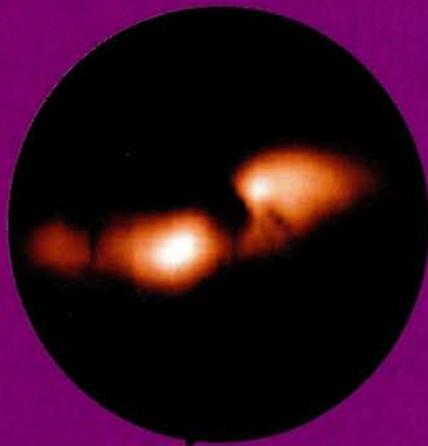
Some workers aim to use television cameras that will record directly the positions of the sparks in digital form on magnetic tape, without the use of film at all. More radically, the new types of spark chamber reported at the conference may eliminate altogether the detection of light and subsequent digitizing of the track.

• *Taken from* CERN Courier *August 1962 p3.*

JCAP
An IOP and SISSA journal







First birthday success!

Journal of Cosmology and Astroparticle Physics

2004 subscriptions available now

Journal of Cosmology and Astroparticle Physics (JCAP) is one year old in February.

At the end of its first year of publication, JCAP is celebrating:

- Publication of over 1000 pages of research
- Over 100 articles already accepted
- A distinguished board of editors and advisors in place
- Being entered in Harvard's list of core Astronomy and Astrophysics publications
- Being abstracted in Chemical Abstracts; INSPEC® Information Services; NASA Astrophysics Data System; SLAC SPIRES Database; VINITI Abstracts Journal; Zentralblatt MATH and ISI (Science Citation Expanded® and Current Contents®/Physical, Chemical and Earth Sciences.

Visit **www.iop.org/journals/jcap** today to enjoy coverage of cutting-edge research in all aspects of cosmology and related topics in astrophysics and particle physics.

How to subscribe

Please contact: Customer Services Department,
Institute of Physics Publishing,
Dirac House, Temple Back, Bristol BS1 6BE, UK

E-mail: custserv@iop.org
Tel: +44 (0) 117 929 7481
Fax: +44 (0) 117 929 4318

Alternatively e-mail: karen.brixey@iop.org to be sent a library recommendation form.

For information about submissions, please e-mail **jcap-eo@jcap.sissa.it** or visit **http://jcap.sissa.it**.

→ **jcap.sissa.it** | **www.iop.org/journals/jcap**

Image 1: NASA/CXC/ M. Karovska et al. - Image 2: Digitized Sky Survey U.K. Schmidt Image/STScI. - Image 3: NRAO/VLA/ Schiminovich et al.

SISSA International School for Advanced Studies   Institute *of* **Physics** PUBLISHING

Compiled by Steve Reucroft and John Swain

Does dielectric deliver something for nothing?

By now, many people are familiar with the idea that the vacuum contains energy – in fact a great deal of it – and that some can be extracted to do physical work. The standard example is the Casimir effect, where two parallel metal plates are pulled together as they reduce the zero-point energy in the vacuum between them. Now Alexander Feigel of Rockefeller University in New York has predicted an analogous but rather surprising effect: that a dielectric body placed in crossed electric and magnetic fields will extract linear momentum from the vacuum and start to move.

Unlike the Casimir effect, which is insensitive to the ultraviolet cut-off needed to make summations and integrals converge, this new effect depends critically upon high-frequency vacuum modes and is, in this sense, more like the Lamb shift. The effect is calculated to be small – about 50 nm/s for a 17 T magnetic field and an electric field of 100 000 V/m – but might just be observable.

Further reading

A Feigel 2004 *Phys. Rev. Lett.* **92** 020404.

Hydrogen atoms get stuck in ice

Traditional approaches to storing hydrogen in solids involve pushing hydrogen atoms into metals like palladium, but a new strategy that is showing promise is to use ice. Wendy Mao of the University of Chicago in Illinois and Ho-kwang Mao of the Carnegie Institution in Washington DC have synthesized a hydrogen clathrate hydrate (chemical formula $H_2(H_2O)_2$) that holds 50 g per litre of hydrogen by volume or 5.3% by weight.

The material is made at high pressure (200–300 MPa) and moderate temperature (240–249 K), but once formed can be kept at normal pressure if maintained at 77 K. For different pressures and temperatures, even higher concentrations of hydrogen – more than 33% by weight – can be achieved by using methane instead of water. Even better results might be obtained with other molecular solids.

Further reading

W L Mao and H K Mao 2004 *Proc. Nat. Acad. Sci.* **101** 708.

Argon plasma yields coherent X-rays

Coherent X-rays have been coaxed from argon by a group of physicists at JILA, the University of Colorado and the National Institute of Standards and Technology, in Boulder, Colorado. The X-rays are very soft (low energy), but technically still X-rays, or at least extreme ultraviolet radiation. Emily Gibson and her colleagues have used high-order harmonic generation, whereby visible light is multiplied in frequency many times by nonlinear interactions with a plasma of ionized argon. The development of new light sources in this frequency range is expected to play an important role in nanometre-scale imaging, which is clearly of increasing importance in both biology and technology.

Further reading

E A Gibson *et al.* 2004 *Phys. Rev. Lett.* **92** 033001.

Iron gives mussels their superglue

Scientists at Purdue University have solved a major mystery: how mussels stick to things so amazingly well. Jonathan Wilker and colleagues found that the key is in the cross-linking of proteins provided by iron extracted from sea water.

This is the first time that transition metals have been found to play a role in biological structural materials. It is now a fascinating problem to figure out if this is perhaps a widespread phenomenon that simply has not been recognized until now. Many interesting spinoffs could follow from this work, including new, more environmentally friendly antifouling agents for boats and new classes of adhesives. Amazingly, mussels can even stick to Teflon!

Further reading

M J Sever *et al.* 2004 *Angewandte Chemie* (International Edition) **43** 448.

Champagne method beats ammonia

In the quest for heat pumps based on something rather more environmentally friendly than ammonia, Jack Jones of Caltech, with funding from NASA's Jet Propulsion Laboratory in Pasadena, has found that a mixture of carbon dioxide and alcohol will do the job nicely. Instead of being mechanically driven, the "champagne heat pump" uses heat to drive the absorption/desorption cycle of carbon dioxide in ethanol. The danger of fire is mitigated by the omnipresent carbon dioxide – and at a pinch you could drain the thing, add some water and perhaps get a drinkable "Californian champagne"!

Further reading

http://www.nasatech.com/Briefs/Jan04/NPO19855.html.

cerncourier.com

Explore Absorb Link Digest Browse Search Bookmark Discover

ASTROWATCH

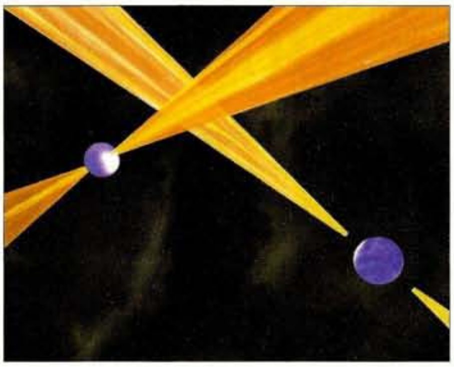
Compiled by Marc Türler

Double pulsar opens up new astrophysics

An international team of scientists working with the 64 m Parkes Telescope in Australia and the 76 m Lovell Telescope at the Jodrell Bank Observatory in the UK has found that the recently discovered neutron-star binary J0737-3039 is in fact a double-pulsar system. Because the two pulsars are very tightly orbiting each other, this discovery will allow unprecedented tests of Einstein's general theory of relativity.

A neutron star is the collapsed core of a massive star that has ended its life in a supernova explosion. Neutron stars are about the same mass as the Sun, but only about 20 km across. These incredibly dense objects are called pulsars if they produce a pulsating radio signal, as first detected in 1967. A pulse occurs each time the rapidly spinning neutron star has its beam of radio waves pointing towards the Earth. Pulsars spinning at a rate of hundreds of times a second are more accurate time keepers than even the best atomic clocks on Earth, and this very precise timing allowed the discovery in 1990 of the two first extrasolar planets, orbiting the pulsar PSR 1257+12.

Observations of systems in which a pulsar is in orbit around another neutron star have been able to prove the existence of gravitational radiation as predicted by Albert Einstein and have provided very sensitive tests of his general theory of relativity. In 1993 Joseph Taylor and Russell Hulse earned the Nobel prize for their discovery of such a binary pulsar, PSR B1913+16, and their precise measurement of the rate of the binary system's orbital decay through the emission of gravitational waves.



Artist's impression of the two pulsars orbiting around the common centre of mass in 2.4 hours. The faster rotating pulsar spins 45 times per second, or almost 3000 times per minute. In the same time, the slower rotating pulsar spins only 22 times, or every 2.8 seconds. (Courtesy Michael Kramer, Jodrell Bank Observatory, University of Manchester.)

What makes the newly discovered neutron-star binary J0737-3039 special, is that its orbital period is only 2.4 hours, which is three times shorter than that of the Hulse–Taylor binary pulsar (Burgay *et al.* 2003). The two neutron stars orbit each other so tightly that the orbit would fit inside the Sun. Because of gravitational wave emission, the two stars will coalesce in only around 85 million years, sending an ultimate ripple of gravity waves across the universe. The discovery of this closely orbiting system implies that such coalescences must occur more frequently than was previously thought.

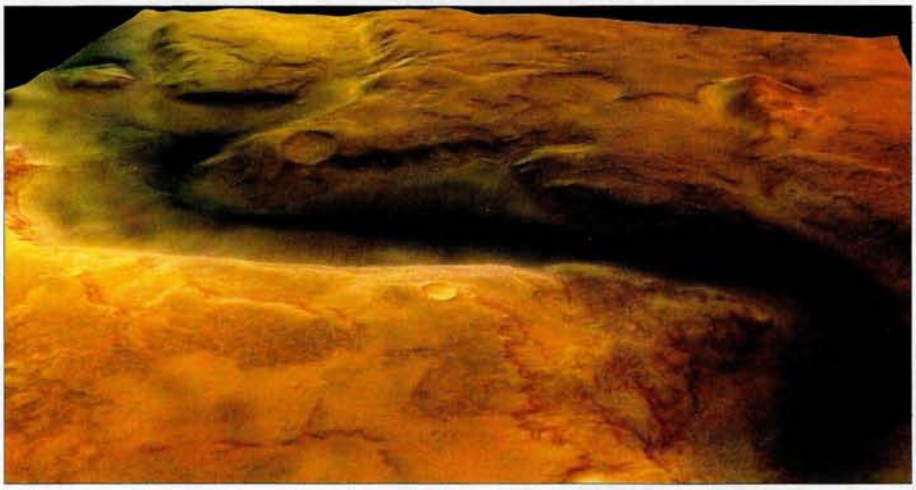
This result, published at the end of December 2003, proved however not to be the end of the story. The same team, from Australia, India, Italy and the UK, has now announced the detection of a pulsed signal from the second neutron star of the J0737-3039 system (Lyne *et al.* 2004). Already four different effects beyond those predicted by Newton's laws of gravity have been measured and found to be completely consistent with Einstein's general theory of relativity. On a time-scale of a few years, other relativistic effects should be detectable. Andrew Lyne of Manchester points out that, "While experiments on one pulsar in such an extreme system as this are exciting enough, the discovery of two pulsars orbiting one another will allow us to undertake precise new tests of general relativity and probe energetic physical processes that occur in the magnetosphere, or 'extended atmosphere', of a neutron star."

Further reading

M Burgay *et al.* 2003 *Nature* **426** 531.
A Lyne *et al.* 2004 *Science* (in press) http://arxiv.org/abs/astro-ph/0401086.

Picture of the month

While the two NASA rovers Spirit and Opportunity are rolling around on opposite sides of the red planet, the Mars Express orbiter of the European Space Agency has detected water ice for the first time at the south pole of Mars. This colour picture shows a channel (Reull Vallis) that was once formed by flowing water. The landscape is shown in perspective and is based on the three-dimensional measurements of the High Resolution Stereo Camera (HRSC) onboard the Mars Express. The area shown is 100 km across and is located to the east of the Hellas basin. (Courtesy ESA/DLR/ FU Berlin, G Neukum.)



Gigabits, the Grid and the Guinness Book of Records

High-speed networking over the Internet is becoming increasingly important as CERN and other laboratories around the world gear up for the Grid. **Olivier Martin** takes a look at the evolution towards CERN's current involvement in long-distance data-transfer records.

Some of the members of the DataTAG project team at CERN and a member of the Caltech team who, together with their partners, were behind the first record-breaking transfer of data between CERN and California in February 2003. From left to right: Martin Fluckiger, Stan Cannon, Paolo Moroni, Sylvain Ravot (Caltech), Elise Guyot, Daniel Davids, Olivier Martin (project manager), Rosy Mondardini and Edoardo Martelli.

On five separate occasions during 2003, a team led by Harvey Newman of Caltech and Olivier Martin of CERN established new records for long-distance data transfer, earning a place for these renowned academic institutions in the *Guinness Book of Records*. This year, new records are expected to be set as the performance of single-stream TCP (Transmission Control Protocol) is pushed closer towards 10 Gbps (gigabits per second). In 1980 "high speed" meant data transfers of 9.6 kbps (kilobits per second), using analogue transmission lines. So the achievement of 10 Gbps in 2004 corresponds to an increase by a factor of 1 million in 25 years – an advance that is even more impressive than the classic "Moore's law" of computer processing, in which the number of transistors per integrated circuit (i.e. the processing power) follows an almost exponential curve, increasing by a factor of two every 18 months, or 1000 every 15 years.

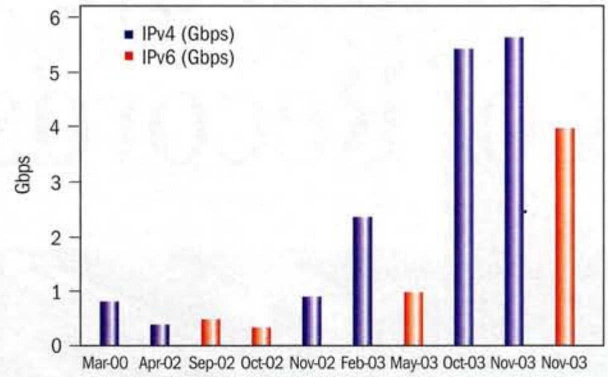
While chasing such records may sound like an irrelevant game, the underlying goal is of great importance for the future of data-intensive computing Grids. In particular, for CERN and all the physicists across the world working on experiments at the Large Hadron Collider (LHC), the LHC Computing Grid will depend critically on sustainable multi-gigabit per second throughput between different sites. The evolution of such long-distance computing capabilities at CERN has been an important part of CERN's development as a laboratory, not only for European users but also for those across the globe.

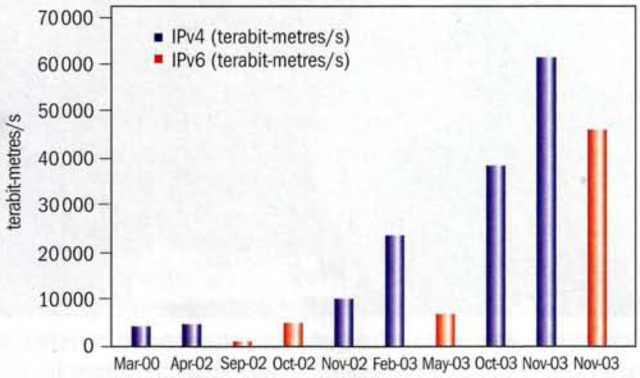
The early days

Computer networks have been of increasing importance at CERN since the early 1970s, when the first links were set up between experiments and the computer centre. The first external links, for example to the Rutherford Laboratory in the UK, were only established during the late 1970s and had very limited purposes, such as remote job submission and output file retrieval. Then from 1974 onwards, together with the EARN/BITnet and UUCP mail network initiatives, there was an extraordinary development in electronic mail. However, it was only in the late 1980s that the foundations for today's high-speed networks were truly laid down. Indeed, the first international 2 Mbps (megabits per second) link was installed by INFN during the summer of 1989, just in time for the start-up of CERN's Large Electron Positron collider. However, there was still no Europe-wide consensus on a common protocol, and as a consequence multiple backbones had to be maintained, e.g. DECnet, SNA, X25 and TCP/IP (TCP/Internet Protocol).

Back in late 1988, the National Science Foundation (NSF) in the US made an all-important choice when it established NSFnet, the first TCP/IP-based nationwide 1.5 Mbps backbone. This was initially used to connect the NSF-sponsored Super Computer Centers and was later extended to serve regional networks, which themselves connected universities. The NSFnet, which is at the origin of the academic as well as the commercial Internet, served as the emerging commercial Internet backbone until its shutdown in 1995.

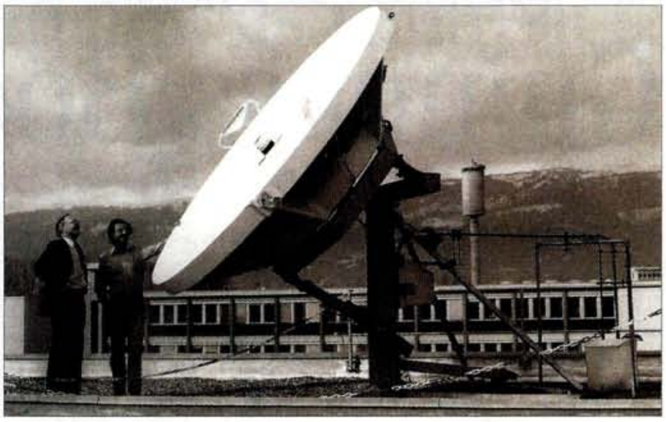
In 1990 CERN picked up on this development – not without ▷





The evolution of the Internet2 land-speed records, in gigabits per second (top) and the unit of terabit-metres per second used for the record (bottom), from their inception in March 2000 to the records recently established by the team led by Caltech and CERN.

Satellite days – the STELLA project



The 3 m diameter antenna that was installed at CERN for data transmission via the OTS satellite in the STELLA project.

On 11 May 1978 a rocket carrying the OTS-2 satellite of the European Space Agency was successfully launched. The satellite was a key part of a pioneering experiment, funded by the EEC (the forerunner of the European Union), for high-speed large-volume data transmission. The project – STELLA – involved CERN and other European particle-physics centres, including the Centro Nazionale universitario di calcolo elettronico (CNUCE) in Pisa, Italy, the DESY laboratory in Germany and the Rutherford Laboratory in the UK. By 1981 the system had been used for various tests of technical performance at the design transmission speed, with a 1600 bpi (bits per inch) magnetic tape being sent in about 10 minutes, corresponding to about 500 kilobits per second.

courage – and together with IBM and other academic partners in Europe developed the use of EASInet (European Academic Supercomputer Initiative Network), a multi-protocol backbone that took account of Europe's networking idiosyncrasies. EASInet, which also provided a 2 Mbps TCP/IP backbone to European researchers, had a 1.5 Mbps link to NSFnet through Cornell University and was at the origin of the European Internet, together with EBONE. These developments established TCP/IP as the major protocol for Internet backbones around the world.

The Internet2 land-speed records

In 2000, to stimulate continuing research and experimentation in TCP transfers, the Internet2 project, a consortium of approximately 200 US universities working in partnership with industry and government, created a contest – the Internet2 land-speed record (I2LSR). This involves sending data across long distances by "terrestrial" means – that is, by underground as well as undersea fibre-optic networks, as opposed to by satellite – using both the current Internet standard, IPv4, and the next-generation Internet, IPv6. The unit of measurement for the contest is bit-metres per second – a very wise and fair decision as the complexity of achieving high throughput with standard TCP installations, e.g. on Linux, is indeed proportional to the distance.

In 2003 CERN and its partners were involved in several record-breaking feats. On 27–28 February a team from Caltech, CERN, LANL and SLAC entered the science and technology section of the *Guinness Book of Records* when they set an IPv4 record with a single 2.38 Gbps stream over a 10 000 km path between Geneva and Sunnyvale, California, by way of Chicago. Less than three months later, a new IPv6 record was established on 6 May by a team from Caltech and CERN, with a single 983 Mbps stream over 7067 km between Geneva and Chicago.

However, thanks to the 10 Gbps DataTAG circuit (see "DataTAG" box, p15), which became available in September 2003, new IPv4 and IPv6 records were established only a few months later, first between Geneva and Chicago, and then between Geneva, California and Arizona. On 1 October a team from Caltech and CERN achieved the amazing result of 38.42 petabit-metres per second with a single 5.44 Gbps stream over the 7073 km path between Geneva and Chicago. This corresponds to the transfer of 1.1 terabytes of physics data in less than 30 minutes, or the transfer of a full-length DVD to Los Angeles in about 7 seconds.

Then in November a longer 10 Gbps path to Los Angeles, California and Phoenix, Arizona, became available through Abilene, the US universities' backbone, and CALREN, the California Research and Education Network. This allowed the IPv4 and IPv6 records to be broken yet again on 6 November, achieving 5.64 Gbps with IPv4 over a path of 10 949 km between CERN and Los Angeles, i.e. 61.7 petabit-metres per second. Five days later, a transfer at 4 Gbps with IPv6 over 11 539 km between CERN and Phoenix through Chicago and Los Angeles established a record of 46.15 petabit-metres per second.

As with all records, there is still ample room for improvement. With the advent of PCI Express chips, faster processors, improved motherboards and better 10GigE network adapters, there is little doubt it will be feasible to push the performance of single-stream TCP transport much closer to 10 Gbps in the near future, that is, well above 100 petabit-metres per second.

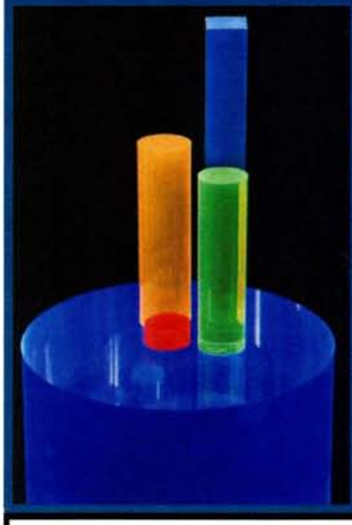
As Harvey Newman, head of the Caltech team and chair of the ICFA Standing Committee on Inter-Regional Connectivity, has pointed out, these records are a major milestone towards the goal of providing on-demand access to high-energy physics data from around the world, using servers that are affordable to physicists from all regions. Indeed, for the first time in the history of wide-area networking, performance has been limited only by the end systems and not by the network: servers side by side have the same TCP performance as servers separated by 10 000 km.

Olivier Martin, *CERN*.

DataTAG

The DataTAG project is co-funded by the European Union, the US Department of Energy through the California Institute of Technology (Caltech) and the US National Science Foundation through the Electronic Visualization Lab at the University of Illinois in Chicago. It is led by CERN and brings together the following leading European research agencies: Italy's Istituto Nazionale di Fisica Nucleare (INFN), France's Institut National de Recherche en Informatique et en Automatique, the UK's Particle Physics and Astronomy Research Council and the Dutch Universiteit van Amsterdam. Its mission is to establish a very high bandwidth bridge between the European and American scientific communities. DataTAG will create a large-scale intercontinental Grid testbed that will focus on advanced networking issues and interoperability between European and US projects. Two types of network connections will be used: a new link for high-performance network service and data-transfer application development, and a set of existing production links for interoperability test activities that do not require separation from production traffic. The current testbed is running at 10 Gbps. For more information, see the website at: http://datatag.web.cern.ch/datatag.

PLASTIC SCINTILLATOR
Organic Scintillators for Tomorrow's Technology



- Plastic Scintillators
  Thin Films
  Large Sheets
- Liquid Scintillators
- Reflective Paints
- Optical Cement
- Wavelength Shifting Plastics
- ZnS-Ag Coating
  Discs / Sheets
- Custom Design and Manufacturing

ELJEN TECHNOLOGY
PO Box 870 / 300 Crane Street
Sweetwater, Texas 79556 (USA)
Ph: 915-235-4276 or 888-800-8771
Fax: 915-235-2872
e-mail: eljen@eljentechnology.com
www.eljentechnology.com

Visit our website or contact us for a brochure

Photomultiplier Tubes

Sizes available: 13mm, 19mm, 29mm, 38mm, 51mm, 76mm, 89mm, 133mm

Designer and Manufacturer of Photomultiplier Tubes

ADIT
www.aditpmt.com
PO Box 870 / 300 Crane Street
Sweetwater, Texas 79556 (USA)
Ph: 915-235-1418 or 800-399-4557
Fax: 915-235-2872
e-mail: adit@aditpmt.com

Visit our website or contact us for a brochure

Exploiting the transatlantic light path

Recent major exhibitions have provided the opportunity to demonstrate the potential of the high-speed link between Europe and North America, as **Chris Jones** reports.

Romanian president Ion Iliescu (left) talks with Harvey Newman (centre) and Iosif Legrand of Caltech at CERN's SIS-on-line stand during the ICT4D exhibition at the WSIS in Geneva in December.

Jazz players in Geneva play with others in Canada via the transatlantic link-up at ICT4D. (Photo: Daniel Davids.)

In two world exhibitions in Geneva in 2003, a collaboration between Caltech, CERN and other international institutes set out to demonstrate the possibilities and opportunities provided by the DataTAG transatlantic high-speed "light path" (see "DataTAG" box, p15), which currently allows data transmission rates up to 10 gigabits per second (Gbps). The Services Industriels de Genève extended the light path into the heart of the exhibition floor in Geneva's exhibition centre, Palexpo, both for ITU Telecom World 2003 in October and the Information and Communication Technologies for Development (ICT4D) exhibition at the World Summit on the Information Society (WSIS) in December.

A substantial, portable data centre was built on the exhibition floor in collaboration with Telehouse, CERN's partner in the CERN Internet Exchange Point (CIXP), which is the major centre for interchange between telecommunications operators in the Geneva area. The CIXP was extended directly to the stand in Palexpo and the DataTAG light path was able to provide 10 Gbps Ethernet connectivity from the stand to collaborators in North America – Los Angeles and Chicago in the US and Ottawa in Canada. (Ethernet has come a long way from the days when it was considered to be a technology fit only for very-local-area networks!) The equipment to operate the DataTAG link at these highest state-of-the-art speeds was provided by CISCO, Intel and HP at several points on the light path.

The aims of the two world exhibitions were slightly different. Telecom World 2003 continued the 20 year tradition of CERN's involvement in demonstrations of the latest high-speed networking, and succeeded in breaking – yet again – the Internet2 records for high-speed data transmission over long distances. The ICT4D exhibition at the WSIS focused on demonstrations aimed at "turning the digital divide into a digital opportunity", in line with the summit's declarations.

Nonetheless, a number of items were common to both exhibitions, such as the Virtual Rooms Videoconferencing System (VRVS), which runs over the Internet; the Grid Café portal, which aims to explain and demonstrate the Grid and is proving extremely popular as a website; and the MonALISA system, which was developed by Caltech and portrays in an elegant and highly visual manner the performance of a worldwide networking system or the machines in a world Grid, and demonstrates how essential such systems are to the successful operation of Grids.

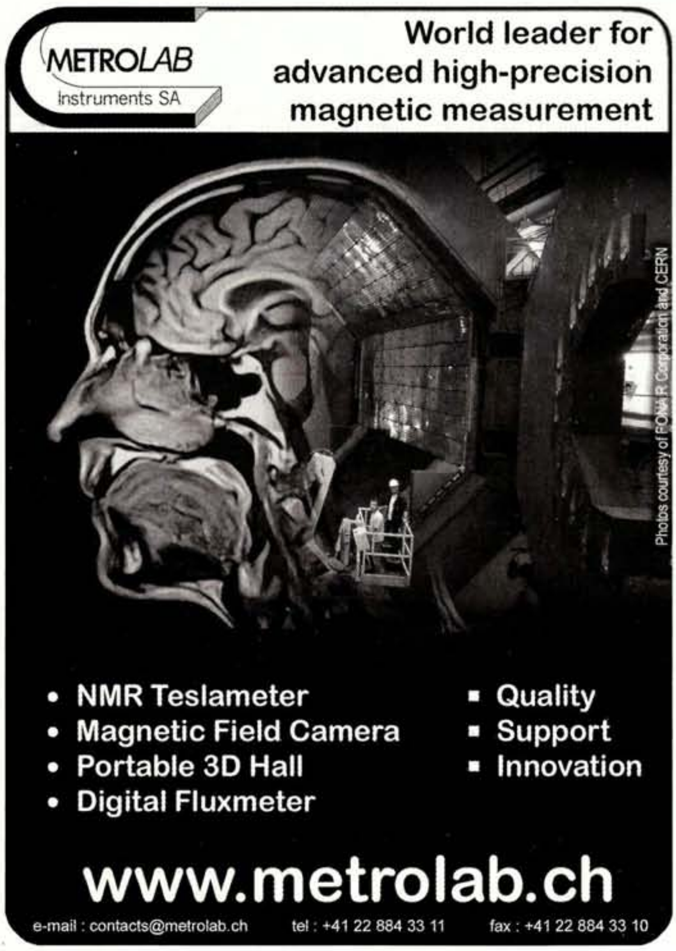
The VRVS system was fundamental to many of the demonstrations. It showed its use for international collaboration in virtual organizations, as well as in e-learning and e-lectures of several varieties, including Tokyo Lectures, a global teaching project in modern artificial intelligence in conjunction with the Swiss Education and Research Network; an impromptu presentation from the stand to the e-health conference in London; and direct sessions to the Internet2 conference in Indianapolis, including the ceremony where Harvey Newman from Caltech and Olivier Martin from CERN jointly received two Internet2 Landspeed Record awards over the Internet and announced that these records had already been broken again during Telecom World 2003 (see *CERN Courier* December 2003 p36).

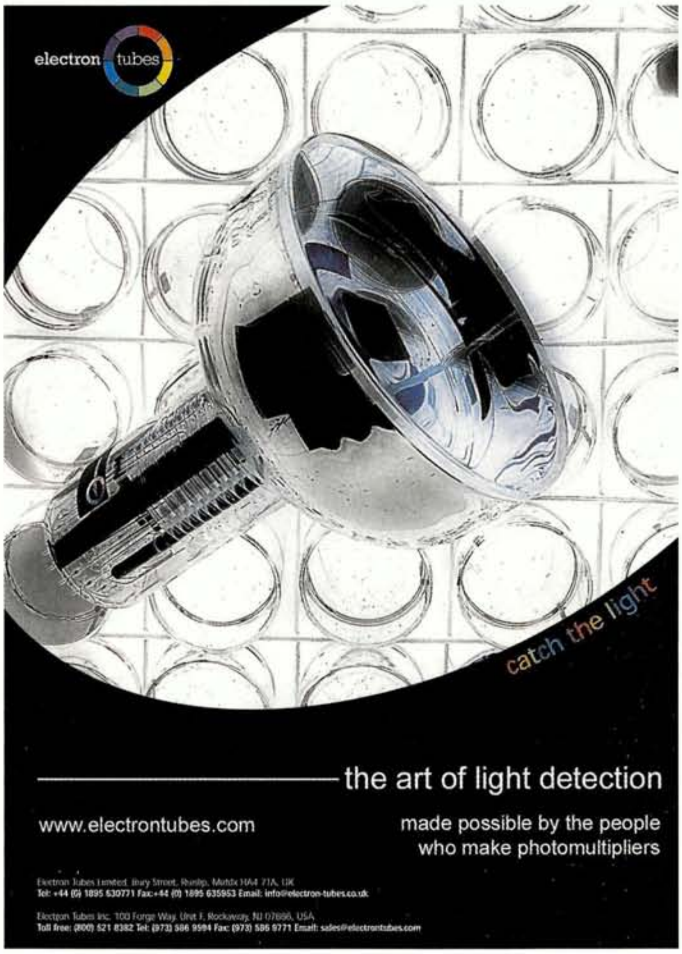
The ICT4D exhibition included a "touch and feel" haptic-feedback demonstration between Geneva and Ottawa. (Photo: Daniel Davids.)

VRVS was also used when the Romanian president, Ion Iliescu, made an extended visit to the ICT4D stand at WSIS and participated in a videoconference with his compatriots back in Bucharest. President Iliescu was also able to appreciate the efforts of his compatriot Iosif Legrand, who has made the major contribution to MonALISA. E-learning and the global transmission of lectures is a strong point of such systems, especially in the context of WSIS, and plans for such exploitation are now taking off in a really meaningful manner.

Two of the highlights on the ICT4D stand were provided by a collaboration with the Communications Research Centre in Canada. A remote "touch and feel" demonstration of haptic feedback allowed visitors to the stand in Geneva to "shake hands" with people in Ottawa and to feel the body of a dummy, as is necessary in telemedicine. This equipment is being used on a real basis in Canada for trials of remote operations. The final "bouquet" was a jazz concert, with musicians on both sides of the Atlantic playing together. Musicians from the Geneva Conservatoire de Musique played along with those from the Holy Heart of Mary Secondary School in St John's in Newfoundland. This two-hour session demonstrated the well-developed ability of musicians to adapt to delays of a few hundred milliseconds, and the show was closed by a final jam session.

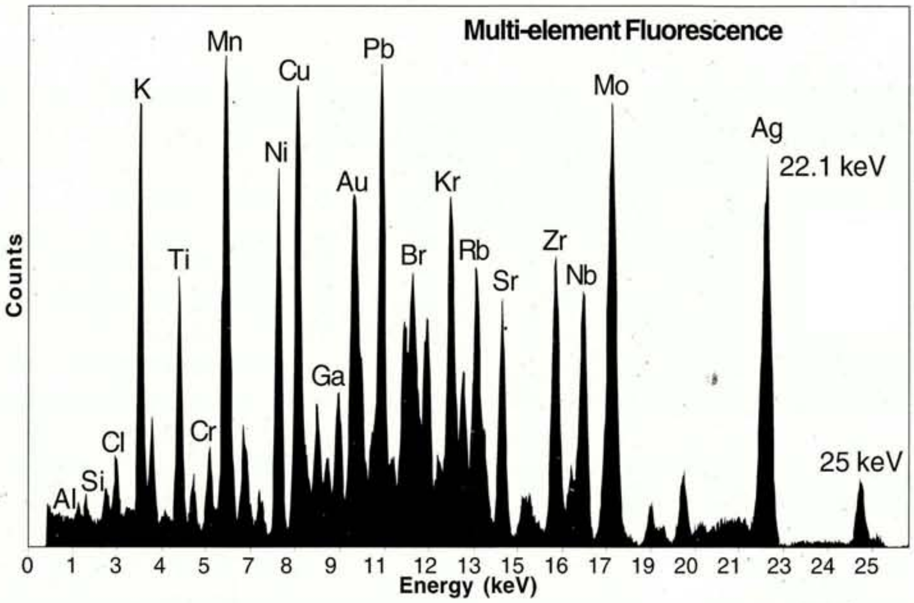
Chris Jones, *CERN.*





X-Ray Detector

XR-100CR at 186 FWHM Resolution



No Liquid Nitrogen!!!

Solid State Design

APPLICATIONS

- Nuclear Physics
- Synchroton Radiation
- High Energy Physics
- Neutron Experiments
- Astrophysics
- Research & Teaching
- Nuclear Medicine
- X-Ray Fluorescence

Easy - simple to operate and portable
Performance - approaching that of Si(Li) detectors
Affordable - visit www.amptek.com

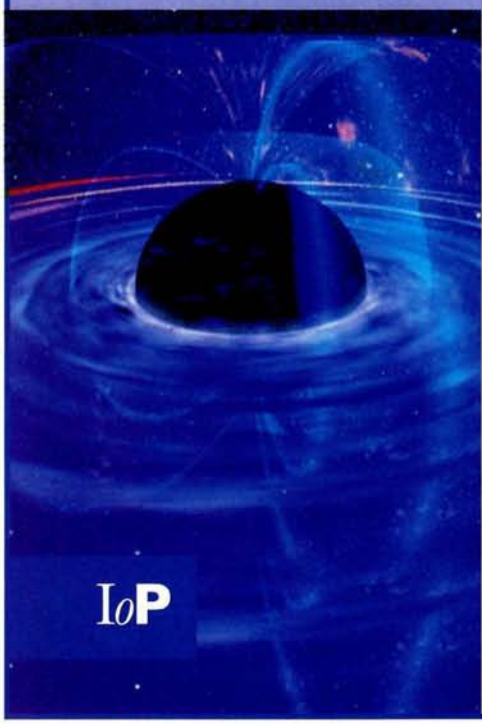
XR100CR X-Ray Detector with Power Supply & Amplifier

XR100CR fitted for vacuum applications

AMPTEK Inc.
6 De Angelo Drive, Bedford, MA 01730-2204 USA
Tel: +1 (781) 275-2242 Fax: +1 (781) 275-3470
E-mail: sales@amptek.com **www.amptek.com**

CERN COURIER

Unrivalled authority with international reach



If you want your advertisement to be seen by more than 70 000 key buyers and influential figures in the physics industry, you should be using *CERN Courier* in your marketing campaign.

- For 40 years *CERN Courier* has been the only dedicated international particle-physics magazine.
- Our readers are in every major principal research site worldwide, working on high-budget projects such as the Large Hadron Collider and the Spallation Neutron Source.
- Your message is guaranteed to target a global audience in all major physics sectors.
- There is bonus distribution at all of the industry's major shows

***CERN Courier* provides the ideal opportunity to promote your product and reinforce your corporate identity. For further information on the advertising options available, contact our dedicated and experienced sales team.**

Jonathan Baron, Ed Jost
Tel: +44 (0)117 929 7481 Fax: +44 (0)117 930 1178
E-mail: sales@cerncourier.com
cerncourier.com/media

The atomic nucleus as a laboratory

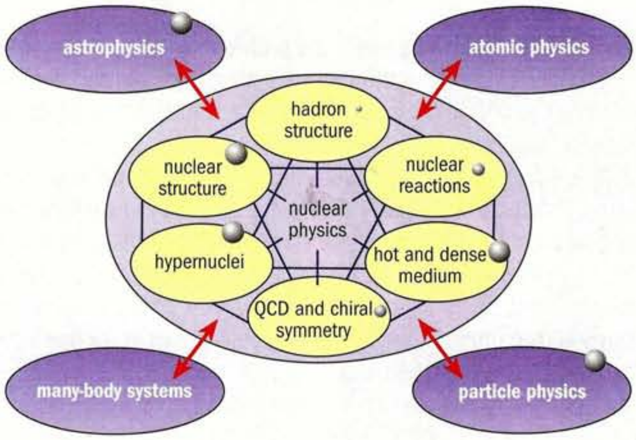


Fig. 1. The variety of fields in modern nuclear physics.

The 28th Mazurian Lakes Conference on Physics, which took place from 31 August to 7 September 2003 in Krzyze, Poland, looked at the atomic nucleus as a laboratory for fundamental processes.

The Mazurian Lakes meeting, held in a picturesque region with thousands of lakes and forests, has evolved from a bi-annual school on nuclear physics into the conference it is nowadays. At the same time, nuclear physics has also evolved, so that it now contains many more subfields than the traditional areas of nuclear structure and reactions (figure 1). The 2003 meeting covered several of these subfields and included important excursions into astrophysics (neutron stars and supernovae) and particle physics (neutrinos).

There was a special anniversary touch to the subjects of the 2003 conference. In 1953 the first hypernucleus was observed in Warsaw by Marian Danysz and Jerzy Pniewski, followed by the discovery of a double hypernucleus by the same two physicists. Fifty years later, the physics of hypernuclei is experiencing a large-scale revival, in particular with the FINUDA program at DAFNE in Frascati (*CERN Courier* April 2003 p13) and the PANDA project at GSI in Darmstadt, both of which were the subject of presentations at the conference. Andrzej Wróblewski from Warsaw gave a historical review, describing – with many previously unknown or neglected details – the turbulent history of hypernuclei and strangeness, their discovery and progress in the field during the past half century.

Strange behaviour

Numerous hypernuclei containing a single-Λ particle and a few double-Λ hypernuclei have now been discovered and studied experimentally. However, compared with the enormous amount of data and knowledge that has been accumulated over the years for normal nuclei, relatively little is still known about hypernuclei. The reasons, of course, lie in the difficulties related both to producing them and studying them within the narrow window of their lifetimes. At the meeting, Yusuke Miura from Tohoku talked about the recent important progress in the γ-spectroscopy studies of hypernuclei. The basic strengths of Λ–Λ versus nucleon–Λ interactions, which were discussed by Abraham Gal from Jerusalem, are still being debated, but some conclusions can be drawn from the simplest binding-energy differences between single-Λ and double-Λ hypernuclei.

Both Wanda Alberico of Torino and Hyoung Chan Bhang of Seoul discussed the weak non-mesonic decay rates of hypernuclei. The long-standing and still-debated issue here is the so-called Γ_n/Γ_p puzzle, i.e. the fact that the observed widths for $\Lambda + n \rightarrow n + n$ decays seem to be much larger relative to $\Lambda + p \rightarrow n + p$ than those that were obtained theoretically. However, the recent progress, both in theory and in experiment, seems to yield more convergent results.

Helmut Oeschler from CERN and Helena Bialkowska from Warsaw presented some theoretical and experimental studies that aim at seeing the quark–gluon plasma (QGP) through the "lens" of strangeness production in high-energy heavy-ion collisions. If a flavour-equilibrated fireball of quark matter is produced in energetic nucleus–nucleus collisions, then the production of strange and non-strange particles should be comparable. This can be quantified in the form of the Wróblewski factor, $\lambda_S = 2s\bar{s}/(u\bar{u} + d\bar{d})$, and studied through the production of strange mesons, strange baryons, or hidden strangeness. However, experimental maxima in λ_S, which reach values of approximately 0.6, can also be explained in a statistical model by a kinematical cut through the T–μ_B plane (where T is temperature and μ_B is baryon chemical potential). These maxima therefore do not necessarily signal the presence of the QGP. Other signals, such as an atypical energy dependence for strangeness production, may also be invoked but must be confronted with data from hadron–hadron and hadron–nucleus collisions.

Nuclear medium and nuclear matter

The question of how to measure the hadron mass in the nuclear medium was discussed by Piotr Salabura from Cracow. He argued that the two-body decays into e^+e^- pairs could be used to measure the invariant mass of a decaying hadron directly, because leptons travelling through the nuclear medium are not perturbed in their final states. Dalitz decays, in which the e^+e^- pair is accompanied ▷

by a hadron, can also be used; the problem here lies in the necessity of disentangling contributions coming from various decaying hadrons. The HADES experiment at GSI in Darmstadt is directed at studies of this kind.

A very interesting idea to study the equilibration process in nucleus–nucleus collisions – that is, the extent to which they come to equilibrium in an intermediate state – was discussed by Norbert Herrmann from Heidelberg. By using projectiles and targets that have different isospin compositions, one can, in a sense, tag the nucleons that originate from the projectile or target, to see if they bounce off each other, equilibrate, or pass each other. Experimental data obtained at GSI at the heavy-ion synchrotron, SIS, at energies of 100–200 A MeV clearly indicate that the colliding systems are never fully stopped and that the transparency increases with incident energy. Thus, at least in this case, we have a clear experimental indication that the systems are not really equilibrated.

At a completely different scale of energies of 130 and 200 GeV, studied at Brookhaven's Relativistic Heavy Ion Collider (RHIC), Terry Awes from Oak Ridge compared the nuclear modification factors for Au + Au and d + Au collisions in order to pin down the so-called jet-quenching effect (*CERN Courier* September 2003 p18). At these energies, jets of particles are produced when the projectile and target quarks collide and create flux tubes that then break into colourless hadrons. The nuclear modification factor gives a rate of the production of a given hadron in a nucleus–nucleus collision relative to that for a proton–proton collision. It is supposed to tell us how much the medium in which the particle is produced influences the observed outflow of particles after the collision. For a fairly wide region of transverse momenta, the values of the d + Au modification factor are close to 1, while those for Au + Au are suppressed at about 0.3. This is a strong indication that a new kind of medium (possibly the QGP) is created in the Au + Au collisions.


The Mazurian conference participants at the lakeside.

Neutron stars and neutrinos

In the session on astrophysics, Karlheinz Langanke from Aarhus talked about how the properties of stellar objects may depend strongly on detailed nuclear-structure properties. First he showed the impressive results of large-scale shell-model calculations for the Gamow–Teller strength distributions. These calculations agree incredibly well with the newly measured data (obtained with 100 keV resolution), indicating that the low-energy nuclear properties are kept well under control by using two-body interactions in a restricted valence space. Then he showed how similar calculations, performed in heavier nuclei within the Monte Carlo shell model, modify simplistic electron capture rates, which have been used up till now to model supernovae explosions. The effect is truly dramatic because the capture on nuclei now turns out to be more important than the capture on protons as assumed previously. During a special session, Piotr Magierski from Warsaw, the winner of the 2003 Zdzislaw Szymanski Prize, also talked about neutron stars when he gave a lecture on the thermodynamic properties of the neutron star crust.

At the frontier between astrophysics and neutrino physics, there were two interesting talks about stellar objects viewed through their neutrino emission. Matthias Liebendörfer from Toronto has investigated the time and energy characteristics of neutrinos emitted during a supernova explosion. If such an explosion happens again nearby, we may be able to learn from the observed neutrino flux about how such an event proceeds, provided we have a good model at hand. Dima Yakovlev from St Petersburg and Pawel Haensel from Warsaw both talked about neutron-star cooling due to neutrino emission and strange particles in the core. Since the cooling process crucially depends on details of occupations near the Fermi surfaces, and thus on correlations, proton and neutron pairing in the neutron star matter may strongly influence the rate of cooling. Experimental data seem to suggest that proton pairing may be preferred over neutron pairing.

Among several talks on neutrino physics, Yuri Kamyshkov of Oak Ridge and Joanna Zalipska of Warsaw presented experimental studies performed at the KamLAND and Super-Kamiokande facilities, respectively. They discussed neutrino oscillation phenomena studied by the observations of reactor electron antineutrinos and atmospheric muon neutrinos, and the so-called large mixing angle solution for the neutrino mass difference and mixing angle.

Calculating the nucleus

Wolfram Weise from Trento presented studies at the triple frontier between quantum chromodynamics (QCD), the hadronic medium and nuclear structure. Recent developments in this field are fascinating because we may be witnessing the birth of derivations of nuclear forces from first principles, and an explanation of nuclear binding based on QCD. By applying ideas based on chiral symmetry breaking, the chiral condensate and effective field theory (EFT), we can describe nucleon–nucleon (NN) scattering and finite nuclei almost directly from low-energy QCD considerations. One starts by postulating the chiral Lagrangian of nucleons and pions, then adding symmetry-dictated contact terms that are supposed to describe all unresolved high-energy effects. Such a result shows that the short-distance NN repulsion does not need to be modelled by any kind of hard-core potential or heavy-meson exchange potential, but is a generic feature of these unresolved high-energy effects. As Weise explained, one may perform in-medium chiral calculations and derive the energy-density functional, which within the relativistic-

The regatta is a highlight of the meeting and this year's sailing race was won by Krystyna Wosinska of Warsaw Institute of Technology.

mean-field approximation is directly applicable to finite nuclei. At the expense of fitting one parameter – the EFT cut-off energy – the correct saturation energy, saturation density and symmetry energy can be obtained. From there, standard nuclear-structure calculations lead to describing nuclear masses (only for N = Z nuclei at present) with a precision of about 1 MeV.

Witek Nazarewicz of Oak Ridge and Warsaw talked, among other things, about recent progress in the exact calculations for low-energy states in light nuclei. There, the necessity for NNN interactions has been convincingly shown. Moreover, the NNN forces may also be responsible for a known inadequacy of the G-matrix method to derive the shell-model interactions. Nazarewicz discussed the challenges that nuclear-structure theory faces in describing exotic systems such as those with very large neutron or proton excess, very large angular momentum, or very large mass. In view of the important projects to study these exotica in experiments (RIA, GSI, RIKEN, EURISOL, etc), theoretical efforts in these domains must also be adequately expanded.

In two more talks, Marek Ploszajczak from GANIL and Krzysztof Rykaczewski from Oak Ridge discussed other aspects of exotic nuclei. Ploszajczak presented methods that combine advanced descriptions of bound nuclear states with equally advanced descriptions of scattering states. For weakly bound nuclei, such combined methods are essential. Unfortunately, however, they remained neglected for too long a time because of the necessity to treat expertly two fairly different physical situations. The so-called Gamow shell model has recently been devised to remedy this through a shell-model-like treatment of the particle continuum. Rykaczewski showed that, on the other side of the mass table, i.e. for proton-unstable nuclei, proton emission could be used as a fantastically efficient probe of nuclear states. By a careful analysis of proton radioactivity in deformed nuclei, we can explicitly see that the initial proton really is in a deformed state. This is one of the nicest examples of how spontaneous symmetry breaking works in finite systems.

Recent advances in experimental verifications of the Standard Model of particle physics were also presented at the conference, in the talk by Krzysztof Doroba of Warsaw. He described experiments that precisely measure the mass, width and other characteristics of the Z and W bosons, and convinced us that once these basic physical constants are measured many things can be calculated rigorously within the Standard Model. Some recent novelties were also reported, with Hideki Kohri from Osaka talking about the observation of the pentaquark baryon, Θ (*CERN Courier* September 2003 p5).

Looking to the future of experiments in nuclear physics, Peter Senger from Darmstadt gave a very interesting account of the international accelerator facility planned for GSI. He described the main scientific directions in which the facility will aim, namely hadron spectroscopy, the structure of nuclei far from stability and compressed baryonic matter, which will make it a true nuclear-physics facility! This is a superb project that will provide a tremendous amount of data and boost our knowledge of nuclear systems. We all hope that the missing 25% of European funding will be found, and that the project will go ahead at full steam as rapidly as possible.

Altogether about 100 participants – experienced lecturers as well as young PhD students – attended the conference, coming from 14 countries; mostly European but also from China, Israel, Russia and the US. Whilst evolving, the school/conference has maintained most of the traditions for which it is widely known. Matching the scientific programme were a number of social highlights. Two of these are hallmarks of the Mazurian meetings: the first-class chamber music in the local church (the Warsaw string quartet, Camerata, with Samuel Barber, Karol Szymanowski and Johannes Brahms) and of course the regatta, with the the sailing race being won by a woman, Krystyna Wosinska, for the first time. The conference was organized by the Andrzej Soltan Institute for Nuclear Studies in Swierk and Warsaw University, and thanks to the support of the European Physical Society, young European physicists could apply for grants to attend.

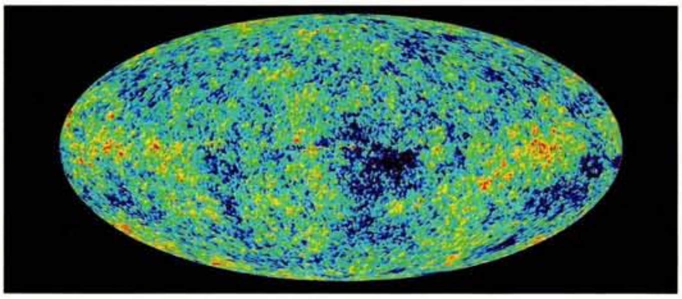
Further reading

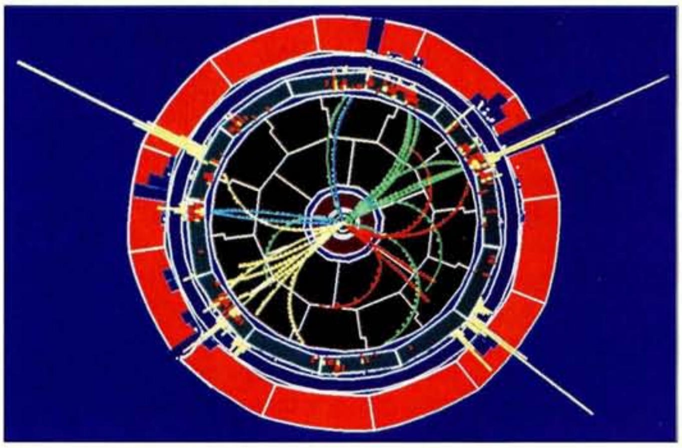
For more details about the conference, see: http://zfjavs.fuw.edu.pl/mazurian/mazurian.html.

Helena Bialkowska *and* **Ziemowid Sujkowski**, *Soltan Institute for Nuclear Studies, and* **Jacek Dobaczewski**, *Warsaw University.*

PHYSTAT 2003: statistics for quarks and quasars

Astronomers, cosmologists, particle physicists and statisticians came together at SLAC to learn from each other about different aspects of statistical analysis techniques. **Glen Cowan** reports.





Statistical analysis techniques are equally fundamental in producing, for example, this image (top) from the WMAP collaboration, which reveals temperature fluctuations in the early universe (shown as colour differences), or in searching for the Higgs boson in events such as these from the ALEPH experiment (bottom). (WMAP photo courtesy of NASA/WMAP Science Team.)

Given the impressive price tags of particle accelerators and telescopes, scientists are keen to extract the most from their hard-won data. In response to this, statistical analysis techniques have continued to grow in sophistication. To discuss recent developments in the field, 124 particle physicists, cosmologists, astronomers and statisticians met last September at SLAC for PHYSTAT 2003, the International Conference on Statistical Problems in Particle Physics, Astrophysics and Cosmology.

PHYSTAT 2003 was the most recent of several fruitful meetings devoted to data analysis, including the workshops on confidence limits at CERN in 2000 and Fermilab in 2001, and the Durham Conference on Advanced Statistical Techniques in Particle Physics in 2002. In contrast to these, however, PHYSTAT 2003 brought high-energy physicists together with astronomers and cosmologists in an effort to share insights on what for all has become a crucial aspect of their science. Conference organizer Louis Lyons of Oxford explained that, "In particle physics, astrophysics and cosmology, people work with different tools – accelerators versus telescopes – but nonetheless a lot of the data analysis techniques are very similar."

Another difference from previous meetings was the strong presence of the professional statistics community. Half of the invited talks were by statisticians and the keynote address, "Bayesians, frequentists and physicists", was given by Brad Efron of Stanford, the president of the American Statistical Association.

Old and new directions

Driven by the need to understand advanced data analysis methods, many experimental collaborations have recently established statistics working groups to advise and guide their colleagues. Frank Porter of Caltech gave the view from the BaBar collaboration, which studies the decays of more than 100 000 000 B mesons produced at the PEP-II B-factory at SLAC. Porter observed that, "statistical sophistication in particle physics has grown significantly, not so much in the choice of methods, which are often long-established, but in the understanding attached to them."

Multivariate methods emerged as one of the most widely discussed issues at the meeting. In a high-energy particle collision, for example, one measures a large number of quantities, such as the energies of all of the particle tracks. In recent years physicists have become accustomed to using multivariate tools such as neural networks to reduce these inputs to a single usable number. It appears that the statistics community has moved on and that neural networks are no longer considered as "cutting edge" as other techniques, such as kernel density methods, decision trees and support vector machines. Statistician and physicist Jerome Friedman of Stanford reviewed recent advances in these areas, noting that: "As with any endeavour, one must match the tool to the problem."

The Reverend Bayes reloaded

The long-standing controversy between frequentist and Bayesian approaches continued to provoke debate. The main difference boils down to whether a probability is meant to reflect the frequency of the outcome of a repeatable experiment, or rather a subjective "degree of belief". For example, a physicist could ask: "what is the probability that I will produce a Higgs boson if I collide together two protons?" A frequentist theory can predict an answer, which can be tested by colliding many protons and seeing what happens what fraction of the time. The same physicist could also ask: "What is the probability that the Higgs mechanism is true?" It either is or it isn't, and this won't change no matter how many protons we collide. Nonetheless, Bayesian or subjective probability can reflect our state of knowledge about nature.

Physicist Fred James from CERN noted that one of the most widely used frequentist techniques, Pearson's chi-square test, is used more than a million times per second in high-energy physics experiments, making it one of the most successful statistical devices in human history. On the other hand, Bayesian decision making is used implicitly by everyone every day. "Both of these elements must be part of every statistical philosophy," said James, who teaches statistics using a "unified approach". "If your principles restrict you to only one formalism, you won't get the right answer to all your problems." Members of the statistics community appeared to agree with this sentiment. Statistician Persi Diaconis from Stanford observed that in data analysis, as in other endeavours, it's not as if you are restricted to using only a hammer or a saw – you're allowed to use both.

Blinding bias

Many experimental groups have embraced "blind analyses", whereby the physicists do not see the final result of a complicated measurement until the technique has been adequately optimized and checked. The idea is to avoid any bias in the final result from prior expectations. Aaron Roodman of SLAC, working with the BaBar experiment, explained that the collaboration had initial reservations about the blind analysis technique, but that it has become a standard method. "Results are presented and reviewed before they are unblinded, and changes are made while the analysis is still blind. Then when an internal review committee is satisfied, the result is unblinded, ultimately to be published." Roodman noted that a similar practice in the medical community dates from the 17th century, when John Baptista van Helmont proposed a double-blind trial to determine the efficacy of blood letting!

For the particle physicists, finding an appropriate recipe for the treatment of systematic errors emerged as one of those problems that will not go away. With many measurements being based on very large samples of data, the "random" or "statistical" error in the result may become smaller than uncertainties from systematic bias. Pekka Sinervo of Toronto noted that many procedures exist more in the manner of "oral tradition". Sinervo pointed out that some systematic effects reflect a "paradigm uncertainty", having no relevant interpretation in frequentist statistics.

This focus on systematics seems not to have received comparable attention within the professional statistics community. John Rice from Berkeley noted in his conference summary, "Physicists are deeply concerned with systematic bias, much more so than is usual in statistics. In more typical statistical applications, bias is often swamped by variance."

A PHYSTAT phrase book

A panel discussion led by Diaconis, Friedman, James and Tom Loredo, of Cornell, provided an insight into how well the physicists, statisticians and astronomers succeeded in sharing their knowledge. Helped by introductory talks on statistics in high-energy physics by Roger Barlow of Manchester, and in astronomy by Eric Feiglson of Pennsylvania State, language barriers were largely overcome. Nevertheless, many astronomers and statisticians puzzled over "cuts", as physicists pondered "iid random variables" (identically and independently distributed).

Although the astronomers and physicists found much common ground, in a number of ways the approaches used by the two groups seemed to remain quite separate. John Rice noted in his summary, "High-energy physics relies on carefully designed experiments, and astronomy is necessarily observational. Formal inference thus plays a larger role in the former, and exploratory data analysis a larger role in the latter." With respect to the development of new techniques, Rice voiced some concern. "The explosion of computing power, coupled with unfettered imagination, is leading to the degeneration of the stern discipline of statistics established by our forebears to a highly esoteric form of performance art." However, he noted that "evolutionary pressures will lead to the extinction of the frail and the survival of the fittest techniques."

The local organizing committee at SLAC was chaired by Richard Mount and included Arla LeCount, Joseph Perl and David Lee; the scientific committee was led by Louis Lyons. To the dismay of the organizers, four of the invited speakers were unable to attend owing to recent difficulties in obtaining US visas (*CERN Courier* November 2003 p50). A future meeting is planned for 2005, by which time one hopes that this situation will improve. The conference proceedings are now in preparation and will appear as a SLAC publication. More information and links to presentations can be found on the conference website at: www-conf.slac.stanford.edu/phystat2003.

Glen Cowan, *Royal Holloway University of London.*

VAT® VACUUM VALVES
New 2004 catalogue available: www.vatvalve.com

German astroparticle p

Despite strong pressure on the budget for education and research, astroparticle physics in

On 16–18 September 2003 German astroparticle physicists and ministry representatives met at the University of Karlsruhe to discuss recent scientific advances, future funding and organizational support by the German Ministry of Education and Research (BMBF). The Karlsruhe workshop was the third in a series initiated by BMBF deputy director-general Hermann-Friedrich Wagner to maintain a close contact between scientists and the ministry. These open discussions have allowed each side to understand the other's needs better, and have led to the very fast and fruitful development of astroparticle physics in Germany.

As in the previous workshops, which took place in 1999 and 2001 at DESY Zeuthen (*CERN Courier* November 2001 p17), high-energy and nuclear physicists, astronomers and astrophysicists also joined and participated in lively cross-disciplinary debates. The large increase in the number of participants (rising from 57 and 124 in 1999 and 2001, respectively, to more than 240 in 2003) reflects the growing interest in astroparticle physics.

The workshop began with special lectures for students, and Werner Hofmann of MPI for Nuclear Physics, Heidelberg, gave an entertaining and surprising evening talk on two very different fictional futures of high-energy physics. Scientific achievements, future prospects and new ideas were then presented in sessions dedicated to selected astroparticle-physics topics.

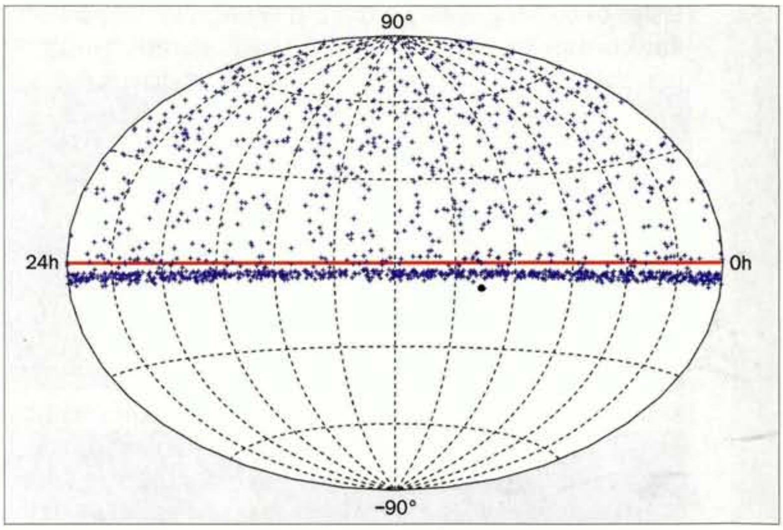


Fig. 1. The neutrino sky as seen by AMANDA-II. The map does not show any evidence for extra-terrestrial neutrino sources but is compatible with neutrino production by cosmic-ray interactions in the atmosphere.

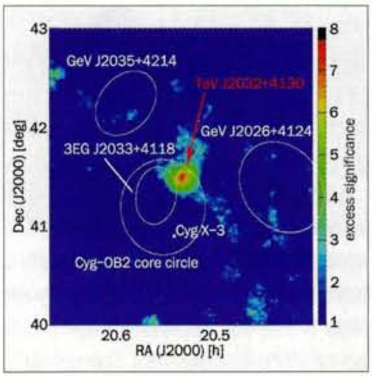


Fig. 2. The observation by the HEGRA experiment of a previously unknown source of TeV gamma rays in the Cygnus region. No counterpart at other photon energies has yet been found.

The Pierre Auger Observatory comb at the highest energies. Water tanks charged particles, while on dark night emitted as the showers cause fluores

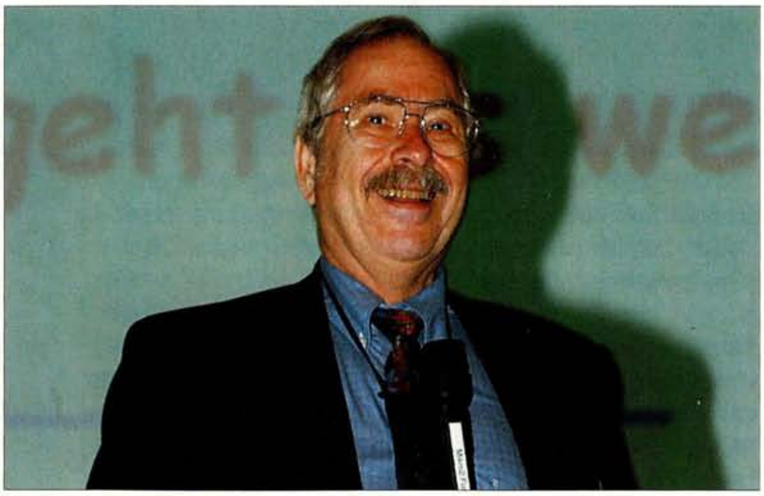
New astronomies

Wolfgang Rhode of Wuppertal and Jürgen Hößl from Erlangen-Nürnberg reported on the ongoing activities related to large-volume neutrino detectors in the Antarctic ice shield and in natural water in Lake Baikal and the Mediterranean sea. Results from AMANDA at the South Pole and BAIKAL are already beginning to constrain theoretical models on dark-matter annihilations, magnetic monopoles and astrophysical high-energy neutrino production. AMANDA has shown the first ever 100 GeV neutrino sky map and thus opened a new window for astrophysics (figure 1). As expected from the detector's moderate sensitivity, the sky map does not show evidence for extra-terrestrial neutrino sources, but is compatible with the predicted neutrino production by charged cosmic rays in the Earth's atmosphere. Based on this proof of principle, the significantly larger ICECUBE project is now under way. The first photomultiplier strings for the 1 km^3 detector will be deployed during the next Antarctic summer, in 2004/2005. The installation of all the strings will be finished in 2010. The ANTARES collaboration plans to install six detector strings in the Mediterranean by 2006 to test the experimental concept and address the first astrophysical questions (*CERN Courier* June 2003 p22). The possibility of realizing a km^3 detector in the Mediterranean seems, however, to depend not only on technology and engineering, but also on the strong will of the ANTARES, NEMO and NESTOR (*CERN Courier* November 2003 p23) collaborations to join behind one common proposal.

Götz Heinzelmann of Hamburg gave an introduction on high-energy gamma astronomy, focusing on the results of the imaging air Cherenkov telescopes (IACTs) of the HEGRA (High Energy Gamma Ray Astronomy) detector on La Palma in the Canary Islands. The pioneering work of HEGRA on new experimental techniques and analysis methods has been extremely fruitful. Although the experiment shut down in 2002, surprising results

hysics shows its strength

Germany is becoming a strong and autonomous branch of science, as **Axel Lindner** explains.



Hermann-Friedrich Wagner, deputy director-general of the German Ministry of Education and Research, welcomes the participants of the workshop. He initiated the series in 1999 and contributes a great deal to the organization of astroparticle physics in Germany and Europe.

mbines techniques used in earlier experiments to study cosmic-ray air showers nks such as the one on the right, detect Cherenkov radiation produced by nights optical detectors housed in larger buildings (left) record the faint light orescence of atmospheric nitrogen. (Photos: Pierre Auger Laboratory.)

have since been announced: TeV gamma rays from the shell-type supernova remnant Cassiopeia A may indicate that this source accelerates nucleons to relativistic energies. This observation could be a key to the solution of the 90-year-old mystery of the acceleration sites of cosmic rays. The HEGRA collaboration also presented the first TeV gamma source unidentified at other wavelengths (figure 2), thereby giving an insight into a previously unknown area of the relativistic universe.

Many even more exciting results are expected with the new generation of IACTs now coming into operation. These experiments will be an order of magnitude more sensitive and will provide a reduced energy threshold. Werner Hofmann presented first results of the HESS (High Energy Stereoscopic System) detector in Namibia (*CERN Courier* November 2002 p7), and Florian Goebel from MPI for Physics, Munich, reported on the status of the MAGIC telescope at La Palma (*CERN Courier* December 2003 p7). Measurements of the cosmologically important extragalactic background light, of dark-matter annihilations, and perhaps even of hints on quantum gravitation are to be expected. Roland Diehl and Gottfried Kanbach, both from MPI for Extraterrestrial Physics, Garching, Martin Merck of Würzburg, Hinrich Meyer of Wuppertal and Masahiro Teshima from MPI for Physics, complemented the session with talks on gamma-ray astronomy with satellites, new ideas for IACTs, and the ultra-high-energy cosmic-ray detector, EUSO, which will be based on the International Space Station (ISS).

Charged cosmic rays

Air shower experiments on the energy spectrum and mass composition of charged cosmic rays focus on the so-called knee region around 10^{15} eV, where the slope of the energy spectrum suddenly changes, and on the highest energies beyond 10^{19} eV. Peter Biermann from MPI for Radioastronomy, Bonn, summarized the current theoretical models, while Andreas Haungs from the Research Centre Karlsruhe explained the still puzzling experimental situation around the knee. Data from the KASCADE experiment at Karlsruhe hint at a knee position proportional to the charge, Z, of the nuclei in cosmic rays, but uncertainties in the interpretation of the air shower data remain. At present no simulation is able to provide a consistent description of all KASCADE's data on particle interactions in the atmosphere; more multi-parameter data are required. In recent years KASCADE has been expanded to KASCADE Grande (covering 640 000 m^2), which will extend the accessible energy range up to 3×10^{17} eV. KASCADE Grande should be able to identify the knee for iron-like nuclei and hence prove the above-mentioned Z dependence. This would strongly support the assumption of cosmic-ray acceleration in the shells of supernova remnants – as is also implied by the HEGRA Cherenkov telescope data on Cassiopeia A.

Karl-Heinz Kampert of Wuppertal reported on the experimental situation at the highest cosmic-ray energies. Data from the Akeno Giant Air Shower Array (AGASA) in Japan provide strong evidence for the existence of cosmic rays with energies beyond the Greisen–Zatzepin–Kuzmin (GZK) cut-off – the energy threshold of pion production due to the interaction of very energetic protons with the cosmic 2.7 K background radiation. By contrast, data from the HIRES detector in the US are also compatible with the existence of the GZK cut-off. This discrepancy should be resolved by the 3000 km^2 AUGER ▷

experiment in Argentina (*CERN Courier* December 2003 p11). AUGER will provide much larger event statistics at the highest energies and combine the experimental techniques of AGASA and HIRES to minimize systematic uncertainties. The first data for extended air showers have already been taken successfully, while the production of detector components for AUGER will be finished in 2005. Hans Klages from the Research Centre Karlsruhe described possible expansions of AUGER on its southern and northern sites and stressed the sensitivity of AUGER to neutrino-induced horizontal air showers.

Heino Falcke from MPI for Radioastronomy and the University of Nijmegen, reported on a prototype set-up to detect radio emission from air showers. This project was launched after a discussion at the 2001 astroparticle workshop at DESY Zeuthen, and combined data taking with KASCADE has just begun. With a proof of principle at KASCADE, radio detection of air showers would allow the realization of inexpensive and very extended air shower experiments. Rolf Nahnhauer of DESY presented studies on the acoustic detection of neutrino interactions in ice and water, which potentially would also make extended and inexpensive set-ups possible. Manfred Simon of Siegen closed this session with a summary of the status of the PAMELA experiment, which is to be launched in 2004.

Cosmology and dark matter

Hans Böhringer from MPI for Extraterrestrial Physics opened the session on cosmology and dark matter with a talk on the astrophysical evidence for the existence of dark matter. The recent detailed data of the WMAP satellite on cosmic background radiation rule out the as-yet alternative scenarios of modified Newtonian dynamics (MOND) models. Wolfgang Seidel from MPI for Physics then summarized experimental attempts to detect dark-matter particles directly. The positive evidence published by the DAMA collaboration is still controversial. New experiments with event-by-event background suppression through the simultaneous measurement of heat and ionization are beginning to overtake the sensitivity of older large-mass detectors. In the near future an increase in sensitivity by two orders of magnitude will be reached by different experiments. Wim de Boer of Karlsruhe hinted at a surprising concordance: both the not very well understood galactic emission of GeV photons and the measured amount of positrons and antiprotons can be described very well hypothetically if neutralino annihilations are taken into account together with standard astrophysics. However, experimental uncertainties and a lack of knowledge about the astrophysical sources in the galaxy still prevent firmer conclusions on the existence of supersymmetric particles. Next-generation dark-matter experiments, the indirect searches with IACTs, and the AMS-II experiment on board the ISS will help to clarify the situation.

Dieter Hoffmann from the Technical University of Darmstadt presented the successful start-up of the CAST experiment at CERN, which is looking for axions from the Sun. This experiment is an example of the symbiosis of different branches of physics in astroparticle physics: CAST uses an old prototype magnet for the Large Hadron Collider, combined with particle-physics detectors and X-ray techniques from space-born experiments. Finally, Jens Niemeyer of Würzburg presented the current understanding of the most mysterious ingredient of our universe, dark energy.

The CAST experiment at CERN, which is looking for axions from the Sun. It uses a prototype magnet for the Large Hadron Collider combined with particle-physics detectors and X-ray techniques from space-born experiments.

Further topics

Christian Weinheimer of Bonn began the session on neutrino masses and low-energy neutrino astronomy with an overview on the limits on neutrino masses derived from astrophysical observations. Although new astrophysical data are already quite sensitive to neutrino properties, firm model-independent measurements of the neutrino mass require analysis of the endpoint of the energy spectrum in beta decays. Here the KATRIN experiment at Karlsruhe, which should start up in 2007, will improve the sensitivity of the current experiments by an order of magnitude, to 0.2 eV. Supplementary experiments will look for neutrinoless double-beta decays. Stefan Schönert from MPI for Nuclear Physics reported on a proposal for a corresponding initiative to realize a large-scale ^{76}Ge underground detector, and Thierry Lasserre of CEA proposed new reactor neutrino experiments to determine mixing parameters. Franz von Feilitzsch from the Technical University of Munich presented the status of low-energy neutrino astronomy, focusing on the Gallium Neutrino Observatory and the somewhat unlucky BOREXINO experiment, which was at the origin of the environmental issues at the Gran Sasso underground laboratory (*CERN Courier* September 2003 p6). However, BOREXINO is still important as the ultimate test of astrophysical models of the Sun.

Lothar Oberauer, also from the Technical University of Munich, described a feasibility study for a 30 kilotonne liquid-scintillator underground detector and its fundamental impact on geophysics, astrophysics, neutrino physics and proton-decay searches. Such an experiment on Low Energy Neutrino Astrophysics (LENA) would also be sensitive enough to detect relic supernova neutrinos, and hence provide data on the history of star formation. A large European initiative will be necessary to realize LENA. Hans Thomas Janka from MPI for Extraterrestrial Physics complemented the session with a presentation on supernova neutrinos.

Karsten Danzmann from MPI for Gravitational Physics, Hannover/Golm, gave a summary on the status of laser interferometer experiments to detect gravitational waves. Four first-generation experiments – GEO600 near Hannover, LIGO at two sites in the US, TAMA close to Tokyo and VIRGO near Pisa – have begun to or will take data within the next year. Their observation programmes are coordinated to increase the probability of correlated detections. Second-generation experiments are already planned (LIGO with the GEO600 technique) and the path to even more ambitious experiments seems to lie straight ahead, pointing to the ultimate challenge of observing primordial gravitational waves. The Big Bang Observatory could be realized around 2020.

Franz Käppeler from the Research Centre Karlsruhe stressed the need for the central topics of nuclear astrophysics of precise measurements of cross-sections, as well as of the lifetimes and masses of neutron-rich isotopes. Experimental uncertainties on these quantities currently limit our understanding of the energy production in stars and nuclear synthesis.

A strong future

Looking ahead, Hermann-Friedrich Wagner announced that from 2005 the funding of astroparticle physics in German universities will change from the present start-up scenario to a three-year periodic scheme, as applied, for example, in high-energy, nuclear and astrophysics. This decision means that astroparticle physicists in Germany can now make plans on a solid funding basis. In addition, the German Helmholtz association of large research centres now supports so-called "virtual institutes". These networks will strengthen the co-operation of university groups and research centres.

The maturity astroparticle physics has now reached and the self-confidence of its proponents was also visible at the workshop with the establishment of the KAT (Komitee für Astroteilchenphysik) committee. KAT will be an elected committee responsible for expressing the opinions and needs of astroparticle physicists in Germany, and will be a negotiation partner for similar groups in other branches of physics, funding agencies and international organizations.

On the European scene APPEC, the Astroparticle Physics European Coordination (*CERN Courier* July/August 2002 p6) has grown through new members Belgium, Greece, Spain and Poland. APPEC, as Thomas Berghöfer and Christian Spiering of DESY reported, is continuing its peer reviews of major astroparticle-physics activities in Europe. The ILIAS (Integrating Large Infrastructures for Astroparticle Science) proposal, triggered by APPEC as a joint proposal, was recently funded by a €7.5 million grant within the EU's 6th Framework Programme.

This third workshop on the status and perspectives of astroparticle physics in Germany has revealed a research field that has left its teenage years. Astroparticle physics is now much better anchored in Germany than it was three years ago. Fortunately, however, both the growing importance of astroparticle physics for fundamental physics and astrophysics, as well as the personal enthusiasm of the physicists in this field of research, have retained their youthful sprightliness.

• For further information on the workshop, visit the website at http://www-ik.fzk.de/workshop/atw.

Axel Lindner, *DESY.*

SUPPLIER INFORMATION

Janis Research Company Inc

Janis offers APD Cryogenics 10 K cryocoolers

Visit Janis at the APS March Meeting, Booth #900

Janis is pleased to announce that the original APD Cryogenics pneumatically driven, 10 K cryocoolers are once again available. These cryocoolers are supplied with either Janis cryostats or as "bare" systems, and are provided in either the DE-202 or DE-204SL configurations. A complete range of accessories and ancillary equipment are available.

Janis Research Company Inc, 2 Jewel Drive, Wilmington, MA 01887, USA
Tel: +1 978 657 8750
Fax: +1 978 658 0349
E-mail: sales@janis.com
Web: www.janis.com

SUPPLIER INFORMATION

- **Do you want to promote your latest catalogue?**
- **Have you recently upgraded your company website/ or do you just want to increase the traffic?**
- **Have you had a new product launch that you want to continue to promote?**

If you have answered YES to one or more of these questions, you should reserve your space on the Supplier Information page.

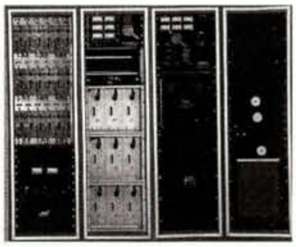
FOR ONLY £625, 50 WORDS OF TEXT AND AN IMAGE OF YOUR HOMEPAGE, LATEST CATALOGUE OR NEW PRODUCT CAN APPEAR ON THE NEXT SUPPLIER INFORMATION PAGE.

Call Jonathan Baron or Edward Jost on +44 (0)117 930 1265 or +44 (0)117 930 1026, respectively, to be included.

RF Amplifiers

QEI Corporation will design and manufacture to your RF Amplifier needs. Our 30 years of experience allows us to work with you to complete your requirements. Whether you require solid state or tube, air or water cooling, CW or pulse, LF to UHF, we can meet your needs. To discuss your project, contact QEI at 800-334-9154 (USA), 1-856-728-2020 (International), or via e-mail at qeisales@qei-broadcast.com.

8KW, 200MHz, CW, Water Cooled, Solid State RF Amp



65KW, 200MHz, CW, Single Tetrode RF Amp

QEI

QEI Corporation•One Airport Dr•PO Box 805•Williamstown, NJ 08094 USA•800-334-9154 (USA)
1-856-728-2020 (International) • qeisales@qei-broadcast.com (e-mail) •http://www.qei-broadcast.com

From 'tau' to 'top' – the man behind the Dalitz plot

Richard (Dick) Dalitz has spent more than 50 years in the study of elementary particles, the quark model and quantum chromodynamics. Here he talks to **Melanie O'Byrne**.

Let's start right at the beginning. Where were you born?
I was born in Dimboola, in the state of Victoria, Australia. Back then it was a town of about 2000 people, but it's more like 1000 today. It is by the Wimmera River, which carries rainwater falling inside the Great Dividing Range of Australia northwards until it sinks into the sands. My mother, a schoolteacher, was very keen that her children should have an education in Melbourne, so we moved there when I was two years old; all of my schooling was in Melbourne. At Melbourne University I took a four-year course for a Bachelor of Arts (Honours Mathematics) and a Bachelor of Science (Physics), and then I took my PhD in Cambridge.

Dick Dalitz – quark-model pioneer.

How did you become interested in science?
I was always interested in mathematics. Physics was a later interest, since it involved the use of mathematics.

What led you to Cambridge?
In 1946 I was awarded the Aitchison Travelling Scholarship of Melbourne University. I married at age 21 and took my wife with me [to Cambridge]. My supervisor there was Kemmer and my first aim was to learn how to use quantum mechanics. There wasn't much knowledge of that in Melbourne in those days.

What sparked your interest in quantum mechanics?
Quantum mechanics was essential for research in physics. Paul Dirac's *The Principles of Quantum Mechanics* was the book to study. Its first edition in 1930 was sparse in words and very difficult to read. The 1935 edition was rewritten but was unobtainable after the war. Dirac lectured from third-edition proofs in 1946 and I attended a second time in 1947, with my own copy. Mrs [Bertha Swirles] Jeffreys also gave very intelligible and useful lectures. Lectures were not required for postgraduate students, but we went along out of interest.

What was your PhD thesis work?
Its title was "Zero–zero transitions in nuclei". Primarily it was a study of the transitions from the first level of oxygen, which has spin-parity 0^+, to the ground state, which also has 0^+, together with a number of other topics added as appendices.

Was your thesis entirely theoretical?
Yes, it was entirely theoretical but it stemmed from experiments by [Samuel] Devons at the Cavendish Laboratory. After two years at Cambridge, I ran out of money. We had a young child by that time so I took up a one-year post at the University of Bristol.

What came next?
I was a student assistant to Professor Mott. He began in nuclear physics in the early 1930s but many students at the Cavendish Laboratory consulted him (himself a student) about their solid-state physics research. He did this so well that he quickly became known as a solid-state physics expert. He never found time to take a PhD himself. However, he recognized the high quality of the research being done by the Cosmic Ray Group on the fourth floor of the Physics Department at Bristol University. He wished to know more about this work and perhaps even to take part in it. This was the group of C F Powell, who not long before had identified the pion as Yukawa's nuclear-force meson. It was there that I learned about elementary particles first-hand, because they were the people finding them. Mott was in such demand in solid-state problems that I never managed to help him make the transition back to nuclear physics.

At Bristol I got involved in problems of cosmic-ray particles. I took a particular interest in the "tau meson", which we call the K^+ meson today. That tau meson decayed into three pions. I started collecting evidence about them and their decay configurations. Although I thought a lot about them, I did not do any work on them until I had completed my thesis in 1960, more than a year later.

This year at Bristol was vital for my development in many ways, a very important year for me, in my opinion. I was invited to join the department of Professor Peierls at Birmingham University. My first year there was mainly occupied with completing my thesis work. I was also learning how to use the quantum-electrodynamical methods of Feynman, which I used to generate a number of appendices to my thesis.

Did you stay at Birmingham after completing your thesis?

Yes, I wrote the thesis in the first year, then I was a research fellow and later a lecturer. It was a strong group, centred on Peierls. This was his style; Peierls supervised all of the students. He had a wide range of understanding in physics and in life.

I was very lucky. Dyson, who had worked in America showing that the theoretical formalisms of Feynman and Schwinger were equivalent, did so on a UK fellowship that required him to return to England for two years after his work there. He chose to work at Birmingham. He was in a fairly relaxed state then, because he'd done his most important work and so he had an amount of time to talk with me now and then. His presence, and my contact with him, was considerable and important for me.

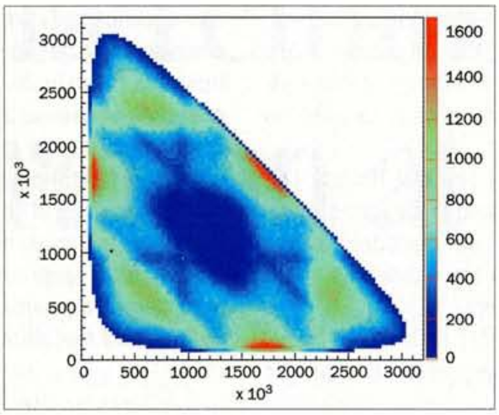
I did my work then [in 1951] on the neutral pion decay, to a photon and an electron–positron pair [the "Dalitz pair"], before moving on to the tau-meson decay, for which I devised a convenient representation, the so-called "Dalitz plot".

How did you come up with the Dalitz plot?

The Dalitz plot is a kind of map, summarizing all of the possible final configurations, each dot representing one event. I came at it from a geometrical perspective because I visualize geometry better than numbers. The idea was convenient then for all systems decaying into three particles. Tau-meson decay to three pions is particularly simple. With parity conservation (P), I used the plot to show that if the tau meson was also capable of decay to two pions, then the three-pion plot should show special features, which are absent in the data; and also to show that the tau meson had zero spin. If the K^+ meson can decay to three-pion and two-pion states, then these two final states must have opposite parity. These facts were the first intimation that P might fail for weak decay interactions.

When did you visit Cornell University, from Birmingham?

I was at Birmingham University from 1949 to 1953. Then I was given two years leave to work in America, primarily at Cornell University in Ithaca, upstate New York, in the group of Professor Bethe, at his invitation. He was a tremendous stimulation. Our names appear together on one paper, but our contributions were made at different places and different times. My work was mostly on pion–nucleon scattering and the production of pions. I was also very fortunate to be able to work at a number of places for short periods. I spent one summer at Stanford University, another at the Brookhaven National Laboratory and one semester at the Institute for Advanced Studies at Princeton.



A Dalitz plot from the Crystal Barrel experiment, for $p\bar{p}\rightarrow 3\pi^0$. The axes are $m(\pi^0,\pi^0)^2/(MeV)^2$ for each pair of π^0 mesons.

And when did you go to the University of Chicago?

I joined the faculty of the University of Chicago and its Enrico Fermi Institute for Nuclear Studies in 1956. After Fermi died in 1954, a number of senior theoretical physicists left Chicago – Gell-Mann went to CalTech, Goldberger went to Princeton University, and there were others. Those appointed to senior posts at the University of Chicago then had a tremendous opportunity – to build up groups again and get things going, with the junior faculty still to be appointed. There were quite a number of good students there too, many from other countries.

My interest in hypernuclear events developed particularly well in Chicago because a young emulsion experimenter, Riccardo Levi-Setti, whose work I had known from his hypernuclear studies at Milan, came to the Institute for Nuclear Studies at this time. We each benefited from the other, I think, and we got quite a lot done.

Did all of this happen over just two years in Chicago?

No, I was connected to the University of Chicago for 10 years in all. I enjoyed Chicago. I thought it a very interesting place and a very fine university. I approved of the way the university did things, although the place wasn't very fashionable with American physicists. At that time they tended to go to either the east coast or the west coast. Relatively few of them were interested in being in the middle of the country; perhaps more do these days.

After Chicago, you went to Oxford University

Peierls became the Wykeham professor of theoretical physics in Oxford, where there had not really been any central department for this. There were some individual theoretical physicists, but only a small number. Peierls brought all that together, and he was very keen for me to go back with him to Oxford.

I became a research professor of the Royal Society. They have no buildings for research, but they had funds and could appoint some researchers to be in various universities. I was responsible for organizing particle-physics theory in Oxford. Besides quark-model work, I still did work on hypernuclear physics, much of this with Avraham Gal of Jerusalem.

Life became increasingly busy as the years went by. I was attached to the Rutherford High-Energy Laboratory, as it was called in those days. They had their own accelerator and I was their adviser on theoretical matters. That was quite a happy arrangement, also.

I've heard scientists call you the "father of QCD". Do you think that's fair to say?

Oh, no. I wouldn't claim that. I first heard quark colours mentioned in a seminar by Gell-Mann. I just picked up the ball very quickly ▷

since this concept immediately resolved some deep difficulties with the quark model that we had adopted in 1965. Of course, many people wouldn't give any credence for the quark theory at that early stage, but I was always interested in it, and others came to Oxford to join in the work.

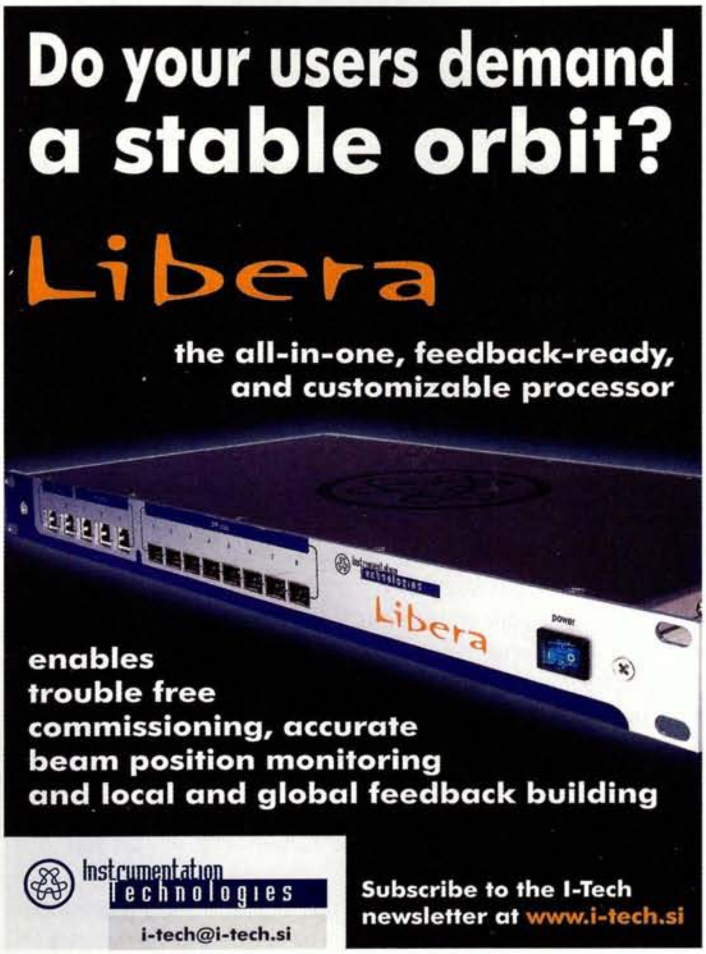
As time passed, heavier quarks, charm (c) and bottom (b), became established and we became interested in the spin correlations between the quark and antiquark jets from electron–positron annihilation events. Finally we came to the top quarks, for which these effects would probably be quite different.

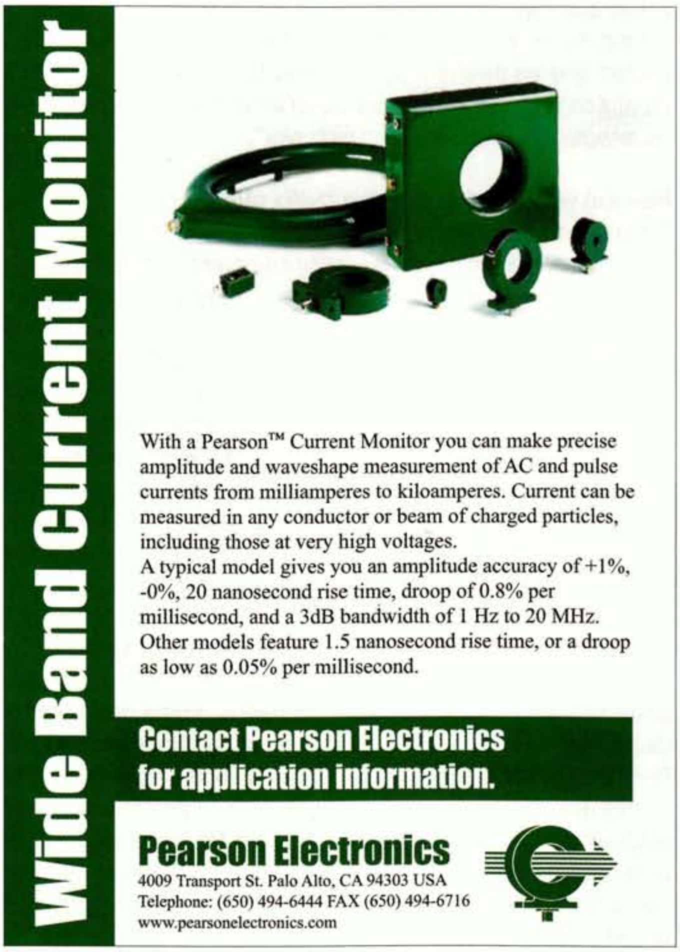
What was your involvement in the discovery of the top quark?
Two groups at the Tevatron (Fermilab) were doing experiments at sufficiently high energies to find the top (t) quark, but little was known about their progress. We – myself and Gary Goldstein (at Tufts University) – thought about the problems of how one might identify tops and antitops from the decay processes that seemed most natural for them, and worked out a geometrical method by which experimental data could be used to deduce the top quark mass.

It was known that there was one event that seemed to have the features needed – this had been shown at a conference by the CDF group at Fermilab – but which the CDF experimenters would not accept as a possible top–antitop production and decay event. Since they wished to determine the top pair-production cross-section, they had laid down fiducial limits for such events. However, these limits were not always relevant for determining the existence and mass of the top quark. Knowledge of this one event made us think very hard about devising this method – empirical data drive the theoretical mind! We tried out our method, with the conclusion that, if this event were top–antitop production and decay, the top quark mass must be greater than about 130 GeV, an unexpectedly large value. But of course this one event might not have been a top–antitop event. This could only be decided on the basis of a large number of observed events, all of them being consistent with a unique mass, and this was the case when the two experimental groups came to conclude later that the top mass was about 180 GeV.

You've had a lot of good fortune and hard work along the way!
Yes, I know...I'm very aware of that. I have been lucky.

Melanie O'Byrne, *Thomas Jefferson Laboratory, talked to* **Richard Dalitz** *during the 8th International Conference on Hypernuclear and Strange Particle Physics, held at Jefferson Lab in October 2003. This article is based on the interview published in Jefferson Lab's newsletter,* On Target, *in March 2004, and is published with the laboratory's permission.*





China reinforces collaboration at the LHC

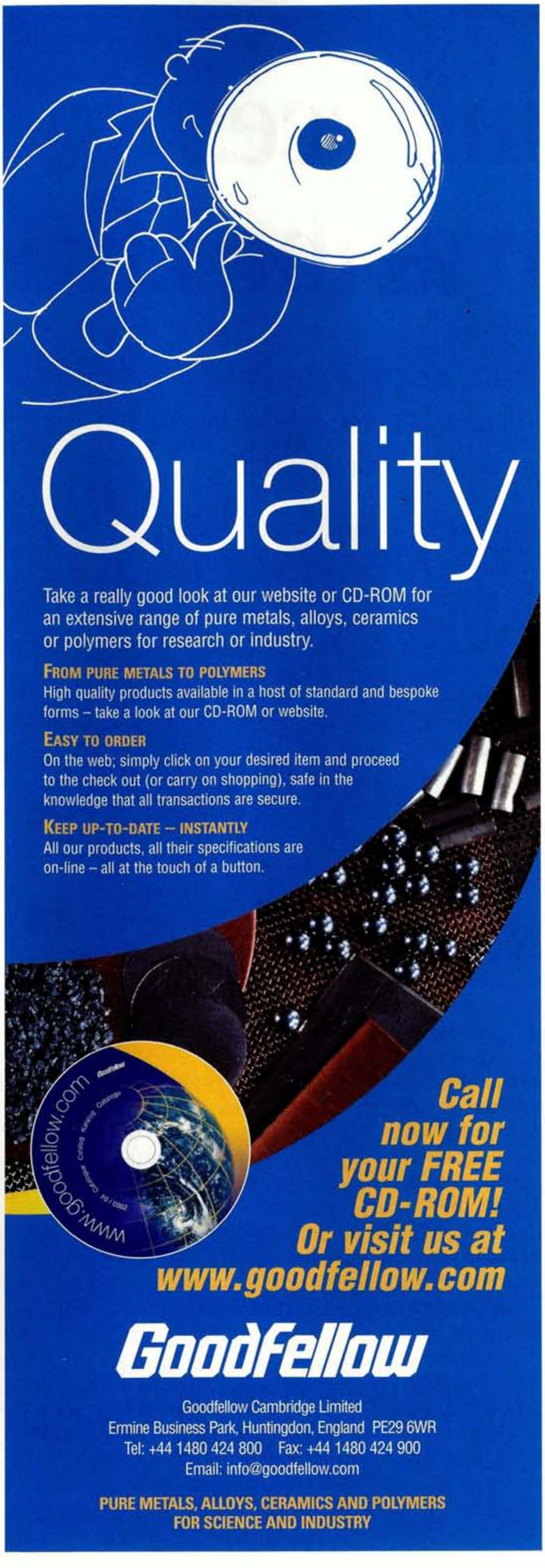
A workshop in China provided the occasion for a rare event in particle physics – the simultaneous participation of the spokesmen for the four major experiments being prepared for the LHC.

The participants of the second China–CERN Workshop assembled on the beach in front of the new amphitheatre of the Weihai branch of Shandong University. On 6 October, World Habitat Day, the city of Weihai received the United Nations Habitat Scroll of Honour Award for 2003, for its outstanding contributions in improving its habitat and environment.

The second CHINA–CERN Workshop took place from 31 October to 1 November 2003 in Weihai City in the Shandong province, some 800 km south-east of Beijing. Co-organized by the National Natural Science Foundation of China (NSFC) – China's main funding agency for the Large Hadron Collider (LHC) – and CERN, the workshop allowed the attending spokesmen to review the status of their collaborations with Chinese colleagues and funding agencies.

The first CHINA–CERN Workshop was held 1999, and at that time China participated mainly in the CMS experiment, and to a lesser extent in ATLAS. Since then, however, Chinese scientists have joined all four major LHC collaborations, three of which are now formally funded by China. The second workshop was attended by 62 participants. The 13 non-Chinese members of the LHC collaborations included the spokesmen Michel Della Negra (CMS), Peter Jenni (ATLAS), Tatsuya Nakada (LHCb) and Jürgen Schukraft (ALICE). Representatives from the Chinese funding agencies – the NSFC, the Chinese Ministry of Science and Technology, the Ministry of Education, and the Chinese Academy of Sciences – acted as reviewers and organizers. Chinese institutions and universities were also represented by 36 participants from: the Central China Normal University; the China Institute of Atomic Energy; the Central China Science and Technology University; the Institute of High Energy Physics (IHEP); the Institute of Theoretical Physics (ITP) of the Chinese Academy of Sciences; Nanjing University; Peking University; Shandong University; Tsinghua University; and the University of Science and Technology in Hefei/Anhui.

The workshop consisted mainly of plenary presentations, and there were opening addresses from Peiwen Ji (NSFC), Diether Blechschmidt (CERN) and Tao Zhan, president of the host Shandong University. Zhan pledged continued support for the LHC programme at Shandong University, which has been a member of the ATLAS collaboration since 1999. The four spokesmen of the LHC collaborations then presented the status of their experiments, and representatives of the Chinese collaborators reported on their ▷



contributions to three LHC experiments: Guoliang Tong of IHEP reviewed work on the ATLAS experiment in China, and Chunhua Jiang and Yuanning Gao described progress on CMS and LHCb at IHEP and Tsinghua University, respectively.

The sessions continued with Yuqi Chen of ITP, reporting on the progress of theoretical studies in collider physics in China for the past two years, and Gang Chen of IHEP, who looked at the computing needs for future physics. Alexandre Nikitenko from Imperial College in the UK gave an outlook on the early physics reach of CMS, and Torsten Akesson of Lund presented the prospects for computing for ATLAS.

On the second day, reports on muon projects for ATLAS and CMS were given by George Mikenberg from the Weizmann Institute and Guenakh Mitselmakher of Florida, respectively. Chris Seez of Imperial College talked about the trigger system for CMS, and Antonio Pellegrino from NIKHEF reported on the outer tracking system for LHCb. Activities in China were presented by Guoming Chen of IHEP, who described his studies on B_c physics at CMS; Yong Ban and Sijin Qian, who reviewed the work at Peking University on the resistive plate chambers for CMS and on the CMS physics programme, respectively; and Chengguang Zhu, who reported on the production of the thin gap chambers for ATLAS in the host university of Shandong.

After almost one-and-a-half days of plenary sessions, Chinese physicists and their colleagues in the LHC experiments met in four parallel sessions – one for each experiment – to review progress, address problems and plan future work, especially for the upcoming LHC physics analysis. In the afternoon of the second day, there was a lively and broad discussion among all workshop participants on LHC computing, with Jürgen Knobloch of CERN's Information Technology Division acting as convener. As a result of these meetings, the current situation and problems of computing and networking in China have become much clearer. As a next step, Chinese groups will have to find a solution to their problems with the help of CERN and supported by their funding agencies.

In summary, the 2003 CHINA–CERN Workshop provided an ideal forum to review the progress and commitment of China to the LHC programme. The venue and agenda were well prepared by the NSFC and CERN, and issues of common concern to all LHC experiments, such as computing and networking, were well addressed. The finding of appropriate solutions to such common issues is of key importance, not only to the LHC collaborations but also to their Chinese participants, who wish to harvest and analyse the overwhelming flow of physics data that the LHC experiments will provide as of 2007.

The workshop encouraged Chinese colleagues to participate more actively in various LHC conferences, especially in computing and LHC physics studies, so that ideas and research results can be promptly communicated within the whole collaboration community, and so that problems may be solved more effectively with help from experts at CERN and other institutes around the world.

In view of the success of the second China–CERN Workshop, it can be expected that similar workshops will be held in the future.

Diether Blechschmidt, *CERN, and* **Sijin Qian**, *Peking University.*

PEOPLE

LABORATORIES

ANTARES inaugurates scientific station

The land-based scientific station for the ANTARES underwater neutrino telescope, located at La Seyne-sur-Mer near Toulon, was inaugurated on 18 November 2003. Guests at the inauguration ceremony included Claudie Haigneré, the French minister for research and new technologies, and Guido Possa, the vice-minister delegate for research, who represented the Italian minister for education Letizia Moratti.

ANTARES will deploy 900 downward-oriented photomultiplier tubes in the Mediterranean Sea at a depth of −2400 m in order to detect light produced by high-energy cosmic neutrinos that have traversed the Earth and interacted near the sea floor (see *CERN Courier* June 2003 p22). This configuration will enable the telescope to study the sky in the southern hemisphere, including the galactic centre, which is a site of numerous intense and energetic astrophysical phenomena.

Claudie Haigneré (left), the French minister for research and new technologies, and Guido Possa, the vice-minister delegate for research, at the inauguration ceremony of the ANTARES scientific station.

An artist's view of the ANTARES neutrino detector. The magnifying glasses pinpoint different components. (Lagier, CNRS/IN2P3.)

The 0.1 km^2 ANTARES telescope is a prelude to a future array, which will instrument a volume of 1 km^3 of seawater. Such a telescope should be capable of identifying enough cosmic neutrino events per year to identify the principal sources of high-energy neutrinos in the universe, thereby opening a new era of neutrino astronomy.

Initiated seven years ago, the ANTARES project is a collaboration between 14 institutes in seven European countries. The telescope will begin operation in 2006 and will also offer a platform for multidisciplinary studies in oceanology, seismology and marine biology in the deep Mediterranean.

Brookhaven opens Space Radiation Laboratory for NASA

Brookhaven's director Praveen Chaudhari (centre) wields the scissors at the inauguration of NASA's Space Radiation Laboratory. The ceremony was attended by dignitaries including officials from NASA and the Department of Energy. (Photo: Roger Stoutenburgh.)

The risk of exposure to space radiation is one of the major problems that needs to be resolved to ensure that humans leaving Earth to explore Mars, the Moon or other planetary surfaces are safe. The risk cannot be measured directly, but must be estimated from calculations based on measurements of the kind of radiation that exists in space. This is the purpose of the NASA Space Radiation Laboratory (NSRL) that has been set up at the Brookhaven National Laboratory in New York. Here, NASA scientists will be able to gather the necessary information on the physics and radiobiology of space radiation so that, within the next 10–15 years, enough will be known about the health effects of exposure to the radiation to enable the design of spacecraft that can keep the explorers safe.

For the new facility, the Booster Synchrotron, which is the injector to the Alternating Gradient Synchrotron, has been modified to provide slow-extracted beams of ion species, from protons to gold. A new beam-transport system has also been constructed to deliver the beams to the NSRL. The beam energy, intensity and spill length can be varied for each experiment, and the plan is to provide 600–1200 hours of beam operation per year in three to four sessions. In addition to the beam delivery, the facility can provide full dosimetry and support, including cell and animal research laboratories, for radiobiological studies prior to and after exposure.

The NSRL is managed for NASA by the Brookhaven National Laboratory and the Department of Energy's Office of Science.

VISITS

The Spanish secretary of state for scientific and technological policy, **Pedro Morenés Eulate**, visited CERN on 23 January. His tour included the test facility for superconducting magnets for the Large Hadron Collider, the civil-engineering works for CMS at Point 5, the assembly halls for CMS and ATLAS, and the ISOLDE experimental hall. He also received a brief presentation by Sam Ting on the Alpha Magnetic Spectrometer, which will be installed on the International Space Station, and finished his visit by meeting with the Spanish scientific community working at CERN. He is seen here (left) signing the visitor's book, together with CERN's director-general **Robert Aymar**.

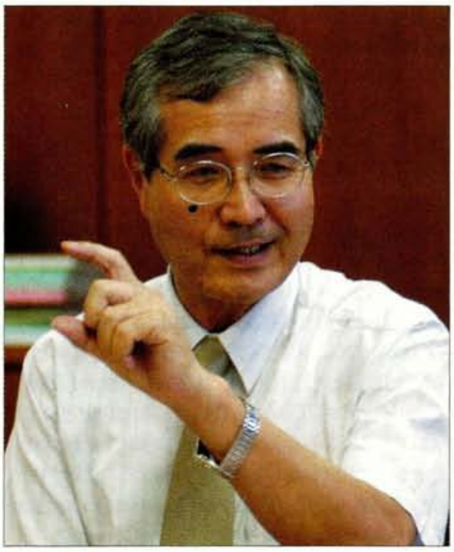
Going to work on an experiment at CERN?

Visit

http://cern.ch/ep-div/UsersOffice/

PRIZES

Bruno Pontecorvo Prize is awarded to Yoji Totsuka...



The 2003 Bruno Pontecorvo Prize of the Joint Institute of Nuclear Research in Dubna, Russia, has been awarded to Yoji Totsuka, the director-general of the High Energy Accelerator Research Organization (KEK), in Tsukuba, Japan, for his outstanding contribution to the discovery of atmospheric muon–neutrino oscillations.

Totsuka was one of the central figures in the Kamiokande collaboration, which reported the detection of a deficit in the number of atmospheric muon neutrinos in 1988. He then led the SuperKamiokande collaboration, which one decade later, in 1998, announced the discovery of atmospheric neutrino oscillations by determining the relative numbers of muon neutrinos and electron neutrinos as a function of the distance from their creation point.

...while Till Kirsten and Federico Capasso receive Tomassoni prizes

The 2004 Tomassoni prizes, awarded by the Physics Department of the University of Rome La Sapienza, are to be given to Till Kirsten of the Max Planck Institute for Nuclear Physics in Heidelberg, and Federico Capasso of Harvard University. The two prizes, which recognize and encourage outstanding achievements in physics, are based on a grant from the Tomassoni–Chisesi family. They are awarded in memory of Felice Pietro Chisesi, a graduate in physics from the University of Rome La Sapienza, and Caterina Tomassoni.

Kirsten receives the Tomassoni–Chisesi award (€25 000) for his pioneering work on weak interactions, including the first observation of double beta-decay in isotopes of tellurium and xenon using geochemical methods. He also led the Heidelberg group in building the GALLEX detector at the Gran Sasso Laboratories, which was the first experiment to detect neutrinos from proton–proton reactions in the Sun. Capasso receives the Chisesi–Tomassoni award (€13 000) for his pioneering work on the quantum-cascade laser.

Call for nominations for Outreach Prize

The High Energy Particle Physics (HEPP) Board of the EPS is calling for nominations for its Outreach Prize for 2004. The prize is intended for outstanding outreach achievements connected to high-energy physics and/or particle astrophysics.

The prize can be attributed to a scientist or non-scientist, and will consist of a diploma specifying the work of the recipient(s), as well as a cash prize of 2000 Swiss Francs (about €1300), contributed by the HEPP division. The prize diploma will be handed over to the recipient(s) at the EPS General Meeting in Bern in July 2005.

Nominations should be sent to Jorma Tuominiemi (Jorma.Tuominiemi@cern.ch) before 15 April 2004.

ANNIVERSARIES

Memorial meeting at CERN remembers Rolf Hagedorn

Hans Gutbrod of GSI (right) and Jean Letessier of Paris-VII (centre) in conversation with Laszlo Gutay of Purdue University at the Hagedorn memorial meeting last November.

On 28 November CERN remembered one of its well-respected theorists with a memorial meeting to recall the life and work of Rolf Hagedorn, who died in March 2003 (*CERN Courier* September 2003 p45). The speakers were mainly physicists who had collaborated with Hagedorn. They covered a wide range of subjects, from Jan Rafelski of Arizona who talked on nuclear matter at the Hagedorn temperature, and Gabriele Veneziano of CERN and KITP, Santa Barbara, who addressed Hagedorn and Hawking temperatures from a string perspective, to Carlo Vandoni, now retired from CERN, who worked with Hagedorn on interactive computing with a graphical interface.

The meeting brought together not only theorists but also experimenters working in studies of hadronic matter to which Hagedorn made seminal contributions, and that continue today with experiments investigating the boundary between hadronic matter and quark matter in heavy-ion collisions. The talks are available at wwwth.cern.ch/hagedorn/Hagedorn.htm.

Karel Safarik from CERN and the ALICE heavy-ion experiment (right) with Emanuele Quercigh from Padova.

Orsay puts on birthday Fest for Jean-Paul Repellin

The Laboratoire de l'Accelerateur Lineaire at Orsay celebrated the 65th birthday of Jean-Paul Repellin with a Fest on 9 January that was attended by many of his colleagues, students and friends. Repellin, who is seen here between Jean Iliopoulos (left) and Luigi Di Lella (right) spent a large part of his scientific career at Orsay working on experiments at CERN, in particular WA2, UA2 and OPERA/CNGS. He was also vice-director of IN2P3 for six years, with responsibility for high-energy physics. Speakers at the symposium consisted of friends Bernard D'Almagne, Jacques Lefrancois, Jean-Marc Gaillard, Manoël Dialinas, Di Lella, Claude Détraz, Yves Declais, Daniel Froidevaux and Michel Spiro.

MEETINGS

An Oberon Day on "Efficient Programming for Sciences and Engineering in the 21st Century" will be held at CERN on 10 March 2004. The workshop will explore the unique blend of simplicity, reliability and efficiency that the Oberon family of programming languages and the paradigm of component-oriented programming are bringing to a variety of areas. For further information, see: http://cern.ch/oberon.day.

The first meeting of **A workshop on the implications of HERA for LHC physics**, jointly organized by CERN and DESY, will be held at CERN on 26–27 March. The meeting aims to bring together experimentalists and theorists working on LHC and HERA physics to explore the impact of HERA measurements on the physics reach of the LHC. Five working groups will cover topics such as parton density functions, multijet final states and energy flow, heavy quarks, diffraction and Monte Carlo tools. Details can be found at: www.desy.de/~heralhc.

The CERN Accelerator School and CLRC Daresbury Laboratory will organize a course on **Power Converters for Particle Accelerators** at the Hanover International Hotel, Warrington, UK, on 12–18 May. The course will be of interest to staff in accelerator laboratories, universities and companies specializing in power converters and their electronics. For further information, see: www.cern.ch/schools/CAS, e-mail: Suzanne.von.Wartburg@cern.ch, or fax: +41 22 767 5460.

Hadron Collider Physics 2004 (HCP2004), the 15th Topical Conference on Hadron Collider Physics, will be held at Michigan State University on 14–18 June. For more information, see: www.pa.msu.edu/hcp2004, contact Lorie Neuman, Conference Office, Department of Physics and Astronomy, Michigan State University, East Lansing, MI 48824-1111, USA, or e-mail: conference@pa.msu.edu.

NEW PRODUCTS

Agilent Technologies has introduced a new simulation model for high-frequency GaAs and InP heterojunction bipolar transistors, which provides greater accuracy and improved convergence over existing models. The new model is part of the Agilent Advanced Design System of software for electronic design automation. For further information, contact Janet Smith, tel: +1 970 679 5397, e-mail: janet_smith@agilent.com, or Michaela Marchesani, tel: +49 7031 464 1955, e-mail: michaela_marchesani@agilent.com.

Atlas Technologies builds aluminium UHV chambers for synchrotron and semiconductor facilities. Their use can overcome the problem of carbon outgassing from stainless steel, which can be a serious source of contamination and can damage synchrotron optics. For more details, tel: +1 360 385 3123, e-mail: Sales@AtlasUHV.com, or see: www.AtlasUHV.com.

Burle Electro-Optics has announced the development of a new 40 mm diameter advanced-performance time-of-flight (TOF) detector. The detector's unique small-pore 5 μm microchannel plate technology, combined with a larger collection area, offers higher performance, improved mass resolution and fast timing for TOF mass spectrometry. For further information, please call: +1 800 648 1800 or +1 508 347 4000, or e-mail: sales@burle-eo.com.

CEDIP Infrared Systems has used its JADE infrared focal-plane array camera, together with digital image processing software, to create the ALTAIR Li system, which produces high-quality images of stress in materials under dynamic loading conditions. When used to measure heat dissipation under dynamic loading, the system can also be used to determine the material's fatigue limit. For further information, call Pierre Potet on: +33 1 60 37 0100, e-mail: cedip@cedip-infrared.com, or see: www.cedip-infrared.com.

Integrated Engineering Software (IES) has released its Lorentz 2D EM package, which provides an improved simulation tool for a range of charged-particle optics applications, including electron guns and photomultiplier tubes. IES has also announced the release of COULOMB 6.1, the latest version of their 3D electrostatic design and simulation software, with applications that include striplines, transmission lines, cables and connectors. For further information, tel: +1 204 632 5636, e-mail: info@integratedsoft.com, or see: www.integratedsoft.com.

PI (Physik Instrumente) has introduced a new servo-amplifier motion interface for use with controllers from National Instruments. Typical applications include nanopositioning, micromanipulation and semiconductor test equipment. For more details, contact Stefan Vorndran on: +1 508 832 3456, or see: www.nanopositioners.com.

VAT®

«Easy close» All-metal Angle Valves

Series 54 for UHV applications

No torque wrench needed

- Low price
- 300°C bakeable
- High conductance
- Maintenance-free

Swiss Headquarters
Tel ++41 81 771 61 61
Fax ++41 81 771 48 30
Email reception@vat.ch

VAT France
Tel 01 69 20 69 11
Fax 01 69 20 90 08
Email france@vatvalve.com

VAT Germany
Tel (089) 46 50 15
Fax (089) 46 37 65
Email deutschland@vatvalve.com

VAT U.K.
Tel 01926 452 753
Fax 01926 452 758
Email uk@vatvalve.com

VAT Japan
Tel (045) 333 11 44
Fax (045) 333 70 24
Email sales@vatskk.co.jp

VAT USA
Tel (781) 935 1446
Fax (781) 935 3940
Email usa@vatvalve.com

http://www.vatvalve.com

VAT

RECRUITMENT

For advertising enquiries, contact *CERN Courier* recruitment/classified, Institute of Physics Publishing, Dirac House, Temple Back, Bristol BS1 6BE, UK.
Tel: +44 (0)117 930 1028. Fax: +44 (0)117 930 1178. E-mail: sales@cerncourier.com.
Rates per single column centimetre: mono $66/€72/£44, single colour $69/€75/£46, full colour $72/€78/£48. Please contact us for more information about publication dates and deadlines.

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Chair of the Energy Center

at the Swiss Federal Institute of Technology Lausanne (EPFL)

The EPFL is a leading university, with strong emphasis on basic, engineering and life sciences. In order to develop our research and education programs in the field of energy, we plan to create a new transdisciplinary "Energy Center" as a high priority program with strong funding and a series of academic positions at the junior and senior level.

To set up, establish and lead the center, EPFL invites applications for the position of « Chair of the Energy Center ». The ideal candidate has an outstanding academic record and a strong vision for research, teaching and industrial developments in the field.

The appointment is planned at the Full Professor rank. The personal scientific areas of interest are very flexible but a strong expertise in renewable energies would be an additional asset.

We offer a dynamic and entrepreneurial academic environment as well as internationally competitive salaries, benefits and resources package.

Applications including CV, publication list, addresses for references, and a vision statement should be sent as soon as possible, but not later than **April 1, 2004** to:

Professor Marcel Jufer
Vice-President for Education
EPFL
CH-1015 Lausanne
Switzerland
(vp.formation@epfl.ch)

For additional information on the EPFL, please consult: **http://www.epfl.ch**

The EPFL is an equal opportunity employer.

Universität Karlsruhe (TH)

Am **Institut für Theoretische Teilchenphysik der Fakultät für Physik** der Universität Karlsruhe (TH) ist eine

Professur (C3)
für Theoretische Teilchenphysik

baldmöglichst zu besetzen.

Aufgabe der Professur ist die Vertretung des Fachgebiets Theoretische Physik in Forschung und Lehre. Das Forschungsgebiet soll im Bereich der Theoretischen Elementarteilchenphysik liegen mit möglichen Schwerpunkten in der Flavorphysik (Quarks und Leptonen) oder der Physik jenseits des Standardmodells. Die Mitarbeit im Exzellenzzentrum "Teilchenphysik und Astroteilchenphysik", im Sonderforschungsbereich/Transregio "Computational Particle Physics" sowie im Graduiertenkolleg "Hochenergiephysik und Teilchenastrophysik" ist erwünscht.

Habilitation oder gleichwertige Qualifikation wird vorausgesetzt.

Die Universität Karlsruhe ist bestrebt, den Anteil an Professorinnen zu erhöhen, und begrüßt deshalb die Bewerbung entsprechend qualifizierter Frauen. Schwerbehinderte Bewerber/Bewerberinnen werden bei gleicher Eignung bevorzugt berücksichtigt.

Das Land Baden-Württemberg beabsichtigt, das Professorenbesoldungsreformgesetz des Bundes zum 01.01.2005 in Landesrecht umzusetzen. Bei einer Ernennung ab diesem Zeitpunkt wird die W-Besoldung angewandt. Im Falle einer erstmaligen Berufung in ein Professorenamt wird das Dienstverhältnis zunächst grundsätzlich befristet; Ausnahmen von der Befristung sind möglich.

Bewerbungen mit den üblichen Unterlagen, einer Darstellung der bisherigen Forschungs- und Lehrtätigkeit sowie fünf ausgewählten Sonderdrucken eigener Publikationen sind bis zum

8. April 2004

an den Dekan der Fakultät für Physik, Universität Karlsruhe (TH), 76128 Karlsruhe zu richten.

Electronics Research Engineer

TRIUMF, Canada's National Laboratory for Particle and Nuclear Physics, has an immediate opening for a Research Engineer or Scientist to lead electronics efforts associated with its new Laboratory for Advanced Detector Development (LADD). The initial focus will be on front end signal processing electronics for detector systems associated with current TRIUMF-LADD physics projects involving tracking chambers and photo-sensors. In the longer term, the engineer/scientist will be expected to participate in, and possibly initiate, development of electronics associated with new detector research areas.

The successful candidate will provide leadership in the specification, design, and implementation of experimental physics equipment and will lead a team of electronics engineers and technologists. The position requires extensive knowledge of analog and digital circuitry and of the physics of materials and semiconductor devices. As group and project leader, he/she will be responsible for specification and maintenance of test equipment, and design and preparation of circuits and associated mechanical assemblies. The incumbent may be eligible to apply for NSERC peer-reviewed funding.

Minimum qualifications include the equivalent of a B.Sc. in electrical engineering or engineering physics and at least four years practical experience including a record of completing significant projects. Additional academic qualifications such as M.Sc. or Ph.D. degrees are desirable. The position is located at TRIUMF, in Vancouver, British Columbia, and the initial appointment is for a two-year renewable term leading to a continuing appointment after five years.

Applications should include a detailed CV and at least three reference letters sent separately to the following address, or by fax, prior to April 15th, 2004. **TRIUMF Human Resources, Competition No. 925, 4004 Wesbrook Mall, Vancouver, B.C. V6T 2A3 Canada. Fax: (604) 222-1074.** Electronic applications will not be accepted. In the event where two final applicants are equally qualified, preference will be given to a Canadian citizen or permanent resident. EOE

Forschungszentrum Karlsruhe
in der Helmholtz-Gemeinschaft

We are one of the biggest science and engineering research institutions of the Hermann von Helmholtz Association of National Research Centers. For us, research and development are an investment in trend-setting, humane, and environmentally sustainable technologies.

For the position of

Scientist

at our **Institute for Synchrotron Radiation (ISS)**, we offer an employment contract of unlimited duration from 01 May 2004.

Your scope of tasks will comprise the optimization, further development, and operation of the 500 MHz HF facility of the 2.5 GeV accelerator of our ANKA synchrotron radiation source. Furthermore, you will take part in national and international R&D projects. A part-time working scheme may be arranged.

Applicants should have a university degree in physics or electrical engineering, including doctorate, as well as several years of professional experience in the fields of high-frequency technology and machine physics. You should be familiar with the operation of accelerators and the support of HF components and experienced in interdisciplinary R&D project management. Knowledge of the English language that is suited for publication is required.

We offer a challenging scientific task that is associated with a high degree of independence, a variety of training opportunities, and the use of latest technical equipment.

In line with our policy of equal opportunities in the scientific-technical sector, applications from qualified women are particularly encouraged.

For technical information, please contact Dr. M. Hagelstein, ISS, phone +49 7247 82-6186.

Applications should be submitted online via our homepage under jobs/training or by ordinary mail to Ms. Hase, HPS, at the address given below, making explicit reference to the vacancy No. 20/2004:

Forschungszentrum Karlsruhe GmbH
in der Helmholtz-Gemeinschaft
Hauptabteilung Personal und Soziales (HPS)
Postfach 36 40
76021 Karlsruhe, Germany

Internet: www.fzk.de

PSI PAUL SCHERRER INSTITUT

research for the future

Physicist

Detector Development Swiss Light Source

Your Tasks

The detector group develops high-speed and large-area solid state detector systems, which are used at the beamlines of the Swiss Light Source. As a member of the SLS detector group you will work on our innovative hardware and software solutions for the use of the detectors at the beamlines. You will actively participate in X-ray scattering experiments using these detectors, in which the structure and dynamics of condensed matter is investigated.

Your Profile

You have completed a Ph.D. in physics and are interested in the field of solid state detector development. You have knowledge about solid state detectors as well as experience in synchrotron radiation instrumentation would be appreciated. You have programming experience in C and other high-level languages under Linux. You will work as a team player in a stimulating international environment, giving you excellent opportunities for new initiatives and independent research.

Please contact Dr. Ch. Brönnimann, tel.: +41 56 310 37 64,

e-mail: christian.broennimann@psi.ch, for further informations.

We look forward to your application: PAUL SCHERRER INSTITUT, Human Resources, Mr Thomas Erb, ref. code 6118, CH-5232 Villigen PSI, Switzerland

Research Scientist

TRIUMF, Canada's national research laboratory for particle and nuclear physics, invites applications for a "tenure-track" Research Scientist who will lead the TRIUMF-ATLAS analysis group, and establish a new large-scale computing center at TRIUMF. The data center will coordinate ATLAS data analysis in Canada and be the Canadian node on the LHC Computing Grid (LCG). The successful candidate will, in addition to leading this effort, collaborate with ATLAS-Canada in setting up the framework for the calibration and analysis of the calorimeter's data. This position is grant-eligible and the successful candidate will be expected to establish his/her own research program within the ATLAS collaboration. TRIUMF has been involved in most aspects of Canada's contribution to ATLAS and the LHC. The detector contributions are centered on the liquid Argon hadronic calorimetry. The project is now progressing to the stage where preparations are taking place to handle the large amount of data that will be produced at the LHC.

Qualifications for this position are a PhD or equivalent in Particle or Nuclear Physics and at least 2 years of post-graduate experience with an extensive data analysis and Monte Carlo simulation component. Strong analytical skills as well as good communication and organizational skills are required. A broad knowledge of computing techniques, data handling, and system operation/ management will be expected. Evidence of leadership in driving projects from inception to completion is also required.

The appointment will be made initially at a level equivalent to assistant professor at Canadian Universities, but may be elevated to a higher level if appropriate. Salary will be commensurate with experience.

TRIUMF invites qualified applicants to submit a detailed CV, and three reference letters sent separately to the following address or fax: **TRIUMF, Human Resource Dept. Competition No. 927, 4004 Wesbrook Mall, Vancouver, BC, V6T 2A3. Fax (604) 222-1074.** Electronic applications will not be accepted. Closing date is April 30th, 2004. Please note that in the event where two final applicants are equally qualified, preference will be given to the Canadian citizen or permanent resident. EOE

Peoples Fellows Program

The Peoples Fellowship Program at Fermilab supports accelerator scientists and high energy physicists early in their careers by providing unique opportunities for self-directed research in accelerator physics and technology. The Fermilab accelerator complex provides beams for collider physics at the energy frontier, and high intensity beams for neutrino physics and other fixed target programs. Current areas of accelerator research include stochastic and electron cooling, muon cooling, superconducting magnet R&D, superconducting RF R&D, linear colliders, large hadron colliders, advanced acceleration methods, accelerator controls and feedback, and computational physics and modeling.

The fellowships are awarded on a competitive basis to Ph.D. physicists of exceptional talent as evidenced by their graduate or postdoctoral work. Peoples Fellowships are open to accelerator scientists within three years of receiving their Ph.D. and to high energy physics post-docs within 5 years of their Ph.D. Fellows will work at Fermilab in areas of accelerator physics or technology of their choice. Peoples Fellowships are tenure track positions with an initial term appointment of three years.

Applicants should submit a statement describing a proposed research program, a curriculum vitae, and the names of at least four references no later than April 30, 2004. Applications, either in paper or electronic form, and requests for information should be sent to:

James Strait, Chair, Peoples Fellows Committee
Fermi National Accelerator Laboratory, MS 343
P.O. Box 500, Batavia, IL 60510-0500
e-mail: strait@fnal.gov

http://www.fnal.gov/pub/forphysicists/fellowships/peoples.html

Fermilab

A U.S. Department of Energy laboratory. Fermilab is an equal opportunity employer. M/F/D/V

UNIVERSITY OF FLORIDA

Postdoctoral or Senior Research Associate High Energy Experimental Physics

The Institute of High Energy Physics and Astrophysics at the University of Florida invites applicants for a Postdoctoral Research Associate or Senior Research Associate position to work on the CMS Experiment at the Large Hadron Collider, CERN. The University of Florida is one of the leading university groups in the CMS experiment, contributing strongly to the physics program, development of the detector, trigger, software and computing.

The successful candidate will be expected to focus on the development of the CMS physics program and contribute to the CMS offline and possibly online software. Good data analysis skills in the context of high energy physics experiments are essential. Broader experience with high energy physics detectors and electronics is a plus. Ph.D. degree in physics is required.

The initial term of this position is two years with the possibility of extension, subject to the availability of funds. Longer initial appointments for highly qualified candidates are possible.

Salary will be commensurate with experience.

Resume and three letters of recommendation are to be sent to

the Search Committee c/o Dee Dee Carver,
Physics Department, University of Florida, P.O. Box 118440,
Gainesville FL 32611
(dcarver@phys.ufl.edu).

In order to ensure full consideration, applications should be received by May 7, 2004. The position will remain open until filled.

The University of Florida is an Equal Opportunity, Affirmative Action Institution.

UNIVERSITY OF OXFORD

Mathematical and Physical Sciences Division
Department of Physics
in association with Balliol College

University Lecturer in Theoretical Physics

The Department of Physics proposes to appoint a University Lecturer in Theoretical Physics with research interests in the area of elementary particle theory, with effect from 1st October 2004 or as soon as possible thereafter. The successful candidate will be offered a Tutorial Fellowship by Balliol College, under arrangements described in the further particulars. The combined University and College salary will be according to age on a scale up to £42,900 p.a. (pay award pending).

The research interests of candidates should overlap those of the Particle Theory Group, with some preference for the general area of string theory or non-perturbative quantum field theory. The successful candidate will be expected to participate actively in undergraduate and graduate teaching, research and relevant administration.

Further particulars of the post are available from Professor D Sherrington, Theoretical Physics, 1 Keble Road, Oxford OX1 3NP, England, e-mail: d.sherrington1@physics.ox.ac.uk Applicants should submit nine copies (one in the case of applicants based overseas) of a letter of application supported by a curriculum vitae and statement of research interests, together with the names of three referees (not more than two from the same institution). Applications should be sent to Professor Sherrington at the above address to arrive no later than 2nd April 2004. Referees should be asked to send their references (by post or e-mail) directly to Professor Sherrington by 2nd April 2004.

The University is an Equal Opportunities Employer.

PhysicsJobs@**physicsweb.org**

Deputy Group Leader for Subatomic Physics

The Experimental Physics Division of the University of California's Los Alamos National Laboratory is seeking a Deputy Group Leader for its Subatomic Physics Group, with strong programs in neutrino, heavy ion, and neutron physics. Additionally, there are exciting programs in radiography as applied to national security and homeland defense. New efforts are being developed in photon and neutron imaging for homeland defense. The successful applicant will be expected to spend roughly half time co-leading the group and half time conducting forefront research.

For complete description and application information, please visit http://www.hr.lanl.gov/jps/regjobsearch.stm search for Job# 206708. List CERN as the referral source when applying.

Operated by the University of California for the National Nuclear Security Administration of the Department of Energy. The Laboratory is an Equal Opportunity/Affirmative Action Employer.

Los Alamos
NATIONAL LABORATORY
www.lanl.gov/jobs

EGO
European Gravitational Observatory

The European Gravitational Observatory, a French-Italian consortium dedicated to the research on gravitational waves, operates the 3 km-long VIRGO detector, located in Pisa–Italy. EGO is recruiting:

Electro-optical Engineer/Physicist Ref. OP/EO/02
Interferometer Operator Ref. OP/OP/01

EGO also offers Post-doctoral Research Fellowships

Priorities will be given to EC nationals

Job descriptions are available on: **www.ego-gw.it/employment.htm**

CERN COURIER RECRUITMENT BOOKING DEADLINE

April issue: 5 March

Publication date: 17 March

Contact Reena Gupta

Tel: +44 (0)117 930 1028 **Fax:** +44 (0)117 930 1178

E-mail: reena.gupta@iop.org

cerncourier.com

ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE
EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
Laboratoire Européen pour la Physique des Particules
European Laboratory for Particle Physics

The Physics Department invites applicants for a long term position of a

PHYSICIST

in experimental particle physics research.

Candidates are expected to have a PhD in particle physics and an excellent record of successful work with typically 5-10 years of post-doctoral experience in this field. Further requirements include: a high capacity for innovation and leadership; competence in detection techniques and in the use of on-line and off-line software; potential for making a significant medium to long-term contribution to the scientific programme of the Organization. Very good communication skills and an aptitude for team work.

The position is of a long-term nature and offers a competitive remuneration package and excellent career prospects.

The selected candidate will take a leading role in all aspects of particle physics experiments, involving the conception and design of experiments, the development and operation of detectors and the analysis of data. He/she will also coordinate or make important contributions to studies, projects or committee work and represent the Organization at conferences, workshops, or in other research laboratories and institutions.

Interested candidates are asked to submit an application form (including the names of two referees), along with a letter of motivation, curriculum vitae and a list of their ten most significant publications using the CERN e-recruitment system (http://ert.cern.ch) by 10 May 2004. This position is published under reference PH-DI-2004-17-FT.

Preference will be given to nationals of CERN Member States*.

CERN is an equal opportunity employer and encourages both men and women with the relevant qualifications to apply.

* AT, BE, BG, CH, CZ, DE, DK, ES, FI, FR, GR, HU, IT, NL, NO, PL, PT, SE, SK, UK

Research Scientist

TRIUMF, Canada's National Laboratory for Particle and Nuclear Physics, has an immediate opening for a Research Scientist to lead physics efforts associated with its new Laboratory for Advanced Detector Development (LADD). The initial focus will be on detector systems associated with current TRIUMF-LADD physics projects including KOPIO, liquid xenon TPC imaging, JPARC neutrino experiments, and ISAC. The scientist will be expected to participate in and initiate new detector-related and physics research areas.

A recent Ph.D. in experimental particle or nuclear physics with strong abilities in detector technologies, electronics, simulation, and data analysis is required. In particular, the candidate will have a significant record related to detector hardware and software development and will have demonstrated the ability to carry out projects to the stage of publication of physics results. The initial appointment will be for a two-year renewable term, leading to a continuing appointment (tenure track) after five years. The successful candidate will be eligible to apply for NSERC peer-reviewed funding and will be encouraged to develop his/her own proposals.

The position will be based at TRIUMF, located in Vancouver, British Columbia. Applications from qualified candidates should include a detailed CV and at least three reference letters sent separately to the following address, or fax, prior to April 15, 2004. **TRIUMF Human Resources, Competition No. 926, 4004 Wesbrook Mall, Vancouver, B.C. V6T 2A3 Canada. Fax: (604) 222-1074.** Electronic applications will not be accepted. In the event where two final applicants are equally qualified, preference will be given to a Canadian Citizen or permanent resident. EOE

Dublin Institute for Advanced Studies
Schrödinger Fellowships -
School of Theoretical Physics

The Dublin Institute for Advanced Studies is launching a new Senior Fellowship scheme. In the School of Theoretical Physics up to two fellowship positions will be available this year, to be called Schrödinger Fellowships. These are exclusively research positions on a fixed-term contract of up to 5 years. Candidates with a proven research record in the areas of Quantum Field Theory, Conformal Field Theory, String Theory or Statistical Mechanics are encouraged to apply.

Further details about these positions are available on the website **www.stp.dias.ie** or from the following: **Tony C. Dorlas, Denjoe O'Connor or Werner Nahm**
School of Theoretical Physics, Dublin Institute for Advanced Studies, 10 Burlington Road, Dublin 4, Ireland. tel. +353-1-614 0100

PAUL SCHERRER INSTITUT

research for the future

The Paul Scherrer Institut is a multi-disciplinary institute for research in the natural and engineering sciences with emphasis in the areas of condensed matter physics, material science, elementary particle physics, astrophysics and life sciences as well as in energy and the environment.

PSI is operating since 1997 a novel proton therapy facility for cancer treatments, using a dynamic beam delivery technique applied on a very compact proton gantry. The positive experience with the present system at PSI is now bringing a further expansion of the facility, with the installation of a dedicated medical accelerator and of a second-generation proton gantry, which shall be operated with new advanced beam delivery techniques. We are looking for an

Experimental physicist or software engineer

Your Tasks
- development of the real-time data acquisition and control system frontend software for the dynamic control of the scanned proton beam to be used for patient treatments on the new gantry.
- participation to the experimental activities in the context of the realization of the new gantry

Your Profile
- University degree in physics or informatics, preferably with a Ph.D.
- Practical experience in working with particle beams, in an accelerator environment.
- Experience in software development, preferably using VxWorks, for distributed realtime systems.
- Required are a good team spirit and a good knowledge in English and German.

For further information, Dr. E. Pedroni is at your disposition. Tel. +41 (0)56 310 35 18.
We are looking forward to your application: PAUL SCHERRER INSTITUT, Human Resources, Ms Esther Spörri, ref.code 2104, 5232 Villigen PSI, Switzerland. E-mail: esther.spoerri@psi.ch

More Information about PSI and the proton therapy program can be found at www.psi.ch

Looking for a new challenge for 2004?

Positions for PhD and Postdoctoral Researchers and Fellows in the Netherlands Institute for Metals Research (NIMR)

We are looking for highly motivated international scientists with at least a Masters degree in Metallurgy, Materials Science or Mechanical Engineering. As an employee of the NIMR, you will be expected to achieve at the highest level. You will have frequent contact with companies (SKF, Corus, Stork Fokker, Polynorm, DAF and Philips amongst others), addressing highly relevant industrial problems. You will be based in one of four Universities (Delft, Eindhoven, Groningen or Twente) in the Netherlands.

Salaries range from €2050 to €2390 (gross per month) for PhD Researchers and start from €2550 for Postdoctoral Researchers (varies according to results and experience). We offer all employees a performance-related bonus scheme, 8% on top of the annual salary, a savings plan and several courses amongst other benefits.

The official language of the NIMR is English and around half of our 90 reseachers are from outside the Netherlands.

Netherlands Institute
for Metals Research

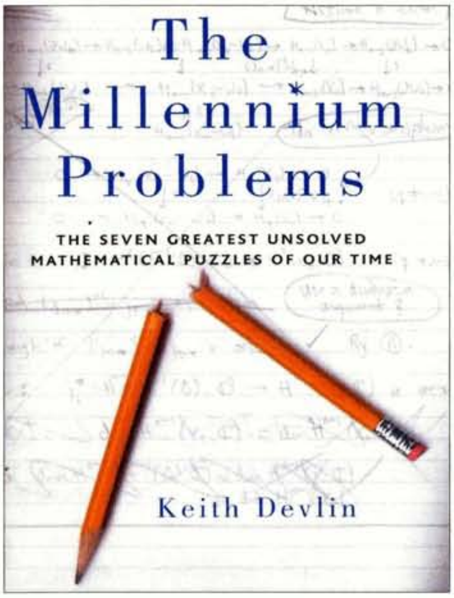
Check out our website
www.nimr.nl
for more details and an on-line application form.

INDEX TO DISPLAY ADVERTISERS

The index is provided as a service and, while every effort is made to ensure its accuracy, *CERN Courier* accepts no liability for error.

BOOKSHELF

The Millennium Problems by Keith Devlin, Granta Books. Hardback ISBN 1862076863, £20.00 ($29.95).



On 24 May 2000 in a lecture hall at the College de France in Paris, Michael Atiyah from the UK and John Tate from the US announced that a $1 million prize would be granted to those who first solved one of the seven most difficult open problems in mathematics. These are known as the "Millennium Problems", and the whole idea was an initiative of the Clay Mathematical Institute (CMI), which was established one year earlier by magnate Landon Clay. The list of problems was selected by a committee of top mathematicians, including – along with Atiyah and Tate – Arthur Jaffe, the current director of the CMI, Alain Connes, Andrew Wiles and Edward Witten, the only physicist, who is also a Fields medallist.

One-hundred years before, also in Paris, David Hilbert had given the famous address laying out an agenda for the mathematics of the 20th century. He proposed a total of 23 problems; a few turned out to be simpler than anticipated, or were too imprecise to admit a definite answer, but most were genuine, difficult and important problems that brought instant fame and glory (if not necessarily wealth) to those who solved them.

Some of the differences between the two sets of problems should be mentioned. While Hilbert's set provided a guideline for mathematics research, the Millennium Problems provide a description of the current frontier of knowledge in the subject. The other important difference is that among the CMI set, two are inspired by deep physics problems: fluid dynamics and the structure of gauge theories.

In this book, Keith Devlin, a well known mathematician who writes excellent books and articles for a lay audience, takes up the daunting task of explaining these problems as best as can be done to an audience assumed to have no mathematical sophistication beyond the high-school curriculum – and all this in only about 200 pages! Although such an ambitious aim is nigh on surreal, the results are quite satisfactory. The book is able to communicate to a large extent the depth and importance of the problems, and to give a glimpse of the deep elation whoever solves them will feel. For anyone involved in research, the $1 million prize is almost beside the point.

The author chooses to present the problems from the "simplest" to the most arcane. The first is the Riemann hypothesis. Deeply related to the distribution of prime numbers, this is the only one of the problems proposed by Hilbert that has not been settled. Technically, one needs to find the location of the zeros of a certain function (Riemann's zeta function). If proven true, there are literally hundreds of important results in number theory that would follow, and it is quite likely that a poll among mathematicians would identify this as the most important open problem in mathematics.

The second problem has a physics flavour to it. All the basic interactions in the Standard Model of particle physics are gauge interactions. If we consider the idealized situation of a pure gauge theory, we would like to have a mathematically sound proof that the quantum theory exhibits confinement, and that the mass of the first excited state is definitely positive (there is a mass gap). Most physicists would agree with these properties, however, a real proof may provide completely new methods in quantum field theory that may bring a revolution similar to the invention of calculus by Leibnitz and Newton.

The third problem is related to computational complexity where one can ask, among those functions or propositions that can be computed, which are "easy" and which are "hard". Problems that can be solved in polynomial time with respect to the length of the input (in bits) are assigned to complexity class P, while the class NP contains problems that are considered hard because, so far, any algorithm used to solve them requires exponential time. Among the latter, one of the most famous is the travelling-salesman problem. Nobody knows whether the classes P and NP are equivalent. This is a central problem in computational theory and its resolution may have far-reaching technological consequences.

The fourth problem again has a physics flavour, and is related to the Navier–Stokes equation describing the fluid flow of an incompressible fluid with viscosity. It is difficult to exaggerate the importance of this equation in the design of aeroplanes and ships. Although there are plenty of approximation and numerical methods, as in the case of gauge theories, we are still lacking a deep mathematical methodology that will allow us to understand in detail the space of solutions for given initial data. To appreciate the difficulty of the problem, a solution would imply a detailed understanding of the phenomenon of turbulence – no small accomplishment.

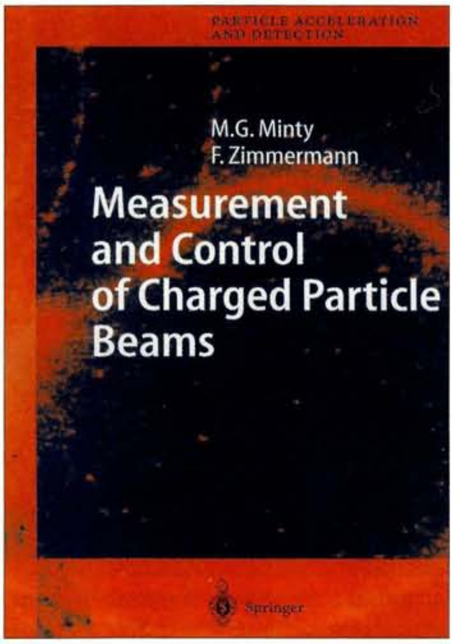
The fifth problem is at the root of modern topology: the Poincaré conjecture. Roughly speaking, topology is the study of spaces that are stable under arbitrary continuous deformations. Thus a tetrahedron or cube can be continuously deformed to a sphere, while it is impossible to do the same with the surface of a doughnut. It is a very interesting and legitimate question to ask for the complete set of topological invariants in a given dimension. In the case of a two-dimensional sphere it is clear that we cannot lasso it. This property is known as simple-connectedness and it characterizes the sphere topologically. Poincaré asked whether a similar property would completely characterize a three-dimensional sphere. During the 20th century we have achieved a topological classification for spaces whose dimension is different from three, curiously the dimension where Poincaré's conjecture was formulated. Progress in the past two decades seems to indicate that it may be settled in the positive in a few years time.

The last two problems are truly arcane. They go under the names of the Birch and Swinnerton-Dyer, and the Hodge conjectures. To exhibit the difficulty in explaining the first, it should be noted that definite support for it came from the settling of Fermat's last theorem by Wiles and the subsequent progress in the so-called Taniyama–Shimura conjectures. The problem is deeply rooted in the study of rational solutions to special types of equations (elliptic curves), which in turn are contained in the apparently unfathomable ▷

world of Diophantine equations. The Hodge conjecture is, according to Devlin, the one most difficult to formulate for a lay audience. Its resolution would provide deep insights into analysis, topology and geometry, but its mere formulation requires advanced knowledge in all three subjects.

Devlin comes out with flying colours in his effort to make these fascinating problems accessible to a wide audience. It is inevitable that there are some dark corners and a few inaccuracies in such a challenging task. However, for anyone interested in the frontiers of mathematics and scientific knowledge, this book provides enthralling reading.
Luis Alvarez-Gaume, CERN.

Measurement and Control of Charged Particle Beams by M G Minty and F Zimmermann, Springer. Hardback ISBN 3540441875, €74.85 (£54.00, $79.95).



This is a specialist book written primarily for the high-energy particle-accelerator community, in which Minty and Zimmermann present a contemporary view of charged-particle beam measurement and control in high-energy physics (HEP) machines. With an eye on the next generation of such machines, the authors cover, in some detail, the pioneering work being carried out around the world on electron–positron linear colliders.

The subject matter and references are laudably taken from worldwide resources. The references are given in abundance and the authors have provided an admirable service by trawling through the ever-more voluminous proceedings of conferences and schools to list the key papers. There are 172 figures, which are frequently of "live" examples taken from the world's foremost HEP laboratories, and the authors have also taken care to expand the theory in the more advanced or less well known areas. Each chapter is backed up by exercises with solutions that provide the authors with a useful vehicle for more theoretical explanations and alternative views that could not be conveniently integrated into the text. Newcomers to HEP machines, however, should heed the warning on page 5 that the reader is expected to know basic optics and, one might add, advanced applied mathematics as well.

The experienced reader can omit the introductory chapter 1, while newcomers would be better served by building their knowledge through the more basic references given by the authors. Thereafter, the book reads smoothly, starting with single-particle optics and moving progressively through emittance, photo-injectors, collimation, longitudinal optics, longitudinal manipulation, injection and extraction, polarization and cooling. In general, the authors start by reviewing how to measure the parameters in a particular category and then continue with how to control those parameters.

Chapter 2 starts with the measurement of transverse optical parameters. Many of the techniques described are relatively recent and depend on the tremendous advances that have been made in digital electronics and online computing power. The use of "multiknobs" is described. This concept has existed for many decades in the form of tune and chromaticity control using two independent corrector families, but it can be greatly extended using matrix techniques for quasi-linear systems and powerful matching routines for the more non-linear cases.

Chapter 3 addresses the important subject of closed-orbit correction, where the reader will be brought up to date with jargon such as "corrector ironing" (page 87). This chapter also includes newer topics such as wake-field bumps, dispersion-free steering, orbit feedback and dynamic orbits excited by an alternating-current dipole. Chapter 4 deals with the difficult task of emittance measurement and tackles both the transverse and longitudinal planes, bringing in equilibrium emittances and the control of partition damping numbers. The next chapter briefly breaks the mould of the earlier ones by reviewing low-emittance photoinjectors and the production of flat beams using a solenoid, which together are of great importance to linear colliders.

Chapter 6 takes up collimation, but with only seven pages the reader sees relatively little of this critical subject. Collimation is important in low-energy high-intensity machines, high-energy superconducting machines and in electron–positron linear colliders. In each of these cases the problems and parameters are different. The collimation proposals for linear colliders would have fitted well into the context of this book, as the authors are clearly preparing for the next generation, while high-efficiency collimation for machines like the LHC is arguably an even more important topic that could have been included.

The book then returns to the basic mould with excellent accounts of the measurement of longitudinal optics parameters in chapter 7, followed logically by the manipulation of the longitudinal phase space in chapter 8. One small disappointment is that the tomographic measurement of longitudinal phase space, although mentioned in one of the examples and referenced, is not treated in a separate section as a diagnostic tool in its own right.

Chapter 9 could be arguably more suited to a book on lattice design and contains somewhat surprising excursions into septum and kicker magnet design. However, the reader will no doubt find extraction by resonance islands and bent crystals highly interesting. Chapter 10 on polarization fills a gap in the literature and the authors have accordingly paid more attention to theory. The practicalities of the harmonic correction of depolarizing resonances, adiabatic spin flipping, tune jumps and Siberian snakes of complete and partial types are all addressed. The final chapter describes the fascinating topics of stochastic cooling, electron cooling, laser cooling, ionization cooling, crystal beams and beam echoes, many of which merit their own monograph.

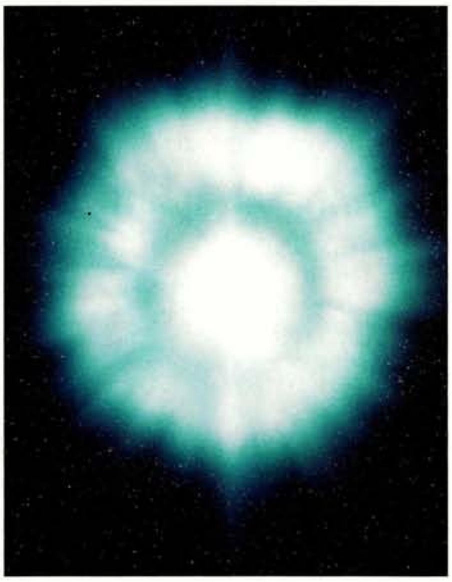
In summary, this book is a very welcome and valuable addition to the accelerator literature. As noted by the authors, there is relatively little material in the book specifically for low-energy machines, but industrial users may still find it useful to read the book and adapt or develop the ideas rather than apply them directly.
Philip Bryant, CERN.

Supernovae and Gamma Ray Bursters by Kurt Weiler (ed), Springer. Hardback ISBN 3540440534, €89.95 (£69.00, $115.80).

The association of gamma-ray bursts (GRBs) with supernova (SN) explosions has been suspected since the discovery of GRBs by the Vela satellites in 1967. However, observational evidence for a GRB–SN association was first found accidentally after the discovery of GRB afterglows 30 years later. The prompt search for an optical afterglow of GRB980425 led to the discovery, two days after the burst, of a relatively nearby supernova, SN1998bw, whose sky position and estimated explosion time were consistent with those of GRB980425. The physical association between them suggested that GRB980425 was produced by a highly relativistic and narrowly collimated jet viewed off axis and ejected by SN1998bw, which appeared to be unusually energetic for a supernova because it was viewed near axis.

These conclusions were not immediately reached by the majority of the GRB and SN communities, who were more accustomed to spherical models of SN explosions and GRB "fireballs". So the above evidence for a GRB–SN association was at first dismissed as being either an accidental sky coincidence between a distant GRB and a close SN, or as a physical association between a new type of faint GRB (see p293 in the book) and a new type of SN, much more energetic than ordinary supernovae (SNe) and dubbed "hypernovae" (see pp243–281).

These interpretations began to erode, however, as observational data on optical afterglows of other GRBs accumulated. The data indicated that GRBs take place in star formation regions in host galaxies and their afterglows. In particular those of the relatively close GRBs show evidence that long duration GRBs are produced by jetted ejecta in SN explosions akin to SN1998bw, and not in fireballs produced by the merger of neutron stars in binary systems due to gravitational wave emission. But it was the dramatic spectroscopic discovery on 8 April 2003 of SN2003dh in the late afterglow of GRB030329 (see *CERN Courier* June 2003 p5, p13; September 2003 p15) that convinced the majority of the GRB and SN communities that ordinary, long duration GRBs are produced in SN explosions akin to SN1998bw.



An artist's impression of a gamma-ray burst. (Illustration by ESA/ECF.)

The book *Supernovae and Gamma Ray Bursters* edited by Kurt Weiler, an expert on radio SNe, appeared shortly before the discovery of GRB030329 and SN2003dh. It contains a collection of contributions on SNe and GRBs. Many of the contributions are very informative, well written and satisfy the stated aim of *Springer's Lecture Notes In Physics*: "intended for broader readership, especially graduate students and non-specialist researchers wishing to familiarize themselves with the topic concerned."

The first half of the book is devoted to SNe and includes contributions such as "Supernova Rates" by Enrico Capelaro and "Measuring Cosmology with Supernovae" by Saul Perlmutter and Brian Schmidt. The second half is devoted to GRBs and includes contributions such as "Observational Properties of Cosmic GRBs" by Kevin Hurley, "X-ray Observations of GRB Afterglows" by Filippo Frontera and "Optical Observations of GRB Afterglows" by Elena Pian.

However, the book as a whole is unbalanced, both in its coverage of SNe and GRBs and in its coverage of the possible GRB–SN association, which presumably was its main aim. The first half covers in great detail (seven out of ten chapters) the fireworks from the interaction of the SN ejecta with the SN environment, but lacks a detailed discussion of our current knowledge of the different SN progenitors, the mechanisms that explode them and the compact remnants that are left over. It is needless to emphasize the importance and relevance of these subjects to the GRB–SN association. The second part of the book, which is devoted to GRBs and their afterglows, focuses mainly (four chapters extending over 100 pages) on the observations of GRB afterglows, with only a single chapter (16 pages long) on the prompt gamma-ray emission. Our current "theoretical understanding" of GRBs is summarized in a single chapter, which is exclusively devoted to the presentation of the party line – the fireball model – as if it were a dogma. It does not discuss the model's severe problems, nor possible future tests of the model. It does not even mention alternative models, such as the "Cannonball Model", which is *ab initio* based on a GRB–SN association, is falsifiable, and is much more predictive and successful than the fireball models.

In summary, the book contains some useful summaries of observational data on SNe and GRBs, but sheds no light on the production mechanism of SNe and GRBs, nor on the GRB–SN association.

Arnon Dar, Technion – Israel Institute of Technology, Haifa.

Chercheurs entre rêve et réalité
(Scientists at the rim of reality) a film by Samy Brunett (in French or English versions), Blue in Green Productions. DVD or VHS PAL €20.00. (Available directly from samy.brunett@village.uunet.be.)

Bringing the fundamental physics research of today, or of the last 30–40 years, within the reach of the general public is a very difficult task. It is verging on the impossible, to be perfectly honest, as it requires some prior general scientific knowledge on the ▷

part of the public and a great command of the subject on the part of the author(s). Having said that, the difficulty of the task does not imply that it should not be attempted, in fact quite the reverse. And this is what Samy Brunett does in his DVD on the theory of everything.

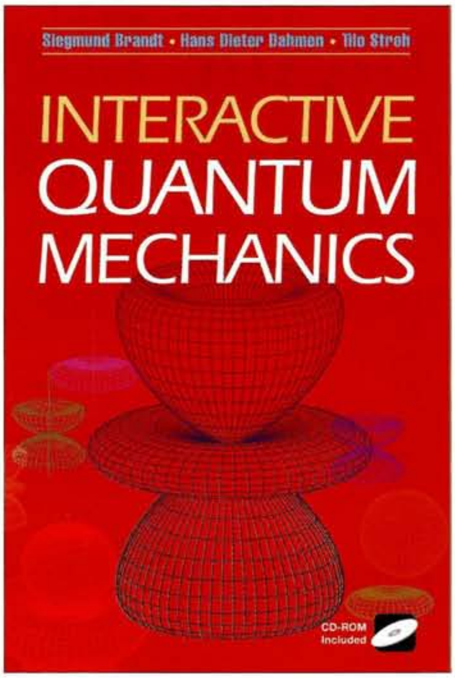
The approach chosen for Brunett's DVD is to use interviews and discussions with a number of young and not-so-young physicists who are working for or at CERN, some of whom are well known and some of whom are not (in any case, the general public is unlikely to tell the difference). These physicists are fairly representative of their profession, which is already a point in the DVD's favour, as they all speak with enthusiasm and passion.

The interviews are preceded by a number of computer-generated images, not all of which are entirely appropriate to the subject matter, which is, quite simply, the origins of the universe – a different kettle of fish altogether to the famous magic potion of Asterix the Gaul! However, having said this, once the introduction is over we do go on to meet the actual people working in physics. Those of us who will recognize it may lament the rather drab setting of the CERN cafeteria, but the sentiments are well expressed and quite convincing, whether they are uttered by young physicists or by the leading lights of the field.

Of course from a single viewing of this DVD alone, the "man in the street" is not going to aspire to understand what "we" mean today by the theory of everything, extra dimensions, the very early universe or particle mass, especially since the links between the different subjects are not always clear. However, its great merit – and certainly not the only one – is that it has been made and that it allows the viewer to get an idea of today's leading figures in fundamental research.

In the current wave of commemorative events (the recent centenaries of the discovery of radioactivity and of Einstein's first articles, for example, or CERN's 50th anniversary this year), this kind of modern technology-based publication can do nothing but good for the rather stale image of this discipline of ours that is so difficult to popularize.

Alain Méric de Bellefon, PCC-Collège de France.



Interactive Quantum Mechanics by Siegmund Brandt, Hans Dieter Dahmen and Tilo Stroh, Springer-Verlag. Hardback ISBN 387002316, €69.95 (£54.00, $69.95).

"Physical intuition" is a precious commodity for all physicists. Richard Feynman, when asked once what his intuition was concerning a certain problem, is said to have replied that he didn't have any because he hadn't done the calculation yet. Common sense is frequently a poor guide, even in the classical domain, but there our intuition can be built up with the help of reasoned interpretations of phenomena we can experience directly, and by the performance of many relatively simple and realistic calculations. Gaining intuition about the quantum world is much harder: we have little, if any, direct perception of it, and few realistic problems are mathematically easy to solve. Thus, students have a hard time "thinking physically" when faced with quantum problems.

Surely computers ought to be able to help. Quite complicated problems can be quickly solved numerically, and – most importantly – the results can be presented in a variety of graphical forms. Indeed, several recent undergraduate texts on quantum mechanics have included disks demonstrating the solutions of standard problems. These generally have a modest capability for the student to "play with the parameters", but there has been nothing more radically interactive. This book is the first (so far as I know) to fill this gap.

In fact, it might be more accurate to describe it as a computer program on a CD, accompanied by extended notes, rather than as a book accompanied by a CD. The program, called "INTERQUANTA" or IQ for short, has a self-explanatory user interface written in Java. It is easy to install and simple to work with – the instructions are even suitable for computer illiterates like myself. It can be used passively, to watch (and listen to) demonstrations that illustrate the main points in the text, but in the second, interactive mode the user is offered considerable freedom in designing the problems to be solved and the ways in which the answers may be displayed. As the authors put it, users can enter a "computer laboratory in quantum mechanics".

Eight physics topics are treated in as many chapters: free-particle motion, bound states and scattering, first in one and then in three dimensions; two-particle systems in one dimension; and special functions of mathematical physics. Each chapter begins with a section called "Physical Concepts", in which the relevant concepts and formulae are assembled without proof. Each section of the text is carefully keyed to a corresponding part of IQ, and the graphical outputs are well designed and easy to read. More than 300 numerical exercises are included to stimulate the reader's exploration, and many contain useful prompts encouraging the reader to suggest a physical explanation for particular results. A final chapter contains hints for the solution of some exercises, and an appendix provides a systematic guide to IQ.

IQ contains much useful material, and the authors are to be congratulated on having produced something rather novel that is so user friendly. But I believe its value would be greatly enhanced if the range of topics were to be significantly extended. For example, all the presentations are static, yet there are many fascinating and important time-dependent phenomena in quantum theory for which a "movie" would be a valuable aid to understanding. And it is a pity that the whole vital area of perturbation theory is omitted, where there is ample scope for numerical instruction. A program that included topics such as these would surely be a major resource for both students and teachers.

Ian Aitchison, Oxford.

VIEWPOINT

CERN's role on the European stage

CERN's new director-general, **Robert Aymar**, believes that the CERN Council should strengthen its mission to "sponsor co-operation" in particle physics across Europe.

When the convention for the establishment of a European organization for nuclear research was signed in Paris on 1 July 1953, the 12 states who signed up to the formal establishment of CERN agreed that: "The basic programme of the organization shall comprise: (a) the construction of an international laboratory for research on high-energy particles; (b) the operation of the laboratory specified above." (Article II, paragraph 3.) So CERN was born, and it is well known that over the past 50 years the laboratory has fulfilled its mandate extremely well in these respects. However, the paragraph continues with a third part: "(c) the organization and sponsoring of international co-operation in nuclear research, including co-operation outside the laboratory." This part of CERN's mission is less well known, and it seems to have been less strongly implemented by the member states.

As I begin my mandate as director-general of CERN, in the organization's 50th anniversary year, it seems increasingly important that the member states should place more emphasis on this neglected aspect of CERN's mission. In particular I believe that CERN should come to be recognized as the place where the European programme in particle physics is coordinated, shared and supported by all the European players in the field.

The connection between CERN and the rest of Europe is of the utmost importance, especially now that the European Commission (EC) is doing a great deal to help science. In March 2000 the Lisbon European Council endorsed the project of creating a European Research Area (ERA), as a central element of its strategy for Europe to become, by 2010, "the most competitive and dynamic knowledge-based economy in the world". The aim is that connections in Europe in one discipline can help to strengthen the players, and that synergy between laboratories in different countries can avoid a wasteful duplication of effort in research and development.

Within this context we now have the opportunity for the EC to help us recover the "lost" part of CERN's original mission. Building a research area across Europe requires coordination, and in particle physics this coordination should be the task of the CERN Council. In this way, the investment of the member states in CERN could be seen more overtly to be fed back into those states.

What steps can we now take? CERN's co-operation with other European particle-physics laboratories should be strengthened and deepened, with more collaboration towards common goals. In line with the policy of the EC for structuring the ERA, CERN could participate with other laboratories in research and development and new infrastructure, and help to launch a variety of studies in co-operation with other laboratories. The programme of the CARE (Coordinated Accelerator Research in Europe) network, funded by the EC within Framework Programme 6, is an example of this kind of initiative.

For many years there has been collaboration between CERN and groups in the member states in detector development and data analysis, for example, which has been driven by an obvious necessity. However, collaboration in the accelerator domain has been less common, and competence in accelerators has become more concentrated at a few centres, such as CERN and DESY. The benefits back in the member states themselves have therefore not been as obvious as in the case of the physics collaborations, where there has been clearly defined work to be done within member states, with related local benefits.

The time now seems right for the accelerator domain to follow this example, with multilateral collaborations between CERN and other laboratories in the member states. This would be collaboration at a system level rather than at a component level as has so far generally been the case. CERN can in this respect take on a specific role in coordinating the realization of the infrastructure. Interestingly, such collaborative work has occurred in the past, but mostly with non-member states, such as the Russians, for example, rather than with the member states.

As an example of what might be possible in future, consider CLIC (the compact linear collider) project. This year the CLIC Test Facility 3 (CTF3) will be used to demonstrate the technical feasibility of the key concepts of the new radiofrequency power source for CLIC, and for further tests with high field gradients. This facility has already received some technical contributions from other laboratories: INFN (Italy), LAL (France), RAL (UK) and Uppsala (Sweden) in Europe, and SLAC in the US. Nevertheless, development work for CLIC could provide the right opportunity to set up a collaborative venture with a much larger group of European laboratories, to be blessed by the CERN Council.

So my vision is to see CERN, in particular at the level of the CERN Council, develop beyond its mission to supervise the CERN laboratory, and to develop a new – or rather old – objective to promote and steer the activities in particle physics across Europe. Remember that CERN belongs to the member states and also to their laboratories: CERN belongs to you!

Robert Aymar, CERN.

Electron and Ion Guns / Systems
UHV Components, Vacuum Chambers

UHV Electron Guns/Systems
UHV Ion Guns/Systems

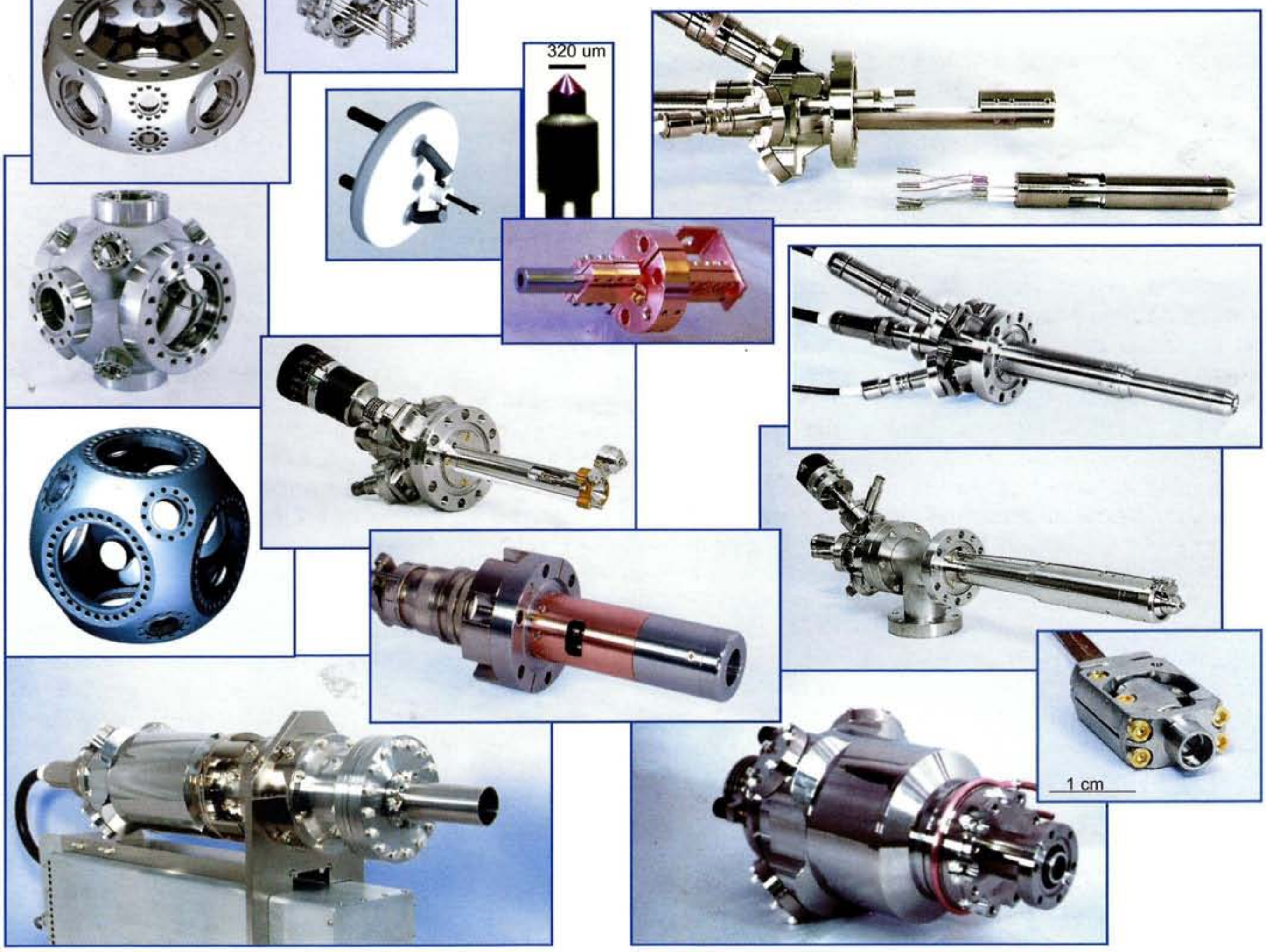
Beam energies: <1 eV to 100 keV.
Beam currents: femtoamps to amperes

Energy sweeping, deflection, rastering, fast pulsing, emission current control, computer control, arc-resistant electronics, remote control, and multiple cathode options (ThO_2, LaB_6, Ta disc, W, BaO),

Applications: Surface physics, vacuum physics, charge neutralization, cathodoluminescence, phosphor testing, RHEED, ESD, IPES, SIMS, semiconductor processing,Custom.

Components: Multi-CF Fittings, Compact UHV Chambers, Instrument Chambers, Modular Components, Cathodes, Cathode cartridges, Faraday cups, Phosphor Screens, eV Parts (rods, cylinders, spacers, plates, tubes, brackets, insulators, balls, brackets, fasteners; alumina & stainless steel)

CF Fittings not seen before!



Excellence in Electron and Ion Optics

KIMBALL PHYSICS INC. KPI

311 KIMBALL HILL ROAD, WILTON, NH 03086-9742 USA

www.kimballphysics.com

Toll Free: 1 888 KIM-PHYS (1 888 546-7497)
e-mail: info@kimphys.com
Tel. 1 603 878-1616 Fax: 1 603 878-3700

In a Galaxy not so far away...

One supplier, Glassman Europe, provides design engineers with a comprehensive range of well regulated high-voltage DC power supplies, boasting a unique combination of high-performance, small-size, light-weight. Glassman Europe offers unsurpassed levels of quality, reliability and price performance. In addition, the power supplies come in a fully-serviceable, 'air-insulated' chassis. Glassman Europe delivers what design engineers demand in a standard power supply: unsurpassed quality and performance as well as a range of features and options to cater for any applications. Our standard model range can be adapted to fit your OEM requirements. All products are certified by an independent testing laboratory for CE compliance. Further, a comprehensive three year warranty provides complete peace of mind.

Glassman. The power and performance you need - at the right price.

May the Source be with you

Starring, Directed and Supplied by:

GLASSMAN EUROPE	GLASSMAN USA	GLASSMAN JAPAN
Tel: +44 (0) 1256 883007	Tel: (908) 638-3800	Tel: (045) 902-9988
Fax: +44 (0) 1256 883017	Fax: (908) 638-3700	Fax: (045) 902-2268

GLASSMAN europe

www.glassmanhv.com