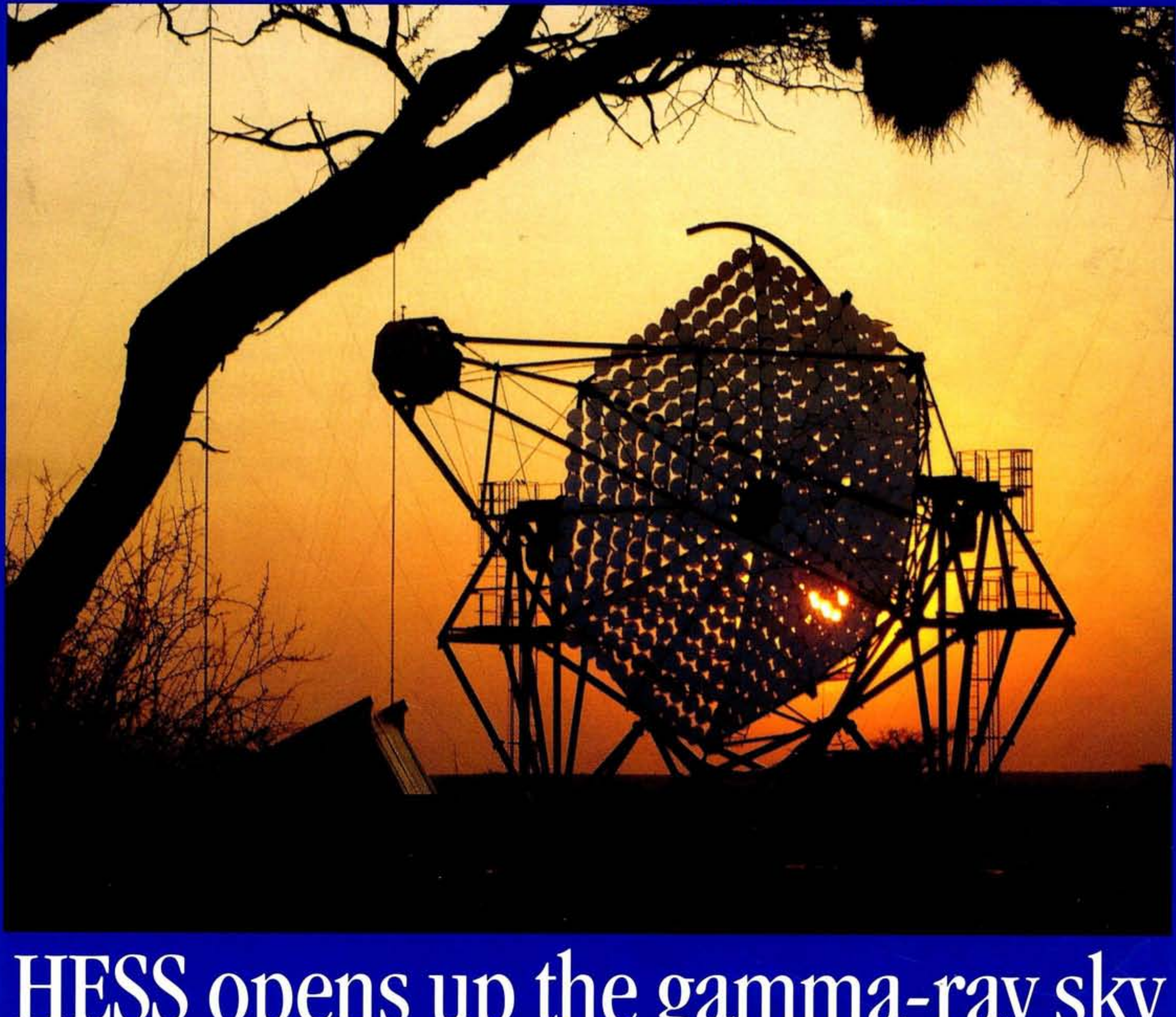
INTERNATIONAL JOURNAL OF HIGH-ENERGY PHYSICS

CERN COURIER

VOLUME 45 NUMBER 1 JANUARY/FEBRUARY 2005



HESS opens up the gamma-ray sky

NUCLEAR PHYSICS
ISOLDE and IGISOL cast new light on how carbon forms p6

COMPUTING NEWS
Logbook brings note-taking into the 21st century p18

VIEWPOINT
Simon Singh on how to amaze the public p58

CABURN
Vacuum Science Limited

20% off all feedthrough products*

To mark the new year and celebrate our expansion and relocation, Caburn is pleased to offer customers 20% off all feedthrough products ordered before the end of March, 2005*.

Offer applies to all standard feedthrough products, including:

- Multipin feedthroughs
- Subminiature C & D
- Coaxial feedthroughs
- Fibre optics
- Thermocouples
- Power feedthroughs
- Breaks and envelopes
- Connectors and cables

*Offer applicable to orders placed by Thursdsay, March 31, 2005.

Visit our comprehensive website:

www.caburn.co.uk

see section 6 of our online catalog for discounted products

BSI REGISTERED UKAS QUALITY MANAGEMENT 003
ISO 9001 : 2000
FM 51327

UNITED KINGDOM
Caburn Vacuum Science Ltd
1st Floor, Martlet Heights,
The Martlets, Burgess Hill,
West Sussex RH15 9NJ UK
Tel: +44 (0)1444 873900
Fax: +44 (0)1444 258577
sales@caburn.co.uk

GERMANY
Caburn Vacuum Science GmbH
Am Zirkus 3a
D-10117 Berlin
Tel: +49 (0)30-787 743 0
Fax: +49 (0)30-787 743 50
info@caburn.de

FRANCE
Caburn Vacuum Science Sarl
38 Place des Pavillons
69007 LYON
Tel: +33 (0)437 65 17 50
Fax: +33 (0)437 65 17 55
info@caburn.fr

ITALY
Caburn Vacuum Science SrL
Corso Lombardia, 153/15
10149 TORINO
Tel: +39 011 4530791
Fax: +39 011 4550298
sales@caburn.it

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 (0) 22 785 0247
Web: cerncourier.com

Advisory board James Gillies, Rolf Landua and Maximilian Metzger

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): Steven Corneliussen
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
PPARC (UK): Peter Barratt
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): Neil Calder
TRIUMF Laboratory (Canada): Marcello Pavan

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 Seth Burgess
Technical illustrator Alison Tovey
Display advertisement manager Jonathan Baron
Recruitment advertisement manager Jayne Orsborn
Display sales Ed Jost and Helen Brook
Recruitment and classified sales Yasmin Agilah and Moo Ali
Advertisement production Tanwen Haf, Katie Graham
Product manager Claire Webber

Advertising Jonathan Baron, Ed Jost, Helen Brook, Jayne Orsborn, Yasmin Agilah or Moo Ali
Tel: +44 (0)117 930 1265 (for display advertising) or +44 (0)117 930 1196 (for recruitment advertising);
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 Barrie Bunning, Library and Information Services Group, R61 Library, Rutherford Appleton Laboratory, Chilton, Didcot, Oxon OX11 0QX. E-mail: B.J.Bunning@rl.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 (0) 22 767 61 11
Telefax: +41 (0) 22 767 65 55

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

© 2005 CERN ISSN 0304-288X

IoP

CERN COURIER

VOLUME 45 NUMBER 1 JANUARY/FEBRUARY 2005

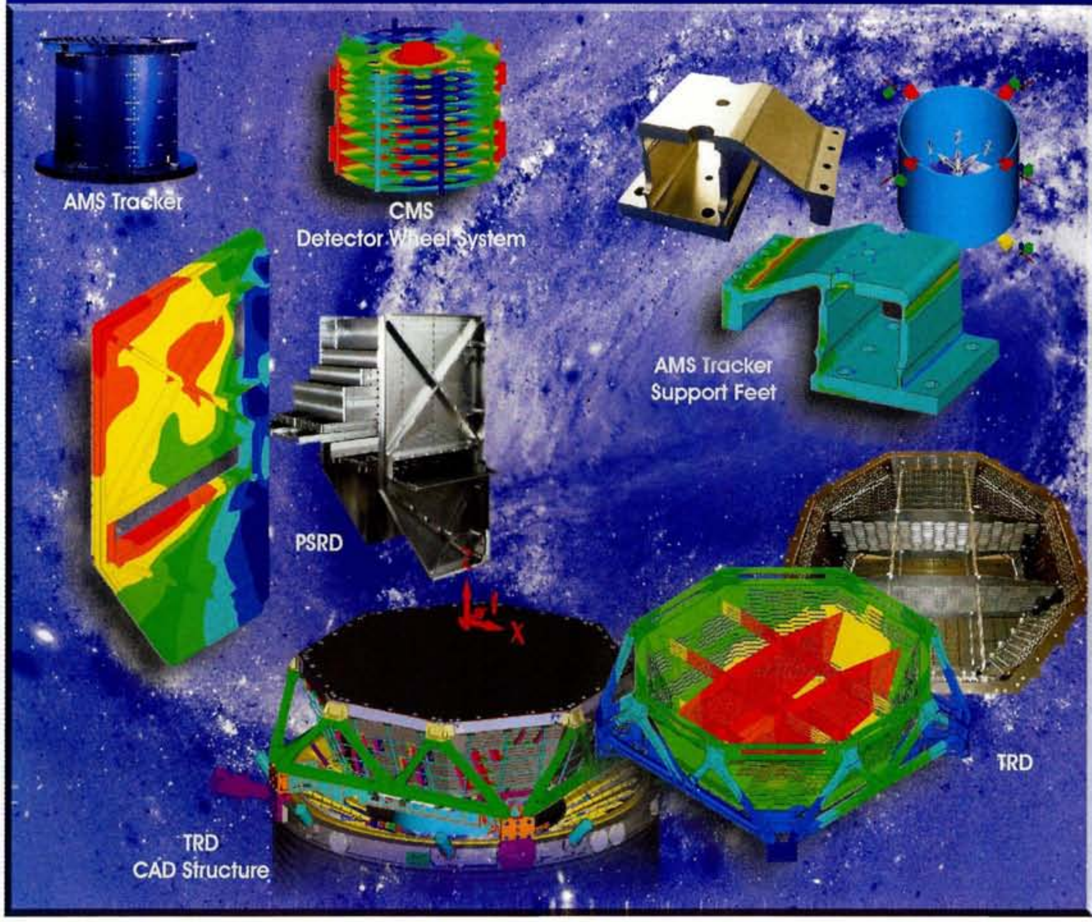
ATLAS rolls out the barrel p6

Grid computing in Interlaken p23

Telling it the way it is p58

Cover: The first of four Cherenkov telescopes built for the HESS project, which is already providing exciting results on cosmic gamma rays at very high energies (p30). (Courtesy HESS collaboration.)

Realizing your ideas with our engineering experience ...



... Development
Optimization
Cost Reduction
FE - Simulation
Production.

ISATEC GmbH
Rathausstraße 10
D-52072 Aachen

Contact:
Dr.-Ing. E.A. Werner
Dr.-Ing. J. Krieger
Phone +49 / 241 / 9800-308
Fax +49 / 241 / 9800-312

www.isatec-aachen.de
engineering@isatec-aachen.de

... since 1990

I.S.A. tec
ENGINEERING

VAT®

«Easy close» All-metal Angle Valves

Series 54 for UHV applications

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

No torque wrench needed

Swiss Headquarters
Tel ++41 81 771 61 61
reception@vat.ch

VAT Japan
Tel (045) 333 11 44
sales@vatskk.co.jp

VAT Taiwan
Tel 03 516 90 88
taiwan@vatvalve.com

VAT France
Tel 01 69 20 69 11
france@vatvalve.com

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

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

VAT Korea
Tel 031 704 68 57
korea@vatvalve.com

VAT Benelux
Tel ++31 30 6018251
benelux@vatvalve.com

VAT Germany
Tel (089) 46 50 15
deutschland@vatvalve.com

www.vatvalve.com

VAT

CERN COUNCIL

LHC must keep to 2007 start-up

At the 131st session of Council on 17 December, CERN's director-general Robert Aymar confirmed that the organization's top priority is to maintain the goal of starting up the Large Hadron Collider (LHC) in 2007.

Preparations for the LHC project are advancing well, with half of the most technologically challenging components – the cold masses for the dipole magnets that will steer high-energy protons around the LHC's 27 km ring – having arrived at CERN. In October the new transfer line that delivers protons from the Super Proton Synchrotron (SPS) to the LHC tunnel worked on the first attempt. The line is based on 540 magnets supplied by the Budker Institute for Nuclear Physics in Novosibirsk, and has been set up with the help of a team from the institute.

The discovery in 2004 of defects in newly installed components in the system that will distribute cryogenic cooling fluids around the ring meant that installation, which began in 2003, had to be put on hold. However, technical corrections have since been made, and in October the manufacture of new unflawed components began (see box). Repair of the faulty components started in November at CERN and the first modified items have been successfully installed in the LHC tunnel.

Various options to make up the delay have been discussed, and a strategy has been established to limit the impact on the overall schedule for the LHC. One option considered was to shut down the SPS in 2006 in order to divert human resources to LHC installation. However, this will not be necessary as long as technicians can be seconded for a few months from other accelerator laboratories.

A status report presented to Council on the four large experiments for the LHC – ATLAS, CMS, LHCb and ALICE – recognized the great progress that is being made. The schedule to get ready for collisions in the LHC in 2007 will be tight, but there is confidence that with some effort the experiments will start on time.

The SPS programme reached a natural pause at the end of the 2004 run, with most of its approved experiments reaching their conclusion; the SPS will not run in 2005. "This allows the community to take stock of where they are," said Aymar, "and to plan for an exciting and well-focused programme for future fixed-target physics at CERN." This procedure began in September in the Swiss village of Villars, where the SPS Committee met to set priorities for 2006 and beyond. As a result, Council will be examining proposals for new experiments during the course of 2005.

Repair of faulty elements in the cryogenic distribution line is under way at CERN.

LHC cryogenics are on the mend

Back in June 2004 engineers at CERN discovered a defective component in a module for the LHC cryogenic distribution line – the QRL. The fault occurred in sliding tables that are designed to support pipes inside the elements and allow them to slide past one another. This prevents the pipes from snapping or buckling when changing temperatures cause them to expand or contract. Subsequent investigations revealed that many other modules suffered from the same defect and analysis showed that the fault was due to the wrong choice of material for the offending part. CERN then took the decision to replace the component systematically in all elements.

The elements already on site are being repaired by replacing the faulty tables with new ones built using the correct material. CERN's Technical Support Department is working on some 140 elements, namely service modules, vacuum barriers and fixed points, repairs on which are expected to take about a year and a half. Other elements, known as pipe elements, currently stored on the surface at CERN, are being repaired by the ICS consortium, which is in charge of installing the superconducting magnets in their cryostats.

ICS began repair of these 263 pipe elements at the beginning of November 2004, and was initially able to fix 10 elements per week. When the five-week winter shutdown of the LHC magnet test facility began, ICS gained 20 additional personnel who normally work on magnet testing, and with the extra help an improved repair rate of five pipe elements a day was reached. By 7 January, 90 of the 263 faulty pipe elements had been repaired in building 927, which now houses five assembly benches where repair operations can be carried out simultaneously on different pipe elements. All 263 pipe elements are expected to be repaired by the end of March.

DETECTORS

The heart of ATLAS takes shape

Particle physicists in the UK have completed the first critical element of the largest semiconductor tracker ever built, the ATLAS SCT, which is to form the innermost core of the giant detector that will operate at CERN's Large Hadron Collider (LHC). The SCT will track charged particles to an accuracy of better than 20 μm over its diameter of 1 m. In all, more than 200 physicists and engineers from 12 countries have taken 10 years to bring the project to this stage.

The ATLAS SCT consists of 60 m^2 of silicon detectors in the form of four concentric barrels and two end-caps. Each of the four barrels is tiled with hundreds of silicon detector modules measuring about 6 × 12 cm, 710 of which were built by a collaboration involving the Rutherford Appleton Laboratory (RAL), the Universities of Birmingham and Cambridge, UK, and Queen Mary College, London. The remaining modules have been provided by similar collaborations in Japan, the US and Scandinavia. All four barrels of the SCT are being assembled in the UK using components from a total of 37 institutes worldwide.

The first completed barrel has now been populated with all of its 384 silicon modules. Each module contains four silicon wafers mounted on a thermal pyrolytic graphite baseboard with a flexible circuit hybrid strip containing 12 application-specific integrated circuits. The three outer barrels will carry progressively more modules, with the fourth and final barrel containing 672 silicon modules. Overall, the SCT is divided into 6 million channels and every channel has its own amplifier and data buffer.

Above: the robot mounts a module on the first barrel of the ATLAS SCT. (Oxford PPU.) Left: the barrel modules are seen more clearly in close-up. (CCLRC.)

The fabrication of the ATLAS barrel modules has been a technically challenging project. The very stringent mechanical, thermal and electrical performance demanded by the ATLAS physics programme is already tough, but on top of that the modules will have to survive in a very-high-radiation environment at −10 °C for 10 years, providing continuous operation without failure. The team at RAL has been working in purpose-built cleanrooms, with separate areas for the construction of the mechanical components, for the state-of-the-art bonding facility where the components are integrated, and for electrical test and characterization. The completed modules are then sent from RAL to collaborating UK universities for burn-in testing, and finally to Oxford for mounting onto the barrel.

The UK team has also been working on the barrel structure. These lightweight structures were built in Germany and came to RAL via the University of Geneva. At RAL, the electrical services, optical read-out fibres, custom bi-phase cooling circuits and alignment systems are added to each barrel. The barrels are then sent to Oxford in custom refrigerated transporters where the modules are mounted onto the barrels with remarkable accuracy.

NUCLEAR PHYSICS

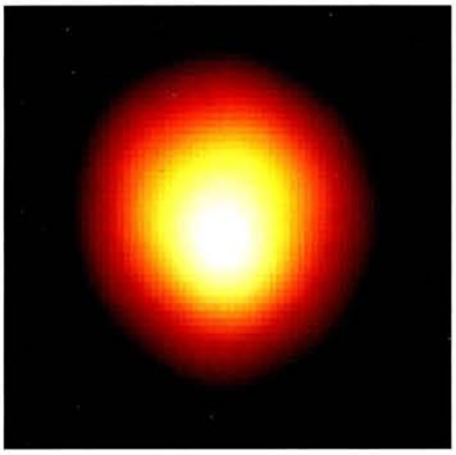
Carbon sheds light on star creation

New measurements of unstable nuclei caught in the act of decay have gone a long way towards resolving long-standing questions about the triple-alpha process that creates carbon nuclei. The results, from experiments at CERN's ISOLDE facility and the IGISOL facility at the University of Jyväskylä in Finland, were recently published in *Nature* (Fynbo *et al.* 2005).

Although physicists first discovered how stars build up atomic nuclei in the 1950s, they have been unable to pin down key properties of carbon nuclei that determine the triple-alpha rate over a wide temperature range. Now, thanks to the isotope separate online method for creating and isolating isotopes (largely developed at CERN) and to developments in particle detectors, a team of researchers has been able to tackle this problem.

The collaboration – involving more than 30 people at eight European universities and institutes, including CERN – first isolated short-lived isotopes of ^{12}B and ^{12}N. These transform via beta decay into ^{12}C, populating resonances in carbon that then break into three alpha particles. By measuring precisely the timing and energies of alpha particles emitted by the samples, the team was able to infer the energy, spin and parity of the carbon nuclei just before decay.

The triple-alpha process is more probable only because ^{12}C can exist at particular energies close to the combined energies of ^{8}Be and ^{4}He. At the temperature levels in most stars – 10^8 to 10^9 K – carbon's so-called Hoyle resonance at 7.65 MeV determines the



The new results on the triple-alpha process will influence estimates of the time taken for the evolution of stars such as red supergiant Betelgeuse in the constellation Orion, seen here by NASA's Hubble Space Telescope. This massive star is nearing the end of its life and will be fuelled by the CNO cycle. (Andrea Dupree (Harvard-Smithsonian CfA), Ronald Gilliland (STScI), NASA and ESA.)

triple-alpha rate. But at higher and lower temperatures, other resonances – some observed, some theorized – come into play.

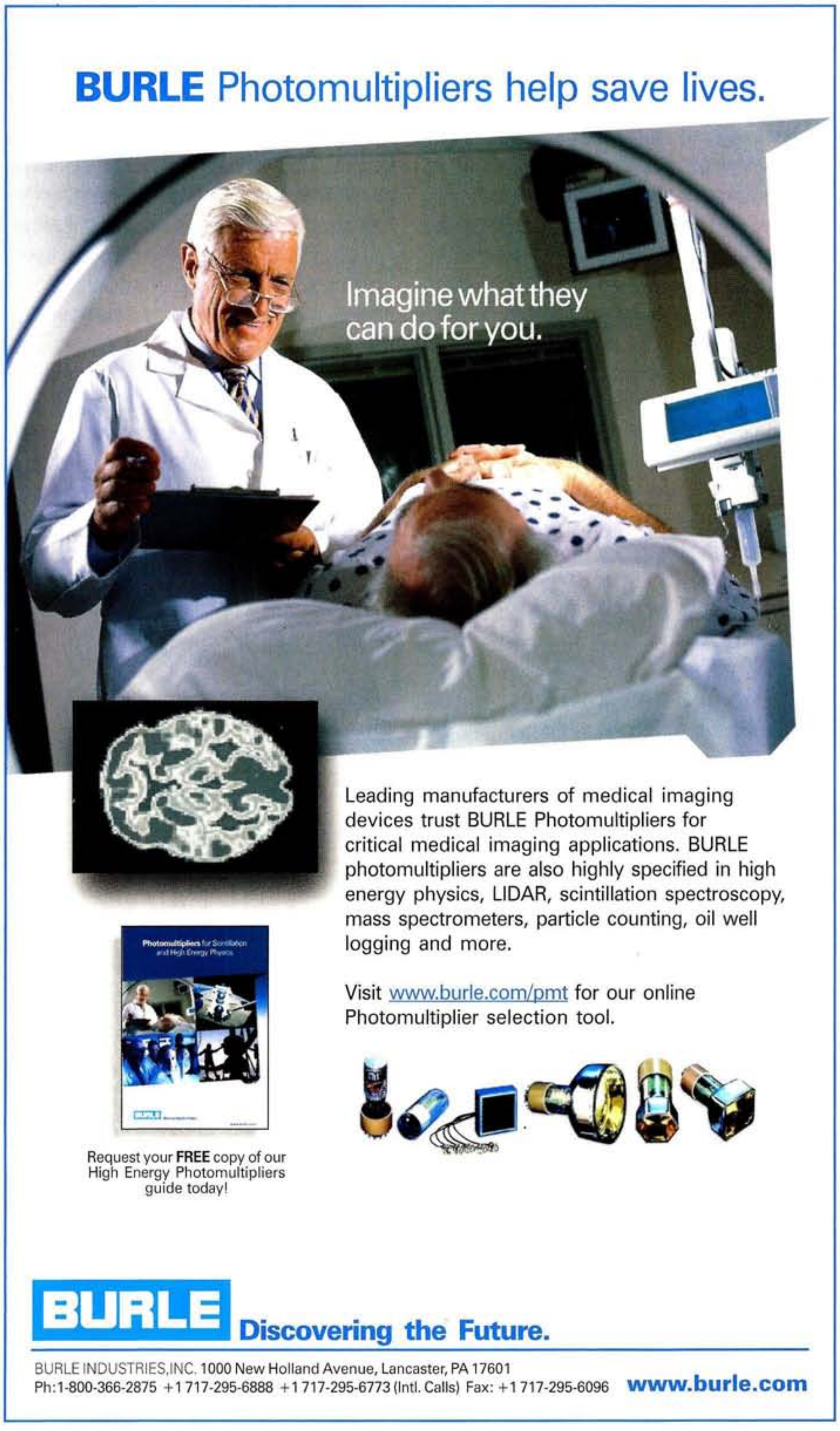
In the recent experiments, the researchers were able to pin down the spin and parity of the wide resonance near 10 MeV. First observed in 1958, it had been measured at 10.1 MeV (width 3 MeV), but its spin-parity could be determined only as either 0^+ or 2^+. The new study puts this resonance at 11.23(5) MeV with width 2.5(2) MeV, and finds its spin-parity to be 0^+.

The group also looked for a long-theorized 2^+ resonance at 9.1 MeV, width 0.56 MeV. If it existed, it would play a dominant role at temperatures of more than 10^9 K, but there was no evidence for it. However, to fit the data, the team needed to introduce a 2^+ resonance at 13.9(3) MeV with width 0.7(3) MeV. They were then able to calculate a revised triple-alpha rate over a wide temperature range, from 10^7 to 10^{10} K. Compared with the previously calculated rate, the new rate is significantly faster at low temperatures (10^7 to 10^8 K); the same in the middle range dominated by the Hoyle resonance; and slower at high temperatures (10^9 to 10^{10} K).

The revised rate has several astrophysical implications. One such is that in the universe's first stars, which began with no carbon and burned at relatively low temperatures, the only form of hydrogen fusion would be through the proton–proton chain. Once enough carbon had formed through the triple-alpha process, however, the CNO (carbon–nitrogen–oxygen) chain could begin. With the higher triple-alpha rate, this evolution might have taken only half as long as was previously thought. Also, in type-II supernovae, the lower rate above 10^9 K implies that the fraction of ^{56}Ni produced would be less than previously thought.

Further reading

H Fynbo *et al.* 2005 *Nature* **433** 136.



LABORATORIES

Astroparticle physics and cosmology laboratory opens in Paris

New Year's Day 2005 saw the official birth of the Laboratoire d'AstroParticule et Cosmologie (APC) in Paris. The APC's core physics activities are high-energy astrophysics, cosmology and neutrino physics – fields that are linked by a high level of theoretical activity and innovative data-handling methods.

In gestation for more than four years, this multi-disciplinary, ultra-modern laboratory at the interface between particle physics and astrophysics has existed in the form of a "research federation" since January 2002. The APC was born from the converging scientific interests of the University of Paris VII Denis Diderot and the three research organizations that supported and moulded it: CNRS (via three of its scientific departments, IN2P3, INSU and SPM), CEA (Material Sciences Department) and the Paris Observatory. A scientific council has been in operation for several years, and in spring 2004, an evaluation committee gave the green light for the APC to be established.

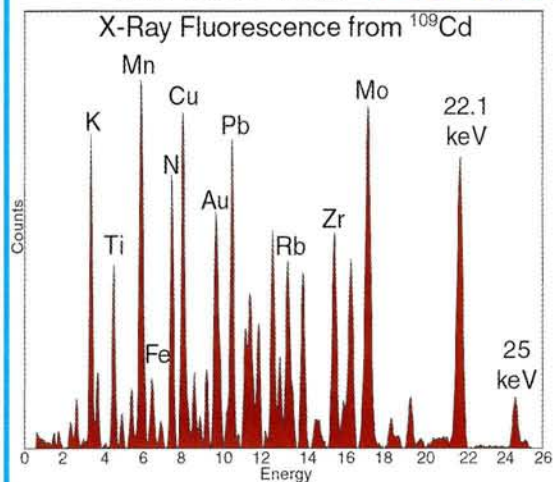
Directed by Pierre Binétruy, the laboratory currently employs 65 scientists and research scientists from the Ile-de-France region, more than 50 engineers, technicians and administrative staff and some 50 post-docs, visiting scientists and students. It should ultimately have a complement of around 200 people. The scientists come from varying backgrounds: physicists from the Collège de France's PCC laboratory, which closed down on 31 December to be merged into the APC; particle and astroparticle physicists from CEA's DAPNIA laboratory; astrophysicists from the Paris Observatory; and theorists from the Orsay Theoretical Physics Laboratory and the Paris Astrophysics Institute. These groups have already joined forces in a series of jointly run research projects and rapprochement should continue in 2005, albeit at separate geographical locations. The APC will enter a second phase at the beginning of 2006, when the laboratory moves into the new premises of the University of Paris VII's physics department, currently under construction on the Left Bank.

The APC physicists have already initiated or participated in projects and experiments. These include Auger and EUSO in the field of cosmic rays; INTEGRAL, HESS, GLAST and X-shooter in gamma astronomy· ANTARES in neutrino astronomy; Borexino and Double Chooz in neutrino physics; Planck and BRAIN for the study of the cosmological background; SNLS for the study of supernovae; and LISA for gravitational waves. An annual international scientific workshop has been organized since 2001; the next is scheduled for June 2005.

• For more information see www.apc-p7.org.

X-Ray Detector

XR-100CR at 149 eV FWHM Resolution



XR100CR X-Ray Detector with PX4 Digital Pulse Processor, Power Supply, Shaping Amplifier & MCA

XR100CR fitted for vacuum applications

No Liquid Nitrogen

Solid State Design

Easy to Use

Low Cost

APPLICATIONS

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

Visit Us Now
www.amptek.com

Digital Pulse Processor

NEW!!!

PX4

Digital Pulse Processor
Power Supply
Shaping Amplifier
MCA

Features

- Trapezoidal shaping to reduce ballistic deficit
- Wide range of shaping time settings
- High count rate capability
- High throughput
- MCA with 8 k channels
- High energy resolution
- Excellent pile-up rejection
- Enhanced stability
- USB interface
- Software instrument control, data acquisition and analysis
- Oscilloscope mode available
- Compatible with all Amptek XR100 detectors and detectors of other manufacturers

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

A look back to *CERN Courier* vol. 2, February 1962

COUNCIL

CERN and high-energy physics

During 1961, the American counterpart to the PS, the alternating gradient synchrotron (AGS), was put into running condition at Brookhaven. Its performance is now equal to that of the CERN PS, and its yield somewhat larger since it is a slightly bigger machine. Hence, the CERN accelerator no longer enjoys a unique position. There is no reason to fear, however, that the research activities at the AGS will from now on make it impossible for the PS to remain in a leading position with regard to fundamental physics. The field is wide enough to keep two machines of this type busy for a long time, particularly in view of the new perspectives seen now in strange-particle physics, which indicate that the region of a few thousand million volts is in fact much richer in phenomena than anticipated.

The work carried out so far at the AGS reflects both experience acquired at Brookhaven in the running of the Cosmotron and the high quality of the staff. For instance, their investigations of the composition of the secondary beams coming from internal targets have been done more systematically than at CERN. The results will be very useful for them and, to some extent, also to CERN in the planning of future experiments. So far, they have repeated with better accuracy and extended to higher energy the total-cross-section measurements of secondary particles with hydrogen. They have also undertaken an antiproton annihilation run in a hydrogen bubble chamber at 3 GeV energy, similar to the next annihilation run scheduled at CERN. They also plan to carry out a neutrino experiment in the immediate future, the planning of which has been partially based on the experience of CERN's abortive attempt. It is probable that they will succeed in their aim to solve the fundamental question of the existence of one or more types of neutrino.

If the neutrino experiment is considered as a race between the AGS and the PS, they would, in this case, have won the first lap. It should not be considered in this light, however; it is rather a double attempt to penetrate into a new area of knowledge, not unlike two climbers on one rope. The first climber tries a difficult stretch and fails; whereupon the second climber tries again and, with the help of the negative experience of the first one, avoids the worst pitfalls, and succeeds. In either case, the mountain is much higher than the first pitch.

- Taken from an article based on a paper prepared by the director-general, Victor Weisskopf, for the 20th session of Council in December 1961.

LAST MONTH AT CERN

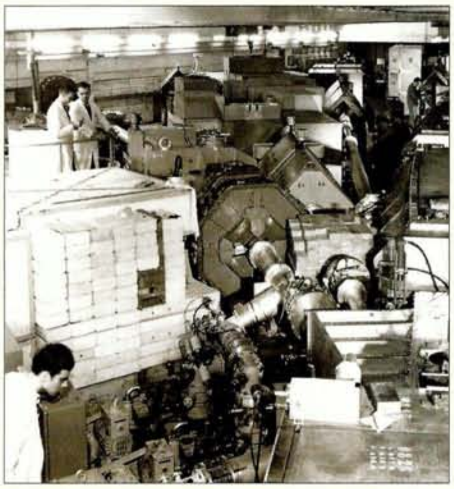
Three new beams installed during New Year shutdown

Most members of the Laboratory were able to enjoy a holiday from Christmas to the New Year, but among the changes they found on their return were new telephone numbers. Between 26 and 29 December, S B Division Technical Services had installed a new telephone exchange, increasing the number of available lines from 700 to 1100.

The proton synchrotron was shut down from 23 December to 16 January for routine maintenance and for carrying out a number of improvements. Among the latter, the 500 kV pre-injector system was realigned mechanically, and no correction currents are now required in the steering coils. Back-leg windings were installed on 60 magnet units and the counter cable network in the South Hall almost doubled. The first remote-control units for the radio-frequency system have been installed in the Main Control Room.

A more rapid change of target units has been made possible by modification to the accelerator vacuum system, and a new vacuum box in straight section no. 1 allows the extraction of secondary beams at a greater angle than previously.

Three new beams were installed during the shutdown:



The start of some of the secondary particle beams produced by the 28 GeV proton synchrotron. On the left, shielding bricks form a collimator; to their right are vacuum pipes, passing through guiding lenses and magnets, for beams of charged particles.

- q_1: 1.15 GeV/c negative pions, using four lenses and a bending magnet;
- s_2: a 30° neutral beam with adjustable collimators on each side of the shielding wall;
- v_1: similar to s_2 but at 45°.

The new beams and the positioning of the NPA electrostatic separator in the South Hall have led to considerable alterations in the layout of the shielding. Much of the shielding previously arranged for the neutrino experiment has now been removed, and the 1 m heavy-liquid bubble chamber has been removed to the NPA building for modifications.

EDITOR'S NOTE

The *CERN Courier* came into being in August 1959, and in 1962 it became a regular monthly publication, appearing in something like its present form.

Following on from the selection of extracts published during 2004, CERN's 50th anniversary year, this regular archive feature will tell the story of particle physics through the pages of the *CERN Courier* from 1962 onwards.

METALS & ALLOYS ADVENT

Standard Catalogue Items

Element Name
Atomic No. Symbol
Atomic weight
Density ← Solids & **Liquids** (g/cm^3) Gases(g/l)
M.pt./B.pt.(°C) ← Melting point (Solids & **Liquids**) • Boiling point (Gases)

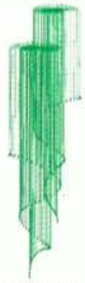
Element Name	Atomic No.	Symbol	Atomic weight	Density	M.pt./B.pt.(°C)
Hydrogen	1	H	1.0079	0.090	-252.87
Helium	2	He	4.0026	0.177	-268.93
Lithium	3	Li	6.941	0.54	180.5
Beryllium	4	Be	9.0122	1.85	1287
Boron	5	B	10.811	2.46	2076
Carbon	6	C	12.011	2.27	3900
Nitrogen	7	N	14.007	1.251	-195.79
Oxygen	8	O	15.999	1.429	-182.95
Fluorine	9	F	18.998	1.696	-188.12
Neon	10	Ne	20.180	0.900	-246.08
Sodium	11	Na	22.990	0.97	97.7
Magnesium	12	Mg	24.305	1.74	650
Aluminium	13	Al	26.982	2.70	660.3
Silicon	14	Si	28.086	2.33	1414
Phosphorus	15	P	30.974	1.82	44.2
Sulphur	16	S	32.065	1.96	115.2
Chlorine	17	Cl	35.453	3.214	-34.04
Argon	18	Ar	39.948	1.784	-185.85
Potassium	19	K	39.098	0.86	63.4
Calcium	20	Ca	40.078	1.55	842
Scandium	21	Sc	44.956	2.99	1541
Titanium	22	Ti	47.867	4.51	1668
Vanadium	23	V	50.942	6.11	1910
Chromium	24	Cr	51.996	7.14	1907
Manganese	25	Mn	54.938	7.47	1246
Iron	26	Fe	55.845	7.87	1538
Cobalt	27	Co	58.933	8.90	1495
Nickel	28	Ni	58.693	8.91	1455
Copper	29	Cu	63.546	8.92	1084.6
Zinc	30	Zn	65.39	7.14	419.5
Gallium	31	Ga	69.723	5.90	29.8
Germanium	32	Ge	72.64	5.32	938.3
Arsenic	33	As	74.922	5.73	816.9
Selenium	34	Se	78.96	4.82	221
Bromine	35	Br	79.904	**3.12**	**-7.3**
Krypton	36	Kr	83.80	3.733	-153.22
Rubidium	37	Rb	85.468	1.53	39.3
Strontium	38	Sr	87.62	2.63	777
Yttrium	39	Y	88.906	4.47	1526
Zirconium	40	Zr	91.224	6.51	1855
Niobium	41	Nb	92.906	8.57	2477
Molybdenum	42	Mo	95.94	10.28	2623
Technetium	43	Tc	[98]	11.5	2157
Ruthenium	44	Ru	101.07	12.37	2334
Rhodium	45	Rh	102.91	12.45	1964
Palladium	46	Pd	106.42	12.02	1554.9
Silver	47	Ag	107.87	10.49	961.8
Cadmium	48	Cd	112.41	8.65	321.1
Indium	49	In	114.82	7.31	156.6
Tin	50	Sn	118.71	7.31	231.9
Antimony	51	Sb	121.76	6.70	630.6
Tellurium	52	Te	127.60	6.24	449.5
Iodine	53	I	126.90	4.94	113.7
Xenon	54	Xe	131.29	5.887	-108.05
Caesium	55	Cs	132.91	1.88	28.4
Barium	56	Ba	137.33	3.51	727
*	57-70				
Lutetium	71	Lu	174.97	9.84	1652
Hafnium	72	Hf	178.49	13.31	2233
Tantalum	73	Ta	180.95	16.65	3017
Tungsten	74	W	183.84	19.25	3422
Rhenium	75	Re	186.21	21.02	3186
Osmium	76	Os	190.23	22.61	3033
Iridium	77	Ir	192.22	22.65	2466
Platinum	78	Pt	195.08	21.09	1768.3
Gold	79	Au	196.97	19.30	1064.2
Mercury	80	Hg	200.59	**13.55**	**-38.83**
Thallium	81	Tl	204.38	11.85	304
Lead	82	Pb	207.2	11.34	327.5
Bismuth	83	Bi	208.98	9.78	271.3
Polonium	84	Po	[209]	9.20	254
Astatine	85	At	[210]	-	302
Radon	86	Rn	[222]	9.73	-61.85
Francium	87	Fr	[223]	-	-
Radium	88	Ra	[226]	5.0	700
**	89-102				
Lawrencium	103	Lr	[262]	-	1627
Rutherfordium	104	Rf	[262]	-	-
Dubnium	105	Db	[262]	-	-
Seaborgium	106	Sg	[266]	-	-
Bohrium	107	Bh	[264]	-	-
Hassium	108	Hs	[277]	-	-
Meitnerium	109	Mt	[268]	-	-
Darmstadtium	110	Ds	[281]	-	-
Unununium	111	Uuu	[272]	-	-
Ununbium	112	Uub	[285]	-	-
Ununquadium	114	Uuq	[289]	-	-

Tel + 44 1865 884440
Fax + 44 1865 884460
info@advent-rm.com

Order on line
Visit our web site for latest Catalogue prices
£ • € • Sfr • US$
+ new stock lines

www.advent-rm.com

Advent Research Materials Ltd • Eynsham • Oxford • England OX29 4JA



*Lanthanoids

Element Name	Atomic No.	Symbol	Atomic weight	Density	M.pt./B.pt.(°C)
Lanthanum	57	La	138.91	6.146	920
Cerium	58	Ce	140.12	6.689	795
Praseodymium	59	Pr	140.91	6.64	935
Neodymium	60	Nd	144.24	6.80	1024
Promethium	61	Pm	[145]	7.264	1100
Samarium	62	Sm	150.36	7.353	1072
Europium	63	Eu	151.96	5.244	826
Gadolinium	64	Gd	157.25	7.901	1312
Terbium	65	Tb	158.93	8.219	1356
Dysprosium	66	Dy	162.50	8.551	1407
Holmium	67	Ho	164.93	8.795	1461
Erbium	68	Er	167.26	9.066	1497
Thulium	69	Tm	168.93	9.321	1545
Ytterbium	70	Yb	173.04	6.57	824

**Actinoids

Element Name	Atomic No.	Symbol	Atomic weight	Density	M.pt./B.pt.(°C)
Actinium	89	Ac	[227]	10.07	1050
Thorium	90	Th	232.04	11.72	1842
Protactinium	91	Pa	231.04	15.37	1568
Uranium	92	U	238.03	19.05	1132
Neptunium	93	Np	[237]	20.45	637
Plutonium	94	Pu	[244]	19.816	639
Americium	95	Am	[243]	-	1176
Curium	96	Cm	[247]	13.51	1340
Berkelium	97	Bk	[247]	14.78	986
Californium	98	Cf	[251]	15.1	900
Einsteinium	99	Es	[252]	-	860
Fermium	100	Fm	[257]	-	1527
Mendelevium	101	Md	[258]	-	827
Nobelium	102	No	[259]	-	827

Metals – Alloys • Foils • Sheets • Wires • Mesh • Rods • Tubes • for Research/Development and Industry

Free Catalogue • 800 Stock Lines • 4500 Standard Packs • Small Quantities • Competitive Prices • Fast Shipment

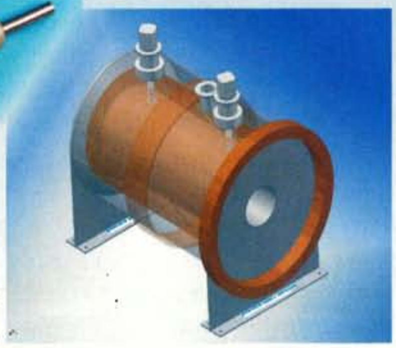
Your Expert in Magnet Technology

From Design to Operation of Systems and Installations

Electrical Breaker:
separation of high voltage from cooling circuit under cryogenic conditions

Studies: industrial production of cavities for the TESLA project, DESY (Hamburg)

Magnet Prototypes:
Superconductive dipoles for the Large Hadron Collider at CERN (Geneva)



Magnet Systems

Babcock Noell Nuclear GmbH
Magnettechnik
Alfred-Nobel-Str. 20
97080 Würzburg
Germany

Tel: +49.(0)931.903-4101
Fax: +49.(0)931.903-4171

E-mail: info@bn-nuclear.de
www.babcocknoellnuclear.de

Others promise the future....

We work on it

BABCOCK NOELL NUCLEAR GmbH

Compiled by Steve Reucroft and John Swain, Northeastern University

Lasers test Einstein's theory one century on

Tests of special relativity always attract interest, and they are likely to do so especially during 2005 – the centenary of the publication of Albert Einstein's first paper on the subject, and the World Year of Physics. Special relativity is in any case a hot topic, with speculation that something might be wrong with Lorentz invariance (*CERN Courier* December 2004 p27). A general theory for studying Lorentz-symmetry violation, known as the Standard Model Extension (SME), has been developed by Alan Kostelecký from Indiana University, and is being tested by Kostelecký and a team at the Harvard-Smithsonian Center for Astrophysics, led by Ron Walsworth. In a recent paper they presented evidence that indicates that all is well with the usual Minkowski space–time.

The researchers looked for an annual variation of a daily sidereal modulation of the frequency difference between colocated ^{129}Xe and ^{3}He Zeeman masers. Coupling of the nuclear spins to Lorentz-violating background fields would lead to such a variation in the nuclear Zeeman splitting as the Earth rotates and revolves round the Sun. The team found nothing at the level of 150 nHz, which translates, as the authors put it, into "the first clean test for the fermion sector of the symmetry of spacetime under boost transformations at a level of 10^{-27} GeV". The nuclear spins of ^{129}Xe and ^{3}He depend principally on the unpaired neutron in each case, and the results also provide equally stringent limits on CPT violation for the neutron.

Further reading

F Canè *et al.* 2004 *Phys. Rev. Lett.* **93** 230801.

The right spin for a neutrino superfluid

Right-handed neutrinos, with the intrinsic spin oriented in the direction of motion, have yet to be observed, but if they do exist then they could make neutrino superfluids possible. Joe Kapusta of the University of Minnesota has shown that such an exotic medium could arise because the right-handed particles could exchange Higgs bosons with the well known left-handed neutrinos and pair up to make bosons, which could then form a superfluid.

Kapusta points out that the condensation temperature would be well below the cosmic background temperature, so it would be quite a feat to make this superfluid. However, Kapusta also notes that a sufficiently advanced civilization might use pulses of neutrino superfluid for long-distance communications.

Further reading

J I Kapusta 2004 *Phys. Rev. Lett.* **93** 251801.

Nature's parameters give perfect balance

Our sense of balance is about as good as it can possibly be. This extra "sixth" sense (in addition to smell, touch, sight, hearing and taste) is available to us via a set of three mutually perpendicular, fluid-filled tubes called vestibular semicircular canals, or SCCs. Housed in the inner ear, each is more or less doughnut-shaped, with a major radius of 3 mm and minor radius of 0.2 mm. A membrane called the cupula, which has sensory hairs, detects the motion of fluid in the SCCs and relays information about acceleration and gravity.

Interestingly, SCCs are about the same size in all vertebrates, at least within a factor of three or so, and this has long been something of a puzzle. Now Todd Squires of Caltech has provided an explanation. Varying four key parameters – the SCC major radius, minor radius, cupula thickness and height – he has found that the highest sensitivity occurs for the parameter values found in nature.

Further reading

Todd Squires 2004 *Phys. Rev. Lett.* **93** 198106.

Clutter facilitates communication

Radio-reflective clutter is usually considered to be an obstacle to communications, providing unwanted echoes, television "ghost images" and the like. A little lateral thinking, however, shows that clutter can be used to achieve very useful effects. Benjamin E Henty and Daniel D Stancil of Carnegie Mellon University have shown that a multipath indoor environment can be used to focus 2.45 GHz radio waves to two locations about a half-wavelength apart.

This requires some tricky phase conjugation, essentially to undo the scattering from obstacles at the transmitter end, so the benefit does not come without effort. However, the result amounts to two separate channels, running at the same time and at the same frequency. The experiment was performed in a "cluttered" laboratory, but the real impact will be in the communications business, where buildings and other "clutter" have previously been seen as a problem not a solution.

Further reading

Benjamin E Henty and Daniel D Stancil 2004 *Phys. Rev. Lett.* **93** 243904.

VAT® VACUUM VALVES

www.vatvalve.com

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

Signs that black holes swarm at galaxy centre

A swarm of 10 000 black holes may be orbiting the Milky Way's supermassive black hole. This estimate is based on theoretical expectations of the migration of black holes in our galaxy and the observation by NASA's Chandra X-ray Observatory of an over-density of X-ray binaries at the galactic centre.

The centre of our galaxy, the Milky Way, is known to host a black hole called Sagittarius A* (Sgr A*) with a mass of about 3.7 million suns. Around this supermassive black hole there should be a high concentration of stellar-mass black holes, which would have migrated into the galactic centre over several billion years. Stellar-mass black holes form in the core of supernova explosions of stars with masses typically 5–10 times that of the Sun.

When such a massive object flies by one of the greater number of less massive stars, the lighter body gains speed while the heavier body loses speed. Several such two-body interactions make heavier bodies fall towards the galactic centre, while lightweight stars are ejected towards the outer regions of the galaxy. Such a mass segregation is well known in dense globular clusters, and was predicted a decade ago to cause stellar black holes to sink towards the centre of the galaxy. From the estimated number of stars and black holes in the galactic centre region, this effect is expected to produce a dense swarm of 20 000 black holes within three light-years of Sgr A*.

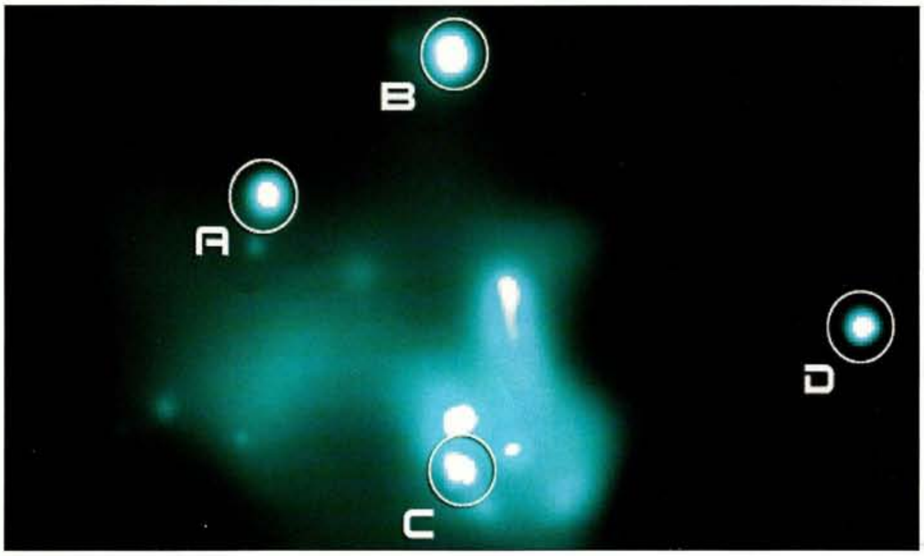
Once black holes are concentrated near Sgr A* they will have many close encounters with normal stars there, some of which are in binary star systems. The intense gravity of a black hole can induce an ordinary star to "change partners" and pair up with the black hole. This process is expected to produce several hundred binary systems with a black hole or a neutron star.

The Chandra X-ray observations of the central region of the galaxy now show evidence of a high concentration of binary systems around Sgr A*. M P Muno, from the University of California, Los Angeles, and colleagues found four active X-ray binary sources at less than three light-years from Sgr A*, while there would be only a 20% chance of finding one such source in this small area. This estimate is based on the density of sources observed at a slightly larger distance from Sgr A*, between 3 and 75 light-years. The derived over-abundance of X-ray binaries by a factor of 20 suggests that a huge number of black holes and/or neutron stars have gathered at the galaxy centre.

Although this study clearly shows an excess of X-ray binaries at the centre of the galaxy, it is difficult to extrapolate from the four sources that are active at a given moment to the total number of black holes orbiting Sgr A*. Many processes are difficult to quantify, in particular the fraction of black holes and neutron stars that are paired with a normal star to form an X-ray binary system, and the rate of activity of these systems. Further theoretical and observational studies will be needed to confirm the presence of a swarm of some 10 000 black holes at the heart of our galaxy.

Further reading:

M P Muno *et al.*, submitted to *ApJL*, http://arxiv.org/abs/astro-ph/0412492.



Chandra X-ray image of the centre of our galaxy. The four labelled sources are variable binary systems hosting a black hole or a neutron star, located within three light-years from Sgr A. (NASA/CXC/UCLA/M P Muno et al.)*

Picture of the month

This relatively nearby galaxy captured by the Hubble Space Telescope might well be the youngest galaxy ever seen, in the sense that its stars are all younger than 500 million years. This means that this galaxy, called I Zwicky 18, waited for some 13 billion years after the Big Bang before producing stars. Now it is producing them at a very high rate in its two bluish-white knots. This nearby dwarf galaxy offers the opportunity to study the kinds of galaxies that inhabited the early universe and that are thought to be the building blocks of spiral galaxies like our Milky Way. (NASA; ESA; Y Izotov, Main Astronomical Observatory, Kiev, Ukraine; and T Thuan, University of Virginia.)

GERMANY AT CERN

made in Germany

In an official presentation 28 German companies will be demonstrating at CERN from 28 February to 3 March 2005 their supply and service offers for the construction of the LARGE HADRON COLLIDER (LHC) and other key CERN programmes.

We look forward to meeting you on the German presentation „GERMANY AT CERN"

The official German presentation is sponsored by

Federal Ministry of Education and Research

in cooperation with

Federal Ministry of Economics and Labour

and

AUMA

Association of the German Trade Fair Industry (AUMA), Berlin

EXHIBITORS:

ACCEL Instruments GmbH

Friedrich-Ebert-Str. 1 · D-51429 Bergisch Gladbach
Tel.: +49-22 04/84-25 00 · Fax: +49-22 04/84-25 01
accel@accel.de · www.accel.de

Superconducting Accelerator Magnets. Custom Designed Magnet Systems. Normal- and Superconducting RF Accelerating Units. Custom Designed RF and Control Systems. Turn Key Linacs. Synchrotrons and Cyclotrons. Proton/Ion Therapy Systems. Synchrotron Radiation Beamlines & Instrumentation. Monochromators,UHV-Devices. LTS and HTS Current Leads. Insertion Devices (Undulators, Wigglers). Cryogenic Low Loss and Zero Boil Off Systems. Engineering and Manufacturing Services. (Vacuum Brazing, EB-Welding etc.) International Project Management.

Representative:
ACCEL Instruments GmbH
Molliserstr. 41 · CH-8754 Netstal

apra-norm Elektromechanik GmbH

Gewerbegebiet · D-54552 Mehren
Tel.: +49-65 92/204-0 · Fax: +49-65 92/204-100
vertrieb@apranorm.apra.de · www.apra.de

19"-Cabinets, 19"-Racks, 19"-enclosure systems, 19"-Wall mounting enclosure, 19"-Subracks and Plug-in modules, 19"-Plug-in units, Small cases, Customized Enclosures, Panel Instrument Cases according to DIN 43700/IEC61554

Representative:
Rotronic ag
Grindelstr. 6 · CH-8303 Bassersdorf
Tel.: 044 838 11 11 · Fax: 044 837 00 74

Babcock Noell Nuclear GmbH

Alfred-Nobel-Str. 20 · D-97080 Würzburg
Tel.: +49-931/903-41 01 · Fax +49-931/903-41 71
info@bn-nuclear.de · www.babcocknoellnuclear.de

Magnets and components for fusion experiments and accelerators. Development and fabrication of superconducting magnets and magnet systems, e.g. dipoles and quadrupoles Cryostates and vacuum vessels. Special purpose tools for fabrication of magnets. Manipulator systems for magnets. Feasibility and fabrication studies. Design and calculation of magnets. Individual developments. Complete planning and construction of nuclear facilities and components. Remote handling systems, manipulators and handling systems for fuel elements. Radiation Shielding Windows Double lid systems. Planning and execution of decommissioning and dismantling of nuclear facilities. Conditioning of radioactive waste. Developments for final disposal of spent fuel. Nuclear service.

H. BUTTING GmbH & Co. KG

Gifhorner Str. 59 · D-29379 Knesebeck
Tel.: +49-58 34/50-0 · Fax +49-58 34/50-320
info@butting.de · www.butting.de

Longitudinally welded pipes, piping spools, components and vessels for various industries in:

- Stainless steels (e.g. 316L, Duplex)
- Titanium alloys
- Nickel alloys
- Clad materials

in sizes from 25 mm OD up to 1.000 mm OD – not only for the stock but also according to customers' specifications.

CEROBEAR GmbH

Kaiserstr. 100 · D-52134 Herzogenrath
Tel.: +49-24 07/95 56-0 · Fax: +49-24 07/9 62 24
info@cerobear.de · www.cerobear.de

Cerobear® is the leading manufacturer of all ceramic bearings, the essential bearing to realize advanced motion technology. The non-magnetic all ceramic bearing allows dry run or media lubrication, offers 50% reduction in weight and friction moment and is resistant to corrosion and highest temperatures. The all ceramic bearing technology is one key enabling factor for industries they have to meet highest requirements in their products and processing under extreme operating conditions like vacuum, aerospace, food and pharmaceutical processing and semiconductor industry.
The combination of ceramic rolling elements with conventional and special alloy bearing steels promise considerable application advantages, Cerobear® hybrid rolling bearings possess excellent tribological properties and avoids the feared bearing seizing effect under poor lubrication. Hybrid bearings broaden the limits of current bearing technology in a wide range of sophisticated applications and industries.

CiS Institut für Mikrosensorik gGmbH Erfurt

Konrad-Zuse-Str. 14 · D-99099 Erfurt
Tel. +49-361/663 1410 · Fax +49-361/663 1413
info@cismst.de · www.cismst.de

CiS - Institute for Microsensorics is an acknowledged industry-oriented research institute in the Free State Thuringia.
Si-based-Microsensors delivered by CiS are applicable especially to miniaturization and system integration.
Our Products are:
- radiation detector for nuclear physics
- customer specific photo diodes
- pressure sensors
- sensors for dew point, condensation

Our Services are:
- Industry-oriented research for sensors
- Customer-specific development
- R&D- Services for Sensor Design, Wafer

Processing, Assembly, Metrology
- Prototyping, Wafer Foundry, Packaging

CST - Computer Simulation Technology

Bad Nauheimer Str. 19 · D-64289 Darmstadt
Tel.: +49-61 51/73 03-0 · Fax: +49-61 51/73 03-10
info@cst.com · www.cst.com

CST's simulation tools help engineers achieve improved product performance and reduced time-to-market, by providing accurate 3D EM design solutions. With the underlying FIT (Finite Integration Technique), the proprietary Perfect Boundary Approximation (PBA)® and Smart Grid™ technology, CST has successfully combined short calculation times with highly accurate results. The simulators CST MICROWAVE STUDIO®, CST DESIGN STUDIO™, CST EM STUDIO™ CST PARTICLE STUDIO™ and MAFIA-4 have benefited from over 20 years experience in the area of numerical field calculation, and are used world-wide by market leaders such as Motorola, Nokia, Philips, Raytheon, Siemens, and Sony. A comprehensive network of distribution and support centres in Europe, the Far East and North America, ensures optimal service for every customer. More information about CST is available on the web at www.cst.com.
CST-Computer Simulation Technology
"Changing the standards for 3D EM simulation".

Draka Comteq

Piccolministr. 2 · D-51063 Köln
Tel.: +49-221/677-0 · Fax: +49-221/677-38 90
info@drakact.de · www.drakact.de

RF pulse cables

EUCHNER GmbH + Co. KG

Kohlhammerstr. 16 · D-70771 Leinfelden-Echterdingen
Tel.: +49-711/75 97-0 · Fax: +49-711/75 33 16
info@euchner. de · www.euchner.de

Stable and constant growth signifies the successful story of the family-owned company EUCHNER GmbH + Co. KG in Leinfelden, nearby the city of Stuttgart. Today, it has become a global player. The design and development of switching devices for controlling a wide variety of motions in the field of machine and plant construction is its main business. Safety has been the main topic of EUCHNER within the last decades: Safety Engineering in order to protect people, machines and products. Quality, reliability and precision are the characteristics of EUCHNER's philosophy.
EUCHNER GmbH + Co. KG employs 360 employees world-wide and maintains three production sites in Germany. The brothers Stefan and Michael Euchner are the Managing Directors of the Swabian family company.

Representative:
EUCHNER AG, Ing.- und Vertriebsbüro
Grofstr. 17 · CH-8887 Mels/St. Gallen
Tel.: +41-81/7 20 45 90 · Fax: +41-81/7 20 45 99
euchner.schweiz@bluewin.ch · www.euchner.com

F. u. G. Elektronik GmbH

Florianstr. 2 · D-83024 Rosenheim
Tel.: +49-80 31/28 51-0 · Fax: +49-80 31/8 10 99
info@fug-elektronik.de · www.fug-elektronik.de

High Voltage Power Supplies up to >300kV, up to 250kW
stability/ripple 100pmm (Standard) (on request less 10ppm possible)
High Voltage Cassettes up to 35kV; 7W, 35W, 140W, 350W
Low Voltage Power Supplies up to >5000A, up to 250kW
Special Power Supplies, customized

Habia Kabel GmbH

Vertriebsbüro Süd
Zeppelinstr. 5/1 · D-89231 Neu-Ulm
Tel.: +49-731/70 47 95-20 · Fax: +49-731/70 47 95-99
norbert.mueller@habia-kabel.de · www.habia-kabel.de

Cables for
Defence: Military Communication. Radar Systems.
Control & Instrumentation: Sensors. Heating.
Nuclear: Drag chain cables. Waste processing. Fuel handling.
Industrial: Gas Turbines. Offshore. Raw material processing.
Transport: Automotive. Space. Marine Diesel.
Telecom: Base stations. Switching Systems.

Heinzinger electronic GmbH
The Power Supply Company

Anton-Jakob-Str. 4 · D-83026 Rosenheim
Tel.: +49-80 31/24 58-0 · Fax: +49-80 31/24 58-58
info@heinzinger.de · www.heinzinger.de

POWER SUPPLIES for HIGH VOLTAGE, HIGH CURRENT, HIGH POWER with HIGH PRECISION, Power Supplies and Capacitor Charger for voltages up to >300000 Volt, currents up to >5000 Ampere with accuracy up to <0,001 %. With an experienced team of specialists Heinzinger electronic GmbH focus on development, production and sales of high-quality power supplies. The company has competence and experience for many years in all ranges of high precise power supply solutions, also for very high performance. Heinzinger supplies not only power supply solutions, tuned to the application, they also offer a lot of services covering High-Voltage and High-Current.

HEW-KABEL/CDT GmbH & Co. KG

Klingsiepen 12 · D-51688 Wipperfürth
Tel.: +49-22 67/683-0 · Fax: +49-22 67/22 03
mail@hew-kabel.com · www.hew-kabel.com

Manufacture and development of specialty cables and wires for high performance applications conforming to German and international specifications as well as custom-made solutions for specific conditions; heating cable. Applications areas: Instrumentation, control and automation techniques, industrial plant and power engineering, medical engineering, sensory analysis, communication electronics, high-frequency engineering, automotive industry, chemical industry. HEW-KABEL is a Belden CDT Company.

iseg Spezialelektronik GmbH
Bautzner Landstr. 23 · D-01454 Radeberg/Rossendorf
Tel.: +49-351/2 69 96-0 · Fax: +49-351/2 69 96-21
sales@iseg-hv.de · www.iseg-hv.com

The **iseg Spezialelektronik GmbH** company specialises in the development and production of High Voltage Power Supplies for Industry and Research.
Competence in all concerns referred to High Voltage is the essence of our company philosophy.
During the last years iseg became an important part of HV PS systems in High Energy Physics, e.g. the coming accelerator based LHC experiments and several Neutrino experiments. iseg also offers the most comprehensive HV PS portfolio for applications in Labs and Test fields for the assembly of big detectors.

Representative:
AIP Wild AG
Wehntaler Str. 6 · CH-8154 Oberglatt · Mr. James Martin Schneider
Tel.: +41-1-852 20 20 · Fax: +41-1-852 20 21
james.schneider@aip-wild.ch · www.aip-wild.ch

Selectronics, AIP Agent for West-Swiss
ch. Sur-le-Blétru 8b · CH-1132 Lully · Mr. Erwin Stoll
Tel.: +41-21-803 12 33 · Mobile: +41-79-606 32 35 · Fax: +41-21-803 12 29
estoll@swissonline.ch

KNF Neuberger GmbH
Diaphragm Pumps and Systems
Alter Weg 3 · D-79112 Freiburg
Tel.: +49-76 64/59 09-0 · Fax: +49-76 64/59 05-99
info@knf.de · www.knf.de

KNF Neuberger AG
Stockenstr. 6 · CH-8362 Balterswil
Tel.: 071-971 14 85 · Fax: 071-971 13 60
knf@knf.ch · www.knf.ch

KNF Neuberger – INNOVATIVE TECHNOLOGY WORLDWIDE
the expert for diaphragm pumps. Whether diaphragm pumps for gases or liquids, swing piston compressors and vacuum pumps the KNF Neuberger range provides the right type of pump. KNF pumps are used where gases and vapors must be transferred, evacuated or compressed or where liquids must be transferred or metered. In addition to pumps which are incorporated into equipment or used in process technology, KNF produces a wide range of portable pumps. They are mainly used in laboratories. Miniature magnetic valves and pressure control valves round up the KNF range of products.
KNF diaphragm pumps are robust, need no maintenance and do not pollute the media, they are therefore used in various versatile application areas, such as: medical equipment, environmental protection, process engineering, food technology, research and nuclear technology.
The large KNF product program permits a high degree of flexibility. When customer requirements are too specific to be met by standard products, KNF carries out customized projects.
KNF Neuberger has a worldwide presence, either through its own 13 companies in Europe, America and Asia or through representatives in major industrialized countries.

Leybold Vacuum GmbH
Bonner Str. 498 · D-50968 Köln
Tel.: +49-211/347-0 · Fax: +49-211/347-12 50
info@leybold.com · www.leybold.com

Leybold Vacuum offers a broad range of advance vacuum solutions for use in industrial manufacturing and research purposes. The core capabilities center on the development of application- and customer-specific systems for the creation of vacuums and of process gases.
Leybold Vacuum develops, manufactures and distributes vacuum products, such as vacuum pumps, complete vacuum systems, components, gauges, and lead detectors.
The installations, equipment and/or vacuum components needed for such R&D efforts may of course vary in size and/or capacity. Hence we also develop and manufacture customized products specifically for R&D purposes, because we want to be involved in the entire process from the very beginning. Leybold Vacuum employs more than 1500 employees worldwide and has the largest sales and service networks in the industry, present in 70 countries around the world. With manufacturing facilities in the USA, Europe and Asia, Vacuum Solutions is close to its customers everywhere.

Branch office:
Leybold Vacuum Schweiz AG
Leutschenbachstr. 55 · CH-8050 Zürich
Tel.: +41-1 308 40 50 · Fax: +41-1 302 43 73
sales@leybold.ch · www.leybold.com

Linde AG
Linde Engineering Division
Dr.-Carl-von-Linde-Str. 6-14 · D-82049 Hoellriegelskreuth
Tel.: +49-89/74 45-0 · Fax: +49-89/74 45-49 08
info@linde-le.com · www.linde.com

The Linde Engineering Division designs and builds turnkey plants and supplies all services for process engineering projects. The scope of activities comprises: petrochemical plants, synthesis gas plants, hydrogen plants, gas processing plants, natural gas plants, air separation plants, cryogenic plants, environmental protection plants, pharmaceutical plants. Linde and its subsidiaries manufacture coldboxes, plate-fin heat exchangers, specialized butterfly valves and actuators.

Linde Kryotechnik AG
Plants to provide cooling capacity or liquefaction at very low temperatures, have a very long tradition within the Linde AG. 1932 Linde has delivered the first industrial helium liquefaction plant of the world to the university of Charkov, Ukraine. In the meantime, more than 500 plants are built, delivered and successfully operated all over the world.

At our competence centers in Switzerland and the United States, scientists, engineers and technicians are assigned with the design, construction, and the building of helium refrigerators, helium liquefiers, and hydrogen liquefiers.

Representative:
Linde Kryotechnik AG
Daetlikonerstr. 5 · CH-8422 Pfungen
Tel.: +41-5230 405 55 · Fax: +41-5230 405 50
info@linde.kryotechnik.ch · www.linde-kryotechnik.ch

Nexans Deutschland Industries GmbH & Co. KG
Kabelkamp 20 · D-30179 Hannover
Tel.: +49-511/676-32 50 · Fax +49-511/676-37 77
Klaus.Schippl@nexans.com · www.nexans.de

CRYOFLEX Transfer Lines.
Completely assembled flexible transfer line systems for the transport of liquefied gases and components

Pfeiffer Vacuum GmbH
Berliner Str. 43 · D-35614 Asslar
Tel.: +49-64 41/802-0 · Fax: +49-64 41/802-202
info@pfeiffer-vacuum.de · www.pfeiffer-vacuum.net

Leading-edge technology for today's high tech world
Whether we are wearing a pair of glasses, watching a TV set, working on the PC, or driving a car, we all benefit from vacuum technology. The manufacture of semiconductors, compact disks and DVDs, heat-absorbing glass, eye glasses and the coating of heavy-duty mechanical tools are only a few examples of vacuum technology application. Vacuum also plays an important role in research, space technology, analysis, and environmental technology. Pfeiffer Vacuum, as a manufacturer of components and systems for vacuum generation, control and measurement is continually faced with new vacuum applications and new markets with high growth potential.

The range of Pfeiffer Vacuum products and services
Turbo pumps. Rotary vane pumps. Roots pumps. Diaphragm pumps. Dry pumps. Helium leak detectors. Components. Vacuum measuring and control devices. Gas analysis. Coating and leak test systems, vacuum pumping stations. Customer training. Application support and technical service.

Representative:
Pfeiffer Vacuum Schweiz AG
Foerrlibuckstr. 30 · CH-8037 Zürich
Tel.: +41-44/4 44 22 55 · Fax: +41-44/4 44 22 66
info@pfeiffer-vacuum.ch · www.pfeiffer-vacuum.net

PINK GmbH
Vakuumtechnik
Am Kessler 6 · D-97877 Wertheim
Tel.: +49-93 42/919-0 · Fax: +49-93 42/919-111
info@pink.de · www.pink.de

The production line of PINK includes: standard components, customized vaccum chambers, coating systems, accelerator components, helium leak test facilities, soldering systems, vacuum drying ovens, UHV-systems, thermal technology, aerospace technology, customized vacuum systems.
The main customers of PINK you could find in the automotive, semiconductor, chemical and pharmaceutical industry as well as in the research and science sectors of institutes and universities and also in the aerospace industry.

Radio Frequency Systems

Kabelkamp 20 · D-30179 Hannover
Tel.: +49-511/32 49 · Fax: +49-511/6 76 37 50
harald.zietz@rfsworld.com · www.rfsworld.com

Radio Frequency Systems is a global designer and manufacturer of cable and antenna systems plus active and passive RF conditioning modules, providing total-package solutions for wireless infrastructure.
RFS serves OEMs, distributors, system integrators, operators and installers in the broadcast, cellular, land-mobile and microwave market sectors. As an ISO compliant organization with manufacturing and customer service facilities that span the globe, RFS offers cutting-edge engineering capabilities, superior field suppport and innovative product design. RFS is a leader in wireless infrastructure.

Skodock GmbH

Heinrich-Nordhoff-Ring 2 · D-80626 Garbsen/Hannover
Tel.: +49-51 31/445-0 · Fax: +49-51 31/445-502
info@skodock.de · www.skodock.de

SKODOCK is a worldwide approved Specialist for Tailor-Made solutions. Skodock specialists develop, manufacture and sell Metal-Hoses, -Bellows and Compensators (Expansion Joints) in sizes from 6mm diameter up to 2400mm diameter. Skodock is certified according to DIN EN ISO 9001:2000, homologated and validated by a large number of Audit Organisations and Certification Bodies in all relevant Industrial Branches. SKODOCK designs and manufactures according to the European Pressure Vessel Guideline 97/23/EG and is authorized by the TÜV to carry out tests according to Module H.
Flexible Stainless Austenitic Steel Bellows, Bellow Units, Expansion Joints and Flexible Hoses, thin wall tubes, membrane bellows

Struck Innovative Systeme GmbH

Harksheider Str. 102A · D-22399 Hamburg
Tel.: +49-40/60 87 30 50 · Fax: +49-40/6 08 73 05 20
info@struck.de · www.struck.de

Struck Innovative Systeme GmbH offers a range of high performance open standard data acquisition products.
The main focus is on VME based electronics. The well established Gigabit link based SIS1100/3100 cPCI/PCI to VME interface got a USB2.0 to VME counterpart with TigerSHARC DSP for test and demanding realtime applications recently. Our SIS330x 8 channel ADC/digitizer family with sampling rates up to 105 MHz and resolutions up to 14-bit is under extension towards higher sampling rates. The first new card is the SIS3320 8 channel 200 MHz digitizer with 32 MSamples of memory per channel. VME and USB2.0 systems on the base of the SIS3150 dual TigerSHARC twin CMC carrier and a comprehensive digital I/O board family will be presented.

Thermo Electron (Erlangen) GmbH

Frauenauracher Str. 96 · D-91056 Erlangen
Tel.: +49-91 31/909-0 · Fax: +49-91 31/909-205
info@thermo-esm.com · www.thermo.com/rmp

Starting under the company name of "Frieseke & Hoepfner" in Erlangen, Thermo RM&P have been experts in health physics, radiation monitoring and monitoring of particulate in ambient air since 1949. Renowned as "FAG Radiation Measurement" for more than a decade, and later ESM, Thermo RM&P now belong to Thermo Electron Corporation, the world leader in the analytical and environmental instruments industry. With our innovative products we provide our customers portable and stationary detection systems for

- Health physics: dose and dose rate, contamination
- The detection of illicit radioactivity trafficking at steel- and recycling plants, nuclear power plants, at harbours, airports, border transitions
- Environmental monitoring of dose rate and airborne radioactivity
- On-line stack monitoring of aerosols, noble gas, iodine
- Activity measurement of samples: Manual, automatic and low level counters
- Monitoring and sampling of particulate material in air

SIEMENS

represented by
Siemens Schweiz AG
Freilager Str. 40 · CH-8047 Zürich
Tel.: +41-5855 8 56 52 · Fax: +41-5855 54 88 41
urs.frankenhausen@siemens.com

Siempelkamp Nukleartechnik GmbH

Siempelkampstr. 45 · D-47719 Krefeld
Tel.: +49-21 51/89 48-481 · Fax: +49-21 51/89 48-488
snt.krefeld@siempelkamp.com · www.siempelkamp.com

Siempelkamp offers products and service for Nuclear Power Plants.
The concentration of our activities are on the key fields: waste management and decommissioning, casks and container construction, engineering and calculation, stud technology, manipulators, recycling, equipment, radiation protection and health physics, all completed by our service division.

VACOM Vakuum Komponenten & Messtechnik GmbH

Gabelsbergerstr. 9 · D-07749 Jena
Tel.: +49-36 41/42 75-0 · Fax: +49-36 41/42 75-24
info@vacom.de · www.vacom.de

Development, production and sales of vacuum components and measurement equipment, project consultation, development of customized products and solutions, service.
Product range: Fittings and Fabrications. Viewports. Vacuum Valves. Vacuum Chambers. Vacuum Measurement Equipment. Electrical Feedthroughs. Mechanical Feedthroughs. Forevacuum Pumps. Mass Flow Controllers. Edge Welded Bellows. Residual Gas Analyzers. Filters and Traps. Heating Components. Vacuum Pump Oils. Vented Screws

Representative:
Baruvac AG Druckluft- und Vakuumtechnik
Vogelsangstr. 11 ·P.O. Box 105, CH-8307 Effretikon
Tel.: +41-52 3 43 17-72 · Fax: +41-52 3 43 17-11
info@baruvac.ch · www.baruvac.ch

W-IE-NE-R, Plein & Baus GmbH

Muellersbaum 20 · D-51399 Burscheid
Tel.: +49-21 74/678-0 · Fax: +49-21 74/678-55
plein@wiener-d.com · www.wiener-d.com

W-Ie-Ne-R provides innovative products and creative solutions to the world of physics. Products, designed in compliance with CERN standards and specifications for highest performance and world-wide compatibility:

VME-Crates:	VME, VME 64, VME 64x, VME64xP (VIPA), VXI, CPCI 3-6-9U height, 160-220-280-340-400mm various depth, up to 3kW in 3U power box, 6kW in 6U power box
NIM-Crates:	non ventilated 5U high 12 slot, 7 slot transportable (150W) ventilated 5U+2U high intelligent fan tray 150-300-600W linear regulated power supplies
CAMAC-Crates:	ventilated 5+2U high, intelligent fan tray, 25 slot 300-600W linear regulated, 1650W switching power supplies
Crate Controller:	VME- PCI, VME- USB2 bridges, CAMAC- PCI, CAMAC- VME, CAMAC- USB2 bridges
Power Supplies:	Multi-channel programmable "low-noise" Floating DC power supplies for standard and hostile environment (magnetic field tolerant and radiation hard), up to 6kW output power
Slow Control:	CANbus, TCP/IP-Telnet, OPC-Server, Crate and Power Supply Monitoring Software

Representative:
ELCOTRON S.A.
5, route du Reposoir · CH-1260 Nyon
Tel.: +41-22/361 53 52 · Fax: +41-22/361 53 51
tech@elcotron.ch

Compiled by Hannelore Hämmerle and Nicole Crémel

GRID CONFERENCE

European Grid community hails progress at meeting in The Hague

The second Enabling Grids for E-sciencE (EGEE) conference was attended by more than 400 project members, invited guests and interested people from many fields.

The end of November 2004 saw a series of Grid meetings and conferences organized in The Hague in the context of the Dutch European Union presidency. The main event was the second conference of the Enabling Grids for E-SciencE (EGEE) project on 22–26 November, which had more than 400 participants. This made it the biggest Grid conference in Europe ever, topped only by the Global Grid Forum. This was pointed out by Patrick Aerts, director of the National Computer Facilities Foundation (NCF), the Dutch organization responsible for scientific supercomputing in the Netherlands, and chair of the e-Infrastructure Reflection Group.

The two-week sequence of Grid-related events also included meetings of other European Grid research projects, such as SEE-GRID (South Eastern European Grid-enabled e-Infrastructure Development), DILIGENT (Digital Library Infrastucture on Grid-Enabled Technology) and DEISA (Distributed European Infrastructure for Supercomputing Applications), as well as part of the annual conference of the Sixth Framework Programme of Information Society Technologies (IST2004, 15–17 November), where several Grid-related talks and dissemination activities about Grids and e-science were presented and workshops held.

While the first EGEE project conference in Cork in April 2004 was mainly about planning, the November conference was about reality. It highlighted the state of the deployment of applications and development of the re-engineered Grid middleware, showing that the Grid production service is now in full swing, servicing several applications over a large set of resources.

The first eight months of the project have seen the growth of the initial EGEE Grid production service, in close collaboration with the LHC Computing Grid project (LCG), to 90 sites, providing more than 8000 CPUs of computing power and a storage capacity of more than 4 petabytes. To ensure that the EGEE infrastructure can continue to grow to the target of 20 000 CPUs set for the beginning of 2006, Regional Operations Centres provide a decentralized but efficiently coordinated support structure with front-line user and deployment support. These are supplemented by four Core Infrastructure Centres running essential core Grid services while the operational activity is coordinated by the Operations Management Centre at CERN.

Security procedures are agreed upon and being implemented, and the release of the robust "gLite" Grid middleware developed by EGEE is planned for spring 2005. This has been engineered to make sure that it will serve the highly demanding needs of high-energy physics, while remaining versatile enough to serve other sciences.

While the use of Grid technology is well established in high-energy physics, EGEE is actively seeking new applications and has set up the GILDA testbed (Grid INFN Laboratory for Dissemination Activities), a virtual laboratory that demonstrates the Grid's capabilities. The importance and success of GILDA were emphasized by several speakers, and delegates were given the opportunity to view live demonstrations of applications that have already been ported to the Grid (both on the EGEE Grid production service and on GILDA): these related to medicine, earth science, computational chemistry, astro-particle physics, high-energy physics and video-on-demand.

Requests from several new scientific groups to use the EGEE infrastructure were also considered during the conference. In a session of the EGEE Generic Applications Advisory Panel (EGAAP), seven projects were presented, and the panel approved applications in drug discovery, cosmology and digital libraries to use the services that are offered by EGEE.

The final plenary session provided summaries from the parallel sessions dedicated to cross-activity subjects as well as a talk on the status of Grid standardization work and feedback from the project's External Advisory Committee. An overview of the LCG project provided high-level input from the high-energy physics pilot application area, and a summary of industrial interest in Grids hinted that the Grid might soon extend into non-scientific areas.

During the EGEE conference, members of the DEISA project, a consortium of national supercomputing centres, met and held joint ▷

meetings with other projects. DILIGENT and SEE-GRID also held working meetings and SEE-GRID organized a policy workshop to discuss a roadmap for establishing national Grid initiatives.

In the framework of the "European Leadership in Grids and e-Science", a workshop and meeting of the e-Infrastructure Reflection Group (e-IRG) was also held on 18–19 November. This brought together Grid experts and representatives from European governments to discuss common policies and provide recommendations on the shared use of electronic resources in Europe. Topics discussed included security, accounting, usage policies, user support, and general-purpose versus disciplinary Grids.

The Hague also saw the first joint meeting of the various Grid infrastructure projects in a "Grid Summit" to stimulate co-operation and knowledge exchange. This was followed by an effective and productive "concertation" meeting on e-Infrastructures. Its main objective is the creation of a political, technological and administrative framework for the easy and cost-effective shared use of distributed electronic resources across Europe. An impressive suite of European Grid projects was presented, both providing (EGEE, Géant2, DEISA, SEE-GRID) and benefiting from e-Infrastructures (DILIGENT, SIMDAT, GRIDCC, CoreGRID, GridLab). Grid research concertation efforts (GRIDSTART, NextGRID) were presented, as well as Grid mobility (Akogrimo).

The topic of synergies between Grid research and infrastructure projects generated much enthusiasm at the meeting and many of the participants expressed their interest in joining working groups to take the concertation effort between research and infrastructure further forward.

Early feedback from the participants showed that they appreciated the general good atmosphere and the many possibilities for social networking. In his closing remarks, CERN's Fabrizio Gagliardi, project director of EGEE, expressed his satisfaction with the achievements to date and emphasized the importance of face-to-face meetings for the project: "During this week we have consolidated our plans for the changes coming up. But the conference was also important for building a strong team spirit, which is a challenge in itself for such a large, international project."

Further information

www.e-irg.org

http://public.eu-egee.org/conferences/2nd

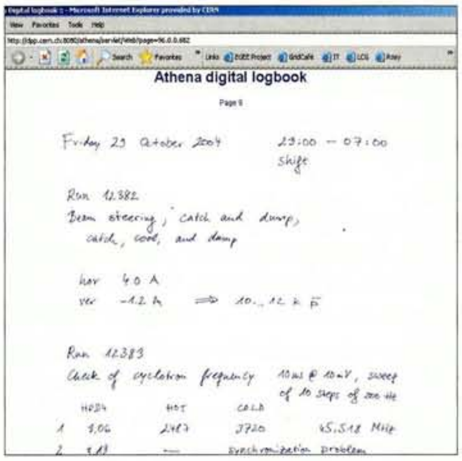
DIGITAL TECHNOLOGY

ATHENA tests the digital logbook

Even in this digital age, most scientists prefer old-fashioned paper logbooks to computer-based systems. This is not just a case of scientific conservatism – the paper version has several benefits in terms of ease of use: tables can be drawn and modified rapidly, sketches can be added and there is no risk of a computer crash causing delays.

However, in many experiments the hand-written logbooks are laboriously copied and distributed to the labs around the world involved in the project. Until this is done, the contents of the logbook are accessible only locally. Also, notes jotted down in haste during an eventful nightshift may be hard to interpret a few months later, even for the person who wrote them.

A summer student project run by CERN's IT Department has produced a better solution. With the generous assistance of Hewlett-Packard, students supported by the Helsinki Institute of Physics were able to develop a logbook using the firm's recently launched HP Forms Automation System. The technology involves printing a very fine pattern on every page, which provides a unique code for every point on each page. The digital pens used are normal ball-points with a built-in infrared sensor that reads and stores the code while writing, and uploads this information to the Web when the pen is docked to a PC.



A page from ATHENA's digital log-book.

With this approach, all the advantages of traditional pen and paper are preserved, but the information from the logbook can be made immediately accessible to collaborators around the world on a password-protected website. During testing, members of the ATHENA antimatter collaboration in Genoa were able to follow what their colleagues at CERN were writing on a daily basis.

Moreover, because the data stored by the pen are time-stamped, it is possible to link notes in the logbook much more accurately to digital recordings from various instruments at the experiment. By incorporating character-recognition software, it is possible to search these digital logbooks for keywords, making them even more practical.

A spin-off of this activity, prepared for CERN's 50th anniversary celebrations, was a digital guestbook, which was signed by visitors to the open day and official ceremony. Hundreds of entries from well-wishers were posted immediately on the Web, and can be seen at http://gridcafe.web.cern.ch/gridcafe/guestbook.html.

IT executives rate Red Hat #1 for Value
redhat

AWARDS

CERN honours INFN for Grid development

CERN's director-general, Robert Aymar, has presented the Italian National Institute for Nuclear Physics (INFN) with an award to recognize its contributions to developing computational Grids, and its pioneering efforts to establish and promote Grid technology at a national level and in Europe. The award was presented to Roberto Petronzio, president of INFN, on 30 November 2004 during a ceremony in Rome at the seat of the Ministry of Education, University and Research in the presence of the minister Letizia Moratti.

One of the first major national Grid initiatives in Europe, the INFN Grid project was launched in 1999. The objective was to investigate the potential of Grid software for high-energy physics applications.

INFN has also promoted the new EGEE (Enabling Grids for E-science in Europe) project that started on 1 April 2004 with CERN as lead partner and with the collaboration of other institutes from almost all European countries and partner institutions in the US, Russia and Asia.

Roberto Petronzio, president of INFN.

GRID DEVELOPMENT

ARDA celebrates prototype success

In December 2004 the ARDA project, which aims to develop a prototype Grid analysis system for the experiments at the Large Hadron Collider (LHC), reached a milestone: end-to-end prototypes that are capable of analysis for the LHC experiments.

ARDA, which stands for "A Realization of Distributed Analysis of LHC", develops prototype systems that integrate Grid middleware developed by the EGEE (Enabling Grids for E-science in Europe) project with common analysis tools in high-energy physics and the analysis software of the LHC experiments. This means that ARDA is running programs that could actually be used in 2007, when the LHC is scheduled to start up. Testing the Grid under real conditions gives effective feedback to the developers of Grid middleware.

"The LHC experiments are the best way to influence EGEE middleware to get an optimal system," said Massimo Lamanna, ARDA project leader. "But it also works the other way: the experiments get an early flavour of the middleware, can already run examples of real applications, and thus will be able to make maximum use of the facilities provided."

The third ARDA project workshop in October 2004 coincided with an important transition inside the project from a closed development environment to a preproduction test bed. This involved a scaling up of the activity both by an increase of available computing resources and by an expansion of the user community. From 2007, out of the thousands of physicists involved in the LHC experiments, several hundred will have direct access to the Grid. Although the Grid analysis prototypes are still evolving, they demonstrate already that the new system will be able to cope with the LHC data.

The fourth ARDA workshop, to be held at CERN at the beginning of 2005, will present the prototype activity and review the Grid middleware status, as well as clarifying strategy and priorities for the experiments.

Calendar of events

February

7–11 GlobusWORLD 2005 Boston, MA, US, www.globusworld.org

14–16 European Grid Conference Amsterdam, The Netherlands, http://genias.biz/egc2005/

21–25 Tridentcom 2005 – First International Conference on Testbeds and Research Infrastructures for the Development of Networks and Communities Trento, Italy, www.tridentcom.org

March

14–17 GGF13 Seoul, South Korea, www.gridforum.org

April

2–8 HPC High Performance Computing Symposium San Diego, CA, US, www.caip.rutgers.edu/hpc2005

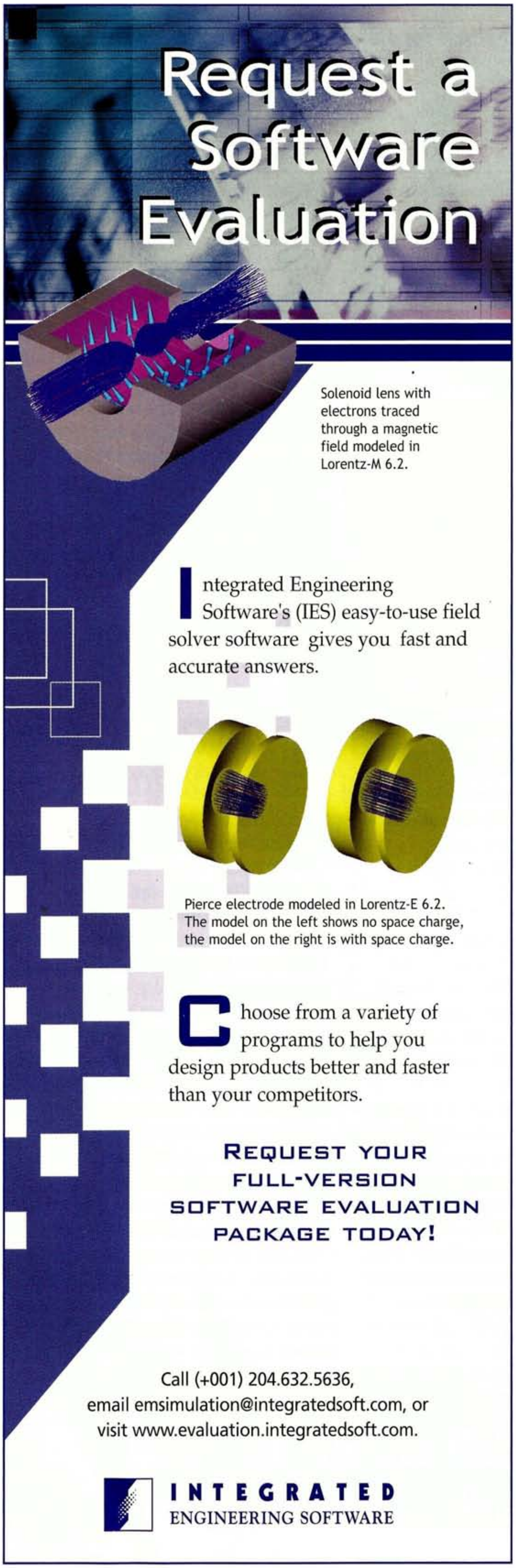
5–6 PVSS Users Meeting CERN, Switzerland, www.etm.at/cern.htm

7–9 HealthGRID 2005 Oxford, UK, http://oxford2005.healthgrid.org

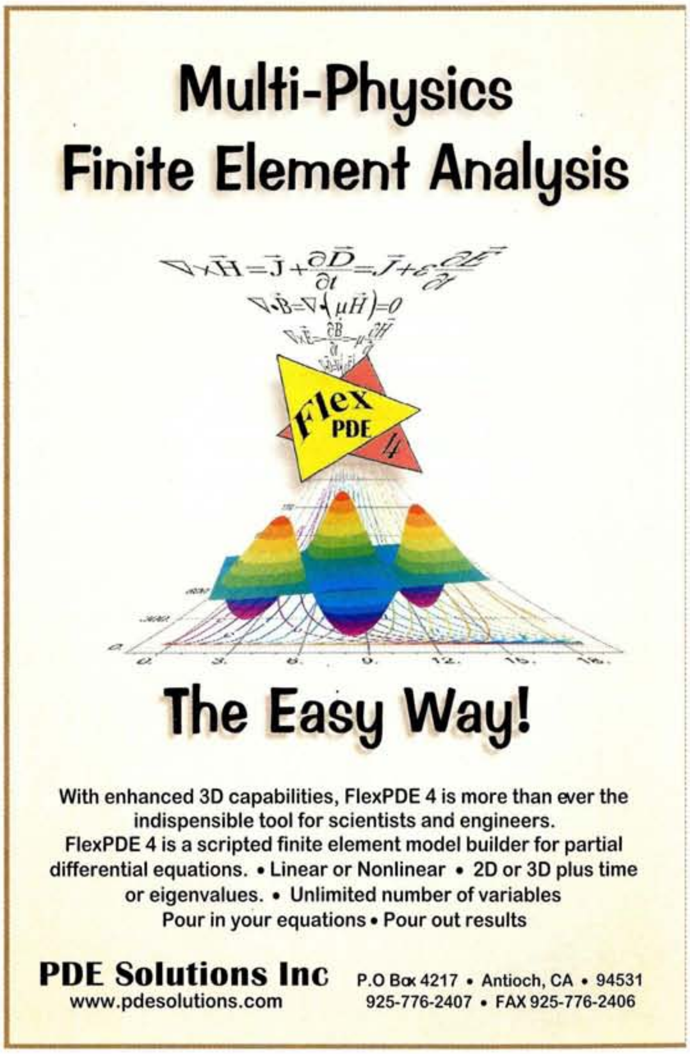
18–22 Third EGEE conference Athens, Greece, http://eu-egee.org

PRODUCT INFORMATION

gridMathematica2, an optimized parallel Mathematica environment for high-performance computing, has been released. It is based on the Parallel Computing Toolkit, a programming environment inside Mathematica. Features include shared or distributed memory, automatic and explicit scheduling, concurrency including synchronization, and failure recovery. gridMathematica provides a quick way to set up and run large calculations by bundling Mathematica kernels and the Parallel Computing Toolkit 2 in a way that is easy to install on parallel computers. gridMathematica is platform-independent and can be used on dedicated multiprocessor machines as well as on homogeneous and heterogeneous clusters. For more information see www.mathconsult.ch/pct.

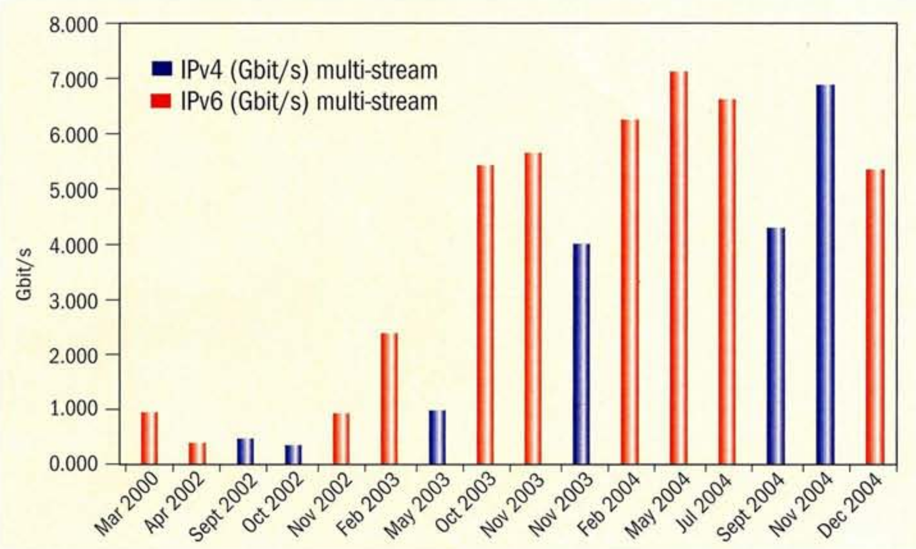

Request a Software Evaluation
Solenoid lens with electrons traced through a magnetic field modeled in Lorentz-M 6.2.
Integrated Engineering Software's (IES) easy-to-use field solver software gives you fast and accurate answers.
Pierce electrode modeled in Lorentz-E 6.2. The model on the left shows no space charge, the model on the right is with space charge.
Choose from a variety of programs to help you design products better and faster than your competitors.
REQUEST YOUR FULL-VERSION SOFTWARE EVALUATION PACKAGE TODAY!
Call (+001) 204.632.5636,
email emsimulation@integratedsoft.com, or
visit www.evaluation.integratedsoft.com.
INTEGRATED
ENGINEERING SOFTWARE


highprecision DC Power Supplies & more
HEINZINGER SUPPLIES CERN AND OTHER LEADING INSTITUTES WORLDWIDE WITH PROFESSIONAL POWER SUPPLIES AND CAPACITOR CHARGING POWER SUPPLIES.
HIGHPRECISION
up to <0.001%
HIGHCURRENT
up to >5,000A
HIGHVOLTAGE
up to >400,000V
Germany at CERN
28. FEB - 02. MAR 2005
Heinzinger at CERN
made
in
Germany
Heinzinger Power Supplies
Heinzinger electronic GmbH
The Power Supply Company
Anton-Jakob-Strasse 4
83026 Rosenheim - Germany
Phone: +49-8031-2458-0
Fax: +49-8031-2458-58
info@heinzinger.de
www.heinzinger.de
Heinzinger®
power supplies
supplies your world


Multi-Physics
Finite Element Analysis
Flex PDE 4
The Easy Way!
With enhanced 3D capabilities, FlexPDE 4 is more than ever the indispensible tool for scientists and engineers.
FlexPDE 4 is a scripted finite element model builder for partial differential equations. • Linear or Nonlinear • 2D or 3D plus time or eigenvalues. • Unlimited number of variables
Pour in your equations • Pour out results
PDE Solutions Inc
www.pdesolutions.com
P.O Box 4217 • Antioch, CA • 94531
925-776-2407 • FAX 925-776-2406

NETWORKS

Speed records tumble as networks get faster



Evolution of the Internet 2 Landspeed Record, a speed contest for end-to-end networks over large distances. The Supercomputing Bandwidth Challenge reaches higher speeds but over shorter distances.

An international team of physicists, computer scientists and network engineers has won the Supercomputing Bandwidth Challenge 2004 with a sustained data transfer of 101 Gbit/s between Pittsburgh and Los Angeles. This is equivalent to downloading three DVD-quality movies per second and more than four times faster than the previous record of 23.2 Gbit/s, which was set by the same team.

The Challenge allowed the scientists and engineers to preview the globally distributed Grid system that is being developed for the next generation of experiments at CERN's future Large Hadron Collider (LHC). To exploit fully the potential for discoveries, many petabytes of data will have to be processed, distributed and analysed. A hybrid network integrating both the traditional switching and routing of packets, and dynamically constructed optical paths to support the largest data flows, is central to the near-term future vision that the scientific community has adopted to meet the challenges of data-intensive science in many fields.

The team is led by the California Institute of Technology and includes Fermilab and CERN.

DIGITAL DIVIDE

UNESCO asks cyber-volunteers to aid developing nations

On 26 January, International Conference Volunteers (ICV), a non-governmental organization with its headquarters in Geneva, officially launched its new Cyber-Volunteers Programme. The programme, which is under the patronage of the United Nations Educational, Scientific and Cultural Organization (UNESCO), is aimed at helping to reduce the digital divide between the industrialized world and developing countries.

ICV has already been recruiting experts in information and communication technologies. They will voluntarily join development projects in Mali and Cameroon that need IT knowledge and skills but do not have the money for them. The volunteers will carry out internships of about six months, which will provide them with the opportunity not only to teach but also to gain knowledge and skills.

With contacts with non-governmental organizations in Mali, Cameroon, Uganda, the Republic of Congo, South Africa, Tanzania and Switzerland (Informaticiens sans Frontières at CERN), ICV aims to recruit 45 cyber-volunteers over a period of three years. The first to be selected will contribute to helping local authorities in Mali set up their administration in digital form and will teach school dropouts from poor neighbourhoods in Cameroon to develop interactive websites and other skills to give them more opportunities on the labour market.

Further information
www.icvolunteers.org

E-SCIENCE

German project set up to help scientific communication

In September 2004, the FIZ Karlsruhe and the Max Planck Society were awarded €6.1 million to develop a new platform for Web-based scientific collaboration – eSciDoc. The five-year funding is being provided by the German Federal Ministry of Education and Research (BMBF), under the framework of the German national e-Science initiative.

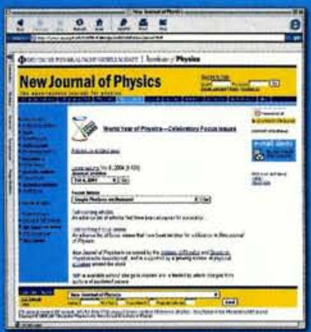
eSciDoc will address all aspects of scientific communication, from the creation and editing of information, sharing of data, and publication of research results, to storage and long-term archiving of papers. It will include interactive tools and handle multiple data sources and types, including video and audio. The ability to link to external data sources will be integral to the platform.

The results of the project will be shared with other scientific organizations and could in the future be utilized as a publication and communication platform by other research institutions. Individual services developed as part of the project may also be made available to other scientific institutions as open-source tools, enabling them to be used in a variety of other environments.

New Journal of Physics

The open-access journal for physics

FREE TO READ



Now in its 6th year, *New Journal of Physics* has firmly established itself as a vital source of outstanding research papers serving the whole physics community.

In 2004 the journal's growing high energy physics content has been supplemented by the current outstanding Focus Issue on **'Neutrino Physics'** edited by Francis Halzen, Manfred Lindner and Atsuto Suzuki.

Author benefits:

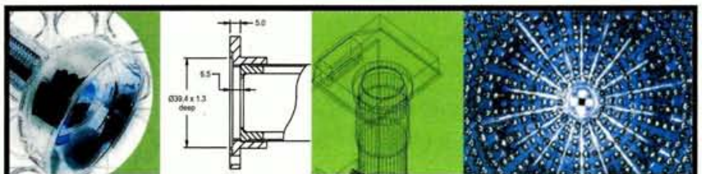
- **High editorial standards** – over 70% of regular submissions are rejected
- **High article visibility** – hundreds of downloads within weeks of publication
- **Fast publication** – average receipt-to-publication time less than 90 days
- **Multimedia and colour** – available at no extra charge

2003 Impact Factor 2.48

(ISI®'s Science Citation Index Journal citation reports)

New Journal of Physics is financed by an author article charge.
To submit a paper or to access published articles, please visit **www.njp.org**.

DEUTSCHE PHYSIKALISCHE GESELLSCHAFT | Institute *of* **Physics**



new website at www.electrontubes.com

Electron Tubes is pleased to announce the launch of an all-new website

www.electrontubes.com now includes:

- an interactive selection tool to help you find the photomultiplier that matches your specification
- download section for technical papers

whether you need X-ray detection systems, light detection systems, or photomultipliers, we offer a design service and the products to meet your requirements for light detection

Electron Tubes Limited
Bury Street, Ruislip,
Middx, HA4 7TA, UK
tel: +44 (0) 1895 630771
fax: +44 (0) 1895 635953
e-mail: info@electron-tubes.co.uk

Electron Tubes Inc.
100 Forge Way, Unit F
Rockaway, NJ 07866, USA
tel: (973) 586 9594
toll free: (800) 521 8382
fax: (973) 586 9771
e-mail: sales@electrontubes.com

electron tubes

When you don't want to compromise on quality

ZERO-FLUX™ DCCT measuring systems are globally recognised as the standard for scientific purposes. Why? Because we are like you - we don't compromise on quality!

HITEC Power Protection

Made in Holland

ZERO-FLUX™
sales@hitecsms.com
www.hitecups.com/sms

Computing conference goes to the Swiss Alps

CHEP '04 was an opportunity to review progress in Grid technology, discuss experience gained from experiments and look to the future. **John Harvey** reports.

Computing in High Energy and Nuclear Physics (CHEP) is a major series of conferences that has been held at roughly 18 month intervals since the 1980s, alternating between Europe, North America and other parts of the world. The latest meeting – CHEP '04 – was organized by CERN and took place in Interlaken from 26 September to 1 October 2004. As the conference chairman, Wolfgang von Rüden from CERN, pointed out in his welcome address, this was the last opportunity for CERN to organize the conference prior to the start-up of the Large Hadron Collider (LHC). An important theme therefore was to review progress in making the Grid a powerful and reliable computing resource in time for processing LHC data. The conference also aimed to learn from the experience of experiments that are currently running, to stay in touch with other sciences and to have a look into the future.

The conference began with several interesting reviews of computing at existing experiments. Amber Boehnlein from Fermilab described the software and computing facilities that have been developed to support the CDF and D0 experiments in Run II of the Tevatron. These experiments are already starting to experience data management and data-access rates on the scale expected in the first years of the LHC. Good progress has been made in handling event data and structured metadata with throughput disk caching of 60 terabytes (Tb) a day being reported by the CDF experiment.

Nobu Katayama of KEK reported on the situation at the Belle experiment at the KEKB accelerator, which is currently operating at the world's highest luminosity of $10^{34}\ cm^{-2}\ s^{-1}$. Belle accumulates more than 1.2 Tb of data each day and the complete dataset now exceeds 1.4 petabytes (Pb). Belle adopted a traditional computing model, which has been successfully implemented with very few people, and is planning to upgrade its system to prepare for the expected luminosity upgrade of the machine.

Peter Elmer, from Princeton, described the status of computing in the BaBar experiment at the PEP II collider at SLAC. BaBar has developed a highly distributed and automatic production facility for managing the generation of simulated data samples at more than 25 sites, as well as the full reconstruction of real data within 24 hours at a site remote from the collaboration centre (Padova). A sophisticated analysis model has also been introduced in the past year that makes more than 100 analysis-specific skims of events that can be accessed via the same distributed-computing system. It is clear that much of the knowledge and experience being gained from providing computing at running experiments can be abstracted and applied to the design and planning for future experiments with large-scale computing.

A lunch break in the Concert Hall of the Congress Centre.

Unprecedented challenges

High-energy physics software and computing infrastructures will be confronted with unprecedented challenges by data from the LHC and much attention focused on reporting progress in preparations for the start-up in 2007. It is the job of the LHC Computing Grid Project (LCG) to prepare, deploy and operate the computing environment to provide a general service to all four LHC experiments. The enabling technology is Grid computing, which is a paradigm for creating a worldwide network of computers interconnected so that they perform as a coherent system. The LCG project aims to deploy and operate a Grid comprising as many as 100 000 of today's fastest PCs for storage and analysis of the ~15 Pb of data that will be produced each year at the LHC.

The first production Grid (LCG-1) started to provide a bare-bones service to high-energy physicists a year ago, with at first only 12 centres involved. Currently version 2 of this Grid (LCG-2) has been deployed on some 80 computing centres in 25 countries contributing more than 9800 computers. Significant improvements in reli- ▷

Terminals were provided in the Club Casino room.

ability, performance and scalability of the service offered by LCG-2 were reported, largely resulting from the improved stability of the middleware – the software that handles supply and demand of resources on the Grid effectively, as well as security and the other necessities that a distributed system entails.

However, LCG is by no means the only Grid project and particle physicists have access to substantial resources provided, for example, by NorduGrid, a Scandinavian Grid initiative, and Grid3, a consortium based in the US. In addition LCG is working closely with the EGEE project, which is funded to create a Europe-wide production-quality Grid infrastructure on top of present regional Grid programmes. The core infrastructure of the LCG and EGEE Grids is now operated as a single service spanning North America, the Asia-Pacific region and Europe, and encompasses other scientific disciplines in addition to high-energy physics. As Les Robertson, LCG project leader, pointed out, "It is clear that on the timescale of LHC start-up we are going to have to live with a few different middleware implementations and standards. Nevertheless strenuous efforts are being made to improve compatibility and inter-working."

Successful stress tests

LHC physicists reported on a number of "data challenges" designed to act as stress tests of the robustness, performance and quality of the complete computing infrastructure. The basic goal is to produce many millions of simulated events in a concentrated period and to analyse them, thereby exercising the full software chain. During 2004 more than 400 Tb of data have been generated and stored using new data-management software developed in the ROOT and POOL projects. Moreover, extensive comparisons with test-beam data have demonstrated the ability of physics models in the simulation engines (e.g. Geant 4 and Fluka) to predict the detector response to better than a few per cent. This validation activity is still in progress, but the vast improvements reported over the past two years have been achieved as a result of a huge combined effort by both experimentalists and simulation experts. Attention must now be given to providing a simple and transparent data-analysis framework so that physicists can get the fast delivery of physics results they need.

The data challenges also provide a way of measuring the progress made in deploying and operating resources on the Grid, as well as testing the production-software tools used to submit and manage jobs and the data they generate. For instance, one challenge used the Grid to process simulated LHC data, but at only one-quarter of the rate physicists expect from the collider. In another, more than 3500 production jobs were run concurrently on resources located in more than 30 computer centres. This is still far short of the requirements of the LHC, but with three years to go before the collider is ready to produce collisions the prospects for narrowing the gap look good.

Peter Clarke, from Edinburgh, reported on the status of the global wide-area network, which is more than ever taking its role as the great "enabler" for many branches of science and research. The LHC computing models estimate that a connectivity of around 100 Gbit/s between CERN and the Tier-1 centres will be required in order to distribute data for processing at remote sites. Clarke's main message was that wide-area networks currently provide our community with excellent performance and reliability, his primary concern being that they are in fact significantly underused at present. Most networks, such as GÉANT in Europe and ESNET in the US, currently have 10 Gbit/s backbones with 1.0–2.5 Gbit/s links into national networks, but they typically experience peak sustained loads of only 10–30%. High-energy physics traffic is barely visible. Clarke's appeal to the conference was for high-energy physics to perform network data challenges demonstrating sustained data flows of at least 1 Gbit/s between the main centres in 2005.

Ken Peach, of the Rutherford Appleton Laboratory, gave an extremely informative and entertaining talk on e-Science, which is already making a big impact on many scientific disciplines and facilitating new scientific discoveries. The new methodology of e-Science claims that by connecting different sources of data collected independently and analysing them with computers, new knowledge and understanding can be extracted. Policy-makers in government, academia, and industry are driving the initiative. Clearly massive data storage and large-scale computing are required, which explains the significant investment worldwide in support of underlying technologies, in particular Grid computing.

Delegates were also able to interact with 16 high-tech companies through the CHEP '04 Industrial Programme – coordinated by Chris Parkman and Evelyne Dho of CERN – which featured an exhibition and a number of special seminars. The involvement and support of these companies added a vital dimension to the overall success of the conference. In particular, CERN's partners in the CERN openlab for DataGrid applications (Enterasys, Hewlett-Packard, IBM, Intel and Oracle) not only gave generously to sponsor the event but also provided keynote speakers from their research labs in a special plenary session dedicated to looking at future technology trends. Special thanks are due to Enterasys, which provided the wireless network at the conference venue and donated wireless cards to conference delegates.

Jai Menon, from IBM, predicted continuous improvements in storage density and disk capacity such that by 2010 desktop commodity machines will have 1 Tb storage capacity on a single 2.5 inch (10 cm) disk. Large systems with 10 000 spinning disks will have a total capacity of 10 Pb, with around 7 Tb/s of streaming bandwidth. However, the traditional RAID (redundant array of independent disks) systems will not be sufficient to protect against multiple simultaneous disk failures and new schemes are under development to provide higher forms of redundancy at the expense of additional storage overhead. A great deal of growth in tape capacity is also foreseen and attempts will be made to demonstrate 8 and 16 Tb of storage on a single cartridge in the near future.

Stan Williams from HP reported on work that his group is doing on fundamental research in nanotechnology, which is expected to have an impact on a 10–20 year timescale. The combined wisdom of the semiconductor industry foresees feature sizes of semiconductor devices reducing to 65 nm by 2007–2008 and 45 nm by 2010–11 giving a 10 to 100-fold increase in performance over today's CPUs. Beyond that, problems arise due to fundamental limits on the ability to improve the electrical-power efficiency of traditional microprocessor chips as well as the relatively large number of "defects" that must be contended with at the nanometre scale. New CPU architectures that run at very low clock speeds but with many processes in parallel were presented as a way to achieve the best electrical-power efficiency.

Conference wrap-up

In the last talk of the conference Lothar Bauerdick from Fermilab gave his personal impressions of the conference highlights. He looked forward to the opportunity of working with people from existing experiments that are joining the LHC programme. He concluded that our Grid systems are successfully enabling broad participation although much needs to be done to improve the completion efficiency of the jobs that run and to use all the resources made available by Grids more effectively. He reiterated a comment, made earlier in the conference by CERN's David Williams, that the LHC experiments are running at the limit of what is feasible, not in funding, nor in complexity of the detectors, but rather in the possibility of keeping a large number of smart people working actively towards a common goal.

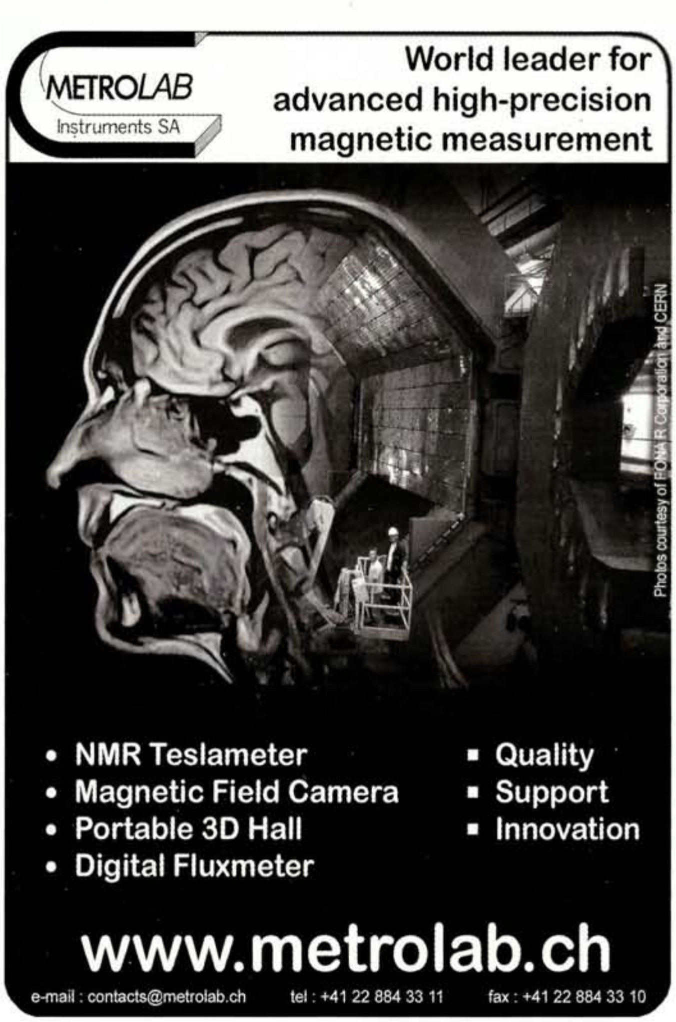
CHEP '04 was one of the best attended CHEP conferences with 520 delegates coming from all over the world. The organizers are very grateful to INTAS, UNESCO-ROSTE and the Abdus Salam International Centre for Theoretical Physics for agreeing to sponsor more than 25 of these delegates who would otherwise have been unable to attend. The Programme Committee considered a total of 493 abstracts of which 34 were scheduled as plenary talks, 219 more were scheduled for oral presentation in seven parallel sessions and 153 were presented as posters. They also edited and produced the proceedings published on DVD.

Thanks to the hard work of the enthusiastic team of organizers and student volunteers, led by Alan Silverman and Miguel Marquina of CERN, there were no noticeable problems during the whole week of the conference. The network worked perfectly with a total of 246 portables connected (and only four were infected with viruses, a good omen for the future). Even the weather was kind and permitted the delegates to explore the surrounding mountains and lakes in clement conditions during the half-day devoted to excursions.

By coincidence, the day of the conference banquet (29 September) was also CERN's 50th birthday, and the conference delegates celebrated the event in the presence of the director-general, Robert Aymar. His speech was transmitted live from Interlaken to the birthday party held near Geneva via a special teleconference link. In his closing address von Rüden warmly thanked all those who had contributed to the success of the conference and invited delegates to reconvene for CHEP '06 in February 2006 in the Tata Institute of Fundamental Research (TIFR), Mumbai, India, the venue selected by the International Advisory Committee.

Impression from an excursion to the top of the Schilthorn.

John Harvey, *CERN, chair of the CHEP '04 Programme Committee.*



RF Amplifiers Klystron Drivers

Solid-State Linear Power Amplifiers for High Energy Physics

- *500w 1Kw & 2Kw output power*
- *Class A & AB linear designs*
- *Pulsed power or CW designs*
- *Low distortion pulsed class A*
- *Ultra fast switching speeds*
- *Unconditional stability*
- *Open & short circuit protection*
- *TTL Remote interface*
- *Optimisation to user defined bands*
- *Forced air or watercooling*
- *Modular, rack mountable/bench top*

Model AM86-1.3Hz 1Kw

Customers include:

CPI
SLAC
BESSY
ORNL
CCLRC
GSI
NSLS
SINCROTRONE
DESY
E2V
THALES

For a wide range of GaAs fet amplifiers for industrial and communications systems development and research
Come to us first for all your amplifier needs

Top quality products designed and manufactured in the UK, delivered fast - and at sensible prices

Microwave Amplifiers Ltd 4 High St Nailsea, Bristol, BS48 1BT. UK

Tel: +44 (0)1275 853196 Fax: +44 (0)1275 858502 Web: maltd.com email: sales@maltd.com ISO9001 LRQ0963054

Space Cryomagnetics

World Leaders in Superconducting Technology

At Space Cryomagnetics, we offer "tailor-made superconducting and cryogenic solutions". From your specification we can develop a magnet system from the initial geometry of the coils, through design, to assembly, test and commissioning. We manufacture magnets from both low-temperature and high-temperature superconductor, in circular and non-circular geometries. We design and build cryostats operating at temperatures down to 1,5 K, including normal and superfluid helium systems, zero boil-off (recondensing) systems, and cryogen-free magnets.

Our world firsts include:

- The world's first large superconducting magnet for use in space;
- The world's first cryogen-free magnet for use in space;
- The world's first commercially-produced HTS magnets;
- The world's first HTS magneto-hydrodynamic drive (MHD).

Contact us to discuss your own superconducting magnet requirements.

Space Cryomagnetics Ltd
E1 Culham Science Centre
Abingdon
OX14 3DB
United Kingdom
Tel: +44-1865-409200
Fax: +44-1865-409222
www.spacecryo.com

HTS magnets

Cryogen-free ADR magnet

3D Vector magnet

AMS - a 1.1 m clear bore actively-shielded dipole magnet for use in space

The GATE opens in nuclear medicine

The Geant4 package for Monte Carlo simulations in particle physics has found application in nuclear medicine, with the GATE toolkit. **Christian Morel** explains.

Emission tomography, where the detection of radiation emitted by a radioactive tracer administered to a patient allows the estimation of the tracer's distribution inside the body, is becoming increasingly important in medicine, in both diagnosis and treatment. This increased interest has led to a demand for higher imaging quality, accuracy and speed. The development of new medical-imaging devices, image-reconstruction algorithms and correction techniques, and the optimization of acquisition protocols all depend on appropriate simulations, in particular using the Monte Carlo techniques familiar in particle physics.

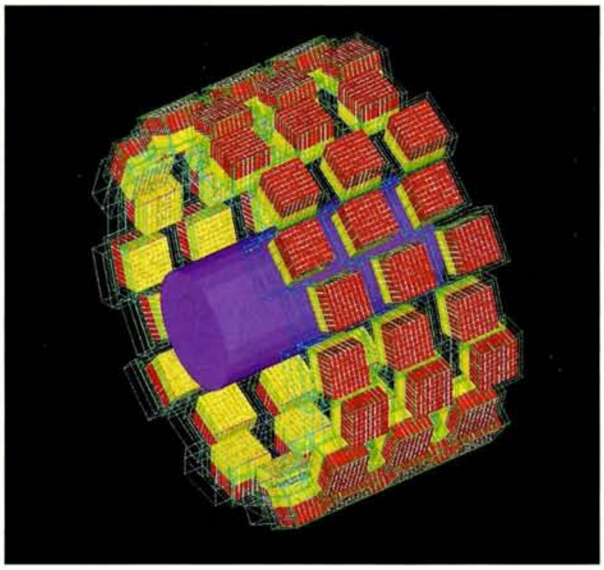


Fig. 1. ClearPET scanner design for the Crystal Clear Collaboration, with four rings of 20 interleaved LSO/LuYAP phoswich detector modules. (Courtesy EPFL.)

The main techniques for emission tomography are PET (positron emission tomography) and SPECT (single photon emission computed tomography). Both involve surrounding the subject to some extent with an array of suitable detectors (e.g. scintillator crystals) and detecting the radiation emitted from the tracer. At least a dozen Monte Carlo simulation packages can be used for either technique, with different advantages and disadvantages. Accurate and versatile general-purpose simulation packages such as Geant3 from CERN, EGS4 from SLAC, MCNP from the Los Alamos National Laboratory and most recently Geant4 include well validated physics models, geometry-modelling tools and efficient visualization utilities, but they require a major effort to be tailored to PET and SPECT.

On the other hand, dedicated Monte Carlo codes developed for PET and SPECT suffer from a variety of drawbacks. For example, SimSET, developed at the University of Washington, is one of the most powerful dedicated codes for PET and SPECT simulations, modelling physics phenomena and basic detector designs precisely and efficiently. However, it has limitations with respect to the range of detector geometries that can be simulated: for instance, a detector ring cannot be subdivided into individual crystals. In addition, neither SimSET nor other dedicated codes account explicitly for time, which limits their use for modelling time-dependent processes such as the movement of tracers.

Clearly, there is a need for a Monte Carlo tool that readily accommodates complex scanner geometries, while retaining the comprehensive physics-modelling abilities of the general-purpose codes. To meet this demand an international collaboration of physicists at centres in different countries has developed the simulation toolkit GATE – the Geant4 Application for Tomographic Emission.

Opening the GATE

The origin of GATE can be traced back to a workshop held in July 2001 in Paris, which focused on the future of Monte Carlo simulations in nuclear medicine. The various drawbacks of the existing dedicated and general-purpose codes were discussed, and it became clear that it would be to everyone's advantage to develop a simulation toolkit that would combine the best of both worlds: namely, to have a dedicated Monte Carlo platform for emission tomography that could on one hand model decay kinetics, dead time and movement, and on the other hand benefit from the versatility and support of general-purpose simulation tools. Moreover, object-oriented technology appeared to be the best choice to ensure high modularity and reusability for the simulation tools developed specifically for PET and SPECT.

The consensus was therefore to select the simulation toolkit developed in C++ by the Geant4 collaboration and to foster long-term support and maintenance by sharing this development among many research groups. This effort was launched by the PET instrumentation group in the Laboratory for High Energy Physics at the Ecole Polytechnique Fédérale de Lausanne (EPFL), in the first instance as an aid for the design of the ClearPET prototype developed by the Crystal Clear Collaboration at CERN (figure 1).

Specifications of the Geant4-based simulation framework were circulated in December 2001. The C++ coding began at the Lausanne PET instrumentation group with the help of the Geant4 low-energy electromagnetic physics working group, the corpuscular ▷

physics for life science group at Laboratoire de Physique Corpusculaire in Clermont-Ferrand and the medical image and signal-processing group in the Electronics and Information Systems Department at the University of Ghent. The development strategy was defined at a second workshop organized in January 2002 in Lausanne, and on 23 May 2002, at a meeting again held in Lausanne, a live demonstration of the first version of the GATE platform was given. At this meeting the research groups at Lausanne, Clermont-Ferrand and Ghent decided to start the OpenGATE collaboration in order to improve, validate, document and test GATE with a view to preparing a public release of the software.

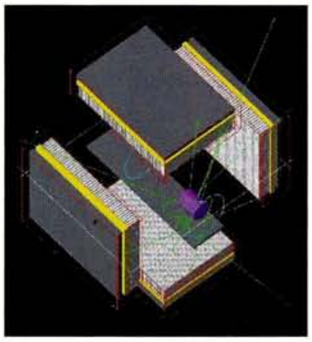


Fig. 2. SPECT benchmark to test the installation of GATE. (Ghent University and U678 INSERM.)

Since then, the collaboration has grown, currently comprising 21 laboratories in nine countries in Europe, the US and Asia, and in May 2004 the first public release of GATE was made available. At present, GATE has been downloaded and is run by more than 200 individuals in academic institutes and commercial companies around the world.

How does it work?

GATE incorporates the Geant4 libraries in a modular, versatile and scripted simulation toolkit adapted to nuclear medicine. In addition, it allows the accurate description of time-dependent phenomena such as source and detector movement and source decay kinetics. The elements of the geometry of the system can be set into movement via scripting, and all the movements of these elements are kept synchronized with the evolution of the activity of the radioactive source. For this purpose, the data acquisition is subdivided into a number of time steps during which the elements of the geometry are considered to be at rest. Radioactive decay times are generated within these time steps so that the number of events decreases exponentially from one time step to the next according to the decay profile of the particular radioisotope. The ability to synchronize all time-dependent components in this way is one of the most innovative features of GATE, making it possible to perform realistic simulations of data acquisition in time.

GATE uses approximately 200 C++ classes from the Geant4 simulation toolkit and an application layer allows the implementation of user classes derived from the core layer classes. Provided the application layer contains appropriate features, the use of GATE does not require any C++ programming, thanks to a dedicated scripting mechanism that extends the native command interpreter of Geant4.

The GATE source code resides in a CVS (Concurrent Versions System) repository maintained by the OpenGATE collaboration. There is documentation to support the simulation toolkit, including installation and user guides, online source-code documentation (via the doxygen documentation tool) and a list of frequently asked questions (FAQs). In addition, two benchmarks have been developed for PET and SPECT to check the installation of GATE and as a tutorial for users. The SPECT benchmark, for example, simulates a gamma camera based on four detector heads, with a cylinder of water as specimen, containing the gamma-emitter technetium-99m (figure 2).

GATE has been validated by comparing its simulated data to real data obtained from commercial systems currently in use or under consideration. Factors such as spatial resolution and energy resolution generally agree to within a few per cent or better. Overall these studies illustrate the flexibility and reliability of GATE for the accurate modelling of different detector designs.

The price of GATE's versatility, compared with simpler codes such as SimSET, comes in terms of longer computation times, but already there are efforts to improve this. One approach is the "gridification" of GATE – subdividing the simulations to run on processors geographically distributed. Following successful tests on the European DataGrid testbed, GATE is now deployed on EGEE grid production infrastructure, where computing time can be reduced by a factor of 16 when a simulation is run on 20 processors as opposed to one. However, the study also showed that computing time is not directly inversely proportional to the number of jobs running in parallel.

In general, the future of GATE is closely linked to the developing role of Monte Carlo simulations in nuclear medicine, where they are becoming increasingly important. GATE also has the potential to be useful beyond PET and SPECT, for example in in-line tomography in hadron therapy and dose calculations in radiotherapy. By providing free access to the GATE source code, the OpenGATE collaboration hopes that GATE will continue to evolve to become a comprehensive simulation tool at the service of the nuclear medicine community.

Further reading

S Jan *et al.* 2004 *Phys. Med. Biol.* **49** 4543.
See the GATE website located at www-lphe.epfl.ch/GATE/.

• Member institutes of the OpenGATE collaboration are: Ecole Polytechnique Fédérale de Lausanne (LPHE); University of Clermont-Ferrand (LPC); University of Ghent (ELIS); CHU Pitié-Salpêtrière (U494 INSERM), Paris; Vrije Universiteit Brussel (IIHE); Centre d'Exploration et de Recherche Médicales par Emission de Positons (CERMEP), Lyon; Service Hospitalier Frédéric Joliot (SHFJ), CEA-Orsay; CHU Nantes (U601 INSERM); Sungkyunkwan University School of Medicine (Division of Nuclear Medicine), Seoul; University Claude Bernard (IPNL), Lyon; University Louis Pasteur (IRES), Strasbourg; University Joseph Fourier (LPSC), Grenoble; Forschungszentrum-Juelich (IME); University of Massachusetts Medical School (Division of Nuclear Medicine); CHU Morvan (LATIM, U650 INSERM), Brest; University of California (Crump Institute for Molecular Imaging); University of Toronto (CAMH); DAPNIA, CEA-Saclay; Memorial Sloan-Kettering Cancer Center (Department of Medical Physics), New York; University of Athens (IASA); Delft University of Technology (IRI).

Christian Morel, *spokesman of the OpenGATE collaboration, Laboratory for High Energy Physics, Ecole Polytechnique Fédérale de Lausanne.*

Two methods, one solution:
CST MICROWAVE STUDIO®
»Technology on Demand™«

→ ... They say that two heads are better than one for solving problems. While Time Domain is obviously superior for the shown antenna array this is not necessarily the case for all applications. CST MICROWAVE STUDIO® now provides Time and Frequency Domain, hexahedral and tetrahedral meshing in one single interface. Choose the technology best suited to your structure. In critical cases, cross verification can give you exceptional confidence in results. Demand complete technology, demand CST MWS.

3 D EM SIMULATION

CST MICROWAVE STUDIO® has become the standard time domain tool for 3D EM simulation, and is used world-wide by market leaders such as Motorola, Nokia, Philips, Raytheon, Siemens, Saab and Sony. Typical applications include the simulation of waveguides, couplers, filters, power splitters, multiplexers, planar structures, coax and multipin connectors, LTCCs, MMIC packages, RLC extraction, and all kinds of antennas. **Come and visit us on booth #26 at Germany at CERN!**

CST
CHANGING THE STANDARDS.

CST – COMPUTER SIMULATION TECHNOLOGY | www.cst.com | info@cst.com | +49 (0) 6151/73 03-30

HESS provides new vi

The first results from the HESS array of Cherenkov telescopes are introducing a new era

On 28 September 2004 the four telescopes representing the first phase of the High Energy Stereoscopic System (HESS) were inaugurated by the Namibian Prime Minister Theo-Ben Gurirab. The event represented the culmination of a five-year construction and commissioning effort, carried out by physicists and technicians from 19 institutes in Germany, France, the UK, Ireland, the Czech Republic, Armenia, South Africa and Namibia.

The HESS telescopes measure cosmic gamma rays in the energy range above 100 GeV with unprecedented sensitivity and resolution. They achieve this by detecting the Cherenkov light that is emitted when a high-energy gamma ray is absorbed in our atmosphere, resulting in a cascade of electrons and positrons rushing through the air at speeds close to that of light. Viewed in its Cherenkov light, the cascade resembles the trail of a shooting star, pointing back to the origin of the primary gamma ray (figure 1a). However, the light is very faint – about 10 photons per square metre at a gamma-ray energy of 100 GeV – and the duration of the light flash is only a few nanoseconds. Large mirrors, fast photon detectors and short signal-integration times are required to collect enough light from the shower, with minimal contamination from night-sky background light.

The telescopes in the HESS array provide up to four different views of the same shower, which enable the direction of the gamma ray to be reconstructed to better than 0.1°, and its impact point can be located with a precision of 10–20 m. Knowing the distance from the telescope to the shower axis, the intensity of the Cherenkov image is converted into an energy estimate for the gamma ray, with a precision of about 15%. The requirement that multiple telescopes register a shower in coincidence virtually eliminates one major source of background – penetrating muons that hit the ground close to a telescope, resulting in Cherenkov rings like those seen in ring-imaging Cherenkov counters in particle-physics experiments (figure 1b).

The HESS telescopes are located in the scenic Khomas highland region of Namibia, within 20 km of the tropic of Capricorn, in an area cherished by professional and amateur astronomers for its clear and dark skies. Equally important, the southern location provides optimum views towards the central part of our galaxy, a region that hosts a variety of objects suspected to serve as cosmic particle accelerators. These include supernova remnants, pulsars, star associations with strong stellar winds, and of course the supermassive black hole at the very centre of our galaxy.

Indeed, one of the main goals of the HESS experiment is to identify positively sources of cosmic rays in the galaxy, ending a search that has been going on for almost 100 years, since the discovery in 1912 of cosmic rays by Victor Hess. Locating the origin of the abundant cosmic rays is so difficult because they are deflected in the interstellar magnetic fields; their arrival directions are uniformly distributed and give no clues concerning their origin. Real images of

One of the four HESS telescopes. During daytime, the mirrors are normally

cosmic accelerators can be taken using very-high-energy (VHE) gamma rays, which are produced when the accelerated protons or electrons interact in or near their source with ambient material or – in the case of electrons – scatter off starlight or the cosmic microwave background radiation.

Just as the HESS collaboration encompasses particle physicists and astrophysicists, the HESS Cherenkov telescopes combine technologies from different fields. The design of the telescope structures and of the telescope mirrors – each segmented into 382 mirror facets with a combined area of 107 m^2 – builds upon the experience collected in the design of low-cost solar concentrators. The mirrors are aluminized ground glass, manufactured like mirrors of astronomical telescopes, but with reduced requirements for optical quality. The focal-plane instrumentation – the "camera", supported at 15 m focal length by a quadrupod attached to the telescope dish – contains 960 Photonis photomultiplier tubes (PMTs). PMT signals are sampled at a rate of 1 GHz by the analogue memory of the ASIC (application-specific integrated circuit) originally developed for the

ew of gamma-ray sky

in the study of very-high-energy cosmic gamma rays, as **Werner Hofmann** describes.

parked looking down, with the "camera" protected in its shelter.

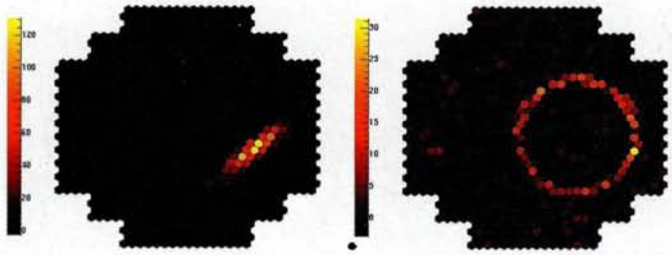


Fig. 1. (a) Left, typical image of an air shower as seen by a HESS telescope. (b) Right, map of a muon traversing the mirror; for such particles, the full Cherenkov ring is captured.

Inauguration of the HESS Phase I telescopes last September. Left to right: German ambassador W Massing, E Giacobino, Prime Minister Theo-Ben Gurirab pressing the button to start the telescopes, M Spiro, W Hofmann and H Völk.

ANTARES neutrino detector. When an air shower is detected by several telescopes in coincidence, the signals are digitized, pre-processed and transmitted to a central computer cluster for recording. A novel feature of the HESS cameras is that the entire electronics is contained in the $1.5 \times 1.5 \times 1.5\ m^3$ camera body, connected only by a few optical fibres.

While the last of the four HESS telescopes was completed in December 2003, data collection began in summer 2002 with the first telescope alone, and later with two and three telescopes. Even with a single telescope, HESS was the most sensitive instrument in the southern hemisphere. With four telescopes, gamma-ray sources with a flux below 1% of the flux from the Crab Nebula – which is often used as a standard candle of VHE gamma-ray astronomy – are routinely detected. For comparison, when the Whipple instrument discovered the Crab Nebula as the first tera-electron-volt gamma-ray source in 1989, a significant detection required about 50 hours of observation time; the HESS telescopes will detect such a source within 30 s!

It was no surprise therefore that the first HESS data taken during the construction and commissioning phase have already provided exciting results, many of which were presented at the International Symposium on High Energy Gamma-Ray Astronomy in Heidelberg, in July 2004. The active galaxy PKS 2155-304, detected previously only by the Durham Cherenkov telescope with a significance of about 6.8σ, exhibits a signal with more than 100σ, allowing for the first time an in-depth study of the emission and propagation of tera-electron-volt gamma rays for such a distant active galactic nucleus, at a redshift of $z \approx 0.12$.

In HESS data taken towards the centre of our galaxy (figure 2, p32), a strong gamma-ray source stands out, coincident with Sagittarius A*, the supermassive black hole at the galactic core (Aharonian *et al.* 2004b). HESS can locate the source of the VHE radiation to within 30 arcseconds from the Galactic Centre, an order-of-magnitude improvement in precision compared with other instruments. The Galactic Centre has long been predicted as a source of VHE gamma rays generated in the accumulation and annihilation ▷

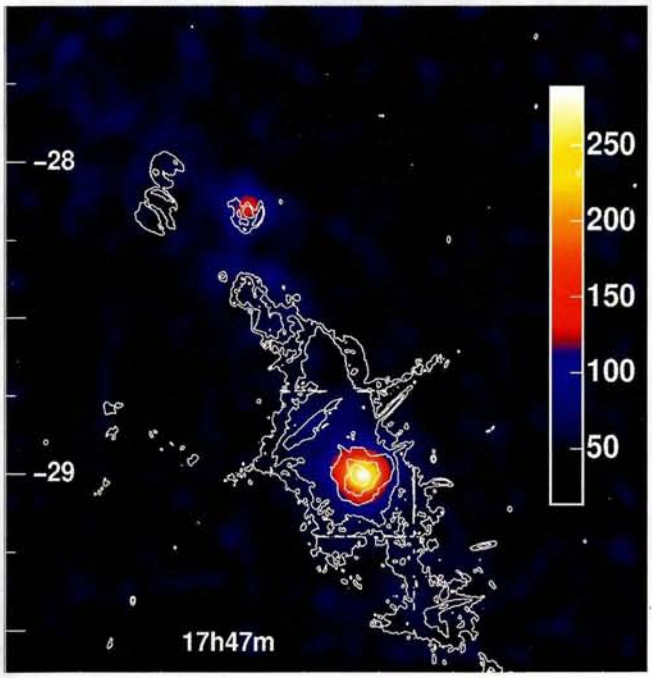


Fig. 2. Map of the tera-electron-volt gamma-ray sky in the region of the Galactic Centre, as seen by HESS. The lower tera-electron-volt source coincides with the Galactic Centre, the upper with the supernova remnant G0.9+0.1. White contours indicate radio emission at 90 cm (LaRosa et al. *2000).*

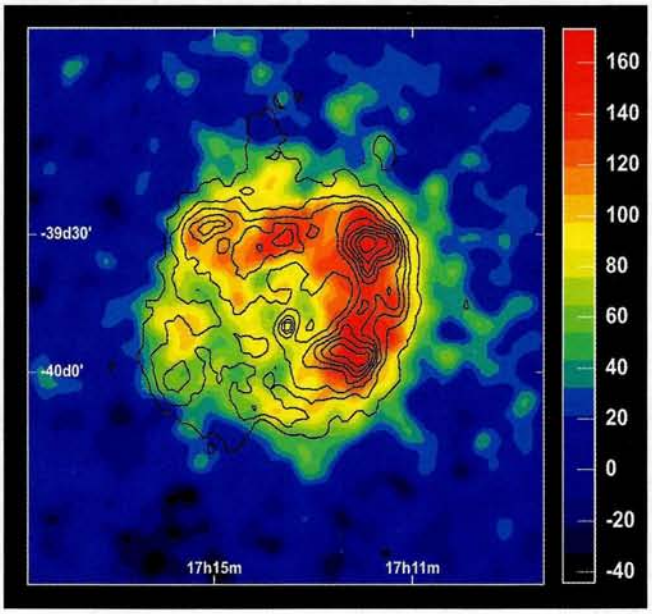


Fig. 3. Gamma-ray image of the supernova remnant RX J1713.7-3946. The gamma-ray count map is smoothed with a Gaussian of standard deviation of 3 arcmin, matched to the resolution of the instrument for this data-set. No background subtraction has been applied. The superimposed contours show the X-ray surface brightness as seen by the ASCA satellite.

of dark-matter particles, for example the lightest stable supersymmetric particles. The characteristics of the gamma-ray signal detected by HESS are indeed consistent with the expected features for dark-matter annihilation, but would require very heavy (> 10 TeV) dark-matter particles and a large annihilation rate or enhanced density of the dark matter at the Galactic Centre. More conventional explanations include particle acceleration in the 10 000-year-old supernova remnant Sagittarius A East, which is still consistent with the HESS error circle for the source location. Future data should pin down the source location even better. Another key question is whether the gamma-ray flux is constant, or whether it varies, pointing to an origin near the Schwarzschild radius of the central black hole.

For the first time, a tera-electron-volt instrument is sensitive enough that several sources appear in the field of view. The field of the Galactic Centre shows, in addition to the strong source close to Sagittarius A*, a second source, which appears to be associated with the pulsar nebula inside the supernova remnant G0.9+0.1. Similarly, observations targeted at the pulsar PSR B1259-63 have revealed – besides a gamma-ray signal from the pulsar – evidence of a second source about 0.6° north of the pulsar. This source HESS J1303-631 could not so far be associated with a counterpart in other wavelength regimes and may represent a type of cosmic accelerator hitherto unknown.

The most exciting of the first results from HESS is the image of the supernova RX J1713.7-3946, which shows a ring of twice the size of the Moon glowing in tera-electron-volt gamma rays (figure 3). Gamma-ray emission from this remnant was detected before with the CANGAROO instrument, but only HESS, with its high sensitivity and angular resolution, could actually resolve the supernova shell as the source of the radiation. This image provides the unequivocal proof that supernova shocks can accelerate particles to multi-tera-electron-volt energies. The measured energy spectrum of gamma rays extends to beyond 10 TeV and exhibits a power-law energy dependence with a spectral index of 2.2±0.2, consistent with predictions of theories for the shock acceleration of cosmic rays (Aharonian *et al.* 2004b).

To demonstrate fully that the gamma rays result from interactions of accelerated cosmic-ray protons – as opposed to processes involving high-energy electrons (of which the signature is evident in the strong synchrotron X-ray emission of the supernova shell) – will require more detailed studies of the morphology and wide-band spectra of the remnant.

These first results from HESS illustrate the power of the new generation of Cherenkov instruments, which include CANGAROO III, MAGIC and VERITAS. Tera-electron-volt gamma-ray astronomy has finally entered a stage where sources are no longer featureless points in the sky. Instruments have achieved the sensitivity to reach beyond the few exceptionally strong sources, and provide images of a new tera-electron-volt sky.

- For more information see www.mpi-hd.mpg.de/HESS.

Further reading

F Aharonian *et al.* 2004a *Astron. Astrophys.* **425** L13.
F A Aharonian *et al.* 2004b *Nature* **432** 75.
T N LaRosa *et al.* 2000 *AJ* **119** 207.

Werner Hofmann, *MPI für Kernphysik, Heidelberg.*

Neutrino physics gains new levels of popularity

A few years ago, the question was whether or not neutrinos had mass; today we are asking what their exact mass is, as participants at Neutrino 2004 discovered.

The 21st International Conference on Neutrino Physics and Astrophysics was held on 14–19 June in the splendid Marguerite de Navarre auditorium at the Collège de France, in the heart of Paris. Organized by the CEA, the CNRS, the Collège de France and the University of Paris7-Denis Diderot, its aim was to review the latest developments in this rapidly evolving branch of physics. It attracted 520 participants – a record turnout for this series of meetings, and a clear sign of the renewed interest in neutrinos within the particle-physics community. All the advances made in neutrino physics were reviewed over the course of six days, and the most significant new results are summarized here.

The buildings of Collège de France provided an imposing setting for Neutrino 2004. (Bigot and Le Roux, CEA/Dapnia.)

Solar neutrinos formed the topic of the first session, beginning with a presentation of the latest measurements from the Sudbury Neutrino Observatory in Canada. This was followed by a report from Giorgio Gratta of Stanford on the results from the KamLAND experiment in Japan, which has provided new and definitive proof of neutrino oscillation in the energy range of a few million electron-volts.

Here, the neutrinos are not of extraterrestrial origin – instead they come from an artificial source, namely nuclear reactors. The detector, which has been built on the site of the old Kamiokande experiment, uses 1 kt of liquid scintillator as the target and seeks to observe the neutrino interactions of nearby reactors – mainly those at installations in Japan, but also some in South Korea. The average distance between the sources and the detector is 180 km, which has proven sufficient to confirm the deficit observed by the experiments designed to measure solar neutrinos.

After two years of taking data, KamLAND has reported 258 events, compared with an expected 365. Furthermore, the study of the energy distribution of these events indicates a spectral distortion in the low-energy range. This is a crucial result, because in addition to confirming oscillation, it allows a much more precise measurement than that made possible by solar neutrinos of the essential oscillation parameter Δm^2, the difference in the mass-squared of the two oscillating neutrinos. The result can be expressed as $\Delta m^2 = 8.2 + 0.6 - 0.5\ 10^{-5}\ eV^2$. In a simple mass-hierarchy scenario, this determines the mass of the second neutrino ν_μ at 9 meV, which is about 100 000 million times lighter than the proton.

The results from KamLAND also open up a new line of research, namely the study of geoneutrinos, which was presented by Gianni Fiorentini of Ferrara and INFN. The Earth emits a tiny heat flux, and what scientists want to know is whether it comes exclusively from radioactivity. The uranium, thorium and potassium content could be determined by studying the neutrinos emitted, but the energy of these neutrinos is even lower than that of neutrinos from nuclear power plants, and KamLAND is close to the observation limits (*CERN Courier* October 2003 p20).

With neutrinos it is also possible to spy on what is going on inside nuclear reactors, and on the various fission products that produce neutrinos with different spectra, as John Learned from Hawaii described. The International Atomic Energy Agency, the watchdog organization for the non-proliferation of nuclear weapons, is beginning to be interested in this means of control.

Oscillation experiments

Following the presentations on low-energy neutrinos, it was the turn of atmospheric neutrinos and the results obtained with the new Super-Kamiokande detector. Edward Kearns from Boston presented the expected distribution of ν_μ interactions as a function of the L/E parameter, the ratio between the length of flight and the energy of the neutrinos detected, which agrees very well with the oscillation hypothesis. These results have been supported by those from the ▷

Quality

It's now even easier to find pure metals, alloys, ceramics or polymers for research or industry – check out our CD-ROM or website.

FROM PURE METALS TO POLYMERS
High quality products available in a host of standard and bespoke forms – take a look at our CD-ROM or website.

EASY TO ORDER
On the web; simply click on your desired item and proceed to the checkout (or carry on shopping), safe in the knowledge that all transactions are secure.

KEEP UP-TO-DATE – INSTANTLY
All our products and all their specifications are on-line – all at the touch of a button.

Call now for your FREE CD-ROM! Or visit us at www.goodfellow.com

PURE METALS, ALLOYS, CERAMICS AND POLYMERS FOR SCIENCE AND INDUSTRY

GoodFellow

GOODFELLOW CAMBRIDGE LIMITED
ERMINE BUSINESS PARK, HUNTINGDON, PE29 6WR, ENGLAND
TEL: +44 1480 424 800 / 0800 731 4653 FAX: +44 1480 424 900 / 0800 328 7689
EMAIL: INFO@GOODFELLOW.COM

Contact person: Jörg Pollmann

Shaping the future together

BUTTING is a family business and produces more than 40 000 tons of high quality pipes and high-tech products for various industrial sectors in a year. The name BUTTING stands for welding, forming and materials technology. From the production of prototypes to the production of series – the result of long-standing experience combined with engineering competence and state-of-the-art facilities – all rolled into one package at BUTTING.

For nearly four years we have been producing more than 50 000 m of copper plated oval beam screens and 1336 half shells for the LHC for CERN. Progress is based on experience and competence. Come to BUTTING.

For more information about our company and our new brochures, please visit us under www.butting.de

BUTTING
PROGRESS BY TRADITION

Gifhorner Straße 59 · 29379 Knesebeck · Germany
Contact person: Mr. Jörg Pollmann
Phone: + 49 5834 50-486 · Fax: + 49 5834 50-320
E-Mail: joerg.pollmann@butting.de

Left to right: co-organizer Daniel Vignaud (front), together with Michel Spiro, Jacques Glowinski and Herbert Pietshmann (back), enjoying the welcome address by the other co-organizer, François Vannucci. (Bigot and Le Roux, CEA/Dapnia.)

K2K experiment, in which neutrinos produced at the KEK laboratory are observed in the Super-Kamiokande detector 250 km away.

Overall, analyses from all the oscillation experiments are placing increasingly severe constraints on Δm^2 and on the mixing angles of the leptonic, or MNSP (Maki–Nakagawa–Sakata–Pontecorvo), mixing matrix. Srubabati Goswami of Allahabad summarized the state of progress. The third angle θ_{13} is the least well known; we have only one limit, from the experiment at the Chooz reactor in France. The determination of this angle, together with CP violation in the field of neutrinos, is crucial, and various projects at different reactors were discussed (*CERN Courier* June 2004 p31). Intense activity surrounds the preparation of the longer-term future; pending the construction of neutrino factories, super beams and radioactive beams are under consideration, particularly at CERN (*CERN Courier* July/August 2004 p30).

Direct measurements of neutrino masses, limits on the magnetic moment, and searches for double beta-decay (with or without neutrinos) were also presented, in particular the first results from the Neutrino Ettore Majorana Observatory (NEMO3) experiment in Fréjus Underground Laboratory, France, and the Cuoricino project in the Gran Sasso Laboratory, Italy. The presentations on this subject covered evidence, indications and enigma. The latter category includes a signal for neutrinoless double-beta decay that comes from an analysis of the Heidelberg–Moscow germanium experiment, which will probably be the subject of discussion for several years to come. The field of unresolved enigma also includes the result from the Liquid Scintillator Neutrino Detector (LSND) at Los Alamos, which should soon be clarified by the MiniBoone experiment at Fermilab.

The last part of the conference covered neutrino astrophysics. The neutrino sky map is still very incomplete; only the Sun and the brief signal from supernova SN1987A in February 1987 have been observed. Other sources are at work in the vast expanse of the sky, but their detection requires instruments 10 000 times larger than those that exist at present. Current projects, which tend towards a detector of 1 km^3, were reviewed. In parallel with neutrinos, attention at the conference focused on research into astroparticles – high-energy photons, charged cosmic rays and gravitational waves. Michel Davier of Orsay demonstrated the potential richness of the "multi-messenger" approach for the future.

There is a fine line between astrophysics and cosmology, especially since constraints on neutrino mass are starting to emerge from experiments on the study of cosmic background radiation and in-depth explorations of the universe. The constantly evolving results of this discipline were presented, and research into dark matter – both direct (new results from the Cryogenic Dark Matter Search, CDMS) and indirect – was discussed, along with dark energy.

Herbert Pietshmann of Vienna began the meeting with a tribute to the late George Marx, the Hungarian pioneer of neutrino astrophysics who organized the first conference in the Neutrino series in 1972. (Bigot and Le Roux, CEA/Dapnia.)

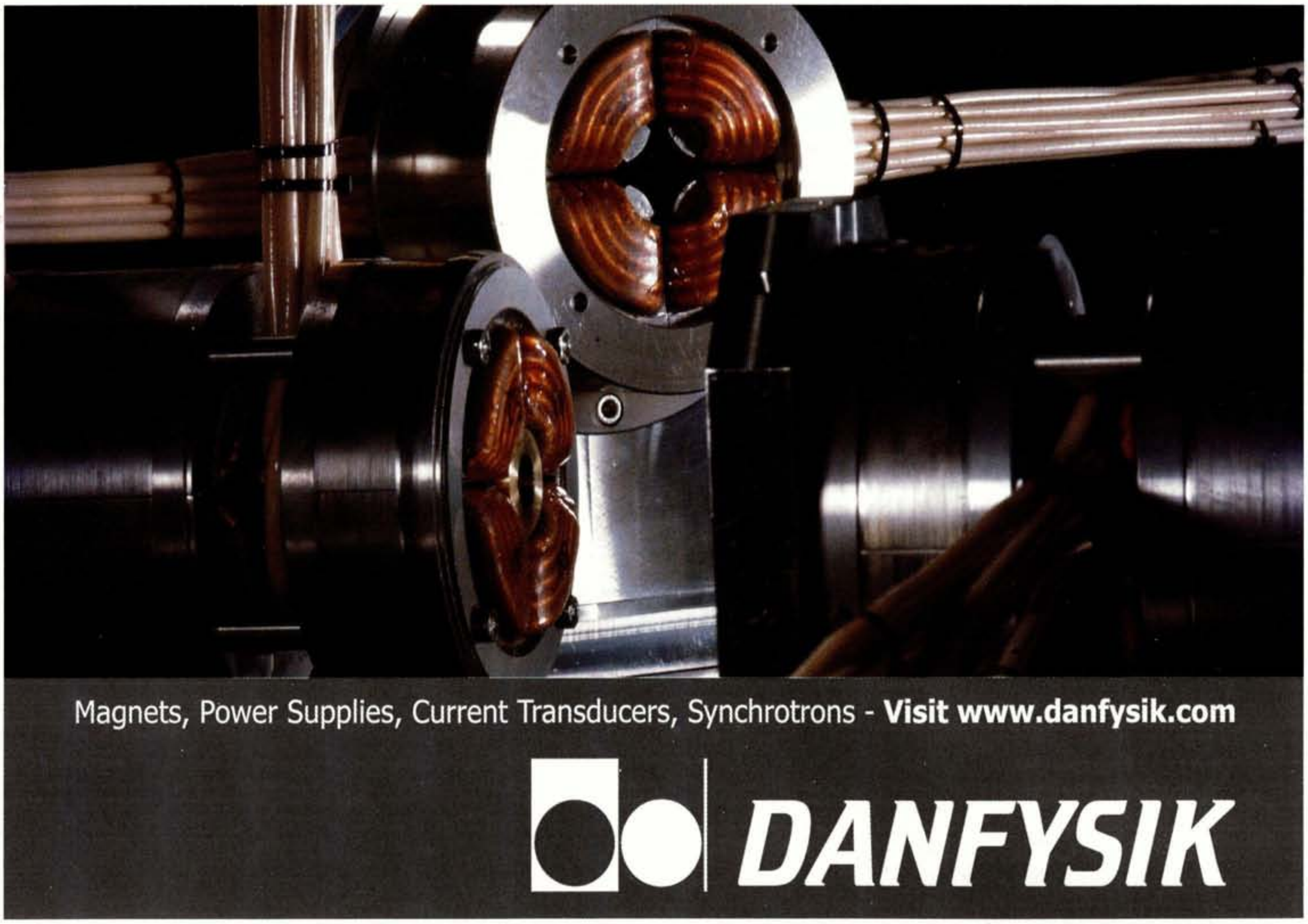
Theory was not forgotten, and there was discussion of recent progress on neutrino mass models, tests of the various CP, T and CPT symmetries, flavour violations, and the implications of neutrinoless double-beta decay. The previous week, a two-day satellite conference involving almost 100 physicists had been held to commemorate the 25th anniversary of the discovery of the "seesaw mechanism", currently the most promising explanation for the smallness of neutrino masses.

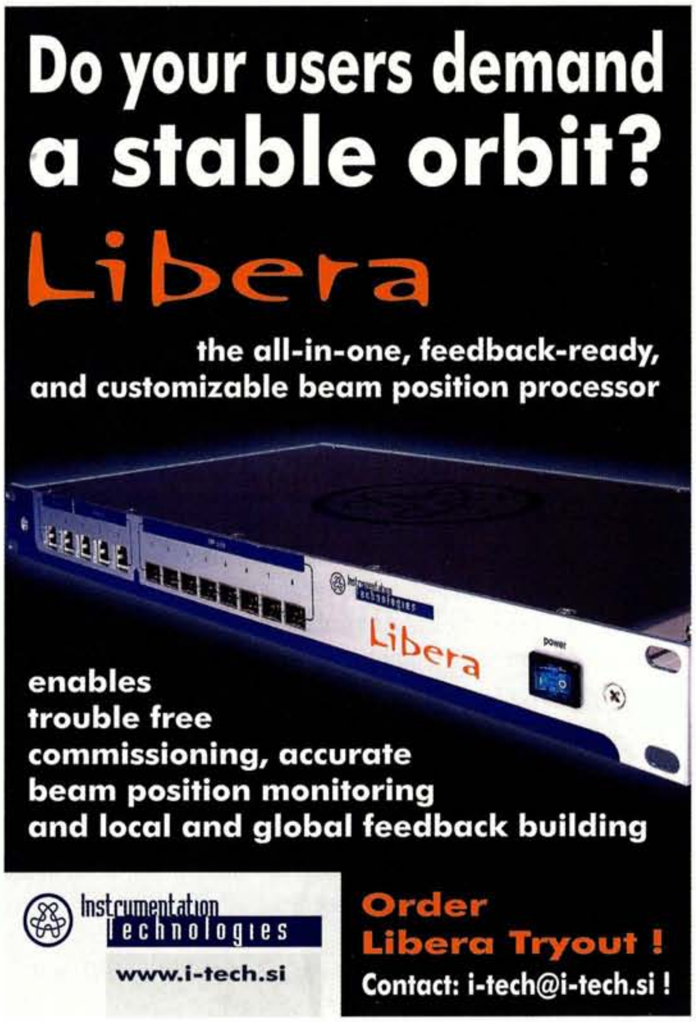
Remote visitors

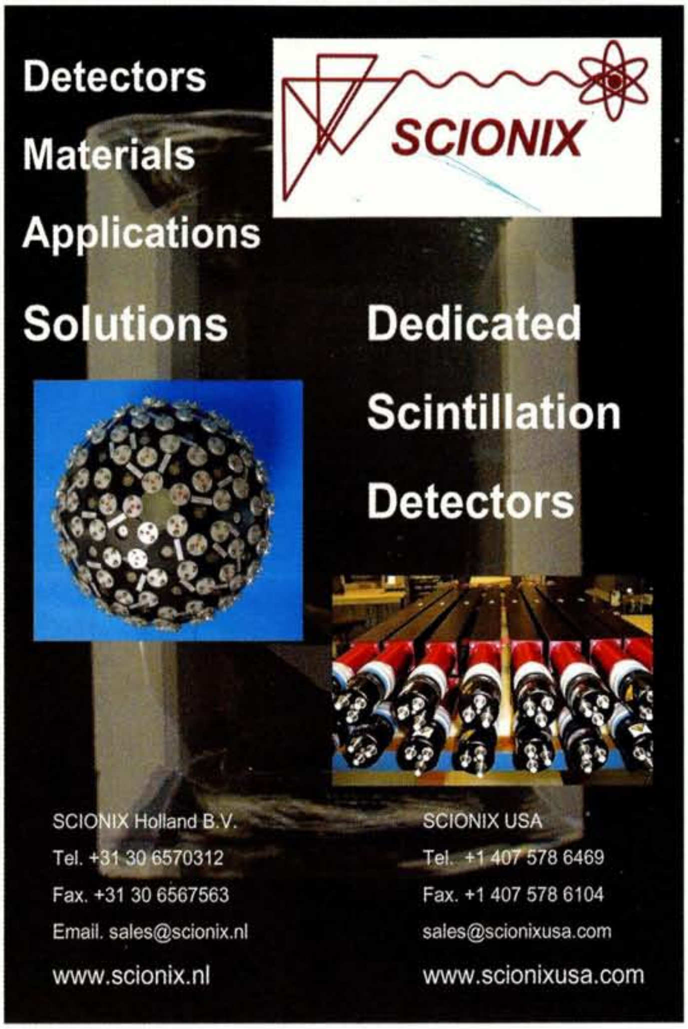
Thanks to a successful webcast, some 800 Web users interested in neutrinos were able to follow the conference remotely, and anyone wishing to hear the presentations again will be able to do so during the next few months by logging onto the conference website at http://neutrino2004.in2p3.fr, where copies of the speakers' transparencies are also available. The event was also a media success, thanks to a press conference organized the previous week involving around 15 journalists representing the main French newspapers and radio stations.

Neutrino physics has undergone dynamic changes in recent years. New ideas have been put forward in both the theoretical and the experimental fields, which should help this branch of physics to continue making major advances for many more years to come. The next step will be discussed during June 2006 in Santa Fe, at the next conference to be held in this series.

François Vannucci, *University of Paris 7 and LPNHE/APC, and*
Daniel Vignaud, *PCC Collège de France/APC.*


Magnets, Power Supplies, Current Transducers, Synchrotrons - Visit www.danfysik.com
DANFYSIK


Do your users demand a stable orbit?
Libera
the all-in-one, feedback-ready, and customizable beam position processor
Libera
power
enables trouble free commissioning, accurate beam position monitoring and local and global feedback building
Instrumentation Technologies
www.i-tech.si
Order Libera Tryout !
Contact: i-tech@i-tech.si !


Detectors
Materials
Applications
Solutions
SCIONIX
Dedicated
Scintillation
Detectors
SCIONIX Holland B.V.
Tel. +31 30 6570312
Fax. +31 30 6567563
Email. sales@scionix.nl
www.scionix.nl
SCIONIX USA
Tel. +1 407 578 6469
Fax. +1 407 578 6104
sales@scionixusa.com
www.scionixusa.com

ICHEP lays on a Chinese banquet of physics

The ICHEP '04 conference provided a major opportunity to review a wide range of recent progress in particle physics.

In 2004, the biennial International Conference on High-Energy Physics (ICHEP) took place for the first time in China, in the capital Beijing, where it was hosted by the Institute of High Energy Physics (IHEP). IHEP was founded in 1950, around the same time that the first conference in this series took place in Rochester, New York. As has become traditional, the conference began with parallel sessions where participants could learn first-hand about the latest results across a broad range of high-energy particle physics. Then, reminiscent of a Chinese banquet of many courses, the plenary sessions presented a succession of offerings reviewing recent progress in the field. A recurring theme was that of precision in areas in which it had once seemed impossible, as in charge–parity (CP) violation and neutrino physics. While studies at the high-energy frontier continue, in general, to bolster the Standard Model, lower energies provided several hot topics, such as the new particle states seen over the past year or so.

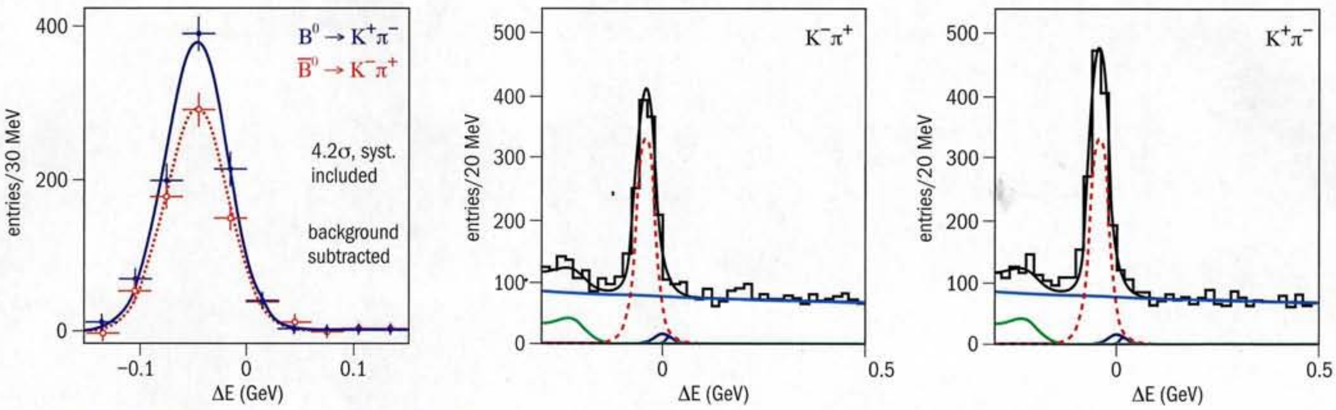
ICHEP '04 included a visit to IHEP's own accelerator facility, the Beijing Electron–Positron Collider. (IHEP.)

During the conference, ICFA announced its approval of the recommendation for "cold" technology for a future International Linear Collider. The members of ICFA are seen here at a press conference held during ICHEP '04. Back, left to right: Mike Witherell (Fermilab), Robert Aymar (CERN), Yoji Totsuka (KEK), Won Namkung (ALCSC), Brian Foster (chairman, Oxford); front, left to right, Giorgio Bellettini (INFN), Jonathan Dorfan (SLAC), Hesheng Chen (IHEP), Albrecht Wagner (DESY), Maury Tigner (Cornell). (IHEP.)

Quarks of all flavours

The physics of quarks provided many dishes at this year's feast of physics, from weak decays through tests of quantum chromodynamics (QCD), the theory of quarks and gluons, to the complex behaviour of quark matter in heavy-ion collisions. In the plenary sessions the menu began with the physics of flavour, where the strange, charm and bottom quarks are all providing a quantitative testing ground for flavour-mixing through the Cabbibo–Kobayashi–Maskawa (CKM) matrix as well as for CP violation. In his talk on the strange quark sector, Vincenzo Patera, from LNF/INFN and Rome, was keen to show that kaons can still make significant contributions. In particular, studies of rare kaon decays, though difficult, are becoming increasingly important: the branching ratios provide the opportunity for direct measurements of the unitarity triangle for CKM flavour-mixing. Also, as recently as 2002, the first row of the CKM matrix (V_{ud}, V_{us}, V_{ub}) disagreed with unitarity at the level of 2.4σ. Now, new determinations from experiments on the decays $K\rightarrow\pi e\nu$ (Ke3) and $K\rightarrow\pi\mu\nu$ (Kμ3) at several laboratories – E865 at Brookhaven, KLOE at the Dafne facility, KTeV at Fermilab and NA48 at CERN – provide better agreement with unitarity, and the crisis here seems to be over.

Moving on to the heavier flavour of charm, Ian Shipsey of Purdue spoke of a forthcoming era of precision in absolute charm branching ratios, with data coming from the experiments BESII at IHEP, CLEO-c at Cornell and, later, BESIII. In particular, it will be possible to make precision tests of lattice QCD calculations, which will feed back into determinations of the CKM matrix elements in experiments at the B-factories and elsewhere. Shoji Hashimoto of KEK presented recent results from so-called staggered unquenched lattice QCD simulations, which include the fermion determinant, and yield some interesting results (*CERN Courier* May 2004 p23). In particular, in calculations ▷



The first evidence was presented for direct CP violation in B-decays, visible in the data from BaBar (left) and Belle (centre and right).

of the CKM matrix elements lattice, QCD can put constraints on the Standard Model and hence provide a guide to new physics.

In the still-heavier bottom-quark sector, the Belle experiment at KEK and BaBar at SLAC are making measurements allowing precision tests of the CKM matrix on many fronts. Now running with continuous injection, the KEKB facility is providing 1 fb^{-1} a day – or 1 million $B\bar{B}$-pairs – as reported by Yoshihide Sakai from KEK. PEP-II at SLAC has also been performing well and, in his presentation on results from BaBar, Marcello Giorgi of INFN/Pisa pointed out that, between them, BaBar and Belle have accumulated an integrated luminosity of 0.53 attobarn^{-1}. Perhaps the hottest "dish" served up by the two experiments, however, concerned the first observation of direct CP violation in B-physics. The two experiments measure the difference between the decay $B^0 \to K^+\pi^-$ and the decay of the antiparticle, $\bar{B}^0 \to K^-\pi^+$. Both observe an excess of B-decays, with an average asymmetry of $A_{CP} = -0.114 \pm 0.020$. A similar asymmetry in the decay of the charged $B \to K\pi^0$ is not seen, with $A_{CP} = 0.04 \pm 0.05 \pm 0.02$, leaving open a door, perhaps, to new physics. The CDF experiment at Fermilab also finds a value for $A_{CP}(B^0 \to K^+\pi^-)$ compatible with BaBar and Belle.

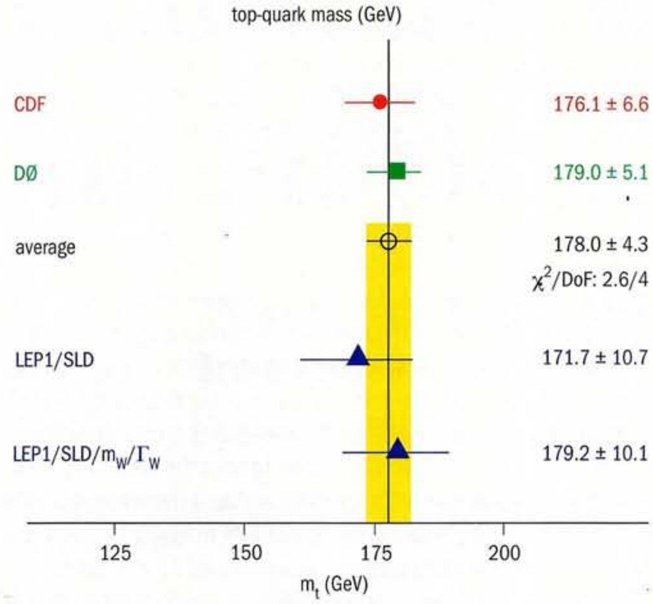
Measurements of other decay modes allow different parts of the unitarity triangle to be pinned down. The decay $B^0 \to \pi^0\pi^0$ has been observed for the first time by BaBar and Belle. This is useful in the determination of the angle α, although the decay to $\rho\rho$ is better, and the combined result of $\alpha = 100 + 12 - 10°$ provides good agreement with a global fit to the CKM matrix. The first measurements of the angle γ are also emerging from other decay modes and are beginning to put constraints on new physics. As Zoltan Ligeti from Lawrence Berkeley Laboratory noted, these first precise tests of the CKM picture are leading to a paradigm change; the aim now is to look for corrections to the picture, rather than alternatives to it. Ahmed Ali of DESY provided a theorist's overview of heavy quark physics, looking systematically at the parameters of the CKM matrix and the unitarity triangle. Now the precision on V_{cb} is fast approaching V_{us}, while more data from the B-factories are needed to pin down V_{ub}. Rare B-decays can also allow the determination of V_{ts} and V_{td}.

Top, the heaviest of the quarks, is so much heavier that its study lies in the domain of the highest energies, currently at the Tevatron at Fermilab. Dmitri Denisov of Fermilab showed that Run II at the Tevatron is proceeding well, with a peak luminosity above $1 \times 10^{32}\ cm^{-2}s^{-1}$ and a total integrated luminosity so far of 0.7 fb^{-1}. A new combined result from the CDF and D0 experiments from Run I data is now available, putting the top mass at 178.0 ± 4.3 GeV.

Back in the realm of relatively low-energy quark physics, the story of the pentaquarks presents a picture of "now you see them, now you don't", leading many participants at IHEP'04 to question whether pentaquarks exist. The $\Theta^+(1540)$ state is seen in as many as 14 different experiments, but it is not seen in nine others. Both experimentalist Shan Jin of IHEP and theorist Frank Close of Oxford emphasized the need to confirm the existence of pentaquarks, as these particles may lead beyond the naïve quark model. In his plenary talk, Close took a vote from the audience and found that sceptics outnumbered believers. Other possible multiquark states that have been observed include the X(3872), seen in Belle at KEK and in both CDF and D0 at Fermilab, and the $D_{sJ}(2632)$ seen at Fermilab in the SELEX experiment (*CERN Courier* July/August 2004 p6). Close argued the case that the former is a D–D* molecular state, while the latter may be an artefact – both assertions to be disproved.

Precision and the Standard Model

QCD, the theory of quarks and the strong force, is now becoming more quantitative, with precision measurements at the Tevatron, as presented by Donatella Lucchesi of INFN/Padova, and at HERA, as described by Max Klein of DESY. New results from HERA include the first measurement of the bottom structure function, using b-lifetime tagging and the data from the upgrade, HERA II, where there has been efficient data-taking since October 2003. The HERMES experiment has made the first measurement of the transverse spin structure of the proton, using a target polarized transversely to the direction of the positron beam (*CERN Courier* October 2004 p7). The Tevatron, meanwhile, is producing data that allow "precision phenomenology" as highlighted by James Stirling of IPP Durham, with excellent fits to next-to-leading order and next-to-next-to-leading order QCD (*CERN Courier* September 2004 p27). Stirling commented that QCD is now established – we are no longer testing it, but are instead using it as part of the toolkit for studying physics at the Large Hadron Collider (LHC). For hard processes, it is a precision tool operating at the per-cent level. He also presented a new scalar graphical approach to QCD calculations by Freddy Cachazo, Peter Svrcek and Edward Witten. This alternative to using Feynman graphs leads to a dramatic simplification and could herald an important breakthrough.



The latest results on the mass of the top quark from CDF and D0 at Fermilab, using Run I data from the Tevatron, are important for pinning down the mass of the Higgs particle.

An extreme testing ground for theories of quarks and gluons lies in the physics of heavy-ion collisions where the key question continues to be: has the quark–gluon plasma been seen? In the past couple of years, attention has turned to the experiments at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven, which is producing results in high-energy gold–gold collisions. James Dunlop of Brookhaven National Laboratory described the state of heavy-ion theory as a patchwork; the picture emerging from RHIC is of five observations of bulk, dense, highly interacting matter, which invoke different models. For a compelling argument for quark–gluon plasma, quantitative estimates of theoretical uncertainties are still needed.

The electroweak sector of the Standard Model (SM) has, for some time, been dominated by precision measurements, which are now described at the level of 0.1%. As Frederic Teubert of CERN remarked, this precision is at the level of pure electroweak radiative corrections that are sensitive to heavy particles. This leads to a fitted value for the mass of the Higgs particle, $m_H = 114 + 69 - 45$ GeV, or $m_H < 260$ GeV at a 95% confidence level (CL). The biggest discrepancy in electroweak results is in the interpretation of the ratio of neutral to charged currents as measured in Fermilab's NuTeV experiment in evaluating the effective weak mixing angle, $\sin^2\theta_{eff}$. The biggest challenge, however, is the deviation from the SM of measurements of the anomalous magnetic moment of the muon, which at $(a_\mu - 11659000) \times 10^{-10} = 208 \pm 6$ now yields a 2.7σ difference from SM theory.

Beyond the Standard Model

Physics beyond the SM provided the dessert course of the plenary session's "banquet". Despite, or perhaps because of, their rare interactions with matter through the weak force only, neutrinos are giving a first taste of new physics.

Clark McGrew of Stony Brook and Yifang Wang of IHEP reviewed the current state of accelerator and non-accelerator neutrino experiments respectively, where neutrino oscillations are now clearly established with both man-made and naturally produced neutrinos. The KamLAND reactor-based experiment and the K2K accelerator-based experiment are both revealing a picture consistent with that from Super-Kamiokande (atmospheric neutrinos) and the Sudbury Neutrino Observatory (solar neutrinos). Solar neutrinos yield $\Delta m^2_{12} = (8.2 + 0.6 - 0.5) \times 10^{-3}$ eV^2, and a large, but not maximal, mixing angle of $\tan^2\theta_{12} = 0.4 + 0.09 - 0.07$; atmospheric neutrinos give $\Delta m^2_{23} = (2.4 \pm 0.4) \times 10^{-3}$ eV^2 and a maximal mixing angle of $\sin^2 2\theta_{23} > 0.92$ at a 90% CL. The third angle, θ_{13}, is least well known, but from a global fit $\sin^2 2\theta_{13}$ can be put at < 0.09, 90% CL. Pinning down this angle, which provides a key to CP violation in neutrinos, is one of the big challenges for this field.

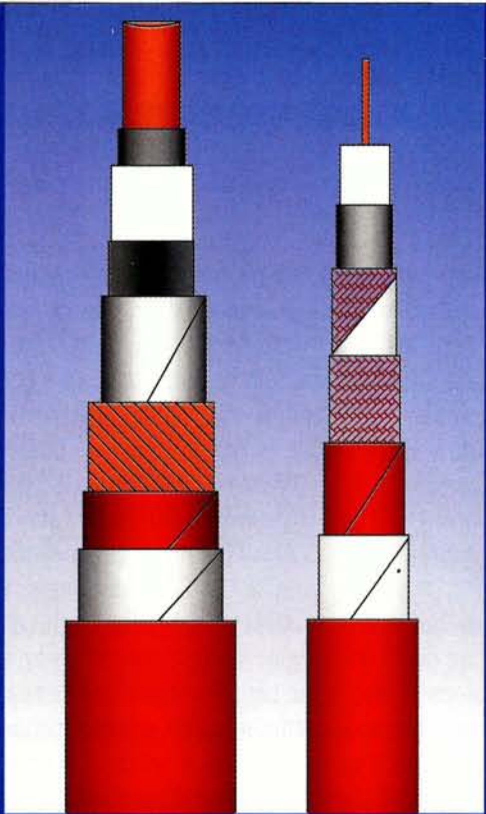
New neutrino experiments are coming online. MiniBooNE at Fermilab is going well despite a set-back with a broken neutrino horn (after 10^8 pulses) and should have sufficient data to release an electron–neutrino appearance result in 2005. The MINOS project, detecting neutrinos from Fermilab in the Soudan Mine 730 km away, should begin its first runs to test beam physics early in 2005. On the theoretical side, Paul Langacker from Pennsylvania noted that the neutrino mixing matrix is very different from the CKM matrix for mixing quark flavours. He pointed to the many possibilities for interpreting this first break with the SM when it comes down to specific models for mixing.

Looking elsewhere in current experiments for new physics beyond the SM, the collaborations working at the recently upgraded Tevatron and HERA machines have reported new limits. As Beate Heinemann from Liverpool summarized, the two machines are now running well and are already providing the world's best constraints on a great deal of new physics (although nothing novel has yet been found). Uncovering the mechanism of electroweak symmetry-breaking is probably the most important immediate challenge for particle physics. For example, why is the photon massless but the Z not so? Riccardo Barbieri of INFN/Pisa examined the two physical principles behind the calculable models for this symmetry breaking: supersymmetry and the Higgs boson as a pseudo-Goldstone boson. The LHC should make the first real test of these ideas.

For theoretical developments beyond the SM, in particular regarding a quantum theory of gravity, string theory has been offering promise for two decades. Hong Liu of the Massachusetts Institute of Technology reviewed the situation using string theories to address the problems of space–time singularities, in particular the Big Bang and black holes. There is hope for understanding these cosmological singularities and going beyond the SM, with string unification the dream.

Particle physics beyond the Earth was reviewed by Pierre Binetruy of LPTHE Orsay. High-energy gamma rays are providing a wealth of information about the heavens, with the HESS facility in Namibia now bringing in new data (see p30). Ultra-high-energy cosmic rays continue to tantalize regarding the existence of the Greisen–Zatsepin–Kuzmin cut-off at 5×10^{19} eV, above which protons from distant sources are "lost" as they interact with the photons of the cosmic microwave background. The AGASA array in Japan has found events at energies above the cut-off, but now the HiRes experiment, based on two nitrogen fluorescence detectors 13 km apart in Utah, has data that confirm the presence of the cut-off. ▷

COAXIAL CABLES ACCORDING TO CUSTOMER REQUIREMENTS



SPECIALITIES

Draka Comteq Datacom produces and supplies high voltage pulse cables as coaxial cables, which will be used for the beam dumping system of the Large Hadron Collider (LHC) being constructed at CERN.

These cables are used in accelerators which require switching devices, so called kicker magnets. These electromagnets have to send very fast magnetic field pulses and can be switched on in a very short time. Therefore this technology involves transient high voltages and high currents.

Draka Comteq Datacom has more than 100 years of experience in cable design and cable manufacturing of innovative cables for video, data and voice signals in office, home, industrial and research applications.

For further information please visit our website: www.drakact.com or call us: +49(0)221.677 2250

Draka Comteq

Beyond the present

The final dishes of the physics feast looked beyond the present to future accelerators and detectors, and were dominated by considerations of a future International Linear Collider (ILC). Two days previously, Jonathan Dorfan, chairman of the International Committee for Future Accelerators, had announced at the conference that the committee had approved the recommendation of the International Technology Recommendation Panel that "cold" technology should be adopted for the future ILC (*CERN Courier* October 2004 p5). In discussing R&D for future detectors, Jim Brau of Oregon concentrated on detectors for such a machine. He pointed out that, with the technology selection made, detector efforts could now concentrate on one set of parameters – for example, bunch spacing and the number of bunches per train. The challenges and opportunities differ in many respects from those of detectors for the LHC – events will be simpler, making reconstruction of particle tracks more feasible, while the resolution requirements for the masses of the heavy bosons will set goals for energy measurements.

David Miller of University College, London, presented the case for building a tera-electron-volt ILC as soon as possible (to exploit the findings of the LHC) and argued that a further multi-tera-electron-volt linear collider, and perhaps a larger hadron collider, would also be necessary. Kaoru Yokoya of KEK presented a personal view of the future for accelerators in which he argued that the technology for a Compact Linear Collider (CLIC), although less advanced than the ILC, is much more advanced than for a muon collider. Hence, as a CLIC machine could reach around 3 TeV, the target energy for a muon collider should be greater than 10 TeV.

In a conference demonstrating so much the strength and value of international collaboration, Vera Lüth of SLAC brought the 737 attendees from all over the world up to date on the ongoing problems with US visa approval (*CERN Courier* November 2003 p50). In her report on the activities of the International Union of Pure and Applied Physics (IUPAP), she said there is growing recognition that the impact is severe and damage might be irreparable. Despite recent streamlining, the overall process remains "inefficient, unnecessarily lengthy and opaque". IUPAP has advised it cannot feel confident to sponsor conferences in the US until scientists are guaranteed free access.

The ICHEP conference in China, however, proved very successful. Customs formalities were mercifully brief, and traditional Chinese hospitality was evident in the meals provided and in the tours organized, both for attendees and their guests. These included a trip to IHEP arranged by conference chairman and IHEP director Chen Hesheng, as well as visits to the famous Great Wall and Forbidden City. In his conference summary – the post-banquet drink – John Ellis from CERN was upbeat about the current state of particle physics. QCD works, the CKM matrix is looking better and better, the LHC (with all its promise) is on its way and there are good ideas for the future. Now, as the memories of China begin to fade, there is the next conference in the series to look forward to: ICHEP '06 in Moscow.

• This report is largely based on the presentations of the plenary speakers. These can be found, together with those from the parallel sessions, at http://chep04.ihep.ac.cn.

Christine Sutton, *CERN.*

CERN, the violin and the music of the spheres

The World Year of Physics is upon us, designated Einstein Year in the UK. Brian Foster considers the complex web of connections between two of the famous scientist's main passions – music and physics.

Music has always seemed to attract physicists, perhaps because its clear and complex mathematical structure is somehow familiar, perhaps because creativity in music is refreshingly different from that in science. This link can be traced back to the ancient Greek philosophers, such as Heraclitus and Pythagoras, who discovered the mathematical basis of harmony and applied it to the movements of the planets.

In modern times at CERN, Vicky Weisskopf (director-general 1961–1964) was a gifted pianist and famously said, "When things get tough, there are two things that make life worth living: Mozart, and quantum mechanics." One of his successors, Herwig Schopper (director-general 1980–1988), is also a keen pianist. It was music that brought together Jack Steinberger and Konrad Kleinknecht to work on CP violation in the K meson system. Steinberger played the flute and Kleinknecht the violin in the CERN chamber orchestra; over a beer after a rehearsal in 1965 the two agreed to collaborate. The collaboration extended to many memorable chamber-music sessions at Steinberger's house, involving Heinrich Wahl, Jürgen May, Günther Lütjens, Yves Goldschmidt-Clermont and others.

Kleinknecht also forms a link to another great physicist-musician prominent in the pioneering days of CERN, Werner Heisenberg, a very fine pianist; Kleinknecht was part of a small orchestra brought together to celebrate Heisenberg's 60th birthday by accompanying him in a performance of Mozart's Piano Concerto, K488.

Turning specifically to the violin, many physicists, including the author of this article, have been fascinated by it, and found relaxation and fulfilment in playing. Of these, the most famous is Einstein. His violin rarely left his side and he played it often, at an accomplished level, throughout his life, saying that "life without playing music is inconceivable to me". Max Planck was also a highly gifted pianist, composer and singer. Lise Meitner once remembered a musical evening at the Plancks' house in Berlin, in which Planck, Einstein and a professional cellist played Beethoven's Piano Trio in B-flat major. "Listening to this was marvellously enjoyable, despite a couple of unimportant slips from Einstein... Einstein was visibly filled with the joy of the music and smiled in a light-hearted way that he was ashamed of his dreadful technique. Planck stood quietly by with a blissfully happy face and, hand on heart, said 'That wonderful second movement!' "

Einstein was an inveterate concert-goer. He attended the famous debut of Yehudi Menuhin with the Berlin Philharmonic under Bruno Walter, in which the 13-year-old Menuhin was soloist in a programme of the Bach, Beethoven and Brahms concertos that would be nowadays inconceivable. Einstein was so moved by Menuhin's playing that he rushed into the boy's room after the performance and took him in his arms, exclaiming "Now I know that there is a God in heaven!" He once said that had he not been a physicist, he would have been a musician: "I often think about music. I daydream about music. I see my life in the form of music."

Einstein must be the most famous of violin-playing physicists. (Emil Orlick/AIP Emilio Segrè Visual Archives.)

The other side of the coin is violinists who have been interested ▷

Jack Liebeck and Katya Apekisheva rehearse in the main auditorium before a concert to celebrate CERN's half-century.

in physics. In the modern age, the well known American violinist, Joshua Bell, has a great interest in physics and has collaborated with physicists and engineers at the Massachusetts Institute of Technology in a project to enhance and expand the violin electronically. There is indeed a curious though tenuous link between Bell and Einstein. The great virtuoso Bronislav Huberman was a friend of Einstein, and visited him at his home in Princeton, no doubt together with his great Stradivarius violin, known as the "Gibson" Strad, made in 1713 during the "golden period" of his work. One day, the Strad was stolen from Huberman's dressing room at Carnegie Hall in New York. It disappeared and was lost for more than 50 years, during which time the thief played it around the backstreet bars of New York City until he died. In 2001, Bell acquired the "Gibson" for almost $4 million and now uses it as his sole concert instrument.

Given their friendship and mutual interest, it seems likely that Huberman would have allowed Einstein to play this marvellous instrument, providing a link between Bell and Einstein through this great masterpiece of the violin-maker's art.

Another violinist who is keenly interested in the work of CERN is Jack Liebeck, one of Britain's outstanding young violinists. Liebeck, who was born in 1980, has been playing the violin since he was eight. He made his first public appearance playing the young Mozart on BBC television at the age of 10. Liebeck plays one of the finest instruments by another great maestro of Italian violin-making, Giovanni Battista Guadagnini. The violin dates from 1785 and is known as the "ex-Wilhemj".

On 11 October 2004 Liebeck played with Russian pianist Katya Apekisheva in the CERN Auditorium. The occasion was a special gala concert sponsored by the UK Particle Physics and Astronomy Research Council as a tribute to the CERN staff on the organization's 50th anniversary. In the morning, Liebeck toured CERN and visited the locations where the ATLAS and CMS detectors are being installed for the Large Hadron Collider. The concert that evening featured an electrifying performance of the Prokofiev Sonata No. 1, as well as very fine readings of the Debussy Sonata and Beethoven's "Kreutzer" Sonata. After a brief tuning-up variation on "Happy birthday to you", the pair played a beautiful encore: "Vocalise" by Rachmaninov. A further concert in honour of CERN's 50th anniversary, sponsored by the UK's Central Laboratory of the Research Councils, was held at the Rutherford Appleton Laboratory in Oxfordshire on 9 December, when Liebeck was accompanied by the British pianist Charles Owen.

Hardly was CERN's birthday over when an even bigger cause for celebration arrived at the start of 2005 with the World Year of Physics, designated by the Institute of Physics as Einstein Year in the UK. Liebeck is embarking on a world tour giving concerts to celebrate this, and is also accompanying the author on a world lecture tour in which descriptions of Einstein's universe and modern ideas in particle physics, including superstrings, will be illustrated with demonstrations on Liebeck's Guadagnini and specially commissioned music from two young British composers, Emily Hall and Anna Meredith. Thus the long tradition of cross-fertilization between physics and music continues.

Einstein's own words form a fitting conclusion: "I am happy because I want nothing from anyone. I do not care for money. Decorations, titles, or distinctions mean nothing to me. I do not crave praise. The only thing that gives me pleasure, apart from my work, my violin, and my sailboat, is the appreciation of my fellow workers."

• The author is very grateful to Konrad Kleinknecht for supplying some of the information on CERN and music.

Brian Foster, *University of Oxford.*

SUPPLIER INFORMATION

Janis Research Company Inc

Pulse Tube Cooled 4 K Closed Cycle Refrigerator Systems

With a base temperature of <5 K (1.5 K optional) and an ultra-low vibration design, these systems are ideal for samples with low thermal conductivity. The top loading sample chamber is mechanically isolated from the cryocooler cold stages. The sample is in helium gas for fast sample exchange. High temperature options available.

Janis Research Company Inc, 2 Jewel Drive, PO Box 696, Wilmington, MA 01887-0696, 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?**

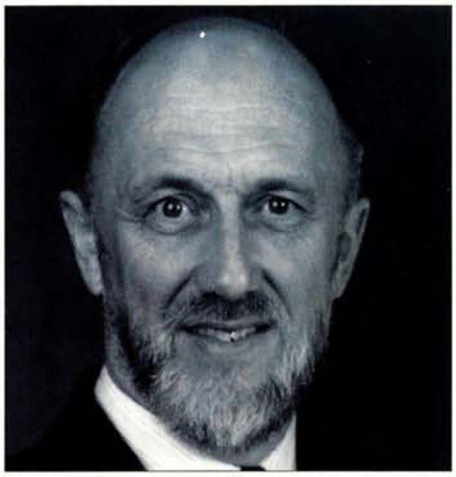
If you have answered YES to one or more of these questions, you should reserve your space on the Supplier Information page.

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.

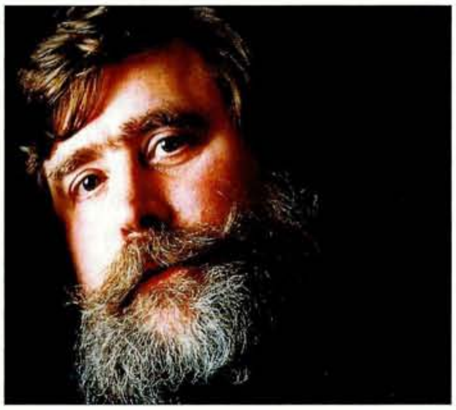
Call Jonathan Baron or Edward Jost on +44 (0)117 930 1265 or +44 (0)117 930 1026, respectively, to be included.

AWARDS

EPS prizes for nuclear physics and outreach



Peter Twin (left) and Bent Herskind won the 2004 Lise Meitner Prize for Nuclear Science.

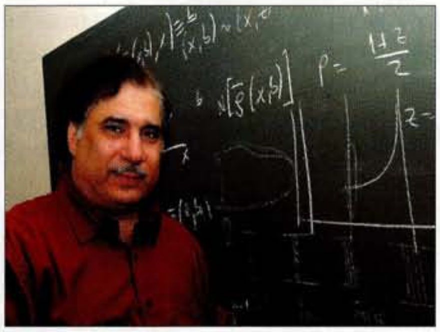


Alessandro Pascolini of the University of Padua has won the 2004 Outreach Prize of the EPS High Energy Particle Physics Board.

The European Physical Society (EPS) has awarded the Lise Meitner Prize for Nuclear Science 2004 to Bent Herskind of the Niels Bohr Institute, Copenhagen, and Peter Twin of the University of Liverpool. They receive the prize for their pioneering development of experimental tools, methods of analysis and experimental discoveries concerning rapidly spinning nuclei, resulting in particular in the discovery of super deformed bands. Medals and cheques were presented to the two laureates at a ceremony last summer during the International Nuclear Physics Conference, INPC2004, in Goteborg, Sweden.

Alessandro Pascolini of the University of Padua and INFN has been awarded the 2004 Outreach Prize of the EPS High Energy Particle Physics Board for his contribution to public awareness of high-energy particle physics, astroparticle physics and nuclear physics in Italy and Europe. A lecturer and researcher in theoretical and mathematical physics at Padua, Pascolini has for many years devoted a great deal of energy to promoting scientific culture, in particular through a variety of exhibitions in Italy and further afield. He has also collaborated with teachers and high schools, and was the founder of *INFN-Notizie*, the magazine of INFN. He will receive the prize at the EPS meeting in Berne in July 2005.

The most prestigious prize in Japan, an Order of Culture, has been awarded to Yoji Totsuka, director-general of KEK, for his distinguished research in neutrino physics, in particular for discovering the oscillation of atmospheric muon neutrinos with the Super-Kamiokande detector. Totsuka received the prize directly from the Emperor of Japan at the Imperial Palace on 3 November, the Culture Day of Japan. The previous recipient of the prize from the field of particle physics and astrophysics, in 1997, was Masatoshi Koshiba. Koshbia taught Totsuka at the University of Tokyo and was leader of the Kamiokande collaboration that preceded Super-Kamiokande.



TWAS, the Third World Academy of Sciences, has awarded its 2004 Prize in Physics to Spenta Wadia of the Tata Institute of Fundamental Research "for his significant contributions to non-pertubative quantum field theory and string theory, in particular (i) in the use of the large N limit; (ii) two-dimensional gravity and non-critical string theory; and (iii) the treatment of black holes in string theory". Wadia has also been responsible for creating a world-class research group at the Tata Institute, widely regarded as the strongest in Asia.

On 15 November, Belgium honoured Robert Cailliau of CERN with the distinction of Commandeur de l'Ordre de Léopold for his pioneering work in developing the World Wide Web. Cailliau, who is Belgian, worked closely with Tim Berners-Lee, the inventor of the Web.

FERMILAB

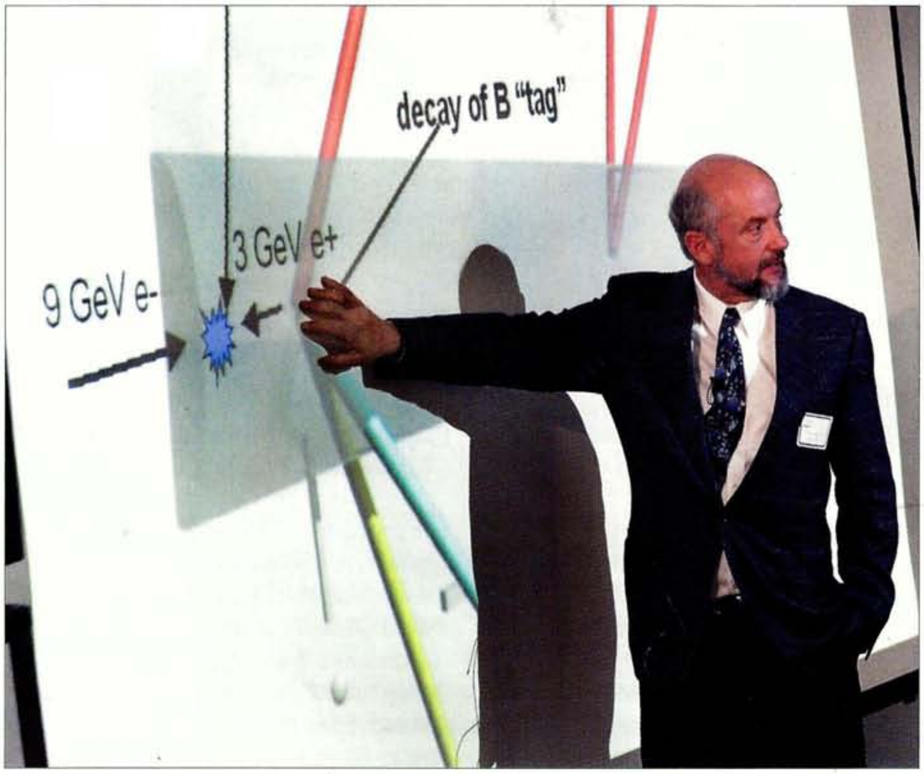
Oddone chosen as Fermilab's next director...

Officials of the Universities Research Association, the consortium of universities that operates the US Department of Energy's Fermi National Accelerator Laboratory, have announced the appointment of Pier Oddone as the laboratory's fifth director. He will succeed the current director, Michael Witherell, on 1 July.

Oddone is at present deputy director of Lawrence Berkeley National Laboratory and is well known as the inventor of the asymmetric B-factory, for which he has been awarded the 2005 Panofsky Prize of the American Physical Society (*CERN Courier* December 2004 p30).

Witherell, in turn, is to become vice-chancellor for research at the University of California, Santa Barbara. He was recently honoured by Secretary of Energy Spencer Abraham with the Secretary's Gold Award "for outstanding leadership combining excellence in science with excellence in safety" during his tenure as Fermilab's director since 1999.

Oddone says he is looking forward to the opportunity to serve as Fermilab's director at a key moment for the field of high-energy physics and for the laboratory. "We are living in a time of remarkable opportunity for particle physics. The next few years will bring a revolution in our understanding of the universe. As one of the world's great physics laboratories, Fermilab will make vital contributions to the discoveries ahead. I am excited and honoured to lead this unique laboratory during such an extraordinary era."



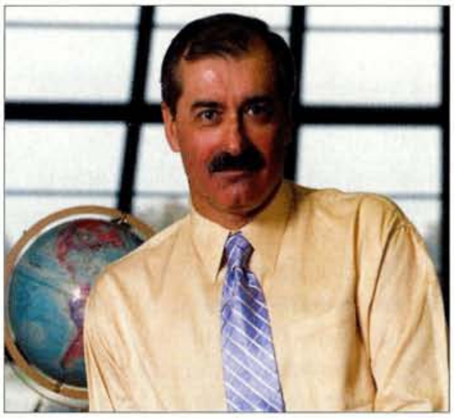
Pier Oddone, who will take over at Fermilab. (Lawrence Berkeley National Laboratory.)

...while Kolb will direct new Center for Particle Astrophysics

A new centre to provide a focus for efforts in particle astrophysics is to be established at Fermilab, with cosmologist Edward "Rocky" Kolb of Fermilab and the University of Chicago as director. The Center for Particle Astrophysics will bring together the Theoretical and Experimental Astrophysics Groups and will also encompass existing projects, including the Sloan Digital Sky Survey and the Pierre Auger Cosmic Ray Observatory, as well as proposed projects, including the SuperNova Acceleration Probe to study dark energy as part of the Joint Dark Energy Mission.

Following his appointment, which was made public on 1 November, Kolb announced that the Center for Particle Astrophysics will also support a graduate student for a year of work and study at Fermilab. The Brinson Pre-Doctoral Fellowship will be funded by The Brinson Foundation of Chicago, whose interests in scientific research include astrophysics and cosmology as well as geophysics and medical research. The Brinson Foundation lists Chicago's Adler Planetarium among its many annual grants. The Fellowship will be offered to students in the final year of their doctoral studies, who would work alongside a member of a Fermilab project.

Kolb noted that, while Fermilab is not specifically an educational institution, the opportunity to train "the stars of the future" in particle astrophysics is invaluable. "Particle cosmology is a reasonably new field," he said. "Establishing this world-class centre means we can attract future leaders with the chance to further their career and their education, and to have an impact on the field for many years to come."



Edward "Rocky" Kolb will be the director of Fermilab's Center for Particle Astrophysics.

CELEBRATION

Aachen honours laureates Rubbia and Ting

The Rheinisch Westfälische Technische Hochschule (RWTH), Aachen, chose a particularly suitable academic tribute to CERN's 50th anniversary, by granting Carlo Rubbia and Samuel Ting the *Doktor rerum naturalium honoris causa* on 22 November.

To begin the celebration, former director-general Herwig Schopper summarized CERN's history, highlighting its scientific successes and its contributions to bringing nations together peacefully. Then in his *laudatio* Günther Flügge of RWTH outlined the scientific careers of the two outstanding scientists.

When modern particle physics began in the late 1960s and early 1970s Rubbia and Ting were already highly respected experimentalists, and groups from Aachen, centred on Helmut Faissner and Albrecht Boehm, were already working with Rubbia. Then in November 1974 news broke of the discovery by Ting and his team, then at Brookhaven, of the J particle – discovered also (as the Ψ) by Burton Richter's group at SLAC (*CERN Courier* December 2004 p25). For their discovery Ting and Richter were awarded the Nobel prize in 1976.

That same year Rubbia came up with his revolutionary idea of a proton–antiproton collider at the International Neutrino Conference in Aachen, paving the way to his discovery of the heavy vector bosons, W and Z.

Meanwhile Ting had moved to DESY to set up the MarkJ experiment at the new PETRA electron–positron collider, then the highest-energy machine of its kind worldwide. Several groups from Aachen joined MarkJ and other collaborations at PETRA. Success came soon after the machine was switched on – in 1978 the first evidence for gluons, the carriers of the strong interaction, was seen, and in 1979 their existence was finally established (*CERN Courier* November 2004 p33).

Left to right: Carlo Rubbia, Sam Ting and Burkhart Rauhut, Rector of RWTH Aachen.

In 1978 Rubbia also set up the UA1 collaboration at CERN to build a detector for the hunt for the heavy bosons, with major contributions from Aachen, which provided the big muon chambers that covered the outside of the huge detector. The W and Z bosons were discovered in 1983, and the following year Rubbia was awarded the Nobel prize together with Simon van der Meer.

In the meantime CERN had opted for the new Large Electron Positron collider, LEP. Like many researchers at PETRA, Ting moved his activity to the new machine to build the gigantic L3 detector. This time he could convince all the high-energy physics institutes in Aachen to join his enterprise.

LEP was a great success. It showed that the current Standard Model remains valid even under the closest scrutiny. However, the masses of the particles vary widely and their origin is not understood at all. To attack such problems, Rubbia, who became director-general of CERN in 1989, pushed for the Large Hadron Collider (LHC) to be built in the LEP tunnel. One of the important meetings to prepare for the LHC took place in Aachen in 1990 and attracted more than 500 people; several groups at Aachen are now involved in the experimental programme.

The two laureates are now working on new projects: at the meeting Rubbia presented "The Future of Energy" and Ting "The Anti Matter Universe". Some groups in Aachen have again joined in this latter activity, with the antimatter search in space with the Alpha Magnetic Spectrometer. The ceremony illustrated the successes of the collaboration of RWTH and other universities with two brilliant scientists within the framework of two great laboratories – altogether a fitting celebration of CERN's 50th anniversary.

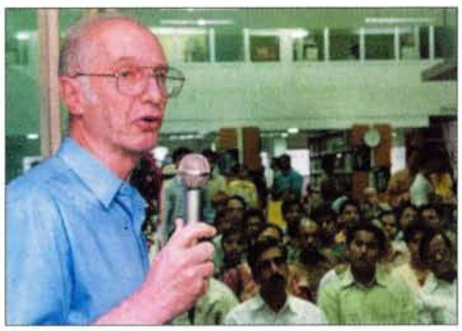
OUTREACH

Particle physics goes on the road in India

In a tour organized and sponsored by the British Council of India, Peter Kalmus, emeritus professor at Queen Mary, University of London, recently visited India to give lectures on particle physics.

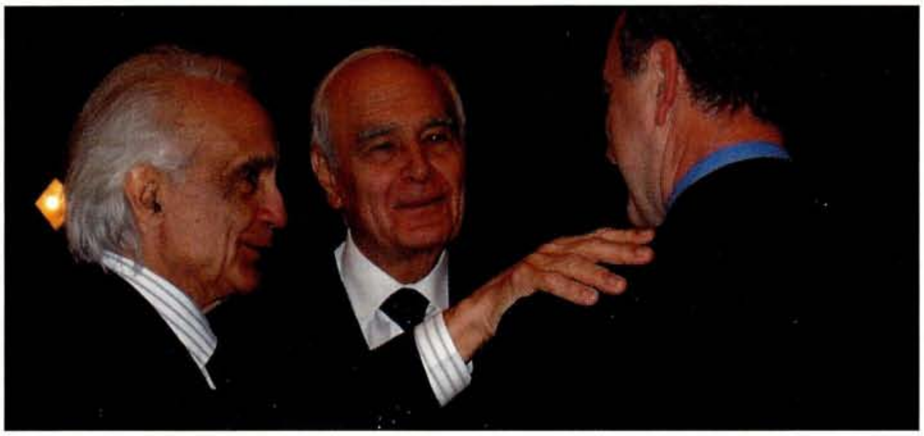
He gave 15 talks in 10 days in Delhi, Kolkata, Mumbai, Pune, Ahmedabad and Bhopal, to audiences ranging from 14-year-old pupils to university academics and national laboratory staff, as well as members of the general public. There were also discussions with Indian scientists and staff of the British Council, as well as interviews with newspaper and television journalists.

An experienced speaker in the UK and elsewhere, Kalmus noted interesting differences in India. These included Hindu prayers sung by 14-year-old girls before and after his talk, the presentation of flowers and other gifts, and celebrity treatment such as requests from the audience for autographs and photographs. The tour involved a great deal of travelling, but as the presentations had been e-mailed to India in advance, and computer-projection worked at all venues, Kalmus had no need for his laptop, and even the back-up CD-ROM was not used. This left the speaker able to savour the enthusiasm of the audiences, who asked many good questions, and the friendship shown by his hosts at all the venues.


Peter Kalmus talks on the forces of nature in the British Library in Bhopal, India. (Courtesy of the British Library, Bhopal.)

CELEBRATION

Fermi, CERN and the renaissance of INFN



Italian minister Girolamo Sirchia, centre, with Antonino Zichichi, left, and Lucio Rossi.

Italian minister Gianfranco Fini.

Some 170 scientists from all over the world came to Rome at the beginning of December to commemorate the legacy of Enrico Fermi 50 years after his untimely death, to celebrate the 50th anniversary of CERN, and to mark the 25th anniversary of the "renaissance" of INFN. Invited by Antonino Zichichi, president of the Enrico Fermi Centre and of the World Federation of Scientists, they met in the International Meeting Hall of the Italian Foreign Ministry, in the Palazzo La Farnesina, under the patronage of the minister of foreign affairs, Gianfranco Fini.

The symposium was opened by Zichichi, who reminded the audience of Fermi's legacy of a great alliance between science and society. Fermi's "pupil", Tsung-Dao Lee, and Yoichiro Nambu from the Enrico Fermi Institute in Chicago talked about his life in the city and their personal encounters with him. Robert Aymar, director-general of CERN, then presented CERN's scientific projects and strategy for the future. He recalled the roots of the Large Electron Positron (LEP) collider and the Large Hadron Collider (LHC), as documented in a CERN report recently published in Zichichi's honour. A special memoir highlighting CERN's history, edited by Zichichi, was presented to the minister.

The talks that followed covered the renaissance of INFN, after Zichichi became the institute's president. Twenty-five years ago, he elaborated a new scientific strategy for INFN based on three projects – Gran Sasso, LEP and the HERA machine at DESY – and convinced the Italian government to increase the budget considerably to allow adequate financial support for Italian research activities at the frontier of physics at CERN and other international laboratories.

Lorenzo Foà recalled the impact of INFN's renaissance on physicists working at CERN, citing his personal experience. As an example of the impact in Germany, Günter Wolf presented the latest scientific results from HERA, a project that was approved thanks to the participation and contribution of INFN. The current president of INFN, Roberto Petronzio, then gave the keynote speech on 25 years of INFN, its renaissance and its future. Carlo Rizzuto recalled the impact of INFN's renaissance on the establishment of Italy's Institute for Material Science, and Enzo Boschi spoke of the impulse given to the Institute for Geophysics and Vulcanology. Lucio Rossi, head of the LHC magnet group at CERN, recalled Zichichi's vision of investing in advanced superconducting magnet technology in Italian industry.

Among further talks, Alex Müller spoke of a workshop at Erice, where he first had the idea about where and how to look for high T_c superconducting materials, which later won him a Nobel prize. Finally, Raffaella Schneider presented the projects of the young researchers holding special grants from the Enrico Fermi Centre. During the meeting, several welcome messages were read out from the Italian President and various ministers.

The second day was devoted to presentations on projects, planned and implemented within the framework of ILSEAT, the International Laboratory for Science, Engineering and Advanced Physical and Biomedical Technologies. Speaking in the Augustinian conference hall in the Vatican, Zichichi introduced ILSEAT with its three components: science, technology and global emergencies. The morning session continued with presentations on interdisciplinary topics ranging from extreme weather events and pollution, to health physics, to accelerator and detector R&D, and parallel computing.

In the afternoon, a talk by the minister of health, Girolamo Sirchia, was followed by several presentations on the Cultural Emergency and the Extreme Energy Events project – an educational project to measure the effects of very-high-energy primary cosmic rays (*CERN Courier* July/August 2004 p35). The meeting closed with a review by the national representatives on the status of the World Federation of Scientists' National Scholarship Programmes, established in 30 countries around the globe. The day concluded with a concert in the Basilica Santa Maria degli Angeli e dei Martiri, when the Erice Prize winners for 2003 and 2004 were announced and the awards presented to Robert Clark, Maurice Cosandey and Alex Müller.

Further reading

CERN/DG-2004-306, "The Roots of LEP and LHC", published in honour of Antonino Zichichi and his contribution to particle physics in Italy as INFN president and in Europe as chairman of the 1979 ECFA Working Group defining the layout of LEP.

WORLD YEAR OF PHYSICS

'Cryo-illustrator' helps to open the door to physics in Japan

The World Year of Physics – 2005 – marks the centenary of Albert Einstein's *annus mirabilis*, when he published his three seminal papers on Brownian motion, the photoelectric effect and the special theory of relativity. In the image shown here, Tom Haruyama of KEK is assisting Einstein in opening the door he unlocked with these discoveries.

The illustration was adopted by the Japan Physics Society as the promotional poster for a seminar held in Tokyo last summer in anticipation of the World Year of Physics.

Haruyama is a specialist in cryogenics for the high-energy physics experiments at KEK. He is also well known as Asian editor of the international journal, *Cryogenics*, published by Elsevier, and has been the secretary of the International Cryogenic Engineering Committee for many years.

At the same time, Haruyama is able to create this kind of illustration to enhance the popularity of physics with young people in Japan, without compromising his own work in cryogenic research.

• For more on the World Year of Physics, see www.wyp2005.org.

Tom Haruyama of KEK and the journal Cryogenics. *The Japan Physics Society used this poster to promote a seminar held last year in Tokyo anticipating the World Year of Physics.*

NEW PRODUCTS

Creative Group has released a new high-vacuum manual in-line valve, which operates down to 10^{-8} mbar. The unit has a particularly high molecular conductance for this type of valve, and its stainless-steel construction makes it ideal for high-temperature applications. It is small, lightweight and easily serviced, and can accommodate any combination of fittings.

For further information tel. +44 1903 204542, e-mail sales@creativevacuum.co.uk or see www.creativevacuum.co.uk.

Bede has announced BedeMetrix X-ray metrology tools for enhanced spot measuring of semiconductor wafers from 50 to 300 mm. This new capability allows measurement of sub-100 μm test pads in chips and scribe lines on processed wafers, and provides automated characterization of fabrication processes. The BedeMetrix-L tool measures fundamental properties and structures of materials, including epitaxial and non-epitaxial layers.

For further information contact Dan Esdale: tel. +1 978 794 5441, e-mail desdale@wardhillmarketing.com or see www.bede.co.uk.

Glassman has developed low-profile 300 W regulated HV DC power supplies covering the range 1–60 kV. The FX series of supplies deliver high power density in a compact, lightweight unit 4.45 cm (1.75 inch) high in a standard 48.3 cm (19 inch) panel. Air-insulated, the units feature tight voltage regulation of better than 0.005% and current regulation better than 0.05%.

For further details contact Phil James: tel. +44 1256 883007, e-mail phil.james@glassmaneurope.co.uk or see www.glassmanhv.com.

Montena emc, which offers high-voltage and high-frequency products such as pulse generators, coupling networks, sensors and antennas, has recently produced a new pulse generator with a peak voltage of 320 kV, a rise time of 5 ns and a half-value time of 100 ns. The device is very compact, thanks to the choice of insulation (high-pressure nitrogen plus sulphur hexafluoride), which enables the fast rise time.

For further information tel. +41 26 411 9333 or see www.emc.montena.com.

MEETINGS

The **3rd CERN–CLAF School of High Energy Physics** is to take place in Malargüe (Mendoza), Argentina, from 27 February until 12 March. This school is intended mainly for young experimentalists from Latin America preparing a PhD in high-energy physics or engaged in postdoctoral work. For further information see http://physicschool.web.cern.ch/PhysicSchool/LatAmSchool.

LEAP '05, the international conference on Low Energy Antiproton Physics, will take place at the Gustav-Stresemann-Institut in Bonn on 16–22 May. Organized by the Research Centre Jülich it will bring together users of past, present and future antiproton facilities. Topics will include symmetries, hadron–antihadron systems, quark–gluon phenomena, atomic physics and future facilities. For further information see www.fz-juelich.de/leap-05.

A course on **Small Accelerators** will be held at the Hotel Golden Tulip Drenthe, Zeegse, in the Netherlands from 24 May until 2 June. Organized by the CERN Accelerator School and Kernfysisch Versneller Instituut (KVI), Groningen, the course will mainly interest staff in accelerator laboratories, university departments, medical-treatment centres and industries specialized in producing small accelerators or related equipment. For further information see www.cern.ch/schools/CAS.

The **14th IEEE–NPSS Real Time Computing Conference 2005** takes place at the Alba Nova University Centre in Stockholm, Sweden, on 4–10 June. This conference is devoted to the latest real-time applications in plasma physics, nuclear physics, particle physics, astrophysics, space science, accelerators, medicine and biology. For more information see www.physto.se/RT2005.

TAUP 2005, the ninth international conference on Topics in Astroparticle and Underground Physics, will be held in Zaragoza, Spain, on 10–14 September. Topics include cosmology and particle physics, dark matter and dark energy, high-energy astrophysics and cosmic rays. For further information e-mail the TAUP 2005 Secretariat at taup2005@unizar.es or see www.unizar.es/taup2005.

CERN

Supplier gets ATLAS award

Vojtech Novotny, director-general of the Czech company Skoda Hute (left), receives an ATLAS supplier award from Marzio Nessi, ATLAS technical coordinator.

On 3 November the ATLAS collaboration honoured its supplier, Skoda Hute of Plzen in the Czech Republic, for the company's work on forward-shielding elements for the detector. These huge cylinders surround the beam pipe at either end of the detector in order to prevent stray particles from entering ATLAS's muon chambers.

The shields consist of 10 cast-iron pieces with a total weight of 780 t, and although there are many iron foundries in the CERN member states, only a limited number can produce castings of the necessary size – 59–89 t in weight and up to 1.5 m thick.

The forward shielding was designed by the ATLAS Technical Coordination in close collaboration with the ATLAS groups from the Czech Technical University and Charles University in Prague. The Czech groups also supervised the production of the shielding, which was in part a Czech in-kind contribution to ATLAS.

Duke of York opens UK@CERN exhibition

Robert Aymar, right, discusses a piece of technology with the Duke of York, centre.

The Duke of York with UK ATLAS physicists Jo Pater of Manchester University (right) and Neil Jackson of Liverpool University (centre).

HRH Prince Andrew, the Duke of York, visited CERN on 23 November and, in his capacity as the UK's special representative for international trade and investment, inaugurated the UK@CERN exhibition. This biennial trade show was initially held in 1968, the first such exhibition by a CERN member state. This year 22 companies displayed goods and services that could be of interest to physicists and engineers working at CERN. The Duke also met UK researchers working at CERN, in particular at the site where the ATLAS detector is being installed at Point 1 on the ring of the Large Hadron Collider.

OBITUARIES

Bryan Montague (1921–2004)

Bryan William St Leger Montague grew up in London. He left school at 15 and started training as an auto-mechanic, but also took evening classes in electrical engineering. At the outbreak of the Second World War he volunteered for the Royal Air Force, where he became a "radio-mechanic" attached to a top-secret radar division. He received rather little training in the field, but became so interested in the underlying microwave techniques that he signed up for correspondence courses.

When the war was over, Bryan decided to study physics at the University of London, which accepted him after he had passed the required entrance exams. He graduated in 1951, though by that time he had already become a technical information assistant for the Philips office in London.

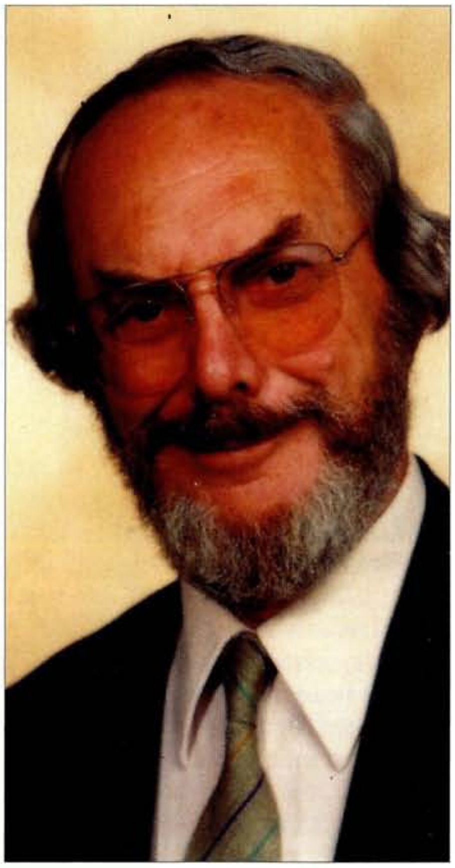
After graduation he joined the television research group, working on electron optics and magnetic amplifiers before moving to the linear accelerator group, where he participated in the design and construction of a 15 MeV microtron. His interest in particle accelerators – as well as the challenge of joining a laboratory recently created to rebuild the unity of Europe – led him to apply for a job at CERN.

Bryan came to Switzerland in May 1955 and was attached to the CERN-PS division. His first task was testing high-power amplifier tubes in the linac group, before he was asked to take on the design of the modulator, as the specialist foreseen for this task had died in an accident. The modulator design was completed by 1960, when the PS was successfully commissioned.

Around 1962 Bryan joined – and later led – the RF separator project in the newly formed Accelerator Research division. The goal was to develop a separator for secondary particles above 5 GeV, where electrostatic separation becomes inefficient.

The design was based on ideas of Panofsky and Schnell for transverse separation, but was modified by Bryan to use hybrid modes, which he and Peter Bramham had (re)discovered experimentally when measuring propagation on disc-loaded structures.

From 1965 Bryan also took part in the



study for a 300 GeV synchrotron, from which the CERN Super Proton Synchrotron evolved. However, when this project was postponed *sine die* in 1969, Bryan joined the newly formed Intersecting Storage Rings (ISR) project led by Kjell Johnson. Here Bryan worked first on the design of scrapers and collimators and then took part in commissioning the ISR, using the scrapers to measure the beam profile.

Later he joined the theoretical group whose task was to analyse and improve the ISR performance, and developed a computer code for the automatic measurement of luminosity. In the general studies group, he worked on the design of proton colliders with higher energy and proposed a method of increasing the luminosity of the ISR by reducing the crossing angle to give head-on collisions, using dipoles over the interaction regions to separate the counter-rotating proton beams. He also investigated non-linear coupling resonances caused by space charge – an effect still referred to as "Montague resonance".

Bryan became a member of the Senior Staff Consultative Committee to the Director-General for three years, and during the third year acted as its spokesman. The task of this committee was to represent the interest of the academic staff of CERN. Hence he acted to balance the negative effects of the Abragam Committee, constituted to reduce the cost of CERN so that the UK would not leave the organization.

In 1980 Bryan began work on the Large Electron Positron collider and concentrated on methods to obtain polarized beams in the machine. He developed rotator magnets, and studied Siberian snakes and spin matching. His most original contribution was a very clear description of polarization effects in storage rings using spinor algebra.

He also participated in the search for new methods of the acceleration of particles to even higher energies, and initiated a collaboration with the Rutherford Appleton Laboratory, which had the highest-power lasers in Europe, and Imperial College, London, to perform experiments on the acceleration of electrons with beat-waves created by two laser beams in a plasma.

From its inception in 1985, Bryan participated in the CLIC study at CERN. In this he explored methods for obtaining polarized beams, and suggested the use of the extremely sensitive Hanbury-Brown–Twiss intensity interferometer for the exact alignment of beams, using the synchrotron radiation emitted in bends.

In 1985, the University of London awarded Bryan the degree of Doctor of Science (DSc) for his work on particle accelerators. He gave lectures at several CERN Accelerator Schools and contributed to the book on accelerator physics edited by Herwig Schopper. Even after retirement Bryan continued to work on accelerators, and also contributed to quantum mechanics, pointing out the importance of the usually neglected phase factor of the complex wave function.

In his early eighties, Bryan suffered a severe aneurysm during a holiday trip to Italy, and finally passed away in May 2004.

Bruno W Zotter, CERN.

OBITUARIES

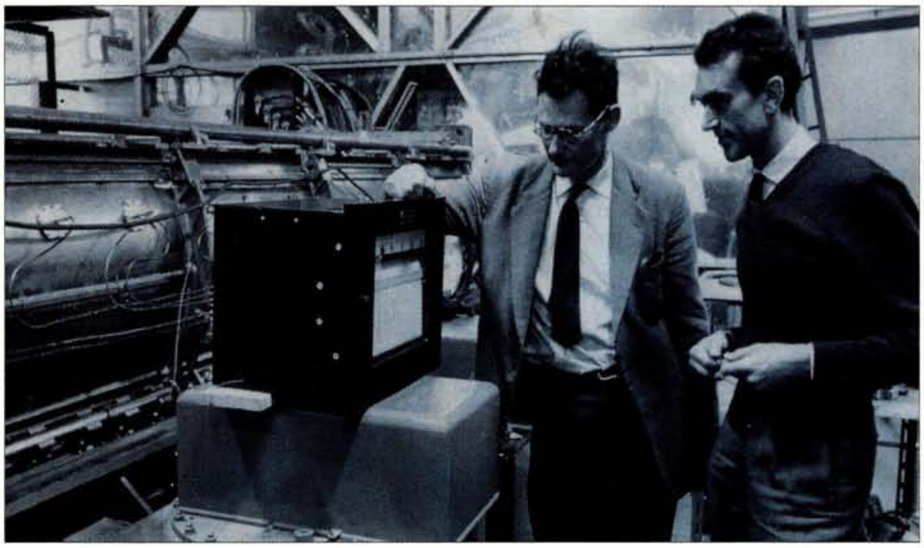
Pierre Lapostolle (1922–2004)

Pierre Lapostolle died in June 2004 at the age of 82 in Paris. He was one of the leading European accelerator physicists who made significant contributions to the development and understanding of linear accelerators, in particular of their beam dynamics.

After attending the prestigious Ecole Polytechnique in Paris, Pierre continued his studies at the Ecole Nationale Supérieure de Télécommunications and defended his thesis in 1947, while working for the Centre National d'Etudes des Télécommunications (CNET). Louis de Broglie was the president of the jury.

In 1953, François Perrin, the French delegate to CERN Council, convinced Pierre, who had become leader of the Electronics Division of CNET, to join CERN for a short period. It turned out that he would stay at CERN for 17 years while being detached from CNET! Hired by John Adams, Pierre was quickly recognized as an outstanding physicist. He served as leader of the PS Linac Group in 1958 and as leader of the Synchro-Cyclotron Division from 1960 to 1962.

Pierre made numerous contributions to the development of analytical approaches and numerical methods for the calculations of particle dynamics in linear accelerators. These treatments are included in many of the computer codes in use today for the design of linear accelerators. His publications have become the Bible for generations of designers and engineers of proton and ion linear accelerators.



Pierre Lapostolle (right) with Peter Standley at CERN's first proton linac in the late 1950s.

From the early 1960s to the mid-1970s Pierre also collaborated with Saclay and Orsay on studies for various accelerator projects, and he contributed to the design, construction and commissioning of a new injector – a 20 MeV proton linac – for the Saturne synchrotron at Saclay.

In 1971, Pierre decided to return to CNET. Despite the fact that he had many responsibilities in important bodies in France, for example scientific director of CNET and scientific advisor for GANIL, he continued his scientific work with great perseverance. He was a frequent and welcome visitor to CERN, lecturing and actively contributing to the development of computational tools. His competence and deep insight, combined with great rigour, were also very much appreciated in the US, in particular by the linear-accelerator experts at LANL, with whom he collaborated very fruitfully over the years.

Pierre is remembered not only as a very talented accelerator physicist who had a significant impact on the field, but also for his personality. His enthusiasm for physics, his generosity, modesty and noble, unassuming attitude deeply impressed all colleagues who had the privilege and pleasure to be taught by him and to work with him.

Kurt Hübner and colleagues, CERN.

LETTERS

CERN Courier welcomes letters from readers. Please e-mail cern.courier@cern.ch. We reserve the right to edit letters.

Remembering the J/Ψ

I read with great interest the account by Frank Close of the day the news of the J/Ψ discovery arrived at CERN (*CERN Courier* December 2004 p25). I would like to add two remarks.

Frank speaks of Jean-Jacques Aubert being called "professor" by Jack Steinberger, and then really becoming a professor. I happen to have been involved in this. My friend, the late Tony Visconti, co-founder with Daniel Kastler of the Centre de Physique Theorique in Marseilles, wanted someone to start a group of experimental high-energy physics in Marseilles. After a previous unsuccessful attempt, he turned to Jean-Jacques, but for this Jean-Jacques had to become a professor in Marseilles. I did some lobbying for that and in the end, Tony and I succeeded. Everybody knows that the lab that Jean-Jacques built in Marseilles was a great success.

Concerning the week of hesitation between the $c\bar{c}$ bound state and the Z^0, I heard that all the distinguished theoreticians of the Rome group were inclined towards the Z^0. The energy of the Frascati machine had been upgraded after the discovery of the J/Ψ and at first the experimentalists believed they were seeing a pattern that would be characteristic of interference between the Z^0 and the photon. This is strange because, in 1970, Luciano Maiani, in Erice, stated that the mass of the charmed quark should be 1–2 GeV and that one should expect $c\bar{c}$ bound states. (These predictions are generally attributed to Gaillard, Lee and Rosner, because they were using a *bona fide* gauge theory, which was not the case with Glashow, Iliopoulos and Maiani). I was present at Luciano's talk, which is published in the Erice proceedings.

Andre Martin, CERN.

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 1196. Fax: +44 (0)117 930 1178. E-mail: sales@cerncourier.com.
Rates per single column centimetre: standard $94/€75/£52, academic $88/€71/£49. Please contact us for more information about colour options, publication dates and deadlines.

The Institute of Particle Physics

Research Scientist

Applications are invited for a position as a Research Scientist with the Institute of Particle Physics of Canada, IPP (http://www.ipp.ca). Candidates should preferably have three years of postdoctoral experience and a demonstrated record of accomplishment in experimental high energy particle physics. The Research Scientist appointment is associated with an academic research position at a Canadian University and includes the right to hold research grants and to supervise graduate students. Such an appointment may lead to permanence after three years of employment.

The current program of IPP includes the following experiments:

p-p collisions at the LHC (ATLAS)
Neutrino physics with the SNO detector
e-p collisions at HERA (ZEUS)
p-p collisions at the TEVATRON (CDF)
B physics at the SLAC B-factory (BaBar)
Long baseline neutrino studies at JPARC (T2K)
High energy gamma-ray astronomy (Veritas)

The choice of experiment and university affiliation will be determined by mutual agreement between the candidate and the IPP.

Send curriculum vitae, statement of research interests and arrange for letters of recommendation from at least three referees, to be received before February 28, 2005, at:

Prof. W.Trischuk, Director

Institute of Particle Physics
Department of Physics
University of Toronto
60 Saint George Street,
Toronto, ON M5S 1A7
Canada
fax: 416-978-8221
email: william@physics.utoronto.ca

THE INSTITUTE OF PARTICLE PHYSICS — L'INSTITUT DE LA PHYSIQUE DES PARTICULES

All qualified candidates are encouraged to apply, however, in accordance with immigration regulations, Canadians and permanent residents will be given priority.

Bonn University, Institute of Physics has the following openings for positions in the **Experimental Particle Physics Group**

Postdoctoral Positions
(PostDoc, Hochschulassistent)

and

PhD Positions

universitätbonn

as of **April 1, 2005.**

Applicants should be interested to carry out research in the experimental particle physics group, which has experiments on Heavy Quark Physics at the TEVATRON (Fermilab) and on Higgs-Physics at the Large Hadron Collider LHC (CERN), as well as hardware developments in the field of pixel detectors for particle physics experiments and for imaging applications in biomedicine and for synchrotron radiation (including chip design). A new working group shall be formed within the environment of the Sofja Kovalevskaja Award of the Alexander von Humboldt Stiftung which strengthens the existing research impact of the group by addressing specific research topics within the above general research programme.

The salary will follow the German standards BAT IIa or W1 (Junior Professor) for applicants holding a PhD or BAT IIa / 2 for PhD students.

Preferential consideration will be given to women according to §49 UG (NRW) if they are equally qualified and possess the same level of competence and professional achievements. Disabled applicants with the same qualifications as other candidates are preferably employed.

Applications should be sent to:

Mrs. V. Gebhardt
Physikalisches Institut der Universität Bonn,
Nussallee 12, D-53115 Bonn, Germany

For further Information please contact:

Dr. E. von Toerne, email: evt@physik.uni-bonn.de, tel. +1-785-532-1638
Prof. Dr. N. Wermes, email: wermes@physik.uni-bonn.de, tel +49-228-733533

POSTDOCTORAL RESEARCH POSITION IN EXPERIMENTAL HIGH ENERGY PHYSICS

UNIVERSITY OF CALIFORNIA, RIVERSIDE

The Department of Physics at the University of California, Riverside, invites applicants for a postdoctoral research position to work with the high energy physics group on the CMS experiment at CERN.

At the University of California, Riverside, we are carrying out a multi-faceted program of detector development and production and preparation for physics in the CMS experiment. We are seeking a postdoctoral researcher to work on the CMS Silicon Tracker in California. We are working on silicon module production in collaboration with the University of California, Santa Barbara, and setting up a module testing and repair facility at U.C. Riverside. The postdoctoral researcher would also work on preparation for physics with CMS.

Applicants should have experience with high energy physics detectors and testing software, preferably with silicon detectors. Candidates must have a Ph.D. degree in high energy physics. Applications, including vitae, list of publications, and three reference letters, should be sent to:

Professor Gail G. Hanson, Department of Physics
University of California, Riverside, CA 92521-0413, U.S.A.
or by e-mail to Gail.Hanson@ucr.edu or Gail.Hanson@cern.ch

The position will be filled as soon as an appropriate candidate is identified.

UCR
UNIVERSITY OF CALIFORNIA, RIVERSIDE

The University of California is an Equal Opportunity/Affirmative Action Employer.

THE UNIVERSITY OF WARWICK

Department of Physics
Experimental Particle Physics Group

Lecturer In Experimental Particle Physics

£27,989 - £35,883 pa **Ref: 34349-124**

Warwick is one of Britain's leading universities with an enviable reputation for educational opportunities, first rate research and its commitment to the local community.

The University Values Diversity

The Warwick Experimental Particle Physics Group invites applications for a University Lectureship to strengthen its existing program of research in flavour physics. The Group is currently involved in the BaBar CP violation experiment at SLAC, the COBRA double beta decay experiment, and the T2K neutrino superbeam experiment in Japan. It is hoped to commence this post in October 2005. You should have a PhD in experimental particle physics, and expertise in detector development and/or data analysis.

Informal enquiries can be made to Prof. Paul Harrison (P.F.Harrison@Warwick.ac.uk).

Application packs are available from Personnel Services on 024 7652 3685 (24 hour answerphone), by email recruit@warwick.ac.uk, our website below or www.jobs.ac.uk/warwick. An application form MUST be completed if you wish to be considered for this post.

Closing date: 1 March 2005

www.warwick.ac.uk/jobs

HadronPhysics I3

Study of Strongly Interacting Matter

HadronPhysics I3
Study of Strongly Interacting Matter

European Commission

Transnational Access to Research Infrastructures

The Integrated Initiative "HadronPhysics I3", financed by the European Commission and coordinated by the Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Frascati, Italy, combines in a single contract several activities, Networking, Research Projects and Transnational Access. The Transnational Access activity involves 9 infrastructures among those operated by the participants in HadronPhysics I3. Its objective is to offer the opportunity for European research teams, performing or planning a research project at these infrastructures, to

APPLY FOR EC FUNDED ACCESS

to these infrastructures, to cover subsistence and travel expenses.
The only eligible teams (made of one or more researchers) are those that conduct their research activity in the EU Member States or in the Associated States. Information about the modalities of application and the **Calls for Proposals** can be obtained by visiting the web site of each infrastructure:

A1. INFN-LNF, http://www.lnf.infn.it/cee/tarifp6/
A2. DESY-HERMES, http://www-hermes.desy.de/I3HP-TA-HERMES/
A3. FZJ-COSY, http://www.fz-juelich.de/ikp/tmr-life.html
A4. FZJ-NIC/ZAM, http://www.fz-juelich.de/nic/i3hp-nic-ta/
A5. GSI-SIS, http://www.gsi.de/informationen/users/EC-funding/I3/SIM_e.html
A6. U Mainz-MAMI, http://www.kph.uni-mainz.de/en/eu/
A7. ZIB, http://www.zib.de/i3hp
A8. LU-MAXLAB, http://www2.maxlab.lu.se/members/proposal_nucl/index.html
A9. UU-TSL, http://www4.tsl.uu.se/tsl/tsl/infrastr.htm

This announcement can also be found at the following URL: http://www.infn.it/eu/i3hp

STANFORD UNIVERSITY

POSTDOCTORAL POSITION IN EXPERIMENTAL PARTICLE PHYSICS

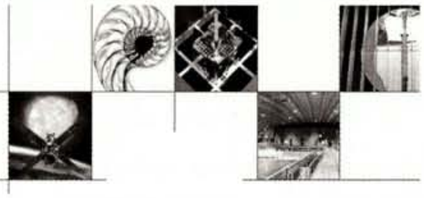
The Stanford University experimental particle physics group on the BABAR experiment invites applications for a Postdoctoral Research Associate position. The BABAR experiment is currently recording data at the PEP-II B Factory at the Stanford Linear Accelerator Center for the study of CP violation in the B meson system as well as precision measurements and searches for rare decays of bottom, charm and tau particles. The Stanford University group has made contributions to the Silicon Vertex Tracker, including data acquisition, detector monitoring and control, and the radiation monitoring and protection system based on silicon PIN diodes and CVD diamond sensors. The group is also involved in an ongoing R&D program with CVD diamond sensors. The successful candidate will have opportunities to contribute in these areas, including possible upgrades, and in the analysis of the large BABAR data set. The Stanford University group enjoys close geographical proximity to the laboratory yet is housed in an academic environment. For more information on the activities of the Stanford University group on BABAR, see **http://hep.stanford.edu/babar/**

Candidates must have a Ph.D. in experimental particle physics. The position is available starting February 1, 2005. Applications are being considered now and until the position is filled.

Interested applicants should send a curriculum vitae, list of publications, and a description of research interests and skills, and arrange for three letters of recommendation to be sent to **Professor Patricia Burchat, Department of Physics, Stanford University, Stanford CA 94305-4060**, or electronically to **burchat@stanford.edu**.

Stanford University is an equal opportunity employer. We especially encourage applications from women and minority scientists.

PAUL SCHERRER INSTITUT
PSI



The Paul Scherrer Institut is a centre for multi-disciplinary research and one of the world's leading user laboratories. With its 1200 employees it belongs as an autonomous institution to the Swiss ETH domain and concentrates its activities on solid-state research and material sciences, elementary particle and astrophysics, energy and environmental research as well as on biology and medicine.

Within the framework of an international collaboration on the European X-ray Free-Electron-Laser project, PSI contributes with the design, fabrication and implementation of a fast, intra-bunchtrain feedback system to stabilize the electron beam in a multi-dimensional phase space volume.

In this respect, the GFA (Large Research Facilities) diagnostics and instrumentation division is seeking a **Postdoctoral Fellow**

Your responsibilities

- Design and simulation of RF structures
- Supervision of the construction and production process of RF structures, as well as, realization of laboratory test measurements
- Simulation of feedback transfer functions and active participation during feedback commissioning at the DESY VUV-FEL

Your profile

The successful candidate should have a Ph.D. in physics, electrical engineering or mathematics with special expertise in numerical simulations and a good working knowledge of electro-magnetical field solvers. Experience in the design of passive microwave structures would be bene-ficial. You should enjoy working in an interdisciplinary, multinational research environment and communicate well in English and German. Being an enthusiastic researcher and a good team player with the willingness of temporary work abroad (at DESY, Hamburg) will help to ensure your success in completing your post-doctoral position in this exciting field of study.

We are looking forward to your application.

For further information please contact **Dr. Volker Schlott, Tel. +41 (0)56 310 42 37, e-mail: volker.schlott@psi.ch.**

Please send your application to: **Paul Scherrer Institut, Human Resources, Mr. Thomas Erb, ref. code 8440-01, 5232 Villigen PSI, Switzerland.**

Further job opportunities: **www.psi.ch**

INSTITUTE FOR NUCLEAR THEORY

Director

The University of Washington seeks to appoint a Director for the Institute for Nuclear Theory, the Department of Energy's national visitor center in this field (see **http://www.int.washington.edu/overview.html**).

The successful applicant will also be appointed as a tenured professor in the UW Department of Physics. We seek an outstanding researcher with a record of leadership and innovation in nuclear physics, who can maintain and enhance the vitality of the INT's programs and local research efforts. The individual should have wide interests and a broad perspective on nuclear physics, and a commitment to building ties with related subfields, including astrophysics and particle, atomic, and condensed matter physics. Applicants must have a Ph.D. degree and a strong record of published research. Opportunities are available for teaching and advising graduate students.

Please provide a c.v. and the names of at least three referees that the committee could consult. Applications should be sent to **Professor R. G. Hamish Robertson, Search Committee Chair, c/o Cynthia Wythe, Office of Research, Box 351202, University of Washington, Seattle, WA 98195-1202**. Consideration of applications will begin March 1.

The University of Washington is building a culturally diverse faculty and strongly encourages applications from women and minority candidates. AA/EOE.

cerncourier.com

Forschungszentrum Jülich
in der Helmholtz-Gemeinschaft

We are the largest interdisciplinary research institution in Europe and work in the fields of "Matter", "Energy", "Information", "Life" and "Environment".

To start work as soon as possible at our Nuclear Physics Institute (IKP) we are seeking a

PHYSICS GRADUATE (PhD), if possible with *Habilitation*

– Ref. 142/2004 –

Tasks:

- contribute to future institute activities in the field of hadron physics
- develop and construct components of a special, large-scale innovative detector system
- design and take responsibility for monitoring the production of the associated data recording and read-out electronics system
- develop the prototype of a microvertex silicon pixel detector and participate in developing the corresponding physics program
- prepare experimental proposals, perform the measurements and evaluate and interprete them
- undertake scientific coordination within the framework of existing collaborations and those to be set up, as well as supervising undergraduates and PhD students.

Requirements:

- extensive experience in the field of hadron physics
- special know-how and experience in the development and application of modern, large-scale systems for detecting D-mesons and extensive knowledge of charm physics
- many years of experience in assembling and modifiying data acquisition and read-out electronics systems and in the field of developing new experimental techniques
- many years of experience in scientific project management as well as in cooperating with large-scale international collaborations
- ability to cope with pressure; fitness pursuant to radiation protection regulations.

Part-time employment is possible in principle.

Equal opportunities is a cornerstone of our staff policy for which we have received the "TOTAL E-QUALITY" accolade.

Applications from disabled persons are welcome.

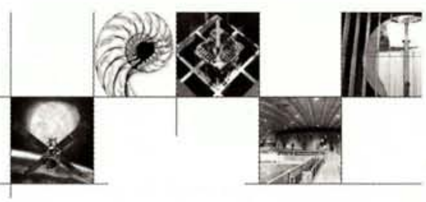
Salary and social benefits conform to the provisions of the Federal Collective Agreement for Public Employees (BAT).

Address for applications: Please mention the above ref.

Forschungszentrum Jülich GmbH
Geschäftsbereich Personal
– Personalbetreuung –
52425 Jülich, Germany
Telephone: + 49 2461 61-5358

FUTURE IS OUR MISSION

Further information at: www.fz-juelich.de



The Paul Scherrer Institut is a centre for multi-disciplinary research and one of the world's leading user laboratories. With its 1200 employees it belongs as an autonomous institution to the Swiss ETH domain and concentrates its activities on solid-state research and material sciences, elementary particle and astrophysics, energy and environmental research as well as on biology and medicine.

Within the framework of an international collaboration on the European X-ray Free-Electron-Laser project, PSI contributes with the design, fabrication and implementation of a fast, intra-bunchtrain feedback system to stabilize the electron beam in a multi-dimensional phase space volume.

In this respect, the GFA (Large Research Facilities) diagnostics and instrumentation division is seeking a **RF Engineer**

Your responsibilities

- Design and fabrication of low level RF electronics (RF front ends) for beam position measurement systems
- Development of analog circuits for fast real-time data processing systems
- Evaluation, procurement and maintenance of RF High power electronics
- Participation during feedback commissioning at the DESY VUV-FEL

Your profile

The successful candidate should be an experienced RF engineer with solid knowledge in the design of fast analog, low level electronics circuits, as well as, RF high power electronics. You should enjoy working in an interdisciplinary, multinational research environment with a team of engineers and scientists and communicate well in English and German. Being a good team player with the willingness of temporary work abroad (at DESY, Hamburg) will help to ensure the success of your work.

We are looking forward to your application.

For further information please contact **Dr. Volker Schlott, Tel. +41 (0)56 310 42 37, e-mail: volker.schlott@psi.ch.**

Please send your application to: **Paul Scherrer Institut, Human Resources, Mr. Thomas Erb, ref. code 8440-01, 5232 Villigen PSI, Switzerland.**

Further job opportunities: **www.psi.ch**

PhysicsJobs @ physicsweb.org

TEXAS TECH UNIVERSITY

FACULTY POSITIONS IN EXPERIMENTAL HIGH ENERGY PHYSICS

The Department of Physics at Texas Tech University invites applications for one or more tenure-track positions in experimental particle physics at the assistant professor level, but exceptional candidates at a more senior level may be considered. The members of the experimental particle physics group actively participate in CMS experiment at CERN and maintain a vigorous R&D program in advanced detector physics. We expect new experimental faculty members to participate in and strengthen our roles in these areas. Candidates must have a Ph.D. in physics and at least two years of post-doctoral experience, possess an outstanding research record, and show promise of excellent teaching at undergraduate and graduate levels.

Applicants should submit a vita, a list of publications, a brief statement of research interests, and the names and contact information for at least three references. Applications and queries should be sent to

Prof. N. Akchurin, Nural.Akchurin@ttu.edu, (806)742-3427 at **Department of Physics, Texas Tech University, Box 41051, Lubbock, TX 79409-1051.**

Applications will be reviewed starting **May 2, 2005** and will continue until the position is filled.

TTU is an equal opportunity/affirmative action employer.

CERN COURIER

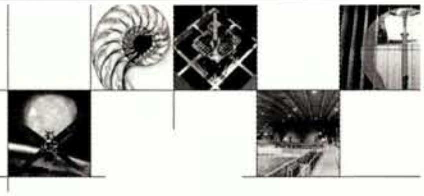
With each advertisement placed in the *CERN Courier* recruitment section, you automatically benefit from the following free of charge:

✓ two months advertising on **cerncourier.com**;
✓ two months advertising on **physicsweb.org/jobs**;
✓ a hyperlink directing potential candidates straight to your website;
✓ e-mail job alerts sent to job seekers who have subscribed to our notify service–our current rolling population is 12,000.

CERN Courier works for you

Please contact Yasmin Agilah on yasmin.agilah@iop.org or +44 117 9301196

PAUL SCHERRER INSTITUT
PSI



The Paul Scherrer Institut is a centre for multi-disciplinary research and one of the world's leading user laboratories. With its 1200 employees it belongs as an autonomous institution to the Swiss ETH domain and concentrates its activities on solid-state research and material sciences, elementary particle and astro-physics, energy and environmental research as well as on biology and medicine.

Within the framework of an international collaboration on the European X-ray Free-Electron-Laser project, PSI contributes with the design, fabrication and implementation of a fast, intra-bunchtrain feedback system to stabilize the electron beam in a multi-dimensional phase space volume.

In this respect, the GFA (Large Research Facilities) diagnostics and instrumentation division is seeking a **Software Engineer**

Your responsibilities

- Development, implementation and test of FPGA firmware (VHDL) and low level programming (DSP / PowerPC) of real-time feedback systems
- Specification of interfaces, development of test procedures and documentation of software and firmware projects
- Integration of software developments in control systems
- Support and participation of feedback commissioning at the DESY VUV-FEL

Your profile

The successful candidate should have an engineering degree in software development with professional expertise in low level programming of real-time data processing systems. We are also welcoming applications from young scientists or engineers who have gathered experience in in-strumentation, system control and digital electronics during their Ph.D. thesis. You should enjoy working in an interdisciplinary, multinational research environment and communicate well in English and German. Being a good team player with the willingness of temporary assignments abroad (at DESY, Hamburg) will support the success of your work.

We are looking forward to your application.

For further information please contact **Dr. Volker Schlott, Tel. +41 (0)56 310 42 37, e-mail: volker.schlott@psi.ch.**

Please send your application to: **Paul Scherrer Institut, Human Resources, Mr. Thomas Erb, ref. code 8440-01, 5232 Villigen PSI, Switzerland.**

Further job opportunities: **www.psi.ch**

cerncourier.com

Joint Tenure Track Faculty Position in Accelerator Physics

The Division of Physics at the Illinois Institute of Technology is seeking applications for a tenure track position in accelerator physics at the level of Assistant Professor starting as early as June 2005. The position will be a joint appointment funded 50% by the Fermi National Accelerator Laboratory and 50% by IIT, with a commensurate reduction in the IIT teaching load. The successful candidate will be expected to contribute to FNAL's International Linear Collider research program, and to teach physics courses at the graduate and undergraduate level at IIT. A Ph.D. in physics is required, as is postdoctoral experience in beam physics. For full consideration, submit a curriculum vitae, a summary of research plans, and a statement of teaching interests and philosophies, and arrange for three letters of recommendation to be sent to

Prof. Christopher White, Chair, Accelerator Search Committee,
Illinois Institute of Technology, 3101 S. Dearborn St., Chicago, IL 60616.
E-mail: **physics_search@capp.iit.edu**.

The deadline for applications is March 15, 2005.

ILLINOIS INSTITUTE OF TECHNOLOGY

Illinois Institute of Technology and Fermilab are equal opportunity, affirmative action employers. Women and minorities are strongly encouraged to apply.

POSTDOCTORAL RESEARCH POSITION IN EXPERIMENTAL HIGH ENERGY PHYSICS

UNIVERSITY OF CALIFORNIA, RIVERSIDE

The Department of Physics at the University of California, Riverside, invites applicants for a postdoctoral research position to work with the high energy physics group on the CMS experiment at CERN.

At the University of California, Riverside, we are carrying out a multi-faceted program of detector development and production and preparation for physics in the CMS experiment. We are seeking a postdoctoral researcher to work on CMS tracking software, with an emphasis on physics, based at U.C. Riverside. The postdoctoral researcher would also work on studies for the CMS Physics TDR and serve as a leader and resource for others in the U.S. who want to work on tracking software. The postdoctoral researcher would make frequent trips to CERN and U.S. locations for meetings and consultations.

Applicants should have experience with high energy physics analysis and software. Applicants who are already knowledgeable about CMS software are preferred. Candidates must have a Ph.D. degree in high energy physics. Applications, including vitae, list of publications, and three reference letters, should be sent to:

Professor Gail G. Hanson, Department of Physics
University of California, Riverside, CA 92521-0413, U.S.A.
or by e-mail to Gail.Hanson@ucr.edu or Gail.Hanson@cern.ch

The position will be filled as soon as an appropriate candidate is identified.

UCR
UNIVERSITY OF CALIFORNIA, RIVERSIDE

The University of California is an Equal Opportunity/Affirmative Action Employer.

Postdoc Positions in Hadronic Physics

Two 1-year-postdoc positions in the field of theory and phenomenology of generalized parton distributions and hard exclusive reactions are announced in the EU Integrated Infrastructure Initiative 'Hadron Physics'.

The two successful applicants will have the choice to join two groups out of the following 8 institutes: Bochum (Prof.K.Goeke), Pavia (Prof.S.Boffi), Polytechnique Palaiseau (Prof.B.Pire), Regensburg (Prof.A.Schäfer), Tel Aviv (Prof.L.Frankfurt), Valencia (Prof.S.Noguera), Warsaw (Prof.L.Mankiewicz), Wuppertal (Prof.P.Kroll).

The positions must be filled before the end of 2006. Depending on the institute prolongations for another year are possible. There are no restrictions concerning age and nationality. All involved institutes are equal opportunity employers. Applicants should submit a CV, including list of publications and summary of research interests no later than 15 March 2005 by e-mail to the following e-mail address: gpd-theory-postdoc@tp2.ruhr-uni-bochum.de, and should arrange for two letters of recommendation to be sent by email to the same address. The applicants will be informed in the beginning of April about the outcome of the selection procedure.

Assistant Research Professor in Experimental Nuclear Physics

- Term: **3 years**, non-tenure-accruing.
- Start date: **September 1, 2005**.
- Research Program: Polarized-photon experiments on the nucleon and very light nuclei in Hall B at Jefferson Lab, Newport News, VA.
- Expertise/experience: Data acquisition and analysis/nuclear particle detectors.
- Required: Ph.D. plus a few years experience in medium energy, electromagnetic, and/or few-body nuclear physics.

Applicant should send a curriculum vitae and a one-page statement of research interests, and have three letters of reference sent directly to
Professor B.L. Berman, Department of Physics,
The George Washington University, Washington, D.C. 20052
[fax: (202) 994-3001; e-mail: berman@gwu.edu; website: http://www.gwu.edu/~cns/]

Review of applications will begin **March 1, 2005** and will continue until the position is filled. The George Washington University is an Equal Opportunity—Affirmative Action Employer; women and minorities are particularly encouraged to apply.

THE GEORGE WASHINGTON UNIVERSITY
WASHINGTON DC

MANCHESTER
1824

The University of Manchester

Combining the strengths of UMIST and The Victoria University of Manchester

Postdoctoral Research Associates

Ref: PHY/CV/212

Faculty of Engineering and Physical Sciences
School of Physics and Astronomy

The Manchester High Energy Physics group has a track record of security software development as part of major international Grid projects, such as the European Data Grid and the LHC Computing Grid. This work also involves participation in the international standards process, through the Global Grid Forum, and research into new ways of giving authorised access to valid users of large computing resources.

As part of our continued programme of work, we are recruiting two Research Associates to develop security software for use in Grid environments.

The post holders will need to work within existing software frameworks, such as OpenSSL and Apache, and be able to program in the C language. Knowledge of C++, scripting languages such as Perl or Python, and Java would also be desirable, as would experience with writing code exposed to potentially hostile network environments.

As well as software development, the posts may require attendance at workshops and conferences run by the various Grid projects, and writing documentation for end users and other developers, and so good presentational and communication skills would be an advantage.

The software developed will extend our contributions to the GridPP Project (funded by the UK Particle Physics and Astronomy Research Council), the CERN-led LHC Computing Grid, and the European Union's European Grids for E-Science project.

Salary will be up to £27,116. These posts are initially available for 2 years.

Informal enquires may be made to Professor Robin Marshall (email: robin.marshall@manchester.ac.uk)

To apply you should send a C.V., and the names and addresses of two referees by email or by mail to: Professor Robin Marshall FRS FRAS FinstP, School of Physics and Astronomy, The University of Manchester, Manchester M13 9PL (Tel: +(44)161 275 4170 Email: robin.marshall@manchester.ac.uk). The closing date for applications is 25th February 2005. Please quote above reference number.

www.manchester.ac.uk/vacancies

As an Equal Opportunities Employer the University welcomes applications from suitably qualified people from all sections of the community regardless of race, religion, gender or disability.

CERN COURIER COMPUTING NEWS

Reach key researchers, purchasers and specifiers involved in the LCG, EGEE and other prestigious computing projects worldwide by advertising in the Computing News section of *CERN Courier*.

To discuss promotional opportunities in the April issue, contact:
Yasmin Agilah
Tel: +44 (0)117 930 1031
E-mail: **yasmin.agilah@iop.org**

Advertising deadline is 4 March 2005

1954-2004 CERN · LCG · egee Enabling Grids for E-science in Europe · CERN openlab for DataGrid applications

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.

Infinitely CERN, Editions Suzanne Hurter. Hardback English ISBN 2940031339, hardback French ISBN 2940031320, CHF70.

What a magnificent book! Much more than just a decorative book for the coffee table, the feel and the layout of its 224 large-format pages are as satisfying as they are intellectually stimulating. The book is a captivating volume, full of memories and explanations. It is only with great regret that the reader will close the book's cover.

It is a pleasure to see the book on sale in non-specialist bookshops; and it deserves to be there too. Its initiators the CERN Press Office, its editors, the book's 11 sponsors and the hundred or so people who have worked on the project and assisted in its distribution have all played their part in contributing to the task of commemoration. After 50 years that started out tentatively, were followed by dedication and which finally led to success, the book is a tribute worthy of this great European particle-physics laboratory. It consists of accounts that bear witness to the single-mindedness of CERN's founders, to the know-how of those who have made it a reality and to the competence of its scientists.

The first coil of the Synchrocyclotron arrives at CERN in 1956; one of many evocative images from Infinitely CERN, *a glorious celebration of the organization's 50 years.*

Infinitely CERN is supplemented by a large number of imaginatively selected iconographic images appearing in chronological order, which tell a tale of their own – one of the many that could be told of this great European success story. However, it is a success that has too often been obscured by the rather esoteric nature of CERN's *raison d'être* – the search for the mysteries behind the creation of the universe.

Drawing up an inventory of half a century of diplomatic, technological and scientific endeavour was certainly a challenge, but a challenge that was taken up during the book's two-year gestation period. However, perfection being unattainable in this world, there are a few shortcomings. The omissions include the average CERN staff-member's view of the laboratory, which is often overlooked, and the views of the world's more illustrious personalities, which are to be found in the organization's highly informative VIP *Livres d'Or*.

It would also have been useful to include a list of the presidents of council and directors-general as key milestones through five decades of history. Finally, on a more prosaic note, this reader would have welcomed more systematic identification of all those anonymous faces from the past appearing throughout the book. Identifying them all would certainly have required time-consuming research, but no doubt the legions of retired founder members would willingly have volunteered for the task.

Are these all just details? Perhaps so. In any case, they are details that pale into insignificance when compared with those that give cause for satisfaction. For example, the book includes a substantial and well deserved tribute to Albert Picot, to whom the organization owes its siting in Geneva; it is published in both of CERN's official languages; and the term "electronvolt" is written as one word. The book is written in an accessible style, has an excellent glossary and, with one exception, no typographical errors.

In conclusion, the 230 or so pages of *Infinitely CERN* bear witness to the significant events that have marked CERN's history since it was founded in 1954. This inventory, which of necessity is neither "exhaustive nor objective", concludes with a reference to a future in which dark matter rubs shoulders with the nature of the vacuum and additional dimensions of space–time. On a less abstract note, the book's final message is that, after the huge Large Hadron Collider currently under construction, Europe's sub-nuclear physics programme might be based around a compact linear collider, CLIC. This acronym seems entirely apt for an organization that gave birth to the World Wide Web.

Roger Anthoine, first editor of the CERN Courier.

A Hole in Texas: A Novel by Herman Wouk, Little, Brown. Hardback ISBN 0316525901, $25.

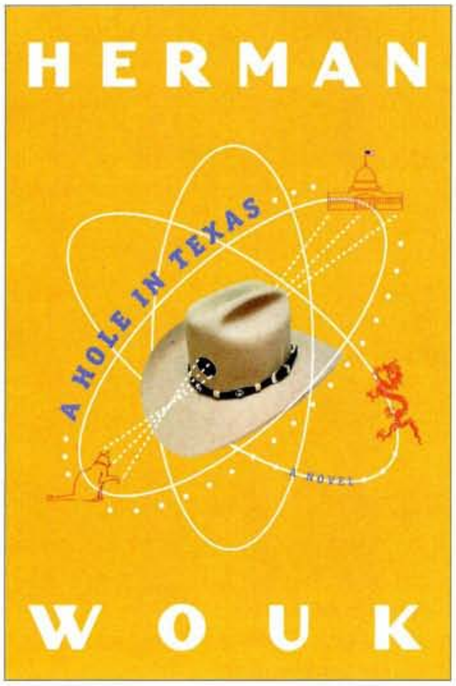
When a Pulitzer-prize winning author decides to write a book about particle physics, it's time to take notice. The Pulitzer is more often associated with incisive political insight than lucid science writing, and that, coupled with a good dose of satire, is what Herman Wouk delivers with *A Hole in Texas*.

The book tells the story of Guy Carpenter, a former Superconducting Super Collider (SSC) physicist, who was saved from the dole queue by NASA's Jet Propulsion Laboratory when the US Congress pulled the plug on the SSC in 1993. When *Nature* runs a story about the discovery in China of the Higgs boson, Carpenter finds his quiet life transformed. For the next few weeks he rides a rollercoaster of highs and lows as he's swept up in the Hollywood, Washington and media three-ring circus.

From an SSC physicist's perspective, the book starts promisingly with a quote from Mark Twain: "It could probably be shown by facts and figures that there is no distinctly native American criminal class except Congress." Having gone on to point out that "at a rough guess, 99.9999 percent of all Americans don't know what the hell a Higgs boson is" – and there's a message for the particle-physics community there – Wouk begins his tale.

The time could be now, or any time in the post-SSC, pre-LHC era, and the Chinese have just discovered the Higgs boson. "How?" you may ask. Unlike many works of science-based fiction, Wouk does not delve too far into the details of the science. He is careful not to get out of his depth, and the scientific scenario he describes is plausible. He simply uses it as a pretext to do what he does best: providing insightful comment on modern society through the time-honoured means of storytelling.

With *A Hole in Texas*, Wouk analyses the American political process and the power of the media (particularly when the bandwagon starts rolling), and he takes the pulse of modern American society. We are treated to the spectre of boson bombs; a media frenzy whipped up by journalists – some unscrupulous, others simply not wanting to miss out on a good story; a glamorous, brilliant and mysterious Chinese physicist; and the inevitable romantic intrigue. We are taken on a whirlwind tour that incorporates JPL, the hole in Texas and Washington DC. We meet a cast that includes an elegant



congresswoman – who certainly does not deserve Mr Twain's disdain, Hollywood moguls, C S Wu and even Dustin Hoffman. It all adds up to a very good read: concise, punchy and highly recommended.
James Gillies, CERN.

The Quantum Quark by Andrew Watson, Cambridge University Press. Hardback ISBN 0521829070, £19.99 ($30).

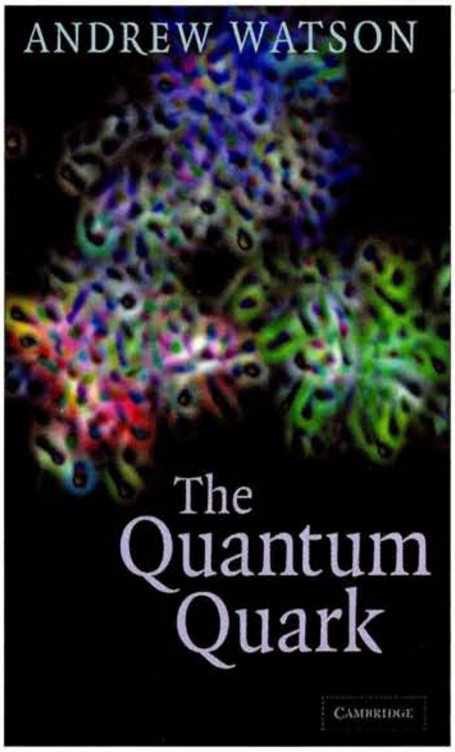
I sometimes think I would have liked being a particle physicist when I grew up: all those tunnels and experiments the size of cathedrals, probing the very nature of the material world and possibly the secrets of its creation. But that could never have been. I'm no good at the mathematics and that seems to underpin everything. So it was as if a prayer had been answered to discover Andrew Watson's book. It appears to give an in-depth understanding of quantum chromodynamics with scarcely a mathematical equation in sight for more than 400 pages. And it's not like some popular-science books that seem as if they have reduced the language to the level of a *Mr Men* picture book! The book does not assume knowledge, nor does it insult the intelligence.

In his preface, Watson describes his work as being rather like a history book that covers just the history of England rather than the whole of Europe, and indeed he has more or less dismissed gravity, electromagnetism and the weak force by page seven. But of course, just as you can't describe England's history without bringing in France, Spain and Germany, and indeed the rest of the world, so many aspects of physics return in later chapters. But none is assumed. Neither are any overlooked that I can think of. By page 11 we are on to group theory and by the time we have completed the course – and it does at times seem like a course – we have met hypercharge and isospin, instantons and the Drell–Yan mechanism.

If it's all a bit much to take in, there is a helpful 15 page glossary at the back. But I could have done with an even larger glossary. With my attention span, there was frequent need to refer back. Although there is an appendix of the Greek alphabet it would have been helpful if the Greek letters that are so frequently used to denote particles also appeared in the alphabetical glossary.

But it's not all work and no play. There is a refreshing scattering of metaphors, a few human stories and plenty of practical, experimental examples from the history of high-energy physics.

One of the many revelations for me was the comparison between the quantum effects in the micro and macro worlds. We know how photons can behave like particles or waves. We know that the same two-slit experiment works on electrons, whole nuclei, even small molecules. So where does it stop? Why not golf balls? Watson reveals that there is an effect even there, but that the quantum wavelength associated with a golf ball is just 6×10^{-34} m. For a car on a motorway, it's 10^{-38} m. So I can't blame quantum uncertainty for a missed putt or a traffic accident!



Watson himself describes his book as a pleasant stroll through great ideas. More like a high-altitude hike perhaps, but worth the effort. But I do wonder for whom it is written. Those embarking on a career or even an undergraduate degree in physics might be happy with more maths; those merely curious about the world around them may want a slimmer volume. I found this book rewarding, but I wonder how many other non-mathemagicians will be prepared to make the effort.
Martin Redfern, senior producer, BBC Radio Science Unit.

The shock of the known

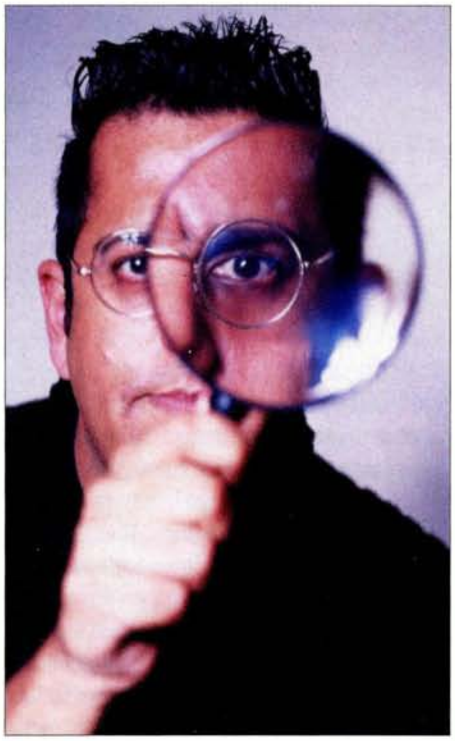
Simon Singh believes that the best way for scientists to interest the public may be to forget the unknown and amaze them with what they know.

Naturally, researchers take for granted that which is known, and instead focus on the unknown. Indeed, when I was at CERN working on the UA2 experiment, everyone was obsessed wih those areas of physics that were not yet understood. The public is also interested in those scientific subjects that still remain a mystery – where is the Higgs boson? Is string theory correct? What is dark matter? So when I left particle physics and became a science journalist, I continued to concentrate on unexplored territory. It was those research topics at the frontiers of knowledge and at the centre of controversy that inevitably resulted in the best stories.

However, when I sat down to write *Big Bang*, I decided to adopt a different approach – I wanted to celebrate how much we do know, and glory in the fact that we belong to the first generation of humans that have access to a coherent, consistent, compelling and verifiable model of the universe. The public is told so much about contentious issues, such as arguments over the existence, type and quantity of dark matter, that they probably have the impression that cosmologists know very little about the universe. In fact, I think the public would be staggered if they realized how much we do know.

The fact that the universe is expanding might seem dull to those of us within science, but to outsiders it probably sounds incredible. I suspect that the majority of the public perceive the expansion of the universe as a weird new hypothesis that will be overturned in a few years. If only they realized that the expansion of the universe was detected more than 75 years ago and has since been measured in detail and verified in a multitude of ways, then they might begin to engage with the staggering and profound implications of an expanding cosmos.

As well as spreading the gospel of our understanding of the universe, including the Big Bang model, I also wanted to show how superior models emerge in science and how they are eventually accepted, regardless of how controversial they are initially and no matter how powerful their detractors might be. Although we should be celebrating Albert Einstein in the centenary of his *annus mirabilis*, it is still worth noting that he vehemently opposed the Big Bang model when it was explained to him by the Belgian cosmologist (and priest) Georges Lemaître. Einstein told him, "Your calculations are correct, but your physics is abominable." But a few years later, the observations showed that Lemaître was right, and Einstein had to concede defeat in the light of reality. The Big Bang model turned out to be basically correct and remains the best game in town.


Simon Singh, photographed by Phil Green.

Despite all the successes of modern cosmology and the Big Bang model, my book does feature an epilogue that explains the ways in which the model is incomplete. There are, of course, still aspects of our universe that cause bewilderment and arguments among cosmologists. For example, was there an inflationary period in the early universe, what is dark matter, what is dark energy and what is the fate of the universe? Such questions currently belong to the realm of speculation, and answering them sometimes seems impossible.

However, perhaps my book offers a note of optimism for cosmologists, because they can take heart by looking back through the history of their subject. After all, what now seems completely obvious was itself mysterious to scientists of the past. There was a time when nobody had any idea of how to measure the distances to the nebulae, but in 1923 Edwin Hubble solved the puzzle and showed that many of them were remote galaxies. He relied on the periodic variation in brightness of a type of star, known as a Cepheid variable, which he spotted in the Andromeda Nebula. The time between peaks in brightness betrays the absolute brightness of a Cepheid star and this could be compared to its apparent brightness in order to deduce its distance – and the distance to the Andromeda Nebula that it inhabited. Today, measuring the distances to galaxies is still not routine, but it is clearly no longer impossible.

Perhaps the best example of a once impossible problem that soon became trivial was discussed in 1835 by the French philosopher Auguste Comte. He had tried to identify areas of knowledge that would forever remain beyond the wit of scientific endeavour. In particular, he thought that some qualities of the stars could never be ascertained. "We see how we may determine their forms, their distances, their bulk, and their motions, but we can never know anything of their chemical or mineralogical structure." In fact, Comte would be proved wrong within a few years of his death, as scientists began to discover which types of atom exist in the Sun.

Simon Singh is the author of Fermat's Last Theorem *and* The Code Book. *His latest book is* Big Bang, *published by Fourth Estate (*CERN Courier *December 2004 p40). After a PhD in particle physics, he joined the BBC for six years before turning freelance.*

POWER CONVERTERS

BRUKER

Tailored Supplies for Specific Needs

1 Set of the 154 true bipolar corrector power supplies for the French **Synchrotron SOLEIL**

For more than 40 years Bruker Biospin demonstrates high level knowledge and capability in customized power converters design and manufacturing. This expertise is rewarded by great success in Science and Industries.

Panel of specs :

- **1V to 100kV**
- **1A up to 30 kA**
- **0.1kVA up to 3.7 MVA**

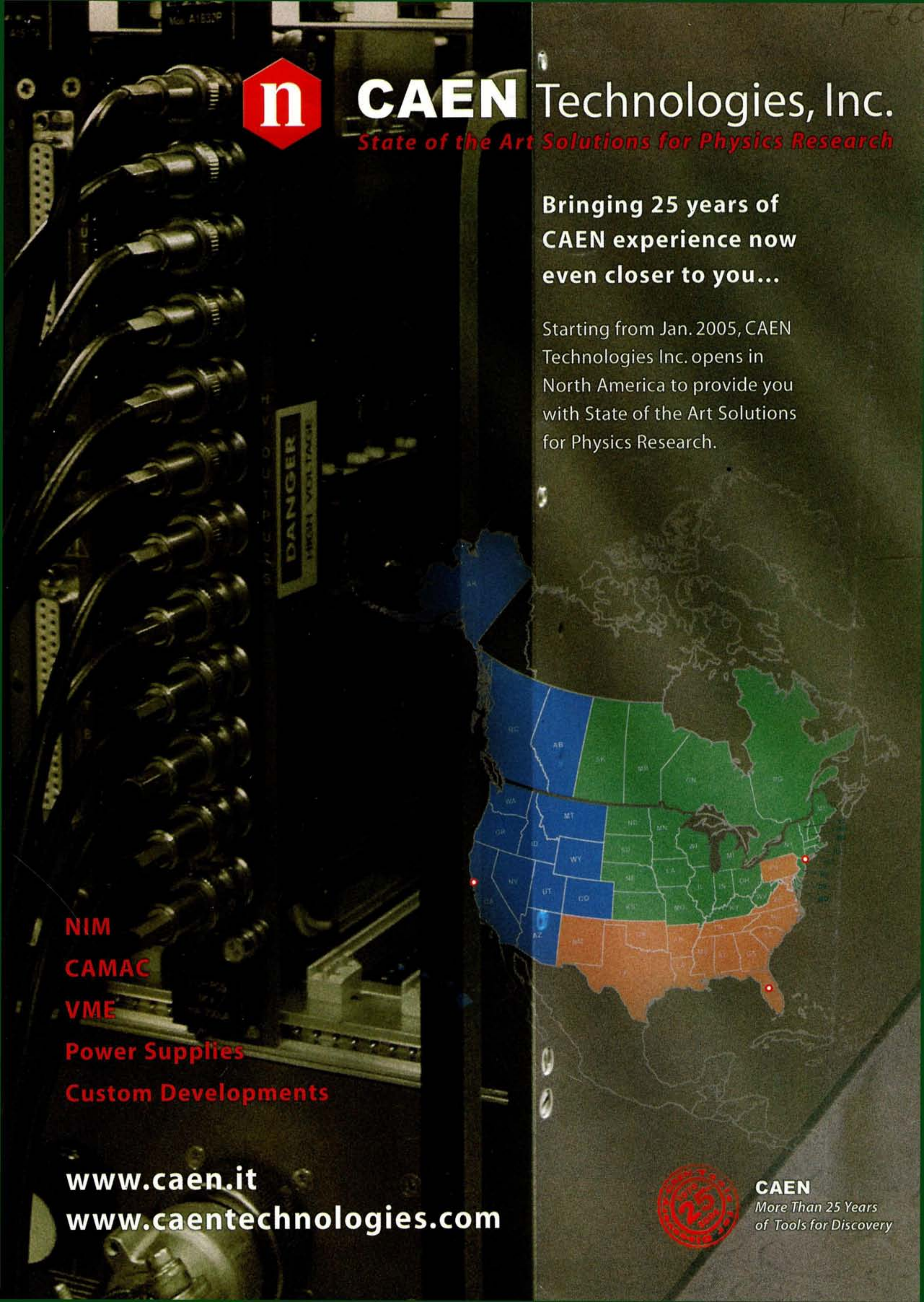
- Current stability : 20 ppm
- 4 quadrants technology
- 19 bits resolution & linearity
- local and remote control : RS232 / Profibus

BRUKER BIOSPIN S.A. • France

for more information : www.bruker.fr/power

or power@bruker.fr

BRUKER BIOSPIN


CAEN Technologies, Inc.
State of the Art Solutions for Physics Research
Bringing 25 years of CAEN experience now even closer to you...
Starting from Jan. 2005, CAEN Technologies Inc. opens in North America to provide you with State of the Art Solutions for Physics Research.
NIM
CAMAC
VME
Power Supplies
Custom Developments
www.caen.it
www.caentechnologies.com
CAEN
More Than 25 Years of Tools for Discovery